

# Bizarro

By Dan Piraro

That lady in the bushes claims that even though they're incredibly weak & have no thumbs on their feet, humans are **STILL** our closest relatives.

Stop it! You're  
creeping me out!



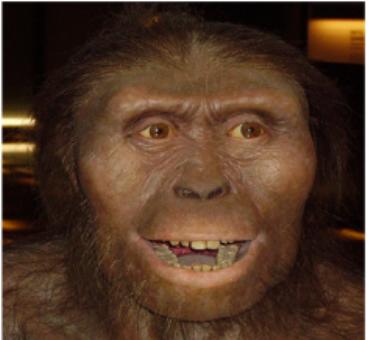
See "Bizarro" online at [www.pe.com/entertainment/comics](http://www.pe.com/entertainment/comics)

www.ucomics.com

## Early Humans Since Lucy

New fossil discovery may provide the missing link.

### 3.2 Million Years Ago



### 2.8 Million Years Ago



### 2.5 Million Years Ago



### 1.8 Million Years Ago

#### “Lucy”

Lucy was from *Australopithecus afarensis*. Although she had several ape-like features, Lucy stood upright and had small canine teeth, much like modern humans.

#### LD 350-1

We have a new oldest human fossil. Briefly, it looks like *Homo* genus arose by about 2.8 million years ago — almost half a million years earlier than once thought.

#### *Homo habilis*

One of the earliest modern humans, *Homo habilis* had a larger head and smaller face than Lucy, but retained many of her ape-like features.

#### *Homo erectus*



### 1.8 Million Years Ago



### 200 Thousand Years Ago



*Homo habilis* had a larger head and smaller face than Lucy, but retained many of her ape-like features.

#### *Homo erectus*

*Homo erectus* had relatively human-like body proportions, with longer legs and shorter arms for walking and possibly even running.

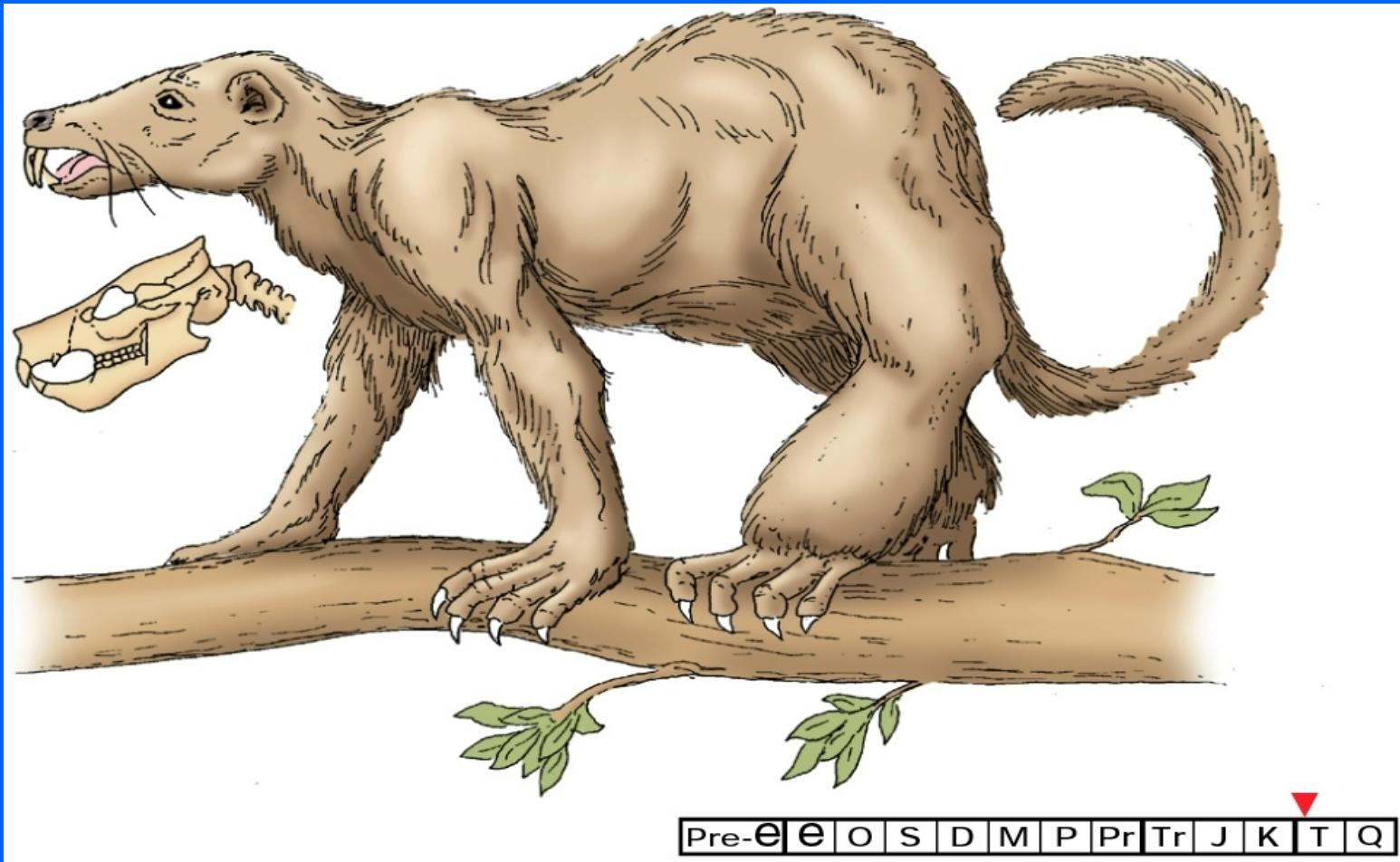
#### *Homo sapiens*

The only surviving species of the genus *Homo*. Molecular studies suggest that all modern humans diverged from a common ancestor about 200,000 years ago.

Order	Suborder	Superfamily	Common Names of Representative Forms
Primates	Prosimii	<i>TUPAIOIDEA</i>	Tree shrew
		<i>LEMUROIDEA</i>	Lemur
		<i>LORISOIDEA</i>	Bush baby, Slender loris
		<i>TARSIOIDEA</i>	Tarsier
	Anthroopoidea	<i>CEBOIDEA</i>	Howler monkey, Spider monkey, Capuchin, Common marmoset, Pinche monkey
		<i>CERCOPITHECOIDEA</i>	Macaque, Baboon, Wanderloo, Common langur, Proboscis monkey
		 <b>Family</b> ↓	<b>HYLOBATIDAE</b>
		<i>HOMINOIDEA</i>	Gibbon, Siamang
		<i>PONGIDAE</i>	Orangutan, Chimpanzee, Gorilla
		<i>HOMINIDAE</i>	Humans

Prosimii (lemurs): Have grooming (toilet) claw on digit 2 (longer claw there but don't ask more) and comb teeth in front (Anthroopoidea lost)

# The Paleocene prosimian *Plesiadapis.*



Pre-e e o s d m p Pr Tr J K T Q

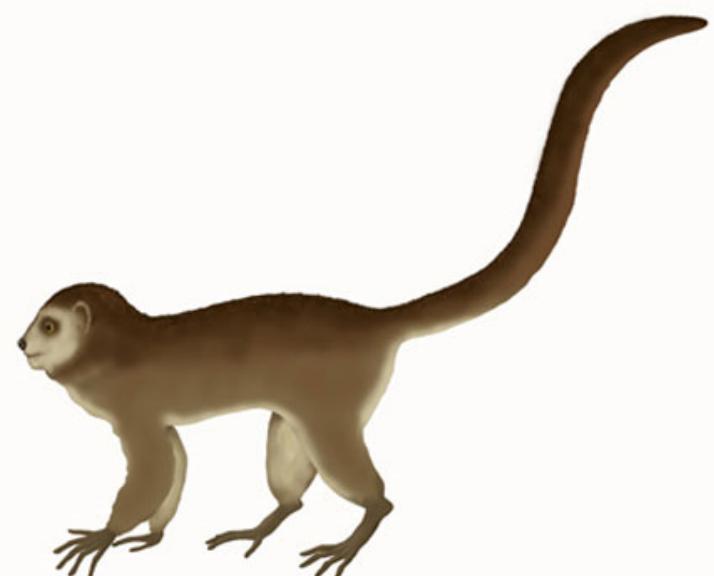


# Eocene prosimian *Notharctus*

► Q  
T  
K  
J  
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Pr  
P  
M  
D  
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e  
Pre

Ida proportionally like this  
lemur but lacks  
lemur features  
so transitional fossil to  
Anthropoidea grp

*Darwinius masillae* “Ida”



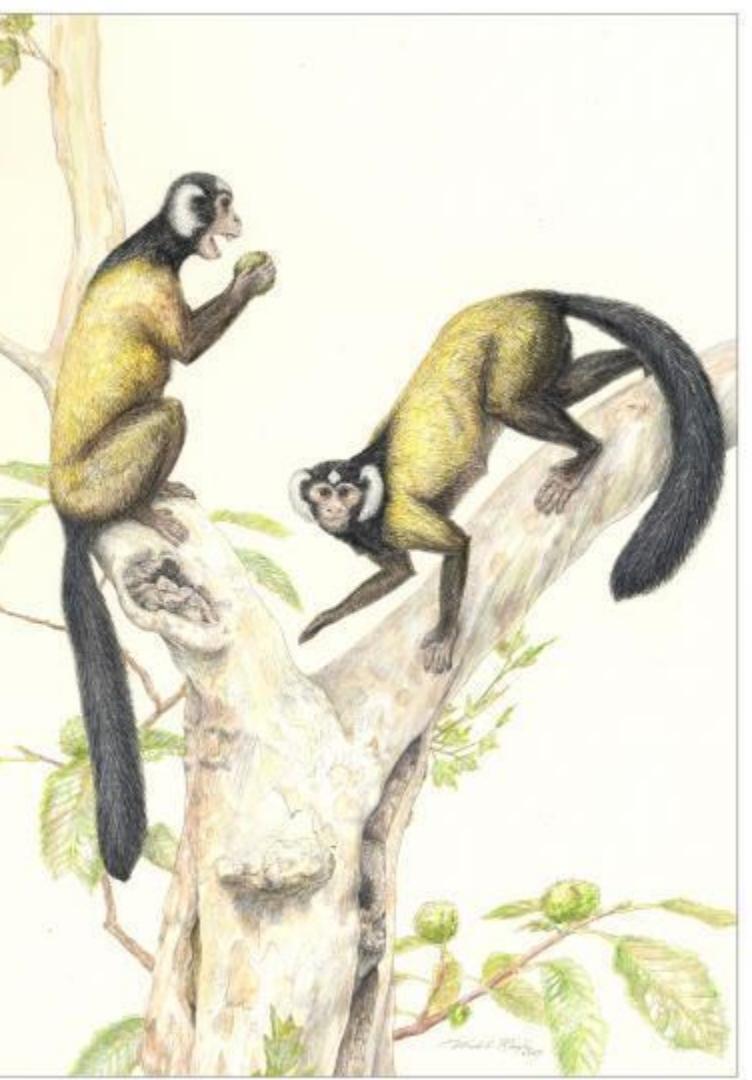
# *Darwinius masillae* 47 MA Germany

<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0005723>



- The Messel site has yielded thousands of superbly preserved fossils including 8 species of crocodile, 20 or so snakes, more than 60 specimens of pygmy horse, the largest ant ever to crawl the planet and 8 fragmentary primate specimens
- Researchers believe it comes from the time when the primate lineage, that diversified into monkeys, apes and ultimately humans, split from a separate group that went on to become lemurs and other less well known species.
  - She is 95% complete and so well preserved that her tissues, hair and even her stomach contents are visible.
- Crucially though, Ida is not on the lemur line because she lacks 2 key characteristics shared by lemurs – a grooming claw on her second toe and a fused set of teeth called a tooth comb. Also, a bone in her ankle called the talus is shaped like members of our branch of the primates. So the researchers believe she may be on our evolutionary line dating from just after the split with the lemurs.
- According to the team's published description of the skeleton in the journal PLoS ONE, Ida was 53cm long and a juvenile around 6-9 months old. The team can be sure Ida is a girl because she does not have a penis bone.

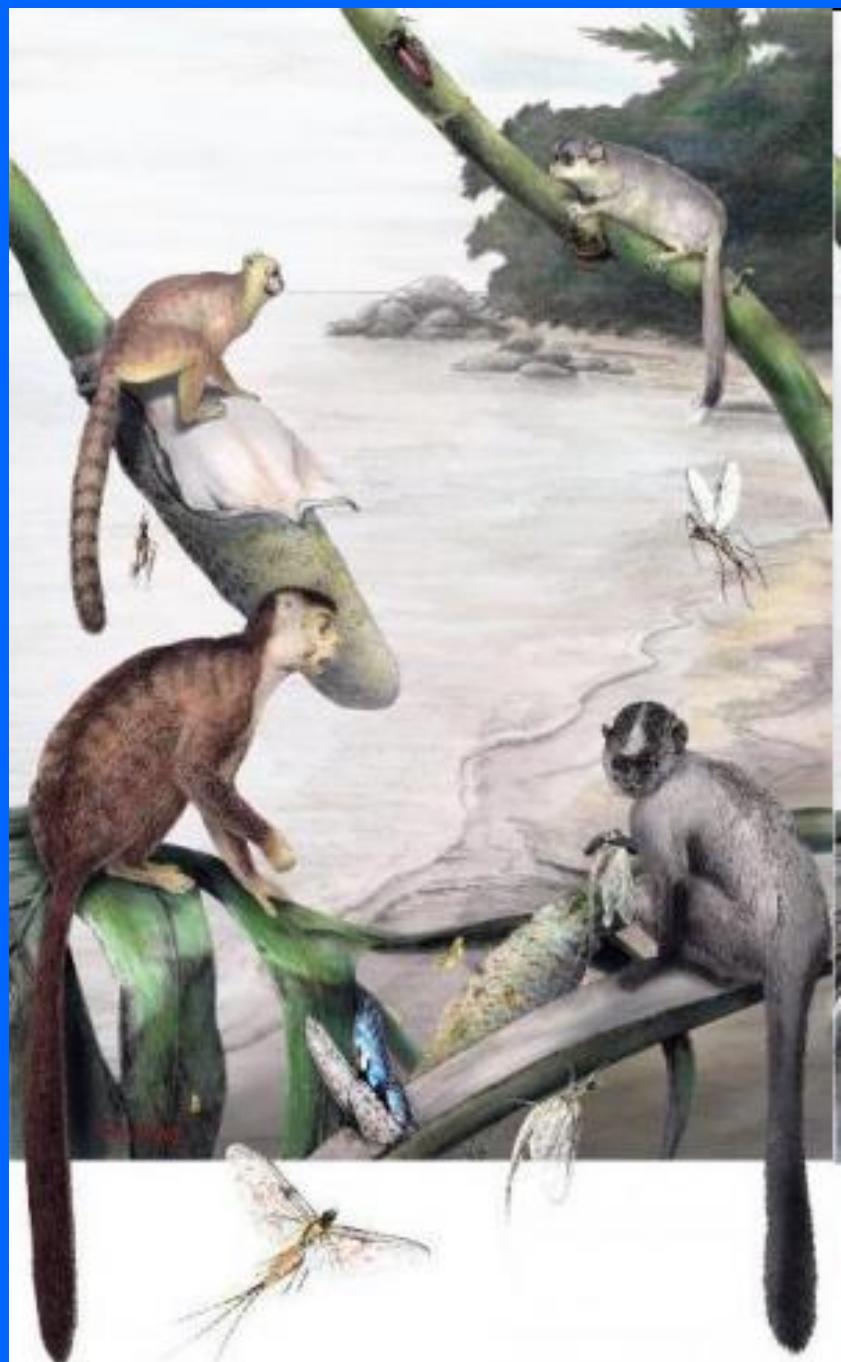
# 38 MA *Ganlea megacanina*



- The discovery of this new fossil primate from Myanmar suggests that the common ancestor of humans, monkeys and apes evolved from primates in Asia, not Africa
- Analysis of their evolutionary relationships shows that amhipithecids are closely related to living anthropoids and that all of the Burmese amhipithecids evolved from a single common ancestor.
  - Some scientists had previously argued that amhipithecids were not anthropoids at all, being more closely related to the lemur-like adapiforms.
- **Ganlea strongly supports the idea that amhipithecids are anthropoids, because adapiforms never evolved the features that are necessary to become specialized seed predators.** Indeed, all of the Burmese amhipithecids appear to have been specialized seed predators, filling the same ecological niche occupied by modern pitheciine monkeys in the Amazon Basin of South America. During the Eocene when *Ganlea* and other amhipithecids were living in Myanmar, they inhabited a tropical floodplain that was very similar to the environment of the modern Amazon Basin.
- The discovery of the fossil primate skeleton known as "Ida" from the Messel oil shale pit in Germany led some scientists to suggest that anthropoid primates evolved from lemur-like ancestors known as adapiforms.

# Asia?

- The primate group that includes humans, apes, and monkeys -- "colonized" Africa, rather than originally evolving in Africa as has been widely accepted.
- What is exceptional about these new fossils -- discovered at the Dur At-Talah escarpment in central Libya -- is the diversity of species present: the site includes three distinct families of anthropoid primates that lived in North Africa at approximately the same time.
- This suggests that anthropoids underwent diversification, through evolution, previous to the time of these newly discovered fossils, which date to 39 million years ago.



# Move from Asia to Africa

Libya  
Dur At-Talah  
late Middle Eocene

Myanmar  
Pondaung Fm.  
late Middle Eocene



# Human Evolution

- Very important & controversial
- Lots of people accept evolution sans humans
- 2 mjr scientific camps:
  - a. Out of Africa (punctuated)
  - b. Regional development in Europe, Asia, & Africa (more gradual)
- Tendency to view early humans like we currently view ourselves

## I. Primates

- i. 3 steps in human history
  1. Bipedalism (chimps & gorillas knuckle-walkers)
  2. Larger brain

# Split by 25 MA

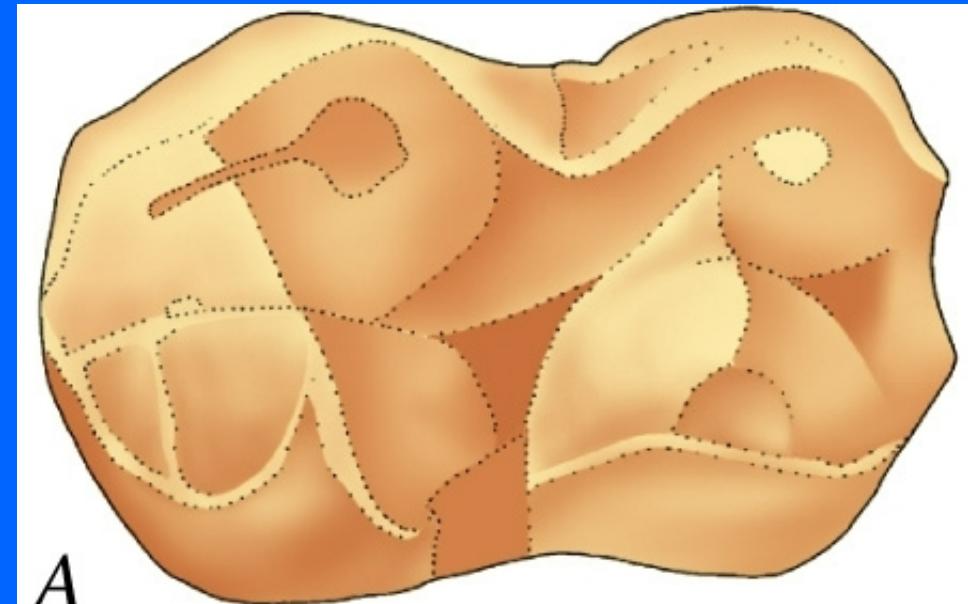
- In Tanzania researchers found a tooth from the newfound species *Nsungwepithecus gunnelli*, the oldest member of the primate group that contains Old World monkeys (cercopithecoids). The team also found a jawbone from the newfound species *Rukwapithecus fleaglei*, an early member of the hominoids, the group containing the great apes (gorillas, chimpanzees, bonobos, orangutans and humans) and lesser apes (gibbons).
- The fossil remnants of these two primate species date back to 25 million years ago, filling a gap in the fossil record that reveals when apes and monkeys first diverged.



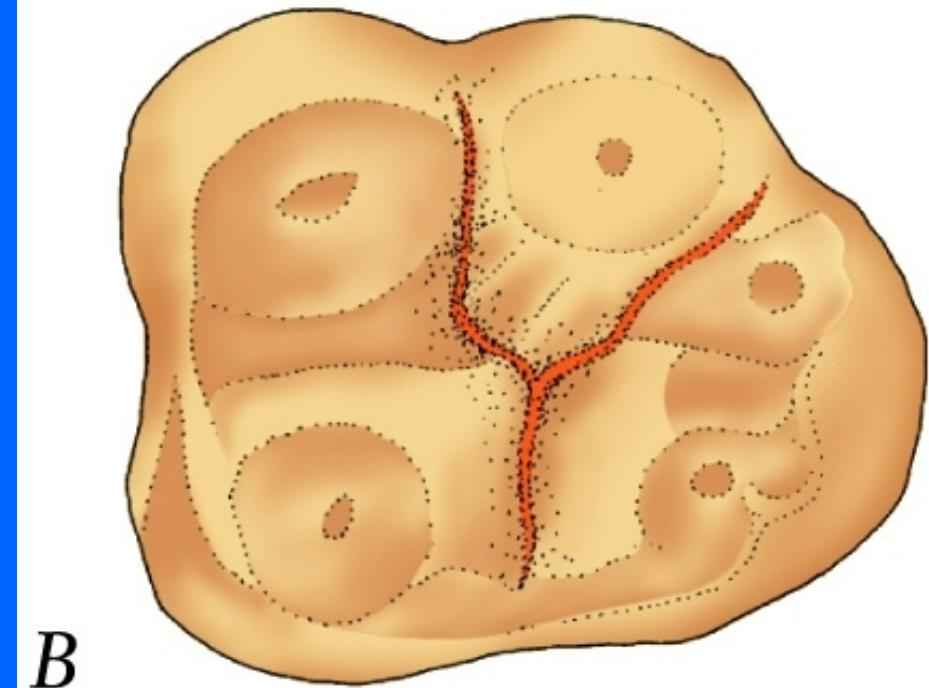
Mauricio Antón

## **General pattern of cusps on the molars of Old World monkeys. (A)**

The lower molar of a baboon, showing a cusp at each corner. (B) The lower molar of a chimpanzee, showing the “lazy Y-5” pattern characterized by a Y-shaped depression that separates five cusps.

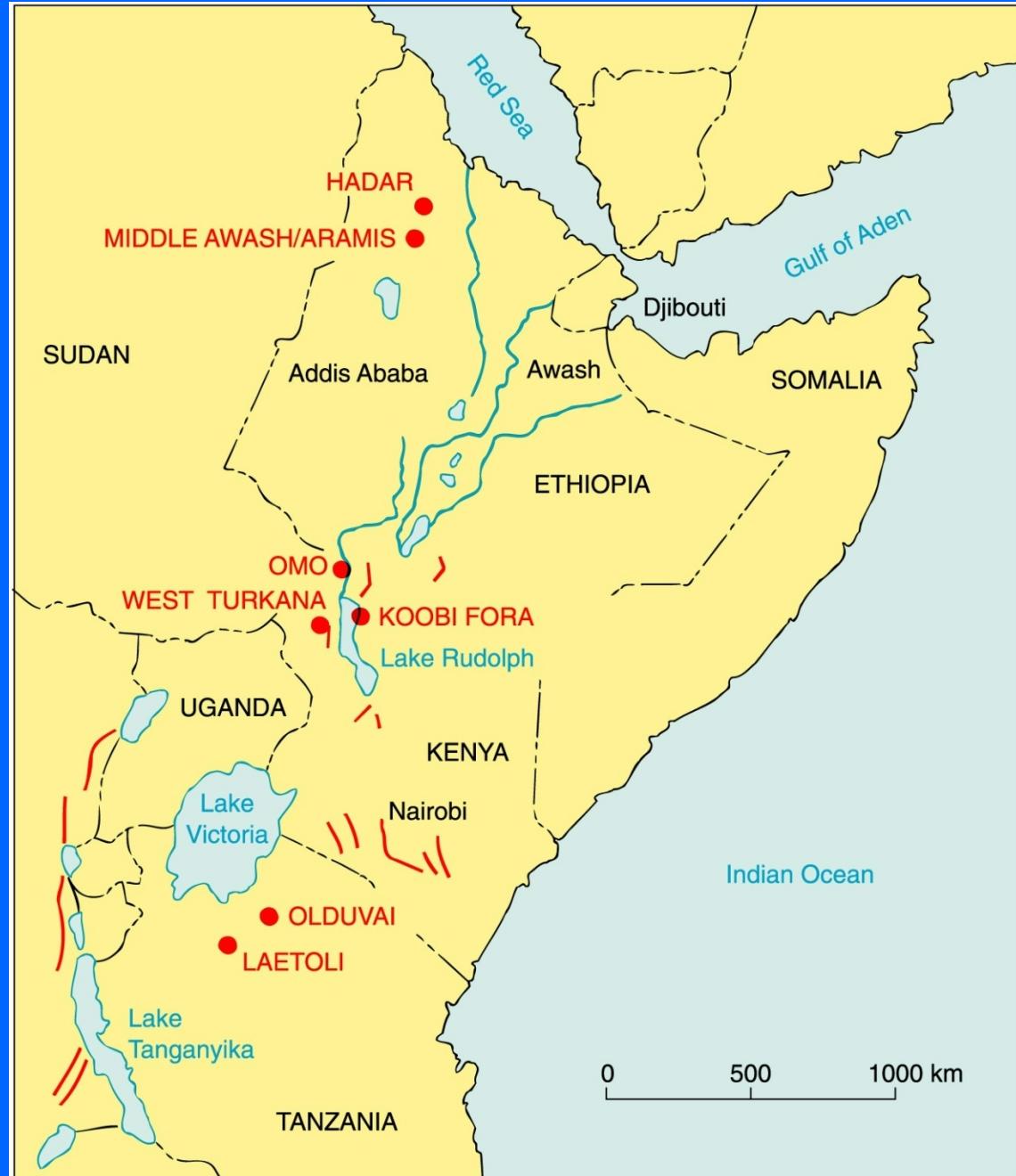


**A**



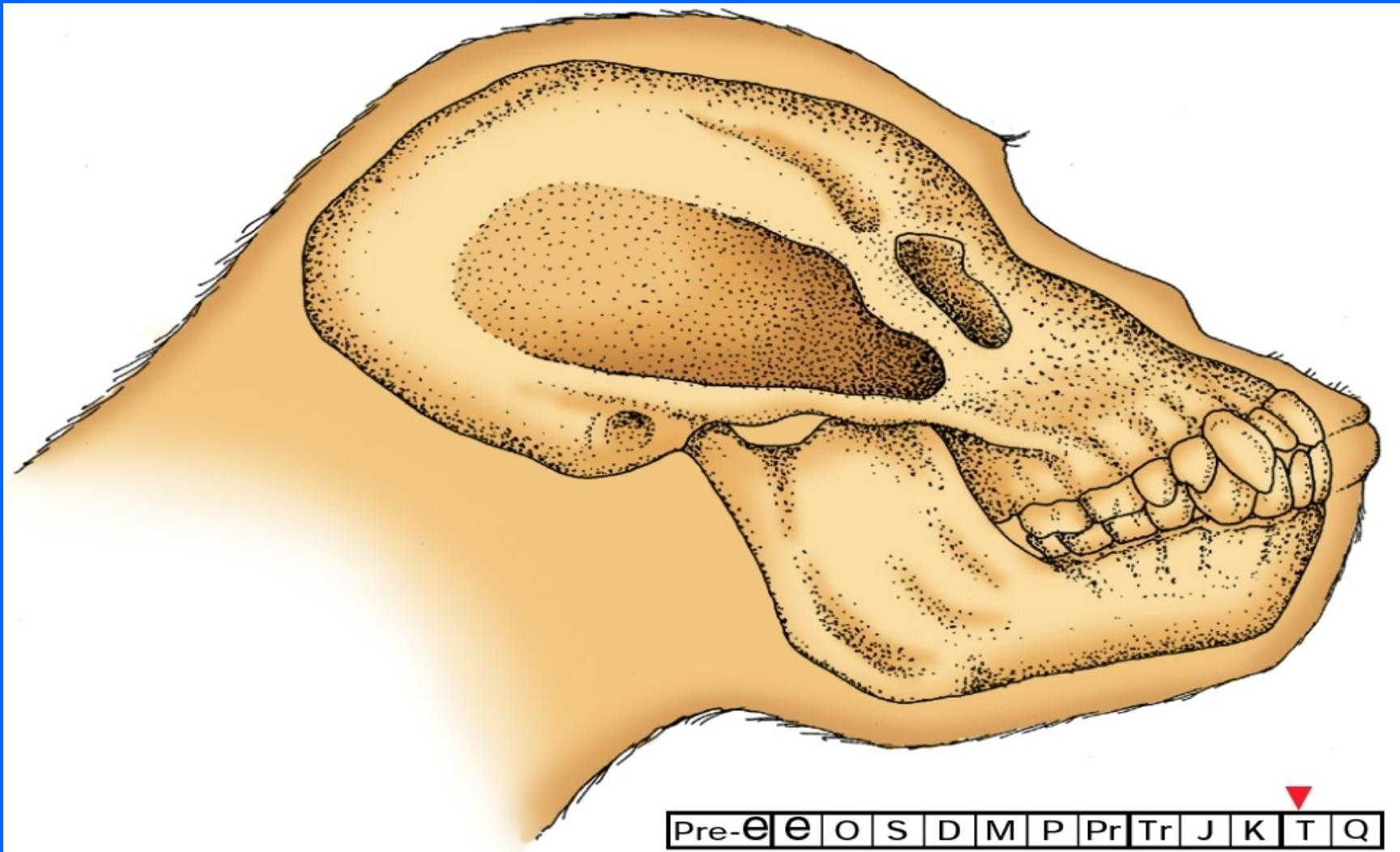
**B**

# Location of some particularly rich hominid fossil sites in East Africa.



# Skull of *Proconsul* (a dryomorph) from Lake Victoria, Kenya.

Weak skulls & couldn't knuckle walk

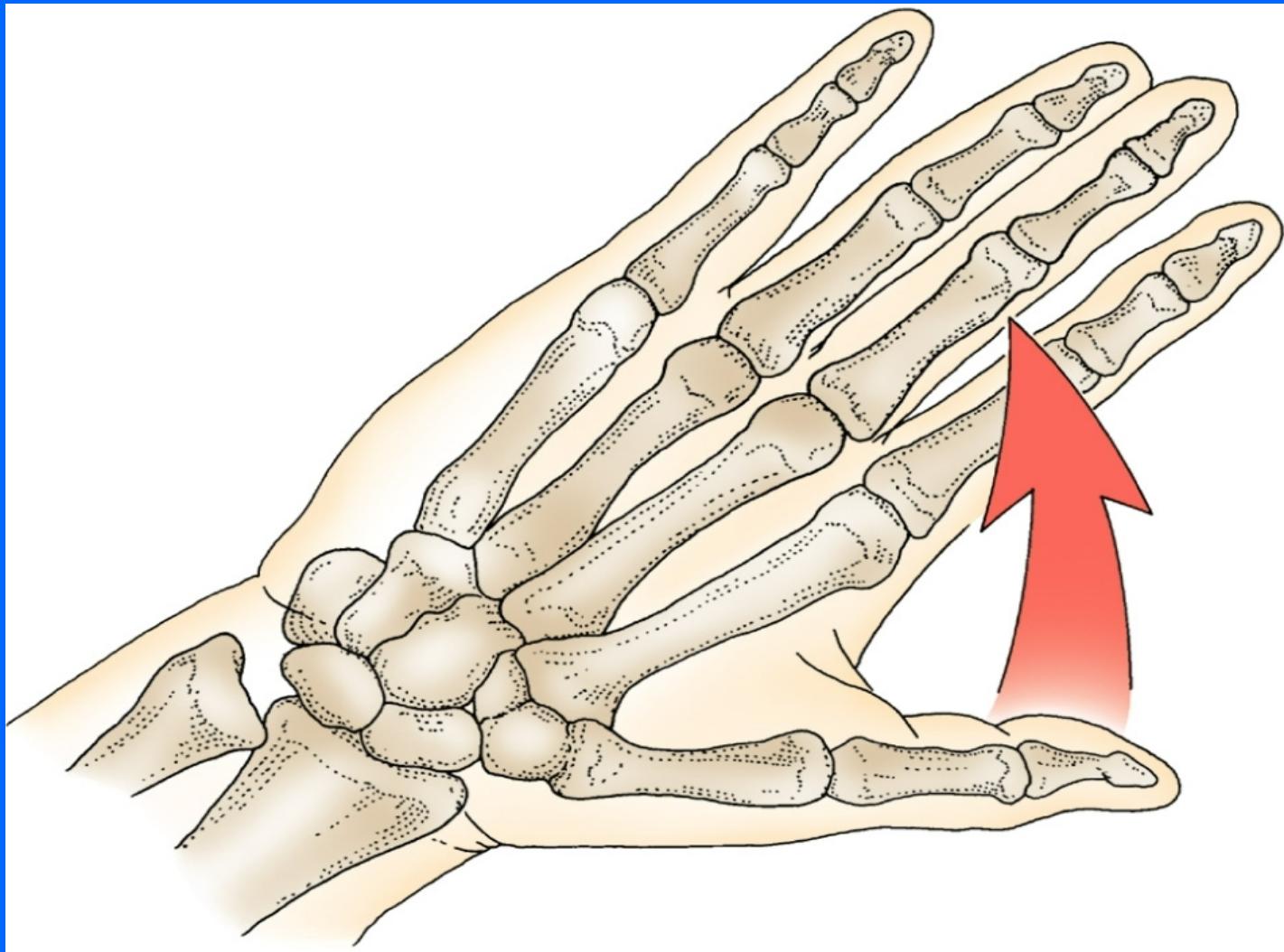


The early ape  
*Proconsul*  
(center) and the  
primate  
*Dendropithecus*  
(upper right)  
inhabited a  
warm and  
relatively wet,  
closed canopy  
tropical  
seasonal forest  
18 million years  
ago in  
equatorial  
eastern Africa  
(Rusinga  
Island, Kenya).



3. **Intelligence** = Introspective consciousness  
(math, good/bad, life after death)
- a. Chimps & other animals ability to reason & recognize self
  - b. Large parrots actually outscore chimps
- ii. Tree-dwelling characteristics
- 1. Large brain
  - 2. Agility
- iii. Primitive characters (misleading means hasn't changed much)
- 1. 5 toes & 5 fingers
  - 2. Unspecialized teeth (eat almost anything)
- II. Miocene 1<sup>st</sup> true apes
- i. Apes dominate monkeys
  - ii. 2 extinct families of species that lived together

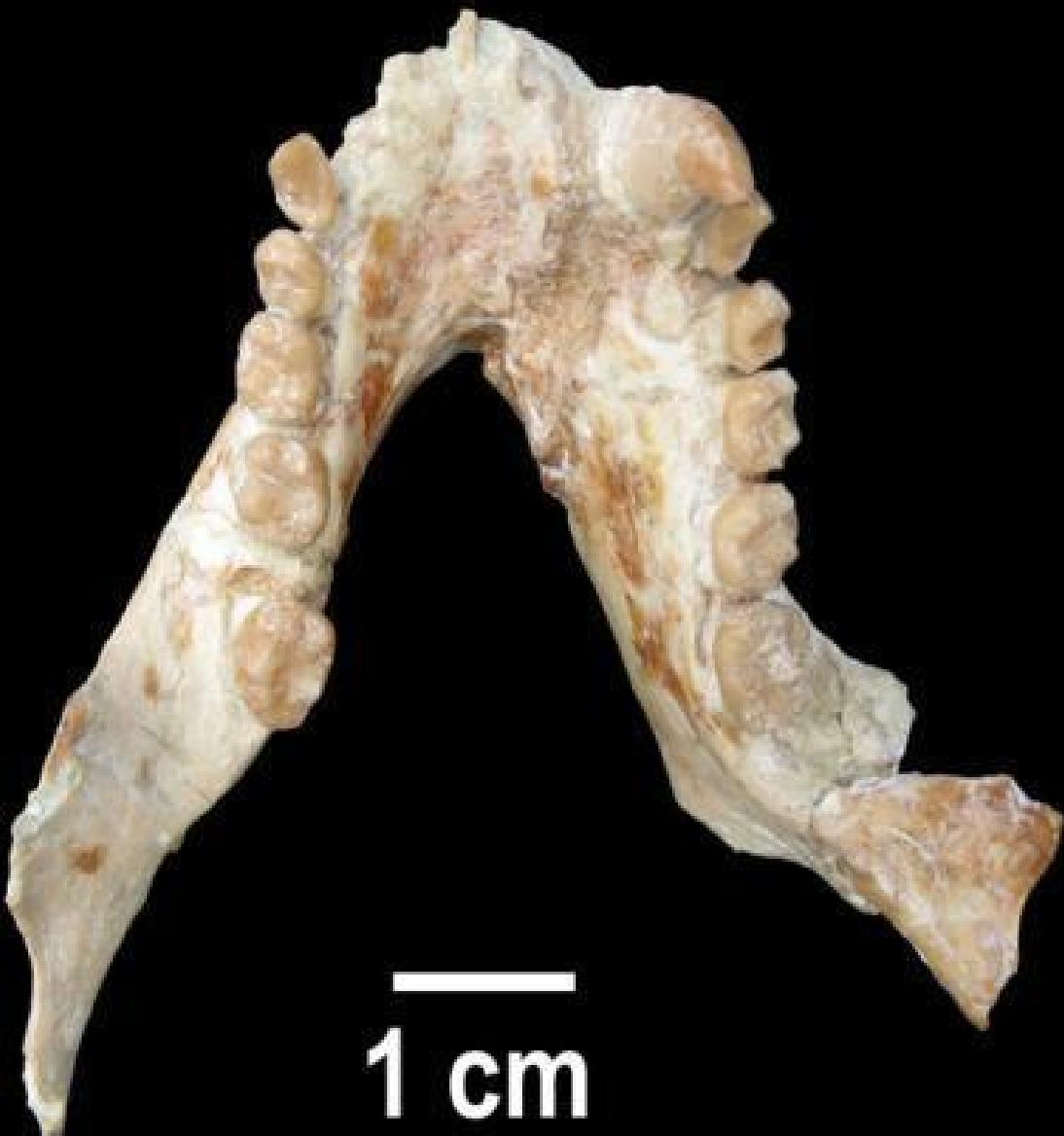
# The right hand of a human (palm up). Since Eocene in primates



1. Both grps migrate N to Eurasia
  2. Very common
- iii. Earliest “dryomorps”
  1. Weak skulls & couldn’t knuckle walk
  2. Some in trees, others so large must only live on ground
- iv. Primate Gap (Maybe not anymore)
  1. in L. Mio hominids split from ape branch
  2. no record
- v. Chimps & humans
  1. By genes split 5-8 MA
  2. At least 97.6 % similarity in DNA
  3. Blood protein can be transfused from one species to the other

# Fill gap

- ***Pliopithecus* primate**, considered an extinct family of primitive Catarrhini primates (or "Old World monkeys"). The fragments of jaw and molars found in this large site demonstrate that *Pliopithecus canmatensis* belongs to this group, which includes the first Catarrhini that dispersed from Africa to Eurasia.
- Named *Pliopithecus canmatensis*, in honour of the place they were discovered in Catalonia
- Experienced an evolutionary radiation in a continent initially deserted of other anthropoids (apes) end of the Early Miocene (some 15 million years ago)



# Ape ancestor found in Spain

Fossil sleuths in Spain unearthed bones of an animal that may have been the last common ancestor to living great apes, including humans, gorillas, chimpanzees, orangutans and others. The nearly 13-million-year-old species is called *Pierolapithecus catalaunicus*.

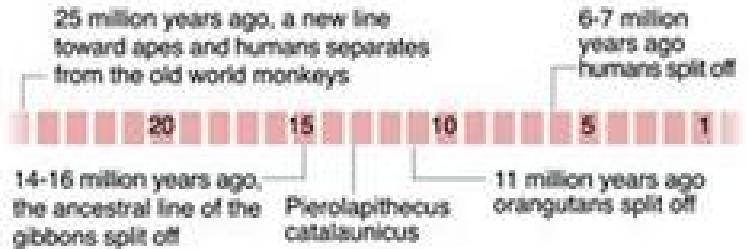


© AAAS/  
Science/  
Illustration by  
Todd Marshall

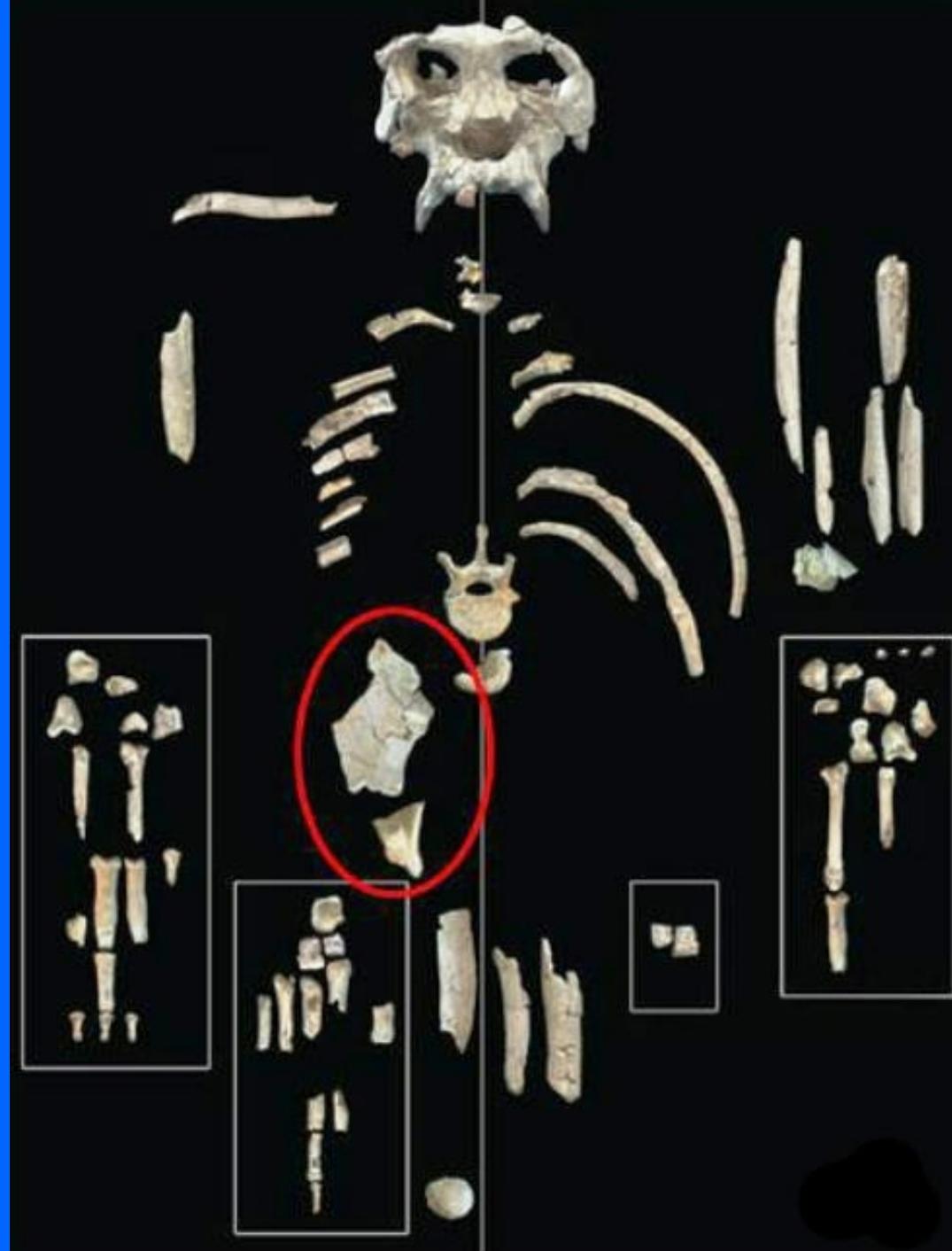
Paleontologists pieced  
together 83 bones and  
fragments of bones  
from a male ape.

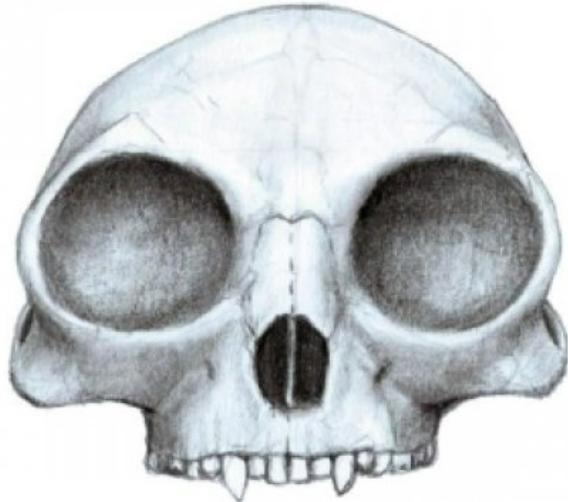
Like other great apes,  
the new find had a large  
thorax, upright posture,  
supple wrists and a flat  
face.

## A timeline of primate evolution



- *Pierolapithecus catalaunicus.*
- ~ 11.9 MA,
- it could be the last common ancestor of modern great apes: chimpanzees, orangutans, bonobos, gorillas & humans.





All extant hominoids share several features, such as the lack of external tail, an orthograde body plan that enables an upright trunk position, and several cranial characteristics.

- All these features might have been present in the common ancestor of hominids and hylobatids that, according to molecular data, would have lived about 15-20 MA

-*Pliobates cataloniae*, based on a partial skeleton composed of 70 fossil remains found in 2011 in one of the sites within the stratigraphic series of Abocador de Can Mata). These include most of the skull and dentition as well as a considerable portion of the left arm, including several elements of the elbow and wrist joints. They belong to an ape similar in size to the smallest of living gibbons (4 to 5 kg), which lived 11.6 million years ago.

-*Pliobates* shows a set of characteristic features of extant hominoids, presumably inherited from their last common ancestor, which probably lived in Africa several million years before *Pliobates*. <http://www.sciencedaily.com/releases/2015/10/151029150247.htm>

Hominoid primate genus in Spain dating to the Middle Miocene era, roughly 12 million years ago.

*Anoiapithecus brevirostris* name from location (l'Anoia) and from its "modern" facial morphology, characterized by a very short face.

*Anoiapithecus* displays a very modern facial morphology, with a muzzle prognathism (i.e., protrusion of the jaw) so reduced that, within the family *Hominidae*, scientists can only find comparable values within the genus *Homo*

- extraordinary resemblance does not indicate that *Anoiapithecus* has any relationship with *Homo*, similarity might be a case of evolutionary convergence.

Some scientists have suspected that a group of primitive hominoids known as kenyapithecines (Mid Miocene of Africa and Eurasia) might have been the ancestral group of all hominids.

- Detailed morphological study of the cranial remains of Lluc showed that, together with the modern anatomical features of hominids (e.g., nasal aperture wide at the base, high zygomatic root, deep palate), it displays a set of primitive features, such as thick dental enamel, teeth with globulous cusps, very robust mandible and very procumbent premaxilla.
- Features characterize a group of primitive hominoids from the African Middle Miocene, known as afropithecids.

Hominids might have originally radiated in Eurasia from kenyapithecine ancestors of African origin. Later on, the ancestors dispersed again into Africa

- "into Africa" theory, controversial idea.
- However, possible that pongines (orangutans etc) and hominines (African apes and humans) separately evolved in Eurasia and Africa, respectively, from different kenyapithecine ancestors.

"Lluc,"



## Apes-Humans



- Miocene apes radiated in Africa and Eurasia
  - Most were arboreal
  - 6-7 M year old fossil skull
    - *Sahelanthropus*
    - Resembles both apes and humans

# Gigantopithecus

OUR  
ORIGINS

CLARK SPENCER LARSEN



Art: Mauricio Anton



A finger of a scientist pointing at a tibia from the lower part of the leg of what is believed to be humankind's first walking ancestor, a hominid that lived in the wooded grasslands of the Horn of Africa nearly 4 million years ago. A team of U.S. and Ethiopian scientists discovered the bones in February at a new site called Mille, in the northeastern Afar region of Ethiopia, said Bruce Latimer, director of the Cleveland Museum of Natural History in the U.S. state of Ohio. They are estimated to be 3.8 to 4 million years old. The fossils include a complete tibia, parts of a thighbone, ribs, vertebrae, a collarbone, pelvis and a complete shoulder blade, or scapula. There is also an anklebone which, with the tibia, proves the creature walked upright, said Latimer, co-leader of the team that discovered the fossils. The picture was taken Sunday Feb. 20 in Mille. (AP Photo/Anthony Mitchell).

# Comparison of DNA sequences indicates degree of evolutionary relation

## Methods:

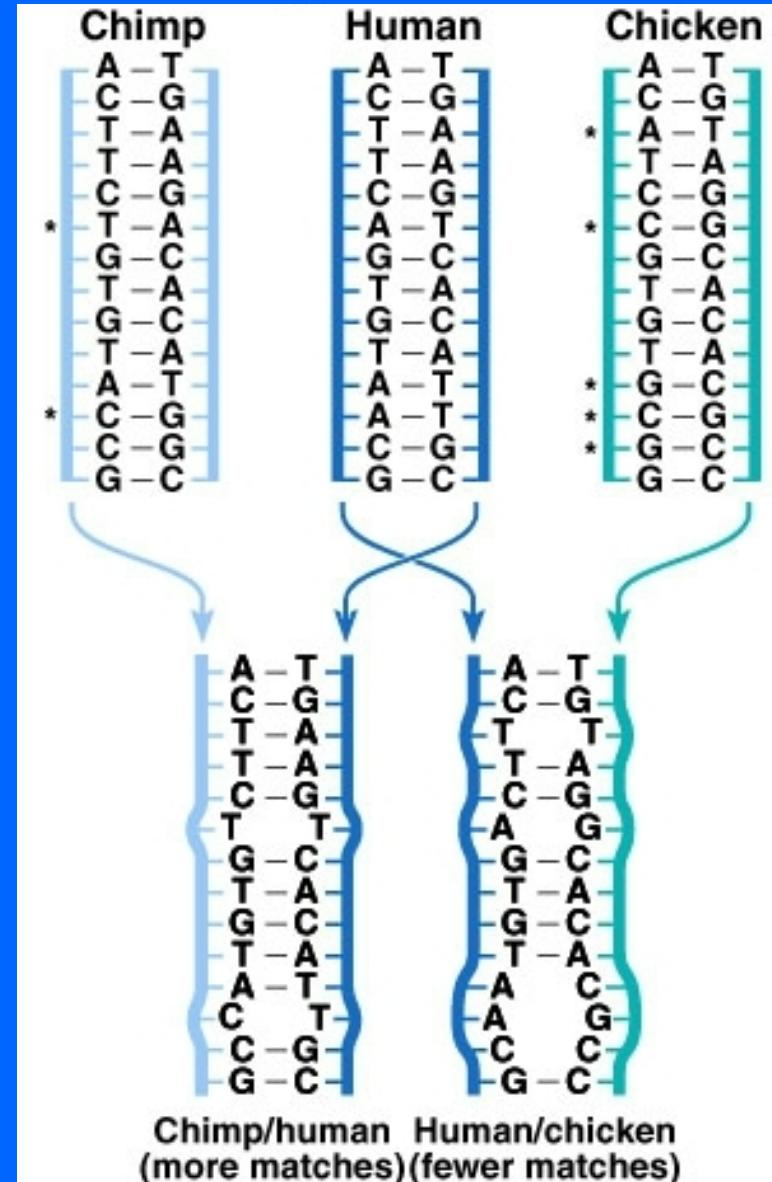
- DNA hybridization of denatured DNA strands
- directly determining the sequence of each organism's genes.

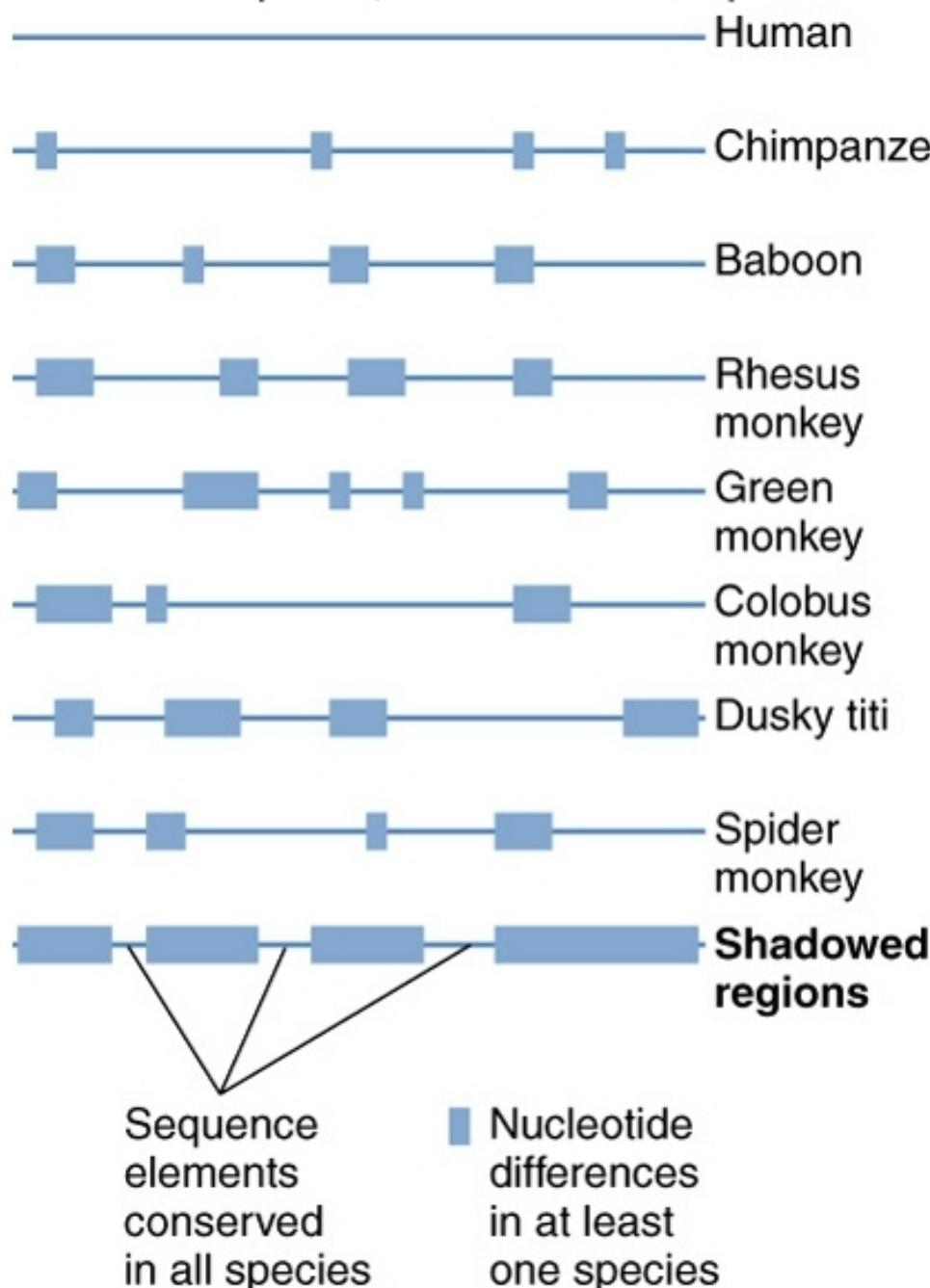
### Percent sequence difference

Human-chimp 1.0%

Human-gorilla 2.3%

Human orangutan 3.7%





# Molecular Evolution: comparing chromosomes

- Human chromosomes banding is highly conserved between humans and the other great apes.
- All mammals share identical X-chromosome banding
  - Percent of chromosomes bands shared between humans and other species

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• Chimpanzees	+99%
• Gorillas	+99%
• Orangutans	+99 %
• African green monkey	95%
• Domestic cats	35%
• Mice	7%



Fruit Fly

**44%**

Mouse

**92%**

Yeast

**26%**



Plant

**18%**



Chimp

**98%**



**What percent  
of your genes  
do you share?**

# Molecular Evolution: comparing protein sequences

Variation in proteins can be used to establish how similar two species are genetically.

Cytochrome c protein is involved in energy production in the mitochondria and is found in all eukaryotes.

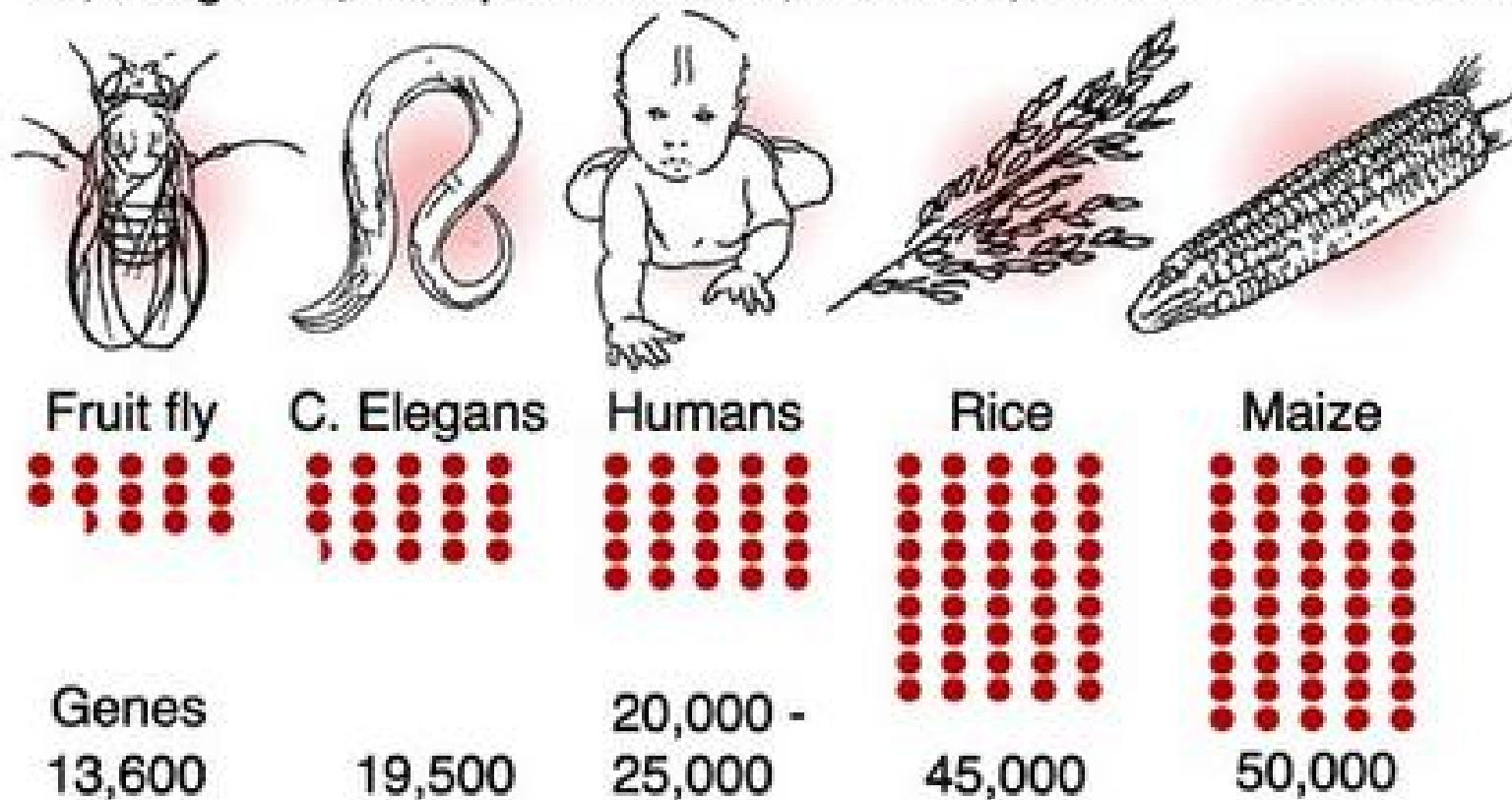
20/104 amino acids are identical in all eukaryotes.

Cytochrome c Evolution		Number of amino acid differences from humans
Organism		
	Chimpanzee	0
	Rhesus monkey	1
	Rabbit	9
	Cow	10
	Pigeon	12
	Bullfrog	20
	Fruit fly	24
	Wheat germ	37
	Yeast	42

Human and chimp cytochrome c are identical in amino acid sequence.

# Humans have fewer genes

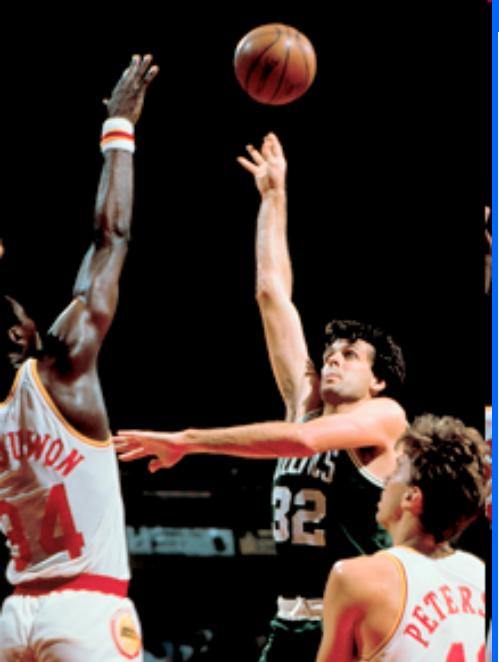
In Thursday's issue of the journal Nature, researchers who decoded the human genome concluded that people have only 20,000 to 25,000 genes, a drop from the 30,000 to 40,000 estimated in 2001.



SOURCE: Nature

AP

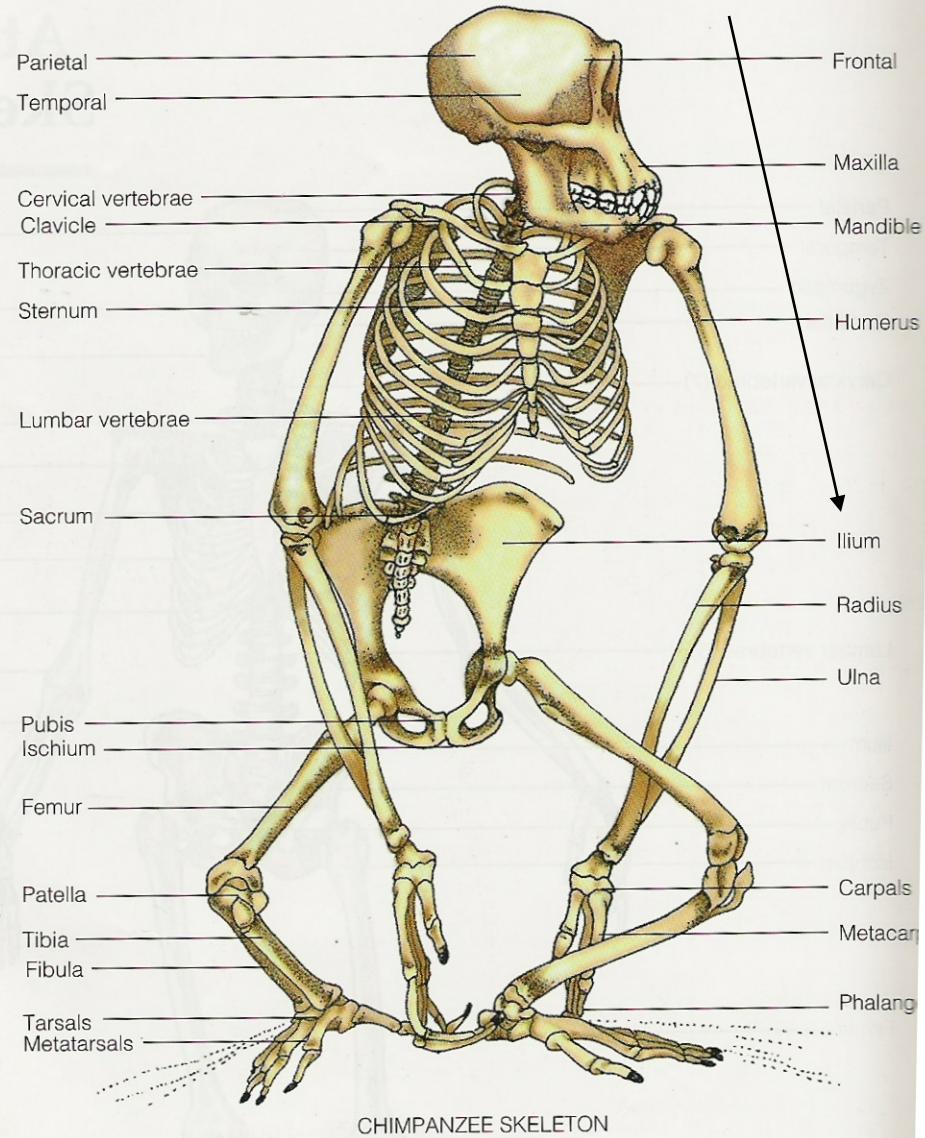
What makes us so special?



**Figure A-2**

Chimpanzee skeleton (*Pan troglodytes*)—  
knuckle-walking pongid.

Notice  
faces  
forward



# Atlas of Primate Skeletal Anatomy

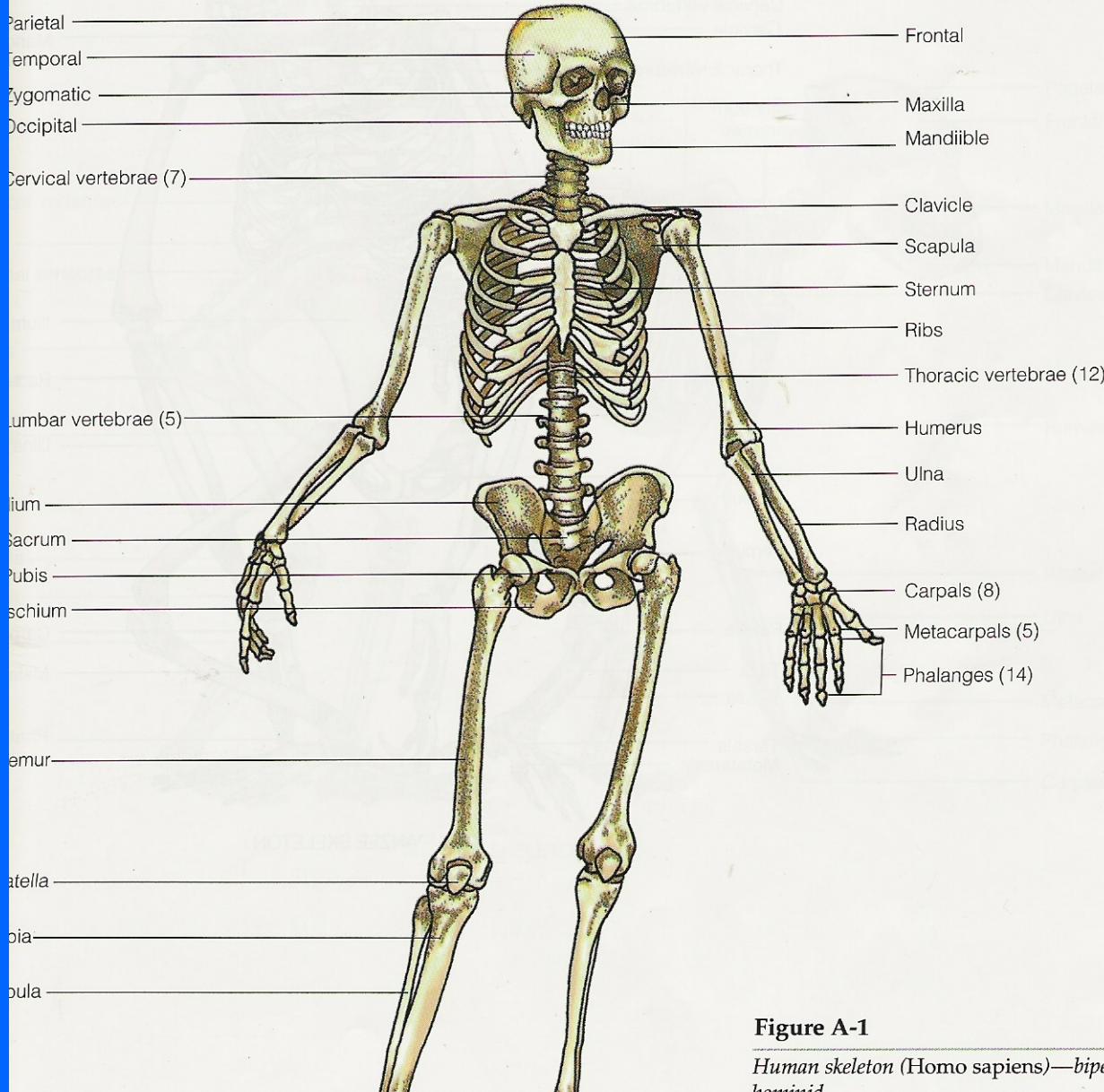
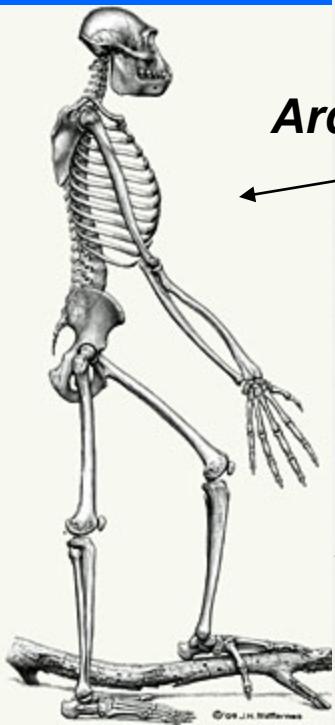
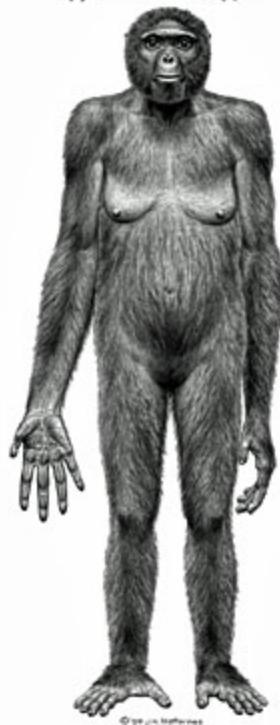


Figure A-1

Human skeleton (*Homo sapiens*)—bipedal hominid



So Chimps  
develop own  
traits from  
common  
ancestor.  
Our  
ancestors  
not chimp-  
like but



### *Ardipithecus ramidus*

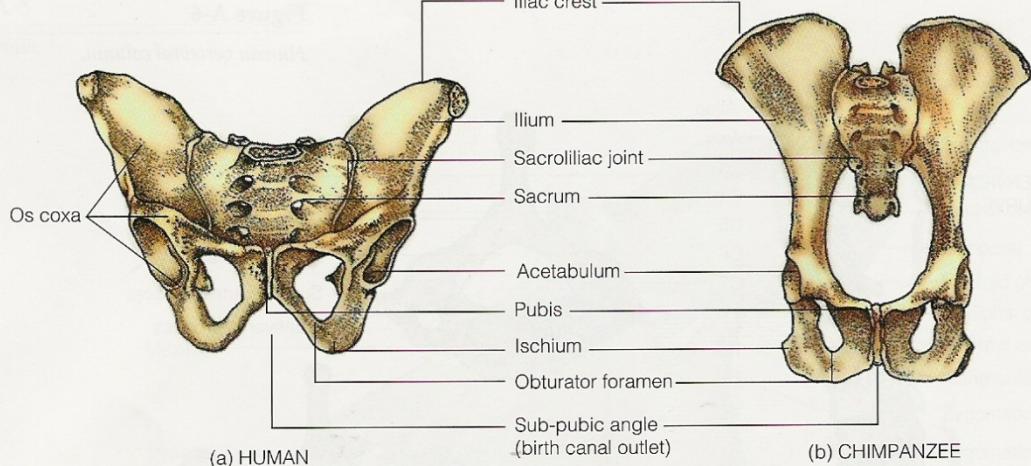
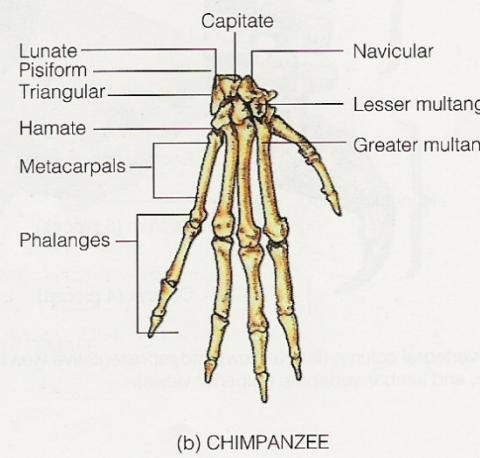
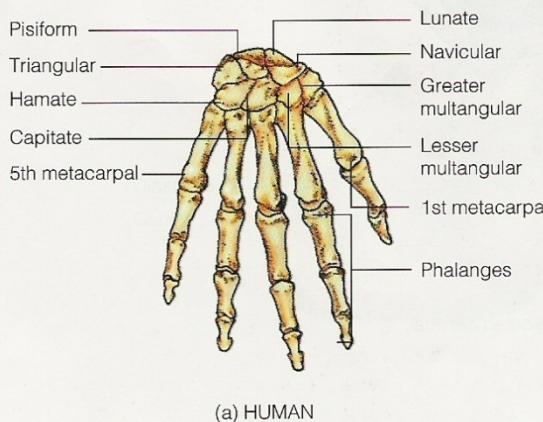
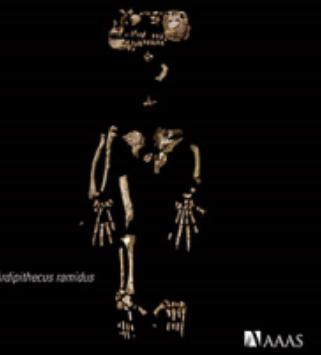


Figure A-7

Pelvic girdles.

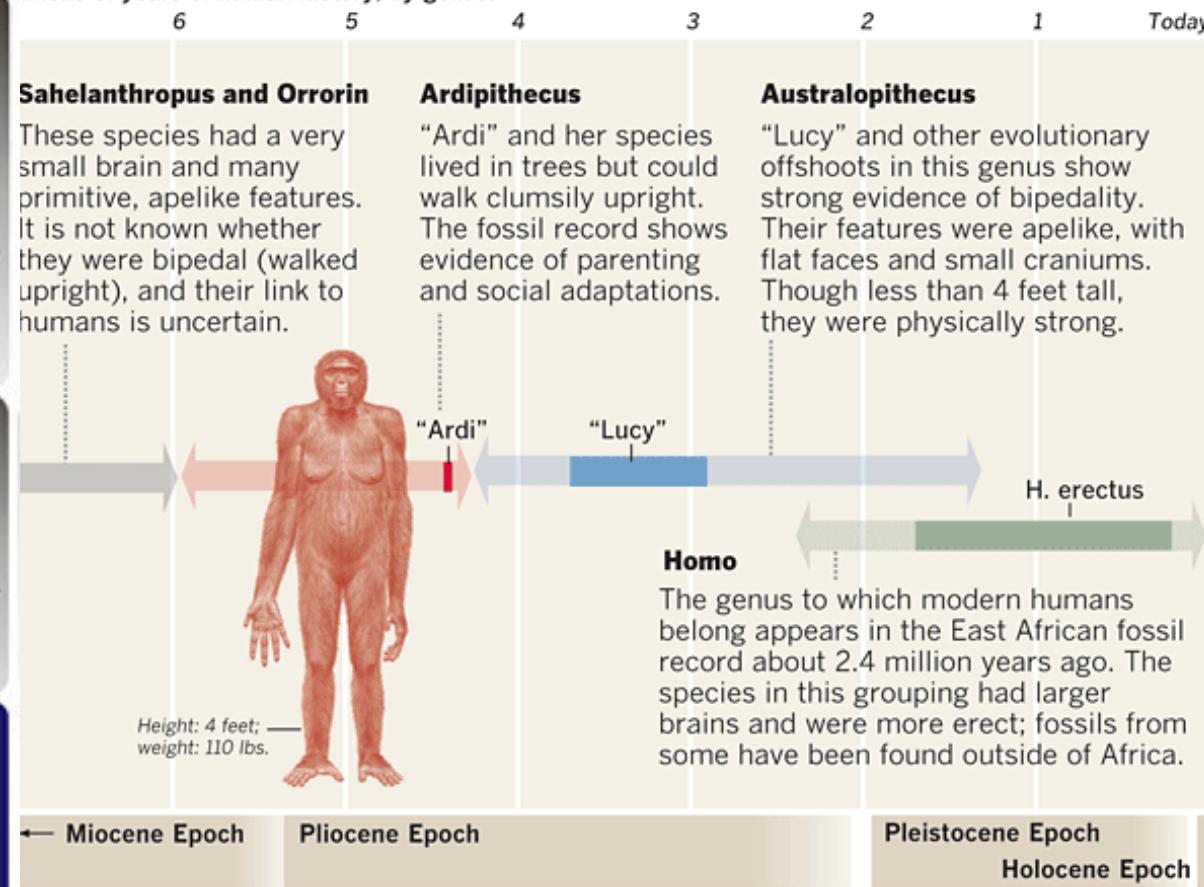
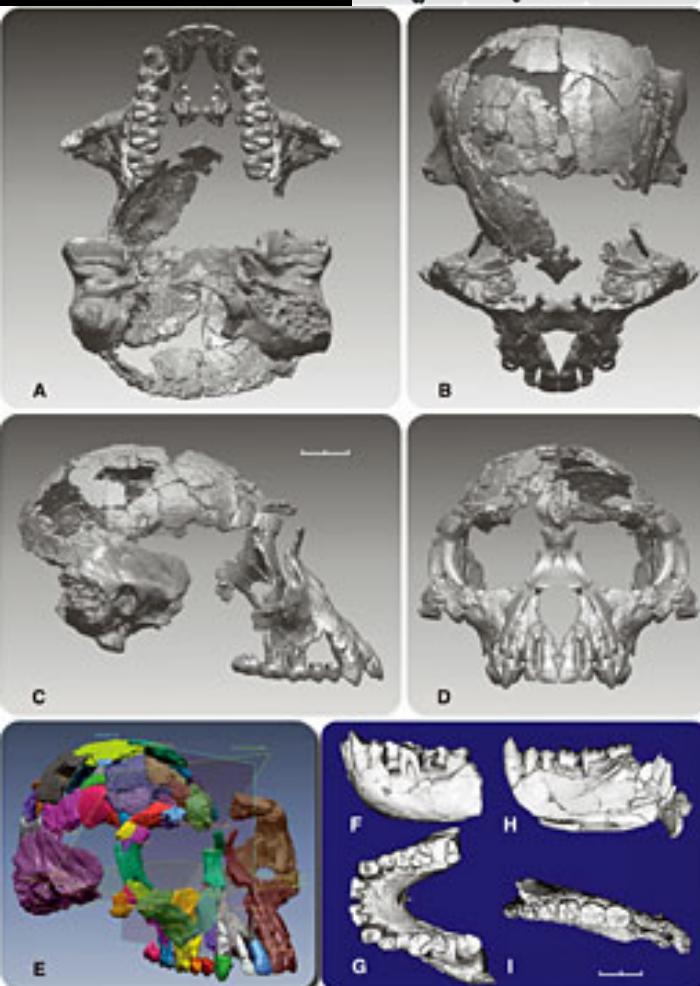




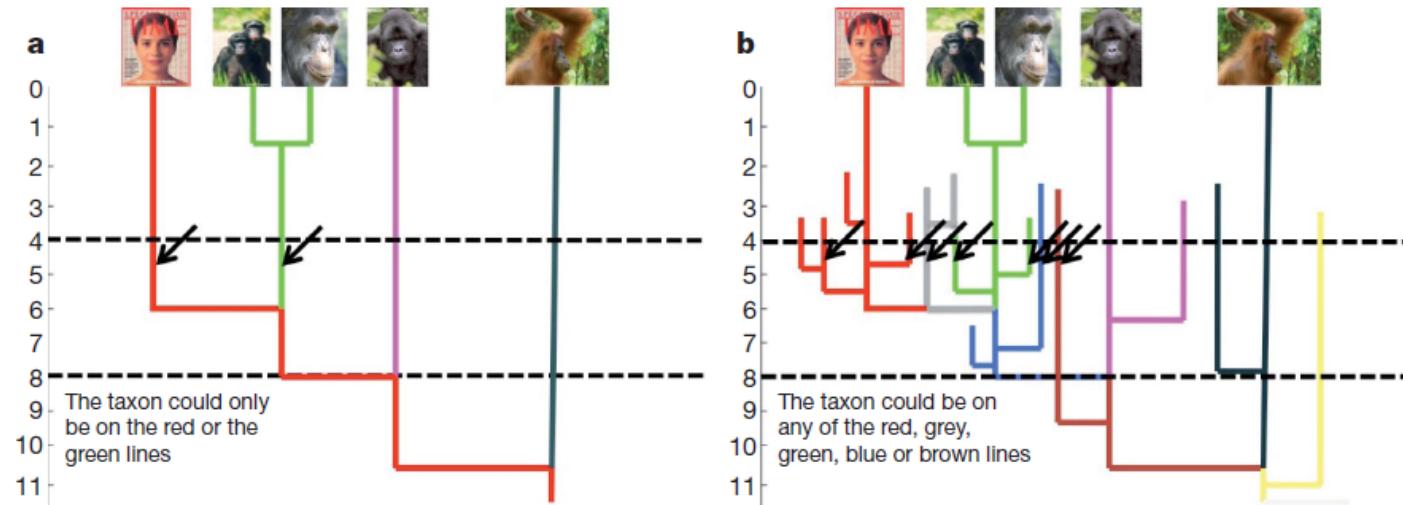
- ***Ardipithecus ramidus* cranium and mandible.** *Ardipithecus ramidus*, a hominid species that lived 4.4 million years ago in what is now Ethiopia (Science 2009)
- Can pick things up with big toe, lower pelvis long to help climbing

The fossil record of human ancestors, or hominids, is often fragmentary, but the evolutionary history since human and ape ancestors split 10-40 million years ago can generally be subdivided by genus. Here's a look at where the 4.4 million-year-old-skeleton dubbed "Ardi" fits within human evolution:

\*millions of years of human history, by genus:



Sources: Science, encyclopedia.com. Graphics reporting by LES DUNSEITH

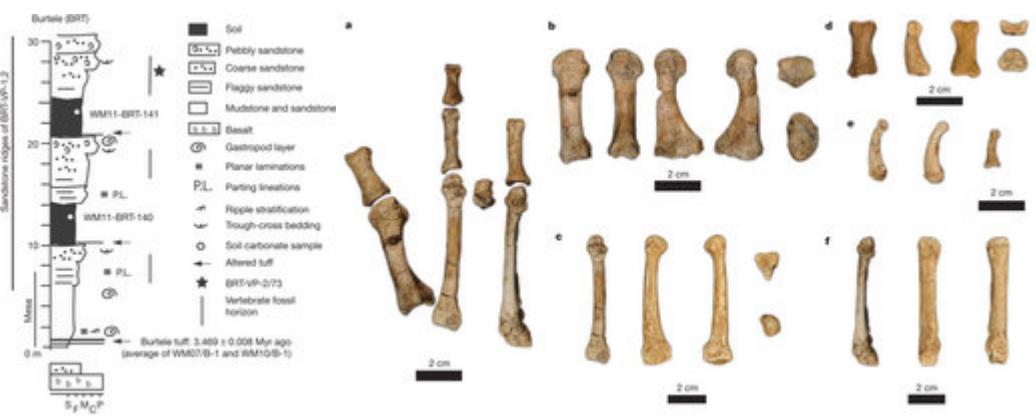


**Figure 1 | Hypothetical trees.** a, According to this hypothesis a 4.4-Myr-old hominid closely related to hominins and panins could only be a hominin ancestor or a panin ancestor. b, According to this hypothesis a 4.4-Myr-old

hominid closely related to hominins and panins could be a hominin or a panin ancestor, but is more probably a member of an extinct clade. This hypothesis more closely reflects the comparative evidence.

# So related directly to us or not?

<http://www.sciencedaily.com/releases/2012/03/120328135930.htm>



The Burtele partial foot clearly shows that at 3.4 million years ago, Lucy's species, which walked upright on two legs, was not the only hominin species living in this region of Ethiopia (most like Ardi)

- a. guess who benefits the most from this kind of transfusion
- b. evolution

### III. Australopithecines (Pliocene)

- i. *Australopithecus* & related genera

#### *Paranthropus*

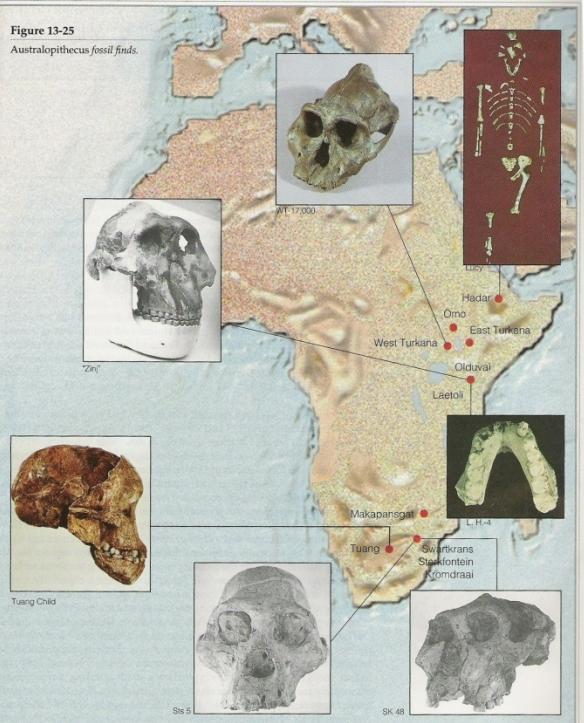
- ii. Genus *Homo* from *Australopithecus*

- iii. *Australopithecus* thought of a go between from humans & chimps (not so now, off man branch)

1.  $\frac{1}{2}$  human brain size
2. Males 5.5'; females 3.5'
3. Active tree climbers that could walk upright like us (knee locks)
4. Large jaw & molars to crush seeds & nuts
5. No tools

Figure 13-25

Australopithecus fossil finds.

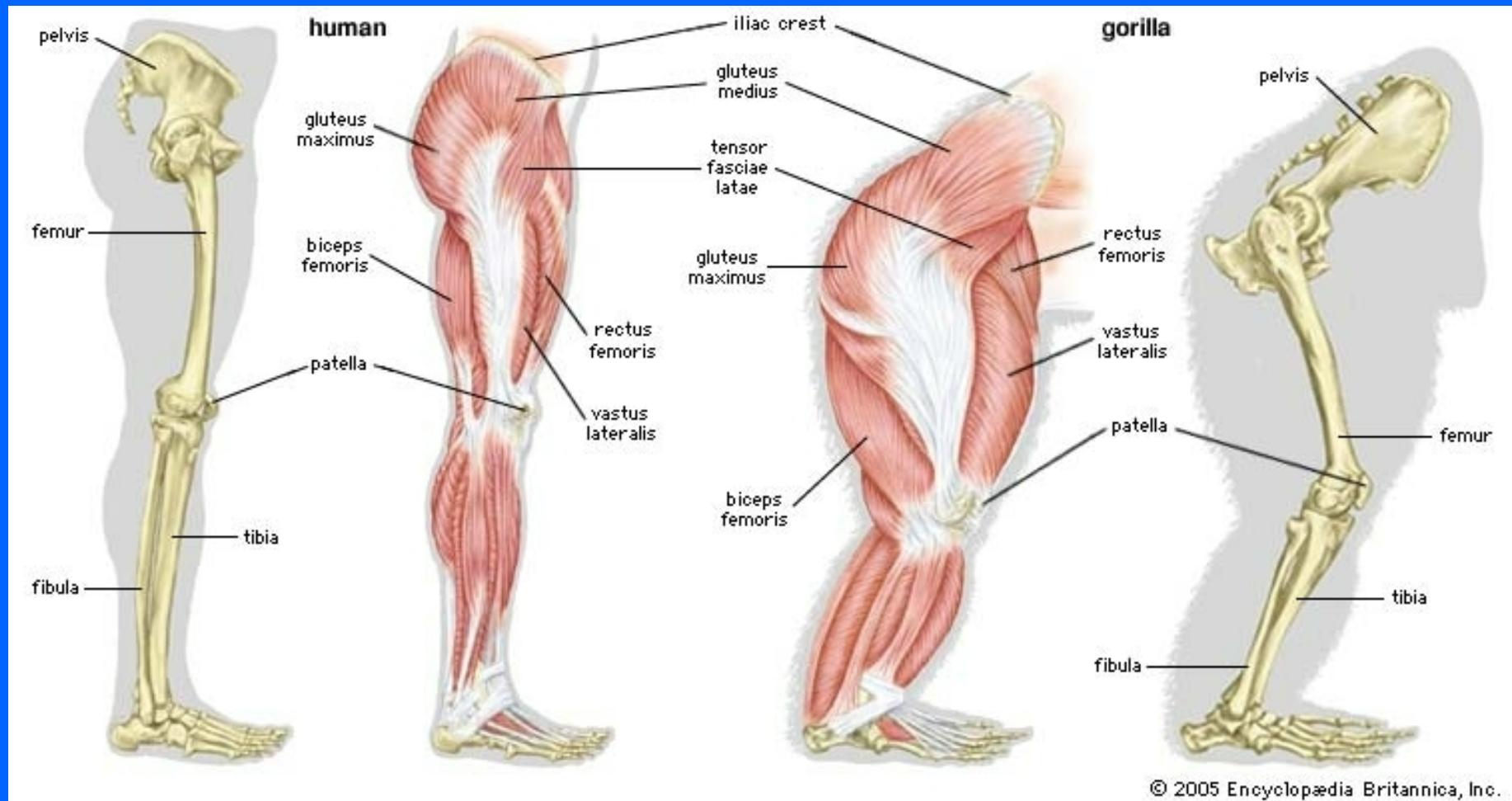


Meet "Lucy's" Great-Grandfather.  
a 3.6 million-year-old partial skeleton  
found in Ethiopia.  
400,000 years older than the famous  
"Lucy" skeleton and is significantly  
larger in size.



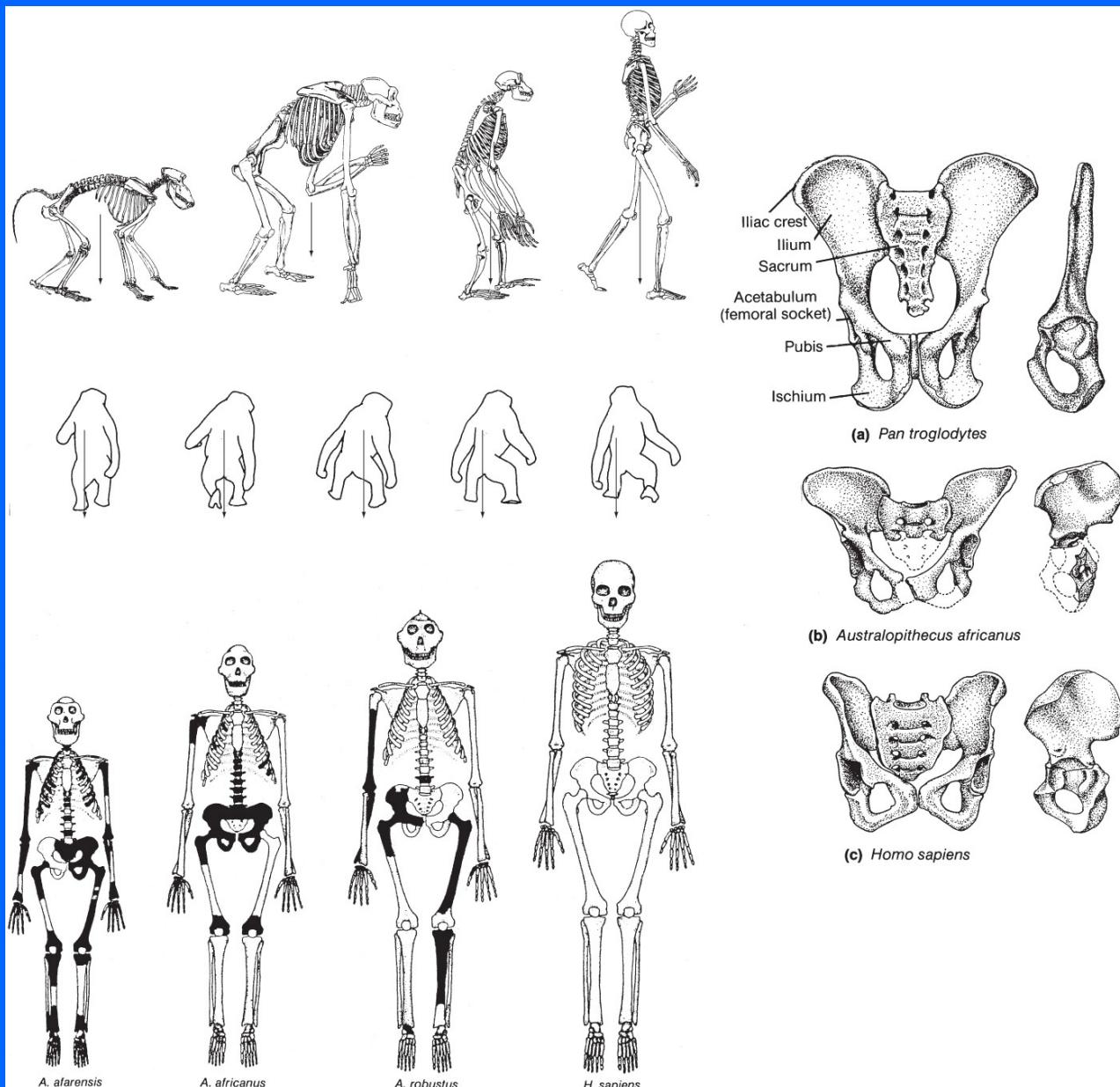
Notice hip bone blades  
rotated  
From chimps to support  
upright walking

# Human vs. Gorilla



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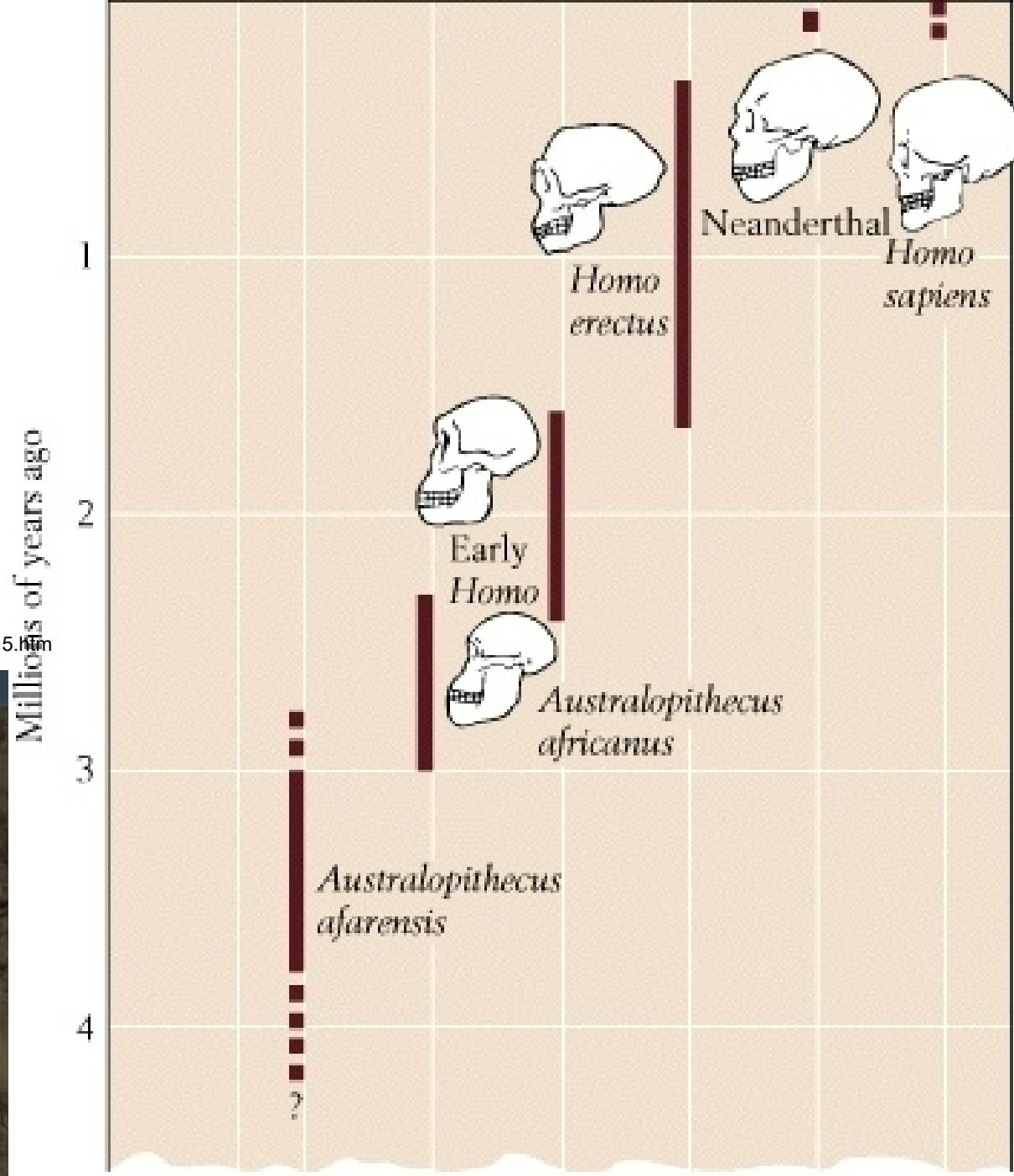
## Humans and apes compared.

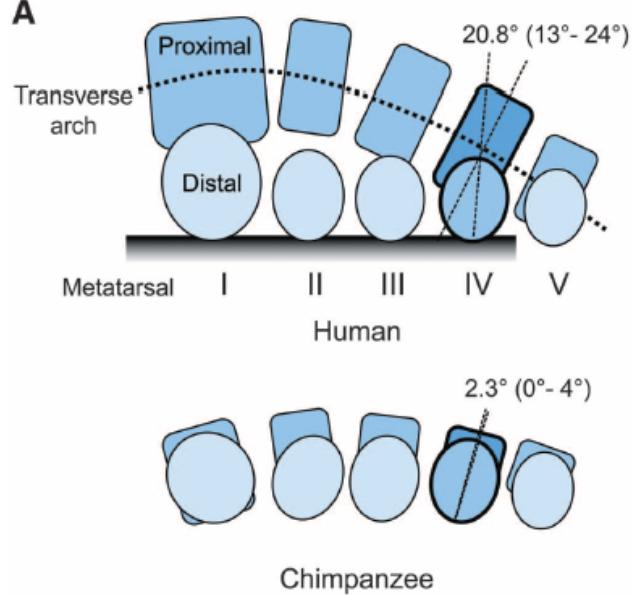


Adapted from: Edey, M. A. and Johanson, D. C. 1989. Blueprints: Solving the Mystery of Evolution. Boston: Little, Brown and Company.

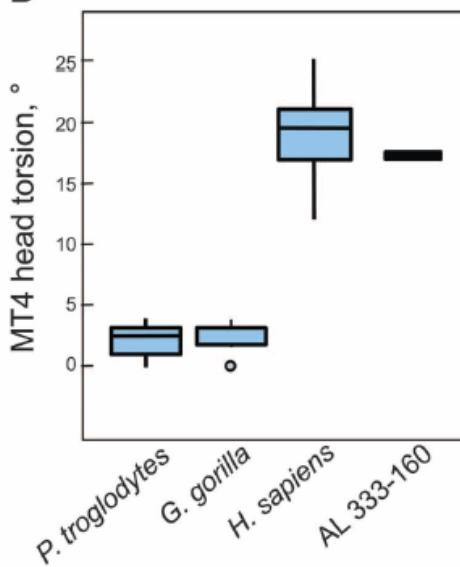
3.2 million years ago  
human ancestors walked  
bipedally with a modern  
human-like foot

The fossil, a fourth  
metatarsal, or midfoot  
bone, indicates that a  
permanently arched foot  
was present in the species  
*Australopithecus afarensis*





B



**Fig. 2. (A)** Schematic representation of metatarsal proximal (rounded rectangles) and distal (ovals) ends seen in distal view in a human above and a chimpanzee below. In both species, the metatarsal heads are in contact with the substrate. Because of the arch, the proximal ends of the human metatarsals are higher and situated in a transverse arch configuration (indicated by the dashed line). This results in axial torsion within the human fourth metatarsal of the head relative to the base, whereas this is not found in apes. [Modified from (23)] **(B)** Box plot of torsion values for chimpanzees, gorillas, humans ( $N = 10$  individuals each), and AL 333-160 showing the distinct torsion in both hominins that is lacking in the apes. MT, metatarsal. Data are in table S1.

**Fig. 3. (A)** Box plots of angular relations of the

A

105

In AL 333-160, the metatarsal head is twisted laterally relative to the base, producing shaft torsion characteristic of modern humans (2) and later fossil hominins, including *Homo habilis* specimen OH 8 (22, 23) and the *H. erectus* foot bones from Dmanisi, Republic of Georgia (24). This torsion contrasts with the ape condition, in which the head and base exhibit minimal relative rotation (Fig. 2). Torsion allows the plantar surface of the metatarsal head to contact the ground in a foot with a strong skeletally supported transverse arch (2, 25, 26), an everted posture characteristic of a foot adapted for the modern human terminal-stance phase of gait, rather than the inverted foot postures of apes used in climbing. This degree of torsion of the AL 333-160 metatarsal demonstrates that a permanent bony transverse arch must have been present in the foot of *A. afarensis*.

In AL 333-160, the diaphysis is angled plantarly, rather than dorsally, relative to the base, as in humans and *H. habilis* [OH 8; see (11)] and unlike in African apes (Fig. 3). This morphology



## A. *Afarensis* foot

iv. “Lucy”

1. Found by Richard Leakey w/ nearby matching footprints (19-34)
2. Named for Beatles song (only record had for 3 month dig in Ethiopia)
3. Thought 1<sup>st</sup> to be fierce carnivore (found near remains of leopard kills, might have been cat food)

IV. Why bipedal?

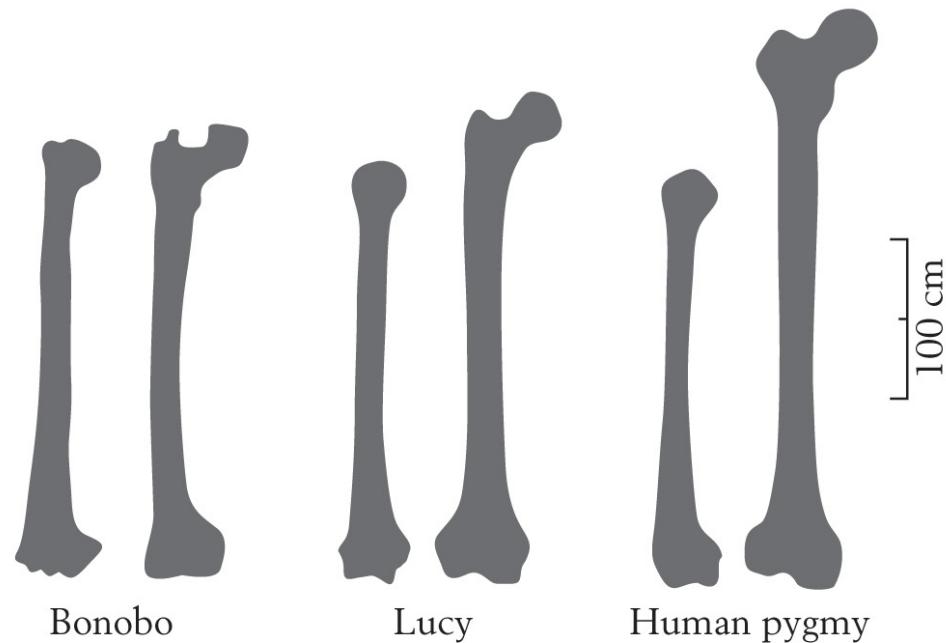
- i. Adaptation for life in the savannah
- ii. Shrinking forest & spreading grasslands
  1. Taller ones can see predators from far away so more likely to survive
  2. Heat response
    - a. Upright posture lessens solar heating during midday (lessens shadow)





A

-46a  
Earth System History, Fourth Edition, © 2014.  
Steven M. Stanley.



B

# Lucy more like humans than bonobos

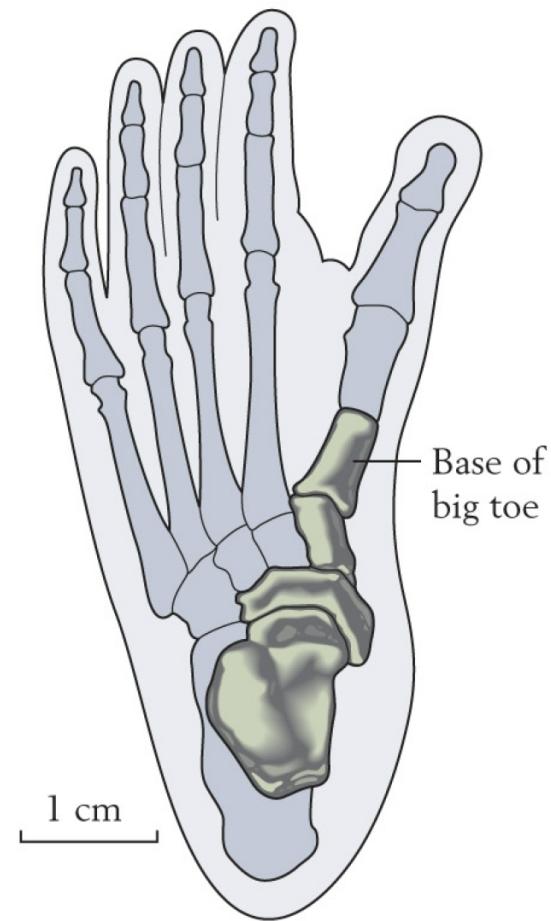


Figure 19–46b

Earth System History, Fourth Edition, © 2014.  
B, after Steven M. Stanley, *Paleobiology* 18:237–257, 1992.

# *Dinofelis* food

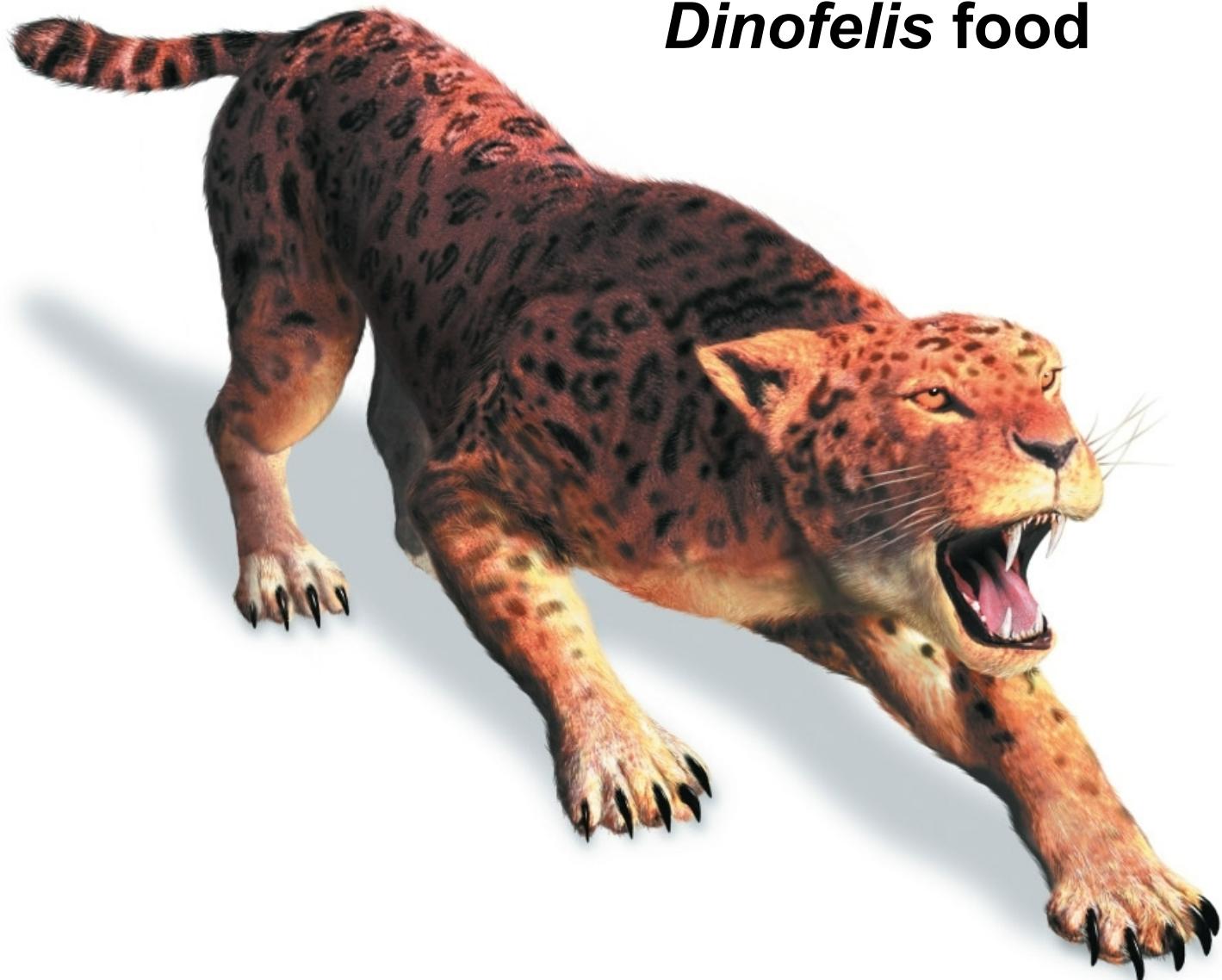


Figure 19–48UN01

Earth System History, Fourth Edition, © 2014.  
Dorling Kindersley/Getty Images.

# 3 year old to 3 year old Taung child *A. africanus*



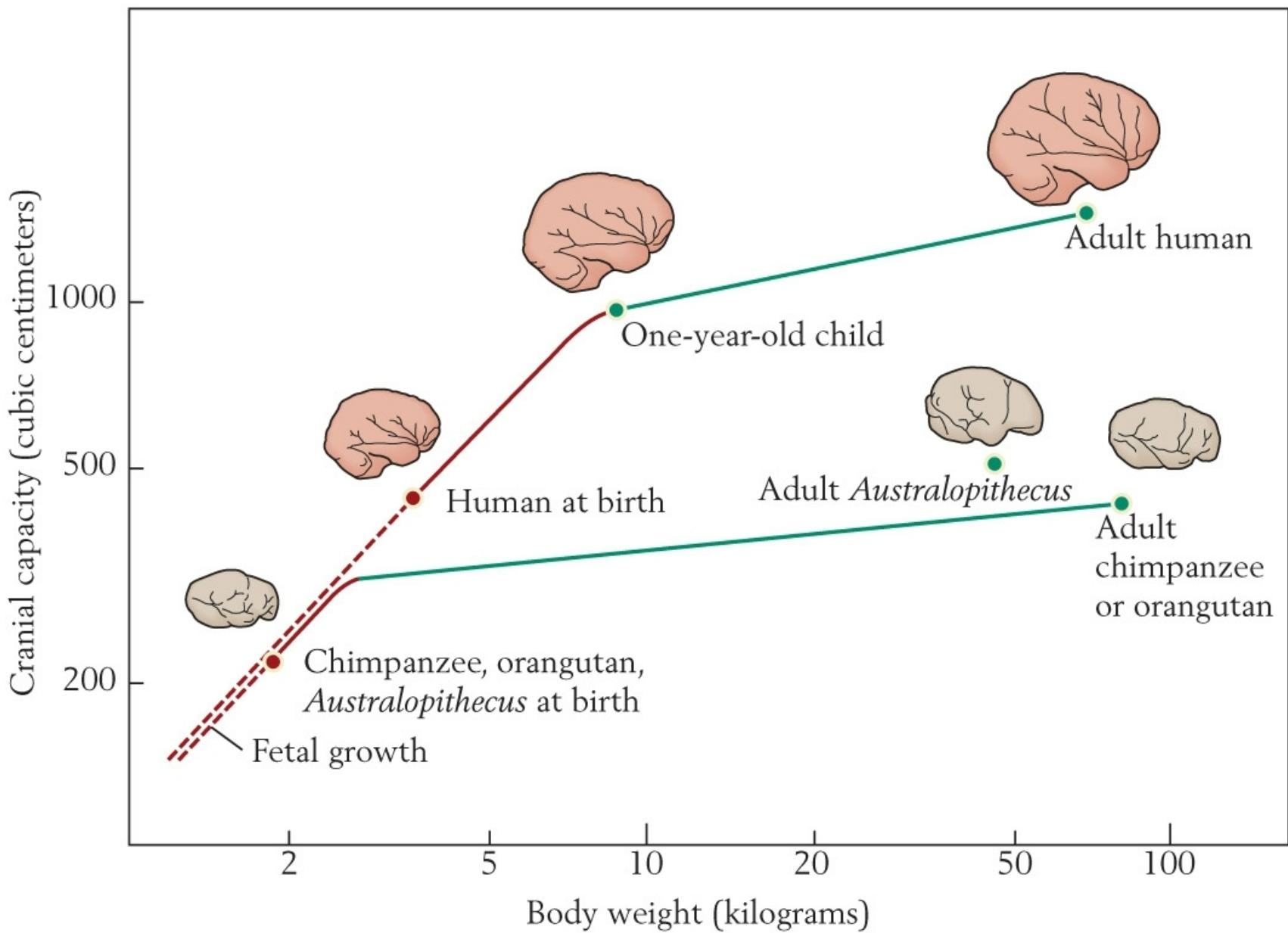


Figure 19–48UN02

Earth System History, Fourth Edition, © 2014.

After Steven M. Stanley, *Paleobiology* 18:237–257, 1996.

b. Keeps brain cool that may have help in its growth & dvlpmnt

V. 1<sup>st</sup> Homo species from uncertain Aust. species

i. Australopithecines unchanged for 1.5 mil yrs then sudden appearance of 1<sup>st</sup> *Homo habilis*

1. Made tools

a. Prepared meat

2. Brain size 2x of Austral.

a. 760cm<sup>3</sup> + to 450 cm<sup>3</sup>

ii. Climate change (cooling) 2.5 MA

1. Forests shrinking

2. Australopithecines abandon tree climbing

a. Longer maternal care

b. Greater dvlpmnt time

c. Increased brain size

iii. Advantageous to avoid predators & catch prey

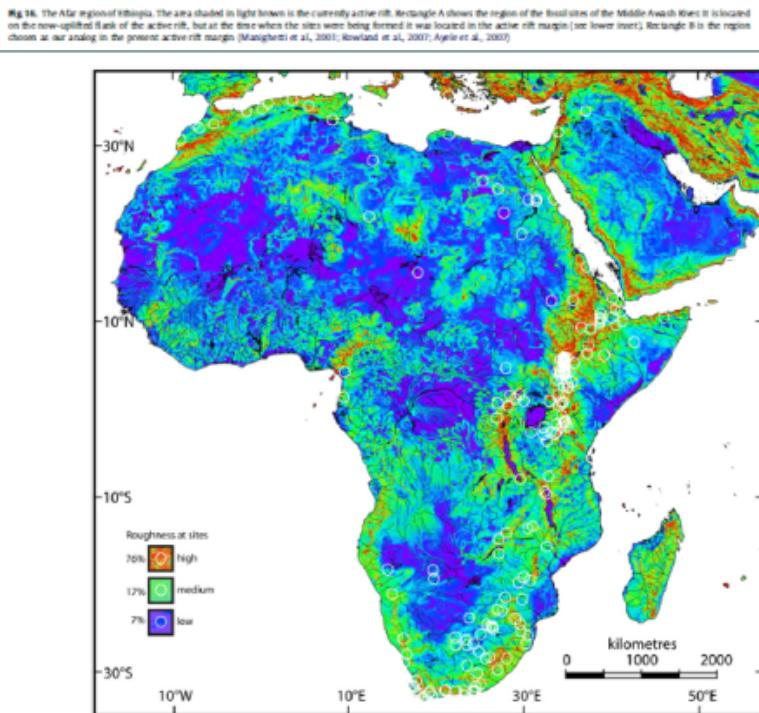
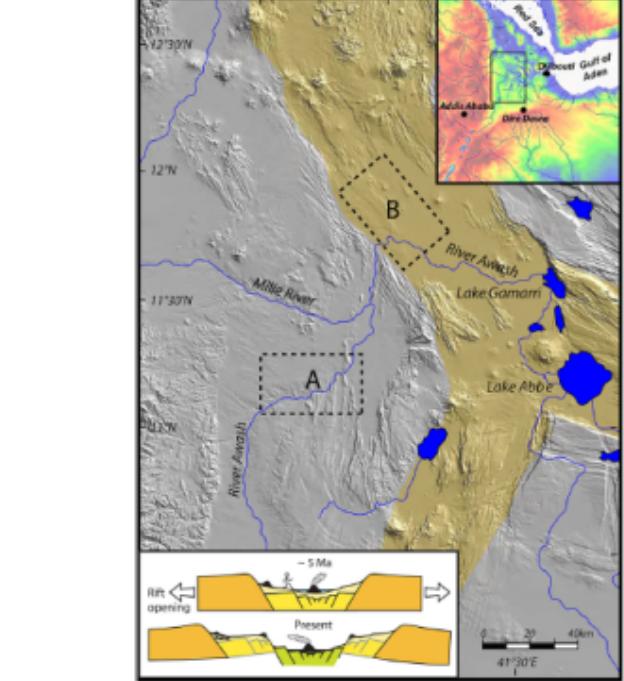
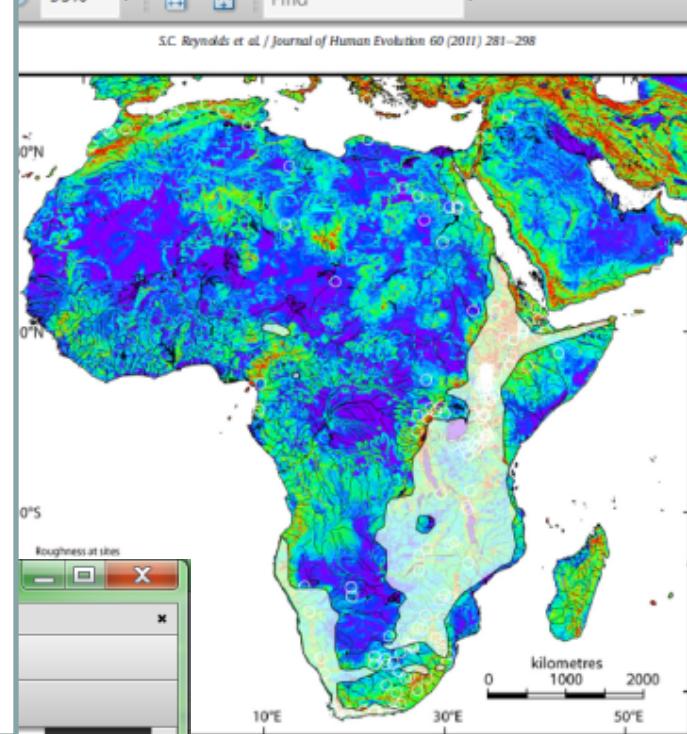
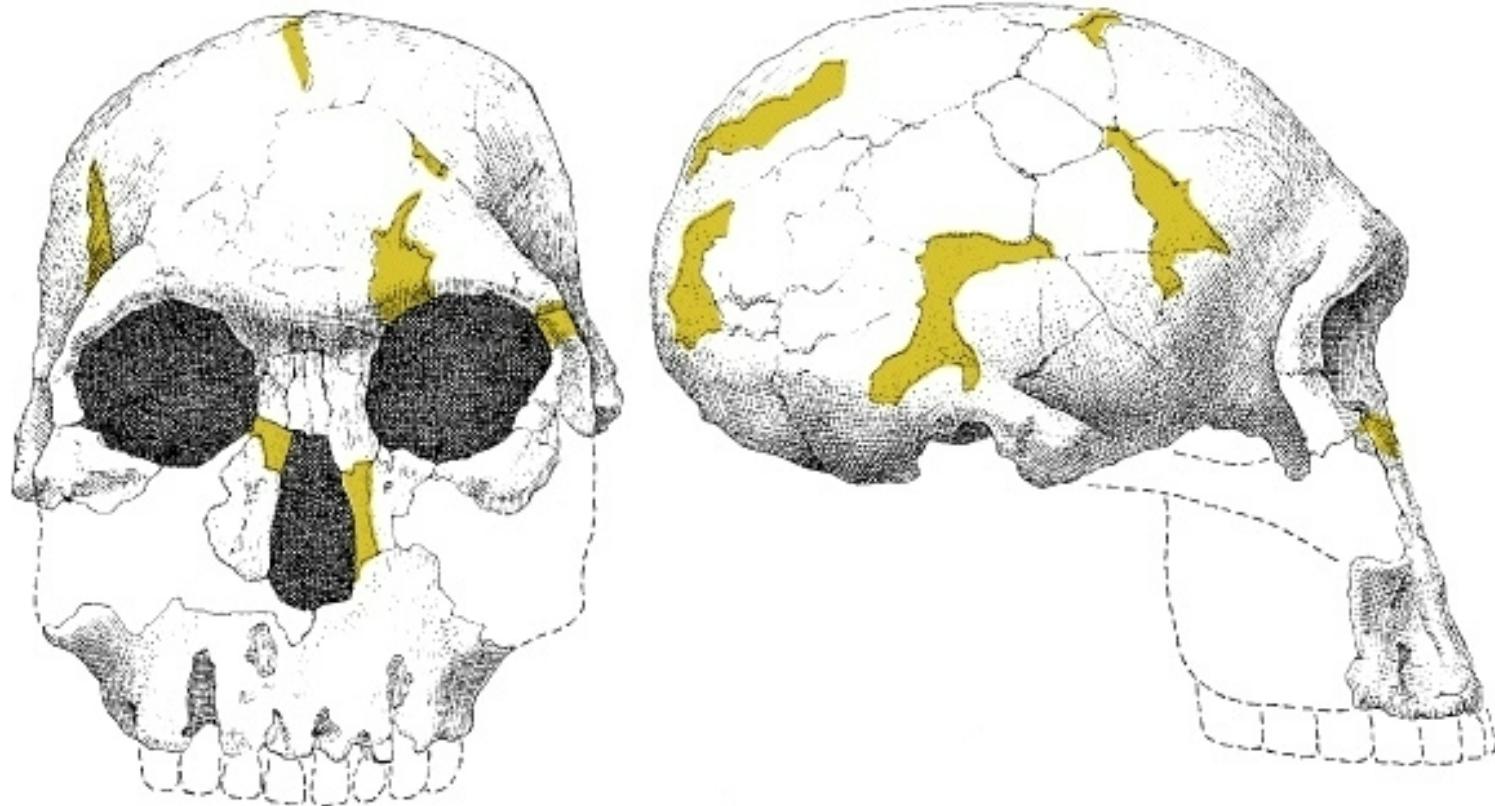


Figure 4. Regions characterized by tectonic roughness, as explained in Bailey et al. (2011), and the location of early hominid sites appear closely correlated.

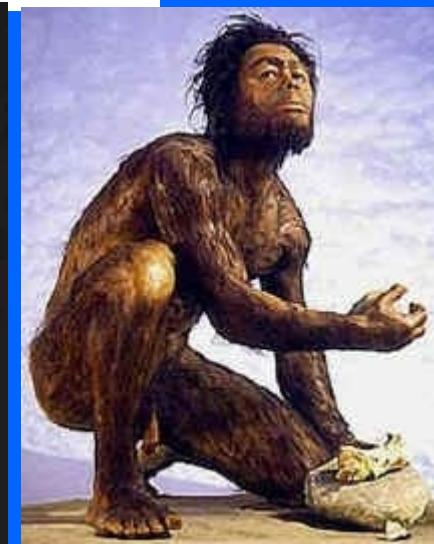
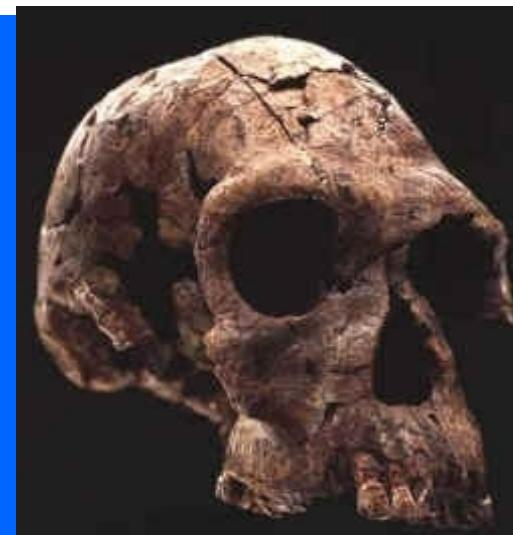


here the lighter areas indicate the present-day habitat of the klipspringer (*Oreotragus oreotragus*). This species prefers safety in volcanically active regions (Estes, 1991). In this respect, the present distribution follows the pattern of (2006) and Bailey et al. (2011).

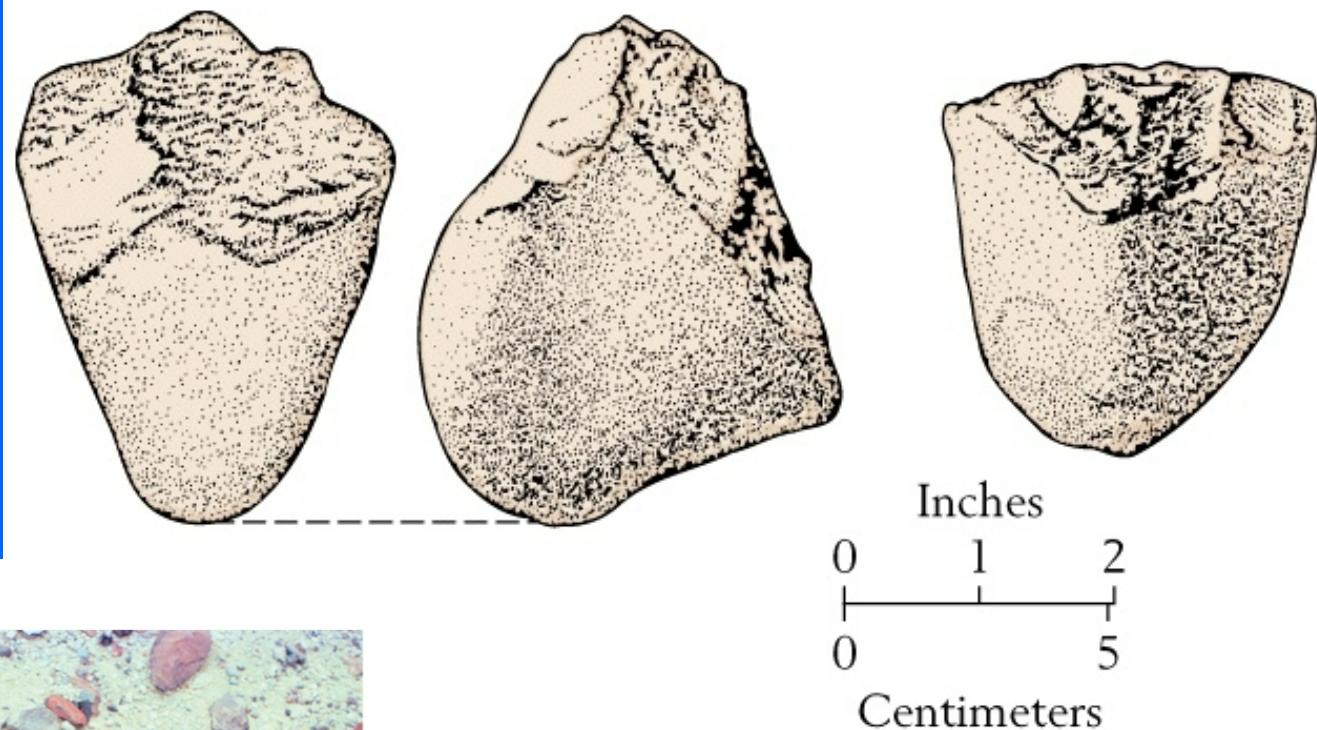
# Early hominids like unstable ground



***Homo habilis***



# Stone tools

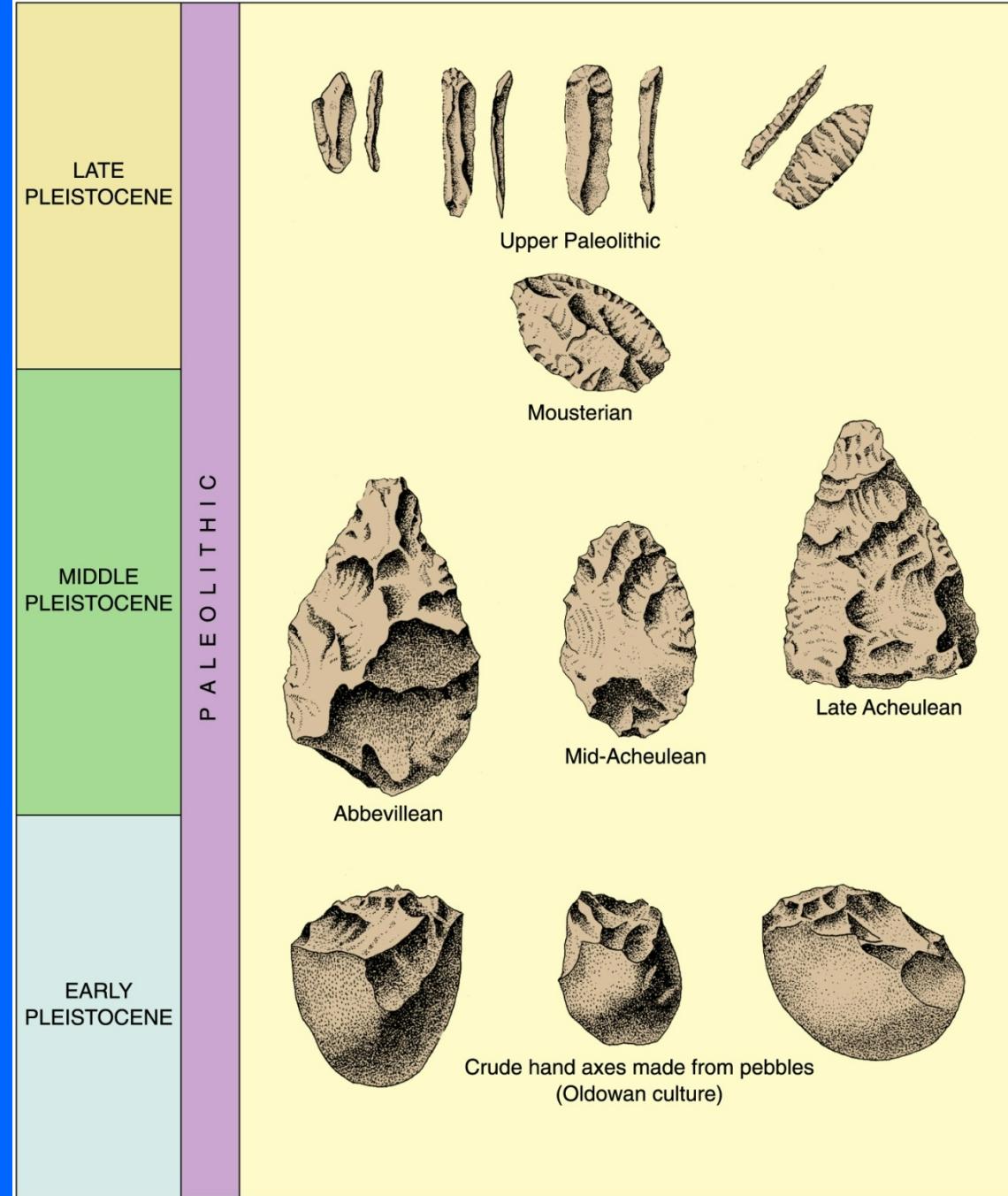


Track  
hominids by  
trash

Still can

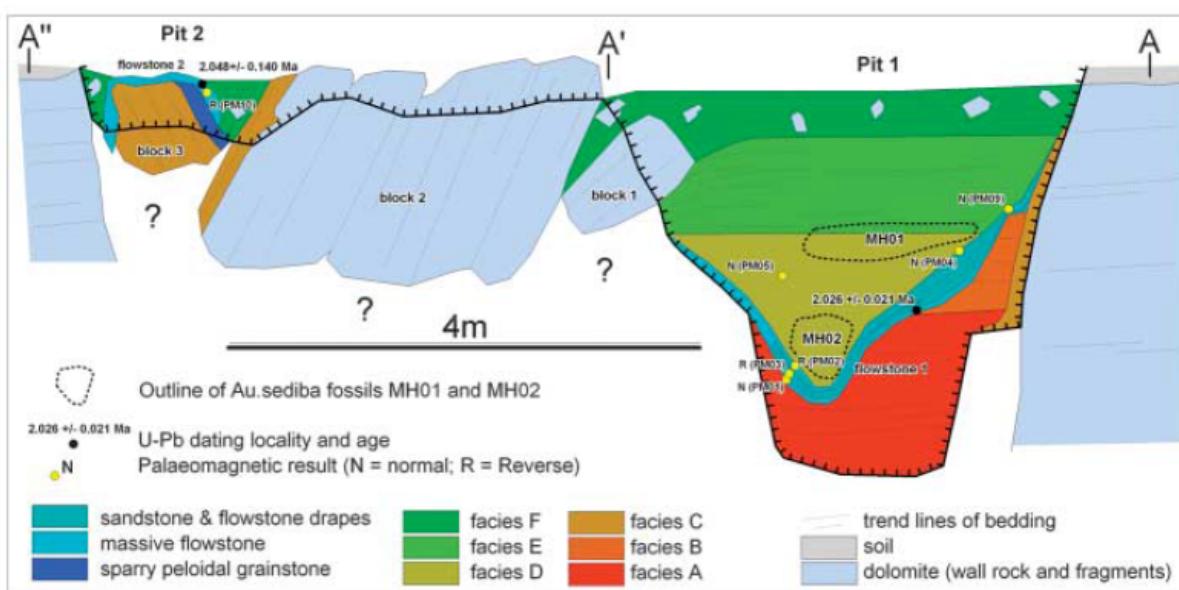


# Progressive improvement in making tools from stone during the Pleistocene



# But.....Sept 2011

- *Australopithecus sediba*, a primitive hominin that existed around the same time early *Homo* species first began to appear on Earth. The new *Au. sediba* findings make it clear that this ancient relative displayed both primitive characteristics as well as more modern, human-like traits. And due to this "mosaic" nature of the hominin's features, researchers are now suggesting that *Au. sediba* is the best candidate for an ancestor to the *Homo* genus.



**Fig. 2.** A NE-SW cross-section sketch map through the Malapa site showing the distribution of sedimentary facies, position of hominin fossils, and U-Pb and palaeomagnetic sample locations, together with U-Pb ages and normal and reversed polarities as reported in this paper and in (3). The sample locations of the dating and paleomagnetic samples have been projected onto the section within their correct stratigraphic position.



**Fig. 1.** *Au. sediba* MH2 right hand. Palmar (left) and dorsal (right) views of all MH2 right hand bones found in association with the right upper limb. Features of the MH2 hand traditionally considered primitive or australopith-like are labeled in gray (palmar view), and features considered derived are labeled in white (dorsal view) [2, 3, 5, but see (14)]. The thumb is pictured in opposition, overlapping with the second metacarpal.

Oddly, *A. sediba*'s grip appears to have been more humanlike than that of the larger-brained and bigger-bodied *Homo habilis*, which is widely considered to be the earliest known member of the genus *Homo*.

However, the *A. sediba* fossils are about 300,000 years younger than an upper jaw, discovered by anthropologist William Kimbel, that's thought to belong to a species of *Homo*, possibly *H. habilis*. Still, Berger and his team think it's possible *A. sediba* gave rise to the *Homo* genus.

The researchers suggest the Malapa specimens could have been younger remnants of an enduring species that gave rise to *Homo* at an earlier date.

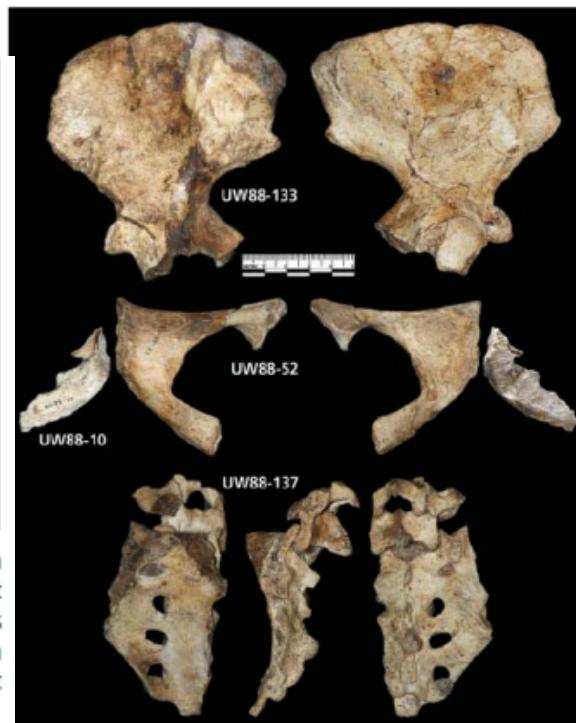
Alternatively, *H. habilis* may have represented a failed side branch of the human family tree, and it was actually *A. sediba* that was the direct ancestor of *Homo erectus*, the species widely regarded as the immediate forerunner of modern humans, *Homo sapiens*.

[http://news.nationalgeographic.com/news/2011/09/110908-apes-humans-evolution-australopithecus-sediba-lee-berger-science/?source=link\\_fb20110908news-humanancestortwist](http://news.nationalgeographic.com/news/2011/09/110908-apes-humans-evolution-australopithecus-sediba-lee-berger-science/?source=link_fb20110908news-humanancestortwist)

**Fig. 1. (Top)** Coxal remains of MH2 in internal (left) and external (right) perspectives. **(Bottom)** MH2 sacrum in ventral (left), lateral (center), and dorsal (right) views. Portions of the pedicles and laminae of the ultimate and penultimate lumbar vertebrae are cemented by matrix to the superior portion of the bone (removed by virtual preparation, fig. S4). Scale bars in centimeters.



**Fig. 2.** Comparison of the MH1 (left), Sts 14 (center), and MH2 (right, mirror-imaged) pelvises in anteroinferior (top row) and anterosuperior (bottom row) views. Areas represented in white or light gray in the MH1 and MH2 pelvises represent reconstructed portions of the pelvis (SOM text S1). Sts 14 is attributed to *Au. africanus* and is represented by the virtual reconstruction of (41). Scale bar in centimeters [note that the anterosuperior view of Sts 14, as provided by (41), is in a slightly different orientation than those of MH1 and MH2]. An additional comparison is provided in fig. S7.





A team of paleoanthropologists makes the case that the fossil remains of *Australopithecus sediba* could be the direct evolutionary link to the *Homo* genus.

***Australopithecus afarensis (Lucy)***

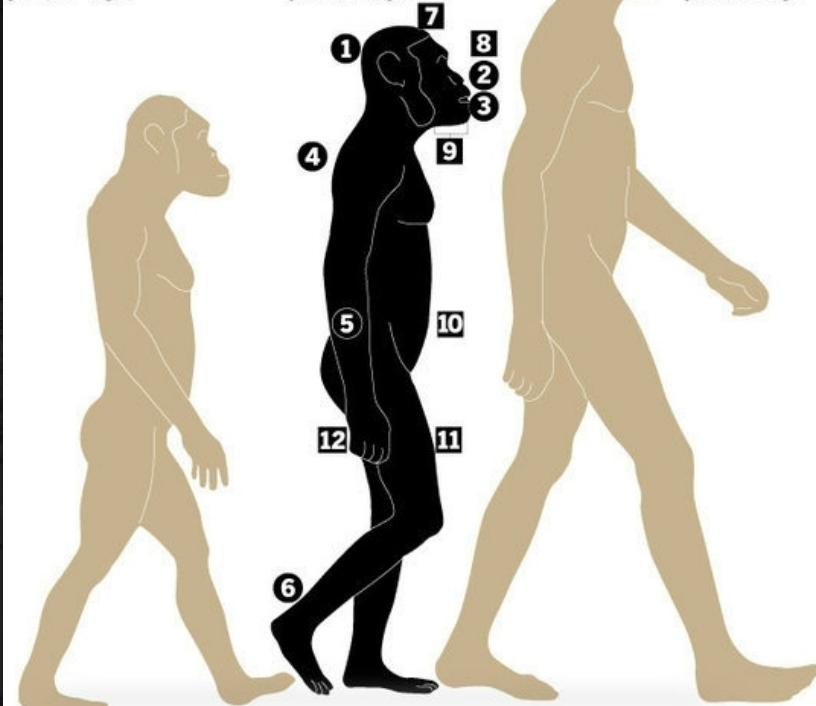
3.2 million years ago

***Australopithecus sediba***

1.95 million years ago

***Homo erectus***

1.6 million years ago



● Similarities with *Australopiths*

- 1 Small brain size
- 2 Long, high cheekbones
- 3 Primitive molar cusps
- 4 Small body size
- 5 Long upper limbs
- 6 Primitive heel bone

■ Similarities with *Homo*

- 7 Reorganized front brain
- 8 Projecting nose
- 9 Smaller teeth and chewing muscles
- 10 Hips less flared (similar to humans)
- 11 Longer legs
- 12 Hand with precision grip

Sources: National Geographic, University of the Witwatersrand, Texas A&M University, Science

# So now the view of the genus *Homo* a bit murky



TODAY

#### THE VIEW FROM MALAPA

Lee Berger's team suggests that the clearest line to *Homo* links *A. sediba* directly to *H. erectus*. If true, more primitive East African *Homo* fossils would represent a lineage that went extinct.

1 MILLION YEARS AGO (M.Y.A.)

*Australopithecus boisei*  
East Africa

*A. robustus*  
South Africa

2 M.Y.A.

*A. aethiopicus*  
East Africa

3 M.Y.A.

*A. africanus*  
South Africa

4 M.Y.A.

*A. afarensis*  
East Africa

*A. anamensis*

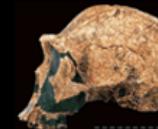
*Ardipithecus ramidus*  
Ethiopia

**PROPOSED VIEW OF HOMO ORIGINS**



*H. heidelbergensis*  
Old World

*H. neanderthalensis*  
Europe and Middle East



*H. erectus*  
Old World



*H. habilis*  
East Africa

*H. rudolfensis*  
East Africa

Hadar jaw  
Ethiopia



*Kenyanthropus platyops*  
Kenya

- *Homo*
- *Kenyanthropus*
- *Australopithecus*
- *Ardipithecus*

#### A CROWDED FIELD

Two or possibly three species assigned to *Homo* coexisted in East Africa around 1.8 million years ago. (Some researchers view a few *H. habilis* fossils as a separate species, *H. rudolfensis*.) Larger brained *H. erectus* eventually gave rise to our own species.



#### EARLIEST TRACES?

A few fragments older than the Malapa fossils, notably a jawbone from Hadar in Ethiopia, have been described as *Homo*—calling into question a link between *A. sediba* and our genus. But Berger's team has challenged both the age of these fossils and their assignment to *Homo*.

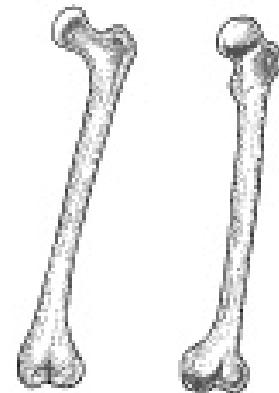
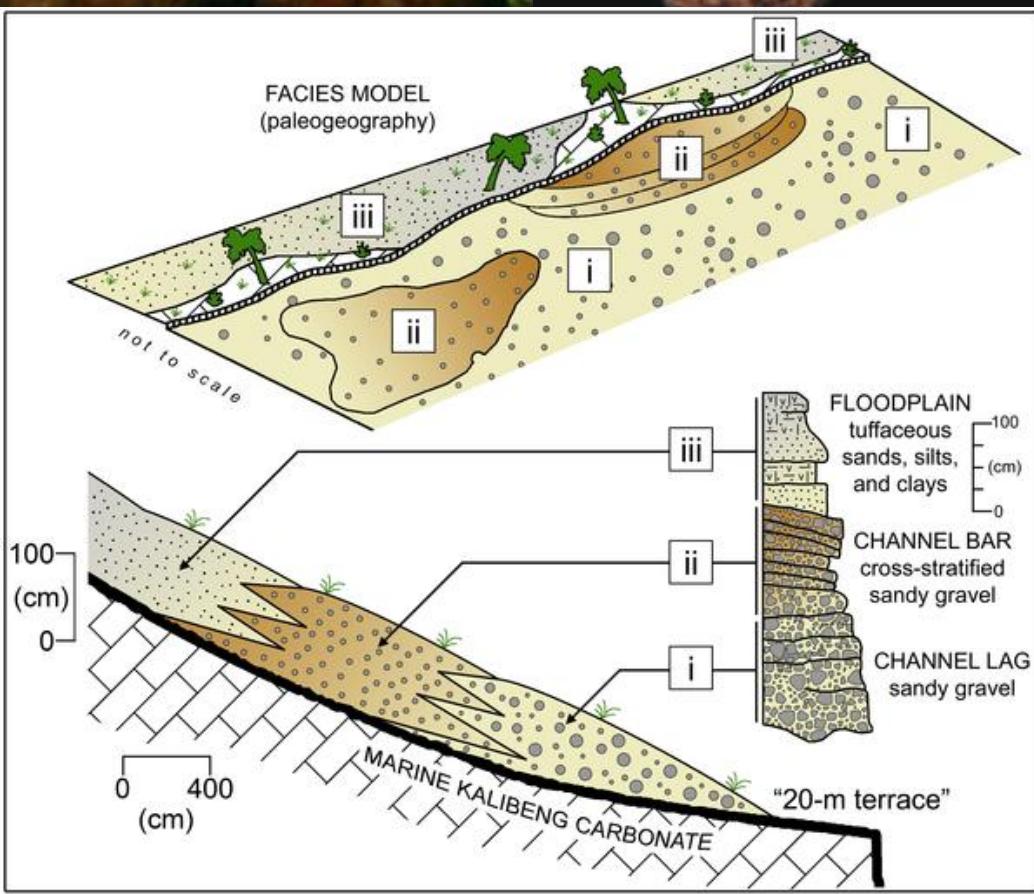
- VI. *Homo erectus* (upright man; 1.6 –0.3 mil yrs)**
- i. > brain size, 1000 cm<sup>3</sup> to our 1400 cm<sup>3</sup>
    - 1. Narrower pelvis (restricts)
  - ii. 1<sup>st</sup> to leave Africa for Eur, China, & Java
  - iii. More advanced tools
  - iv. 6' in height

**VII. In Eur. Evolved into *H. hiedelbergensis* (500,000 BP) that evolved into Neanderthals (200,000 to 32,000 BP)**

- i. A cold adapted species
  - 1. Short, stocky limbs
  - 2. Broad nose
  - 3. Larger skull but more sloped
- ii. Buried dead with ceremony
- iii. Stone knives
  - 1. Do not attach to wooden spears for hunting

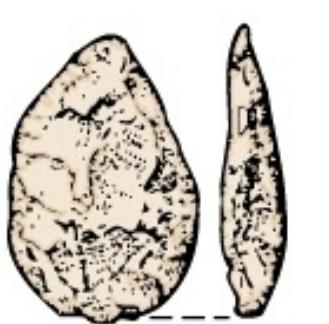
# *H. Erectus*

Bottom right shows extinct in Indonesia by at least 134000 BP

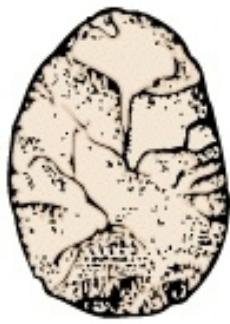


Bigger brains are needed for complex tools so takes time for razor sharp axes

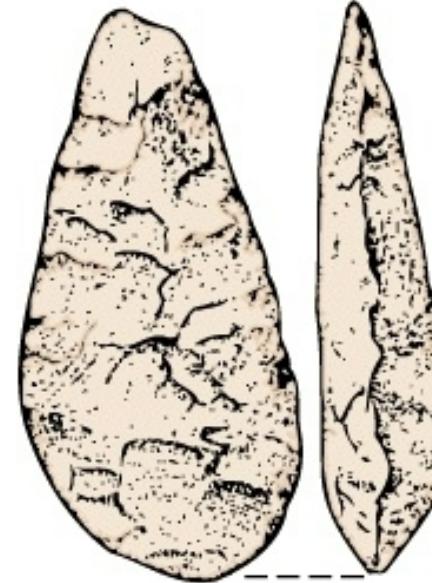
Inches  
0 1 2  
0 5  
Centimeters



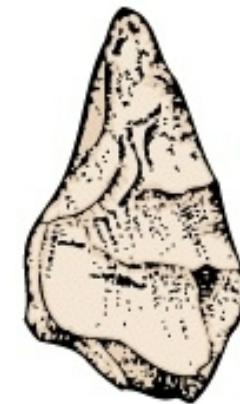
A



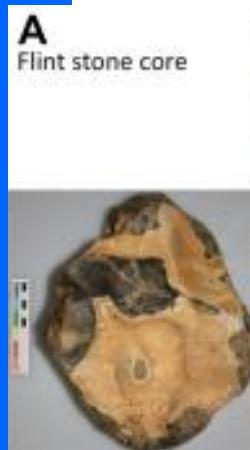
B



C



D



A  
Flint stone core

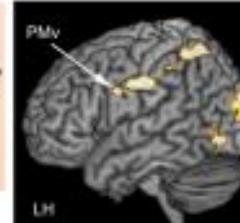


B  
Toolmaking



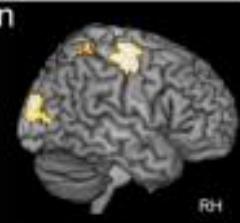
C  
Tool

Oldowan flake & core (ca. 2.5 Mya)



D

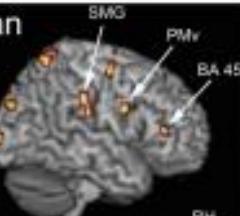
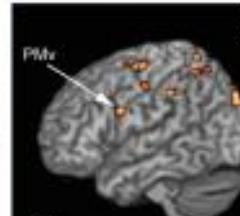
Brain activation during tool production  
Oldowan



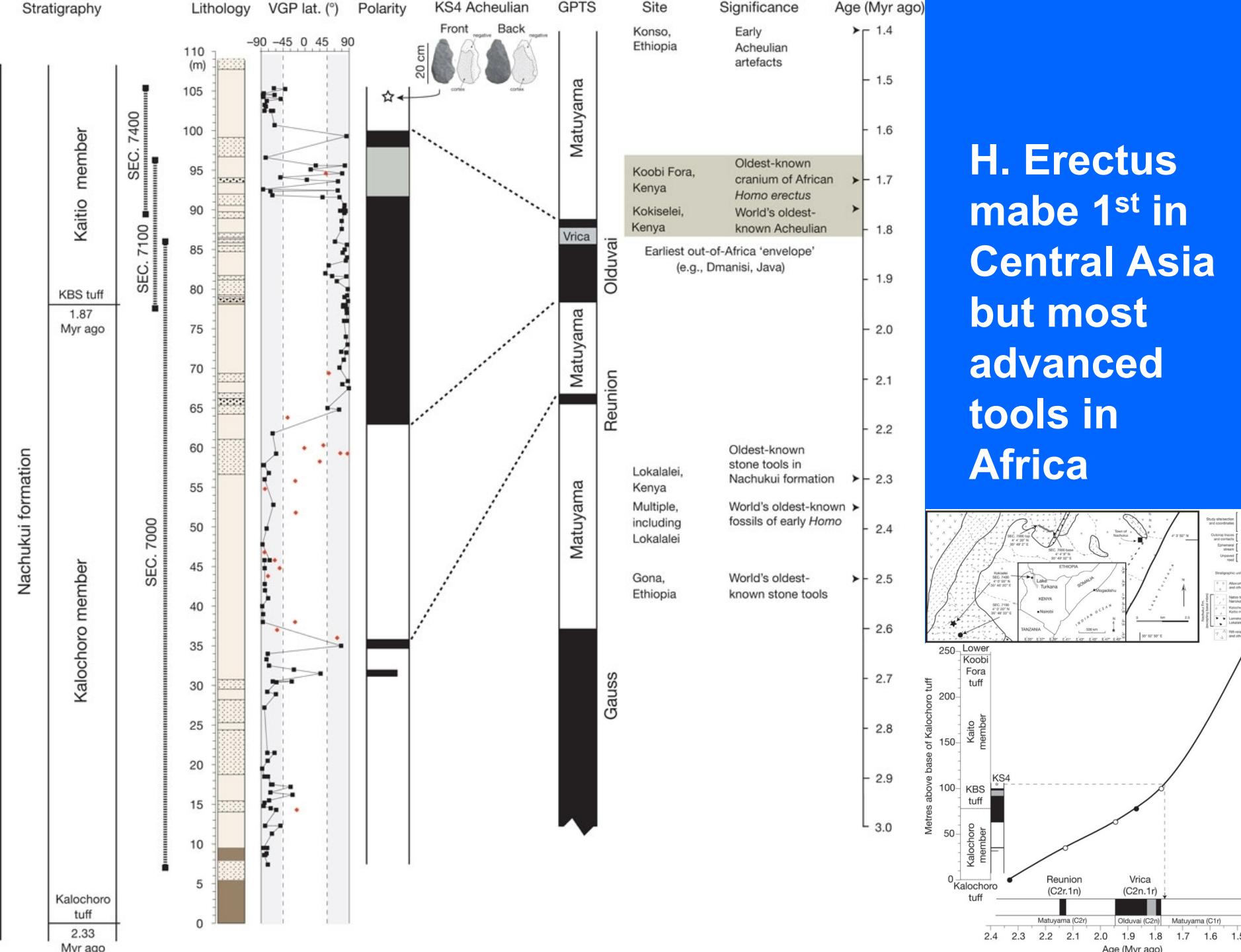
Acheulean



Acheulean handaxe (ca. 0.5 Mya)



SMG  
PMv  
BA 45





Russell L. Ciochon, Univ. of

[http://www.huffingtonpost.com/2013/01/01/peking-man-clothing\\_n\\_2390026.html?utm\\_hp\\_ref=science](http://www.huffingtonpost.com/2013/01/01/peking-man-clothing_n_2390026.html?utm_hp_ref=science)

**Peking Man (top)**  
**750k-200K in China**  
**Used tools to soften**  
**clothes and appears**  
**to have spear like**  
***Homo***  
***heidelbergensis***  
**(right images) from**  
**500k**



a 400k year old fragment of human lower jaw recovered from a Serbian cave is the oldest human ancestor found in this part of Europe.

-BH-1 differs significantly from Middle Pleistocene European hominins generally grouped under *Homo heidelbergensis*. It exhibits primitive features such as a prominent planum alveolare, thick mandibular corpus, wide exomolar sulcus, flat rather than concave sublingual fossa, and poorly defined relief of the submandibular fossa,

-There is a complete lack of derived Neandertal features... Given the size of the mandibular body, the dentition is relatively small, and fits well with Middle Pleistocene European specimens.

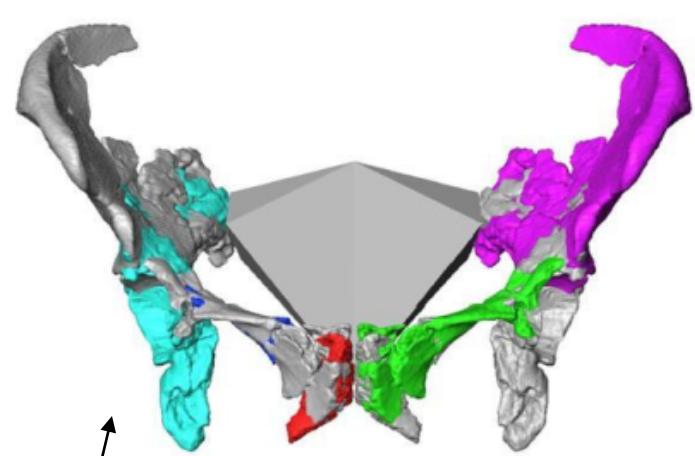
Humans in southeastern Europe were never geographically isolated from Asia and Africa by glaciers, this resulted in different evolutionary forces acting on early human populations in this region.

Dr Mirjana Roksandić of the University of Winnipeg, Canada.

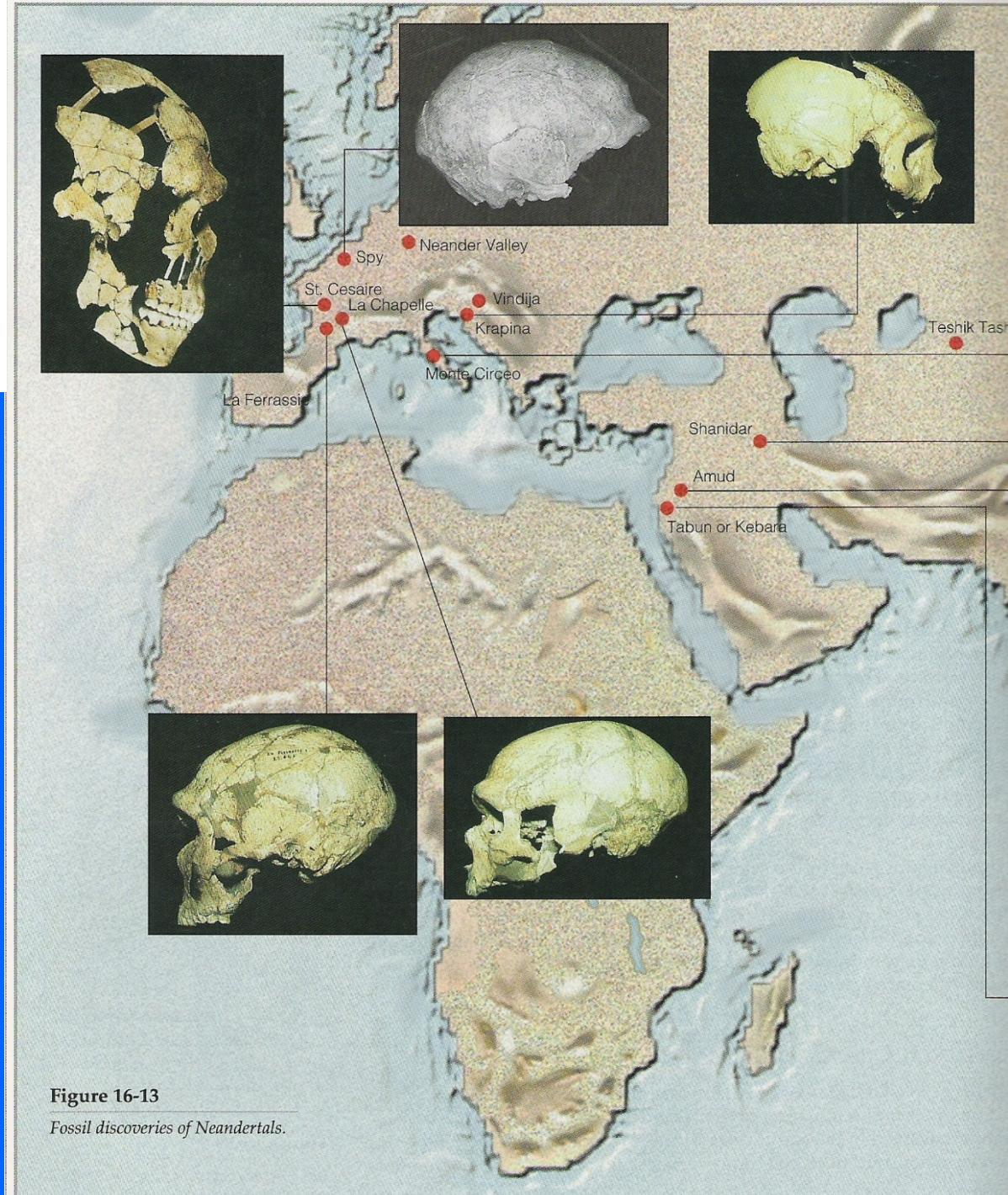
"We have very few fossils of hominins in general from this time, a period that was critical for shaping the appearance and evolution of uniquely human morphology and behaviors," she said

<http://www.sci-news.com/othersciences/anthropology/article00874.html>



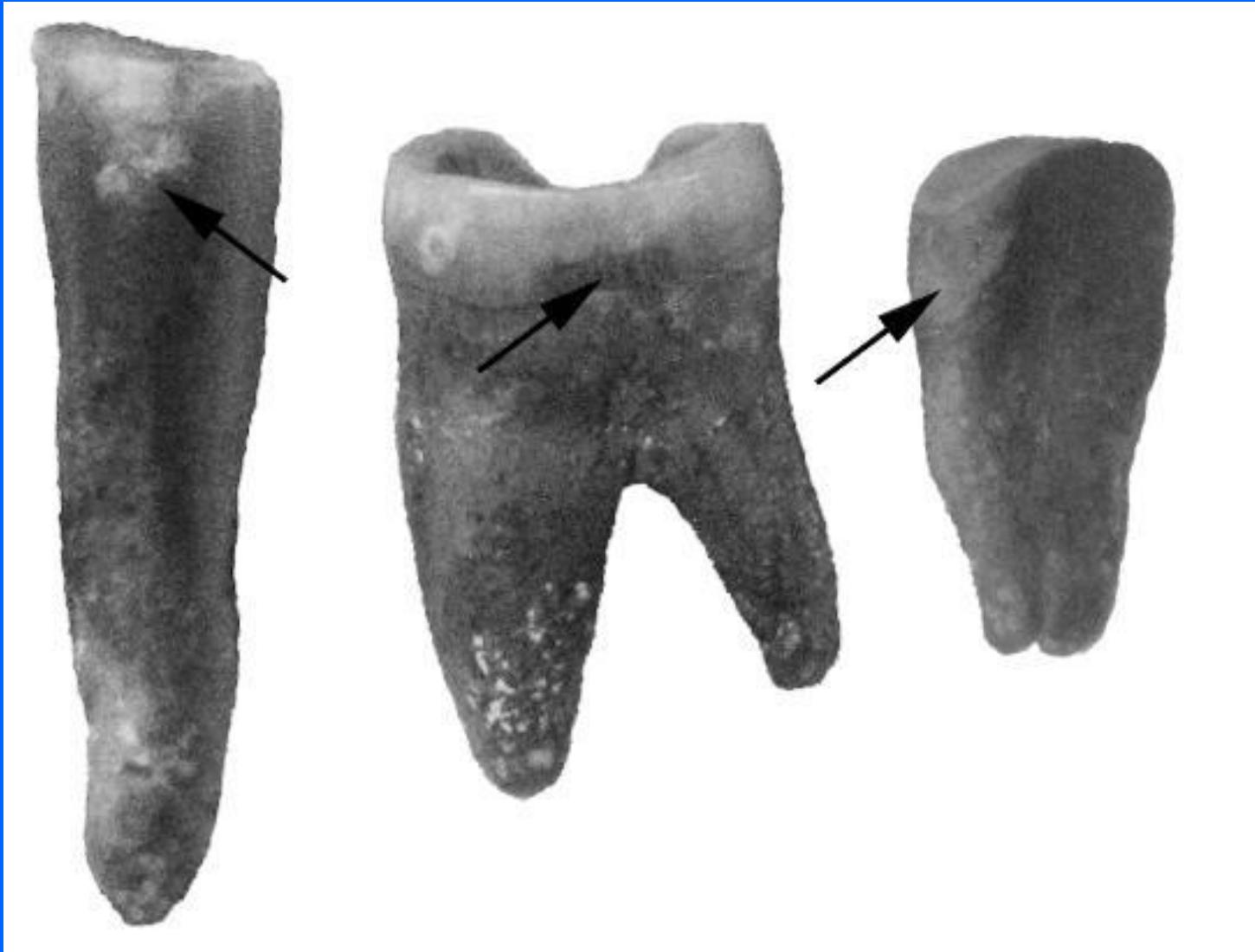


Although the size of Tabun's reconstructed birth canal shows that Neanderthal childbirth was about as difficult as in present-day humans, the shape indicates that Neanderthals retained a more primitive birth mechanism than modern humans (other apes).



# Neanderthal teeth show wear from meat and vegetation indicating balanced diet

<http://www.sciencedaily.com/releases/2010/12/101230113723.htm>

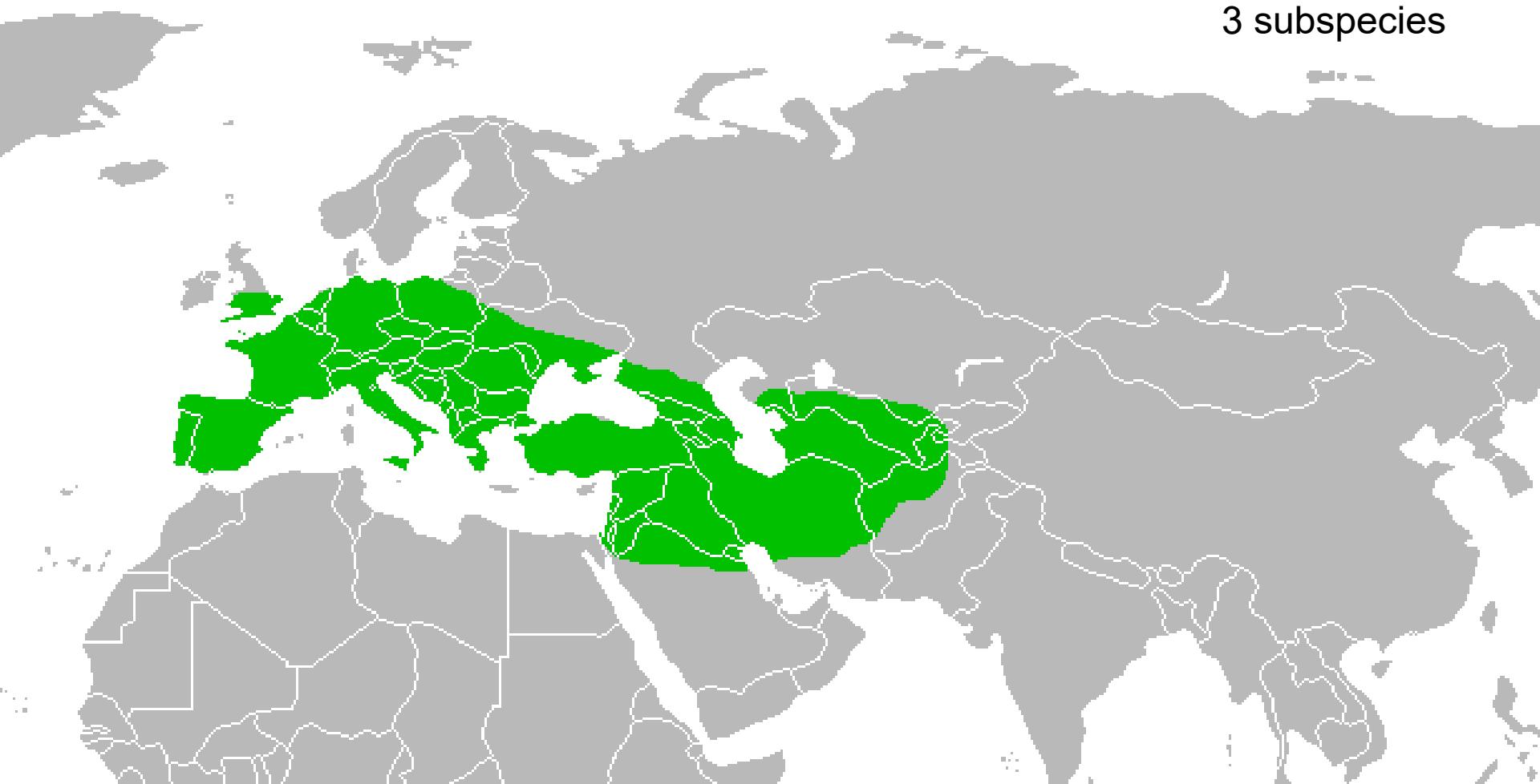


# Range of Neanderthals

- Remember often Ice Cap over Europe



3 subspecies



Lots of  
decorations  
on  
Neanderthal  
s



Mauricio Antón

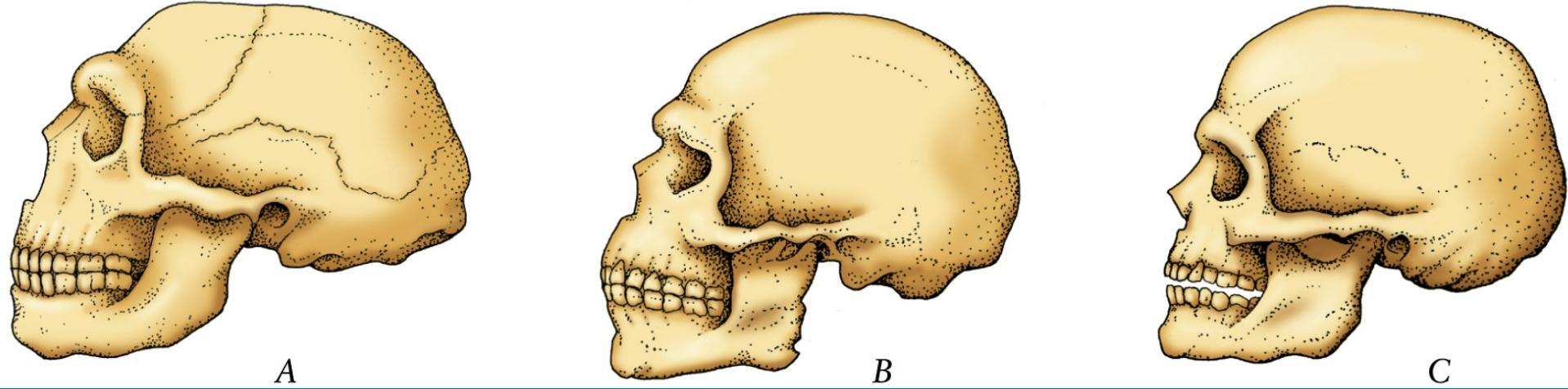


Mauricio Antón

Although Neanderthals' brains were similar in size to their contemporary modern human counterparts, but studies imply that larger areas of the Neanderthal brain, compared to the modern human brain, were given over to vision and movement and this left less room for the higher level thinking required to form large social groups.

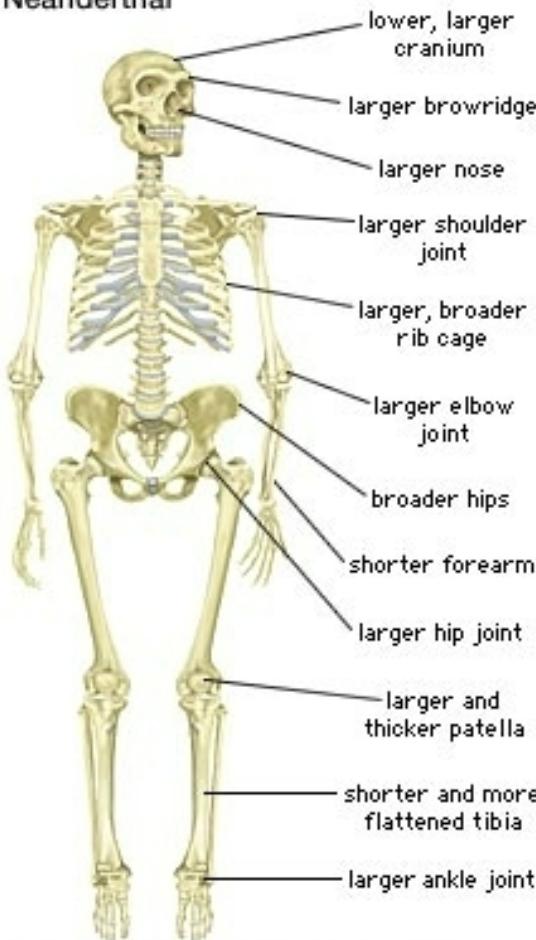


- *The La Ferrassie 1 (Neanderthal) and Cro-Magnon 1 (early modern) skulls. (Credit: © Chris Stringer/Musée de l'Homme Paris)*



**Comparison of skulls.** (A) Neanderthal; (B) skull from a rock shelter on the slope of Mount Carmel that appears to show both Neanderthal and Cro-Magnon features; and (C) Cro-Magnon. The Mount Carmel skull is intermediate in both form and age between Neanderthal and Cro-Magnon.

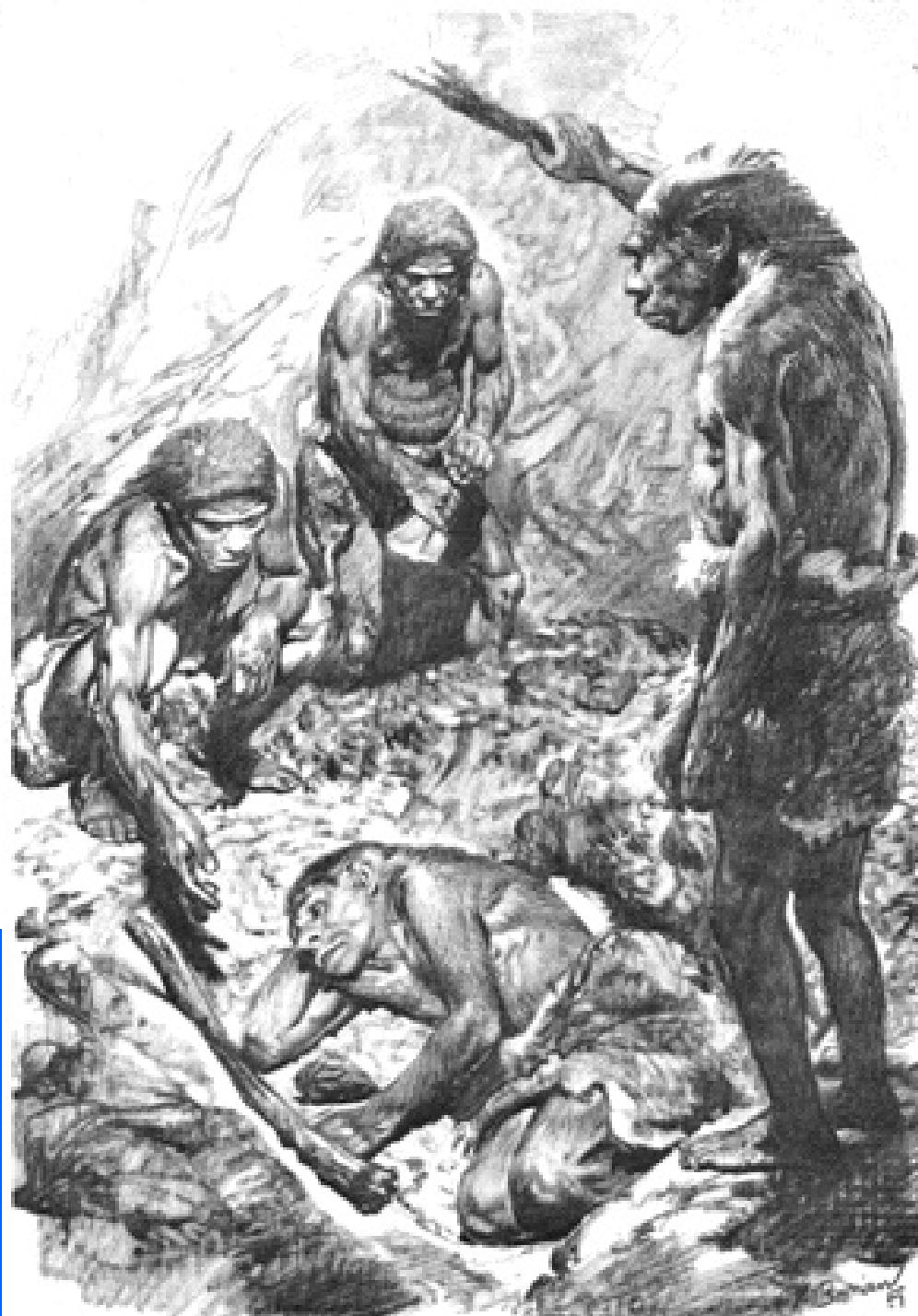
### Neanderthal



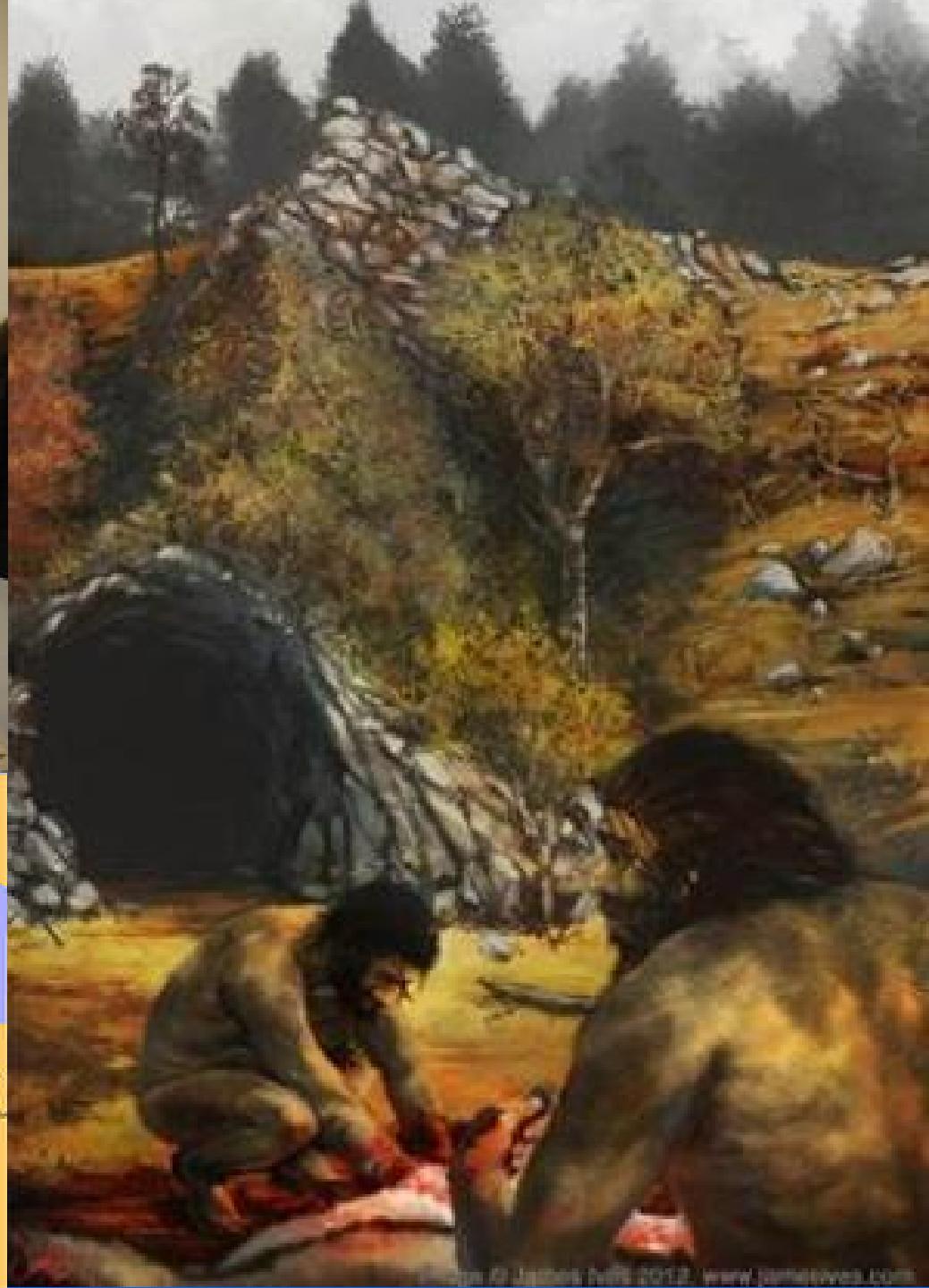
© 2004 Encyclopædia Britannica, Inc.



### modern human



# DNA extraction and Nean derth als fossil sites



2. Unlikely due to shoulder if could throw overhand, likely killed prey in close
- iv. Cared for sick & injured
- v. Unknown if can talk, different throat structure
- vi. Lived in small family grps

### *VIII. H. sapiens*

- i. 1<sup>st</sup> in Africa? (~100,000 BP)
- ii. Grps of 30-50 +
- iii. Spread to Middle East 90,000 BP (or sooner?) but replaced by Neanderthals 60,000 BP
- iv. By 35,000 BP to Eur, Asia & Australia

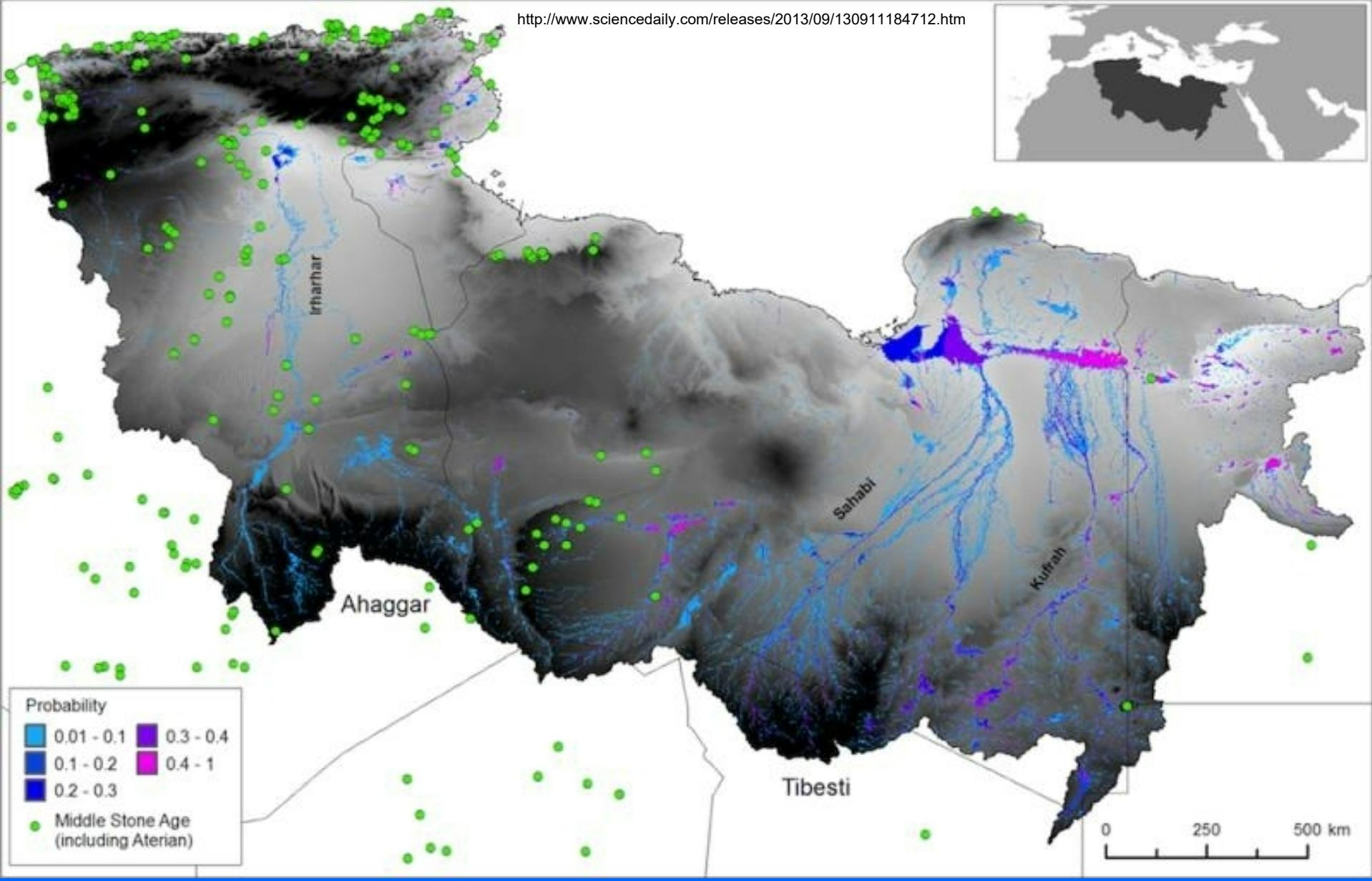
1. In Eur. Cro-Magnum man
  - a. Ave 6'4" males
  - b. Used bow & arrows, spear tips
  - c. Cave paintings



Human hand left, Neanderthal right

3 major river systems that likely existed in North Africa 130,000-100,000 years ago, but are now largely buried by dune systems in the desert. When flowing, these rivers likely provided fertile habitats for animals and vegetation, creating 'green corridors' across the region. At least one river system is estimated to have been 100 km wide and largely perennial. The Irharhar river, westernmost of the three identified, may represent a likely route of human migration across the region. In addition to rivers, simulations predict massive lagoons and wetlands in northeast Libya, some of which span over 70,000-square kilometers.

<http://www.sciencedaily.com/releases/2013/09/130911184712.htm>



# AN EARLY TREK FROM AFRICA

Teeth discovered in southern China suggest that *Homo sapiens* reached Asia between 80,000 and 120,000 years ago.



Teeth in China  
100000 BP

Not sure when  
humans  
migrated out but  
now looks like  
before 100,000  
BP



# Humans continued

- d. Transported shells 100s mi from coast
- e. Viewed according to politics & times
- f. Genetic evidence linking to Neanderthals about 2% in European pop
- g. But over 90% right handed like us



Migration of modern humans into Europe, based on simulation by Currat & Excoffier (2004)<sup>[19]</sup>

(YBP=Years Before Present)

Up to 37 500 YBP



Up to 35 000 YBP



Up to 32 500 YBP

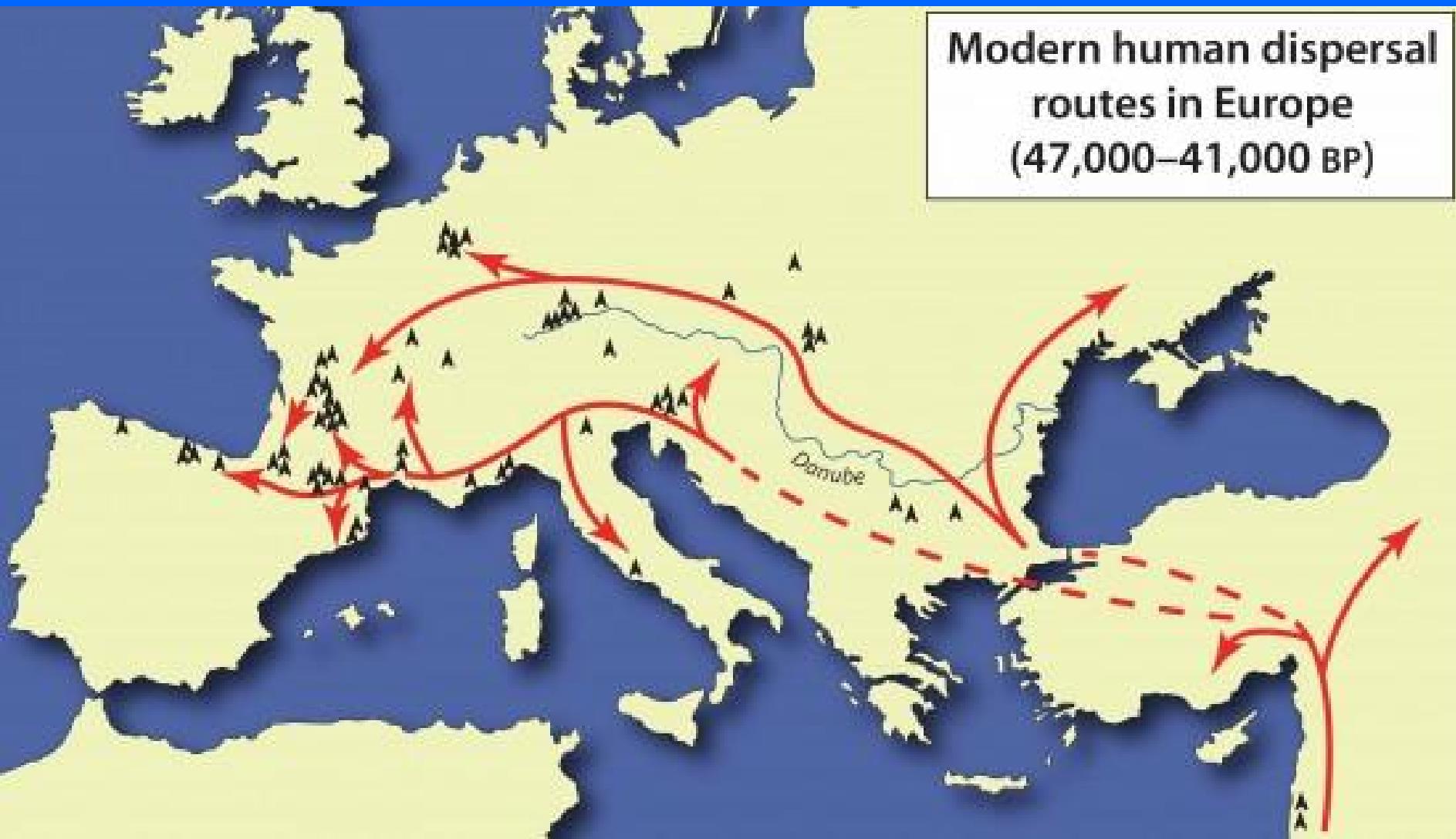


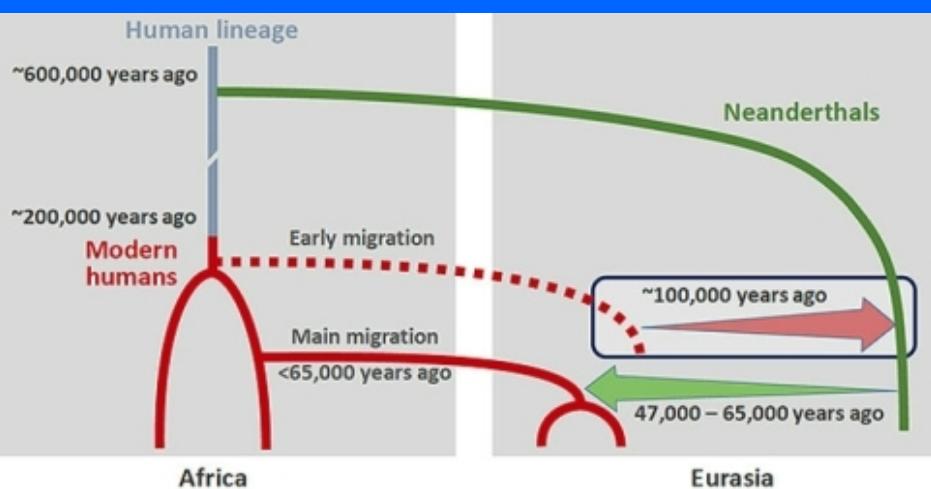
Up to 30 000 YBP



Researchers from the University of Cambridge have discovered that modern humans coming from Africa swarmed the region, arriving with over ten times the population as the Neanderthal inhabitants.

<http://www.sciencedaily.com/releases/2011/07/110728144928.htm>





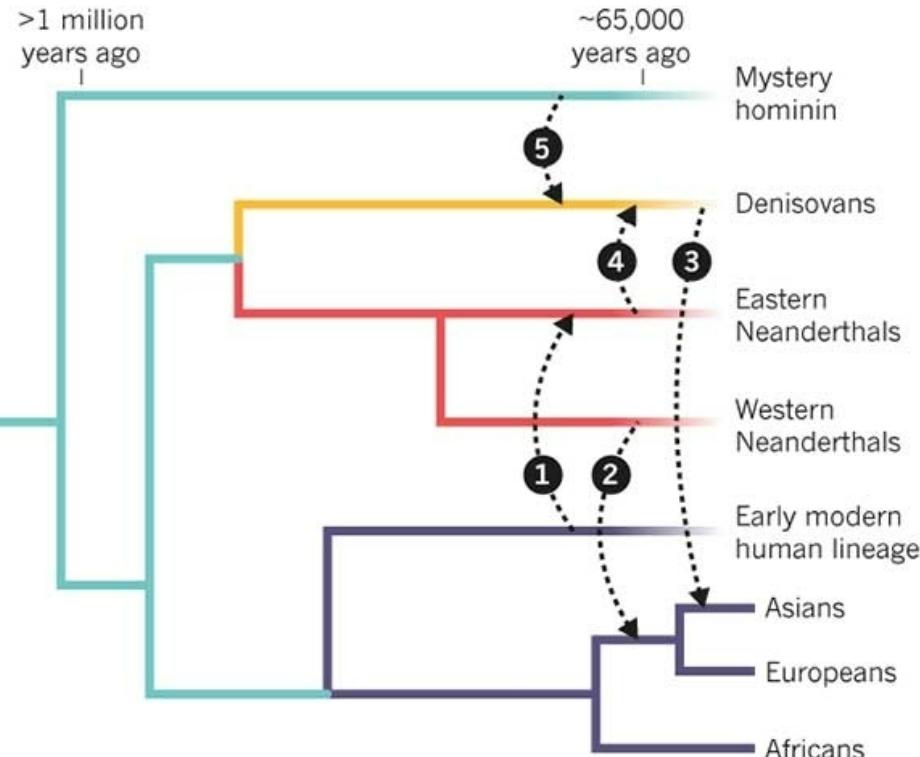
# Mixing

## Mixed toe



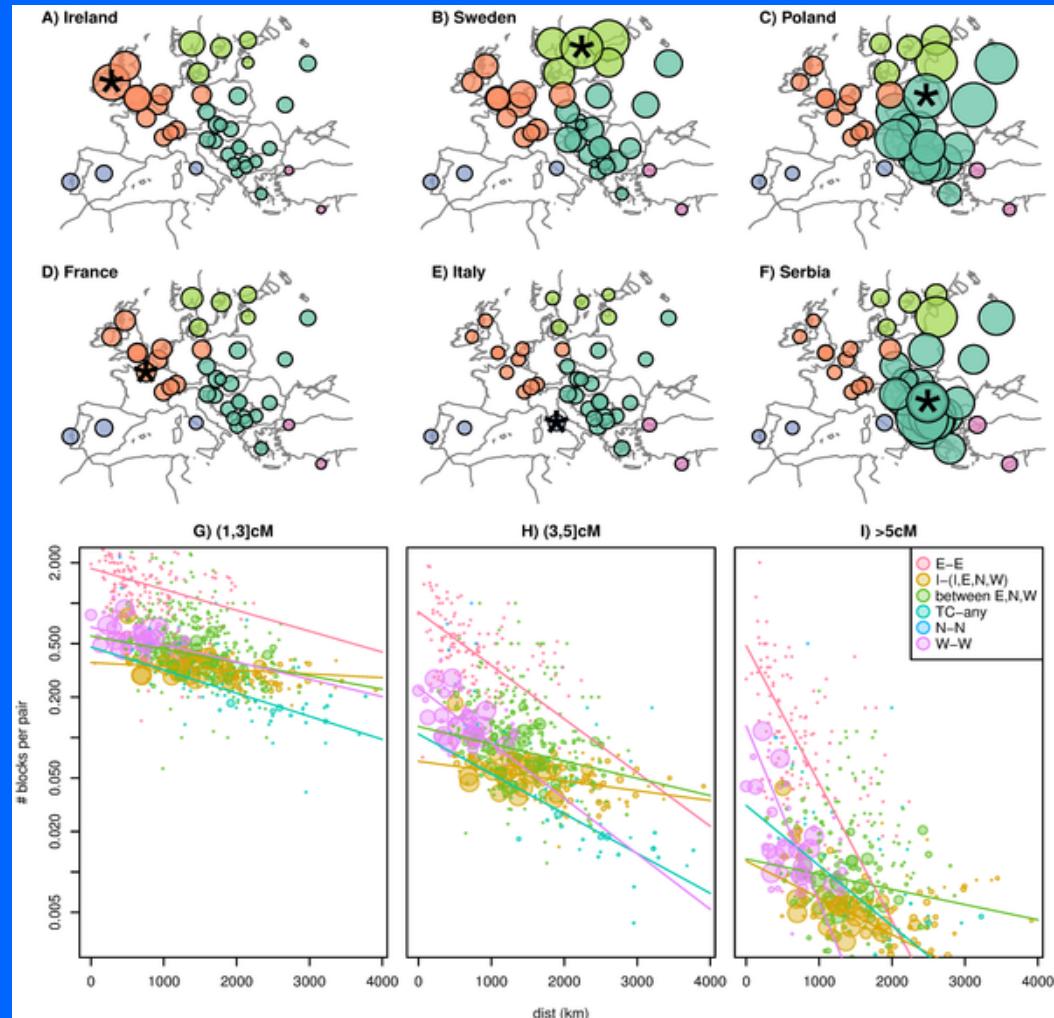
## A HISTORY OF INTERBREEDING

Early modern humans, Denisovans, and Neanderthals all interbred with each other on multiple occasions in the past 100,000 years.



# Geographic decay of recent relatedness.

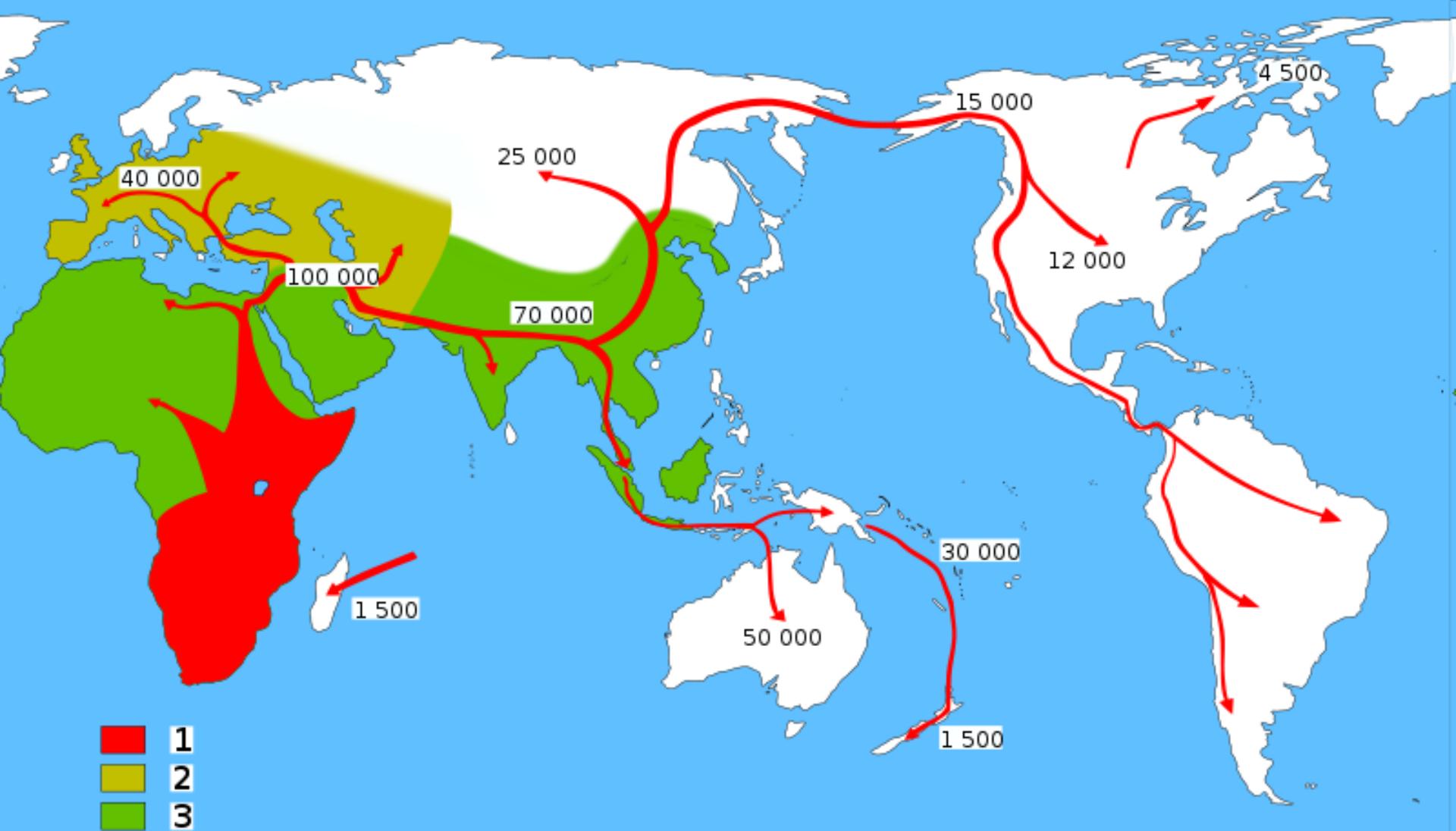
All European populations today from UK to Turkey share a relative from no more than 1000 years ago



Ralph P, Coop G (2013) The Geography of Recent Genetic Ancestry across Europe. PLoS Biol 11(5): e1001555.  
doi:10.1371/journal.pbio.1001555

<http://www.plosbiology.org/article/info:doi/10.1371/journal.pbio.1001555>

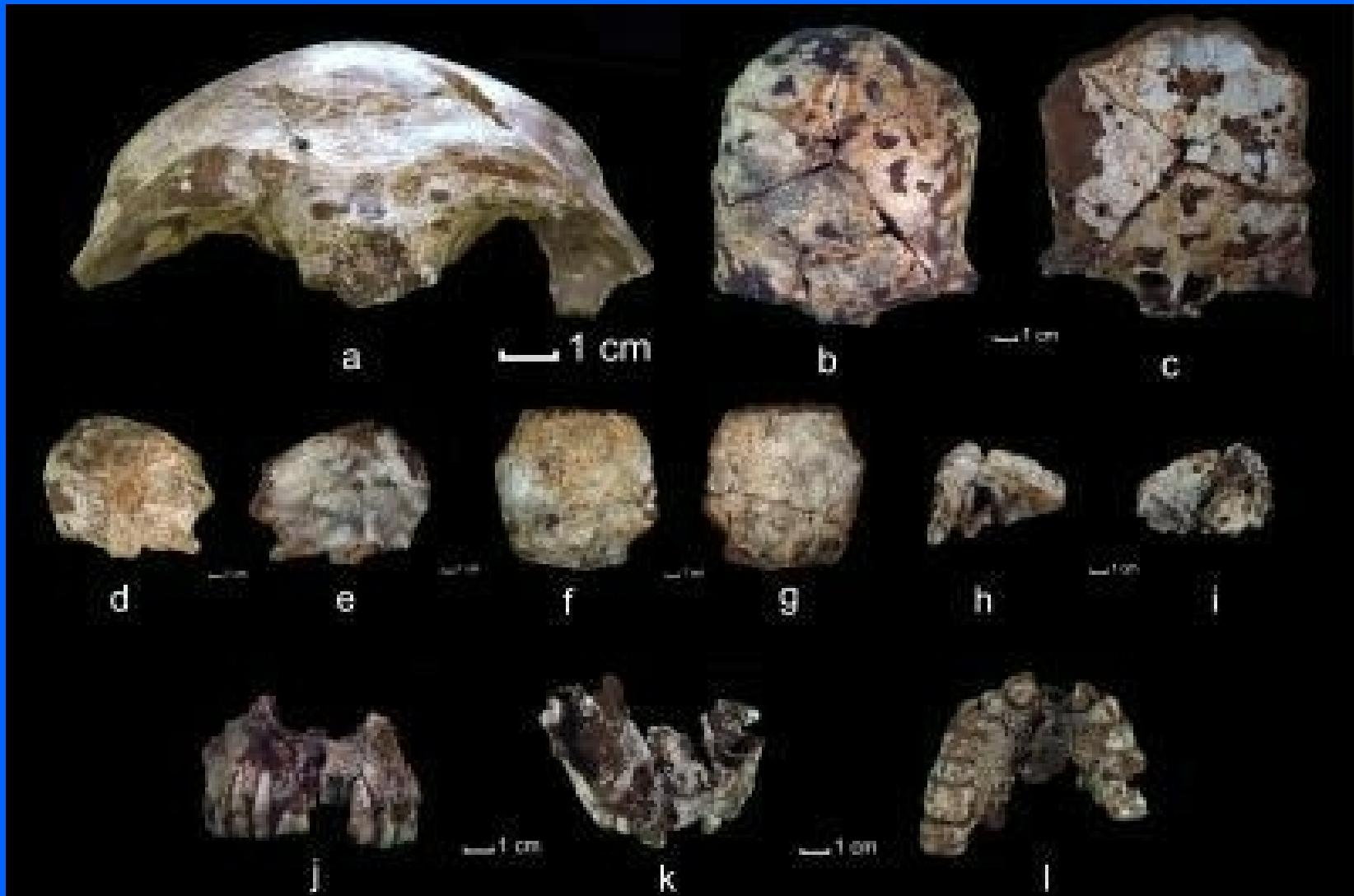
# Maybe sooner? Through Eurasia



Why head east before north from Africa?

# 63000 BP modern human skull fragments found in Laos cave

<http://www.sciencedaily.com/releases/2012/08/120820152204.htm>



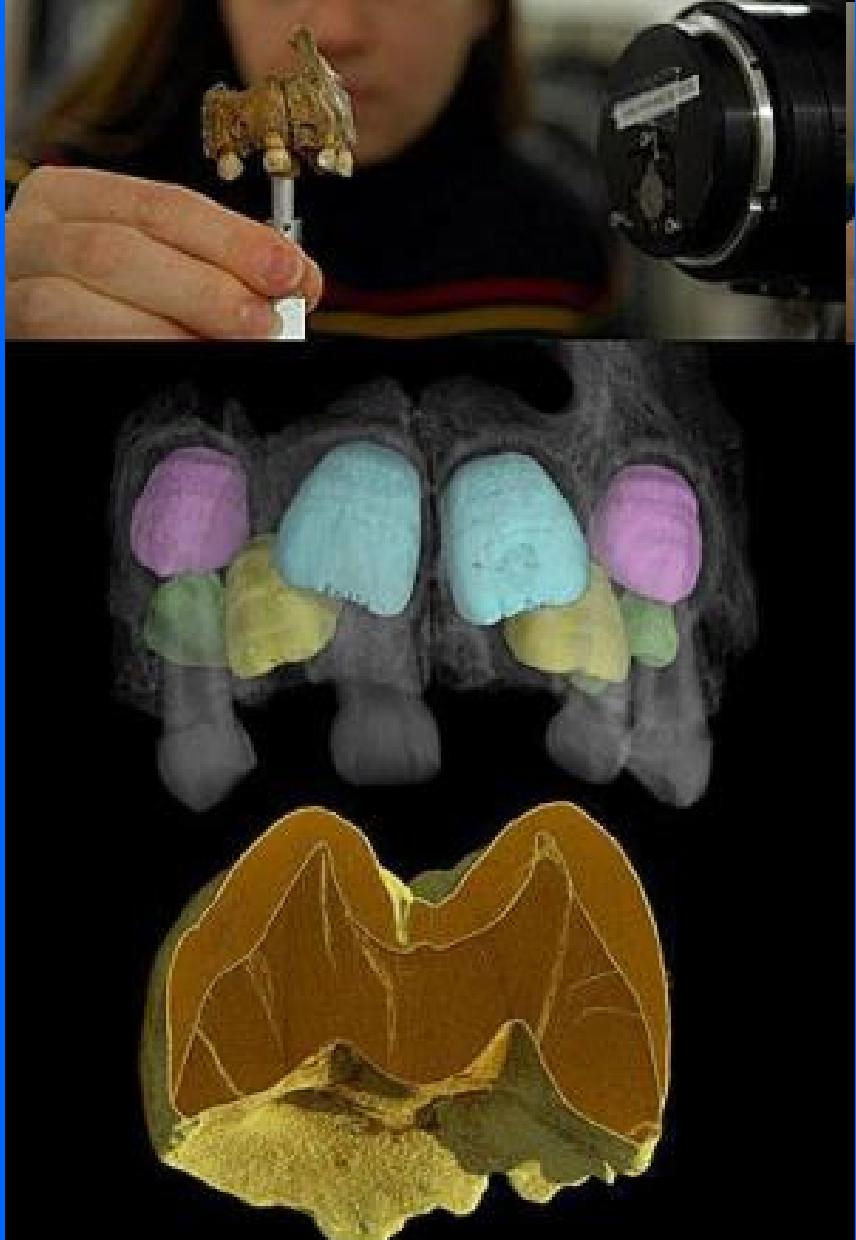
The leg of the early modern human from Tianyuan Cave was used for the genetic analysis as well as for carbon dating. (Credit: MPI for Evolutionary Anthropology)

40K-50K bone DNA is likely ancestral to Asians and American Indians <http://www.sciencedaily.com/releases/2013/01/130121161802.htm>



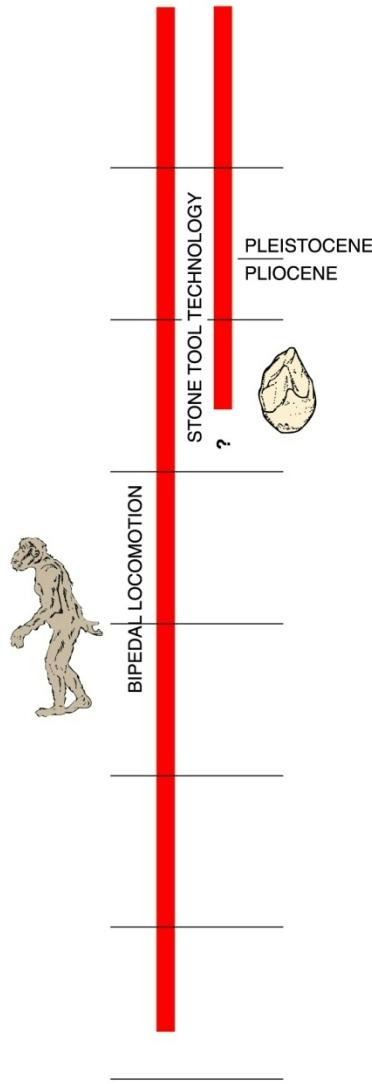
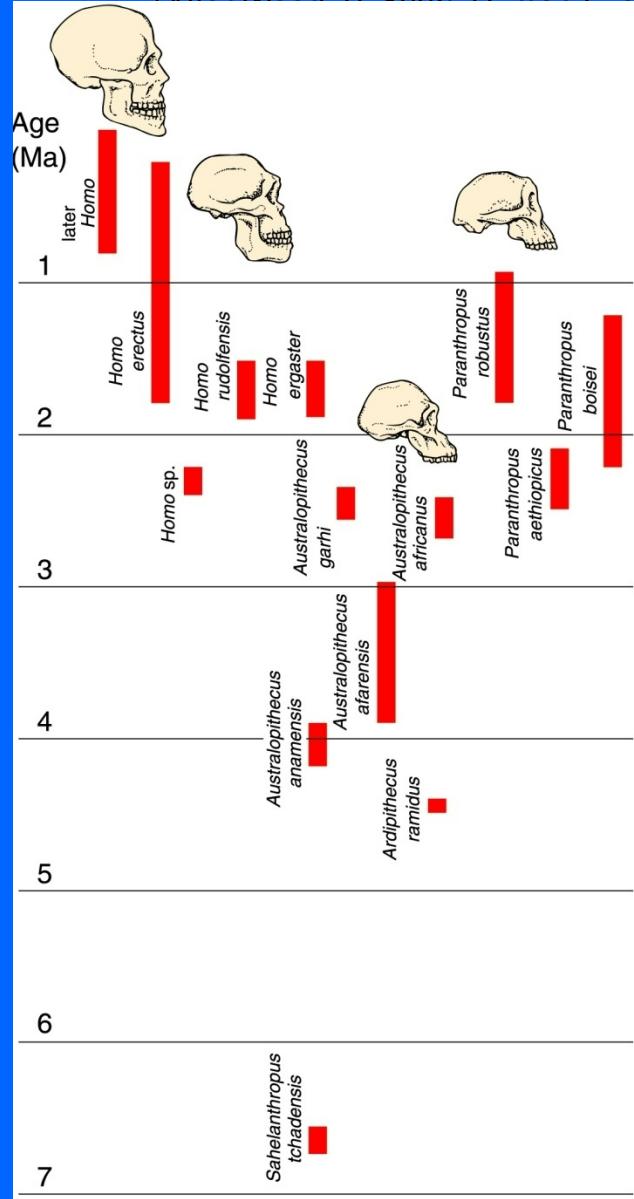
# Teeth

- Teeth show Neanderthals develop into adults faster
- Advantage for humans as slow developed linked to intelligence



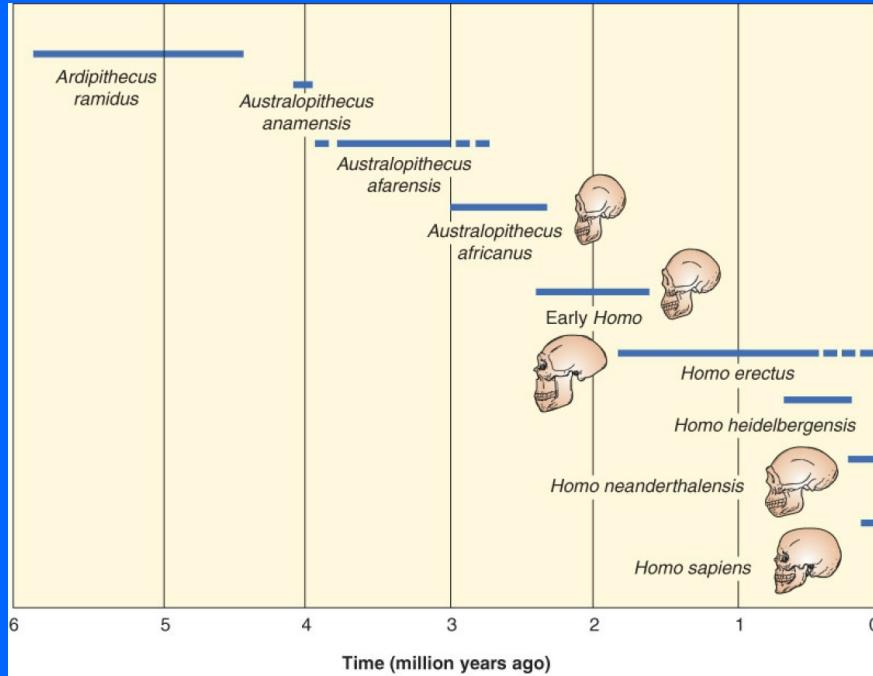
# Chart showing the times during which hominids lived.

(After Wood, B. 1990. Human Evolution. London: Chapman & Hall, p. 10, 245-251.)



75000 BP  
sharpened tool S Africa

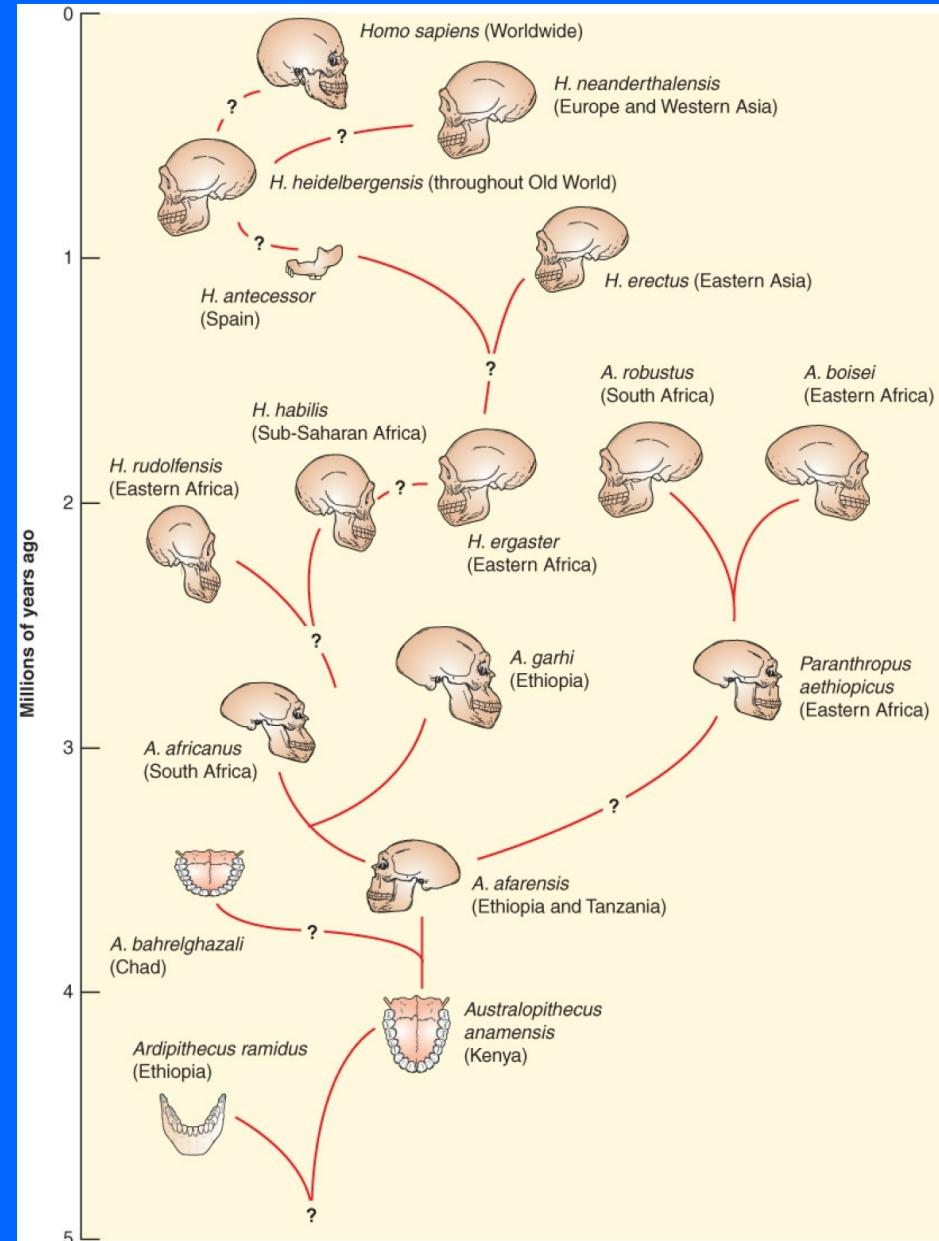




## Ranges of fossil species leading to modern humans.

Adapted from: Stanley, S. M. 1999. Earth System History. 3rd ed. San Francisco: W. H. Freeman and Company. Figure 19-41 (p. 485).

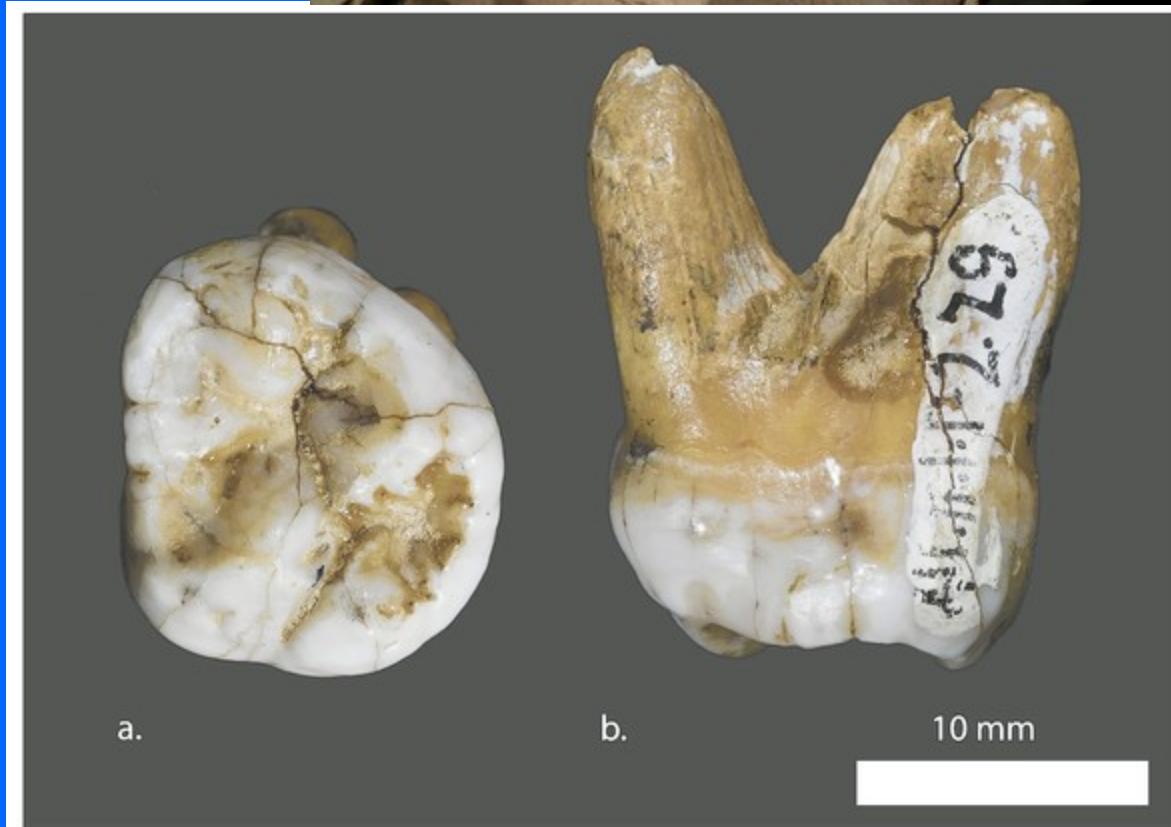
However, human evolution could have been more of a branching process, like that of the horse or the speculative tree shown here.



Adapted from: Tattersall, I. 2000. Once we were not alone. Scientific American, 282(1), 60.

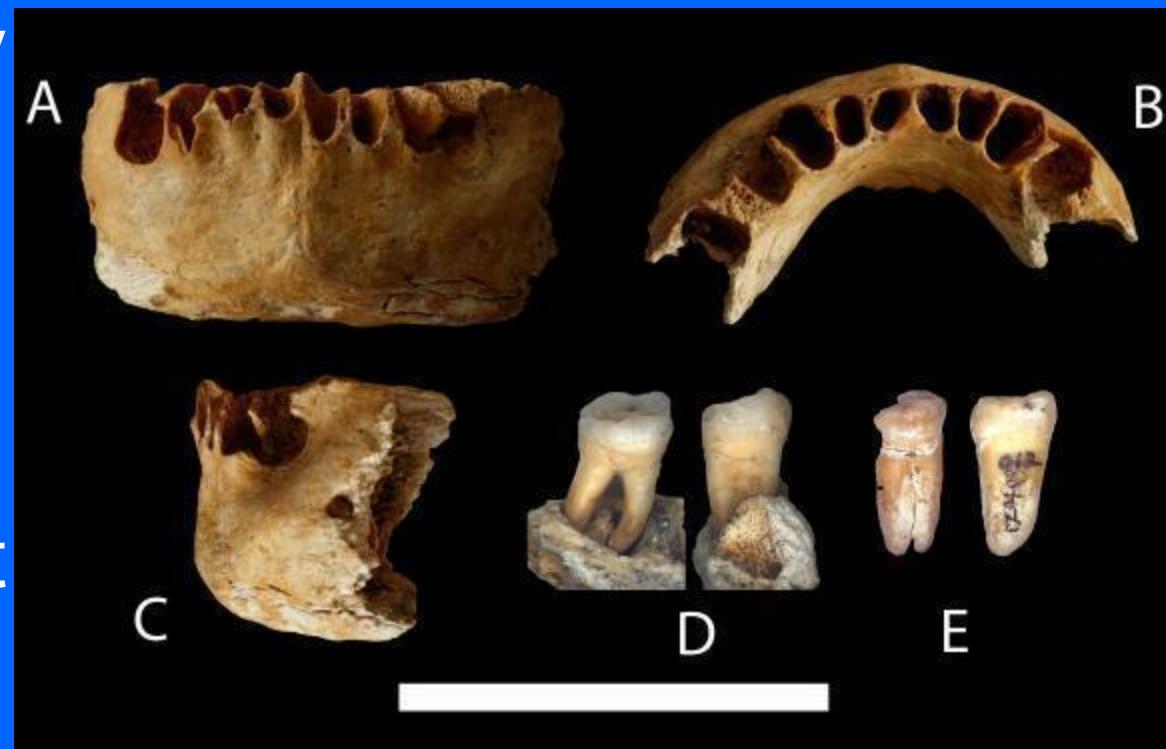
# But other hominid species too?

- Teeth & finger of young girl that genetically tests as neither human or neanderthal
  - After sequencing the DNA from a 30,000-year-old pinkie finger discovered in a Siberian cave, from unknown hominid species that probably diverged from the Neanderthal line about 350,000 years ago.
  - The genetic sequence shares as much as 6% of its segments with modern-day Melanesians in the South Pacific, suggesting that the extinct species — Denisovans because the bone was found in the Denisova Cave — ranged widely throughout East Asia.
  - In May, researchers showed that modern humans of European descent carry 2% to 3% Neanderthal DNA, suggesting that there was interbreeding between the two groups tens of thousands of years ago.



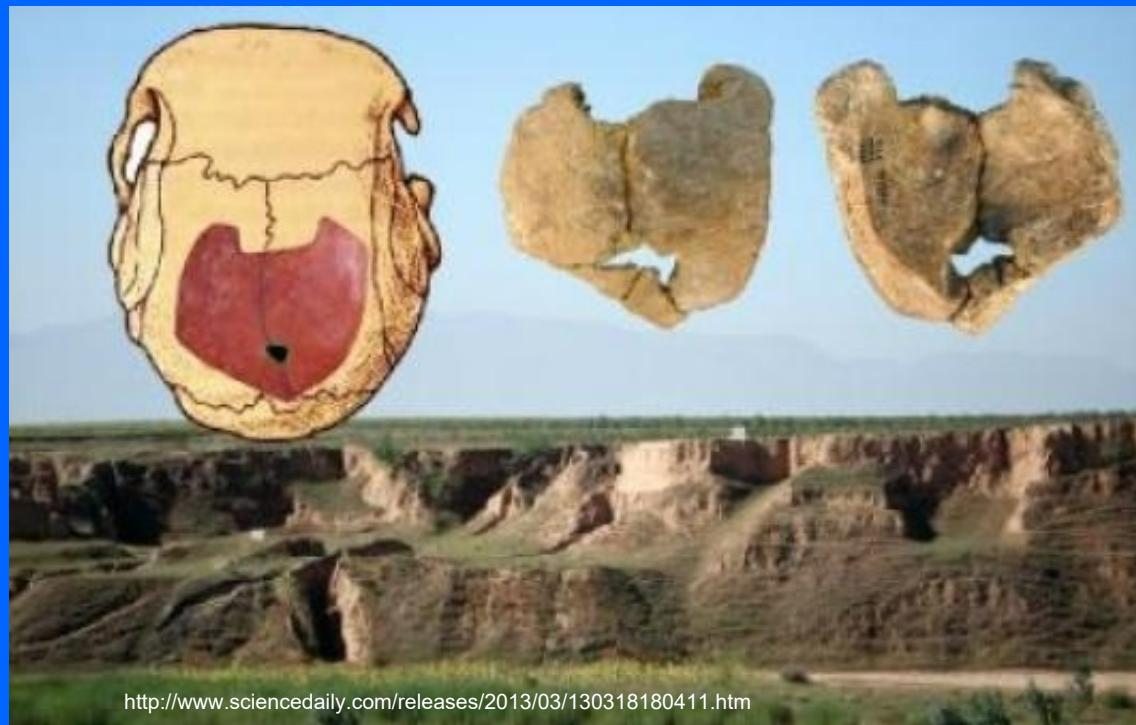
# In Asia 100000 BP?

- Scientists have discovered early modern human fossil remains in the Zhirendong (Zhiren Cave) in south China that are at least 100,000 years old.



# Tree is actually a trunk

- The skull, known as Xujiayao 11, has an unusual perforation through the top of the brain case -- an enlarged parietal foramen (EPF) or "hole in the skull" -- that is consistent with modern humans diagnosed with a rare genetic mutation in the homeobox genes ALX4 on chromosome 11 and MSX2 on chromosome 5.
- These specific genetic mutations interfere with bone formation and prevent the closure of small holes in the back of the prenatal braincase, a process that is normally completed within the first five months of fetal development. It occurs in about one out of every 25,000 modern human births.



**Bone tools 75K from the Howiesons Poort levels of the Sibudu Cave, northern KwaZulu-Natal, South Africa. Left: bone points. Right: bones with parallel cut marks – these lines are deliberately engraved and may have been symbolic markings (Christopher S. Henshilwood)**



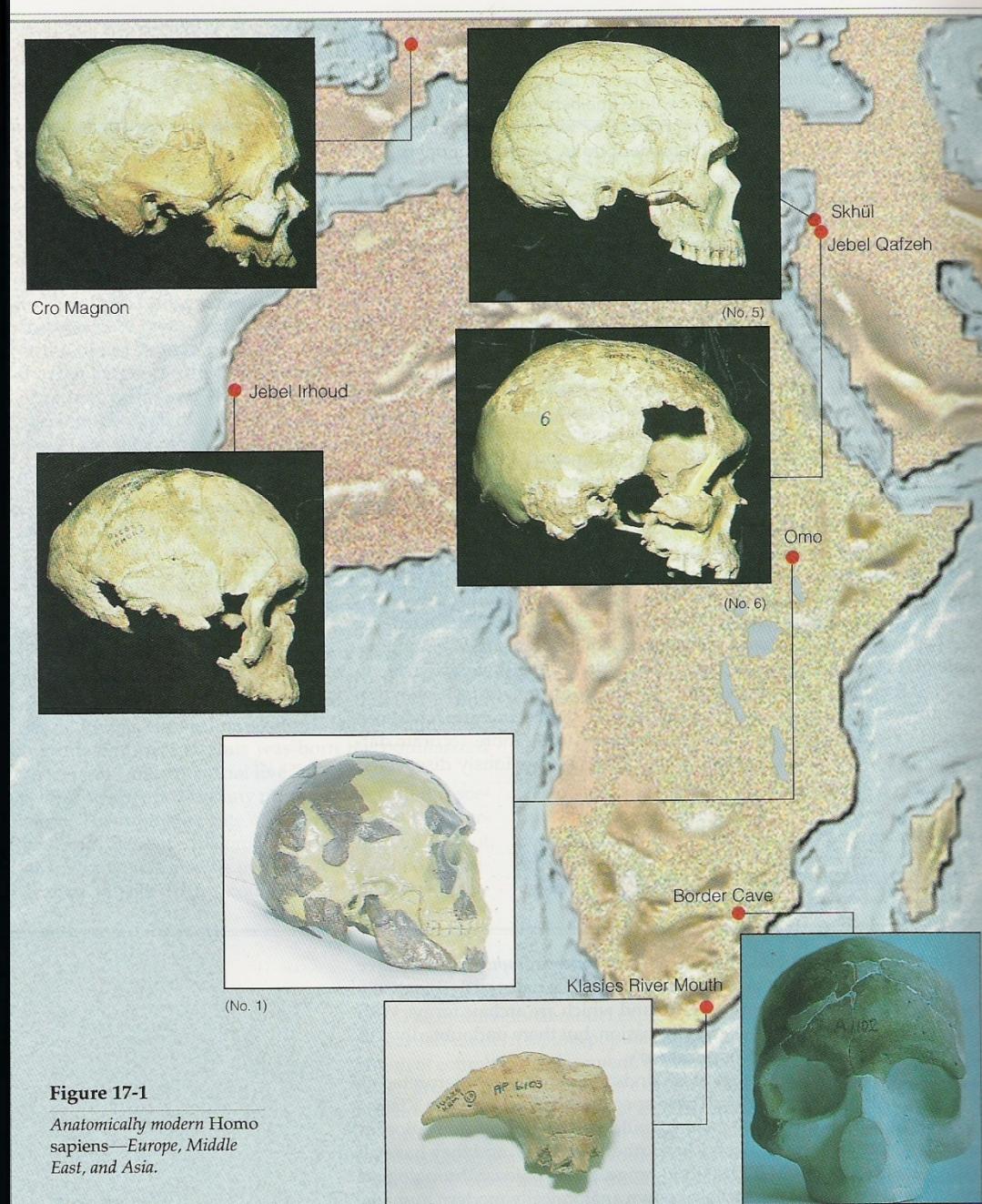
# Mideast 1<sup>st</sup>?

- Qesem Cave, a pre-historic site located near Rosh Ha'ayin Israel 400,000 BP looks like modern human teeth so maybe humans older and developed in Mideast and migrated to Africa too

<http://www.sciencedaily.com/releases/2010/12/101230123554.htm>



32000 yr old flute  
from Germany





## **IX. 3 hypotheses**

### **i. Out of Africa**

**1. Genetic evidence indicates all people very similar with no significant variation (10x genetic variation w/ a chimp family than w/in human races)**

**2. Competitive displacement of Neanderthals with little fighting (lived together in areas for 100s of years)**

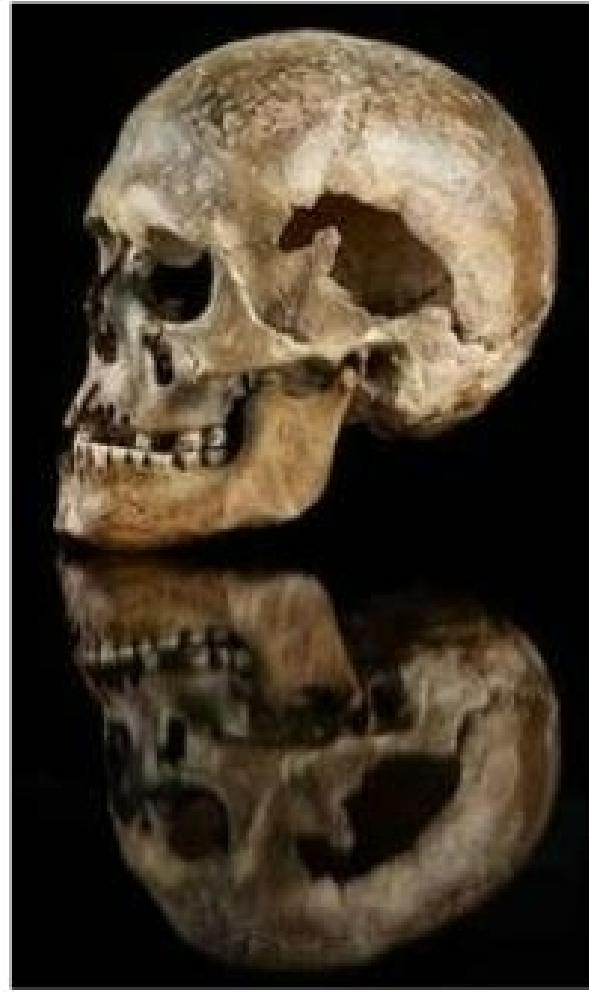
**3. If interbreed no hybrids (sterile?)**

**4. 50000 BP Neanderthal killed by thrown human spear in 2009**

**5. mDNA studies show all humans share a single female ancestor from 160000**

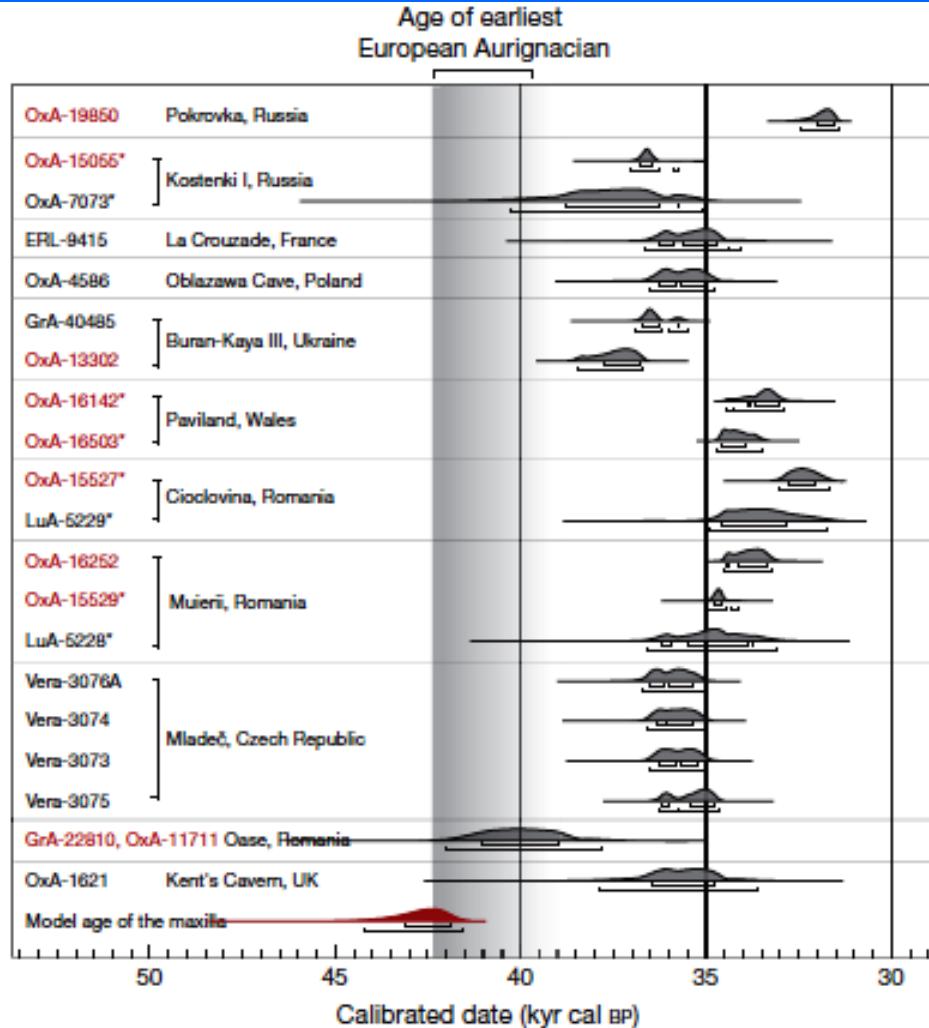
Human spear  
right hand  
neanderthal left  
hand  
<http://www.sciencedaily.com/releases/2009/07/090720163729.htm>





*The oldest modern human skeletons found in Germany from the site of Oberkassel close to Bonn. (Credit: J. Vogel/LVR – LandesMuseum Bonn)*

# Human settlements in Europe



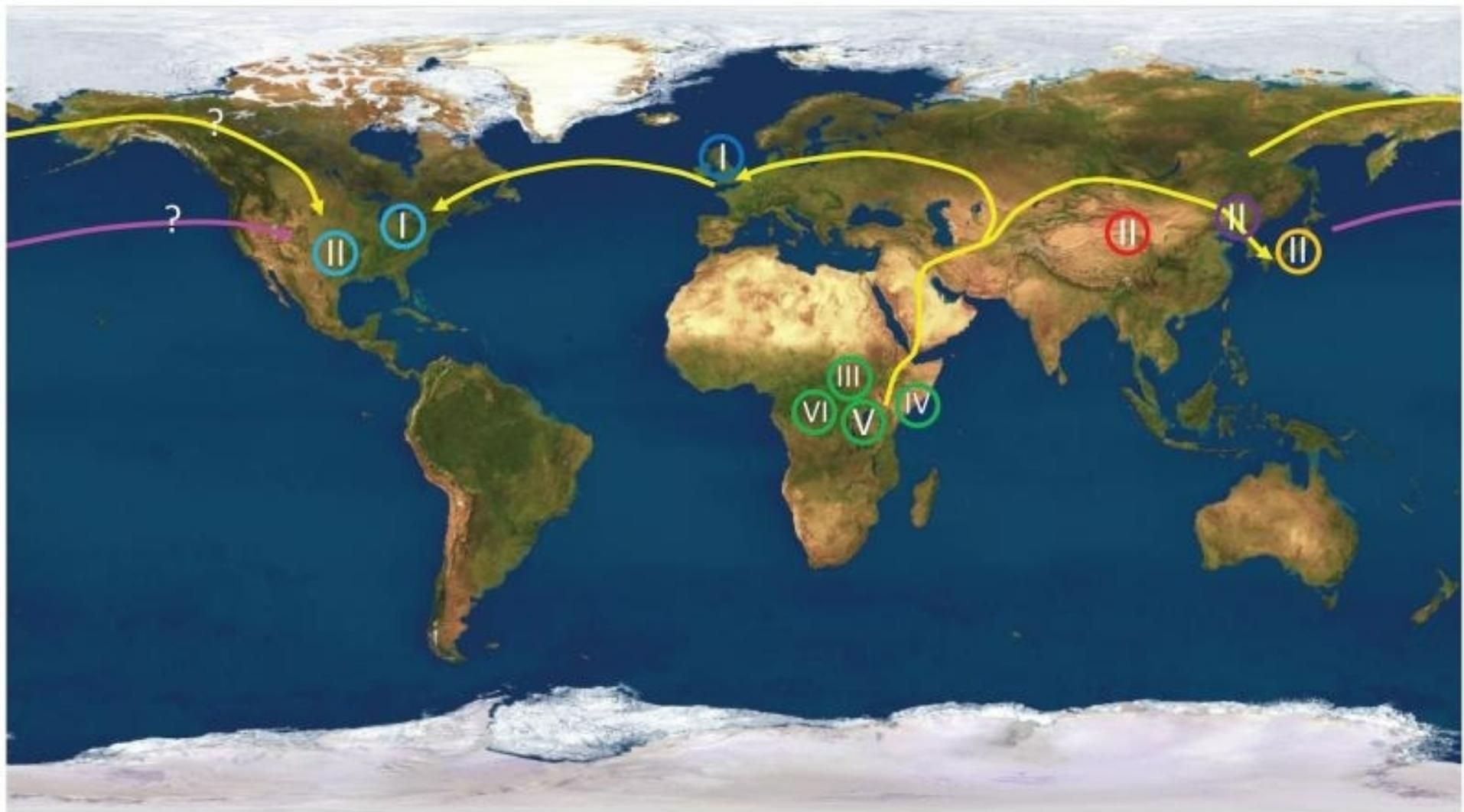
**Figure 3 | Comparison of direct radiocarbon determinations of AMH bones from European Palaeolithic sites<sup>3,9,19–25</sup> with the KC4 model age.** Calibrated using the INTCAL09 curve<sup>12</sup>. Brackets under the distributions represent the 68.2 and 95.4% probability ranges, respectively. The PDF derived from the Bayesian modelling of KC4 (Model age of the maxilla, in red) is earlier than the original direct date from Kent's Cavern (OxA-1621) and all others, and overlaps the start of the age range of the earliest European Aurignacian<sup>15</sup>, which is widely accepted as being linked with the earliest AMH. Ultrafiltered collagen radiocarbon dates are indicated with red text; non-ultrafiltered dates are in black. Asterisks denote duplicate dates on the same human bone. The Oase date is a mean of two determinations, one ultrafiltered and one not<sup>3</sup>.

- ii. Partial displacement (Now Dominant)
  - 1. African and non-African moderns splits  
**62000-95000 BP**
    - 1. Interbreeding w/ dominant African genes
- iii. Multiregional
  - 1. Humans in Africa, Asia, & Europe dvlpd independently into modern humans with little to no genetic change

-Evidence heavily favors out of Africa model with some interbreeding with regional population

- Neanderthals about 1-4% of most people's DNA
- Denisova Cave (see next slide)

-Replacement occurred in Asia & Java as well with sudden disappearance of *H. erectus* coupled w/ appearance of *H. sapiens*



**World map featuring the geographic location of the 6 HSV-1 clades with respect to human migration. The phylogenetic data supports the “out of Africa model” of human migration with HSV-1 traveling and diversifying with its human host. Each clade is depicted by a roman numeral inside a circle. Land migration is depicted by yellow lines and air/sea migration is shown by the pink line. (Credit: Aaron W. Kolb, Cécile Ané, Curtis R. Brandt. Using HSV-1 Genome Phylogenetics to Track Past Human Migrations. PLoS ONE, 2013; 8 (10): e76267 DOI: 10.1371/journal.pone.0076267)**

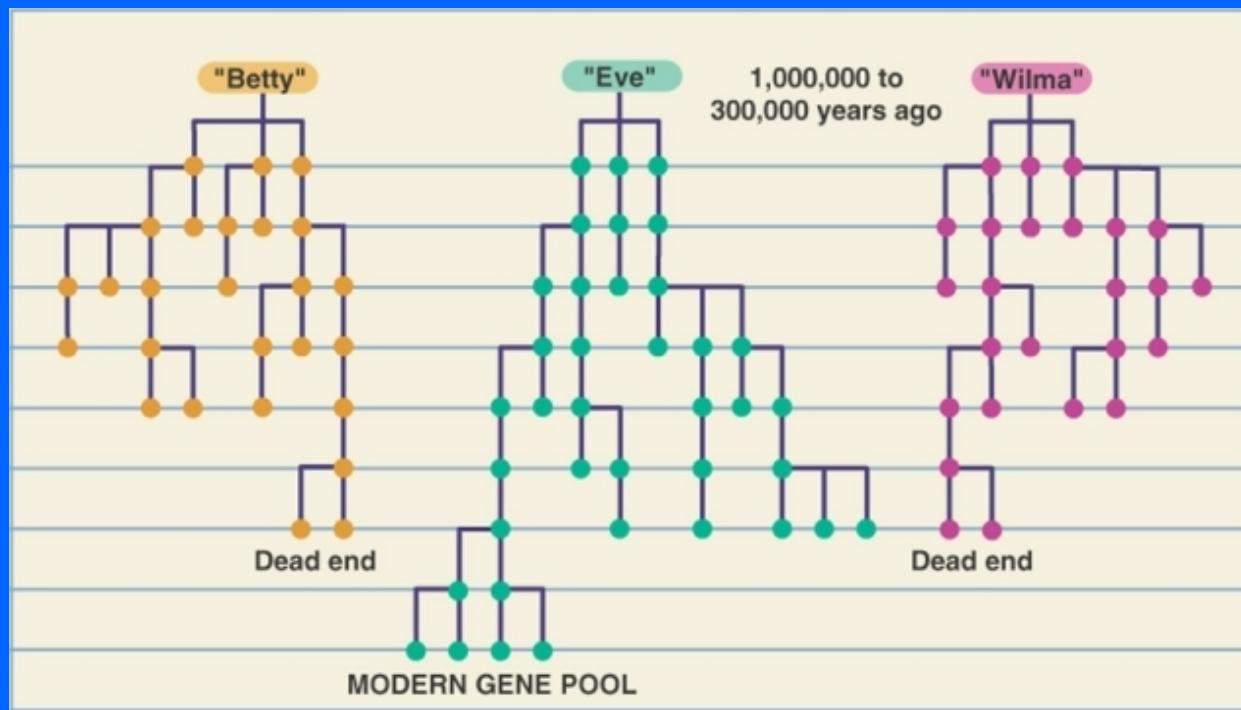
Denisovans, are [Paleolithic](#)-era members of a previously unknown species of [human](#) or subspecies of [Homo sapiens](#). In March 2010, scientists announced the discovery of a finger bone fragment of a juvenile female who lived about 41,000 years ago, found in the remote [Denisova Cave](#) in the [Altai Mountains](#) in Siberia, a cave which has also been inhabited by [Neanderthals](#) and [modern humans](#).<sup>[1][2][3]</sup> A tooth and toe bone belonging to different members of the same population have since been reported.

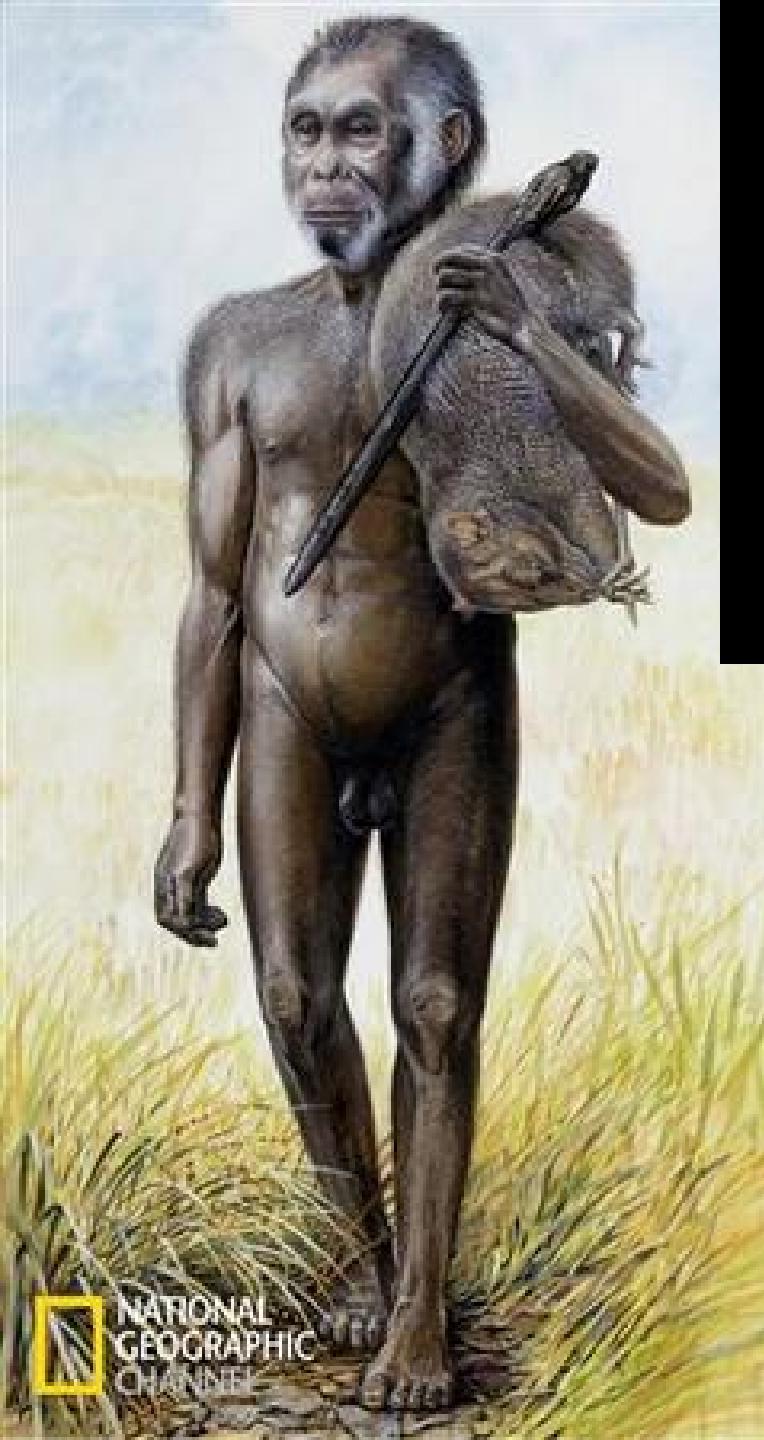
**Analysis of the [mitochondrial DNA](#) (mtDNA) of the finger bone showed it to be genetically distinct from the mtDNAs of Neanderthals and modern humans.**<sup>[4]</sup> Subsequent study of the [nuclear genome](#) from this specimen suggests that this group shares a common origin with Neanderthals, that they ranged from Siberia to Southeast Asia, and that they lived among and interbred with the ancestors of some present-day modern humans, with up to 6% of the DNA of [Melanesians](#) and Australian [Aborigines](#) deriving from Denisovans.<sup>[5][6]</sup>



# Mitochondrial “Eve”

- mtDNA sequences of indigenous peoples worldwide were compared to determine the common ancestral mtDNA sequence.
- Root of tree is in Africa
- Calibration of molecular clock with chimp outgroups indicate the common ancestral sequence existed 100,000 to 300,000 years ago.

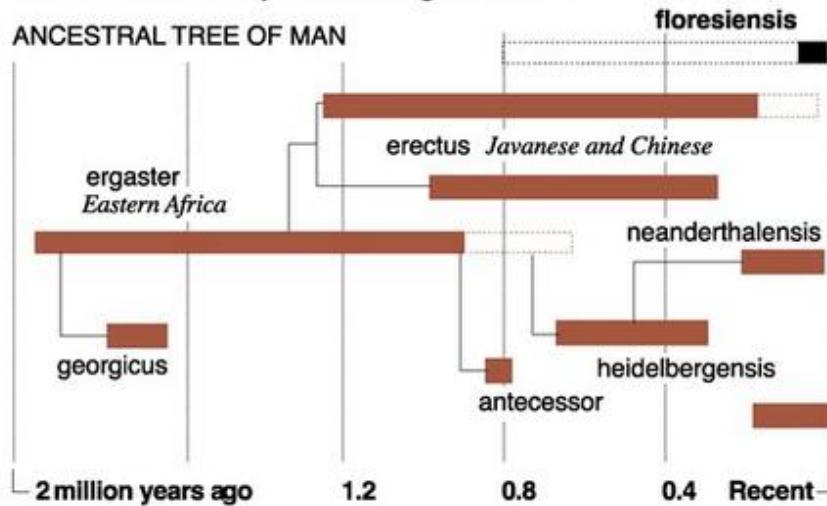




Hobbit feet

## Remote-island fossil human find

Fossil remains of a pygmy-sized, small-brained hominin that lived 18,000 years ago, was found on the remote Indonesian island of Flores. The new fossils called *Homo floresiensis* represent an addition to the family tree of the genus *Homo*.



# Komodo vs Flores





A group of six people, including four adults and two children, are posing with a large Komodo dragon in a natural, outdoor setting. The Komodo dragon is the central focus, lying on the ground with its head raised. The people are arranged behind it, smiling for a photo. The background consists of dense green trees and foliage, suggesting a tropical or subtropical environment. The lighting indicates it might be late afternoon or early evening.

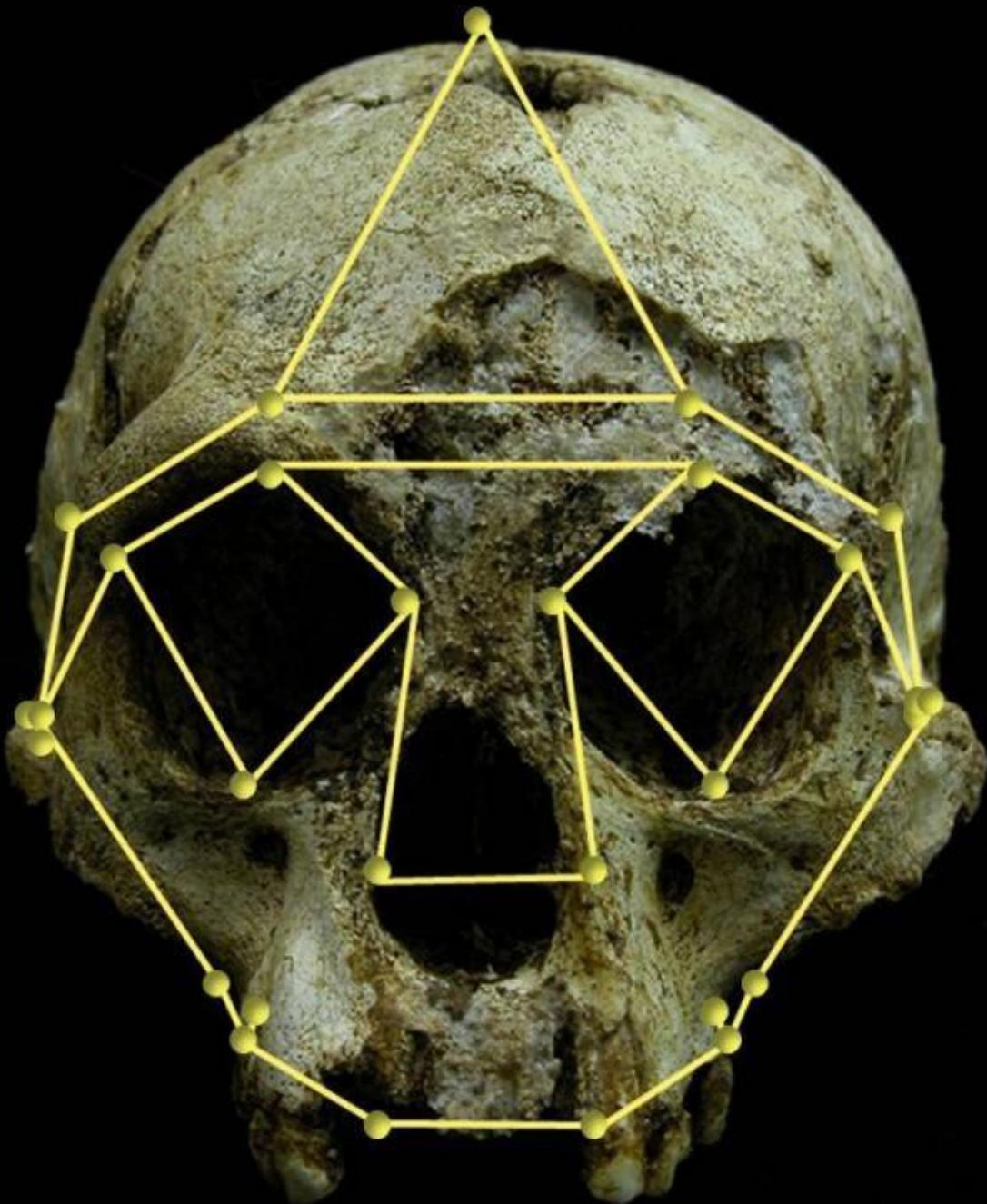


Photo courtesy P. Brown

Brain might function like ours meaning brain size not a good indicator of intelligence

total mass to brain mass

Hobbits' brains like that of *H. habilis* not modern humans



# Virtual brain of fossil provokes debate

Using a reconstruction of the brain of fossil *Homo floresiensis* made with 3-D computer tomographic technology, scientists revealed possible advanced development in this ancestral human.



Front view of brains



Human  
brain



Brain of *Homo  
floresiensis*



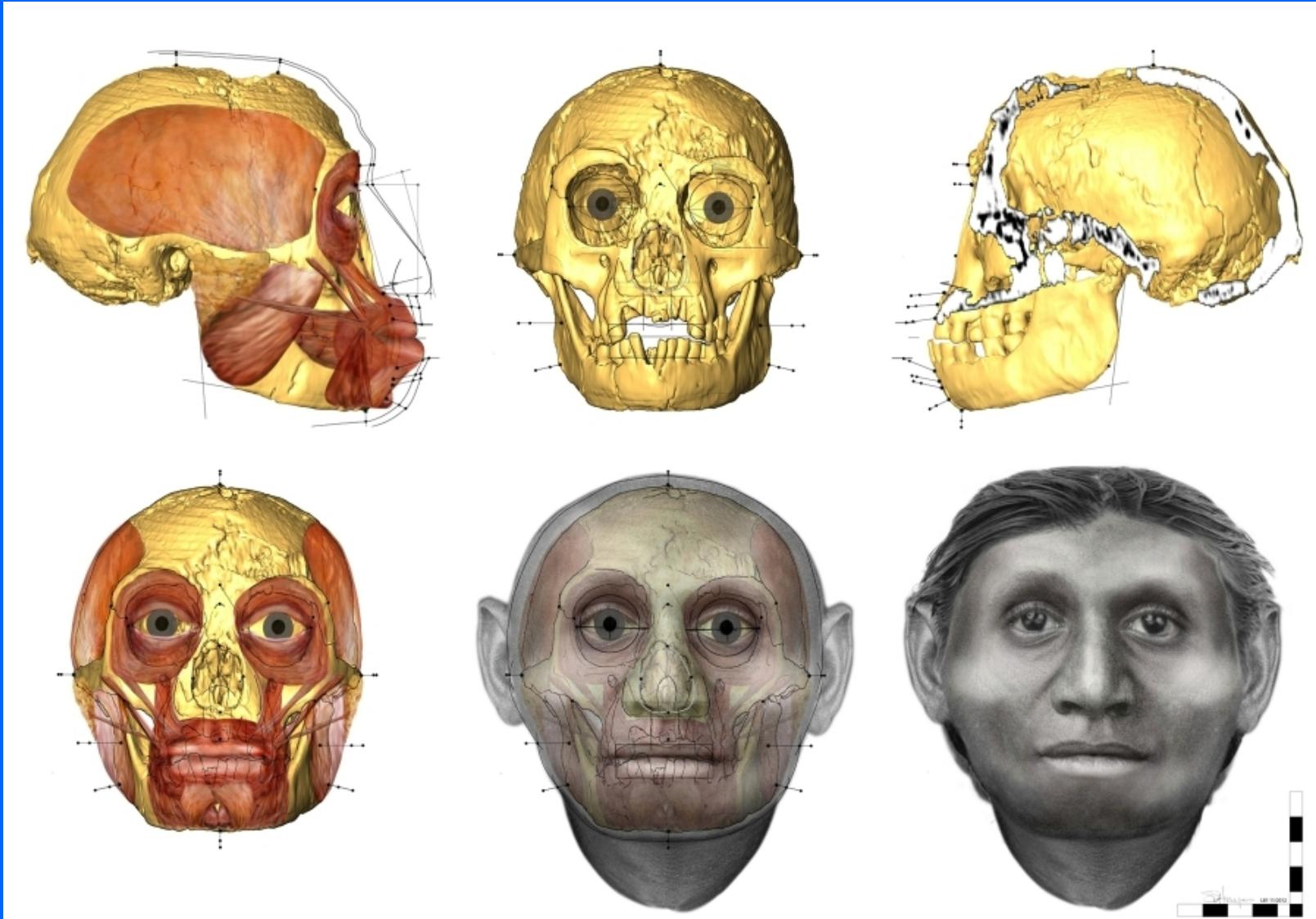
Hippos of Madagascar (dwarves) have smaller brains



Brain bad for small islands?

# Could be *Australopithecus* descendants too

<http://blogs.scientificamerican.com/observations/2012/12/11/reconstructed-face-of-extinct-hobbit-species-is-startlingly-humanlike/>



# Hobbits now new species

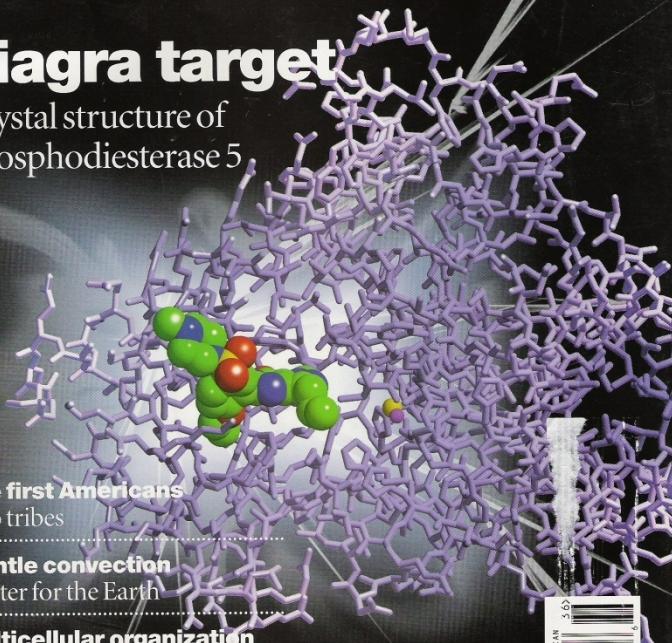
What happened  
to them?

4 September 2003



## Viagra target

Crystal structure of phosphodiesterase 5

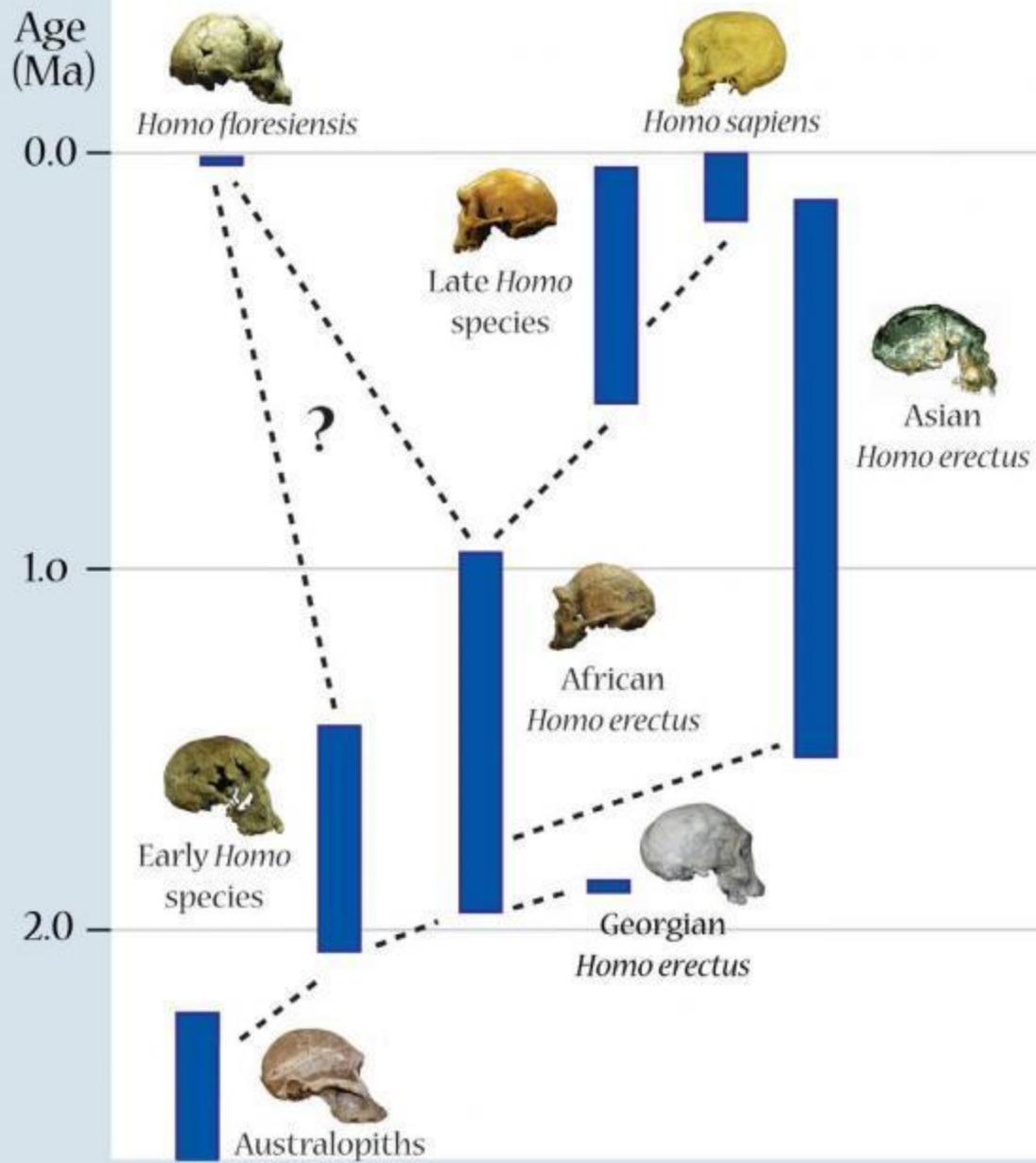


The first Americans  
Two tribes

Mantle convection  
A filter for the Earth

Multicellular organization  
Bacteria get it together

naturejobs Ontario focuses on cancer



# Tracking the first Americans

Tom D. Dillehay

A study of 33 ancient skulls excavated from Mexico invites us to reconsider our view of the ancestry of the early Americans. Unlike most other early American remains, the skulls resemble those from south Asian populations.

Questions of which human populations first arrived in the Americas, and when, where and how this happened, have been debated by scientists for decades<sup>1</sup>. It has long been presumed that the first people entering the New World were the direct ancestors of present-day Native Americans and that they arrived in America from northeast Asia about 12,000 years ago<sup>2</sup>. But this theory has been challenged by new archaeological discoveries and by findings of early human remains bearing anatomical similarities to the people of south Asia and the southern Pacific Rim<sup>3,4</sup> (Fig. 1). Writing on page 62 of this issue, González-José *et al.*<sup>5</sup> add more fuel to this heated debate. They present a comparative study of early historic human skulls from Baja California, Mexico, and their findings lend weight to the view that not all early American populations were directly related to present-day Native Americans.

Human skeletal remains have long been used by palaeoanthropologists to model early human migration. The conventional view is that different skeletal populations with similar craniofacial features (skull form) shared a common ancestry and were genetically related, whereas different features reflect

different ancestry. Migration histories and evolutionary forces explain the similarities or differences.

Piecing together the ancestry of the Americas has been difficult, as early human remains dating from about 10,000 years ago (the end of the last ice age) are fragmentary and scarce. Scientists have typically reconstructed the missing pieces of the most ancient skulls by extrapolating backwards from later, more complete skeletons. Ancient American skulls reconstructed in this way were anatomically indistinguishable from early northeast Asians and also from present-day Native Americans<sup>2</sup>. So a theory arose, supported by dental and other archaeological data<sup>6</sup>, that the first humans entering the Americas were northeast Asians who arrived in three successive migrations beginning around 12,000 years ago. These founding colonizers were thought to be big-game hunters, equipped with so-called Clovis spears<sup>7</sup>, who rapidly populated the Western Hemisphere and gave rise to present-day Native Americans (Fig. 2a).

But more recent archaeological discoveries suggest that there were several different founding populations, arriving from different places, each with different lifestyles and technologies<sup>8</sup>. Some populations not only hunted big game but also exploited a wide range of plant and animal life. To complicate matters further, it is no longer certain that the first colonizers arrived about 12,000 years ago — some archaeological sites in South America date from 12,500 years ago, which suggests that the first humans arrived at least 15,000 years ago.

A similar pattern of diversity is emerging from statistical analyses of cranial and facial measurements of some of the oldest skeletons found in the Americas. The archaeological and skeletal data have led to a new model, in which the Palaeoamericans — the proposed first arrivals in the New World — were not northeast Asians. They came instead from south Asia and the southern Pacific Rim, and they probably shared ancestry with ancient Australians and other southern populations<sup>3,9</sup>. A second group of humans then arrived from northeast Asia or Mongolia, and it was this second population that adapted to the warming climate after the Ice Age and gave rise to the modern Amerindians (an ancient population of Americans whose skeletal remains make up most of the human material found in the New World) and the present-day Native Americans (Fig. 2b). So according to this theory, the Palaeoamericans are unrelated to most modern Amerindians and to the Native Americans.

González-José *et al.*<sup>5</sup> now propose a more complex view of American ancestry.

Figure 1 The skull of an early American, The Kennewick Man, excavated from Washington state, lived about 9,300 years ago. His craniofacial features, which do not resemble living Native Americans, are typical of the skulls that are increasingly being found in ancient American sites.

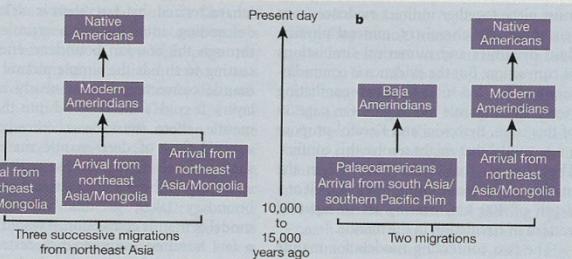
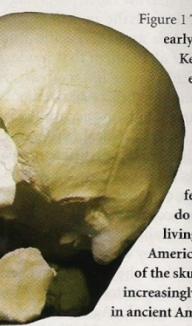


Figure 2 Tracing American ancestry. Analysis of skeletal remains has led to at least two models to explain the origin of early human populations in the Americas. **a**, It was originally thought that the first colonizers were the direct ancestors of present-day Native Americans, who arrived from northeast Asia and possibly central Asia in three successive migrations about 12,000 years ago. **b**, More recent analyses of the craniofacial features of skulls dating from the end of the Ice Age suggest that the first arrivals were from south Asia or the Pacific Rim. These 'Palaeoamericans' were thought to be unrelated to the majority of modern Amerindian remains — a later group of colonizers from northeast Asia were thought to have given rise to these late-prehistoric populations. Now, González-José *et al.*<sup>5</sup> have found that a group of early historic Amerindian skulls from the Baja peninsula in Mexico bear a strong resemblance to the early Palaeoamericans, suggesting that the colonization of the Americas was more complex than had previously been suspected.



## news and views

DISCOVERY TOOLS FOR SIGNAL TRANSDUCTION RESEARCH

These authors analysed the skeletal remains of 33 modern Amerindians from early historic times, excavated from the tip of the Baja peninsula in Mexico. Surprisingly, the craniofacial features of these Baja Amerindians show closer affinity to the Palaeoamerican skulls than to other modern Amerindian remains. The Baja Amerindian and Palaeoamerican skulls have similar long and narrow braincases and relatively short, narrow faces, implying a common ancestry with the ancient inhabitants of south Asia and the Pacific Rim. González-José *et al.* confirm that modern Amerindian skulls from other areas are similar to ancient northeast Asian remains. Their new data add to accumulating evidence of morphological differences between early humans from different areas of the Americas<sup>8,9</sup>.

The authors consider several potential explanations to account for the presence of Palaeoamerican traits in the Baja Amerindian skulls, but they suggest that the best explanation is that the Palaeoamericans were the direct ancestors of the Baja Amerindians. After the Ice Age, the increased aridity could have geographically isolated the founding Palaeoamerican population in the Baja area, and limited its gene flow with other modern Amerindian groups.

Do the new findings tell us anything more about when the first humans arrived in the Americas? The authors do not fully discuss the chronological implications of their work, but their interpretation of shared ancestry between the Palaeoamericans and the Baja Amerindians might best fit a model of Palaeoamerican arrival about 11,000–12,000 years ago. There is no direct evidence to support this view, but if the Palaeoamericans had arrived 15,000 years ago or earlier, the Baja population would have remained isolated for much longer. This seems unlikely, given the rate of population growth and movement that probably occurred after initial colonization and then after the Ice Age when the climate warmed.

But could the similarities between the ancient Palaeoamericans and the later Baja Amerindians instead reflect the influence of other evolutionary forces, such as gene flow or natural selection and convergent adaptation of different populations to similar local environments? Answering this question will depend upon finding more isolated prehistoric populations showing ancient Palaeoamerican traits, and then establishing whether parallel evolutionary forces were acting on them and whether they were derived from a single ancestry. But this will be a difficult task. Human remains from the end of the Ice Age are scarce and often fragmentary, so we have only a vague notion of the skeletal characteristics of the ancient Palaeoamericans. And we have a poor

understanding of the migration history of different American populations and what kind of evolutionary forces might have influenced them<sup>10</sup>.

Given these limitations, the findings of González-José *et al.* do not allow us to draw firm conclusions about the relationship between the ancient Palaeoamericans and the later Baja Amerindians. But the importance of this and other studies<sup>11</sup> is that they suggest a different view of the origins and interactions of early human populations in the Americas. What we really want to know is what took place within and between these populations, how they changed over time, and how quickly they changed. These issues can be resolved only by obtaining more skeletal data<sup>12</sup> and by combining them with regional archaeological records, which should provide information on the social and cultural histories of the different

populations. Slowly, we are realizing that the ancestry of the Americas is as complex and as difficult to trace as that of other human lineages around the world.

*Tom D. Dillehay is in the Department of Anthropology, University of Kentucky, Lexington, Kentucky 40506, USA.  
e-mail: dilleha@uky.edu*

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## Earth science

### Just add water

Albrecht W. Hofmann

A new model could explain why Earth's upper mantle is depleted of many trace elements. At a certain depth, minerals might release water, creating a molten filter that traps trace elements in the mantle beneath.

**S**andwiched between Earth's thin crust and its metallic core lies a layer of pressurized rock at high temperature — the mantle. Convection in this layer drives plate tectonics and sea-floor spreading, but we know little about the pattern of circulation. Indeed, current thinking about mantle dynamics is in a state of turmoil. As we cannot observe convection directly, we must piece together indirect evidence from seismology, geochemistry, mineral physics, fluid dynamics and numerical simulations of convection. But the evidence is contradictory and has led to at least two conflicting views about mantle movement. On page 39 of this issue, Bercovici and Karato<sup>1</sup> propose a new model that might resolve this conflict. They suggest that water dissolved in the mantle might create a thin layer of melt at a depth of 400 km, causing an unexpected pattern of circulation in the mantle.

The two conflicting models for mantle convection (Fig. 1a, b, overleaf) are usually described as 'layered' convection (supported by geochemists) and 'whole-mantle' convection (supported by seismologists).

Geochemists have long insisted on the two-layered model, in which the mantle consists of a relatively primitive layer below a depth of 660 km — containing primordial noble gases, trapped 4.5 billion years ago when the Earth formed — and an upper layer that is highly depleted of heat-producing elements (uranium, thorium, and potassium), noble

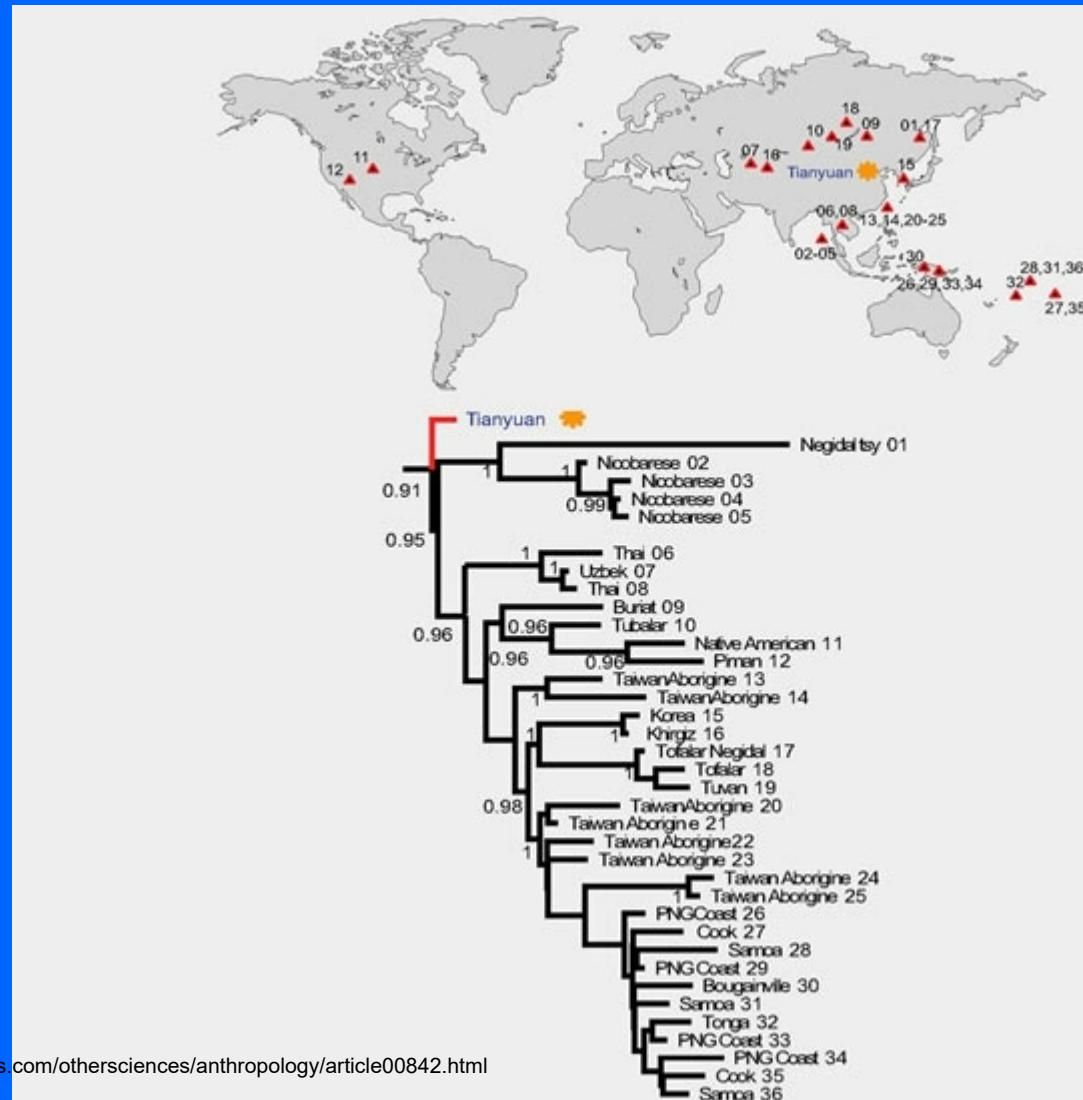
gases and other 'incompatible' elements. The primitive layer serves as a reservoir for these elements (which were depleted from the upper mantle when Earth's crust was formed) and it is occasionally sampled by deep-mantle plumes (Fig. 1a).

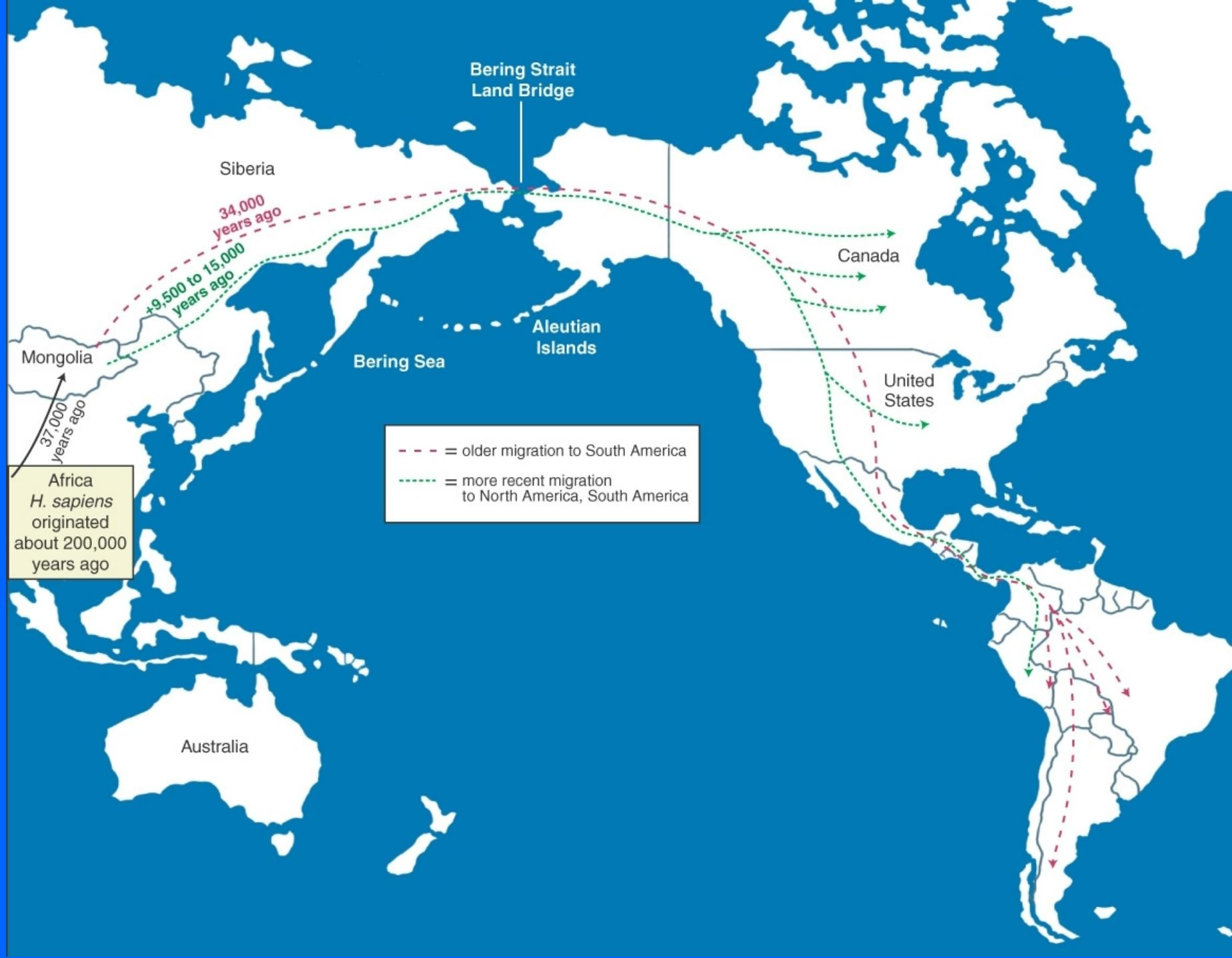
Over the past several years, however, seismic tomography has given us increasingly detailed images of apparently cold 'slabs' (characterized by fast seismic velocities) descending into the deep mantle right through the 660-km boundary, effectively cutting to shreds the simple picture of mantle convecting in two nearly isolated layers. If cold 'slabs' descend into the deep mantle, there must be a corresponding upward flow of deep-mantle material to shallow levels (Fig. 1b). No matter what physical process forms the exchange across the 660-km boundary, in this 'whole-mantle' model of mantle convection, it would within a few hundred million years destroy any compositional layering that had possibly been inherited from early in Earth's history.

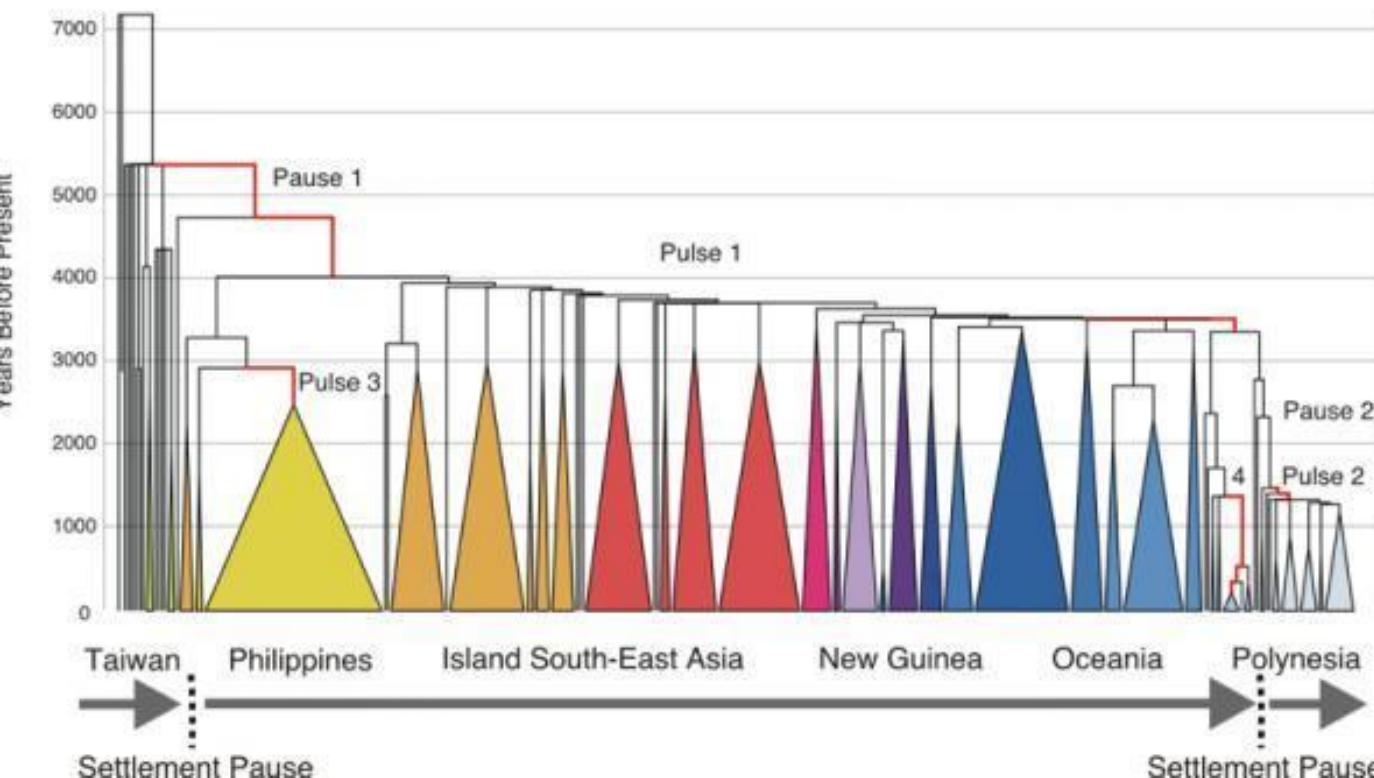
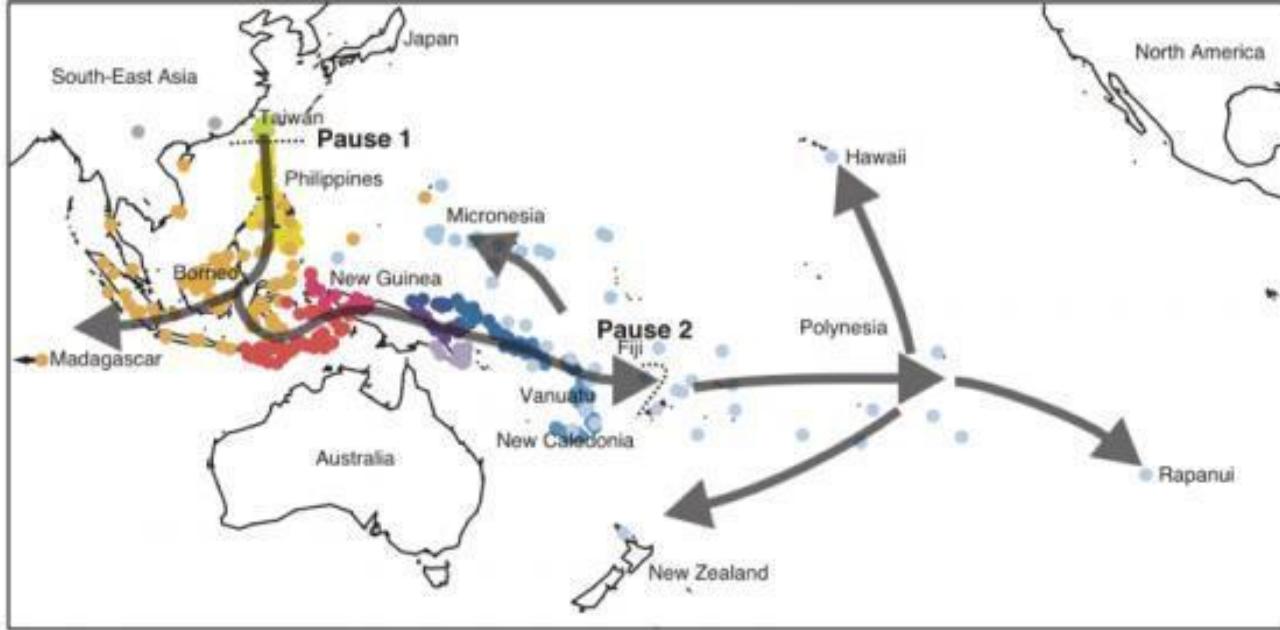
Meanwhile, the geochemical arguments for a separate deep reservoir have not disappeared. Primordial noble gases are still preferentially associated with 'hot spots', at least some of which seem to come from deep-mantle plumes<sup>2</sup>. And much of the upper mantle remains highly depleted of incompatible trace elements, including the heat-producing thorium, uranium and potassium — also suggesting the presence of a less

- Anthropologists hypothesize three migrations to North America from Siberia to explain language and cultural distinctions in Native American populations.

DNA sequence data indicates Native American groups arose from one founding population most similar to Mongolian population.







- From Taiwan settle Polynesia from 7000 BP to 1000 BP New Zealand
- Started fires as they went

<http://www.sciencedaily.com/releases/2010/12/101213151417.htm>