Human Odyssey

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- Downloadable talks:
  - AWE Human Odyssey 2017

- 415-939-6175


Human Odyssey
EXIT
Becoming Human
Human Odyssey

1. We are all Africans: Modern humans and many of our ancestral species evolved in Africa. *

- ( ) True
- ( ) False

2. The five milestones of human evolution are: *

Select the five most applicable options:

- [ ] Bipedalism
- [ ] Teeth
- [ ] Tool Making
- [ ] Modern body plan
- [ ] Big brain
- [ ] Symbolic thinking

3. Natural selection *

- Requires genetic variation between organisms
- Is blind; is not directional
- Is a process that acts on populations, not individuals
- All of the above

4. We are most closely related to: *

- Chimpanzees
- Gorillas
- Orangutans
- Lettuce

5. Modern humans and their extinct ancestors and relatives that evolved following the split from the ancestors for the modern great apes are *

- Homonids
- Hominins

6. Academy curator, Dr. Zeresenay Alemseged , discovered and named the earliest and most complete juvenile human ancestor *

- Lucy
- Zeray
- Dikika
- Selam

7. Lucy's skeleton shows that A.afarensis walked upright. *

- ○ True
- ○ False

8. Fossil evidence shows that Neanderthals lived and went extinct before humans arrived. *

- ○ True
- ○ False

9. Select the examples of human evolution *

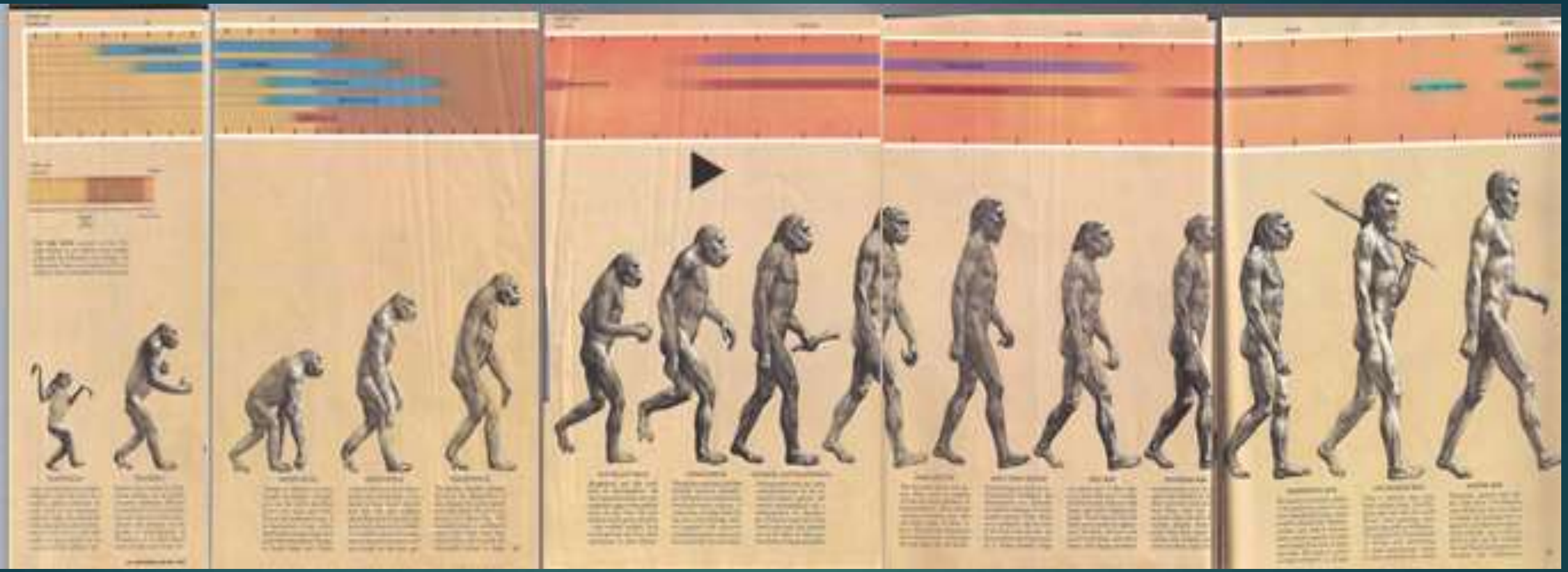
Check all that apply

- [ ] Development of lighter skin color
- [ ] Development of lactose intolerance in adults
- [ ] Longevity
- [ ] None of the above

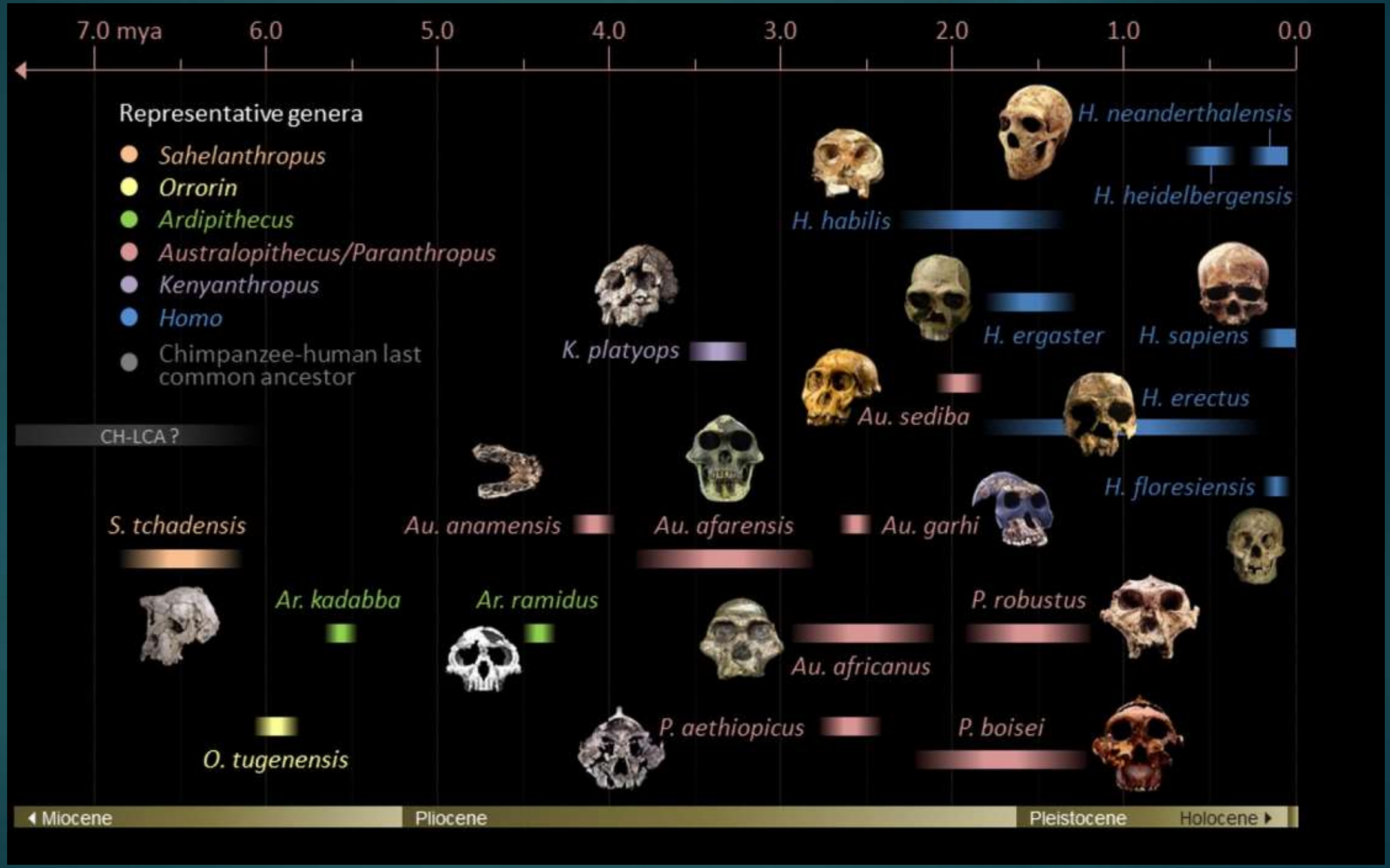
10. The term "genetic bottleneck" impacted the population of *

- ( ) Lions
- ( ) Species Survival Plan for African Penguins
- ( ) Humans about 70,000 years ago
- ( ) All of the above

Famous, but misleading, march of hominin evolution



Early Man by Francis Clark Howell


7.0 mya
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Representative genera
Sahelanthropus
Orrorin
Ardipithecus
Australopithecus/Paranthropus
Kenyanthropus
Homo
Chimpanzee-human last common ancestor
CH-LCA ?
S. tchadensis
O. tugenensis
Ar. kadabba
Ar. ramidus
Au. anamensis
Au. afarensis
Au. sediba
Au. garhi
Au. africanus
P. aethiopicus
P. robustus
P. boisei
K. platyops
H. habilis
H. neanderthalensis
H. heidelbergensis
H. ergaster
H. sapiens
H. erectus
H. floresiensis
Miocene
Pliocene
Pleistocene
Holocene

Textbooks recommended by Bernard Wood

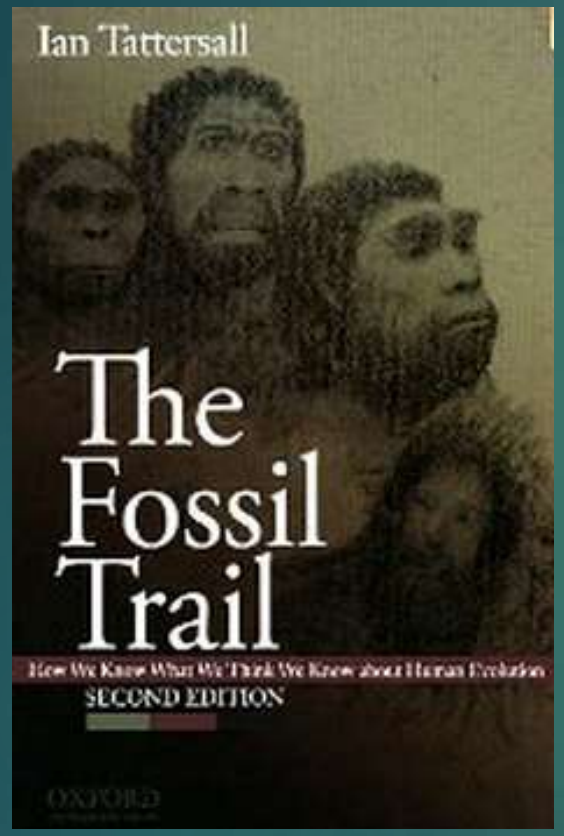
- *Principles of Human Evolution* (2nd ed.) - Robert Lewin & Robert A. Foley, 2004

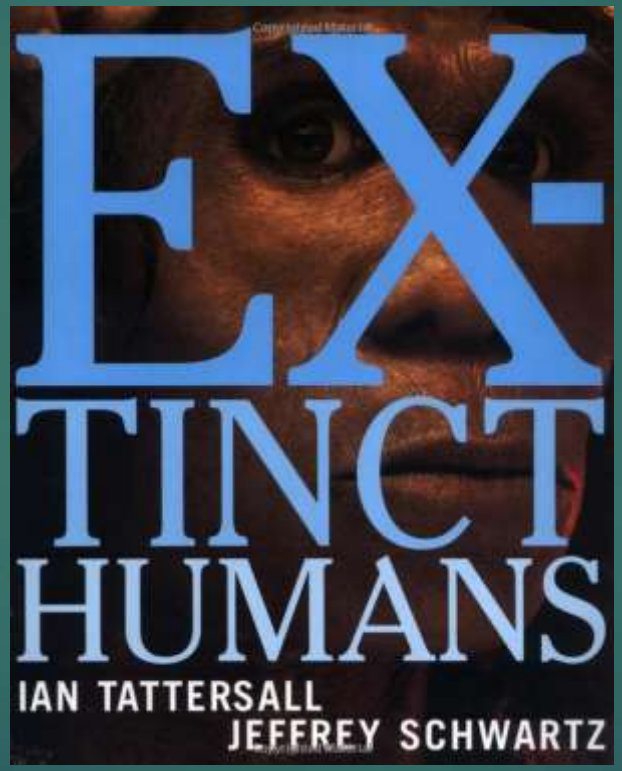
- *Human Career: Human Biological and Cultural Origins* (3rd ed.) – Richard G. Klein, 2009 (1024 pp)

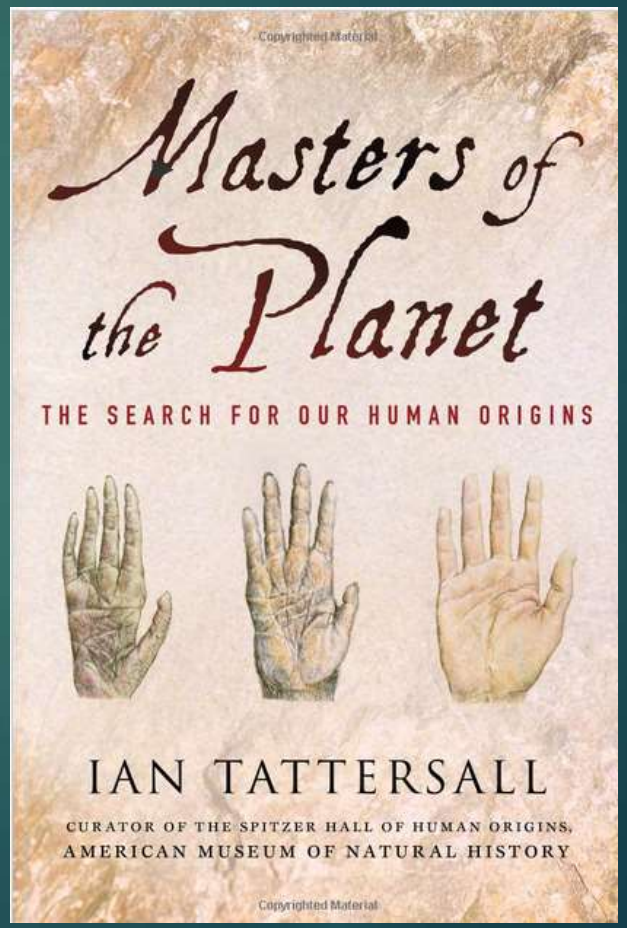
- *Reconstructing Human Origins: A Modern Synthesis* (3rd ed.) – Glenn C. Conroy & Herman Pontzer, 2012

- *Exploring Biological Anthropology: The Essentials* (3rd ed.) – Craig Stanford, John S. Allen, Susan C. Anton, 2013

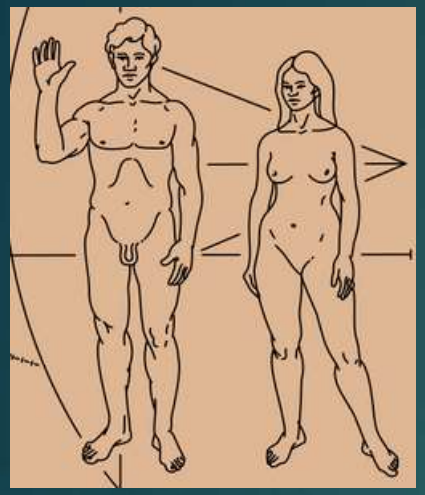
Ian Tattersall: Great Historian of Paleoanthropology







How Much of Your DNA You Share with:



99.9%

Neandertals 99.7%

98.4%

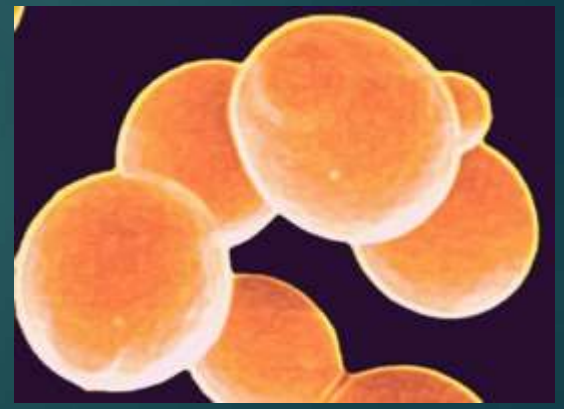
92%

70%

60%

50%

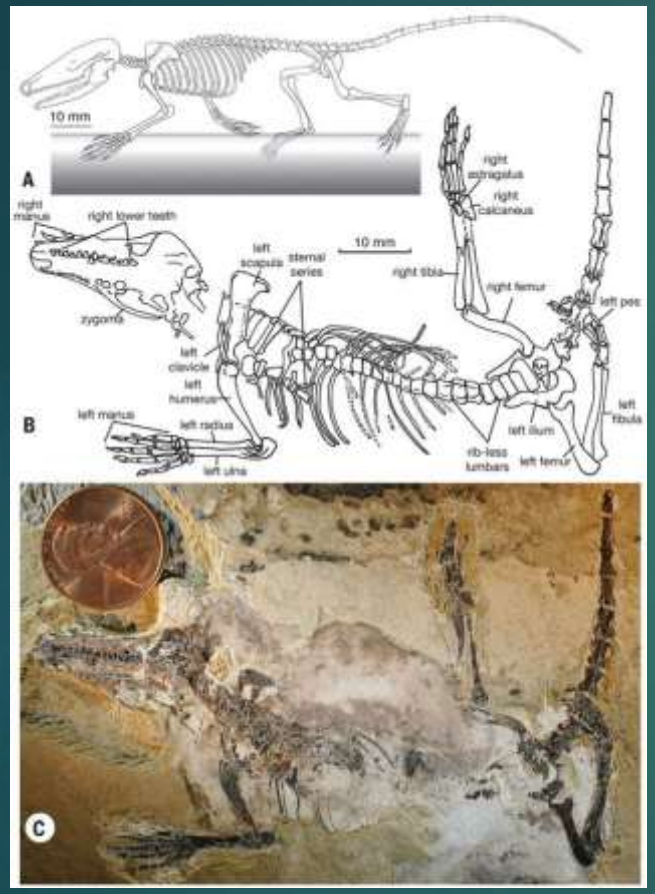
You are related to every living creature on earth



Yeast = 26%

https://www.quora.com/What-percentage-of-human-DNA-is-shared-with-other-things

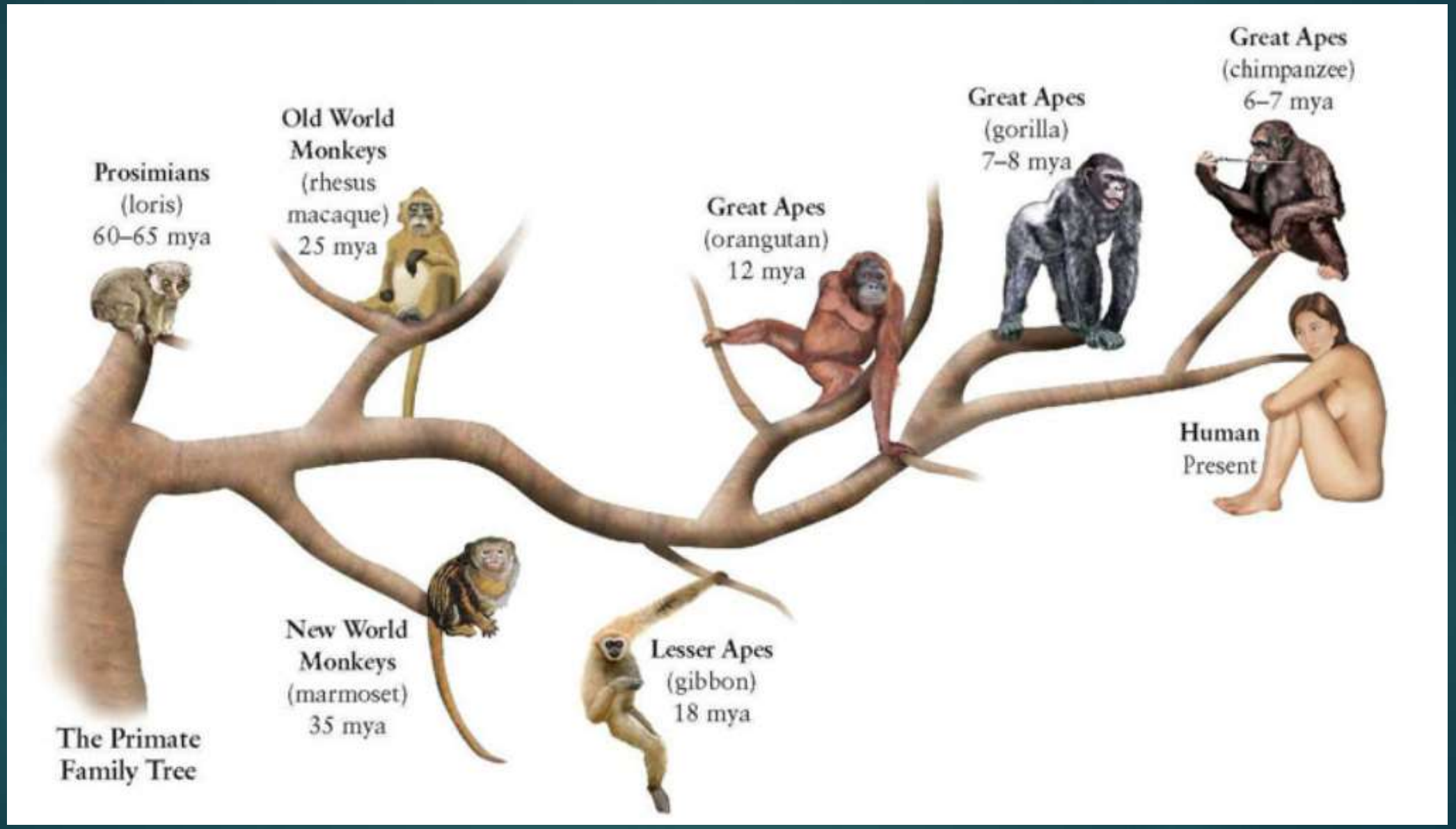
Oldest fossil mammal: 165 MYA – mother of us all?



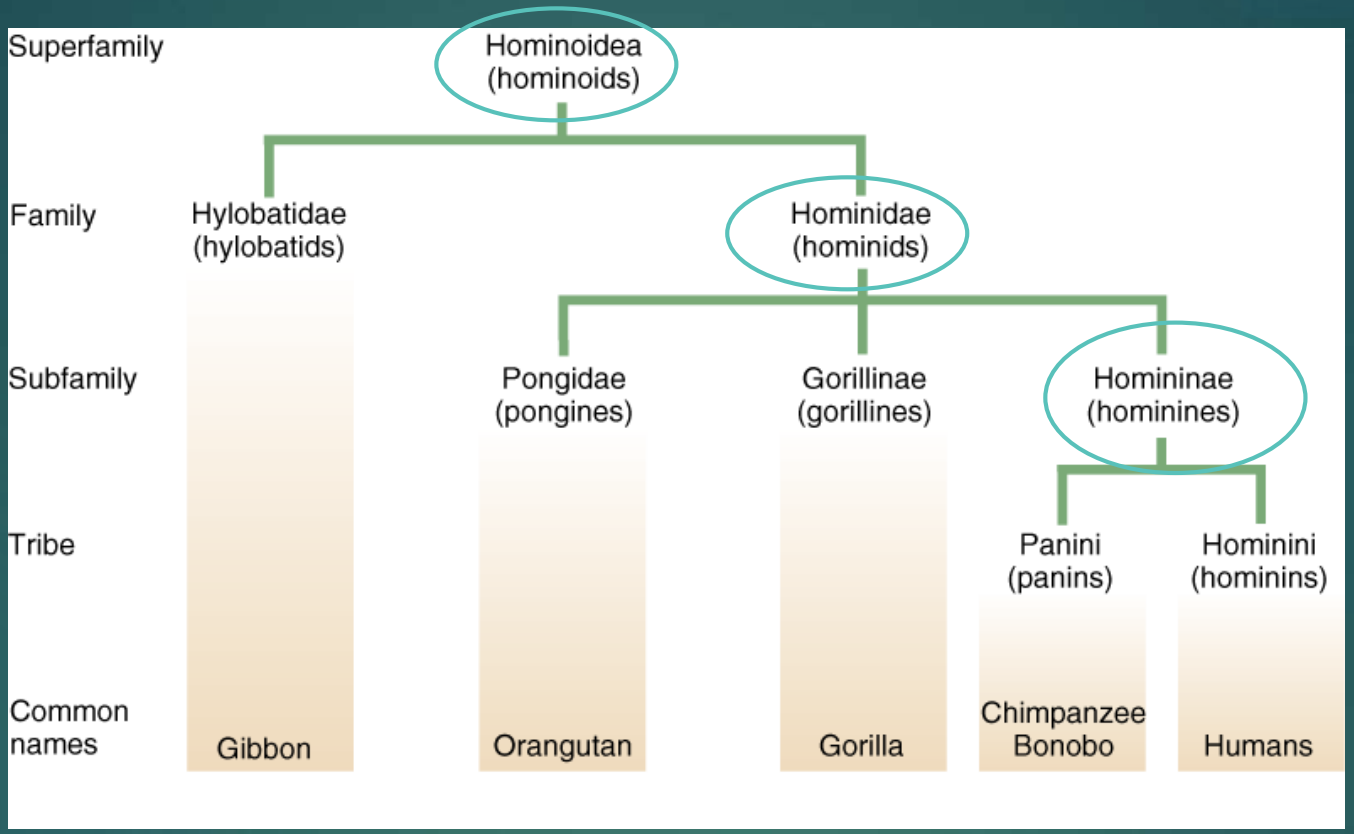
OMNIVORE LIVED 165M YEARS AGO: SCIENTISTS EXPOSE TINY JURASSIC MAMMAL SPECIES IN CHINA

Agilodocodon scansorius, is the earliest tree-dwelling mammal ever found;
Night time insect predator; we still have enzyme to digest insects

Primate Family Tree



Hominid to Hominin



Hominids – all modern AND extinct GREAT apes. Gorillas, chimps, orangs and humans, and their immediate ancestors. Not gibbons.

Hominin – Any species of early human that is more closely related to humans than chimpanzees, including modern humans themselves; all human ancestors

Shared, derived traits of hominins

- Habitual bipedalism
- Chewing apparatus
  - Wide parabolic dental arcade
  - Thick enamel
  - Reduced canines
  - Larger molars in relation to other teeth
- Much larger brains relative to body size
- Slow development with long juvenile period
- Elaborate, highly variable material and symbolic culture, transmitted in part through spoken language

Hominin Tree Implications

- It is a bush not a straight line
- Earlier period gets murky in relation to who ancestors were
- Typically, more than 1 species living at same time and place
- Except for *Homo erectus,* most hominin species lasted for 1 million years or less
- Last ape standing: *Homo sapiens* (us) is the only species to have survived.
- This process was random, with no innate progression; the most adaptable survived

Major discoveries of hominins:
Mainly South Africa and East Africa

Human Odyssey Exhibit: Milestones in Human Evolution

- Five key traits make us who we are today. These traits are listed in the order that they developed—in other words, walking upright developed first, etc. Human Odyssey uses conservative dates.
- **Bipedalism -** We get around by walking upright on two legs. Postural vs locomotor bipedalism
- **Tool Making -** We make and use tools ranging from stone hammers to smart phones.
- **Modern Body Plan -** We have longer legs and shorter arms than other primates.
- **Big Brain-** We have the largest and most complex brain of any primate.
- **Symbolic Thinking -** We communicate using symbols such as images, numbers and letters

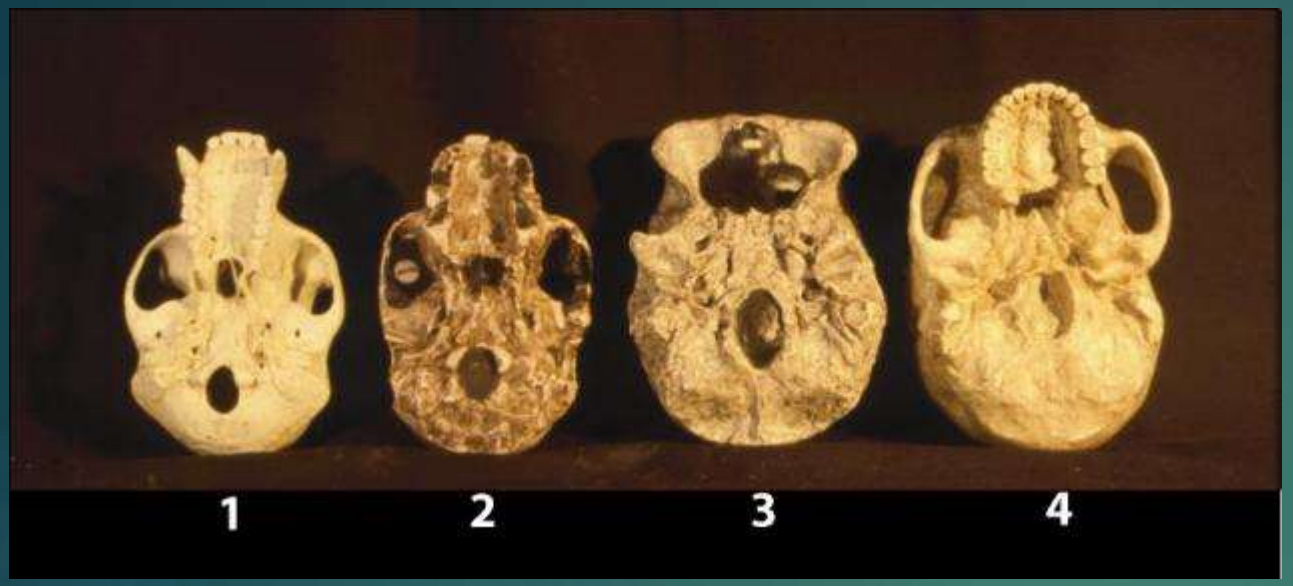
Hominin Evolution: The 5 Major Steps examples

- Bipedalism: *Sahelanthropus*, *Australopithecus afarensis*
- Tool Use:
  - *Homo habilis* (2 mya)
  - *A. afarensis* (3.3 mya) *(*Lomekwi 3 site, cut marks at Dikika site)
- Body Plan: *Homo erectus* (long legs, long distances)
- Bigger Brain: *Homo heidelbergensis & neanderthalensis & sapiens*
- Symbolic thinking: *Homo sapiens* (c 100K), *neanderthalensis?*

Evidence of Bipedalism

- Forward placement of foramen magnum
- Curved lumbar (lower) spine
- Shape of pelvic girdle
- Bicondylar angle of femur (knock-kneed): a femur that slants inward toward the knee
- Parallel toes (no divergent big toe)
- Two fixed arches in foot
  - Side to side / front to back

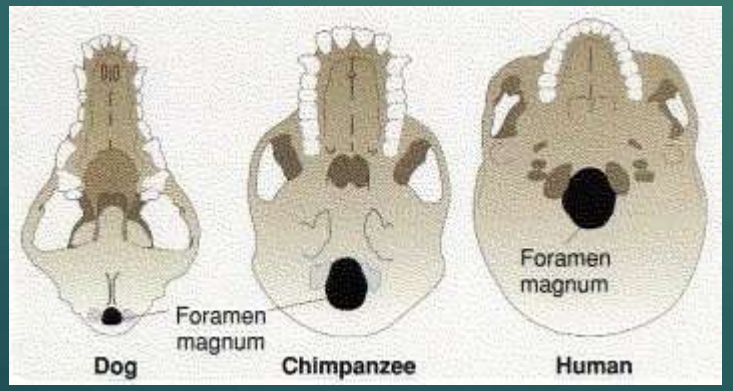
Foramen magnum: Ape vs. hominin



1. Chimpanzee 2. *Australopithecus africanus* 3. *Pithecanthropus erectus* 4. *Homo sapiens*

Modern human

In the back



More forward

Six Major Hypotheses

Hauling Food

Grabbing A Bite

A New World

Keeping Cool

Attracting Mates

Weapons and Tools

ALL these models may have played a role in the emergence of habitual upright bipedalism

Bipedalism: Significance of late Miocene hominins: < 5 Mya

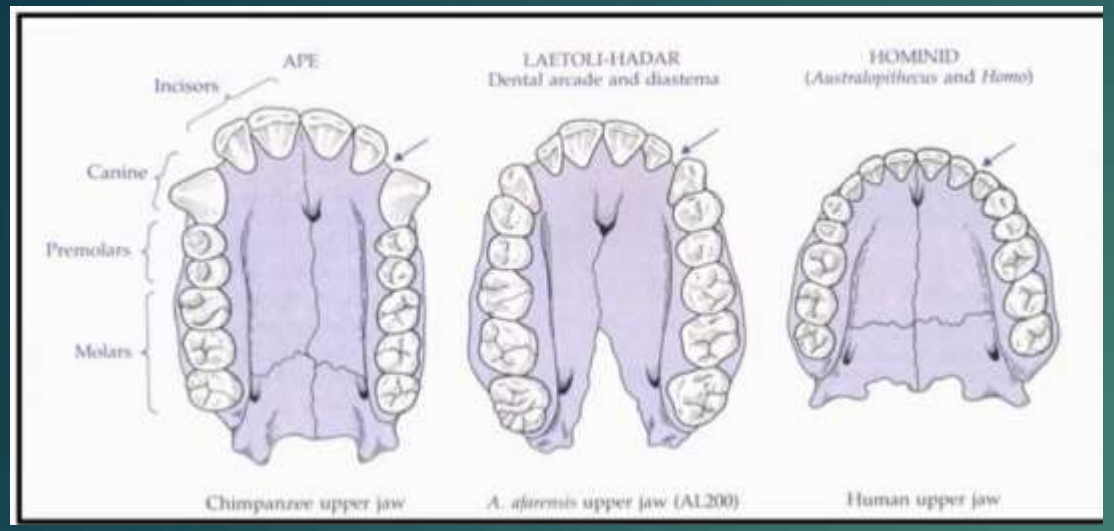
- Originally thought that bipedalism evolved because hominins had to walk great distances on the savanna to get food, avoid predators, etc.

- Sahelanthropus & Orrin push back fossil record of hominins by 2-3 million years
  - Until early 1990s, earliest hominins were < 4 mya
  - Now appears that multiple, diverse hominins may date to late Miocene

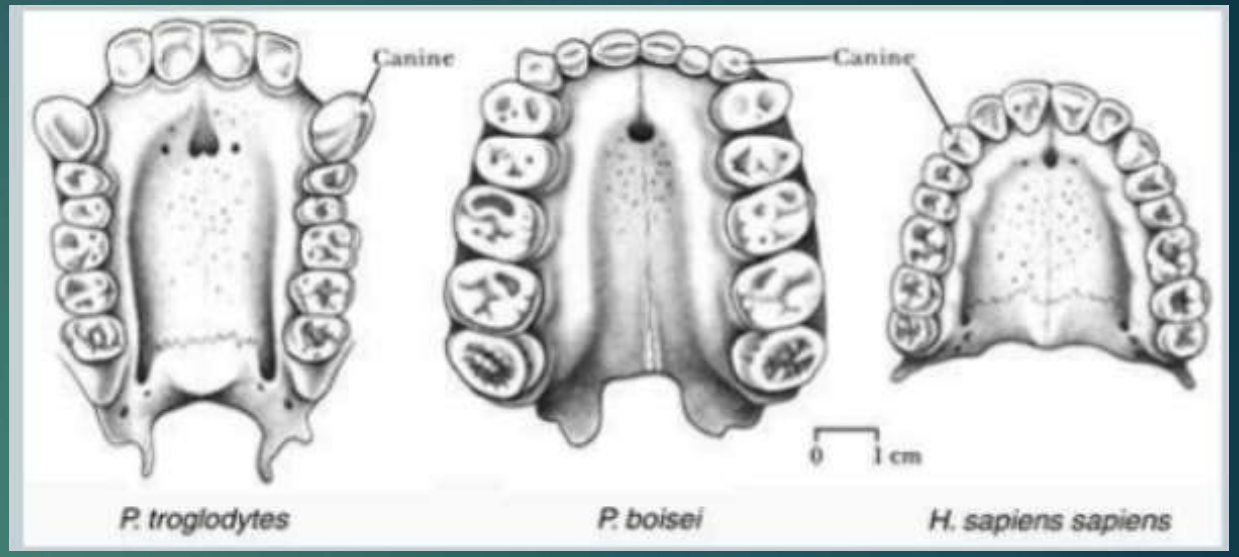
- Forces rethinking of bipedalism
  - Early hominins appear to have inhabited forested environments, not open savannas
  - Having hands free to use tools doesn't seem like a viable option since bipedalism predates tool use by 3.5 mya.

  - Challenges some scenarios for adaptive value of bipedalism

Dentition: as food changed, teeth changed



Boxcar shape
Large canine, gap

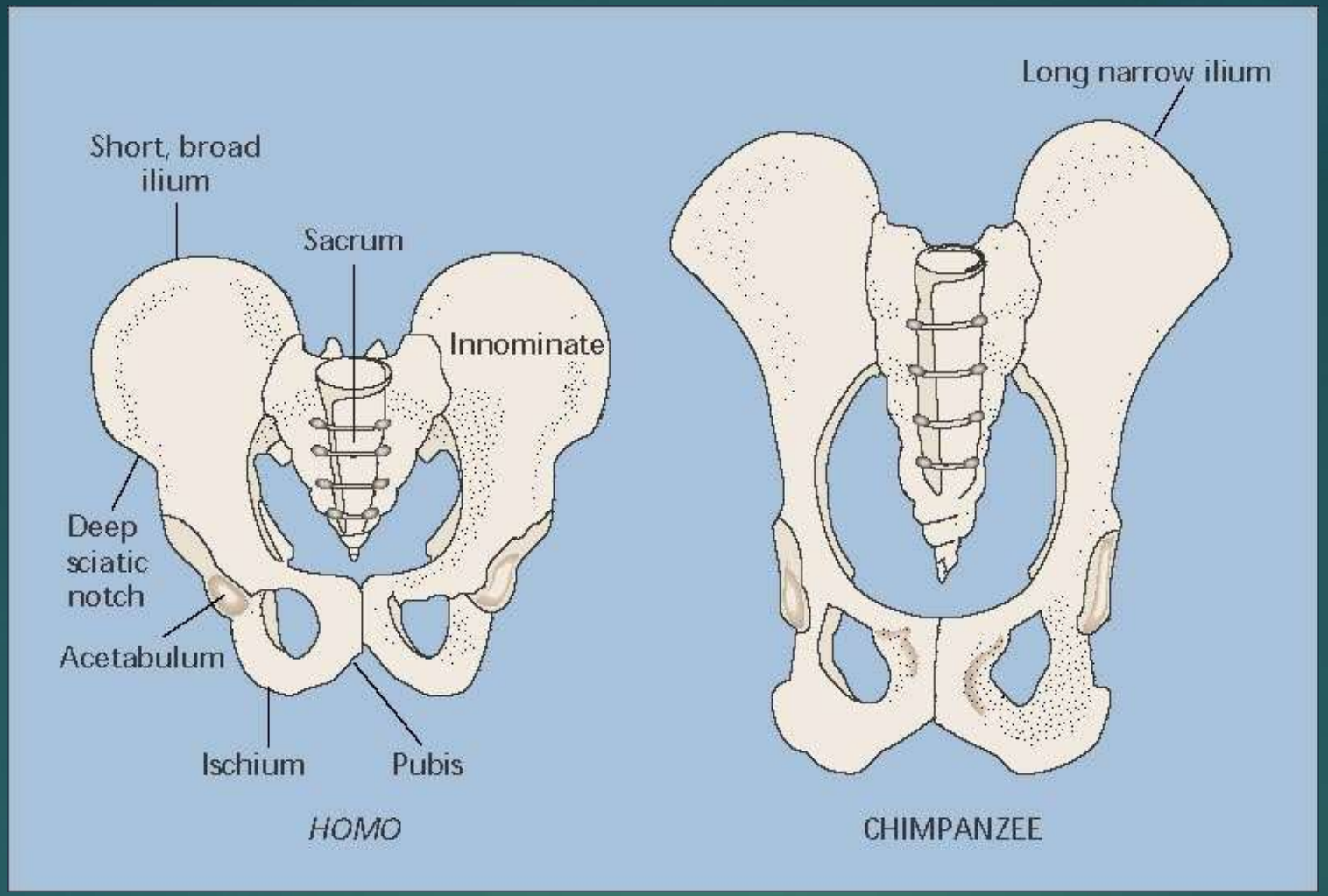


Parabolic
No gap

Reduction in size

Chimp: diastema and the honing facet on LP3

Pelves

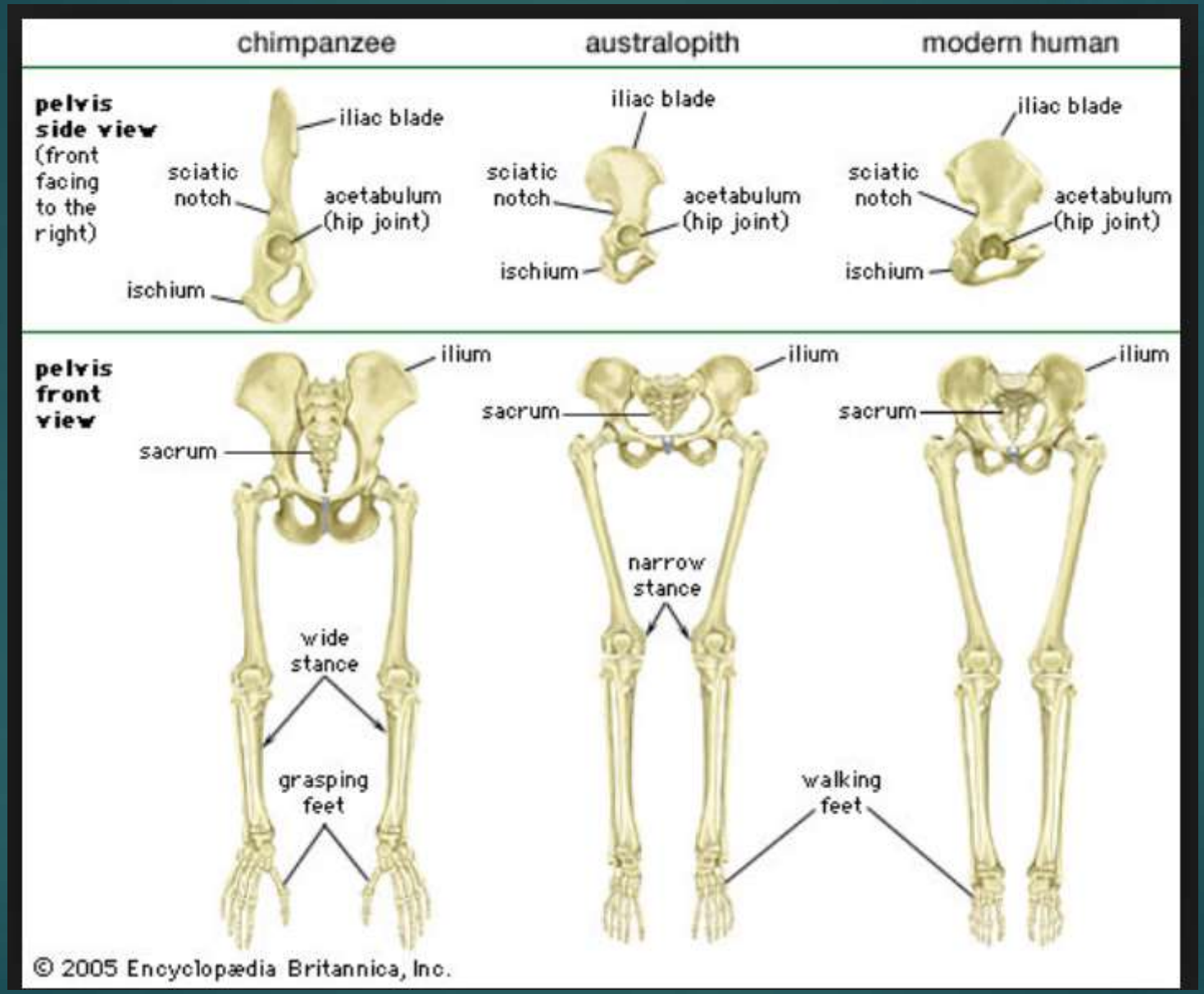


A comparison of human and chimpanze e pelves.

Bipedal bowl vs. Knuckle walking back brace

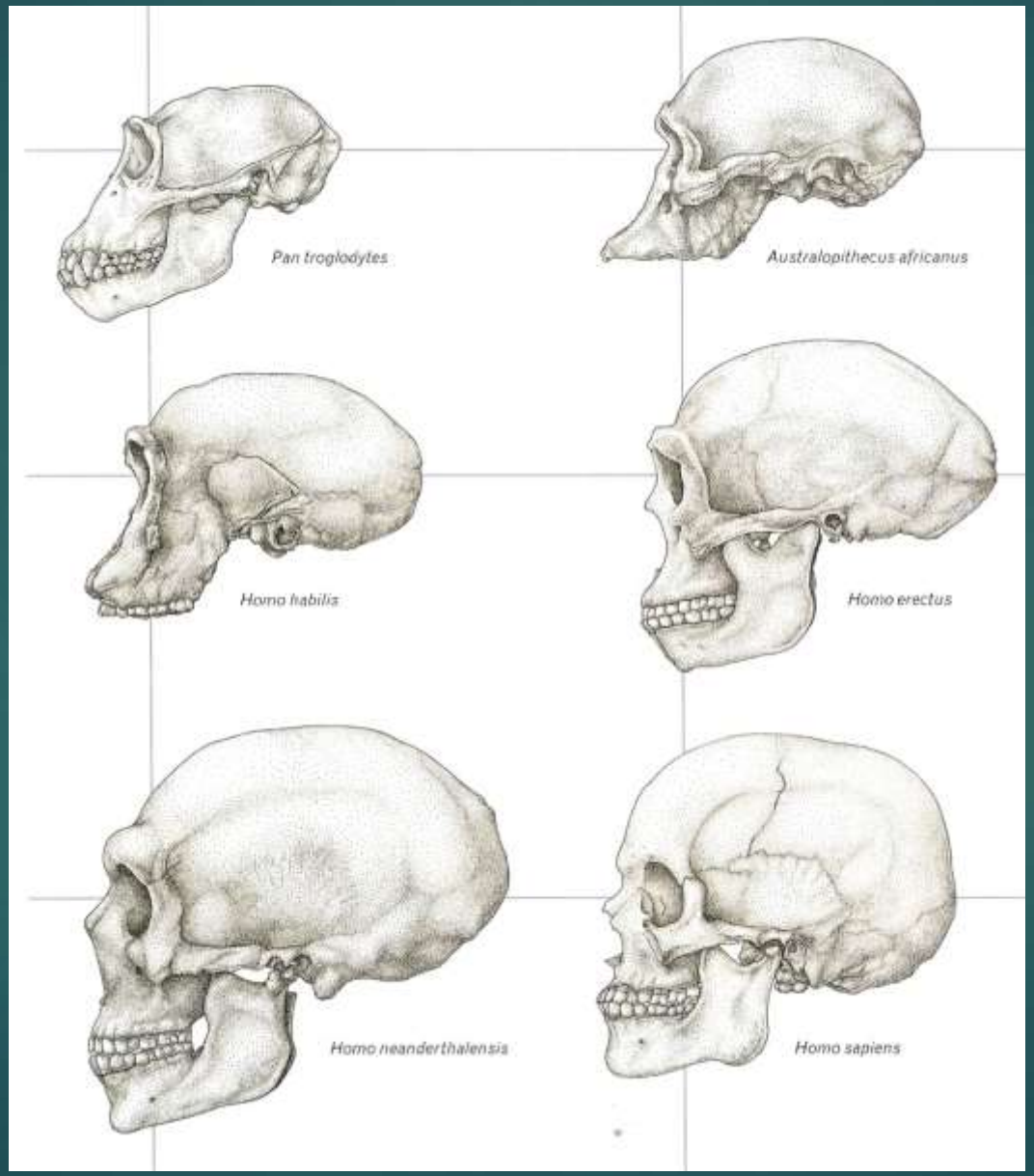
In humans, the blades are rotated inward to support the internal organs and to center the weight of the body over the legs while humans are standing upright. The curved, bowl-like pelvis of Homo sapiens allows us to balance the weight of our trunk effectively over our hips.

Pelvis and knees



Knock-kneed

Skulls got bigger to hold larger brains



Homo habilis to Homo sapiens:
craniums from 300 cc to 1350 cc

Brain size costs

- 1 – Development time: need longer childhood to develop larger brain
- 2 – Construction: need more protein for larger size
- 3 - Energetic cost: Brain is 2% of body mass, but uses 20% of oxygen and metabolism; needs more calories
- Metabolic cost met by diet quality

Number of Brain Cells: 170 Billion:
First Official Count in 2009 by Suzana Herculano-Houzel

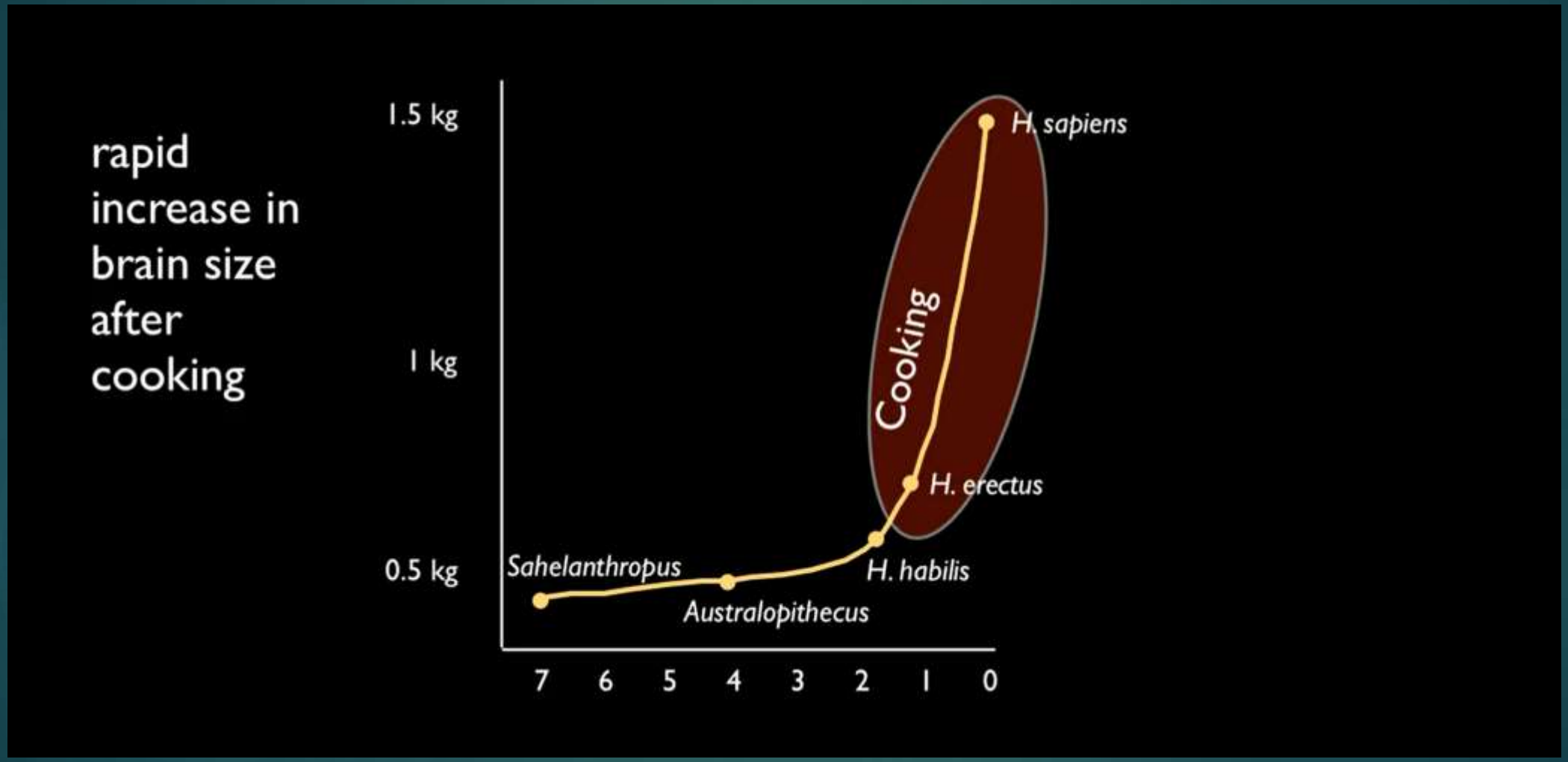
- Adult male human brain contains on average 170 billion cells:
  - 86 ± 8 billion neurons
  - 85 ± 10 billion glial cells.

- Cerebral cortex: 16 billion cells
  - 19% of all neurons in the brain

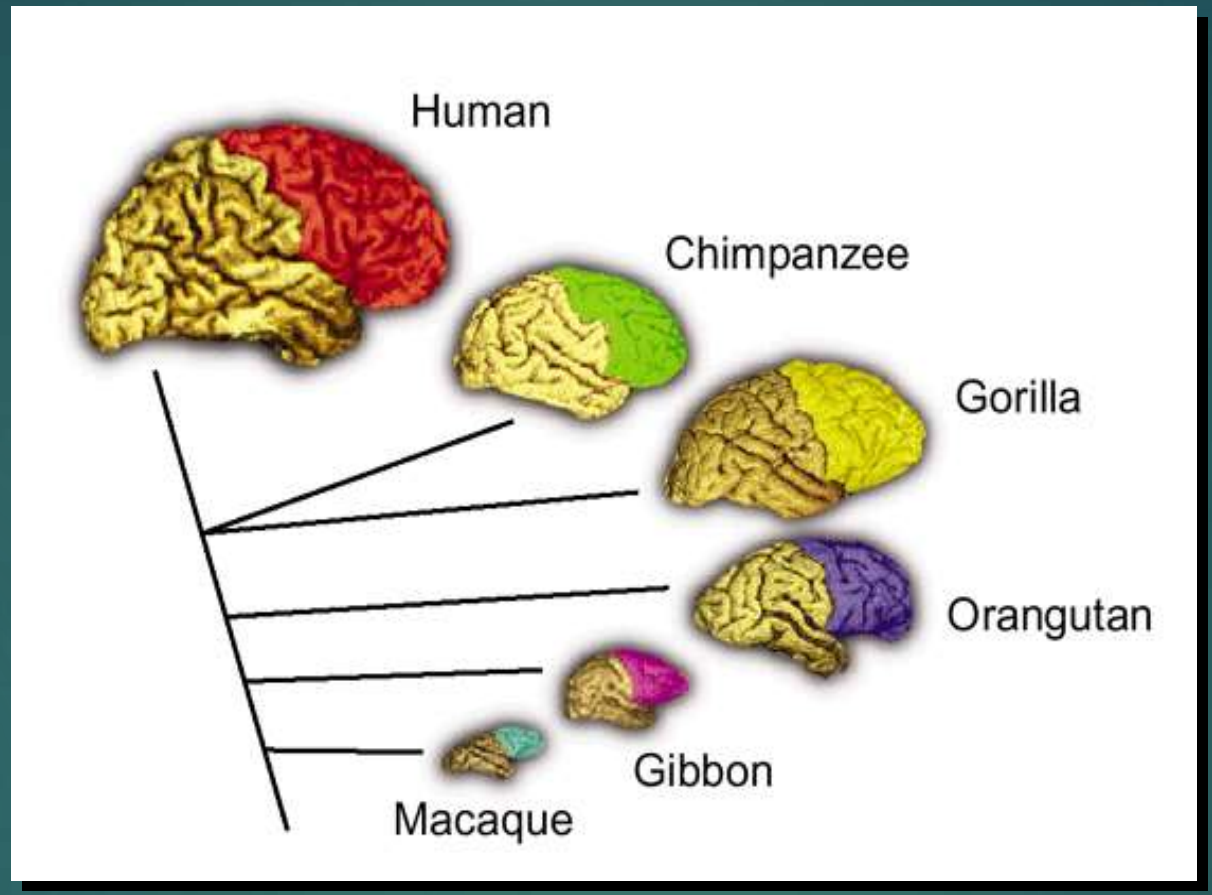
  - 82% of total brain mass.
  - 61 billion glia; 16 billion neurons = 4 to 1

F. Azevedo et al., J. *Comp. Neurol*. 513:532–541, 2009

Rapid increase in brain size after cooking



Evolution of Prefrontal Lobes: Humans do not have larger frontal lobes



34% in all primates; humans greater white matter: greater frontal gyral white matter; greater connectivity

Brain reorganization more important than brain size

- Current studies show that brain size accounts for only 10% of the variance with intelligence.
- It is internal organization, especially amount of white matter connectedness which creates processing speed, that is important.
- Quality of the white matter is highly genetically determined, although the influence of genetics varies by brain area

Robin Ian MacDonald Dunbar (1947-): Social Brain Hypothesis

- British anthropologist and evolutionary psychologist

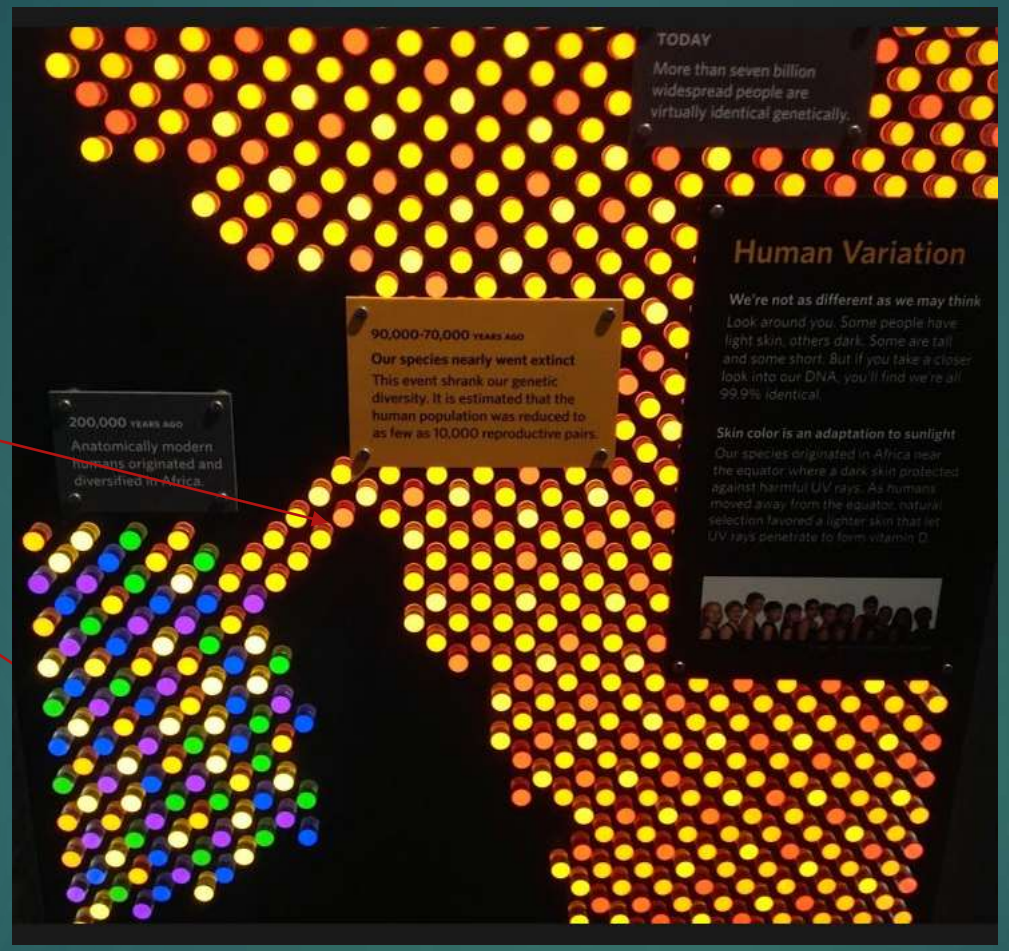
- 1998: study proposing the Social Brain Hypothesis, which states brain size increases with social group size and complexity

Human Migrations: Profoundly interrelated Species

- Out of Africa: Latest 2016 Nature: all non-Africans today trace their ancestry to a single population emerging from Africa between 50,000 and 80,000 years ago.
- All MH DNA is African by origin
- MH originated in Africa circa 200 kya
- MH are 99.9% identical
- 2 humans on separate continents are closer genetically, than 2 chimps on opposite side of an African river in same jungle (100 chimps are more diverse than all 7 B MHs)
- Genetic diversity in non African MHs is incredibly low; of 14 "ancestral clusters" for all of humanity, 9 of those clusters are in Africa (due to longest time to accrue mutations)

Human Odyssey Bottleneck exhibit: Loss of genetic variance

Africa



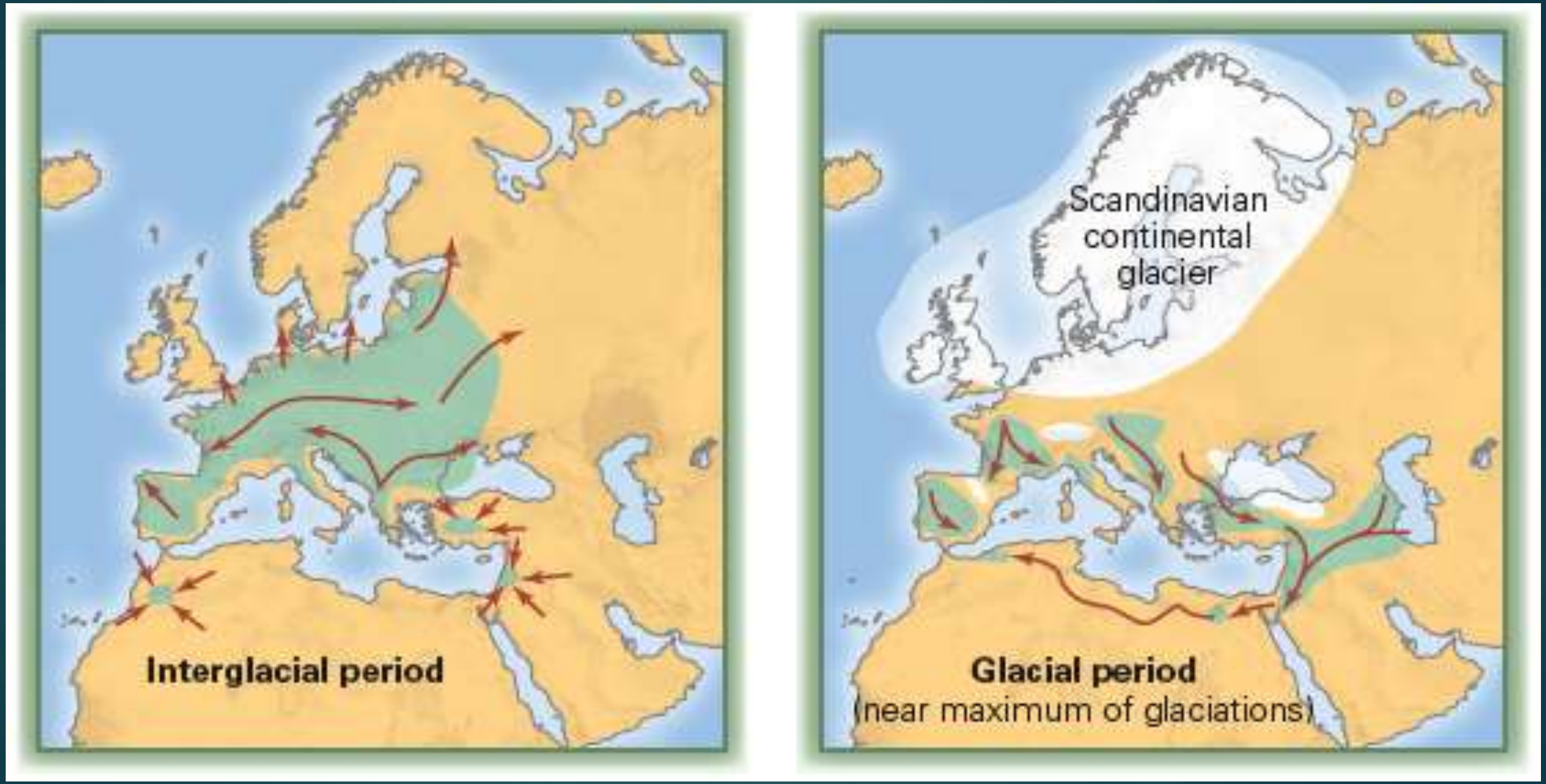
- Two bottleneck events:
- 1- Near extinction event ~70-90K
- 2 - Migration out of Africa ~50K

Time course exhibit: Africa at 250K (vast genetic diversity); Bottleneck in Africa c 70-90K, then bottleneck due to migration. Rest of world today has significantly less genetic diversity due to multiple founder effects

Migrations out of Africa

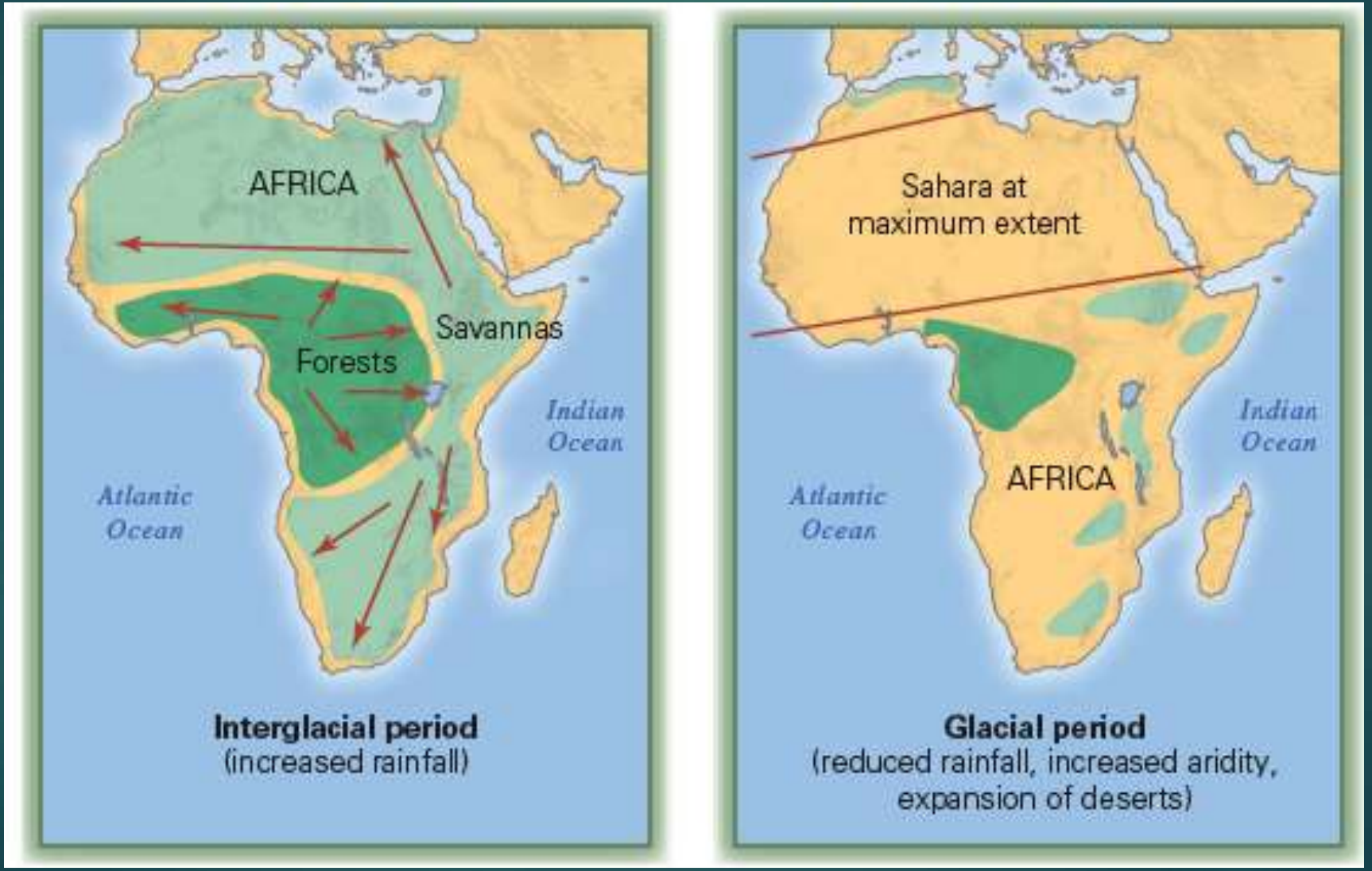
- 1. 8 mya, *H. erectus* to Dmanisi & China; Flores?
- *H. heidelbergensis* develops into Neandertals & Denisovans in Europe & Asia
- MHs, prior to 100 K (South China MH teeth, 80-120 K)
- MHs, 70 K to Levant; probably failed attempt
- Then 1st significant migration out of Africa at 50-60 K
- Australia, c 60 K
- Europe, c 40 K
- Americas, c 20 K

Changing Pleistocene Environments in Eurasia



Changing Pleistocene Environments in Africa

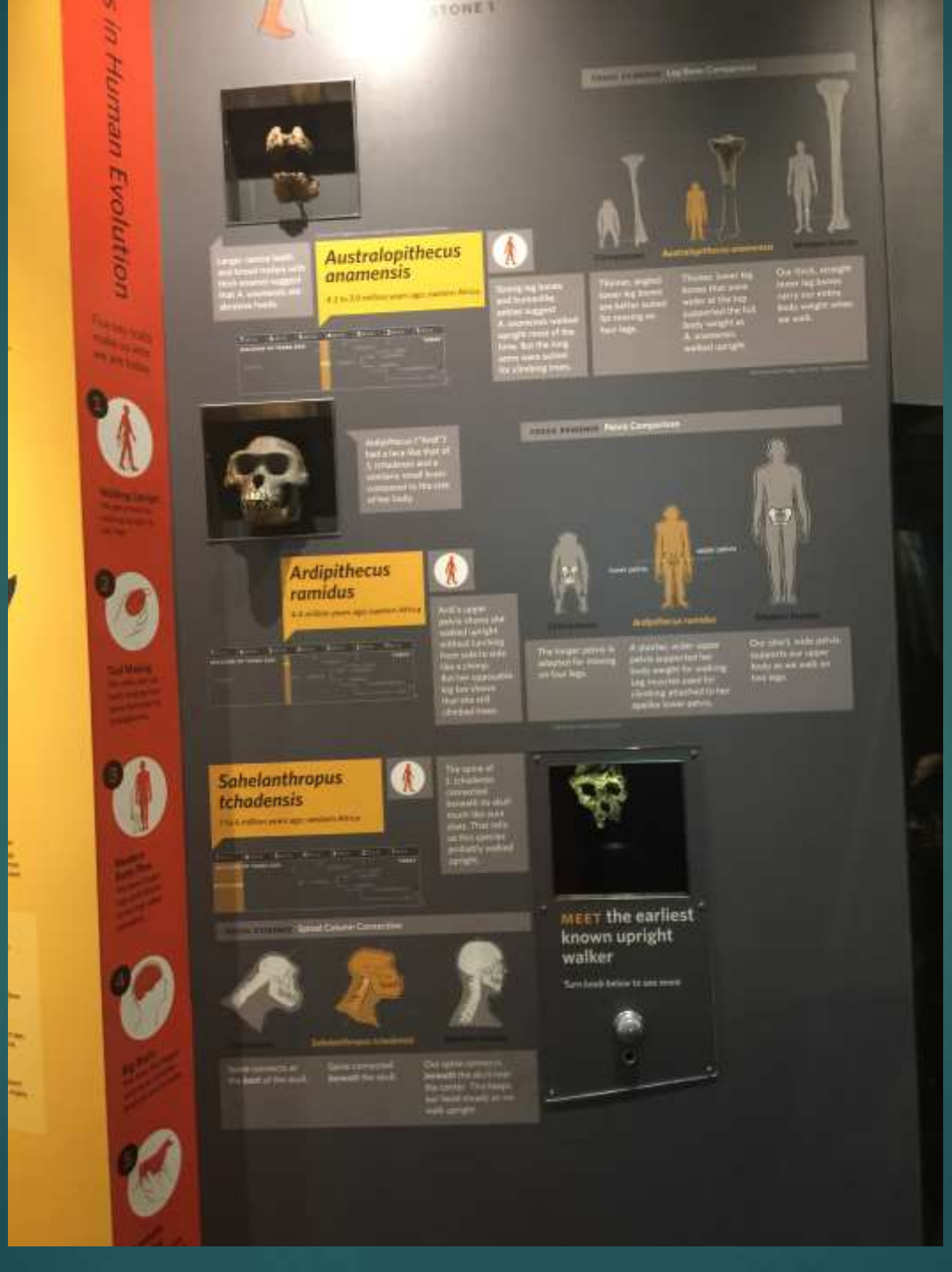
During European Glacial Period



Modern Chimpanzee and Human: both equally evolved

Pan troglodytes

Homo sapiens


Australopithecus anamensis
Ardipithecus ramidus
Sahelanthropus tchadensis
MEET the earliest known upright walker

2001: *Sahelanthropus tchadensis*, Chad, 7-6 M; close to the divergence of hominins and chimpanzee ancestors

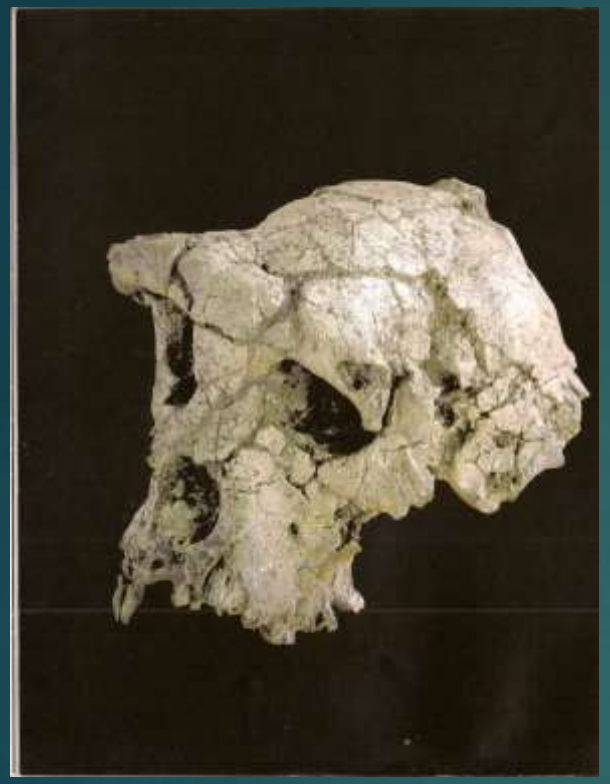
Single Skull (9 parts); no skeleton;
Cranial size: ~350 cc

Largest hominin brow ridge

- Foramen magnum:
  - shape (oval, not rounded as in chimp)
  - forward positioning indicate bipedalism (like Ardi; both upright posture)

Reduced prognathism; widely-spaced eye orbits; canines smaller and shorter than those of the male chimp

Sahelanthropus tchadensis: Toumai, which means "Hope of Life"; late Miocene ape or hominid ancestor?



2001 Sahara Desert

6 to 7 Million years old

Reconstruction

Unique mix of humanlike and apelike features:

Apelike features were an elongated skull, very small brain, massive brow ridges, and no forehead. Back of skull very apelike;

Humanlike features were a short middle part of the face, smaller canine teeth, and the location of foramen magnum.

Orrorin tugenensis, 6 MYA

- Locality: Tugen Hills, Kenya

- No cranial fossils recovered
  - Keeps controversy alive (could be Ardipithecus)

- Mixture of apelike-humanlike
- Incisors, canines, premolars, arm and fingers like chimpanzees; Humerus and finger bone retains evidence of arboreal adaptations
- - Large central incisor and upper canine – more apelike
- Thick enamel & femur more humanlike than Australopithecines

- Bipedalism inferred from femur anatomy (controversial)

1992: *Ardipithecus ramidus*, 4.4 M, Tim White, 15 years before publicat.

Type specimen
ARA-VP-1/129

Discoverer:

Alamayehu Asfaw

Locality: Aramis, Middle Awash, Ethiopia

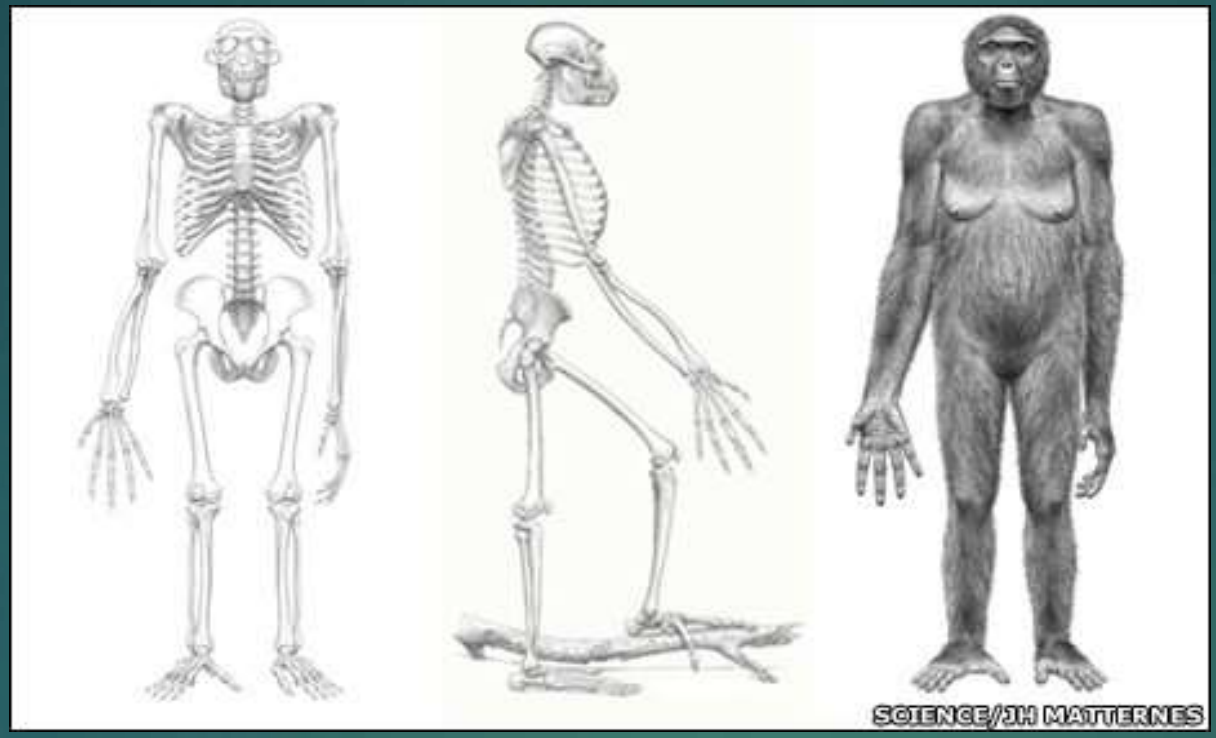
Age: 4.4 M

1992: *Ardipithecus ramidus*

Ardi's bones were so fragile they crumbled when touched

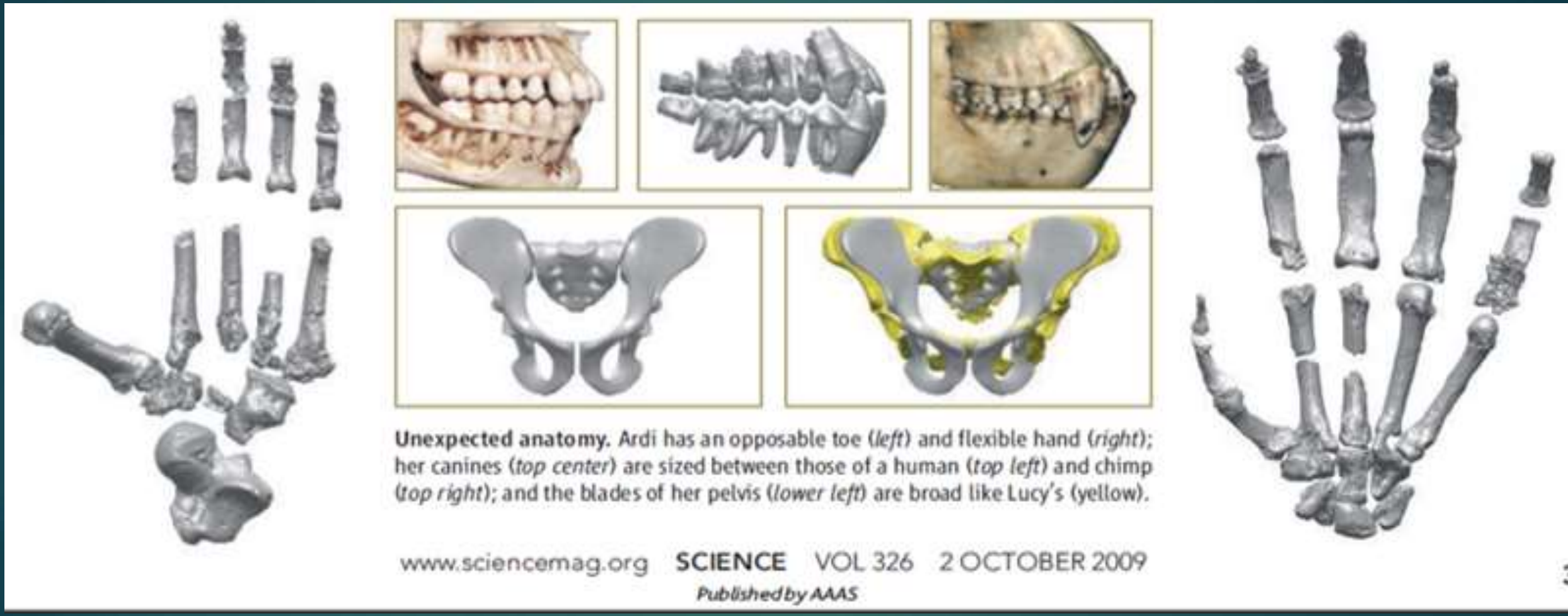
Project participant and famous hominid fossil finder Alemayehu Asfaw discovered a hominid lower jaw on February 9, 2006.
Photo by Yohannes Haile-Selassie.

Ardipithecus: 4.4 million years ago, 300-350cc, omnivore; foramen magnum indicates bipedalism



- **Height:** Females: average 3 ft 11 inches (120 centimeters)
- **Weight:** Females: average 110 lbs. (50 kg)
- Relatively low sexual dimorphism
- Cranial capacity: 300–350 sq. cm
- Ardi's fossils were found alongside faunal remains indicating she lived in a wooded environment. This contradicts the open savanna theory for the origin of bipedalism,

Unexpected anatomy



Unexpected anatomy. Ardi has an opposable toe (*left*) and flexible hand (*right*); her canines (*top center*) are sized between those of a human (*top left*) and chimp (*top right*); and the blades of her pelvis (*lower left*) are broad like Lucy's (yellow).

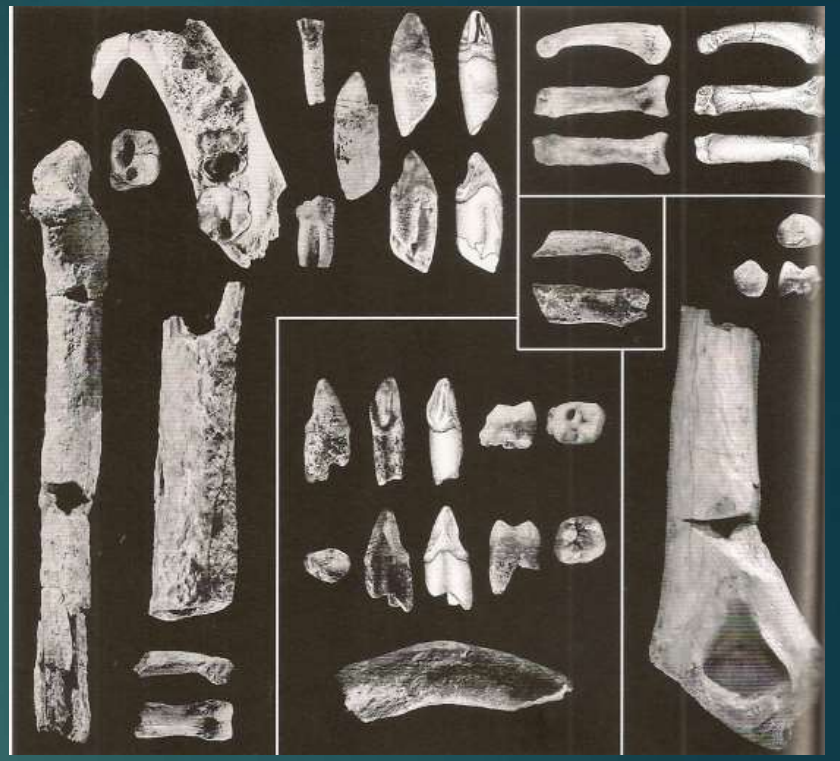
www.sciencemag.org SCIENCE VOL 326 2 OCTOBER 2009
Published by AAAS

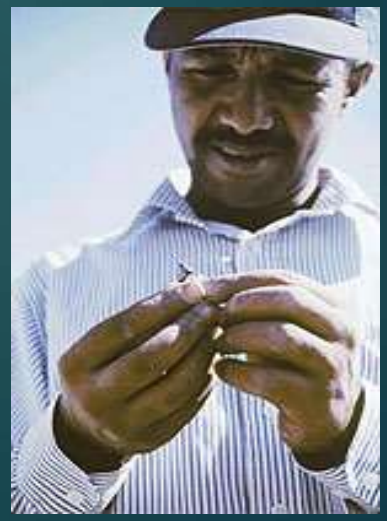
Her pelvis was shorter and broader than an ape's, indicating that she may have walked bipedally;
Ardipithecus foot: divergent, opposable toe & long toes (arboreal).

White, Gibbons (2009) A new kind of ancestor: *Ardipithecus* unveiled. *Science*

Ardipithecus kadabba, 5 mya

- 1st designated as subspecies, then promoted to full species in 2004
- Even older - 5.8 – 5.2 mya
- Ethiopia (Middle Awash)
- Similar to *Sahelanthropus* in mix of features
- Mandibles, teeth, some postcranial bones
- Tall, pointed, upper canines; slightly smaller canines; resemble chimp
- 11 specimens from at least 5 individuals
- Wooded habitat
- Case for being hominin is not strong





Yohannes Haile-Selassie

Haile-Selassie, Y., Suwa, G., White, T.D., 2004. Late Miocene teeth from Middle Awash, Ethiopia, and early hominid dental evolution. Science 303, 1503-1505.

Fossil Preservation: hominin vs chimp

- Hominids may have lived all over Africa, but their remains are found only at sites where conditions allowed for the formation and preservation of fossils.
- Not all environments are conducive to fossil perseveration; some so acidic (forests), fossils rarely survive
- Fossil record for the chimp/bonobo clade is virtually nonexistent.
- The only panin fossil evidence in the last 8 myr consisted of a few 700 kya-old isolated teeth from a site called Baringo, in Kenya.
  - A. Little chance of erosion in forests and therefore no exposures, and thus no places where fossils could be uncovered by erosion.
  - High levels of humic acid in soils of forests dissolve bones before they fossilize.
- B. Wood is unconvinced by above arguments. Thinks fossils are out there but undiscovered.

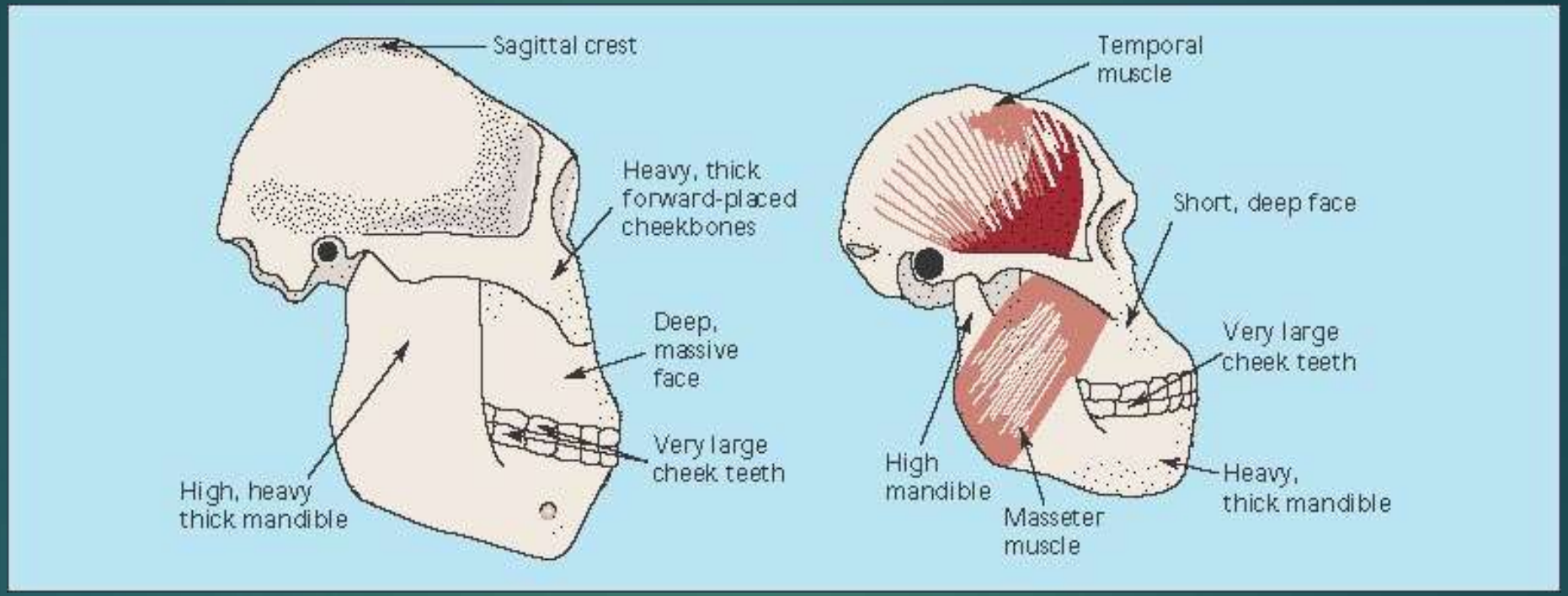
A historical review of the Australopithecines (11 species): 2 M

- 1924: Taung - *Australopithecus africanus*
- 1947: Mrs. Ples – *Australopithecus africanus*
- 1948: *Paranthropus robustus* at Swartkrans
- 1959: Zinj - *Paranthropus boisei* at Olduvai Gorge, Tanzania
- 1974: Lucy - *Australopithecus afarensis* in Ethiopia
- 1985*: Paranthropus aethiopicus*

A historical review of the Australopithecines 2

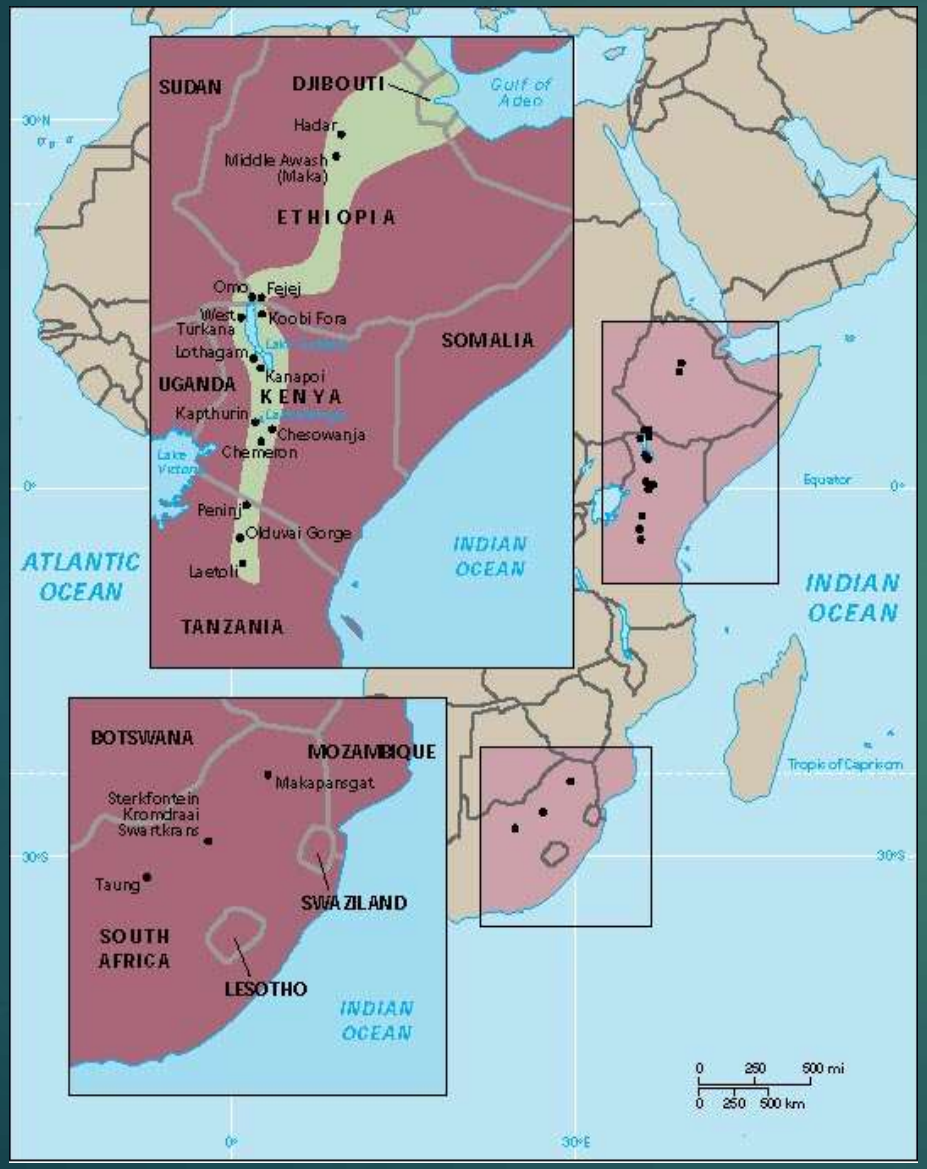
- 1994: *Australopithecus anamensis*
- 1995: Abel - *Australopithecus bahrelghazali*
- 1997: *Australopithecus garhi*
- 1999: *Kenyanthropus platyops*
- 2008*: Australopithecus sediba*
- 2015*: Australopithecus deyiremeda*

Australopithecines



Skulls of Robust (left) and Gracile (right) Australopithecines.

Map of Australopithecine Finds



- Map of major Australopithecus sites in Africa:
- East African rift valley
- Limestone caves of South Africa.

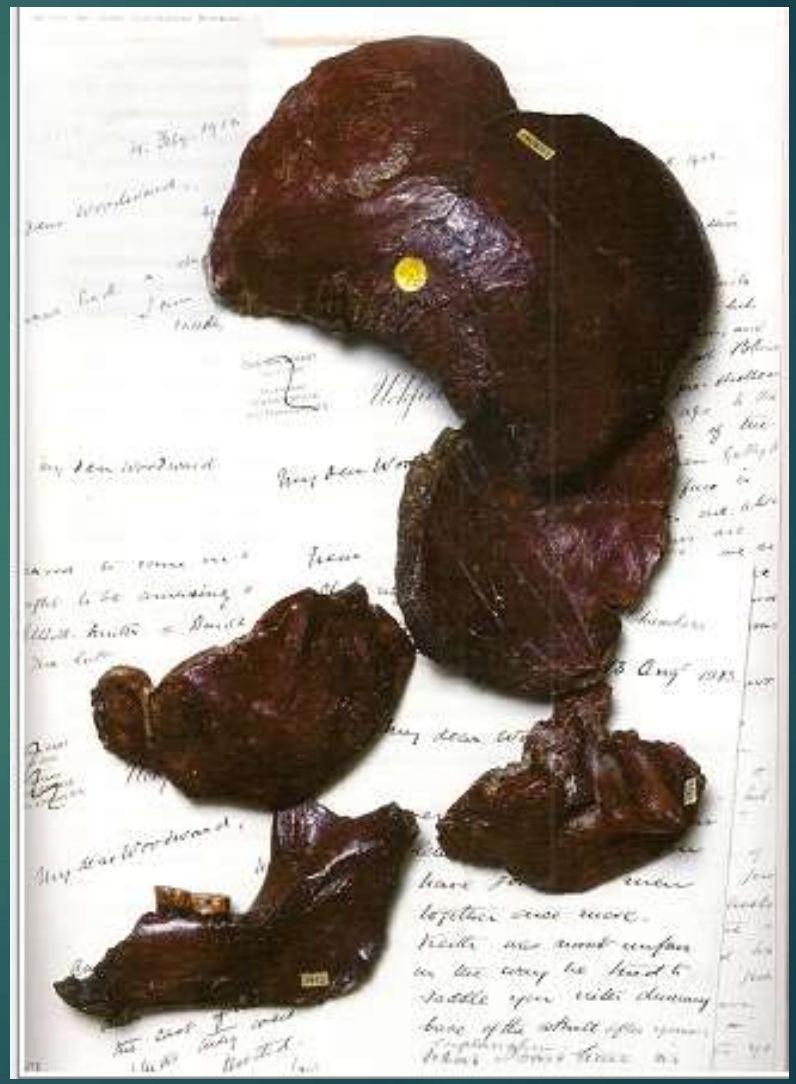
South African Australopithecines

- *Australopithecus africanus*, *Paranthropus*, and *Australopithecus robustus*
- South African sites in very different geological context
- Not open landscapes but caves.
- Fossils cannot be dated reliably
- At all these southern African cave sites early hominin fossils are mixed in with other animal bones in hardened rock and bone-laden cave fillings, or breccias.
- Most dated by comparing remains of mammals found in caves with fossils found at better-dated sites in East Africa
- The ages of the A. africanus-bearing breccias are estimated to be between 2.4 and 3 mya.

Gracile Australopithecines

- *Australopithecus afarensis*
- *Australopithecus africanus (first found)*
- *Australopithecus anamensis*
- *Australopithecus garhi*

1912: *Eoanthropus dawsoni* in England ("Dawson's dawn-man“): a skull & jawbone



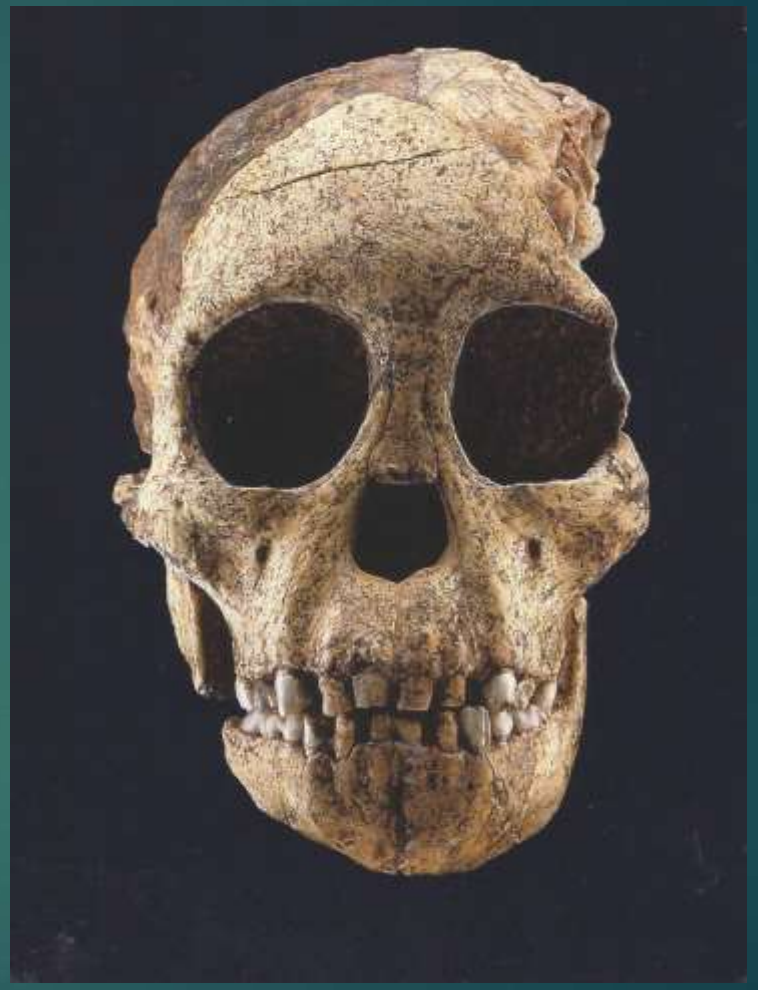
Charles Dawson (1864-1916):
Piltdown Man Hoax

- English solicitor and antiquarian
- Victim (or perpetrator?) of Piltdown Man hoax

- The pairing of a modern human cranium and a stained, broken orangutan jaw confirmed expectations of a human ancestor with a large, rounded braincase.
- Negatively affected paleontology for 40 years.
- Proven a hoax in 1954

1924: First *Australopithecus africanus*, Taung Child, 2.8 mya; 3.3 years old, bipedal, 440 cc

Australopithecus africanus (Taung Child; type)
Discoverer: M. de Bruyn, Robert Dart
Date: 1924
Locality: Taung, S. Africa
Age 2.8 M



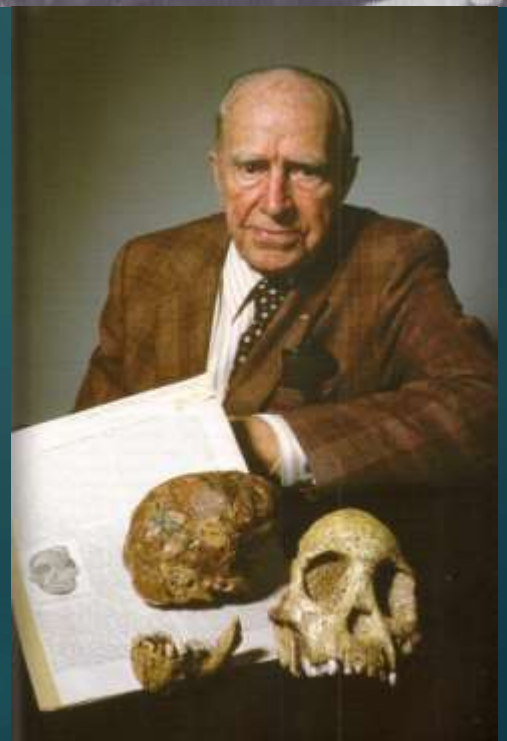
6 months with wife's darning needles; left in backseat of a London taxi

Raymond Dart (1893-1988):

Taung Child: Bipedalism, not large brain, came first

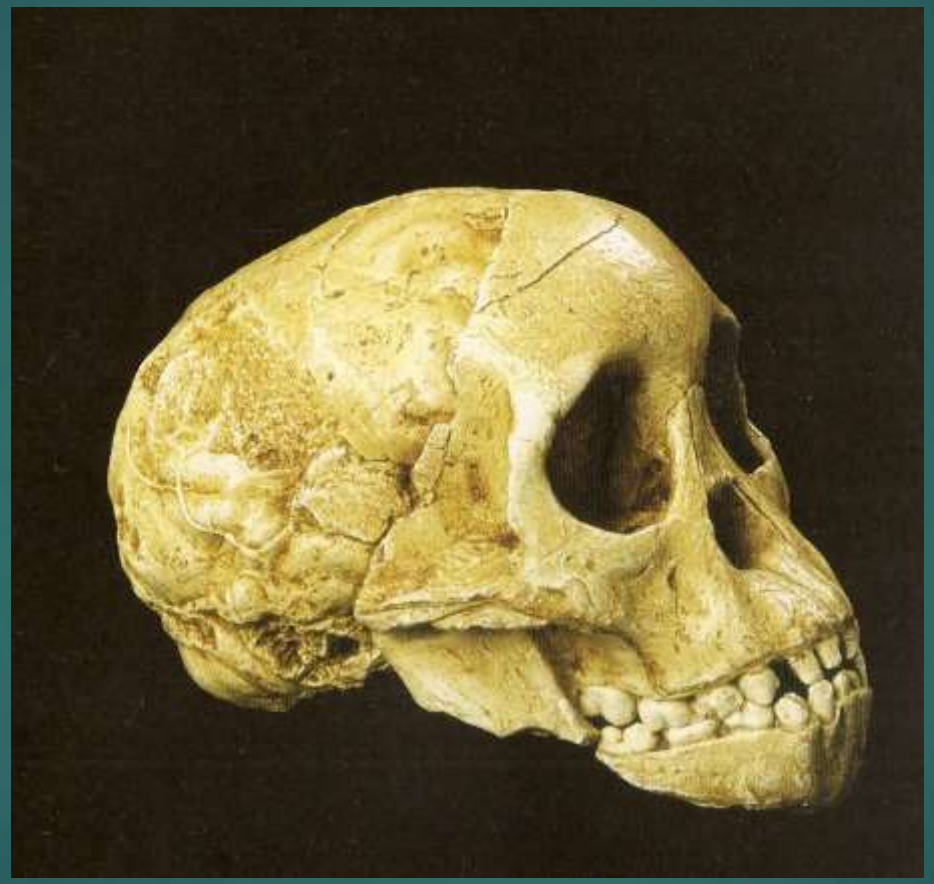
- Australian South African anatomist; Professor of anatomy at Univ. of Witwatersrand

- 1924: Changed course of human paleontology with discovery of the first *Australopithecus africanus*, the Taung child, an erect walking ape
- Interpretation of fossil as human ancestor largely rejected by the British scholars for 30 years
- With Robert Broom, changed human evolution theory by showing australopithecines were earliest hominids
- South African fossils: None associated with stone tools (we don't know about wood, which does not preserve.)



Taung Child: First brain endocast

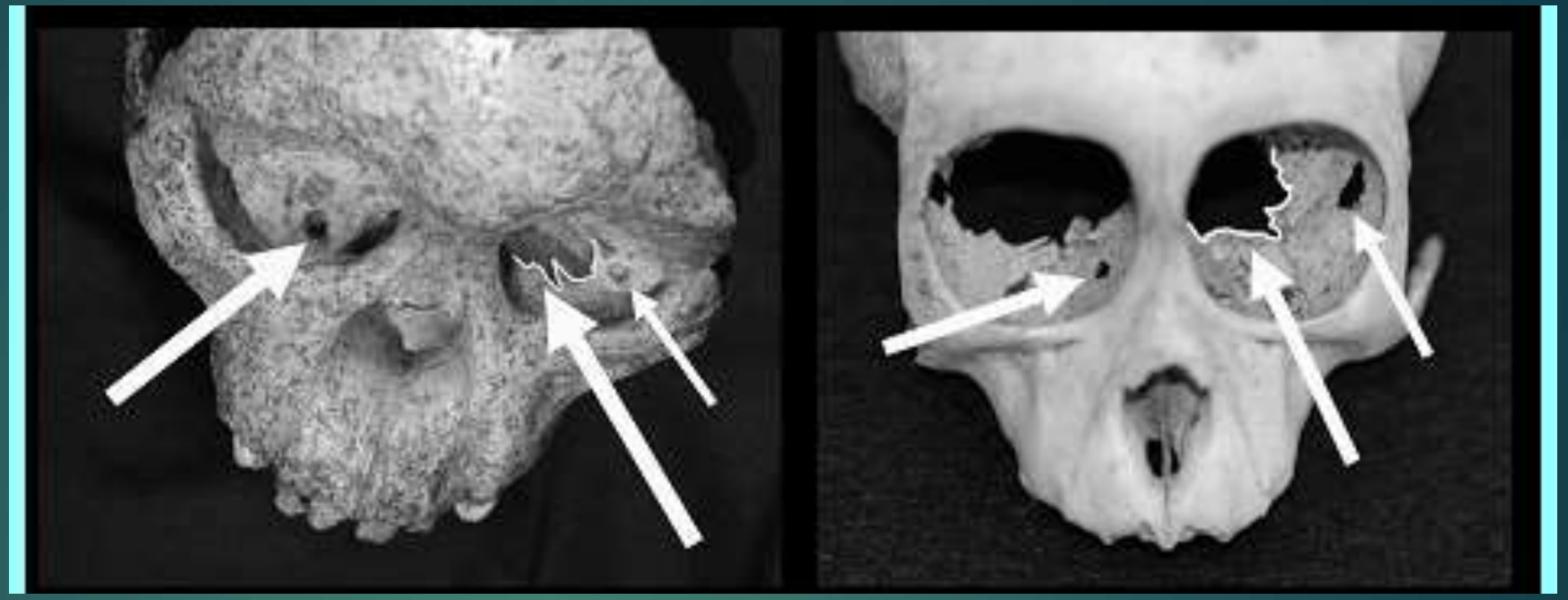
Small Brain: 440cc



British Scholars: He’s an ape.

Australopithecus africanus

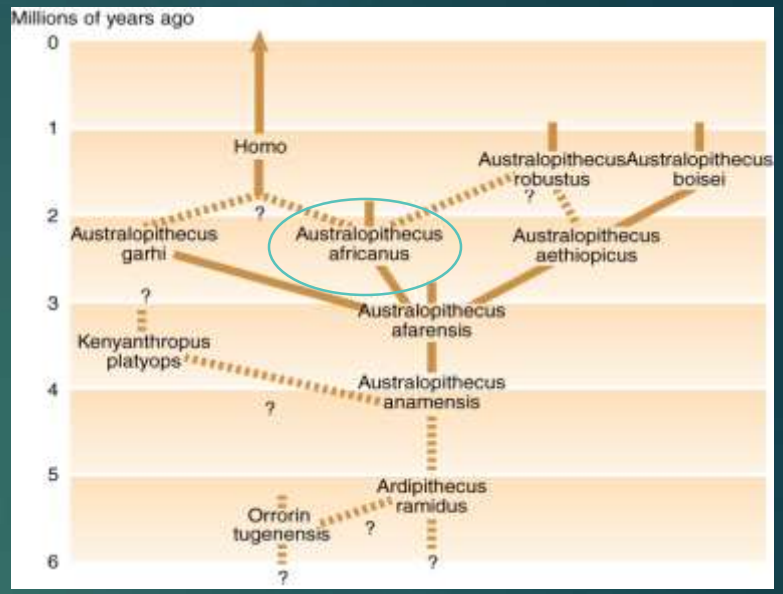
Eagle Attack



Same skull damage as in modern
3 year olds attacked by
African hawk-eagle
(Aquila spilogaster)

Australopithecus africanus

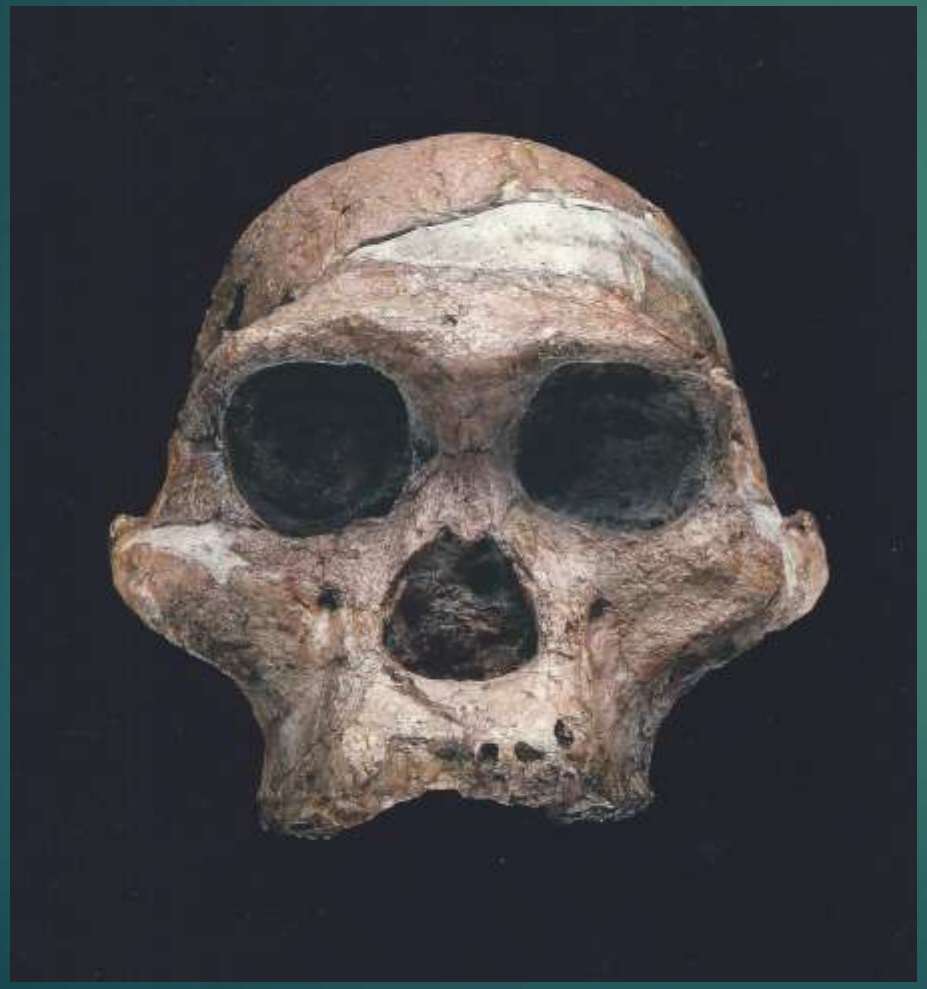
- First known australopithecine (Dart 1925)
- Dated to 3.3-2.1 mya in South Africa
- Cranial capacity: <500 cc
- This species slightly different from *A. afarensis*: slightly taller, less facial prognathism, smaller teeth, slightly larger brain.
- One candidate for immediate ancestor to *Homo*



Taung Child

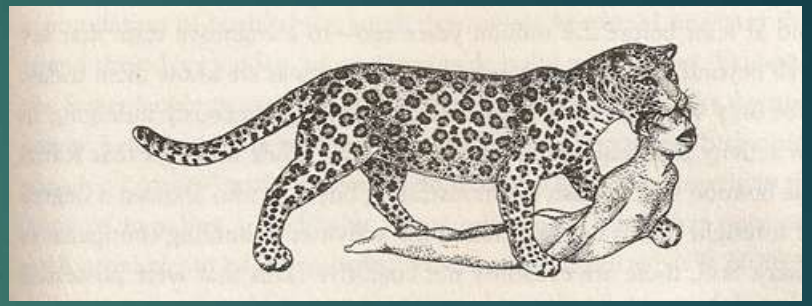
Brain endocasts & cranium of A. africanus, S. Africa; brains less than 500 cc

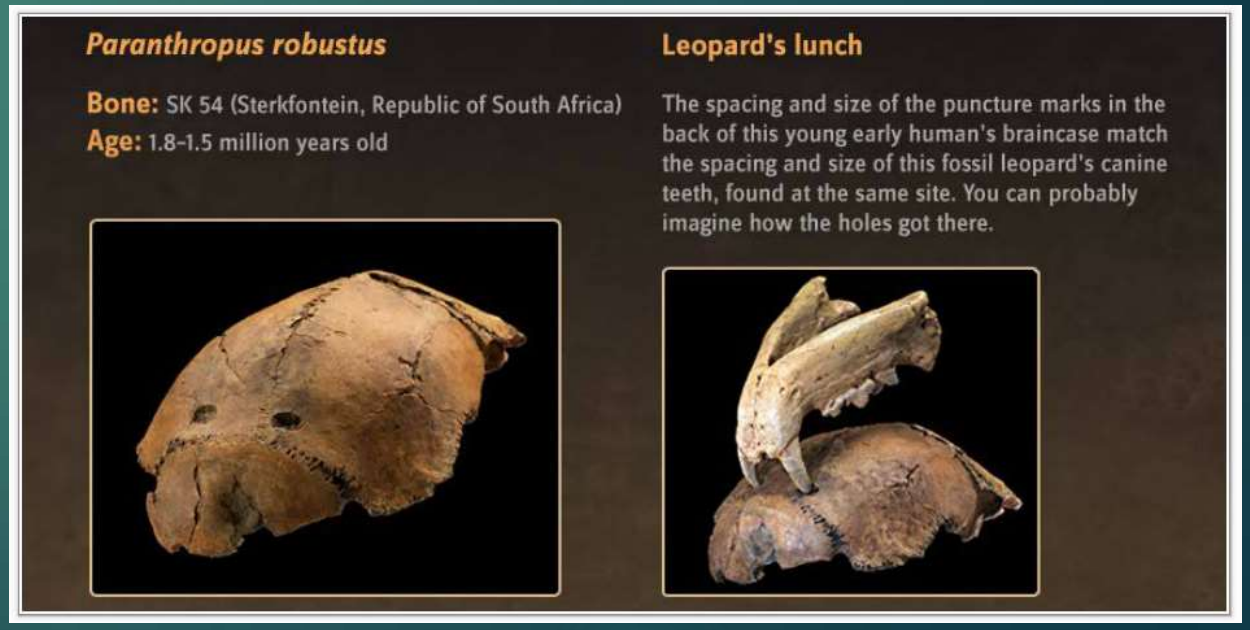
1947: Sts 5, *A. africanus;* Mrs. Ples (a male), 2.4 M



Australopithecus africanus
(STS 5)
Discoverer: Robert Broom &
John T. Robinson
Date: 1947
Locality: Sterfontein
Age 2.4 M

Hominins as prey: C. K. Brain: Hominin Predation at Swartkrans





Swartkrans caves: 1.7 M- 800K: mostly Robustus

Australopithecus africanus

- Paranthropus (1.5-2 mya), compared to *A. africanus*, had larger chewing teeth, broader face, slightly larger brain.

- No sign that either A. africanus or P. robustus lived in the caves their fossils are found in. Either bones were dropped into cave openings by leopards, or brought into the caves by hyenas or porcupines. Or fallen into cave or entered and could not leave.

- The exact role of the australopithecines in human evolution has yet to be resolved.

- 1974: Lucy, *A. afarensis*
- The dark-colored bones represent the bones of Lucy's fossil (42% of total)
- white colored bones were reconstructed from other *A. afarensis* fossils.

"Lucy in the sky with diamonds"

Australopithecus afarensis

- **Fossil Record**: 3.9–3.0 mya;
  - the most widely-known Australopithecine fossil, Lucy, is estimated to be around 3.2 million years old.

- **Brain size**: 375 cc to 550 cc range; Lucy's brain at around 380 cc. Her skull was incomplete.

- **Diet**: Mostly mixed vegetables, fruit, and leaves; no direct evidence of meat eating until 2010, when researchers with the Dikika Research Project found fossil animal bones bearing cut marks, dating to about 3.4 million years ago. These cut marks indicate butchering.

Don Johanson:
Australopithecus afarensis

40% of complete skeleton

Australopithecus afarensis
(A. L. 288-1, “Lucy”)
Discoverer: Don Johanson
Locality: Hadar, Ethiopia
Date: 1974
Age 3.2 M

Australopithecus afarensis
(L.H. 4, type specimen)
Discoverer: Maundu Muluila
Locality: Laetoli, Tanzania
Date: 1974
Age 3.6 M

Latest Lucy reconstruction

A. afarensis, Lucy, 1974
Science reconstruction, 2013

Lucy: 1st *A. afarensis* found

Her discovery revolutionized ways of thinking about early hominids.

Ethiopia

'8" tall; 55 lbs

ms / short legs

when died

mall & unspecialized, indicating a mixed, omnivorous diet of mostly soft foods (fruits)

Left to right: Lucy's bones, reconstructed Lucy, modern human

1978: Laetoli Footprints: A. afarensis, male and female, 3.6 M

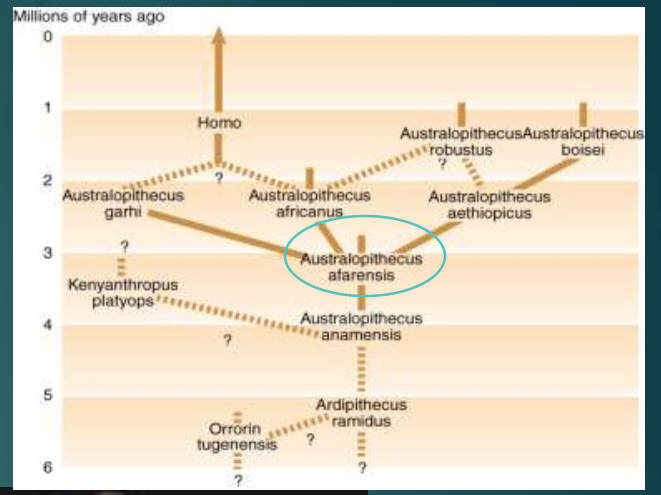
Left: Trail of footprints of A. afarensis made in volcanic ash, discovered by Mary Leakey at Laetoli.

Right: Close-up of footprint at Laetoli

88 feet long, 70 footprints; left foot of female deeper discovered while playing football with elephant dung

Australopithecus afarensis

- Most well-known australopithecine = Lucy
  - Most complete skeleton (40%)
- Dates to 3.5-2.3 mya in East Africa (Don Johanson, 1970s)
- Bipedalism
  - Shape of pelvis, femur, foot, Laetoli footprints
  - May not have been fully modern gait
- Derived characters intermediate between humans and chimps
  - Dental arcade
  - Canines
  - Premolar cusps



1994, Ron Clarke:

Little Foot (*Australopithecus*): Most complete adult

Little Foot

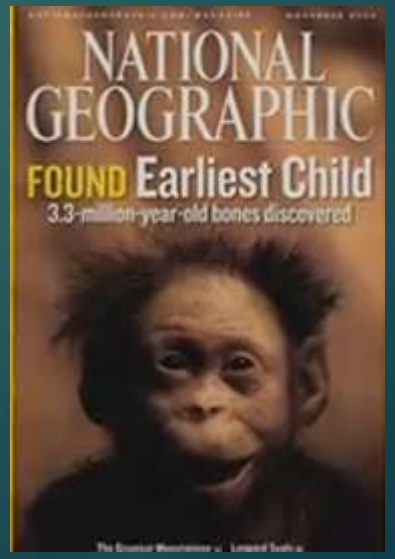
Australopithecus
(StW 573)

Discoverer: Ron Clarke
Locality: Sterkfontein
Date 1994
Age: 3.0 M

Zeresenay Alemseged (1969-): Dikika *A. afarensis* child, Selam

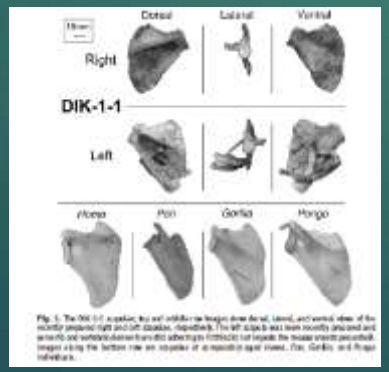
- Ethiopian paleontologist; former curator and chair of anthropology at the California Academy of Sciences; now Univ. of Chicago

- Director, Dikika Research Project (DRP), Afar, Ethiopia.
- 2006: at Dikika, Ethiopia, discovered an *Australopithecus afarensis* child (Selam, 3 yo), 3.3 M



- Humanlike knees and feet with a wide heel showed her species walked upright.
- Structure of her scapula (shoulder blade)—more apelike than human—and her long arms and hands with curved fingers suggest her species were still tree climbers.

2006: *A. afarensis*, Dikika, Selam



2011: Shoulders

6 years to remove face from matrix

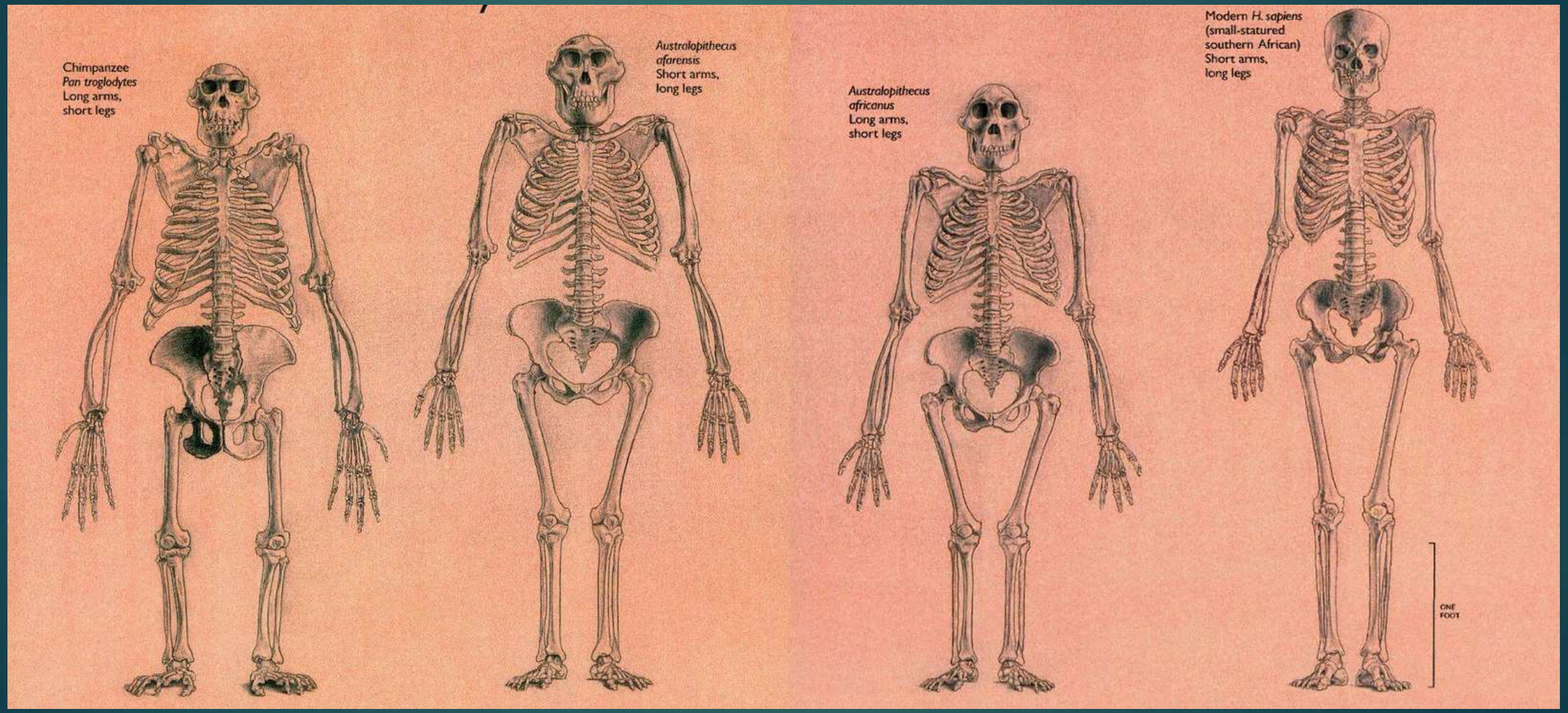
Did *Australopithecus afarensis* carve meat?

Evidence of Stone Tool Use and Meat-Eating in the Australopithecines:
Dikika cut bone at 3.3 MYA

There were 12 marks on the two specimens

Comparison: Chimp, *A. afarensis & africanus*, MH

Chimp *A. afarensis* *A. africanus* *H. sapiens*



Latest: 5’5” male

Gracile Australopithecines

- *Australopithecus afarensis*
- *Australopithecus africanus (first found)*
- *Australopithecus anamensis*
- *Australopithecus garhi*

Robust Australopithicines (now *Paranthropus*)

- *Australopithecus aethiopicus*
- *Australopithecus boisei*
- *Australopithecus robustus*


Paranthropus aethiopicus
Paranthropus robustus
Australopithecus sediba
Australopithecus africanus
MEET a grass-eating specialist


Paranthropus robustus
Paranthropus boisei

Robust Australopithecine Morphology

- 2.5 - 1 mya
- South and East Africa
- 3 species - united by suite of features related to eating tough foods:
  - Extremely large molars / premolars
  - Dished face
  - Extremely large chewing muscles
  - Wide-flaring cheekbones
  - Prominent sagittal crest

Paranthropus aethiopicus
KNM WT 17000, Black Skull

- P. aethiopicus:
- 2.7 to 2.3 mya
- Ethiopia, Kenya
- prominent skull crest, big jaws
- massive teeth

Australopithecus aethiopicus
(KNM-WT 17000, Black skull)
Discoverer: Alan C. Walker
Locality: Lake Turkana, Kenya
Age: 2.5 M
Date 1985

1948: *Paranthropus robustus*, SK 48

Big teeth, huge jaws and strong chewing muscles anchored to a skull crest

Paranthropus robustus, 1.8 to 1.2 mya

- Fossil sites of *Paranthropus robustus* are found only in South Africa in Kromdraai, Swartkrans, Drimolen, Gondolin and Coopers.
- In the cave at Swartkrans, the remains of 130 individuals were discovered.
- The study made on the dentition of the hominins revealed that the average *P. robustus* rarely lived past 17 years of age.
- *Paranthropus robustus* was the first discovery of a "robust" species of hominin; it was found well before *P. boisei* and *P. aethiopicus*.

Louis Leakey: Discoverer of *Zinj & Homo habilis*
First Superstar in Paleoanthropology

1920, Leakey as fully initiated Kikuyu Tribe member

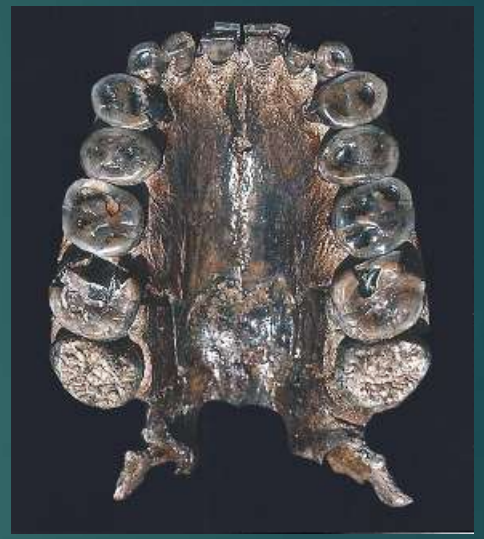
Olduvai Gorge

1959: *Paranthropus boisei:*

Most famous Olduvai Gorge fossil; "Zinj": 1.8 M

"Why it's nothing but a god-damned robust australopithecine!"

1959: Zinj, OH5, 1st dated fossil



Australopithecus/Paranthropus boisei
(OH 5, type)
Discoverer: Mary Leakey

The greatest significance of *Paranthropus boisei* is that its 1959 discovery convinced the scientific world that the place to look for the earliest humans is Africa

Paranthropus boisei: Sexual dimorphism

2.3 to 1.2 mya; Average cranial capacity: ~ 520 cc

OH 5, male

KNM-ER 732, female

Paranthropus boisei, 1.7 M

A. Boisei & prior H. ergaster in sediments of same age invalidated idea that only 1 species could survive in given habitat at any 1 time

Australopithecus boisei
(KNM ER 406)
Discoverers: Richard Leakey & H. Mutua
Date: 1970
Locality: Koobi For a, Kenya
Age: 1.7 M

Largest teeth of any hominin

Teeth: *Paranthropus & H. sapiens*

Paranthropus bosei, 2.3 M
by V. Deak

No postcranial skeletal fossils of *P. boisei;* Only guesswork about posture and locomotion

1994: *Australopithecus anamensis*, 4.2-3.9 mya, biped

Oldest Australopithecine

- The teeth of Australopithecus anamensis are markedly apelike (larger canines, broad molars (abrasive foods), parallel tooth rows)
- Strong leg bones and humanlike ankles suggest A. anamensis walked upright most of the time.
- But the long arms were suited for climbing trees.
- May be earliest incontrovertible evidence of bipedalism

Australopithecus bahrelghazali

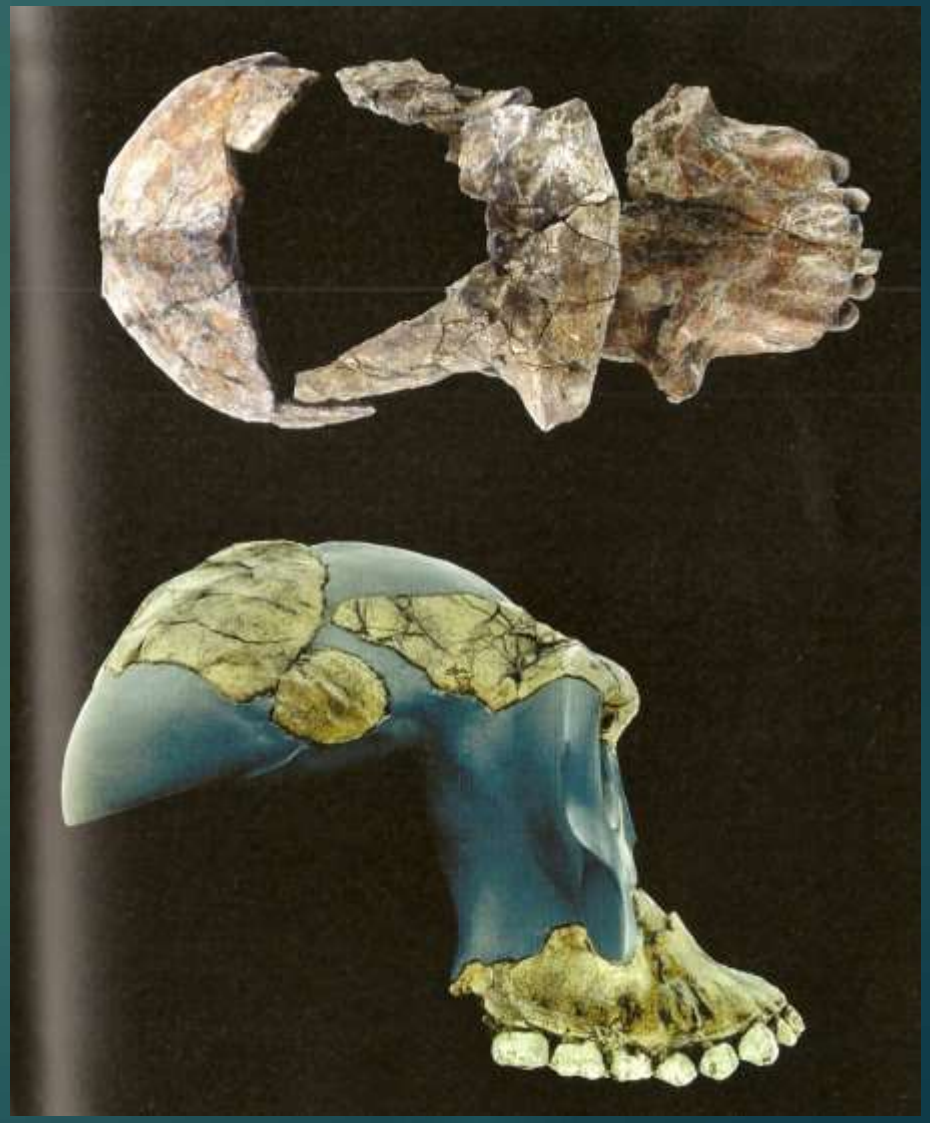
- Discovery 1995: with MPFT, in Koro Toro, Chad (not far from site of *S. tchadensis);*
- *Australopithecus bahrelghazali*
- KT-12, named “Abel”, type specimen in 1996
- age 3.5 M

Australopithecus bahrelghazali Skull ©David L Brill/Atlanta

1997: *Australopithecus garhi*:
Tim White & Berhane Asfaw, 2.5 mya

Australopithecus garhi
(BOU-VP-12/130)

Discoverer: Y. Halle-Selassie
Locality: Bouri, Ethiopia
Date 1997



Kenyanthropus platyops

Location: East Africa
Major sites(s): West Turkana, Kenya

Date Range: 3.5 - 3.3 mya.
Associated paleoanthropologist:
Meave Leakey

Average cranial capacity:
Within range of *A. aferensis* & *A. africanus* (about 420 – 440 cc)

First new hominin genus described in 10 years

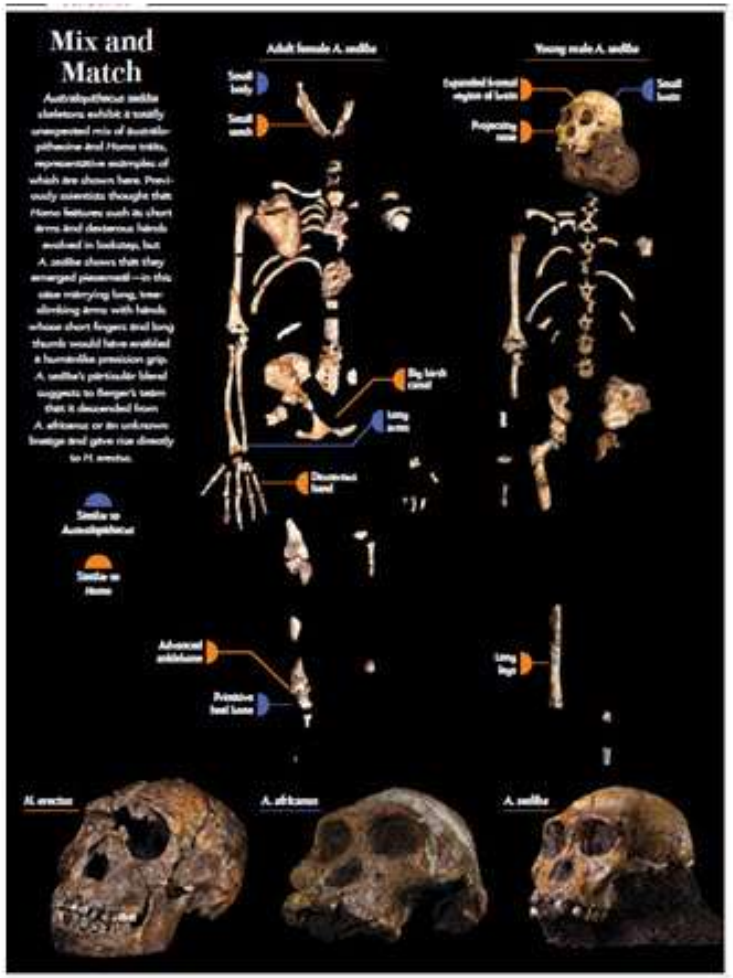
- Latin name translates to: “flat - faced Kenya man”

- Combination of a big, flat face and small cheek teeth make this hominin unique among all hominins

- The above justifies it’s placement in a separate genus

(Leakey et al. 2001)

Australopithecus sediba: Discovery by 9 year old boy



A. sediba, 1.9M, Matthew Berger, 9 Y old
Malapa, South Africa, 2008

2008: *Australopithecus sediba, 1.98 M,*
Malapa Cave, South Africa; Cranial Capacity: 420–450 cc, bipedal


Brett Eloff, via Lee Berger and the University of the Witwatersrand

Australopithecus sediba
(LH1, type, cranium)
Discoverer: Matthew Berger
Locality: Malapa Cave, South Africa

Lee Berger & Malapa, 2009: *Australopithecus sediba*

2 partial skeletons, 2 MYA

Extremely small teeth, gracile face, small brain

Teeth more like us than *H. habilis*

2015, New Species: *Australopithecus deyiremeda* (Holotype BRT-VP-3/1)*: 3.4 MYA*

- *Australopithecus deyiremeda* ("close relative") lived about 3.4 million years ago in northern Ethiopia, around the same time and place (35 km from Hadar) as *Australopithecus afarensis*.
- Lower jaw was beefier, and the teeth smaller, than Lucy's species

Yohannes Haile-Selassie, et al., 2015

Homo: Major adaptive shifts in hominin evolution ca. 2 mya

- Emergence of *Homo* lineage
  - Physically / behaviorally different from earlier & contemporary australopithecines
    - Flatter faces
    - Brain reorganized (lateralization & language regions)
    - Unquestioned manufacture/use of stone tools (bone/horn/wood?)
    - Added meat to diet (scavenging)
    - Some species have brains as large as 750 cc

Early Homo Behavior

- Original theory: Stone tools 1st appear ca. 2.5 mya
  - Most often attributed to *H. habilis* (maybe *A. garhi*)
  - Earliest tools (Oldowan tradition)
    - Flakes (cutting/scraping)
    - Chopper / chopping tools (“smashers / bashers”)
    - Hammerstones
    - Some bone/horn w/ scratches (digging?)
- Meat eating takes on increasing importance after 2.5 mya.
- Now stone tool set from 3.3 M; cutmarks on bone from 3 M

Genus Homo: 8 species

Homo habilis [& Homo rudolfensis]

Homo erectus (Asian) [& Homo ergaster (African)]

Homo naledi

Homo heidelbergensis

Homo neanderthalensis

Homo denisova

Homo sapiens

Homo floresiensis

Ledi-Geraru LD 350-1 mandible: oldest Homo at 2.8 MYA

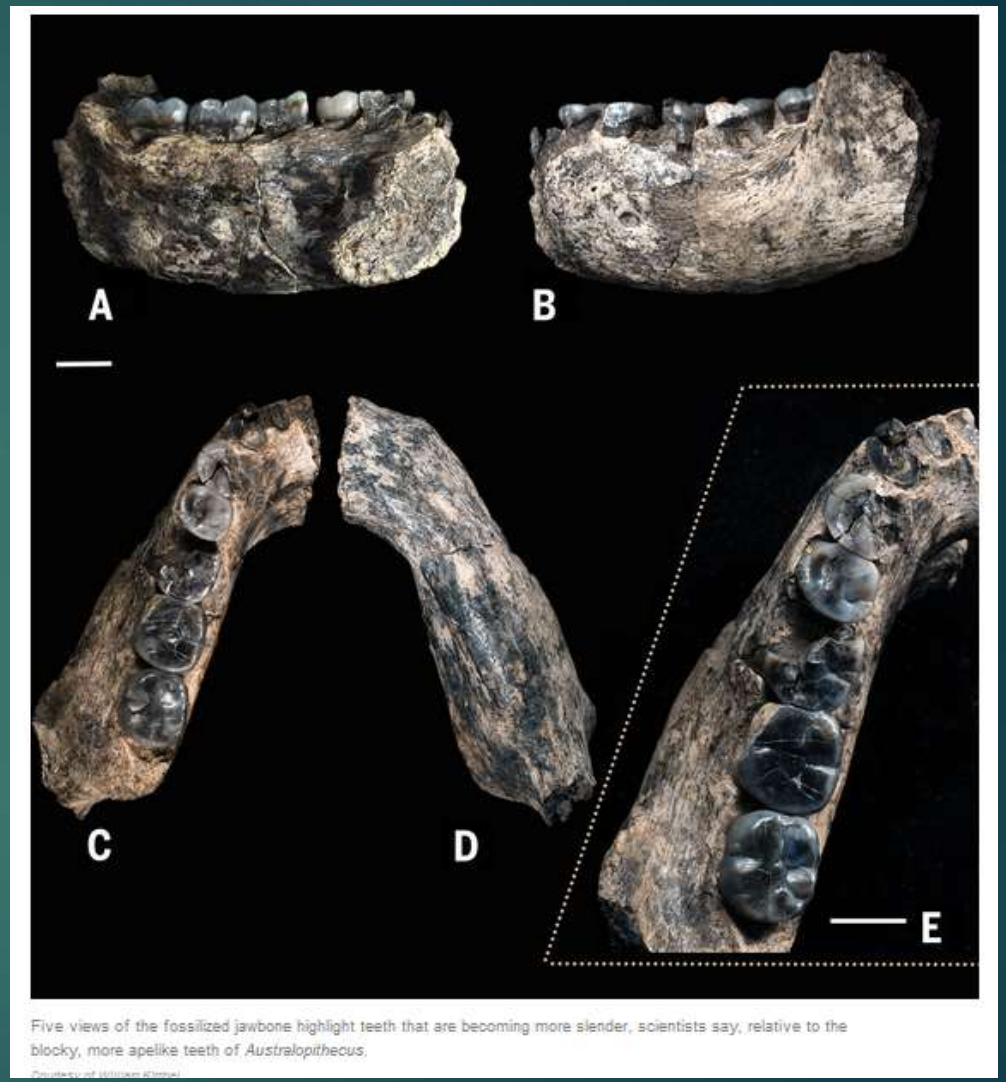
Jaw bone fossil discovered in Ethiopia is oldest known human lineage remains

Teeth becoming more slender than in A. afarensis.

It is the face; it's the way the jaws are built.

Leading edge of the origin of the genus *Homo* was our teeth, not brain.

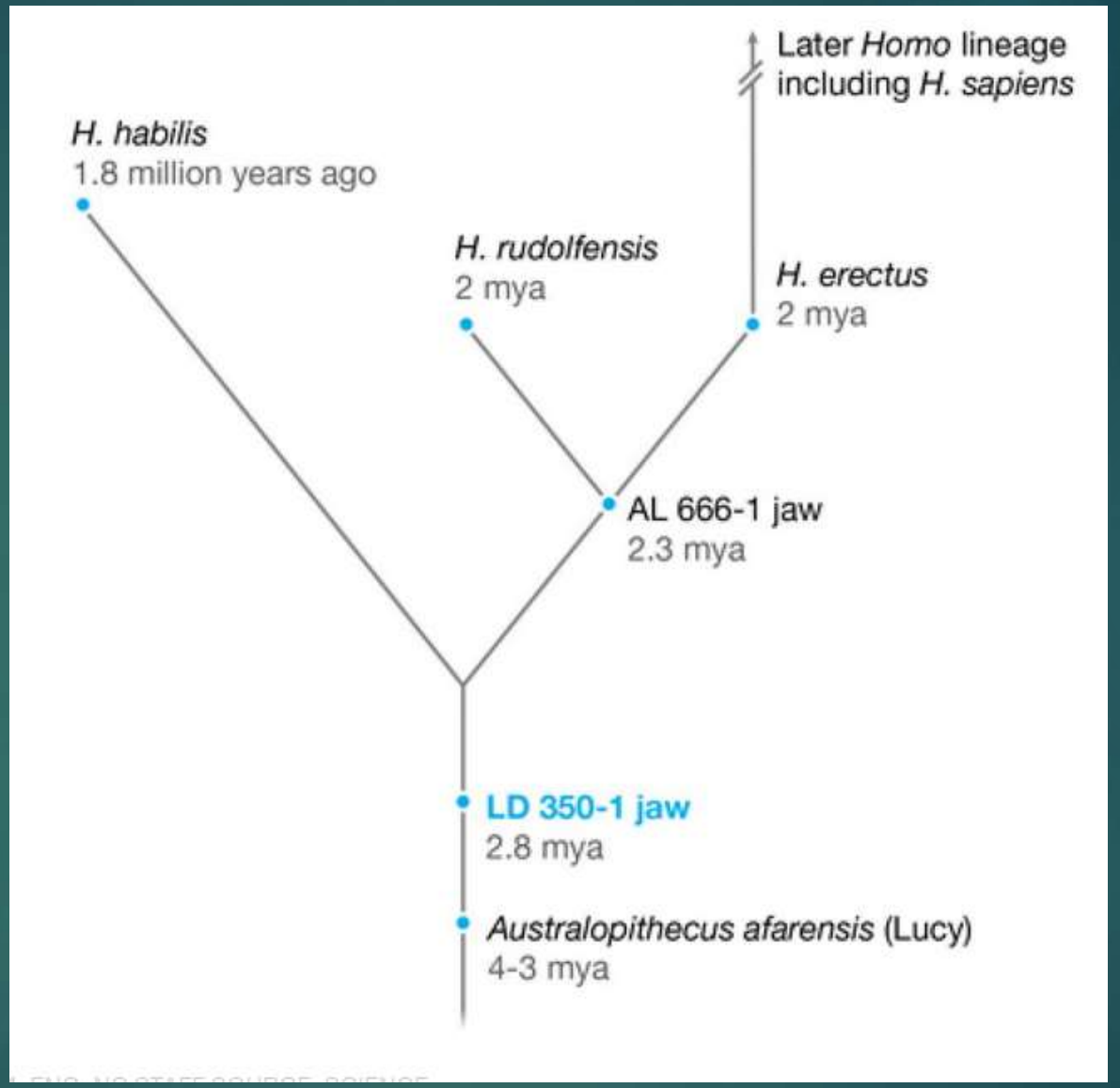
Theory: You don't need big jaws and teeth if you have stone tools to process food



Five views of the fossilized jawbone highlight teeth that are becoming more slender, scientists say, relative to the blocky, more apelike teeth of *Australopithecus*.

Villmoare, et al., 2015

Possible lineage



"The Ledi-Geraru jaw has turned up as if 'on request,' suggesting a plausible evolutionary link between *Australopithecus afarensis* and *Homo habilis*," says Spoor.


Tool Making
MILESTONE 2
The first in our genus, H. habilis, had a slightly larger brain, smaller jaw and smaller teeth than earlier species.
Homo habilis
2.4 to 1.4 million years ago; eastern and southern Africa
H. habilis made stone tools, but was probably not the first. We've found earlier tools, but not evidence of the earlier toolmakers.
Hammer stones were used to strike flakes from a core stone. This created sharp edges for cutting and scraping.
Chopper
Biface

Homo habilis

- 2.6 -1.4 Ma
- E. Africa
- Scavenging significant part of the diet
- Cranial capacity: 500 – 800 cm^3
- Extreme sexual dimorphism
- Height: 3 ft 4 in - 4 ft 5 in (100–135 cm); 70 lbs
- Simple fashioned tools – choppers (Oldowan culture)

Homo habilis

- Some *H. habilis* specimens may have too wide a range of variation to be considered one species. Some specimens have been placed in the species known as *Homo rudolfensis*.
- *Homo habilis* is the oldest hominid assigned to the genus *Homo*, and perhaps the least similar to extant humans (*Homo sapiens*).
- Notice that *Homo habilis* is similar to the australopithecines in many ways
- Evidence of continued arboreal ability
- Homo habilis may be a direct human ancestor, a dead-end side-branch that leads nowhere, or even an invalid species whose designated examples belong in other species.

1960: *Homo habilis,* 1.7 M
First Stone Tool Use? No longer.

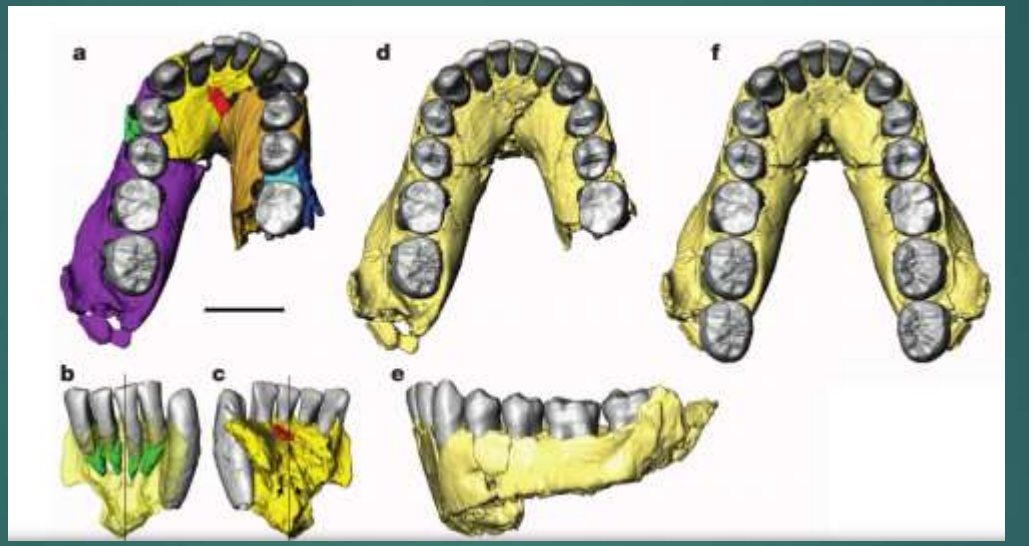
Homo habilis,
(OH 7 type)

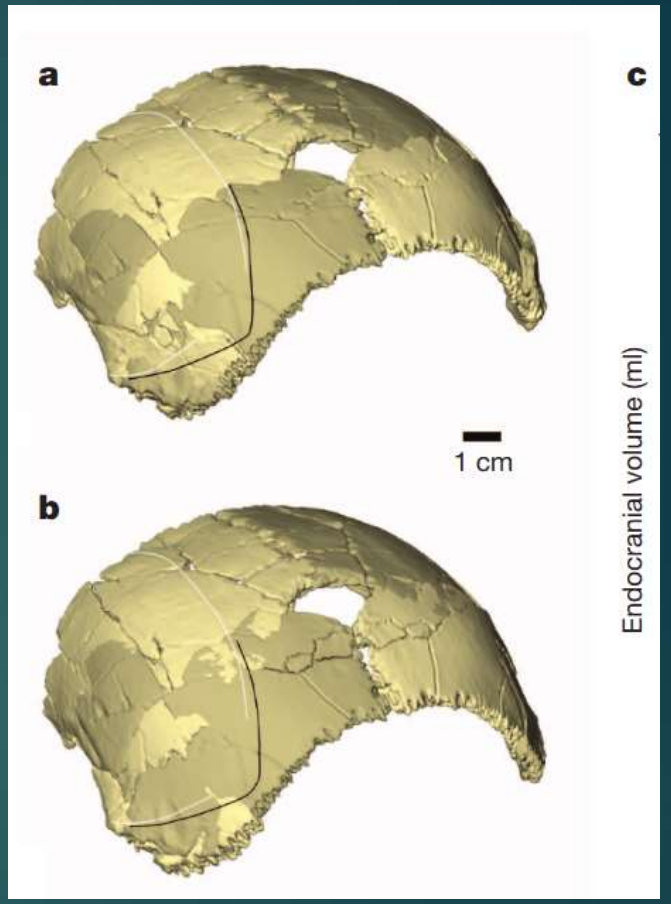
Discoverer: Jonathan Leakey
Locality: Olduvai Gorge, Tanzania
Age: 1.75 M
Date 1960

Controversy: Sits between australopithecines and Homo erectus;
is it Homo or Australopithecine?

New digital reconstruction of *Homo habilis,* OH 7, 1.8 MYA

Cranial size of 729-824 ml

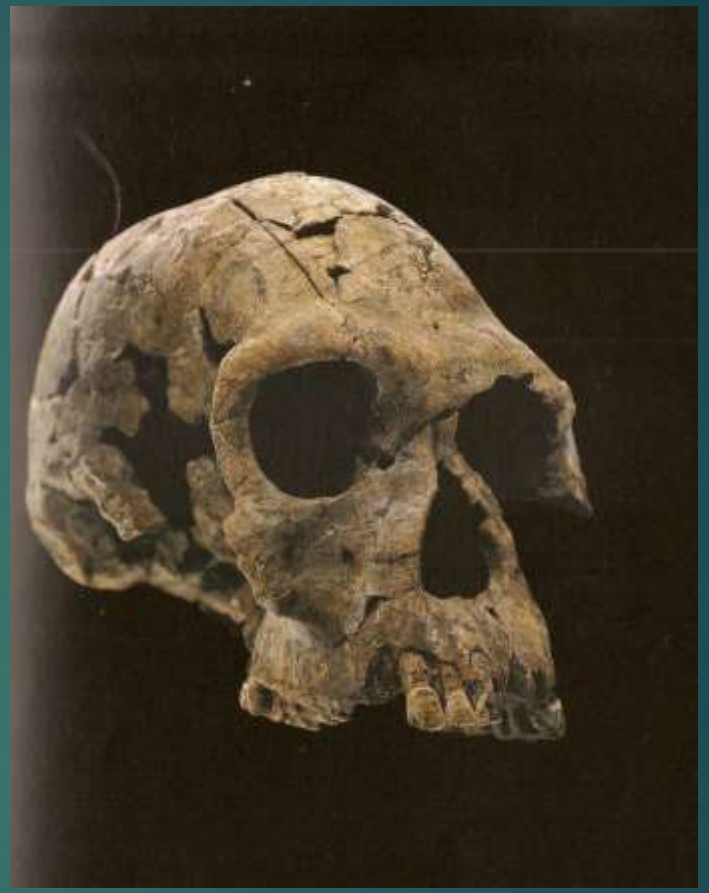




Mandible is remarkably primitive; more similar to *A. afarensis* than to parabolic jaw of *Homo erectus*
Not consistent with any single species of early *Homo, including Homo rudolfensis;* implies origin of Homo species before 2.3 MYA;

F. Spoor, et al., 2015

Homo habilis: Handy Man



2.3-1.6 MYA: long arms, short legs, but more advanced upper jaw

Average cranial capacity: 631 cc

Olduvai Gorge

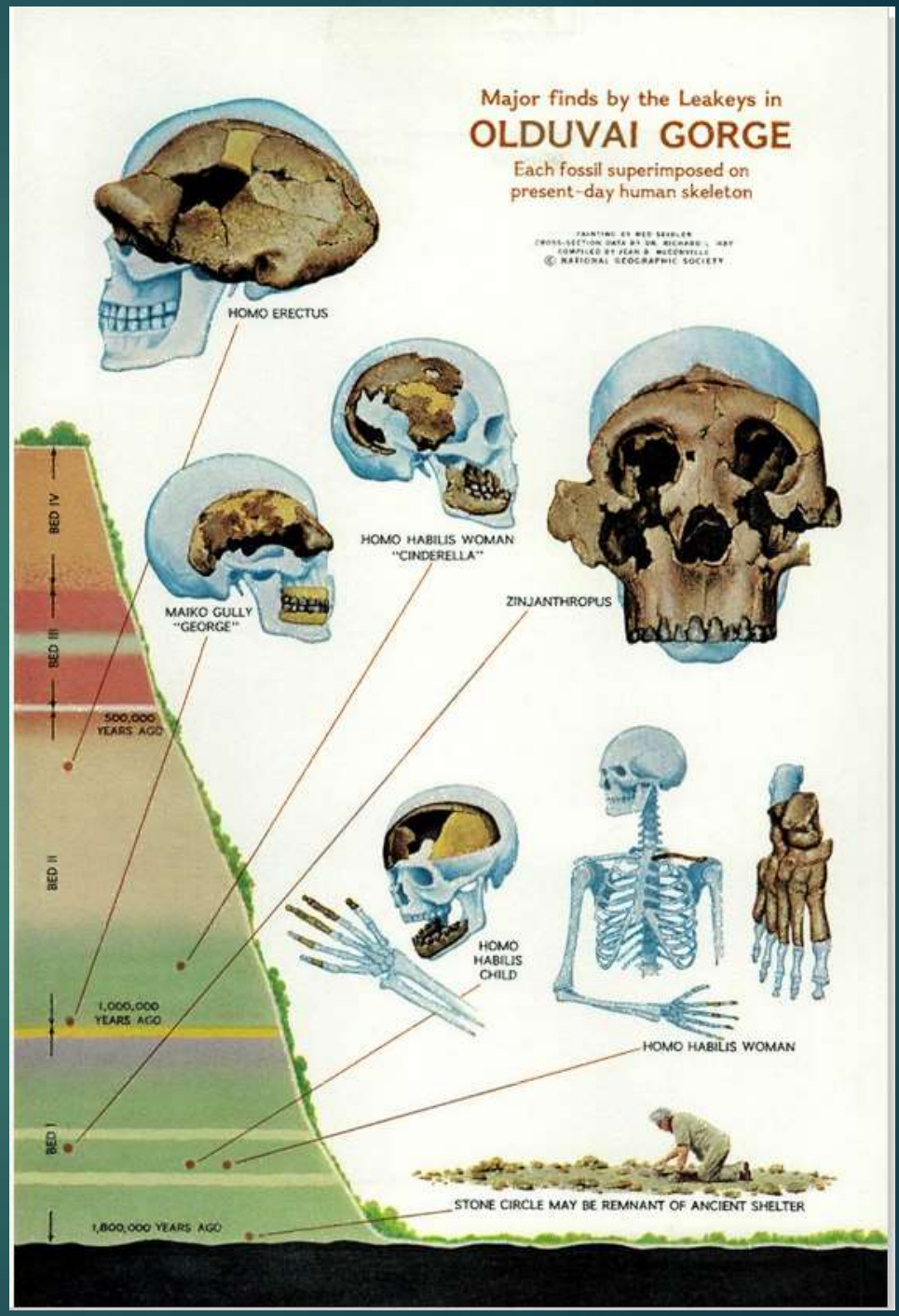
Homo erectus

Homo habilis male George

Homo habilis woman Cinderella

Zinjanthropus

Homo habilis child
Homo habilis woman



Homo habilis. Olduvai Gorge (642cc): Jonny's Child, Twiggy, Cindy, George

"Jonny's Child", H. habilis, OH 7, 1.7 M

"Twiggy", Homo habilis, OH 24, 1.8 M; pancake flat

OH 13 – "Cindy" (H. habilis): 1.6 myr, Aprox 650 cc.; Mandible & teeth, bits of maxilla, cranial fragment.

OH 16 – "George": 1.7 myr. Aprox 640 cc. Teeth & skull fragments.

Homo habilis was right handed

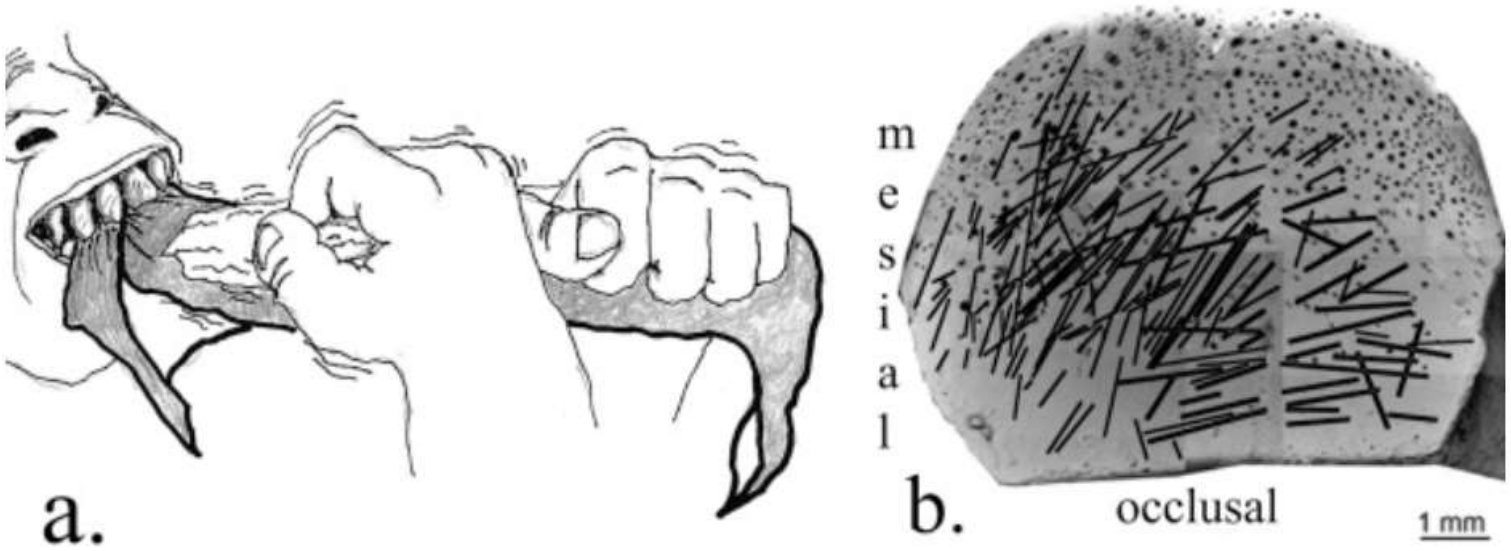


Figure 2.

a. Experimental evidence suggests these labial scratches were produced when material was processed with one hand pulling the object and the other cutting it with a stone tool. Depicted here is a right-hander pulling with the left and cutting with the right. Many scratches are found on the labial face, but right oblique scratches are produced by this action (i.e., striations beginning in the superior right portion of the image). b. A stereomicroscopic composite of the sputter-coated cast of left I^1 used in the analysis. The dense concentrations of striations show that the tooth surface was repeatedly modified by a stone tool and the majority of striations are right oblique. The black dot "bubbles" are artifacts of the casting and sputter-coating.

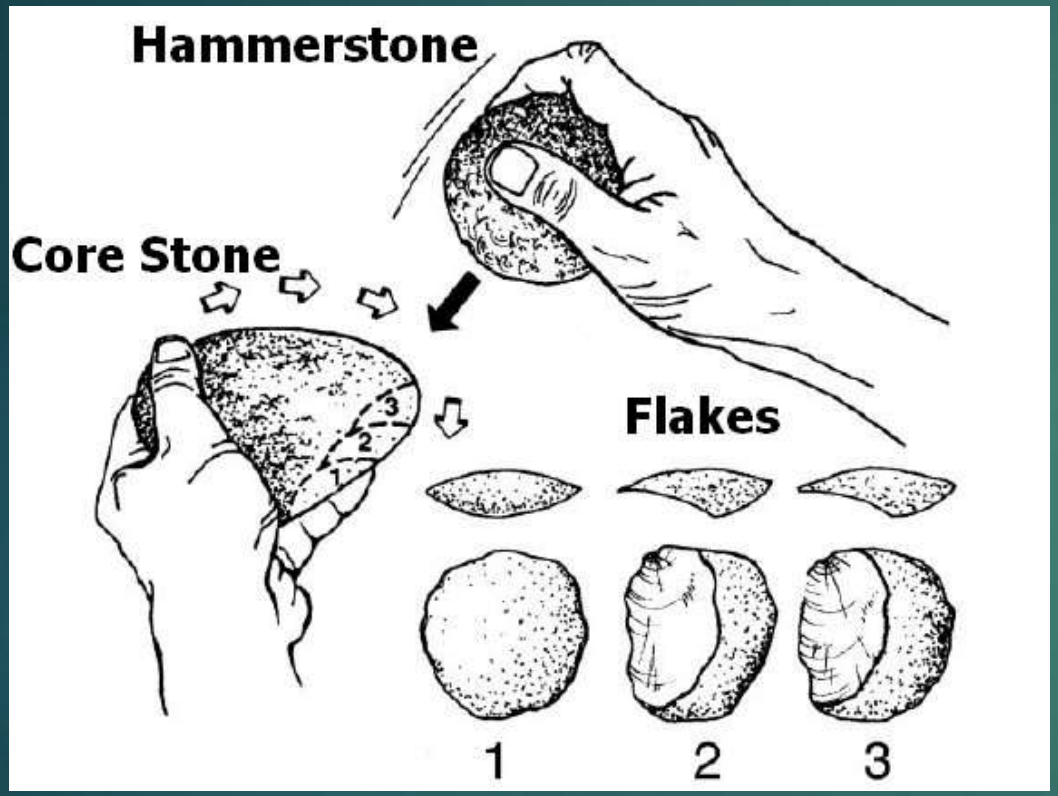
OH-65: The earliest evidence for right-handedness in the fossil record,
D. Frayer, et al., 2016

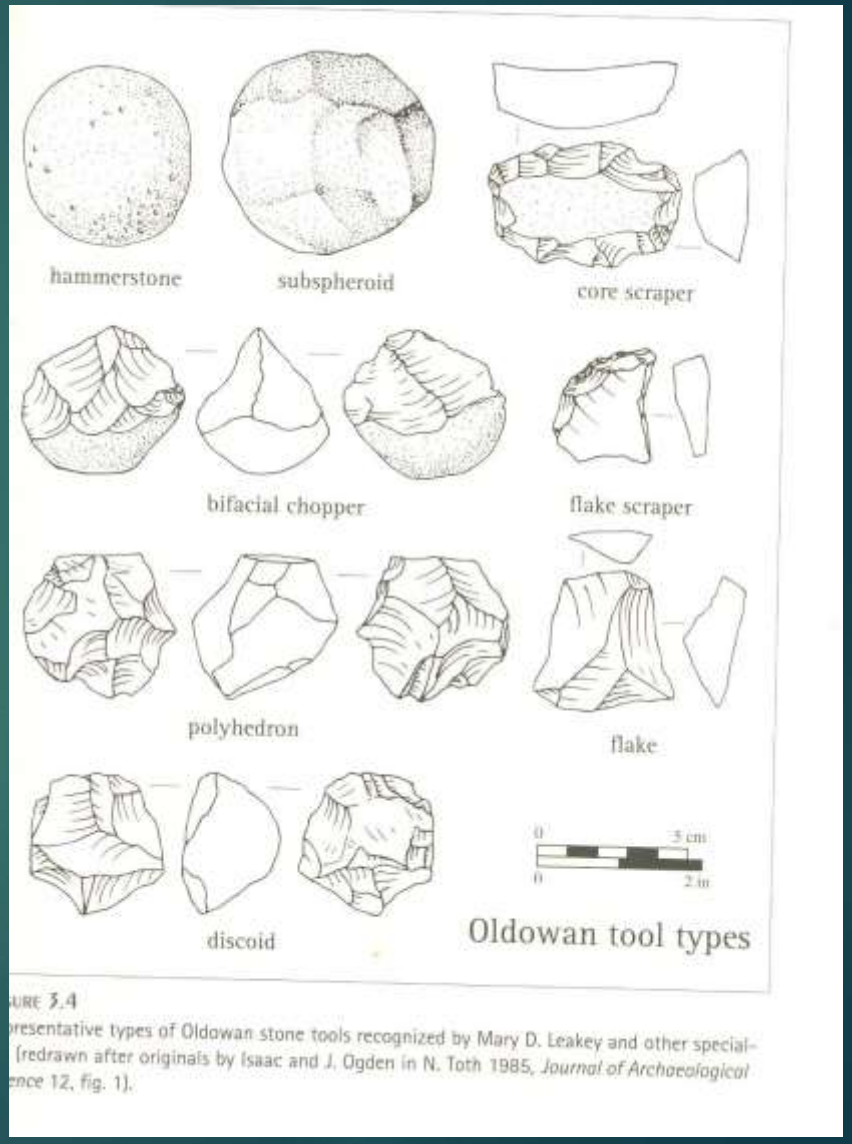
1960, Leakey: *Homo habilis* and stone tools at Olduvai Gorge

- Finds made by Louis and Mary Leakey at Olduvai Gorge, Tanzania, claimed they had discovered the first stone tools, chronologically dated to around 1.85 mya
- The Oldowan, Mode 1 type

(Toth & Schick, 2013).

Oldowan /Mode 1 Tools: 2.6-1.7 M





URE 3.4
presentative types of Oldowan stone tools recognized by Mary D. Leakey and other special-
(redrawn after originals by Isaac and J. Ogden in N. Toth 1985, *Journal of Archaeological*
ence 12, fig. 1).

Language-competent bonobo-chimpanzees Kanzi and Pan-Banisha: Apes produce and use tools

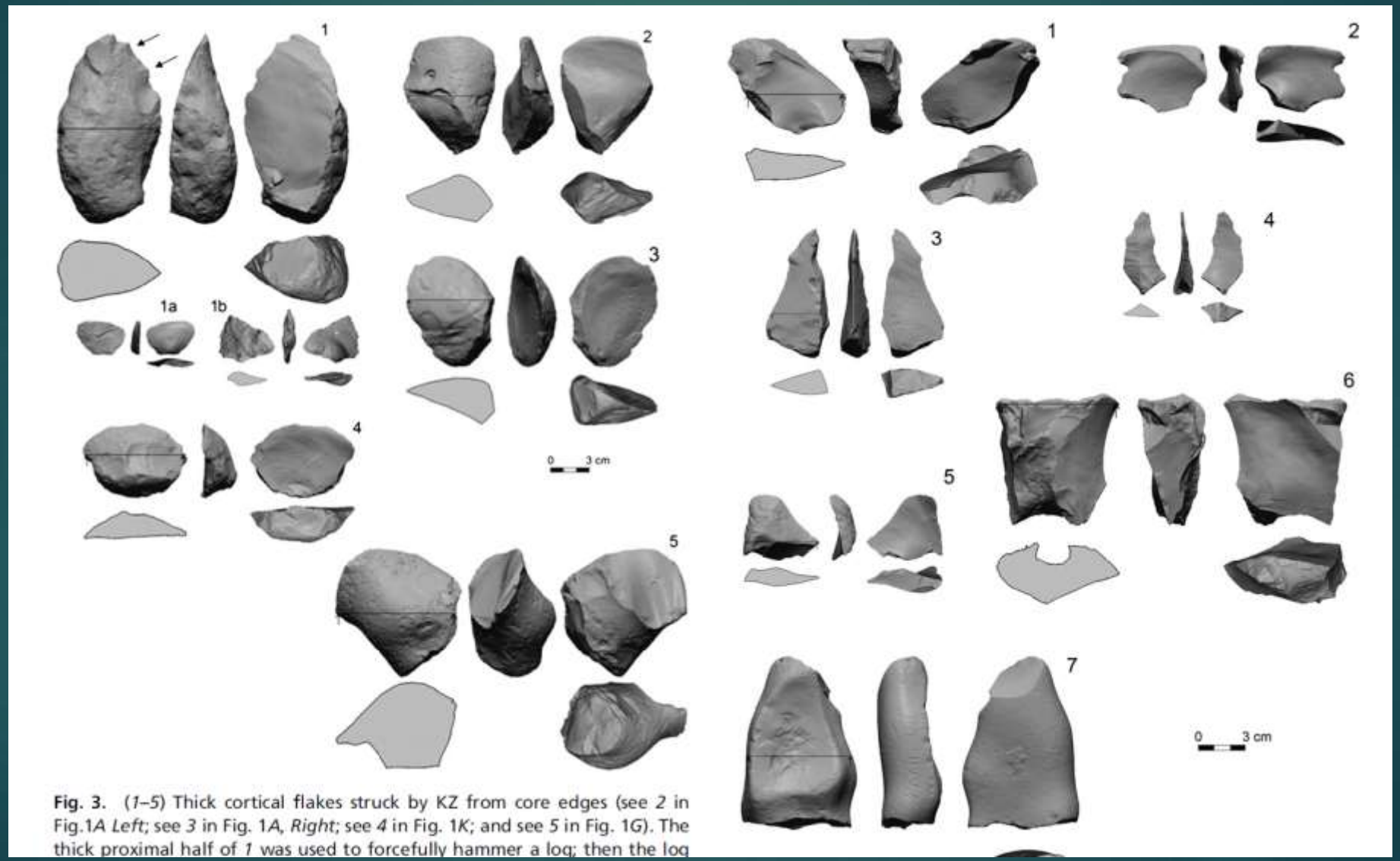


Fig. 3. (*1–5*) Thick cortical flakes struck by KZ from core edges (see *2* in Fig.1*A Left*; see *3* in Fig. 1*A*, *Right*; see *4* in Fig. 1*K*; and see *5* in Fig. 1*G*). The thick proximal half of *1* was used to forcefully hammer a log; then the log

Dmanisi, Georgia: *Homo erectus* 1.8 mya

- Oldowan tools at 1.8 My found in 1984 at Dmanisi, Georgia associated with *H. erectus*

Then Oldest stone tools: 2.6-Million-year-old stone tools and associated bones from Gona, Afar, Ethiopia

No hominid remains were found in association with these Oldowan tools and they predate the oldest known remains of the genus *Homo.*

These tools are unlikely to be evidence of the very first use of tools.

The use of tools in apes and monkeys can be used to argue in favor of tool-use as an ancestral feature of the hominin family.

Oldowan stone tools are simply the oldest evidence for material culture in the archaeological record.

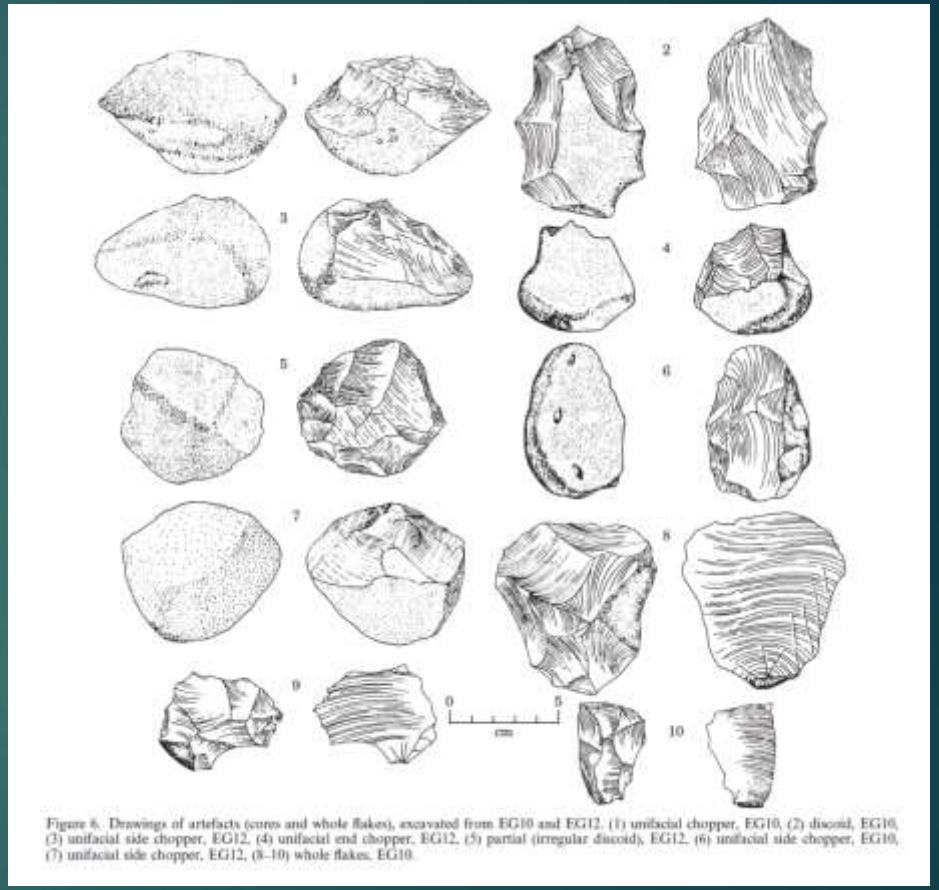


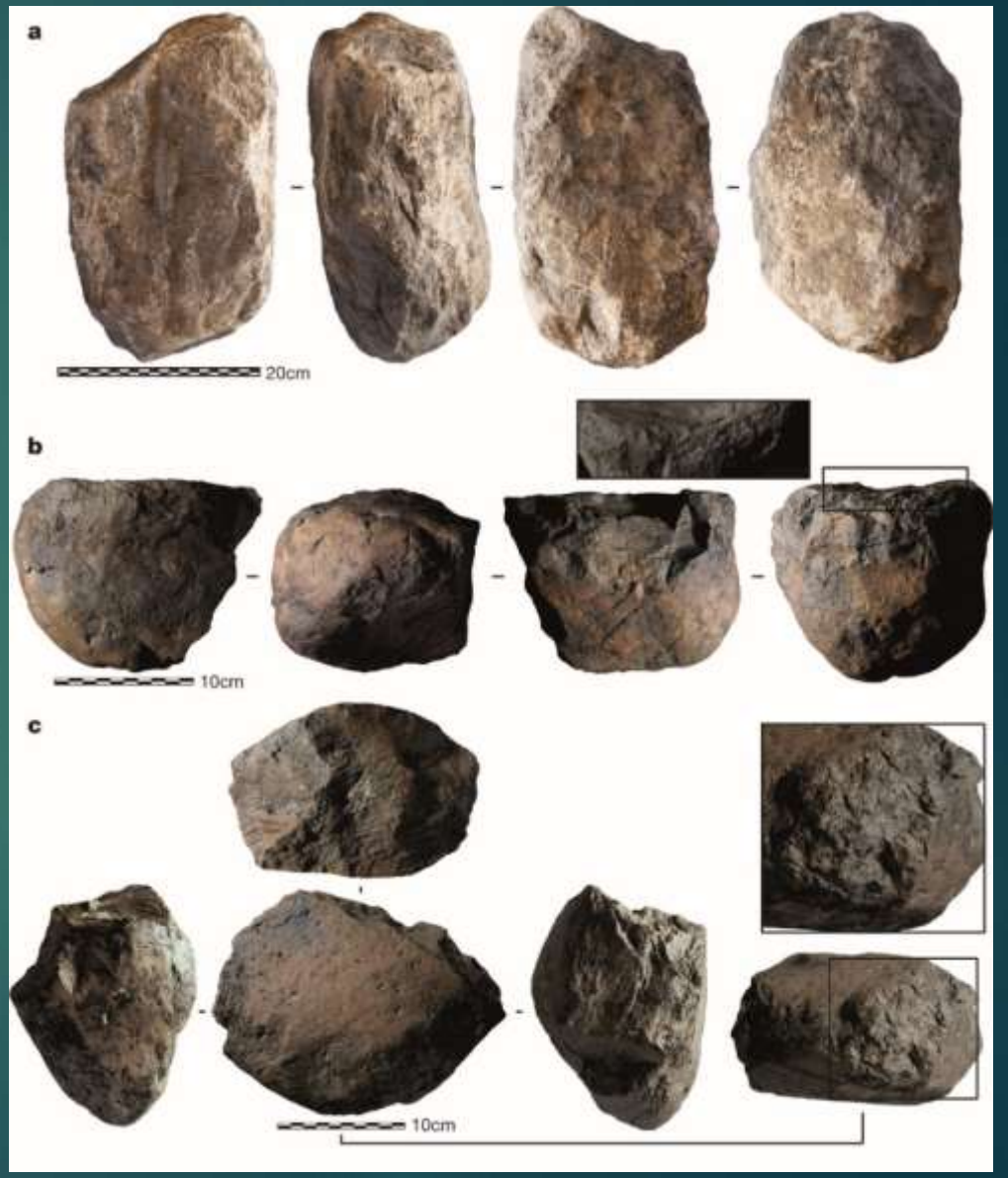
Figure 6. Drawings of artefacts (cores and whole flakes), excavated from EG10 and EG12. (1) unifacial chopper, EG10, (2) discoid, EG10, (3) unifacial side chopper, EG12, (4) unifacial end chopper, EG12, (5) partial (irregular discoid), EG12, (6) unifacial side chopper, EG10, (7) unifacial side chopper, EG12, (8–10) whole flakes, EG10.

Sileshi Semaw et al. 1997 & 2000

Now 3.3 MY old stone tools: Lomekwian

The recent discovery of stone tools, dated at 3.3 MYA, was made near Olduvai Gorge at the site Lomekwi 3, situated to the west of Lake Turkana in Kenya.

The Lomekwian tools are larger; produced sharp flakes by pounding stones against a passive hammer or anvil, rather than through a freehand technique; similar to nut-cracking activities of chimpanzee stone tool-use behavior

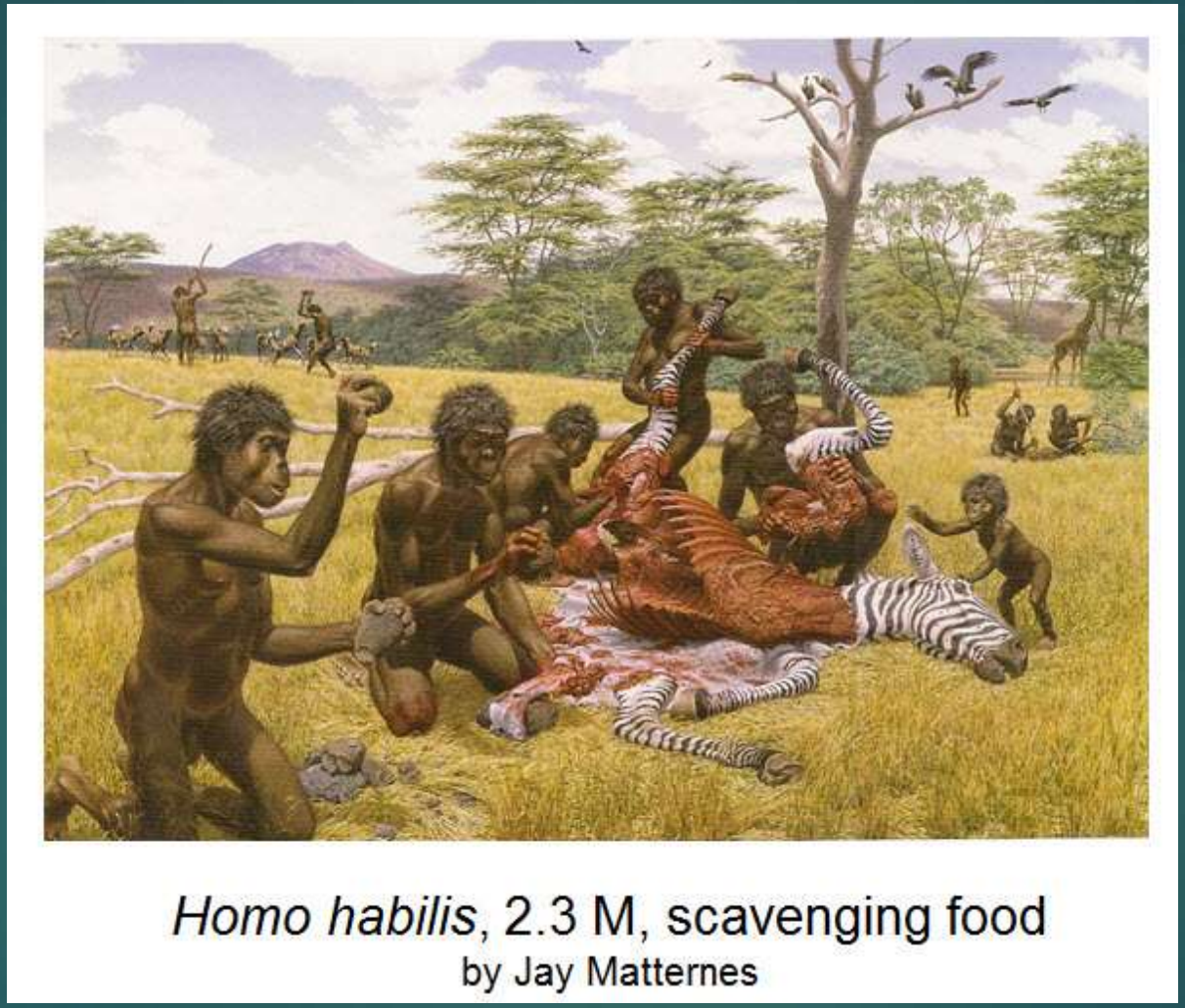


Who made the first stone tools?

Was it *Homo habilis*? Or the Australopithecines?

- Now we have the Lomekwian stone tools at 3.3 MYA
- There are also contested cut marks from stone tools on bones dated at 3.4m years ago at Dikika in Ethiopia (Zeray's discovery).
- Guess which species are around at that time in East Africa? The Australopithecines: *A. afarensis*, *K. platyops* and *A. deyiremeda*.
- Clearly Australopithecines used tools before *Homo.*

Meal time for 1 million years



Homo habilis, 2.3 M, scavenging food
by Jay Matternes

Henry Bunn: active, confrontational scavenging to obtain mostly intact carcasses of large animals; preferred only adult animals in their prime

1972: *Homo habilis-rudolfensis*
KNM-ER 1470, 1.8 M, 700 cc.

1986: Valery Alexeev makes
KNM-ER 1470
the type
specimen of
Pithecanthropus
Rudolfensis

1989: Colin Groves transfers
Pithecanthropus
rudolfensis to Homo
as Homo rudolfensis

Originally 2.9M, until pig sequence disproved date

Homo rudolfensis
(KNM ER 1470, type)
Discoverers: Bernard Ngeneo
Date: 1972
Locality: Koobi For a, Kenya
Age: 1.8 M

2015: *Homo naledi*

- A new species of the genus Homo from the Rising Star Cave system, Dinaledi Chamber, South Africa
- One of the largest finds in the history of paleoanthropology
- Supervised by Lee Berger of University of the Witwatersrand

http://elifesciences.org/content/4/e09560#sthash.ZMyt0Qr5.dpuf

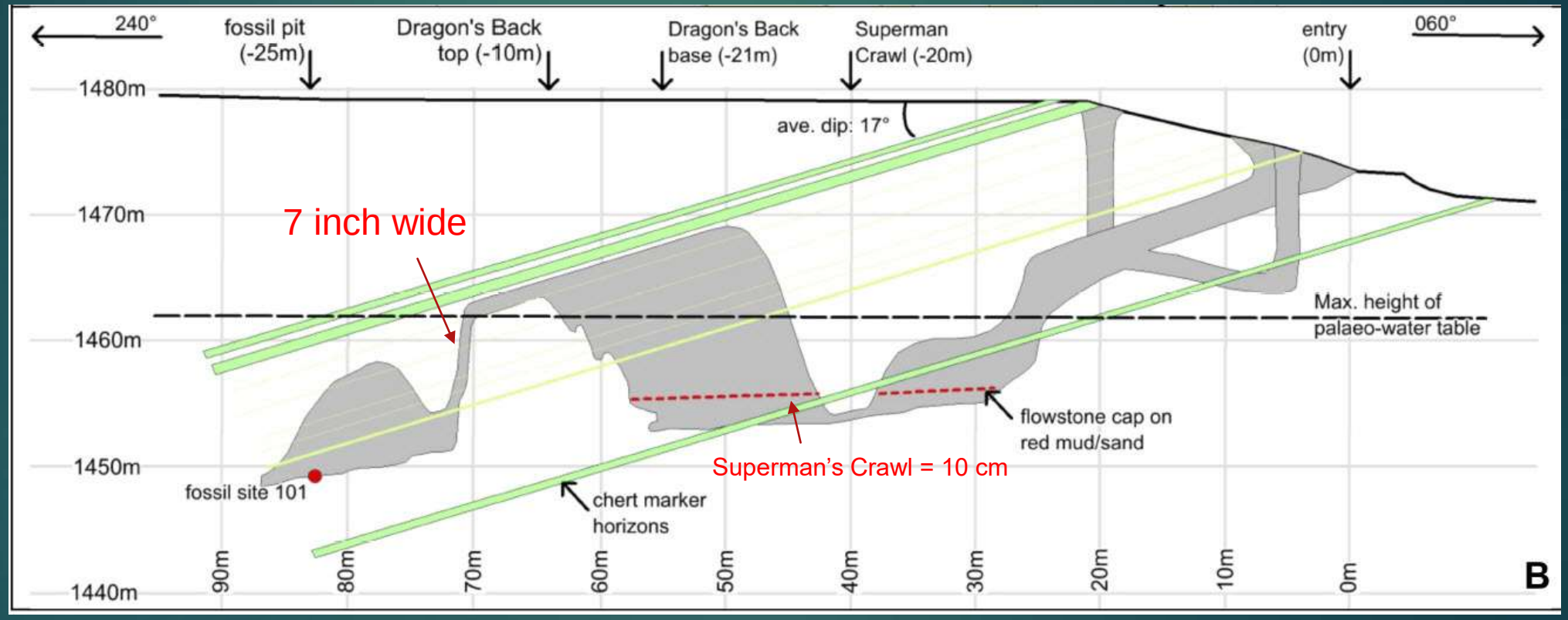
2015:
The “King Tut’s Tomb” of Hominid Fossil Discovery:

Rising Star Cave, Dinaledi Chamber:

Homo naledi

2015: *Homo naledi (*“star” in South African language Sotho; from chamber of stars “Dinaledi”*)*

Lee Burger, 2013 Rising Star dolomite cave system in South Africa (caved for 50 years): new area reveals paleological bonanza



Through a 39-foot crack just seven inches wide at times, finally the Dinaledi Chamber, 30 feet long and only a few feet wide, with bones everywhere

Into the 7 inch 30 foot stone chute

2013 Facebook, Twitter, LinkedIn Ads for “underground astronauts”

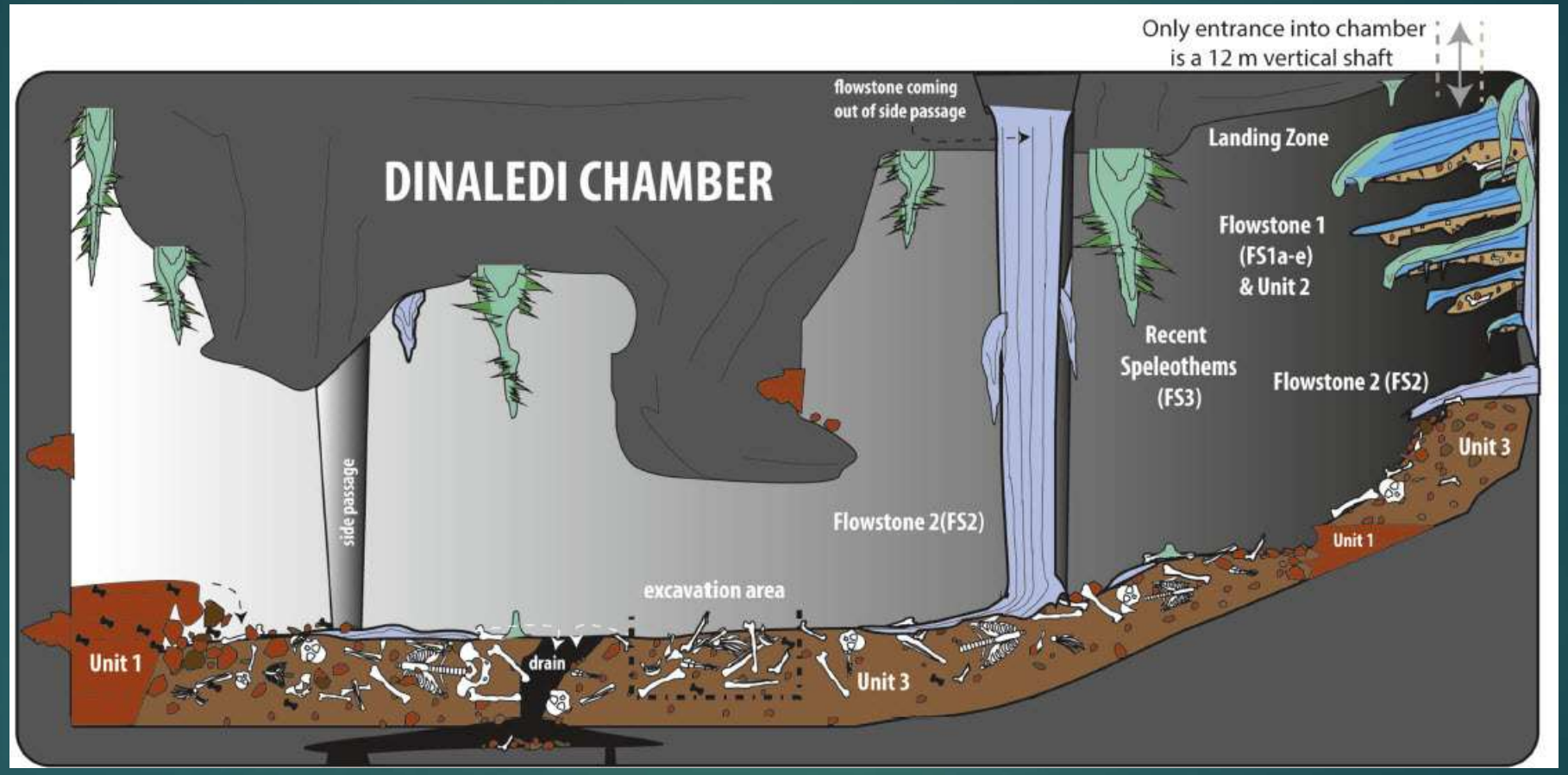
- “We need perhaps three or four Individuals with excellent archaeological/ palaeontological and excavation skills for a short term project...the catch is this, the person must be skinny and preferably small and they must not be claustrophobic; they must be fit; they must have some caving experience, and climbing experience could be a bonus…it will be unpaid work”

- 57 applied, all women; 6 women picked
- Rising Star is the most open paleoanthropological project that has ever been attempted. Published on internet; 50 researchers (20 early career)

Underground astronauts of the Dinaledi Chamber

All-female early career team – Hannah Morris, Marina Elliott (1st down the chute), Becca Peixotto, Alia Gurtov, Lindsay Eaves and Elen Feuerriegel – were drawn from Australia, Canada and the US. Worked for free. They brought out the largest assemblage of fossil human relatives ever discovered in the history of the continent of Africa.

2015: Dinaledi Chamber (“chamber of many stars”)



This cave chamber lies some 80 meters into the Rising Star system, and must have always been in constant darkness. No animal remains except for bones of 1 owl & 2 mice; nothing else except hominid bones

“A sea of bone” just lying on the ground: 400 bones on surface;
“Rick kicked the dirt and hominids fell out”

Homo naledi: 15 separate individuals in1550 bones collected in first sweep of surface (400 bones) and an excavation of 1 square meter x half a foot (1150 bones)

Dinaledi skeletal specimens:
737 partial or complete anatomical elements

3 infants, 3 young juveniles, 1 old juvenile, 1 sub-adult, 4 young adults and 1 old adult. Infants, identified by their thimble-size vertebrae.

Humanlike: Skull, hands, feet

Homo naledi: an anatomical mosaic – both australopithecine and human like

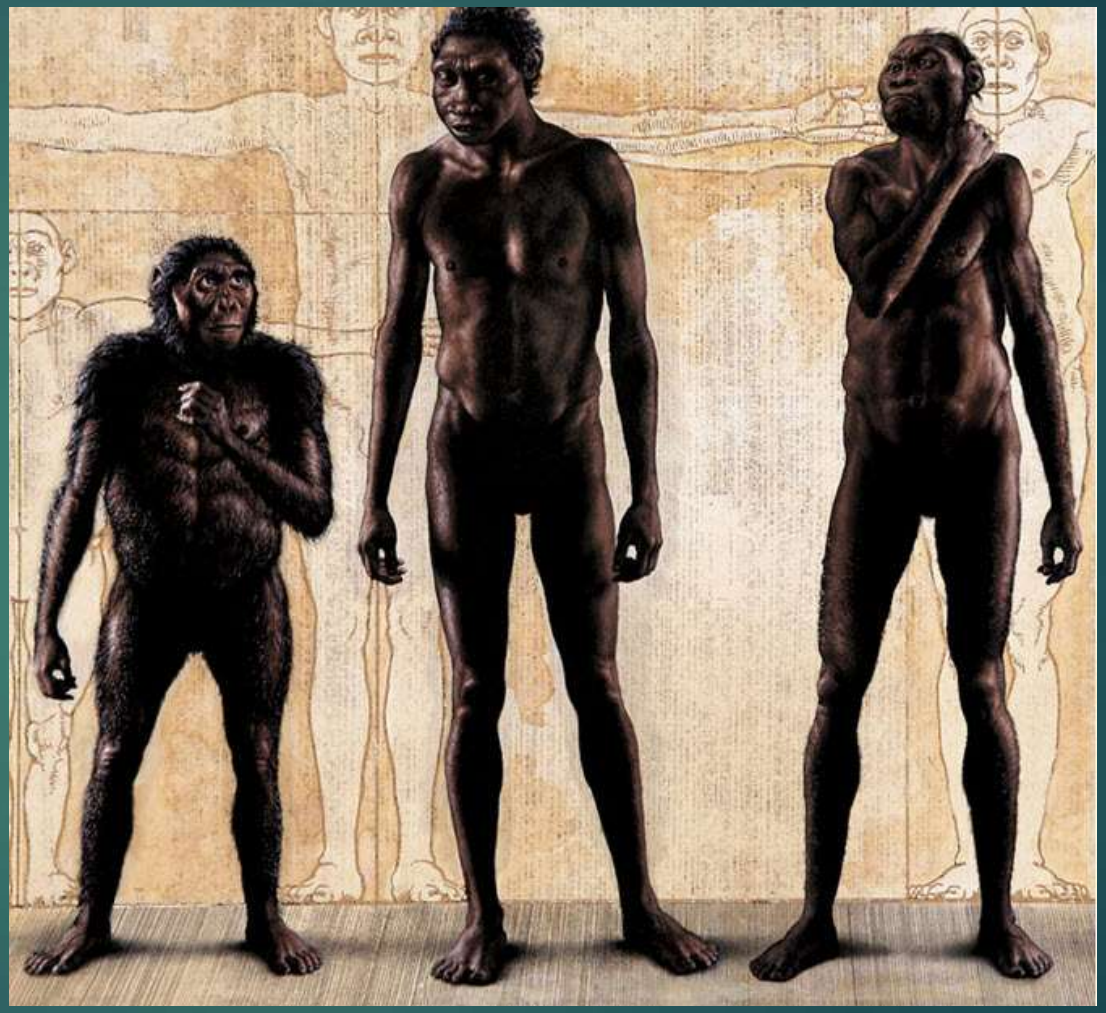
Homo naledi: Hand

Found articulated as seen here

Australopithecine-like *a*rboreal capable curved fingers, but thumb and wrist are stiffer like Homo (tool use)

Homo naledi: 1.5 Meters (5 feet) tall, 100 lbs

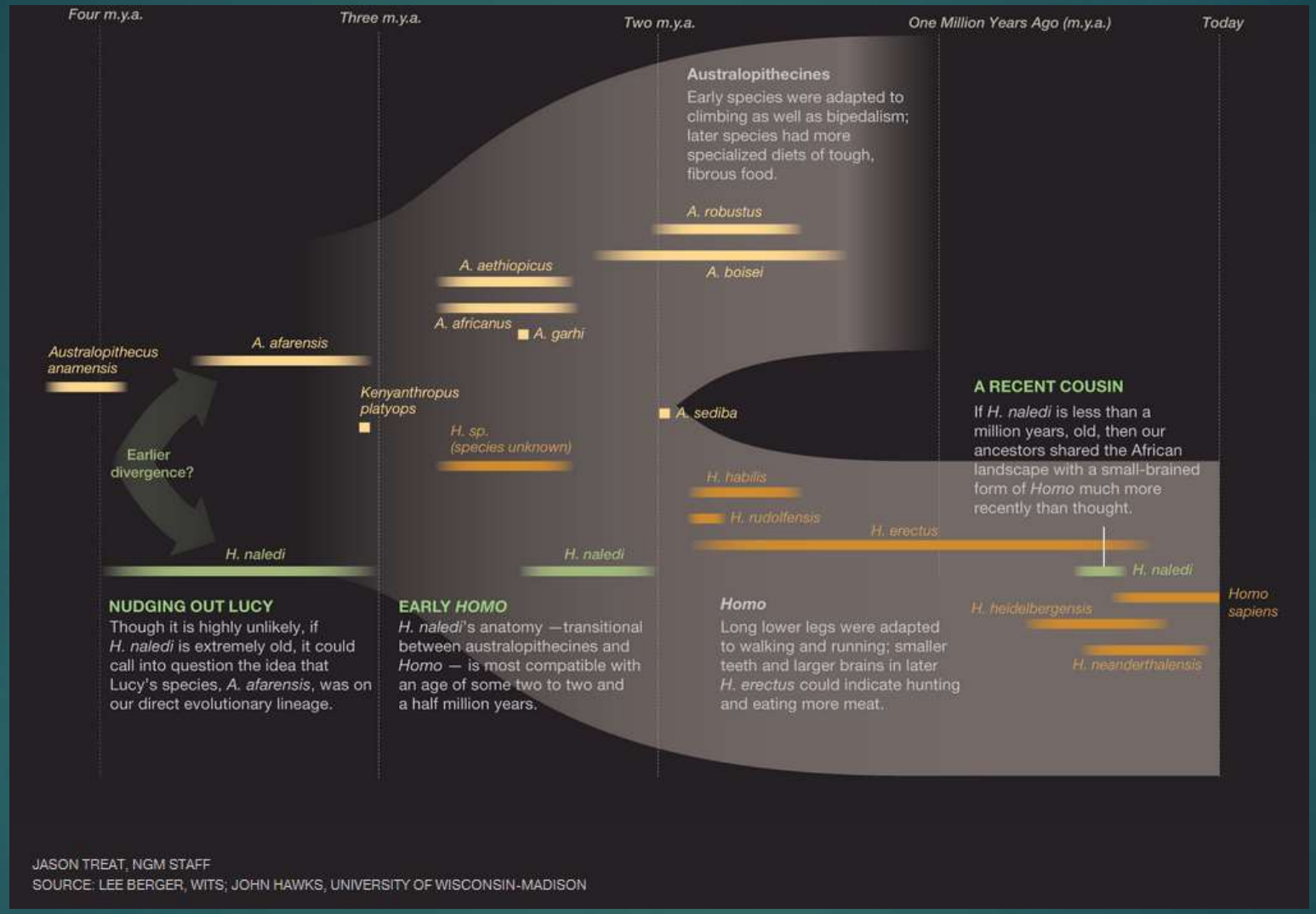
Skinny, humanlike arms, apelike thorax, primitive pelvis, long legs, humanlike feet



"Lucy"	"Turkana Boy"	"Rising Star Hominin"
Australopithecus afarensis	*Homo erectus*	*Homo naledi*
3.2 million years ago	1.6 million years ago	Date Unknown
Adult Female	Adolescent Male	Adult Male
3 ft 8 in	5 ft	4 ft 10 in
60-65 lbs	110-115 lbs	100-110 lbs

Homo naledi: Undated; estimate is <2.5 MYA divergence

If older than Lucy, she would no longer be our ancestor



If less than 1 million ears, then our ancestor *Homo erectus* lived with a small brained form of Homo

No fauna, no upper/lower stone layers, no embedded flowstones to be able to date

Burial Site??: “Deliberate disposal”

Just scratched the surface: Unanswered questions

- Only 1 meter of 12 meters excavated so far.
- Provisionally assigned to the genus *Homo*
- How old are the fossils?
- Where does *H. naledi* fit phylogenetically in human evolution?
- How did the remains arrive deep within the cave system?
- Is it a variation of *Homo erectus?*

Homo erectus:

A Bigger, Smarter, Faster Hominin Lineage

The second most successful hominid;
survived for almost 2 M years

A Bigger, Smarter, Faster Hominin Lineage

Homo erectus was the most successful hominid species of all time, surviving for almost 1.9 M years.

A reconstruction of a *Homo erectus* female (based on fossil ER 3733) by paleoartist John Gurche, part of the Smithsonian National Museum of Natural History's Human Origins Program.

Palaeolithic Hand Axes, Acheulian, ~ 500 kya

From: Abbeville, Northern France. Excavated by Jacques Boucher de Perthes, 1830-40s

Homo erectus basics: First world traveler

- Appearance of *H. erectus* circa 1.9-1.7 mya coincide with expansion of savannah grassland & invention of Acheulean tool kits (1.7 mya)

- Increase in brain size (1100cc); increased metabolic demands

- KNM-WT 15000 (Turkana Boy): increased body size and essentially modern skeletal adaptations (pelvis & long leg bones) for terrestrial walking and running in arid savannah habitats

- Migration simply following animal herds (i.e. Dmanisi, 1.8 mya; China & Ubeidiya, Israel, 1.5 mya;)

Eugene Dubois (1858-1940): "Missing Link": *Pithecanthropus erectus* in Java

- Dutch anatomist & paleontologist
- Joined Medical Corps of Royal Dutch East Indies Army to get to Java

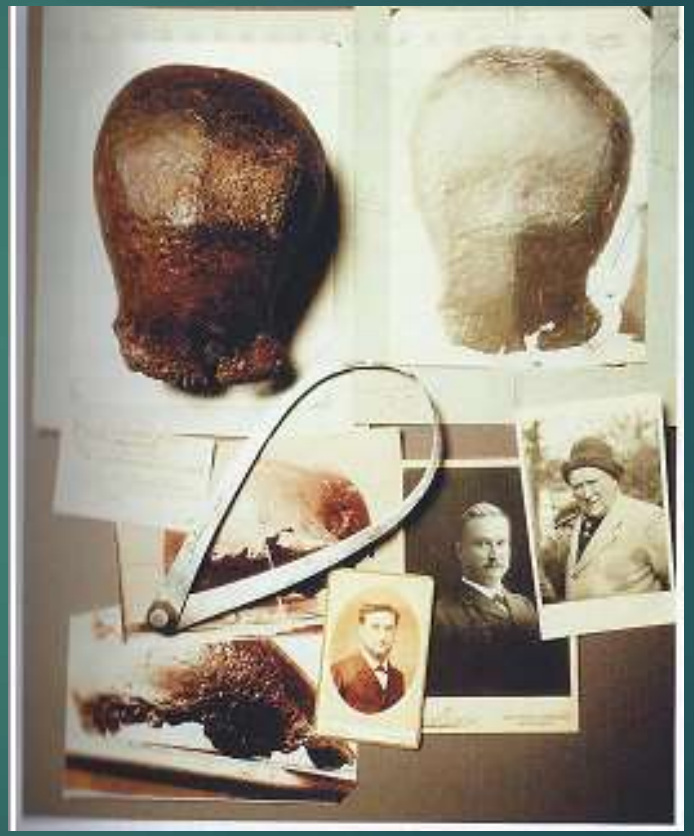
- 1891: First discovery of *Pithecanthropus erectus*, or Java Man at Trinil, Java—"a species in between humans and apes;" a tooth & skull cap in 1891 & femur in 1892

- Reclassified as *Homo erectus*.

- Returned to Netherlands in 1895, buried fossils under his floorboards and did not show for 30 years; became withdrawn; died embittered man

1891: *Pithecanthropus erectus,* 1M, Java Man at Trinil, Java

Homo erectus
(Trinil 2, type)
Discoverer: Eugene Dubois
Locality: Trinil, Java, Indonesia
Date 1891
Age: 1.0 M



First hominin fossil outside of Europe; first fossil *Homo erectus*

Homo erectus
First Out of Africa Migration

- Earliest in Africa = 1.8 mya (*H. ergaster*)
- Dmanisi, Georgia = 1.7 mya (*H. erectus*)
- Continental Asia = 1.4 mya
- Island of Java, SE Asia = 1.0 mya
- Spain = 800 kya (*H. antecessor*?)
- Flores, Indonesia = 700 kya (*H. floresiensis*?)

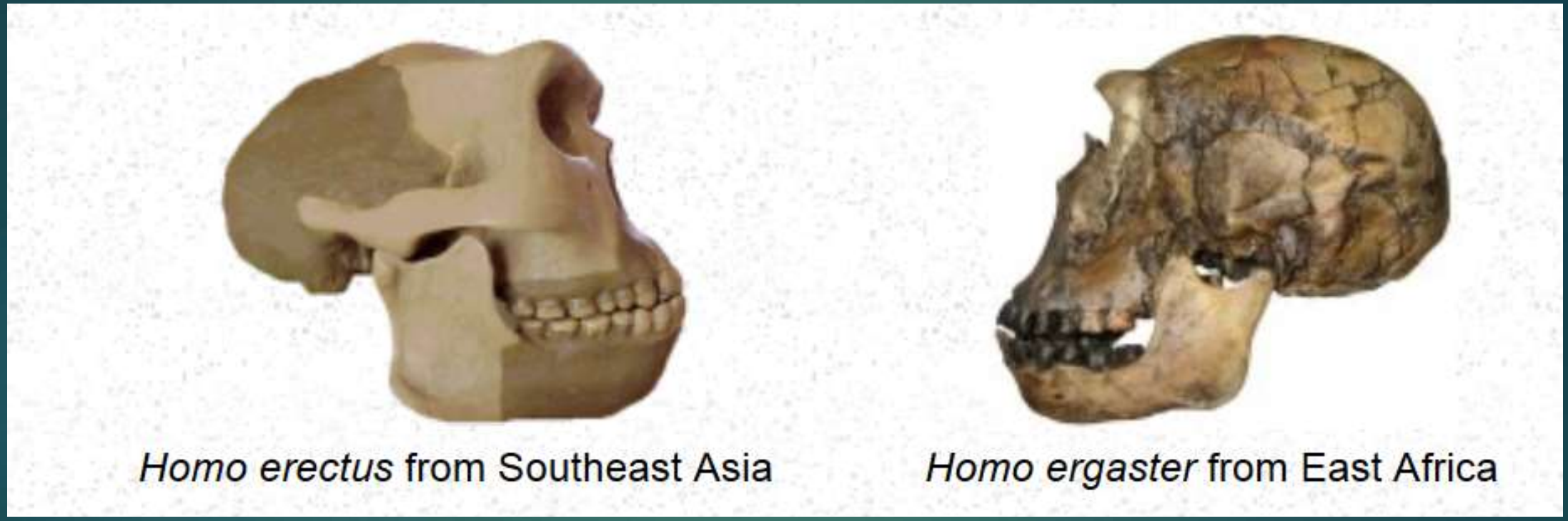
What was Homo erectus

- ***Homo erectus*** (meaning "upright man," from the Latin *ērigere*, "to put up, set upright") is an extinct species of hominin that lived throughout most of the Pleistocene, with the earliest first fossil evidence dating to around 1.9 million years ago and the most recent to around 143,000 years ago.
- It is assumed that the species originated in Africa. Found in:
  - Africa (e.g., Lake Turkana and Olduvai Gorge),
  - Georgia,
  - Indonesia (e.g., Sangiran in Central Java and Trinil in East Java),
  - Vietnam,
  - China (e.g., Shaanxi)
  - India.

Homo erectus:
A hominin “without an ancestor, without a clear past”

- Most assume *H. erectus* is direct ancestor of later hominids such as *Homo heidelbergensis*, *Homo neanderthalensis*, and *Homo sapiens.*
-
- Despite this rich history, few complete fossil postcrania (Turkana Boy; Dmanisi) have been recovered, and basic features of H. erectus body shape remain poorly understood

Early African *Homo ergaster* vs. later Asian *Homo erectus*



Homo erectus from Southeast Asia

Homo ergaster from East Africa

Associated with the earliest handaxes,
the first major innovation in stone tool technology.

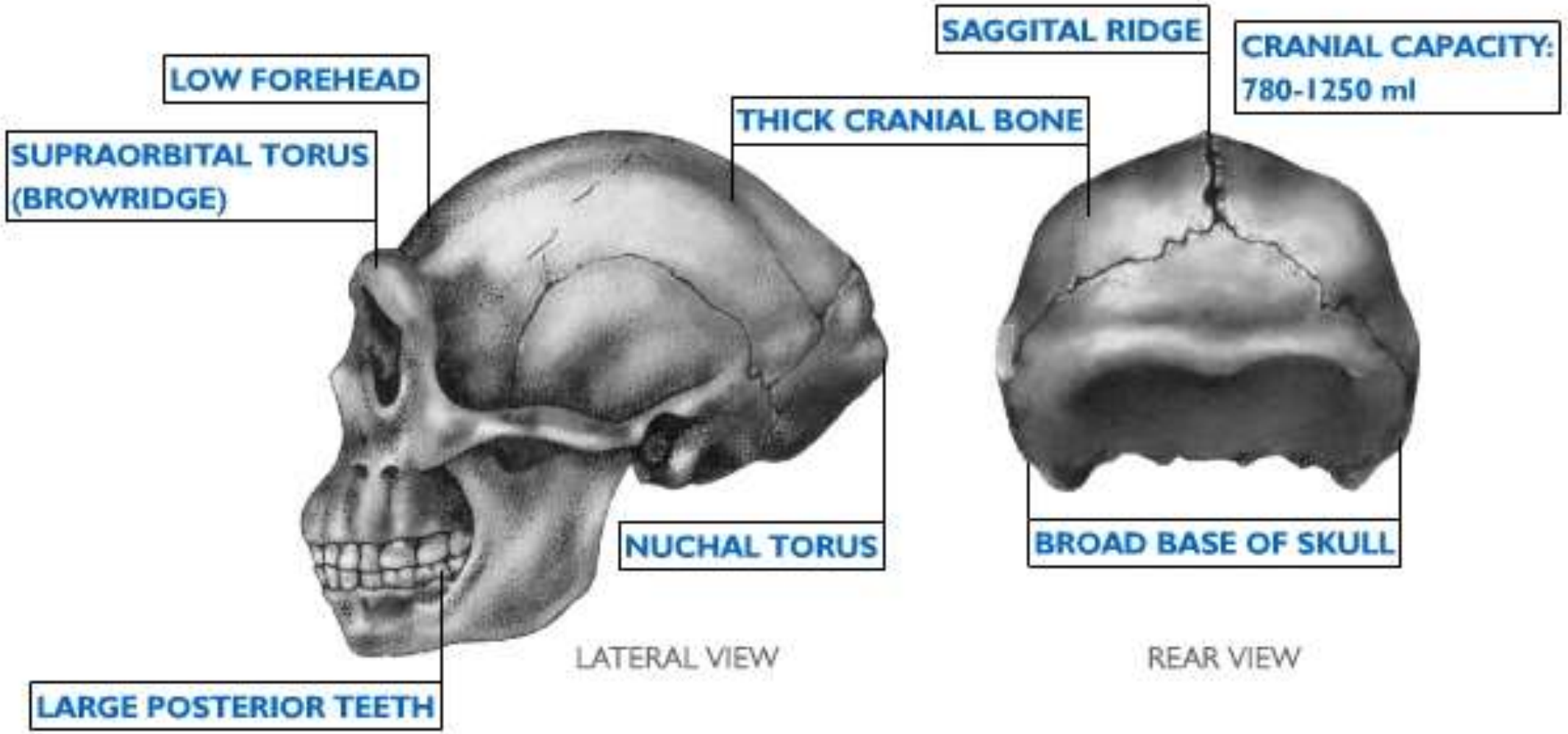
H. erectus: co-existence

- At the beginning of its time range, around 1.9 Mya, *H. erectus* coexisted in East Africa with:
  - *Homo rudolfensis,*
  - *Homo habilis,*
  - *Paranthropus boisei*.
  - Sometimes at the same fossil sites.

- At the end of its time range, around 143,000 years ago, it coexisted with *Homo sapiens* and possibly *Homo floresiensis* in Indonesia.

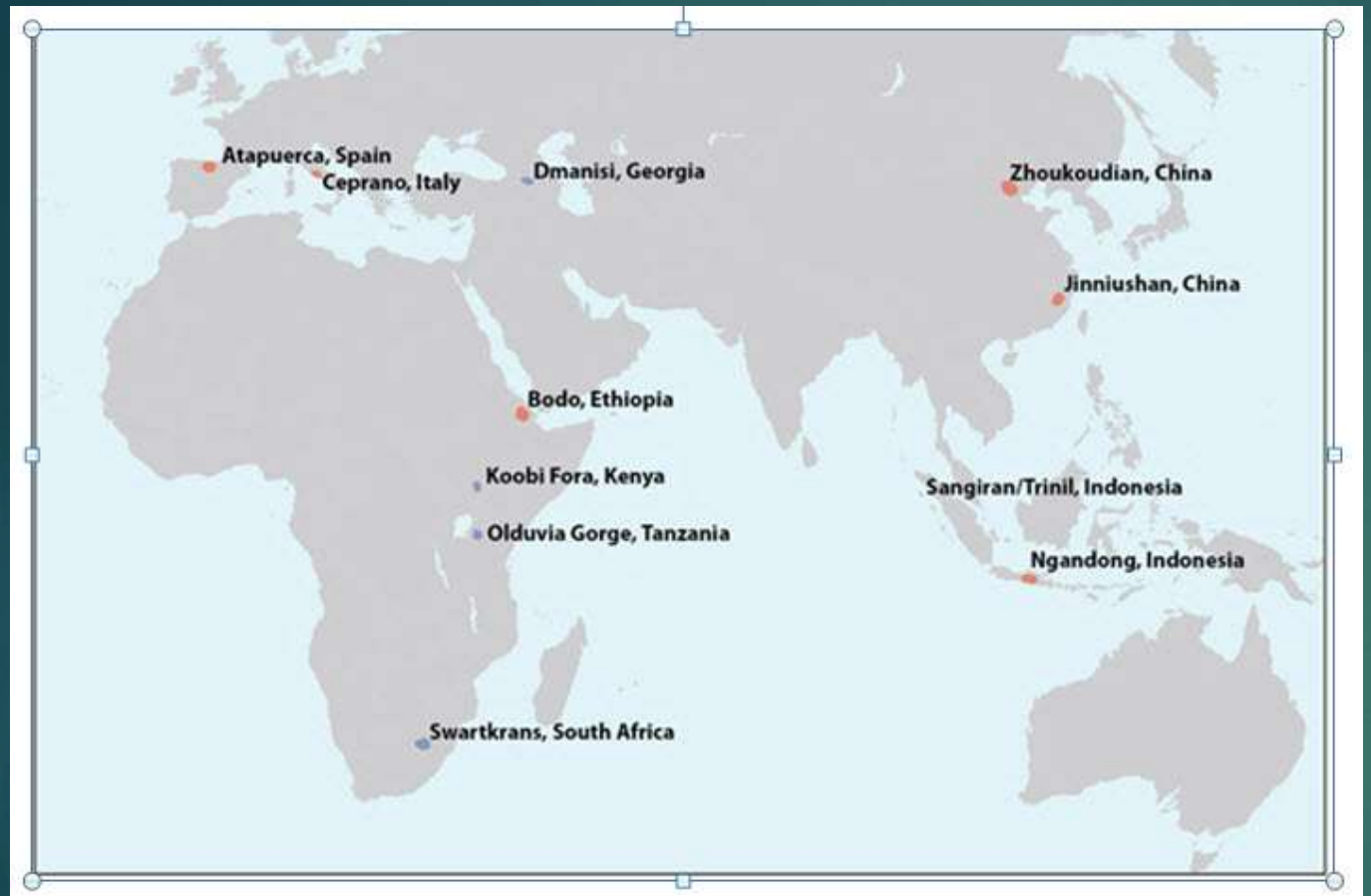
Controlled use of Fire

- Burned materials:
  - 1 million to 1.5 million years ago, at the Swartkrans site in South Africa,
  - 700 to 800 kya, at a site in Israel called Gesher Benot Ya`aqov; burned flint, and fragments of burned fruit, grain and wood scattered about.
  - Wonderwerk Cave, S. Africa: earliest solid evidence that *Homo erectus* were using fire, dating to 1 mya. The plant and animal ash was found thirty meters inside the Wonderwerk Cave — beyond the reach of a lightning strike.



Homo erectus

Homo erectus: Cosmopolitan



Homo erectus,
First cosmopolitan hominid

By 1.8 M, in Dmanisi, Georgia; by 600K, China

Date (mya)	Locality	Key Fossils
1.9 – 1.2	Koobi Fora, Kenya	WT 15000 (Nariokotome), ER-3733, ER-3883
1.9 – 0.7	Olduvia Gorge, Tanzania	OH 9, OH 12
1.8 – 1.7	Dmanisi, Georgia	D3444, D2700, D2280, D2282
1.8 – 1.6	Swartkrans, South Africa	SK 847
1.8 – 0.9	Sangiran/Trinil, Indonesia	Trinil 2, Mojokerto, Sangiran 17, Sangiran 2
1.0 – 0.8	Ceprano, Italy	Ceprano 1
0.8 – 0.4	Zhoukoudian, China	ZKD E1, D1, L1, L2, H3
0.8 – 0.6	Bodo, Ethiopia	Bodo
0.6 – 0.3	Atapuerca, Spain	Sima de los huesos (numerous)
0.3 – 0.1	Jinniushan, China	Jinniushan
0.2 – 0.05	Ngandong, Indonesia	Ngandong 1, 9, 10, 11

Table 1: **Key *Homo erectus* fossil sites**. A partial list of key Homo erectus fossil localities, and some of the key specimens preserved at each. Exact dates are difficult to obtain for many of these localities, so the above dates represent best approximate ranges. In some cases, such as Olduvai Gorge and Koobi Fora, fossils have been recovered from many individual localities within the area, spanning a large range of dates.

Homo erectus: Acheulean/Mode 2 tools

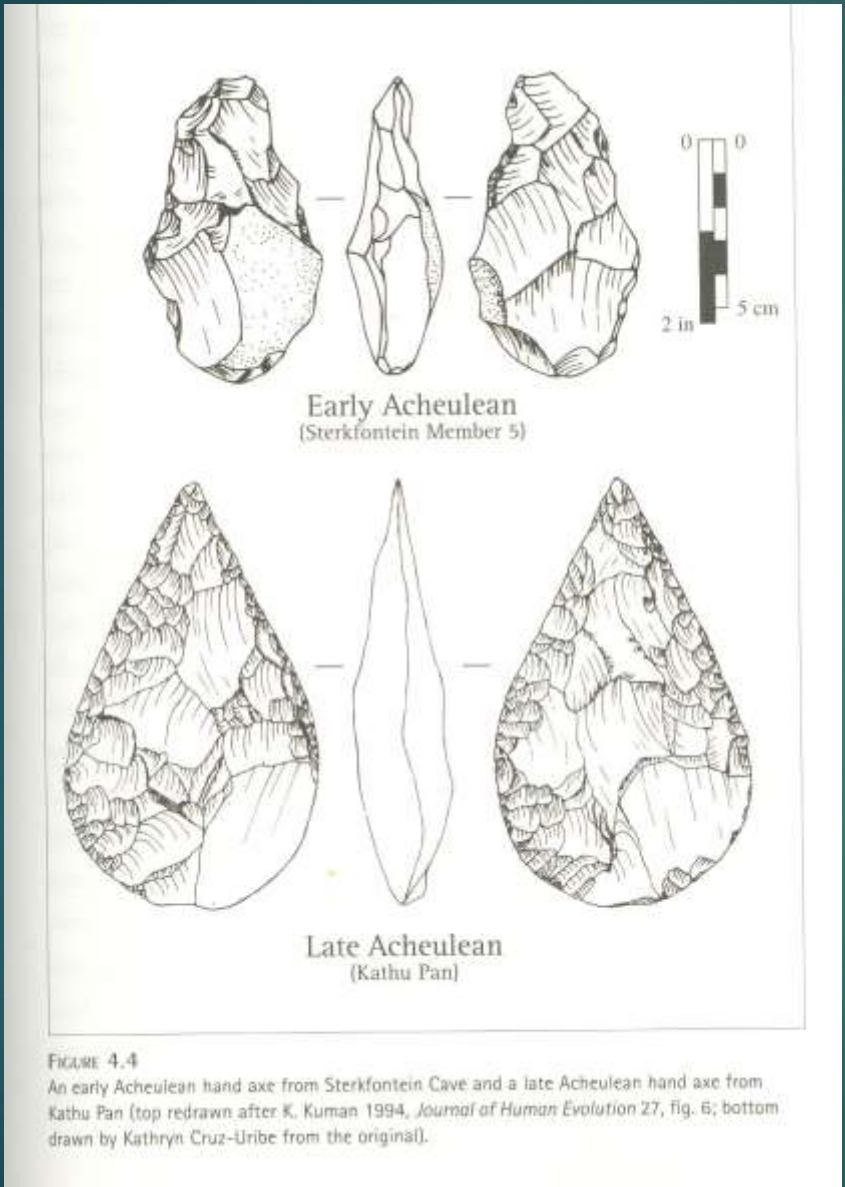


FIGURE 4.4
An early Acheulean hand axe from Sterkfontein Cave and a late Acheulean hand axe from Kathu Pan (top redrawn after K. Kuman 1994, *Journal of Human Evolution* 27, fig. 6; bottom drawn by Kathryn Cruz-Uribe from the original).

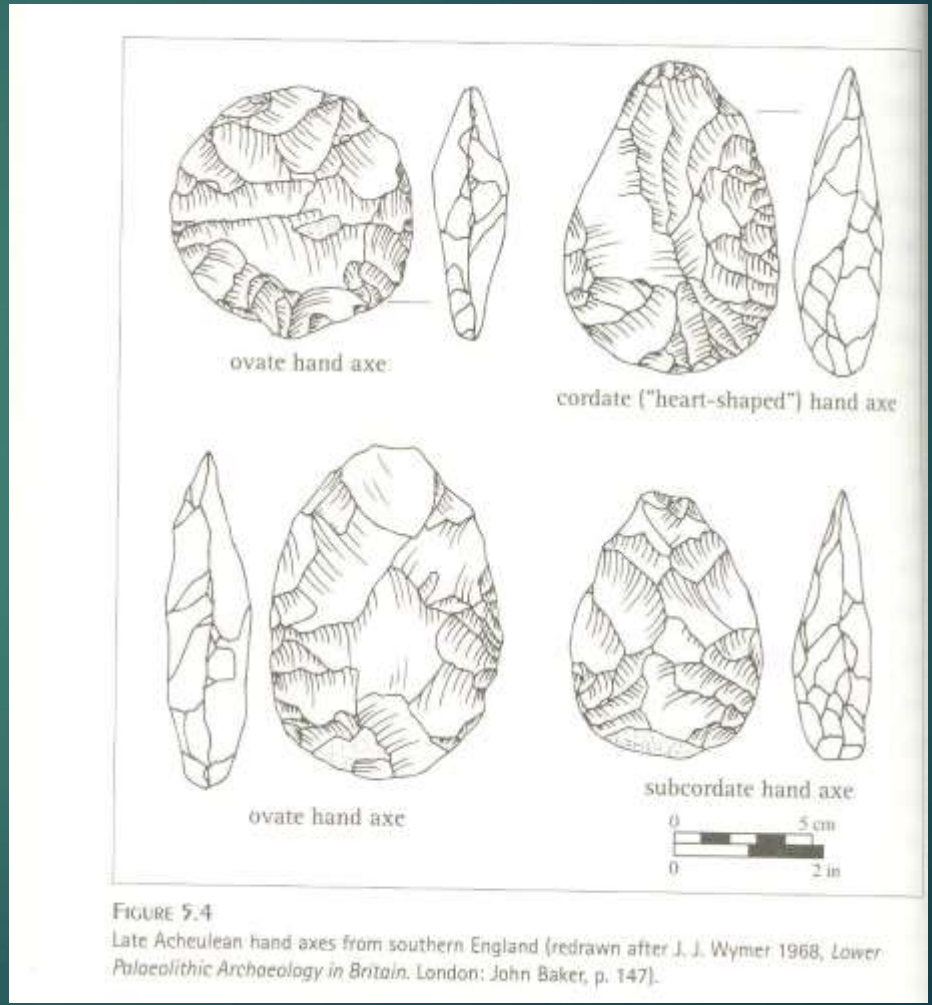


FIGURE 5.4
Late Acheulean hand axes from southern England (redrawn after J. J. Wymer 1968, *Lower Palaeolithic Archaeology in Britain*. London: John Baker, p. 147).

Homo ergaster: early, African version

Location: Africa, Western Asia

Major site: Nariokotome (West Lake Turkana), East Turkana (East Rudolph), Olduvai Gorge, Swartkrans, Dmanisi

Date Range: Approximately 1.9 - 1.4 mya

- *H. ergaster* is considered by many to be the same species as *H. erectus*, with the minor difference being explained by regional variation.

- Early *H. ergaster* in Africa is associated with the Oldowan tool industry.

- *H. ergaster* is the first to move out of Africa & into more temperate regions.

Homo erectus - Eastern

Location: Eastern Asia

Major site: Zhoukoudian, Longgupo, Trinil, Sangiran, Ngandong, Hexian

Date Range: Approximately 1.8 mya - 143,000 ya (?)

Average cranial capacity: ~750 - 1,100 cc

-Has also been known as "*Pithecanthropus erectus",* Java Man, Peking Man, "*Pithecanthropus soloensis", "Sinanthropus".* All have been reclassified into *Homo erectus.*

- *H. erectus* is thought to be the first to use fire, but was likely unable to control it.

Homo erectus

- Cranial capacity: 850 – 1100 cc
  (*H. sapiens* = 1350 cc)
- Use of fire
- Height 5’ to 5’9” (1.55 to 1.8 m)
- Extended childhood
- 1st molar at 4.6 years old (*H. sapiens* = 5.9 y)
- Greater longevity $\rightarrow$ 52 years
- Improved tools: Hand axes (Acheulian culture)
- Speech?

Homo erectus evolution

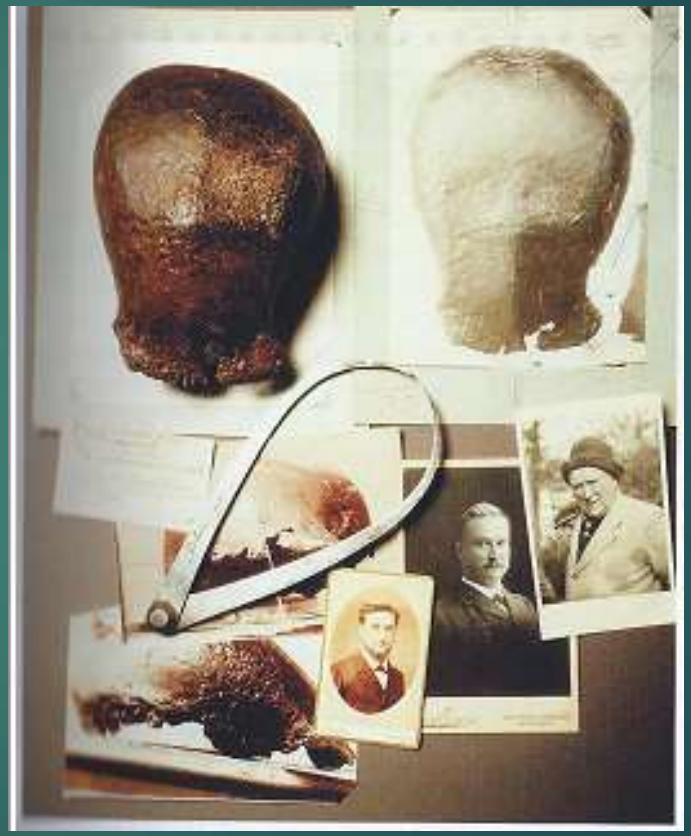
- Current hypothesis: The Asian population of *Homo erectus* went extinct.
- The African population of *Homo erectus* probably gave rise to *Homo heidelbergensis*.
- Homo heidelbergensis in Europe became the Neandertals; in Africa, they became us, *Homo sapiens*

Homo erectus: about 40 skulls, but only 1 complete skeleton (and some postcranial elements from Dmanisi)

Classic East Asia Homo erectus: First to be found

1891: *Pithecanthropus erectus,* Java Man, 1M, 900 cc, at Trinil, Java

Homo erectus
(Trinil 2, type)
Discoverer: Eugene Dubois
Locality: Trinil, Java, Indonesia
Date 1891
Age: 1.0 M



First hominid fossil outside of Europe; first fossil of *Homo erectus*

Trinil 2

Trinil 2

Trinil 2

Trinil 2

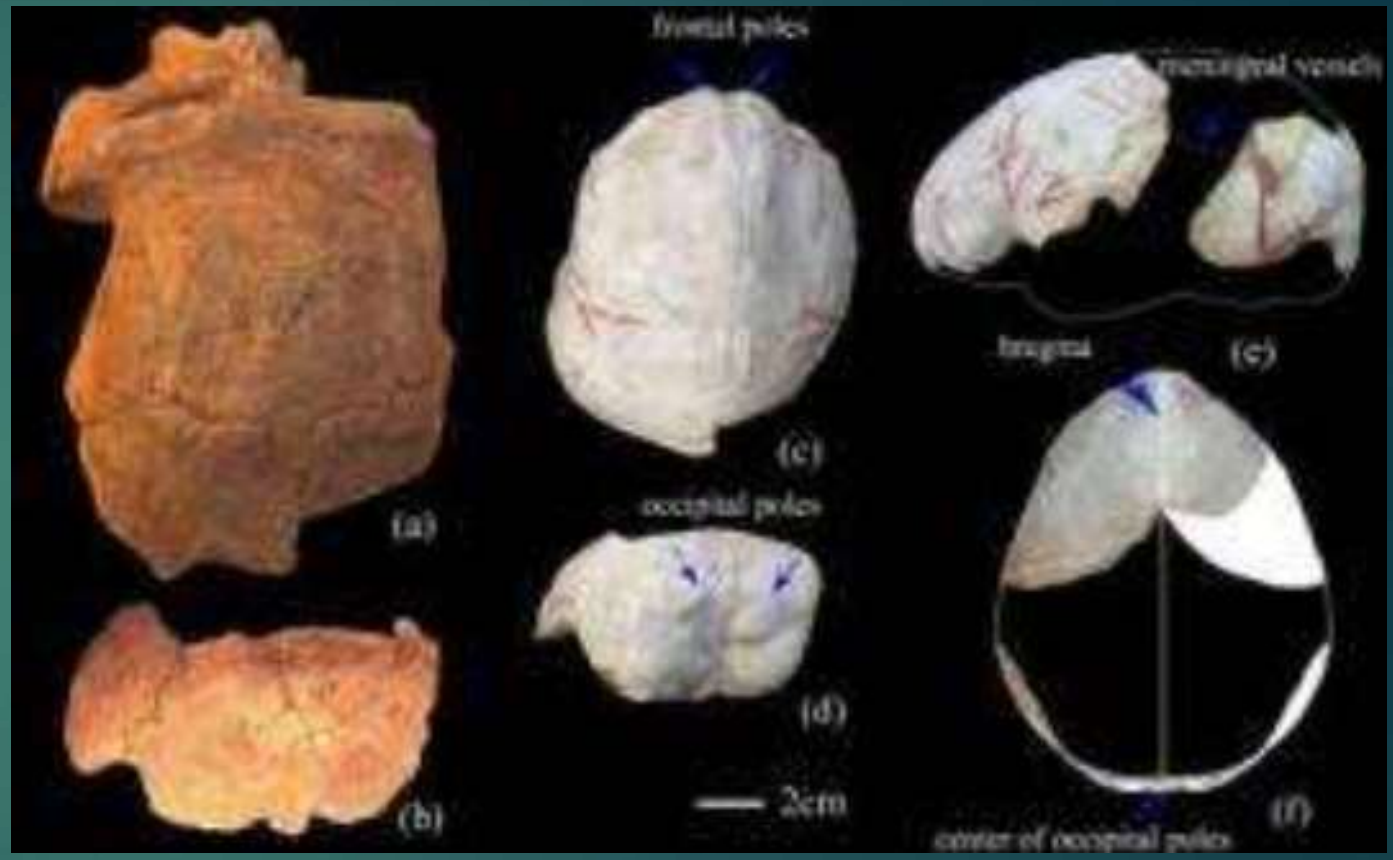
Trinil 2

Lantian, China: 650K, 780 CC

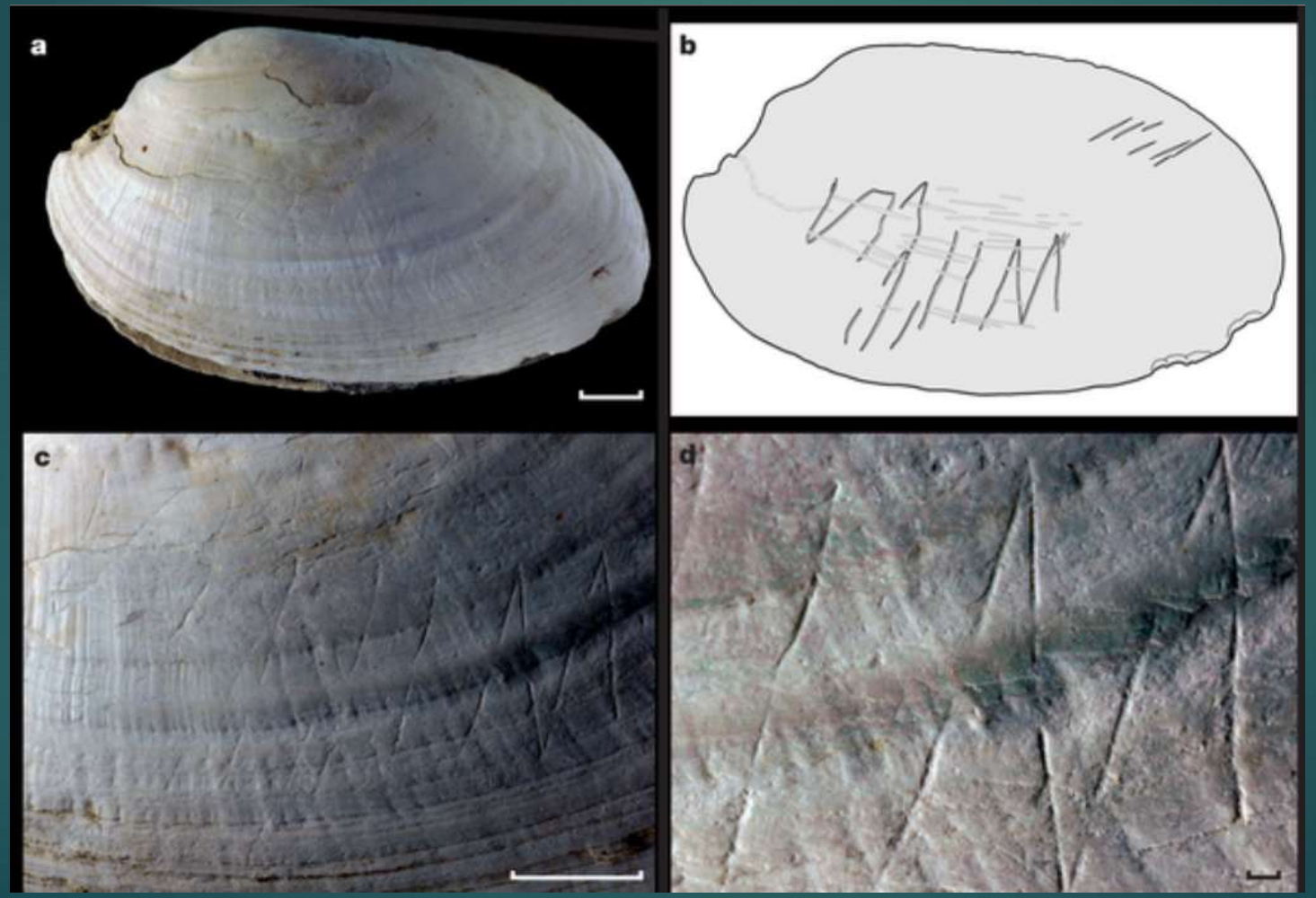
- Formerly *Sinanthropus lantianensis* (currently *Homo erectus lantianensis*); Its discovery in 1963 was first described by J. K. Woo
- Found in Lantian County (Lántián Xiàn), in China's northwestern Shaanxi province
- Age: Chenjiawo skull is 650 K & 780 CC, while Gongzhuling mandible is 800-750K
- Both female

Nanjing: 580-620K

- *Homo erectus nankinensis:* A male and a female skull discovered in 1993 in Tangshan Cave near Nanjing



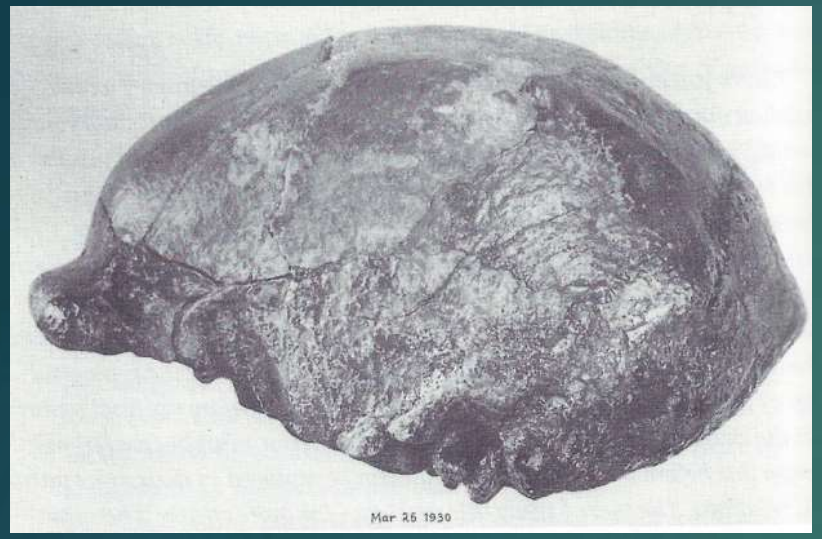
Earliest hominin art work, 2 MYA, Java, *Homo erectus*: Geometric design carved on clam shell



Late Classic East Asia Homo erectus

1921: 1st 2 molars, *Homo erectus*, Peking Man, Dragon Bone Hill at Zhoukoudian, China, from apothecary shop

1928: *Sinanthropus pekinensis:* Zhoukoudian Cave, China (now *Homo erectus pekinensis*)



Homo erectus
(Peking Man)
Discoverer: W. C. Pei
Date: 1928-1937
Locality: Zhoukoudian Cave, China
Age 300-600 K

Homo erectus,
original cast of Peking Man

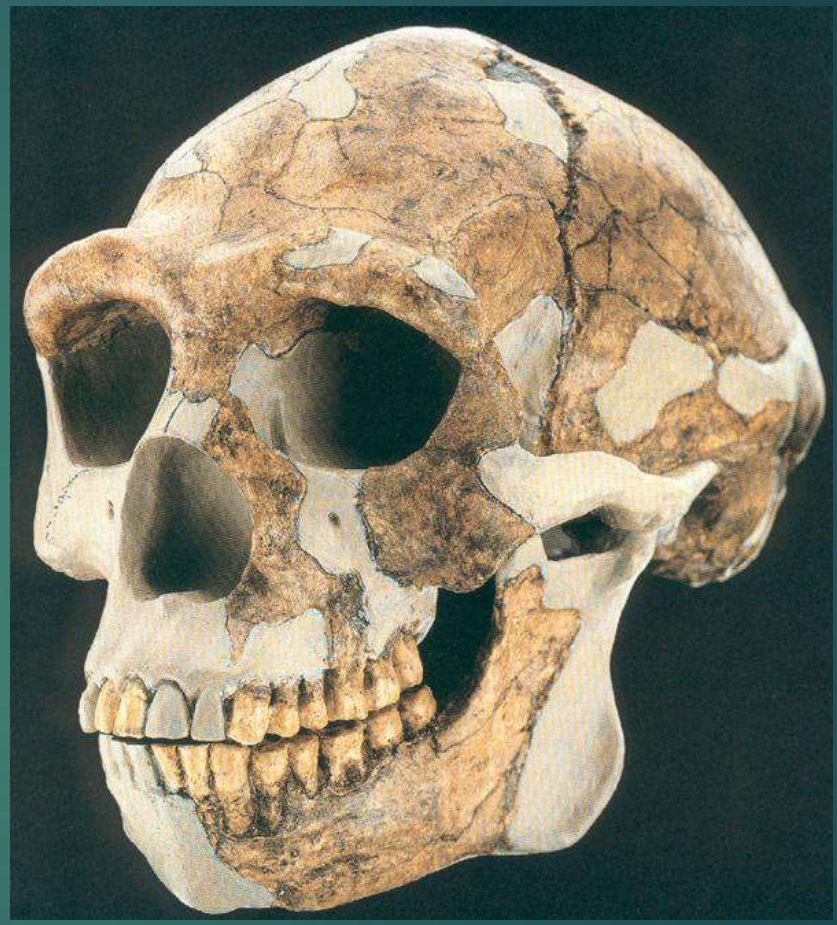
Homo erectus, recontruction

Peking Man

Zhoukoudian produced some 17,000 stone artefacts and fossils of 50 H. erectus individuals, including six skulls

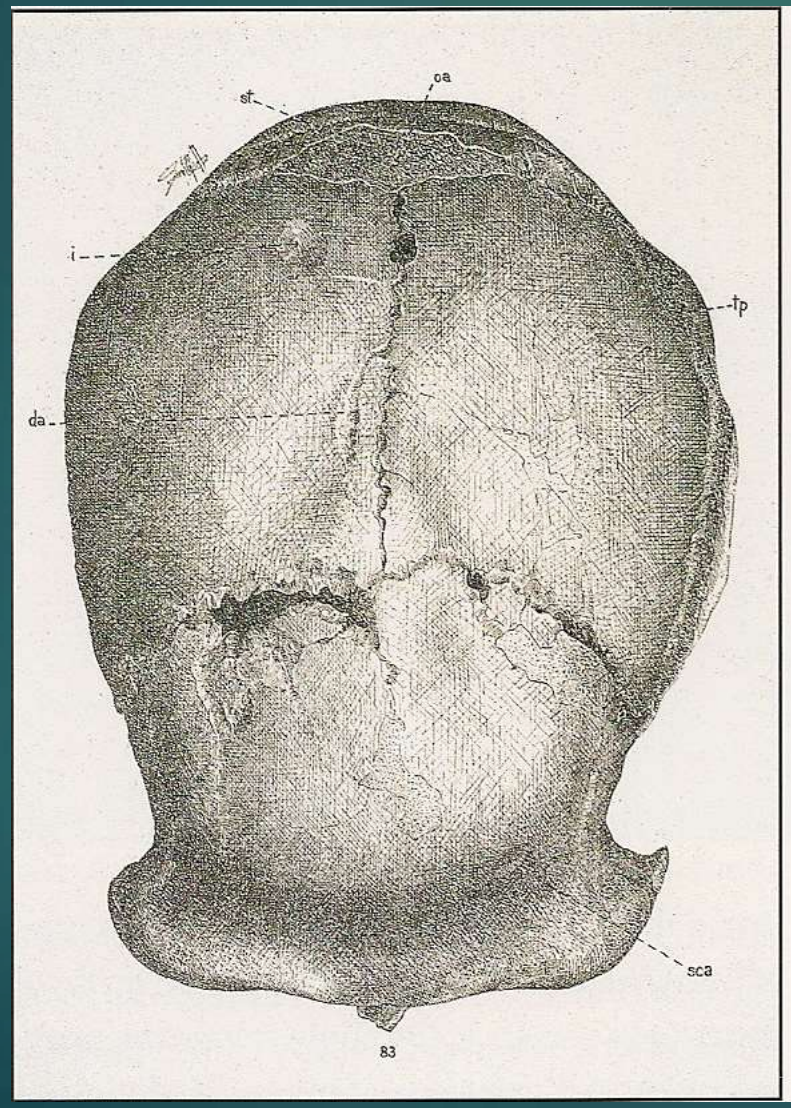
Zhoukoudian: .5-.7 M, 850-1100 CC

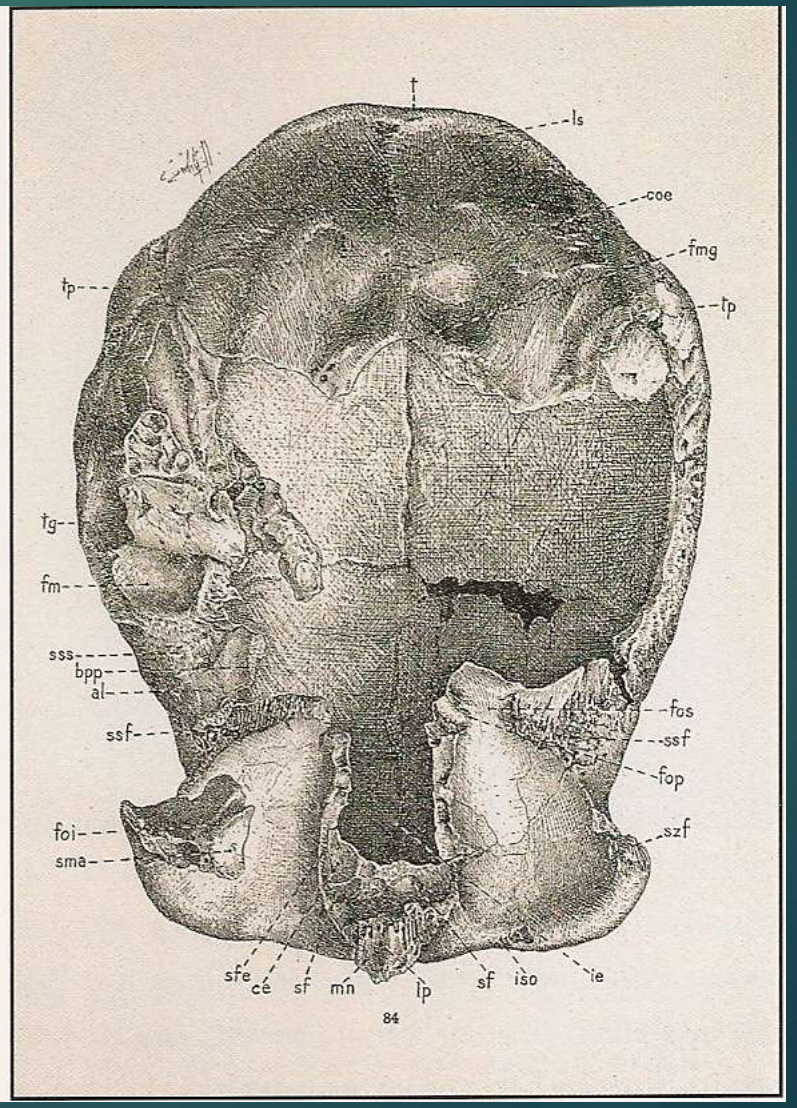
Peking Man



Zhoukoudian produced some 17,000 stone artefacts and fossils of 50 H. erectus individuals, including six skulls

1943: Franz Weidenreich's Reconstruction of *Homo Erectus;* all material lost in WWII





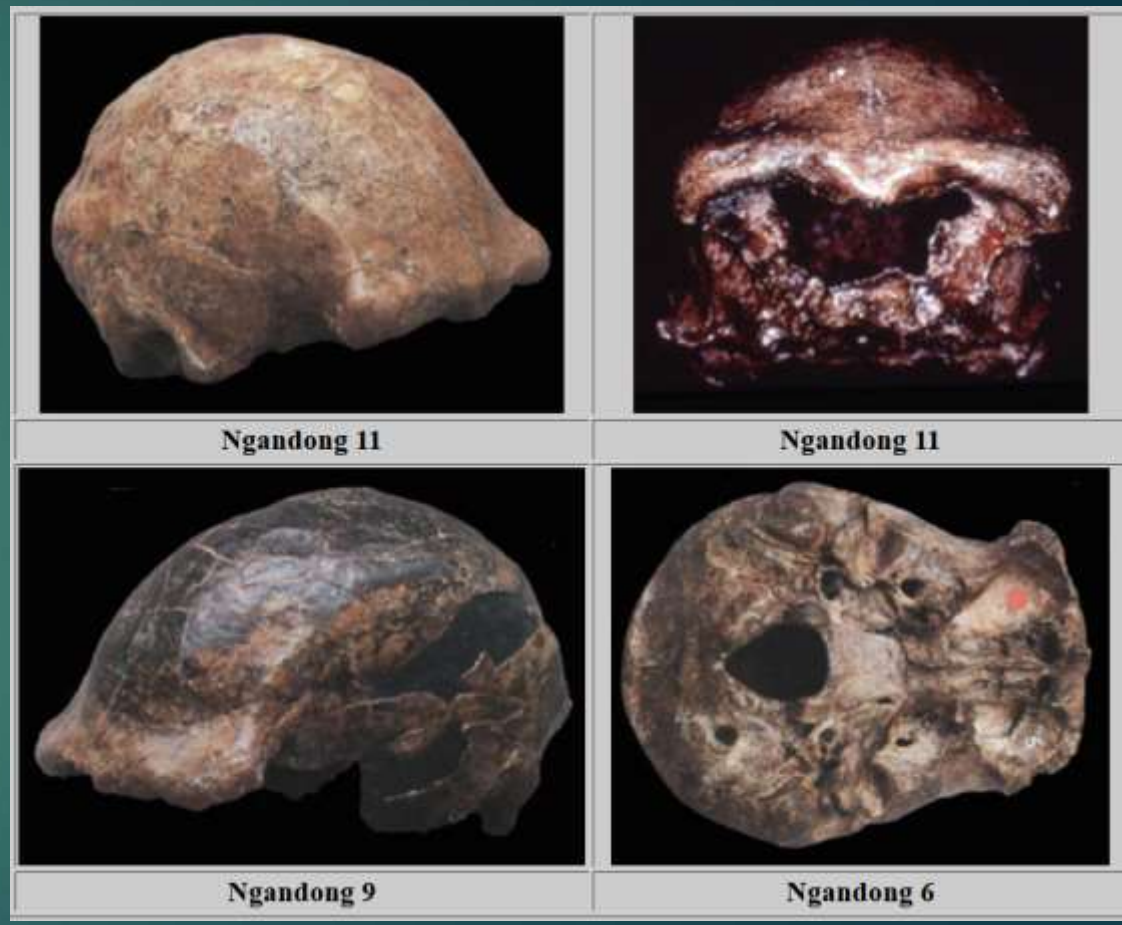
Peking Man skulls

Zhoukoudian: Not a shelter, but a Hyena Den

Zhoukoudian

Ngandong: 500-143K?; 1025-1250 CC

- Between 1931 and 1933 the Dutch Geological Survey conducted excavations in the upper terrace of the Solo River near Ngandong, Java.
- These excavations uncovered a large faunal sample, including the cranial vaults of 11 hominins. Many of the hominin crania were collected before it was clear that they belonged to and their precise stratigraphic position remains unknown.
- Initially assigned to a new species, Homo soloensis, by Oppenoorth (1932), the Ngandong crania are now widely accepted as belonging to H. erectus.



(Santa Luca 1980).

Ngandong 1: 1172 см^3

C. Ter Haar & R. von Koenigswald, 1931–1932

Ngandong 6

Ngandong 6 (Solo V): 1250 см^3

C. Ter Haar & R. von Koenigswald, 1931-1932

Early African Homo erectus

1971: *Homo ergaster*, KNM-ER 992, type specimen, 1.5 Mya Koobi Fora, Kenya

Discovered by Bernard Ngeneo/Richard Leakey in 1971 at Lake Turkana, Kenya.

The mandible was considered by C. Groves and V. Mazak to be the holotype specimen for Homo ergaster.

Type designation based on lightly built jaw and relatively small premolar and molar teeth.

1969, SK 847, Ron Clarke: an early Homo in South Africa

Homo ergaster (an early *Homo erectus* in South Africa)

Homo ergaster
partial cranium

Discoverer: Ron Clarke
Locality: Swartkrans
Date 1969
Age: 1.5 M

1975: *Homo ergaster,* KNM-ER 3733, female, 1.8 M, 800 CC

Homo ergaster
(KNM ER 3733)
Discoverers: Bernard Ngeneo
Locality: Koobi For a, Kenya

This fairly complete cranium is responsible for sinking the single species concept (2 species cannot be in same ecological niche), proving bush theory; *H. habilis* was also in Koobi Fora at same time

KNM-ER 42700, Kenya, 1.5 and 1.6 mya, 691 cc

Image Credit: James Di Loreto, & Donald H. Hurlbert, Smithsonian Institution

Homo erectus crania:
KNM-ER 42700 (small) and OH 9 (large),

It was found in Ileret, Kenya where younger fossils of Homo habilis have been found, demonstrating that these two species existed at the same time, rather than H. habilis being ancestral to H. erectus.

1984: *Turkana Boy, Homo ergaster*, Human Odyssey Exhibit

Modern Body Plan

Modern Body Plan

1984: Turkana Boy, Homo ergaster, KNM-WT 15000, 5’5”, 9 year old

- Boy from Nariokotome
- Very tall hominid at 1.5 mya
- 9 years old when he died (no 3rd molar eruption); male from pelvis
- 5’ 4” tall (6 feet @ maturity)
- Long legs, thick bones
- Well adapted to staying cool in hot, dry climates
- Face, molar teeth, chewing muscles smaller than earlier hominids (softer, high-quality - perhaps cooked - foods)
- Vertebrate opening in spinal cord smaller than moderns
- Brain size large (880cc; adult 910cc)
- Front tooth size increase, back tooth decrease
- Almost 90% of his skeleton was recovered

Homo ergaster
(KNM WT 15000)
Discoverers: Kamoya Kimeu
Date: 1984
Locality: Nariokotome, Kenya
Age: 1.6 M

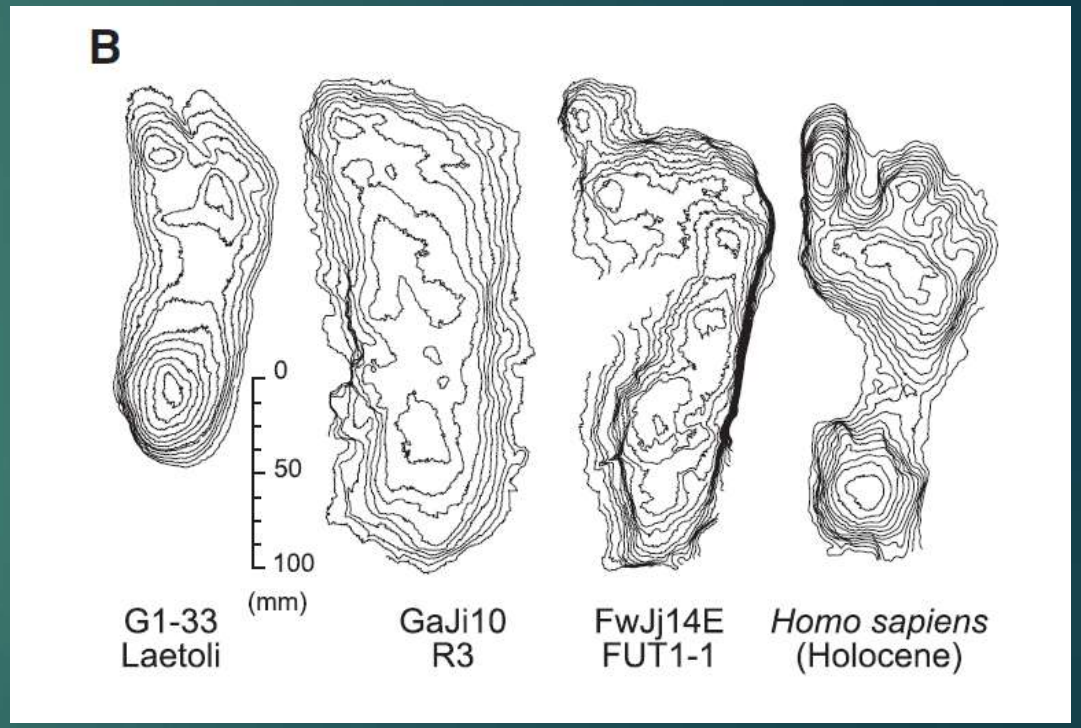
Homo ergaster: WT 15,000 Narikatome Boy

Discovered: 1984 by Kamoya Kimeu in Nariokotome, West Turkana, Kenya.

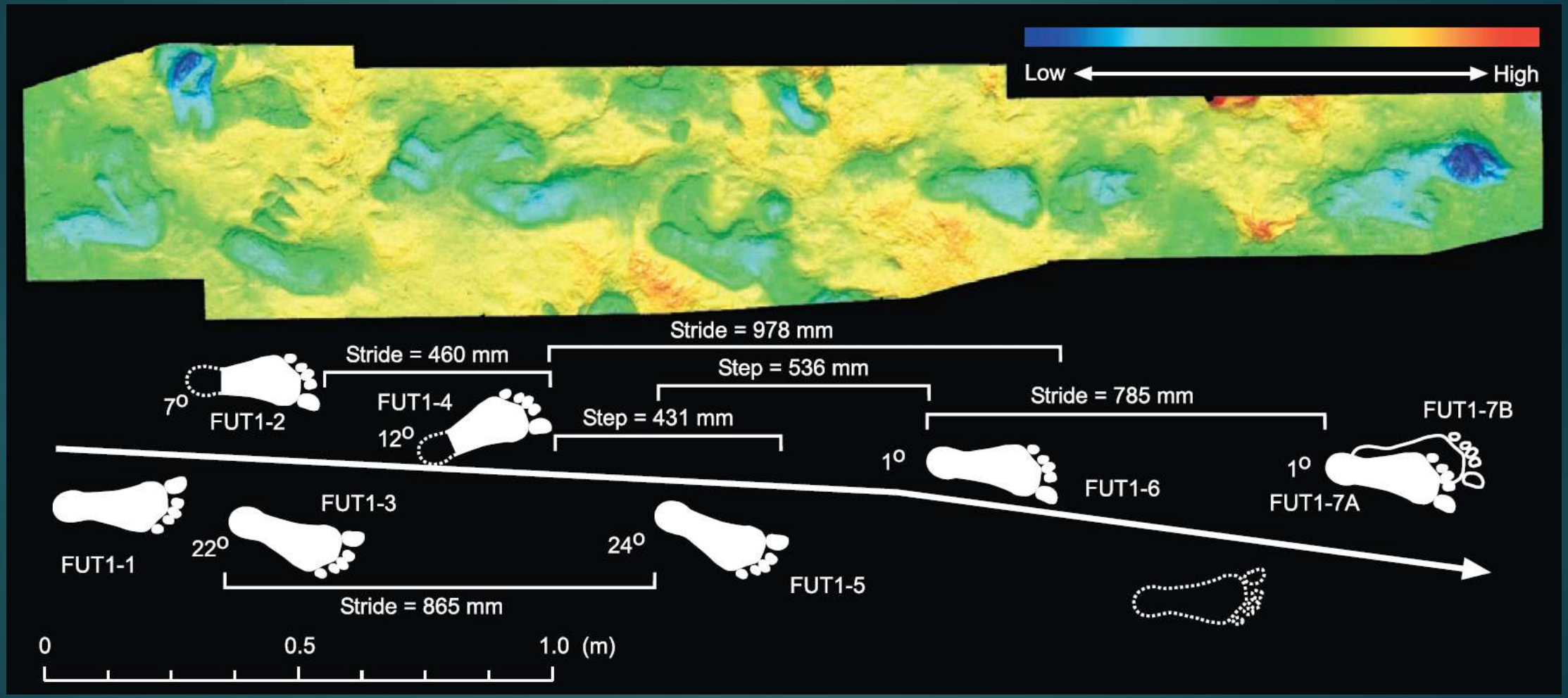
Turkana Boy probably suffered from a disease of the spinal column that resulted in narrower cervical vertebrae

Ileret, Kenya Footprints: 1.5 M

- These are the oldest known evidence of an essentially modern human-like foot anatomy and differ from the Laetoli footprints left by australopithecines 3.6 million years ago.
- The size and shape suggest that they were made by Homo ergaster, which also makes them the oldest surviving footprints made by a human species.



Ileret, Kenya Footprints: 1.5 M



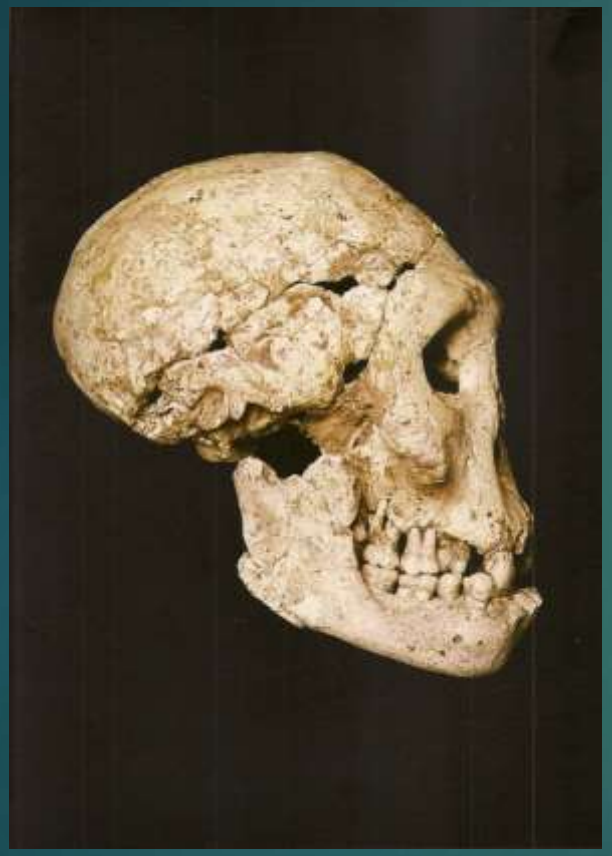
Early West Asia Homo erectus

Dmanisi, Georgia: Earliest known hominin site outside of Africa: small *habilis*-like skulls which have *erectus*-like features.

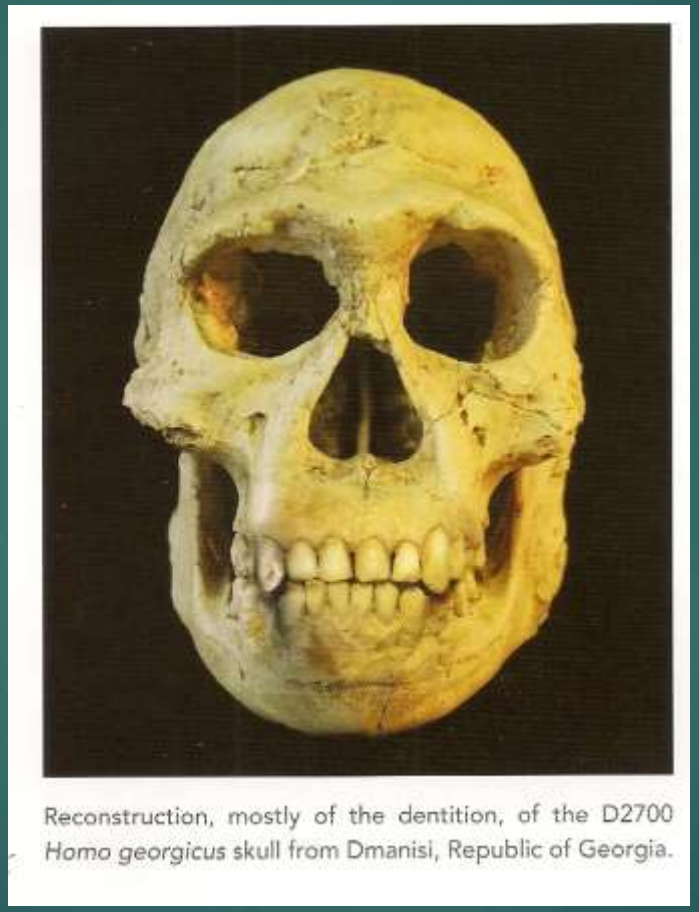
Dmanisi, Georgia: 1.7 to 1.85 million years old, small brains

- Represent the earliest evidence for the emergence of early humans from Africa into Eurasia 1.75 million years ago.
- No evidence of fire
- Oldowan tool technology
- 4 feet tall; smallest of any adult hominid yet found outside Africa
- Key specimens include:
  - Skull D2700 (discovered in 2001) with a brain size of 600 cc;
  - Skull D2280 (discovered in 1999) with a brain szie of 780 cc and features similar to *Homo ergaster* specimens KNM-WT 15000 and KNM-ER 3733;
  - Skull D2282 (discovered in 1999) with a brain size of about 650 cc and features similar to KNM-WT 15000 and KNM-ER 3733.

Dmanisi, Georgia:
Homo georgicus (erectus)



Homo georgicus, D 2600

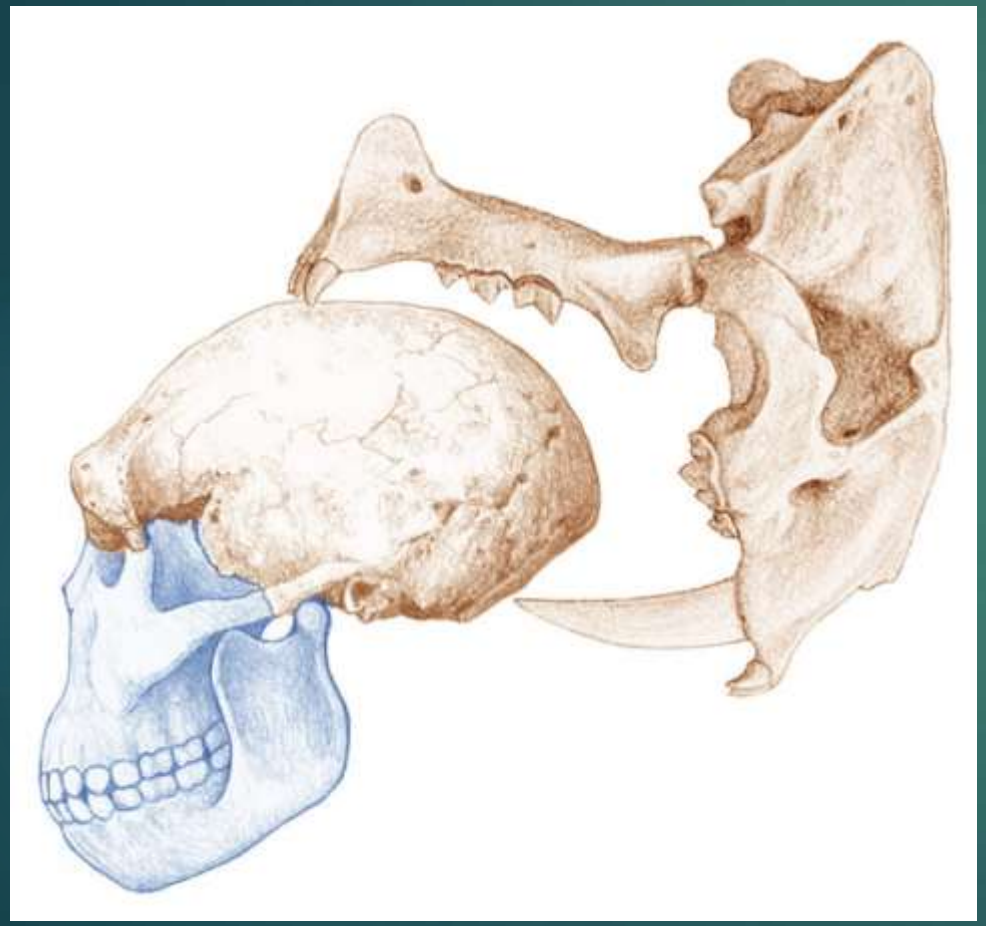


Reconstruction, mostly of the dentition, of the D2700 *Homo georgicus* skull from Dmanisi, Republic of Georgia.

Skull 5: D4500 & mandible D2600; 1.8M, 546 CC

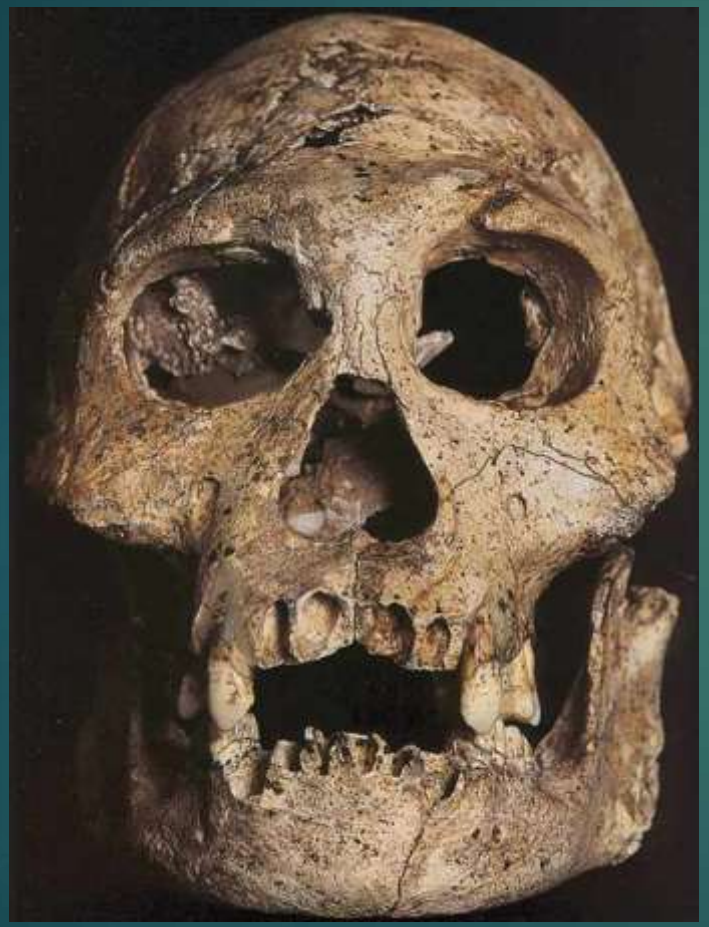
World's first completely preserved adult hominid skull from the early Pleistocene.

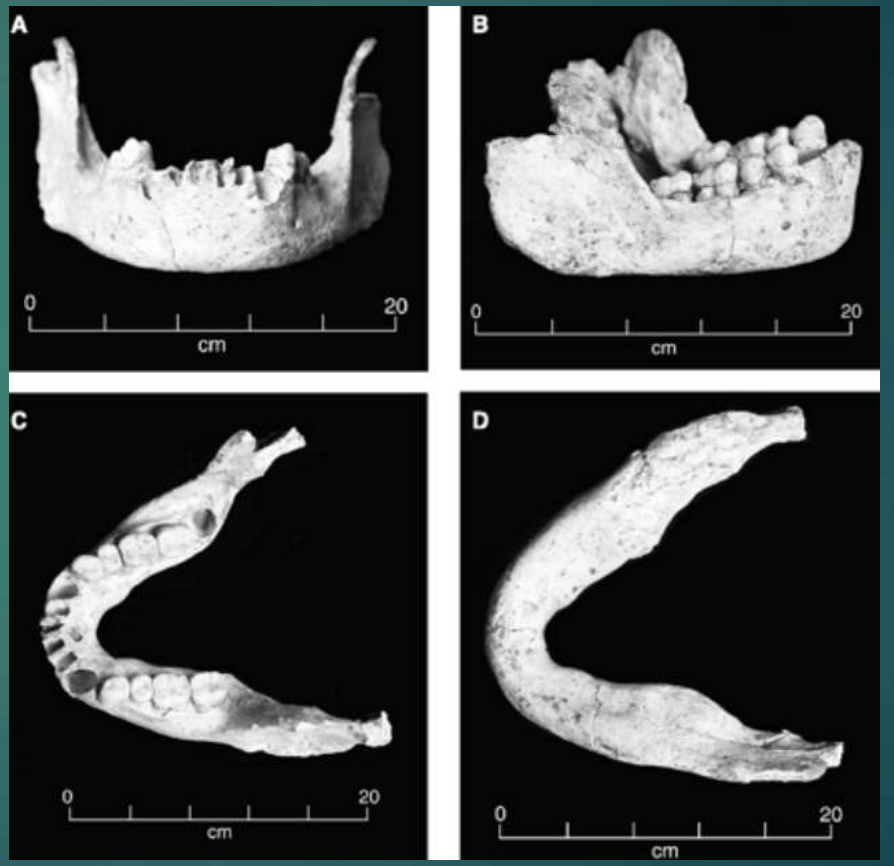
D2280 & Saber tooth tiger



Two punctures in the occipital area that correspond with amazing precision with the size and separation of the tips of Megantereon‘s upper canines.

D 2700 cranium & D 2735 mandible





Discovered: 2001

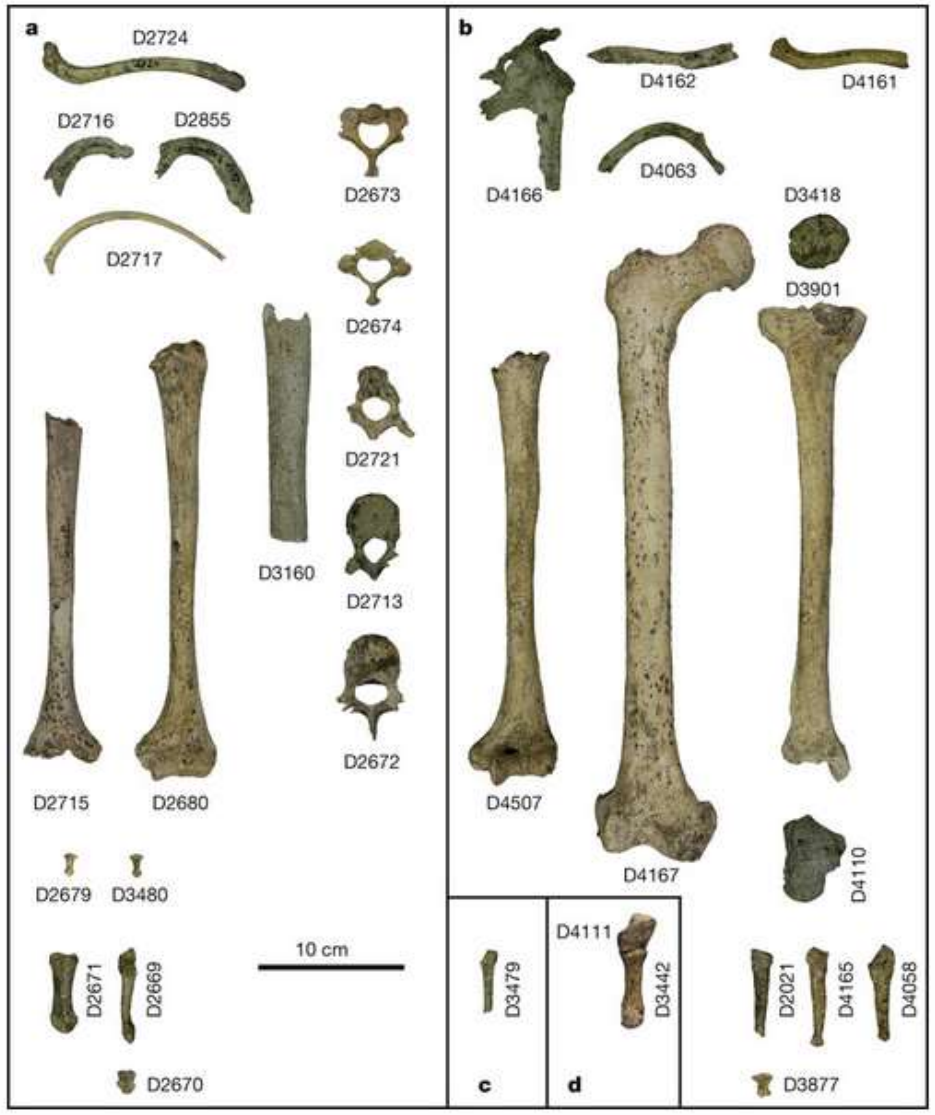
A Vekua et al. Science 2002;297:85-89

Homo erectus at Dmanisi: Empathy at 1.8 M

Old Man of Dmanisi,
Evidence of Empathy at 1.8 M

This elderly male: Most of his teeth fell out long before he died, and his jaw deteriorated as a result. Members of his social group must have taken care of him. This is some of the earliest known evidence for this kind of group care and compassion in the human fossil record.

Dmanisi postcranial elements: 4 individuals



a, Remains of subadult individual. D2724, left clavicle; D2716/D2855, right/left first rib; D2717, eleventh rib; D2673/D2674/D2721/D2713 /D2672, vertebrae C2/C3/Th3/Th10/L1; D2715/D2680, right/left humerus; D3160, left femur; D2679/D3480, distal phalanges of hand; D2671/D2669, right metatarsal I/IV; D2670, first distal phalange of right foot. **b**, Remains of large adult individual. D4166, right scapula; D4162/D4161, right/left clavicles; D4063, right second rib; D4507, left humerus; D4167, right femur; D3418, right patella; D3901, right tibia; D4110, left talus; D2021/D4165, right metatarsals III/IV; D4508, left metatarsal V; D3877, distal phalange of foot. **c**, **d**, Remains of small adult individuals. D3479, right metatarsal III; D4111, right medial cuneiform; D3442, right metatarsal I.

- Estimates between 145–166 cm (4’8”-5”5” ft) and 40–50 kg (88-110 lbs)
- Dmanisi cranial capacity: 600 to 775 cc; Habilis average: 614 cc; Erectus average: 904 cc

The Dmanisi 5

Early East Asia Homo erectus

Mojokerto child (Perning I): 1.49 M

Site: Mojokerto, Java, Indonesia
Date of discovery: 1936
Discovered by: a workman on von Koenigswald team
Age: original 1.81; revision 1.49 M

Only H. erectus non-adult with good estimate of brain size (or rather, the overall volume of the brain case) - probably 630 to 660 CC; 6 m to 4 y old

High, human-like infant brain growth rates in Homo erectus by around 1 million years ago

Sangiran 2, Java

1937: *Homo erectus*, Sangiran 17, 800K

Indonesian characteristics of flat forehead & cheeks; projecting face, & flat braincase on sides and broad at base

Homo erectus
(Sangiran 17)
Discoverer: Mr. Towikromo
Date: 1969
Locality: Sangiran, Java, Indonesia
Age 800 K

Classic African Homo erectus

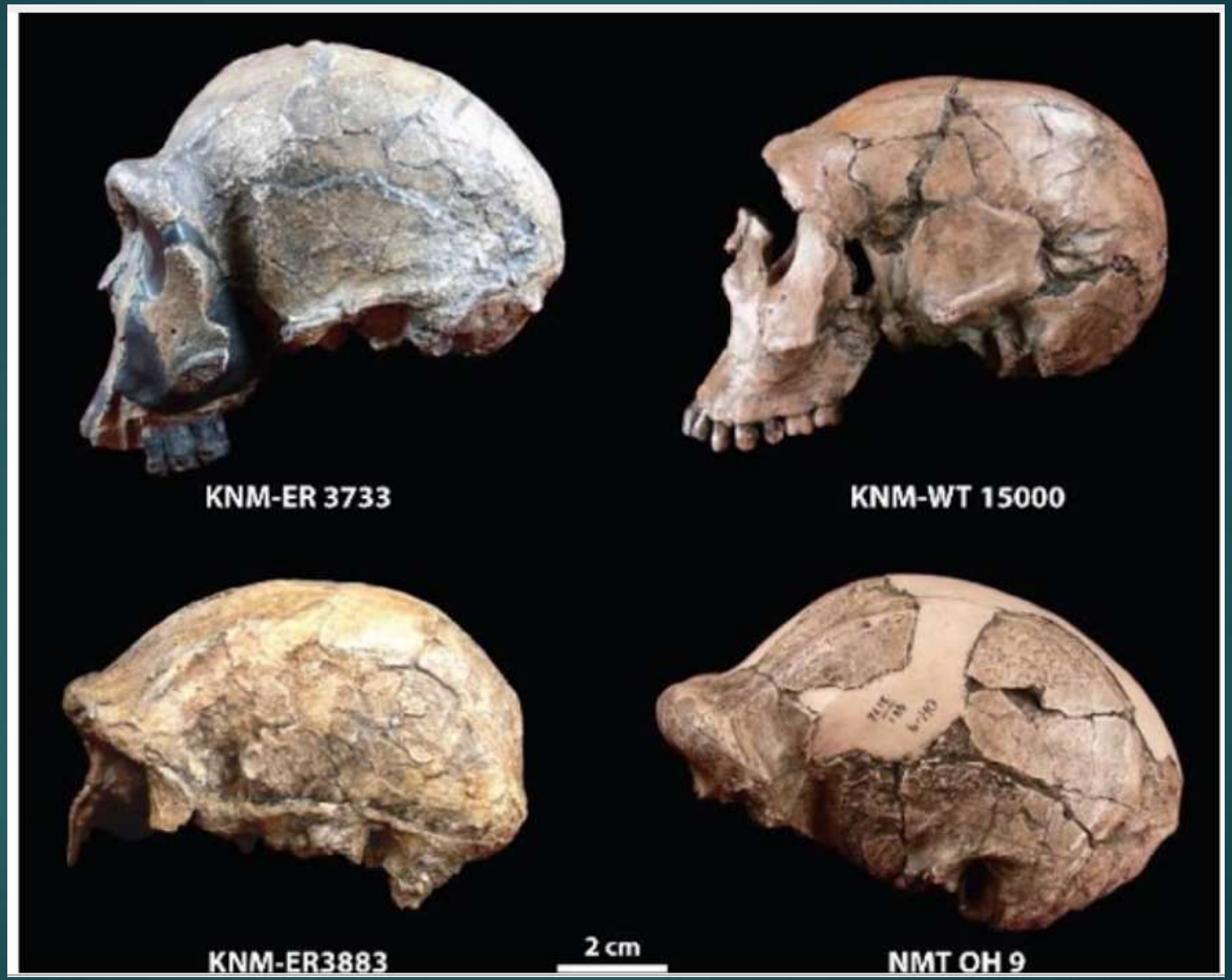
OH9: 780-1.2M, 1050CC

- Olduvai; not found in situ
- OH 9 *Chellean Man* Discovered by Louis Leakey in 1960 at Olduvai Gorge (Tanzania).
- Oldest known early human fossil specimen with a brain size larger than 1000 cubic centimeters.

(Heberer, 1963; Rightmire, 1979)

Koobi Fora

Turkana Boy



Koobi Fora

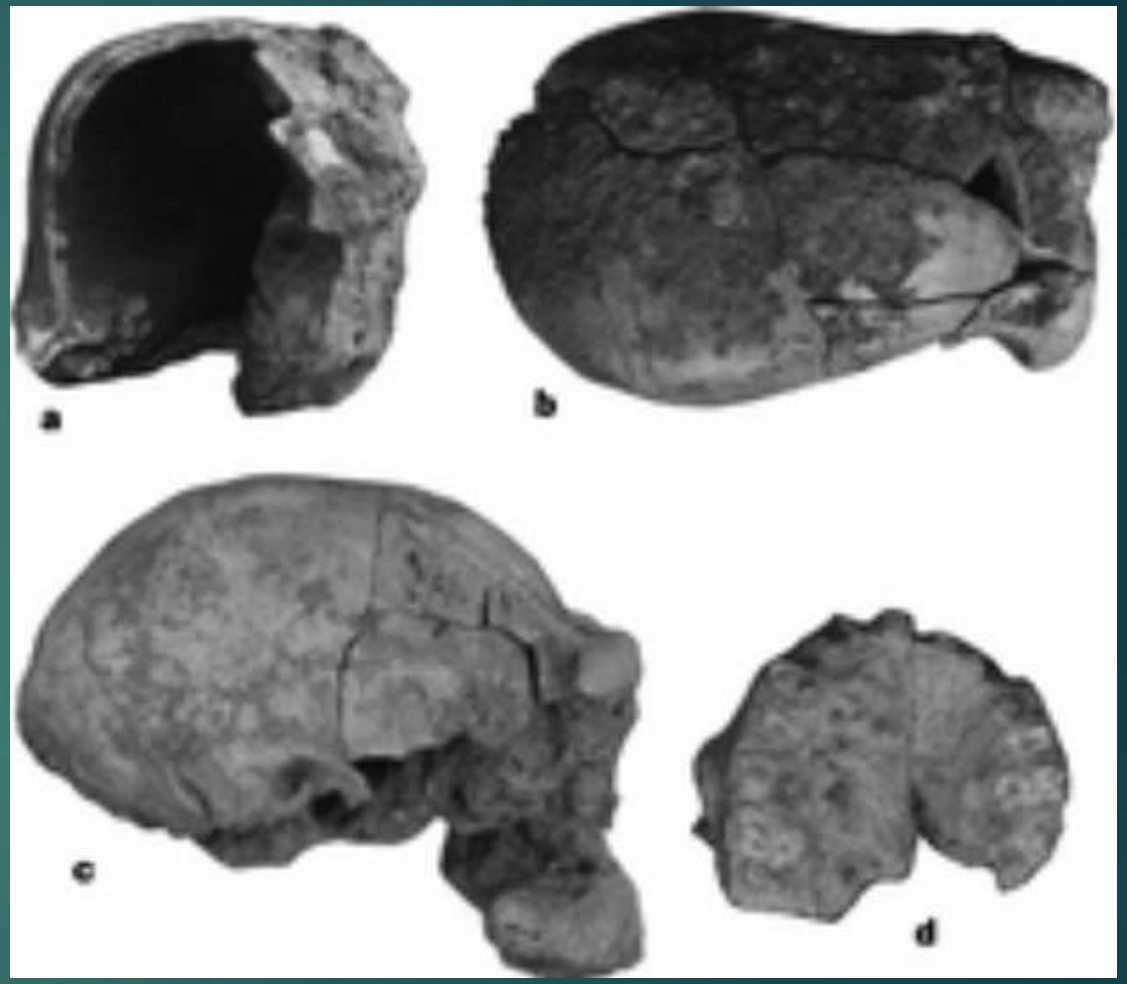
Olduvai Gorge

BOU-VP-2/66: Daka: 1 M, 995 CC

- From the Daka Member of the Bouri Formation in the Middle Awash Study Area of the Awash valley of the Ethiopia Rift.
- Date of discovery: 1997
- Discovered by: W. Henry Gilbert

Buia UA 31: 1M, 750-800 CC, large Parietals

- Northern Danakil (Afar) Depression, Eritrea, Africa
- The skull is long and oval, pointed at the back, and has massive browridges, all features characteristic of Homo erectus, as is the small brain capacity.
- Where the skull differs from erectus is in the parietal bones, which form the curved sides and top of the skull. They are much wider at the top than those of H. erectus and are typical of Homo sapiens.



Olorgesailie, Kenya: 1000s of stone axes

KNM-OG 45500: 900K, 700 to 800 CC

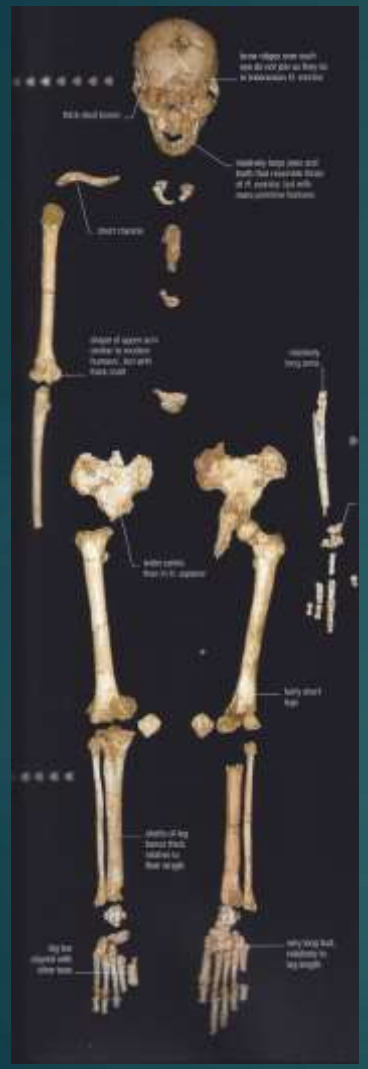
- Olorgesailie, Kenya
- Large number of handaxes found there, along with other bifacial tools (flaked on two sides to create an edge)
- Site was used from 1.2 million and 400,000 years

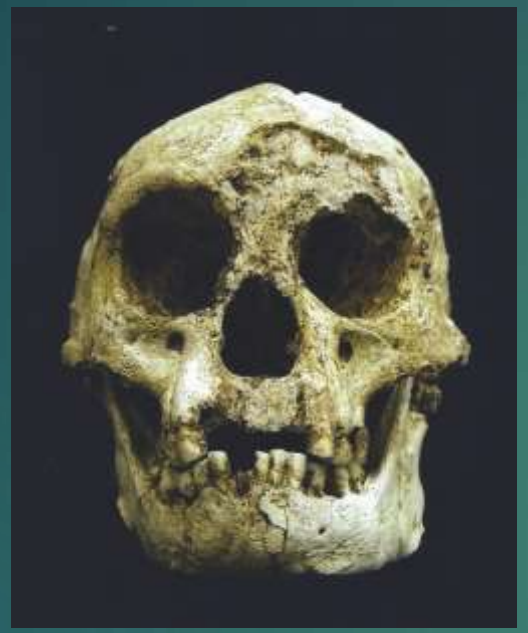
The frontal bone, including the brow ridge, of the hominin skull from Olorgesailie (KNM–OG 45500). Image courtesy of Jennifer Clark and Richard Potts, Smithsonian Institution.

A handaxe from Olorgesailie (handaxe is ~14cm tall). Image courtesy of James Di Loreto and Donald H. Hurlbert, Smithsonian Institution.

Homo floresiensis

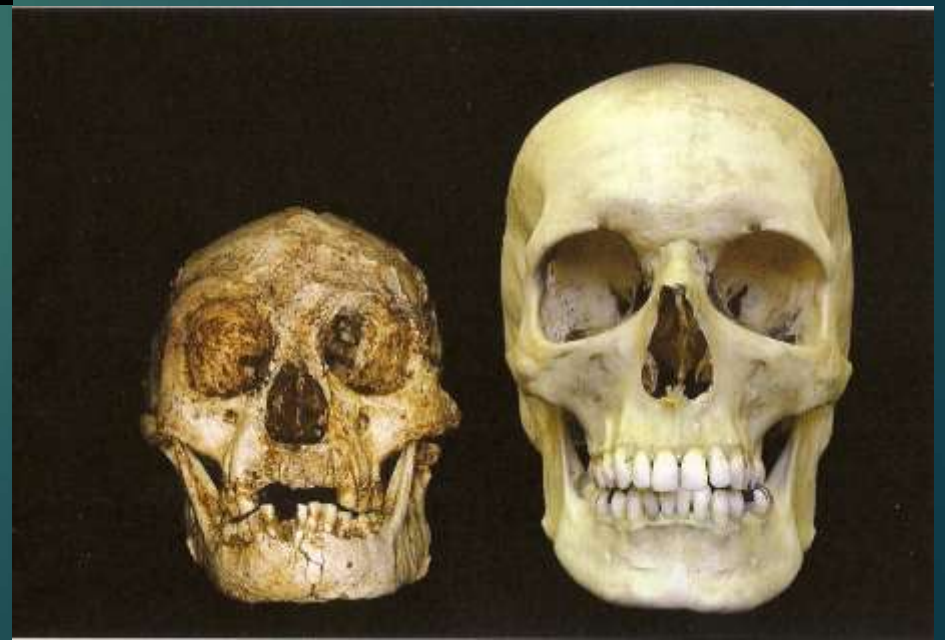
2003: Homo floresiensis, 417cc, 100-8K





3 feet tall

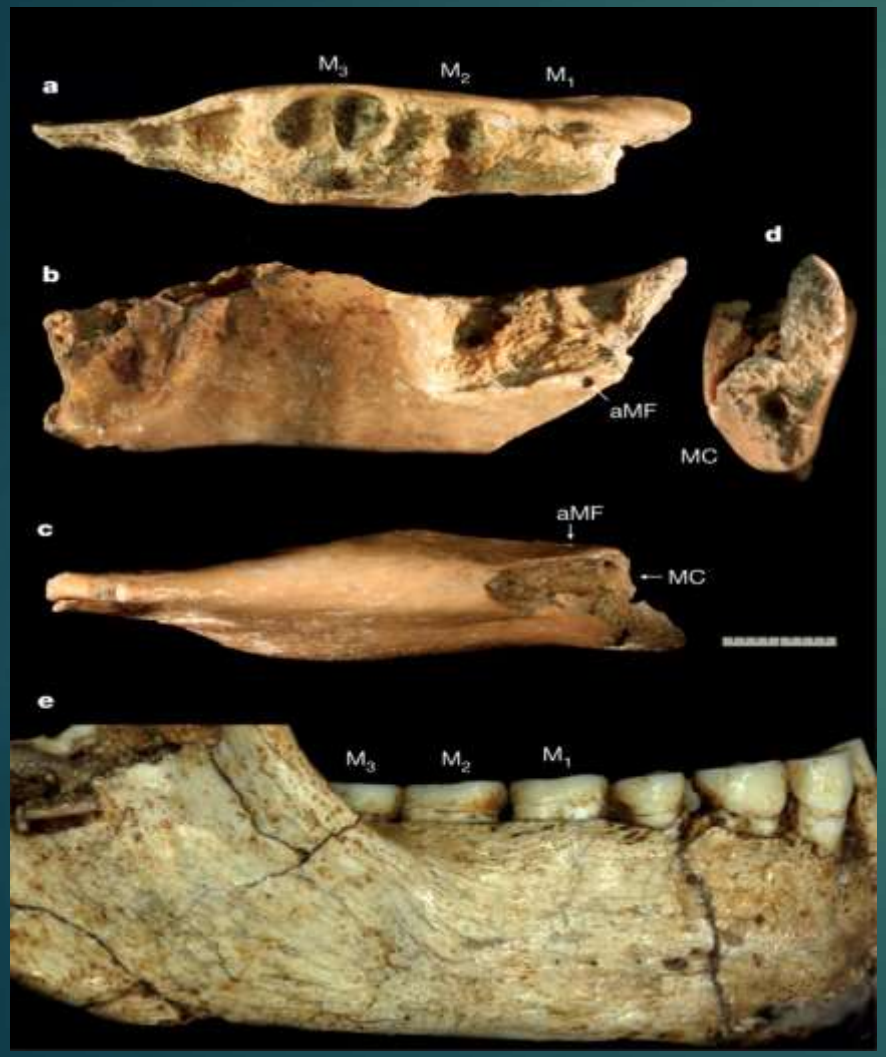
Homo floresiensis
(LB1, type, partial skeleton)
Discoverer: Thomas Sutikna
Locality: Liang Bua, Flores, Indonesia
Date: 2003
Age: 100-60K



Homo floresiensis: 417cc, 700 to 100-60 kya

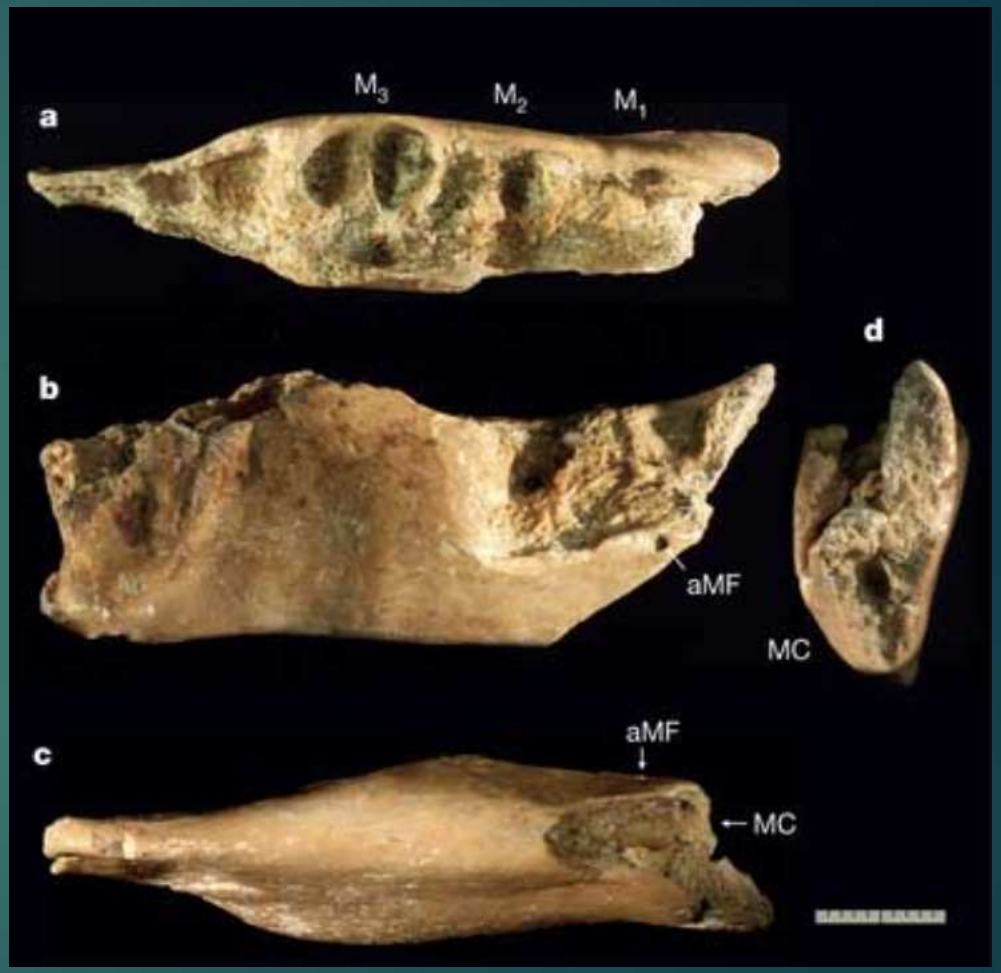
- Originally considered to have survived until 12,000 years ago.
- More extensive stratigraphic and chronological work: 100,000 to 60,000 years ago
- Stone tools recovered alongside the skeletal remains = 190,000 to 50,000 years ago,
- Ancestors: Fossil teeth and a partial jaw from hominins assumed to be ancestral to *H. floresiensis* were discovered in 2014. They date to about 700,000 years ago and are even smaller than the later fossils. These remains are from a site on Flores called Mata Menge, about 74 km from Liang Bua. Stone tools from 840K.
- The form of the fossils has been interpreted as suggesting that they are derived from a population of *H. erectus* that arrived on Flores about a million years ago (as indicated by the oldest artifacts excavated on the island) and rapidly became dwarfed.
- *Homo floresiensis* therefore lived concurrently with modern humans (*Homo sapiens*) for at least 82,000 years, and overlapped with *H. neanderthalensis* for about 60,000 years.

SOA-MM4 mandible (700K) compared with a Liang Bua *H. floresiensis* specimen (100-60K)



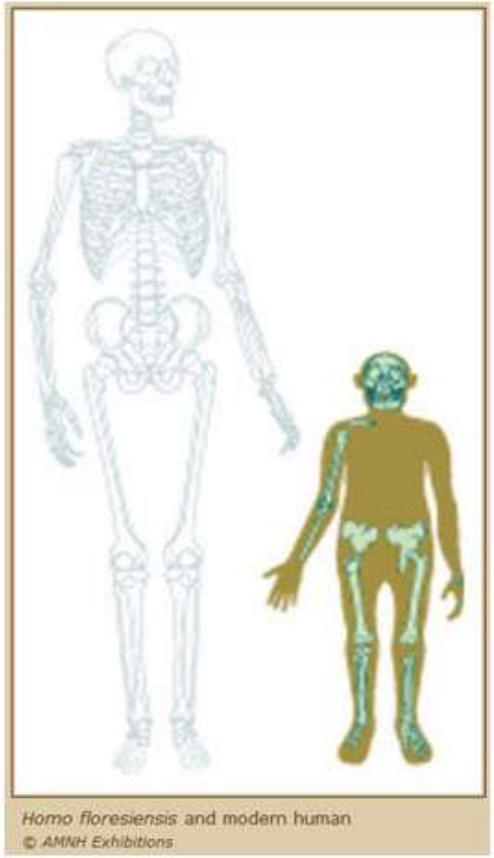
Mata Menge jaw

Liang Bua jaw



G D van den Bergh *et al. Nature* **534,** 245–248 (2016) doi:10.1038/nature17999

Homo floresiensis

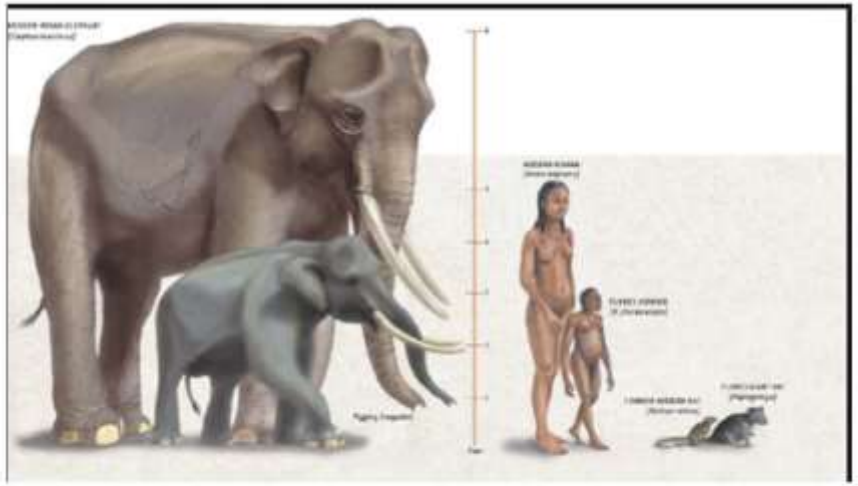


Homo floresiensis and modern human
© AMNH Exhibitions

2003: *Homo floresiensis*, Island of Flores, Indonesia: 1 meter tall
About 95,000 – 17,000 years ago

Homo floresiensis & Large rats

Flores, Indonesia: 100-60K



Island dwarfism on Flores, Indonesia

H. Floresiensis & giant storks

Giant Komodo dragons on Flores

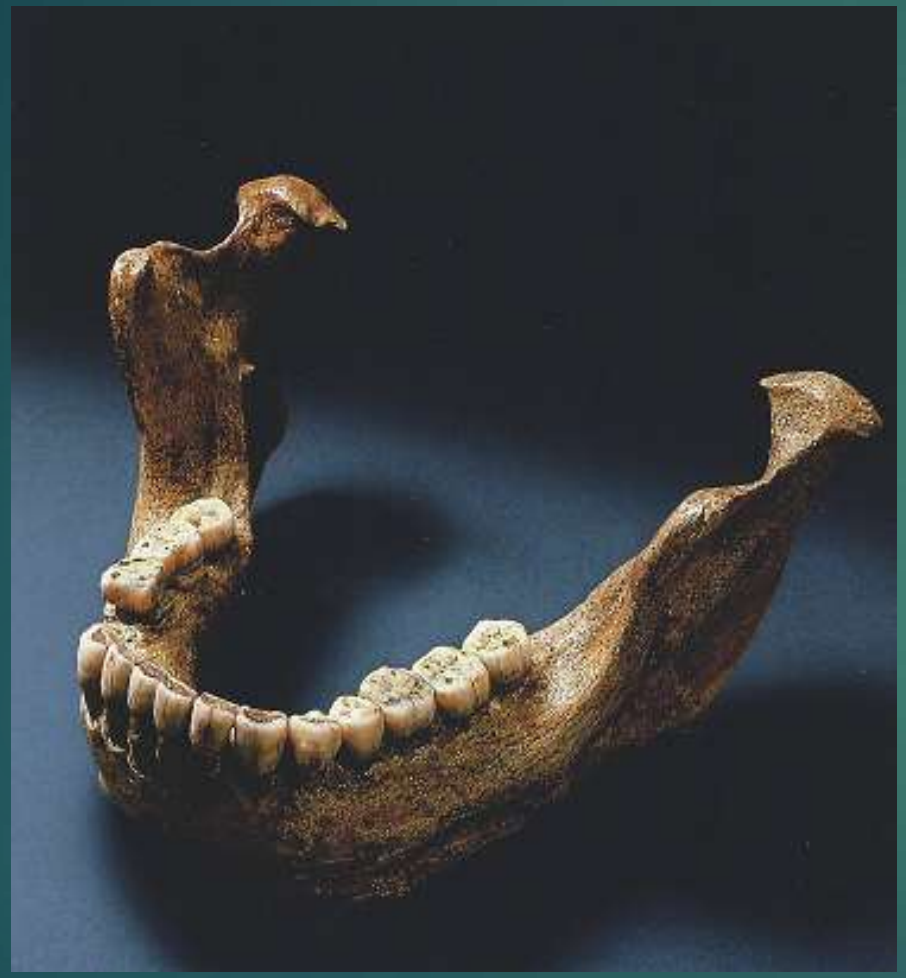
Homo heidelbergensis

Hominins in European Middle Pleistocene

- Sequence of hominins in Europe throughout Middle Pleistocene:
  - Earliest material being *H. erectus*,
  - Leading to more transitional archaic hominins (*H. heidelbergensis*),
  - and resulting finally in classic Neandertals of Europe

1907: *Homo heidelbergensis*

Mauer mandible; one of oldest European fossils



Homo heidelbergensis
(Mauer 1, type)
Discoverer: Daniel Hartman, workman for Joseph Rosch
Date: 1907
Locality: Mauer sand pits, near Heidelberg, Germany
Age 400-500 K

Almost There – But not quite:
"Archaic" Hominins of the Middle Pleistocene

- By 800 kya, African *H. erectus* were supplanted by or evolved into, a highly variable group of hominins that spread into all of Africa and Europe's ecological niches

- Hominin during the Middle Pleistocene (780 - ~130 kya):

- *Homo heidelbergensis:* Considered to be direct ancestor of: *Homo sapiens, Homo neanderthalensis, and Homo denisova*

Muddle in the middle: 780-130 K

- What's the problem?

- The Middle Pleistocene (780-130 K) is often referred to as the 'muddle in the middle' — an apt description given the great debate over which hominin species should be recognized and the attribution of fossils to those species.

- The status of *Homo heidelbergensis* as a distinct type of hominin is controversial

- Very little well-dated evidence from period between 500 and 300 kya

Current Biology 24, : L. Buck & C. Stringer

First Europeans: Spain & Britain

- First Europeans (pre 600 k) in Spain & Britain:
  - Seem to represent an isolated migration from Africa or possibly Asia
  - Either reached a dead end or retreated back out of Europe when climate deteriorated
  - Probably not ancestral to Neandertals

- Circa 650 kya, Europe underwent 40 k of sustained glaciation; probably ended the above earliest migration

Papagianni & Morse, 2015

The Invasion of Europe: Spain

- Sima del Elefante, Atapuerca, Spain: Oldest securely dated site in Europe
  - 1.2-1.1 mya at level of fossil (mandible & a tooth); assigned in 1997 to *Homo antecessor*
  - Primitive pebble & flake stone tools; Oldowan
  - Animal bones with cut marks
  - Similar to Asian H. erectus; may not have survived Europe's 1st glaciation

Carbonell, et al., 2008

Uncooked food at 1.2 mya at Sima del Elefante

- Studying dental plaque from a 1.2 million year old hominin, recovered in 2007 in Sima del Elefante; extracted microfossils to find the earliest direct evidence of food eaten by early humans.
- These microfossils included traces of raw animal tissue, uncooked starch granules indicating consumption of grasses, pollen grains from a species of pine, insect fragments and a possible fragment of a toothpick.
- All detected fibers were uncharred, and there was also no evidence showing inhalation of microcharcoal - normally a clear indicator of proximity to fire.
- However, the lack of evidence for fire at Sima del Elefante suggests that this knowledge was not carried with the earliest humans when they left Africa. The earliest definitive evidence in Europe for use of fire is 800,000 years ago at the Spanish site of Cueva Negra, and at Gesher Benot Ya'aqov, Israel, a short time later..

Karen Hardy, et al., 2016

Homo heidelbergensis

- Heidelbergensis originated about 800,000, and continued until about 200,000 years ago.

- It ranged over Eastern and South Africa, Europe and Western Asia.

- Between 350,000 and 400,000 years ago:
  - the African branch is thought to have started evolving towards modern humans
  - and the Eurasian branch towards Neanderthals.

H. antecessor: .9 M, 1000CC, Oldowan tools

- Atapuerca, Gran Dolina, Spain
- *H. antecessor* is one of the earliest known human species in Europe
- In 1994 and 1995, 80 fossils of six individuals were found in Atapuerca, Spain
- At the site were numerous examples of cuts where the flesh had been flensed from the bones, which indicates that *H. antecessor* may have practiced cannibalism
- Homo antecessor male would have stood approximately 1.6-1.8 meters tall, weighing around 90 kg. Their brain sizes were roughly 1,000-1,150 cm^3
- Stone tools at both sites were simple Oldowan technology

Homo antecessor

- 1994: Gran Dolina, Atapuerca, Spain: 800-960 kya: 2nd oldest site in Europe
  - 200 Oldowan stone tools
  - 7 hominins (100 fragments), ages 3 to 20: share many physical similarities with Homo erectus
    - May represent link between H. erectus and H. heidelbergensis; height 162-186 cm
    - Often given the name Homo antecessor; modern looking midfacial area
    - Spanish researchers think common ancestor of MH and N

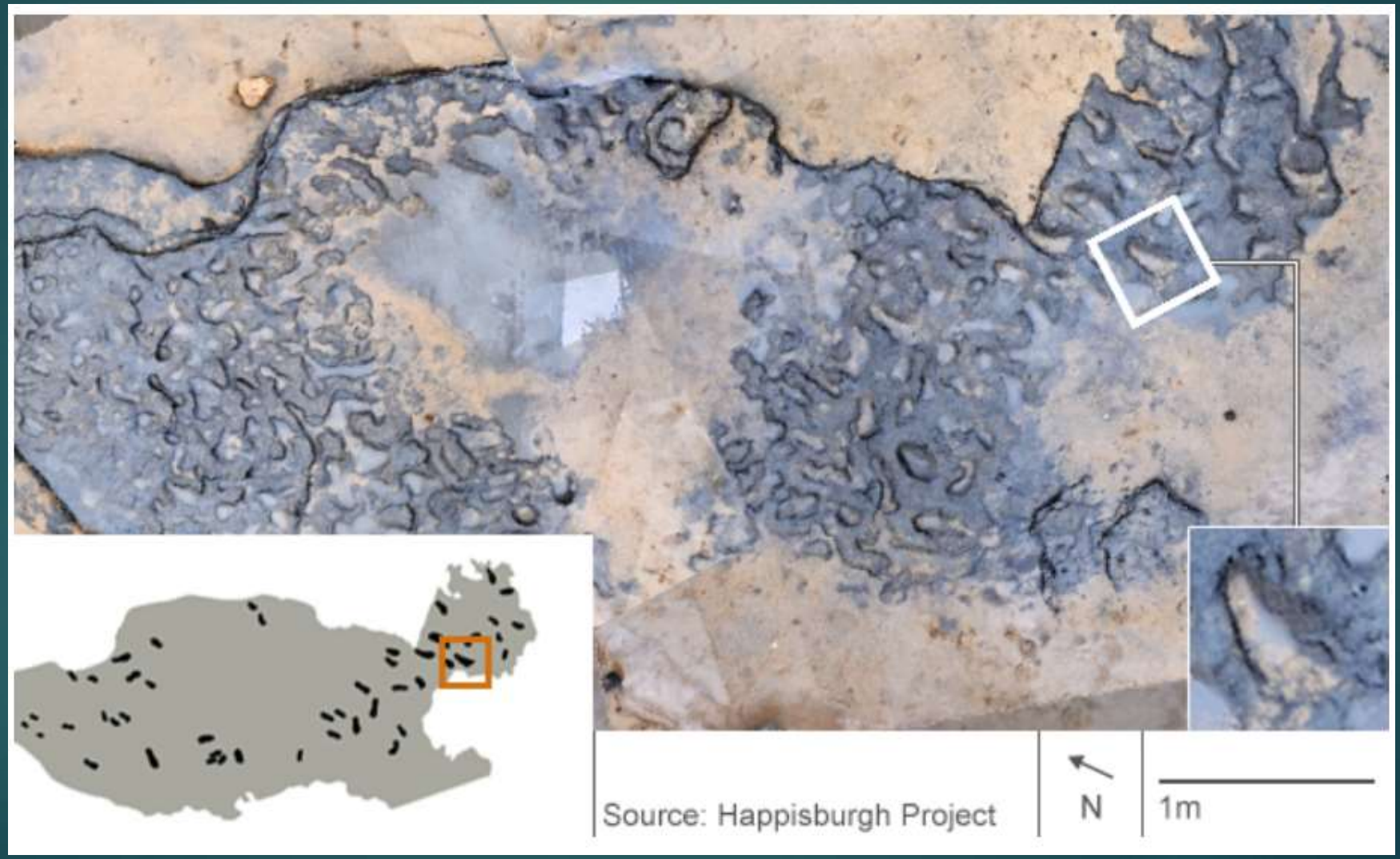
- All hominin remains exhibit evidence of butchering (cutmarks, dismembering, skinning, defleshing); hominin fossils mixed in with food debris; Oldest evidence of human cannibalism
- At El Sidrón, Spain: 12 Ns showing signs of cannibalism; Also at Vindija Cave, Croatia

Homo antecessor

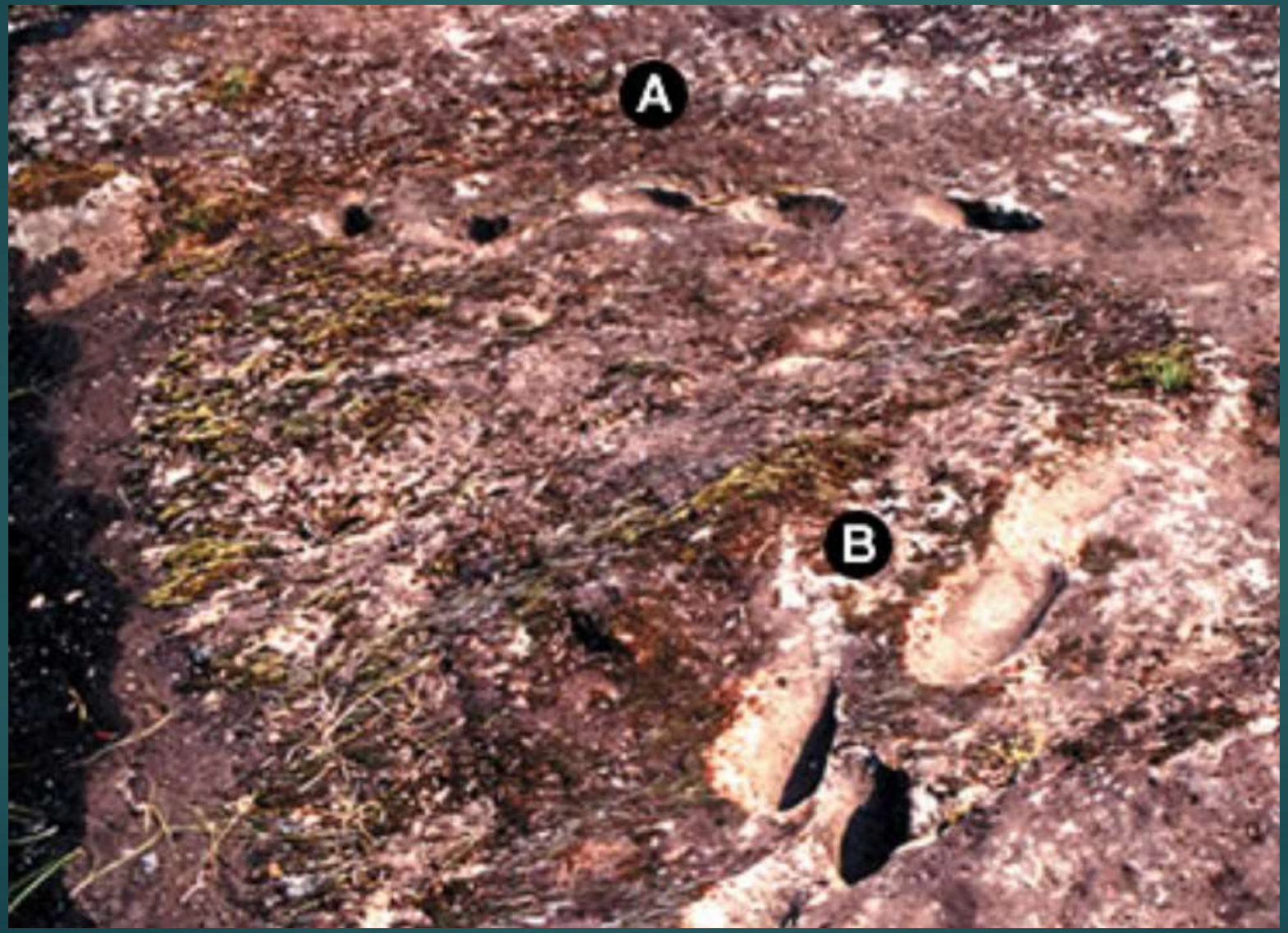
Happisburgh Footprints: 800K, earliest footprints outside Africa

- Shores of Happisburgh, Norfolk, England
- Homo antecessor

Happisburgh Footprints: now washed away

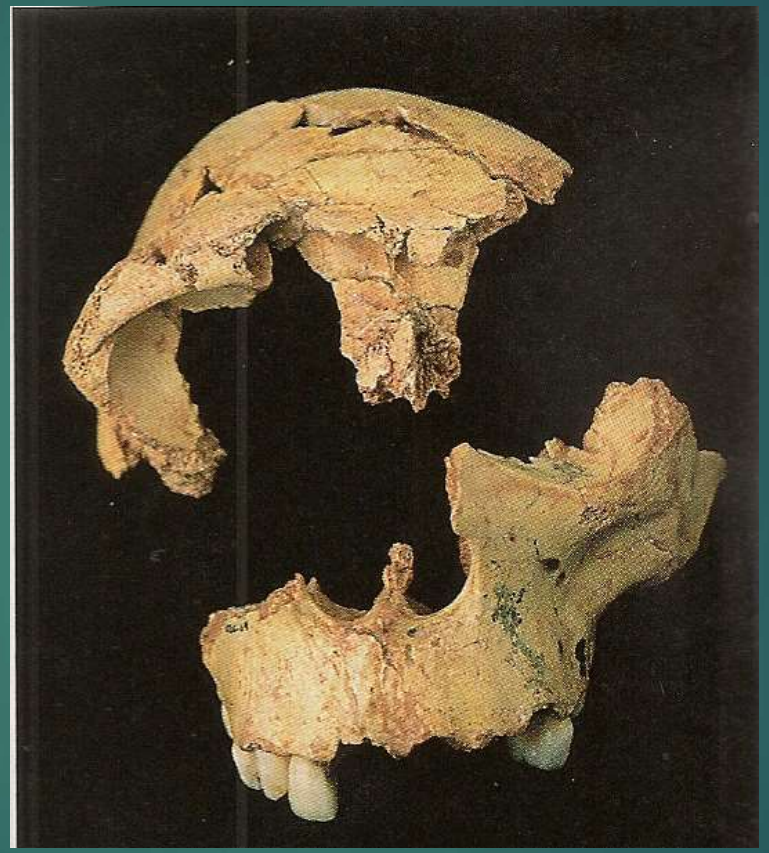


325-385K footprints on 3 tracks, Roccamonfina volcano in southern Italy, 20 cm long and 10 cm wide



Eudald Carbonell & Juan Luis Arsuaga: *Homo antecessor/heidelbergensis*

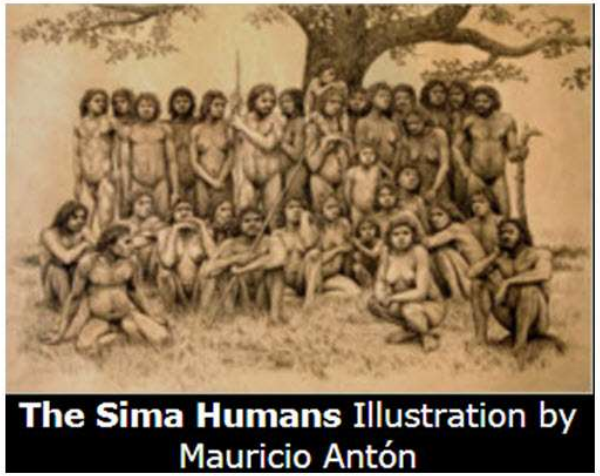
Homo heidelbergensis
(Atapuerca 4; 1390 cc)
Discoverer: Juan-Luis Arsuaga
Locality: Sima del los Huesos, Atapuerca, Spain
Age: 350-500K
Date 1992-1993



1994: *Homo antecessor*

1992: Sima de los Huesos (Pit of the Bones)

Sima de los Huesos, Atapuerca, Spain



Sima de los Huesos
Homo heidelbergensis hominins, 400K

Human fossils, Sima de los Huesos
E436/0172 Rights Managed

- 1992, Juan Arsuaga: Excavated La Sima de los Huesos; remains of 28 bodies have been dug up, the world's greatest single haul of ancient *Homo* fossils; dated 600K, Homo heidelbergensis
- Chris Springer believes the Sima de los Huesos site is filled with Neanderthal remains that are no more than 400,000 years old.
- Homo heidelbergensis?

La Sima de los Huesos (The Pit of Bones)

- 400 kya
- 28 individuals

- Bodybuilder physiques
  - Pronounced muscle markings
  - Thick layers of hard bone around central marrow cavities
- Not a living site
  - Burial? / Washed in?

“One handaxe does not a ritual make.” - crsmith

600 to 250 kya in Eurasia: Defeating the cold

- After end of 1st major glaciation, circa 600 kya, new kind of hominin appears in Europe and Africa bearing Acheulean axes and wooden spears
- Hunters and gatherers
- More extensive occupation of Europe
- Maintained presence through multiple glaciations
- This was *Homo heidelbergensis;* for whom evidence is far richer in Europe than in Africa
- Represents a migration out of Africa or Asia
- Ancestor of Eurasian *Homo neanderthalensis* and African *Homo sapiens*

First Britons: Homo heidelbergensis in England

- Evidence of human occupation of Europe in at least 13 European locations at 500K
- Land bridge between Europe & England
- 1985: Boxgrove, England: 500 kya layer; best preserved butchery site of this period; elephants & rhinos
- 300 early flint Acheulean handaxes

- 1994: Single Long, very robust tibia (lower leg bone): 362-423 kya;
- Implies height of 5’10” to 6’3” & wgt of 200 lbs;

Homo heidelbergensis

Location: Africa (Broken Hill/Kabwe, Bodo, Omo), Europe (Arago, Atapuerca – Sima de los Huesos, Petralona, Schoeningen, Steinheim, Swanscombe), Asia (Dali)

Date range: 800 kya – 130 kya

Average Cranial Capacity: ~ 950-1390 cc

Tool use: Oldowan (in Asia), Acheulean, Mousterian (later in Europe).

- First definite controlled use of fire

- Definite evidence for hunting

- Evidence for semi-permanent shelters

- Reliance on culture – continued increasing brain size (highly variable)

- Co-existed with *H. erectus*

Size and Tools

- **Height:** Males: average 5 ft 9 in (175 cm); Females: average 5 ft 2 in (157 cm)
- **Weight:** Males: average 136 lbs (62 kg); Females: average 112 lbs (51 kg)

- Tools: used Acheulean handaxes

- Right handed

Smithsonian: Human Origins

Europe

- *Heidelbergensis sites are found in Africa, Europe, and Asia*.
- The term, *heidelbergensis*, covers a diverse group of skulls that have features of both *Homo erectus* and modern humans.
- Hominins first appear in Europe circa 1 mya (Homo erectus, or Homo Antecessor, or Homo heidelbergensis – from Africa or Asia?)
- First glaciation circa 650 kya in Europe, with more arid Africa
- Incipient Neandertal traits by 500 kya -- local evolution or new arrival?
- Neandertals take on distinctive form by 250 kya, as well as develop Mousterian tools (which appears simultaneously in Europe, Western Asia, & Southern Africa)
- Warming period circa 130 mya, allowed both N and MH to move into Western Asia; shortly after 130 mya, both reach Near East

H. heidelbergensis: Morphology

- In Africa, circa 600 kya, see evidence (Bodo, Ethiopia; Kabwe, Zambia) of hominins
  - Skull is more rounded than in *H. erectus*: its face is large, and its nose is broad; braincase is higher and more filled out, especially at the sides, which is indicative of a larger average brain size—closer to modern humans than to *H. erectus*.
  - Lack the characteristically horizontal and thick brow ridges seen in *H. erectus; flatter face*
  - Cranial capacity = 1200 cc (vs 800 to 1000 cc for *H. ergaster & erectus*)
  - Further reduction of size of jaws and molars
  - Thicker & stronger limb bones; joint surfaces are larger than modern humans

Fire & shelter

- It was first early human species to live in colder climates, their short, wide bodies were a likely adaptation for conserving heat.

- Fire: There is evidence that *H. heidelbergensis* was capable of controlling fire by building hearths, or early fireplaces; earliest evidence of controlled use of fire ~ 790 kya in the form of fire-altered tools and burnt wood at the site of Gesher Benot Ya-aqov in Israel. Social groups probably often gathered around their hearths sharing food, stay warm, and ward off predators. Naama Goren-Inbar, et al., 2004

- Shelter: *H. heidelbergensis* probably took advantage of natural shelters but this species was also the first to build simple shelters. Evidence for this comes from hearths found at the German site of Bilzinsleben, and the French sites of Terra Amata and Lazaret. The hearth, on which fire had been maintained, was preserved; broken animal bones, charcoal, and worked stones were found in shelters.

790 kya: Fire altered stone tools

Burned flint from the 790,000 year old site of Gesher Benot Ya'aquov, Israel.
Image Credit: Chip Clark, Smithsonian Institution

Gathering at the hearth
During this time period, early humans gathered around campfires that they made and controlled -- perhaps to socialize, to find comfort and warmth, to share food and information, and to find safety from predators. Scientists found this debris from stone toolmaking that had been scorched by fire at the site of Gesher Benot-Ya'aqov, Israel. Close by were concentrations of burned seeds and wood, marking the location of early hearths.

Date of discovery: 2004
Discovered by: A team led by Naama Goren-Inbar
Species:
Site: Gesher Benot-Ya'aqov, Israel

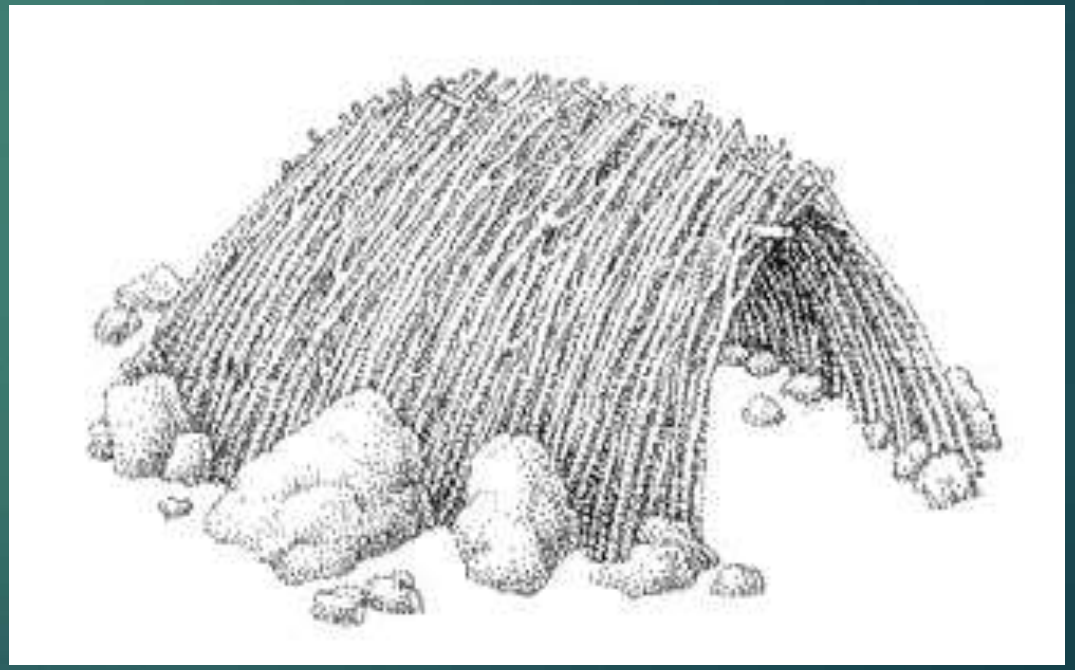
Naama Goren-Inbar, et al., 2004

Controlled Fire and Built Shelters

- Hearths found at the German site of Bilzinsleben, and the French sites of Terra Amata and Lazaret
- Terra Amata and Lazaret-evidence of possible huts in the form of post molds
- Lazaret-internal pattern of remains that also suggests an enclosure (controversial- not as coherent as some have suggested)
- Chichibu, Japan hut circa 500 kya
- This suggests that the technology of Homo heidelbergensis extended beyond stone tools to include materials and knowledge in order to deal with the cold in these higher latitude areas.

Middle Pleistocene Culture: Dwellings

- Definitive dwellings with fire show for the first time by 400 kya
- Terra Amata and Mezin



Shelter: Terra Amata, 400 K

Reconstruction illustration of 400,000-year-old shelter from Terra Amata, France
Image Credit: Courtesy of Karen Carr Studio

Date of discovery: 1966
Discovered by: Henri de Lumley
Species:
Site: Terra Amata, France

- This ancient shelter, reconstructed here, provided protection for an early human family or social group. Scientists found post holes and other evidence of multiple shelters at this site. Some shelters were as long as 14.9 m (49 ft)
- Also found ocher

Hunting & spears

- Hunting:
  - *H. heidelbergensis* was also the first hunter of large game animals;
  - remains of animals such as wild deer, horses, elephants, hippos, and rhinos with butchery marks on their bones have been found together at sites with *H. heidelbergensis* fossils.

Clacton, England, spear point; 300-450K

Direct evidence of wooden implements also comes from the time of *H. heidelbergensis*: in England at the site of Clacton, a preserved 300,000 kya wooden spear point made from yew. Oldest wooden artifact ever found in Britain. Fire hardened. Estimates of its age range from 300-450 kya.

15 x 1 ½ inches

Oldest Wooden Spears: Schöningen, Germany; 400K

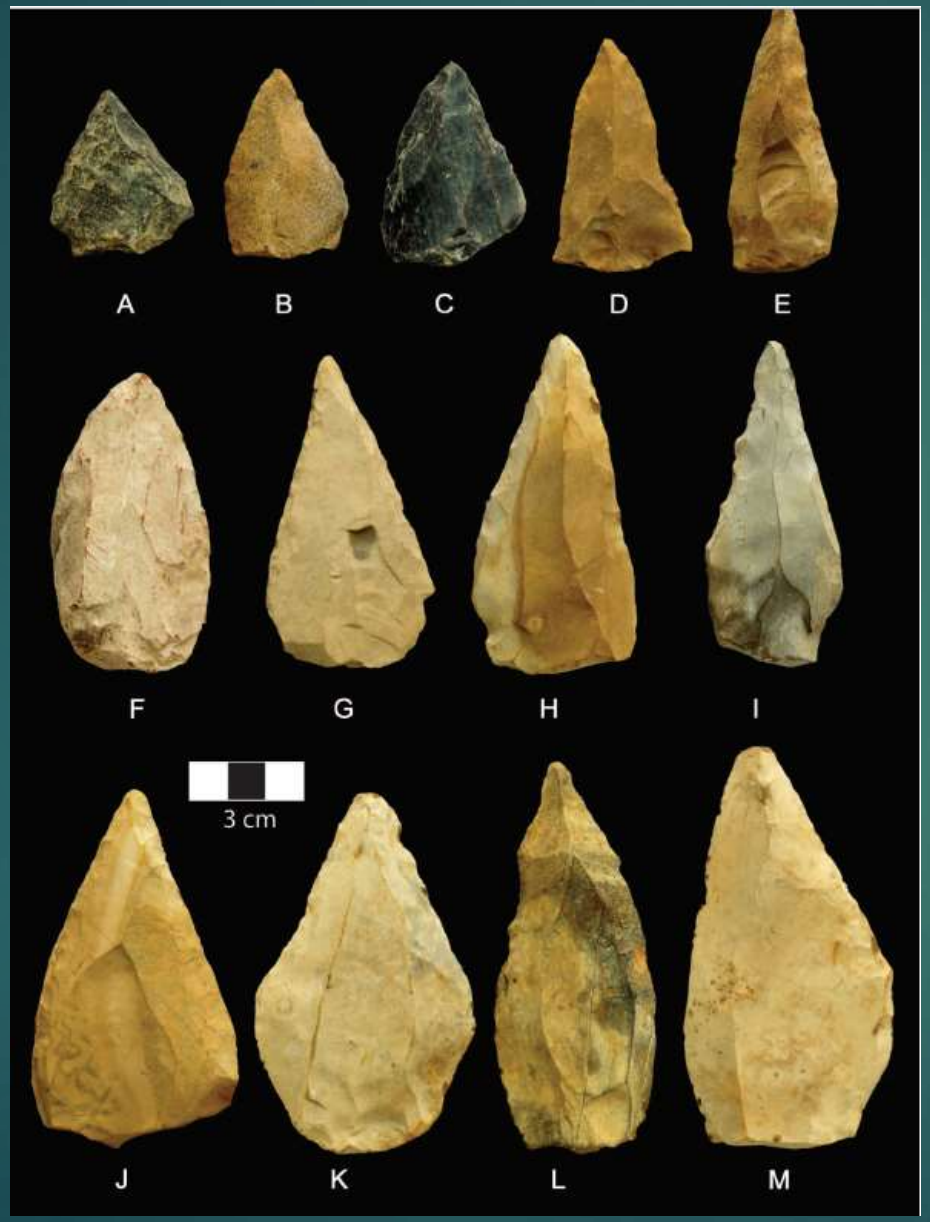
Wooden thrusting spear, Schöningen, Germany, about 400,000 years old.

- Three wooden spears like this one were found at Schöningen, Germany, along with stone tools and the butchered remains of more than 10 horses. These spears are currently the oldest known wooden artifacts in the world.
- Along with some still embedded in horses.
- Schöningen spears had ballistic qualities indicating that they were thrown as javelins.
- The humerus and shoulder morphology associated with overarm throwing were already present in *Homo erectus*.

Wooden thrusting spear, Schöningen, Germany, about 400,000 years old.
Image Credit: Chip Clark, Smithsonian Institution

Date of discovery: 1995
Discovered by: Hartmut Thieme
Site: Schöningen, Germany

Kathu Pan 1, South Africa: ~500 kya stone points functioned as spear tips.



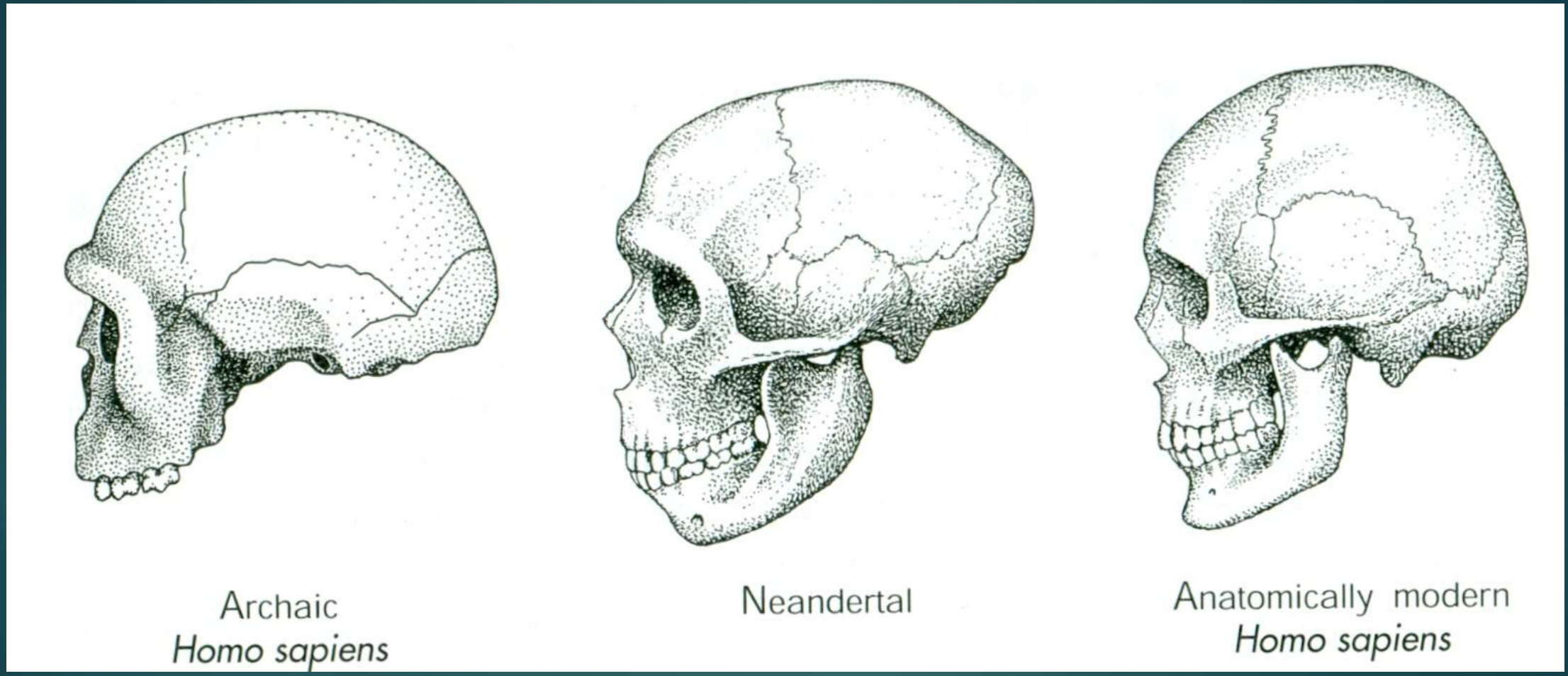
- Evidence for Early Hafted Hunting Technology:
- Multiple lines of evidence indicate that ~500,000-year-old stone points from the archaeological site of Kathu Pan 1 (KP1), South Africa, functioned as spear tips.

Homo heidelbergensis: Tools

- Tools: Oldowan (in Asia), Acheulean, Mousterian (later in Europe).

- About 200 kya, a new stone-working technology appeared that was associated with *H. heidelbergensis*, the Levallois technique.

- This new method provided long cutting edges along sides of flake and greater control over shape of tool. This technology laid the groundwork for later technological advances in tool-making.



Homo heidelbergensis

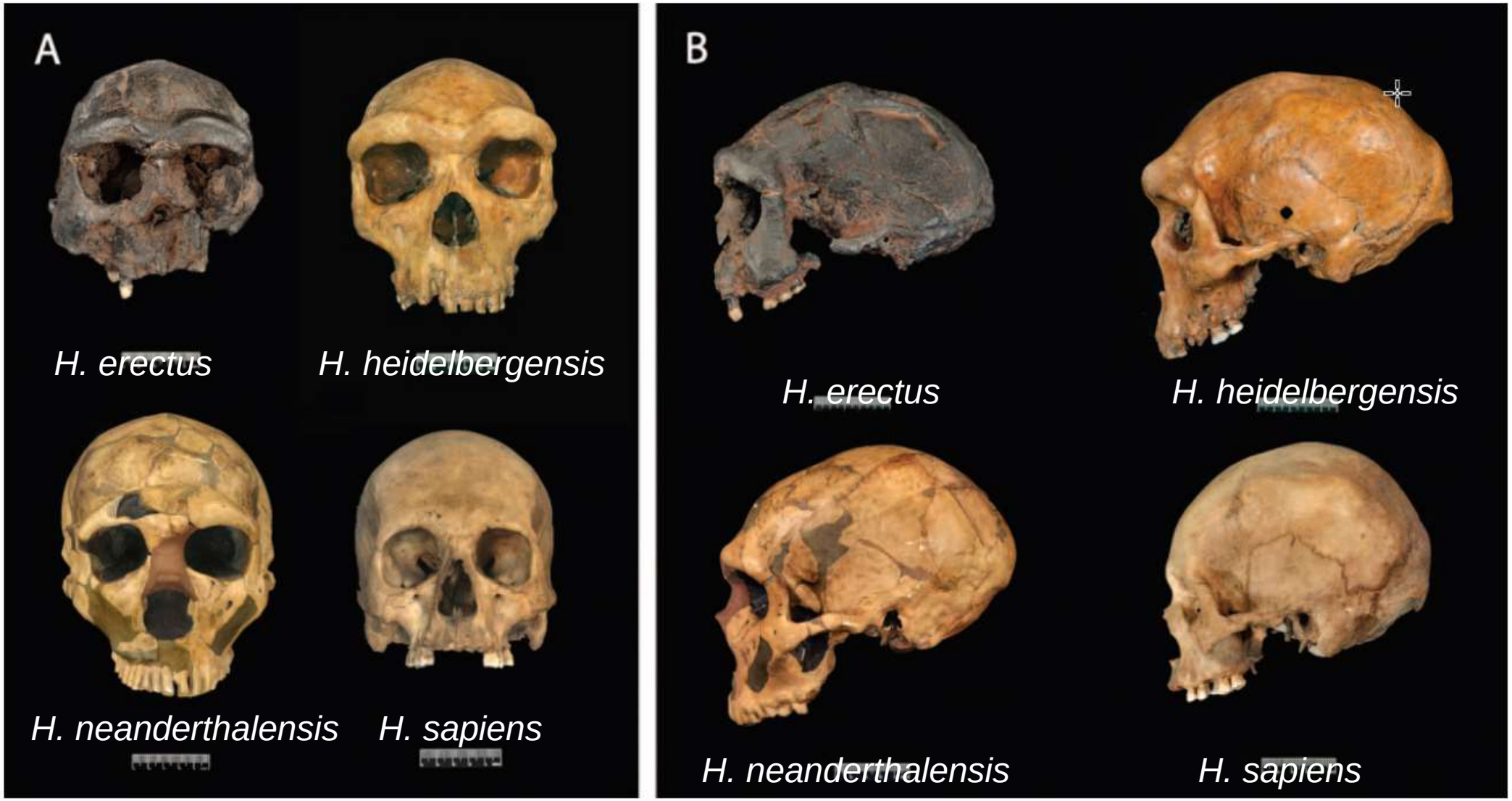
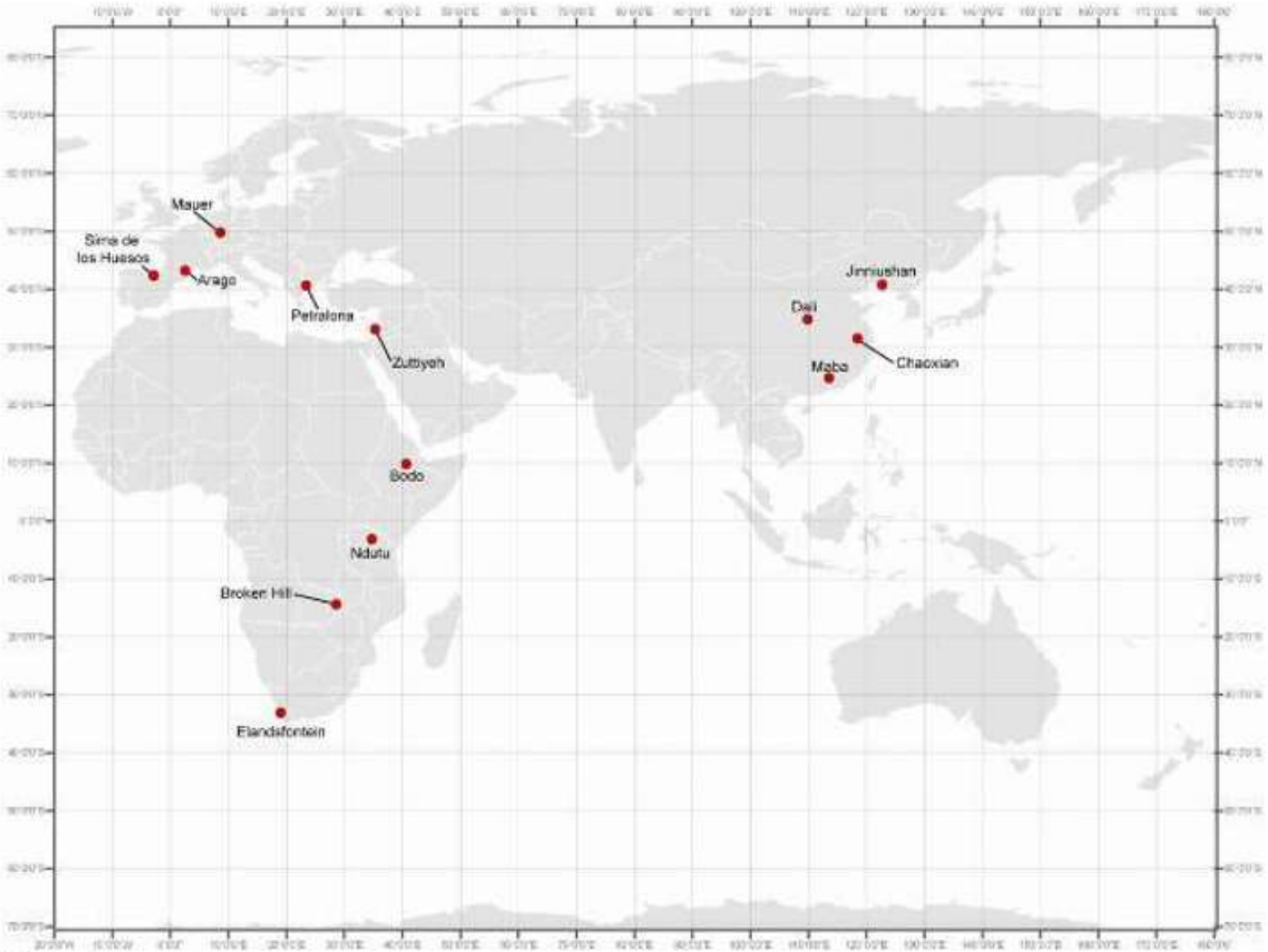


Figure 2. Facial (A) and lateral (B) views of crania. Clockwise from top left: *Homo erectus* (replica, Sangiran, Java), *heidelbergensis* (Broken Hill, Zambia), *sapiens* (recent, Indonesia), and *neanderthalensis* (replica, La Ferrassie, France). All pictures © The Natural Histroy Museum London. (Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.)



Locations of important *homo heidelbergensis* localities across the Old World.

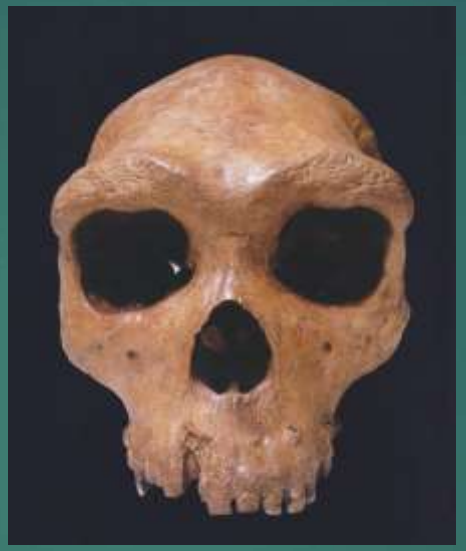
Body Types

- European *heidelbergensis:*
  - large and muscular, like boxers or football players; cold adapted
  - Specialized ambush hunters, using wooden spears in close combat vs. sizeable prey in river valleys

- African *heidelbergensis*:
  - tall and slenderer; heat adapted
  - Threw spears; run down overheated prey over long distances; endurance pursuit running in hot landscape

1921: *Homo heidelbergensis*, Broken Hill, Kabwe, Zambia, 300K

- The first hominid fossil discovered outside Europe



10 cavities, left ear wound

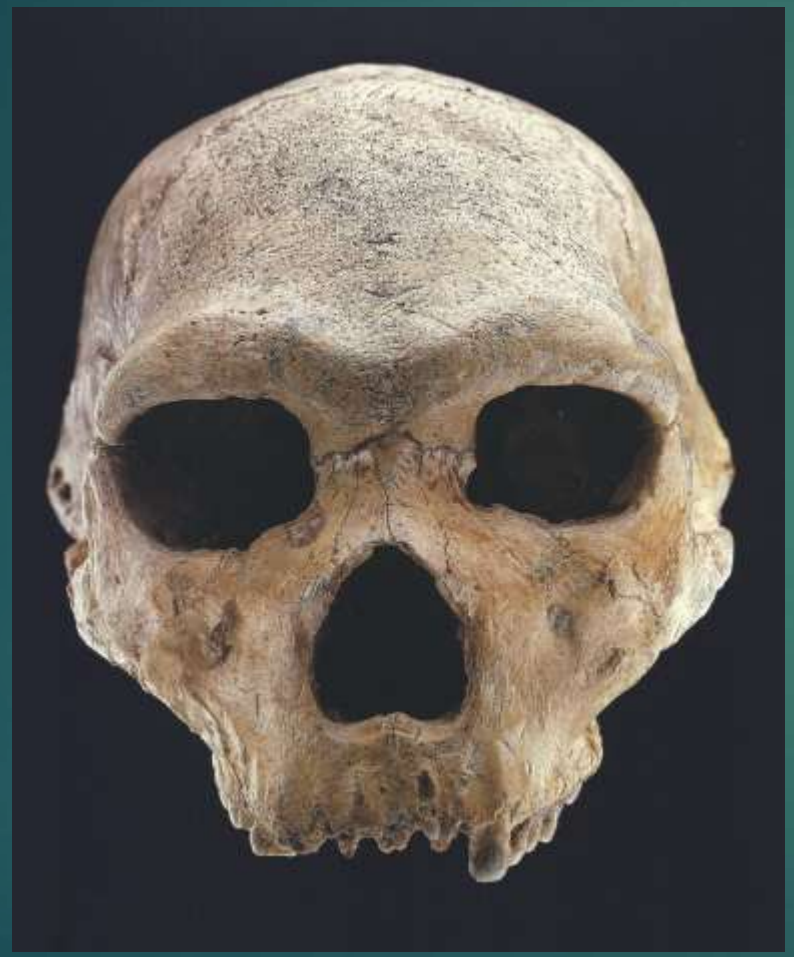
Homo heidelbergensis
(Broken Hill 1)
Discoverer: Tom Zwigelaar
Locality: Kabwe, Zambia
Date 1921
Age: 300K

Tom Zwiglaar

1933: *Homo heidelbergensis*, Steinheim skull, 250K

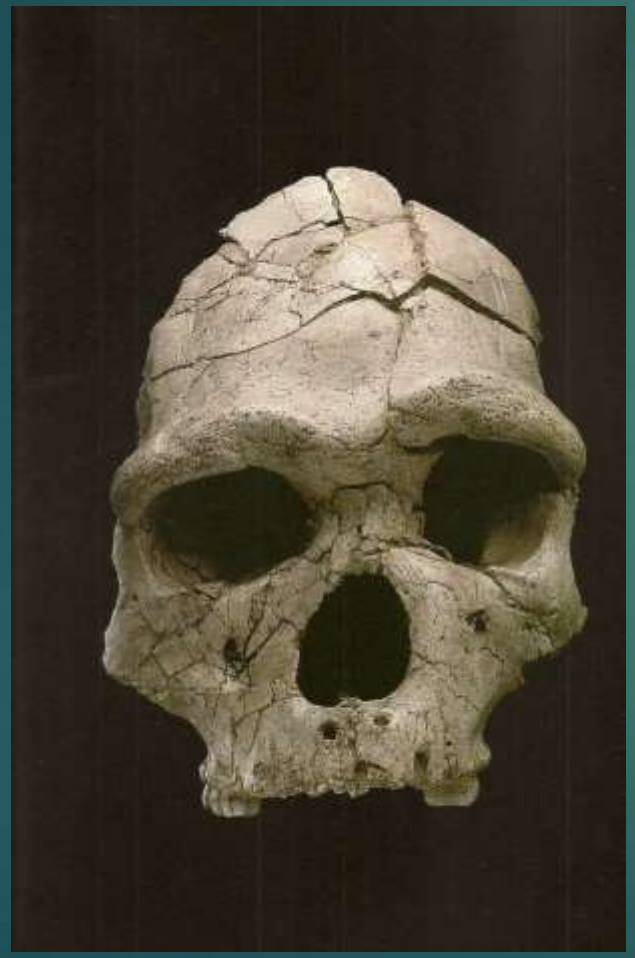
Homo heidelbergensis
(Steinheim)
Discoverer: Karl Sigrist, Jr.
Date: 1933
Locality: Sigrist gravel pit, Steinheim Germany
Age: 250 K

1960: *Homo heidelbergensis*: Petralona skull, 400K

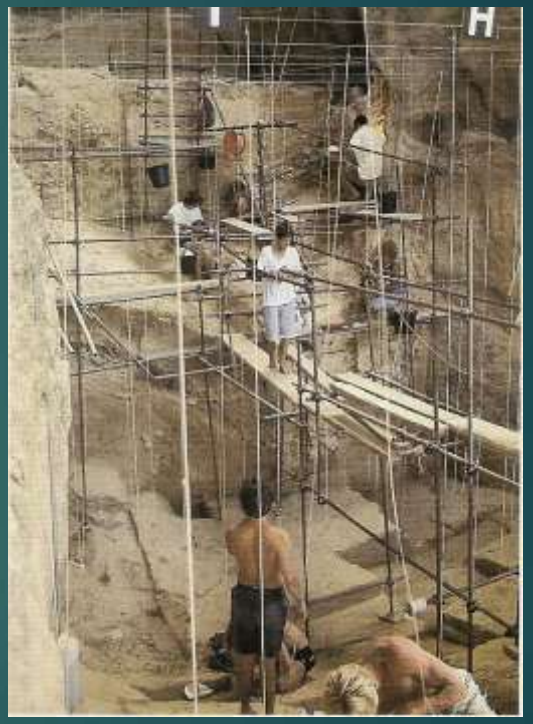


Homo heidelbergensis
(Petralona 1)
Discoverers: J. Malkotsis, J. Stathis, B. Avaramis, C. Sarijanides, & C. St. Hantzarides
Date: 1960
Locality: Katsika Hill, Petralona, Greece
Age 400 K

1964: *Homo heidelbergensis*, Arago 21, 400K



Homo heidelbergensis
(Arago 21)
Discoverer: Henry de Lumley
Date: 1971
Locality: Caune de l'Arago
Tautavel, France
Age 400 K



Arago cave, near
Tautavel, France

1976, *Homo heidelbergensis*, Bodo, *600K*

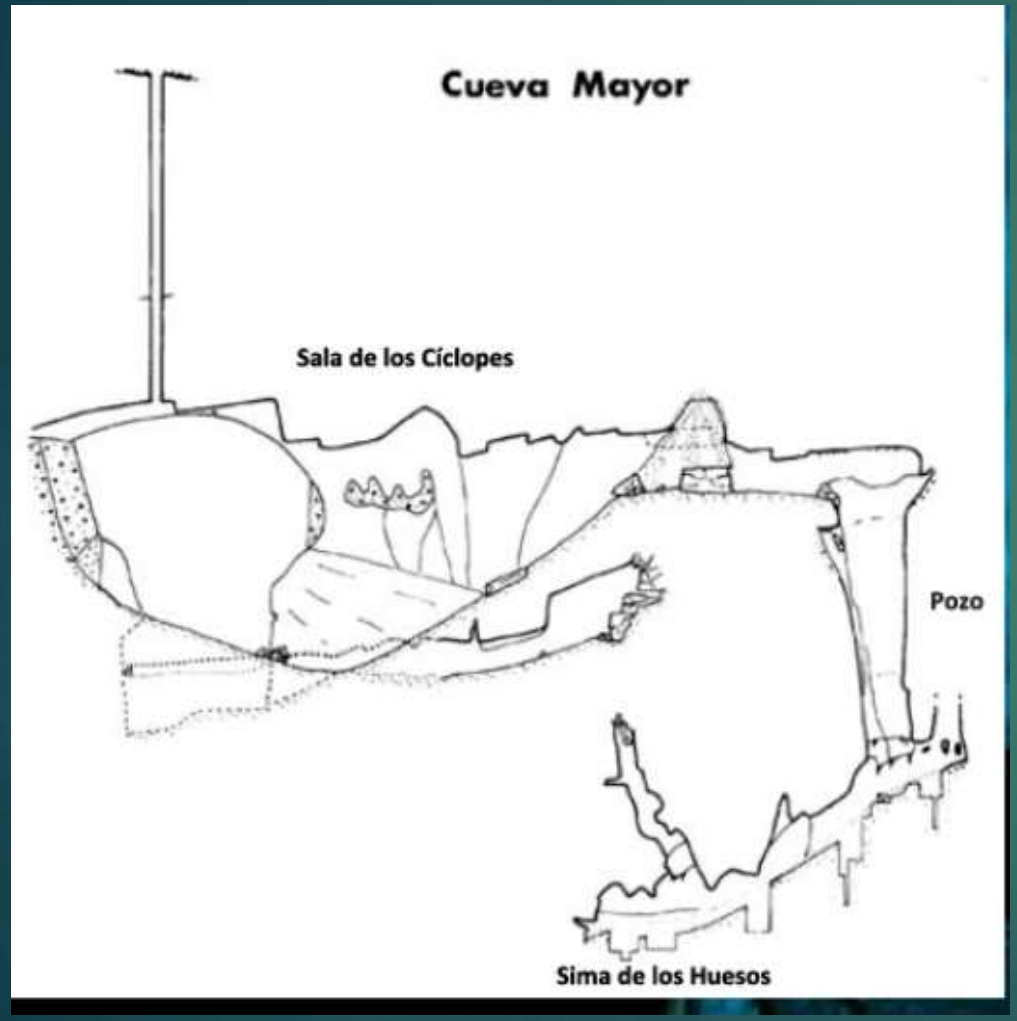
Photograph by Donald Johanson.

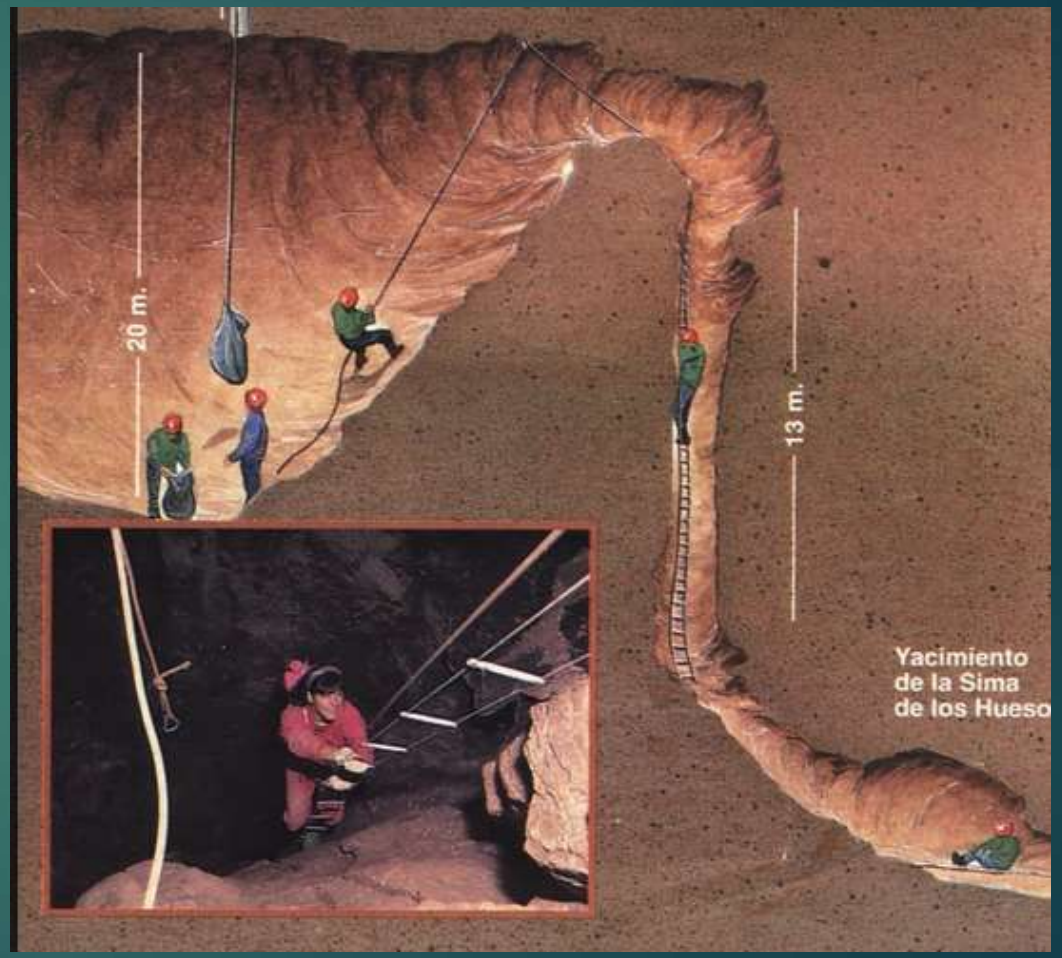
Photograph by Donald Johanson.

- Homo heidelbergensis
- 1976
- Discoverers: Alemayhew Asfaw, Paul Whitehead, and Craig Wood
- Date: c 600K

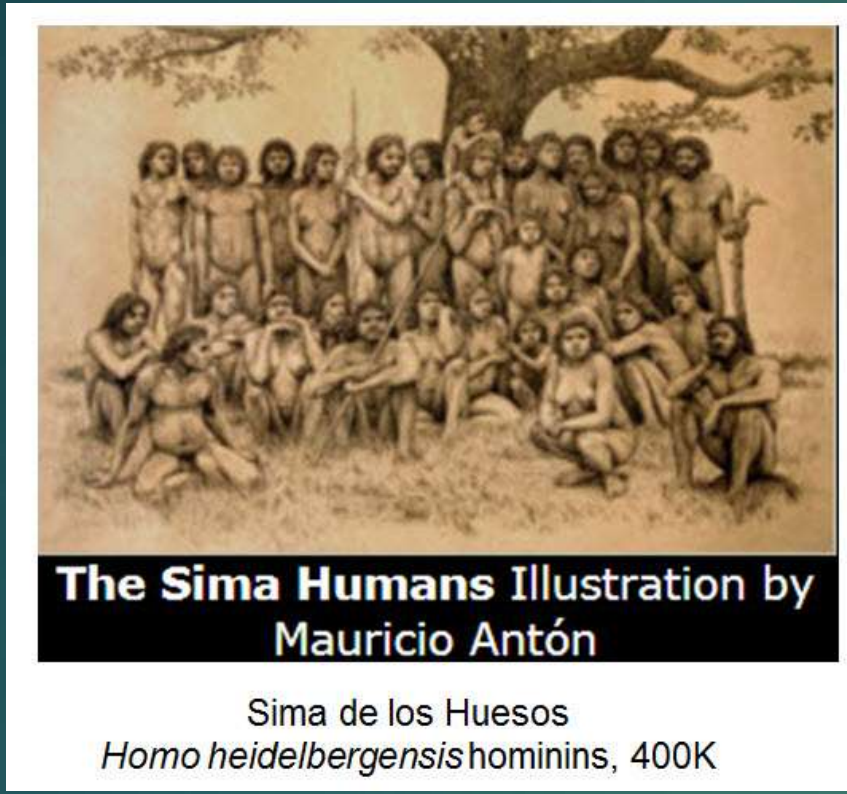
Europe

Sima de los Huesos (Pit of the bones), Atapuerca, Spain





1992: Sima de los Huesos, Atapuerca, Spain: Example of the difficulties of paleoanthropology



Sima de los Huesos
Homo heidelbergensis hominins, 400K

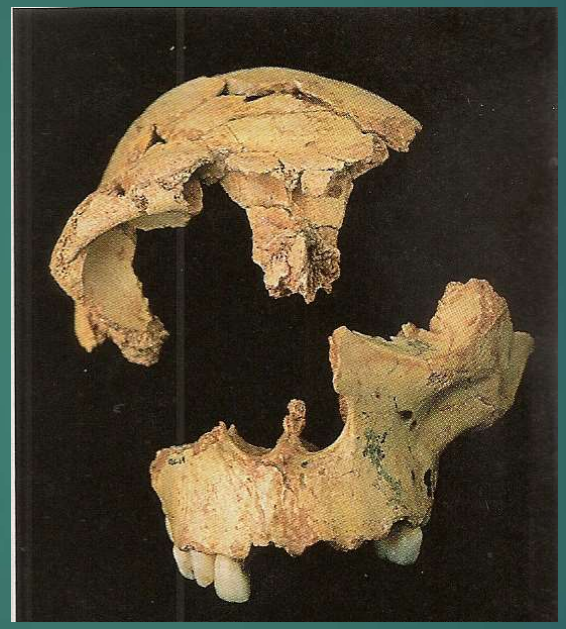
6500 fossil bones

Excavated La Sima de los Huesos;
remains of 28 bodies
World's greatest single collection of ancient *Homo* fossils;
dated 430K, Homo heidelbergensis?

Arsuaga, et al., 1991-1997

Spain: *H. Heidelbergensis & Homo antecessor, 350-500K*

Homo heidelbergensis
(Atapuerca 4; 1390 cc)
Discoverer: Juan-Luis Arsuaga
Locality: Sima del los Huesos, Atapuerca, Spain
Age: 350-500K
Date 1992-1993



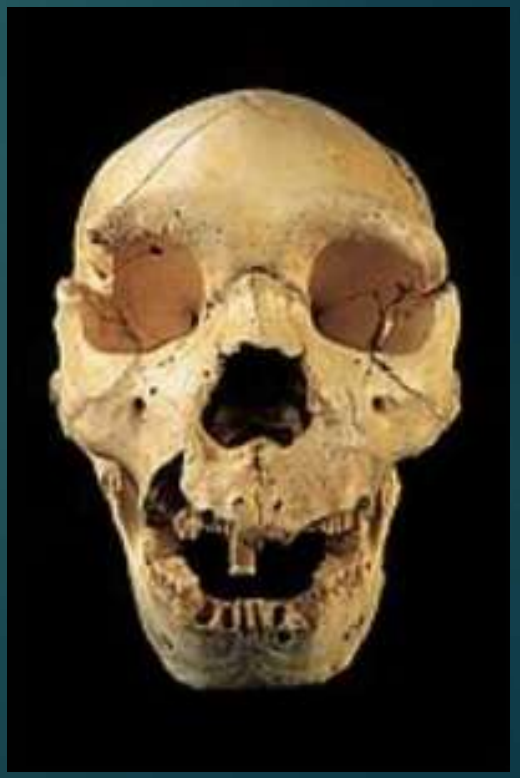
1994: *Homo antecessor*

La Sima de los Huesos (The Pit of Bones)

- 400 to 600 kya; incipient N features
- 28 individuals: richest collection of hominin fossils in the world
- 13 crania (adult; only 3 over age 30; no very young or old), 1 fragmentary cranium (immature), 450 teeth, 5 mandible fragments, postcranial remains, 2 human-like hyoid bones
- Grooving on posterior teeth imply use of toothpicks and/or use of teeth for sinew processing
- Fossil animal bones of 100s of cave bears & other predators (lions, wolves, foxes) ; lack of herbivore bones & paucity of stone tools (only 1 reddish quartz handaxe ("Excalibur") implies it was neither a living site nor product of carnivore activity. Postmortem mortuary practices? / Washed in?
- "One handaxe does not a ritual make." - crsmith

Sima de los Huesos

- Right handed (stronger right arm bones; right frontal lobe petalia and a left occipital lobe petalias)
- Bodybuilder physiques: Pronounced muscle markings thick leg bones; Thick layers of hard bone around central marrow cavities; 95 kg (209 lbs); modern sexual dimorphism
- Cranial capacity ranged from 1390cc (Cranium 4) to 1125 (Cranium 5); skull long with low foreheads, large brow ridges & jaws; no chin'
- Skull 5: senior (>50), dental problems, smaller brain; probably needed social help; it is best preserved fossil hominin



Atapuerca, Cranium 5

Cranium 5 is one of the most important discoveries in the Sima de los Huesos, Atapuerca (Spain). The mandible of this cranium appeared, nearly intact, some years after its find, close to the same location.

SH5: Some primitive features, but mainly derived Neandertal features of face

Atapureca & La Sima de los Huesos

Arsuaga: *Homo heidelbergensis*
Stringer: neanderthalensis

Sima de los Huesos (‘Pit of the bones’), which is where most of the fossils with claimed Neanderthal affinities come from.

The complexity of fossils

- The more than 6000 fossils from that site show distinctive Neanderthal features, but have often been included in the H. Heidelbergensis taxon because of their supposed great age (up to 600 ka).
- Further research has now suggested that the material looks too Neanderthal and is too young (~400 ka) to represent H. Heidelbergensis, making these fossils early Neanderthals instead.
- In 2013 findings showed that their maternally inherited mitochondrial DNA (mtDNA) was distantly related to Denisovans
- In 2016, new nuclear DNA results show that the SH hominins carry mtDNAs more closely related to those of Denisovans in Asia than Neanderthals, even though their nuclear genomes show that they are more closely related to Neanderthals.
- It also indicates that the population divergence between Neanderthals and Denisovans predates 430,000 years ago (550 to 750 K)

Matthias Meyer *et al*. 2016

Are the Sima de los Huesos Fossils part of *Heidelbergensis*?

- combination of *heidelbergensis*-like and Neanderthal-like features
- Age of >530 kya (600+/-66 kyrs (350-500 also); reinforced the Atapuerca team's preference for assigning the material to *heidelbergensis*
- C. Stringer prefers to regard the SH material as an archaic form of *neanderthalensis*, based on the presence of Neanderthal-like features such as an incipient suprainiac fossa and midfacial projection in the crania, dental and mandibular traits, and numerous postcranial characters
- But divergence of the *neanderthalensis* and *sapiens* lineages very likely postdates 530 ka.

Sima: Neandertal

- Data from the large SH dental sample have long suggested Neanderthal affinities. Mandibles of the Sima sample are virtually identical to the Neandertal mandible

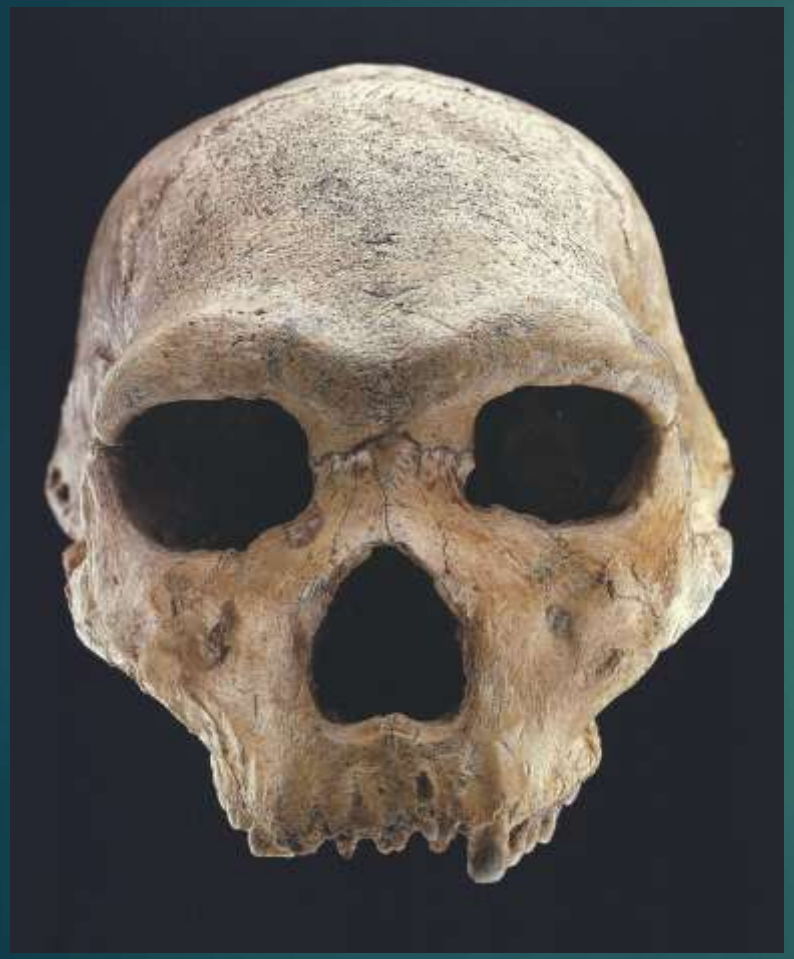
- Recently, even stronger reasons have emerged to place the SH material within the Neanderthal clade rather than within *heidelbergensis*.

- Rak: Sima specimens within the Neandertal clade as a sister group to Neandertals.
- Stringer: Sima de los Huesos material belongs to the Neanderthal clade, and perhaps represents a primitive form of *Homo neanderthalensis*

Bilzingsleben, Germany: 300-414 kya

- In 1927, naturalist Adolf Spengler found and lost a molar at Bilzingsleben, Germany; quarry reopened in 1969 and fossils found in 1974 & 1977
- 25 cranial fragments, 7 molars, 100K artifacts (ivory points, wooden staffs, incised objects)
- 2 occipital fragments, 2 frontal bones, 1 parietal
- Stone, bone, antler tools
- Use of fire: burned flint tools, charcoal traces
- *H. erectus-like*

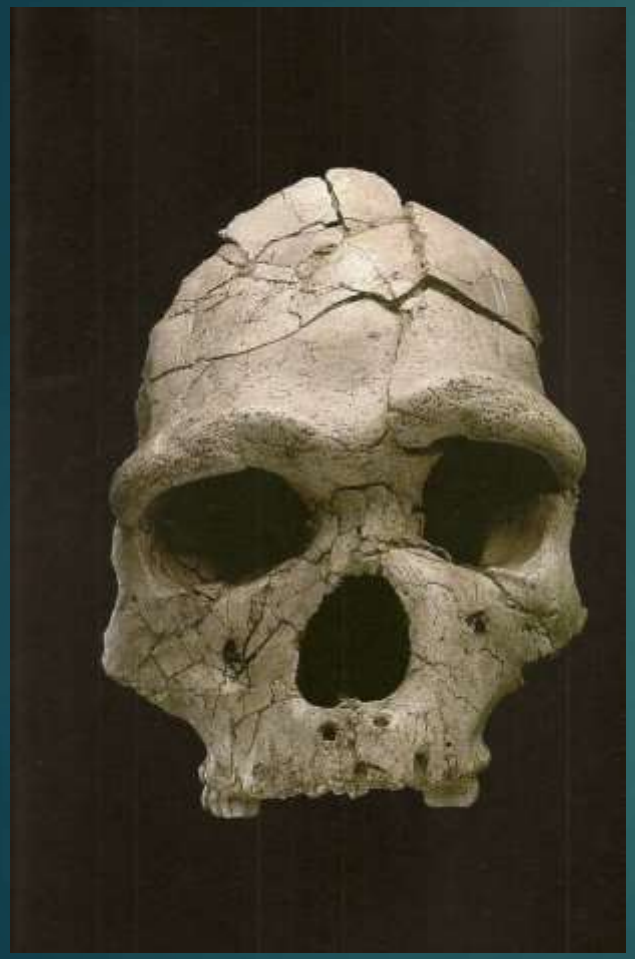
1960: *Homo heidelbergensis*: Petralona skull, 400K

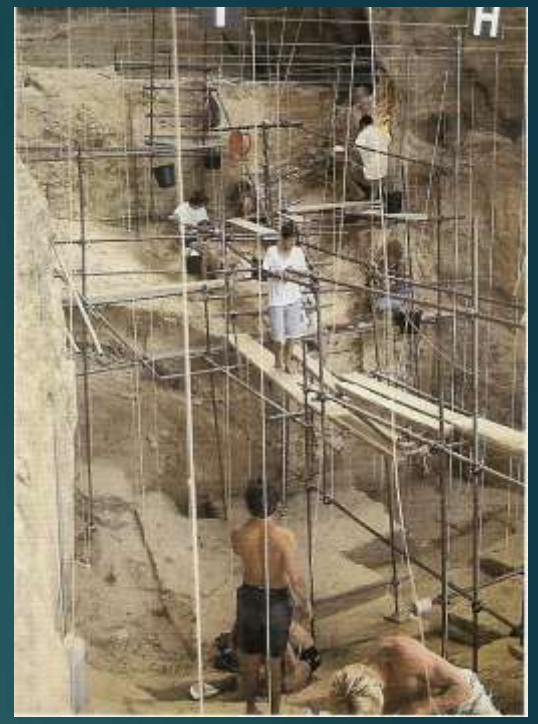


Homo heidelbergensis
(Petralona 1)
Discoverers: J. Malkotsis, J. Stathis, B. Avaramis, C. Sarijanides, & C. St. Hantzarides
Date: 1960
Locality: Katsika Hill, Petralona, Greece
Age 400 K

Notice this older male's worn teeth and huge brow ridges.

1964: *Homo heidelbergensis*, Arago 21, 320-400 K





Arago cave, near Tautavel, France

Homo heidelbergensis
(Arago 21)
Discoverer: Henry de Lumley
Date: 1964
Locality: Caune de l'Arago
Tautavel, France
Age: 320-400 K
Cranial capacity: 1100 cc

The features of this cranium are most similar to much larger specimens of *Homo heidelbergensis*. Its small size suggests that it is a female of this early human species.

Ceprano, 487 K

Site: Ceprano, Italy
Year of Discovery: 1994
Discovered by: Italo Biddittu
Age: Between .8-.9 mya; latest 487 kya
Species: *Homo heidelbergensis*

Low cranial vault, flattened receding forehead; massive shelf-like supraorbital ridges; angle between occipital & nuchal planes; cranium has large breadth relative to length

Difference from H. erectus: shorter cranial vault, thicker cranial bones, more massive & double arched supraorbital torus, larger cranial capacity; widest near temporal squama; no frontal keeling

Cranial capacity: 1185 cc

This skull is among the oldest known fossil human skulls from Europe. Some scientists think it's a unique species, called *Homo cepranensis.*

Composite Digital ancestor of MH & N (based on comparison of 797 elements)

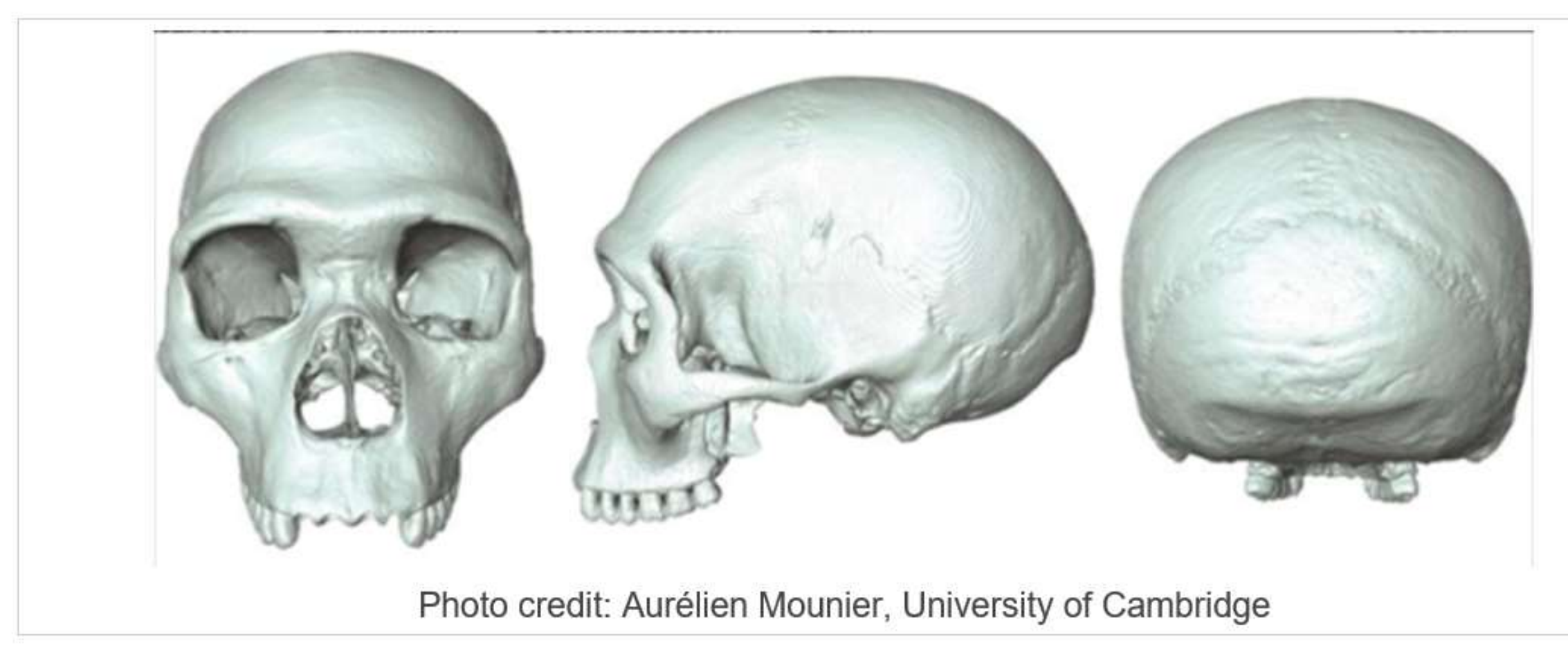


Photo credit: Aurélien Mounier, University of Cambridge

The composite common ancestor skull looks a great deal like the recovered skulls of *Homo heidelbergensis*.

Aurélien Mounier & Marta Mirazón Lahr, 2016

2017: Gruta da Aroeira, Portugal, Cranium 3, 425-390K

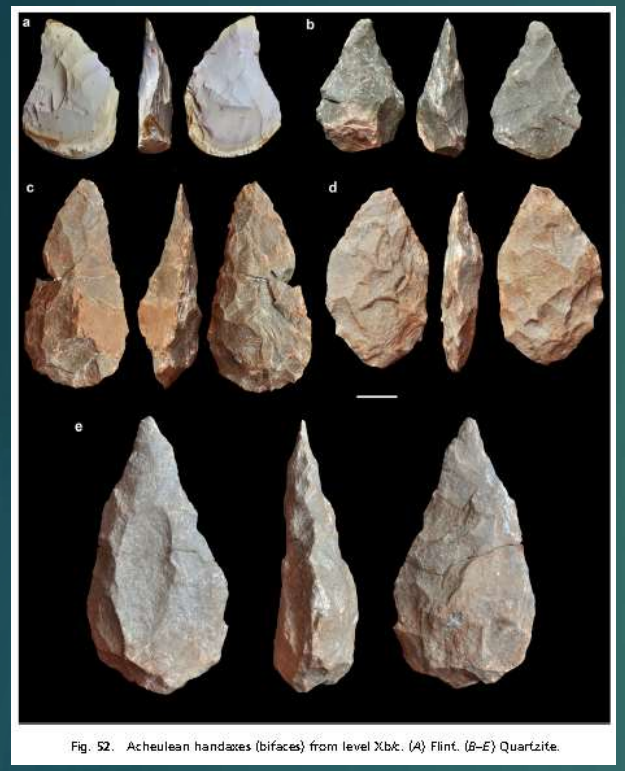


Fig. 52. Acheulean handaxes (bifaces) from level XbA. (A) Flint. (B–E) Quartzite.

Cranium 3 was in direct association with abundant faunal remains and stone tools, & with burnt bones suggests a controlled use of fire. It is the westernmost Middle Pleistocene cranium of Europe and is one of the earliest fossils from this region associated with Acheulean tools. It is reminiscent of the Steinheim specimen

Joan Daura, et al., 2017

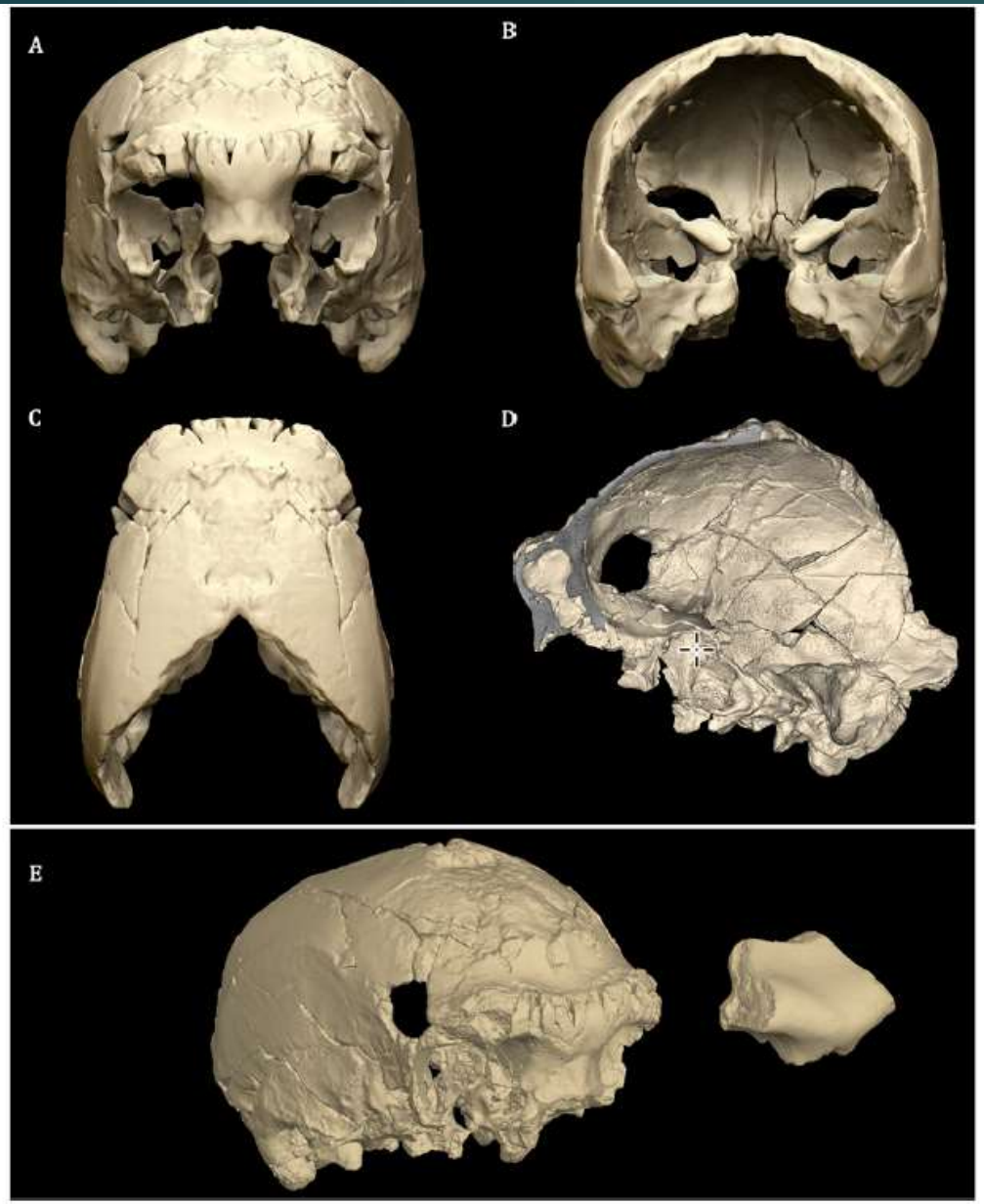


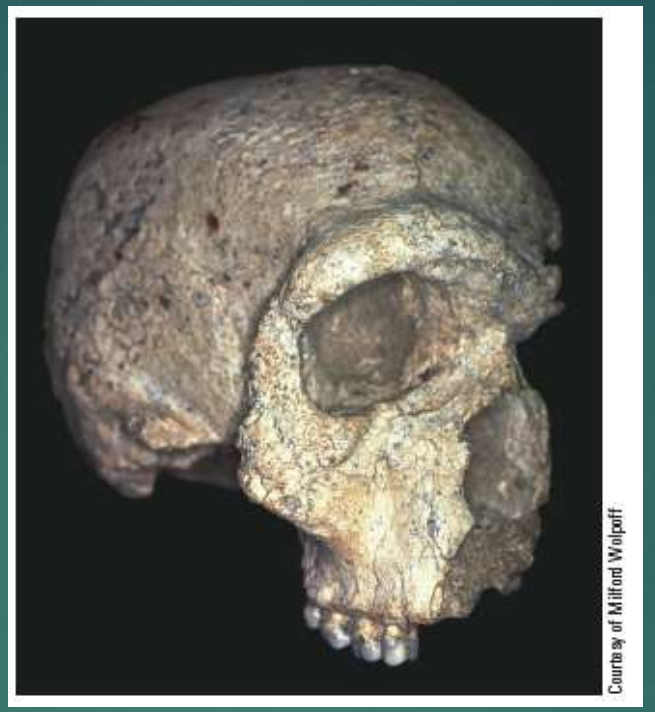
Fig. S5. Virtual reconstruction of the Aroeira 3 cranium in frontal (*A*), posterior (*B*), superior (*C*), and endocranial (*D*) views. The frontal sinus in *D* is exposed in a parasagittal section located 4 mm to the right of the sagittal plane. (*E*) Virtual reconstruction of the Aroeira 3 cranium in a three-quarters view compared with Bilzingsleben B1 (cast).

1935: *Homo heidelbergensis*, Swanscombe, 400K

- Occipital is rounded; lack the marked angulation between occipital & nuchal planes seen in H. erectus crania
- Parietals are thick
- Horizontal oval-shape depression on occipital bone (suprainiac fossa); a distinctive N like feature; oldest skull to show such a feature
- Cranial capacity = c 1300 cc
- presence of a suprainiac fossa (a horizontal oval-shaped depression located on the occipital plane), like N

Oldest human remains in Europe directly associated with Acheulean tools (400K)

1933: Steinheim skull, 250-350 kya



Homo heidelbergensis
(Steinheim)
Discoverer: Karl Sigrist, Jr.
Date: 1933
Locality: Sigrist gravel pit, Steinheim Germany
Age: 250-350 K
Cranial capacity: 1100 cc

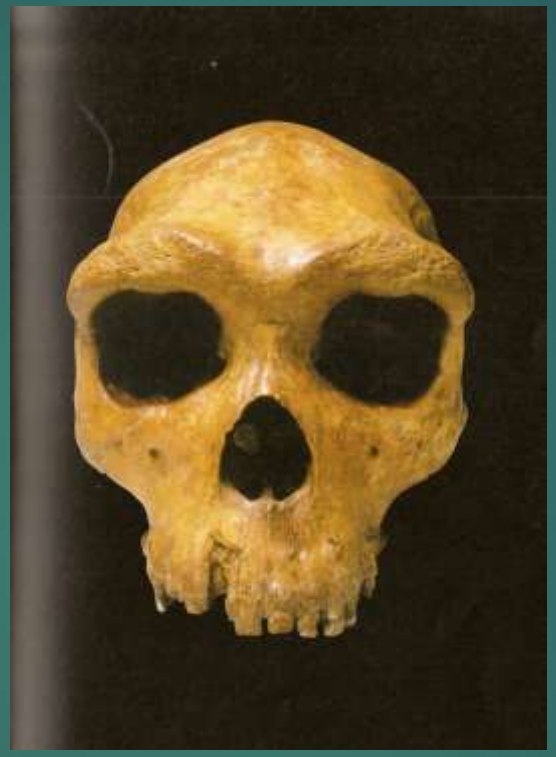
Archaic Hominins: Africa

- African archaic hominin group:
  - Kabwe (Broken Hill)
  - Saldanha (Hopefield)
  - Bodo
  - Ndutu
  - Eyasi
  - Turkana region

1921*: (Rhodesian Man); Homo heidelbergensis,* Broken Hill, Kabwe, Zambia

- The first hominin fossil discovered outside Europe

10 cavities, left ear wound



Homo heidelbergensis
(Broken Hill 1)
Discoverer: Tom Zwigelaar
Locality: Kabwe, Zambia
Date 1921
Age: 300K

Tom Zwiglaar

Broken Hill

Heavy browridges, slightly keeled & constricted frontal bone, short parietals that show little bossing, acutely flexed occiput with prominent occipital torus, lateral expansion of the mastoid & supramastoid regions, and extensive paranasal sinus development; severe dental decay; several pathological lesions in left temporal bone

Cranial volume = 1280 cc

Femoral fragments lack erectus elongated femoral neck, but have thickened cortical bone on lateral side; tibia has modern rounded anterior crest and posteromedial/lateral angles; otherwise modern postcranially

Kabwe 1 (Broken Hill)

Note the very heavy supraorbital torus.

Searching for metal ore deposits in the limestone caves of Kabwe, Zambia, Swiss miner Tom Zwiglaar is credited with finding the first early human fossil ever to be discovered in Africa. When Kabwe (also known as Broken Hill) was sent to Arthur Smith Woodward, Woodward assigned the specimen to a new species: *Homo rhodesiensis*. Today, most scientists assign Kabwe to *Homo heidelbergensis.*

Kabwe shows features similar to *H. erectus* such as a low braincase profile (the area towards the back of the skull), large brow ridges, a slight widening of the midface known as the sagittal keel, and a protrusion at the back of the skull named the occipital torus.

But Kabwe 8
This skull is one of the oldest known to have tooth cavities. They occur in 10 of the upper teeth. The individual may have died from an infection related to dental disease or from a chronic ear infection.

Language?

- H. heidelbergensis had FOXP2 gene
- Endocast of the Kabwe *Homo heidelbergensis* cranium is well within the modern range in terms of size; Demonstrates a modern pattern of left occipital and right frontal petalias, and the left ventral premotor cortex (Broca's area) is enlarged relative to the right
- Basicranium is more angled, a feature that has been linked to lengthening of the pharynx
- Diameter of the hypoglossal canal is in modern range (passage in cranial base (through which pass the nerves that enervate the tongue)-enlarged canal suggest greater control of tongue

Bodo, Ethiopia, 1976, *Homo heidelbergensis, 600K*

Photograph by Donald Johanson.

Photograph by Donald Johanson.

- Homo heidelbergensis
- 1976
- Discoverers: Alemayhew Asfaw, Paul Whitehead, and Craig Wood
- Date: c 600K

Associated with Acheulean tools, much later than in other areas (1.7 M)
More modern: Cranial capacity = 1250 cc; broadest at parietal area;
Cut marks indicate oldest postmortem defleshing of bone

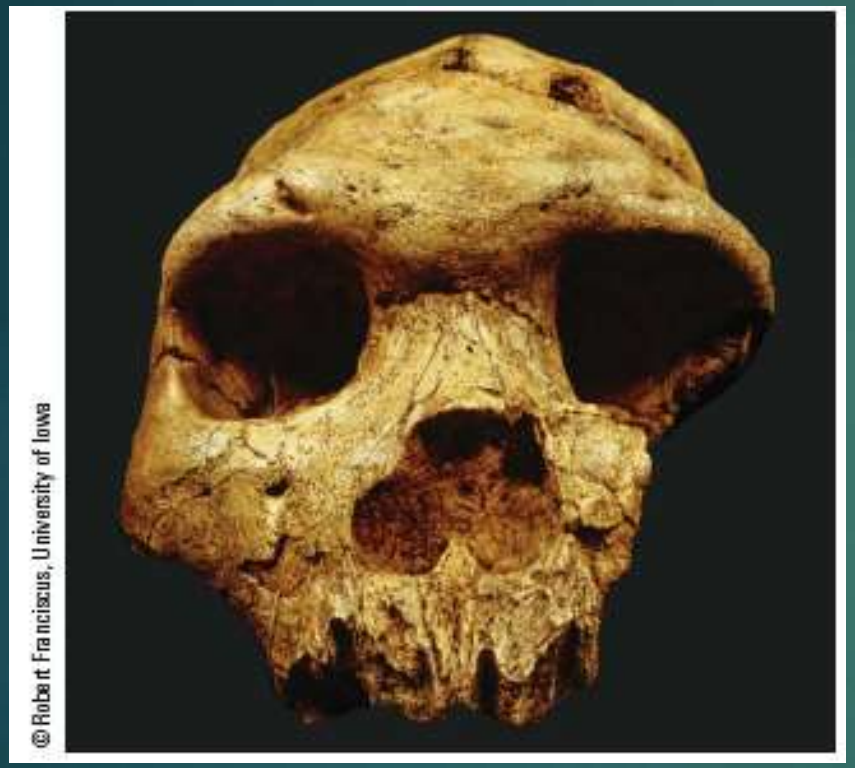
Bodo, 600K

Site: Middle Awash, Ethiopia
Year of Discovery: 1976
Discovered by: Alemayhew Asfaw, Paul Whitehead, and Craig Wood
Age: About 600,000 years old
Species: *Homo heidelbergensis*

The large face and braincase of this cranium connect it with *Homo heidelbergensis*, known in Europe.

African populations of this species were likely the forerunners of the earliest *Homo sapiens*.

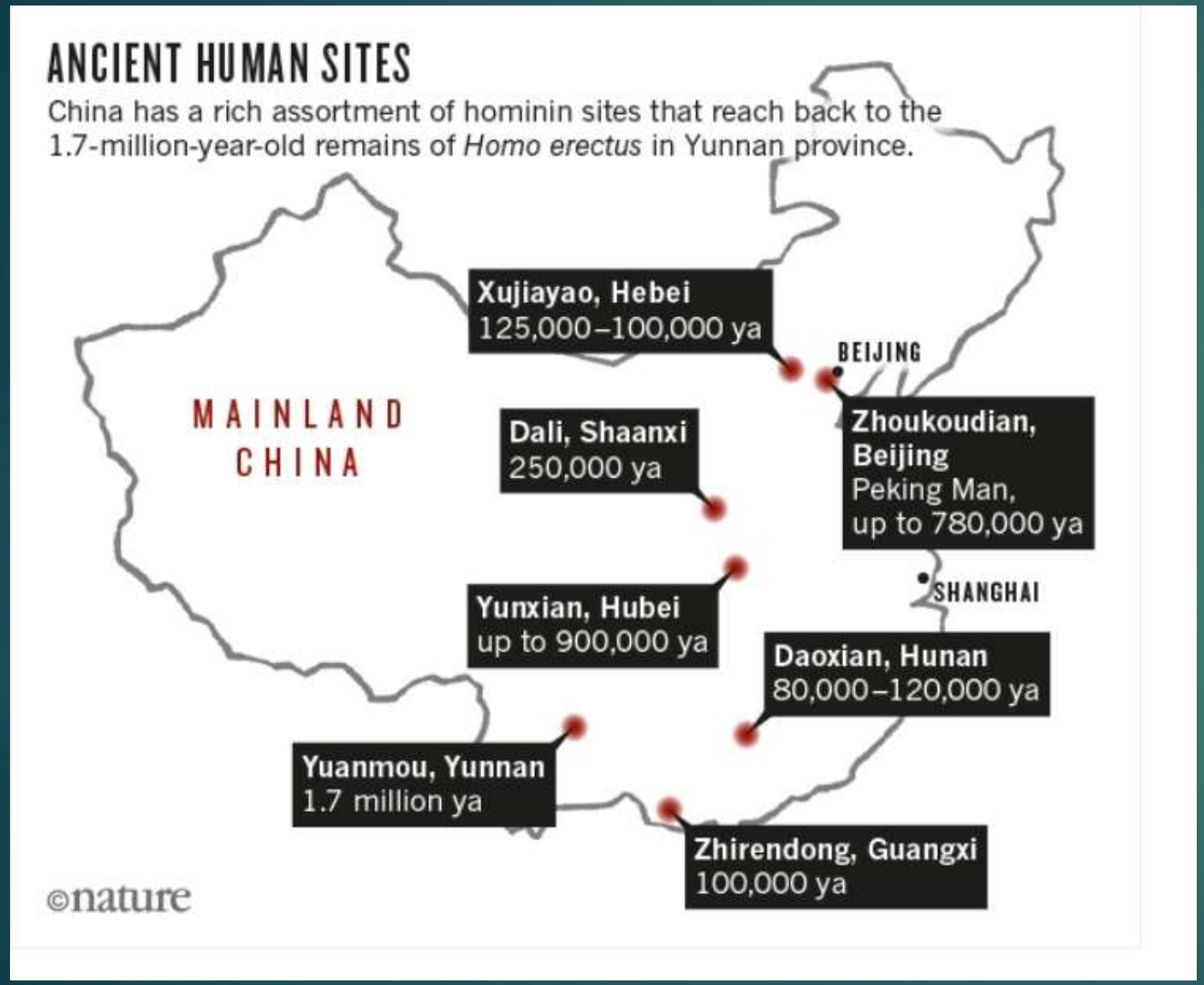
Earliest Evidence of *Homo Heidelbergensis* in Africa



- Bodo cranium; no teeth
- Humerus is much smaller than MH; sexual dimorphism
- 600 kya
- Associated with Acheulean tools, much later than in other areas (1.7 M)
- Very thick cranium; supraorbital ridges are thick, arched, separated by prominent glabellar region;
- Unique depth, width, & robustness of zygomatic bone (more than some Ns)
- Less postorbital constriction
- More modern: Cranial capacity = 1250 cc; broadest at parietal area; vertical nose area
- Cut marks indicate oldest postmortem defleshing of bone
- 1981: discovery of H. erectus-like parietal bone from 2nd individual at Bodo

China

China hominins: 1.7 to 125 kya



"They clearly represent more advanced species than *H. erectus*, but nobody knows what they are because they don't seem to fit into any categories we know."
The fossils' transitional characteristics have prompted researchers such as Stringer to lump them with *H. heidelbergensis*.
Because the oldest of these forms, two skulls uncovered in Yunxian in Hubei province, date back 900,000 years, Stringer even suggests that *H. heidelbergensis* might have originated in Asia and then spread to other continents.

Studies of Chinese populations show that 97.4% of their genetic make-up is from ancestral modern humans from Africa, with the rest coming from extinct forms such as Neanderthals and Denisovans. If there had been significant contributions from Chinese *H. erectus*, they would show up in the genetic data,

Dali, China, 250K

- Archaic H. sapiens.
- Discovered in 1978

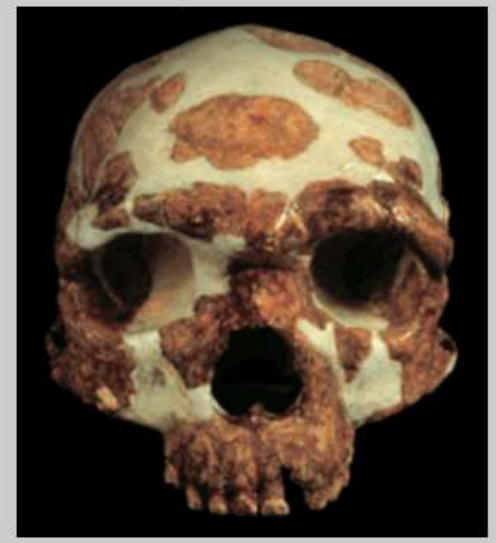
- near Jiefang Village, Dali County,
- Shaanxi Province

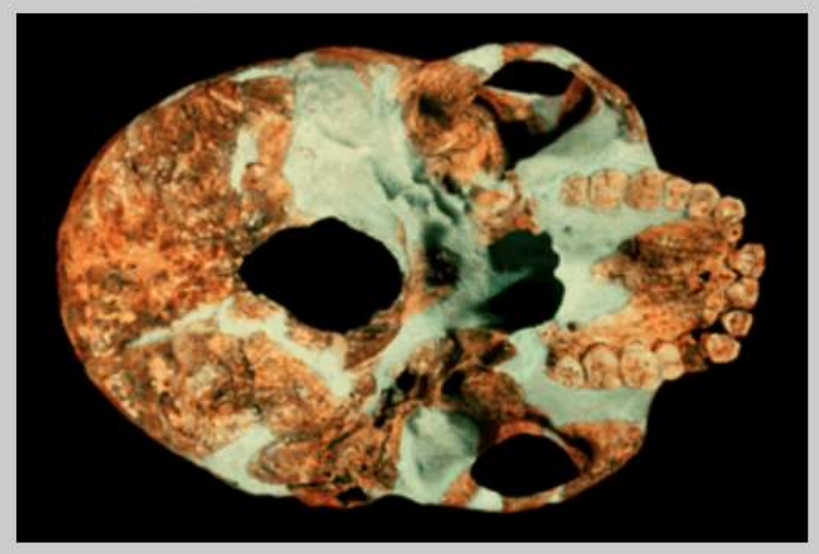
- Cranial capacity = 1200 cc

  - Face is broad & short (possibly crushed); broad bell-shaped nasal aperture, massive supraorbital tori; unlike Eurasian N

  - 200 Oldowan stone tools
  - Chinese paleontologists: Has a bigger braincase, a shorter face and a lower cheekbone than most *H. heidelbergensis* specimens, suggesting that the species was more advanced.

Jinniushan, China, 200K





- Discovered in 1984
- Cave near Sitian Village, southwest of Yinkou in Liaoning Provence, China
- 200 Kya
- Largest cranial capacity (1300 cc) & thinnest cranial bones of any Chinese archaic fossil
- Broad nasal bridge, shovel-shaped incisors, prominent cheekbones differentiate early Chinese H. sapiens from Eurasian archaics (used to support Multiregional theory)
- Hominins in China used the same type of simple stone instruments from about 1.7 million years ago to 10,000 years ago.
- Question of hearths
- Cranium & pelvis may be female

Maba, China, 229 K

Similarities to Eurasian N: shape of supraorbital tori, thickest in medial third; rounded orbits lacking supraorbital notches

Maba
Site: Guangdong Province, China
Year of Discovery: 1958
Discovered by:
Age: 169-229 Kya
Species: *Homo heidelbergensis*

Chinese Fossils & Denisovans

- Recently there has been a tendency to link a group of Chinese hominin fossils, including Maba, Xujiayao, Dali, and Jinniushan, previously considered to be "archaic Homo sapiens", with the Denisovans
- Current DNA going on to prove this hypothesis

Middle & Upper Pleistocene sites in Africa

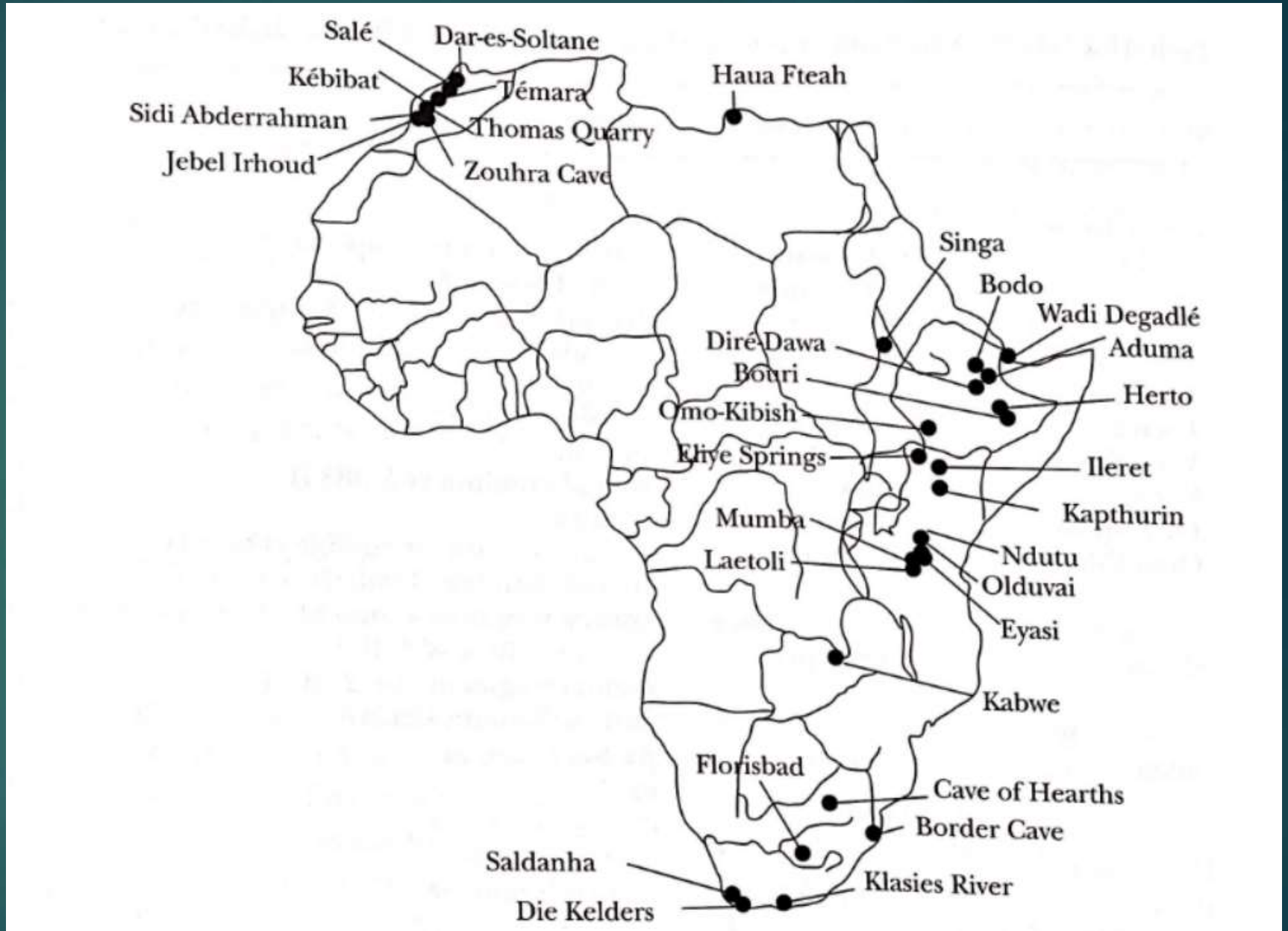


Fig. 11.10. Middle and early late Pleistocene hominin sites in Africa. (From Brauer, 2008.)

G. Conroy & H. Pontzer, 2012

Invention of hafted weapons in Africa

- By 200 kya, crucial change took place in archaeological record of Africa that related to a major technological breakthrough: the invention of tools with handles by which they could be attached or hafted to pieces of wood for use as spears or knives.

- Disappearance of large Acheulean bifaces and their replacement by assemblages of smaller bifaces and Middle Paleolithic flake technology

Homo heidelbergensis, male. Reconstruction based on Kabwe by John Gurche

No DNA

- As yet, no *H. heidelbergensis* DNA has been sequenced, so the species cannot be recognized genetically, but by comparing genetic data from Neanderthals and H. sapiens it is possible to estimate a hypothetical divergence date (~410–440 ka) for the two species, based on mitochondrial DNA,

Homo Neanderthalensis

Neandertal Man
430K-39K

Neandertals were the first extinct hominins identified on the basis of fossil skeletal remains, recovered in 1856 during quarrying work at the Feldhofer Grotte near Düsseldorf, Germany, and baptized as *Homo neanderthalensis* in 1864.

Neanderthals: Ancestors Or Dead Ends?

- No other aspect of human evolution has generated as much public interest for so long a time as the story of the Neanderthals.

- Europe, southwest Asia, central Asia between 430,000 - 39,000 years ago
- Much controversy over
  - their fate
  - relationship to anatomically modern humans (*H. sapiens*)

History of Inferring Neandertal Inferiority

- No hominin group has been more maligned in the history of paleoanthropology than the Ns. Only hominin now known mainly for use of their name as a pejorative.
- Historical perception that H. sapiens was superior has blighted the perception and interpretation of Neandertal capabilities
- For 150 years, Ns were thought of as genetically incapable of language, symbolic behavior, foresight, tool creation, ethnicity, art, hunting, & blade & bone tool production; all characteristics granted only to the “superior” MHs of UP
- There is increasing body of archeological evidence showing that Ns were not significantly different from MHs in their capacity for cultural and symbolic behavior.

Homo neanderthalensis

- *Homo neanderthalensis* (alternatively, *H. sapiens neanderthalensis*) was a late archaic hominin form:
  - N diverged from common ancestor ~ 550 to 765 kya
  - From 430 to 39 kya, fossil record demonstrates gradual development and establishment of typical N morphology in Europe
  - largely disappeared from Europe and Asia by ~41k–39 kya, though evidence from Gibraltar suggests that some may have survived there until ~28 kya.
- During that time, they established themselves in differing environments across the Middle East, Europe, and Asia and interacted with modern humans both ~100 K in Levant and 40 K in Europe (2000-5600 yrs).

Game of Thrones

- Arsuaga: “What I have been telling people is that it was like Game of Thrones, There were a few spread-out populations, some related, some not, emigrating or going extinct over time. And winter was always coming."

Neandertals

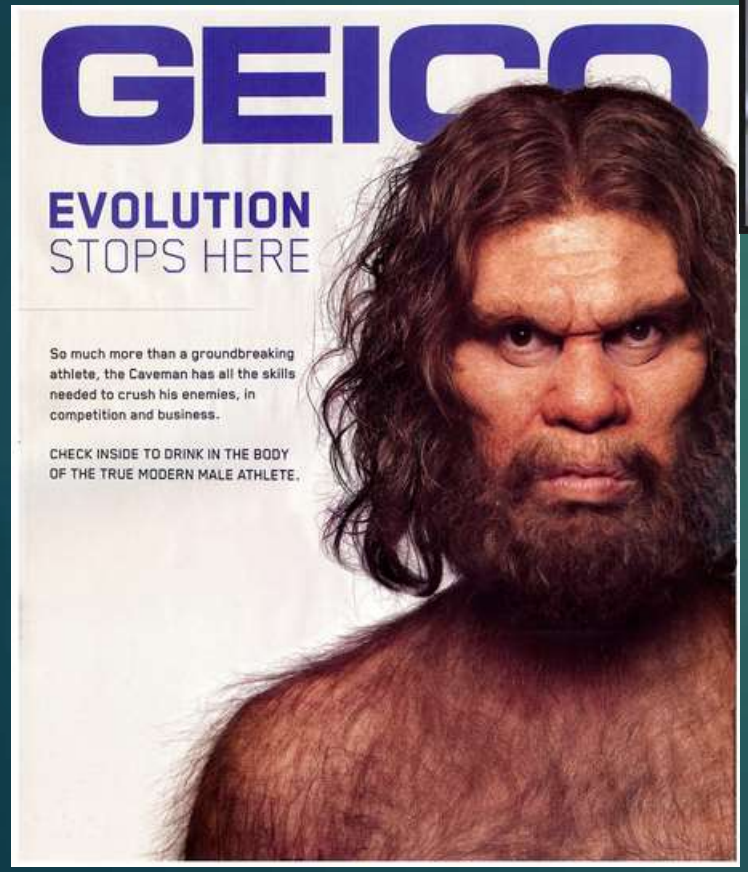
- The extreme cold of the European Ice Ages is considered at least partly responsible for the evolution of some of the distinctive Neanderthal anatomy, although other factors (small population size, effects of chance in small populations) were probably also important.

- The causes for the Neanderthal extinction are not well understood. Worsening climate and competition with modern humans are implicated.

- Neanderthals were our sister species, much more closely related to us than the chimpanzees, our closest living relatives are today.

- But there has been a continuing debate surrounding the relationship of Neanderthals with modern humans.

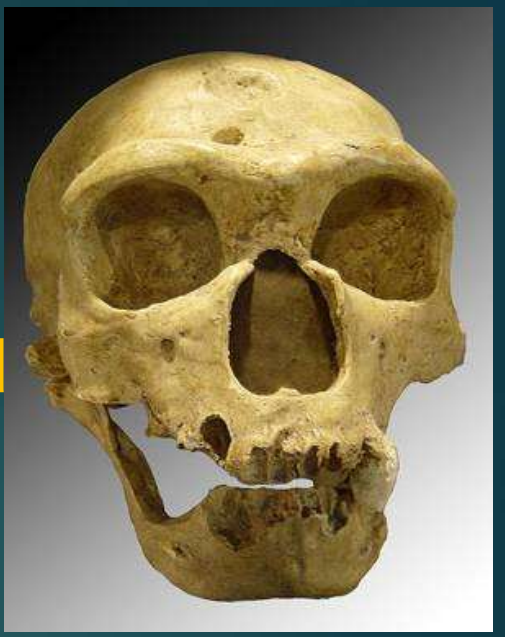
Neandertal: our only fossil curse word: a name synonymous for primitiveness



Sarah Palin characterized an opponent: “a knuckle-dragging Neandertal”

(1909)

Homo neanderthalensis



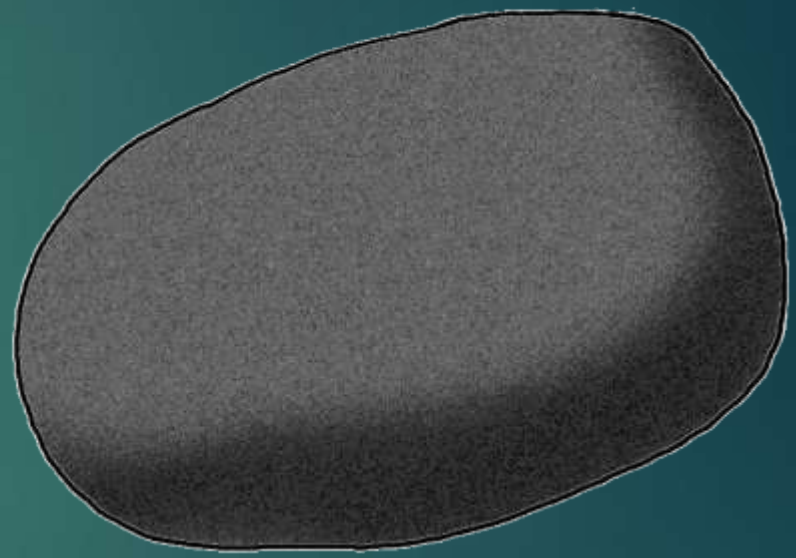
- Evolved from *H. erectus* populations via *Homo heidelbergensis*, then became extinct or were assimilated
- Improved sophisticated tools (Mousterian culture)
- Neanderthals:
  - intentionally buried their dead,
  - may have created cave art,
  - very likely made ornamentation,
  - likely used symbols and very likely had a spoken language,
  - and mated with modern humans.

Mousterian toolkit

A Mousterian point is typologically defined by a triangular flake with the presence of a retouch on one or two sides to form a point.

Levallois Flint Knapping

- Careful retouching of flakes taken off cores
- Specific uses of flakes
  - Animal butchering
  - Woodworking
  - Bone & antler carving
  - Working of animal hides



Homo neanderthalensis

- **Habitat and Distribution**: Neanderthals inhabited Europe and western Asia (but not Africa) during the latter part of the Pleistocene, adapting to extremely cold climatic conditions.
- **Climate**: The climate was much colder than it is today, and several glaciations (Ice Ages) occurred during this time. Neanderthals mostly lived in cold climates, and their body proportions are similar to those of modern cold-adapted peoples: short and solid with short limbs.
- **Size**: Men averaged about five feet six inches (168 cm) tall. Their bones are thick and heavy and show signs of powerful muscle attachments. Neanderthals would have been extraordinarily strong by modern standards.

N thermoregulation: adaptation to cold?

- N's bodies reflected their long exposure to cold
- The short, heavy stature and short distal limb proportions are thought to follow Bergmann's and Allen's rules for adaption to cold environments (Allen's rule: body better adapted to cold when its surface area is limited by shortened limbs)
- Circa 37 K, European climate began slow decline, culminating in Last Glacial Maximum circa 26 K, by which time Ns were extinct
- Why did they die out in a non-severe cold period?
- Estimation that Ns had just 1 centigrade increased tolerance to cold; depended on good clothing, fire, high fat diet, and shelters to stay warm (Aiello and Wheeler 2003).

Homo neanderthalensis

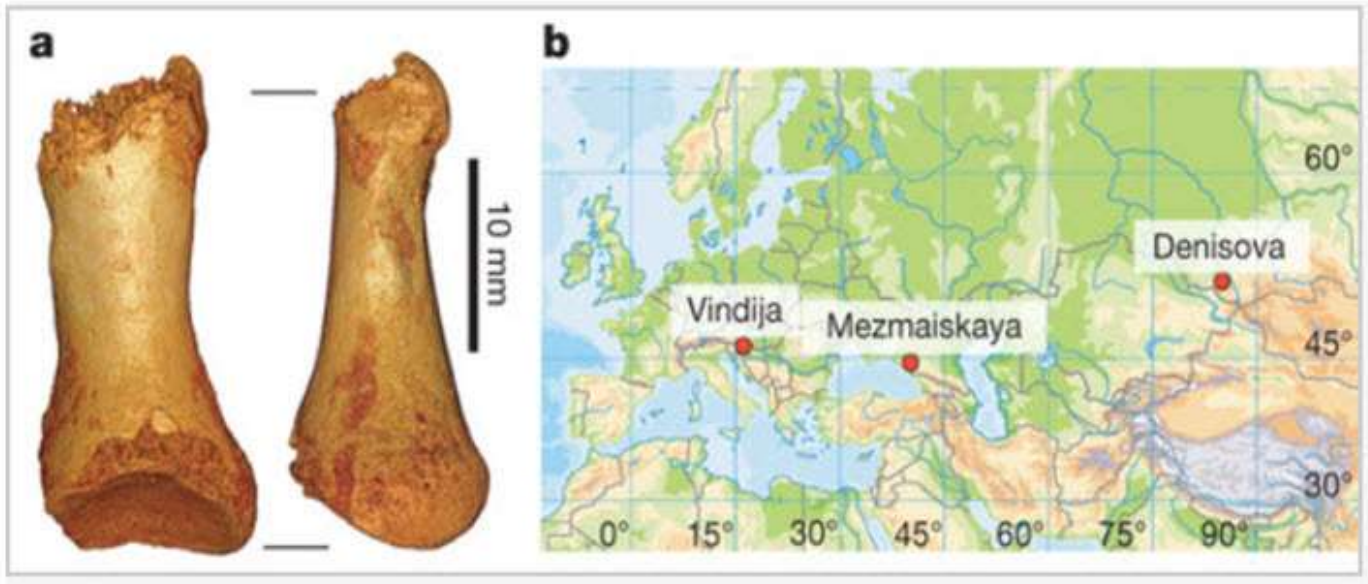
- **Skull**:
  - braincase is longer and lower than that of modern humans
  - marked bulge at the back of the skull (occipital bun).
  - Like *H. erectus*, protruding jaw and receding forehead.
  - Weak chin
  - mid-facial area protrudes, may be an adaptation to cold.

- **Brain size**:
  - average brain size is about 1450 cc, (1,200 to 1,700 cc; (Holloway 1985)) (*H. sapiens* = 1350 cc);
  - relative brain size may have been smaller due to their greater body mass;
  - Neanderthals retaining an archaic brain shape despite larger size,
  - and modern humans exhibiting larger parietals, as well as increasing size (Bruner et al. 2004)

Neandertals

- Population size: Neanderthals were “thin on the ground”:
  - lived in groups of 15-30;
  - Estimates of only 1 person per 40 sq. miles
  - total population in Eurasia = 5,000 to 70,000 (JP Bocquet-Appel - 2013);
  - subjected to bottlenecks: little genetic diversity
  - Familial interbreeding
  - Idea that Neandertals groups were “limiting themselves to a single river valley and only occasionally did they venture farther afield” is refuted by abundant evidence for transport of raw materials across major river valleys in the Middle Paleolithic of western and central Europe
  - Dogandžić and McPherron extensive review show in detail that the Mellars and French analysis (MHs were 10x more numerous than Ns) is severely flawed; MHs did not have larger populations

2014: Reason for Neandertal Demise: Low population number with interbreeding



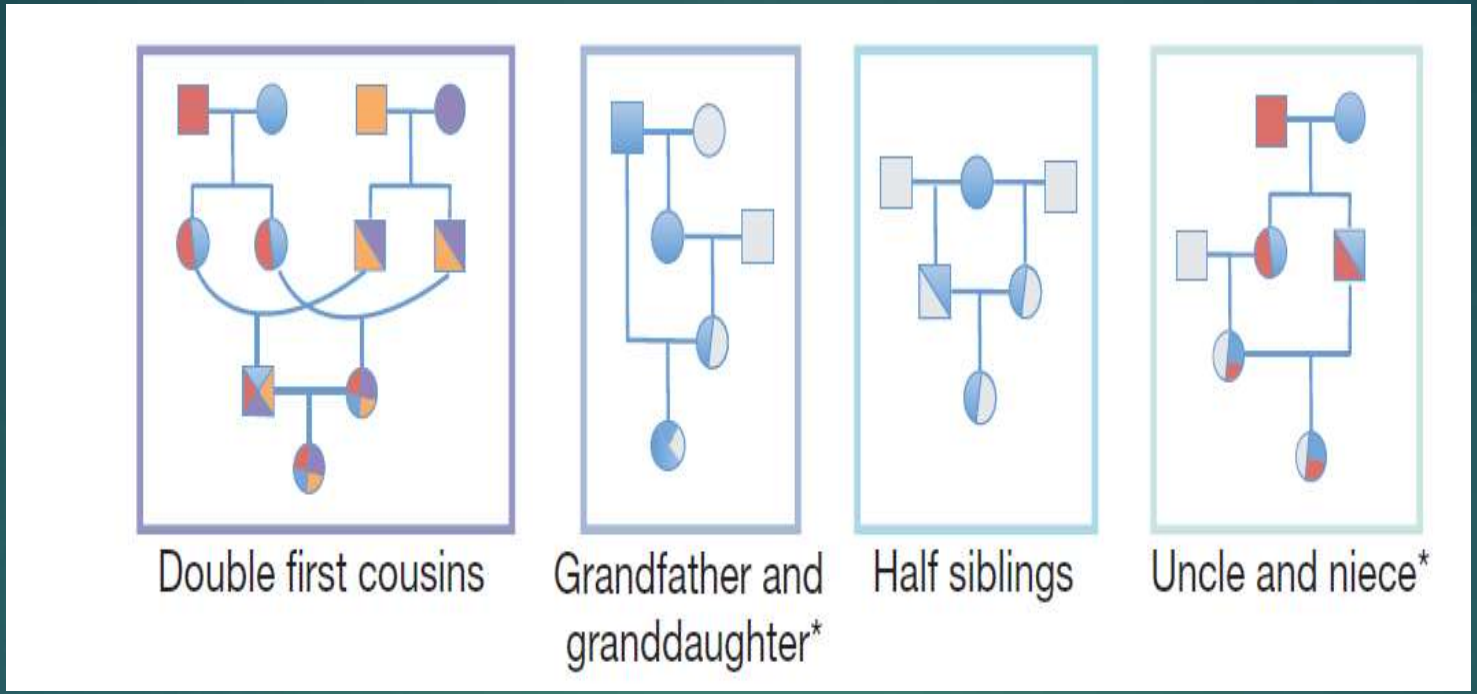
Denisova: woman's toe bone = Neandertal 130K;
Clear inbreeding = her parents were closely related,
possibly half-siblings or another near relation.

Chromosome 21: M & F genetically related (19 Mb base pairs with no difference)

- Half siblings
- Grandfather-granddaughter
- Aunt-nephew
- Double first cousins

Pruefer et al., , Nature, 2014

Altai Neandertal Inbreeding



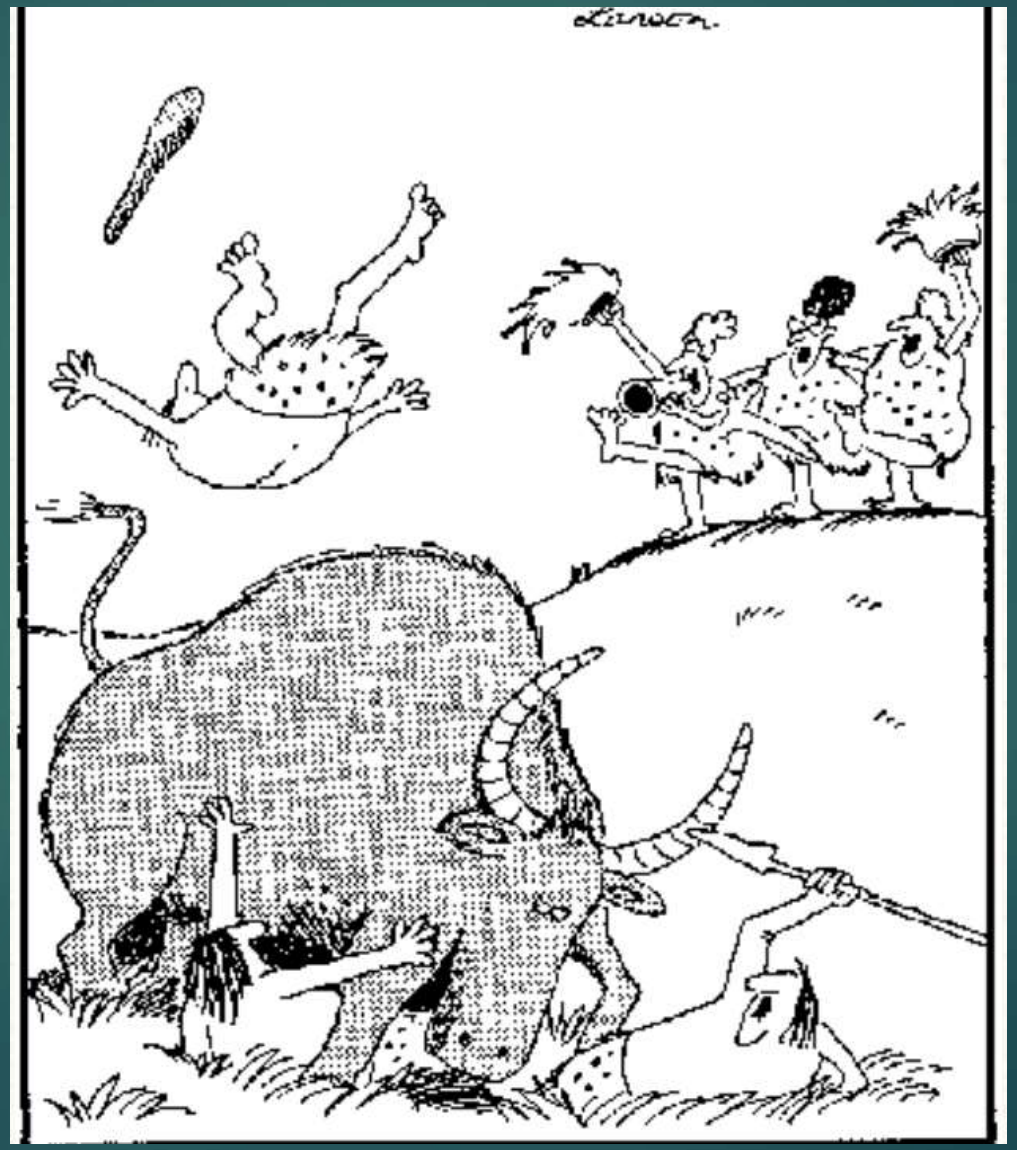
Pedigrees showing four possible scenarios of parental relatedness for the Altai Neandertal (that is, the child at the bottom of each pedigree). Two additional scenarios can be derived by switching the sex of the parents for the panels marked with an asterisk. Parents of this Neandertal individual were either half-siblings who had a mother in common, double first cousins, an uncle and a niece, an aunt and a nephew, a grandfather and a granddaughter, or a grandmother and a grandson

Development & life expectancy

- Neanderthal children grew faster than modern human children: (via teeth growth marks); Le Moustier 12 yo showed 16 yo maturation; shorter developmental period & dependency.

- N had distinct demographics: The percentage of adolescents and prime age adults recovered from Neanderthal sites is unusually high relative to that of older adults and infants (latter more frequent in modern human cemetery populations).
  - Suggests high mortality among young and prime age Neanderthals, with corresponding low adult life expectancy, and high mortality
- But Anthropologist Erik Trinkaus analyzed fossil records to gauge the adult life spans of Neanderthals and early modern humans. He found:
  - roughly the same number of 20- to 40-year-old adults and adults older than 40 in both Neanderthal and early modern human populations, suggesting life expectancy was probably the same for both.

Rodeo Neandertals



Injuries: Rodeo Riders?

- Signs of injury can be found on almost every well-preserved adult Neanderthal skeleton (Trinkaus 1995; Berger and Trinkaus 1995) and are concentrated in the head and neck, producing an uncommon pattern of injury that may have resulted from hunting strategies requiring proximity to large prey animals (Berger and Trinkaus 1995), or interpersonal aggression? (e.g., Churchill et al. 2009).

- The majority of injuries are healed or partially healed, therefore suggesting that Neanderthals showed some level of compassion: Many of the injured individuals would not have survived the period of convalescence without being cared for by others (Trinkaus 1983).

- Recent comparisons to MHs show that latter had very similar injuries.

Hunting

- Hunting was the main method of meat procurement by Neandertals.
- Extremely successful ambush hunters
  - Thrusting spears (not thrown) w/ hafted stone points
  - No long-distance hunting (locally available game)
    - Cave bear, Deer, Woolly rhinoceros, mammoth, wild cattle, reindeer, horse, wild ass, ibex, saiga
- Evidence shows that Ns were able to organize game drives using landscape features as natural traps, intercepting groups of animals at repeatedly used locations.
- At other times large and medium size mammals were hunted individually.
- Hunting efficiency is hardly a measure of modernity.
- San have weak bows & slow acting poison; get more calories from gathering.
- Presence of twisted fibers implies possible use of snares

Neandertals: Locations

- Neanderthals lived in a variety of environments:
  - colder regions of Northern Germany and Siberia's Altai Mountains
  - warmer regions of Mediterranean Gibraltar and the Levant.
- Later N subjected to sustained periods of very cold weather; a tundra landscape

Homo neanderthalensis: Locales

- Neanderthal localities are known today from Spain to Uzbekistan.
- Several sites near Qafzeh Cave, Israel, (90-100 ka) suggest that Neanderthals arrived in the region after modern *H. sapiens*. This indicates that the population of modern humans in this area was not descended from Neanderthals, and that there was some period of coexistence or an alternating series of migrations into this region.
- From 430 to 130 kya, N only in Europe; after 130 kya, advance into Asia (as did H. sapiens)
- Pontnewydd, Wales: among 1st N in Europe, but last in Britain for 100K; no hominin occupation of Britain from 200 K to 60 K due to formation of English Channel, which lead to N extinction there; N return after glaciation

Earliest Locations

- Earliest evidence of hominins that show incipient signs of N skull features come from:
  - Swanscombe, England
  - Arago, France
  - Sima de los Huesos, Atapuerca, Spain
    - Juan Luis Arsuaga: treasure trove of fossils, ~430 kya

Dates of N Discovery & locale

- 1829, Engis, Belgium
- 1848, Forbes' Quarry, Gibraltar
- 1856, Neander, Germany: Neander 1
- 1880, Sipka, Moravia
- 1886, Spy, Belgium – pair of skeletons
- 1899-1906, Krapina, Croatia
- 1908-1925, Ehringsdorf, Germany
- 1908, Le Moustier, France
- 1908, La Chapelle-aux-Saints
- 1909, La Ferrassie – skeleton
- 1911, La Quina
- 1911, St. Brelade, Channel Islands
- 1924, first non-Western Europe, at Kiik-Koba, Crimea

1929, Tabun cave on Mt. Carmel, Israel
1929, Saccopastore, Italy
1938, Teshik-Tash in central Asia
1939, Guattari/Circeo, Italy
1953, Shanidar, Iraq
1961, Amud, Israel
1964, Kebara, Israel
1978, Bontnewydd, Wales
1979, St. Cesaire, France
1983, Zaffaraya, Spain
1993, Dederiyeh, Syria
1999, Lakonis, Greece

A process of repeated phases of colonization, regional extinction, and recolonization, affected their limited genetic variation;

Genetic studies show that (late) Neandertal populations had small effective population sizes and were inbred. They were “thin on the ground”

Neandertal range = 5700 miles

- N range:
  - Gibraltar to Kebara, Israel = 2500 miles; (75% of N sites) (none above 53° north (Norway), or in Africa)
  - Shanidar, Iraq (70-40 kya) = 600 miles;
  - Teshik-Tash, Uzbekistan (70 k) = 600 miles;
  - Okladnikov Cave (30 k) & Denisova Cave, Siberia = 2000 miles
  - Total of 5700 miles W to E; Neandertals ranged over an area of ~10 million km^2
- Ns reached about same distance on east-west axis as Homo sapiens achieved on north-south axis in Africa

N on Mediterranean islands

- Their distinctive “Mousterian” stone tools are found on the Greek mainland and, intriguingly, have also been found on the Greek islands of Lefkada, Kefalonia, Zakynthos, and Crete (130 K-35 K).
- That could be explained in two ways:
  - either the islands weren’t islands at the time (now disproved),
  - or our distant cousins crossed the water somehow.

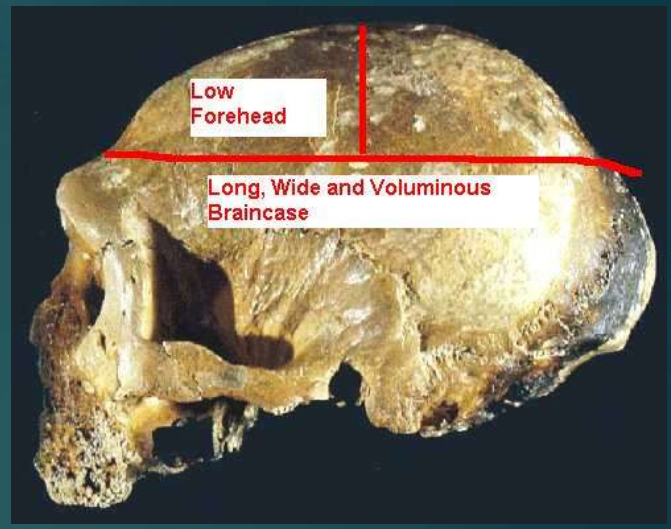
George Ferentinos, et al., 2012

Homo neanderthalensis

- 430 to 39/28 kya
- Europe, Middle East, into Central Asia; not Africa
- Evolved from *H. erectus* populations via *Homo heidelbergensis*, then became extinct
- The enigma of its extinction is not explained

Neanderthal Cranial Morphology

- Cranial capacity: 1450 cc (largest 1700 cc)
  (*H. sapiens* = 1350 cc)
- Long, low skull
- Large midface / large nasal aperture / very big nose that projects forward
- Large gap behind 3rd molar
- Large protruding occipital bone (bunning)
- Marked neck muscle attachments on skull
- Very large incisor teeth
- No chin
- Double-arched brow ridge



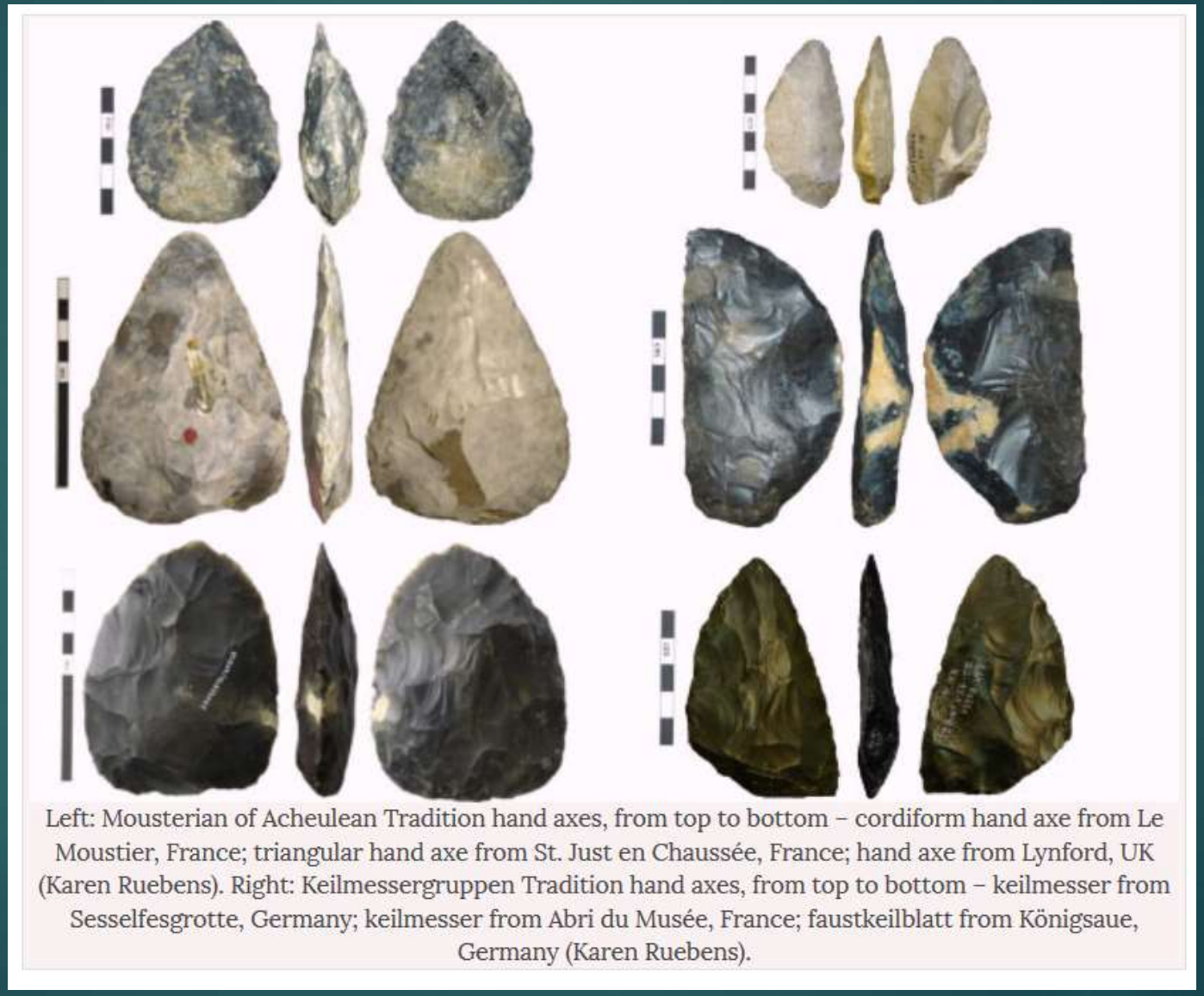
Homo neanderthalensis

- Fully bipedal
- Mousterian stone tools
- could make fire and build shelters with wooden frames.
- buried their dead, apparently with ritual — graves containing pigment red ochre, bones of large game animals are known
- Did not engage in long-distance trade.
- Used large bayonet style spears
- Used open sites, caves, rock-shelters

Neandertals

- Larger body (men = 5’5”; women = 5’) & 171 lb for males and 146 lb for females;
- Needed more energy to survive than any other species of hominid.
- Had sex with humans circa 50K ago in Middle East; N genes into MH; MH genes in N
- Genome is 99.7% identical to modern humans; the two species shared a common ancestor about 550 to 765 kya.
- Some had red hair and blond hair, along with a light skin tone

Mousterian Tools



Left: Mousterian of Acheulean Tradition hand axes, from top to bottom – cordiform hand axe from Le Moustier, France; triangular hand axe from St. Just en Chaussée, France; hand axe from Lynford, UK (Karen Ruebens). Right: Keilmessergruppen Tradition hand axes, from top to bottom – keilmesser from Sesselfesgrotte, Germany; keilmesser from Abri du Musée, France; faustkeilblatt from Königsaue, Germany (Karen Ruebens).

Last 4 Neandertal Strongholds

- Last populations of Neanderthals were concentrated in four strongholds
- (1-4 in order of importance). The south of Iberia stands out as the largest stronghold and it is within this area that the last Neanderthals survived.

Cave in Gibraltar

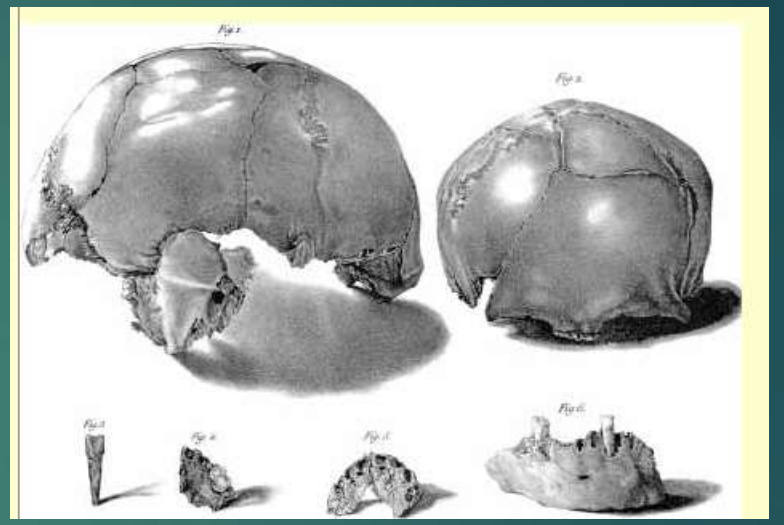
Cave area in pre (bottom) and post (top) Neandertal times.

Gibraltar: Gorham's and Vanguard caves, Neandertals until 28K

- In 2006, researchers radiocarbon dated charcoal to estimate that the Neanderthal populations lived at Gibraltar as recently as 24,000 to 28,000 years before the present & contains the most recent Mousterian assemblages known to date; Neanderthals inhabited Gorham's Cave on and off for 100,000 years, as well as a second cave next to it, called Vanguard Cave. 20 other caves & coastline underwater now

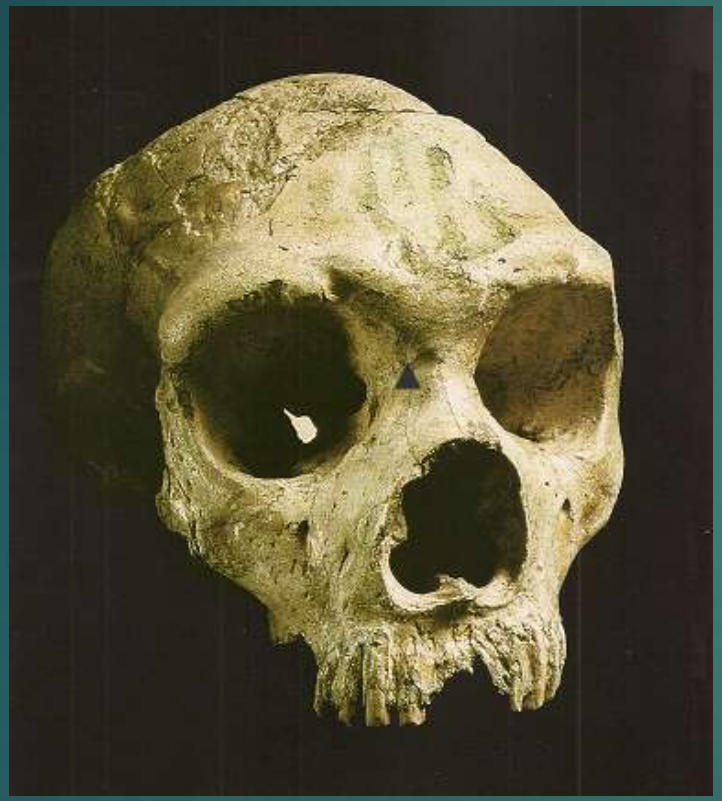
(Finlayson et al. 2006)

1829: Engis, Belgium
1st Neanderthal cranium, a juvenile



1st Neandertal found by Philippe-Charles Schmerling;
2nd discovered fossil hominid

1848: Gibraltar I, 45-70K, 2nd Neandertal discovery, 1st complete adult fossil skull



Homo neanderthalensis
(Gibraltar 1)
Discoverer: Captain Edmund Flint
Locality: Forbes' Quarry, Gibraltar
Age: unknown; Date: 1848

1856: Neandertal 1
Neander Valley, Germany, 40K

Homo neanderthalensis
(Neandertal 1, type)
Discoverer: Local workers
Locality: Feldhofer grotto, Neander Valley, Germany
Age: 40K
Date: 1856

Fossils were given to Johann Carl Fuhlrott, a local teacher and amateur naturalist.
The first description of the remains was made by anatomist Hermann Schaaffhausen

Neanderthal 1 1863 photo, from T. Huxley

Figure 1. A photograph of the Neanderthal cranium, viewed from above. Huxley Papers, Imperial College London, 1863, Volume 105, Box no 105, Series 19.

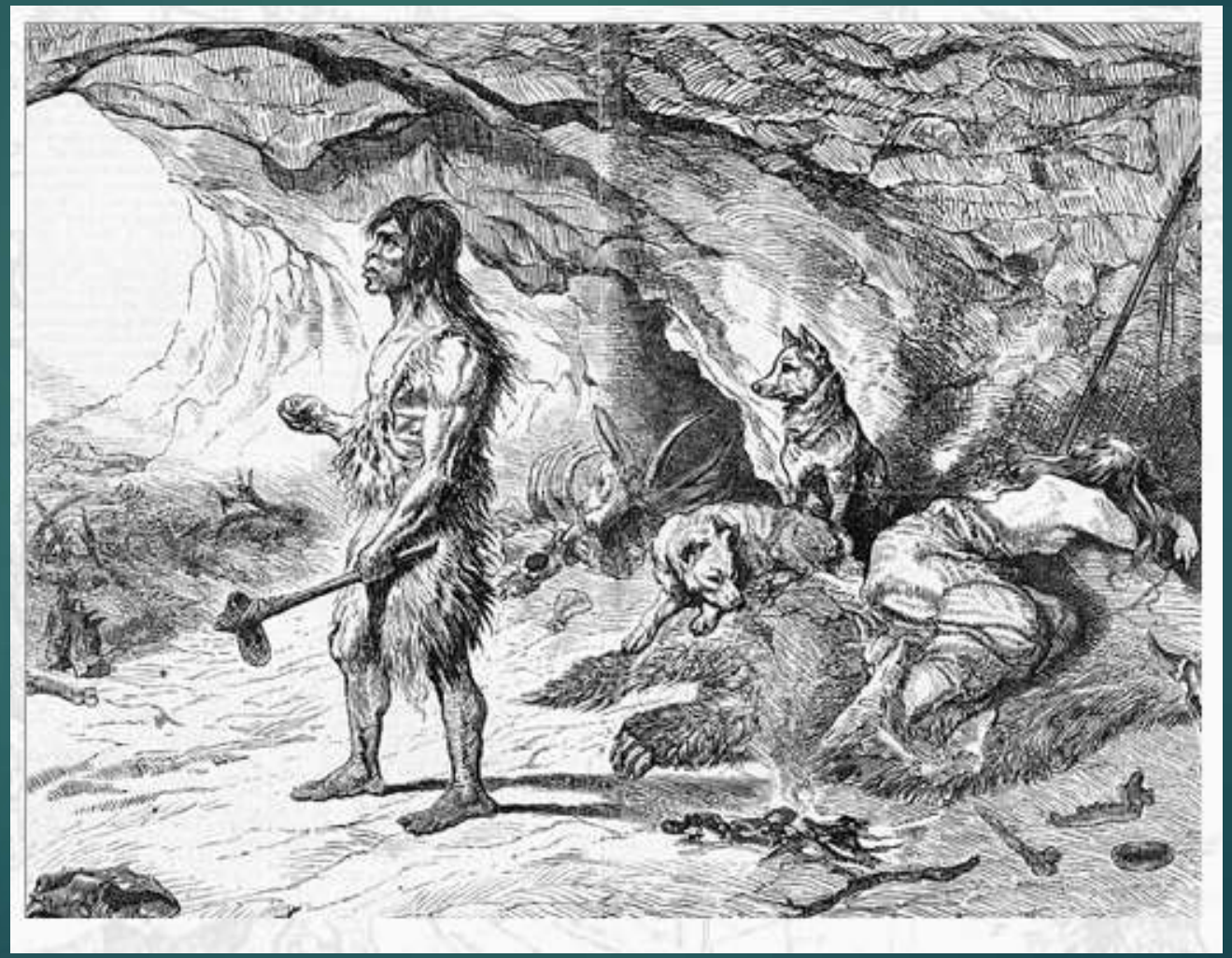
Neandertal 1 skeleton

1864, William King: *Homo neanderthalensis* becomes the first fossil hominin species to be named.

Early improper interpretation of original Neanderthals as MHs malformed "due to pathology"

- The antiquity of the Neanderthal skeleton and its status as an extinct kind of human were not immediately accepted.
- Instead, its peculiar anatomy was attributed to various pathologies:
  - Neanderthal 1: Rudolf Virchow: Insisted Neanderthal was modern man with disease induced deformities of a pathological (microcephalic) idiot or was a Russian soldier; skeleton of a lost, bowlegged Cossack with rickets. The peculiar bony ridge over the man's eyes was a result of the poor Cossack's perpetually furrowing his brow in pain — because of the rickets.
  - La Chapelle-aux-Saints: osteoarthritis
  - N as modern human with congenital hypothyroidism (cretinism)
- Response similar to discovery of *Homo floresiensis* in 2003

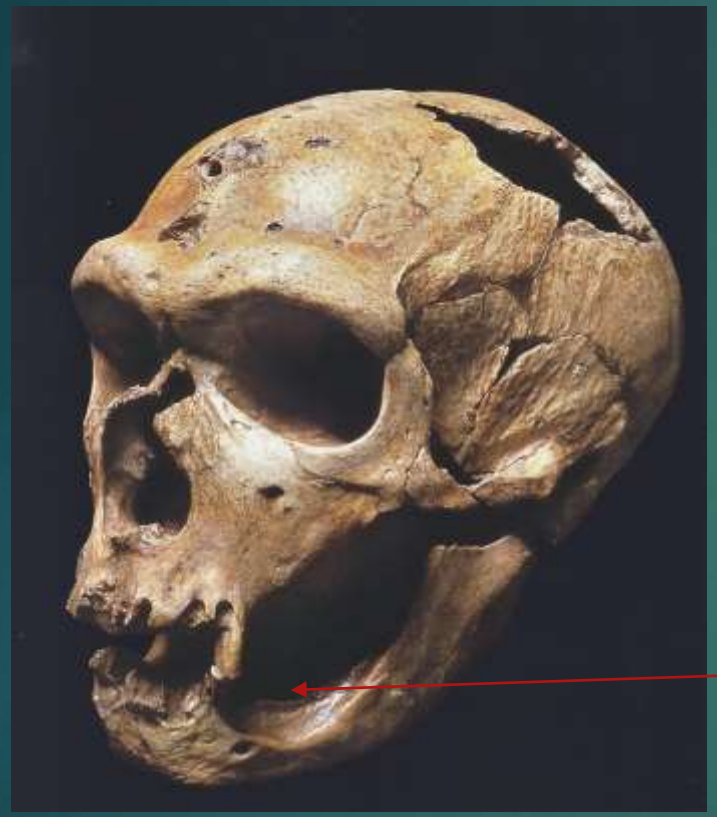
Neandertal hits the press: Harper's Weekly, 1873



Accretion model of full N development

- The appearance of Neanderthals in the fossil record is gradual.
- Neanderthal-like features appear for the first time in *H. heidelbergensis* fossils dating to as early as 600 kya (Bischoff et al. 20 3). The frequency of Neanderthal features increases through time, with specimens dating from approximately 200 to 100 kya showing clear Neanderthal anatomy.
- The full suite of Neanderthal features appears with the “classic” Neanderthals in the Late Pleistocene, dated from approximately 70 to 30 kya.
- This gradual appearance of Neanderthal-like features through time indicates a continuous evolutionary lineage in Europe from H. heidelbergensis to Neanderthals
- This process of Neanderthal evolution has been described as the “Accretion Model” (e.g., Dean et al. 1998; Hublin 2009).

1908: Neandertal, 350K
La Chapelle-Aux-Saints, “Old Man”

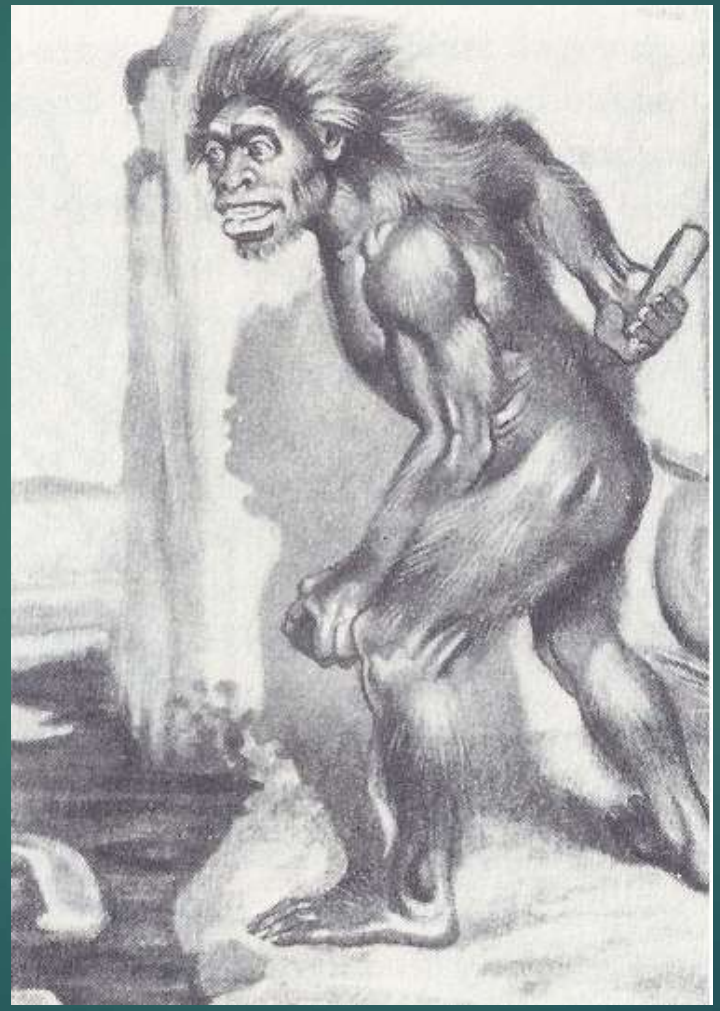


Homo neanderthalensis
(La Chapelle-Aux-Saints)
Discoverer: Fathers Bouyssonie & Josef Bonneval
Locality: Bouffia Bonneval, La Chapelle-Aux-Saints, France

Molars missing and resorbed

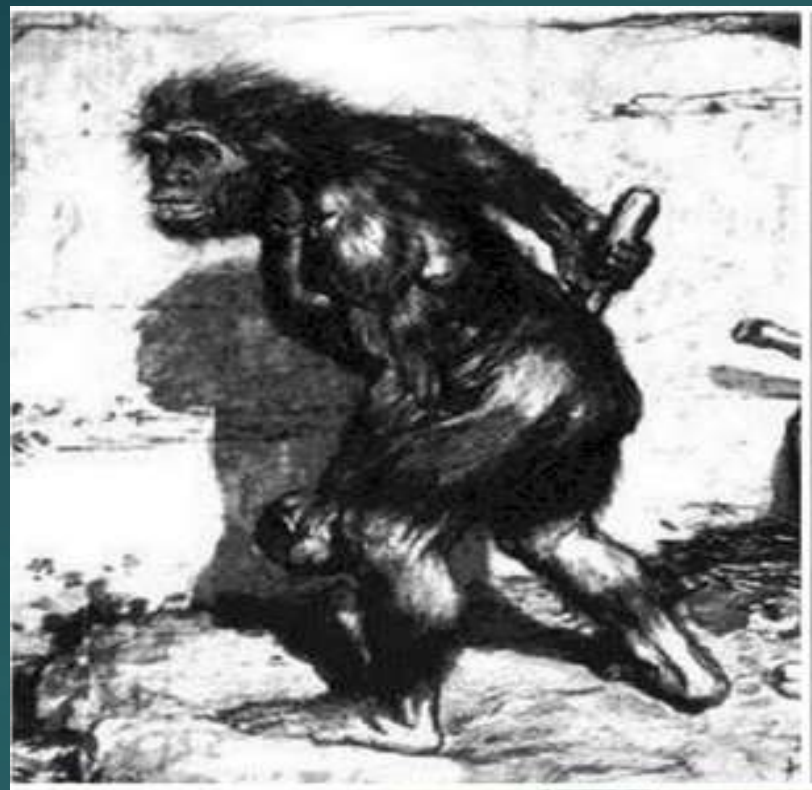
Aged, pathological skeleton formed basis of pervasive negative view of Neandertal

Pierre Marcellin Boule's (1861-1942) monograph: Neandertal as apish brute

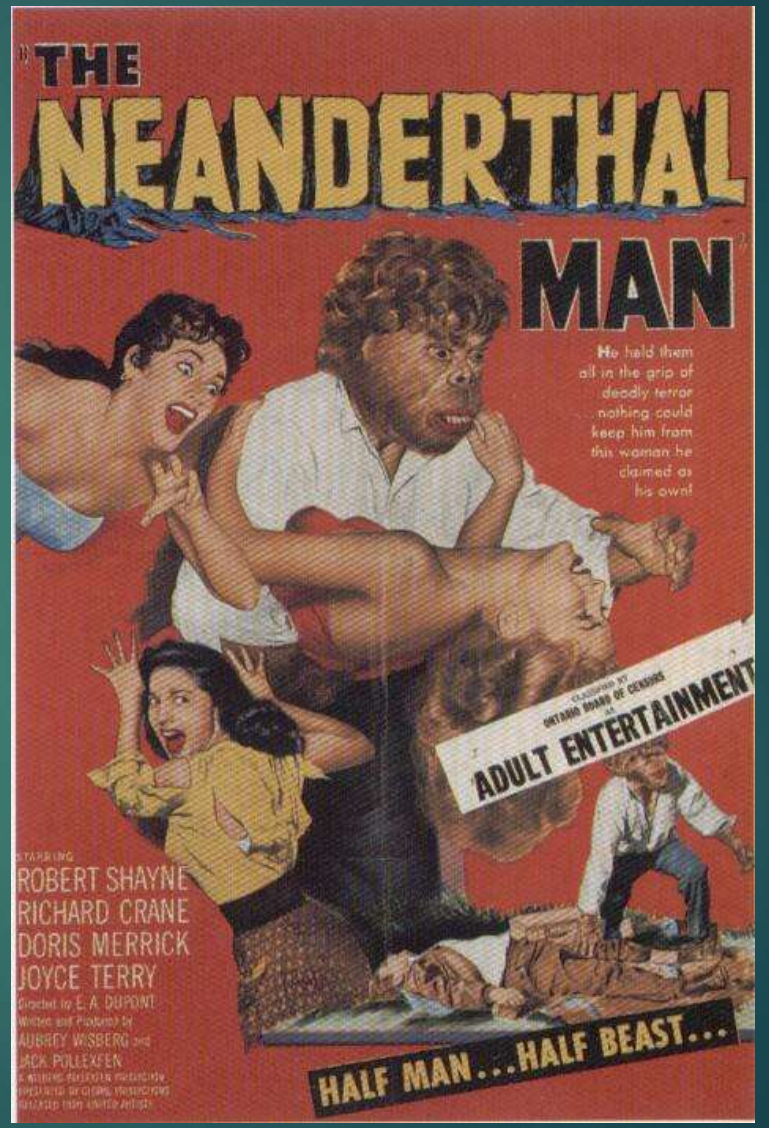


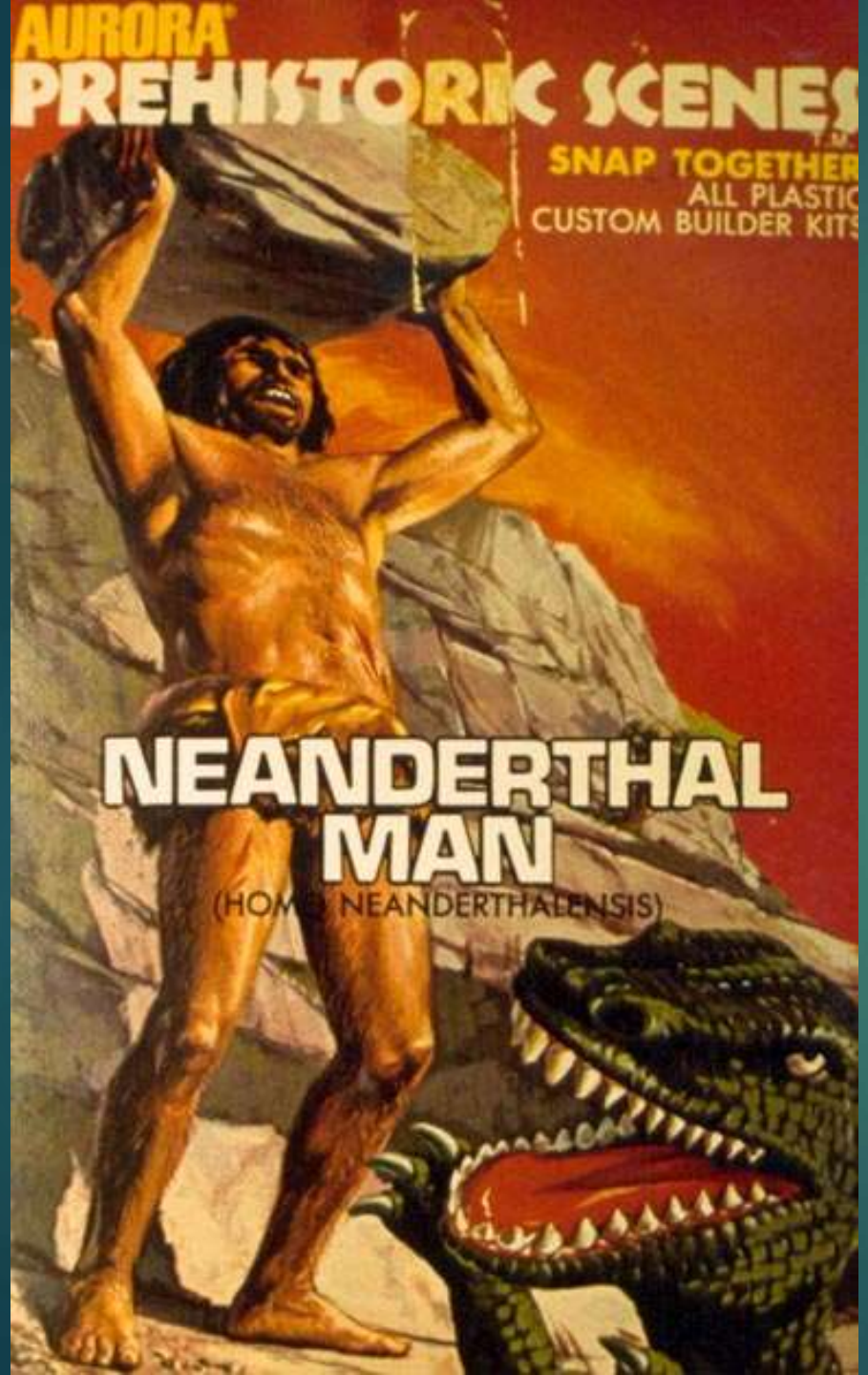
Frantisek Kupka, 1909 bestial reconstruction, per Boule

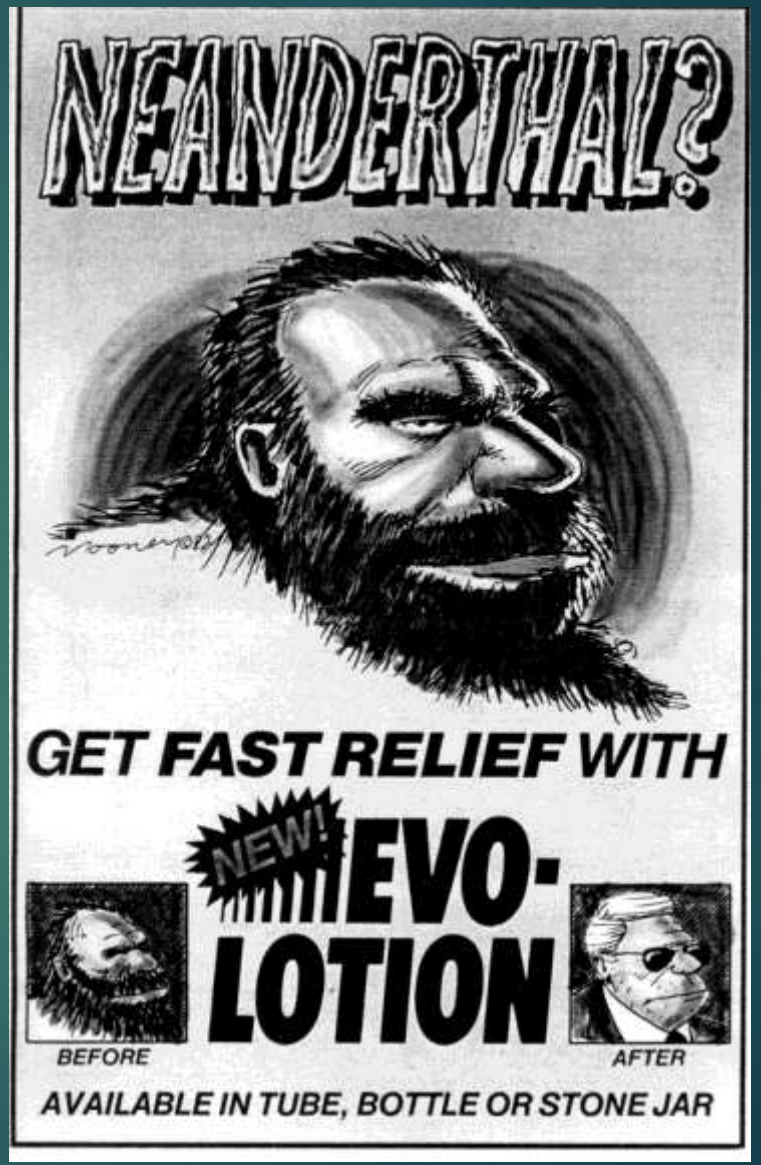
Negative depictions of Ns



Neanderthals: Earlier Views




AURORA
PREHISTORIC SCENES
SNAP TOGETHER
ALL PLASTIC
CUSTOM BUILDER KITS
NEANDERTHAL MAN
(HOMO NEANDERTHALENSIS)


NEANDERTHAL?
GET FAST RELIEF WITH
NEW!
EVO-LOTION
BEFORE
AFTER
AVAILABLE IN TUBE, BOTTLE OR STONE JAR

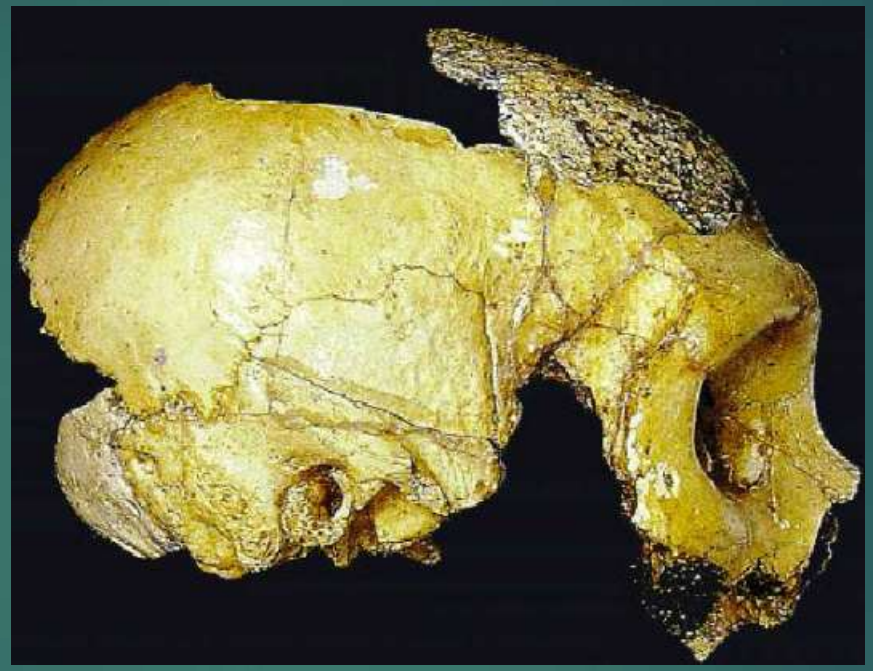
1993: Homo neanderthalensis, Altamura, Italy

Altamura Man, 130-170 K: fell down a hole

Date Discovered: 1993

Represents the most complete skeleton of a single nonmodern human ever found; DNA, 2016: 130,000+ years old; Oldest Neandertal DNA

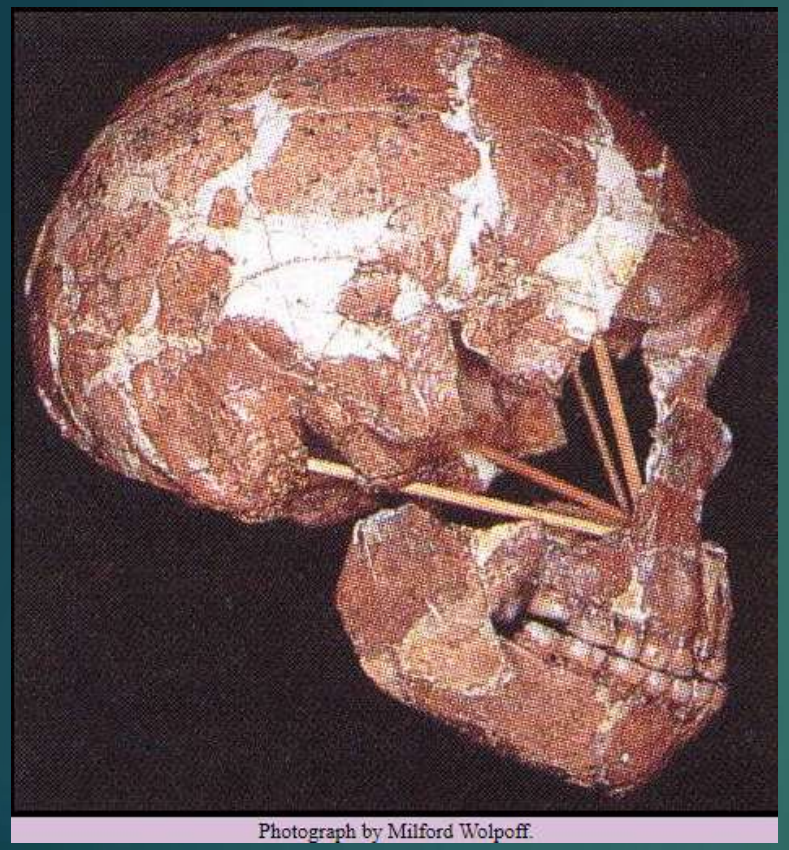
1899: 1000 fossils of 80 Neandertals, Krapina, Croatia, 130K



Homo neanderthalensis
(Karpina C)
Discoverer:
Karl Gorjanovic-Kramberger
Locality: Krapina cave, Croatia
Date:1899
Age: 130K

More than 1000 fossils, 80 individuals, ages of 16-24 years, dated to 130 kyr; over period of 50K; cannibalism?: the marks on the bones found at Krapina are indicative of defleshing, although whether this was for nutritional or ritual purposes cannot be determined with certainty

1932: Neandertal, Tabun I, Mount Carmel, Palestine, 122K



Photograph by Milford Wolpoff.

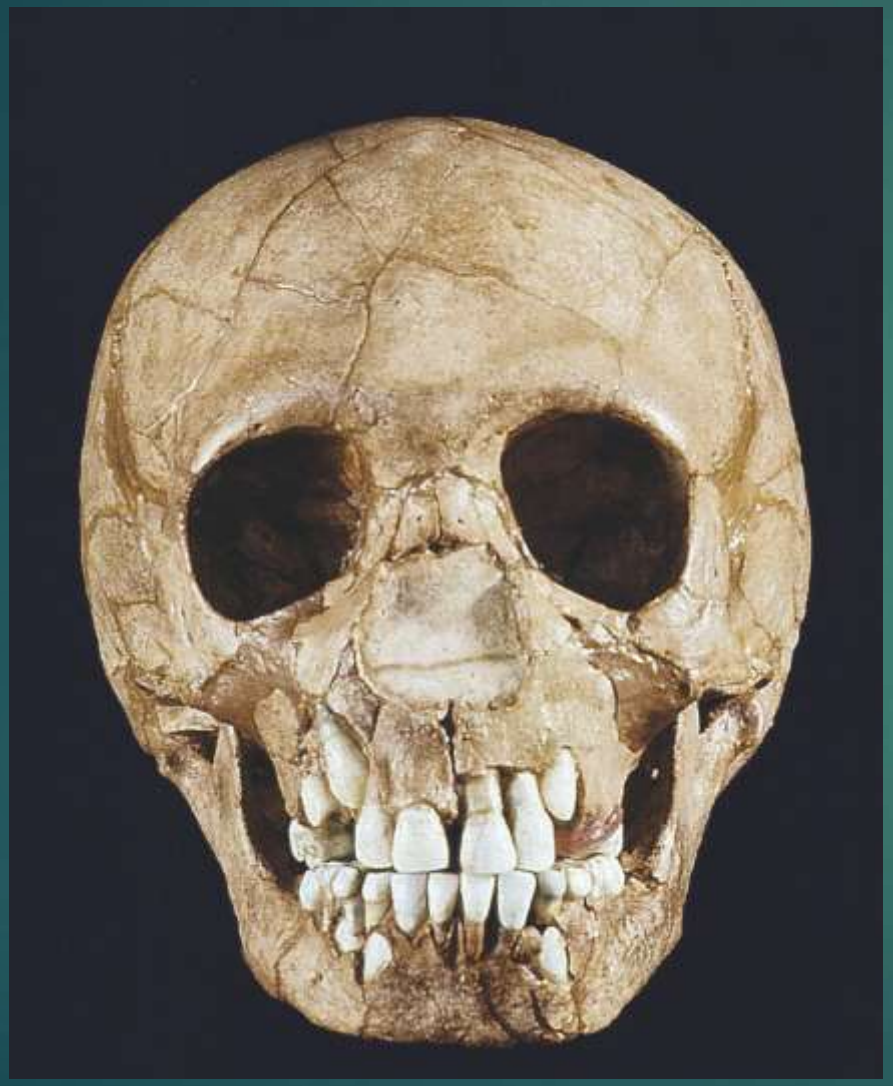
1929: *Homo Neandertalensis,* Saccopastore, Italy, 120K

Similar to N of Krapina, Croatia;
Early N – less thick boned

Homo neanderthalensis
(Saccopastore 1)
Discoverer: Mario Grazioli
Locality: Saccopastore quarry, Rome, Italy
Date:1929
Age: 120K

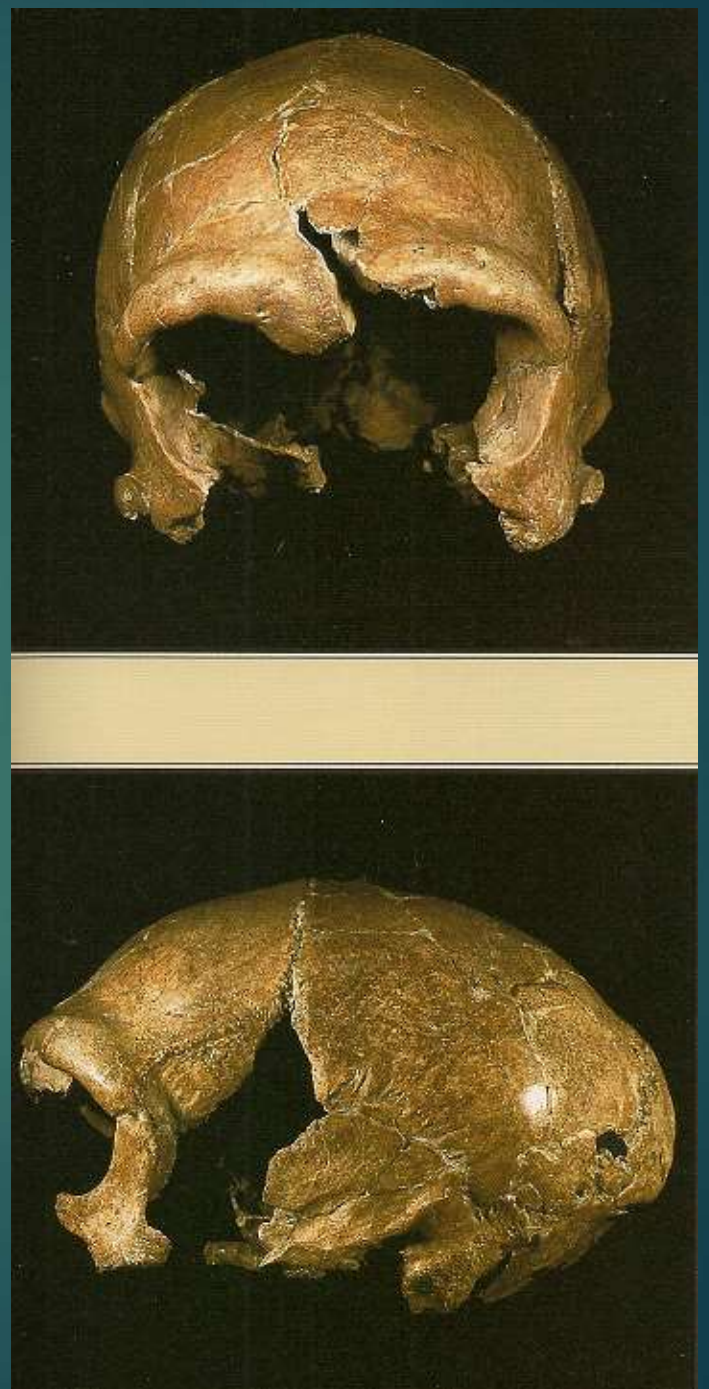
1938: Teshik-Tash Neandertal child, 70K

Bajsuntau, Uzbekistan

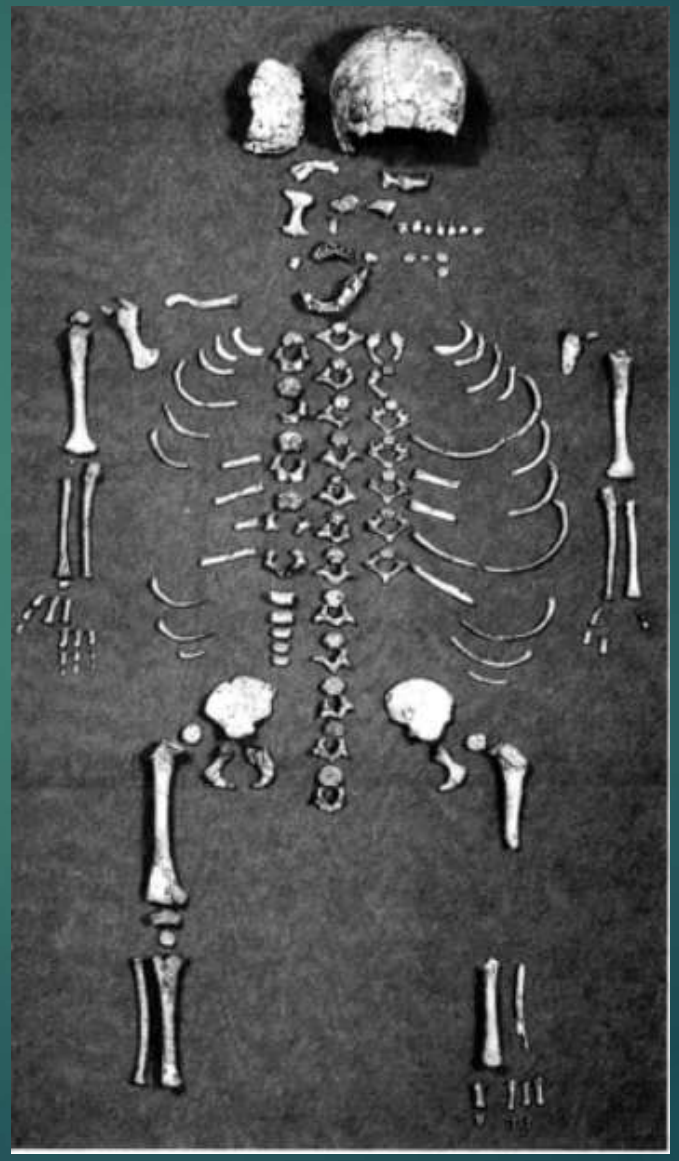


Homo neanderthalensis
(Teshik-Tash)
Discoverer: Alexei Okladnikov
Locality: Teshik-Tash, Uzbekistan
Date:1938
Age: 70K

1910: Neandertal, La Quina, 65K

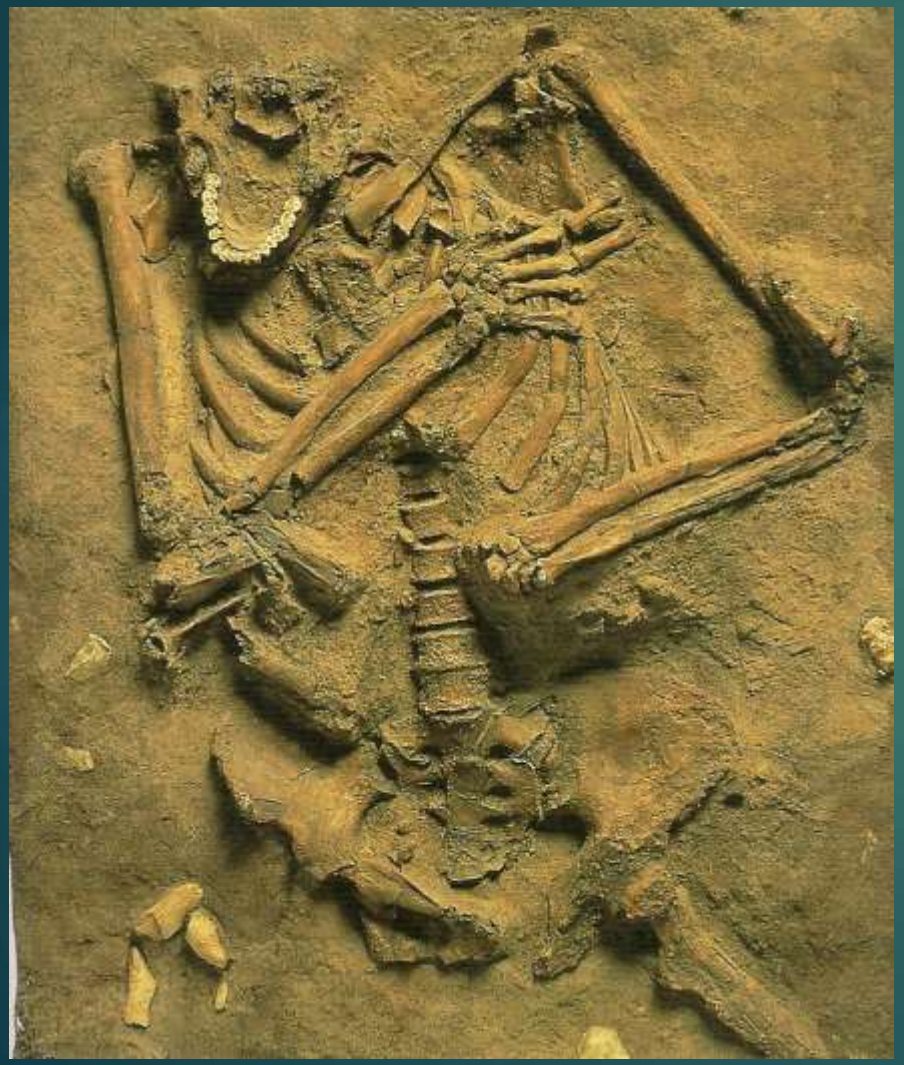


1993, Dederiyeh, Syria Infant, 60K



- Infant
- 60K

1983: *Homo neanderthalensis*, at Kebara, Israel, 60K
Most complete Neandertal specimen & hyoid bone



Homo neanderthalensis
(Kebara 2)
Discoverer: Lynne Schepartz
Locality: Kebara Cave, Israel

Pelvis

Hyoid bone

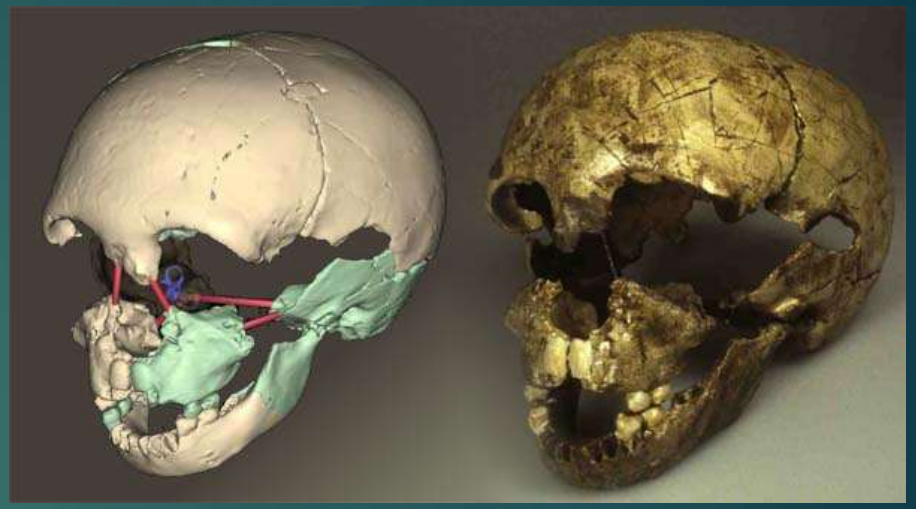
Kebara N skeleton, arms crossed, “Moshe”, 25-35 yo, 1.7 meters

Great Debate: Neandertal language

- A complete hyoid bone was found.
- Whether or not Neandertals possessed the ability to speak is a question that incites more furious debates than those on Neandertal burials.
- This hyoid bone is identical to ours, thus suggesting that the Neandertals shared our capacity for language.

With the discovery of a hyoid bone in Kebara Cave in Israel, scientists have been able to reconstruct the Neanderthal esophagus and deduce that they could indeed speak. The space between the tongue and the throat was smaller than our own, which indicates that they communicated with high pitched, nasally voices contrary to the brutish tones that they are attributed in sci-fi flicks.

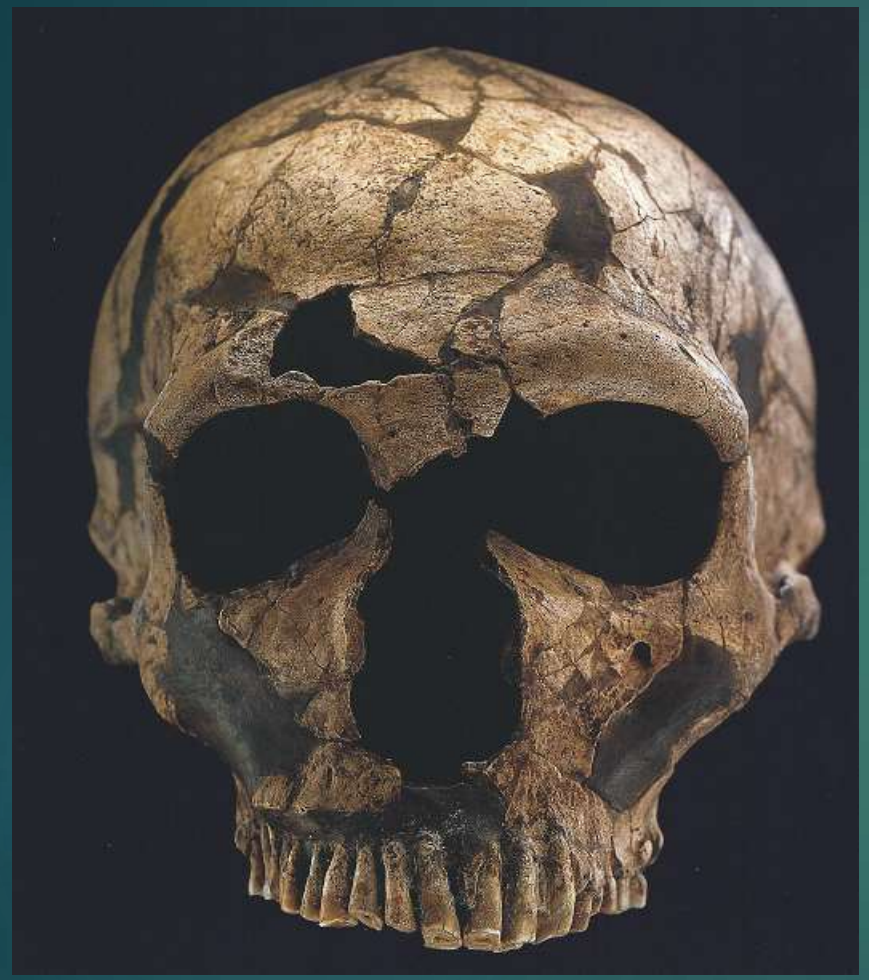
1925: Neandertal child, Devil's Tower, Gibraltar, 50K



Amud 7, Infant , 50-60K

Homo neanderthalensis
(Amud 7)
Discoverer: Tina Hietala & Yoel Rak
Locality: Amud Cave, Israel
Age: 50-60K
~Found at **Amud, Israel** in 1961 by a Japanese excavation team

1909, Discovery of most complete Neandertal skull at La Ferrassie, 50K

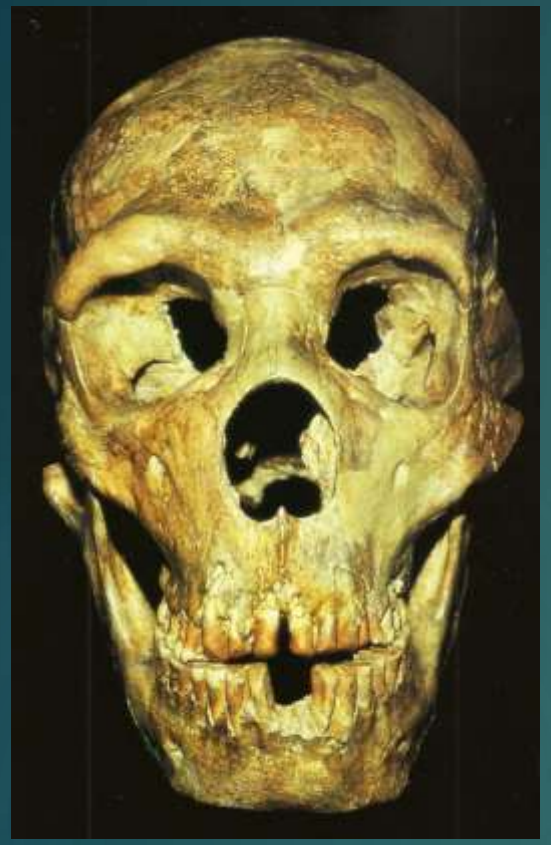


osteo-arthritic condition indicating that the person was cared for despite his lack of mobility

Homo neanderthalensis
(La Ferrassie 1)
Discoverer: Denis Peyrony & Louis Capitan
Locality: La Ferrassie, France
Age: 50K
Date: 1909

1908: Le Moustier, Neanderthal cranium, 45K

1957-1961: *Homo neanderthalensis*, Shanidar I, Iran, 45-35K



Shanidar cave in the Zagros Mountains. (Jan Sefti /CC BY SA 2.0)

- Ralph Solecki: *"Shanidar, the First Flower People"*
- Developed theory that Neandertals had religious beliefs: funeral ceremonies, burying their dead with flowers (although the flower pollen is now thought to be a modern contaminant by Persian Jirds, a gerbil; or bees
- Jean Auel used his ideas for background when she was writing her *Clan of the Cave Bear* series.

Shanidar 1: adult male, 40-50 years, old & injured

- Eye socket crushed- Blinded in that eye
- Had suffered substantial injuries to arms, legs, & head, which had partially healed, suggesting he had been cared for by otters

Left arm amputated above the elbow

Shanidar 1 = He was inspiration for Creb, the disabled shaman in Jean M. Auel's novel *The Clan of the Cave Bear* (1980)

Neandertals of Amud, Israel: Amud 1, 40K

- Amud Cave, Israel
- 16 Neandertals
- Dated: 40 to 60 kya

- Amud 1, 40 kya
- Brain = 1760 cc
- Largest hominid cranial capacity

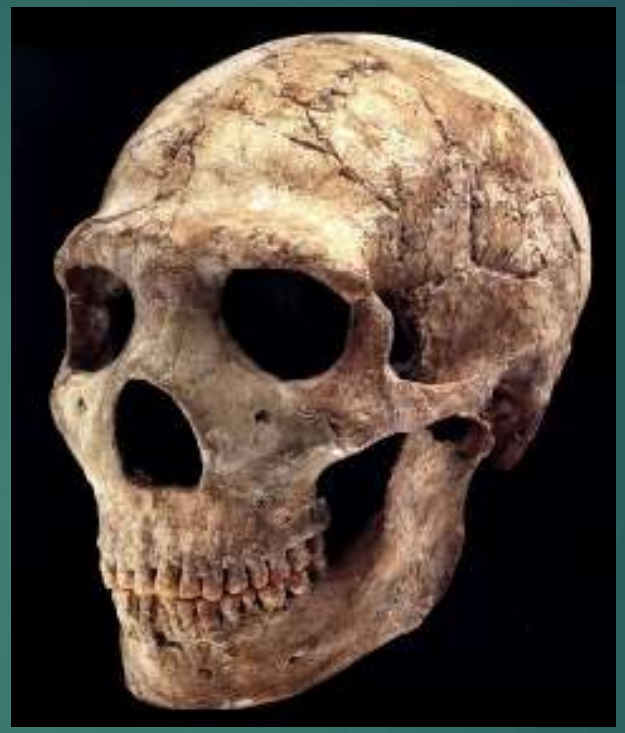
1979: *Homo Neanderthalensis*, Saint-Cesaire, one of last, 39K, associated with Châtelperronian artifacts

Discoverer: Francois Leveque; Locality: Fierrot's Rock, Charente-Maritime, France

Computerized construction

Young adult with cranial fracture likely due to a weapon

Classic Western vs. Levantine Neandertals



Levantine Ns were younger;
Younger also than MHs in area

Amud 1:
Tallest (1.8 m) & largest hominin brain (1740cc)
Date: 53 K

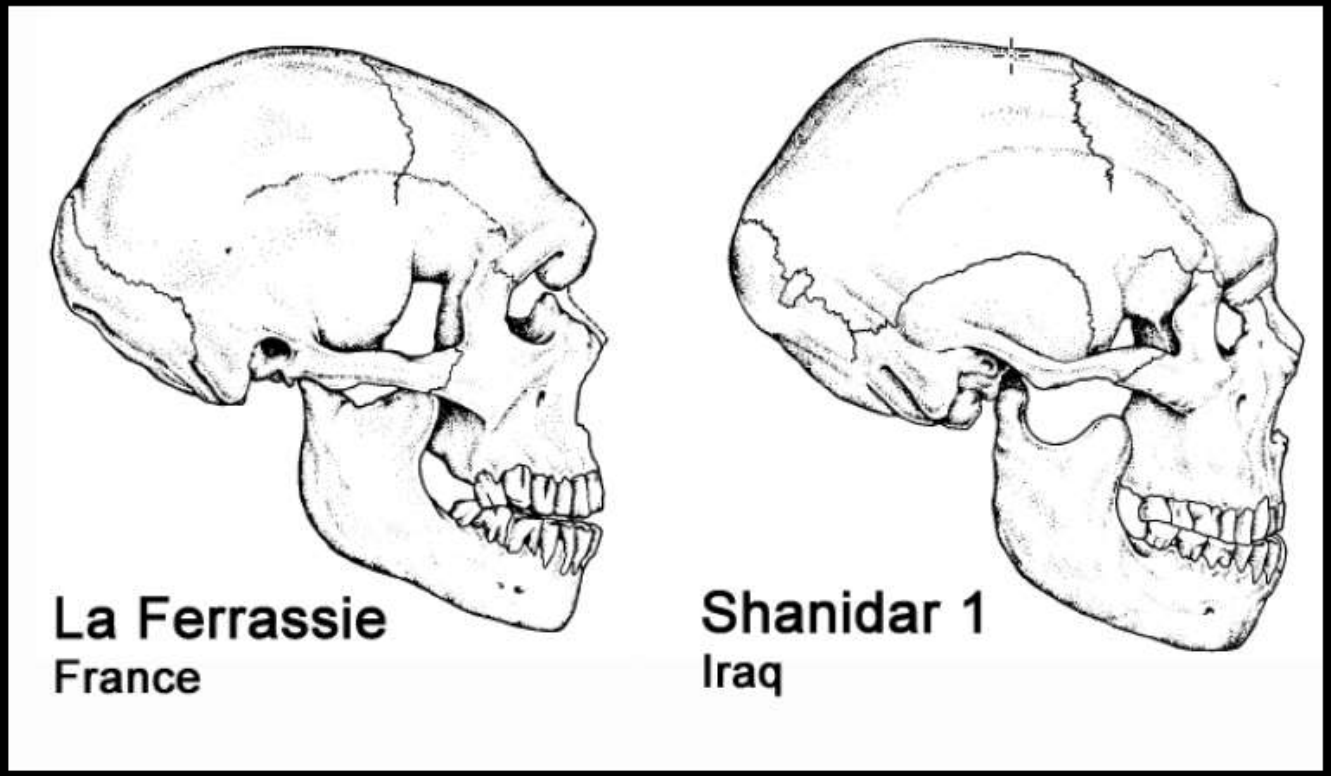
Shanidar 1

· Other features described as “intermediate” between “Classic” Neanderthal and mod H. sap

Less facial prognathism

Cranial capacity varies widely

Males taller



From Trinkaus 1979

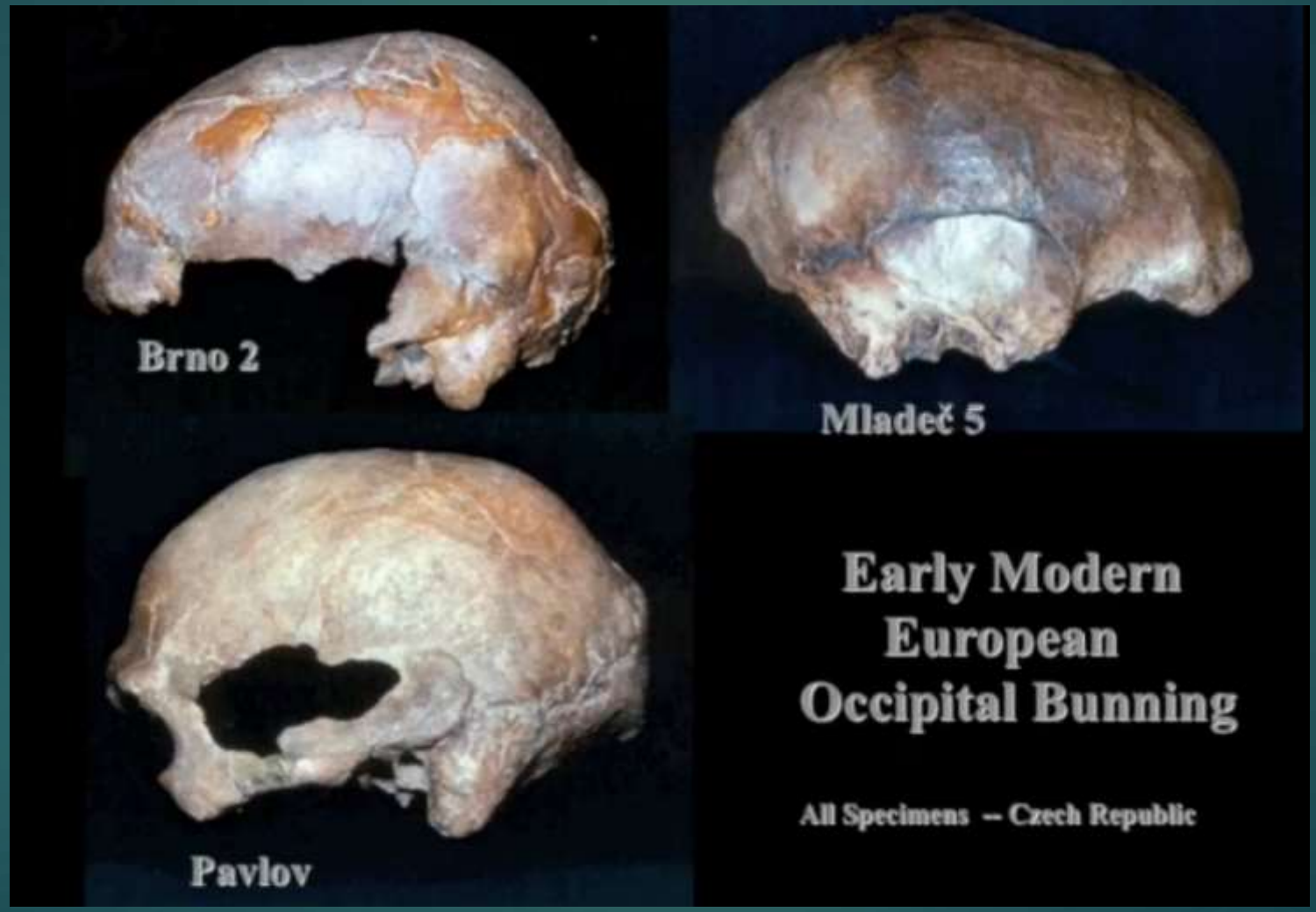
Before DNA Hybrid Debate: Lagar Velho, Portugal, child: 27 K

- 1998: 4 yo child at Gravettian rock shelter, Lagar Velho; buried with pierced shell, red ocher; clearly modern
- Zilhao & Erik Trinkaus: had N traits
- Stringer & Tattersall: just modern child
- Zilhao & Trinkaus: N did not become extinct; absorbed into MH population via hybridization and more widespread population mixing
- Stringer & Tattersall: MHs took over Europe from Ns who became extinct; "leaky replacement" (limited interbreeding at 50-60K in Western Asia)

FIGURE 12.41 Lagar Velho
This skeleton of a child was discovered at a rockshelter site in Portugal's Lapedo Valley.

Duarte et al. 1999

Some Early Moderns had Occipital Bunning from N admixture



Neanderthal Occipital Bunning is brain driven

Endocast

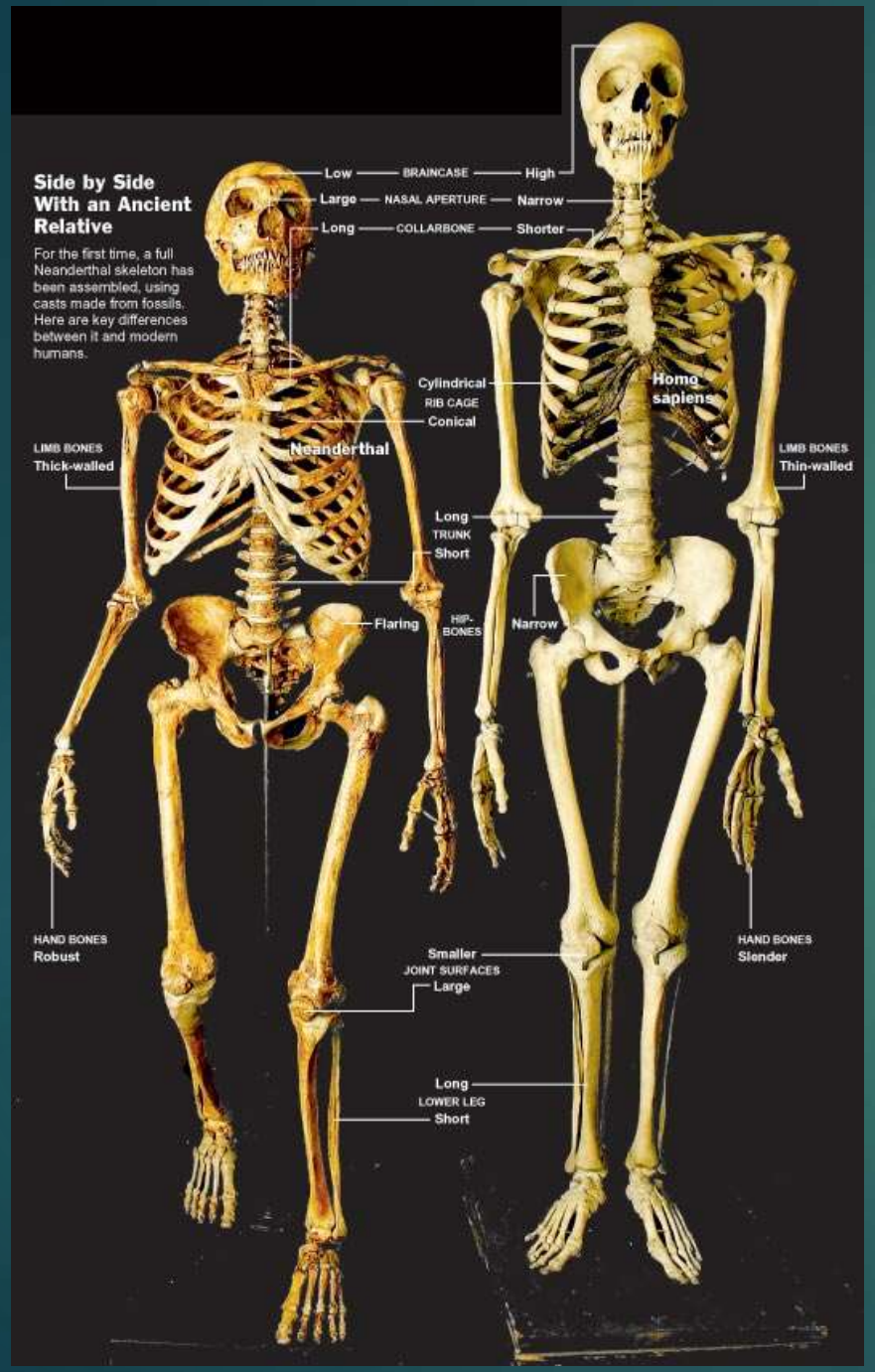
Neandertals had Enhanced Visual system

- In the case of Neanderthals and AMHs, differences in the size of the body and visual system imply differences in organization between the same-sized brains of these two taxa.
- Neanderthals had significantly larger orbits than contemporary AMHs. Neanderthal occipital lobes are relatively larger than those of AMHs. Due to larger bodies, Neanderthal also invested more neural tissue in somatic areas involved in body maintenance and control
- Neanderthals btw 27-75 kay do not show significantly larger brains than contemporary AMHs
- Using endocranial volumes, Neanderthals had significantly larger visual systems than contemporary AMHs (indexed by orbital volume) and that when this, along with their greater body mass, is taken into account, Neanderthals have significantly smaller adjusted endocranial capacities than contemporary AMHs
- Neanderthals enlarged their visual and somatic regions, whereas AMHs achieved similarly large brains by increasing other brain areas (including their parietal lobes)

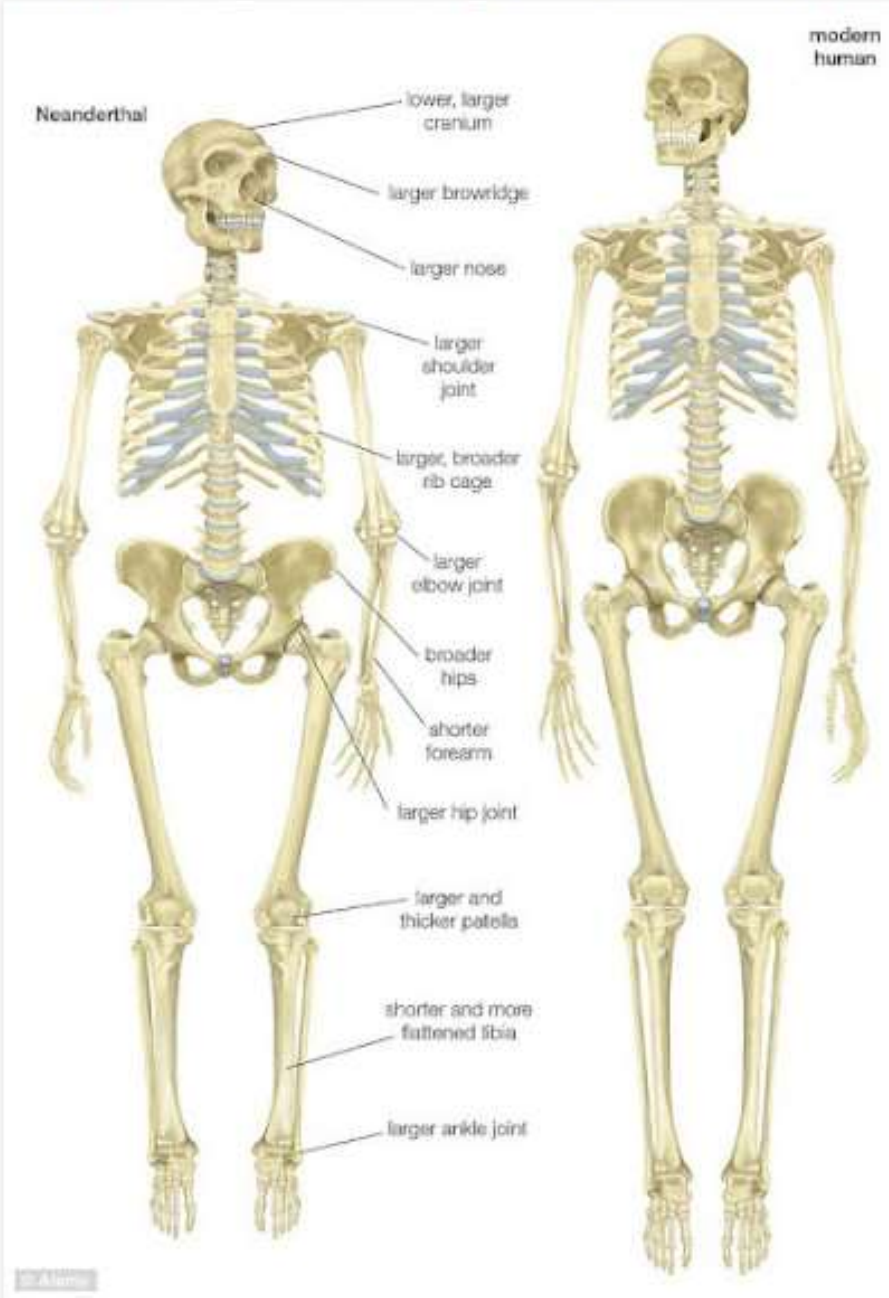
Eiluned Pearce, Chris Stringer and R. I. M. Dunbar,, 2013

A Comparison: Side by Side With A Relative

- Brain case: low vs. high
- Nasal opening: large vs. narrow
- Collarbone: long vs. shorter
- Rib cage: conical vs. cylindrical
- Limb bones: thick-walled vs. thin-walled
- Hand bones: robust vs. slender
- Trunk: short vs. long
- Hips: flaring vs. narrow
- Joint surfaces: large vs. smaller
- Lower leg: shorter vs. longer
- Bowed limbs vs. straight limbs



Neanderthals by Zdenek Burian. Below, Specific points of difference in the Neanderthal skeleton.



Very High Daily Energy Requirements

- Sorenson and Leonard:
- Estimated their total energy expenditure by calculating their basal metabolic rates
- Neanderthals ranged from 3000-5500 kcal/day
- Modern human populations ranged from 2720 +/- 607 kcal/day
- Neanderthals had higher daily energy requirements

N Diet: regional and food diversity

- Neandertal diet was more diverse than generally acknowledged, and varied according to different environments.
- Teeth plaques reveal N ate 80% meat, 20% vegetables; 2014 fossilized feces study indicates more plant usage
- The faunal remains in Mediterranean regions indicate:
  - an abundance of small ungulates i.e. gazelle, roe deer, fallow deer, caprids at cave sites such as Kebara, Misliya, & Amud;
  - also small prey, such as wild rabbits, tortoise, ducks.
  - Capture of raptors, corvids and wood pigeons for removal of wing feathers is documented by cutmarks and bone breakage.
  - Also hare, beaver, marmot and some carnivore (bear, fox), freshwater fish (trout, chub, eel)
- Their diet was not restricted to large and medium size herbivores only.
- Several sites document a broader diet, including aquatic foods, small fast game (birds, rabbits) as well as plant resources

N Plant Diet: N used 61 different plants

- Ns were top predators, expert hunters, who consumed large amounts of meat; they were primary butchers (not just scavengers), selected prey from throughout herds (not just weak)
- 2016 Study: 61 different taxa from 26 different plant families found at 17 different archaeological sites.
- Neanderthals across the entire range probably consumed as many plant species as did modern humans. Fairly efficient gatherers: Berries, greens, roots – plants with limited time frame (few weeks)
- Evidence for the cooking of plants, in the form of smoke-related compounds, methylated lipids, and heat-cracked starch grains trapped in calculus.
- Used plants medicinally: at El Sidrón, yarrow and chamomile, both bitter-tasting plants with little nutritional value; N had bitter taste perception gene.

Gerhard P. Shipley and Kelly Kindscher, 2016

N Diet

- Evidence for the cooking of plants, in the form of smoke-related compounds, methylated lipids, and heat-cracked starch grains trapped in calculus.

- Used plants medicinally: at El Sidrón, yarrow and chamomile, both bitter-tasting plants with little nutritional value; N had bitter taste perception gene.

El Sidrón, Spain adolescent dental plaque: had abscess

Upper jaw of a Neanderthal from El Sidron in norther Spain. Analysis of a dental calculus deposit (visible on the rear molar) suggests the individual ate poplar, a source of aspirin, and *Penicillium* fungus, which produces the antibiotic penicillin.

PALEOANTHROPOLOGY GROUP MNCN-CSIC

Data from N teeth: regional diets at 50K

- DNA extracted from the hardened tooth plaque of five Neanderthals living in the El Sidrón Cave in northern Spain some 50,000 years ago:
- By sequencing DNA in Neandertal dental plaque,
  - At Spy cave, Belgium, Northern Neanderthal diet was heavily meat based and included woolly rhinoceros and wild sheep (mouflon), characteristic of a steppe environment.
  - In contrast, no meat was detected in the diet of Southern Neanderthals from El Sidrón cave, Spain, and dietary components of mushrooms, pine nuts, and moss reflected forest gathering. Also consumed molded herbaceous material.

Laura S. Weyrich, et al., Nature, 2017

Dietary self medication

- El Sidrón 1 may have been self-medicating a dental abscess.
  - ate poplar, which contains the natural pain-killer salicylic acid (the active ingredient in aspirin),
  - natural antibiotic producing Penicillium from the molded herbaceous material.
  - intracellular eukaryotic pathogen microsporidia (Enterocytozoon bieneusi), which causes acute diarrhea in humans
- Humans and Neandertals appeared to swap mouth microbes at one point in time…through kissing or sharing food.

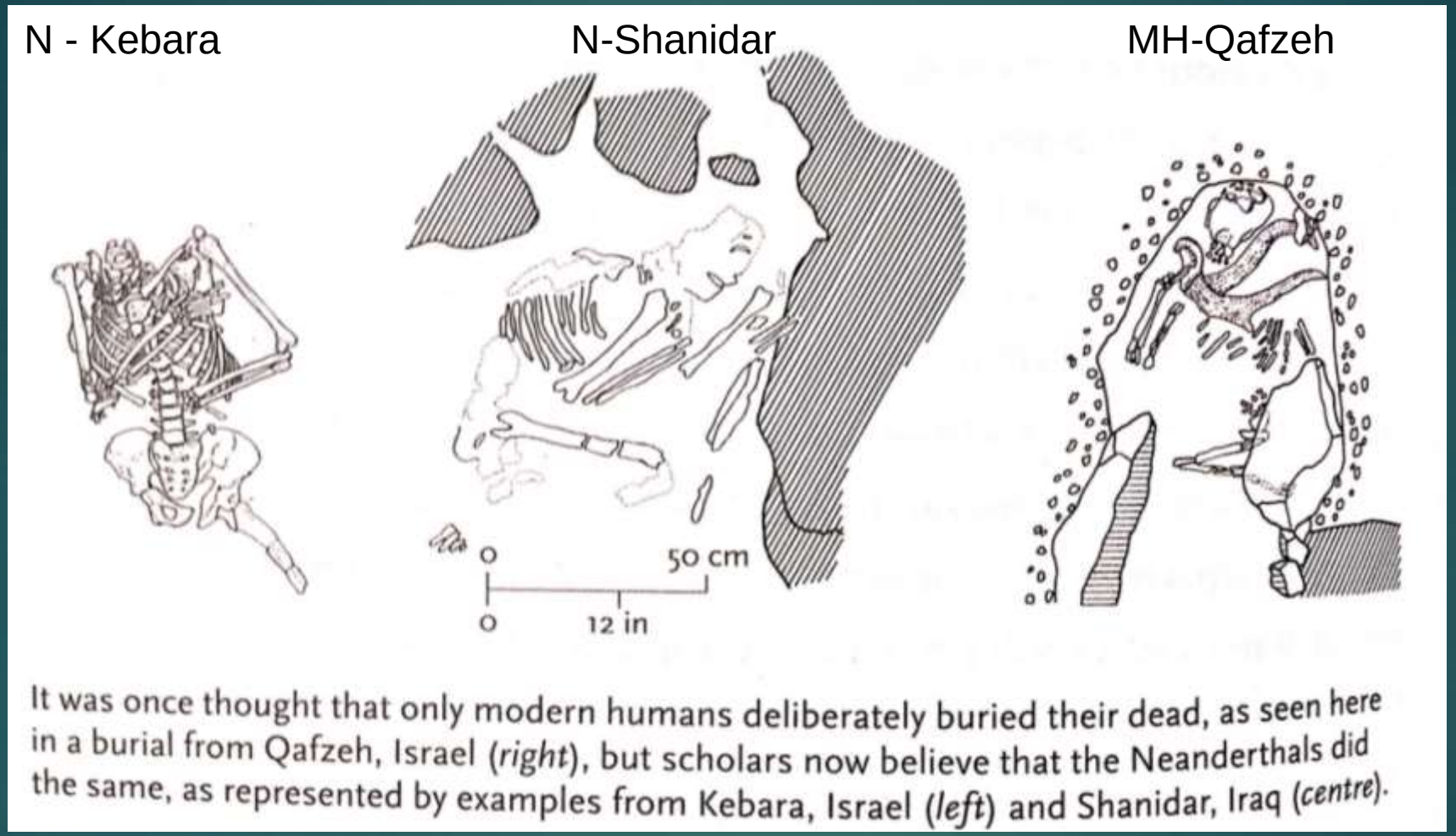
N diet

- At Gibraltar: monk seals, dolphins, shellfish, (mussels, limpets, cockles), tortoises, rock pigeons, rabbit, ibex, red deer
- Evidence for continuous use of coastal resources between ~150 and 40 ka
- They used toothpicks
- Also teeth evidence of that periods of severe starvation were not uncommon

Homo neanderthalensis: Burials

- Burials:
  - first people thought to have buried their dead
  - 36 Neanderthal sites show evidence of intentional internment of the dead, and in some graves there were remains of offerings: stone tools, the pigment red ocher, and the bones of large game animals are known
  - Original idea that some graves at Shanidar, Iran, were adorned with offerings such as flowers, has been reinterpreted (due to Persian Jird intrusions)

Both N and MH buried their dead



It was once thought that only modern humans deliberately buried their dead, as seen here in a burial from Qafzeh, Israel (*right*), but scholars now believe that the Neanderthals did the same, as represented by examples from Kebara, Israel (*left*) and Shanidar, Iraq (*centre*).

Some animal bones found in N burials; but much more at MH burials: shell beads, red ocher

Papagianni & Morse, 2015

Reconstruction of Neandertal Burial

Neandertals

- Used teeth & jaws like vice, as 3rd hand; teeth very worn down

- Mostly right handed; right arm muscles stronger, but unlike us, right arms were very much stronger than left; for clothes-making through hide scraping; but no bone needles; The particular characteristics of Neandertal humeri may reflect adaptation to regular scraping activities and not spear thrusting.

2010: Neandertal Genome

© Max Planck Inst. Evol. Anthropol.

Most of the Neanderthal genome was sequenced from bones found in Vindija cave, Croatia.

Neanderthal Genome 2010,
(S. Paabo, Max Planck Institute)

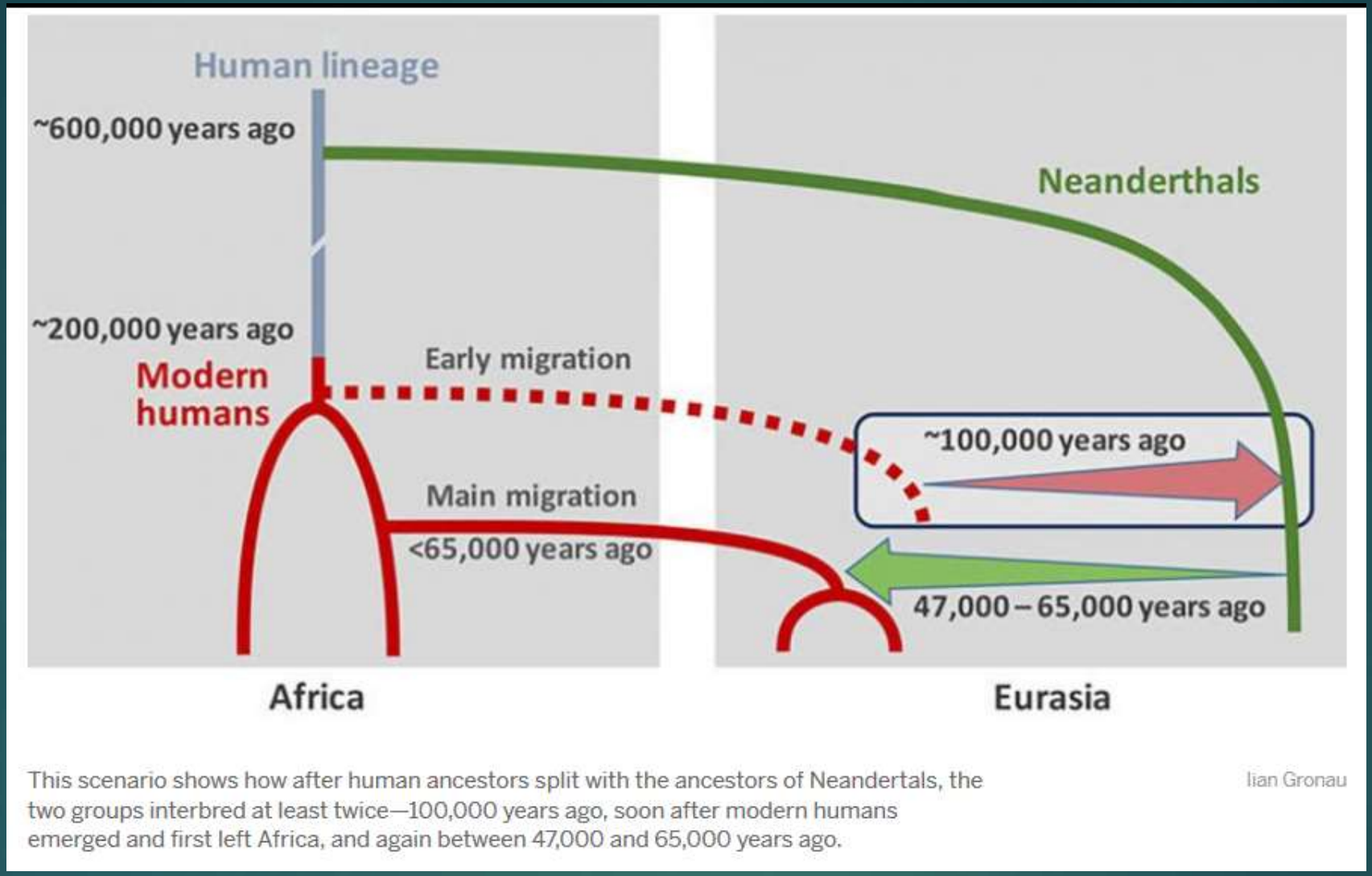
- 2010: proved gene flow from Neanderthals to modern humans between 50-80K ago
- All modern non African humans have 1-2% Neandertal DNA; but not same 1-2%

Green *et al.*, *Science* **328**, 710 (2010)

Divergences & Gene Flow: Lots of interbreeding

- Analysis of Neandertal genome from a cave in the Altai Mountains in Siberia suggests that MH and N diverged 550 to 765 kya.
- Denisovan genome from the same cave in the Altai Mountains suggests that Neanderthals and Denisovans diverged 381-473 kya.
- Multiple admixtures among archaic and modern human populations:
  - gene flow from Neanderthals into modern humans outside of Africa,
  - Denisovan gene flow into MHs in Oceania and mainland Asia,
  - gene flow into the Denisovans from Neanderthals
  - possibly, gene flow into Denisovans (3-6%) from an unknown archaic group (*Homo erectus*, ~400K)that diverged from the other lineages more than one million years ago.
  - gene flow from early MHs into Neanderthals ~100 kya

Martin Kuhlwilm, et al., Nature, 2016



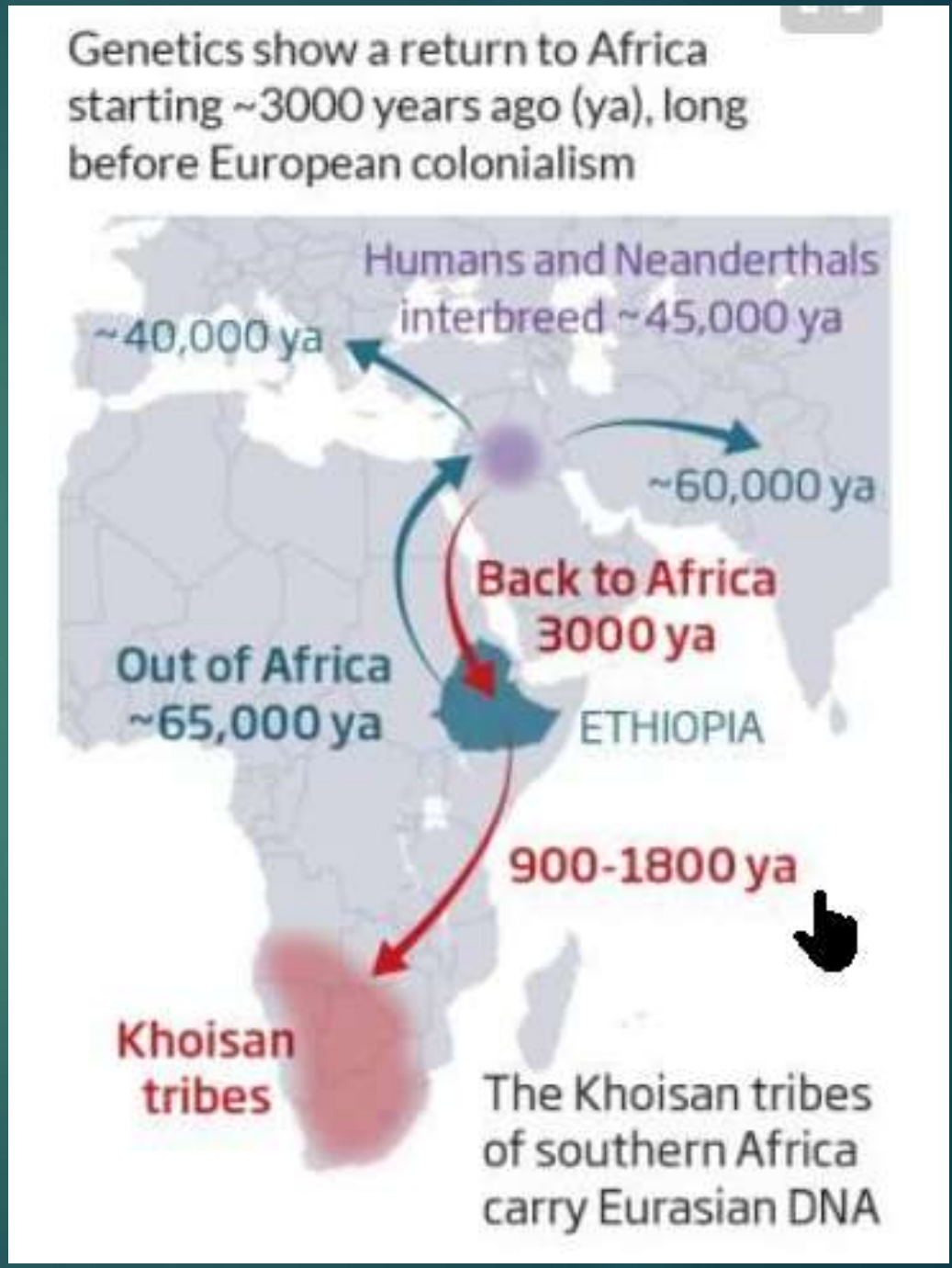
This scenario shows how after human ancestors split with the ancestors of Neandertals, the two groups interbred at least twice—100,000 years ago, soon after modern humans emerged and first left Africa, and again between 47,000 and 65,000 years ago.

Iian Gronau

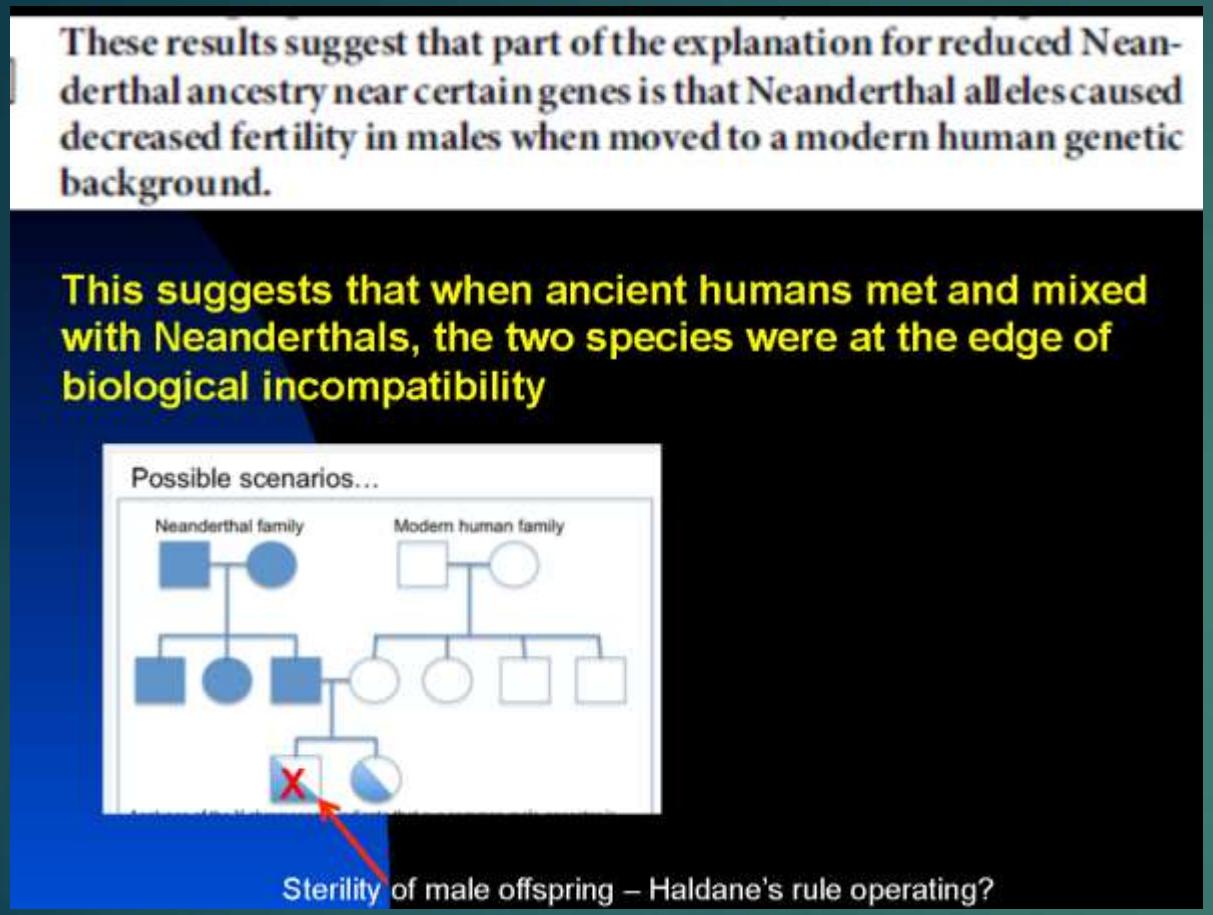
1st, circa 100K, MHs mixed with Neandertals in the Middle East or the Arabian Peninsula, & went extinct; 2nd, another group of modern humans left Africa much later and interbred 50,000 to 60,000 years ago with Neandertals that had headed south from Europe to the Middle East; Some of this group of modern humans also encountered Denisovans,

Some Africans have N DNA:

- "All modern non African humans have 1-2%"
- But ~ 3000 ya MHs with Neandertal DNA returned to Africa
- Today there is N DNA in some Khoisan tribes of S Africa



Neandertal male hybrid sterility



Neandertal versions of genes in the testes, including some needed for sperm function, were also less active than human varieties. That finding is consistent with earlier studies that suggested male human-Neandertal hybrids may have been infertile.

Neanderthals were more inbred than modern humans and accumulated more mutations that have a slightly adverse effect.

Natural selection in the larger human population started purging those mutations

R.C. McCoy et al. Impacts of Neanderthal-introgressed sequences on the landscape of human gene expression. *Cell*. Vol. 168, February 23, 2017,

N gene alleles in MH genome: Conditions associated with N alleles;

Type 2 diabetes
Lupus
Crohn’s disease (2 alleles)
Primary biliary cirrhosis
Variation in keratin in skin & hair
Variation in interleukin-18 levels; & innate immunity genes (Toll-like receptor (TLR) genes--TLR1, TLR6, and TLR10) & more allergies
Variation in optic disc size
Variation in smoking behavior, depression
Green eyes & red & blonde hair
FOXP2 (language)
O blood type

B. Vernot & J. Akey, 2014; Sankaraman et al., Nature, 2014

N gene alleles

- Pale skin
- Human papillomavirus HPV16 strain from N or D
- Propensity to sneeze after eating dark chocolate.
- Propensity to get scaly lesions after extreme sun exposure
- Risk for tobacco addiction.
- Both increased and decreased risk for depression (1-2%).
- Trait for faster blood clotting. In the modern world, however, this trait means greater risk for stroke and pregnancy complications. What helped us then, doesn’t necessarily now.

And the other way…Infections from MHs to Ns

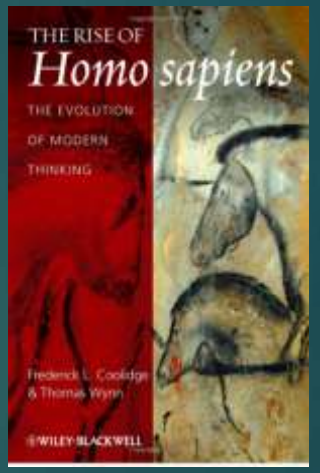
- Tropical infections were likely to have passed from humans to Neanderthals -- such as tapeworm, tuberculosis, stomach ulcers and types of herpes -- chronic diseases that would have weakened the hunter-gathering Neanderthals
  - *Helicobacter pylori*, a bacterium that causes stomach ulcers, as a prime candidate for a disease that humans may have passed to Neanderthals
  - Herpes simplex 2

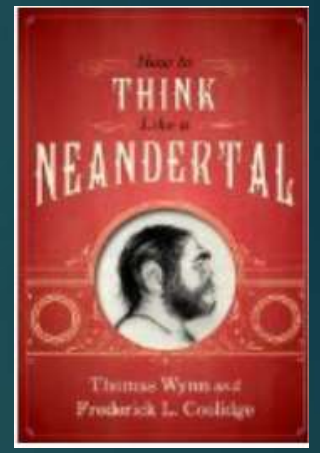
Not Us and Them

- Paabo now recommends against imagining separate species of human evolution altogether: not an Us and a Them, but one enormous “metapopulation” composed of shifting clusters of essentially human-ish things that periodically coincided in time and space and, when they happened to bump into one another, occasionally had sex.
- Finlayson: “Each valley could have told a different story. In one, they may have hit each other over the head. In another, they may have made love. In another, they ignored each other.”
- Jon Mooallem: “a superlong elevator ride with strangers.”
- Can we say that Ns were less than fully human?

N Cognition

- Thomas Wynn & F. Coolidge; Univ. of Colorado; archeologist & neuropsychologist
- T. Wynn helped to found the field of cognitive archeology
- Wynn & Coolidge argue:
  - H. sapiens: advanced working memory was core cognitive feature
  - N's cognition centered primarily on expertise or behavioral memory. Neanderthals were good at "expert" cognition, a form of observational learning and practice acquired through apprenticeship that relies heavily on long-term procedural memory





N symbolism

- This growing body of evidence creates a more dynamic image of Neandertal cultures and challenges the idea that they were essentially static, closed to innovation and without symbolic imaging:
- Burials & Grave goods in the form of faunal remains, stone and bone tools, engraved bone, and rock slab engraved with cupules
- Language: N hyoid bone, FOXP2,
- Pech de l'Azé manganese use as pigment & to rekindle or maintain a fire;
- Use of pigment (ocher), since 250 kya, becomes widespread after 60 ky and is associated with the discovery of pigment processing tools and pigment containers.
- perforated shells in Slovenia, 50 kya
- mollusks as food, klg of seasonal availability
- transport and coloring of exotic objects and their possible use as pendants
- Increased distance that they transported stone to make tools
- extraction of large feathers from raptors, corvids and pigeons
- Self medication with aspirin and penicillin containing plants

N Symbolism 2

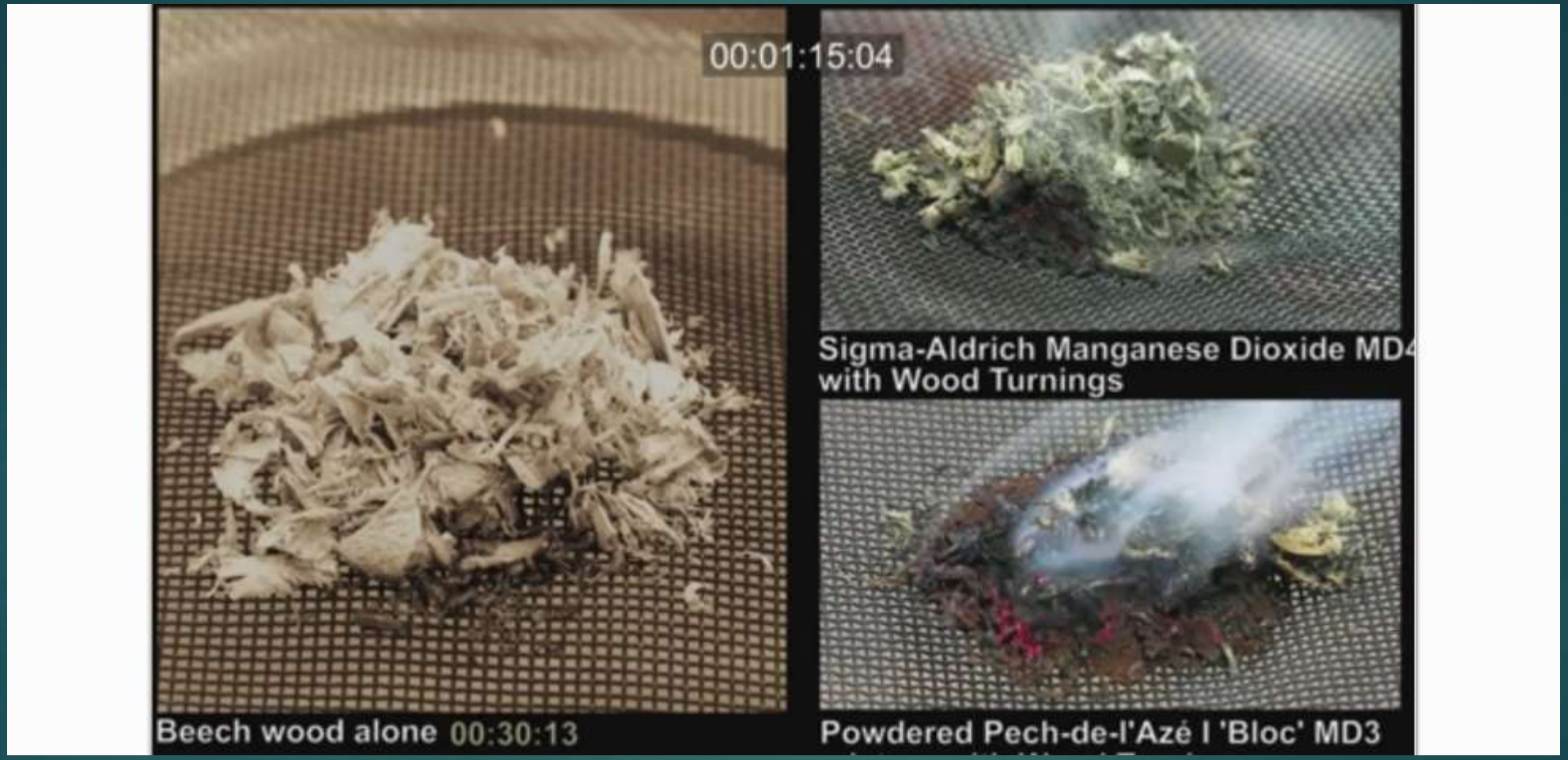
- eagle talon & mollusk shell pendants;
- working both bone and ivory for making tools and ornaments; evidence of bone points, awls, perforated bones & teeth, ivory rings, cut antlers, antler digging picks
- bladelet production occurs in Acheulean and later Mousterian; Levallois spear points
- complex manufacture of birch-bark pitch as adhesive
- use of *lissoirs* (leather working bone tool) (51K);
- perforated animal teeth of different species;
- Chatelperronian tools & jewelry
- all above well before the arrival of MHs circa 42K

Neandertal Symbolic Behavior?

- 2010: Two N sites of Middle Paleolithic of Iberia, dated to as early as approximately 50 kya, yielded perforated and pigment-stained marine shells; recovered in Mousterian levels dated to ca 50 ky BP at Cueva de Los Aviones and Cueva Antón in the Iberian Peninsula.
- Evidence for body ornamentation, implying behavioral modernity.

Perforated and painted shells indicate Neandertal symbolic behavior: Zilhao *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **107**, 1023 (2010).

Use of Manganese Dioxide to ignite fires



40 N sites have manganese dioxide. Neanderthals at Pech-de-l'Azé I used manganese dioxide in fire-making and produced fire on demand. Manganese dioxide reduces wood's auto-ignition temperature and substantially increases the rate of combustion,

Peter J. Heyes, et al., Nature, 2016

Birch-bark pitch technology, 70K

- Some wooden tools (including thrusting spears) tipped with stone points:
  - manufacture of birch-bark pitch at a Neanderthal site at Konigsaue, Germany, used to affix stone points or blades to hafts of wood, antler, or bone; adhesive for composite tools
- From 200 kya, European Neandertals used fire to synthesize pitch from bark, through a process that involved dry distillation in the absence of oxygen and within a temperature interval of 340°C–400°C
- Neandertals used fire to heat-treat existing natural materials, such as bitumen for hafting purposes. This is clear from 70,000-y-old tools with traces of bitumen on their surfaces.

Johann Koller, Ursula Baumer & Dietrich Mania, 2001

A beginning of art and modern culture?

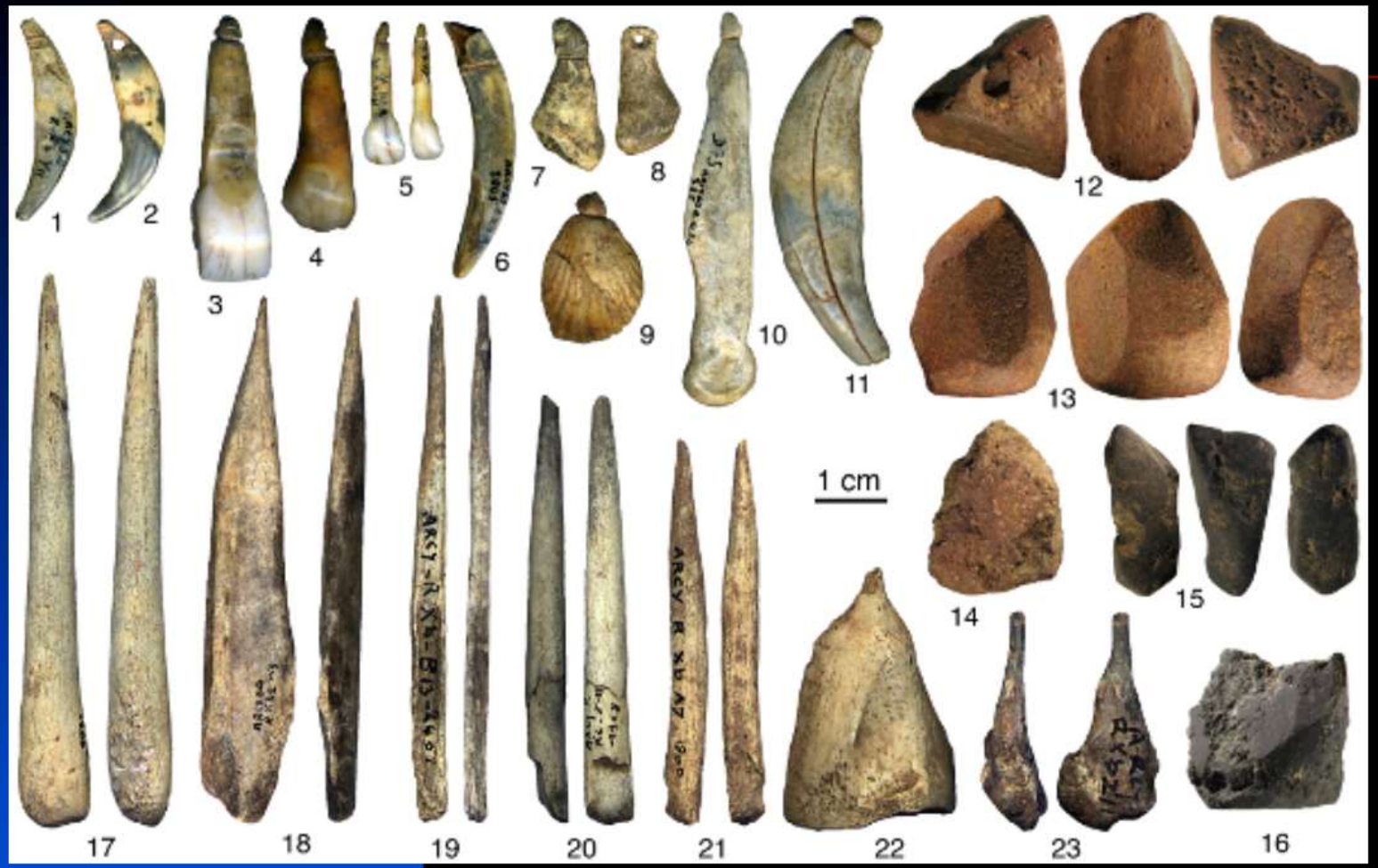
- No representational carvings

- Red & yellow ochre
- Perforated & grooved animal bones & teeth
- Maybe art, maybe natural causes

- One site of Neandertal remains + Chatelperronian industry 40 - 27 kya
  - (usually modern human)
  - Bone tools
  - Carved bone pendant
  - Pierced bones & teeth
  - Blade tools
  - Shelter construction

The final Neanderthals in France (33,000–30,000 years ago) began to make ornaments from animal bone and teeth, such as this necklace from Arcy sur Cure.

Châtelperronian material: the product of Neanderthals ~42,000 years ago?



2016: Chatelperronian tools & jewelry definitely Neandertal

Châtelperronian Neanderthal bone artefacts from the Grotte du Renne (Arcy-sur-Cure, France)

Palaeoproteomic evidence identifies archaic hominins associated with the Châtelperronian at the Grotte du Renne

Frido Welker, et al., 2016

2016: Neandertals made their own jewelry at 42K, new protein method confirms

- The “necklaces” are tiny: beads of animal teeth, shells, and ivory no more than a centimeter long. Found in the Grotte du Renne cave at Arcy-sur-Cure in central France, they accompanied delicate bone tools and were found in the same layers as fossils from Neandertals.
- Others argued that Neandertals were incapable of the kind of **symbolic expression** reflected in the jewelry and insisted that modern humans must have been the creators.
- Study uses a new method that relies on ancient proteins (asparagine collagen specific to N) to identify and directly date Neandertal bone fragments from Grotte du Renne (single, immature, breastfed N) and finds that the connection between the archaic humans and the artifacts is real.

Neanderthals & black Corvid feathers

Clive Finlayson models griffon plumage. The ulna was removed from the carcass with a flint tool and the feathers left intact. Most of the birds Neandertals used were smaller and thus perhaps better suited to headdresses. Image: Kate Wong

- 2012 *PLOS ONE study:* 1699 fossil sites in Eurasia and north Africa spanning the Pleistocene epoch.
- Neandertals across western Eurasia were strongly associated with corvids and raptors (vultures and their relatives)—more so than were the anatomically modern humans who succeeded them.
- Cave sites from Italy, France and Spain yielded evidence of intentional extraction of feathers or terminal pedal phalanges of large raptors and other birds.

Bonelli's eagle is one of the raptor species Neandertals hunted, presumably for its dark feathers. Image: Clive Finlayson

Neandertal Eagle Talon necklace, 130K

Neandertal Pendant, 130K

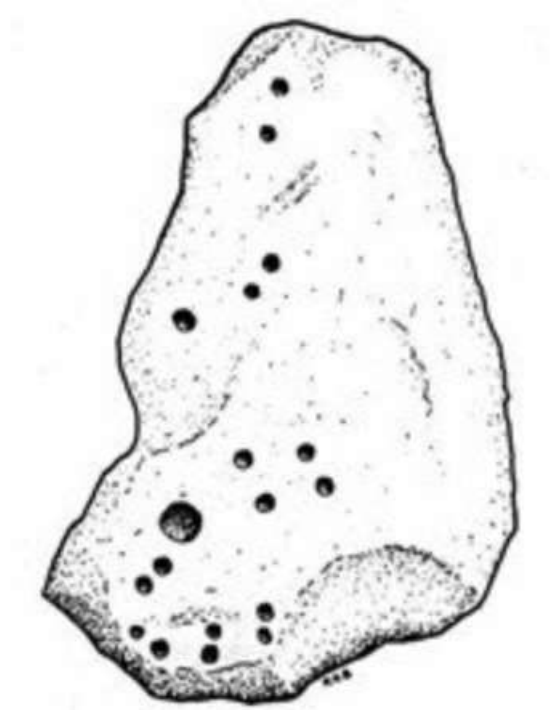
N use of bone 'lissoirs‘ for leather working; 51K

Four views of the most complete lissoir found during excavations at the Neanderthal site of Abri Peyrony in France. Photograph: Abri Peyrony/Pech-de-l'Azé I Projects

Lissoirs, made of deer ribs, would have been used by Neanderthals to prepare hides. Eventually the tips would break off. Illustration: Abri Peyrony/Pech-de-l'Azé I Projects

The slender, curved implements called "lissoirs" were shaped from deer ribs and likely used to work animal hides to make them softer, tougher and more waterproof. Similar tools, called slickers or burnishers, are still in use by leather workers today, Found the first large piece of a lissoir at a cave called Pech-de-l'Azé I on a tributary of the Dordogne in southwest France, dated to 51K; also another site, 41-48 K

La Ferrassie Cave Neandertal Cupules (~ 60 kya)



Sketch of Cupules found on slab over tomb at La Ferrassie Cave

Series of cupules - a primitive form of rock art - dating back to Mousterian culture (c 60,000 BCE), which makes it among the oldest prehistoric art in Europe. At *La Ferrassie burial 6*, a large limestone slab was found covering the grave of a Neanderthal child. On its underside was found an arrangement of cupule-art, consisting of 2 larger hollows and eight pairs of smaller holes.

2014: Neandertal Art

2014: Gotham’s Cave, Gibraltar, 40K

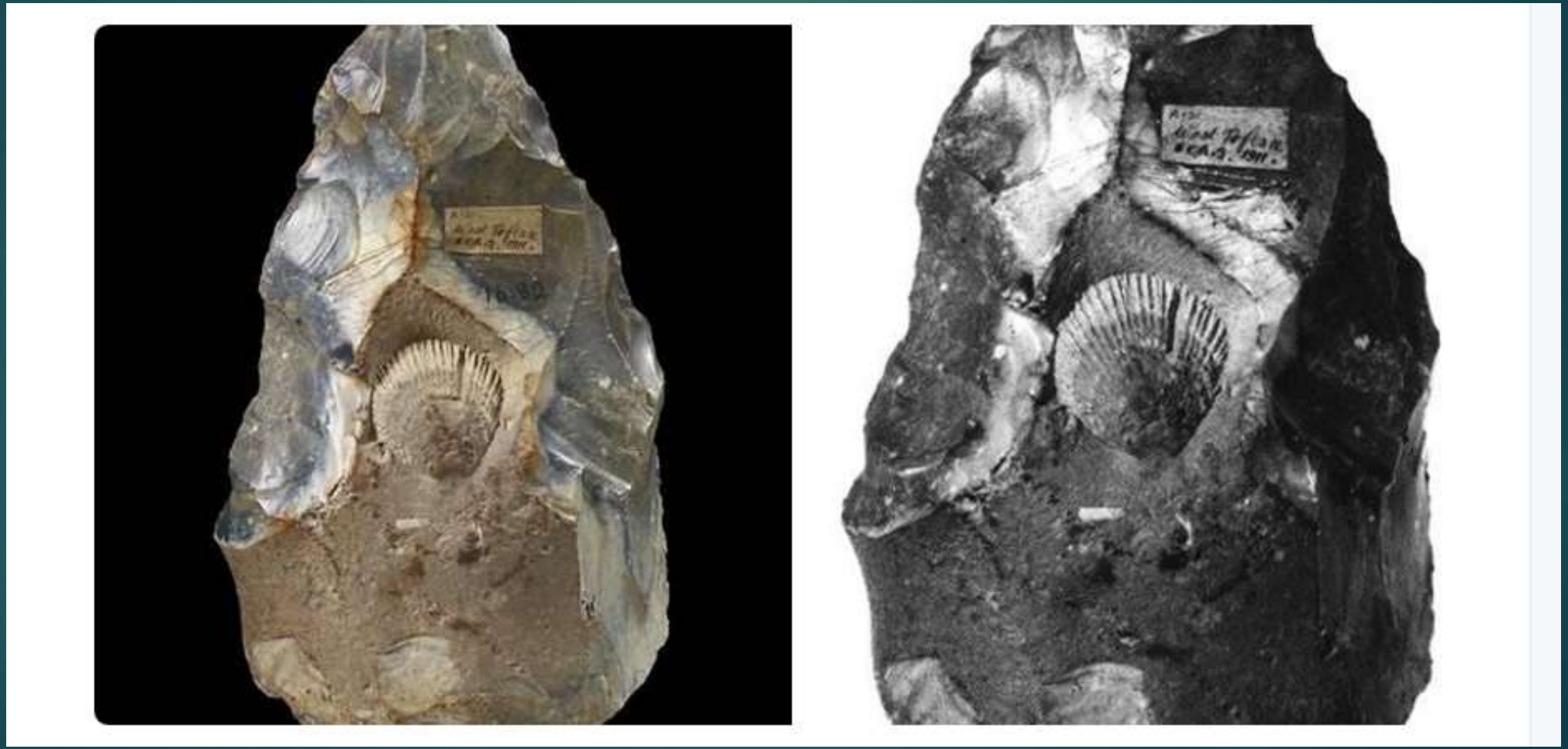
El Castillo, Spain

Prehistoric dots and crimson hand stencils on Spanish cave walls are now the world's oldest known cave art, according to new dating results of 40,800 years—perhaps the best evidence yet that Neanderthals were Earth's first cave painters.

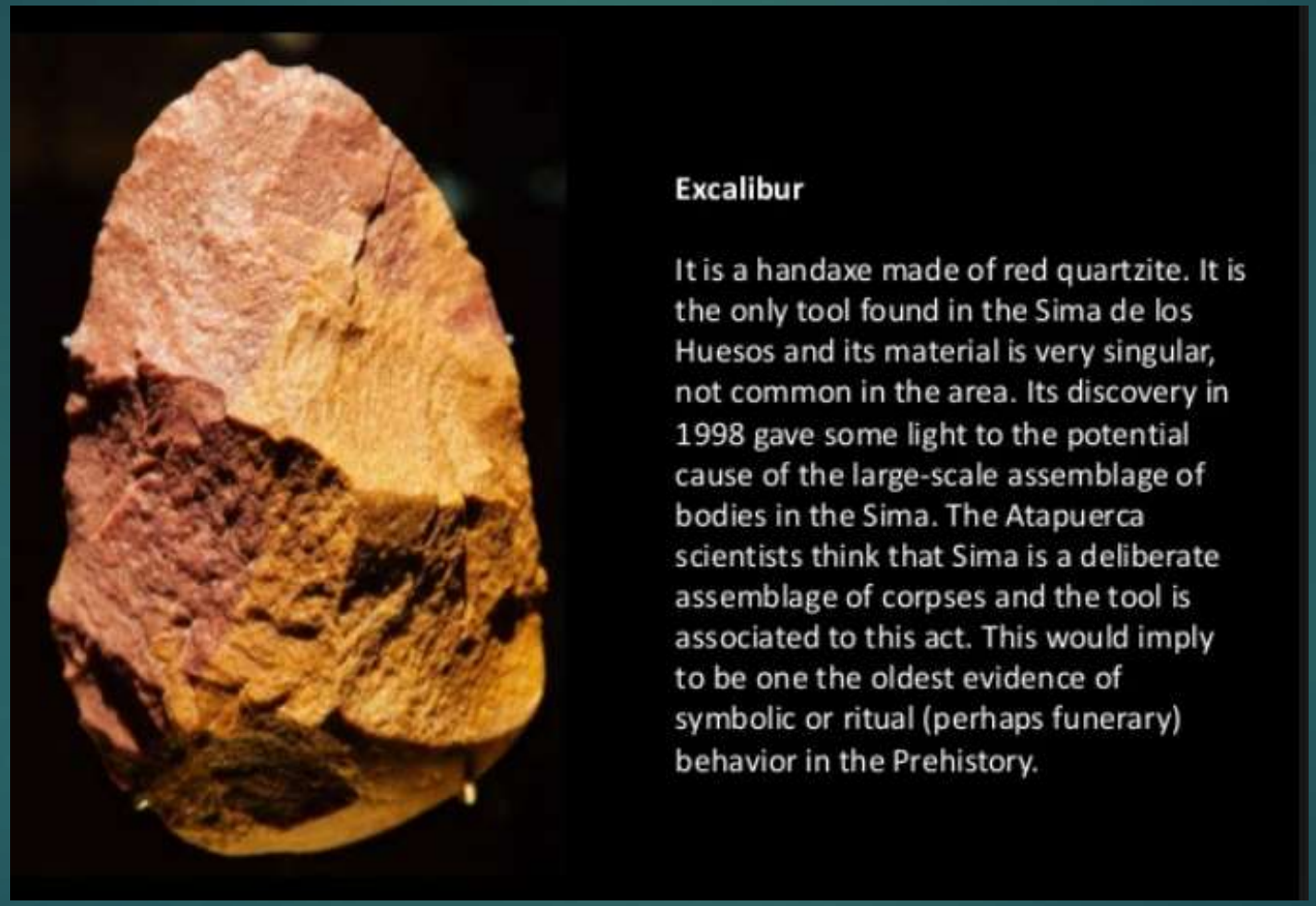
Art appreciation: artistic handaxes

- Rare objects such as crystals and fossils were apparently collected at Mousterian sites such as Combe Grenal and Chez Pourré-Chez-Comte
- Beauty of some bifaces beyond functional need;
- selection of fossiliferous chert or rock crystals for tools;
- flaking of handaxes in a way that single fossils are centrally located;
- long distance transport of fossiliferous cherts and whale teeth

An elegant Acheulean handaxe was carefully shaped so as to display a fossil shell of Spondylus spinosus at its center. It was made around 200,000 years ago by a Neanderthal.



Excalibur from Atapuerca: only tool in Sima de los Huesos



“One handaxe does not a ritual make.” - crsmith

Regional variation in tool culture

Karen Ruebens, analyzed more than 1,300 stone tools from European Neanderthal sites dated to between 115,000 and 35,000 years ago. She found that they belong to at least two distinct tool-making traditions. West of the Rhine River, Neanderthal hand axes are oval or roughly triangular, while to the east, they are rounded on one edge and flat on the other. Near the Rhine, the traditions seem to overlap, as if two cultures were sharing their techniques.

The perforated shells from level II of Cueva de los Aviones (after cleaning): (1) Acanthocardia tuberculata; (2–3).

João Zilhão et al. PNAS 2010;107:1023-1028

A beginning of art and modern culture

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- No representational carvings
- Perforated & grooved animal bones & teeth

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  - Bone tools
  - Carved bone pendant
  - Pierced bones & teeth
  - Blade tools
  - Shelter construction

The Controversial Neandertal flute

- Divje Babe flute (cave bear femur)
- Slovenia site 82 - 43 kya
- Possible flute = Evenly spaced holes in bone
- Or random gnawing and punctures by carnivores?

- d”Errico vs. Turk: carnivore damage vs it’s a flute

d'Errico F, et al. (2003) vs. *Turk, Matija; Dimkaroski, Ljuben (2011).*

Eagle Talon Necklaces used by Neanderdertals

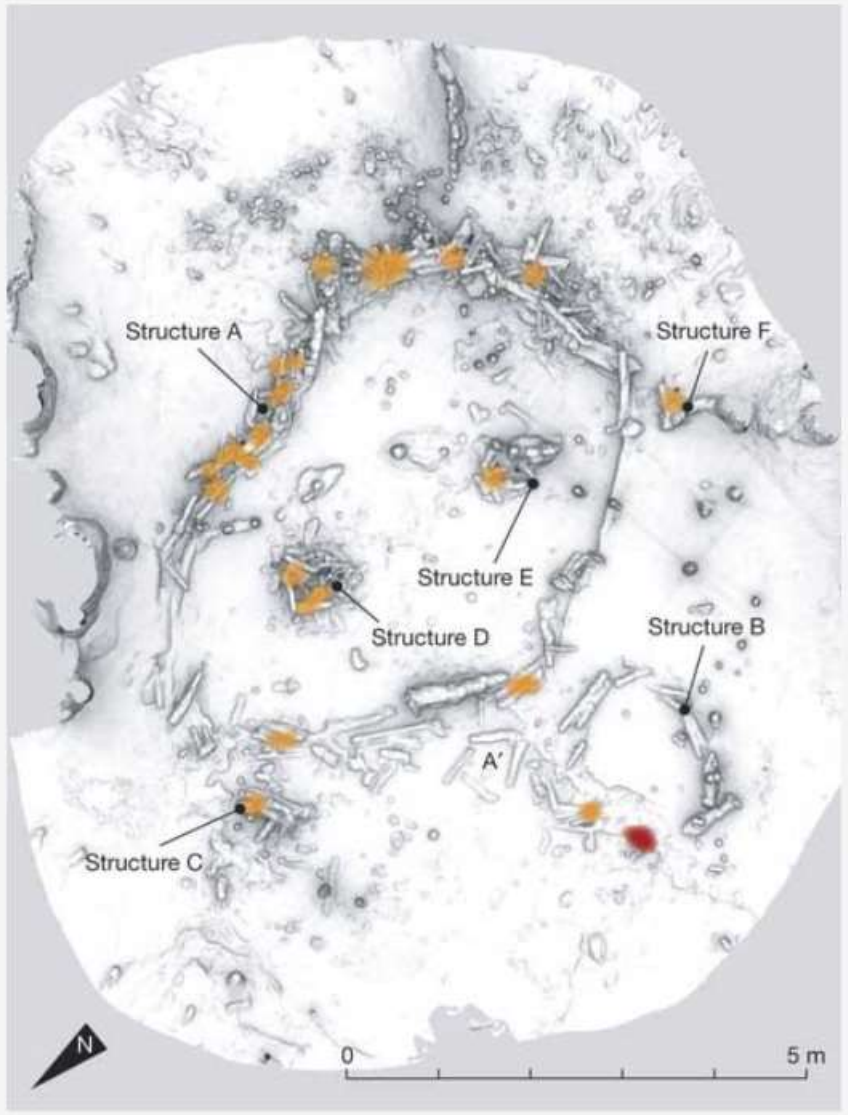
Neandertal Pendant, 130K

2014: Neandertal Art

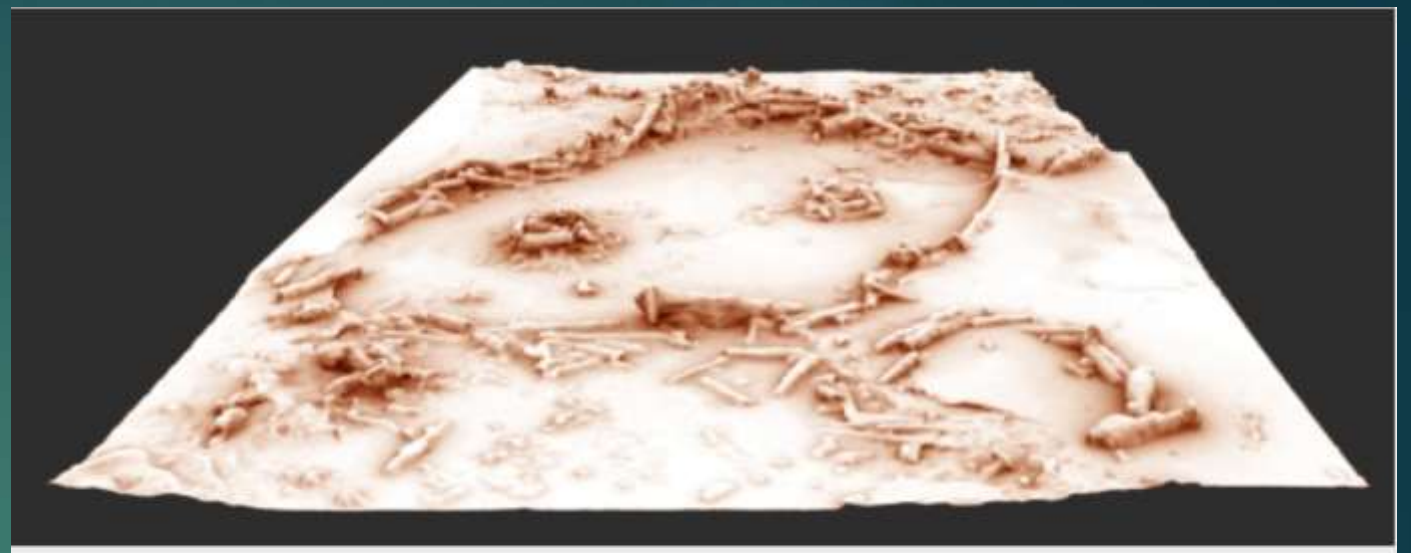
Gibraltar Cave, 2012: 39K, crosshatched pattern of 13 grooves in the bedrock; took between 188 and 317 strokes with a flint tool to create the entire figure.

El Castillo, Spain:
Palm prints & red dots, 40K

A Neandertal structure of stalagmites, 176 kya

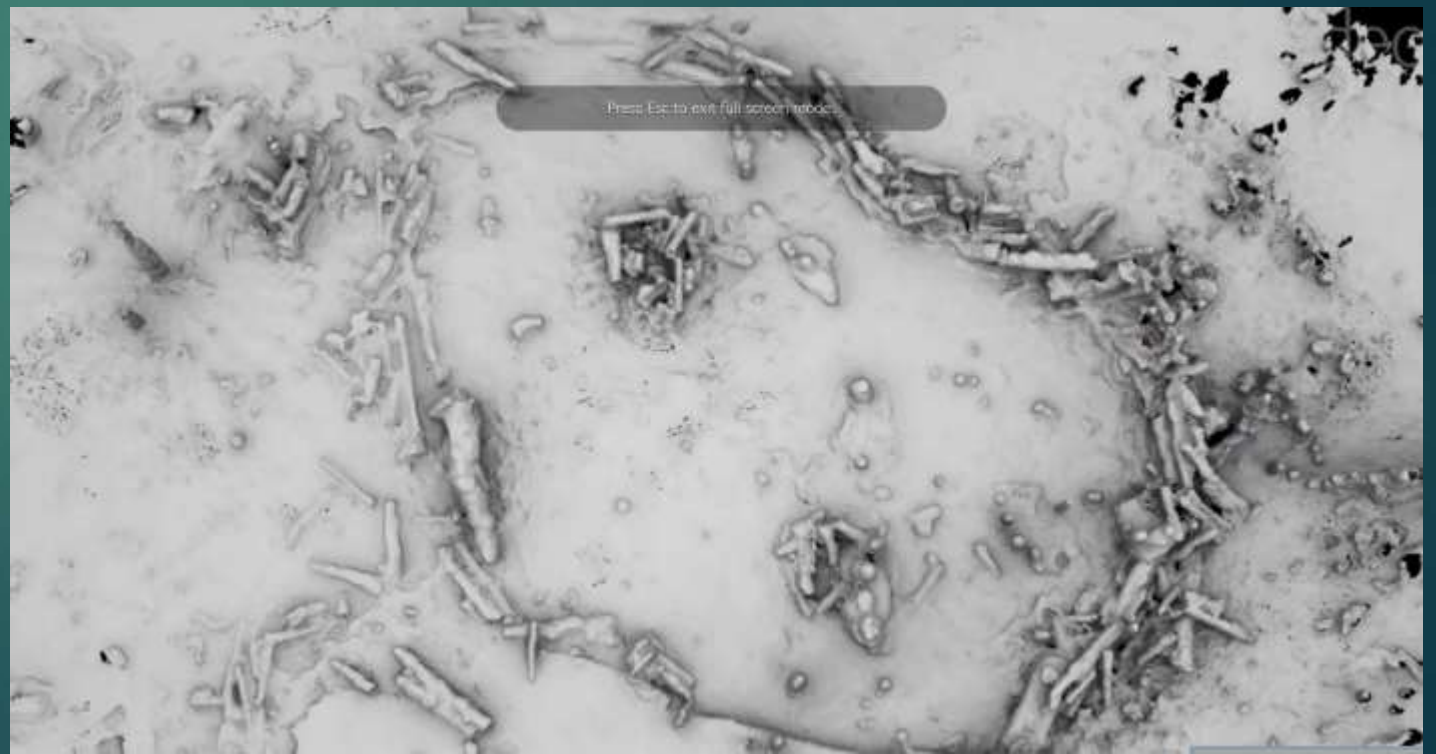


Jaubert et al. 2016.



Xavier MUTH - Get in Situ, Archéotransfert, Archéovision -SHS-3D, base photographique Pascal Mora

A 3D reconstruction of the structures in the Bruniquel Cave.



The timing and spatiotemporal patterning of Neanderthal disappearance: N and MH Overlap: 2600-5400 kya

- Study of 40 N sites
- The Mousterian ended by 41,030-39,260 calibrated years bp (at 95.4% probability) across Europe; so did the Châtelperronian.
- The disappearance of Neanderthals occurred at different times in different regions.
- Comparing the data with results obtained from the earliest dated AMH sites in Europe, associated with the Uluzzian technocomplex, allows us to quantify the temporal overlap between the two human groups. The results reveal a significant overlap of 2,600-5,400 years (at 95.4% probability).
- A mosaic of populations in Europe during the Middle to Upper Paleolithic transition suggests that there was ample time for the transmission of cultural and symbolic behaviors, as well as possible genetic exchanges, between the two groups.

Higham T, et al., Nature, 2014

Causes of Extinction Theories

- Neanderthals disappeared from the fossil record about 39 kya and were replaced in Europe by anatomically modern forms. Possible causation:
- Out competed by MHs: localized quarrels for food or territory; diseases
- Severe climate
- Population too small
- Family interbreeding; decline in genetic diversity
- Hybridization/assimilation with MHs
- Early MH alliance with wolves resulting in domination of the food chain
- Spread of MH disease
- C. Stringer: “There was nothing inevitable about modern human success,” “It was luck.”; Finlayson: “They became a ghost species.”

Extinction theories

- Proposed modern human competitive advantages include demographic and subsistence factors, such as:
  - larger group sizes,
  - slightly higher birth rates,
  - lower mortality rates,
  - shorter interbirth spacing,
  - greater dietary diversity,
  - more complex social networks,
  - better clothing and shelter

Zubrow 1989; Skinner 1997; Flores 1998; Gat 1999; Richards et al. 2001; Stringer et al. 2003; Hockett and Haws 2005

Climate? Unlikely

- Some think worsening climatic and environmental conditions to have been major driving forces in the Neanderthal extinction (e.g., Finlayson 2004).
- Recently available detailed paleoclimatic records have shown that the time period of the Neanderthal disappearance was dominated by very unstable climatic conditions (van Andel and Davies 2003).
- However, none of the proposed dates for the Neanderthal extinction coincides or immediately precedes a major cooling episode, rejecting the hypothesis that catastrophic climate deterioration was the cause for the Neanderthal disappearance (Tzedakis et al. 2007).
- The fact that Neanderthals had successfully survived previous cold phases also makes it difficult to accept climate change as the sole reason for their demise.

MH appearance caused demise of Ns

- An alternative interpretation sees the advent of modern humans, perhaps with better cultural buffering and more effective social networks, as providing the coup de grâce to the highly stressed Neanderthal populations through competition for severely limited resources during the critical time interval of their co-existence in Europe (Stringer et al. 2003; Lahr and Foley 2003; Harvati 2007).

- In this view, it is the interaction between the effects of fluctuating climate and environment and of competition with modern humans that led to the eventual Neanderthal demise.

Neandertal demise: MH Superiority Complex

- Required reading: Villa P, Roebroeks W (2014) *Neandertal Demise: An Archaeological Analysis of the Modern Human Superiority Complex*. PLoS ONE 9(4)
- Modern humans are usually seen as superior in a wide range of domains, including weaponry and subsistence strategies, which would have led to the demise of Neandertals.
- This systematic review of the archaeological records of Neandertals and their modern human contemporaries finds no support for such interpretations, as the Neandertal archaeological record is not different enough to explain the demise in terms of inferiority in archaeologically visible domains.
- Instead, current genetic data suggest that complex processes of interbreeding and assimilation may have been responsible for the disappearance of the specific Neandertal morphology from the fossil record.

Paola Villa, Wil Roebroeks, 2014

See also **Neandertals revised -** Wil Roebroeks& Marie Soressi, 2016

N Demise: MH superior qualities

- Theories about MH superiority in a wide range of domains, either in Africa and/or upon arrival of *Homo sapiens* in the Neandertal geographical ranges. These include:
  - inventiveness and capacity for innovation,
  - complex symbolic and linguistic abilities,
  - more efficient hunting strategies,
  - exploitation of a broader range of resources including plants and aquatic ones,
  - projectile technology, heat treatment of lithic raw materials, hafting technology,
  - planning capacities
  - larger scale social networks as shown by large transport distances of raw materials,
  - environmental flexibility,
  - memory capacity,
  - larger population sizes.
- Inferiority in one or more of these domains has been at the core of many explanations for the demise of the Neandertals.
- These capacities were exclusive manifestations of the western Eurasian Upper Paleolithic

N Demise: Conclusions

- All the 11 “archaeology-based” explanations for the demise of the Neandertals reviewed here are flawed.
- They were based on much less data than we have available today and were at least in part the result of a long tradition of thinking in terms of Neandertals-AMH dichotomies, steered by overstressing developments within the Upper Paleolithic of Europe, the record of which has become almost like a yardstick for modern human behavior.
- Use of ocher, of personal ornaments, production of specialized bone tools and complex hafting techniques were part of the Neandertal repertoire already before the arrival of AMH in western Eurasia.
- Production of bladelets has been securely identified in French Mousterian assemblages. Neandertals, like late MSA humans, mastered the technology of bladelet production by 60 K. It is their frequency, not cognition or technical competence, that distinguishes AMH bladelet production from that of Neandertals

N Demise: Conclusions

- The Neandertal archaeological record was not different enough to explain their demise in terms of inferiority in archaeologically visible domains.
- Thus, if Neandertals were not technologically and cognitively "disadvantaged", how can we explain that they did not survive?
- In 2010 a draft sequence of the Neandertal nuclear DNA provided clear evidence of interbreeding between Neandertals and modern humans. A revised estimate based on a high-coverage sequence of a Neandertal from the Altai Mountains now suggests 1.5–2.1%
- Gene flow from Neandertals to modern humans occurred, and most likely happened at the time when Neandertals and modern humans encountered each other in Europe and the Middle East around 50,000 years ago.

N Demise: Conclusions

- In sum, interbreeding and assimilation (a model first proposed by Fred Smith) are now supported by genetic data
- Interbreeding of Neandertals and modern humans may have helped modern humans to adapt to non-African environments but also introduced alleles that were not tolerated and contributed to male hybrid sterility
- The Neandertal demise appears to have resulted from a complex and protracted process including multiple dynamic factors such as low population density, interbreeding with some cultural contact, possible male hybrid sterility and contraction in geographic distribution followed by genetic swamping and assimilation by the increasing numbers of modern immigrants.
- No significant data supports the supposed technological, social and cognitive inferiority of Neandertals compared to their AMH contemporaries. The results of this study imply that single-factor explanations for the disappearance of the Neandertals are not warranted any more, and that their demise was clearly more complex than many archaeology-based scenarios of “cognitive inferiority” seem to suggest.

More realistic N reconstruction

Juan Luis Arsuaga and Ignacio Martínez

Neanderthals and Us

Modernized Neandertal

Modernized Neanderthal, based on Prof. J. Howard McGregor's classic reconstruction of "Old Man of la Chapelle's" skull, the bust of which was created for display in the American Museum of Natural History around 1918. Originally published in Carleton Coon's (1939) The Races of Europe. Although often attributed to Coon, it is not clear whether the drawing is by Coon or McGregor.

Neandertal Museum in Germany: Stone Age Clooney

Newer reconstructions

Neanderthal
(National Geographic,
by A. Kennis & A. Kennis, photo Joel McNaulty)

Neandertal became part of us

Neandertals Were People, Too.

Based on the 2 Gibraltar skulls: called Nana and Flint

New York Times, 1/15/17:
Adrie & Alfons Kennis

Gibraltar 1 pound coin

Neandertal in fiction & film

- J. H. Rosny-Aine – *La Guerre du feu*, 1911
- J. Darnton - *Neanderthal: Their Time Has Come*
- H.G. Wells – The Grisly Folk
- Edison Marshall - *Dian of the Lost Land*
- Philip K Dick – *The Simulacra*
- Michael Crichton – *Eaters of the Dead*
- Isaac Asimov - *Ugly Little Boy*
- Robert Silverberg – *Child of Time*
- Clifford Simak – *The Goblin Reservation*
- William Golding - *The Inheritors*
- William Shatner - Quest for Tomorrow
- Jean M. Auel – *The Clan of the Cave Bear*
- Jasper Fforde - *Thursday Next* series
- Bjorn Kurten – *Dance of the Tiger*
- Robert J. Sawyer – *Neanderthal Parallax* trilogy: *Hominids, Humans, Hybrids*

Michael Stewart – *Birthright*
Paul Levinson – *The Silk Code*
Stephen Baxter – *Evolution*
Harry Turtledove – *Down in the Bottomlands*
Terrence Hawkins - American Neolithic

Films:
Quest for Fire, 1981
Ice Man, 1984
The Clan of the Cave Bear, 1986
13th Warrior, 1999
Neanderthal, 2001
Walking with Cavemen, 2003
Clash of the Cavemen, 2008

Neandertal Tourism

- Visitor centers and museums:
  - La Chapelle-aux-Saints
  - Le Moustier, France & Tursac Prhisto Parc & La Roque Saint-Christophe
  - Atapuerca, Spain
  - Krapina, Croatia
  - Neander Valley, Germany
  - Neanderthal Museum in Mettmann, Germany
  - Zagros Mountains, Iran
  - Dordogne region of France: Les Eyzies has National Museum of Prehistory
  - AMNH in NY – Hall of Human Origins
  - Smithsonian NMNH in DC – Hall of Human Origins (John Gurche reconstructions

Bibliography

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- *How to Think Like A Neanderthal* – T. Wynn & F. Coolidge, 2012
- Katerina Harvati, *Neanderthals*, Evo Edu Outreach, 2010
- *The Humans Who Went Extinct* - C. Finlayson, 2009
- *The Last Neanderthal* – I. Tattersall, 1999
- *In Search of the Neanderthals* - C. Stringer & C. Gamble, 1993
- *The Neanderthals* – E. Trinkaus & P Shipman, 1992
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Homo Denisova

Denisova Cave, Siberia

2010: Homo Denisova

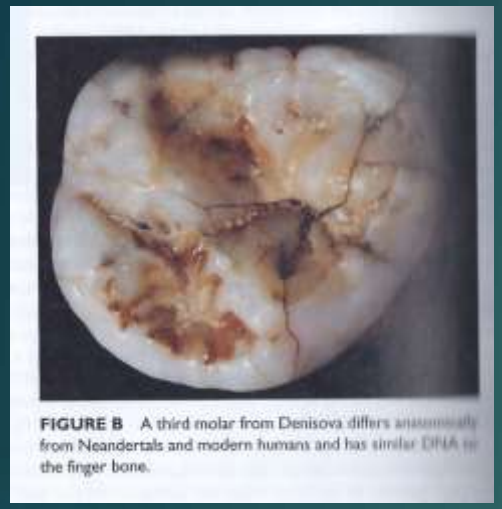


FIGURE B A third molar from Denisova differs anatomically from Neandertals and modern humans and has similar DNA to the finger bone.

A Denisovan molar, one of the three sources of DNA for the high-coverage genome sequencing. (Max Planck Institute for Evolutionary Anthropology)

FRAGMENT OF A FINGER: This replica of the Denisovan finger bone shows just how small of a sample the researchers had to extract DNA from. *Image: Image courtesy of Max Planck Institute for Evolutionary Anthropology*

Pinkie Bone, 30-48K,
Denisova Cave

Krause et al. 2010: When the mitochondrial DNA of the bone was sequenced in 2010 however, it belonged neither to a Neandertal nor to a modern human.

A new species, *Homo denisova*

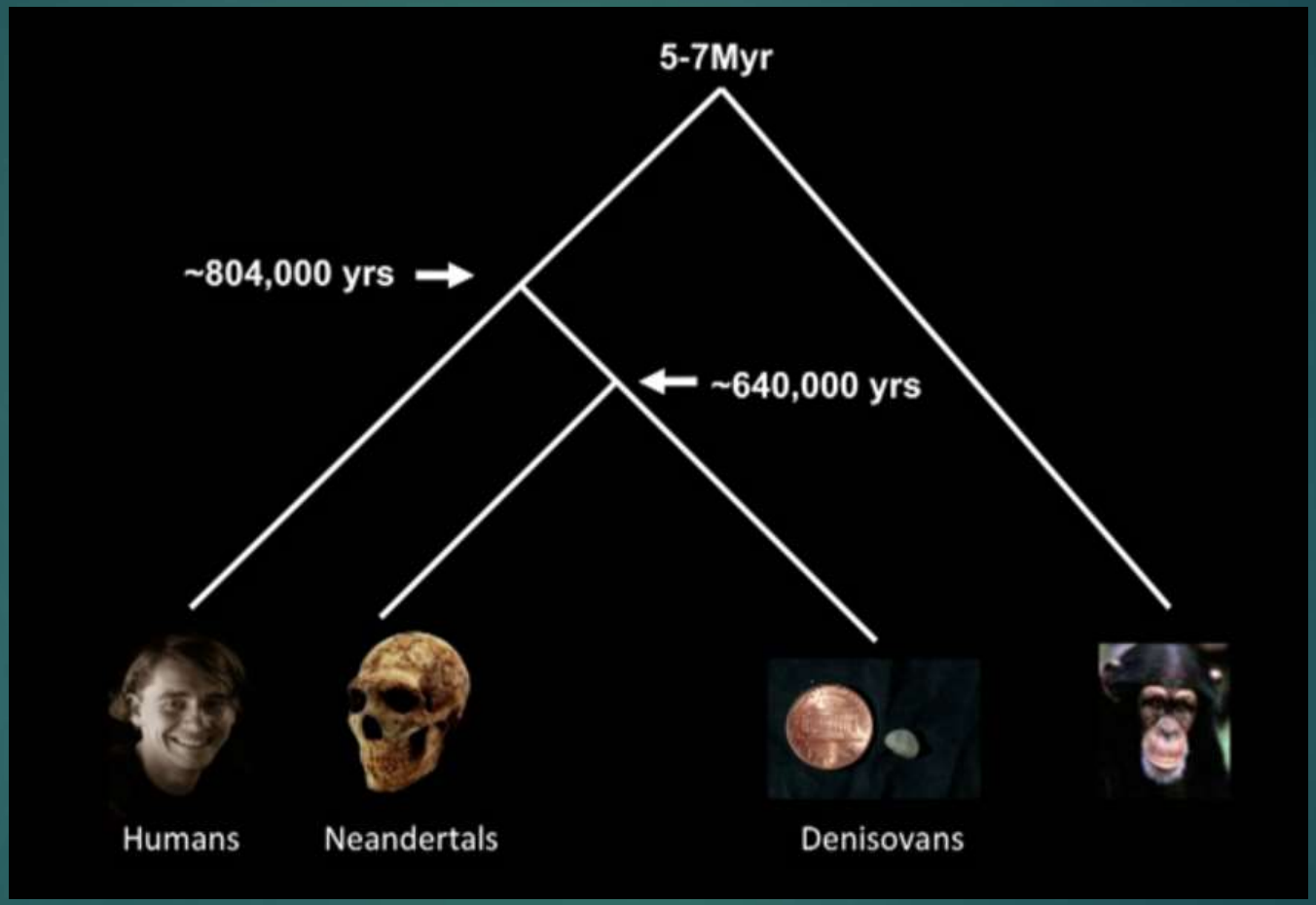
Homo denisova

- Analysis of the mitochondrial DNA of the finger bone showed it to be genetically distinct from the mtDNAs of Neanderthals and modern humans
- This new hominin species was the result of an earlier migration out of Africa, distinct from the later out-of-Africa migrations associated with modern humans, but also distinct from the earlier African exodus of *Homo erectus.*
- They are a sister group to the Neanderthals, branching off from the human lineage 600,000 years ago, and diverging from Neanderthals, probably in the Middle East, 200,000 years later.[

Denisovans

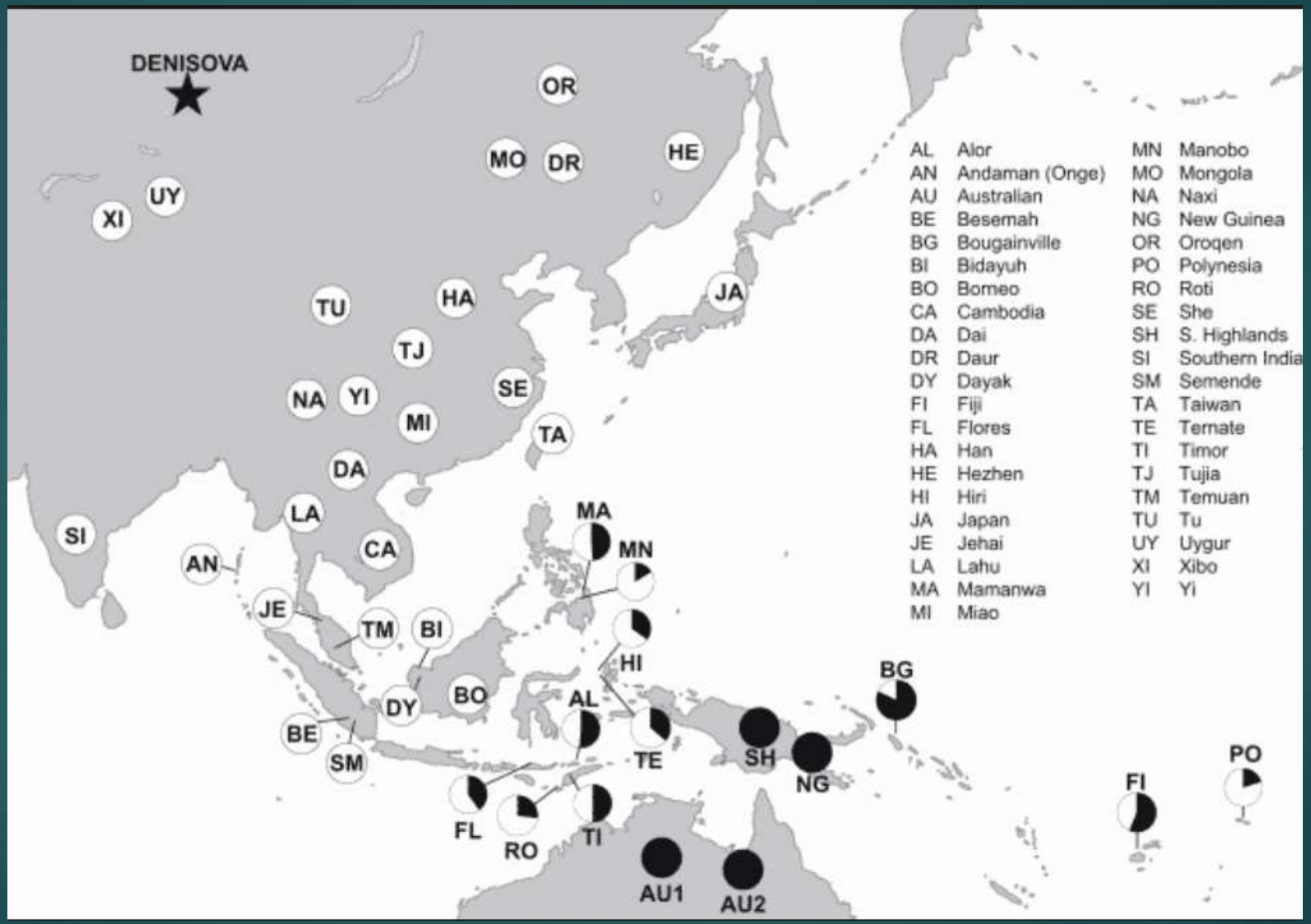
- They ranged from Spain to Siberia to Southeast Asia.
- Had significant local interbreeding, with local Neanderthal DNA representing 17% of the Denisovan genome.
- They lived among and interbred with the ancestors of some present-day modern humans, with about 3% to 6% of the DNA of Pacific Islanders and Aboriginal Australians deriving from Denisovans.
- DNA shows they had dark skin, brown hair and brown eyes

2014: Time to Common Ancestor of 3 hominids: ~804 KYA

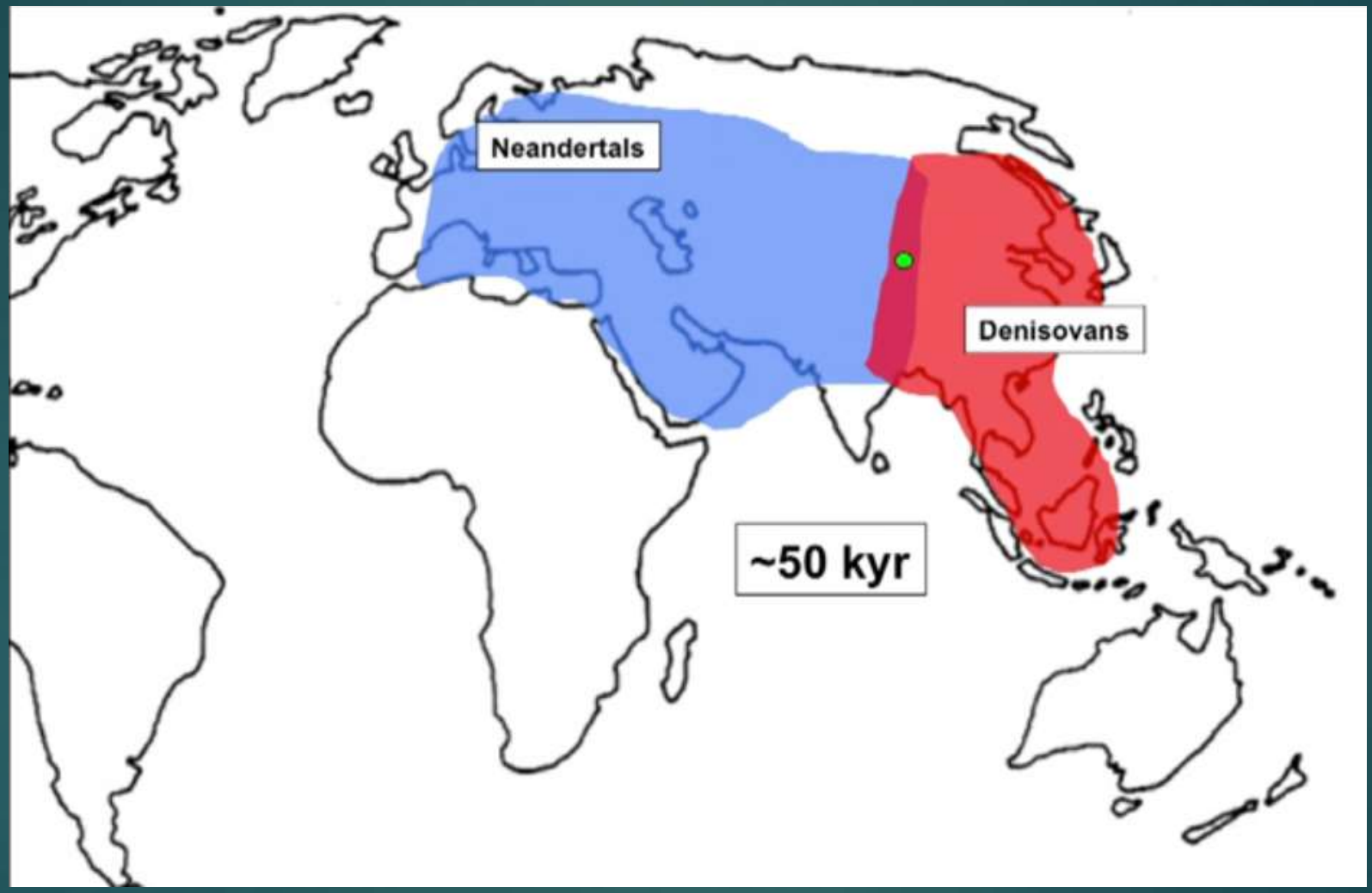


- Denisovans related to both N and MH; both N & D had long independent histories; genetic diversity in these archaic hominins was extremely low

Spread of Denisovans: China to Australia



Neandertal & Denisovan Territories



What world looked like when MH came out of Africa: N in West, D in East; Both in southern Siberia

Denisovan DNA: EPAS1 gene – Oxygen capacity of Sherpas

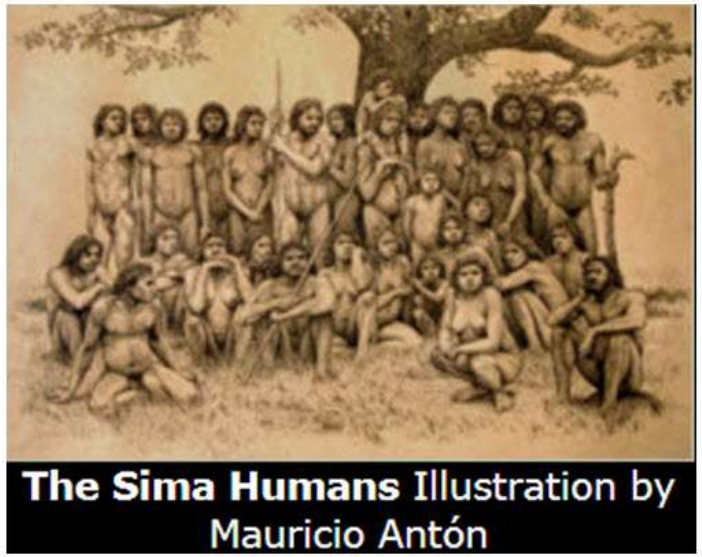
Mt. Everest, 1953: Edmund Hilary & Sherpa Tenzing Norgay (Denisovan DNA) & fastest Darwinian evolution

Hypoxia gene, *EPAS1*, positive selection in Tibetans; hemoglobin & oxygen at high altitude; 3000 year divergence

Less red blood cells & less hemoglobin

Sima de los Huesos (Pit of the Bones), Atapuerca, Spain

Sima de los Huesos, Atapuerca, Spain



The Sima Humans Illustration by Mauricio Antón

Sima de los Huesos
Homo heidelbergensis hominins, 400K

Human fossils, Sima de los Huesos
E436/0172 Rights Managed

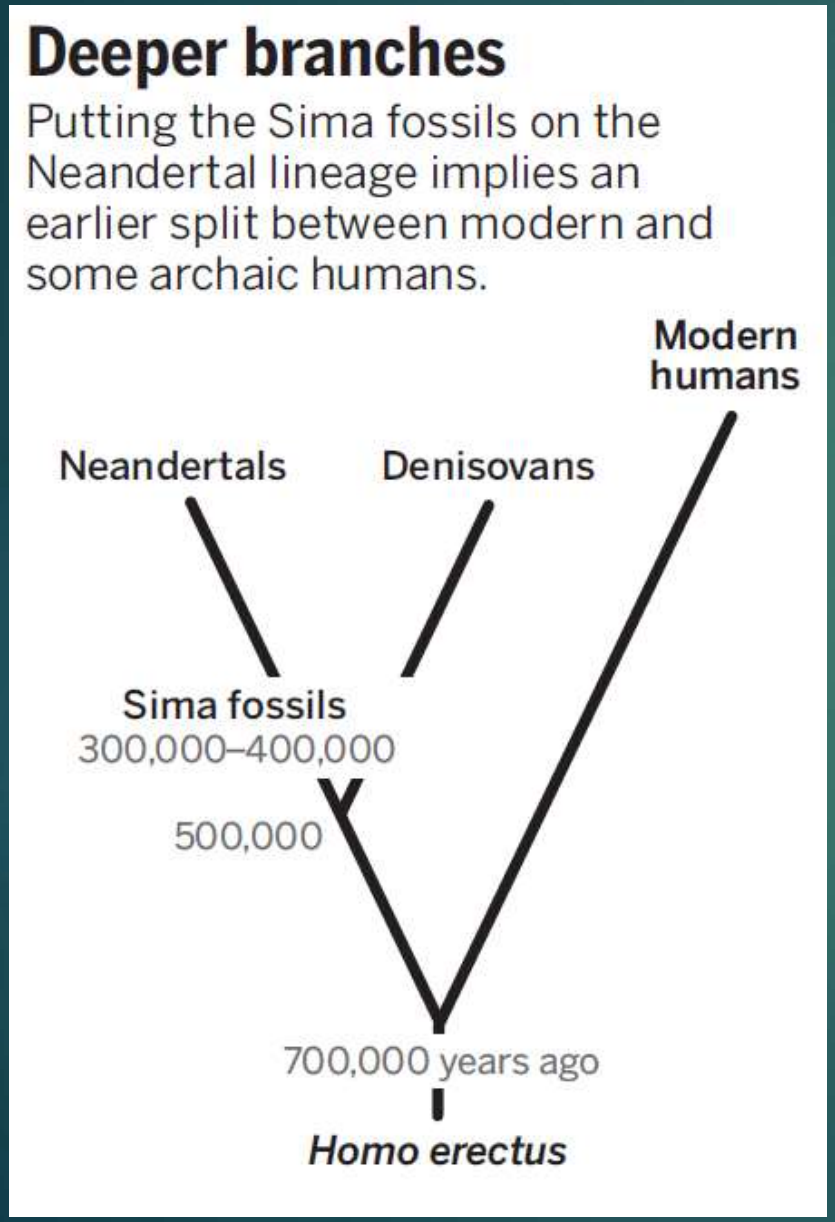
28 people's body parts from 400 KYA

2015: Pit of the Bones in Spain: 430 K – oldest mtDNA = Denisovan; nuclear = Neandertal;

2014: Oldest human mitochondrial genetic material: The thighbone of the 400K hominid from Sima de los Huesos, Credit: Javier Trueba

Originally thought to belong to an ancient human species known as *Homo heidelbergensis*: Original mitochondrial study: Denisovan ancestry
2015 nuclear study: Neandertal ancestry

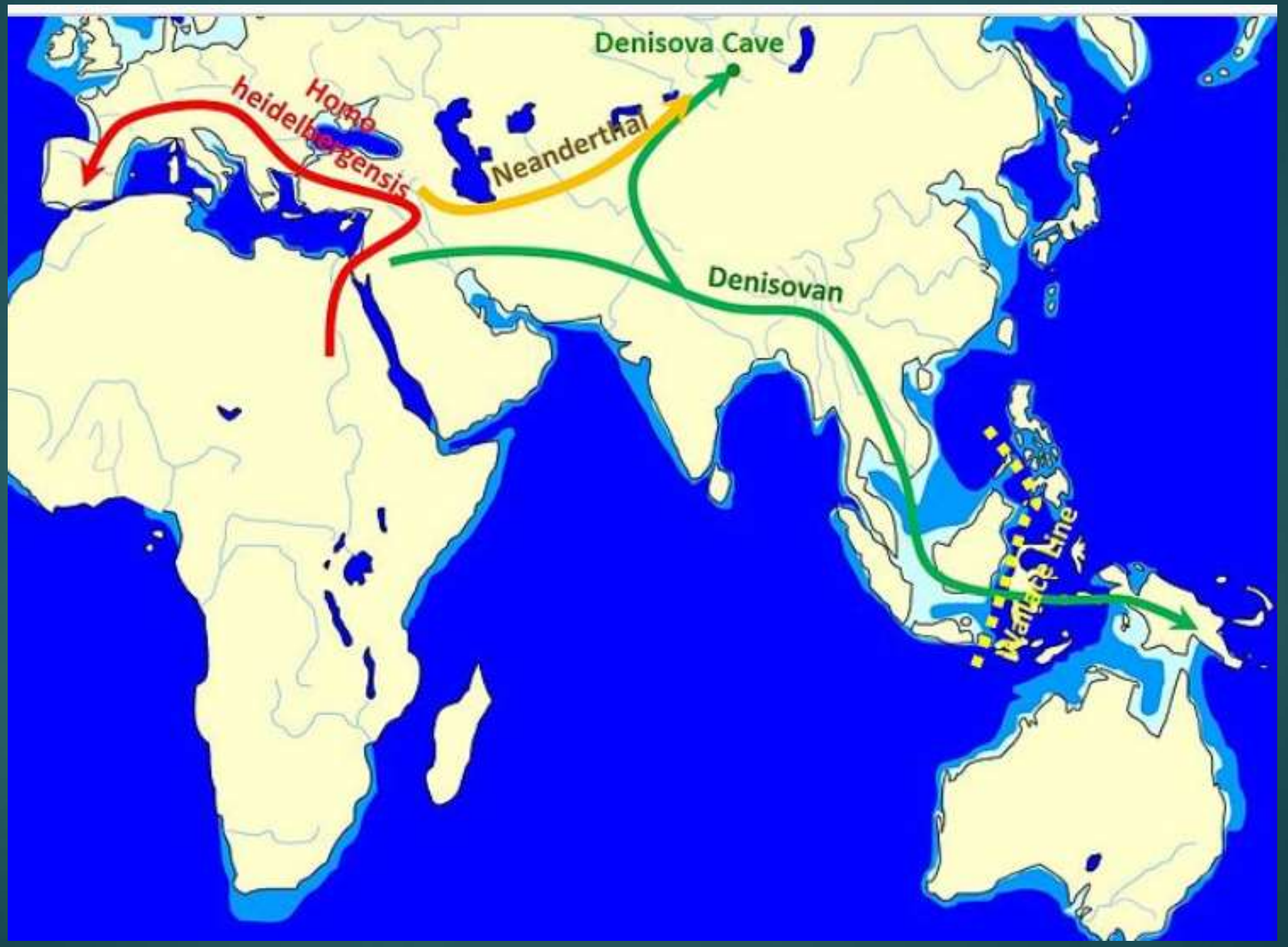
2015: Atapuerca Neandertals: earlier split



Neandertals & Denisovans are more closely related to each other than to modern humans; split from each other ~500 kya

Therefore ancestors of modern humans must have split away even earlier, ~550 to 765 kya

Denisovan Range



Homo Sapiens

Homo sapiens = "wise man"

- Our own species name, *sapiens*, in Latin means "wise"; coined by Carolus Linnaeus in 1758
- Where and when first modern members of our species evolved is still debated
- *Anatomically modern humans:* no inclusive definition of our own species;
- There is no type specimen for *H. sapiens*
- Most would agree on anatomical definition of next 2 slides

Homo sapiens

- ***Homo sapiens***. The species that all living human beings on this planet belong to is *Homo sapiens*.
- **Fossil Record:** Modern *Homo sapiens* first appear about 195,000 years ago in Africa
- **Habitat and Distribution:** Transitional forms (fossils exhibiting both archaic and modern traits) have been found in Kenya, South Africa, Ethiopia, Tanzania, and Morocco and range in age from 100,000 to 300,000 years old. Modern humans also appeared the earliest in Africa and later migrated into Southwest Asia, Europe and East Asia. Later still, modern humans migrated to Australia, the islands of the Pacific, and North and South America.
- **Diet:** *Homo sapiens* utilized the animal and/or plant resources found in their varied environments.

CAS Manual

Basic history of human brain

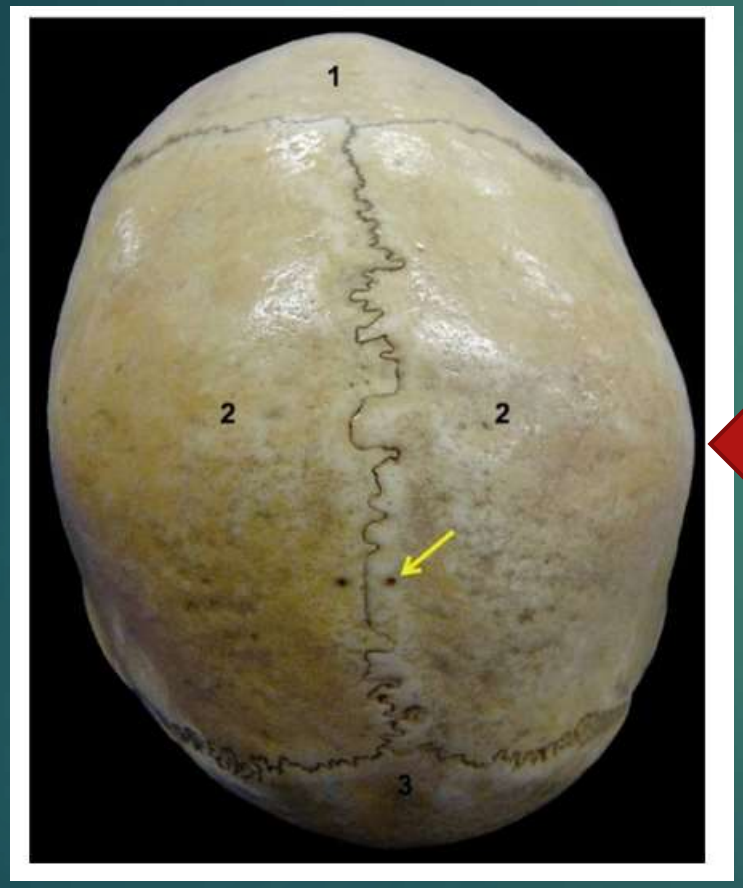
- About 7 MY, first hominids became bipedal with brains about 1/3rd of modern size (400cc)
- For 3-4 MY, their brain did not significantly grow, but maybe became larger as proportion of body size. Stone tools appear at 3.3 MYA.
- About 2 MYA, some hominids developed larger brains (650cc)
- 1.5 to 1 MY, brain expanded fairly rapidly, to 2/3rd of modern size (1000cc)
- Language developed somewhere in last 1.5 MY
- In last MY, brain increased to 1,350 cc
- MH appear in Africa 200 TYA.
- Material culture begins only in last 100,000 years
- Hominids got smarter as their brains got bigger

Homo sapiens

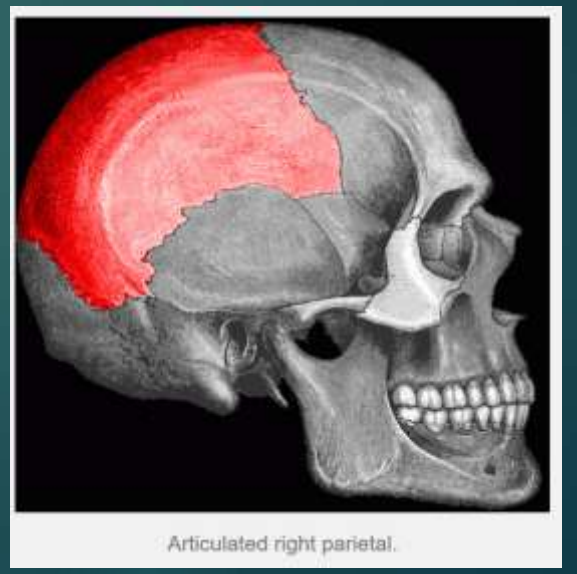
Homo sapiens Neandertal

- **Brain size:** 1350 cc (range 1000 to 2000 cm^3)
- **Intelligence:** made new kinds of tools, had complex language
- **Largest group size:** 150-200
- New geometric morphometrics have shown parietal & cerebellar expansion in modern humans (resulting in globular skull), especially in early postnatal development

Anatomically Modern Human superior view: Parietal bosses

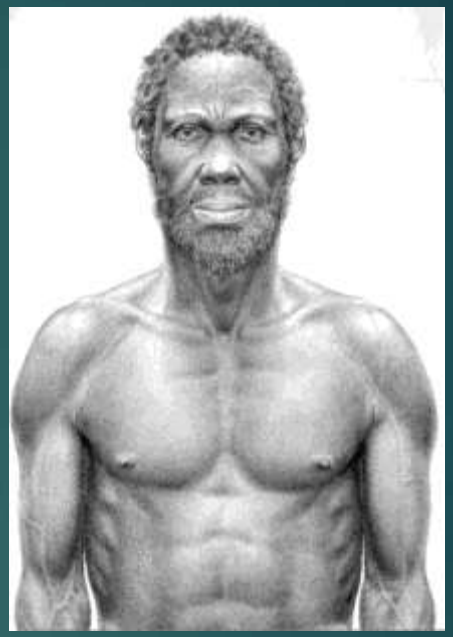


- “2”s indicate the left and right parietals; the bosses are the areas where the parietals bulge out posteriorly
- This convexity is most easily observable to the right of the “2” label
- Yellow area = parietal foramina



Anatomically modern *Homo* sapiens: In Our Own Image

- Descendants of African *H. heidelbergensis*
- First appear about 200 kya
- Tall, almost vertical forehead
- Small to minimal brow ridges
- No retromolar gap (thus impacted wisdom teeth)
- Pointed chin (uniquely modern trait)
- High rounded cranium : widest point on sides of parietals; expansion of parietal lobes; more white matter



Why a chin?

- Most common explanation is that our chin helps buttress the jaw against certain mechanical stresses
- Or chin evolved in response to our unique form of speech
- Others think the chin evolved to safeguard the jaw against forces generated by chewing food. Flora Gröning tested difference between N and MH jaws withstanding structural loads. Chin does help support the jaw during chewing. They suggested the chin may have evolved to maintain the jaw's resistance to loads as our ancestors' teeth, jaws and chewing muscles got smaller early on in our species' history.
- Or sexual selection as the driver of the evolution of the chin. Finding that there is a small but distinct difference in chin shape between the sexes, with men having a taller, more pronounced chin. This argues against above theory.

http://www.smithsonianmag.com/science-nature/

What's really different about *Homo sapiens*?

- Bipedality
- Largest brain for body size
- Lateralization of brain
- Advanced theory of mind
- Symbolic ability
- Complexity of technology
- Complexity of language
- Art (Music, dance, visual arts)
- Use complex burial rites

- Making tools to make tools
- Cooking and food process: French and California cuisine
- Reading and writing
- Mathematics and science
- Sports, theater

Homo Sapiens: Complexity of Culture

- Blade tools: increased technological abilities
- Spearthrower (lightweight spears)
- Small bone & ivory tools
- Fishhooks
- Tailored skin clothing
- Expansion into new eco-niches
- Ubiquitous burial of the dead
- Art and symbolism
  - Cave paintings
  - Portable art (beads/ carved bone - stone - wood)

Homo sapiens leaves Africa ~50-60K ago

Homo sapiens

- Cranial capacity: 1350 cm^3
  (range 1000 to 2000 cm^3)
- 20% of the body's energy consumption for 2% of body mass
- Speech
- Art
- Extensive tool kit including new materials (bone, ivory, antler)
- Symbolic thought
- 1st molar tooth 5.9 years old
- Longevity 66 years

Germany, MH art, ~40 K

Conard, NJ, 2011

The MH Intellectual Explosion: 100-35 kya

- *Homo sapiens* had large brains but did not show significant creativity or intelligence for first 100,000 years. Only between 100,000-35,000 years ago did the following appear:

- Advanced culture.
- Sophisticated tools.
- Long-distance transport.
- Social networks.
- Large dwellings.
- Tailored clothing.
- Rituals.
- Art.

MH Differences

- inventiveness and capacity for innovation
- complex symbolic and linguistic abilities
- more efficient hunting strategies
- exploitation of a broader range of resources including plants and aquatic ones
- projectile technology
- heat treatment of lithic raw materials
- hafting technology
- planning capacities
- larger scale social networks as shown by large transport distances of raw materials
- environmental flexibility
- memory capacity
- larger population sizes

Anatomically modern humans – *Homo sapiens*

Location: Earliest sites are in Middle East Qafzeh, Skhul) and Africa (Border Cave, Klasies River Mouth), with expansion into remainder of Old World (Cro-Magnon, Arene Candide, Mladec, Ordos) Australia (Lake Mungo, Kow Swamp), and into New World.

Date range: ~100,000 – present
Tool use: Associated with Upper Paleolithic industries – (Gravettian, Solutrian, Magdalenian)

Average cranial capacity: ~ 1350 cc

Anatomy: First evidence of chin, overall gracilization of skeleton, especially cranium.

- Proliferation of art - cave art and objects such as Venus figurines.

- Symbolic use of language.

- First to domesticate crops & animals.

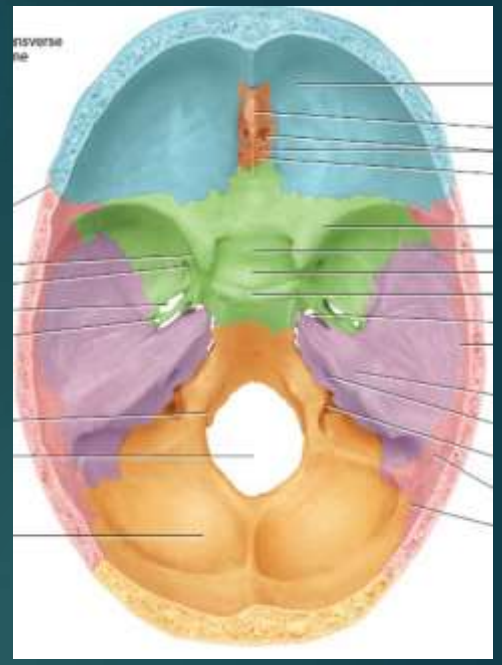
- More complex hearths

- Specialized hunting techniques & use of weaponry.

-

Unique MH face

Green = Sphenoid bone



- Many of the facial features unique to MHs:
  - More globular braincase
  - Vertical forehead
  - Smaller browridges
  - Presence of canine fossa
  - Presence of a chin
- Humans are also unique among mammals in lacking facial projection: the face of the adult H. sapiens lies almost entirely beneath the anterior cranial fossa, whereas the face in all other adult mammals, including Neanderthals, projects to some extent in front of the braincase.
- May all be explained by simple developmental feature, the shortening of the sphenoid bone during early ontogeny. Anterior sphenoidal shortening results in reduction of facial projection by positioning the posterior margin of the face closer to middle cranial fossa. Shorter sphenoid is an adaptation for speech
- May account for rapid evolution of human cranial form. This developmental shift may indicate that AMH should be separate species.

Daniel Lieberman, 1998

Some distinguishing physical characteristics of humans

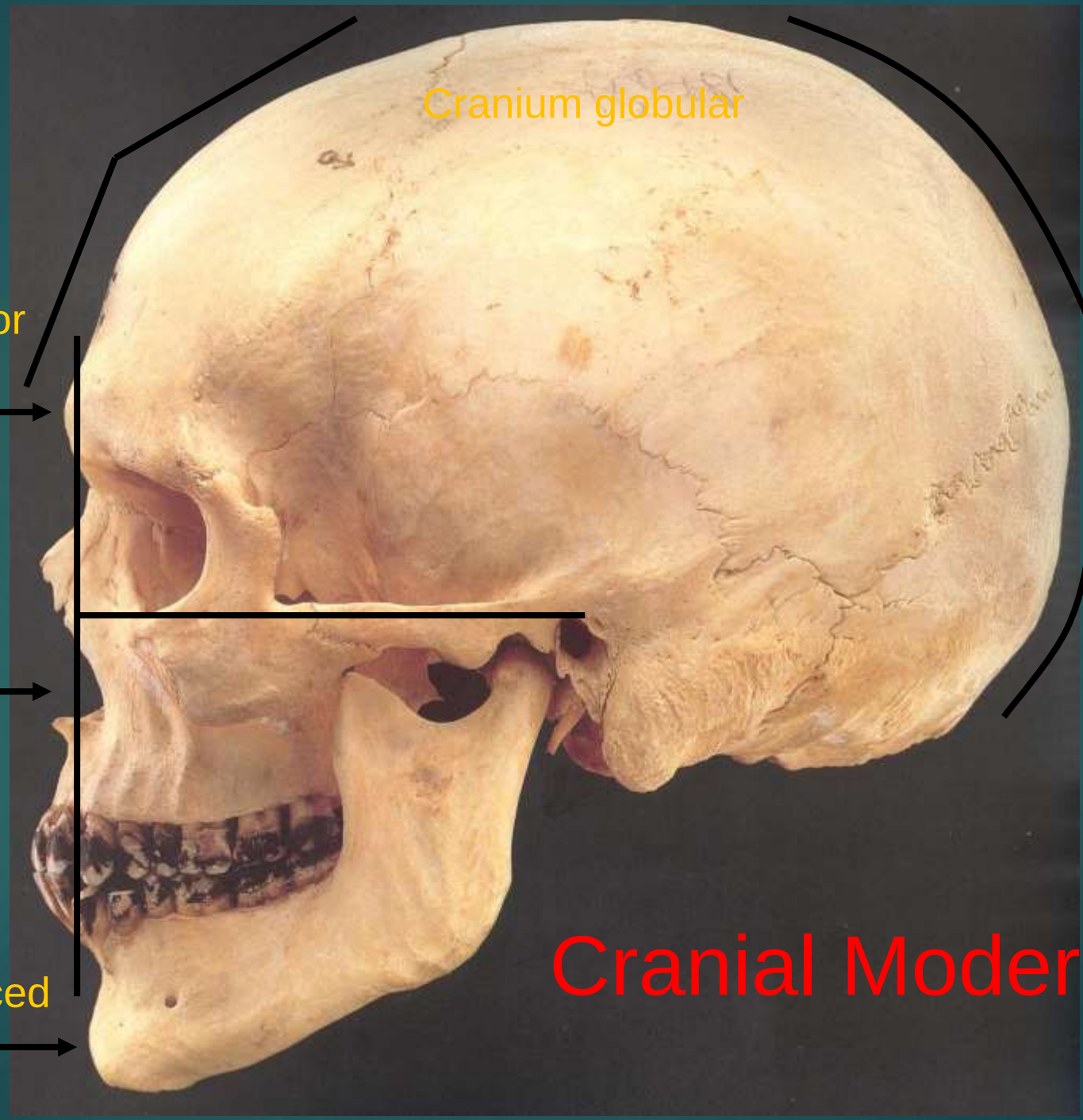
Skull Features:

- Flat face
- Prominent Chin
- Modified teeth
- Large brain case (~1350 cc) vs. early hominins/chimpanzees ~450 cc
- Reduced brow ridges
- Smaller cheek bones

Other skeletal features

- Adapted for bipedal locomotion—changes in pelvis, foot

Cultural ingenuity has led to less cranial robustness; cooked foods lead to dental reduction


Vertical forehead
Cranium globular
Rounded rear vault
Reduced or absent brow ridges
Largest width high up; Parietal
Reduced face
Pronounced chin
Cranial Modernity

Uniquely MH: Parietal Lobe & Precuneus

- Bruner: Parietal lobe has become more rounded in humans (due to intraparietal junction and cuneus); results in globularization of skull
- Precuneus is major evolutionary advance of Homo sapiens
- Right - Control of spatial aspects of motor behavior; execution of spatially guided behavior
- Shifting spatial attention/tracking of different targets in space and between different object features, and in motor imagery tasks
- Visually goal-directed hand movements (optic ataxia)
- Mental imagery (visual rotation, deductive reasoning, music processing; visual reality)
- Episodic memory retrieval; R - regeneration of contextual autobiographic memory
- Personal identity and past personal experiences

Precuneus (& ACC) & Self Perception/Processing

- Precuneus: neural network supporting the mental representation of the self.
- Personal identity and past personal experiences
- Self versus non-self representation:
  - self-referential judgments,
  - first- versus third-person perspective taking,
  - perceived agency
  - mind reading/social cognition (TOM - judgments requiring empathy)
  - Description of your own personality traits and physical appearance
- Part of the DMN: All of these structures show high activity during rest, mind wandering, and conditions of stimulus-independent thought

Concerted vs mosaic brain evolution

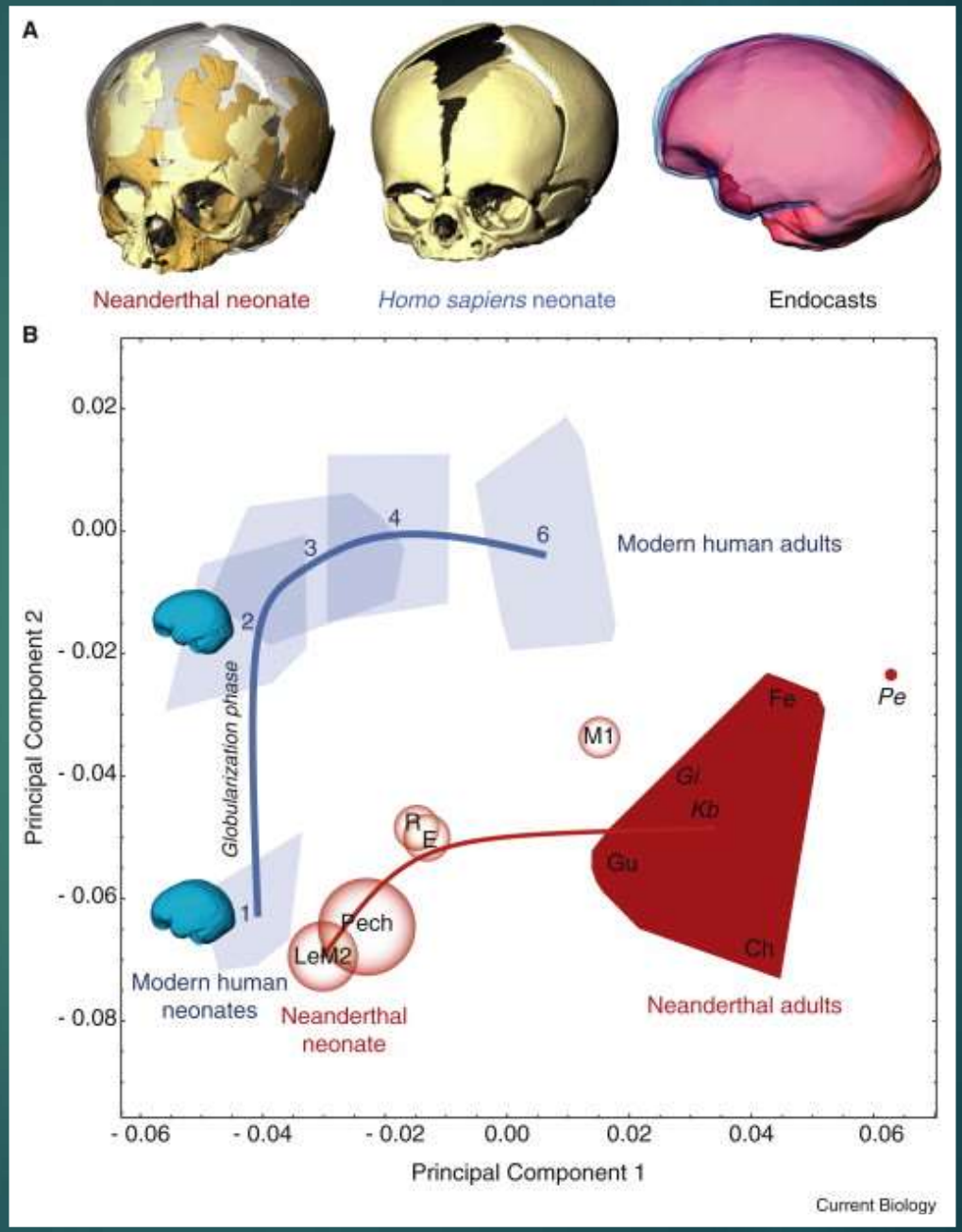
- Evidence of changes occurring in mosaic fashion without a change in overall brain size:
  - *H. sapiens vs. neandertalensis:* marked differences in relative lobe sizes despite similar overall size; differ in both adult & developmental endocranial shape
  - Neandertals - larger frontal and occipital lobes, smaller parietal-temporal lobes than humans; lack early postnatal globularization phase – develop more elongated skull shape
  - Modern humans – parietal and cerebellar expansion (globularization); undergo pronounced expansion during early postnatal development (not seen in chimps or Neandertals)
  - Cranial growth trajectories have influenced shape of the human brain independently of changes in overall brain size

Gunz et al., 2010, 2012)

Neanderthal and modern human brains grew differently.

MH globularization happens in 1st 2 years of development.

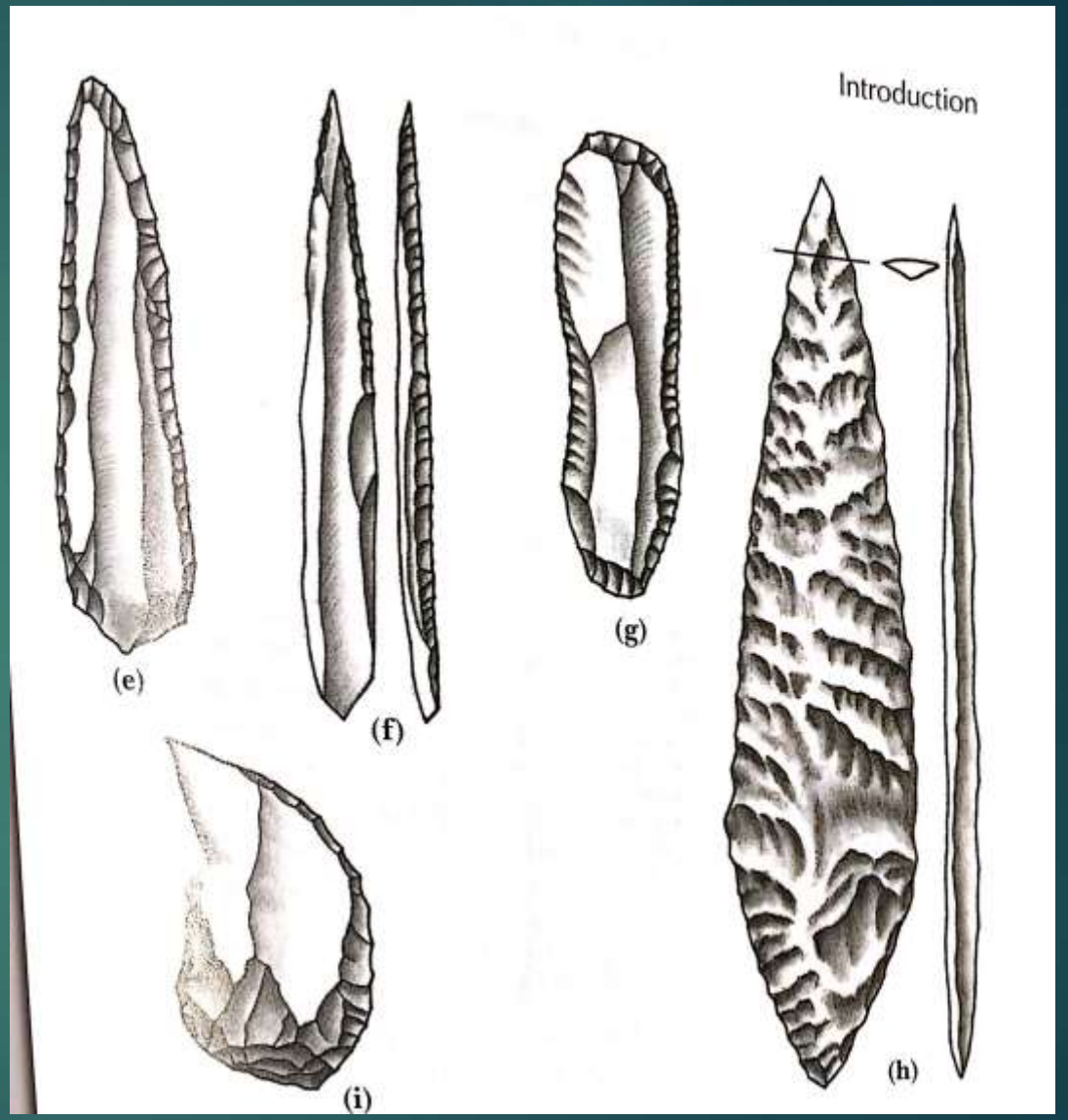
Ns maintained elongated brain after birth (MHs develop globular brain after birth)



Aurignacian culture

- Circa 40 K in Europe, new tool industry called Aurignacian arises
- Paul Mellars criteria:
  - Improved blade production using soft-hammer percussion
  - More sophisticated stone tools with an emphasis on blades
  - Use of tools made of bone, antler, ivory, as well as stone
  - Ornaments (shell beads)
  - Art
  - Expanded trade networks
- Beginning of the Upper Paleolithic period
- Most researchers attribute UP to AMHs

E: Aurignacian blade
F: Gravettian point
G: Gravettian endscraper
H: Solutrean point
I: Magdalenian burin



Disappearance and Spread

- By 40 kya, extinction of:
  - Neandertals
  - Denisovans
  - Homo erectus

- Only survivors:
  - Homo sapiens
  - Homo floresiensis

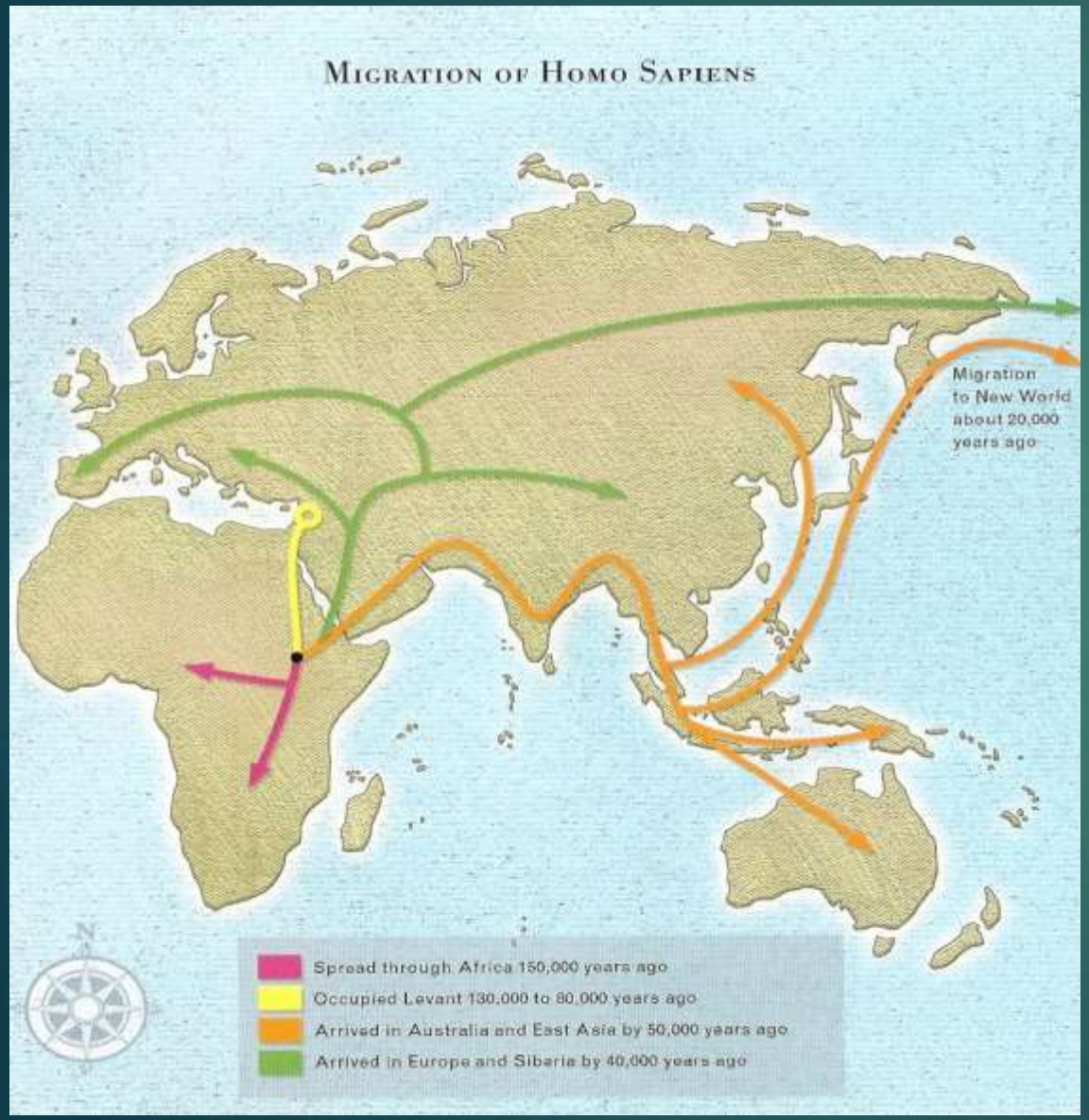
- By 25 kya, MHs had reached N America via Beringia land mass or via skin boats (drift wood & walrus skin)

Leaving Home

- Location: Earliest sites are in Middle East Qafzeh, Skhul) and Africa (Border Cave, Klasies River Mouth), with expansion, into remainder of Old World (Cro-Magnon, Arene Candide, Mladec, Ordos), Australia (Lake Mungo, Kow Swamp), and into New World.

- China: 80 kya
- SE Asia: 60 kya
- Australia: 49 kya
- Europe: 46 kya
- Asia: 40 kya
- Americas: 15-24 kya

Homo sapiens Migration



- Species evolved in Africa ~ 200 kya
- First MHs expanded through Africa
- An expansion into the Levant until 80 kya
- Africans expand into southern Asia, then Europe
- Moved from Asia into New World ~ 20 K

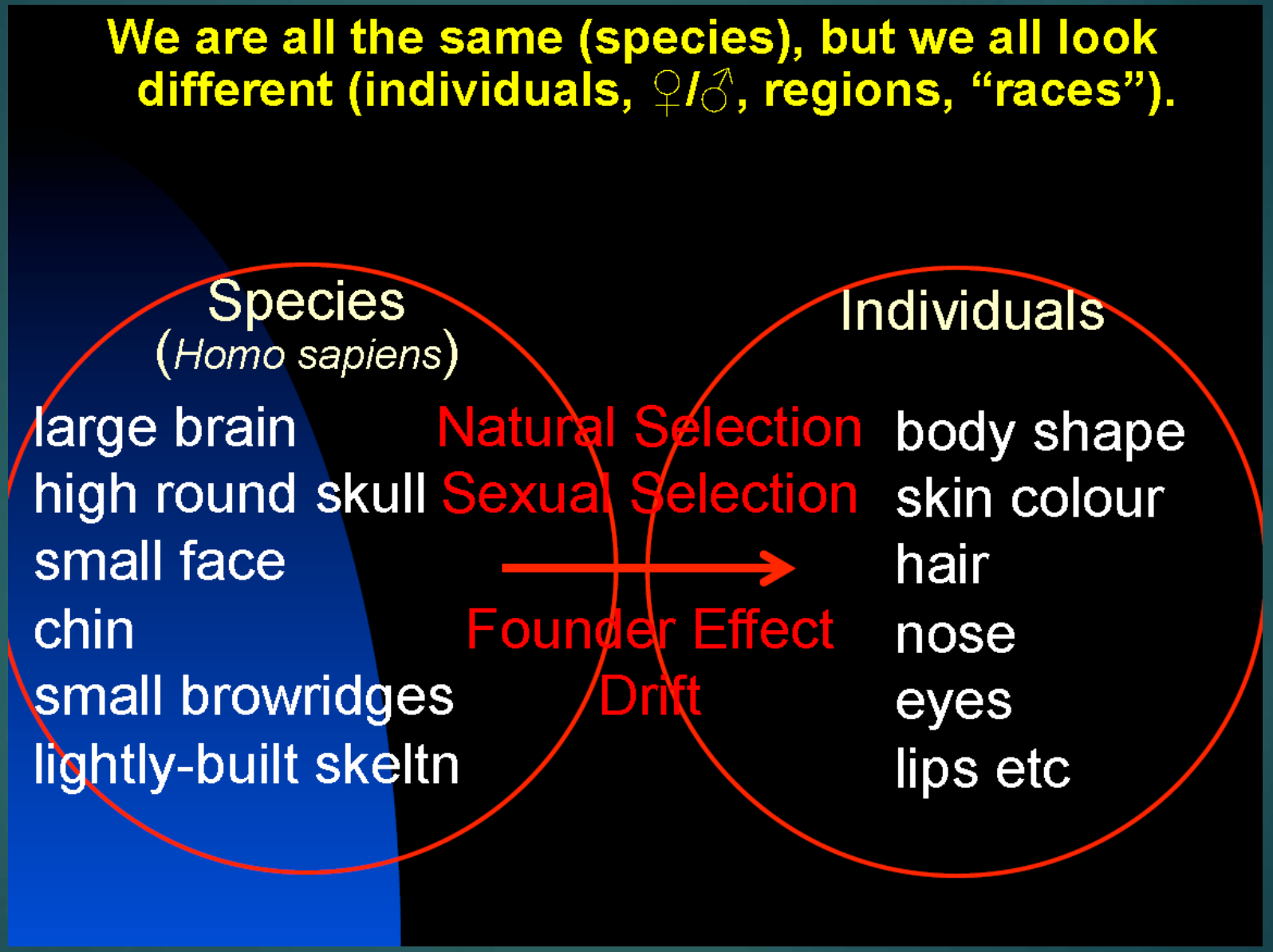
African immigration of AMHs circa 80-50K

- Main African exodus event of AMHs occurred around 80 to 50 kya
- Either across the Bab-el-Mandeb (‘Gate of Grief”), roughly from modern Djbouti in Horn of Africa to Yemen in Arabian Peninsula
- Or alternately around the rim of the Red Sea
- Humans reached Australia circa 50K and southern China by 120-80K
- Europe reached by 40K, probably via Turkey, Bulgaria, and Romania, where they discovered the Danube to central Europe, where earliest European art found
- Earliest MH sites are Oase Cave, Romania & Temnata Cave and Bacho Kiro Cave in Bulgaria
- Kents Cavern, Torquay, England by 41K

China, not Europe, First: South China, 40 teeth, 120-80 K, *H. sapiens*

After leaving Africa circa 50K, headed to China by 80K; entered Europe 40 K later

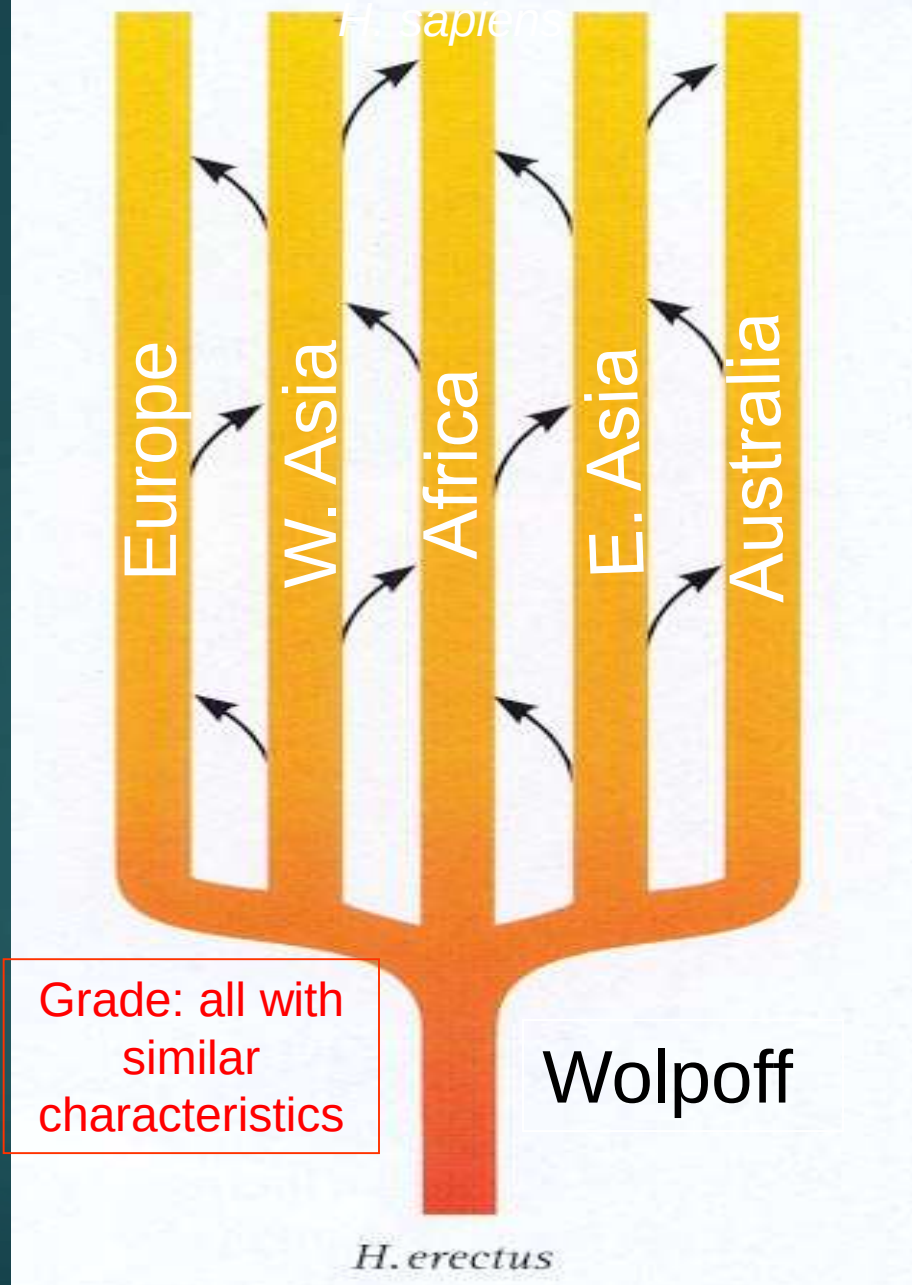
We are all the same (species), but we all look different (individuals, ♀/♂, regions, "races").



Out of Africa vs. Multiregional

- *Pat Shipman:*
- *Out of Africa hypothesis:* modern humans are both relatively recent (100,000 to 200,000 years old) and African in origin. A major prediction of this hypothesis is that the earliest remains of modern humans will be found in Africa, dated to an appropriate time period.
- The rival *Multiregional hypothesis* argues that modern humans evolved in many locations around the world from a precursor species, *Homo erectus*, approximately one to two million years ago; regional groups evolved into modern groups; there was also genetic contacts with African immigrants These regional populations evolved along parallel paths and reached modernity at roughly the same time. Because the populations were largely isolated from one another, they developed distinctive regional features, which people recognize today as "racial" differences.
- Evidence vs Multiregional: Mitochrondrial Eve, Homo Sapiens Idaltu (BOU-VP-16/1, is 1,450cc , Herto, 154-160K, oldest), mtDNA of Neandertals was not closer to that of the modern Europeans. Cro-Magnon mtDNA was unlike the Neandertal sample, early anatomically modern fossils were also genetically modern

Multiregional Evolution



Grade: all with similar characteristics

Wolpoff

Complete Replacement

Clade:

All from common ancestor

Stringer & Andrews

Russell L. Ciochon

Multiregionalism

- The transformation from archaic Homo populations to modern humans took place more or less independently in each of main regions of Old World (Africa, Europe, Asia)
- Multiregionalism: In Europe, Ns evolved into European MH; in Asia, H. erectus became Asian MH
- Geographical variants of MH were separate species with different evolutionary histories
- Weaker version (F. Weidenreich): variation reduced by gene flow via migration or inbreeding) between regions
- Multiregionalism has not been totally discredited, given new interbreeding DNA data.

Recent African Origin of MHs: Africa is origin of MHs

- Overwhelming evidence from genetic studies that Africa is primary source of MH genome: H. sapiens emerged in Africa about 200 kya and all modern humans are descendants of that population
- Africans are oldest group with greatest number of genetic mutations
- Serial Founder Effect Model: Sequential loss of diversity with distance from Africa

Earliest Language: decreasing diversity with distance,

Quentin D. Atkinson looking not at words but at phonemes — the consonants, vowels and tones that are the simplest elements of language.

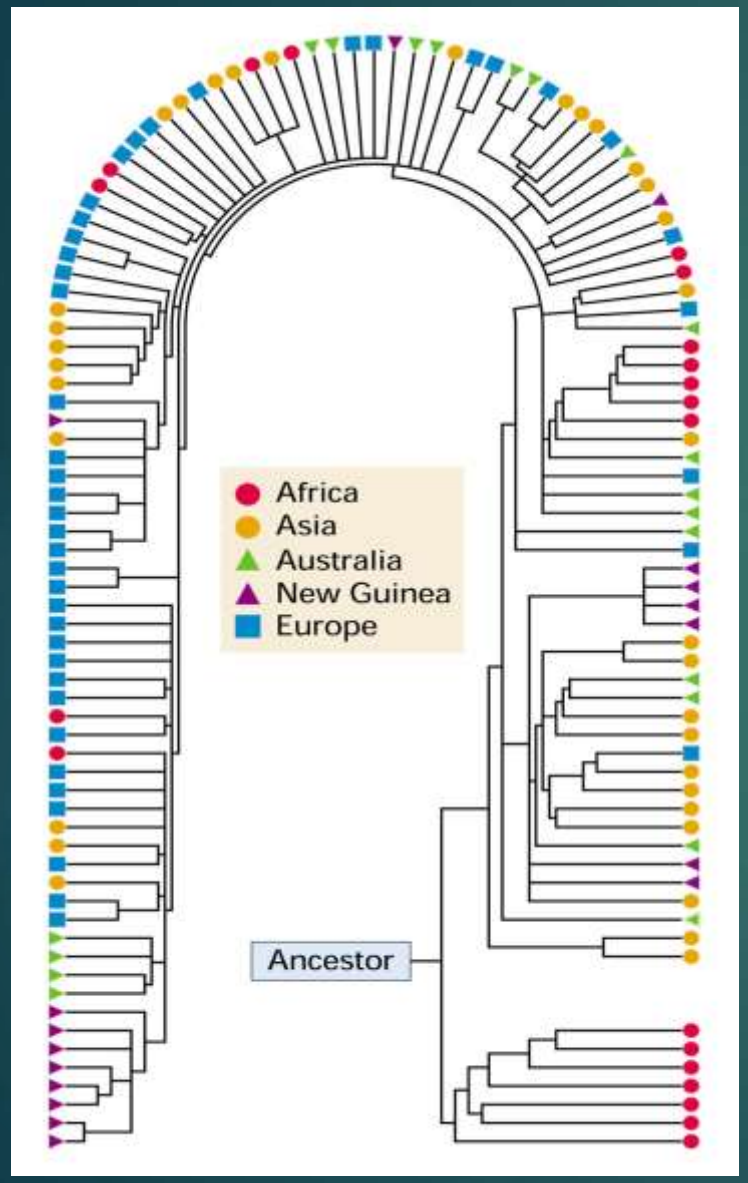
- A simple but striking pattern in some 500 languages spoken throughout the world:
  - A language area uses fewer phonemes the farther that early humans had to travel from Africa to reach it:
  - Click-using languages of Africa have more than 100 phonemes
  - Hawaiian, toward the far end of the human migration route out of Africa, has only 13
  - English has about 45 phonemes.

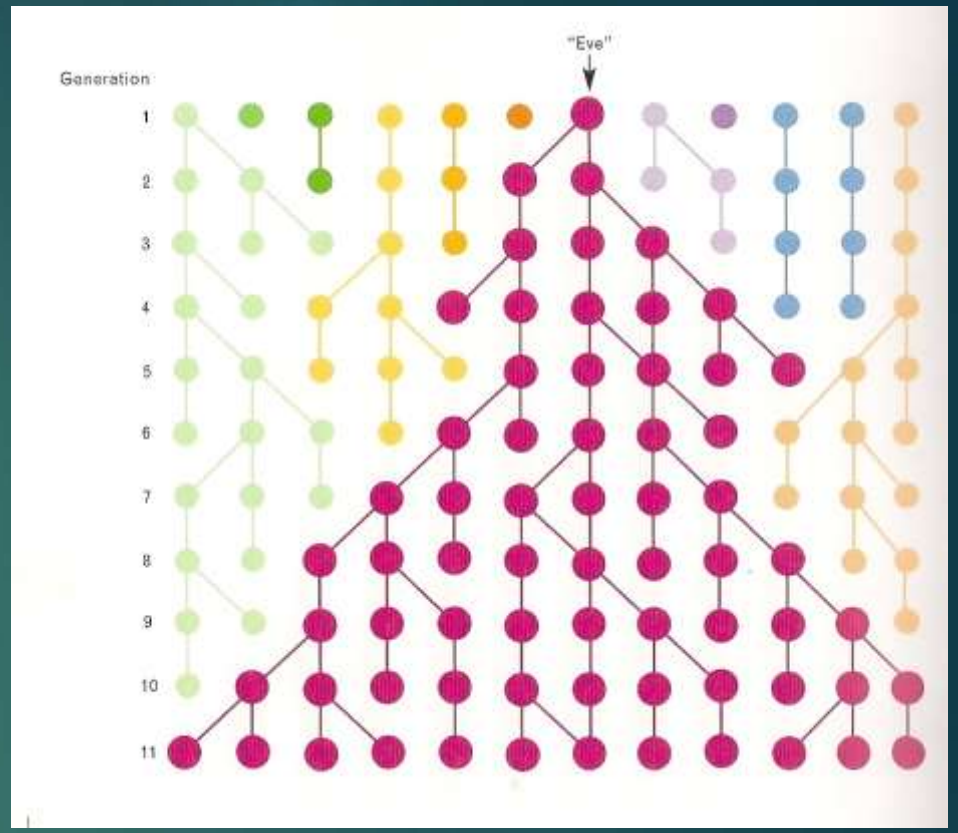
- This pattern of decreasing diversity with distance, similar to the well-established decrease in genetic diversity with distance from Africa, implies that the origin of modern human language is in the region of southwestern Africa.

Africa as cradle of Humanity

- In 1980s, idea that Africa was cradle of Humanity takes hold; 3 lines of evidence
  - 1 – Discovery of MH looking fossils in 1968 at Klasie River Mouth in South Africa dated to 120 kya;
  - MH-like cranium at Kibish in Omo region in Ethiopia (Omo 1) at 195 kya; fossils from Herto, Ethiopia dated btw 200-150 kya;
  - the Omo Kibish 1 and Herto skulls in Ethiopia suggest that the early modern human morphology emerged in East Africa possibly as early as 195,000 year ago

1987: Mitochondrial Eve Hypothesis





- Rebecca Cann: Claims a recent (ca. 290-140 K) origin for all modern humans based on a study of mtDNA haplotype links
- Nuclear Y DNA come up with same results supporting recent African origin of humans; Africans are most genetically diverse; a serial founder effect
- We are African by DNA

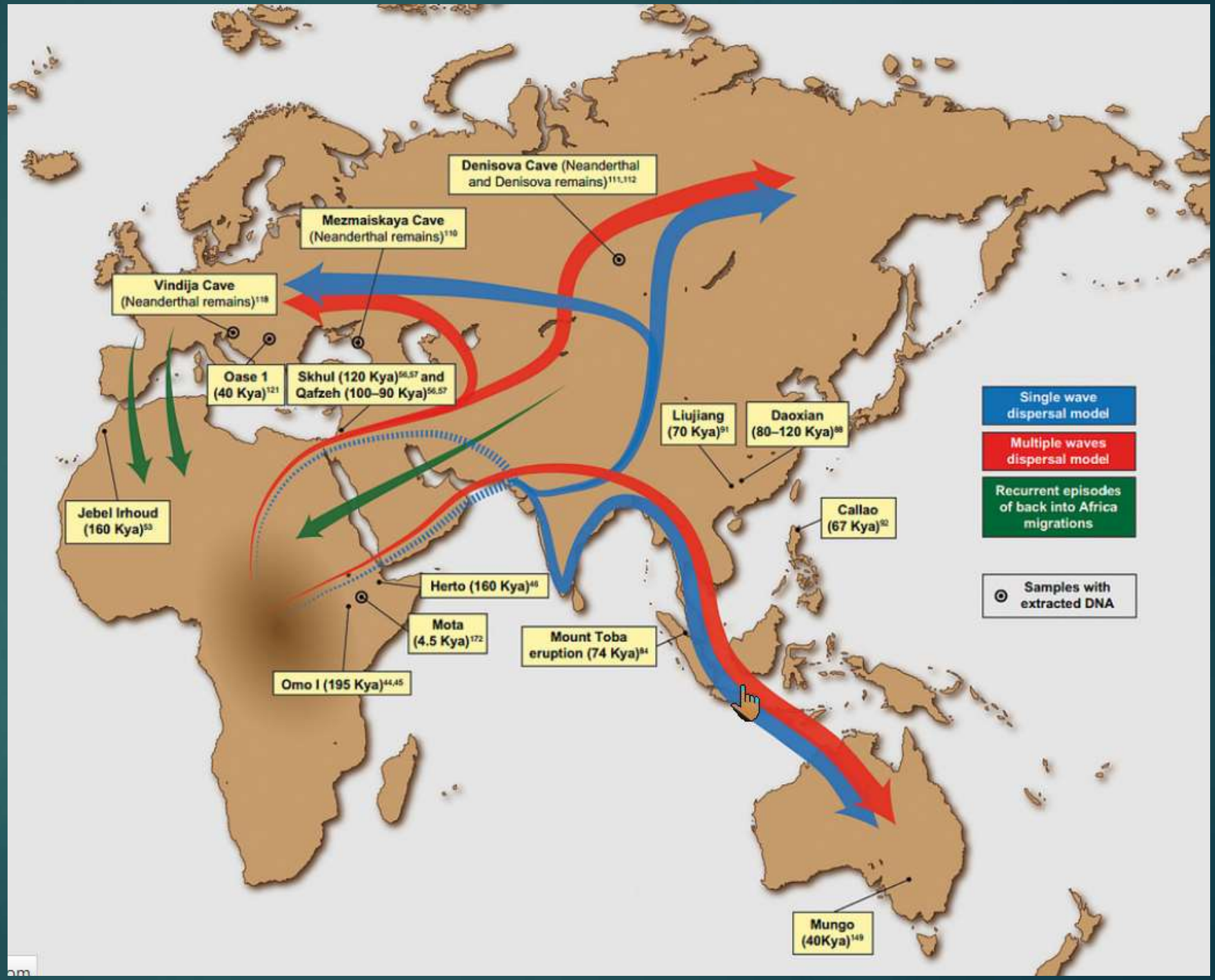
Africa as original locale: mtDNA evidence

- 2 – Molecular biological method published in 1987 by R. Cann, M. Stoneking, & A. Wilson: mtDNA study of 147 MHs – higher mutation rate in mtDNA; 133 different versions of mtDNA;
  - found deep African branch & 2nd non African branch;
  - more variation in the sub-Saharan African mtDNA than in the rest of the world;
  - most of the mtDNA variants had an African origin
  - Based on mutation rate, MH originated in Africa c 200 kya
  - Mitochondrial Eve hypothesis: all MHs descend from African woman c 180K
  - Wrongly, they claimed that all MHs had only African genes

Male Nuclear DNA

- Y chromosome DNA is only male
- 21 of 27 Y chromosome variants originate in Africa
- More variation in Y chromosome of Africans than in all the people from other parts of world
- Conclusion: most, but not all, MH genes originated in Africa
- In past 2 myr Africa seems to have been source of “pulses” of hominin evolutionary novelty
  - 1st pulse was emigration of *H. ergaster*, then *H. heidelbergensis*, then several waves of migration of MHs
  - MHs are derived from a relatively recent, c 50-45 kya migration out of east Africa

2 Possible Migrations based on DNA: single (blue) or double wave (red)



Mark Lipson et al., *Nature*, 2017

Homo sapiens: Symbolic thought

- We communicate with symbols, words and writing..
- By 350 kya: marked objects and possibly their own skin. Colors were symbols by which they identified themselves and their group.
- By 100 kya: buried the dead together with beads and other symbolic objects.
- By 100 kya: used jewelry and other personal adornments to reflect their identity.
- By 77 kya: marks were made on bones, antlers and other objects. These may have been used to count or store information.
- By 40 kya two- and three-dimensional images of the world around them

Homo sapiens: Symbolic thought

- By 17 kya: major representational techniques including painting, drawing, engraving, sculpture, ceramics, and stenciling.
- By 8 kya: symbols to represent words and concepts.
- Art is seen as an expression of symbolic thought: Early examples include red-stained abalone shells from a 100,000-yearold site in South Africa.
- Clay-coated, pierced shells from eastern Morocco were worn as body ornaments 82,000 years ago. Cave paintings in Europe marked the beginnings of figurative art. Intricate rock art in the Northern Territory of Australia may date back to at least 30,000 years ago.
- Cave paintings in Europe marked the beginnings of figurative art
- Ocher, a soft stone, was found at Blombos, a cave on the east coast of South Africa. If scraped it produces a powder that can be mixed with animal fat and used as paint.

South African Coast: 1st Artistic Expression

- AMH sites (130-60 K): Die Kelders Cave, Equus Cave, Border Cave, Klasies River mouth
- Earliest evidence of artistic behavior (red ocher paint (100k) & engraving (80k) at Blombos Cave (but few fossils)

Refuge Sites

- Pinnacle Point, So. Africa (140 - 70 kya)
  - Earliest tools made from beach cobbles; later tools made from stone quarried 20+ km away, then heat treated
  - 70 kya: Some of earliest evidence *H. sapiens* living off sea (cooked shellfish)

- Klasies River Caves, So. Africa (130 - 60 kya)
  - 130-119 kya: systematic use of marine resources: ate shellfish, seals, penguins, hunted antelope, gathered plant foods (roasted in hearths built for the purpose)
  - Fire-blackened fragments of human skulls / other bones showing cut marks = Cannibalism

Klasies River mouth caves: Mandibles, 100-120 K

Fig. 18. Anterior and inferior views of mandibles from Klasies River Mouth. KRM 6222, 6100, and 6101 (top and middle rows, left to right); KRM 6102 (anterior view only); and KRM 6223 (bottom row, left to right). Note in KRM 6223 a distinct triangular development in the symphyseal region and, in inferior view, that the bone of the symphyseal region is somewhat thicker anteroposteriorly than the corporal bone immediately lateral to it. In the other mandibles, although the symphyseal region in some presents various three-dimensional configurations, none approaches the inverted T-shape and, inferiorly, one sees that the bone of the symphyseal region is either thinner anteroposteriorly or of equal thickness compared with the thickness of the bone to its side. Not to scale. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

Klasies River mouth caves, 100-120 K & 65-90 K

- Best evidence for AMH: circa 20 fragmentary fossils (mandibles, isolated teeth, frontal bone, partial temporal bone), incl. some postcranial, repress. 10 individuals
- From 120-60 kya: hearth ash, shells, animal and human fossils; MSA industry
- Mandibles circa 120 k; more modern than Jebel Irhoud 1; other fossils from 90 k
- Shows degree of robusticity, strong sexual dimorphism, modern facial & dental morphology; chin eminence in 2 of 4, no retromolar space; no N features
- No burials; fossils broke, burned, cut marks, cannibalism?

Coast of South Africa: MH symbolism

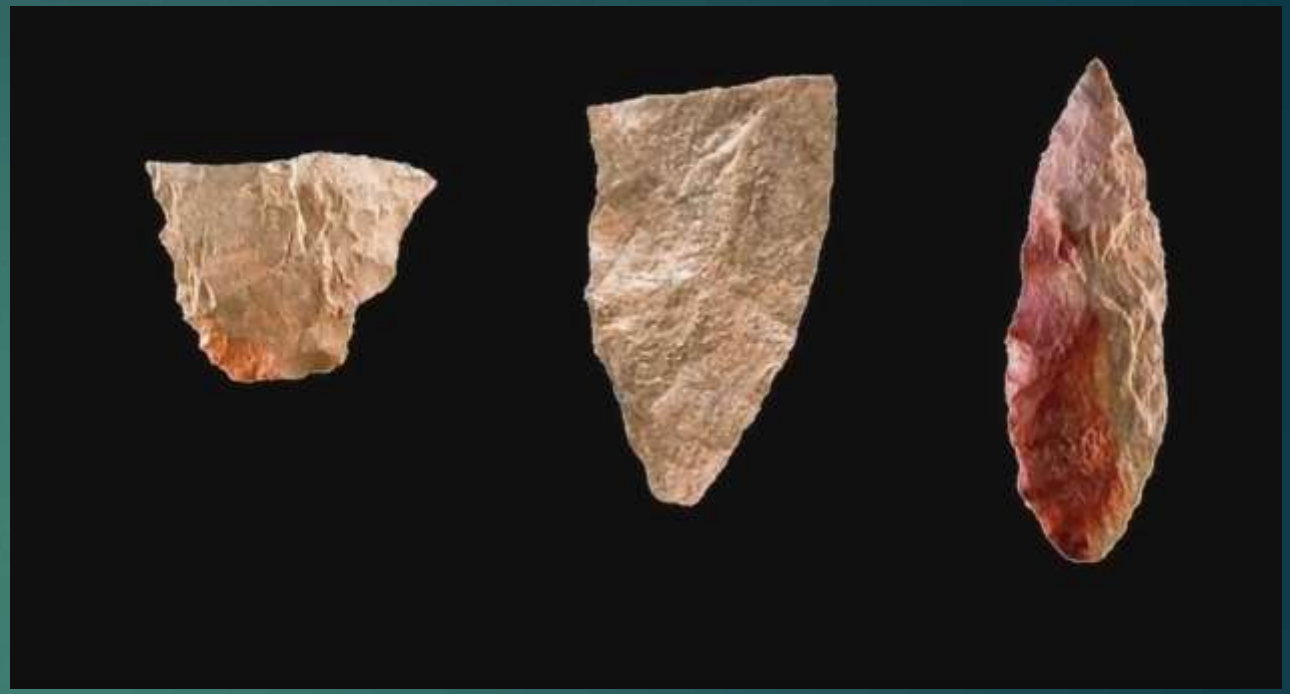
- Four sites in Coastal S. Africa: Blombos Cave, Klasies River Mouth, Pinnacle Point, Diepkloof Rock Shelter; all have nearly modern human fossil bones
- Roots of behavioral modernity, the Upper Paleolithic revolution, can be traced to coastal South Africa
- Early evidence of MH behavior by *H. sapiens*
- Blombos Cave*:* anatomically modern southern African populations had fully modern cognitive abilities and syntactical language dated to 100 kya, earliest symbolism, incl. ornamentation (*Nassarius* mollusk shell beads; fishing; stone tool manufacture called pressure flaking; large amounts of red ocher (iron oxide); red ocher plaque engraved with cross hatches from 77 ka; and heated silcrete artefacts thought to testify to sophisticated pyrotechnological know-how by early modern humans in South Africa; also like the San, oldest eggshells used for water storage (canteens) at 100k; eating fish & shellfish, including diving for deeper abalone

- Pinnacle Point: 220 K archeological artifacts; oldest evidence of shell fishing (dated 160 kya); red ocher; lithics

- Diepkloof Rock shelter: Howiesons Poort tradition of engravings on the ostrich eggshells indicate the existence of a graphic tradition of communicating at 60k;

- Great leap forward in a coastal environment (brain development & Omega 3 in fish)

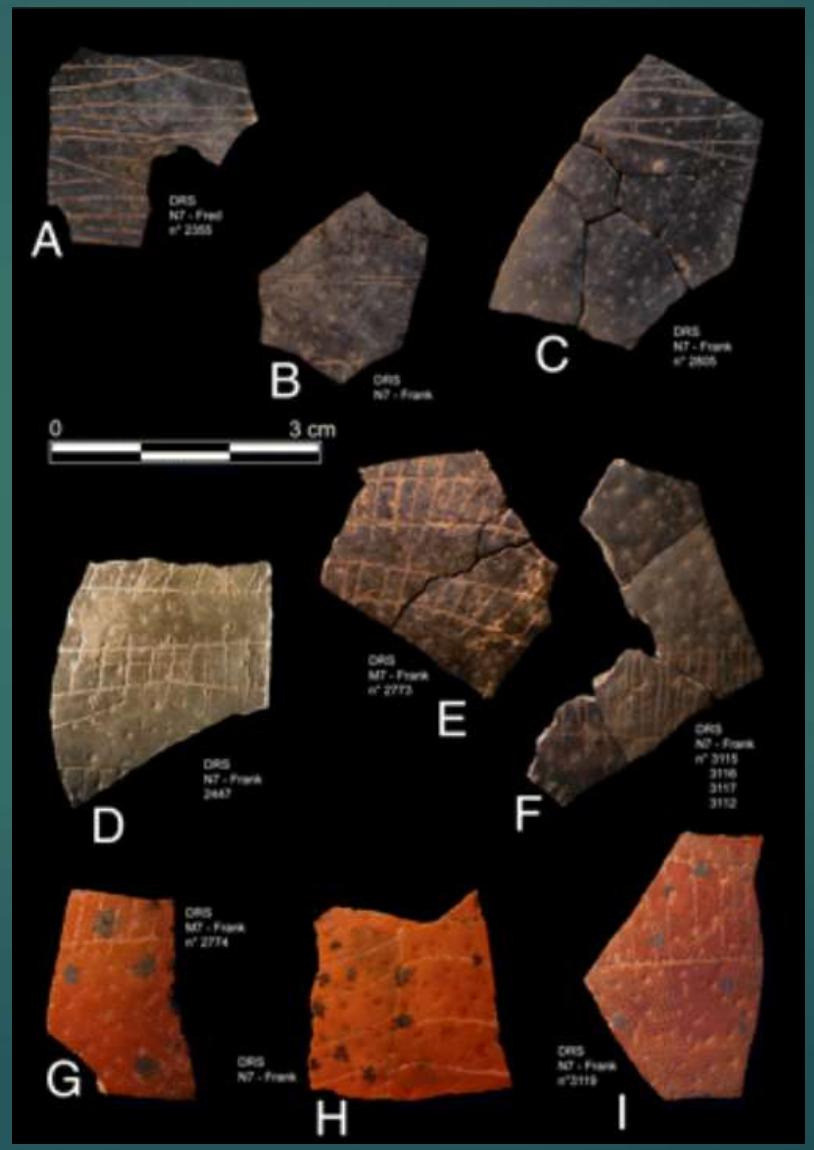
Pinnacle Point lithics



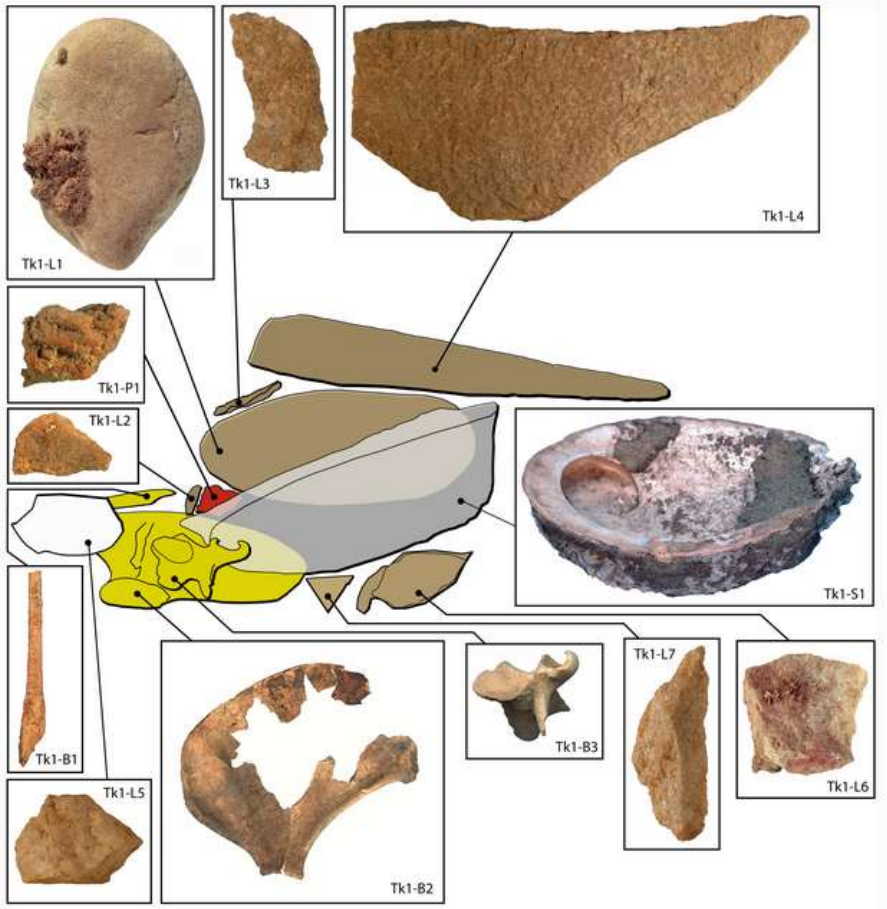
Acheulan blades

100s of thinner blades-- heat treatment of silcrete at c. 72 ka and possibly as early as 164 ka; after heating, flake blades created for hafting of points with glue for projectiles – multicomponent process which needs planning and working memory

Diepkloof Rock shelter: Howiesons Poort tradition of engravings on the ostrich eggshell



Blombos Cave in Cape Town, South Africa: 100K



An ochre-rich mixture, possibly used for decoration, painting and skin protection 100,000 years ago, and stored in two abalone shells, was discovered at Blombos Cave in Cape Town, South Africa. Courtesy Prof. Christopher Henshilwood, University of the Witwatersrand, Johannesburg

Ocher at Blombos Cave: Art is fingerprint of modernity

Christopher Henshilwood: use of paints for body ornamentation, implying symbolic thinking, group identity

First MH art work, 77 k; ocher with cross hatching (Iziko Museum, Cape Town, South Africa)

First Out of Africa MH immigration: >125K?

Monsoons circa 125K created wetter North Africa

125,000 Year Old Hand Axes From Jebel Faya, near Dubai; Evidence of flowing water

2 possible routes to Levant/Middle East:

1 - following Nile River valley north across the desert

2 – followed Bab-el-Mandeb strait when sea levels lower, from Africa to Arabia

One of oldest directly dated AMH mandibles (42-39 K) from Pestera cu Oase, Romania

The morphology of the Pestera cu Oase (Romania) fossils, the first modern humans from Europe, dated to 42–39 ka, was (controversially) interpreted as the result of interbreeding between Neandertals and modern humans, a view recently confirmed by genetic analysis demonstrating that the inferred hybrid had a Neandertal ancestor four to six generations before his time

MHs in Europe

- Earliest evidence of MH behavior in Europe comes from Bacho Kiro & Temnata, Bulgaria, c 43-40 kya & by European sites just less than 40 kya
- MHs in Europe overlapped with Ns; most recent N evidence from St. Cesaire, France & Vindija, Croatia dated to c. 30 kya

- Ns had already retreated from many areas well in advance of arrival of MHs; but some overlap of Mousterian & Aurignacian in northern Spain and France

** Earliest Modern Human Fossils

Specimens	Age
Omo-Kibish KHS & PHS	150-195 K
Herto	150-160 K
Singa	140-150 K
Mumba	110-130 K
Klasies River mouth LBS	100-120 K
Qafzeh	90-100 K
Skhul	90-110 K
Aduma	80-105 K
Bouri	80-105 K
Sea Harvest	82-123 K
Klasies River mouth SAS	65-90 K
Die Kelders 1	60-70 K
Blombos	65-70 K
Taramsa Hill Pinnacle Point	50-80 K 57-81 K

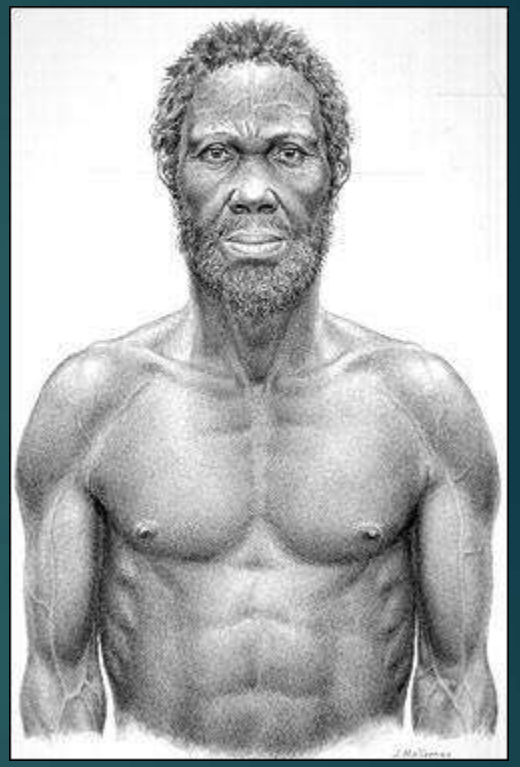
East African AMH Fossils

- Ethiopia: Middle Awash (Herto, Aduma), Omo
- Most convincing & earliest dated cranial fossils of AMH are 3 from Herto, dated 160-154 kya; all defleshed with cutmarks, mortuary practice?
- Most complete Herto cranium (BOU-VP 16/1); cranial capacity = 1450 cc; height and length of cranium exceeds most modern humans; largest breadth is parietal; 2nd adult is even larger cranium; all have high cranial vault, large frontal & parietal; Between Bodo and Qafzeh skulls; with both Acheulean & MSA Lavallois tools; evidence of butchering hippos & bovines
- Cranial remains from 4 AMH at Aduma; 105-79 kya; (ADU-VP 1/3)

Haile-Selassie Y, Asfaw B, White TD, 2004

2003: *Homo sapiens idaltu*, 160K, Herto

Herto, Ethiopia; Bou-VP-16-1



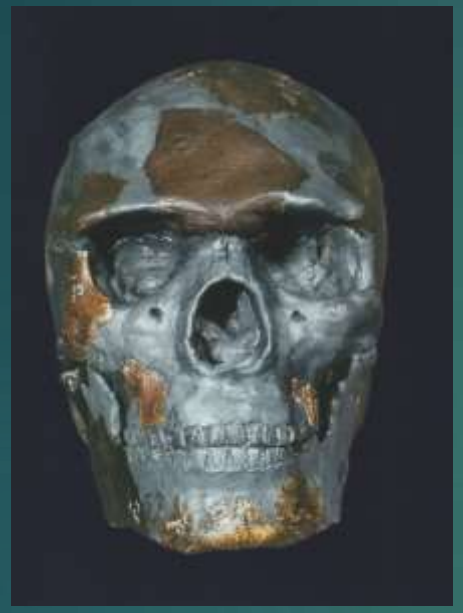
Found with fossils of hippo calves

Tim White & Berhane Asfaw

Tim White considers Herto, Ethiopia; Bou-VP-16-1
Homo sapiens idaltu (“elder”)

Locality: Herto
Date: 1997

1967: oldest *Homo Sapiens,* Omo Basin, 195K: Curved parietal, high forehead, chin

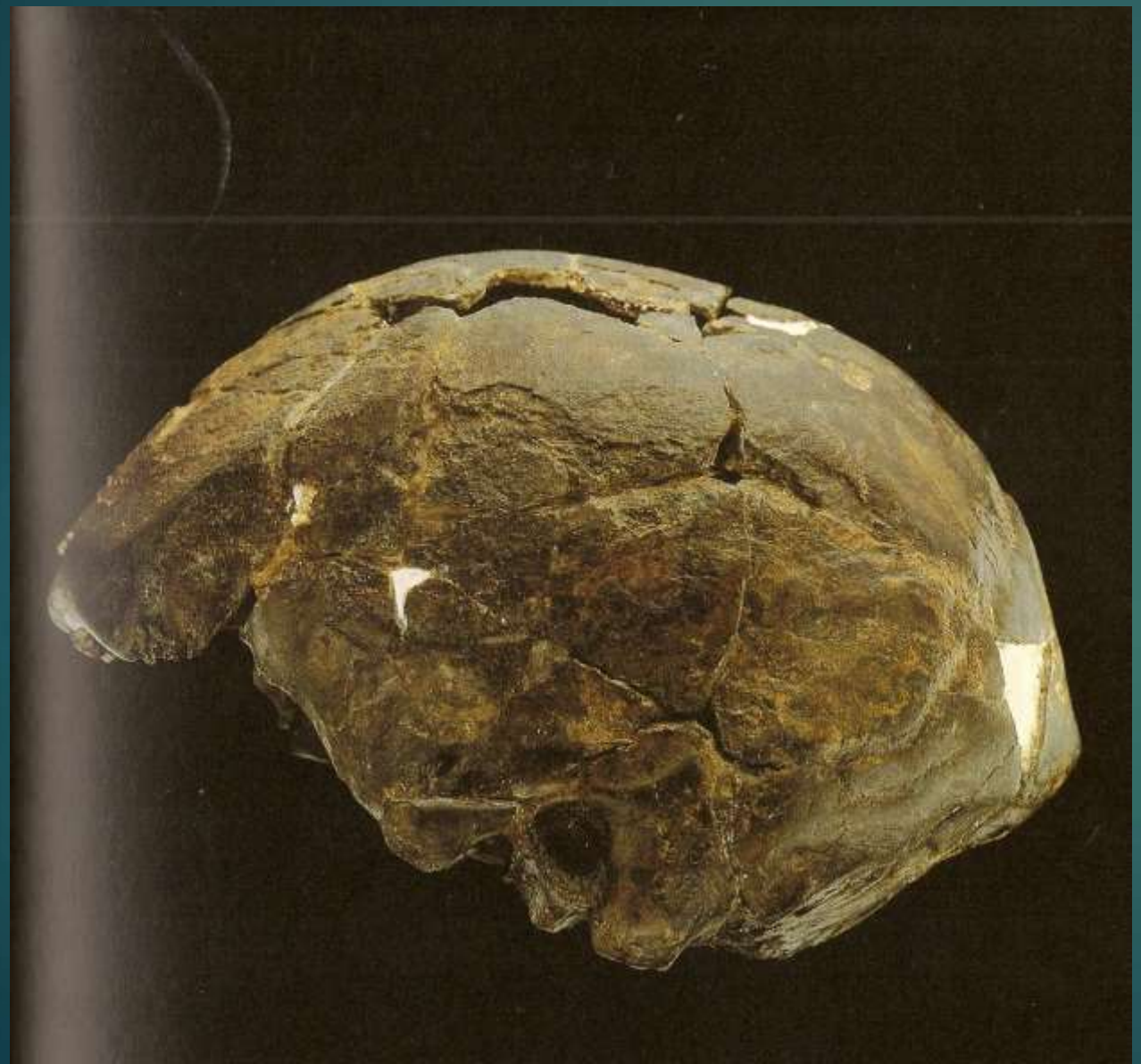


Homo sapiens, Omo II

Homo sapiens
(Omo I)
Discoverer:
Kamoya Kimeu
Date: 1967
Locality: Kibish,
Omo Basin, Ethiopia
Age: 195K

At 195K, oldest known modern human fossils

OMO 2: Oldest *Homo sapiens* Skull

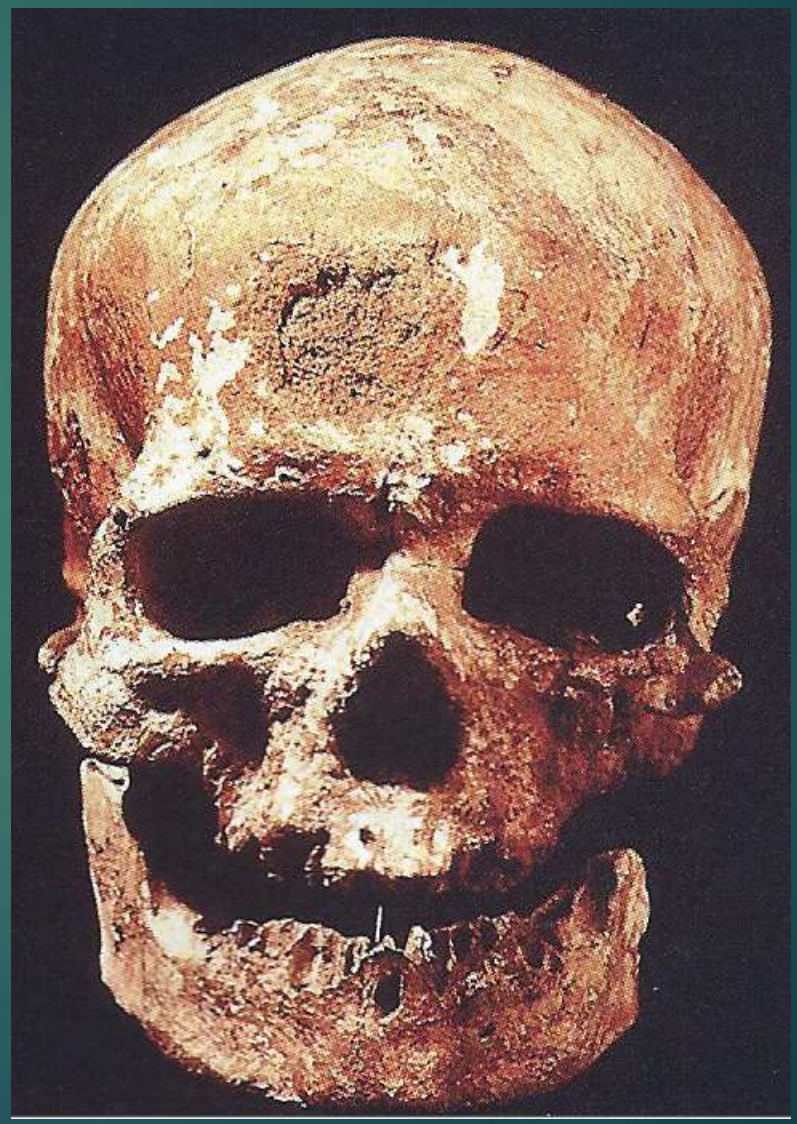


- Discovered 1967 near Omo River in Ethiopia
- 2005 better dating = 196 kya
- Oldest known of our species

1823: Red Lady of Paviland

First *Homo sapiens* fossil discovery;
Rev. William Buckland

1868, European *Homo sapiens*, Cro-Magnon 1, 30 kya



Homo sapiens
(Cro-Magnon *I*)
Discoverer: Louis Lartet & Henry Christy
Locality: Abri Cro-Magnon, Les Eyzies, France
Date 1868
Age: 30-32 K

~1925: *Homo Sapiens*, Skhul V, 90 kya

Homo sapiens
(Skhul V)
Discoverers:
Theodore McCown
& Hallum Movius Jr.
Locality: Skhul cave
Mount Carmel, Israel
Date:1932
Age: 90K

Skhul/Qafzeh robust *H. sapiens* possess brow ridges, no chin, and a projecting facial profile, similar to the Neanderthals.

1894: *Homo sapiens*, Predmostı, Moravia, 26 kya

Skull 3; Cranial capacity = 1580 cc

Homo sapiens, Qafzeh, 90K

Homo sapiens
(Qafzeh IX, female, 13 yo)
Discoverer: Bernard Vandermeersch
Locality: Qafzeh cave, Israel
Date:1969
Age: 90-100K

Near extinction - Bottleneck & founder effects

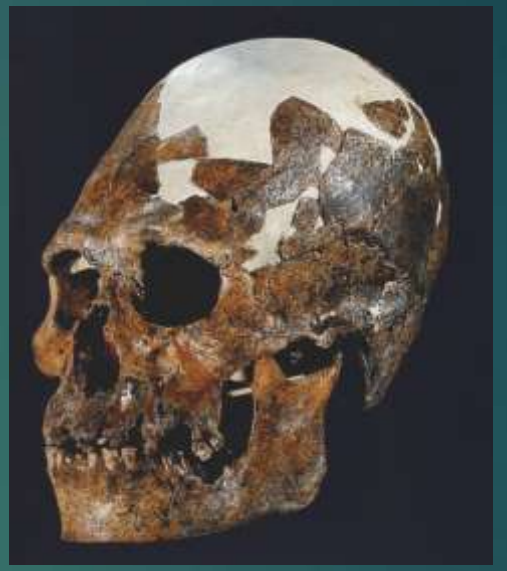
- During our species' near-extinction about 70,000 years ago, the number of humans was reduced to 10,000 mating pairs.
  - There is no associated evidence of mammal decline or extinction even in environmentally-sensitive species.
  - There is no evidence of habitat reduction at that time in Africa.
  - The Toba eruption did not have a significant effect on the climate of East Africa and was not the cause of a human bottleneck in Africa at around 75 ka.
  - Likewise, there is archeological evidence that the Toba eruption did not affect the behavior of populations inhabiting peninsular India.

- When it comes to our DNA, all humans—regardless of race, color, or nationality—are 99.9% alike.
- In fact, studies suggest that there's more genetic diversity in a single troop of 100 chimpanzees than in all 7 billion modern humans.

Homo sapiens, Australia, by 60 K

Lake Mungo Australia
Homo sapiens, Mungo III male, 30K

Kow Swamp 1



Kow Swamp 5

Homo sapiens
(Kow Swamp 1)
Discoverer: Alan Thorne & Phillip Macumber
Locality: Kow Swamp, Victoria, Australia
Date: 1967-1968 Age: 10K

Upper Paleolithic Tools

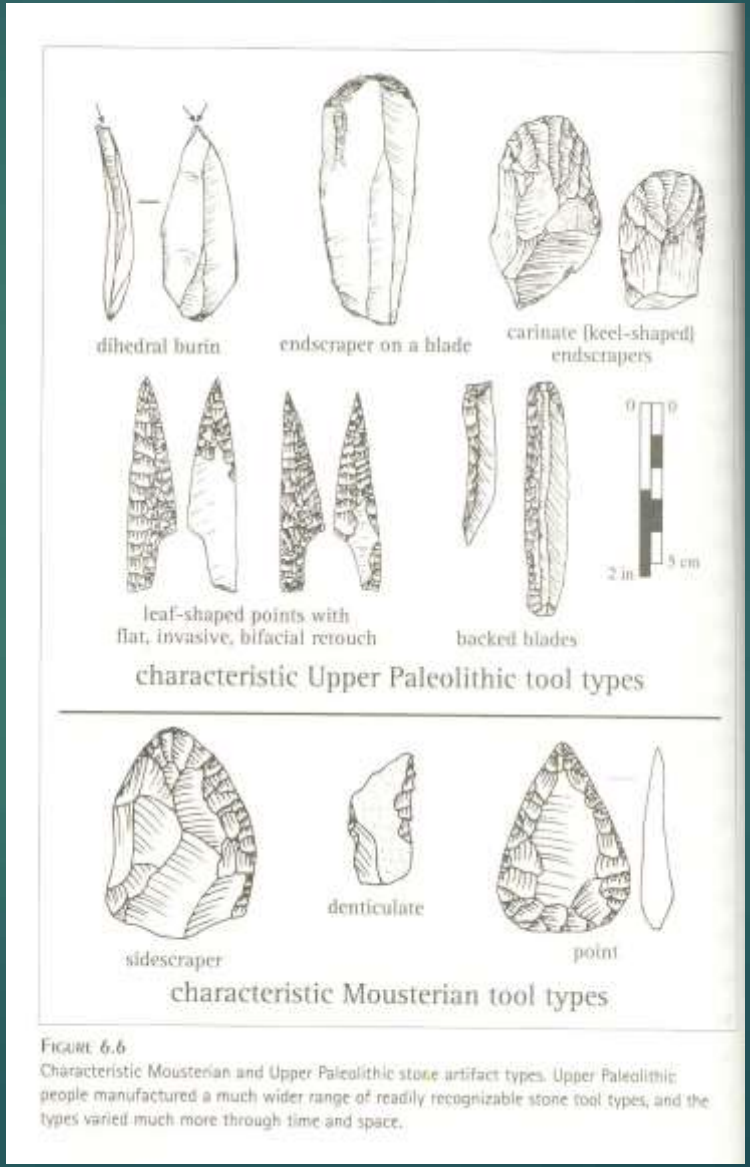
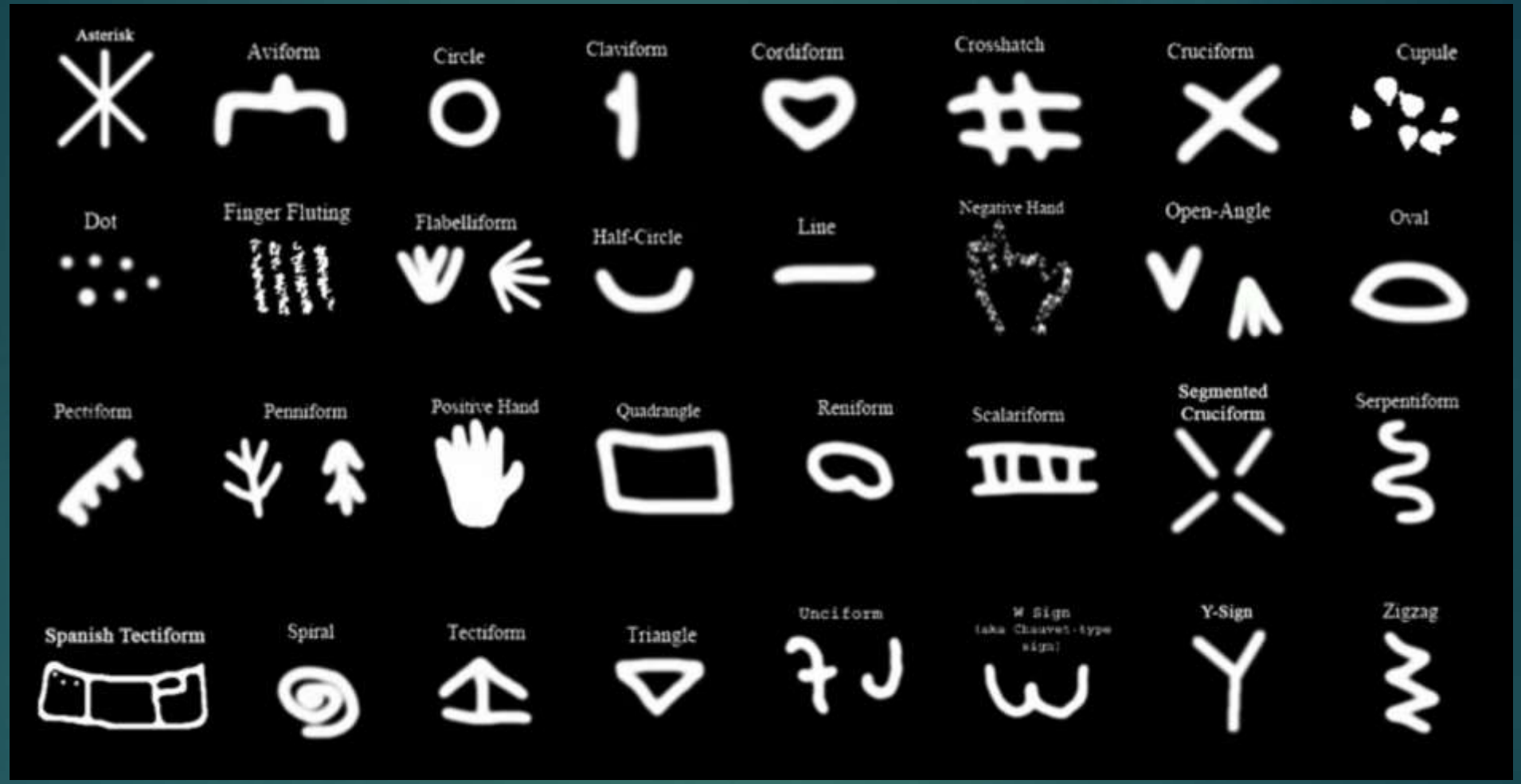


FIGURE 6.6
Characteristic Mousterian and Upper Paleolithic stone artifact types. Upper Paleolithic people manufactured a much wider range of readily recognizable stone tool types, and the types varied much more through time and space.

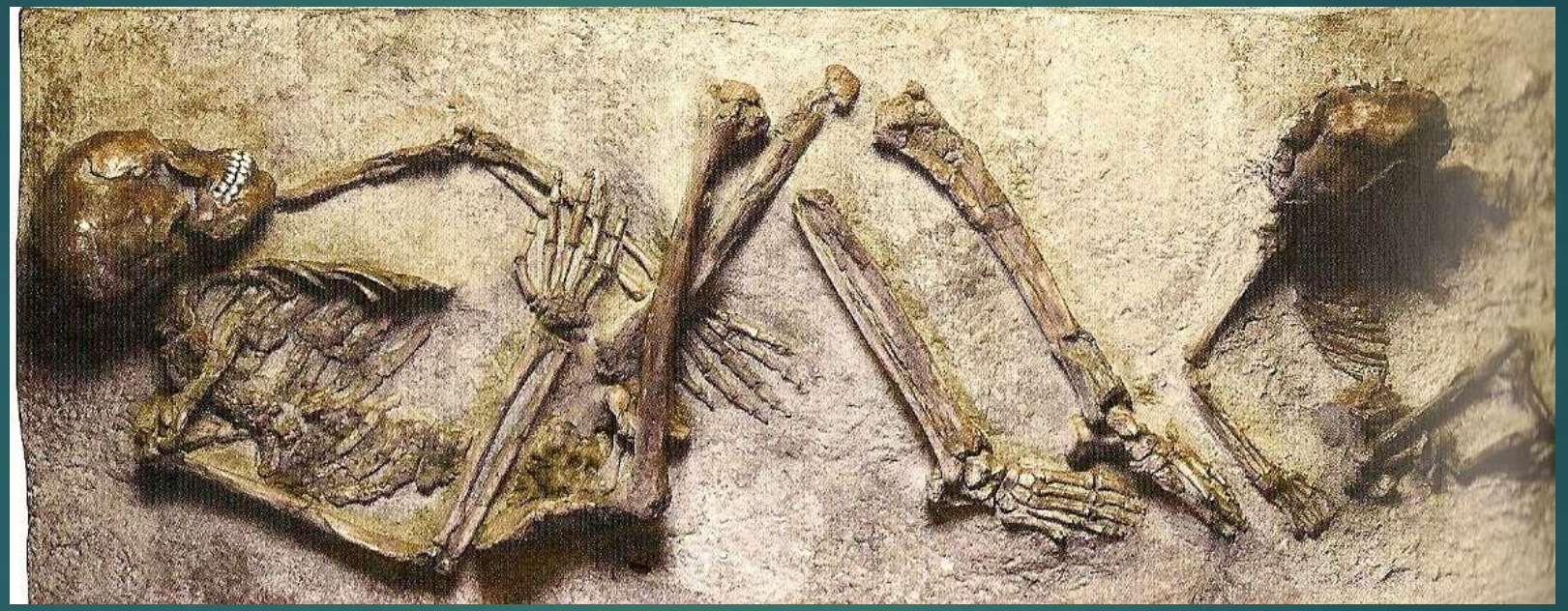
Graphic Communication



52 cave sites in Europe, over 30,000 year period: 75% had symbols; 32 symbols 65% of which stayed in use for entire time period; some clan signs?
Common origin in Africa?

2015, TED, **Genevieve von Petzinger**

Homo sapiens: ritual burial



90-100 kya; Israel; Mother and child

Caves of Lascaux and Altamira

The Hall of Bulls
c. 17,000 BC
Lascaux, France

Altamira Bison
c. 15,000 BC
Altamira, Spain

Symbolism & Art

Geometric figures: 77 kya

Shell beads: 70 kya

Cave paintings: 30 kya

Earliest musical instruments: 35 kya

“Venus” figurines: 35 kya

Indonesian, 39,000 y.a.

Gabarnmung in Northern Australia: 35K

2 foot clay sculpture, France

MHs in Americas

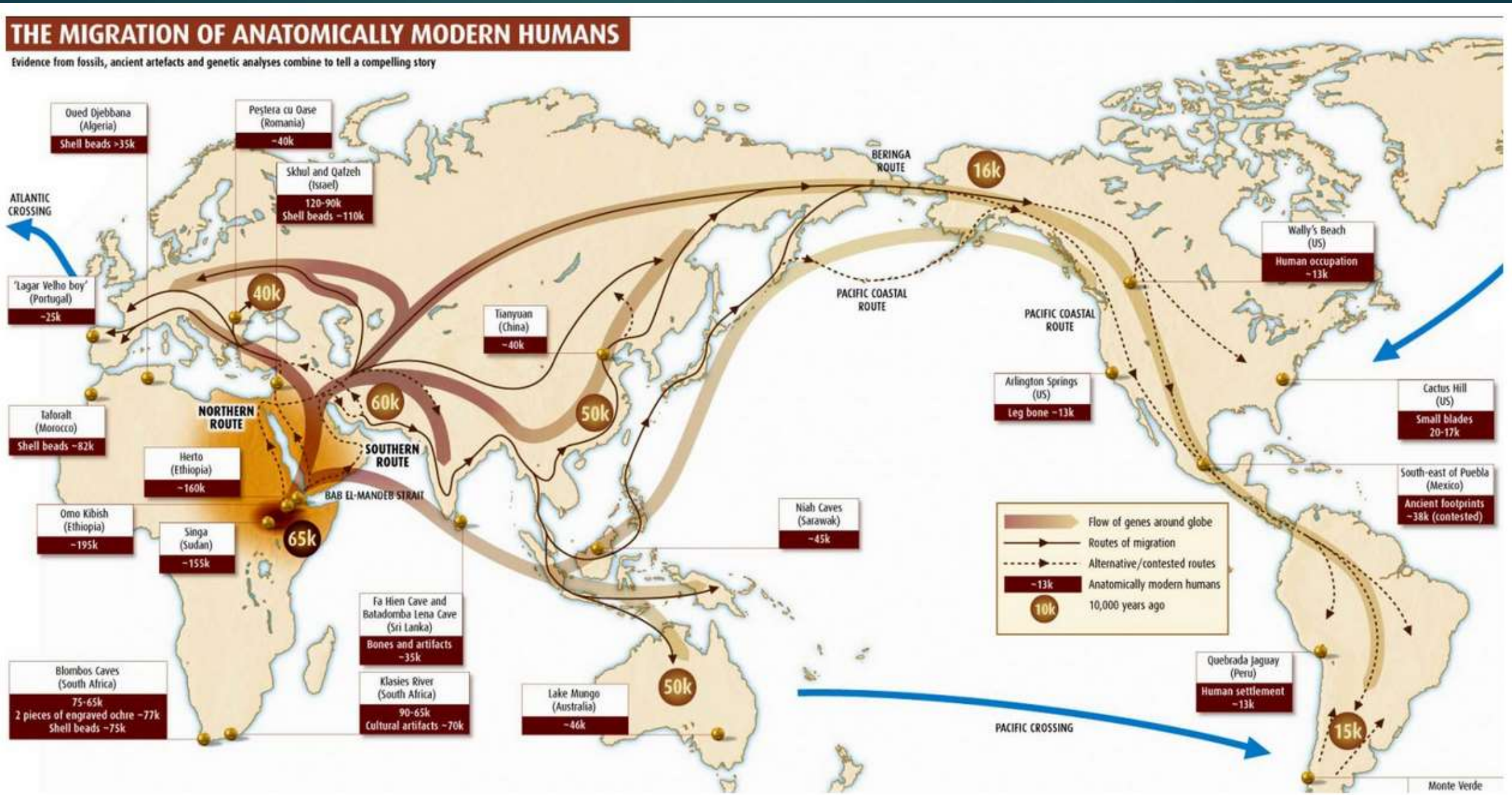
- 3 possible routes to Americas: across Bering Straits, Aleutian island hopping, or across the Atlantic; during 40-30 kya, sea level fall may have closed Bering Straights and linked the islands; issue is cold weather survival
- First evidence for MH occupation of Arctic Circle is 27 kya; long term occupation by 15 kya; following animal herds may have lead to the Americas; but no occupation site in Alaska until 12 kya; found ice free corridor that lead to Americas; but remarkably little evidence on this route south
- Best known archaeological evidence form MHs in Americas is Clovis Culture (known by Clovis points); oldest sites are just before 11 kya
- But Clovis is now clearly not the earliest

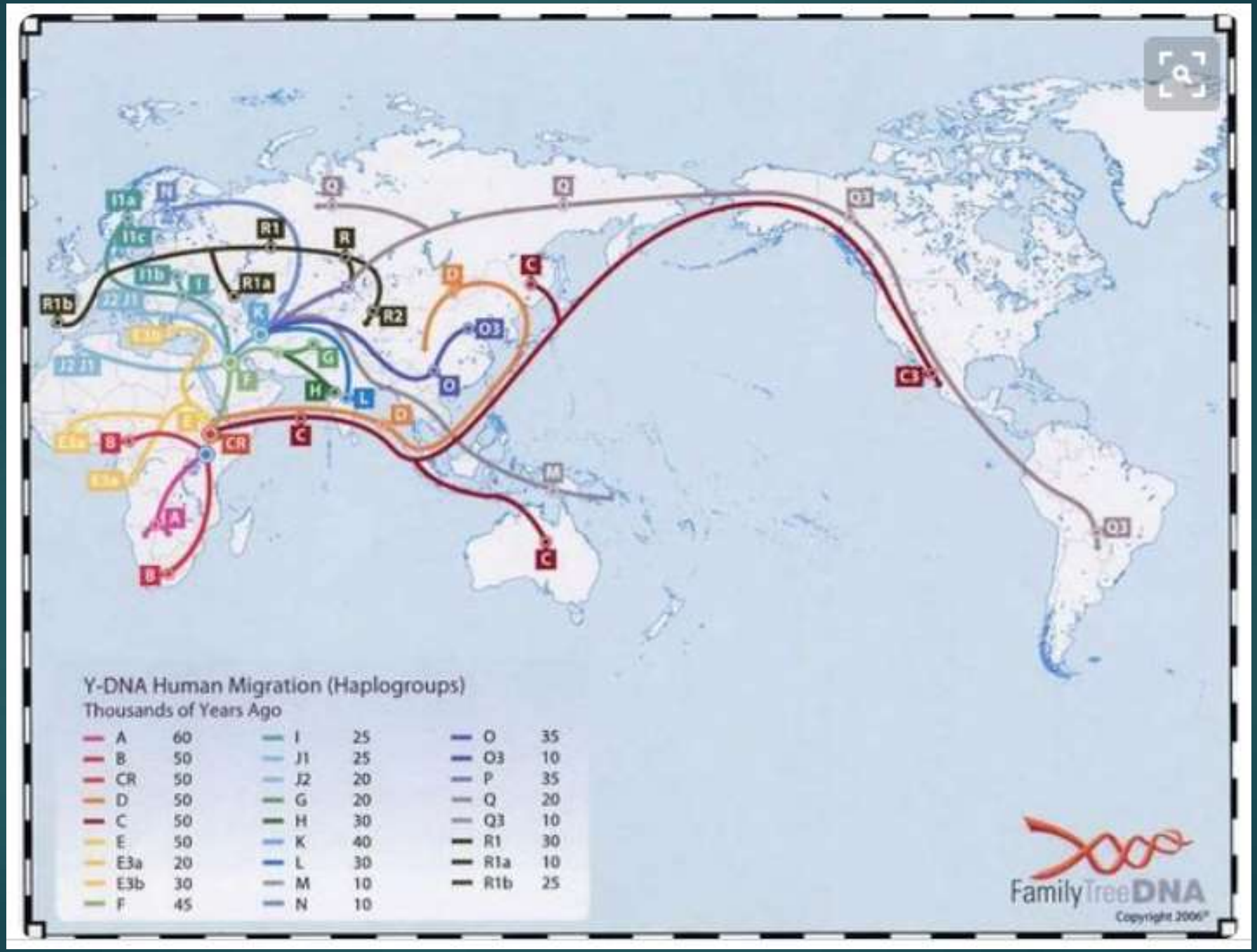
MHs in Americas

- More recent research: evidence of stone industry more primitive than Clovis: Pre-Clovis sites in N America (Duktai in Alaska, Meadowcroft in PA (14-20 kya), Cactus Hill in VA, Topper in SC); in S. America (Taima-Taima in Venezuela, Pedra Furada in Brazil, Monte Verde in Chile)
- Bluefish Caves, Canada: humans occupied the site as early as 24,000 cal BP (19,650 ± 130 ^{14}C BP). In addition to proving that Bluefish Caves is the oldest known archaeological site in North America, the results offer archaeological support for the "Beringian standstill hypothesis", which proposes that a genetically isolated human population persisted in Beringia during the Last Glacial Maximum and dispersed from there to North and South America during the post-LGM period.
- Monte Verde, c 12.5 kya: cords used to tie hides to poles, dwelling remains for 20-30 people; occupied year-round; earliest evidence of semipermanent occupation in New World?

- Western Stemmed points: may be evidence of first arrivals in the Americas

  - Some may be older than 14K
  - Pinkie-sized stone spear-points with a chunky stem


THE MIGRATION OF ANATOMICALLY MODERN HUMANS
Evidence from fossils, ancient artefacts and genetic analyses combine to tell a compelling story
Oued Djebbana (Algeria)
Shell beads >35k
Peştera cu Oase (Romania)
~40k
Skhul and Qafzeh (Israel)
120-90k
Shell beads ~110k
ATLANTIC CROSSING
'Lagar Velho boy' (Portugal)
~25k
40k
Tianyuan (China)
~40k
BERINGA ROUTE
16k
PACIFIC COASTAL ROUTE
PACIFIC COASTAL ROUTE
Wally's Beach (US)
Human occupation
~13k
Arlington Springs (US)
Leg bone ~13k
Cactus Hill (US)
Small blades
20-17k
Taforalt (Morocco)
Shell beads ~82k
NORTHERN ROUTE
60k
50k
SOUTHERN ROUTE
Herto (Ethiopia)
~160k
BAB EL-MANDEB STRAIT
South-east of Puebla (Mexico)
Ancient footprints
~38k (contested)
Omo Kibish (Ethiopia)
~195k
Singa (Sudan)
~155k
65k
Niah Caves (Sarawak)
~45k
Flow of genes around globe
Routes of migration
Alternative/contested routes
~13k
Anatomically modern humans
10k
10,000 years ago
Fa Hien Cave and Batadomba Lena Cave (Sri Lanka)
Bones and artifacts
~35k
Blombos Caves (South Africa)
75-65k
2 pieces of engraved ochre ~77k
Shell beads ~75k
Klasies River (South Africa)
90-65k
Cultural artifacts ~70k
Lake Mungo (Australia)
~46k
50k
Quebrada Jaguay (Peru)
Human settlement
~13k
PACIFIC CROSSING
15k
Monte Verde


Y-DNA Human Migration (Haplogroups)
Thousands of Years Ago
A 60
B 50
CR 50
D 50
C 50
E 50
E3a 20
E3b 30
F 45
I 25
J1 25
J2 20
G 20
H 30
K 40
L 30
M 10
N 10
O 35
O3 10
P 35
Q 20
Q3 10
R1 30
R1a 10
R1b 25
FamilyTreeDNA
Copyright 2006

Skull Wars

- A prehistoric Paleoamerican man found on a bank of the Columbia River in Kennewick, Washington in 1996
- Kennewick Man, 9 kya; one of the most complete ancient skeletons ever found
- The Umatilla people and other tribes have wanted the remains returned to them for reburial under the federal Native American Graves Protection and Repatriation Act (NAGPRA). Said bones were sacred and should be reburied
- Scientists wanted to study it . Nine-year court case between the US Army Corps of Engineers, scientists, and Native American tribes. They got 5 years to study it. They thought it was Polynesian or Ainu of Japan.
- 2015: Kennewick Man had most in common with Native Americans among living peoples, very closely related to the Colville tribe in northeast Washington. Mitochondrial haplogroup X2a and the Y-chromosome haplogroup Q-M3; 38 yo, severely arthritic, & fractures; mobile, water born life.
- Unfortunately there is a major lack of genomes from North American aboriginal populations, due to their religious beliefs about being unique.

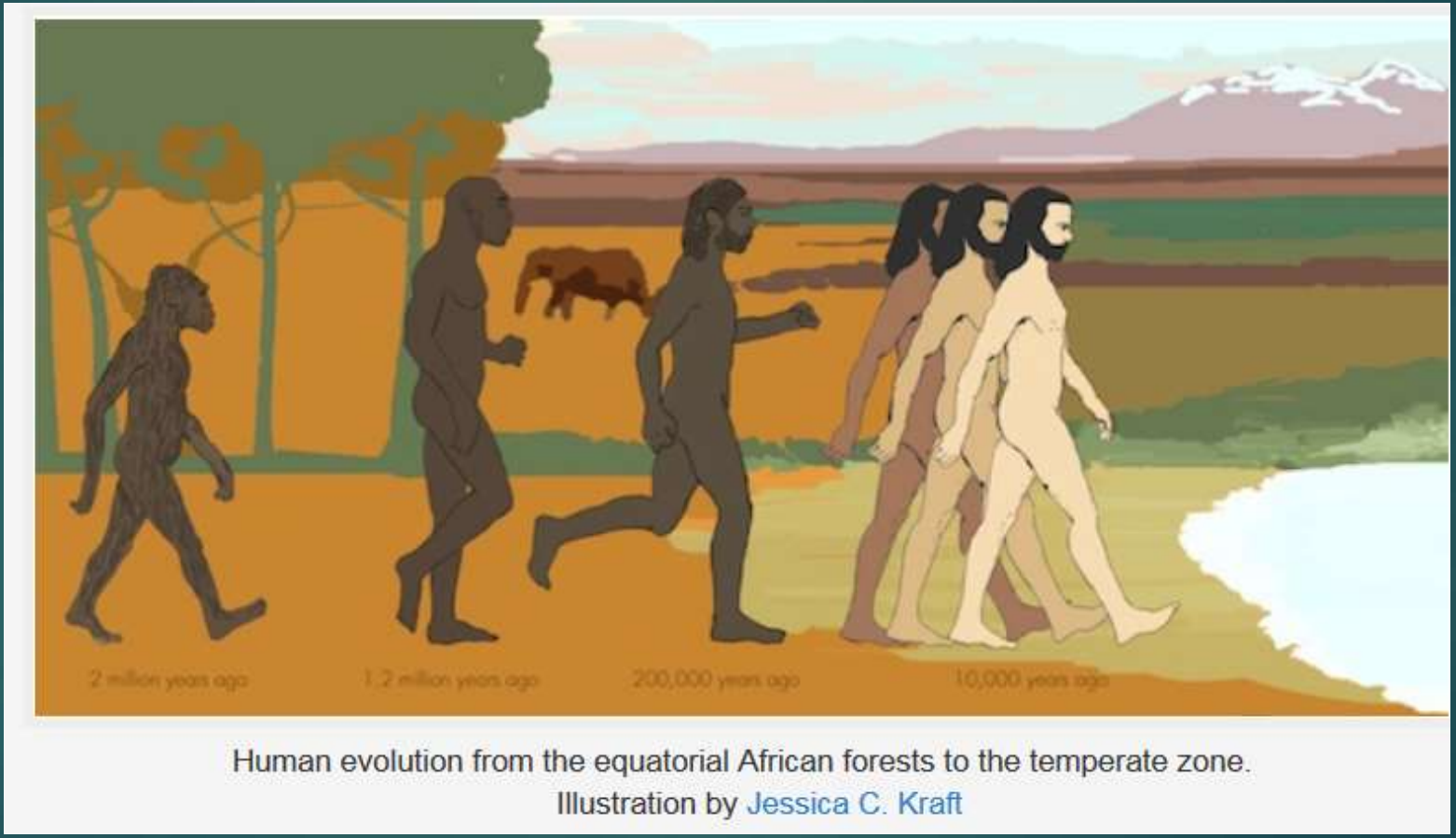
North America: Anzick boy, 13 K

- 1968, Bozeman, MT: Anzick ranch, 115 stone & bone artifacts, dated at 13 kya; Clovis spear points with midline fluting; oldest burial in North America, and the only known human burial associated with the Clovis culture
- One and half year old boy's skeleton covered in red ocher
- 30 % matched 24 kya Siberian; 70% East Asian; 80% of Native Americans carry this genome (higher in central & S America)
- Refutes the Solutrean hypothesis (origin in SW Europe)
- 1 closely related band of humans who crossed Bering Straight
- But his genome no longer exists West of Bering Straight; only in Native Americans east of it
- Native Americans are genetically unique
- Anzick child was reburied in 2014

Pacific colonization

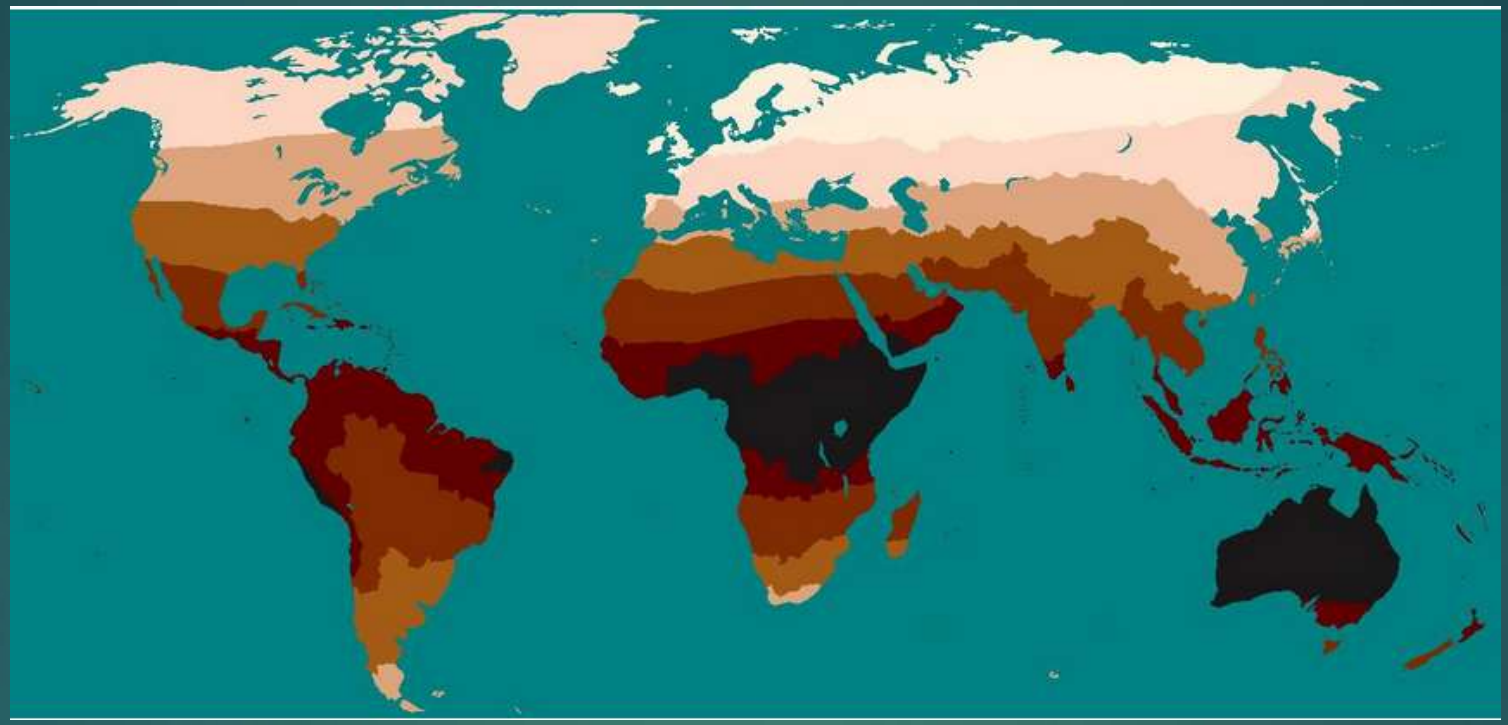
- By 40 kya, MHs in Indonesia & Philippines when sea levels were lower
- Pacific = 10,000 miles wide
- Thor Heyerdahl: accidental drift theory from S America (1947 trip on balsa wood Kontiki)
- Archeological & Linguistic evidence, & Polynesian DNA indicate Asian origin (Taiwan)
- Colonized all Pacific islands;
- Papua, New Guinea: use of dugouts (longer boat, faster it is);
- Eventually added outrigger, then sail; could sail into wind; could tack; eventually double hulled catamarans circa 2500 kya
- No charts or gps; use of rising & setting points of stars/night sky act as compass; on cloudy nights, use swells & currents, & memorization of directions
- From islands east of Indonesia went east, South, North, to Hawaii by 1200 AD; Easter Island last (2500 miles from Chile)
- Evidence: Sweet Potato originated in S. America; in Polynesia 1000 kya; 1300yo Polynesian pentagonally shaped skulls in Chile

Latitude is the key to skin color evolution



Human evolution from the equatorial African forests to the temperate zone.
Illustration by Jessica C. Kraft

Global distribution of skin color



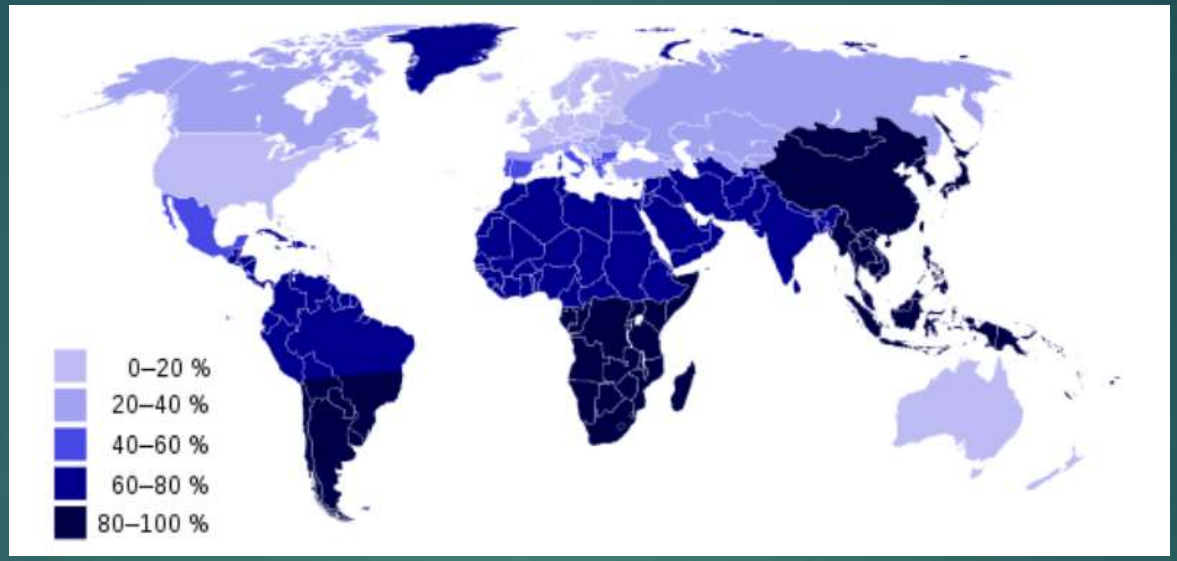
Skin color varies according to latitude and therefore by the intensity of incident ultraviolet light. Populations closer to the equator have darker skin; those further away, lighter skin. Has nothing to do with “race”, a non-biological concept.

Only Skin Deep

- Skin color variations are adaptive traits that correlate closely to geographic latitude and the sun's ultraviolet radiation.

- Darker skin pigmentation developed as body's protection:
  - More Vitamin D (calcium absorption for healthy bones)
  - More Folic acid (healthy fetuses)
  - More competent water barrier than in pale skin,
  - More resistant to injury,
  - Has superior antimicrobial defense

Got Milk!: Example of evolution in last 10,000 years - Evolution of lactose tolerance



Lactase is an enzyme needed for the metabolism of the lactose sugar found in milk. 75% of the global population is lactose intolerant. Ability to drink milk as an adult is due to some individuals living around 4,000 BC in Sweden or the Middle East who acquired a particular mutation on chromosome 2, giving an evolutionary advantage following the first domestication of cattle and rise of dairy farming since milk then became a valuable source of nutriment. Most of Western Europeans have inherited this mutation and can safely consume milk. Native Americans are 100% lactose intolerant.

Evolution continues: as long as there is variation in population

- Brain size decreased from 1,500 cc to 1,350 cc
- Wisdom teeth disappearing (35% born without them)
- Increased life span
- sickle-cell disease
- Since Roman times, the British have evolved to be taller and fairer,
- In the last generation the effect of a gene that favors cigarette smoking has dwindled in some groups.
- Increase in blond hair and blue eyes
- height, head circumference in infants, and hip size in females
- late-onset menstruation
- frequency of the ApoE4 allele, which is associated with Alzheimer's disease, drops in older people

Continued evolution

- 1,800 genes that have only become prevalent in humans in the last 40,000 years, many of which are devoted to fighting infectious diseases
- More resistance to tuberculosis, leprosy, malaria
- A high rate of mortality among living pygmies of the Philippines has been linked to the evolution of faster development, smaller body size and earlier reproduction

5 Lessons from Hominid Evolution

- Do what Lucy did: physical exercise is best protection vs. dementia
- Climate change was major factor in extinction of many human species
- Sixth extinction event is underway: 99 % of all animals have gone extinct;
- Killing the planet: climate denial, rising carbon dioxide levels, anti-evolution thinking, habitat destruction
- Help sustainability: use less lights, recycle, drink tap water, drive less/use less gas, walk, unplug, buy local food

Downloable Evolution Talks

- www.charlesjvellaphd.com
  - What's New in Hominid Evolution 2015
  - What's New in Hominid Evolution 2015 - 2
  - Hominid Evolution 2015
  - Human Brain Evolution 2015
  - A Brief Biographical History of Paleoanthropology 2012

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- Downloadable talks:
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