

Human Evolution

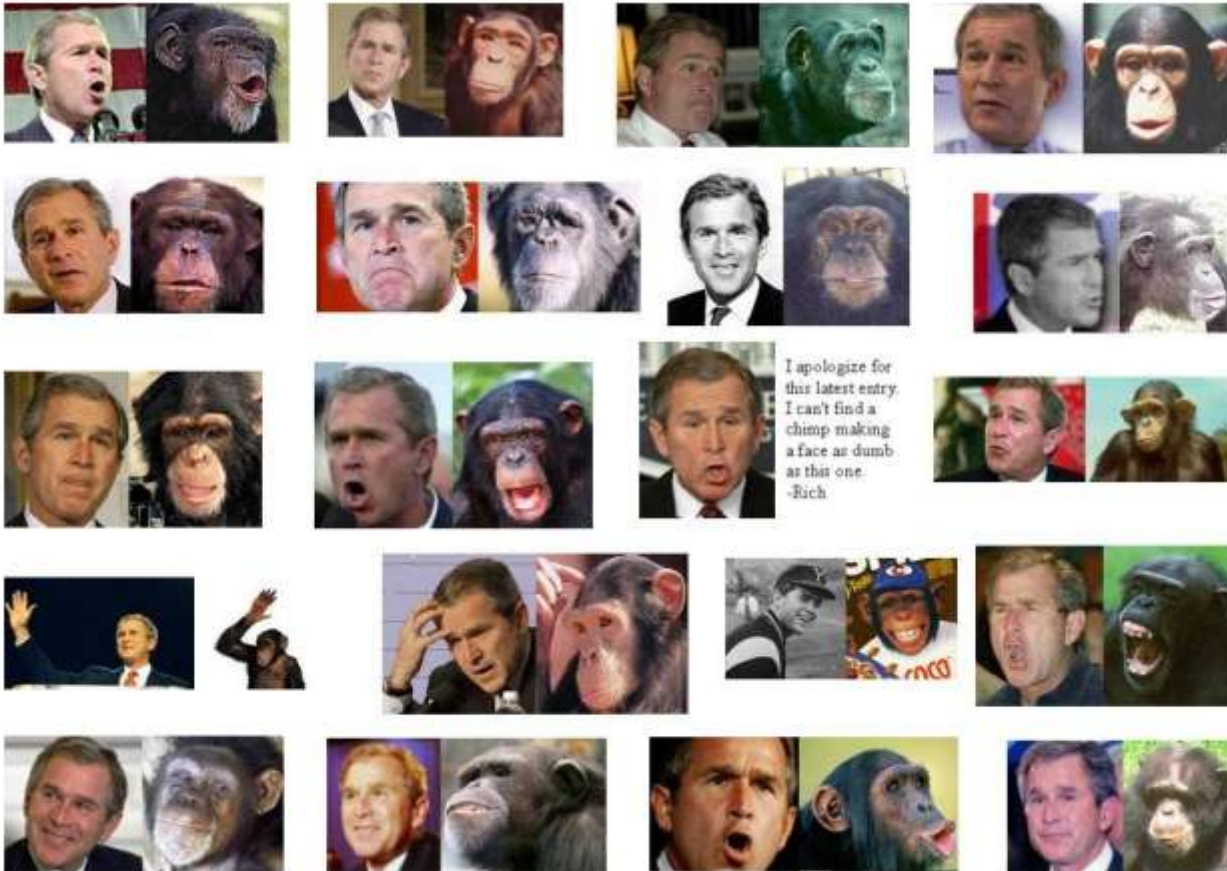
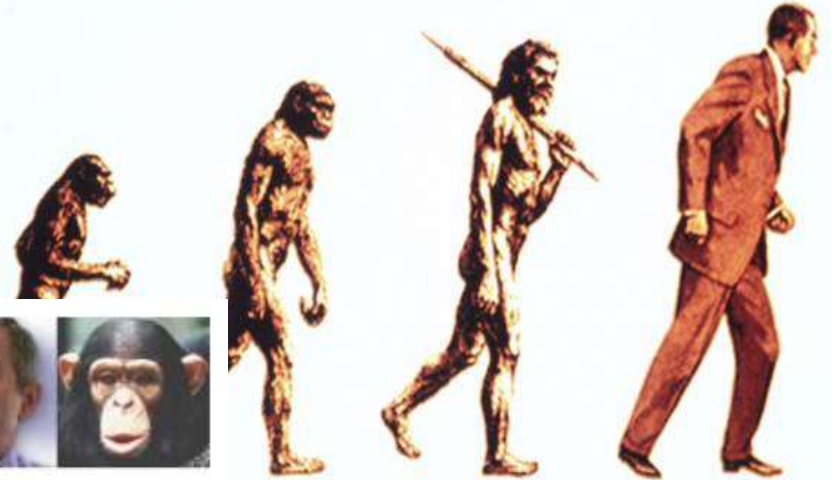
Chris Stringer

The Natural History Museum

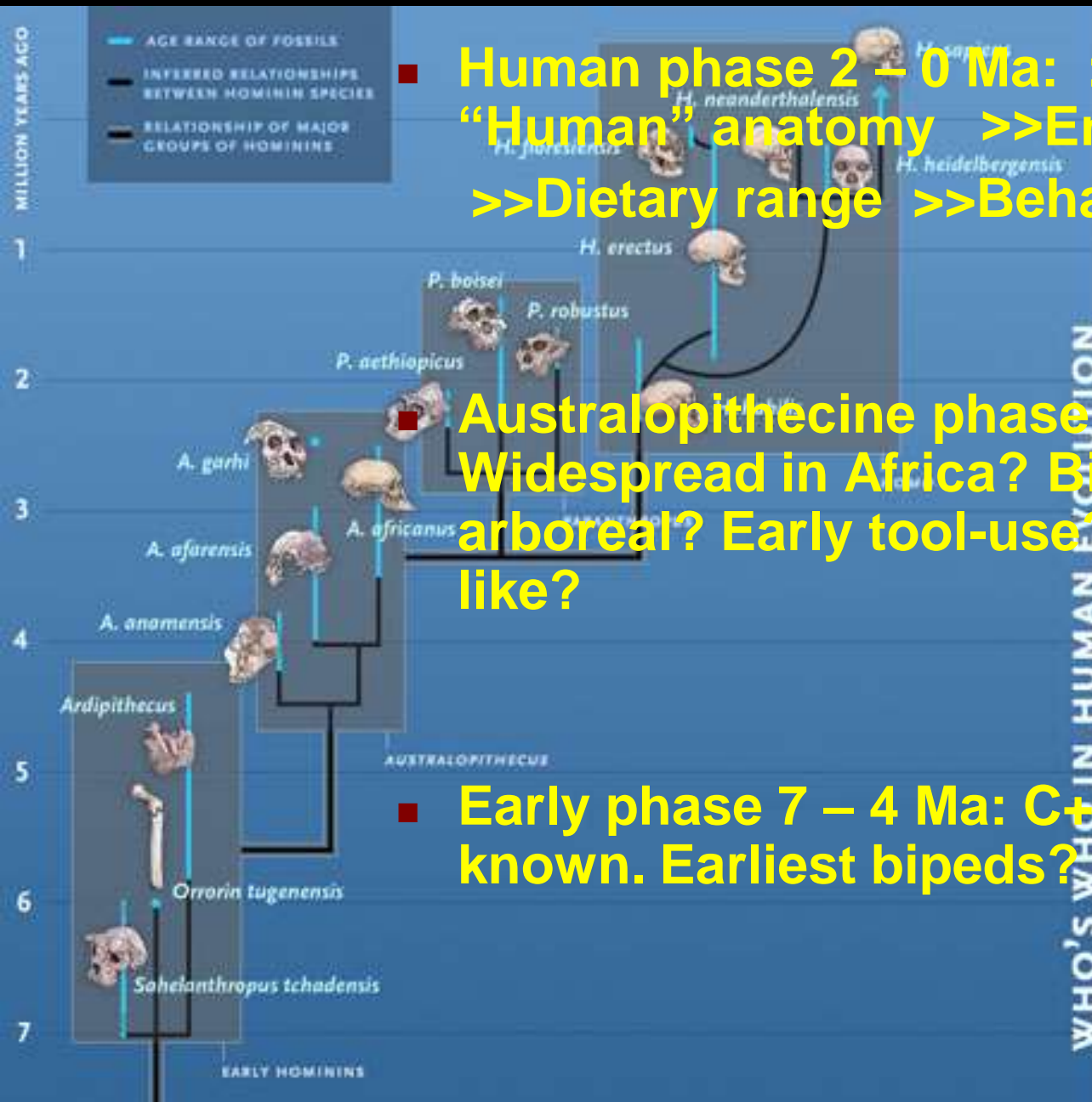
London

Are we nearly there yet?

Are we nearly there yet?



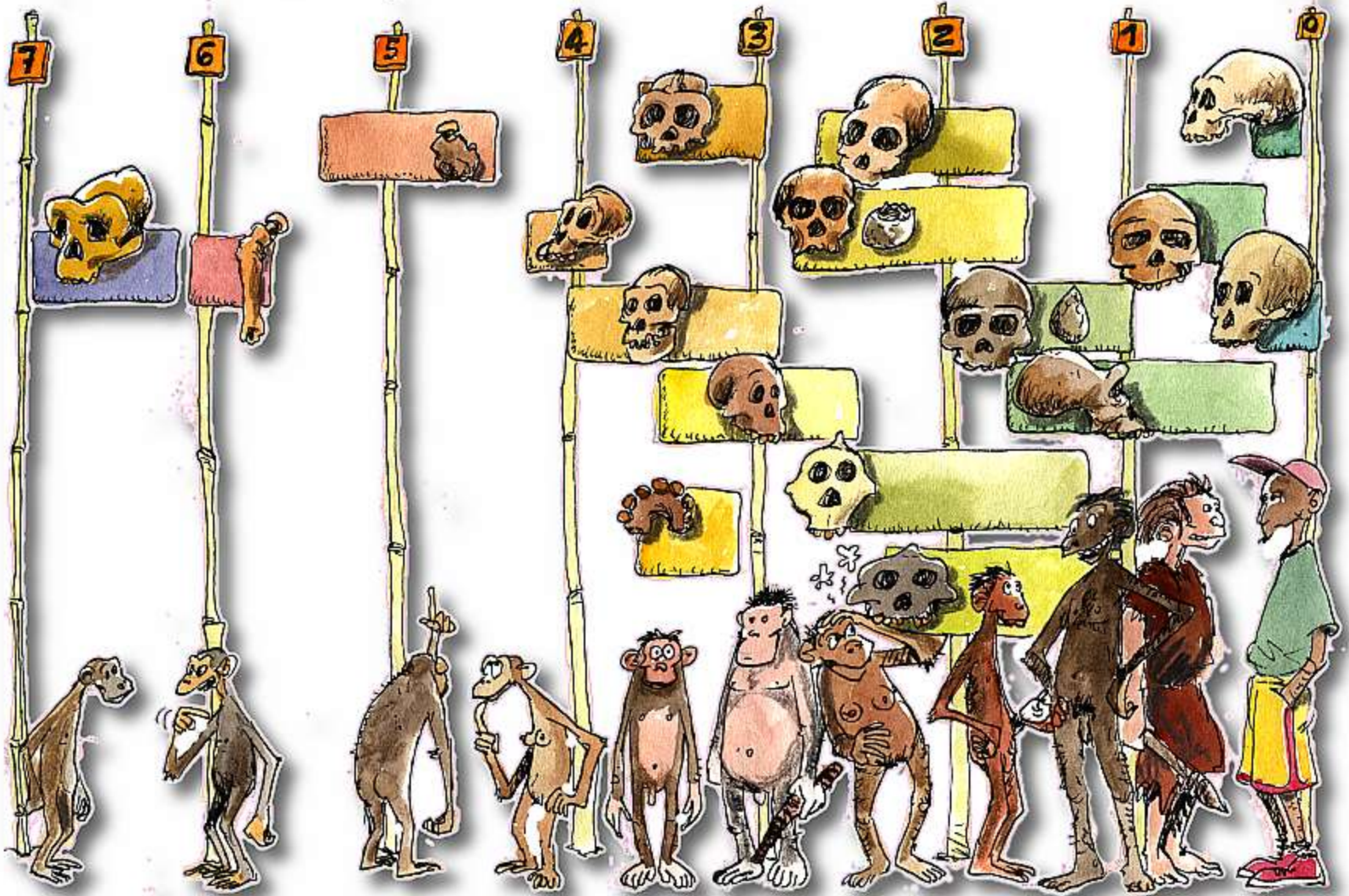
“Phases” of human evolution



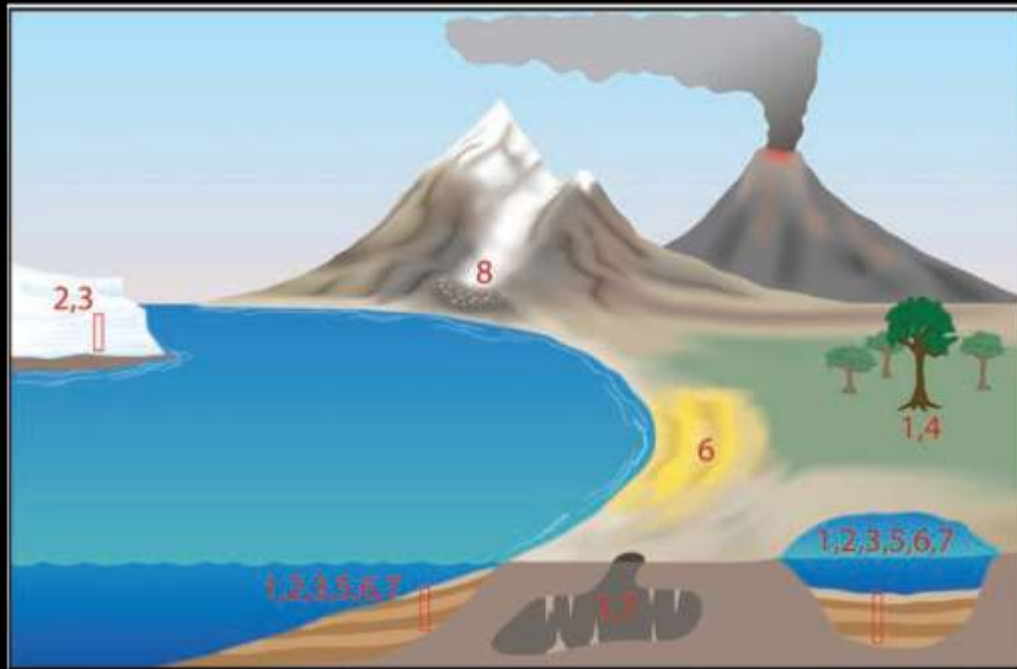
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“Human” anatomy >>Encephalised
>>Dietary range >>Behavioural complexity

- Australopithecine phase 4 – 2 Ma:
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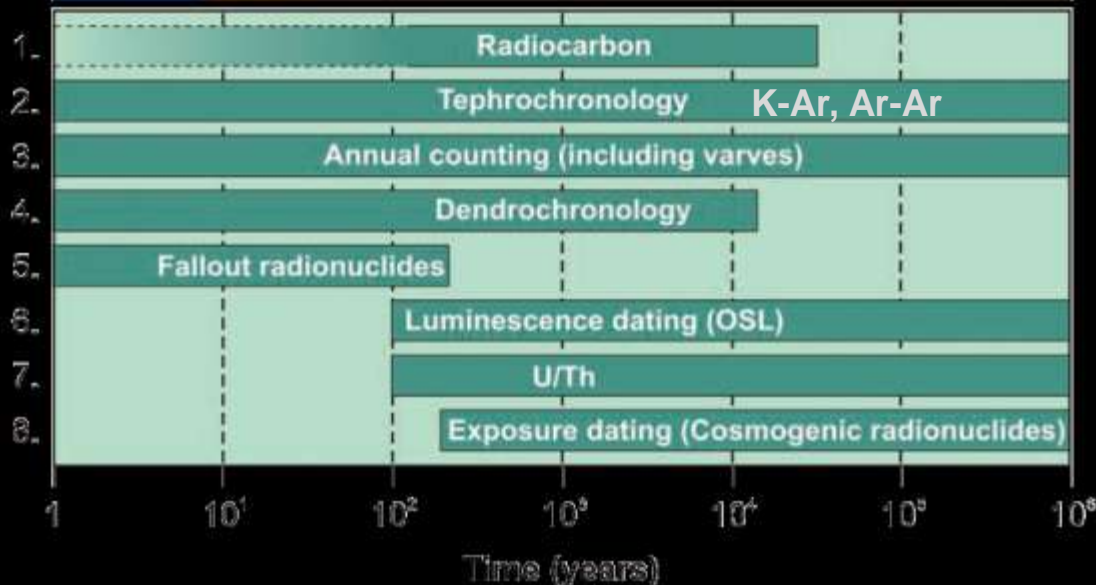
- Early phase 7 – 4 Ma: C + E. Africa. Still poorly
known. Earliest bipeds? Largely ape-like?



Some dating methods....



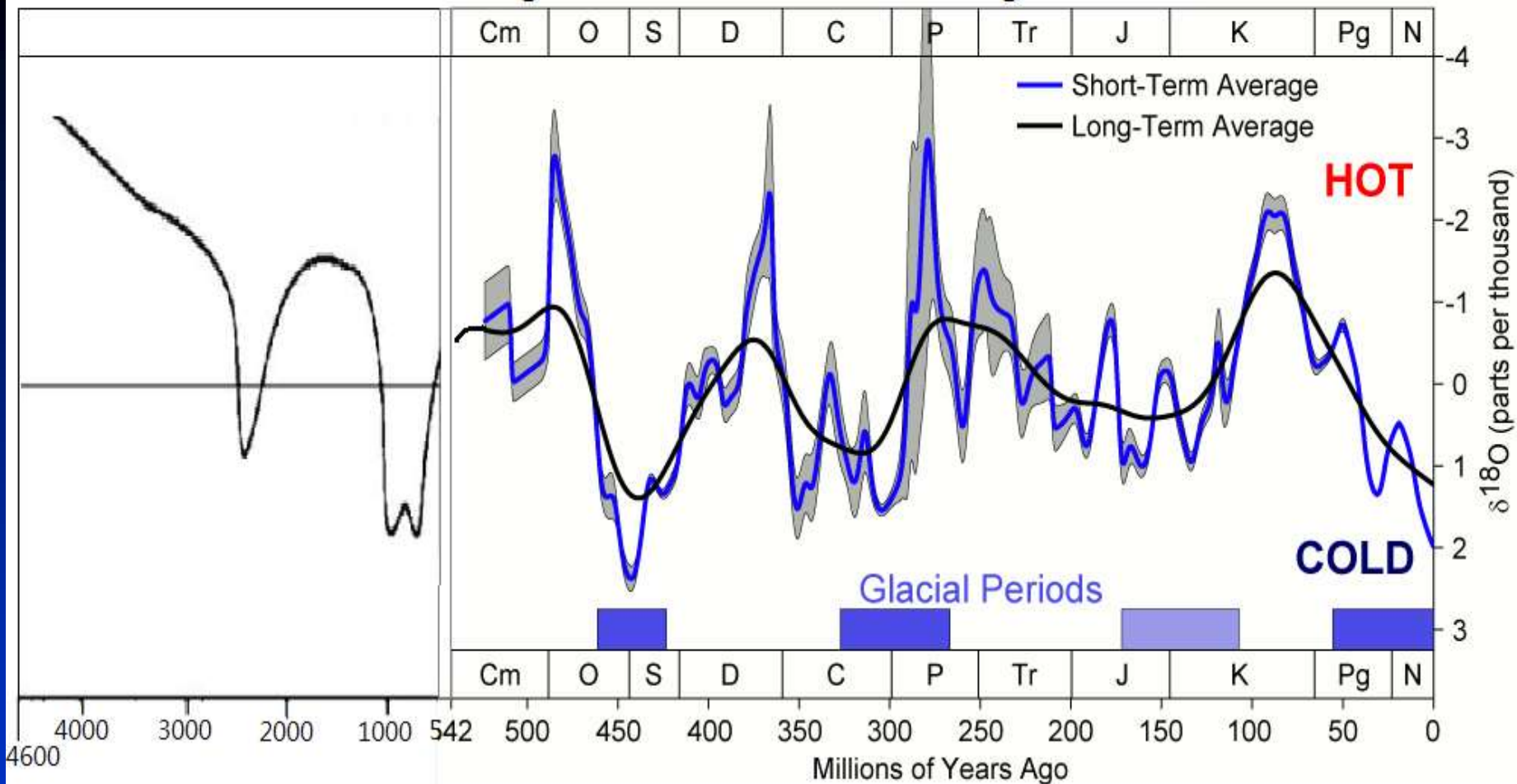
Ma = million yrs
Ka = thousand yrs



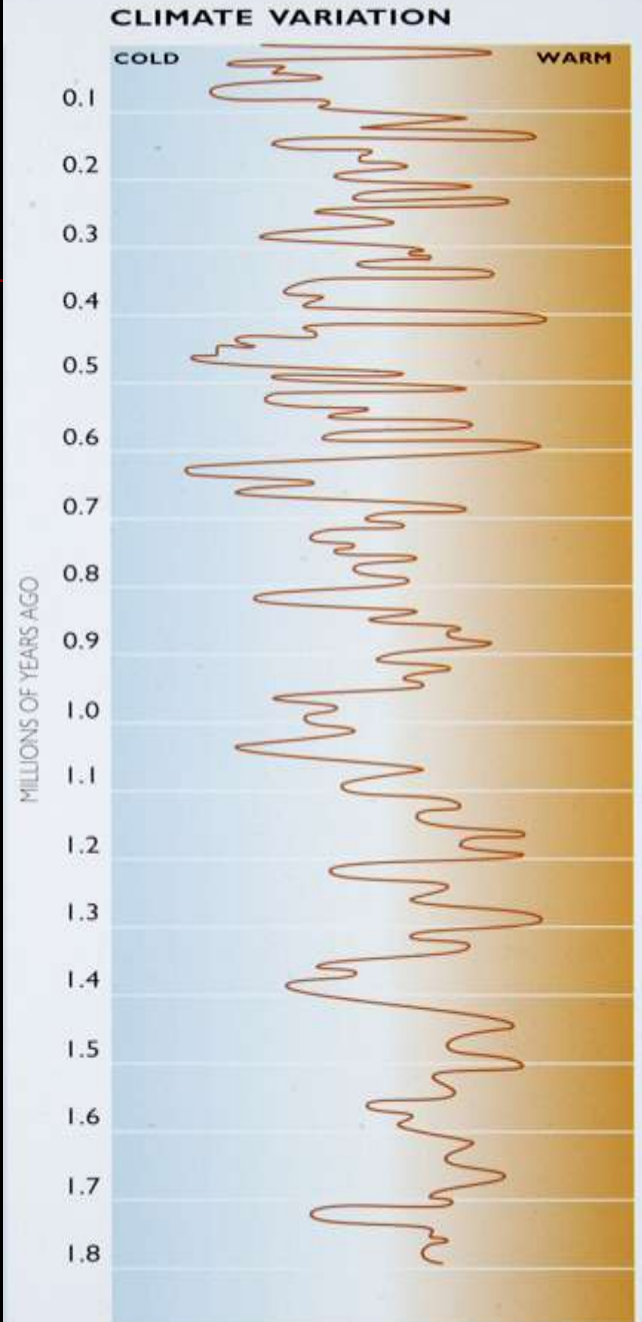
A photograph of a massive glacier wall meeting the ocean. The glacier is a deep blue color, showing vertical crevasses and a jagged edge. In the foreground, there is a snowy slope. The sky is overcast and grey. The text "UNDERSTANDING ICE AGES" is overlaid in white, serif font in the upper right quadrant.

UNDERSTANDING ICE AGES

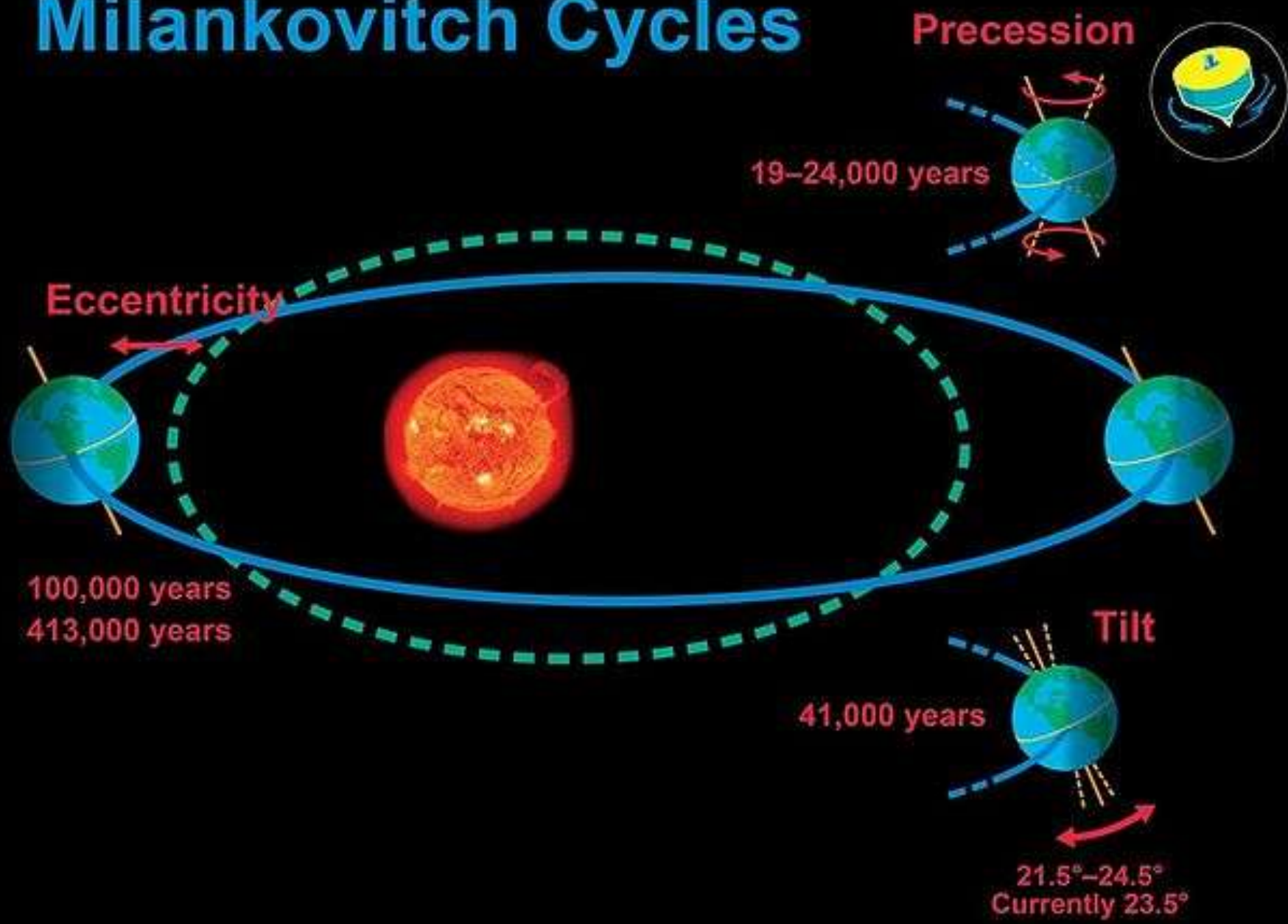
Geologic time scale Climate Change (note variable scale)



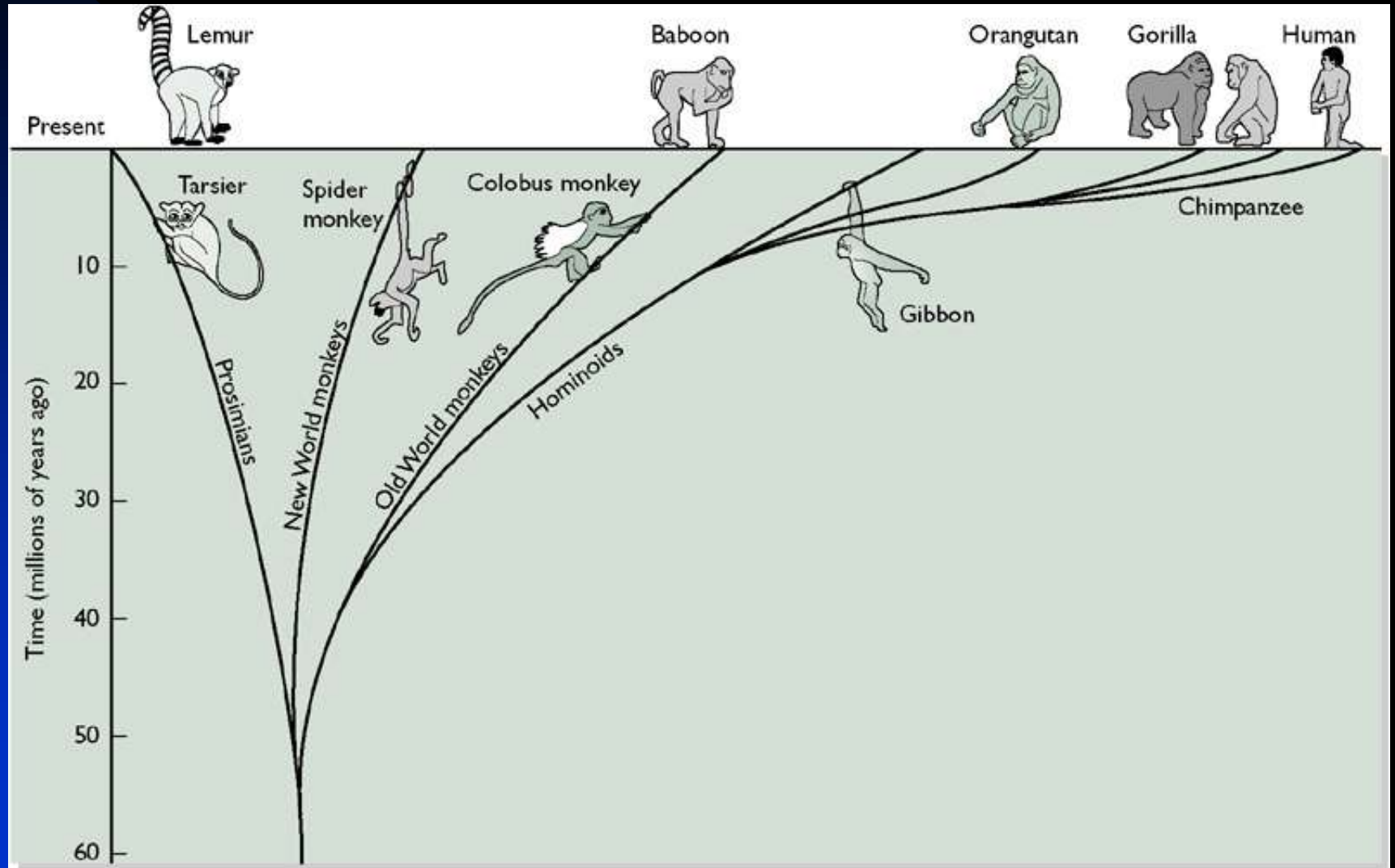
Climate change in the last 2 Ma



Milankovitch Cycles



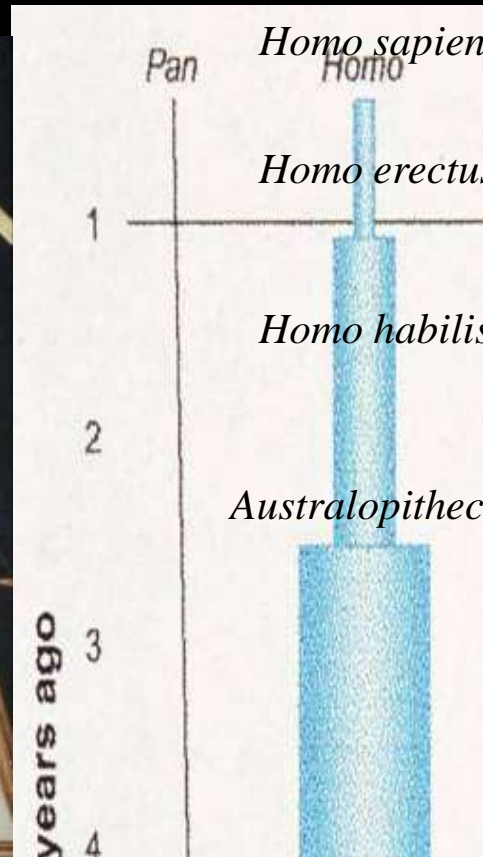
The basics of Primate evolution



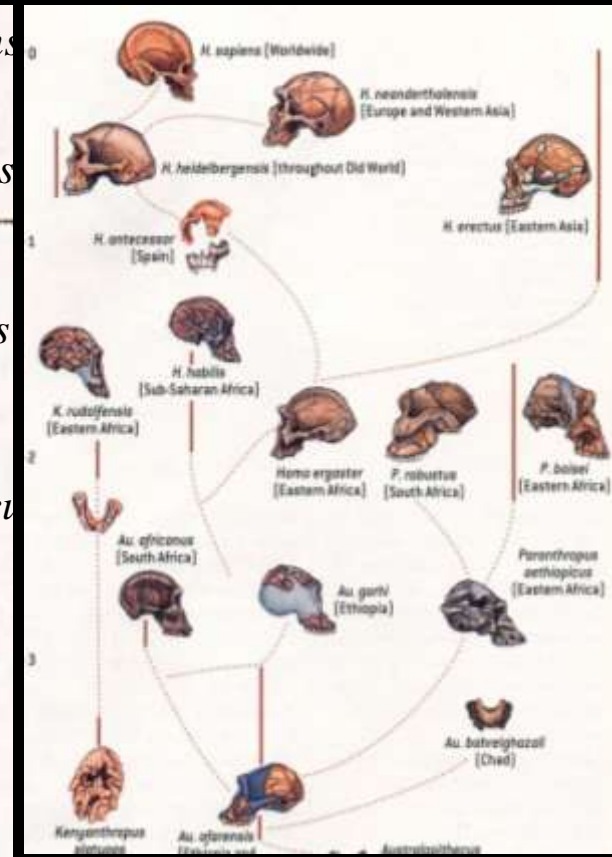
Changing perspectives...



John Reader

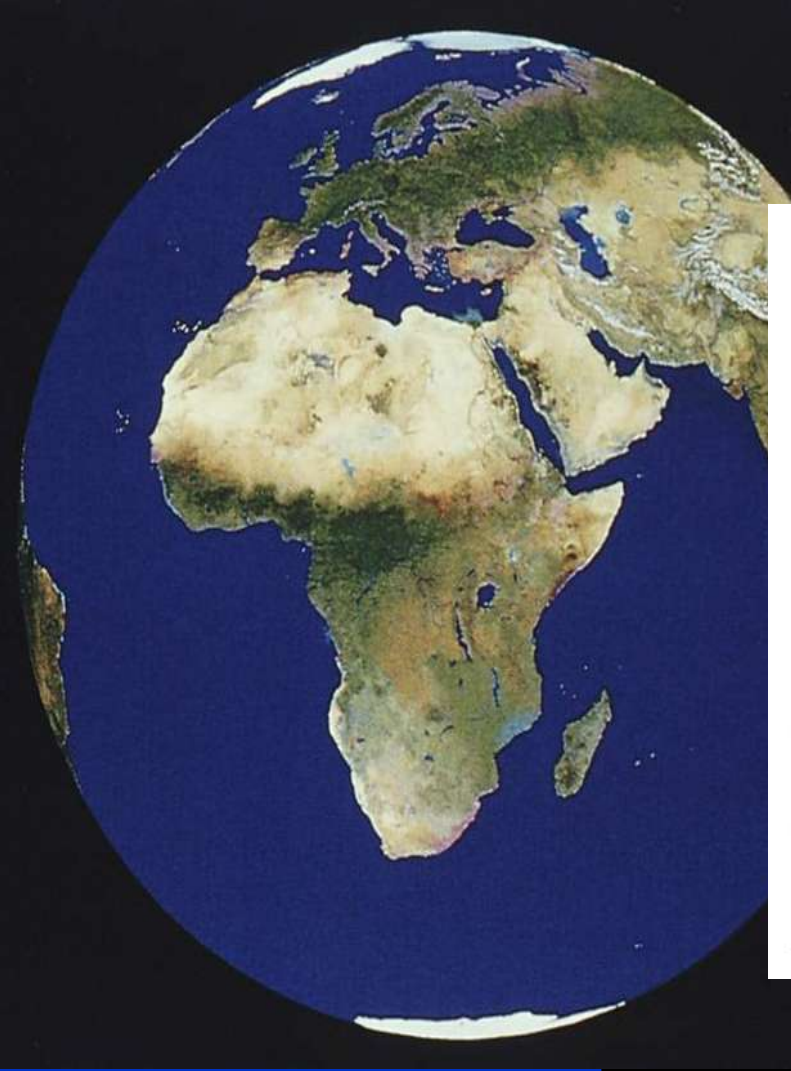


Begun



Tattersall

Darwin (1871): an African origin?

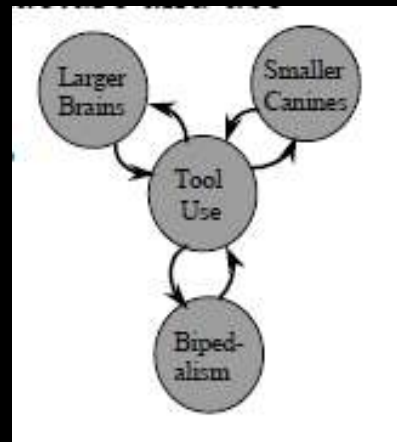


“We are naturally led to enquire where was the birthplace of man at that stage of descent when our progenitors diverged from the Catarhine stock. The fact that they belonged to this stock clearly shews that they inhabited the Old World; but not from Australia nor any oceanic island, as we infer from the laws of geographical distribution. In each great region of the world the living mammals are closely related to the extinct species of the same region. It is therefore probable that Africa was formerly inhabited by extinct apes closely allied to the gorilla and chimpanzee; and as these two species are now man’s nearest allies, it is somewhat more probable that our early progenitors lived on the African continent than elsewhere. “

Descent of Man 1871 p. 199.

Darwin 1871

- The free use of the arms and hands, partly the cause and partly the result of man's erect position, appears to have led...to other modifications of structure. The early male forefathers of Man were, as previously stated, probably furnished with great canine teeth; but as they gradually acquired the habit of using stones, clubs, or other weapons, for fighting with their enemies or rivals, they would use their jaws less and less.
- As the progenitors of man became more and more erect, with their hands and arms more and more modified for prehension and other purposes, with their feet and legs at the same time transformed for firm support and progression, endless other changes of structure would become necessary. The pelvis would have to be broadened, the spine peculiarly curved, and the head fixed in an altered position, all which changes have been attained by Man.

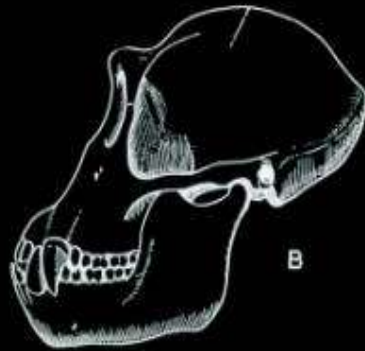


Human and ape anatomy

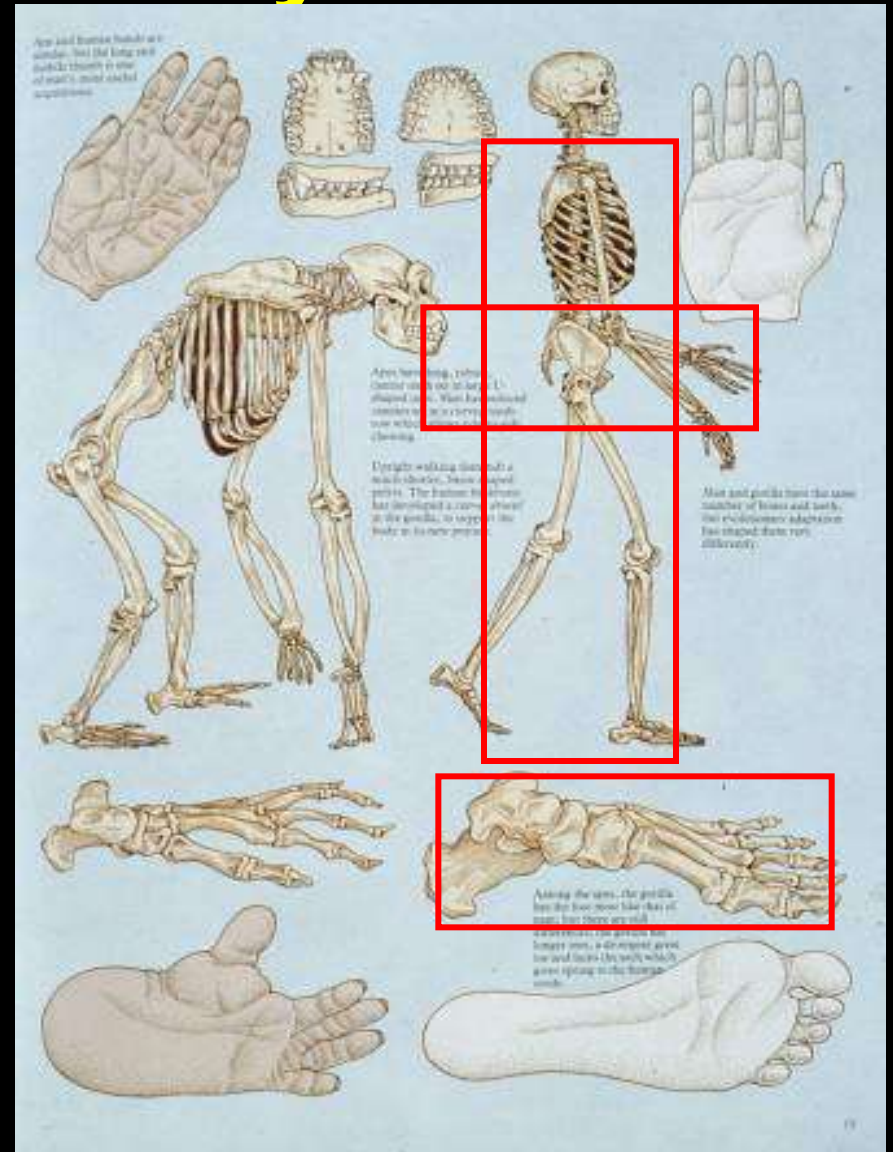
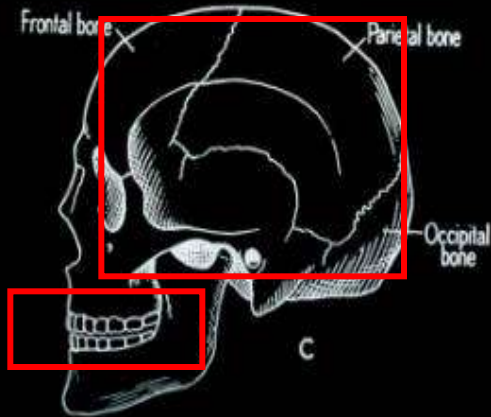
Dog



Chimp



Human



Evidence to reconstruct the past...



Tools



Behaviour



Fossils



Palaeontology

Archaeology

Contextual and other data

Evolution

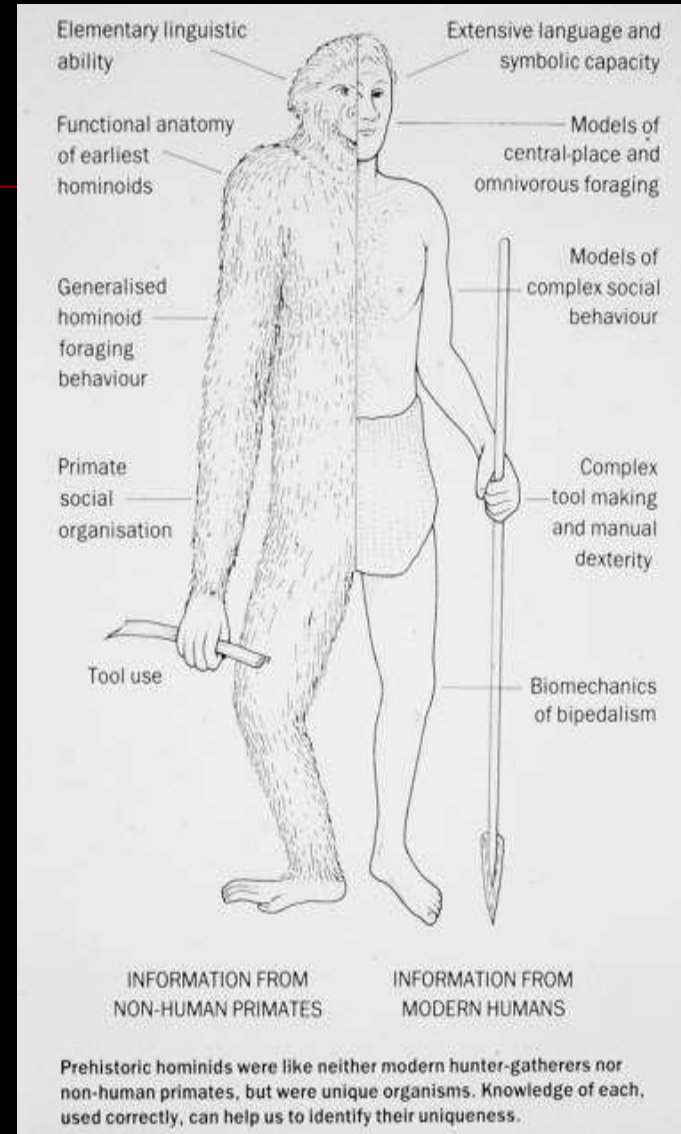
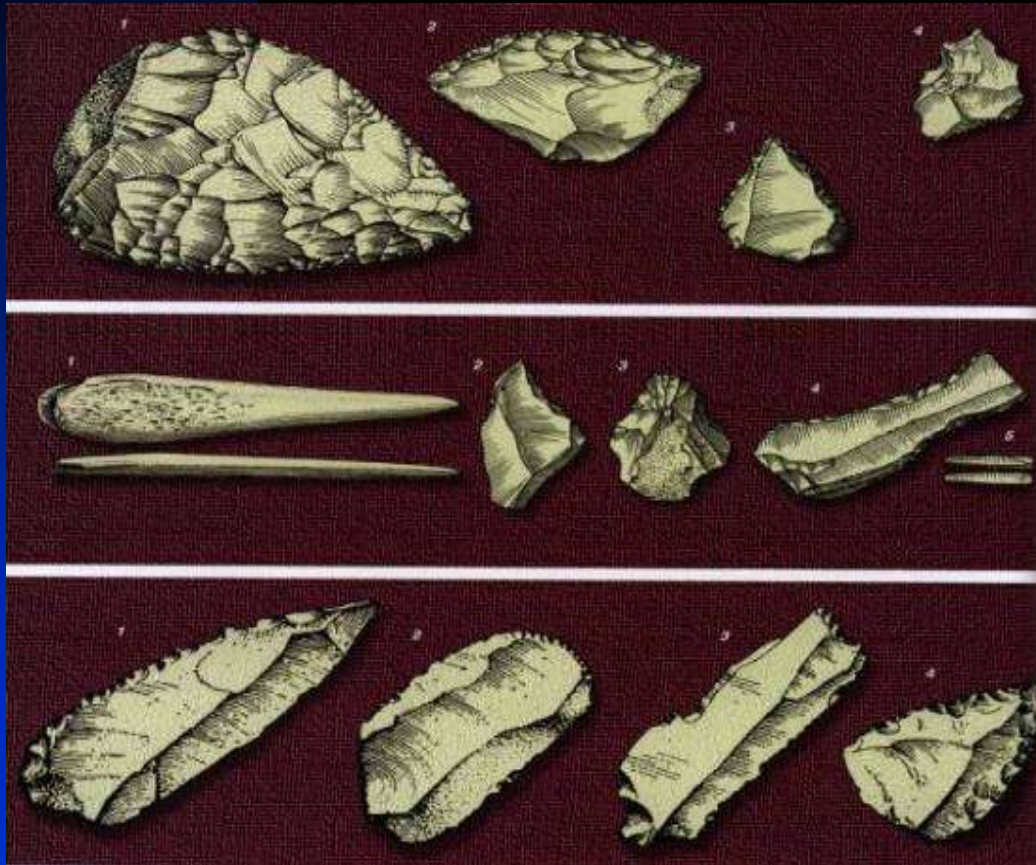
History

Stratigraphy + dating

Isotopes
Calculus
DNA



Human behaviour



R.
Foley

New techniques of investigation

Scanning and morphometrics

Zollikofer & Ponce de Leon

New Techniques for Studying Fossils

Scientists investigating fossil remains have an ever-growing battery of techniques to help them study their finds in greater detail. They can now potentially directly date a fossil using a range of techniques (see pp. 30-33). These include radiocarbon dating, if the specimen is probably no older than about 50,000 years, uranium series dating by pairing it in a gamma ray counter, or electron spin resonance (ESR) dating by using a fragment of its tooth enamel. Computers have allowed the compilation and rapid analysis of large quantities of data obtained from fossils. The slow and methodical use of traditional metal measuring instruments, similar to engineering calipers, is now giving way to the rapid recording of data by electronic, sonic or laser light sensors, which can relate points on surfaces very precisely in three dimensions, and transfer them directly into computers for recall. The resultant network of points can essentially reconstruct the shape of the object, such as a fossil skull, and compare it on screen

with others. Morphing techniques can be used to illustrate the amount of change in shape required to vary, involve one specimen into another, or to grow a series of specimens through their life cycle.

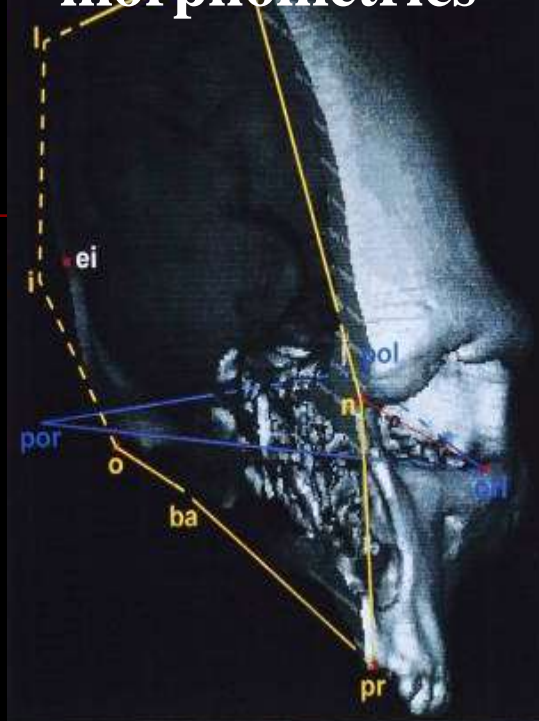
Scanning fossils

Once the technique of X-raying or radiographing objects became widespread, hidden internal information about fossils could be studied for the first time - for example, the shape of sinus chambers within skulls, or the form of tooth roots within jawbones. Now, a powerful new X-ray technique has become available from medicine, called computerized tomography. The resultant images are called CT scans, and these can be processed on computers, printed, or even transformed into solid replicas by a technique called stereolithography. They are providing unprecedentedly detailed internal images of fossils, and the images can be manipulated to 'remove' rock that is still obscuring a fossil, or to reconstruct an incomplete fossil.

For example, in 1993, Neanderthal fossil remains were found in Gibraltar, at a site called Devil's Tower. They consisted of parts of the upper and lower jaws and braincase of a child. The teeth of the child matched those of a modern five-year-old in their state of development. However, the original assumption that they represented a single child of about five was challenged in 1992 by the suggestion that these bones might represent the remains of two



Left: In 1993, the bones of a child's skull were excavated from deposits below the north face of the rock of Gibraltar near Devil's Tower. They were recognized as a very good example of a young Neanderthal. Later research raised the possibility that the bones of two children of different maturity had been mixed up. However, detailed study of the lower and the teeth within the jaws suggested that they all came from a child aged about 4 years or so. The new facilities combined with computerized tomography (CT) have proved to reconstruct the whole skull, showing that the bones did indeed represent



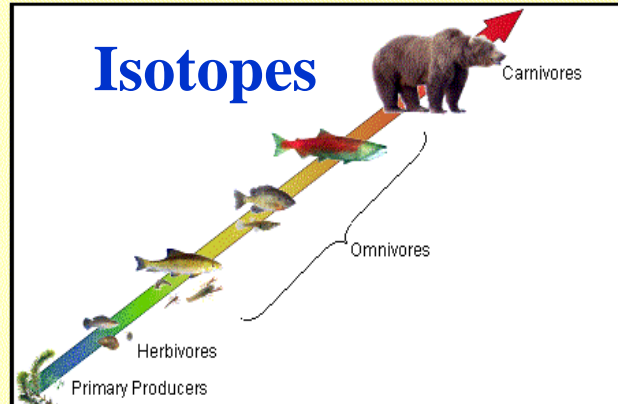
CT study and reconstruction

SEM, MicroCT, Synchrotron

Direct dating

~259 ka

Nitrogen Isotope Ratio ($\delta^{15}\text{N}$)

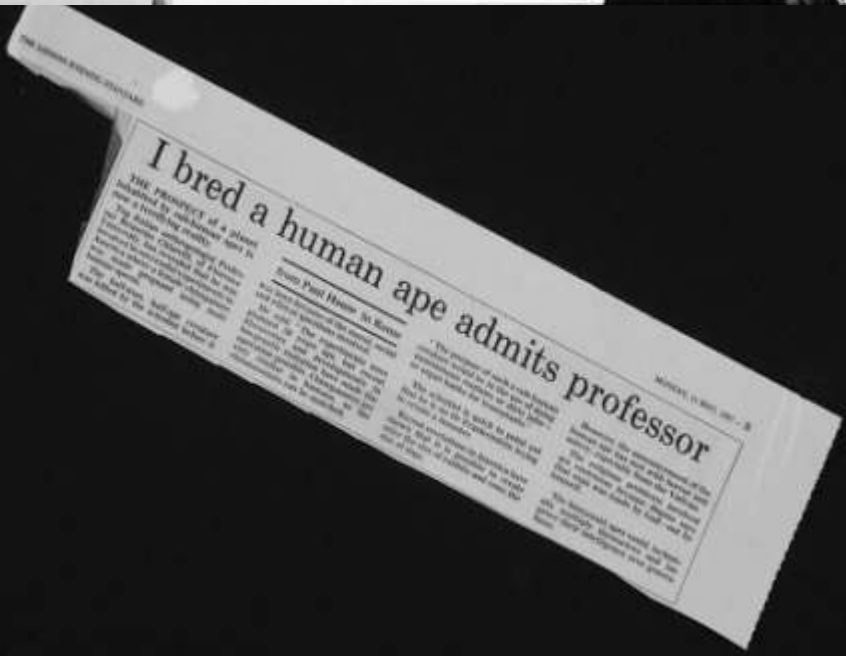
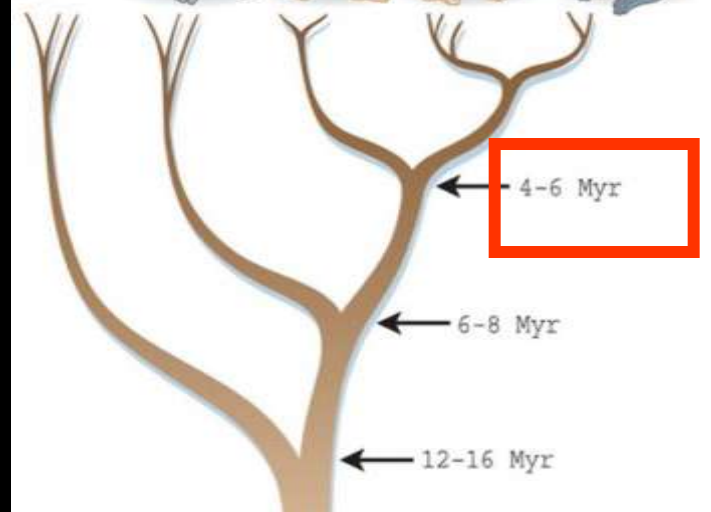
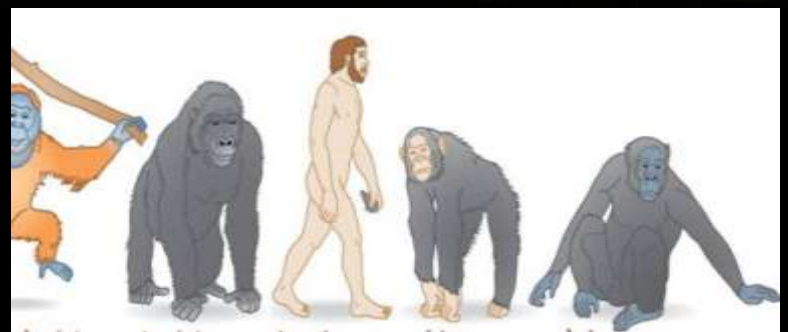
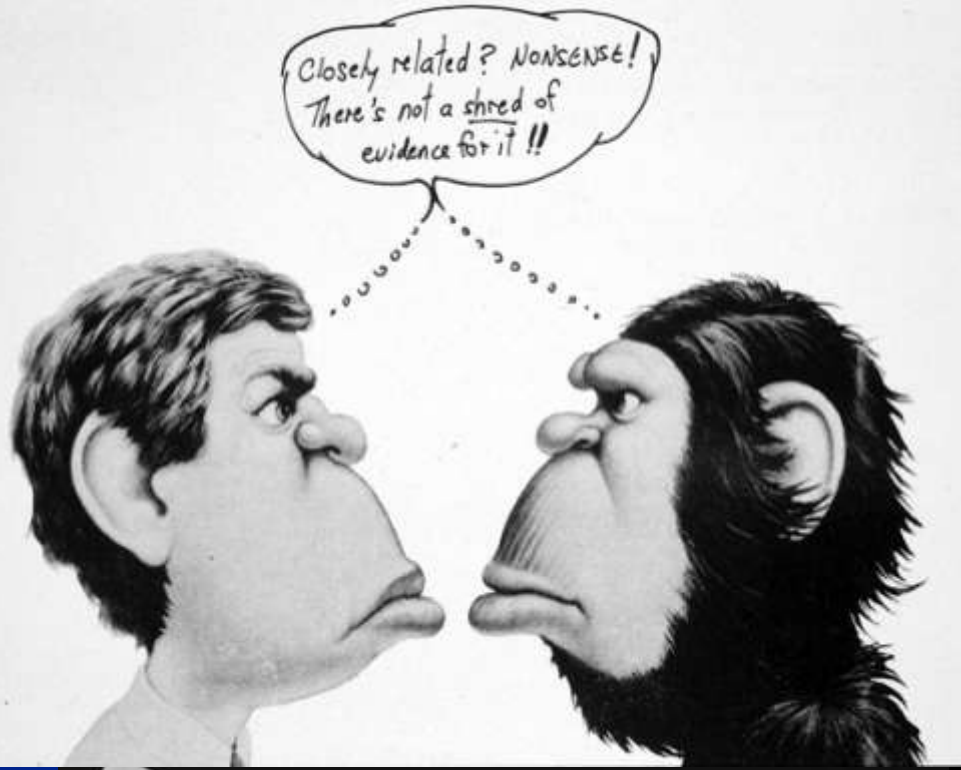


Carbon Isotope Ratio ($\delta^{13}\text{C}$)

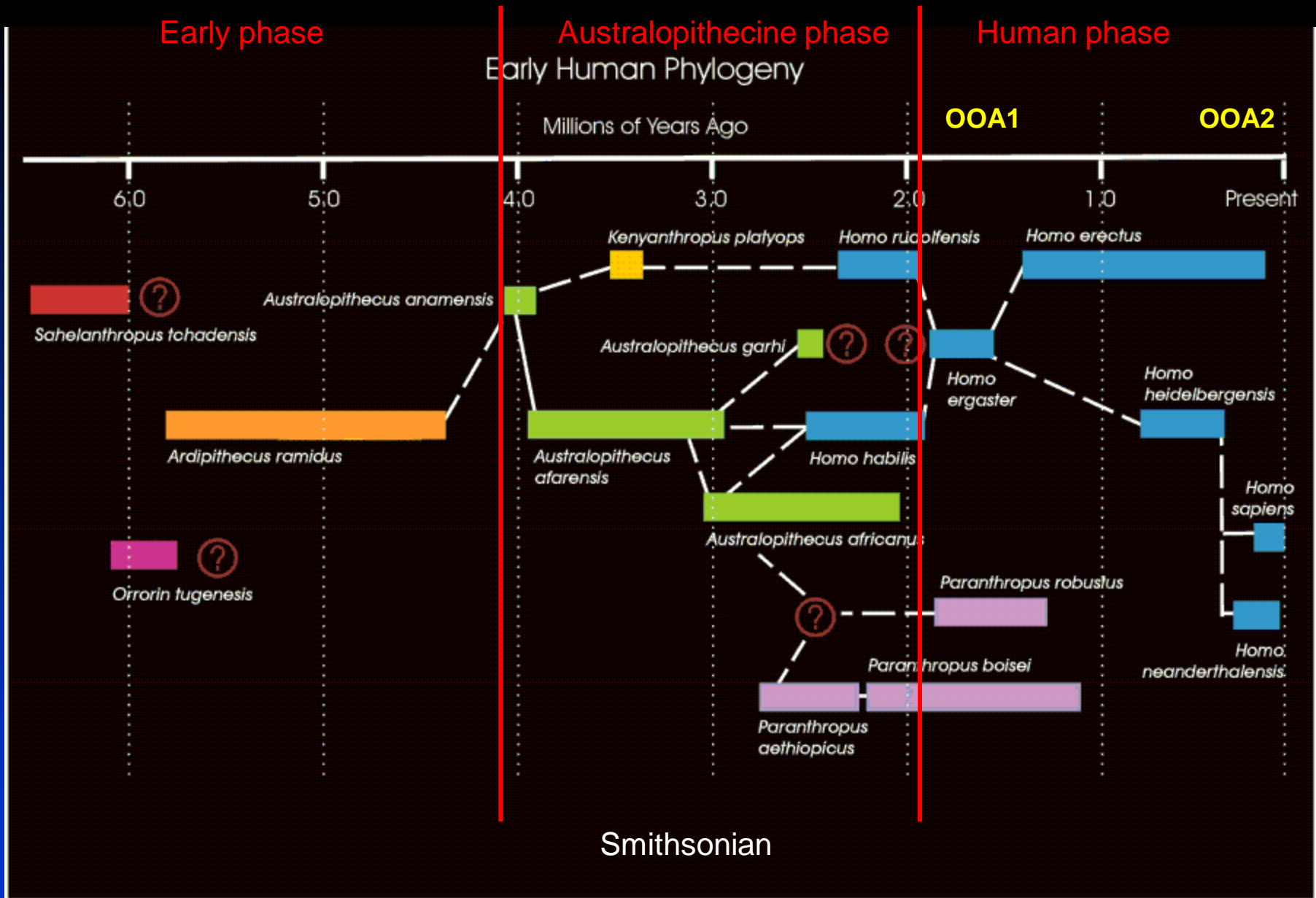
DNA



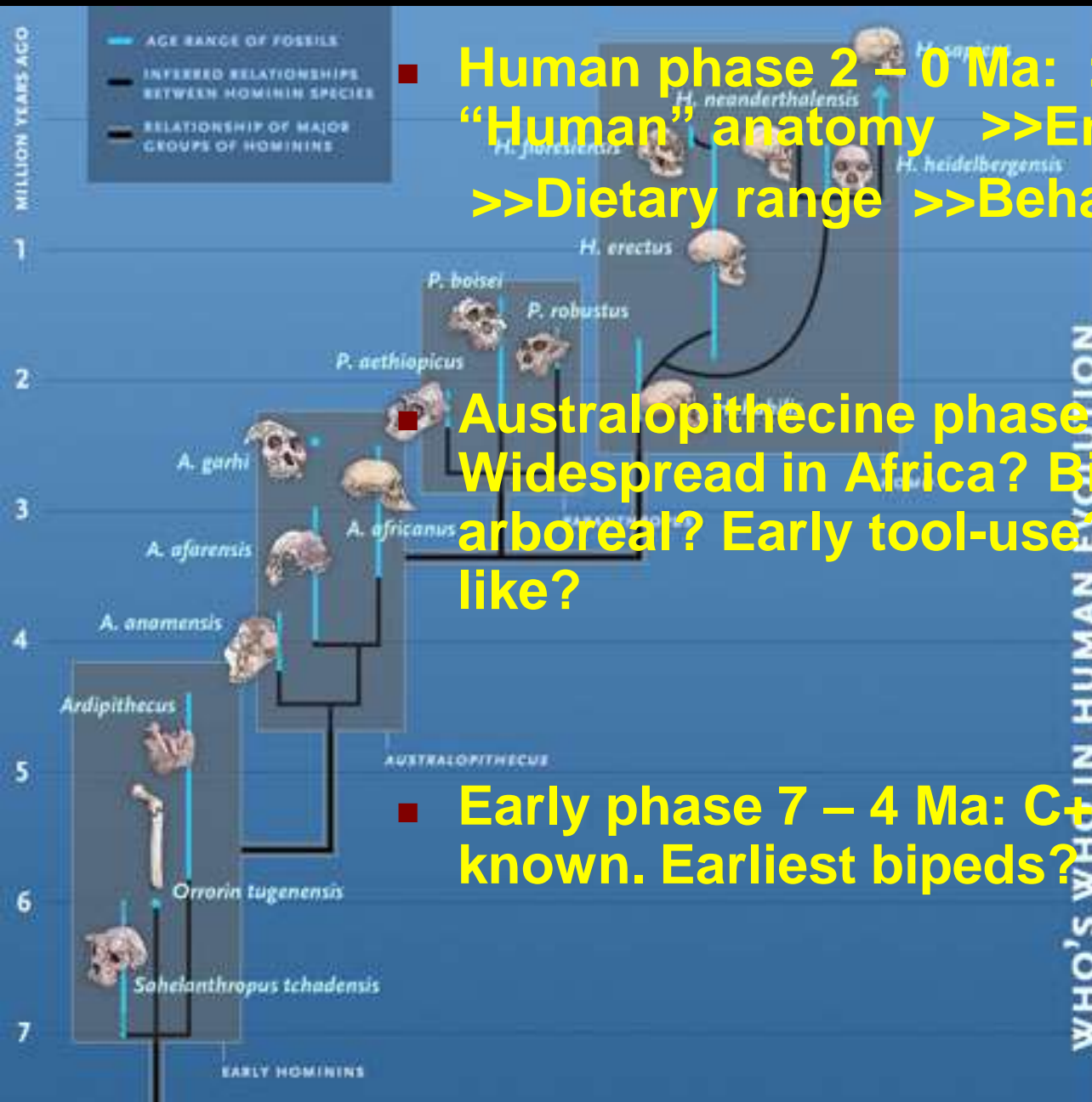
Neanderthals Were Not Our Ancestors



A complex evolutionary history



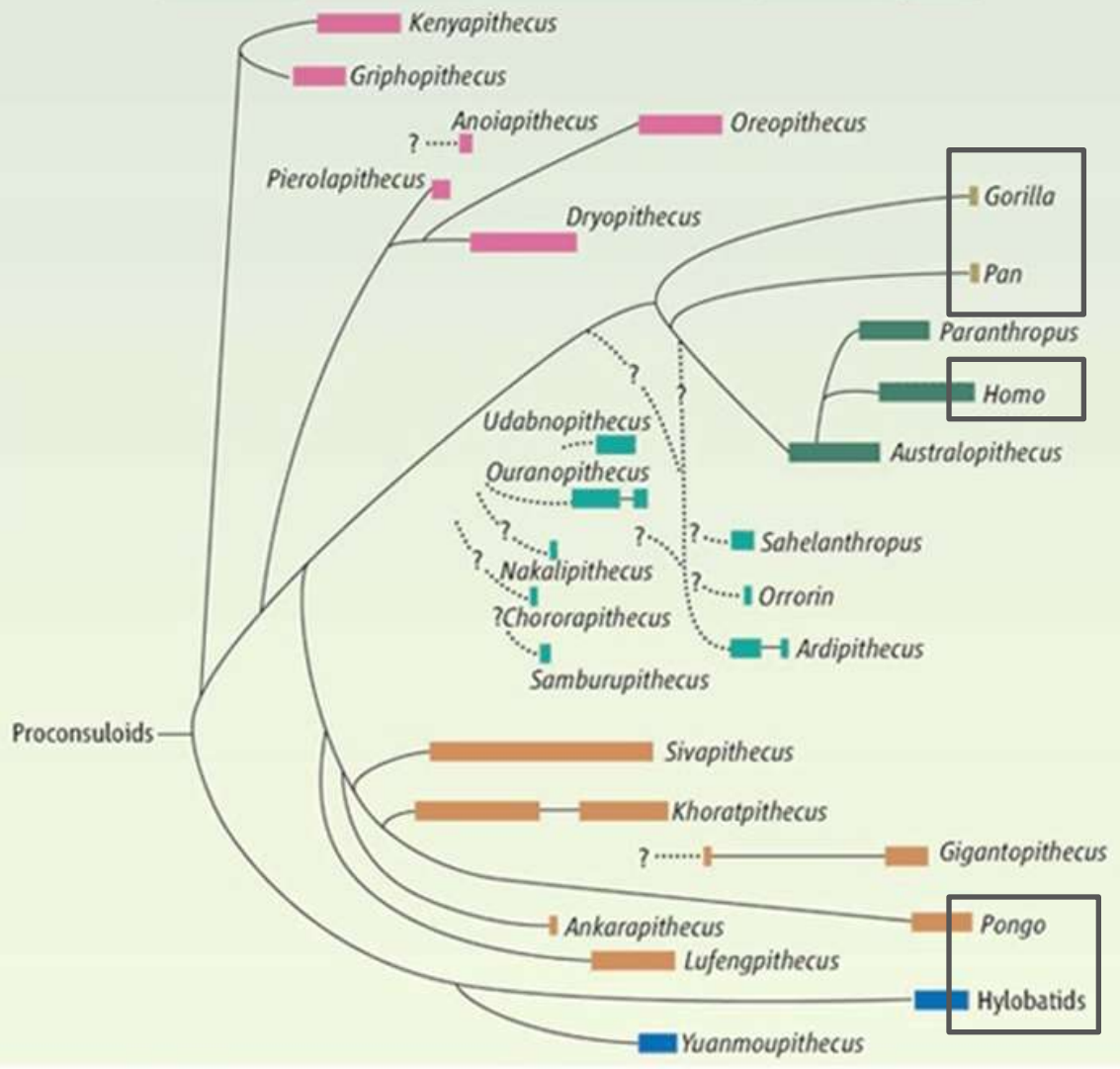
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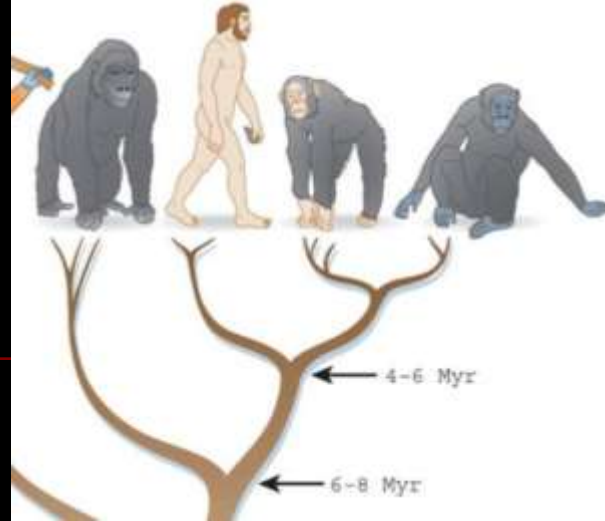
- Early phase 7 – 4 Ma: C + E. Africa. Still poorly
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- Stem hominids
- Hominins
- Pongines
- Extant African great apes
- Stem hominines or stem hominins
- Hylobatids

Africa 4.4 - 7 Ma

Science

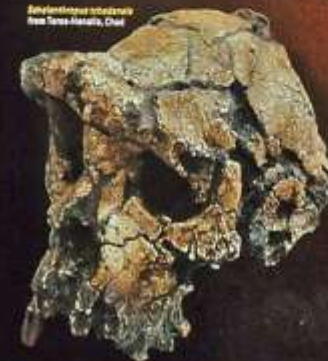


African Roots

RECENT FINDS from Africa could extend in time and space the fossil record of early human ancestors. Just a few years ago, remains more than 4.4 million years old were essentially unknown, and the oldest specimens all came from East Africa. In 2001, paleontologists working in Kenya's Tugen Hills and Ethiopia's Middle Awash region announced that they had discovered hominids dating back to nearly six million years ago [Dorothée Tchernicová and Ardipithecus ramidus Addis, respectively]. Then, last July, University of Pickers...

paleontologist Michel Brunet and his Franco-Chadian Paleoanthropological Mission reported having unearthed a nearly seven-million-year-old hominid, called Sahelanthropus tchadensis, at a site known as Toros-Menalla in northern Chad. The site lies some 2,500 kilometers west of the East African fossil localities. "I think the most important thing we have done in terms of trying to understand our story is to open this new window," Brunet remarks. "We are proud to be the pioneers of the West."

Sahelanthropus



Ardipithecus



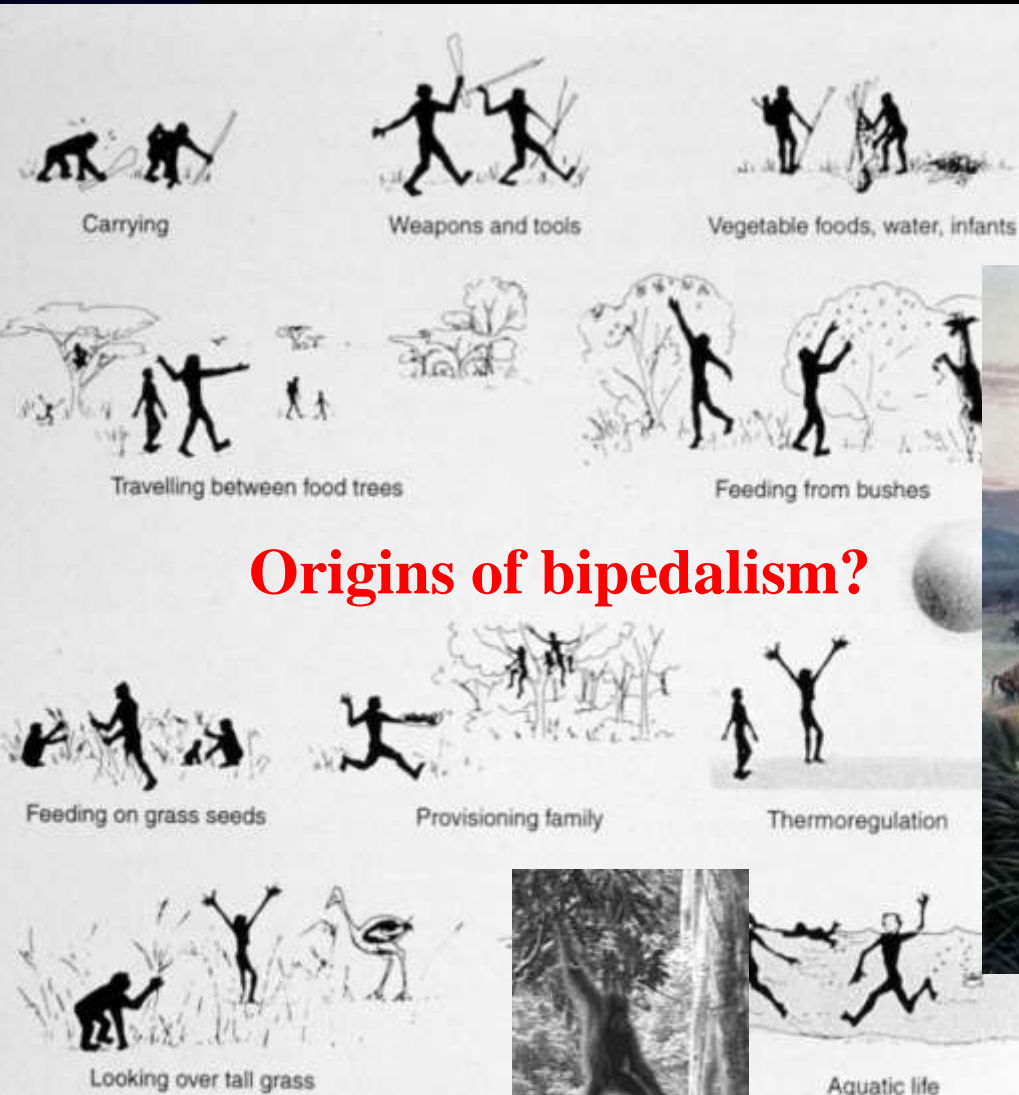
Orrorin



Fossil trail. Many kinds of hominids lived in Africa 6 million to 2.5 million years ago, before *Homo* appeared.

The earliest hominins?

Walking upright and canine reduction seem to happen much earlier than tool use and brain enlargement



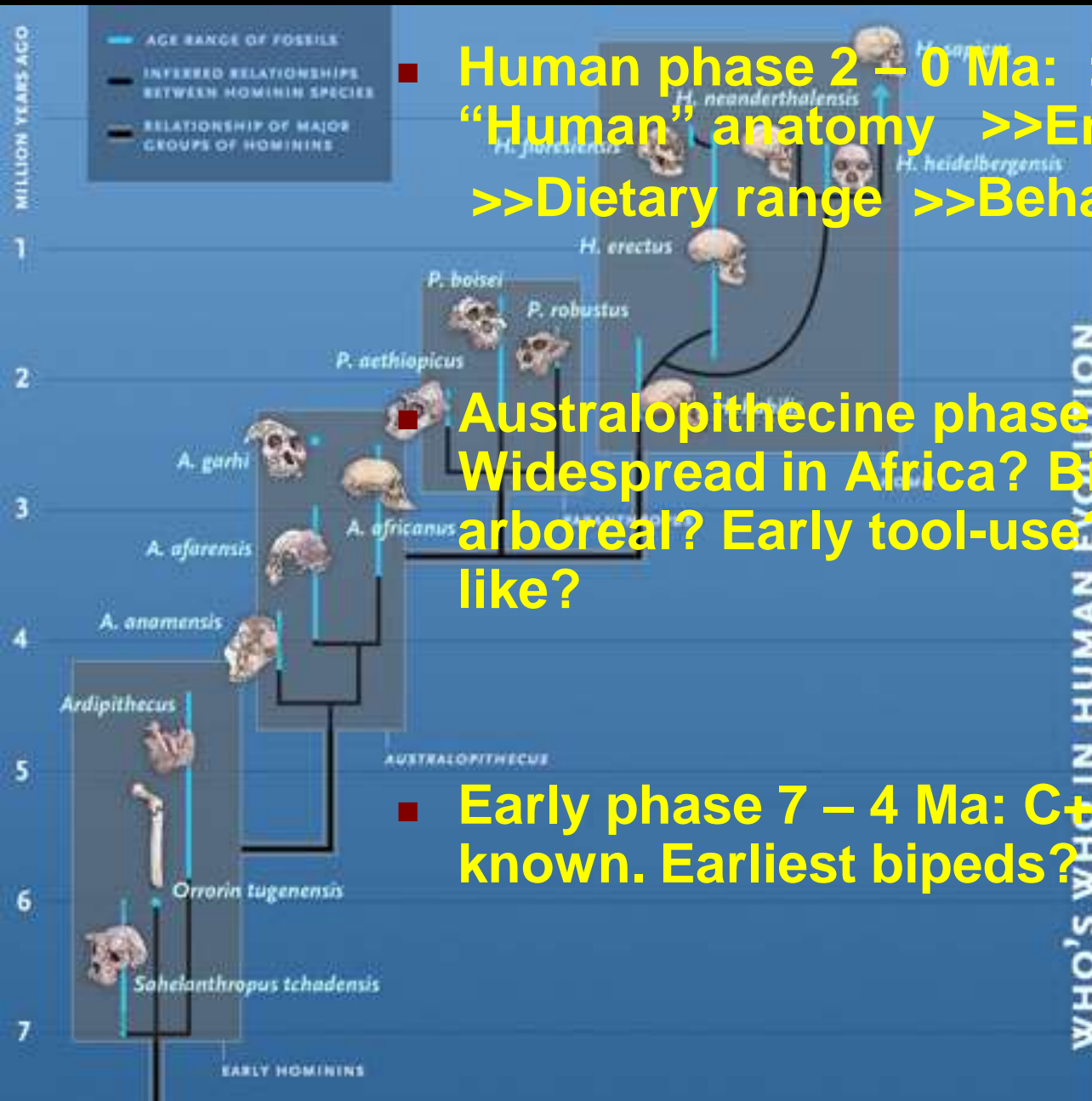
Origins of bipedalism?



FIGURE 17.11 Various theories on the adaptive origin of hominid bipedalism (courtesy of Jeanne Sept and L. Betti).

Aquatic life

“Phases” of human evolution



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APPE-MAN OF AFRICA HAD COMMON SENSE!

On the Way to Speech, says Finder Telling Where Darwin Was Right!

LONDON WAITS BEFORE ACCEPTING THE 500,000-YEAR-OLD LINK.

Professor Dart, the discoverer of the so-called "Missing Link" between *Malpang* and *Kimberly*, proposes to classify its as "Homo-antropoid", or man-ape.

He thinks the six-year-old child of countless ages ago had a brain in advance of the present-day apish, and had such common sense as indicated a milestone on the way to articulate speech. So Darwin was right in fixing the birthplace of Man in Africa!

But Professor G. Elliot Smith, of London, says there are not as much data to prove that the skull is other than that of an anthropoid.

WALKED HALF-UPRIGHT

Link Baby's Facial Line Like that of a Human Child.

Full details of the reported discovery of the "Missing Link" are given by Prof. G. Elliot Smith, of the Johannesburg University, in the current issue of "Nature".

HALF-ERECT, NOT HAND-WALKING

Professor Dart, of the Johannesburg University, writes in the "Daily Chronicle" on Wednesday that the "Missing Link" was a creature that walked on its knuckles and was not a hand-walker. He says that the facial line of the skull is that of a human child of six years of age.

This discovery and others of a similar nature in Africa, writes Professor Dart, "lend promise to the expectation that a tolerably complete story of higher primate evolution in Africa will yet be wrested from our rocks."

"The specimen is of importance because it exhibits an extinct race of ape intermediata between living anthropoids (like gorillas, chimpanzees, and orangutans) and man."

Three of the grounds on which Professor Dart bases the importance of his find are that the cranium, the part of the skull containing the brain, the teeth, and the lower jawbone all show "humanoid" rather than "anthropoid" characteristics.

CHILD MISSING-LINK

It states that in this skull, which is believed to be the oldest of the group, the teeth show a "humanoid" character. The jawbone is also said to be "humanoid."

SOME COMMON SENSE

"This group, however, is a hesitating one in its development, as shown by the fact that it has not yet attained the stage of a fully articulated jawbone. It is, therefore, a creature that is on the way to becoming a fully articulated jawbone, but has not yet attained that stage."

"In other words, this group has not yet attained the stage of a fully articulated jawbone, but has not yet attained that stage."

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Al comparar la mandíbula de Australopithecus africanus con la de un niño de su edad se aprecia que ésta es más grande que la de un niño.

Australopithecus africanus

2.75 Ma



Australopithecines

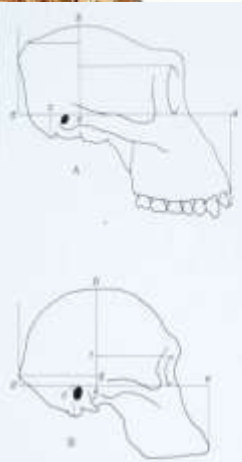
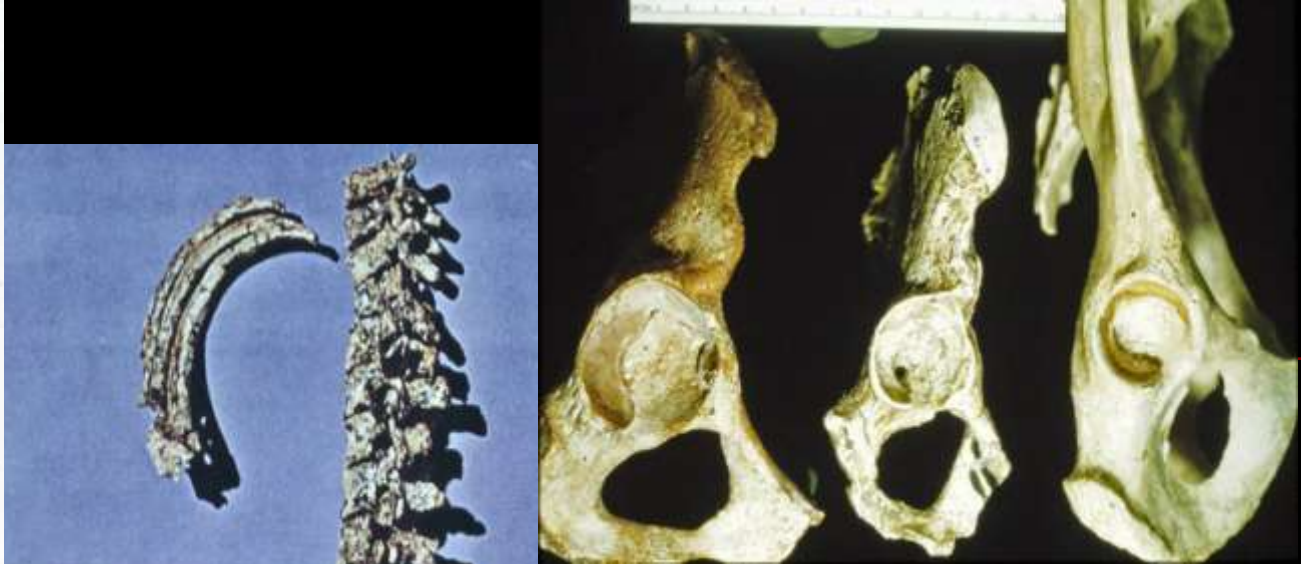
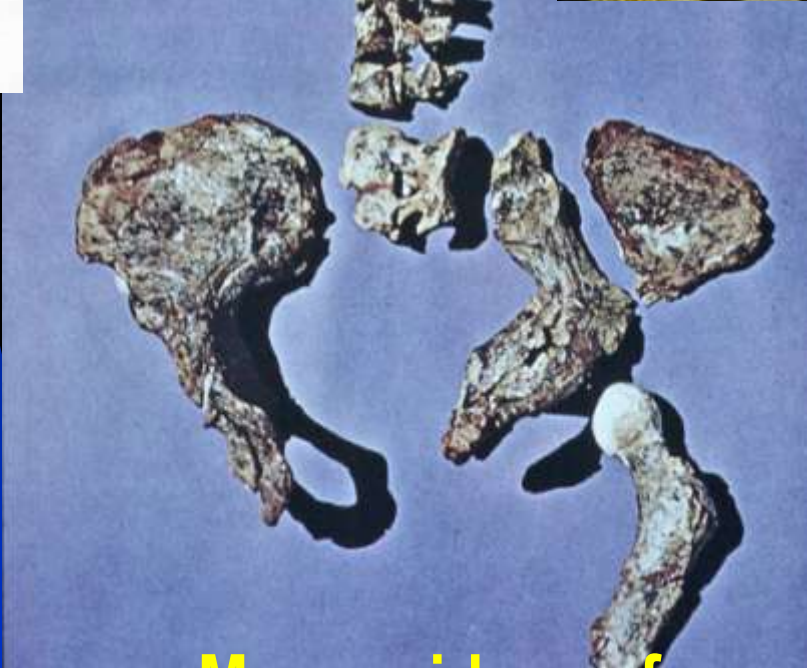
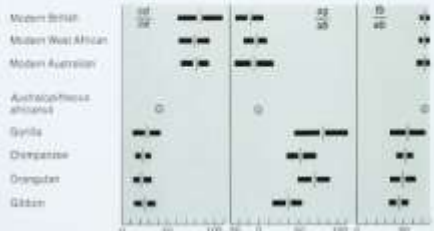
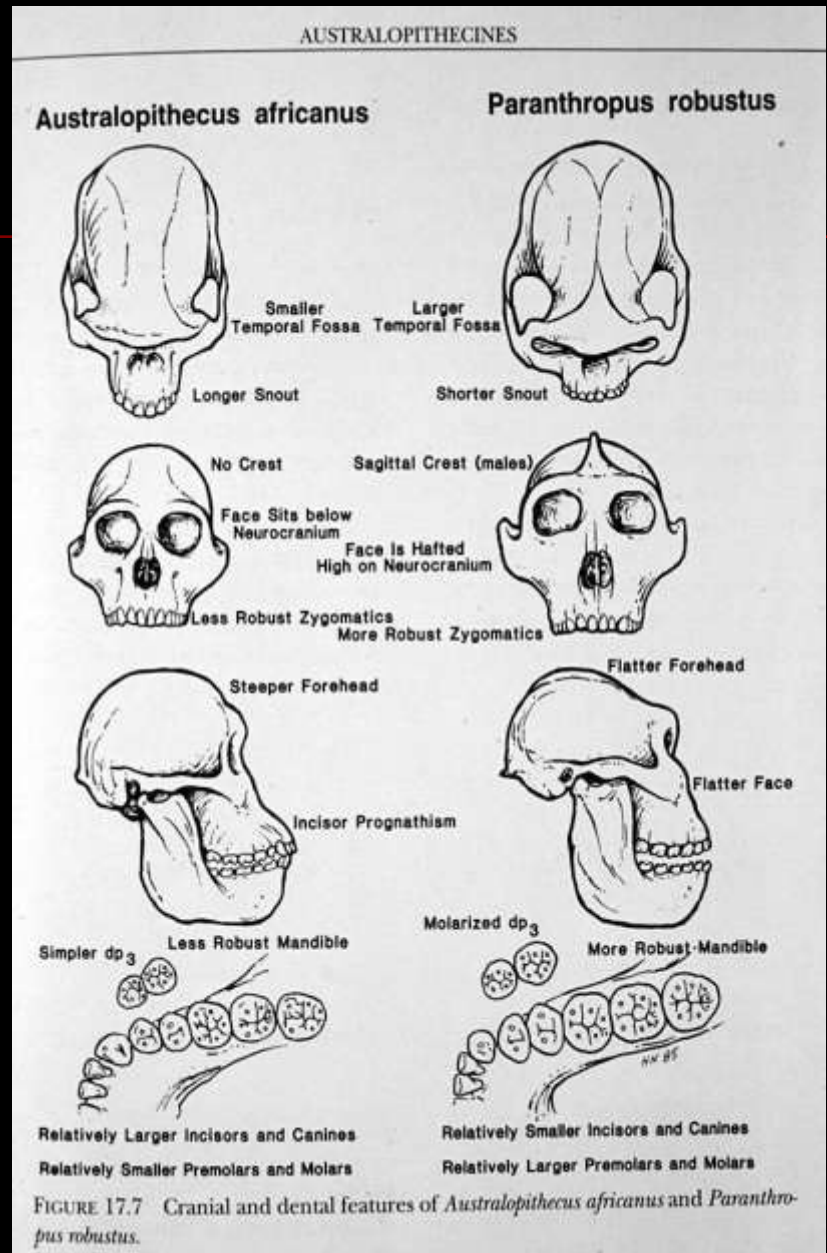


Figure 32. Skulls of gorilla (A) and *Australopithecus africanus* (B) showing major differences in cranial form. The index *ai*, *ai'* reflect the position of the brow-ridge margin, *ai* at the vertex of the neck-muscle mass, and *ai'* at the height of the brain case above the eye socket. The graphs (C) show values for population means and ranges of these indices. (A and B, After Le Gros Clark, 1944. C, After Tobias, 1967.)

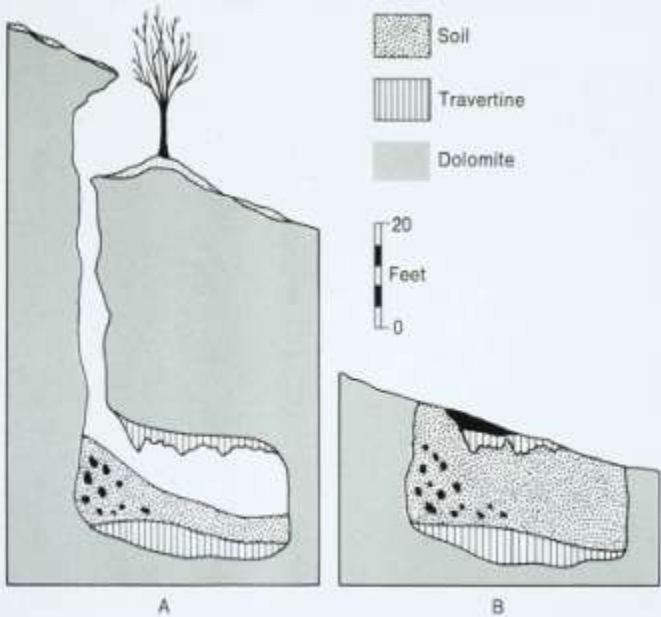


More evidence from S. Africa: Sterkfontein Cave

Paranthropus (Australopithecus) robustus



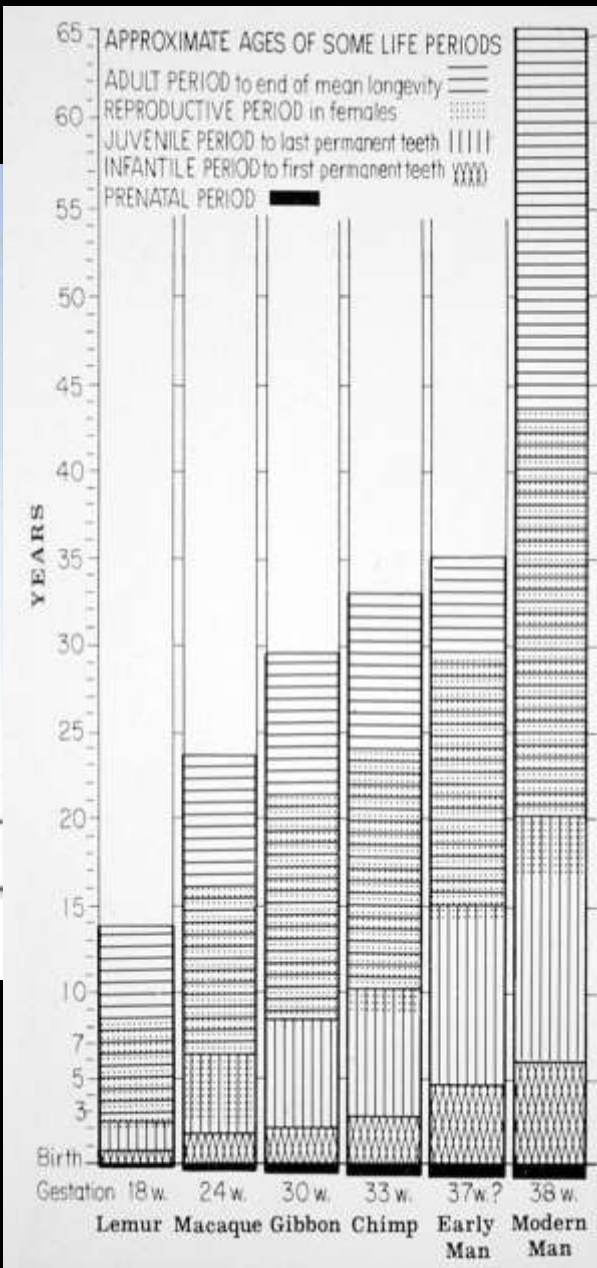
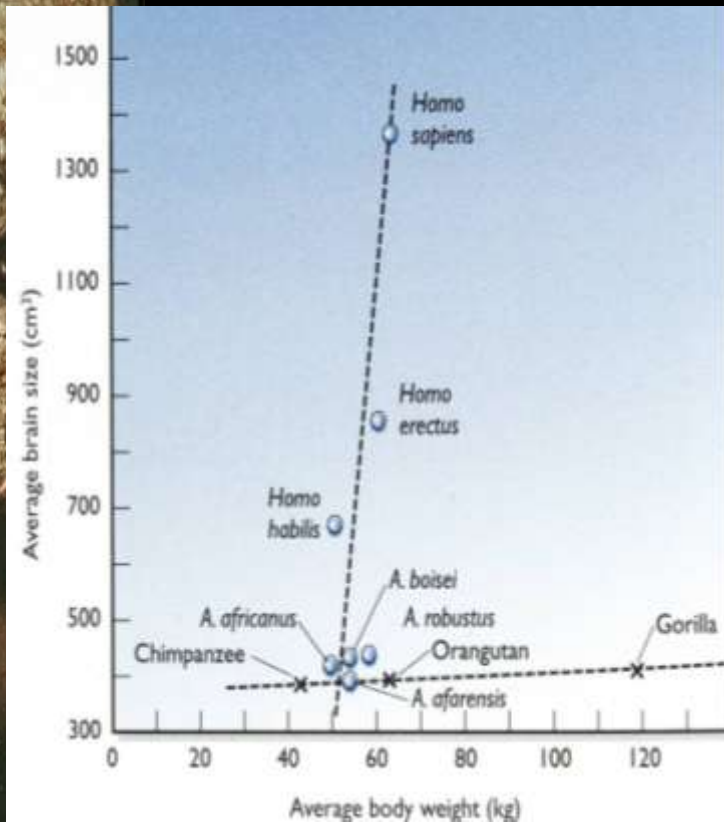
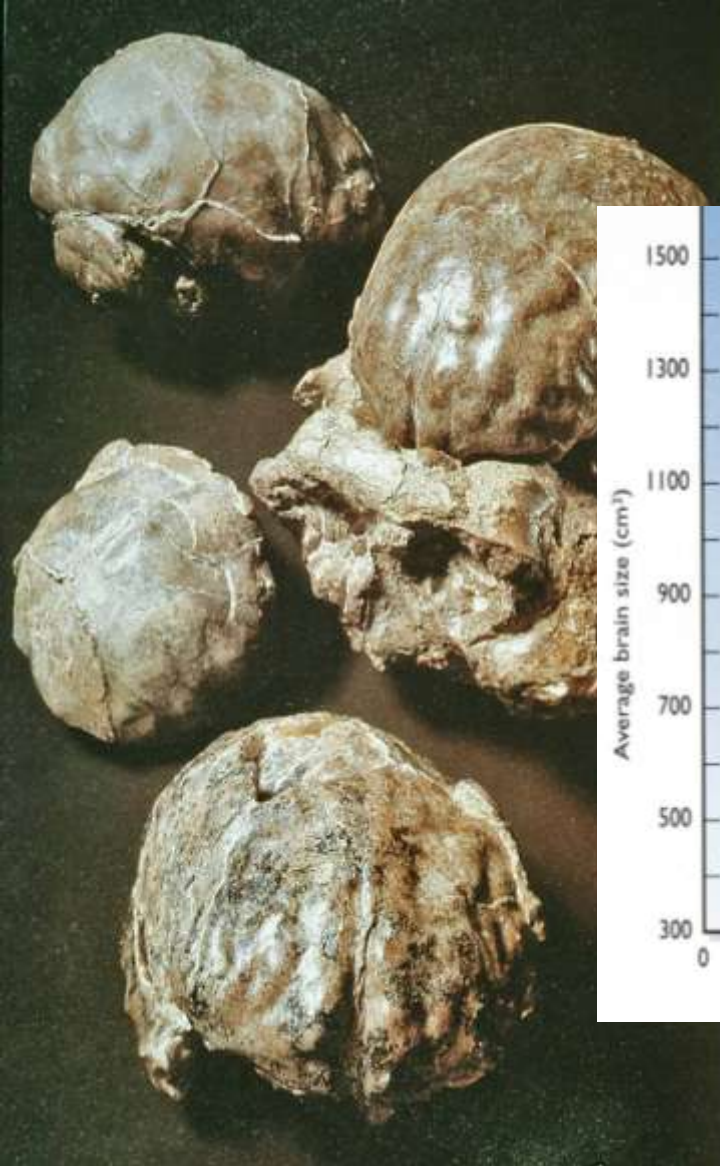
The hunters or the hunted ? (Bob Brain)



Anterior view of the cranium of *Australopithecus africanus*, showing the braincase and the position of the foramen magnum.
(Photo: C.B. Smith)

DID CARNIVORES PREY ON AUSTRALOPITHECUS ROBUSTUS?
Leopards would have preyed mainly on herbivores, small animals and humans. However one day in Swaziland, about 1.5 million years ago, a leopard caught a young "robust" australopithecine. Using its still sharp canine teeth it bit a pair of puncture marks on the skull of a juvenile specimen of *A. robustus*. The distance between the holes matches the distance between a leopard's canine teeth.

Leopard attacking leopard (leopard's skull) in a savanna landscape.



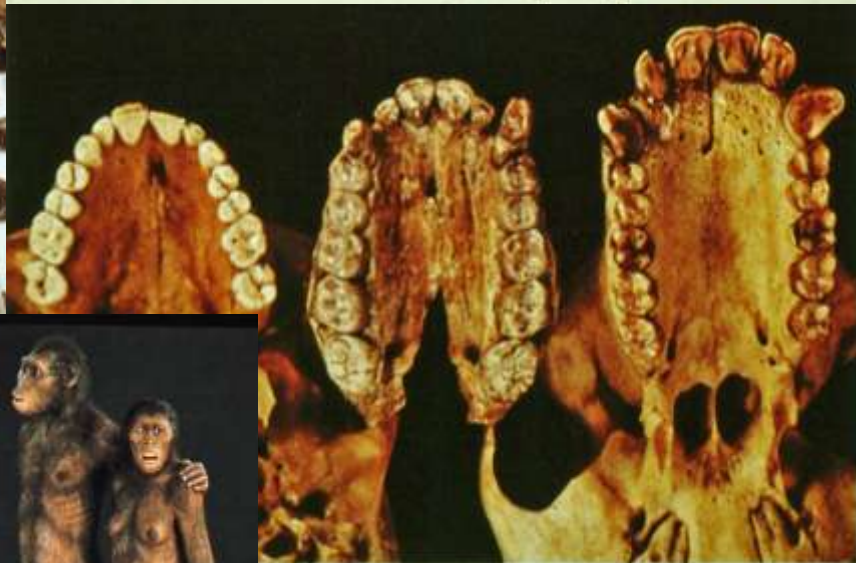
Brains and life histories



*Australopithecus
afarensis*
East Africa



Side views of skulls show small brain size of *A. afarensis*, center. Human is at left, chimp at right.



Upper teeth of the same three

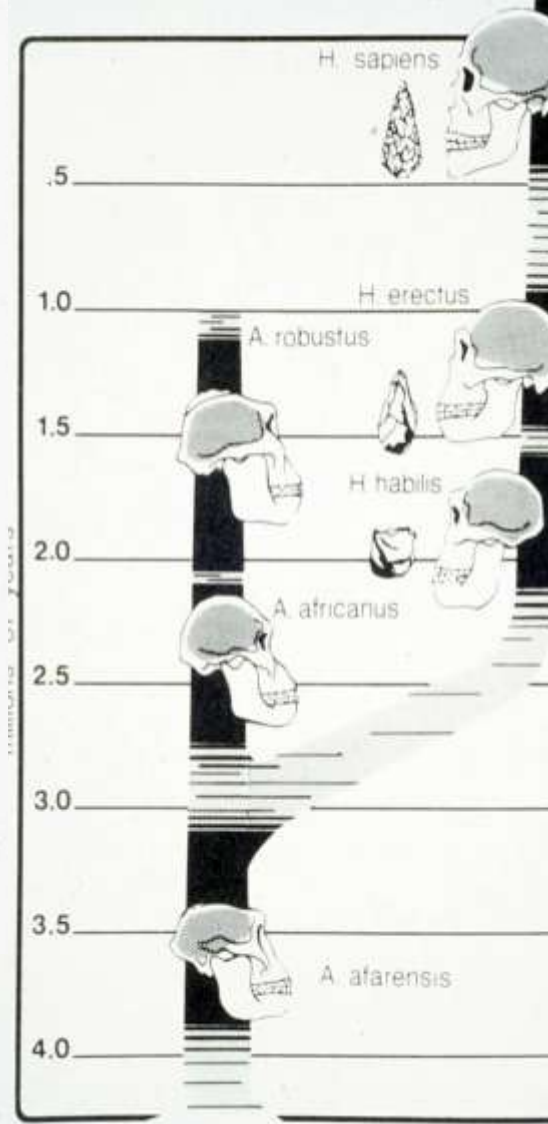
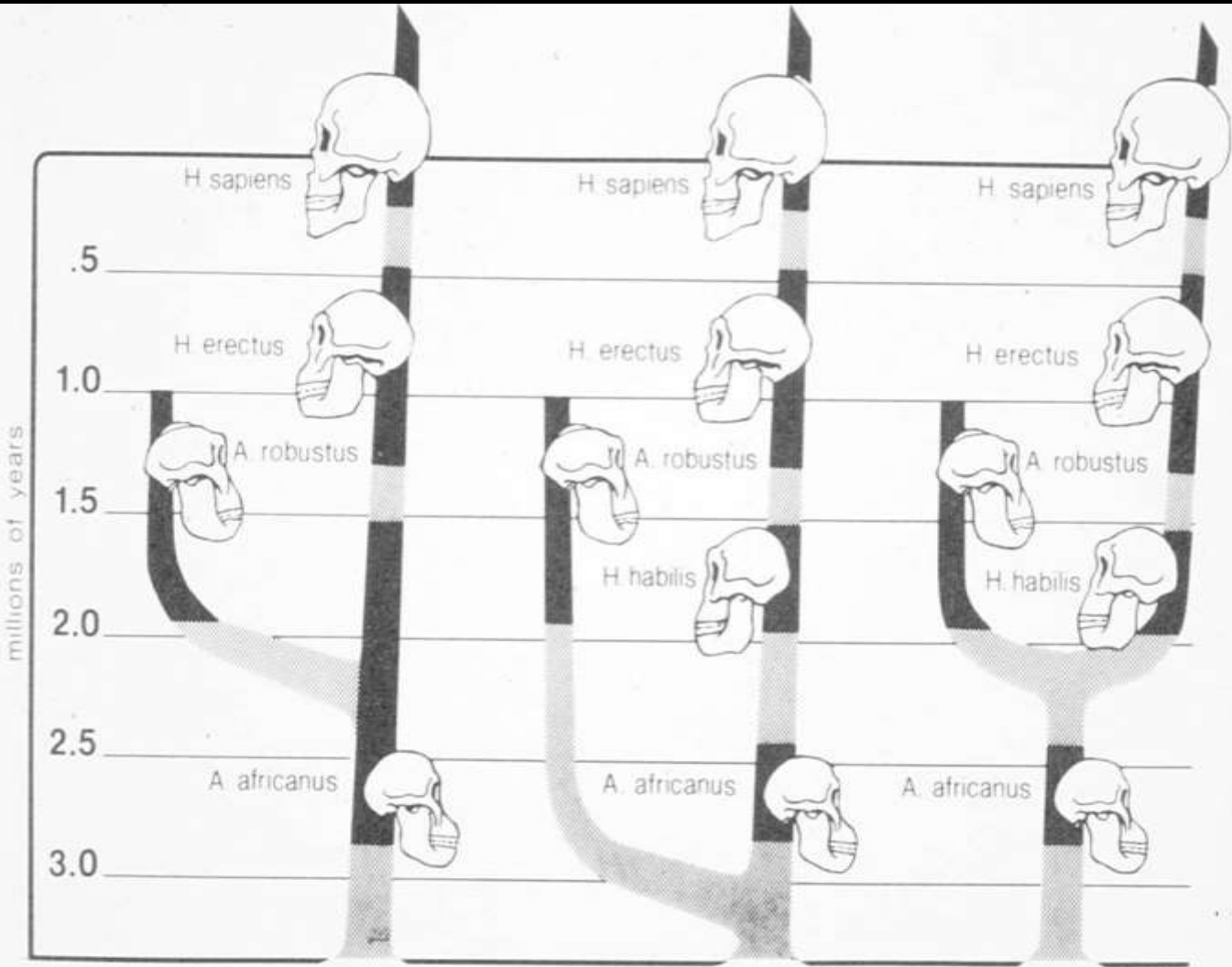
3.1-3.7 Ma

Laetoli (Tanzania): ~3.5 Ma

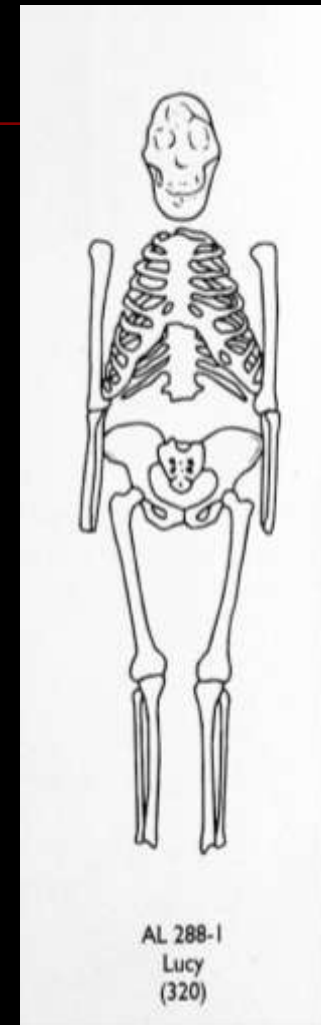
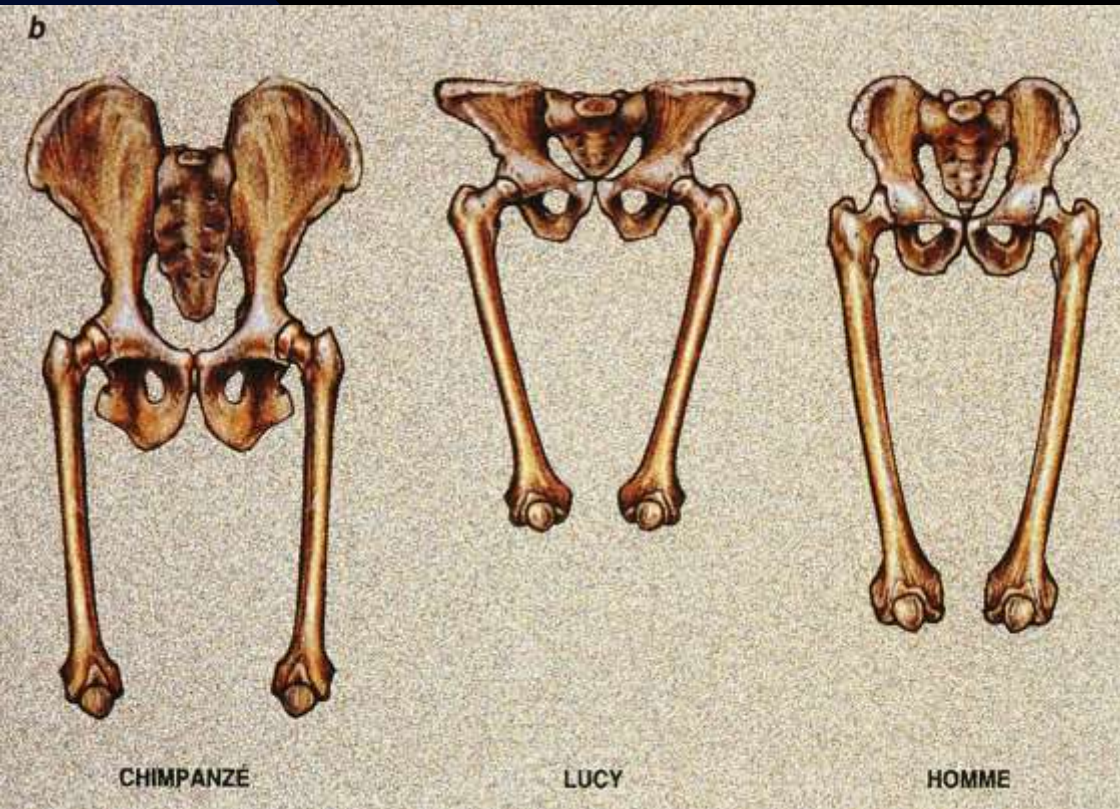
Right) The fossil hominin footprints at Laetoli. The only hominin known from this locality is *A. afarensis*, which is the most likely candidate. The weight transfer of *A. afarensis* when walking is shown below by contouring the depth of the impressions made by the foot. Like human walking, the main stress is on the ball of the foot and the heel, with secondary stress on the outside of the foot in line with the little toe.



africanus vs *afarensis*

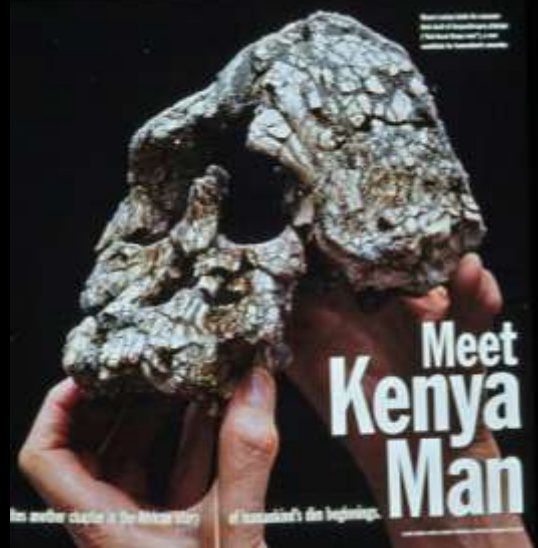
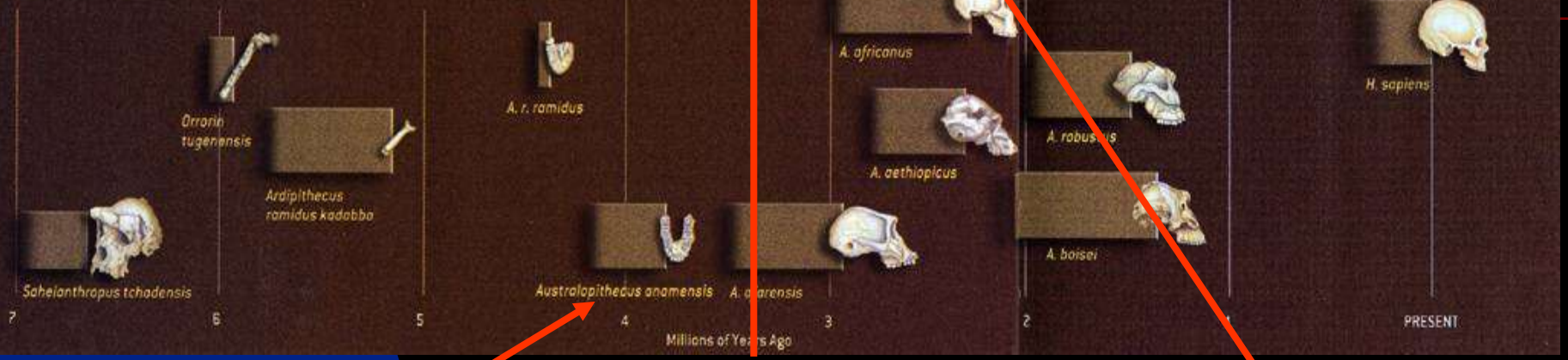


Pelvis and body shape of *afarensis*



Even more diversity!

The branching diagrams (inset) illustrate two competing hypotheses of how the recently discovered *Sahelanthropus*, *Orrorin* and *Ardipithecus ramidus kadabba* are related to humans. In the tree on the left, all the new finds reside on the line leading to humans, with *Sahelanthropus* being the oldest known hominid. In contrast, only *Orrorin* is a human ancestor. *Ardipithecus* is a chimpanzee ancestor, and *Sahelanthropus* a gorilla forebear in this view.



A. anamensis ~4Ma

Kenyanthropus platyops ~3.5Ma

A. garhi ~ 2.5Ma

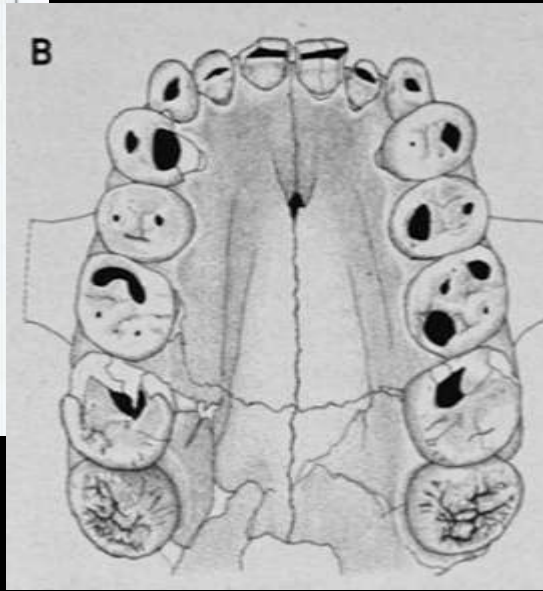
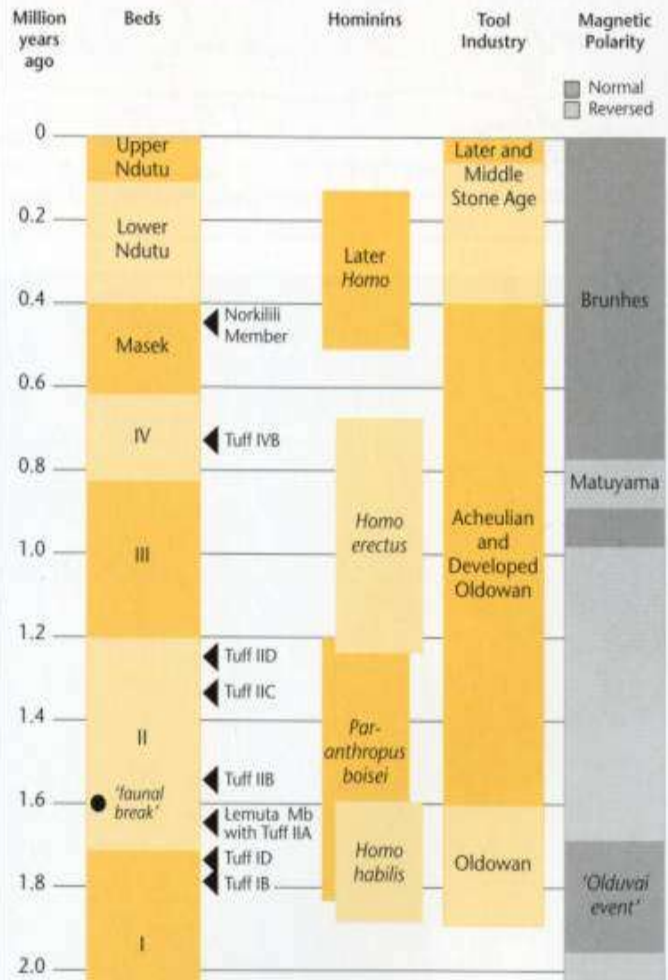
Australopithecines: thousands of fossils and at least 8 species in S., E. and C. Africa





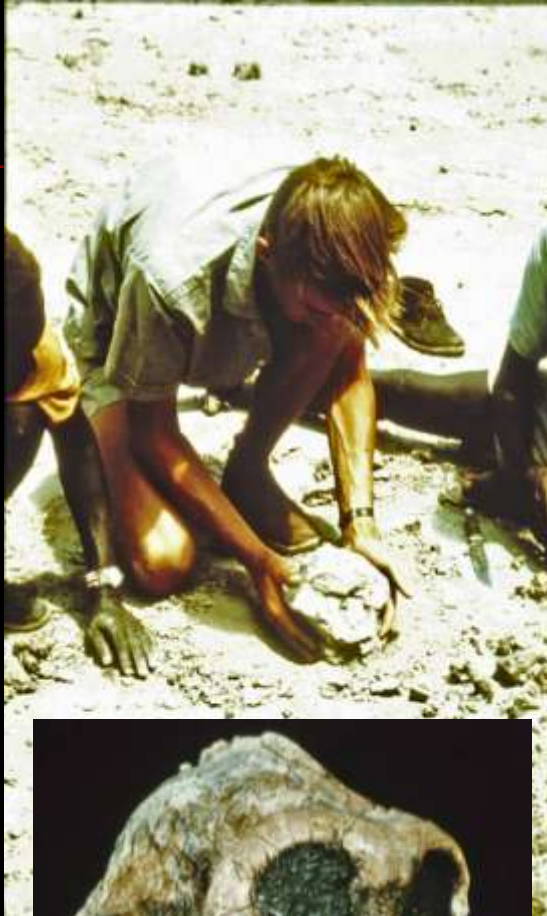
Olduvai Gorge and the Leakeys



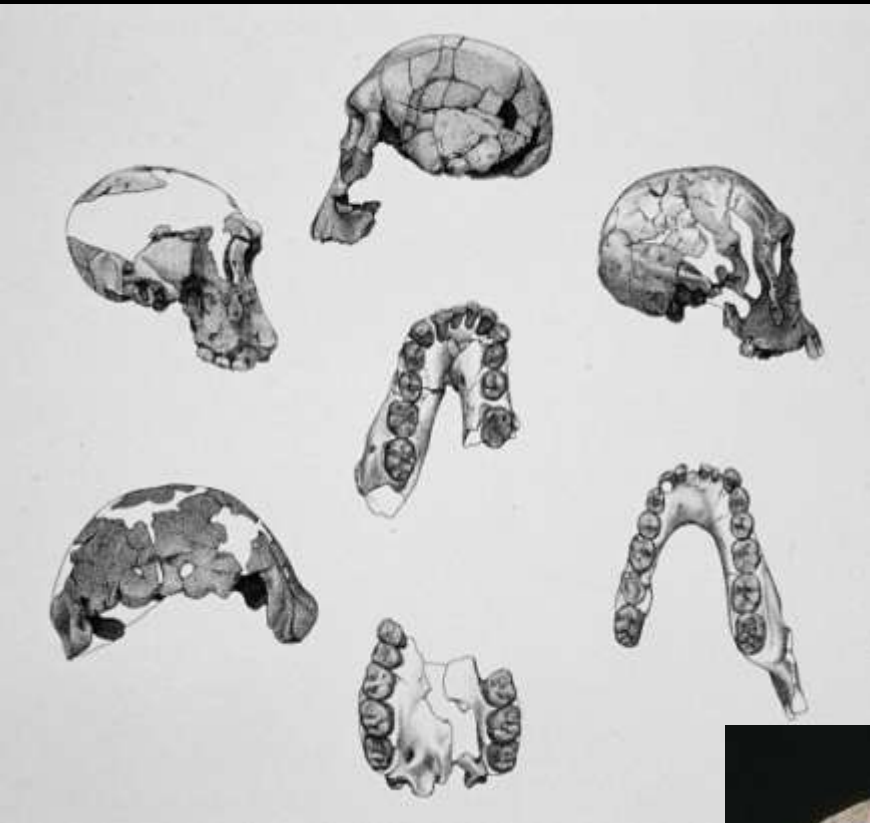


“Zinjanthropus”: human or australopithecine?

East Turkana (N. Kenya): 1.5 – 1.9 Ma



Homo habilis: one or more species?



Homo rudolfensis and *Homo habilis*?

Becoming human

Meat, guts,
and brains



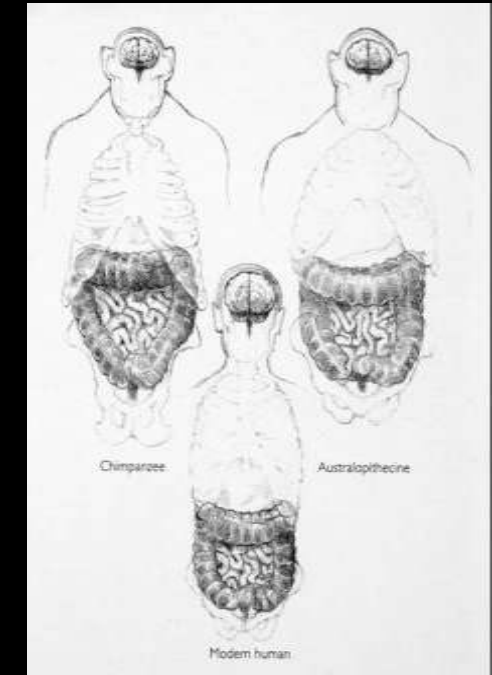
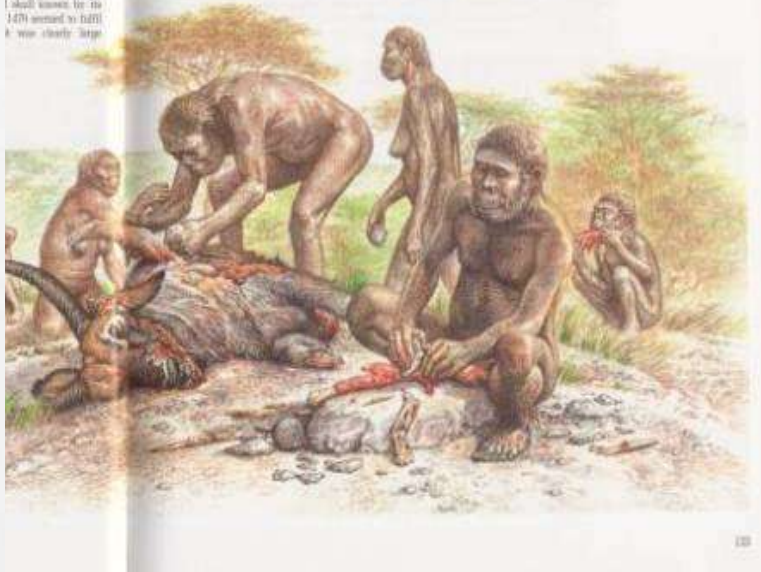
40, retaining barely
anything shifty. He said
in the species representa-
tional of all humans.

He
found for the scientific
link that the material
for the study appears
suggested a new kind of
others left that it
Neolithic, they
with the ability, and
blades and members.
and a new research
of World War, on the
Luzon, apparently. I do
with the kind of stone
the surface layer in
the remains of about
nearly 2 million years
in operation about
I also he found there,
I shall know, for the
1470 seemed to differ
it was clearly large



Body Mass

Body Mass has long been
difficult to estimate within
the species Homo heidelbergensis. The
comparisons shows a small
amount of evidence for the
KNM-WT 15000 from the
African National Museum site
originally called Dier Park
on the right and a larger
amount of evidence from the
KNM-WT 1470 on the left.
The skull shall surely small
skull and large skull
remains of a single species,
with the appearance of different
species (perhaps Homo
heidelbergensis) and Homo
erectus. (1997)



Stone tools
2.6 Ma

Body shape

Australopithecus sediba

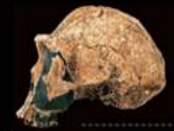
THE VIEW FROM MALAPA
 Lee Berger's team suggests that the clearest line to *Homo* links *A. sediba* directly to *H. erectus*. If true, more primitive East African *Homo* fossils would represent a lineage that went extinct.



Homo sapiens
Worldwide

H. heidelbergensis
Old World

H. neanderthalensis
Europe and Middle East



H. erectus
Old World



H. habilis
East Africa

H. rudolfensis
East Africa

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*.

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

Australopithecus boisei
East Africa

A. robustus
South Africa



A. sediba
South Africa

PROPOSED VIEW OF HOMO ORIGINS

PREVAILING VIEW

2 M.Y.A.

A. aethiopicus
East Africa

A. africanus
South Africa

A. garhi
Ethiopia

Hadar jaw
Ethiopia

3 M.Y.A.



A. afarensis
East Africa

Kenyanthropus platyops
Kenya

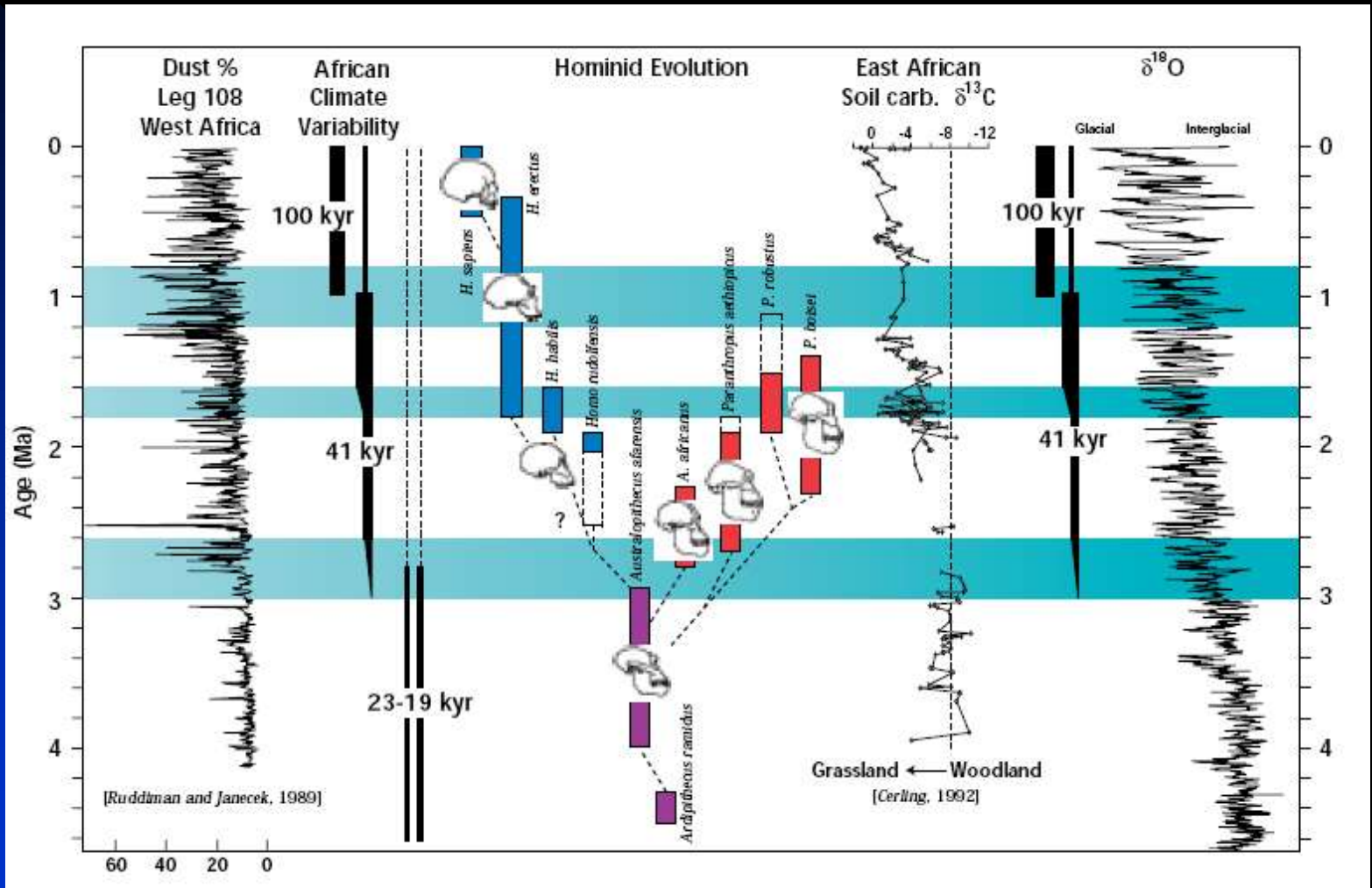
4 M.Y.A.

A. anamensis
East Africa

Ardipithecus ramidus
Ethiopia



Did increasing African aridity drive Pliocene radiations?





**Foraging change
Dietary change
Technology?**

**Increased body
& brain size**



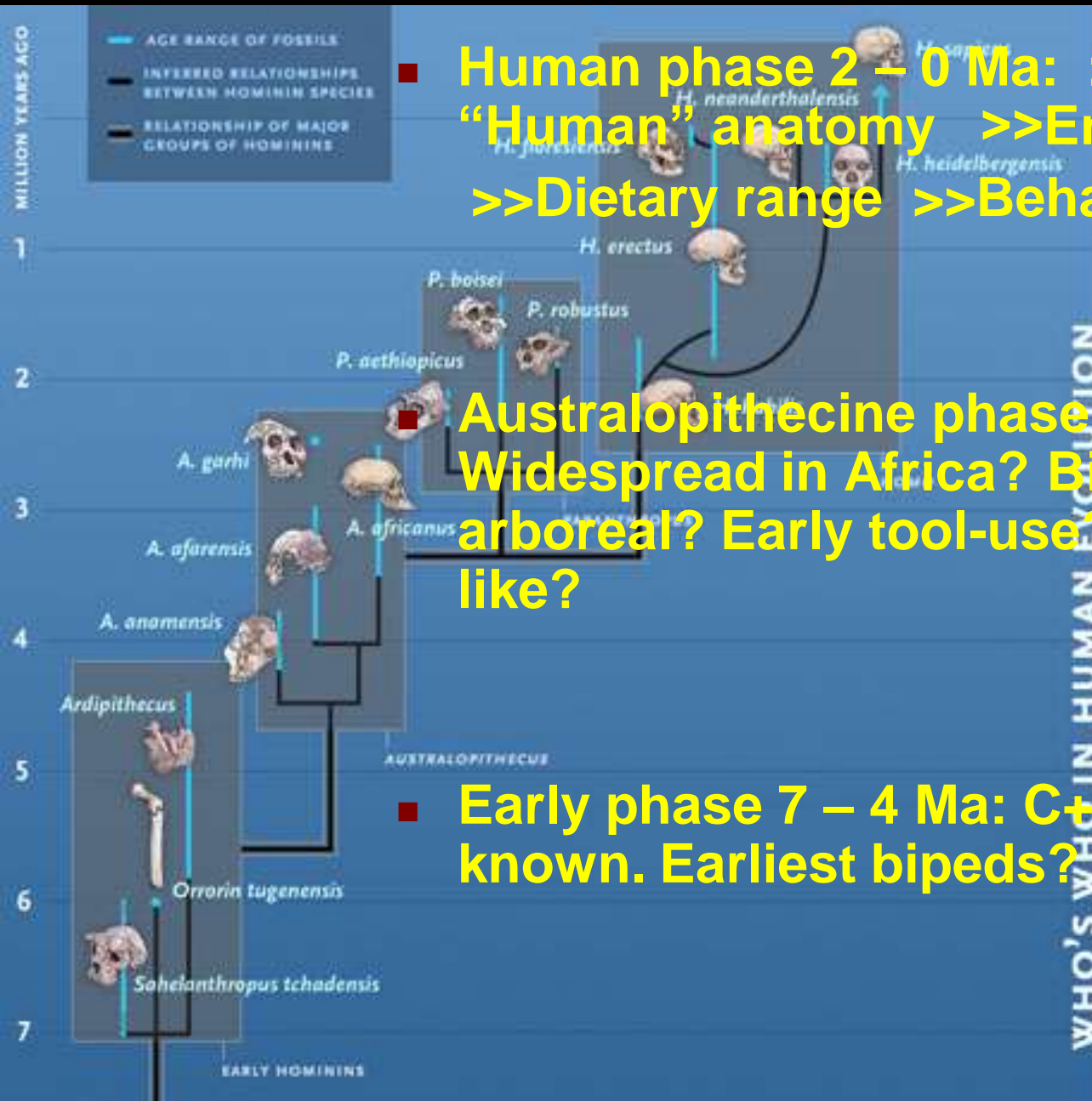
**Increased range/
dispersal potential**

**Ecological
change**

**Declining 1° productivity
Changing resource
distribution**



“Phases” of human evolution

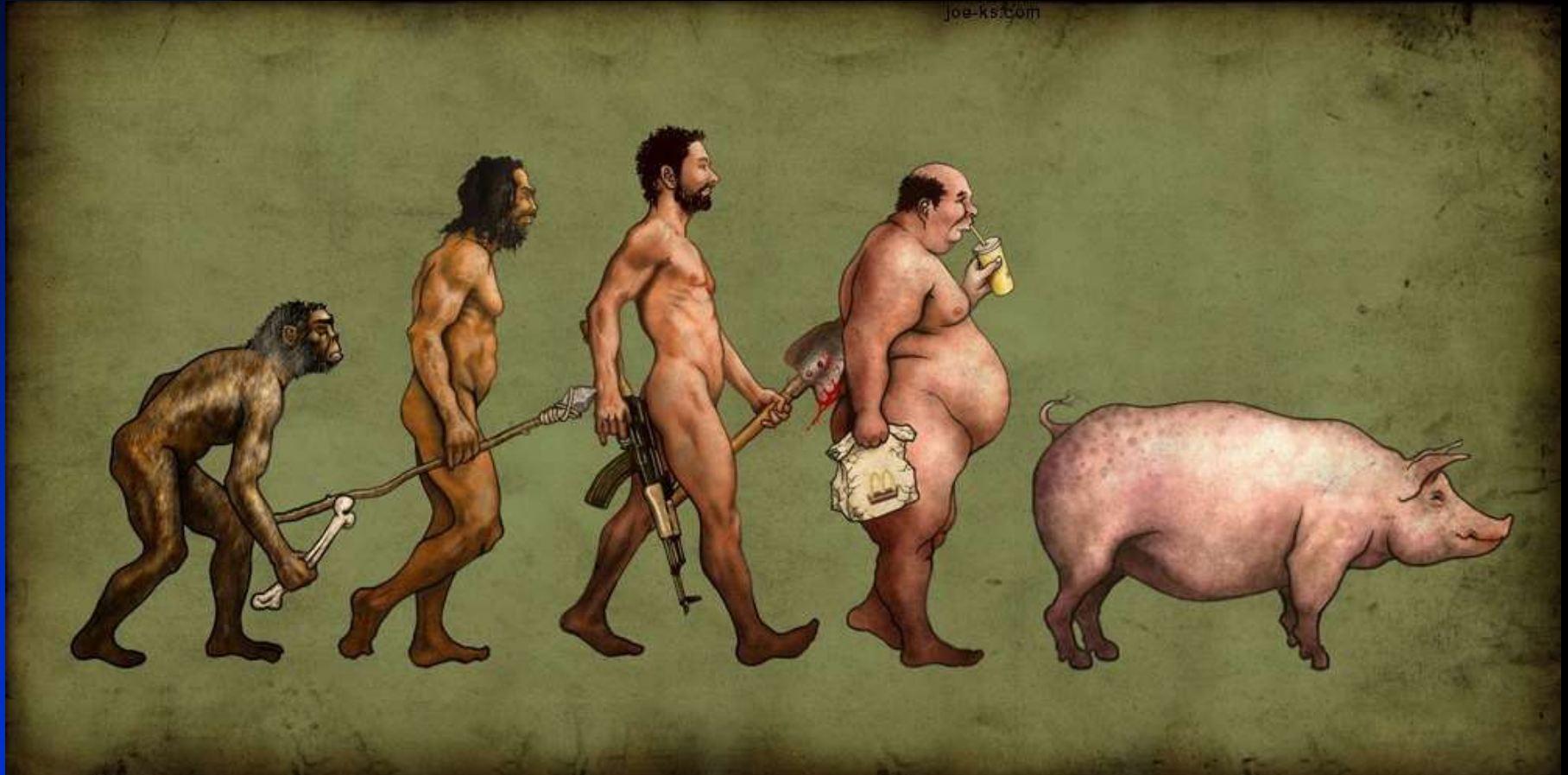


- Human phase 2 – 0 Ma: >>Global spread
“Human” anatomy >>Encephalised
>>Dietary range >>Behavioural complexity

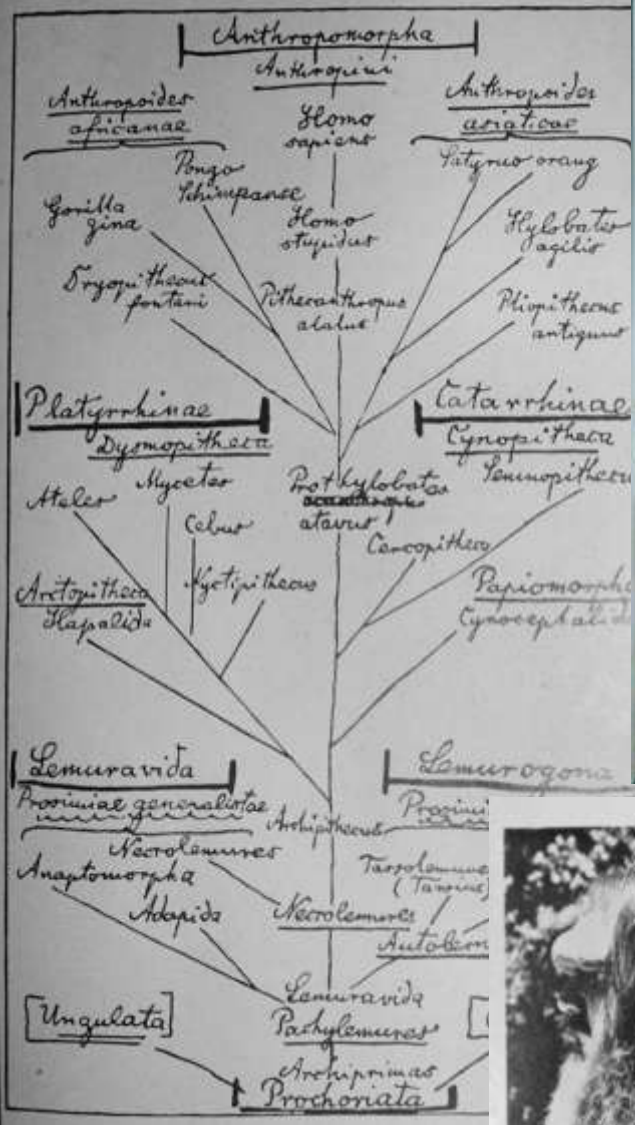
- Australopithecine phase 4 – 2 Ma:
Widespread in Africa? Bipedal but still partly
arboreal? Early tool-use? Predom. still ape-
like?

- Early phase 7 – 4 Ma: C + E. Africa. Still poorly
known. Earliest bipeds? Largely ape-like?

Our future is partly up to us....



Homo erectus



CRANIAL HAIR AND BROWRIDGES Grover S. Krantz

EARLY HOMO

Homo habilis

Homo erectus



Shorter Braincase
Larger Temporal Fossa
Longer Face



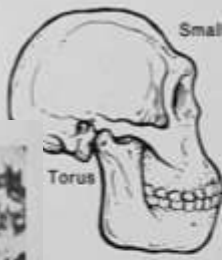
Long, Low Braincase
Smaller Temporal Fossa
Shorter Face



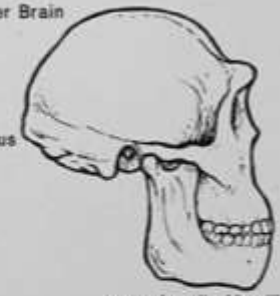
No Keel
Smaller Nose



Sagittal Keel
Larger Nose



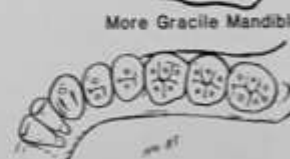
Smaller Brain
Torus



Bigger Brain
Occipital Torus



More Robust Mandible



More Gracile Mandible

More Premolars and Molars

Smaller Premolars and Molars

FIGURE 17.15 Cranial and dental characteristics of *Homo habilis* and *Homo erectus*.

Debate about the earliest human dispersals from Africa

An Asian perspective on early human dispersal from Africa

Robin Dennell & Wil Roebroeks 2005

Nature 438: 1099-1104

...it is time to develop alternatives to one of palaeoanthropology's most basic paradigms: 'Out of Africa 1'.



Flores



Dmanisi

SEEING A RANGE OF BONES IS HELPING SCIENTISTS FIT DMANISI INTO OUR EVOLUTIONARY JOURNEY.

Technology and brain evolution

Archaeology suggests a late “explosion” in behavioural complexity...
...however, brain size shows a steadier increase

