A Review of Paleoanthropological Discoveries: 2000-2023

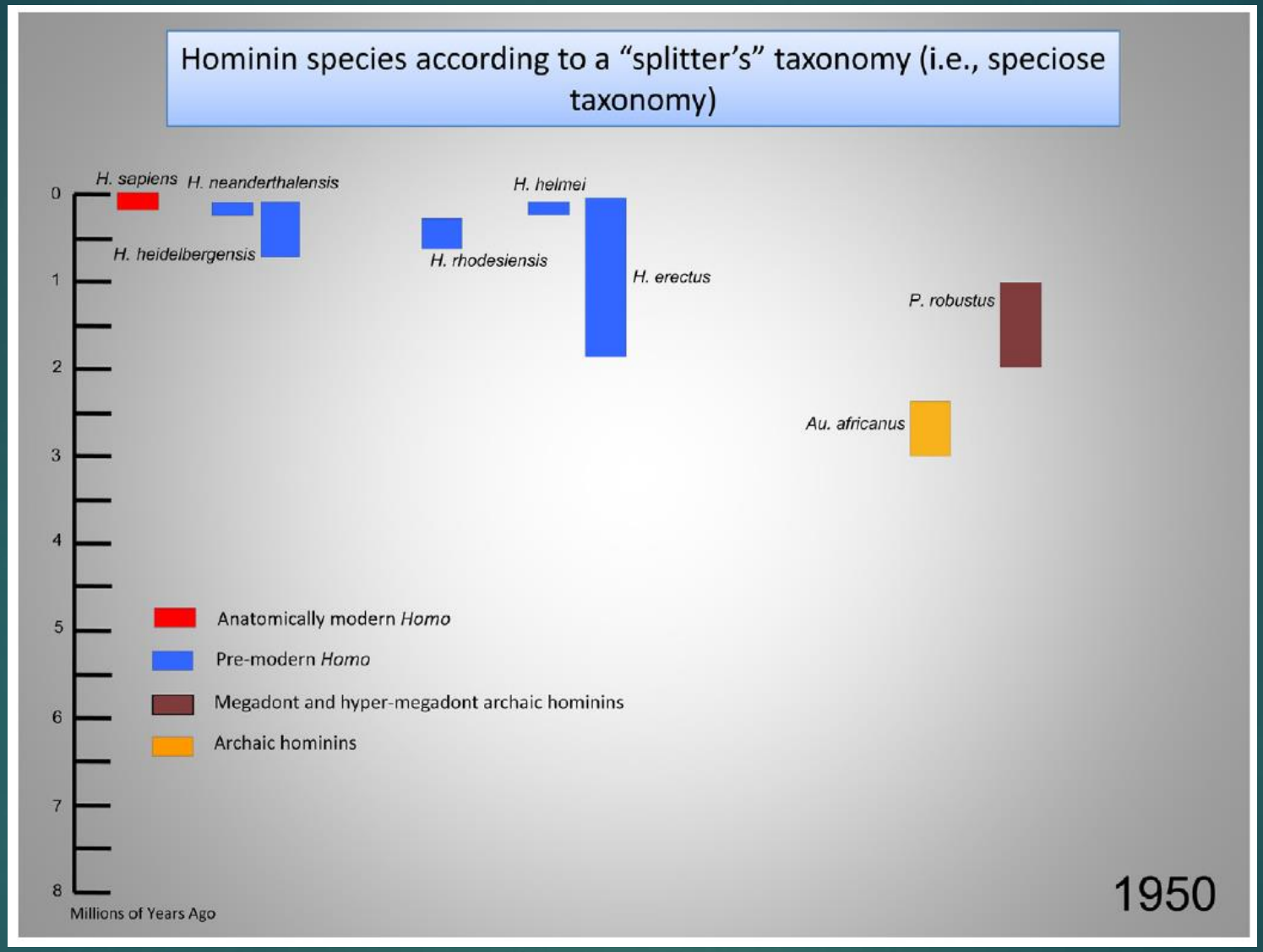
CHARLES J. VELLA, PHD

FEB 27, 2023

Docenting at CAS

1950:

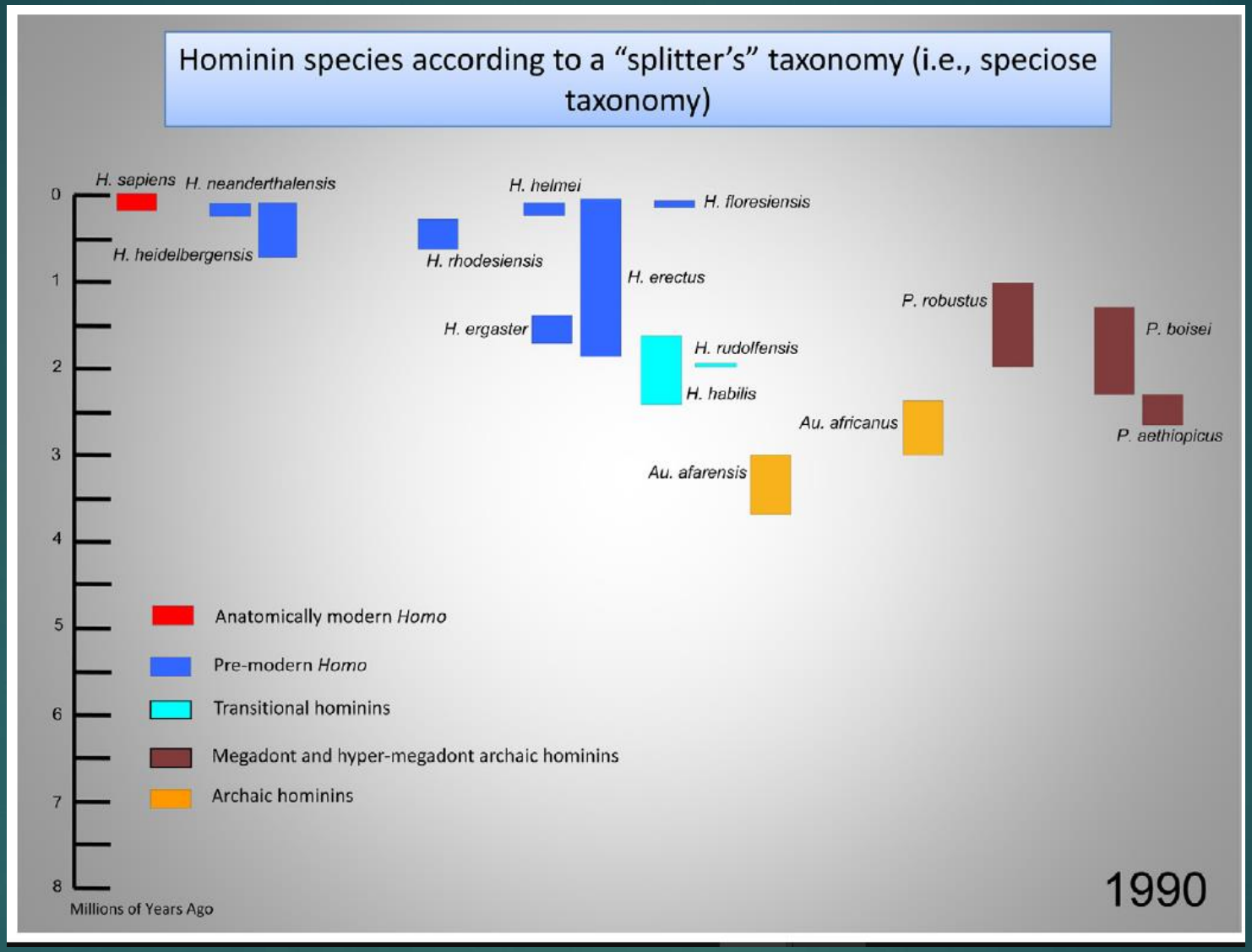
8 known known species



Hominin species recognized in a speciose interpretation of the hominin clade as of 1950.

1990:

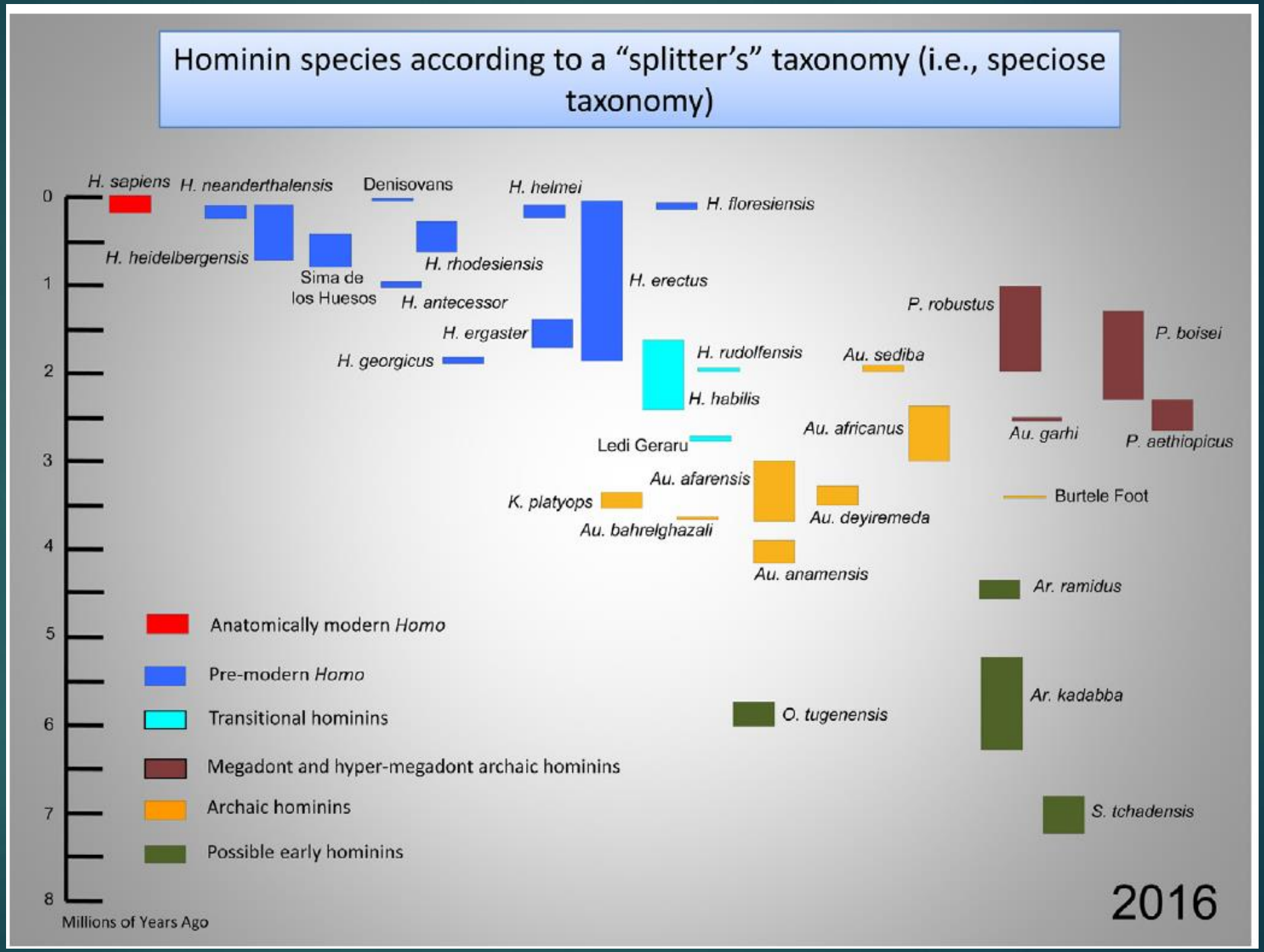
15 Known Hominin species



Hominin species recognized in a speciose interpretation of the hominin clade as of 1990

2016:

31 known Hominin species



We need to decide

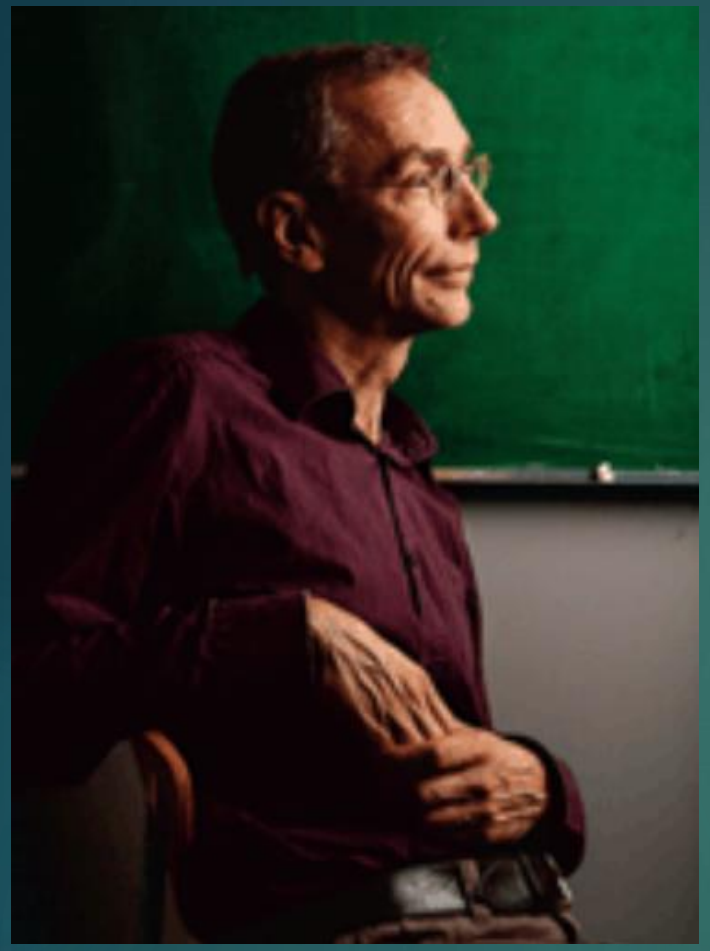
- There is no possibility of summarizing the new paleoanthropological discoveries of the last 20 years in one two-hour talk.
- Multiple fossil discoveries, the discovery of *Homo floresiensis* and *Homo naledi*, the Paleogenetics revolution, the Revisioning of Neanderthals would each require 2 hours each.
- So what to do?
- I am willing to do 2 additional Zoom talks on my Zoom account for you independent of CAS. Perhaps same time last Mondays in Mar & April?

My recommendation

- My first talk today:
- Most of the latest fossil discoveries from 2000 to 2023, including:
- *Homo sediba*
- *Homo antecessor*
- *Homo erectus* at Dmanisi
- *Homo floresiensis/Luzonensis*
- *Homo naledi*

- Second talk: Paleogenetics, including 15 known introgression events; African Multiregionalism

- Third talk: Homo neanderthalensis: New revision & Denisovans



Dedicated to Svante Pääbo who has transformed our view of human evolution by sequencing the genomes of archaic humans.

Svante Pääbo
Father of Paleogenetics

Director, Dept. of Evolutionary Genetics, Institute for Evolutionary Anthropology,
Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

Who is Charlie Vella?

- Retired Neuropsychologist; Kaiser Permanente Hospital, 35 years
- Docent at California Academy of Science since 2009
- Since Covid beginnings, I do a 4th Monday of month, general science update for my old Monday CAS shift
- Since 2019, I have taught a monthly two-hour Human Evolution Zoom class for SFSU OLLI on 4th Wed of each month from 10 to 12 AM. Have covered every conceivable topic in human evolution.
- All prior 45 two-hour lectures (mp4 and pdf) downloadable at www.charlesjvellaphd.com
- This lecture will be available there as well

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- Downloadable talks:
  - www.charlesjvellaphd.com
- 415-939-6175

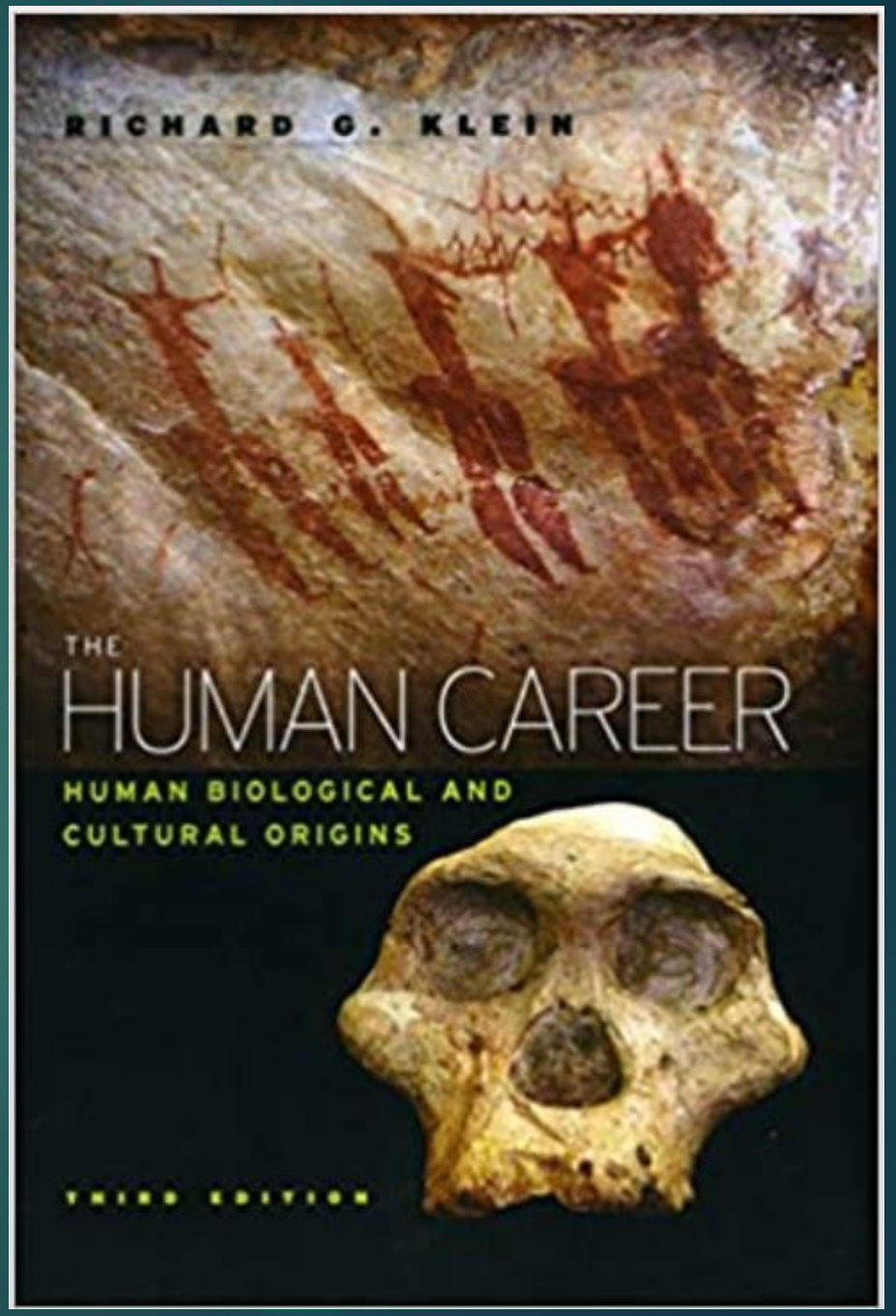
At CAS, 5/2/2018: Charlie caught Don Johanson sneaking around Lucy

My list of most important discoveries of recent times

- Some of the most exciting discoveries in human evolution have happened in the last two decades.
- This is an update to material in CAS Human Odyssey exhibit
- There is a 15-page addendum (with 161 journal citations) to above available from Charlie

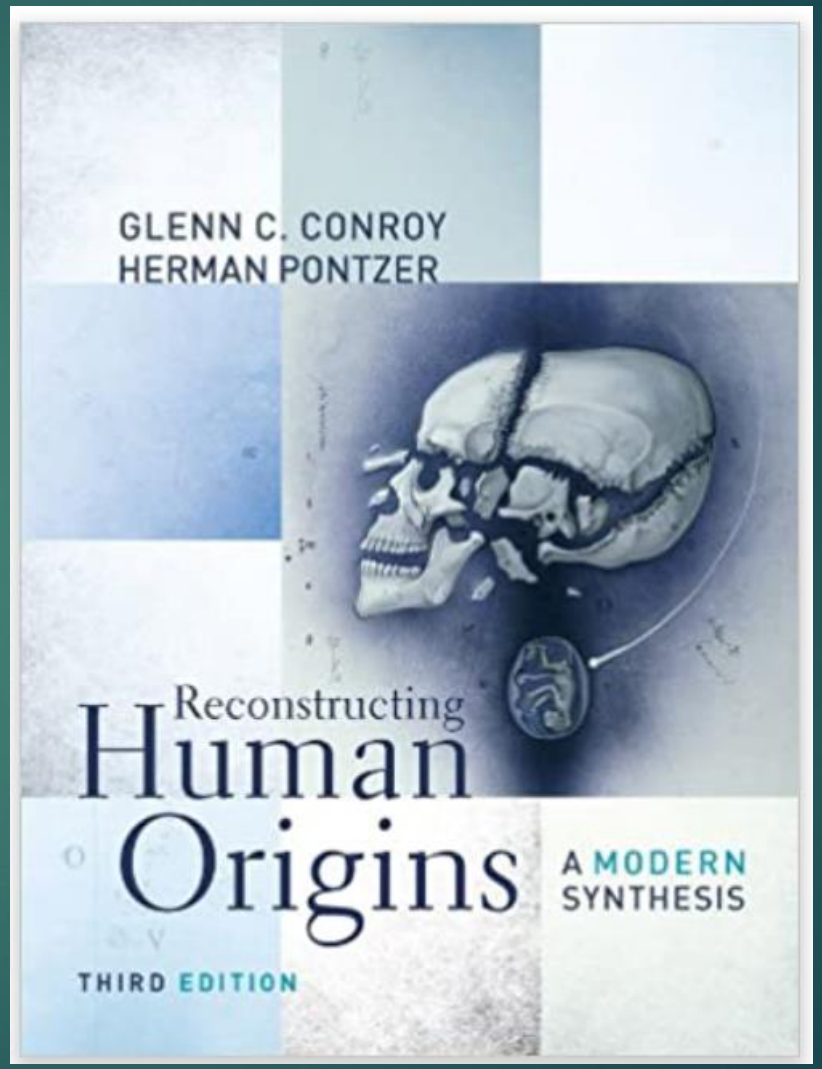
Human Career, Richard Klein:

The definitive textbook (1024 pp) on human evolution as of 2009

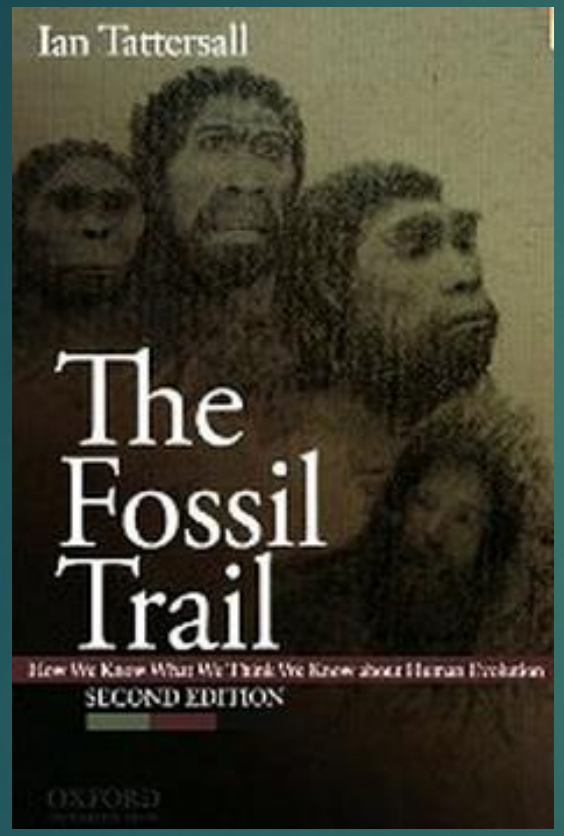


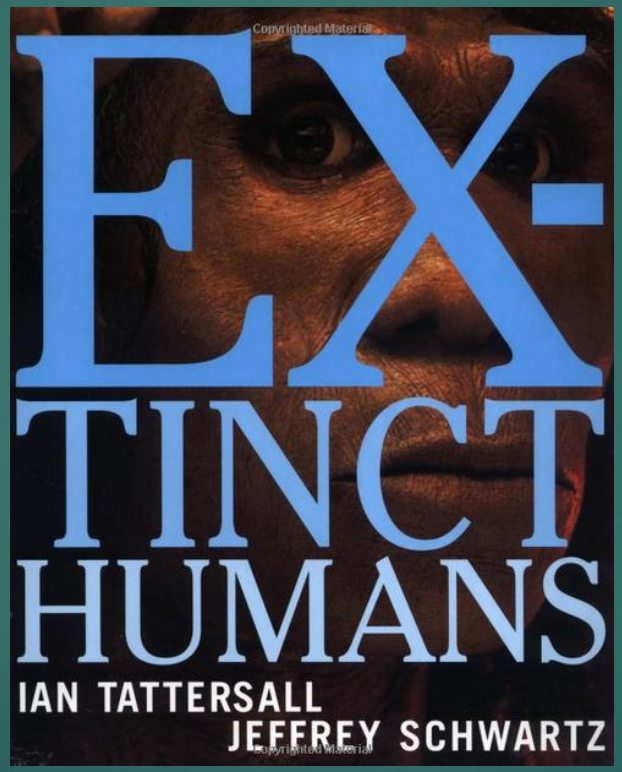
Reconstructing Human Origins, 3rd ed, 2013: Glenn Conroy & H. Pontzer

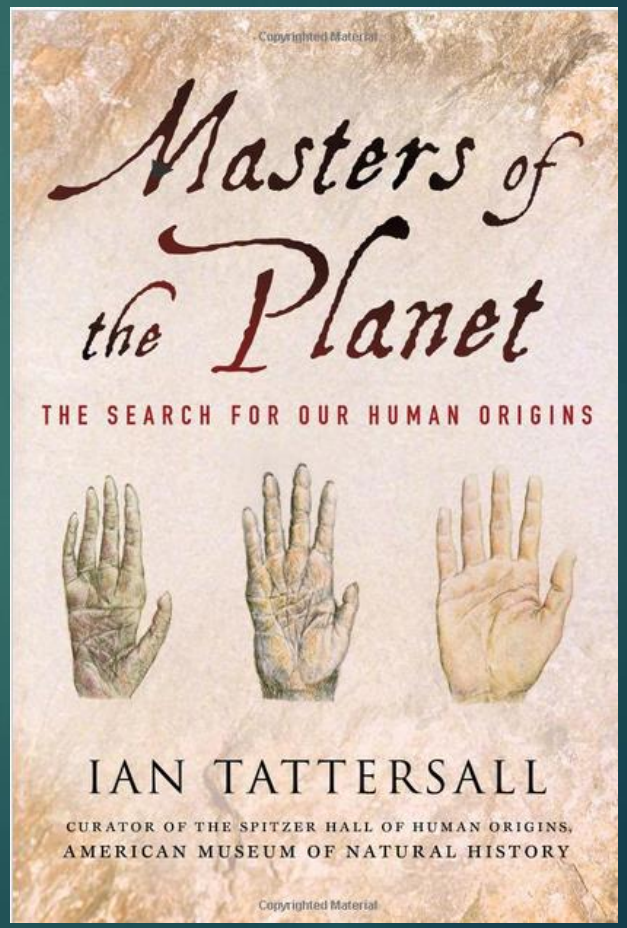
- My second guide
- Highly recommended by Bernard Wood
- Only 672 pp.

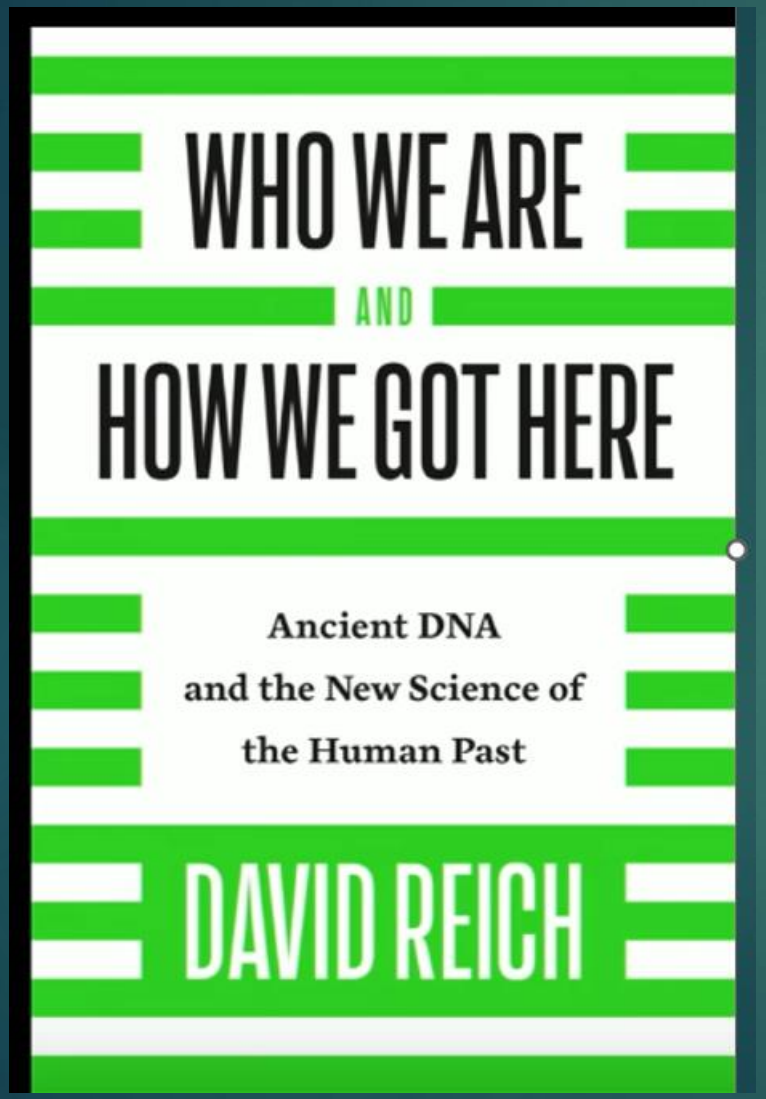


Ian Tattersall: my favorite popular books

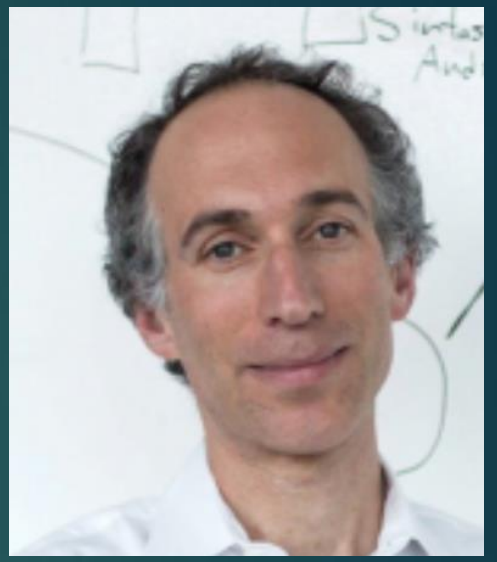




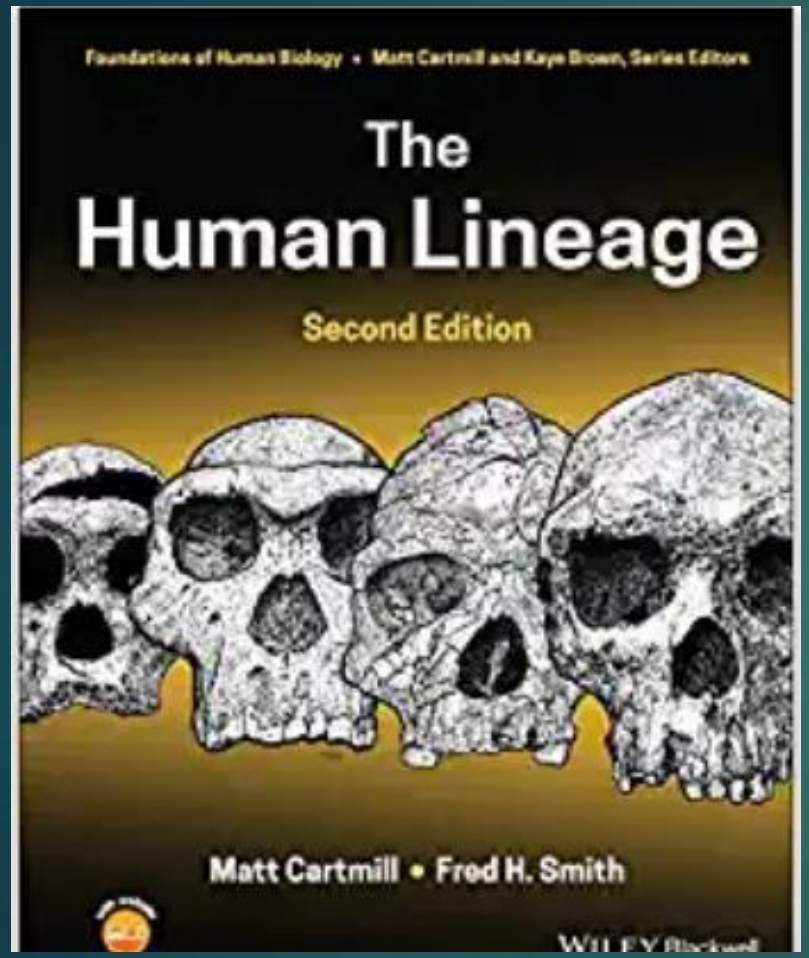




2018: Review of what aDNA has told us about population genetics and genetics of human migrations



The Human Lineage, 2022, 2nd ed, by Matt Cartmill & Fred Smith



8 x 11 inch, 611 p; 100 pages of citations
Clearly the most up to date textbook

1The Fossil Record
2 Analyzing Evolution
3 People as Primates
4 The Bipedal Ape
5 The Migrating Ape
6 The Big-Brained Ape:
7 Talking Apes: The Neandertals
8 The Symbolic Ape: The Origin of Modern Humans

How Much of Your DNA You Share with:

99.9%

Neandertals 99.7%

98.4%

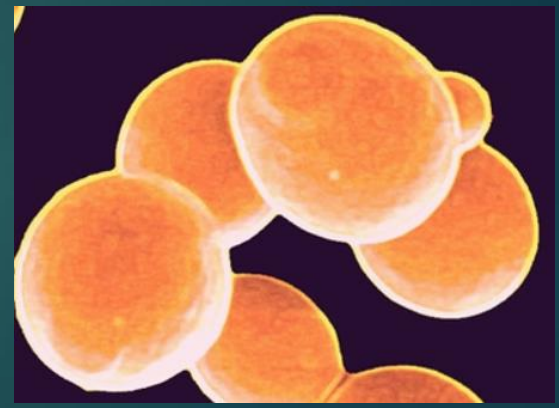
92%

70%

50%

60%

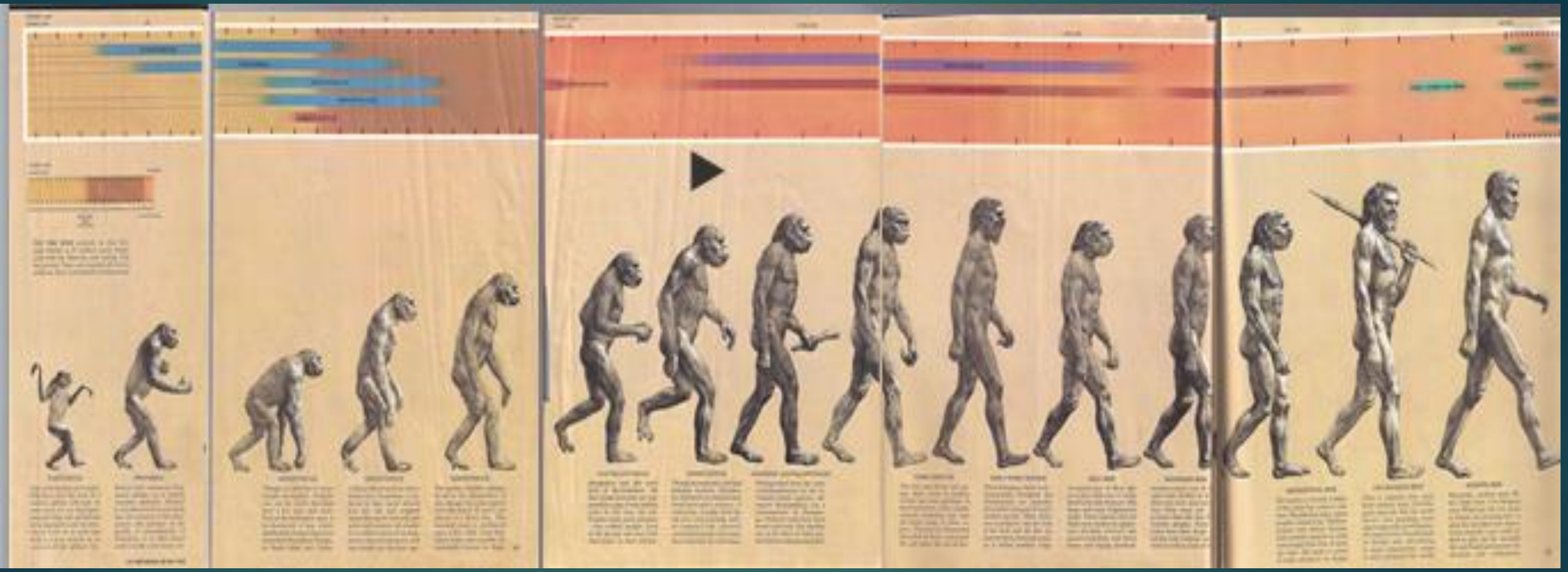
You are related to every living creature on earth



Yeast = 26%

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

Famous, but misleading, march of hominin evolution
Humans are not the goal of evolution.



Early Man by Francis Clark Howell

Evolution: There Are No “Higher or Lower” Creatures, or “More Evolved”

- Naturalist Charles Darwin drafted a note to himself to “Never use the words higher or lower.” Apes did not appear just so they could morph into humans. Nor did reptiles evolve solely to give rise to mammals, nor fish to amphibians.

- Consider that bacteria do countless things humans cannot, including orienting by magnetic fields, encysting to survive hundreds of years in “suspended animation,” and incorporating stray bits of DNA lying around their environment. Many bacteria make their own food by chemosynthesis or photosynthesis. Others glow in the dark, survive in anoxic muck or boiling water, or pick up metal particles to shield themselves from toxic and radioactive environments.

Evolution: a biological entity that becomes more common

- Pseudoscientific baggage: belief that evolution is about climbing a ladder of ever-increasing biological sophistication.
- Richard Dawkins: Evolution can be that, but the reality is usually much less grandiose. “Evolution is changed gene frequencies in populations”. That is it.
- If, for some reason, a given gene in a patch of weeds, say, gets slightly more or less common from one generation to the next, evolution has happened.
- The gene doesn’t have to confer a survival advantage, or be “adaptive” or make the weed “fitter”. It doesn’t have to be “selected for” or increase biological complexity. It simply has to change in frequency, maybe by chance. That is all. “

Evolution

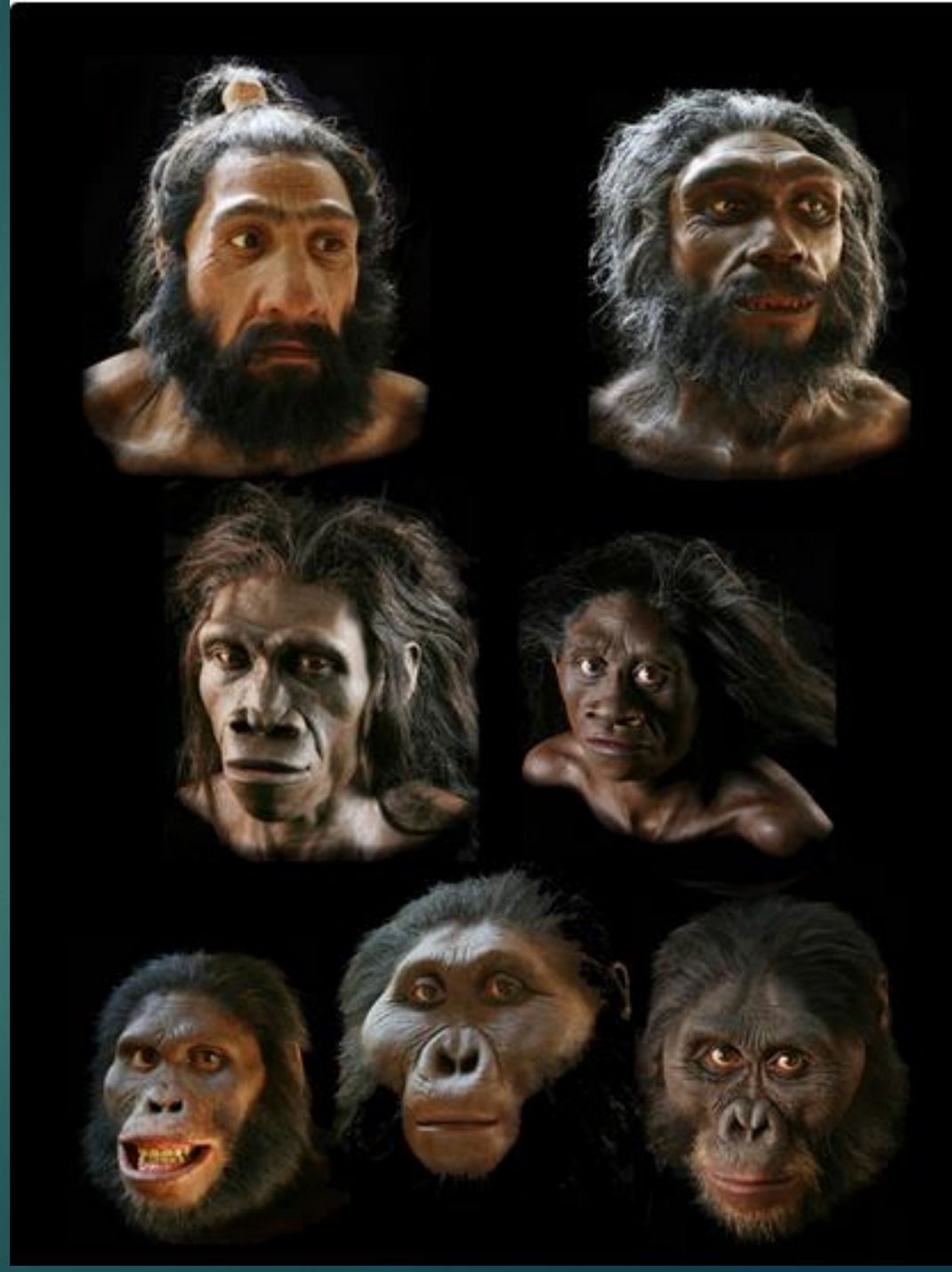
- Under certain circumstances, a certain set of genes expressed in a certain environment can give that organism a slightly better-than-average chance of survival and reproduction.
- These genes are more likely to be passed on.
- Gene frequency has changed, and evolution has happened. But something else has taken place too: adaptation through natural selection. This special case of evolution renders a population fitter – as in a better fit, not physically fitter – for its environment.

Evolution

- This doesn't imply progress towards some higher state of biological perfection.
- Evolution has no goal and no direction, it simply acts on what is in front of it.
- Stephen Jay Gould pointed out that adaptation most often leads to a loss of complexity as organisms take the path of least resistance and become parasites.
- But, occasionally, evolution increases biological complexity or leads to a biological novelty.
- But forget any hubristic notion that we are the pinnacle of evolution – there is no such thing.

Where are all the hominins?

- More than 99 percent of all organisms that have ever lived on Earth are extinct. Few live beyond 1 M years.
- 1 million species of insects
- 5500 species of frogs
- 2000 species of rodents
- 334 species of monkeys
- 200 species of squirrels
- Only 23/31 species of hominins?



John Gurche: Clockwise from top right: *Homo heidelbergensis* (700-200 Ka); *Homo floresiensis* (500-60,Ka); *Australopithecus afarensis* (2.9 to 2.1 Ma); *Paranthropus boisei* (2.3 to 1 Ma); *A. africanus* (3.3 to 2.1 Ma); *Homo erectus* (1.8 Ma to 100 Ka); *H. neanderthalensis* (450- to 39 Ka).

Oldest fossil mammal: this is how we started

Triassic period

- *Brasilodon quadrangularis*, 225 million years old, is the earliest mammal ever found;
- A rodent sized insect predator who lived in burrows

Hominin Bush Implications

- Human evolution is a bush/braided stream, not a straight line
- This process was random, with no innate progression; the most adaptable survived.
- None of our ancestors were trying to be us.
- In the period before 2 Mya, there is no consensus as to who the specific hominin ancestors of MHs were
- Typically, more than 1 hominin species was living at same time and place; 10 hominin species on the planet at 300 Ka
- Except for *Homo erectus,* most hominin species have lasted for 1 million years or less
- Last ape standing: *Homo sapiens* is the only species to have survived.

Hominin evolution

- Evolution is biological change over time.
- All species alive—including humans—evolved from ancestral species.
- The major process responsible for the evolution of adaptive change is natural selection.
- Natural selection is blind; it is not directional.
- None of our ancestors were trying to be us.
- Natural selection is about environmental adaption & survival to reproduce.
- Evolution doesn’t follow a straight line.
- Our evolutionary history is littered with many branches, experiments, adaptations, and dead ends

Milestones in Human Odyssey Display

- 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
- **CJV critique**: This emphasis is like March of Progress picture! Don't need big brain to be a good example of evolution. Only of human evolution.

Hominin Evolution: The 5 Major Steps

- Bipedalism: *Australopithecus afarensis*
- Tool Use: *A. afarensis* (3.3 mya) *(*Lomekwi 3 site, cut marks at Dikika site), *Paranthropus?*, *Homo habilis* (2 Ma); tool use (chimps do) vs tool making (modifying stones)
- Body Plan: *Homo erectus* (long legs, long distances)
- Bigger Brain: *Homo heidelbergensis & neanderthalensis & sapiens; but not H. floresiensis or luzonensis*
- Symbolic thinking: *Homo neanderthalensis & sapiens* (c 300 Ka, pigments, etc.)

32 Taxa First Appearance Date & Last Appearance Date

Sahelanthropus tchadensis	7.2 Ma to 6.8 Ma
Ardipithecus kadabba	6.3 Ma to 5.2 Ma
Orrorin tugenensis	6.0 Ma to 5.7 Ma
Ardipithecus ramidus	4.5 Ma to 4.3 Ma
Australopithecus anamensis	4.2 Ma to 3.9 Ma
Australopithecus afarensis	3.7 Ma to 3.0 Ma
Australopithecus bahrelghazali	3.6 Ma to 3.6 Ma
Kenyanthropus platyops	3.5 Ma to 3.4 Ma
Australopithecus deyiremeda	3.5 Ma to 3.3 Ma
Burtele Foot	3.4 Ma to 3.4 Ma
Australopithecus africanus	3.0 Ma to 2.4 Ma
Ledi-Geraru/Homo	2.8 Ma to 2.8 Ma
Paranthropus aethiopicus	2.7 Ma to 2.3 Ma
Australopithecus garhi	2.5 Ma to 2.5 Ma
Homo habilis sensu lato	2.4 Ma to 1.7 Ma
Paranthropus boisei	2.3 Ma to 1.3 Ma
Homo erectus	2.0 Ma to 110 Ka – only hominin lasting > 1 My

Revised from B. Wood & E. Boyle 2016

32 Taxa

- Paranthropus robustus 2.0 Ma to 1.0 Ma
- Homo rudolfensis 2.0 Ma to 2.0 Ma
- Australopithecus sediba 1.98 Ma to 1.98 Ma
- Homo erectus georgicus 1.85 Ma to 1.8 Ma
- Homo ergaster 1.7 Ma to 1.4 Ma
- Homo antecessor 949-772 Ka to ?
- Homo heidelbergensis 700 Ka to 100 Ka
- Sima de los Huesos 427/780 Ka to 415 Ka
- Homo neanderthalensis 400/130 Ka to 40/29 Ka
- Denisovans 287 Ka to 15 Ka
- Homo sapiens 315 Ka to Present
- Homo rhodesiensis (Broken Hill) 300 Ka to ?
- Homo helmei (Florisbad/sapiens) 260 Ka to 80 Ka
- Homo floresiensis 500 Ka to 50 Ka
- Homo luzonensis 67-50 Ka to ?

Sequential Dates of discovery of hominin species

- 1823 Homo sapiens - Red Lady of Paviland, Wales – a male
- 1829 Homo neandertalensis – Engis, Belgium – 1st N
- 1856 Homo neandertalensis – Feldhofer, Germany – 3rd N
- 1868 Homo sapiens – Cro-Magnon, France
- 1891 Homo erectus (Pithecanthropus/Java Man) - Indonesia
- 1907 Homo heidelbergensis (Mauer jaw – Germany)
- 1908 Homo neandertalensis – La Chapelle aux-Saints – Old Man
- 1921 Homo erectus (Peking Man) – China
- 1921 Homo rhodesiensis (Broken Hill, Zambia)

Dates of discovery of hominin species

- 1924 Australopithecus africanus (Taung child)
- 1927 Homo sapiens – Mal'ta boy, Russia
- 1930 Homo sapiens – Qafzeh, Israel – 95 Ka – MH outside of Africa
- 1931 Homo erectus – Ngandong 7 – 143 ka – last date
- 1933 Homo longi (Dragon man – hidden for 80 years) - Denisovan?
- 1938 Paranthropus robustus
- 1947 Australopithecus africanus (Mrs. Ples)
- 1959 Paranthropus boisei - Olduvai
- 1960 Homo habilis - Olduvai

Dates of discovery of hominin species

- 1965 Australopithecus anamensis
- 1967 Homo sapiens – Omo 1 - 233 Ka – oldest MH until 2015
- 1974 Australopithecus afarensis – Lucy – Beatles' Lucy in Sky
- 1976 Laetoli footprints - bipedalism
- 1976 Homo bodoensis (heidelbergensis) – 600 Ka - Africa
- 1978 Homo sapiens – Apidima 1, Greece, 210 Ka – early OoA
- 1980 Denisovan – Xiahe mandible, 160 Ka – D protein in 2019
- 1984 Homo ergaster – Turkana Boy KNM-WT 15000

Dates of discovery of hominin species = 21 species before 2000

- 1991 Homo rudolfensis
- 1992 Homo heidelbergensis (Sima de los Huesos, Atapuerca - Skull 5)
- 1994 Homo antecessor
- 1994 Australopithecus prometheus – “Little Foot”
- 1994 Ardipithecus ramidus
- 1995 Australopithecus bahrelghazali - central Africa
- 1997 Homo sapiens – Herto – 160 Ka
- 1996: Australopithecus garhi
- 1996: Ardipithecus kadabba – oldest Ardi
- 1999: H. sapiens/neandertal hybrid child, Lagar Velho, Portugal
- 1999 Kenyanthropus platyops

Correct genetic relationships and times of divergence

Hominid vs. Hominin

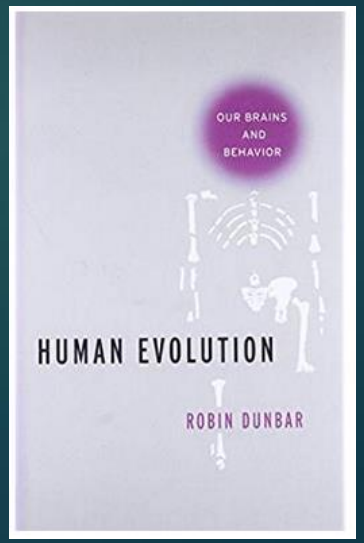
- Older term: Hominid; newer term: Hominin
- **Hominid** – the group consisting of all modern and extinct Great Apes (that is, modern humans, chimpanzees, gorillas and orangutans plus all their immediate ancestors). The Hominidae.

- **Hominin** – the group consisting of modern humans, extinct human species and all our immediate ancestors (including members of the genera *Homo*, *Australopithecus*, *Paranthropus* and *Ardipithecus*). The Homininae – preferred current term

- The subtribe Hominina is the "human" branch; that is, it contains only the genus *Homo*.

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

- British anthropologist and evolutionary psychologist
- Professor of Evolutionary Psychology, Univ. of Oxford
- 1998: study proposing the Social Brain Hypothesis, which states neocortex size increases with social group size and complexity, not ecological variables

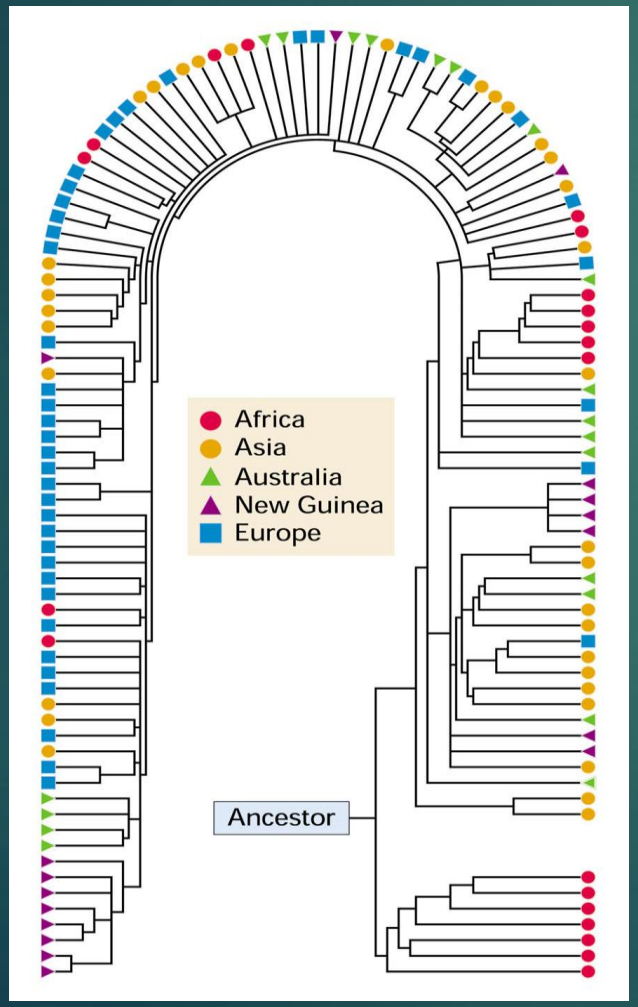


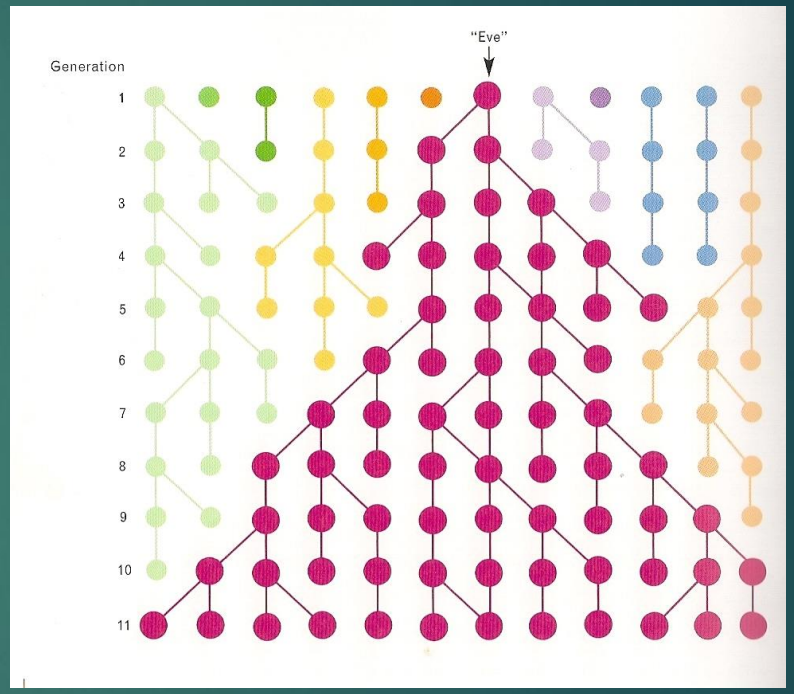
1987: Rebecca Cann: Mitochondrial Eve hypothesis

- American biochemist
- 1987: *Nature* article, elaborated the mitochondrial Eve hypothesis
- Claims a recent (ca. 200 K (99-148 Ka) origin for all modern humans based on a study of mtDNA haplotype links.
- We are African by DNA

Death blow for multiregionalism

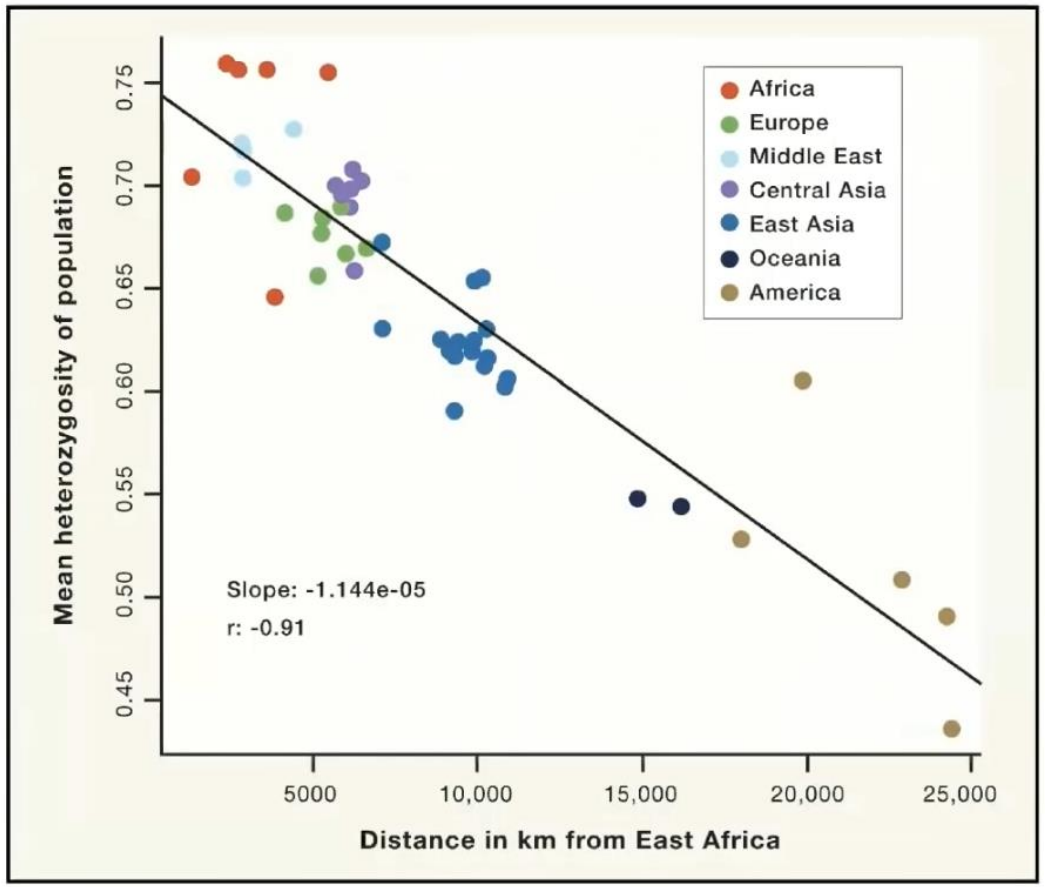
1987: Mitochondrial Eve/Most Recent Common Female Ancestor Hypothesis – not “first woman”; not LCA of *H. sapiens*; 1 woman among many who had 2 daughters; a phylogenetic estimate





There is a “Y-chromosomal Adam” = man from whom all living Humans are patrilineally descended (120-156 Ka)

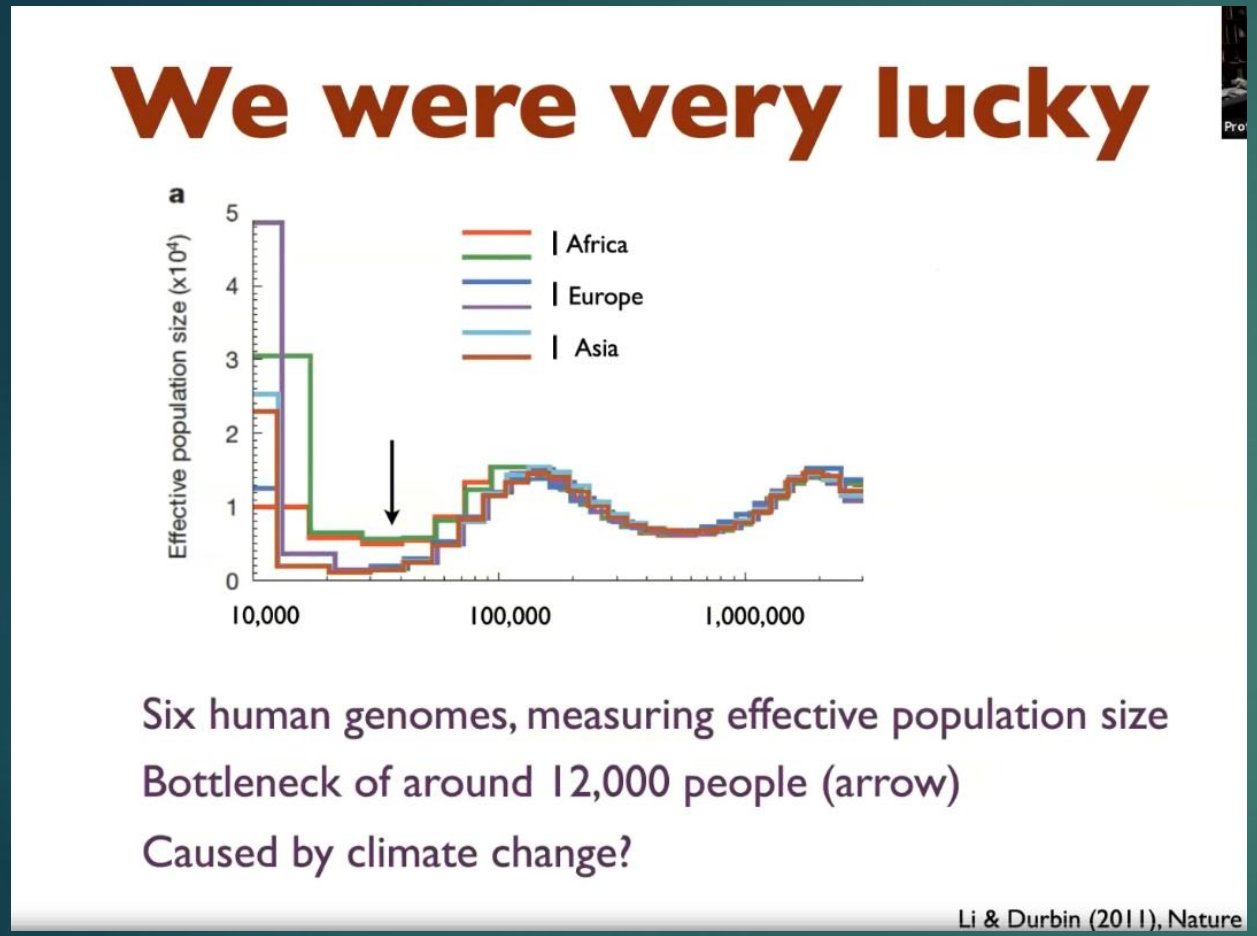
We are all Africans



- Heterozygosity (= genetic variation) decreases with distance from East Africa (NB this is walking distance)
- Richest genetic variation found in ancestral areas

Founder effect: group that moves away always has only a subset of total original genetic variability

The bottleneck: 12 K population size at 60 Ka



Based on n =12 MH genomes

How many ancient individuals produced the variability you now see in these modern MH genomes

A founder event (bottleneck) in East Asian and European populations, associated with the human dispersal out-of-Africa event around 60 Ka

Effective population size (breeding pairs) at 10-60 Ka across Africa, reduced genetic variability

MHs could have crashed and burned - No evolutionary preferential destiny for us = we were lucky

What Human Evolution facts you should know,
in case you get asked at CAS

Example:
African American woman asks me: “If we all genetically originated from Africa, why am I black and you aren’t?”

12 year old boy: “But what about God?”

8 year old boy: “Evolution is a lie.”

Quick Tour of
Stone Tool Technology

Oldowan, Mode 1

Oldowan Stone Tools

Oldowan tools (named after Olduvai Gorge) are the oldest known tools that were initially identified with an associated fossil species, *Homo habilis*

Associated with *P. bosei, H. habilis, A. garhi, H. erectus* in Dmanisi & Asia

Acheulean, Mode 2, 1.6 Ma

Acheulean

Acheulean: associated with *H. erectus & H. heidelbergensis*

Mousterian: Associated with Ns

Bretagne Mousterian Point

Assorted Mousterian Tools

MousterianTools from Gibraltar

Mousterian points

Stone artifacts from the Initial Upper Paleolithic at Bacho Kiro Cave: (1-3, 5-7) pointed blades and

Upper Paleolithic in Europe

Small, sharp micro blades (Magdalenian culture): 11,000 to 17,000 years ago

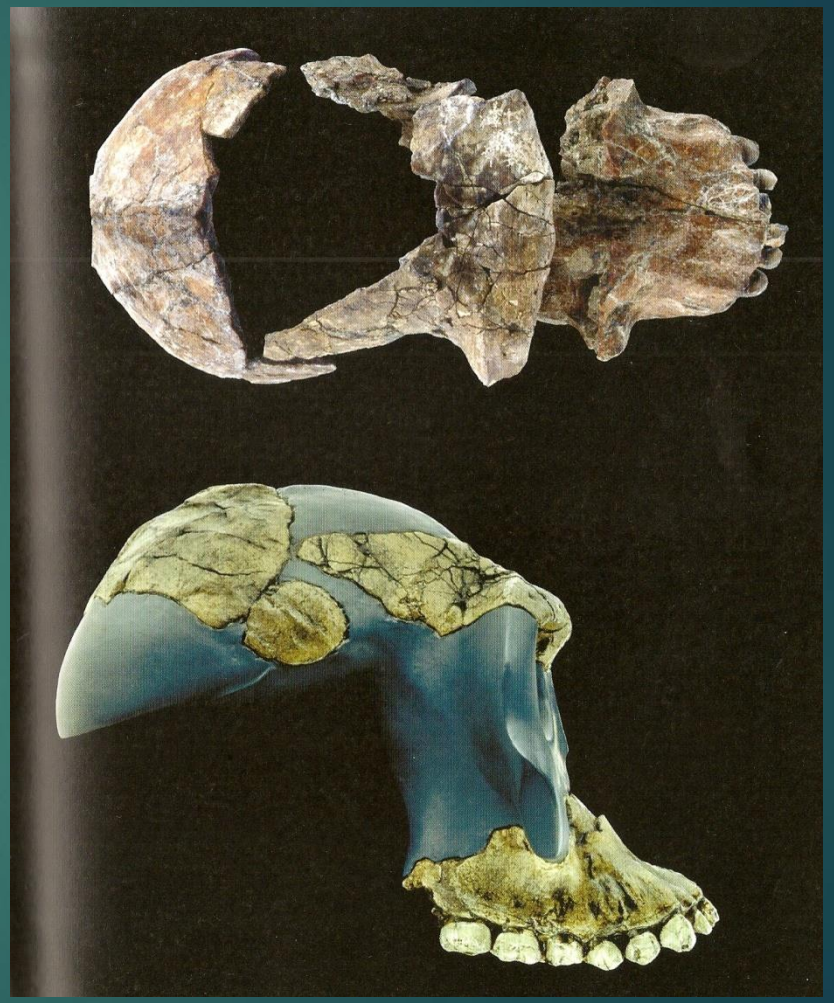
UP Tools

Clovis Points,
13 Ka

Associated with *H. sapiens*

New Discoveries in paleontology: 2000-2023

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



Australopithecus garhi
(BOU-VP-12/130)

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

Australopithecus garhi, 450 cc

- Significantly larger chewing teeth than 3 other East African australopiths & sagittal crest; ate tough, fibrous foods.
- Associated with Oldowan industry
- *A. garhi* is part of the eastern African lineage descended from *A. afarensis; White thinks they are a chronospecies*
- Another candidate for immediate ancestor to *Homo*

BOU-VP-12/130

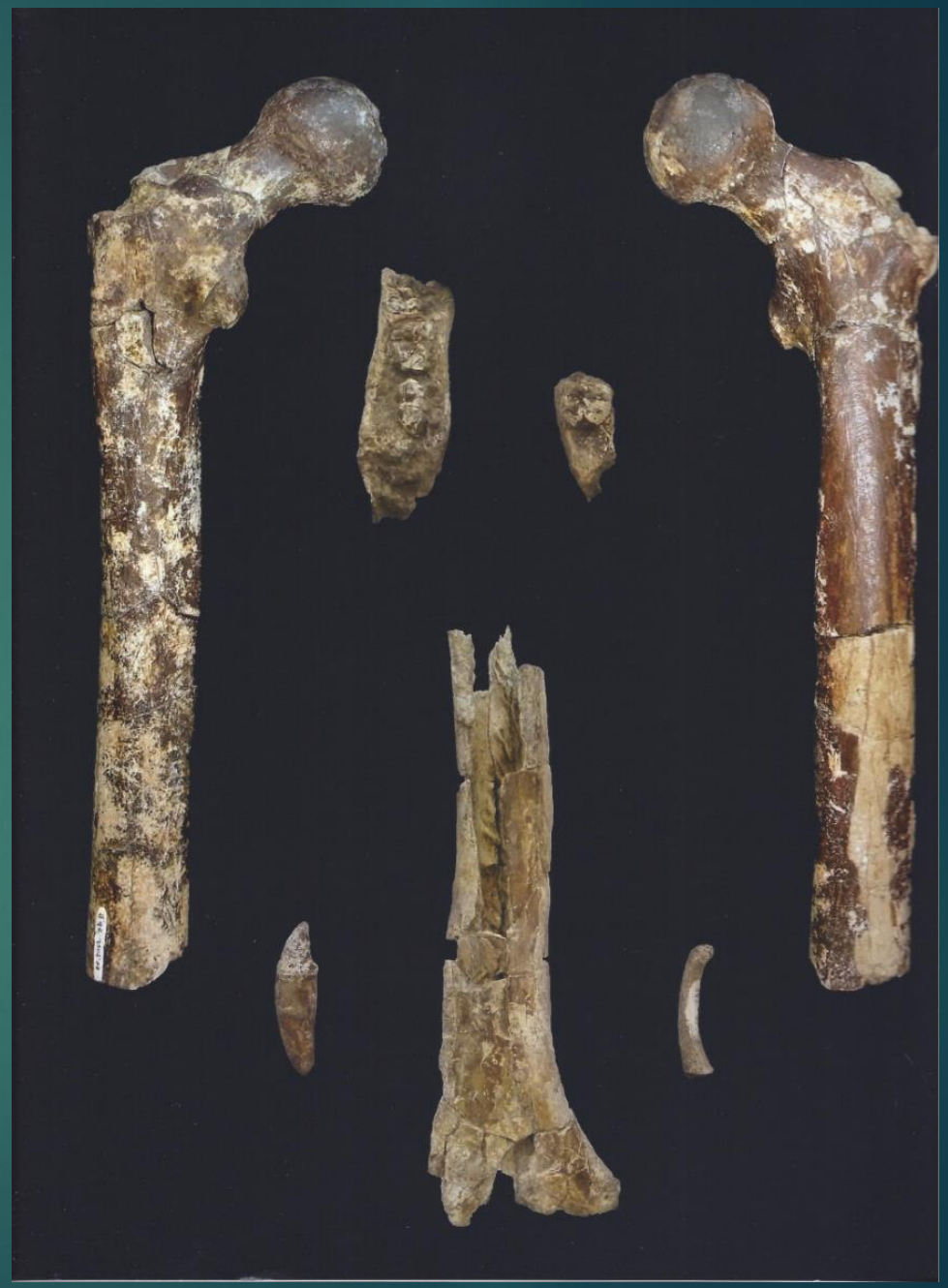
2000: *Orrorin tugenensis*
6 Ma

Locality: Tugen Hills, Kenya

Age: 6.2-5.5 M (potassium/argon dating of sandwich layers); 6.1-5.8 M (magnetic dating)

Earliest bipedality ?

Date: 2000

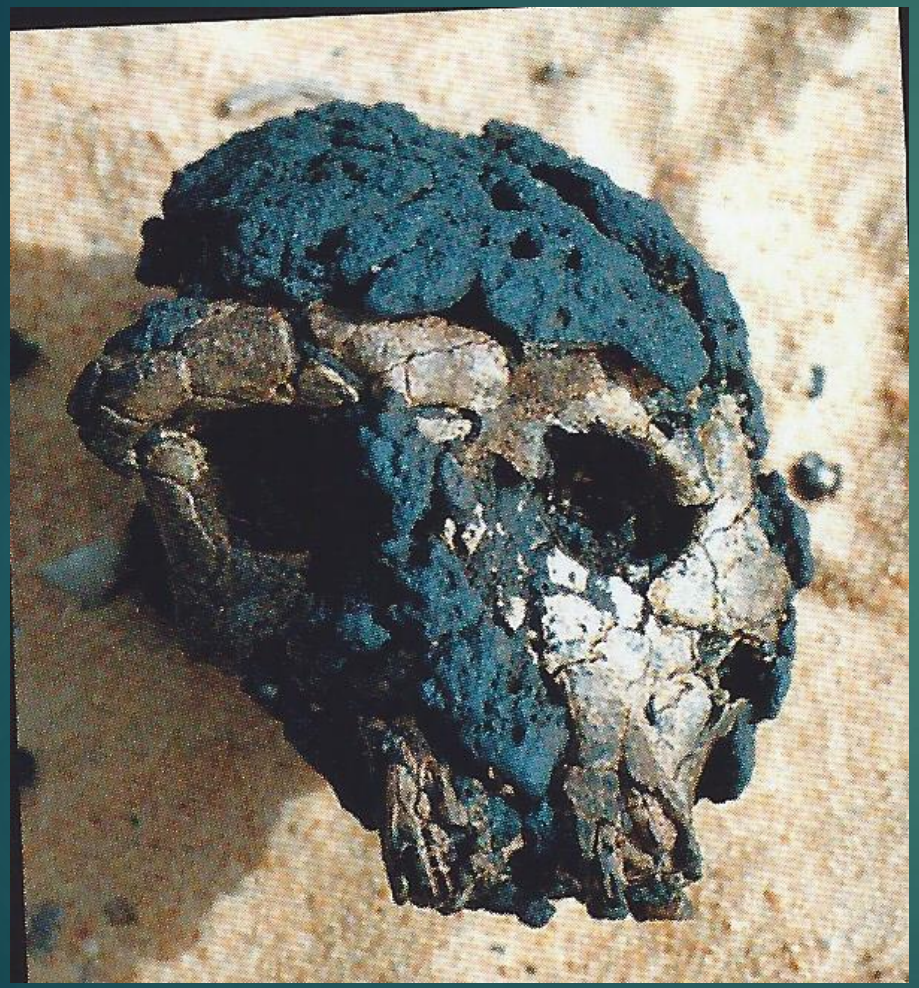


Orrorin tugenensis, 6 Ma

- Only postcranials found: No cranial fossils recovered
  - Keeps controversy alive (could be *Ardipithecus*)
- Bipedalism inferred from femur anatomy
- Mosaic of ancestral-derived features:
  - Humerus and finger bone retains evidence of arboreal adaptations
  - Thick enamel, femur are humanlike

Sahelanthropus: Hominin or hominid?

2001: *Sahelanthropus tchadensis, "Toumai"*



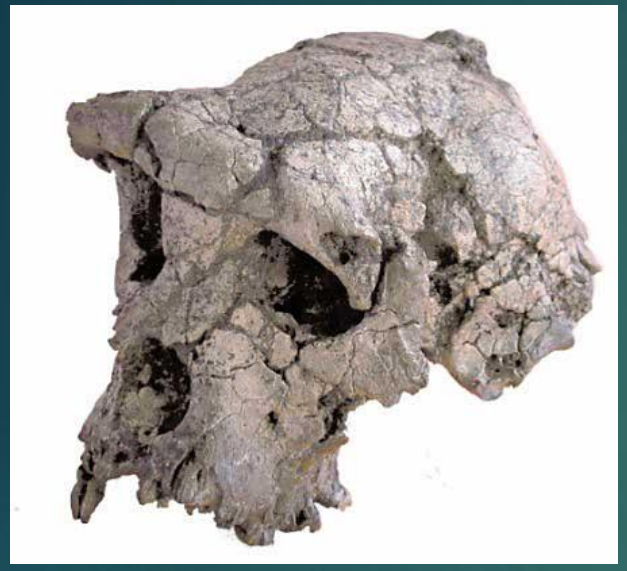
Sahelanthropus tchadensis

Age: 7-6 Ma

Locality: Toros-Manalla, Chad

Date: 2001

2001: *Sahelanthropus tchadensis*, Chad, 7-6 M



Remarkably complete but distorted cranium & 2 mandibles

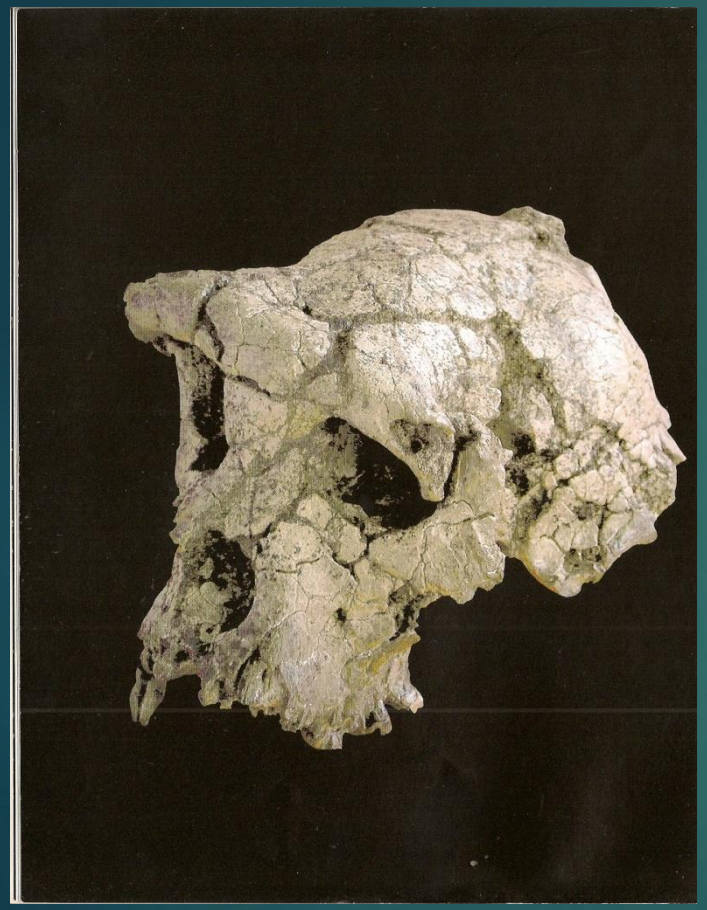
Has been virtually remodeled

Largest hominoid browridge ever discovered

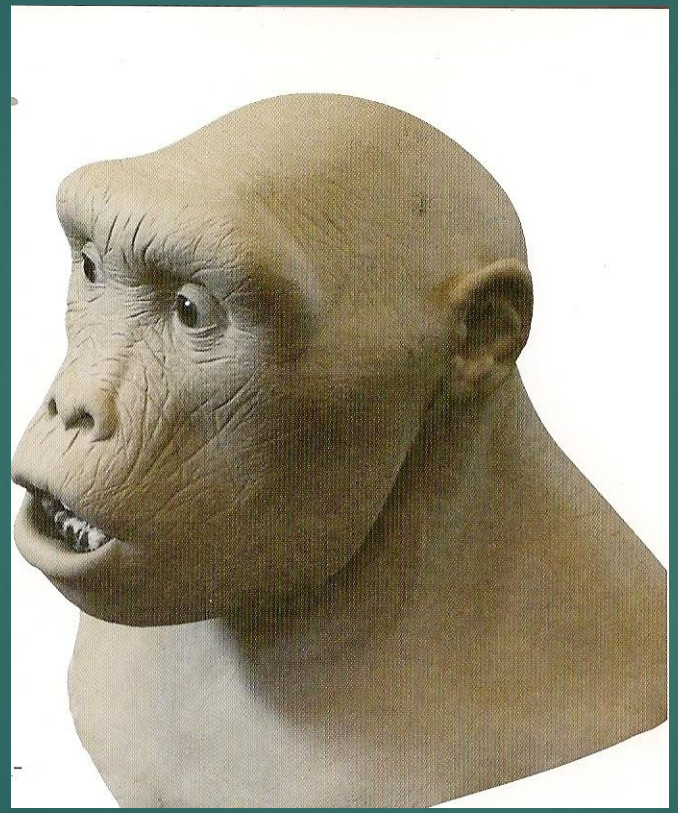
Smaller size than Ardi

Foramen magnum shape and forward position indicate bipedalism (like Ardi; both upright posture)

Sahelanthropus tchadensis:
Late Miocene ape or hominid ancestor?

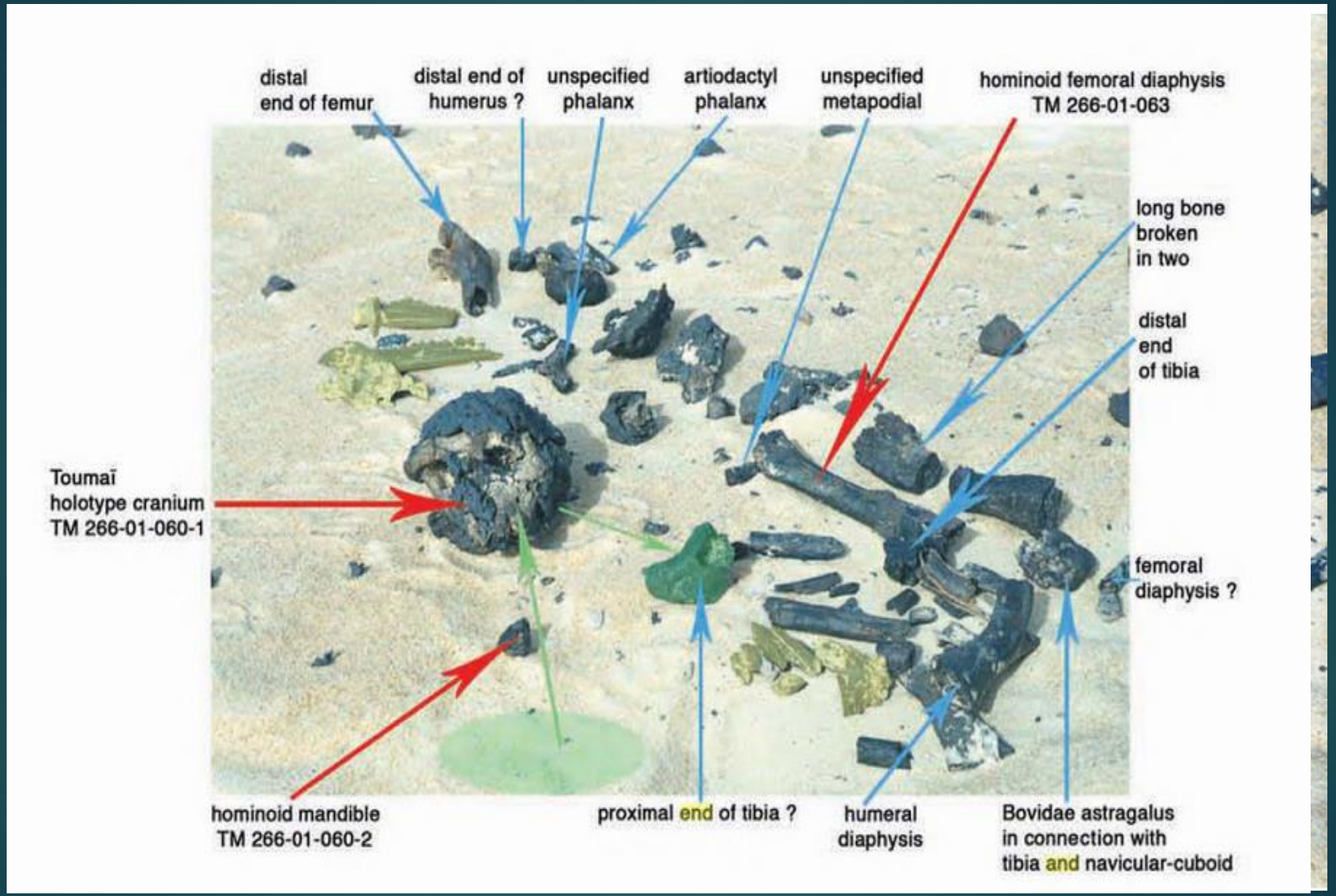


2001 Sahara Desert



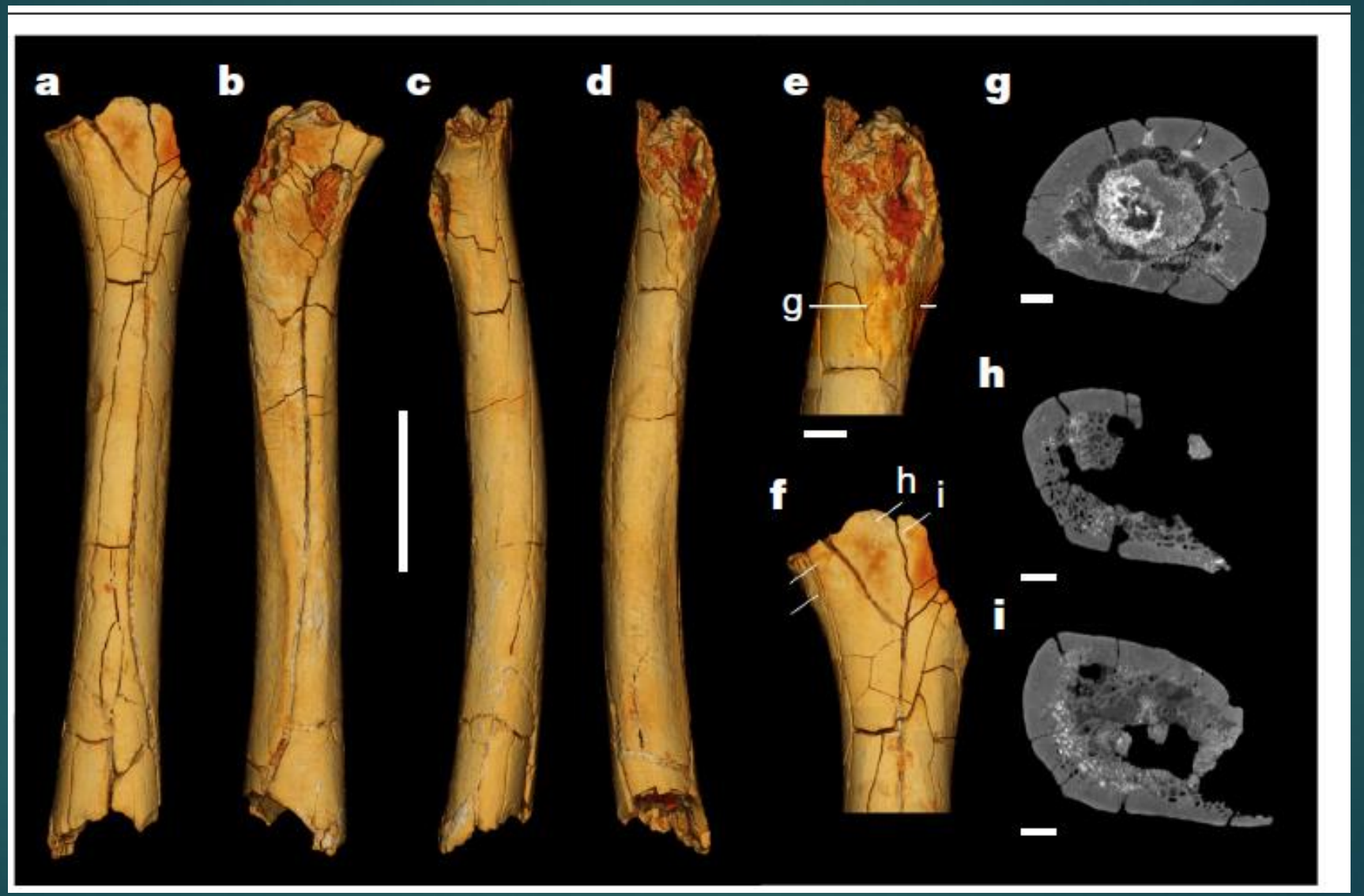
6 to 7 Million years old

Reconstruction



Did camel herders rebury Toumai facing Mecca?

2020: The femur of *Sahelanthropus tchadensis*



Sahelanthropus

- *Sahelanthropus* femur is missing joints at the end of the femur bone, which would have provided insights into how this species moved.

- Over the years, the undescribed fossil femur—even though it's not clear whether the skull and leg bone belonged to the same individual —became one of paleoanthropology's worst kept secrets.

- An account of the femur's discovery was published in 2009.

2022 *Sahelanthropus tchadensis* femur

- A subsequent 2020 analysis argued that the femur's shape was more similar to that of apes than to that of known bipedal hominins; based on several days of study done in 2004. Their preliminary analysis concluded that the remains indicated a species that did routinely walked upright.

- The new 2022 paper describing the femur, alongside the two arm bones, comes to the opposite conclusion. The team contends that more than a dozen features of the femur suggest that Toumaï's kind walked on two feet.

Sahelanthropus

- Despite the new study, don't expect a full resolution just yet, because the femur consists mostly of a shaft that doesn't have the joints at either end that would provide most of the information needed to infer *Sahelanthropus*'s posture and how it walked.

- Whatever you might think about the femur, the arm ulnae are unquestionably chimpanzee-like and are clearly well adapted to climbing trees.

2001 Kenyanthropus platyops

Location: West Turkana, Kenya in 1999

Date Range: 3.5 - 3.3 mya.

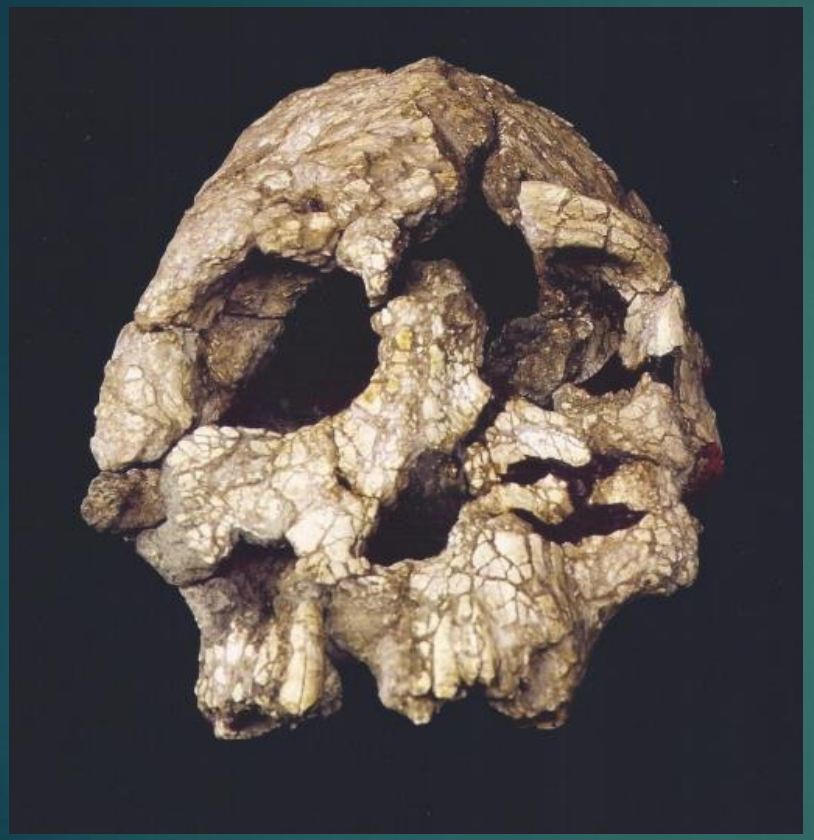
Average cranial capacity: 430 cc

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

(Maeve Leakey et al. 2001)

2001: *Kenyanthropus platyops*, 3.5M



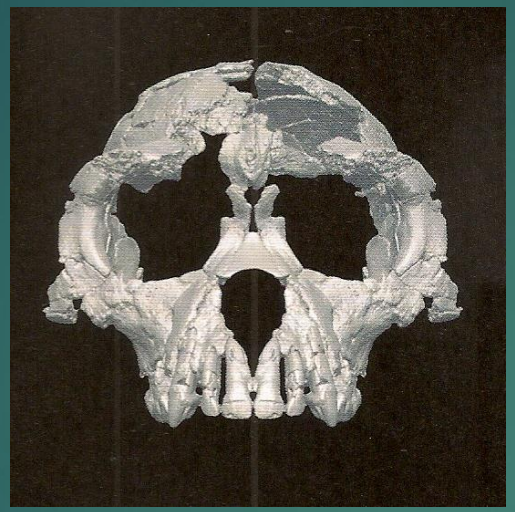
Kenyanthropus platyops
(KNM-WT 40000)

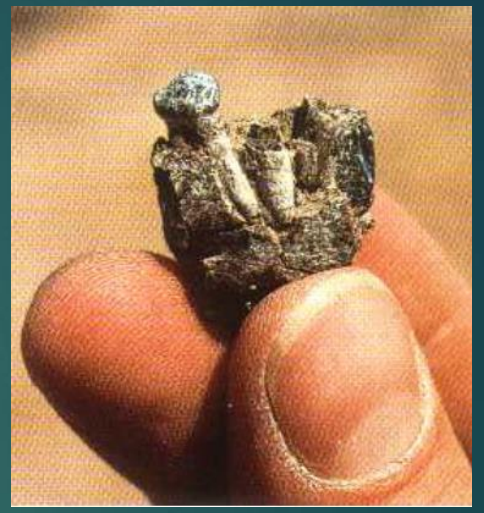
Discoverer: Justus Erus
Locality: Lomekwi,
West Turkana, Keny
Date: 1999
Age: 3.5 M

Fossil skull is highly fragmented and the individual pieces are greatly distorted. Cranium is deformed by many matrix-filled cracks that permeate the face and rest of cranium.

Tim White (2003) has claimed that this fossil is so severely distorted that it cannot be reliably identified, and that it may merely be a Kenyan version of *Australopithecus afarensis*.

1992 Discovery: *Ardipithecus ramidus*, 4.4 Ma





Type specimen
ARA-VP-1/129

Discoverer:

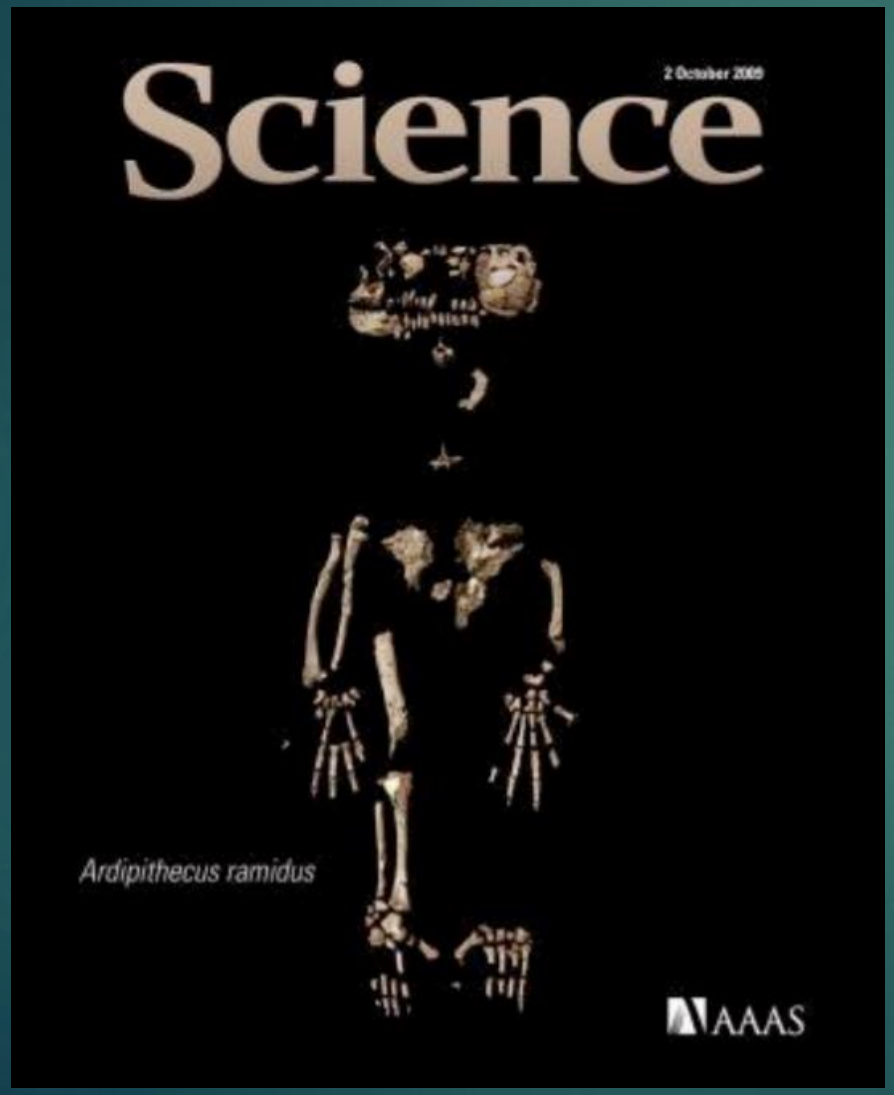
Alamayehu Asfaw

Locality: Aramis, Middle Awash, Ethiopia

Age: 4.4 M

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

Publication 17 years later:
Tim White *et al*. 2009

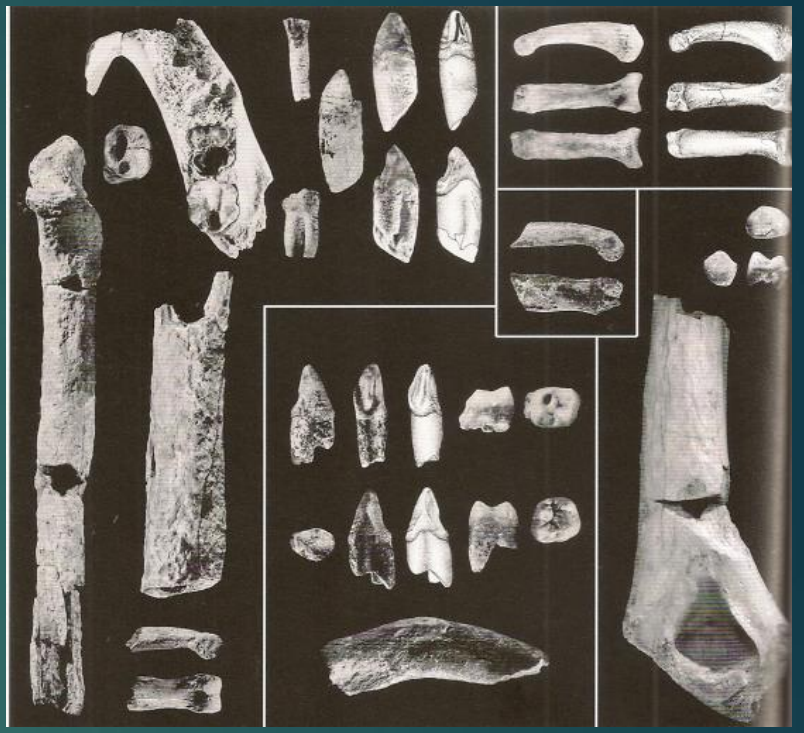


A. ramidus tells us about our LCA

- First substantial fossil evidence about the possible appearance of the last human-chimp common ancestor and confirms that living African apes do not much resemble the LCA, as was commonly thought.
- It is unlike chimpanzees, suggesting that the last common ancestor differs from the modern chimpanzee. Ardi did not knuckle walk.
- Chimp feet are specialized for grasping trees; *A. ramidus* feet are better suited for walking.
- The canine teeth of *A. ramidus* are smaller, and equal in size between males and females, which suggests reduced male-to-male conflict, increased pair-bonding, and increased parental investment.

2004 *Ardipithecus kadabba*

- Even older - 5.8 – 5.2 Ma
- Ethiopia (Middle Awash)
- Similar to *Sahelanthropus* in mix of features
- Mandibles, teeth, some postcranial bones
- Tall, pointed, upper canines; slightly smaller lower canines; resemble chimp
- 17 specimens from at least 5 individuals
- Wooded habitat
- Case for being hominin is still debated



2004 ALA-VP-2/10,
type specimen

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.

Ardipithecus ramidus is descendant of *Ardipithecus kadabba*

- *A. kadabba* 5.2-5.8 Ma
- *A. ramidus* 4.4 Ma

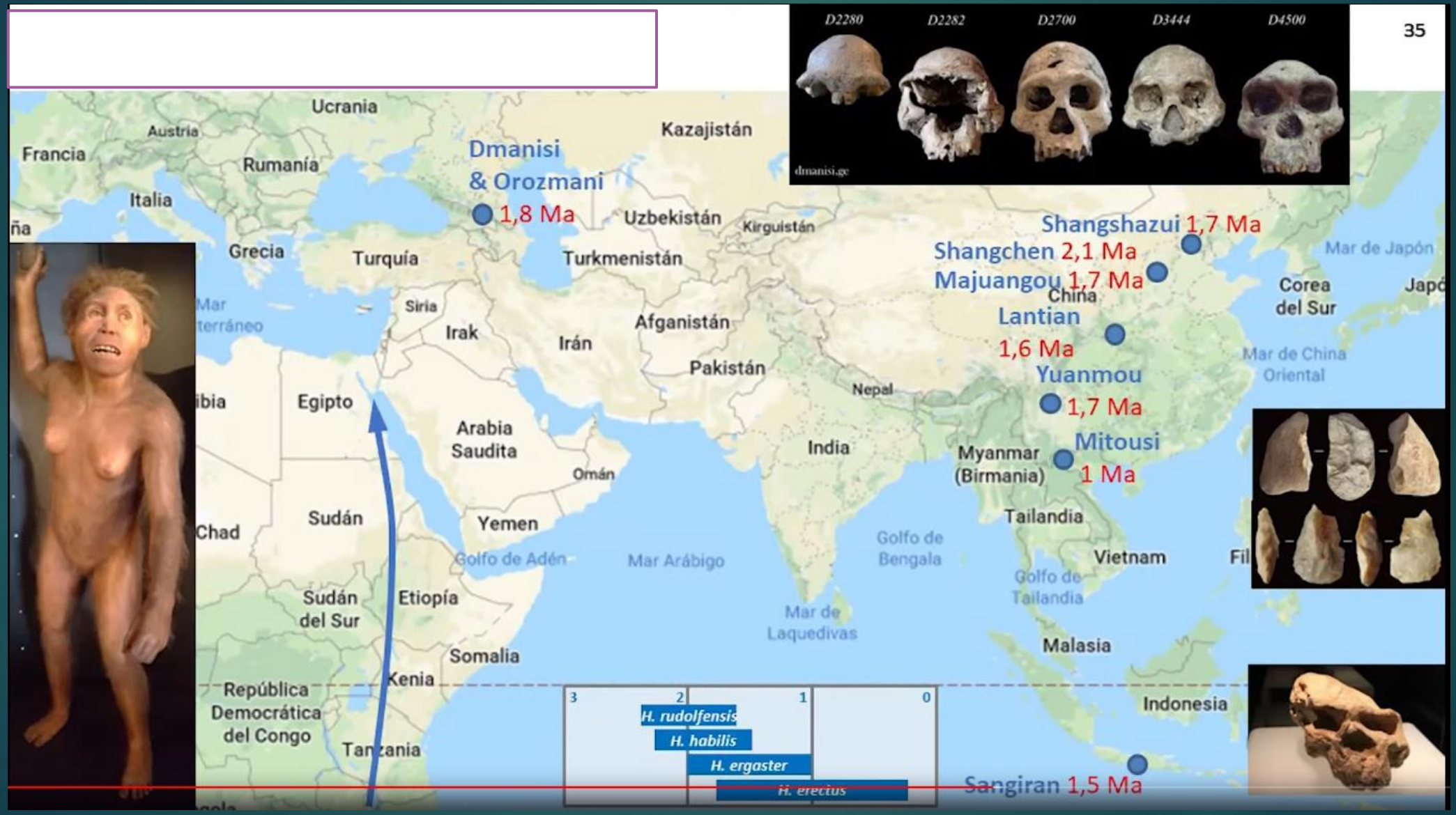
- *A. ramidus* has smaller canine than *A. kadabba*

- Anterior foramen magnum

- Grasping feet

H. erectus
at
Dmanisi, Georgia

An early migration from Africa: *H. erectus* at 1.8 Ma



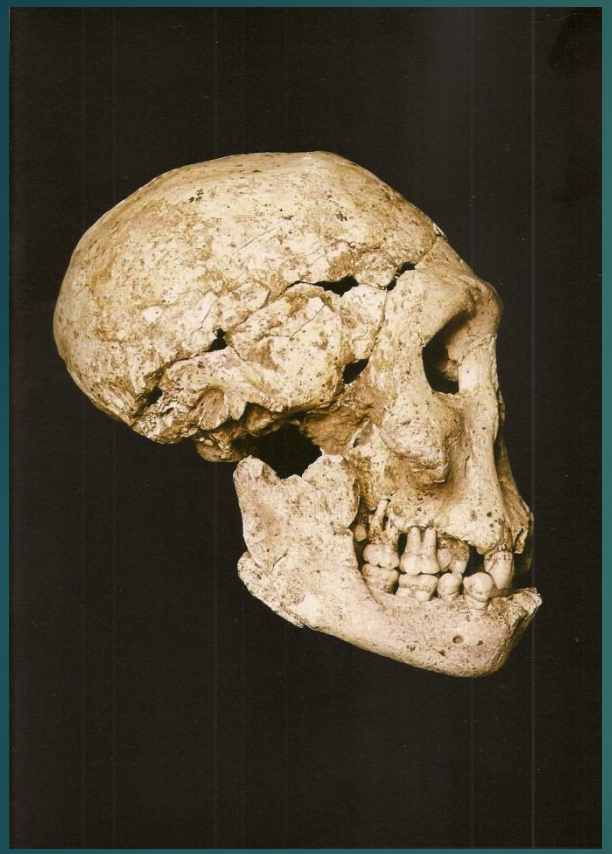
Dmanisi, Georgia: Earliest known hominin site outside of Africa: small *habilis*-like skulls which have *erectus*-like features.

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

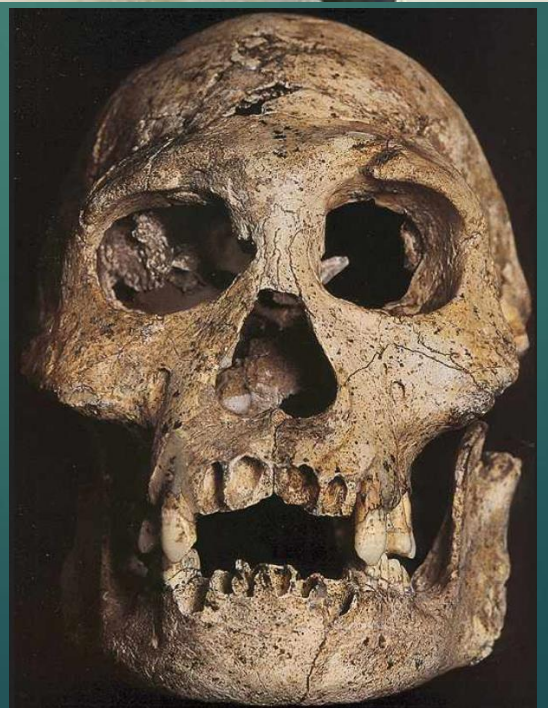
- Represent the earliest evidence for the emergence of early hominins from Africa into Eurasia 1.8 million years ago.
- No evidence of fire
- Oldowan tool technology
- 4 feet tall
- Among smallest *H. erectus* brain sizes, range from 545 to 775 cc

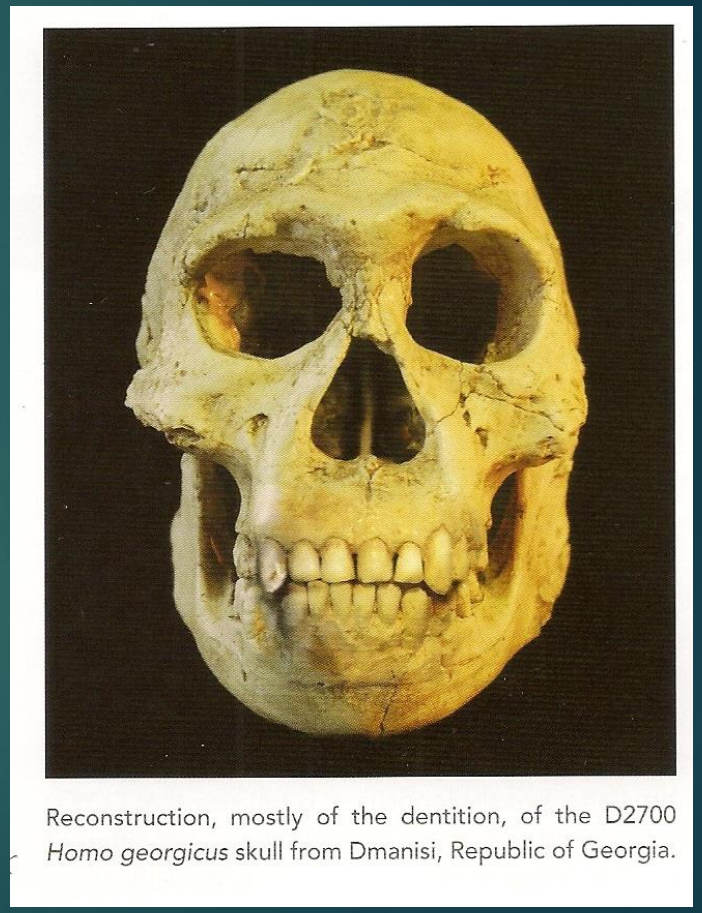
Five *H. erectus* skulls from Dmanisi, Georgia

Dmanisi, Georgia:
Homo georgicus (erectus)



Homo georgicus, D 2600



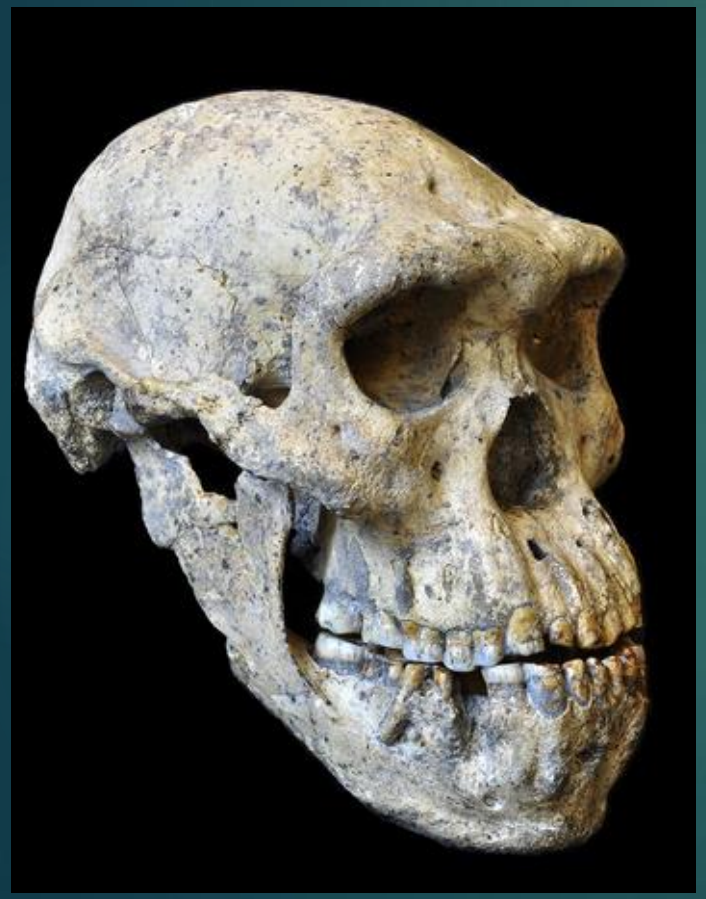


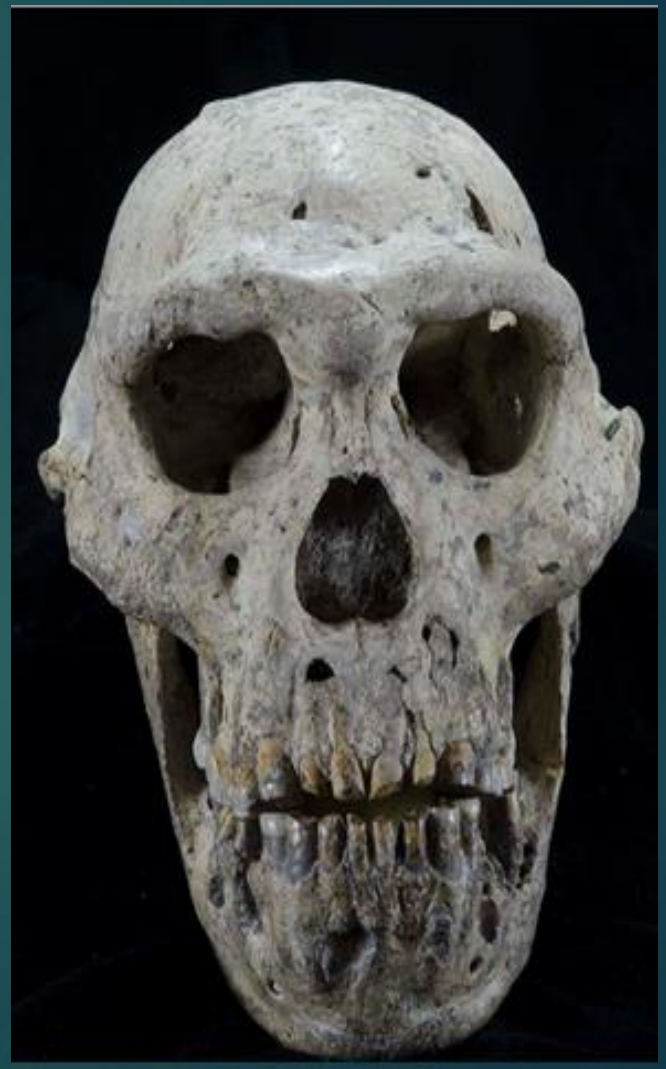
Reconstruction, mostly of the dentition, of the D2700 *Homo georgicus* skull from Dmanisi, Republic of Georgia.

Skull 5: D4500, most recent specimen, 2005

2000 Discovery: Skull 5 mandible D2600; 1.8 Ma, 546 cc

World's first completely preserved adult hominin 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.

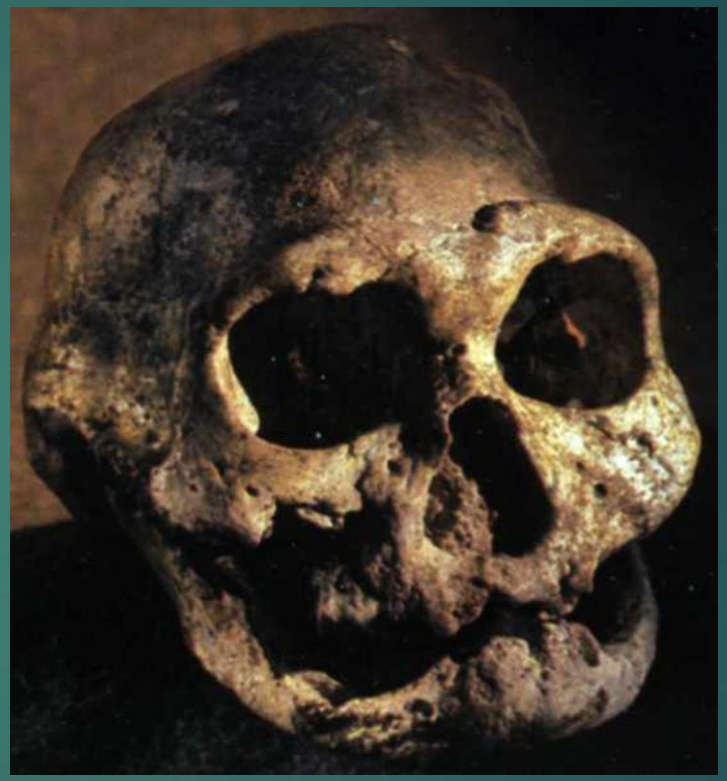
2000: Dmanisi, Georgia

H. erecti, 1.8 Ma: no fire, raw food, Oldowan tools

H. erectus: Dmanisi – 1.8-1.7 Ma – had primitive brains

Skull 4: Empathy at 1.8 Ma:

Dental pathology has implications for the evidence of social behavior.

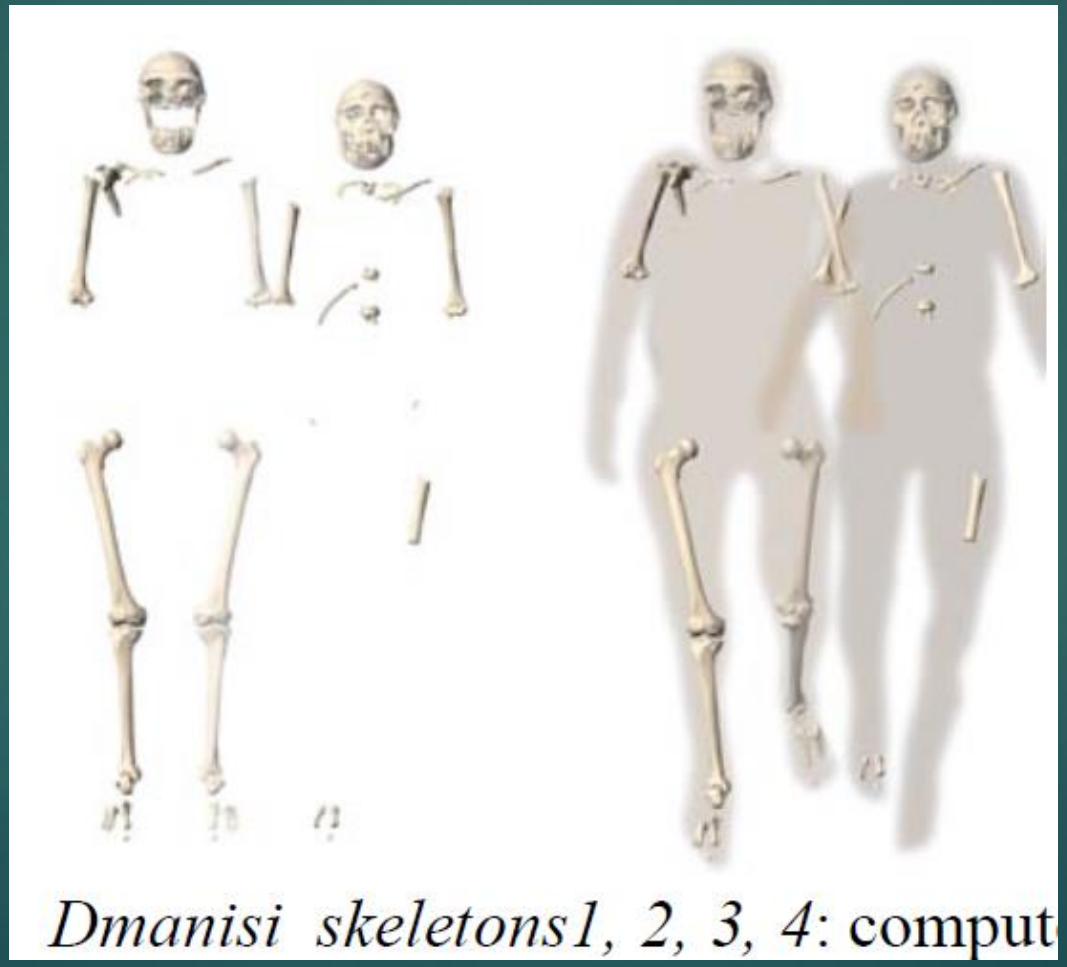


The Old Timer complete resorption of the tooth sockets

Discovered: 2005

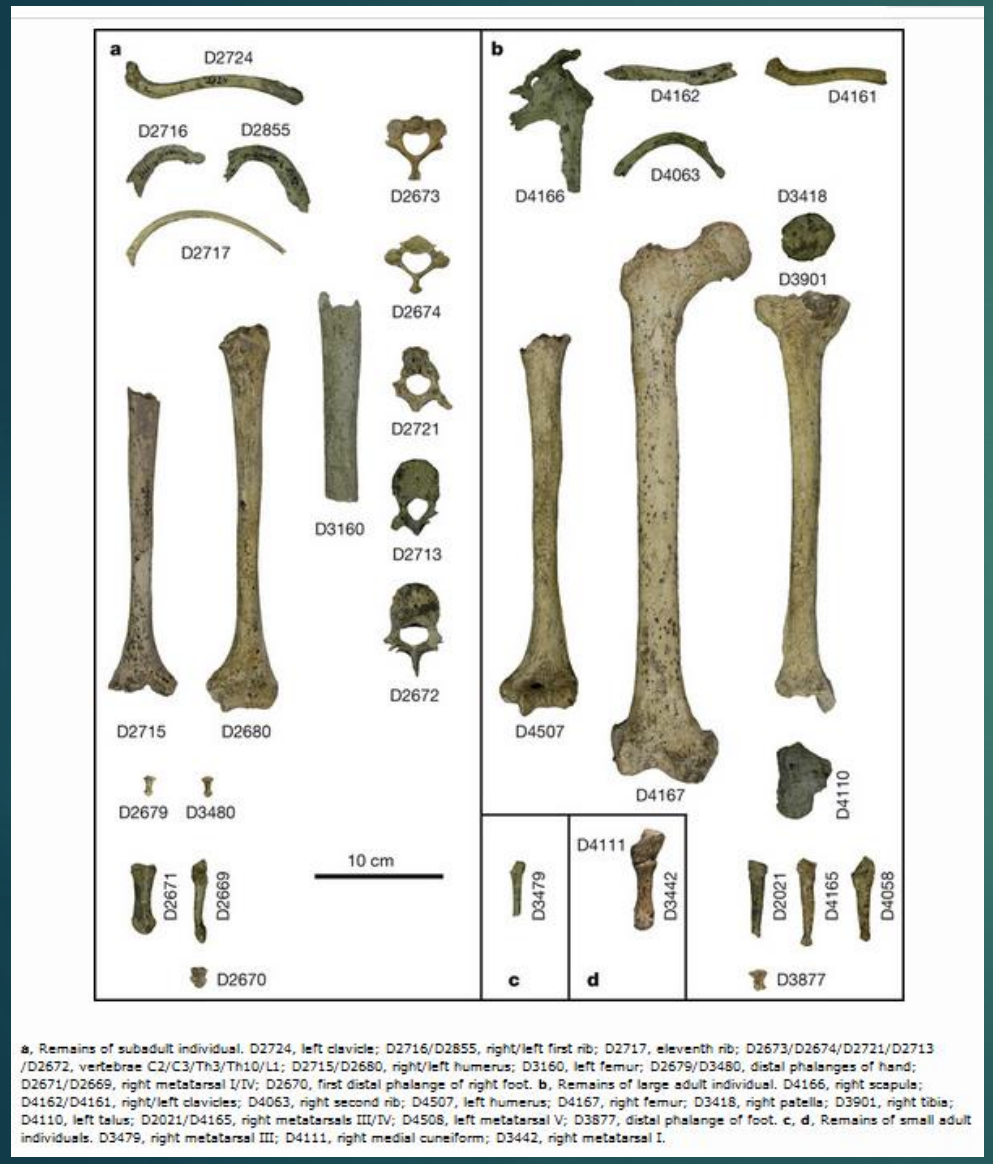
How did the toothless old man survive, unable to chew his food? The implications of how he was cared for in his old age, are significant.

Dmanisi postcranials: small body (145–166 cm; 4.8–5.5 ft) and brain size (545–775 cc), both of which are more comparable to *H. habilis* than to later *H. erectus*.



Dmanisi skeletons1, 2, 3, 4: comput

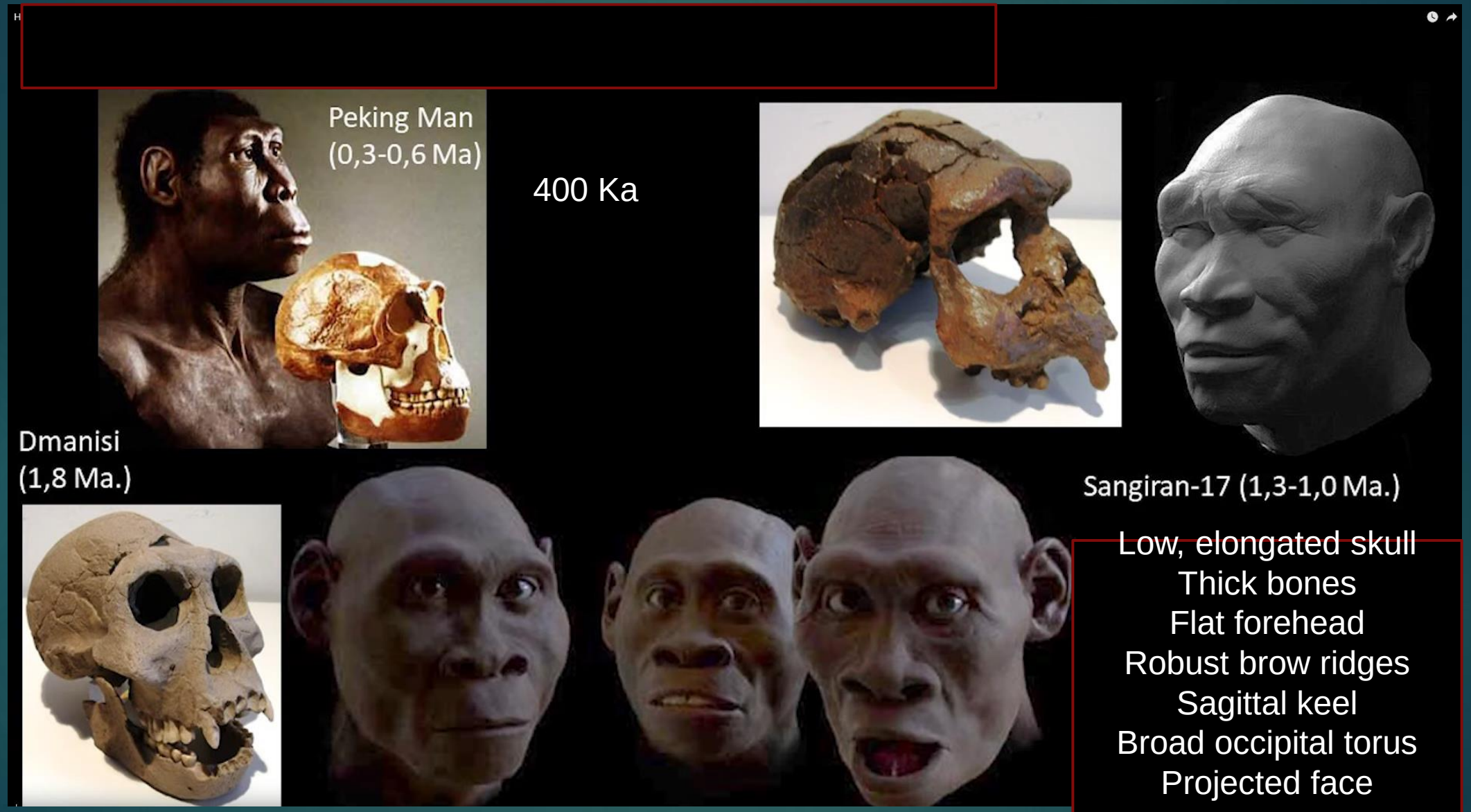
Dmanisi postcranial elements: 4 individuals



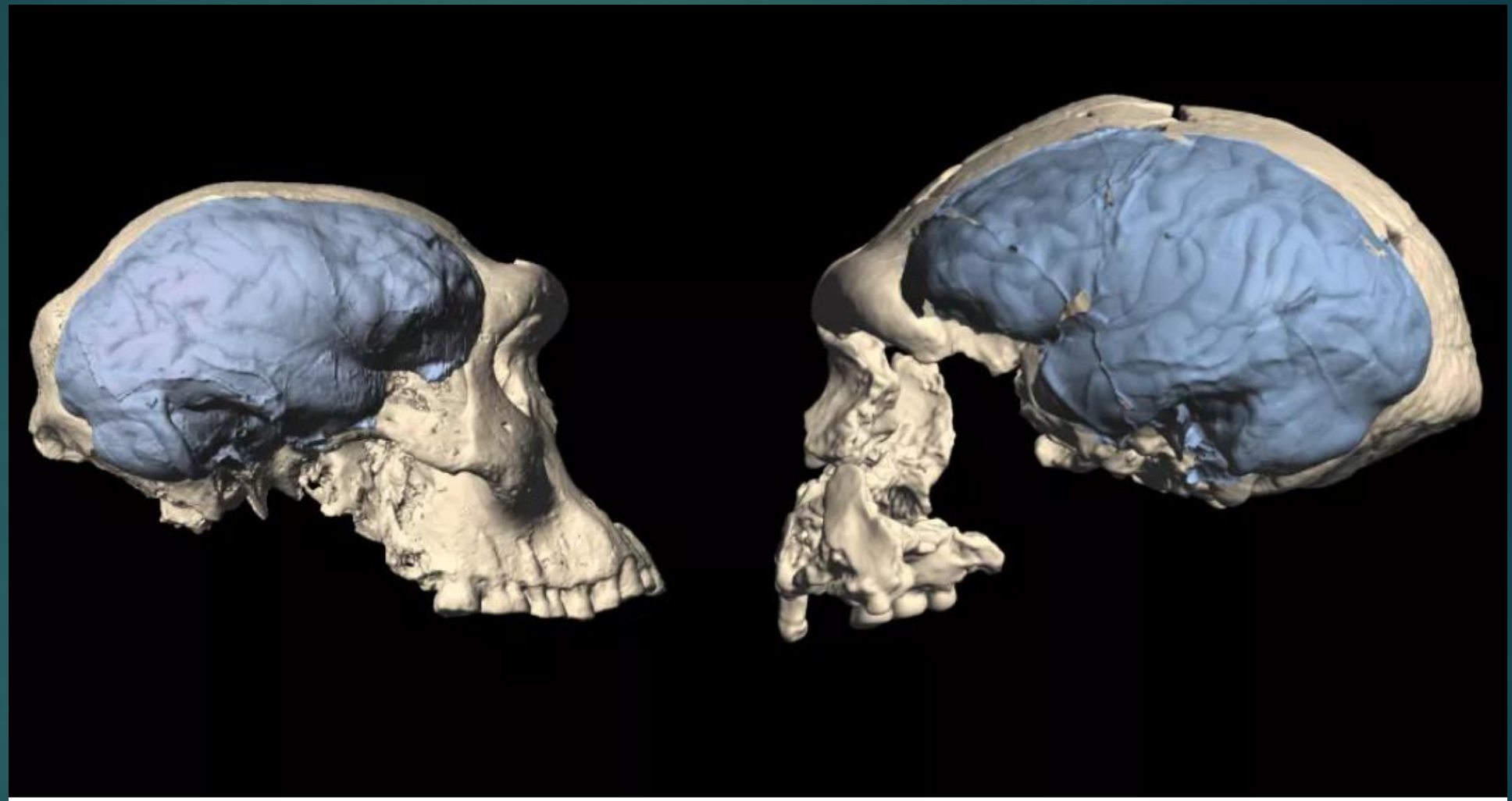
a, Remains of subadult individual. D2724, left clavicle; D2716/D2855, right/left first rib; D2717, eleventh rib; D2673/D2674/D2721/D2713/D2672, vertebrae C2/C3/Th3/Th10/L1; D2715/D2680, right/left humerus; D3160, left femur; D2679/D3480, distal phalanges of hand; D2671/D2669, right metatarsal I/IV; D2670, 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.

- Dmanisi cranial capacity: 545 to 775 cc
- Habilis average: 614 cc; *Erectus* average: 904 cc

Later Asiatic *Homo erectus* was very different from Dmanisi *erectus*



H. erectus: Dmanisi vs Sangiran, ave. 645 cc vs. >1000 cc



An early *Homo* skull from Dmanisi, Georgia (left) next a later *Homo* skull from Sangiran, Indonesia (right). A virtual reconstruction of their brains shows how the Dmanisi individual had a great ape-like brain, while the Sangiran individual had a modern human-like brain.

2020: Smallest *Homo erectus* cranium in Africa and diverse stone tools found at Gona, Ethiopia

The DAN5 cranium. Photo Credit: Dr. Michael J. Rogers, Southern Connecticut State University

Sileshi Simaw and Michael Rogers holding the DAN5 cranium in the field.

DAN5, H. erectus skull, Gona, 1.5 Ma, ~598 cc (smaller brain than 4 of 5 Dmanisi)

Associated with both Oldowan (Mode 1) and more complex Acheulian (Mode 2) stone tool assemblages

Sileshi Semaw et al., 2000

Associated with simple Oldowan-type tools and more complex Acheulian stone tool assemblages

Oldowan

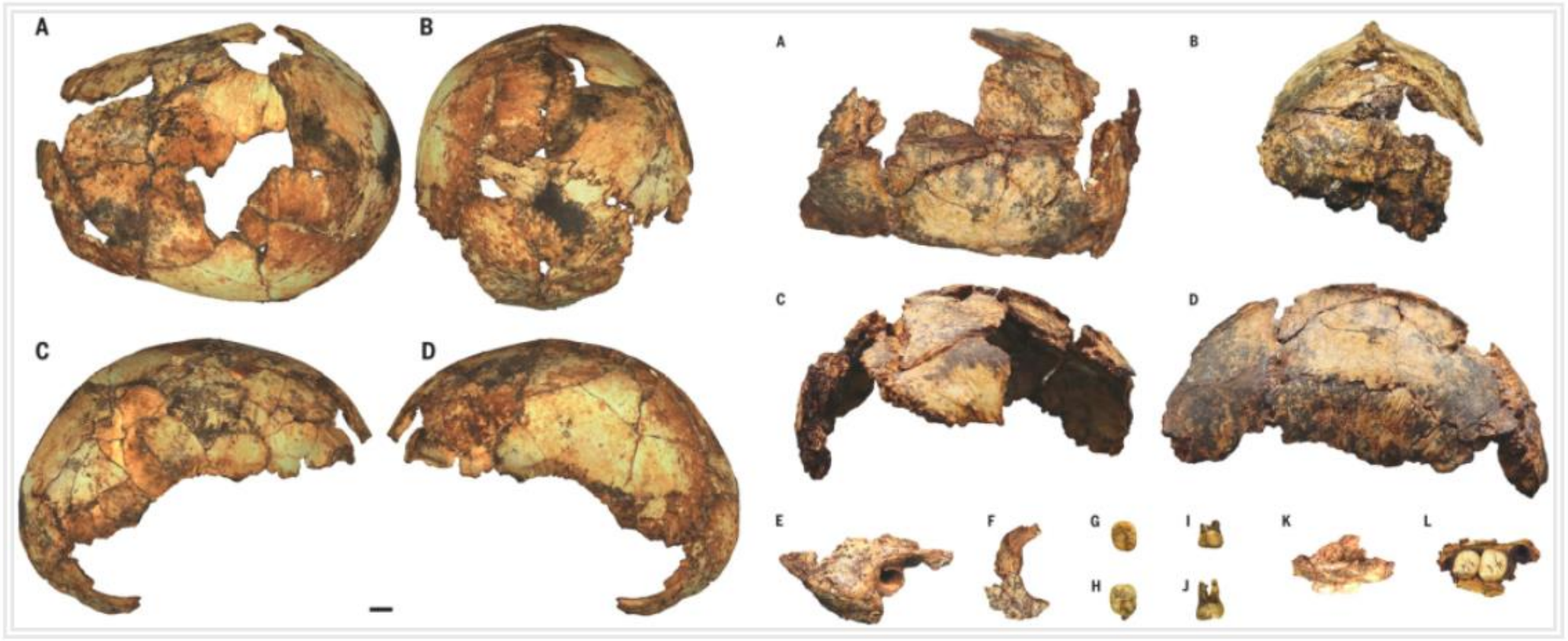
Two opposing views of Oldowan (top) and Acheulian (bottom) stone tools from DAN5. Photo Credit: Dr. Michael J. Rogers, Southern Connecticut State University

Acheulian

Oldest *H. erectus* at 2 Ma

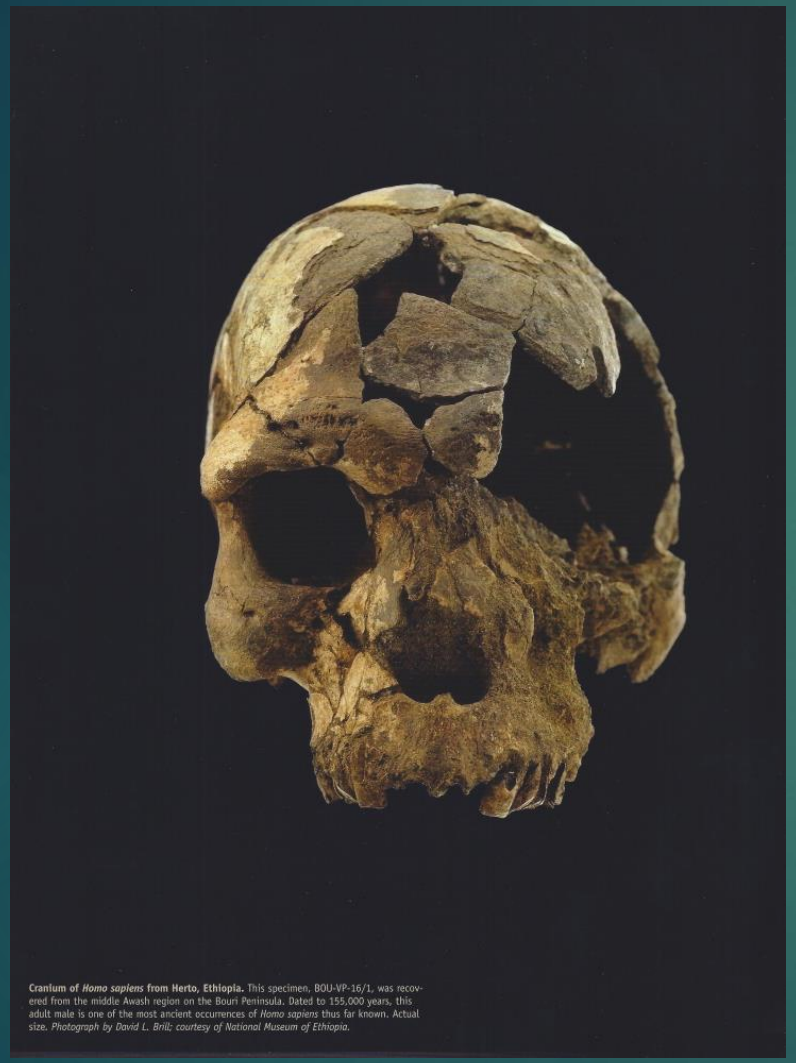
- H. ergaster skulls have been found in South Africa (Drimolen's cave), and they are 2.04-1.95 Ma.
- DNH 134 turns out to be the oldest fossil of *Homo erectus; older than Dmanisi*
- But also a *Paranthropus boisei*
- These hominin species were contemporary in that region with *Australopithecus sediba* and *Paranthropus robustus.*

Contemporaneous: *Homo erectus* 2.04-1.95 Ma *Paranthropus boisei*

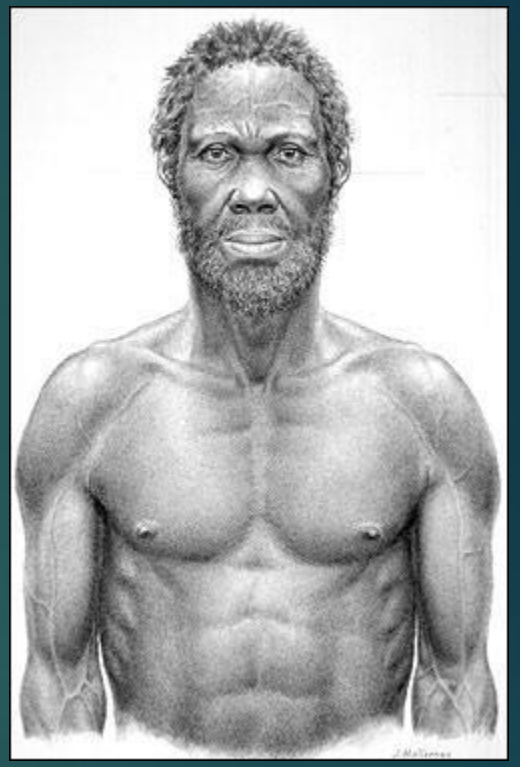


Credit: Herries, AIR et al. (2020). Contemporaneity of Australopithecus, Paranthropus, and early Homo erectus in South Africa.

2003: *Homo sapiens idaltu*, 160 Ka, Herto, Ethiopia



Herto, Ethiopia; Bou-VP-16-1



Found with fossils of hippo calves

2003: 3rd oldest stone tools: 2.6-Million-year-old stone tools and associated bones from Gona, Afar, Ethiopia

No hominin remains were found in association with these Oldowan tools and at the time they predated the oldest known remains of the genus *Homo.*

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.

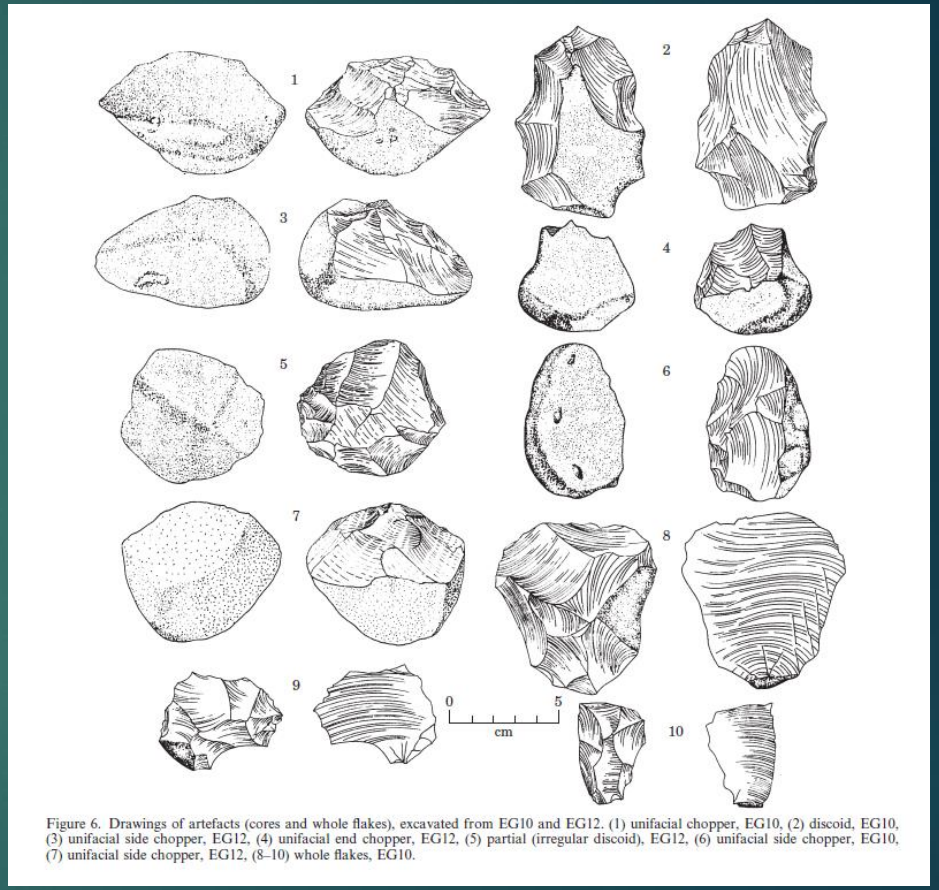


Figure 6. Drawings of artefacts (cores and whole flakes), excavated from EG10 and EG12. (1) unifacial chopper, EG10, (2) discoid, EG10, (3) unifacial side chopper, EG12, (4) unifacial end chopper, EG12, (5) partial (irregular discoid), EG12, (6) unifacial side chopper, EG10, (7) unifacial side chopper,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

Sileshi Semaw, et al. 1997 & 2000

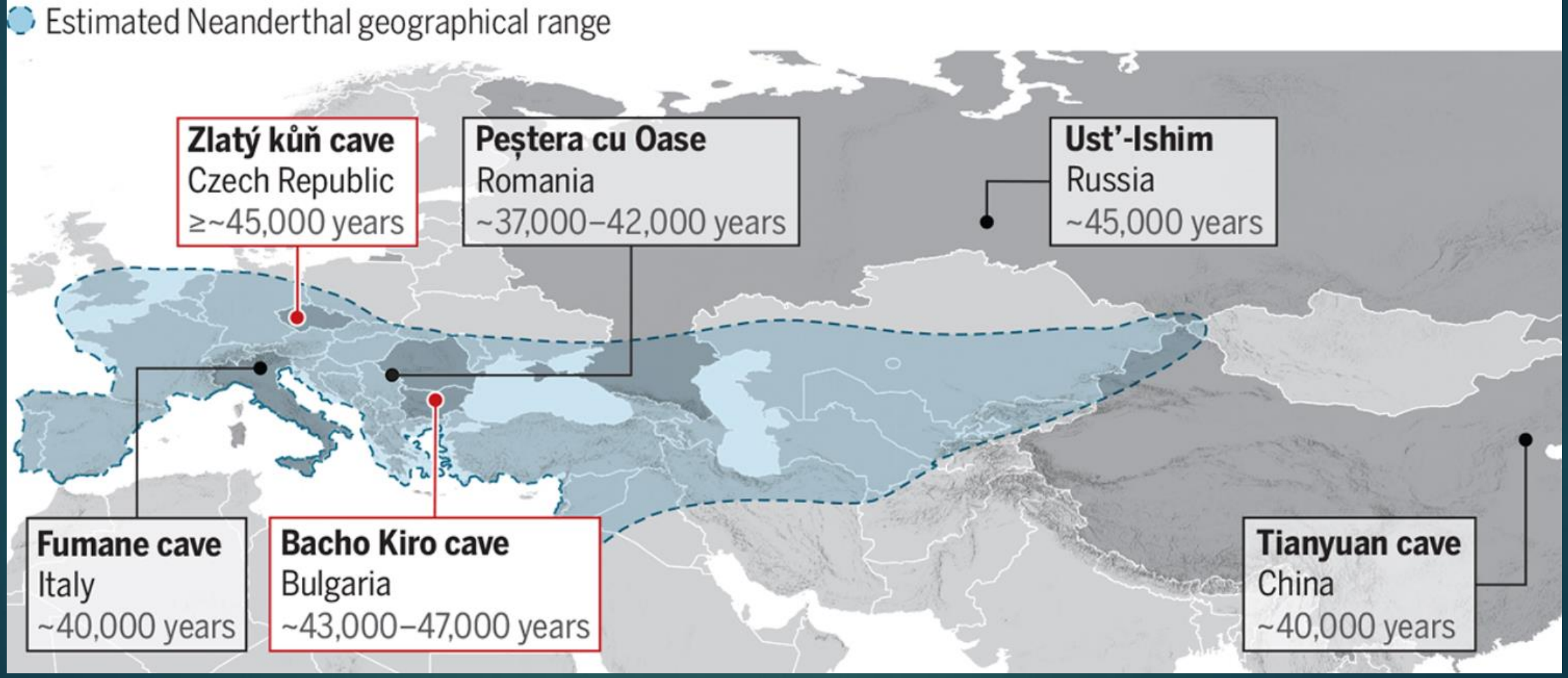
2003: Pestera cu Oase, Romania, 38 Ka (then earliest MH in Europe) – in 2018, DNA surprise – 6-10% N DNA

Fig. 2. Occlusal view of the Oase 2 palate and molars. Scale in centimeters. Note that the M^3s are still in their crypts and are partially visible distal of the M^2s.

Oase 2, modern human, 38 Ka

Modern humans on the move

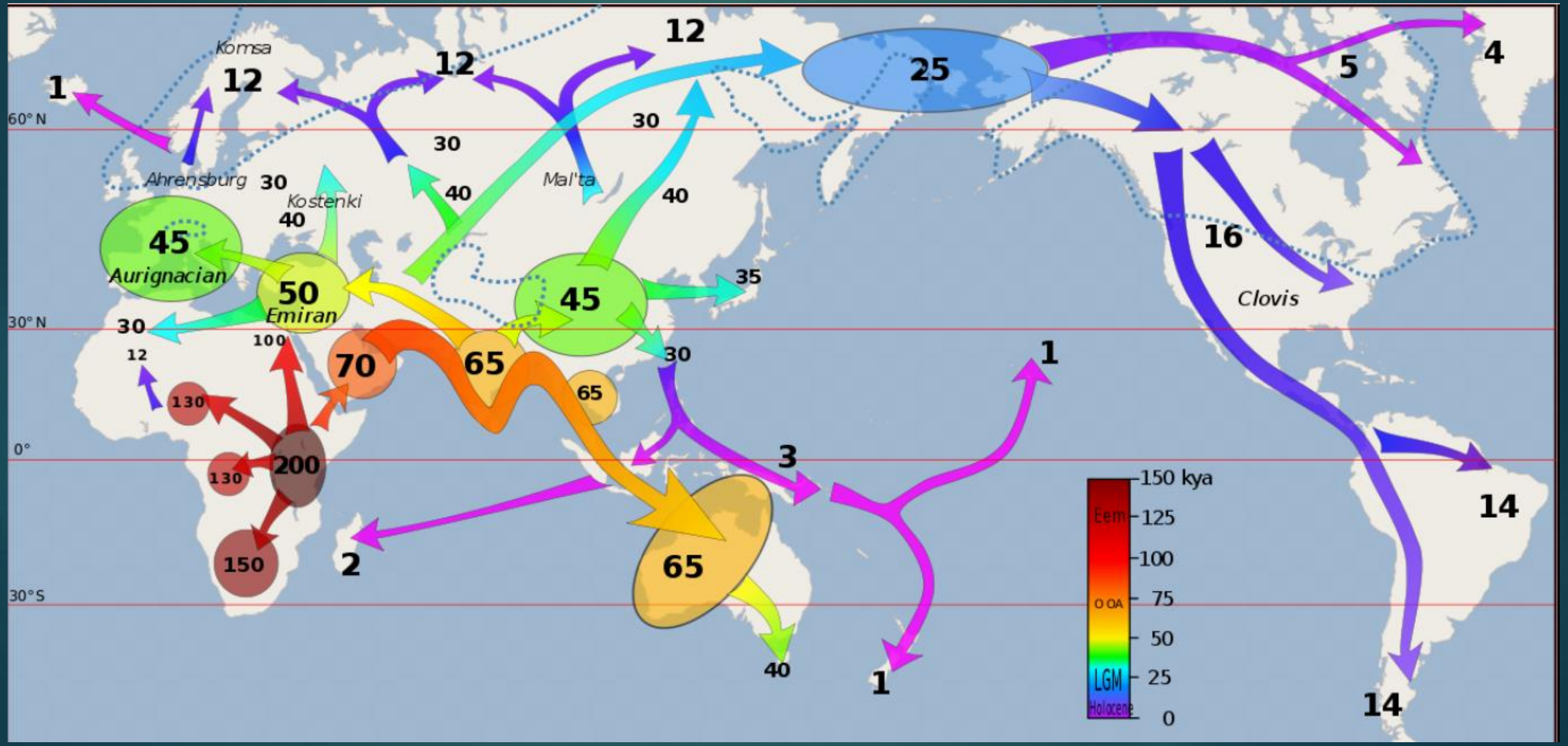
Findings from new sites (red) add to the handful of ancient DNA studies of the mysterious modern humans who first ventured into Eurasia and the Neanderthal homeland (blue).



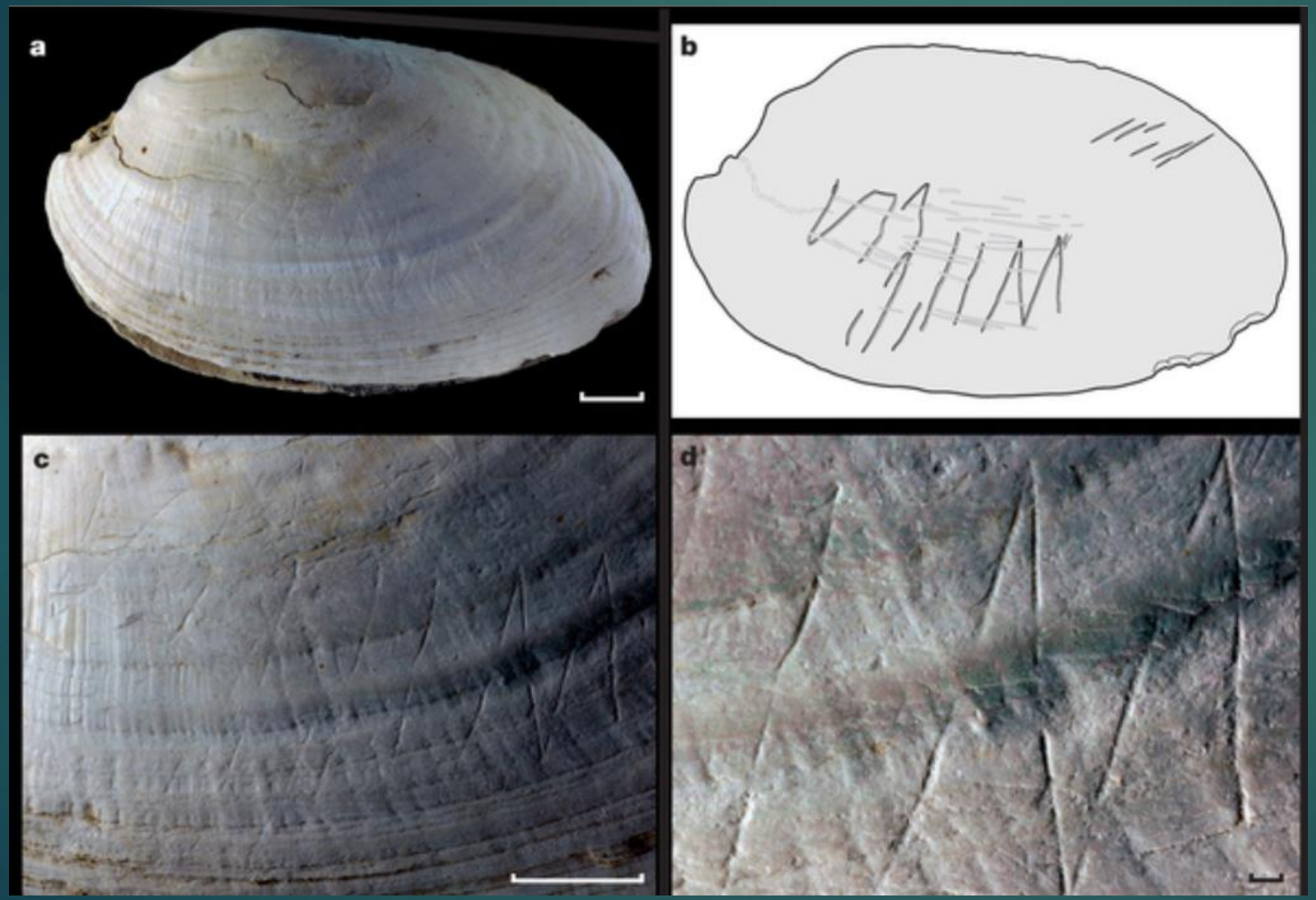
Oldest currently known Modern Humans in Eurasia:

- *Oase 1*: 37-42 Ka, Romania, Modern Human-Neandertal hybrid; with 6-10% Neandertal DNA, GGGgrandparent = full Neandertal
- Zlatý kůň in Czechia; Modern human skull, 45 Ka+; long N fragments
- Ust'-Ishim individual from Siberia, ~45 Ka – N ancestor 7 K before; 2% but much longer fragments
- Bacho Kiro cave, Bulgaria, 43-46 Ka; Earliest Modern Human in Europe; 3.5% N DNA

Modern human migration out of Africa showing approximate dates



540 Ka, Trinil, Java, *Homo erectus* art work?: Geometric design carved on clam shell



The combined evidence for high-dexterity opening of shells, use of shell as a raw material to make tools, and engraving of an abstract pattern on a shell with a minimum age of 436 -540 Ma indicates that H. erectus was the agent responsible for the exploitation of freshwater mussels at Trinil described here. The inclusion of mussels in the diet of H. erectus is not surprising

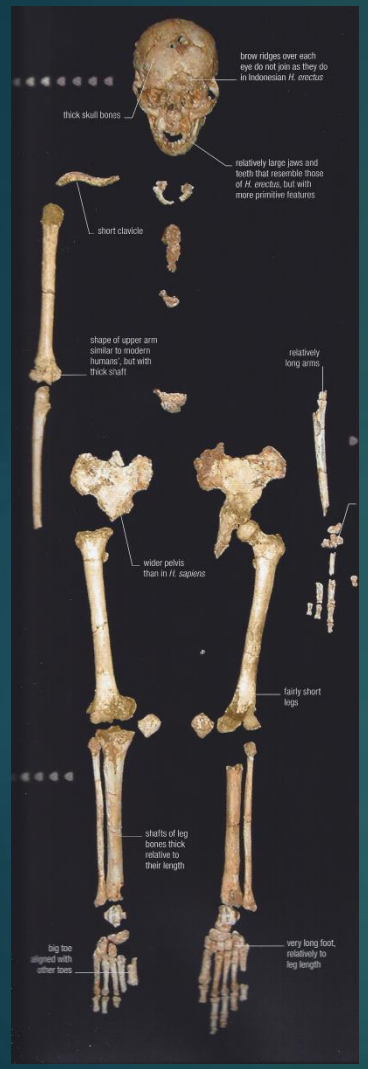
Homo floresiensis
2004

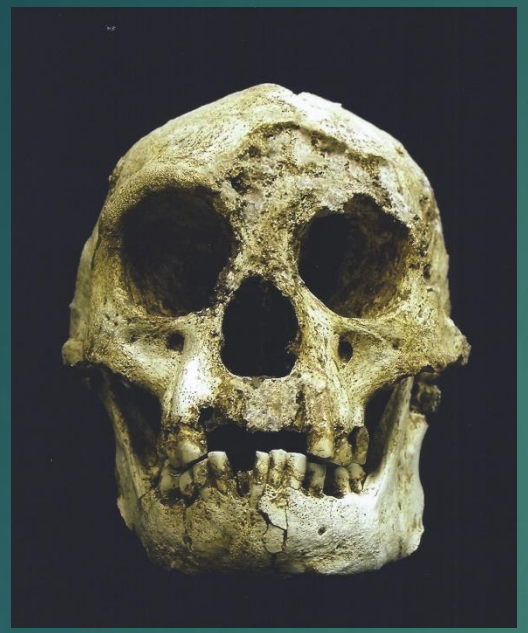
Liang Bua Cave excavation, Flores, Indonesia

Lower Right shaft where LB1 found

Homo floresiensis, Nature, 2004 & 2009

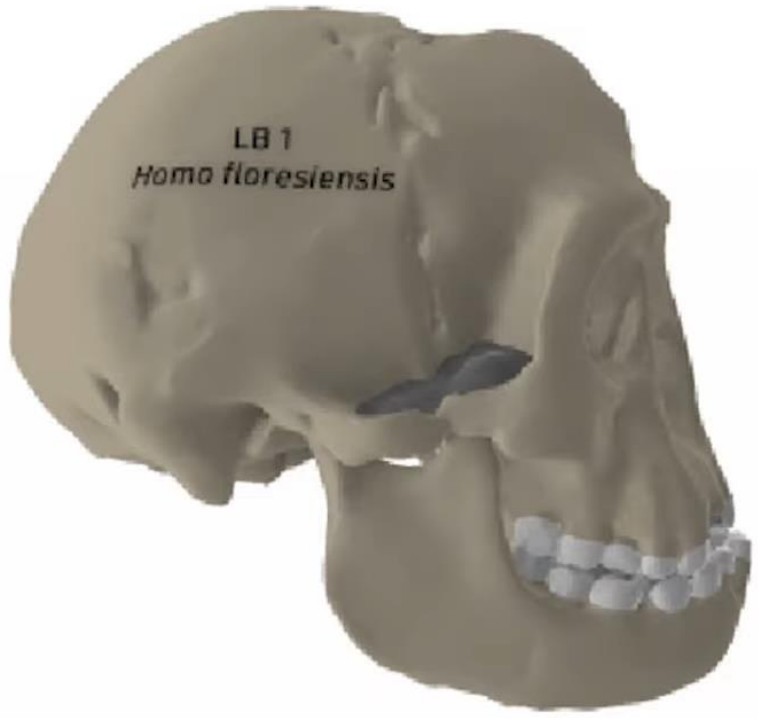
2004: *Homo floresiensis*, 1 meter tall, 426 cc, 100-60 Ka





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

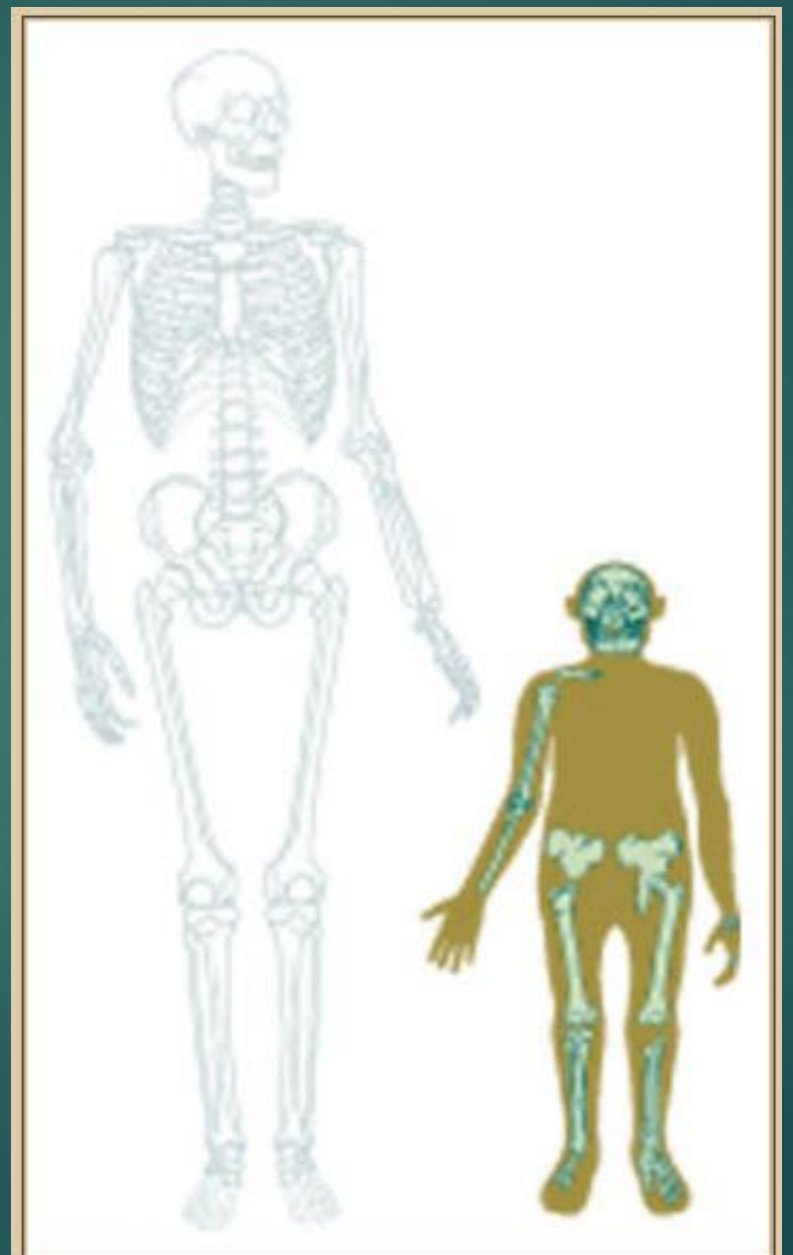
Homo floresiensis



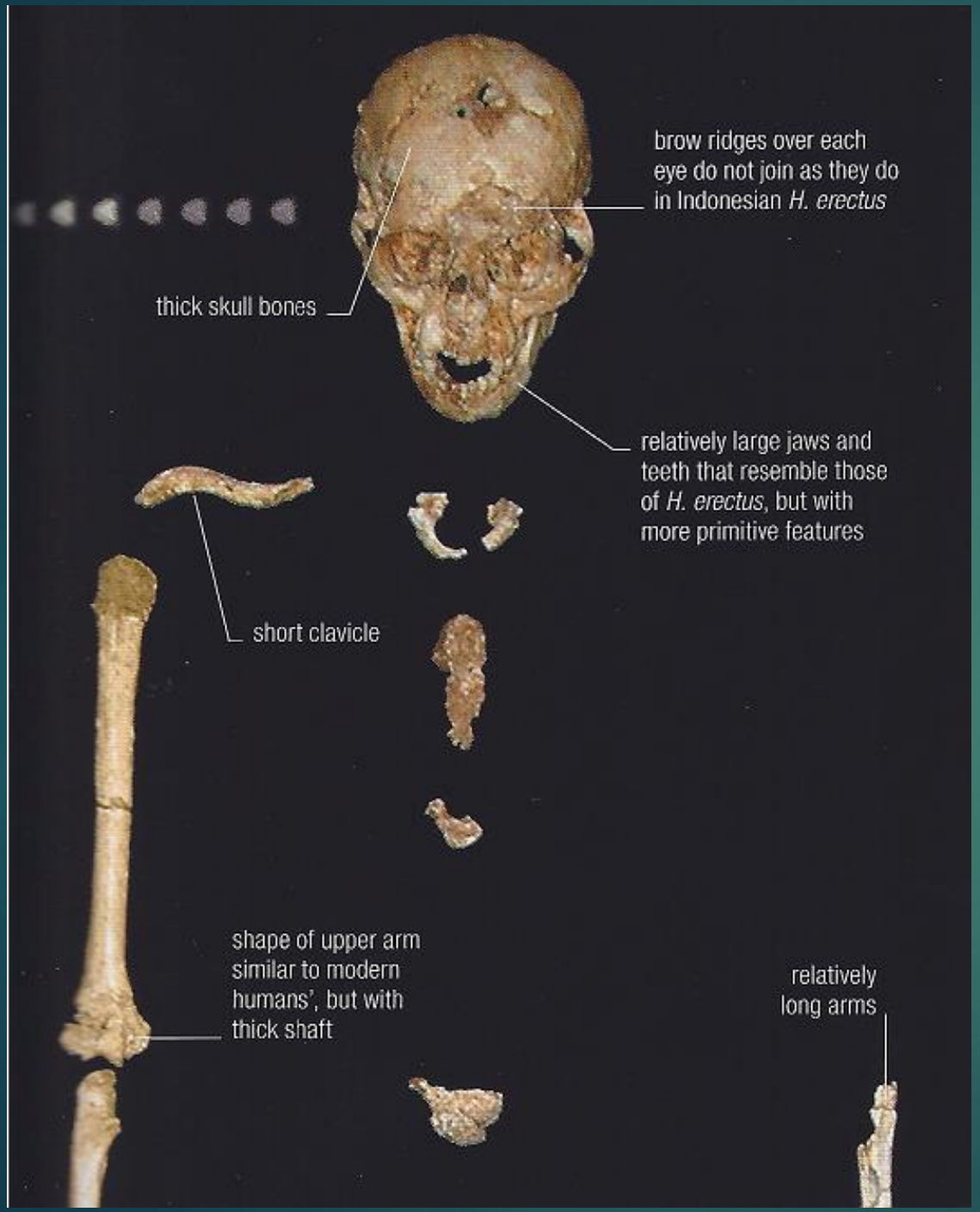
Homo floresiensis: 426 cc, now dated to 100-60 kya

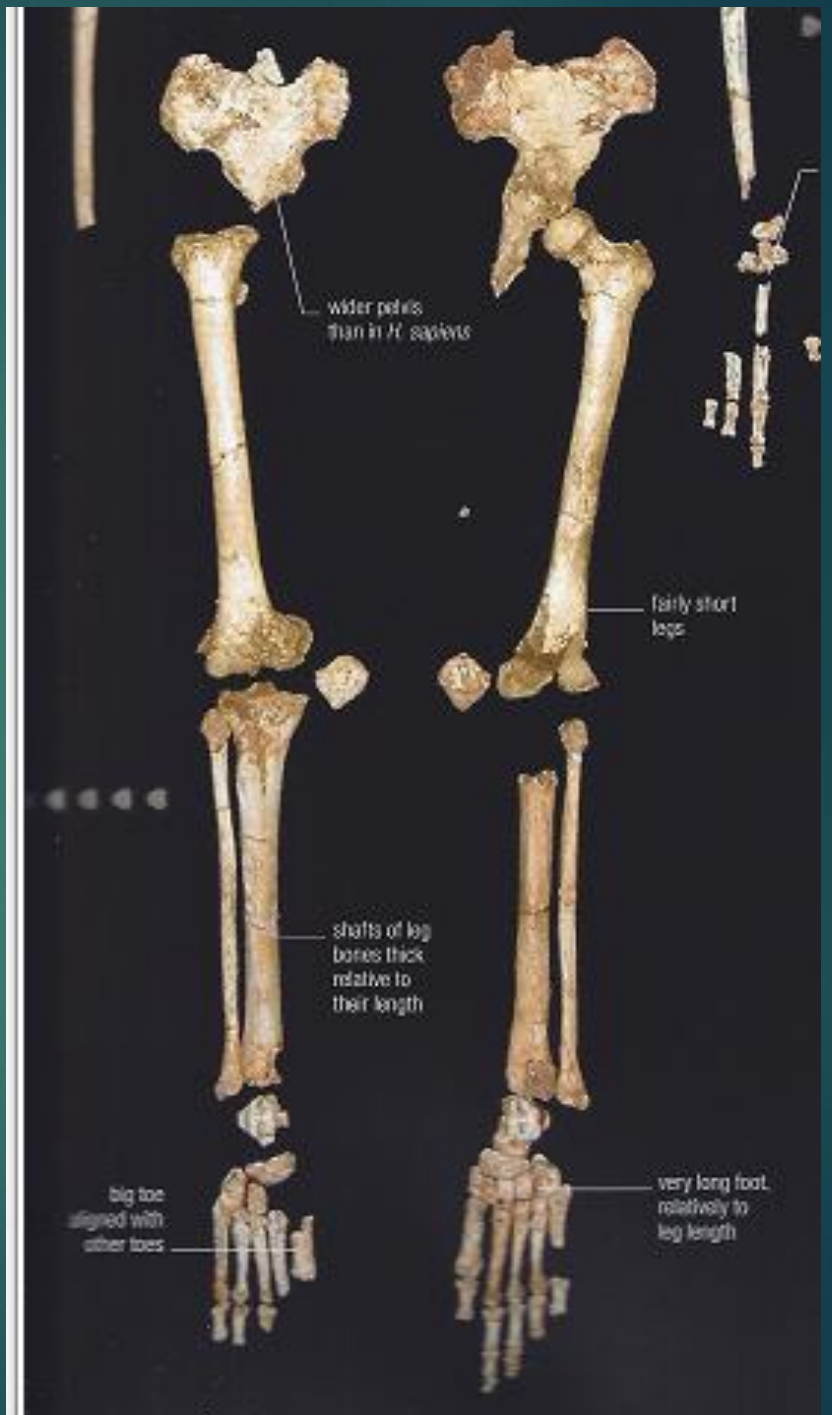
- Originally considered to have survived until 12,000 years ago.
- More extensive stratigraphic and chronological work: 100 to 60 Ka
- Points, blades, and microblades were associated with remains of the dwarf elephant *Stegodon* = dated to 190 to 50 Ka ago
- Modern human bones recovered from the cave date to 46 Ka
- *Homo floresiensis* on Flores therefore lived concurrently with *Homo sapiens* and *H. neanderthalensis* in Europe

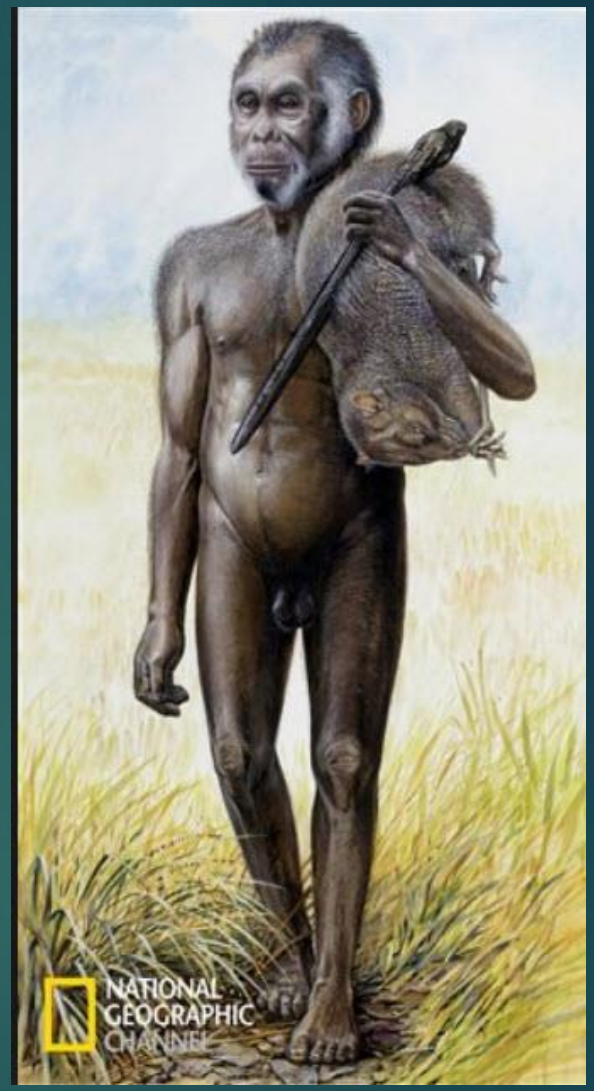
2003: Homo floresiensis, island of Flores



3 feet tall


brow ridges over each eye do not join as they do in Indonesian *H. erectus*
thick skull bones
relatively large jaws and teeth that resemble those of *H. erectus*, but with more primitive features
short clavicle
shape of upper arm similar to modern humans', but with thick shaft
relatively long arms

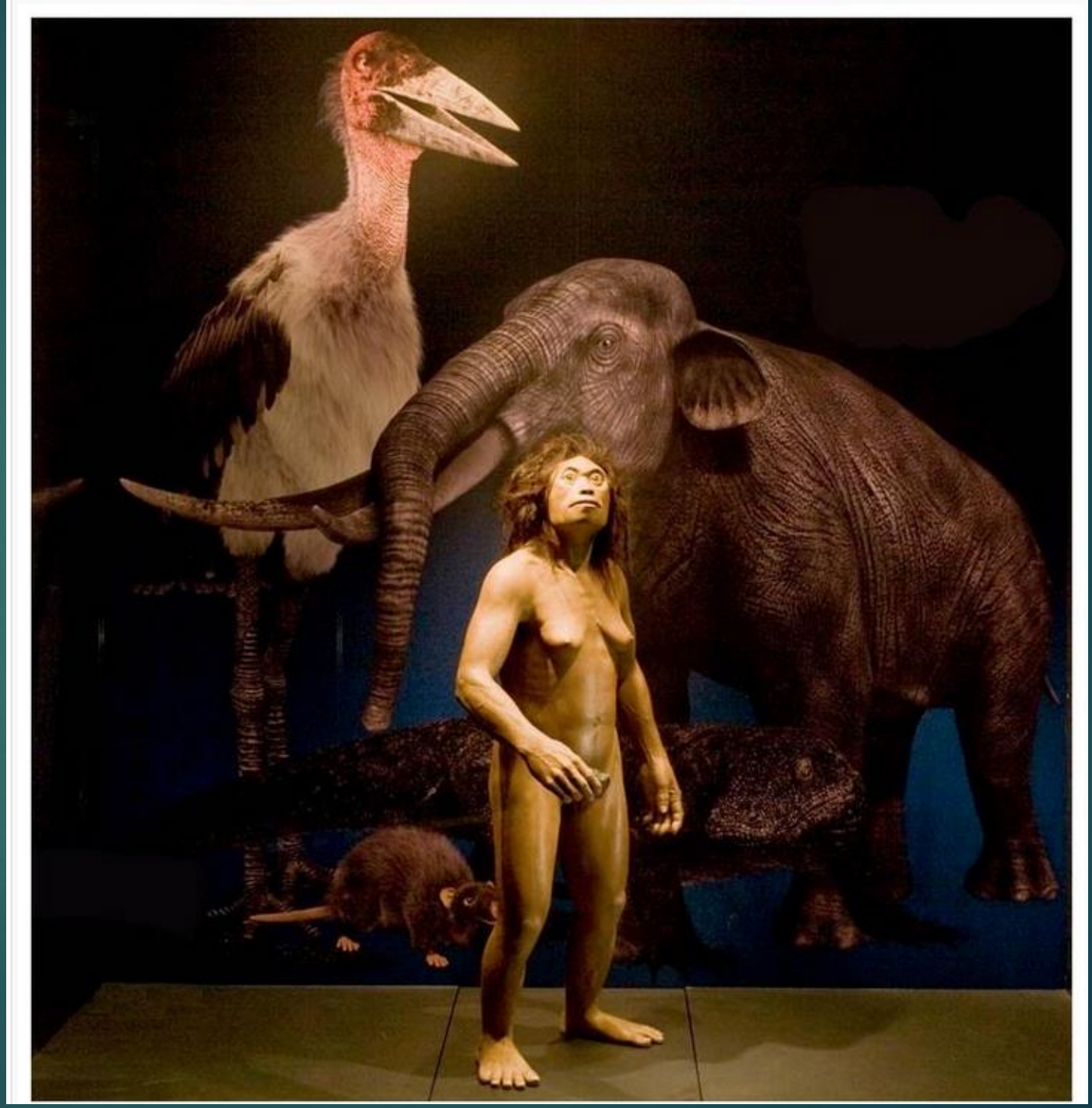

wider pelvis than in *H. sapiens*
fairly short legs
shafts of leg bones thick relative to their length
big toe aligned with other toes
very long foot, relatively to leg length



Killed giant rats and Komodo dragons on Flores

An alien island: Flo and Fauna

Dwarf Stegodon elephant, giant storks, large rats



Explaining *H. floresiensis*: a history of controversy

- Hypothesis 1*: Homo sapiens* with Pathology (not a new species): Sick Hobbit
  - A pathological *H. sapiens, i.e.* Microcephaly, malformed human pygmy, Laron Syndrome, cretinism, etc.
- Hypothesis 2: Early arrival of primitive hominin (i.e. *H. habilis*) (2-3 Ma)
- Hypothesis 3: Later arrival (i.e. *H. erectus*), with subsequent insular dwarfing

The two most popular current evolutionary hypotheses

1) The insular dwarf descendant of *Homo erectus;* Derived from a population of *H. erectus*: rapidly became dwarfed circa a million years ago

2) Descendant of an even more primitive species: a sister clade to *Homo habilis* based on a phylogenetic analyses, implying a >1.8 Ma migration from Africa

   - If true then *Homo floresiensis* was descended from a species such as *Homo habilis* for which there is no evidence elsewhere in Asia – (Debbie Argue, 2017)

Only additional fossils or analyses will determine the evolutionary history of the “Hobbits“ of Flores Island.

New dating

- 2016: new geological assessment places *H. floresiensis* between 100 to 60 Ka.

- Hobbits were gone from the cave by 50 Ka

- But whether *H. floresiensis* survived after this time, or encountered modern humans, Denisovans or other hominin species on Flores or elsewhere, remain open questions that future discoveries may help to answer.

T. Sutikna, et al. 2016

Insular dwarfism happened not once but twice on Flores

- Genetic analysis of the modern pygmies on Flores showed they have Neanderthal and Denisovan ancestry – as do neighboring peoples in southeast Asia – but no traces of a relationship with Homo floresiensis (no ghost trace in modern pygmy DNA).
- The present-day pygmies are a second case of insular dwarfism on the isle, with *Homo floresiensis* being the first or second
- So the pygmies didn't get their short genes from the hobbits.
- Pygmies have no chin despite being *H. sapiens*

2015: Current Excavation at Mata Menge, Flores

Archaeological excavations at the 880,000-year-old site of Mata Menge, Flores, Indonesia

The trenches uncovered a surface area of 380 m^2 and yielded an extraordinary collection of 3,000 animal fossils and 1,500 stone artefacts.

Among this rich haul were a 2.5m long large Stegodon tusk, rare skull pieces from Komodo dragons, even rarer bird and amphibian remains, and abundant evidence for crocodiles and giant rats.

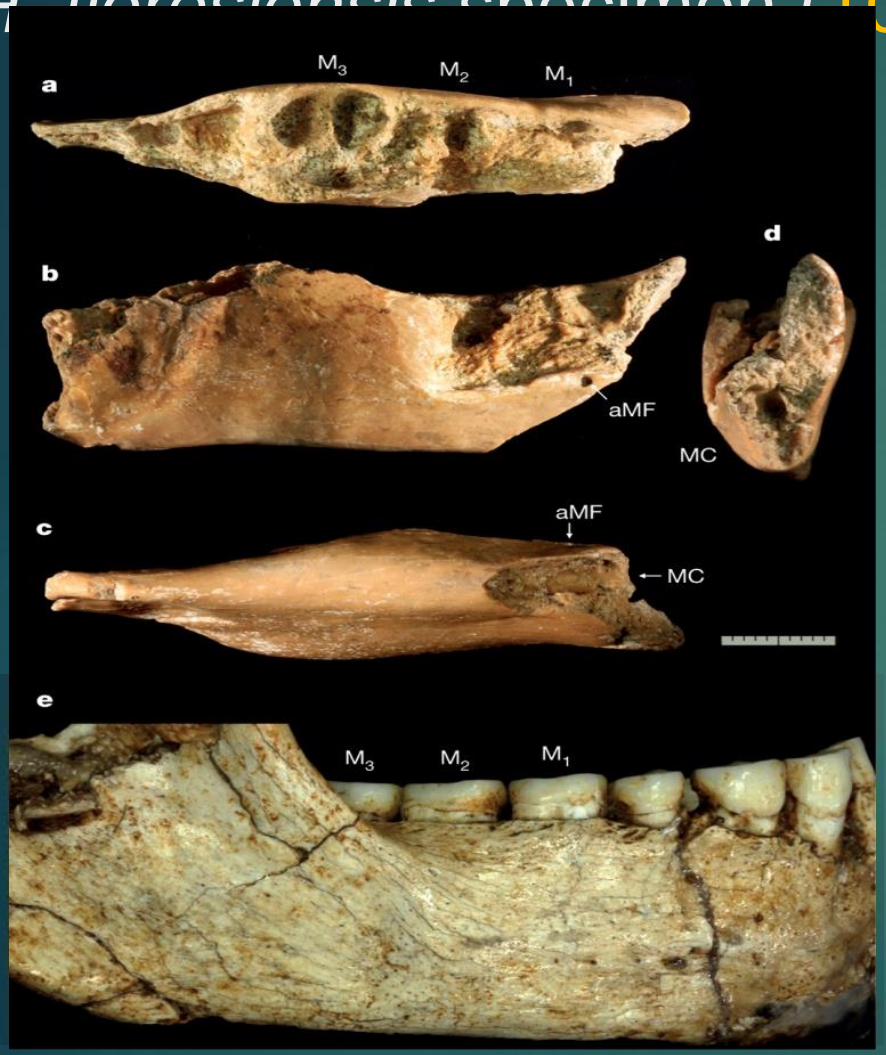
Mata Menge: Stone Tool evidence that Hominins were on Flores by 880 Ka

- 2010: Excavations at Mata Menge and Boa Lesa in the Soa Basin of Flores, Indonesia, recovered
  - stone artefacts dated to 840 Ka, in association with
  - fossilized remains of the large-bodied *Stegodon florensis florensis*
  - new smaller hominin ancestors: Fossil teeth and a partial jaw from hominins assumed to be ancestral to *H. floresiensis*.

- They date to about 700 Ka and are even smaller than the Hobbit fossils. From Mata Menge, about 74 km from Liang Bua.
- Hominins had colonized the island by at least 880 Ka

Adam Brumm, et al., Nature, 2010

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



Mata Menge jaw

28 percent smaller than Hobbits. Might have been just 2 1/2 feet tall as adults.

G D van den Bergh *et al.* (2016)

2017 Flores

- After years of hot debate, a new phylogenetic analysis by Debbie Argue et al. (2017) concluded that the “Hobbit,” *Homo floresiensis*, is not a dwarfed descendent of *Homo erectus*, as had become the majority view.
- Argue concluded it was a descendent of an archaic African hominin close to *Homo habilis*

- DNA extraction from a tooth failed.

- This is not the majority view.
- Where are other *H. habilis* fossils outside Africa?

2018: *H. erectus* in Philippines?

- Discovery of 57 stone tools, dated to 709 Ka
- associated with an almost-complete disarticulated skeleton of *Rhinoceros philippinensis*
- which shows clear signs of butchery,
- together with other fossil fauna remains
- on the Philippines's largest island, Luzon at Kalinga in the Cagayan Valley;

T. Ingicco, et al., Science, 2018.

Luzon, Philippines:

709 Ka
Stone Tools

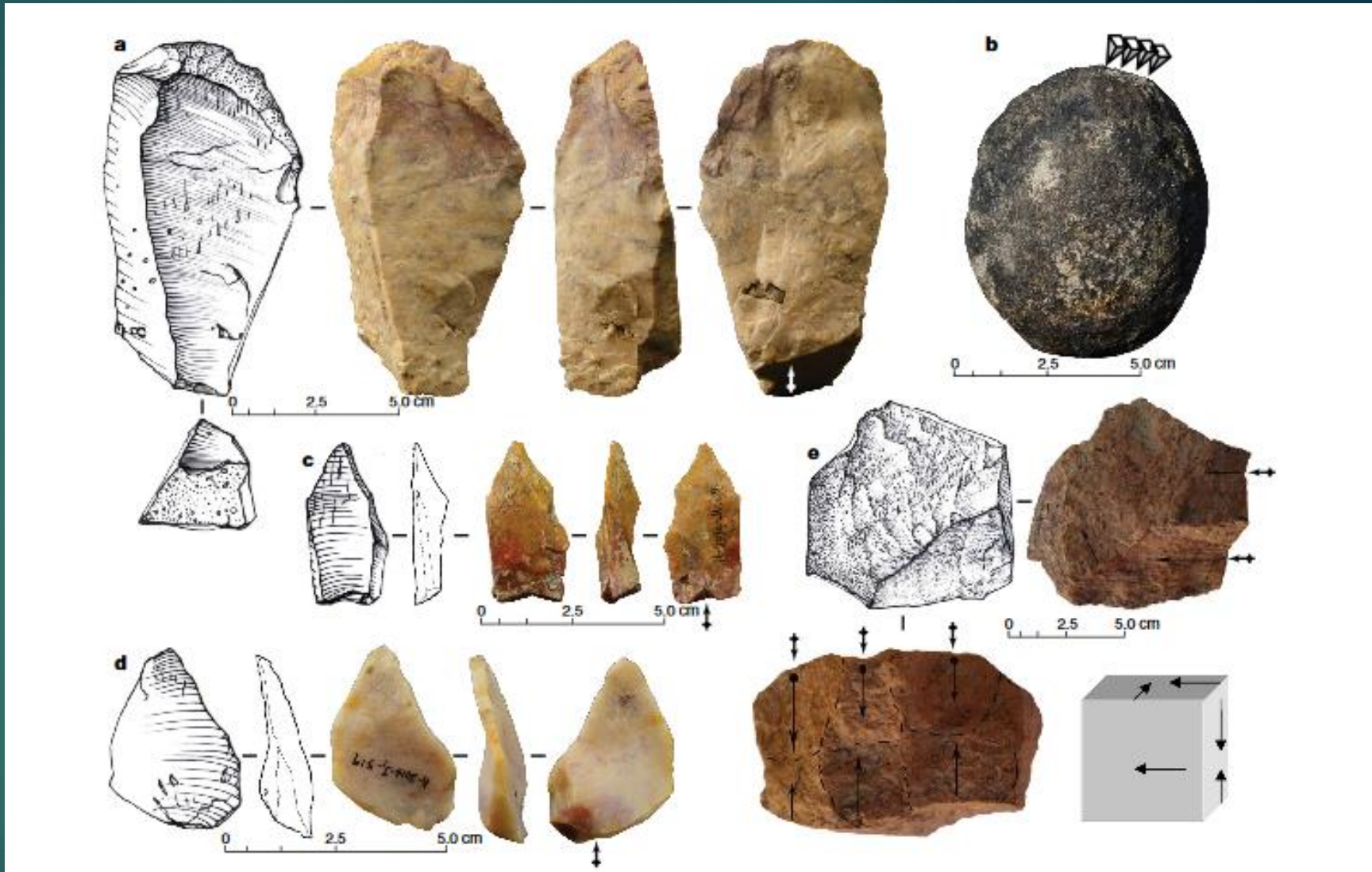


Fig. 2 | Lithic artefacts from Kalinga. a, Cortical flake on chert (II-2014-J1-362; length (L) = 100 mm, breadth (B) = 55 mm, thickness (T) = 33 mm). **b**, Possible hammerstone on dacite (II-2014-J1-371), although its highly eroded aspect precludes any definitive conclusion. Arrows indicate crushed areas interpreted as the result of precussions. **c**, Siret kombewa flake on jasper (II-2014-J1-391; L = 40 mm, B = 18 mm, T = 8 mm) that has a longitudinal and oblique fracture on the inferior two-thirds of the left side resulting from a knapping accident while flaking. **d**, Double-backed flake on flint (II-2014-J1-519). **e**, Core on quartz (II-2014-J1-396), with clear marks of knapping on an anvil, and its diachritic diagram. Arrows indicate the percusion axes.

H. erectus in Philippines?

- It has archaeologists wondering who exactly these ancient humans were (most likely bet is *H. erectus)* —and how they crossed the deep seas that surrounded that island and others in Southeast Asia (probably carried to distant islands by tsunami waves, or arrived there via floating islands of land and debris detached during typhoons)

T. Ingicco, et al., Science, 2018.

Homo luzonensis

Homo floresiensis may have been far from alone

2019

Homo luzonensis: History of the discoveries

- In 2011, discovery of more humanlike fossils, including teeth, part of a femur and hand bones, discovered on island of Luzon, Philippines.
- In 2015, they found two more molars, dated to 50 Ka.
- In 2019, after the discovery of 12 new specimens and based on the apparent presence of both modern-humanlike and primitive *Australopithecus*-like features, they reassigned the remains to a new species, *Homo luzonensis*, the species name deriving from the name of the island.
- Attempts to extract DNA from the remains were unsuccessful.

New species from Luzon: a mosaic

- Small-jawed with very small teeth, able to walk upright but with feet still shaped to climb, these island creatures were a mix-and-match patchwork of primitive and advanced features in a unique variation of the human form.

- On the basis of the unique mosaic of primitive fingers and toes (*Australopithecus*-like) and derived (*H. sapiens*-like) morphological features (molars) observed on these specimens, they assigned them to a new species, *H. luzonensis*.

- At least three individuals (2 right upper third adult molars & a juvenile femoral shaft)

2019: *Homo Luzonensis*, *50*-67 Ka, Callao Cave, Luzon, Philippines: Modern molars & ancient curved toes

- 3 individuals/13 specimens
- a: Type specimen: CCH6, maxillary right postcanine dentition of a single individual discovered in 2011
- Modern molars & ancient curved finger & feet bones
- 1 juvenile femur bone
- 4 feet tall??

Homo luzonensis

- A new analysis of the structural organization of the teeth of *Homo luzonensis* (from ~50 ka) finds more affinity to *H. erectus*

- Results suggest that both *H. floresiensis* and *H. luzonensis* likely evolved from some *H. erectus* groups that dispersed in the various islands of this region and became isolated until endemic speciation events occurred at least twice during the Pleistocene in insular environments.

Insular fossils are evidence that hominin evolution is not linear

- *Homo floresiensis* and *H. luzonensis* reminds us that evolution is not linear.

- While there has been a linear pattern in previous hominin brain size growth patterns and associated archaeological complexity in Indonesia and Africa, it is clear that smaller-brained hominins also evolved simultaneously.

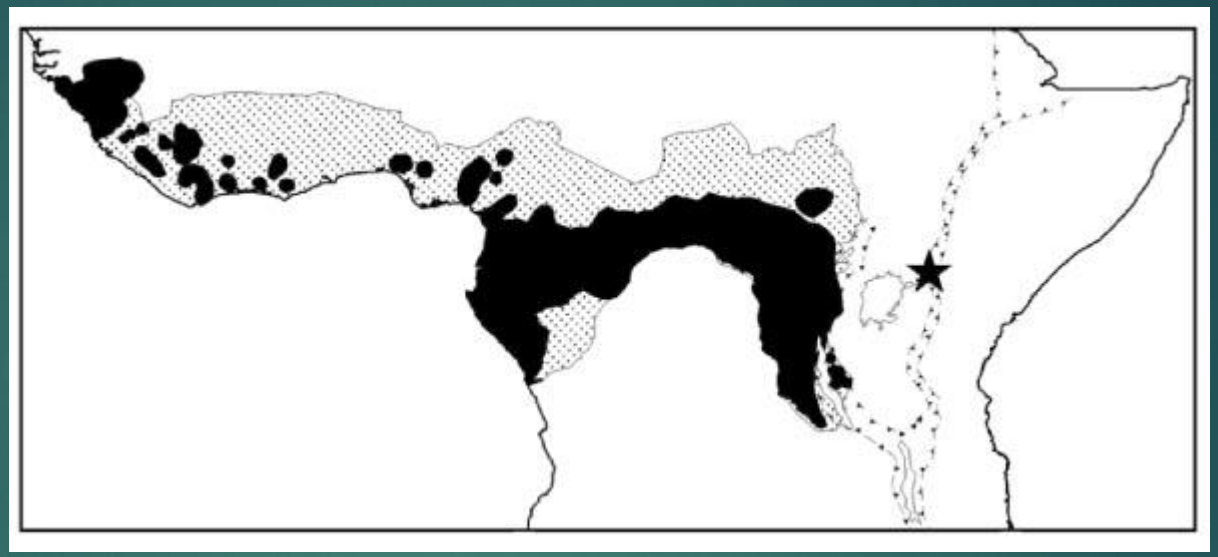
- It continues to challenge the outdated idea that the human line neatly progressed from less “advanced” to “more advanced” species; from smaller to larger brains

A question to ask CAS guests to HO

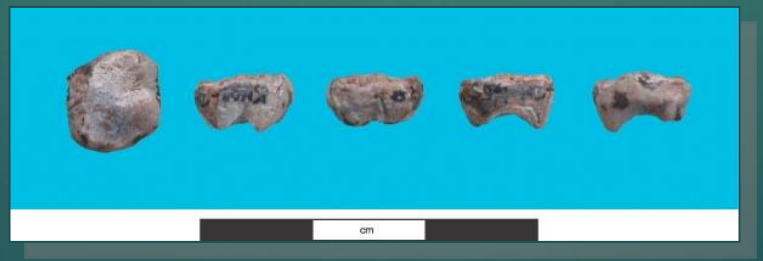
- Chimpanzees and humans separated 7 million years ago and have lived in African rain forests since then.
- We have a multitude of human ancestor fossil bones.
- How many fossilized chimpanzee bones do we have?

2005: First and only chimpanzee fossils, 545 Ka: 5 teeth

Sally McBrearty and Nina G. Jablonski, 2005



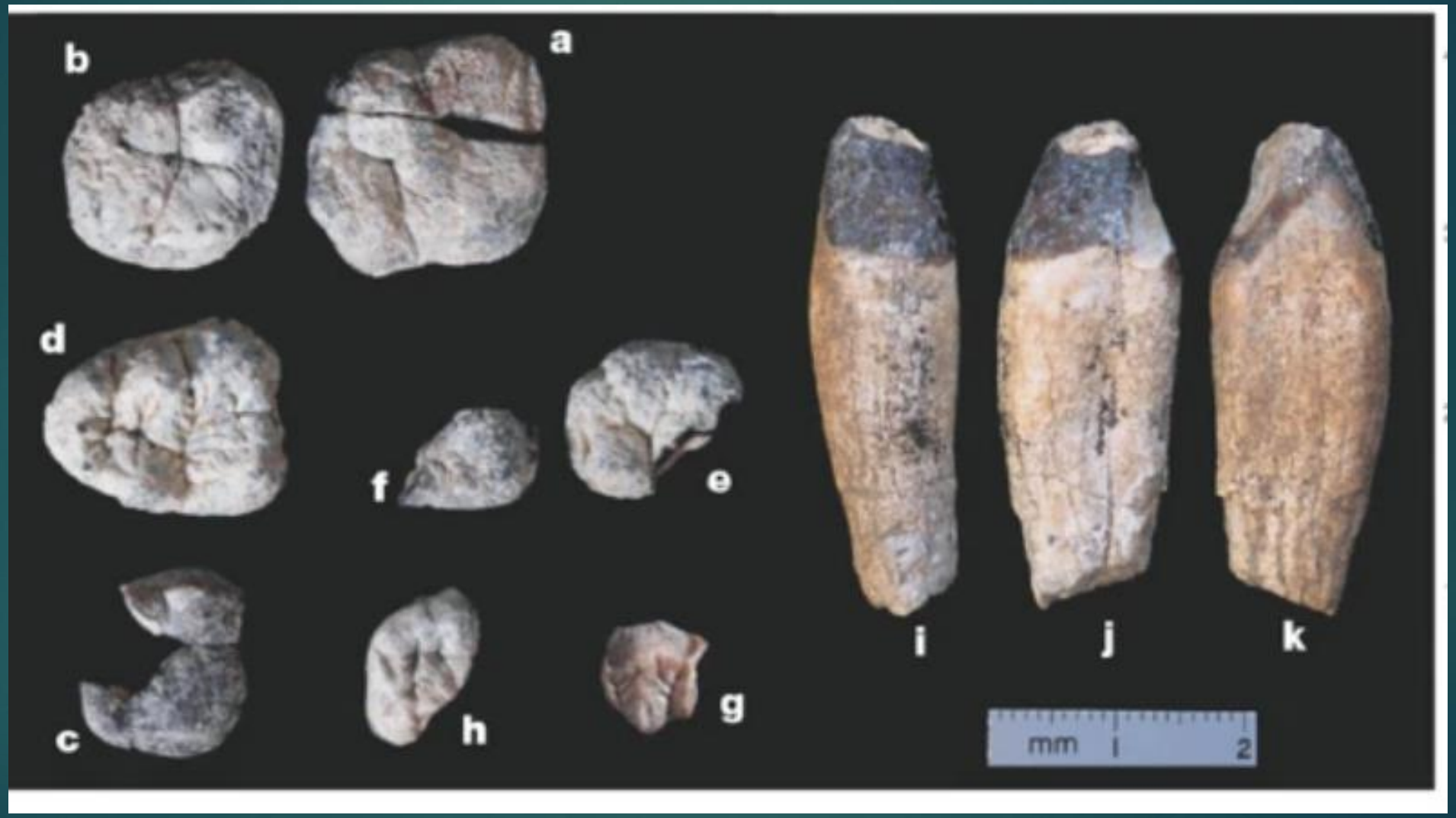
- First unequivocal chimp fossils dated to ~ 545 Ka. Contemporary with *Homo erectus* from the same site.



Nature **437**, 105-108 (1 September 2005)

- Bones rarely fossilized in rain forest & it's difficult to find them
- But remember that 7 M yo *Sahelanthropus* lived in a forest and was found when it became desert

Only Gorilla fossils:



Fossil Preservation: hominin vs chimp

- Fossil record for the chimp/bonobo clade is virtually nonexistent.
- But only 10% of Africa has been paleontologically explored.
- Not all environments are conducive to fossil perseveration; some are so acidic, like rain forest soil, that fossils rarely survive

Fossil perseveration

- The only panin fossil discovered evidence in the last 7 Ma consisted of a five-545-year-old isolated teeth from a site called Baringo, in Kenya.
  - 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.
- Bernard Wood is unconvinced by above arguments. Thinks fossils are out there but undiscovered.

Not just 1 fossil copy of Lucy's group

- Display of *A. afarensis* specimens
- By 2009, 400 specimens (96 skulls)
- Lots of repetition of same skeletal elements
- First family, AL 333:

  200 specimens, 13 individuals

Afar, Location 333

Lucy

Lucy redux: A review of research on *Australopithecus afarensis*", William H. Kimbel and Lucas K. Delezene, (2009)

Australopithecus, Kadanuumuu, 3.6 Ma

2010

"Big Man"

5'5" feet

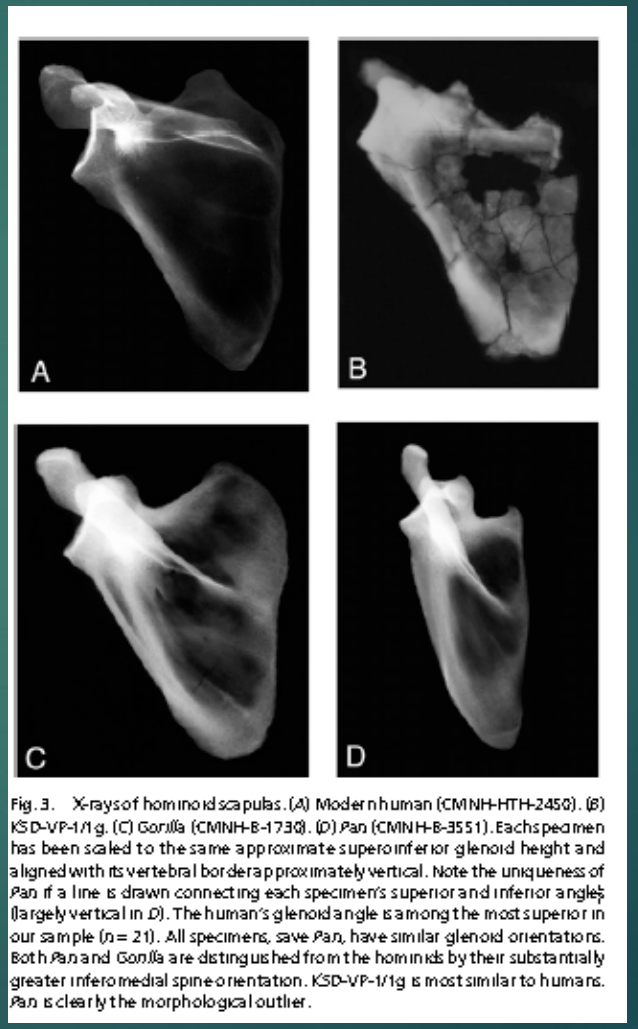


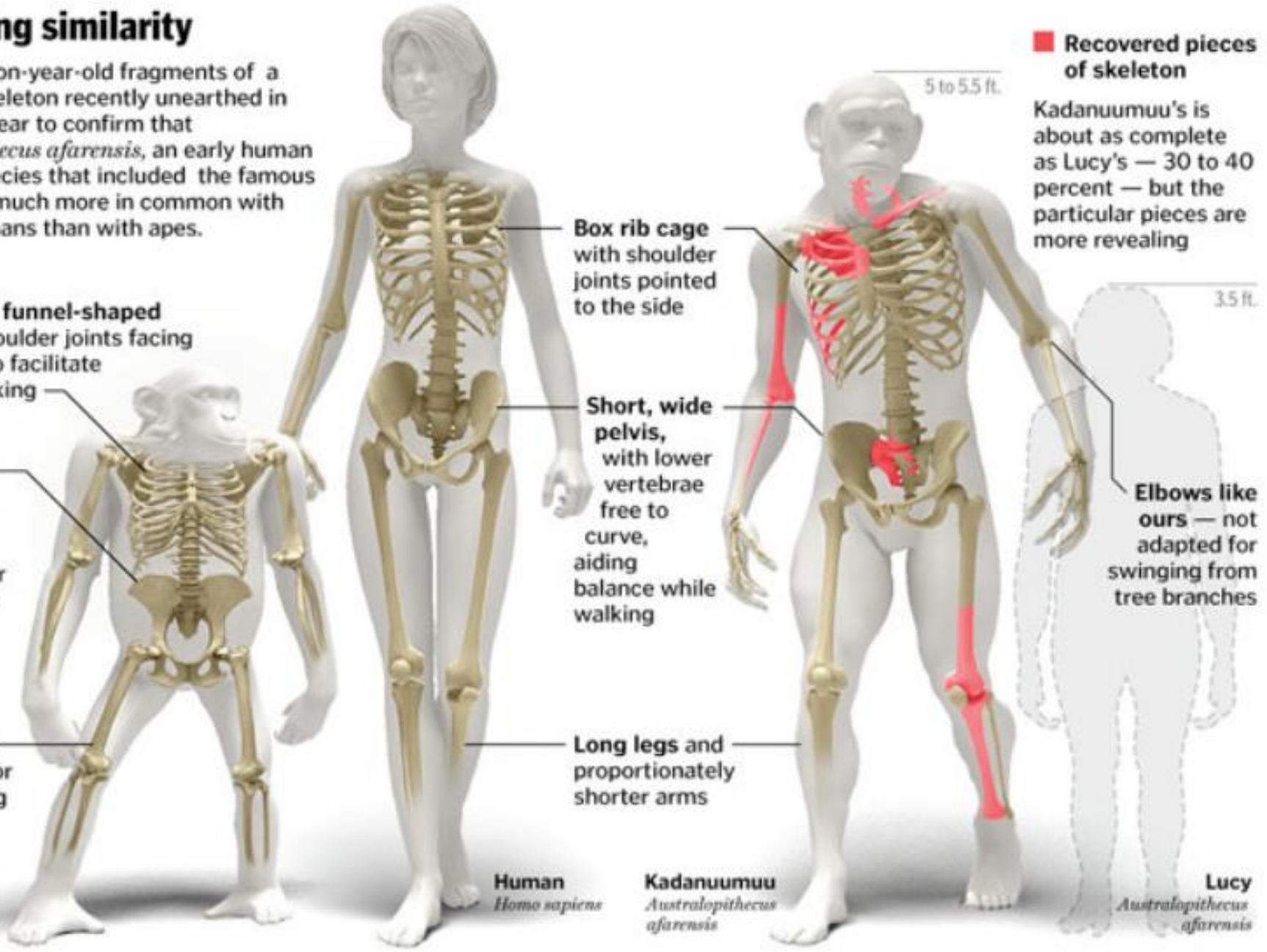
Fig. 3. X-rays of hominoid scapulas. (*A*) Modern human (CMNH-HTH-2458). (*B*) KSD-VP-1/1g. (*C*) *Gorilla* (CMNH-B-1730). (*D*) *Pan* (CMNH-B-3551). Each specimen has been scaled to the same approximate superoinferior glenoid height and aligned with its vertebral border approximately vertical. Note the uniqueness of *Pan* if a line is drawn connecting each specimen's superior and inferior angles (largely vertical in *D*). The human's glenoid angle is among the most superior in our sample ($n = 21$). All specimens, save *Pan*, have similar glenoid orientations. Both *Pan* and *Gorilla* are distinguished from the hominids by their substantially greater inferomedial spine orientation. KSD-VP-1/1g is most similar to humans. *Pan* is clearly the morphological outlier.

Spatula below (B); similar to humans

Yohannes Haile-Selassie et al. PNAS 2010;107:12121-12126

Surprising similarity

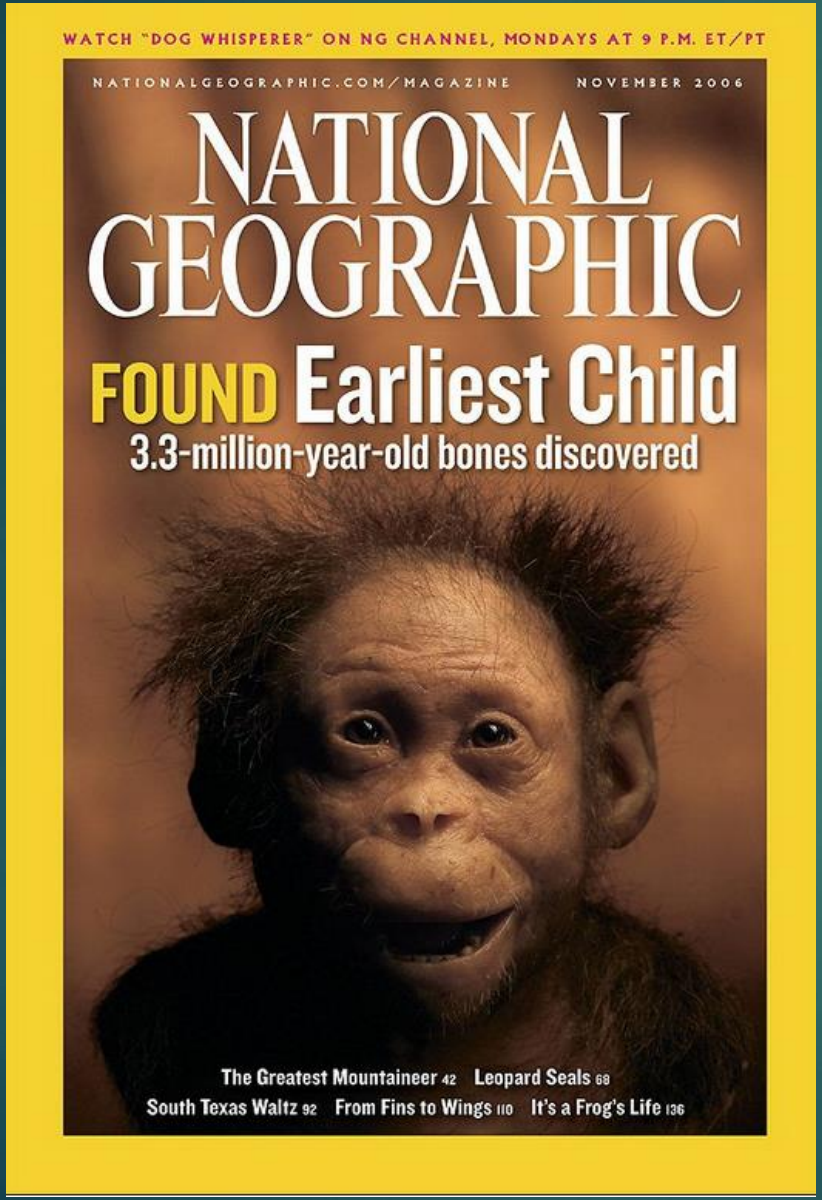
The 3.6 million-year-old fragments of a fossilized skeleton recently unearthed in Ethiopia appear to confirm that *Australopithecus afarensis*, an early human ancestor species that included the famous "Lucy," had much more in common with modern humans than with apes.



SOURCES: Interviews with Yohannes Haile-Selassie, Bruce Latimer, Owen Lovejoy

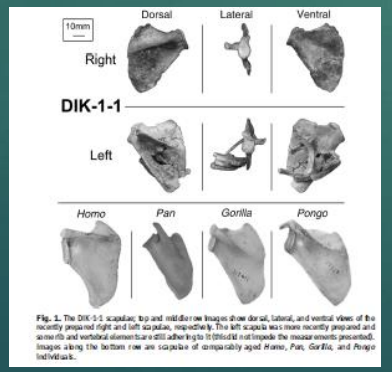
JOHN MANGELS, WILLIAM NEFF | THE PLAIN DEALER

Oldest fossil child at 3.3 Ma: Selam at Dikika, Ethiopia



Selam and Zeresenay Alemseged

2006: *A. afarensis*, Dikika, “Selam”, 3.3 Ma, 3 y o



2011: Shoulders

Did *Australopithecus afarensis* carve meat?

Evidence of Stone Tool Use and Meat-Eating in the Australopithecines:
Cut bone at Dikika at 3.4 Ma; but no tools
There were 12 cut marks on the two specimens

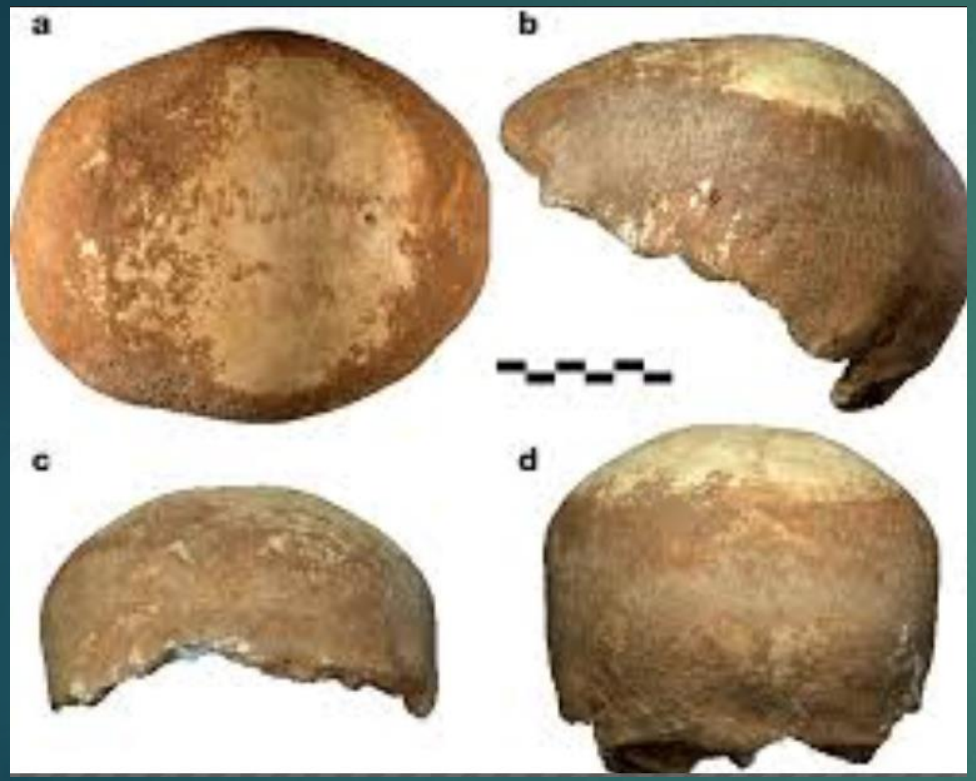
2015 studies confirms Zeray's butchery theory at 3.3 Ma

- Jessica Thompson study: Zeresenay Alemseged was correct about cut marks

- Analysis supports a previous finding, that the best match for the marks is butchery by stone tools (most closely resemble a combination of purposeful cutting and percussion marks, with tremendous force)
- Marks on two 3.3 Ma animal bones found at the site of Dikika, Ethiopia, were not caused by trampling,.
- Extensive statistical analysis in The *Journal of Human Evolution;* which developed new methods of fieldwork and analysis: examined the surfaces of a sample of more than 4000 other bones from the same deposits. Investigated with microscopic scrutiny all non-hominin fossils collected from the Hadar Formation at Dikika. They then used statistical methods to compare more than 450 marks found on those bones. Even investigated the angularity of sand grains at the site (round, not angular). Trample marks tend to be shallow, sinuous or curvy. Purposeful cuts from a tool tend to be straight and create a narrow V-shaped groove, while a tooth tends to make a U-shaped groove. The two cuts were made by tools.

Jessica C. Thompson, et al., 2015

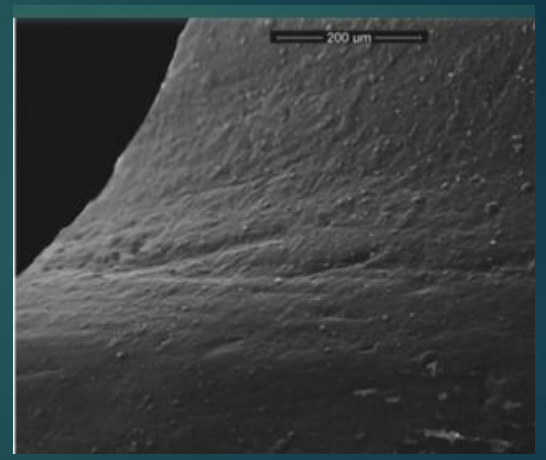
2008: Manot 1, Israel: a MH-N hybrid fossil cranium, 55 Ka



- Clearly Modern Human skull, but occipital bone projects backward into a bun-like structure, typical of Neandertals; a MH-N hybrid; older than Oase MH
- Evidence that modern humans lived side-by-side with Neanderthals
- First physical evidence that supports the Out of Africa theory

Many hominins used toothpicks

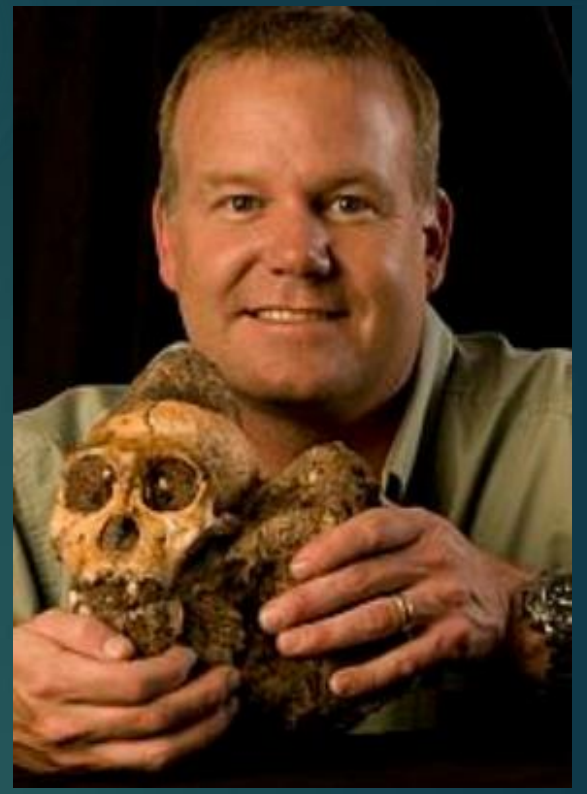
- The iconic OH 62 H*omo habilis*, Olduvai Gorge (Tanzania), joins the group of hominins where marks on the teeth have been observed by the use of small objects as "toothpicks", in a chronology as old as 1.8 Ma.
- Other examples with toothpick evidence:
- *Homo habilis* L 894-1, Shungura Formation, Omo (Ethiopia): 1.84 Ma
- *Homo ergaster* OH 60, Olduvai Gorge (Tanzania): 1.8 Ma
- *Homo erectus* , Dmanisi (Georgia): 1.77 Ma
- *Homo sp.* , Sima del Elefante, Atapuerca (Spain): 1.2 Ma
- *Homo erectus* Yiyuan (China): 420-320 Ka
- Sima de los Huesos, Atapuerca (Spain): 430 Ka
- *Homo neanderthalensis* , Krapina (Croatia): 130 Ka
- *Homo neanderthalensis* , El Sidrón (Spain): 49 Ka
- *Homo neanderthalensis* , Cova Foradà (Spain): 17 Ka



Australopithecus sediba
2008

Lee Rogers Berger (1965-):

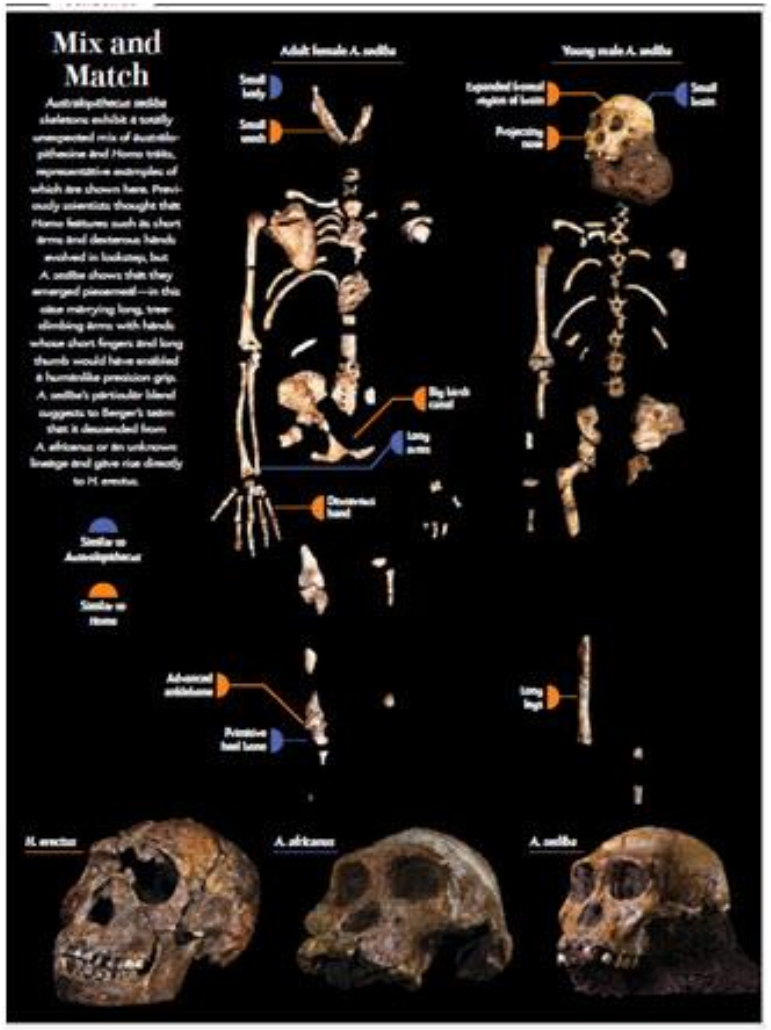
Australopithecus sediba, Taung Bird of Prey Hypothesis, *Homo naledi*



- American paleoanthropologist, physical anthropologist and archeologist
- University of the Witwatersrand
- 30 years of no major fossil discoveries
- 2008: son Matthew discovers *Australopithecus sediba*
- Taung Bird of Prey Hypothesis
- 2015: *Homo naledi*

Lee Berger loves press coverage

A. sediba discovery by 9-year-old boy, 2008

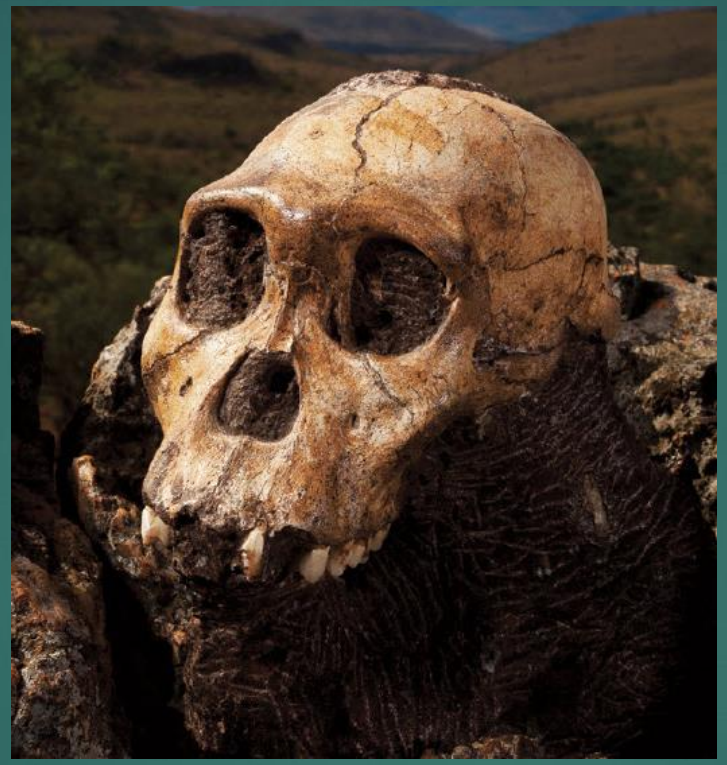


A. sediba, 1.9M, Malapa, South Africa, 2008

Matthew Berger, 9 Y old

2008: *Australopithecus sediba*, *1.98 Ma*, Malapa Cave, South Africa: not ancestral to MHs


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

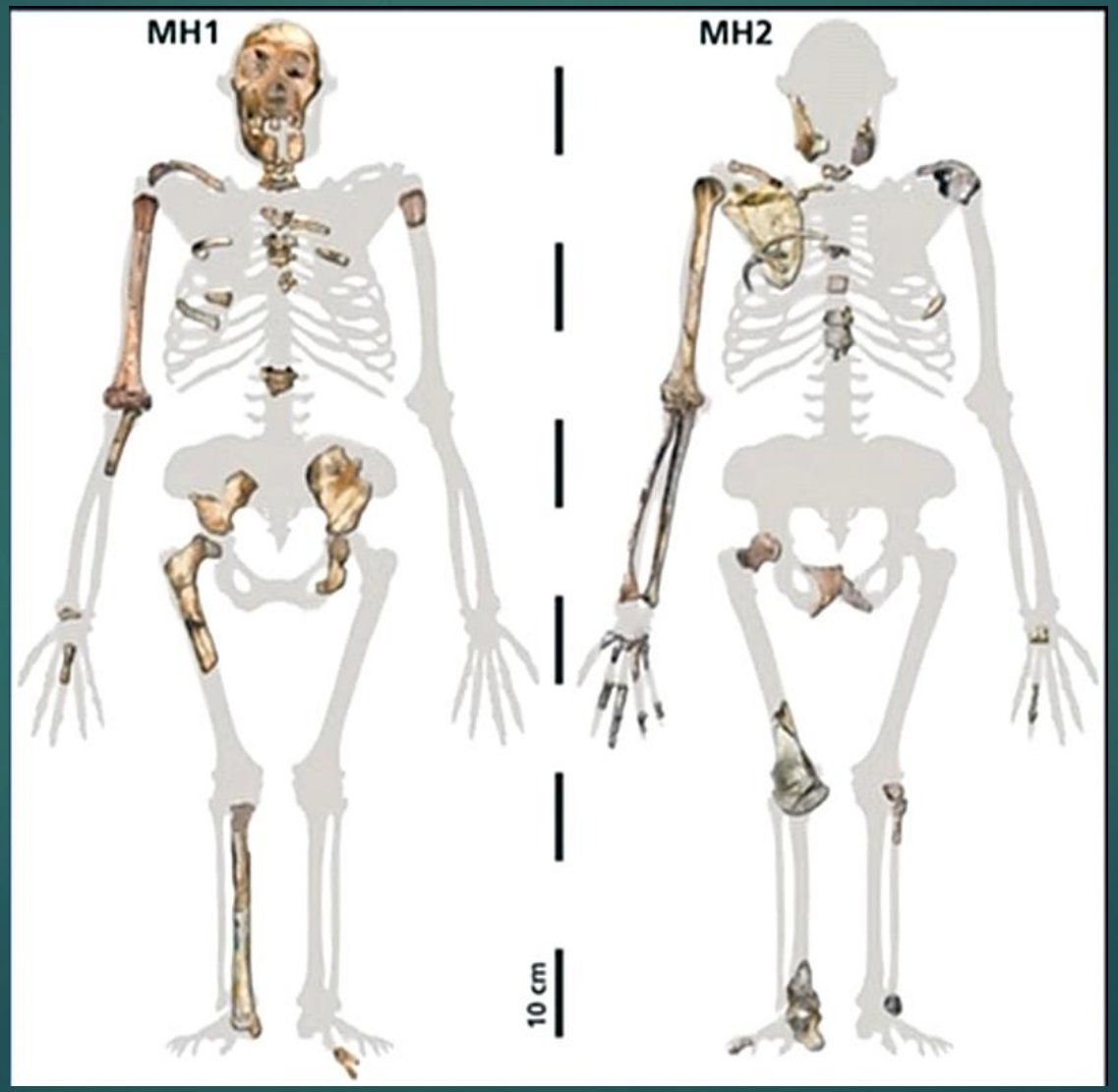


Australopithecus sediba
(LH1, type, cranium)
Discoverer: Matthew Berger
Locality: Malapa Cave, South Africa
Cranial Capacity: 420–450 cc

A. sediba: Mother and child, fatal fall; then buried in mud

Australopithecus sediba

Recent study: Kimbel thinks *Au. sediba* is a closely related "sister species" of *A. africanus*



2 partial skeletons, 2 Ma

Extremely small teeth, gracile face, small brain

Teeth more like us than *H. habilis*

MH1 and MH2

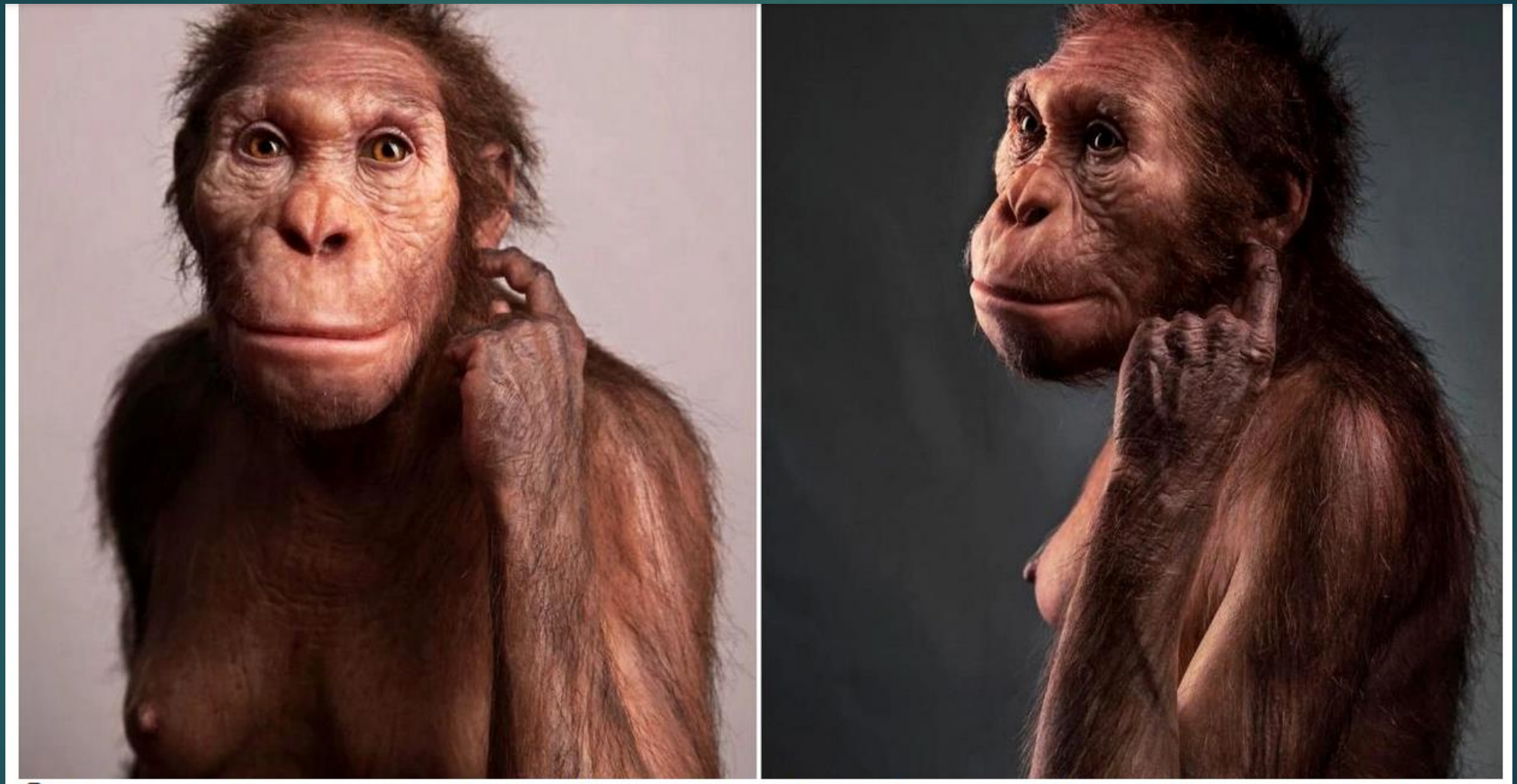
A. sediba: walked like a man, swung like a chimp

A. sediba's diet

- Teeth plaque or tarter: extraction of plant phytoliths (silica from plants) from dental calculus
- First direct evidence of what any australopith ate.
- Implies foods from closed, forested regions; like today's chimps.
- *A*lmost exclusive C_3 diet: tree leaves, fruits, wood and bark, grasses and sedges & fruits.

The diet of *Australopithecus sediba,* Amanda G. Henry et al., 2012

New reconstruction of *H. sediba* by E. Daynes



Life reconstruction of Australopithecus sediba, commissioned by the University of Michigan Museum of Natural History. (Sculpture: Elisabeth Daynes / Photo: S Entressangle)

2010 Discoveries: Start of the aDNA revolution, paleogenetics

- 2010: Neanderthal genome
- 2010: Denisovan genome - first hominin species discovered solely by DNA
- 1-2% N DNA in MHs; 5-6% D DNA in Melanesians & .2% in Asians & Native Americans; .3% N DNA in Africans
- Both from S. Pääbo's Leipzig Lab
- Will be presented in Part 2 on Paleogenetics incl. functional effects of N DNA in MHs

2015: Skin color of European hunter gatherers

- The original European hunter-gatherers, descendants of people who had come from Africa, had dark skin as recently as 9,000 years ago. Farmers arriving from Anatolia were lighter, and this trait spread through Europe. Later, a new gene variant emerged that lightened European skin even more.
- Why? While light skin helped capture more vitamin D in sunlight at high latitudes, early hunter-gatherers managed well with dark skin, because you can ger vitamin D in the type of meat you eat (Inuit have dark skin with a diet rich in vitamin D from organ meats of marine mammals).
- D. Reich thinks that it was the shift to agriculture, which reduced the intake of vitamin D, that lead to a change to lighter skin color.

Iain Mathieson, et al., 2015

2016: Fossil footprints from Laetoli, Tanzania, 3.7 Ma

Two different hominin species walked bipedally in this area 3.66 million years ago.

The famous Site G trackway is thought to have been made by *Australopithecus afarensis*.

Two to 4 individuals walked in muddy ash, leaving 69 stunningly humanlike footprints

The less known Site A trackway was made by a different, as yet unidentified hominin, with divergent big toe.

2 kilometers west of Site G

Originally thought to be bear tracks

2015: New Species: *Australopithecus deyiremeda: 3.4 MYA*

- In northern Ethiopia, around the same time and place (35 km from Hadar) as *Australopithecus afarensis*.
- *A. deyiremeda*: Lower jaw was beefier, and the teeth smaller, than Lucy's species
- Many consider these part of a variable population of *A. afarensis*

Yohannes Haile-Selassie, et al., 2015

Ethiopian Jaw Bone, Ledi-Geraru, (LD 350-1): 2.8 Ma – oldest genus *Homo fossil*

- 2.8 m-year-old jaw and five teeth was found at a site called Ledi-Geraru, 40 miles from where Lucy was found.
- Theory: At 3 Ma, the ape-like *Australopithecus afarensis* died out and was superseded by two very different human forms.
- One, called *Paranthropus*, had a small brain, large teeth and strong jaw muscles for chewing its food.
- The other was the *Homo* lineage, which found itself with smaller teeth & much larger brains

LD 350-1 mandible

Villmoare, et al., 2015

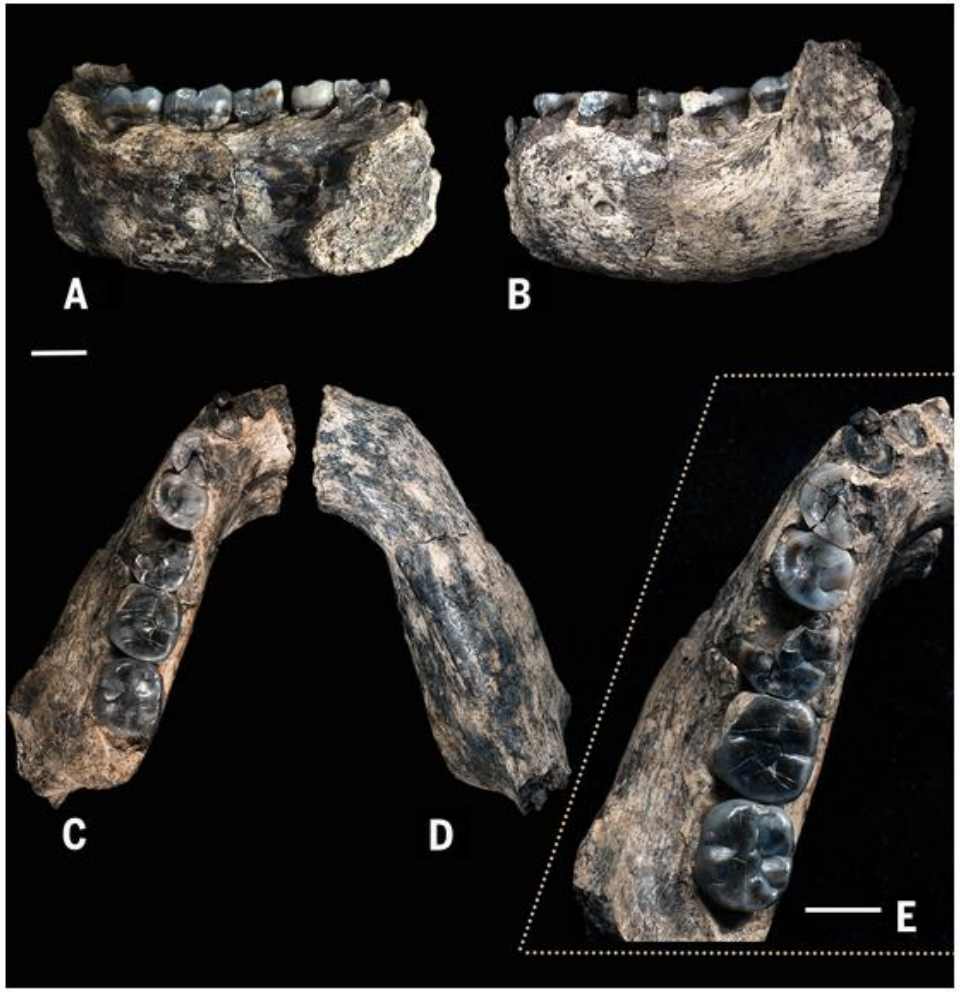
2015: Ledi-Geraru LD 350-1 mandible: 2.8 Ma

Jaw bone fossil discovered in Ethiopia is oldest known *Homo* lineage remains

Teeth becoming more slender than in *A. afarensis.*

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 (This will be challenged in 2023)

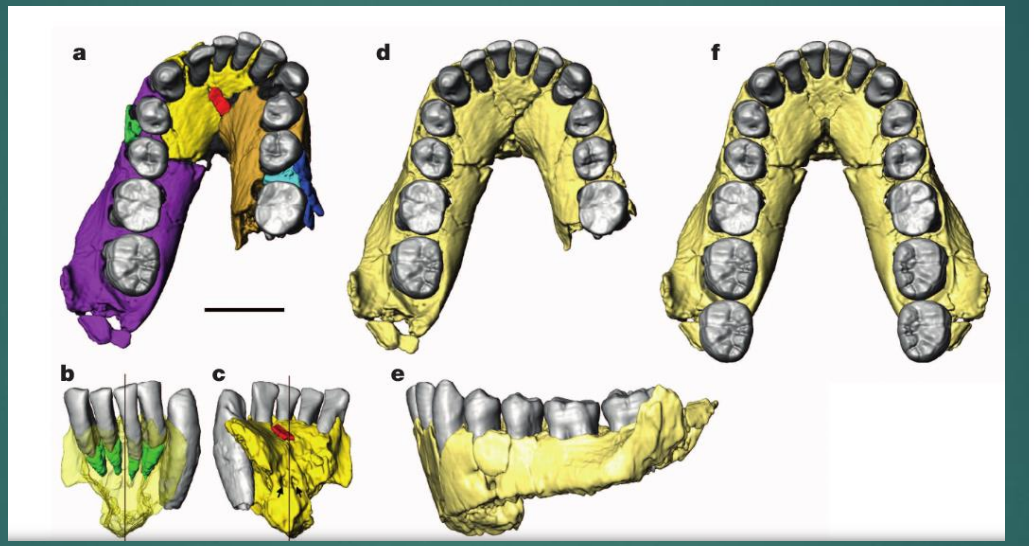


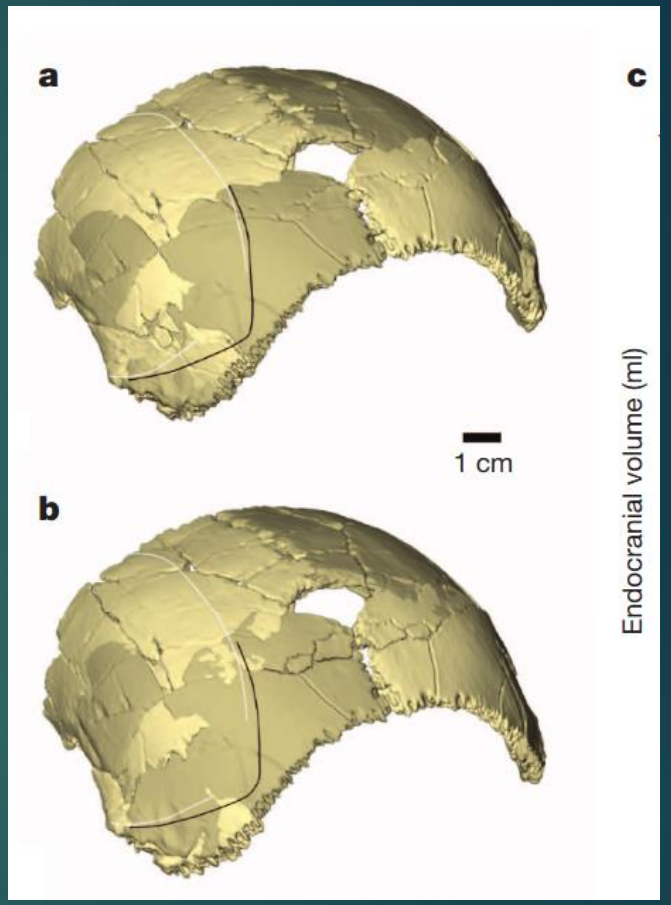
Five views of the fossilized jawbone highlight teeth that are becoming more slender, scientists say, relative to the blocky, more apelike teeth of *Australopithecus*.

Villmoare, et al., 2015

2015 - New digital reconstruction of *Homo habilis,* OH 7, 1.8 Ma (discovered 1960)

Cranial size of 729-824 cc



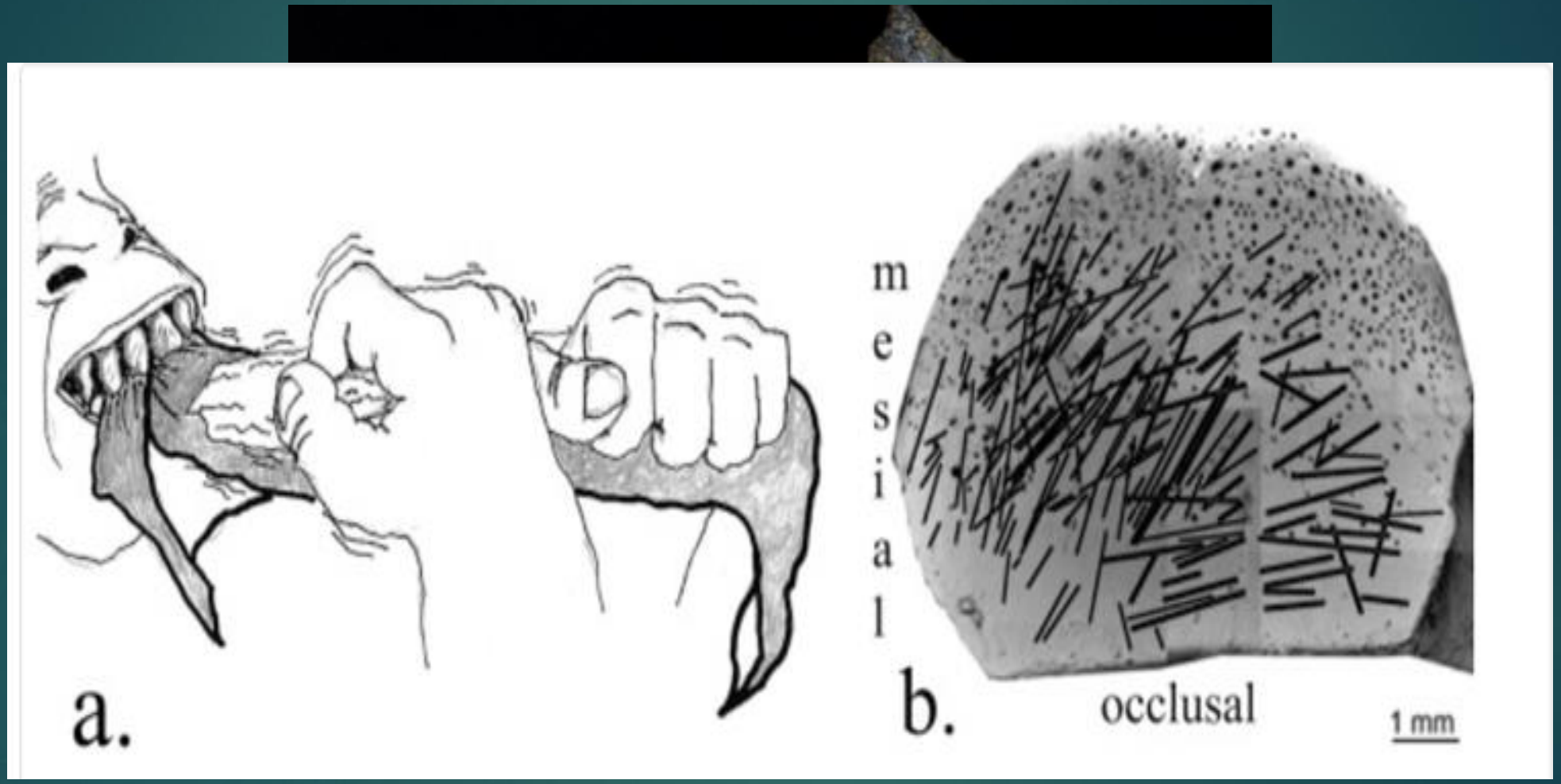


Mandible is remarkably primitive; more similar to *A. afarensis* than to *Homo erectus*

Homo habilis, early *Homo erectus* and *Homo rudolfensis* cannot be distinguished by their brain size, in contrast to their major differences in facial morphology

F. Spoor, et al., 2015

2016: *Homo habilis* was right-handed based on right oblique teeth marks



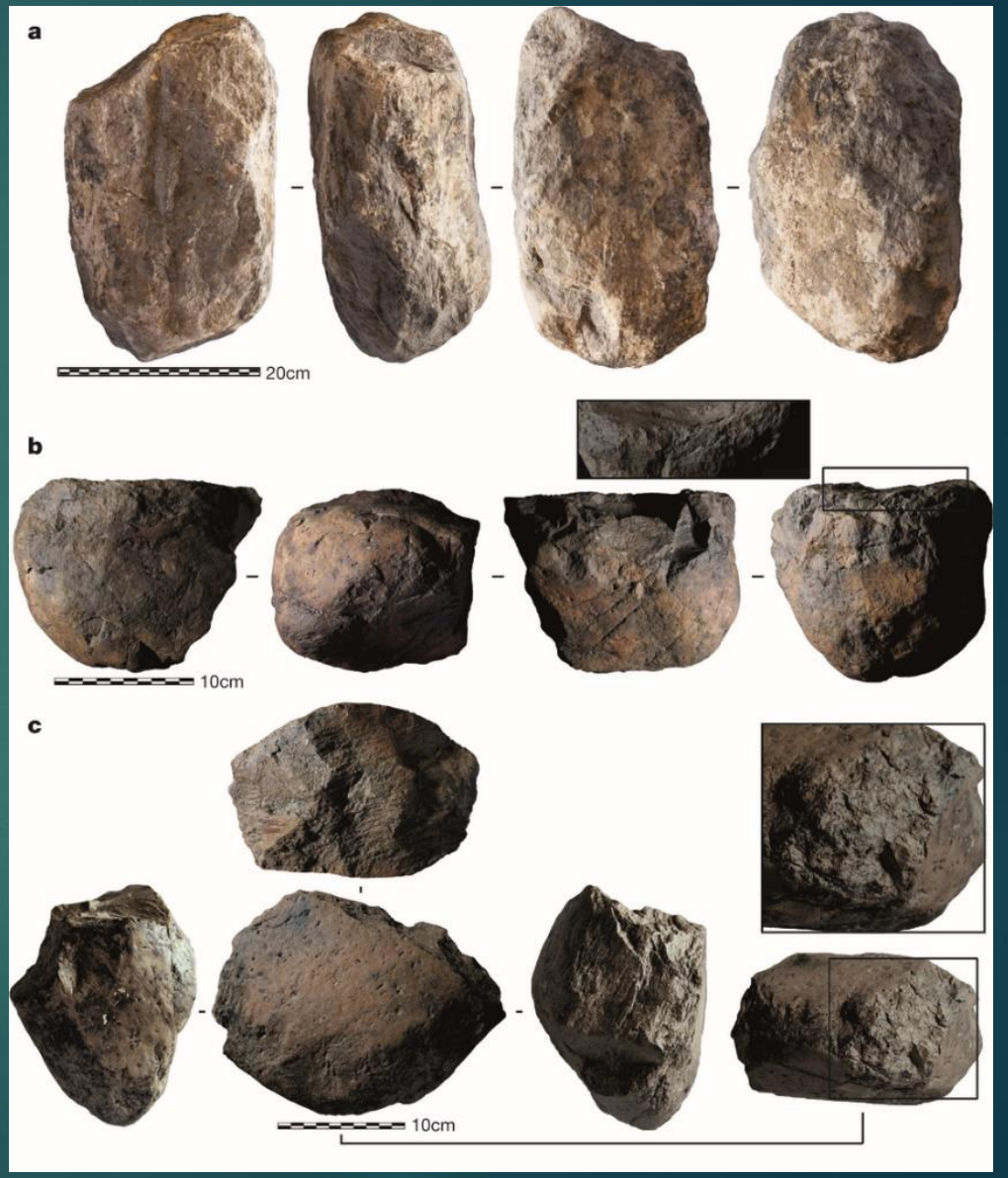
OH-65: The earliest evidence for right-handedness in the fossil record; 1.8 Ma; found 1995

D. Frayer, et al., 2016

2015: 3.3 Ma old “Lomekwian” stone tools

Stone tools, dated at 3.3 Ma, was made near Olduvai Gorge at the site Lomekwi 3, 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 modern chimpanzee stone tool-use behavior



Possibility of tool manufacture by hominins other than *Homo* before 2.8 Ma.

LOM3 predates the oldest fossil specimens attributed to *Homo* at 2.8 Ma from Ledi-Geraru, Afar, Ethiopia.

The only hominin species known to have been living in the West Turkana region at the time is *K. platyops*, while *Australopithecus afarensis* is found in the Lower Awash Valley at 3.4 Ma in association with cut-marked bones from Dikika

2015: First MH migration to South China, 40 teeth, 120-80 Ka, *H. sapiens*

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

Wu Liu, et al., Nature, 2015

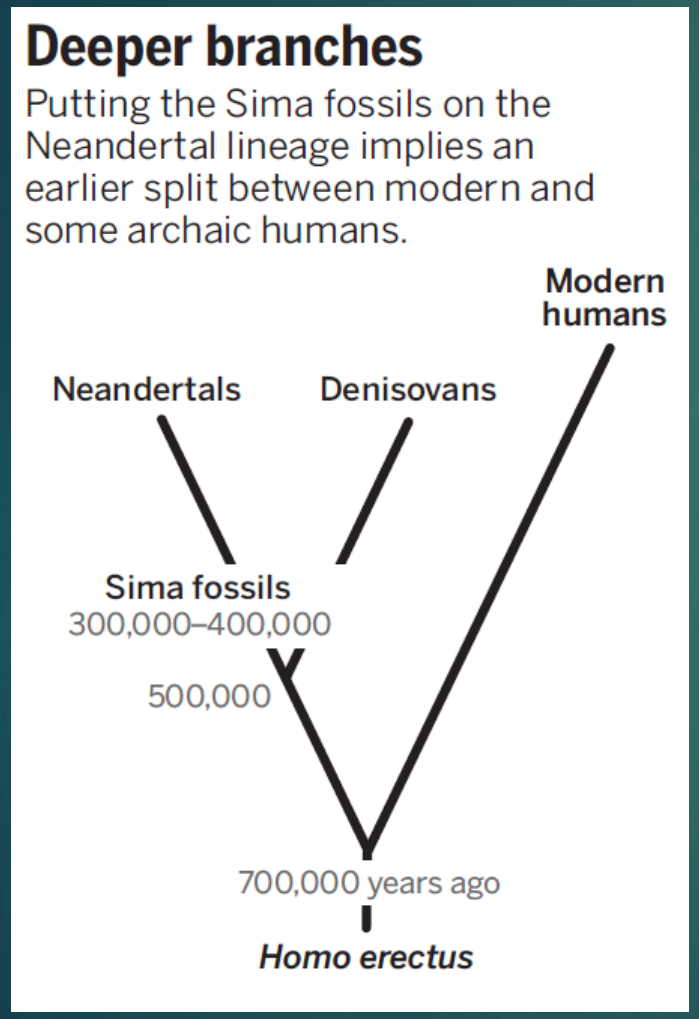
2015: Sima de Los Huesos (Pit of the Bones) in Spain: 426 Ka – oldest dated hominin DNA = Neandertal, not *heidelbergensis*

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

Sima de Los Huesos

- Originally thought fossils belonged to *Homo heidelbergensis*:
- Skeletal remains carry Neandertal-derived features;
- Original mitochondrial study = distant Denisovan ancestry;
- 2015 nuclear study = Neandertal ancestry.
- Sima de los Huesos hominins were indeed early Neandertals

Means an earlier divergence date for Neanderthals & MHs



- Sima de los Huesos: *H. neanderthalensis* dated to 426 Ka: it is oldest dated *Homo* DNA
- Indicates that the population divergence of the "modern human lineage from archaic humans" (Ns and Ds) = 550 to 750 Ka
- Divergence of Ns and Ds = 381 to 473 Ka

R.I.P. for *H. heidelbergensis*

- Historical theory*: Homo heidelbergensis* represents a transitional phase between the earlier *Homo erectus* and modern humans and Neanderthal

- *H. heidelbergensis* has been thought of as the ancestor of both *H. sapiens* and *H. neanderthalensis*

- Dates typically given as 700 to 200 Ka

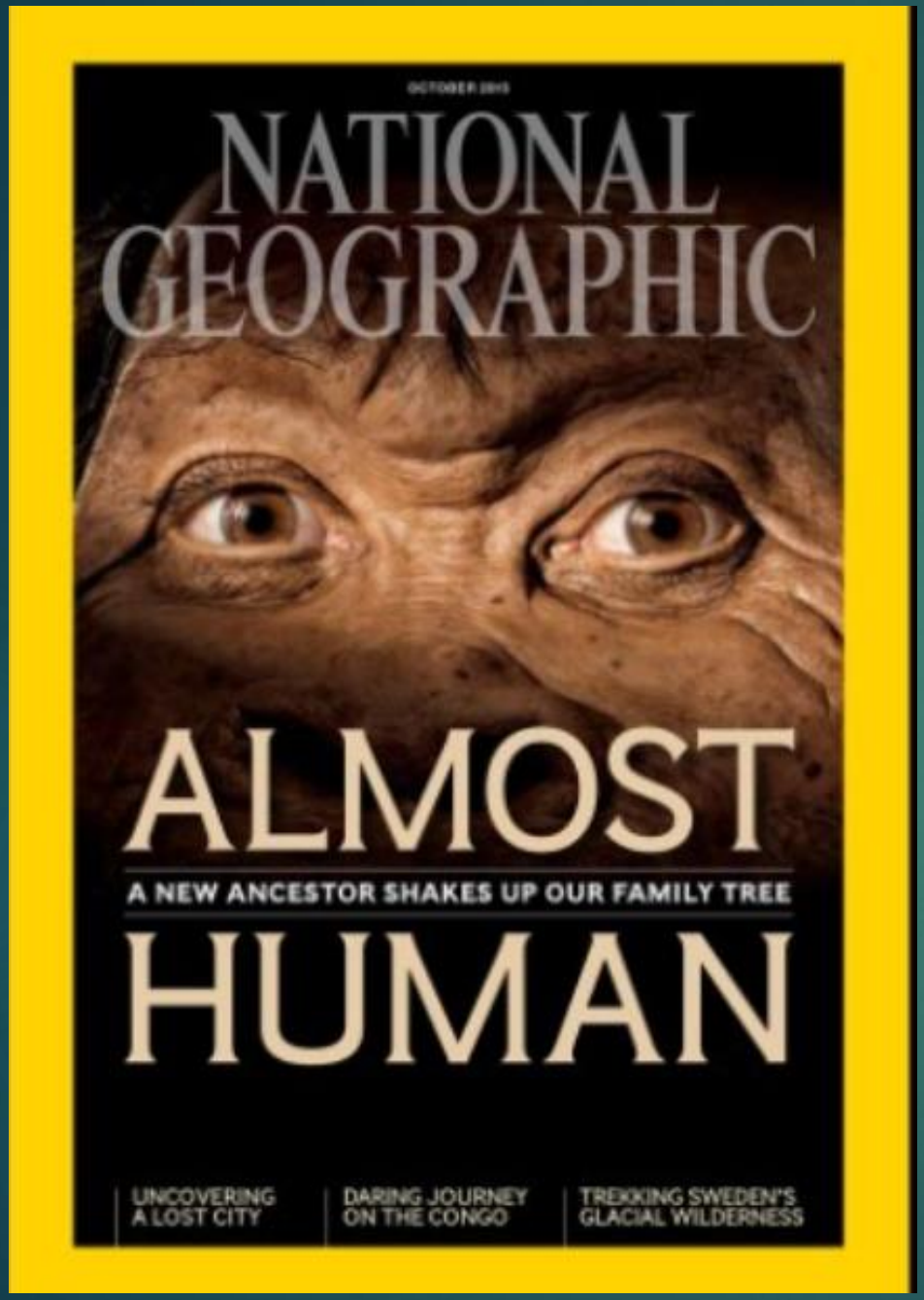
H. heidelbergensis

- But there has been increasing controversy as to the specificity of this species: too many varying morphological types

- Given the new datings of Broken Hill skull at 300 Ka and of Jebel Irhoud at 315 Ka, Chris Stringer and J. Hublin now believe *H. heidelbergensis* is the ancestor of only *H. neanderthalensis* in Europe and not *H. sapiens* in Africa

- Advent of Multiregionalism theory of *Homo sapiens* in Africa as alternative

Homo naledi
2015



2015 - *Homo naledi*

2015: More than one way to be human

Homo naledi, a new species of the genus *Homo* from the Dinaledi Chamber, Rising Star Cave, South Africa

- "The King Tut's Tomb of Paleoanthropology"
- "One of the most staggering finds in the history of paleoanthropology"
- Discovered by Lee Berger's team at the University of the Witwatersrand

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

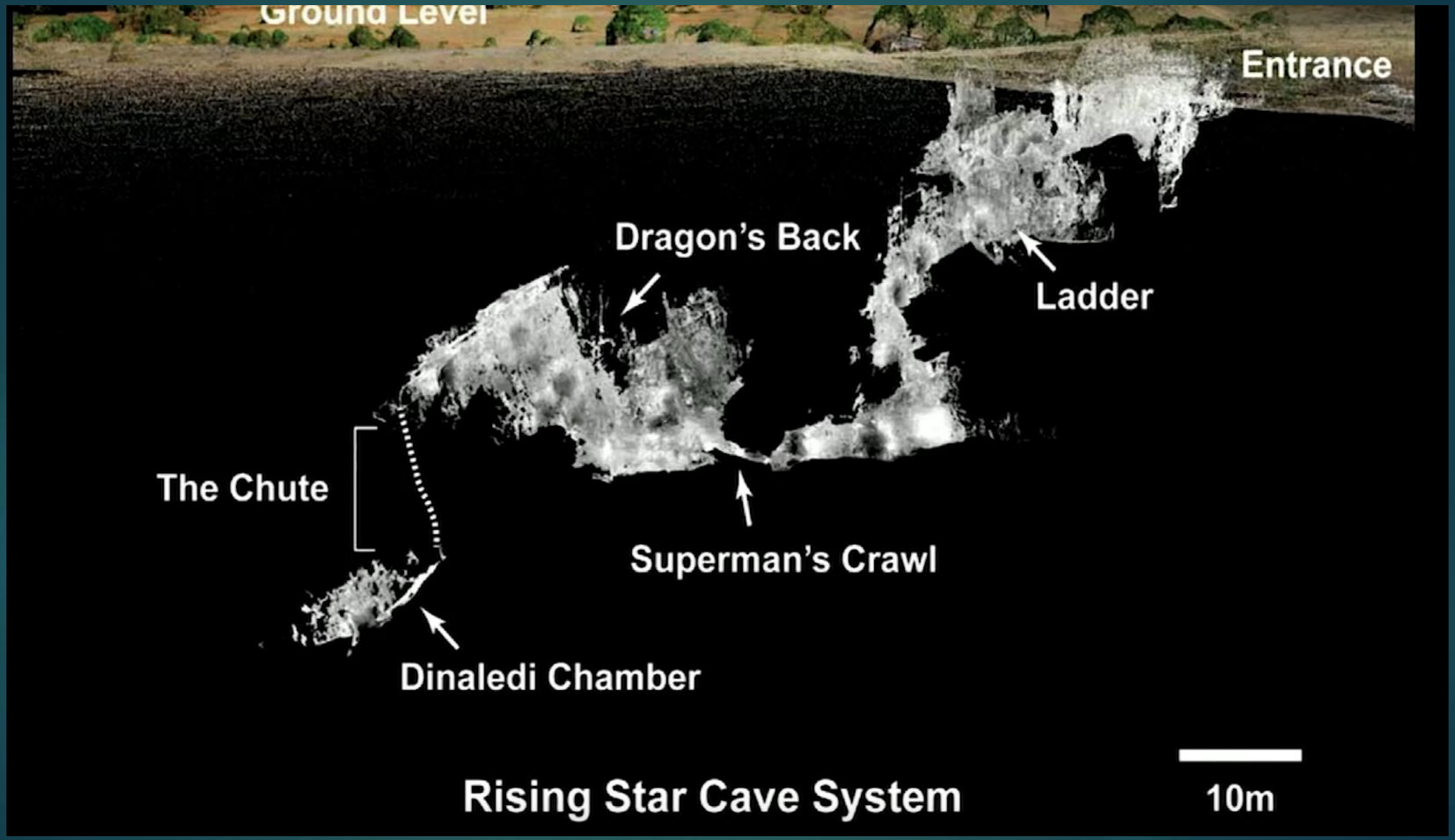
Homo naledi

- The Dinaledi collection is the richest assemblage of associated fossil hominins ever discovered in Africa
- It has one of the most comprehensive representation of skeletal elements across the lifespan, and from multiple individuals, in the entire hominin fossil record.
- For comparison, 50 years of excavations at Olduvai = 100 hominin fossils
- H. naledi has doubled the total African fossil record.

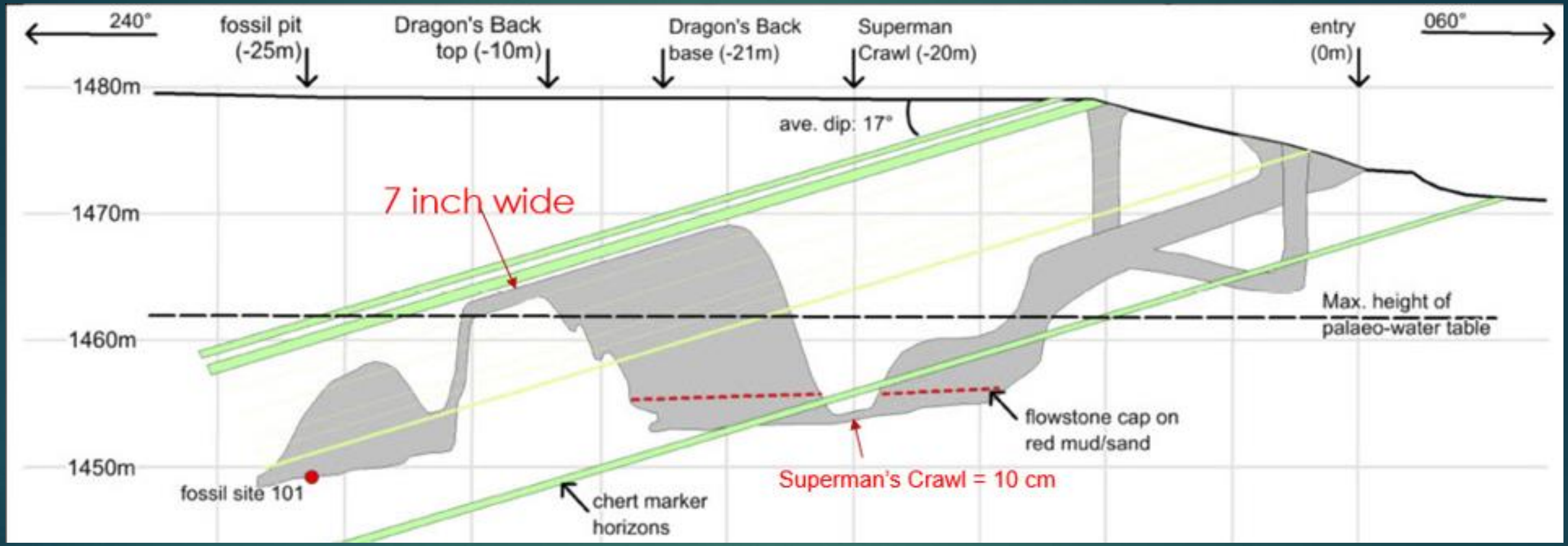
Homo naledi

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

Rising Star Cave, Dinaledi Chamber


Ground Level
Entrance
Dragon's Back
Ladder
The Chute
Superman's Crawl
Dinaledi Chamber
Rising Star Cave System
10m

2013: Rising Star Cave in South Africa: Discovery of *Homo naledi*



One passage is 50 feet long and 7 inches wide

Tunnel: Only seven inches wide for 50 feet

2 Spelunkers in 2013:
Steve Tucker, an accountant
Rick Hunter, a Mensa member, who was kicked out of high school for blowing up a chemistry lab; a construction worker

Rising Star Cave on one evening; after 4 hours of cave exploring; Steve rests on and then descends the Chute

At end of the Chute descent: first time, no rope

Steve Tucker: First Descent

Prior discovery

- Steve and Rick were not the first ones in the Dinaledi cave.

- Among all of the fossils, they found old survey pegs left behind in this chamber, and evidence that some of the fossils on the floor surface had been moved and broken (white ends).

- Instead of dispatching a lithe paleoanthropologist with caving experience, Berger next sent his son Matthew, age 14, down with Tucker and Hunter.

First sight, 2013: bones on surface

Recent dead human?

Berger sent
this photo
to John Hawks &
Steve Churchill.

Facebook: American Association of Physical Anthropologists
October 6, 2013

- “Dear Colleagues,
- I need the help of the whole community to reach out to as many related professional groups as possible. We need...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. They must not be claustrophobic, they must be fit, they should have some caving experience, climbing experience would be a bonus. They must be willing to work in cramped quarters, have a good attitude and be a team player....we will cover flight…field accommodations, food…[no pay!]
- Anyone interested please contact me directly...”

- Many thanks
- Lee Berger

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

- Successful candidates had to come to Johannesburg immediately and accept a blind mission, for no pay.
- 60 applicants, not all women
- Berger’s secretary: “What are you doing?” “I have a bunch of messages from women giving me their body dimensions!”
- On site on Nov. 7th. 20 canvas tents. For 21-day dig. National Geographic and PBS Nova crew.
- Used 3D Artec Scanner with 0.1 mm resolution to map entire Chamber, as well as every time they removed a fossil from soil for absolute location. 3 ½ km of military grade video and audio cabling.

Underground astronauts of the Dinaledi Chamber

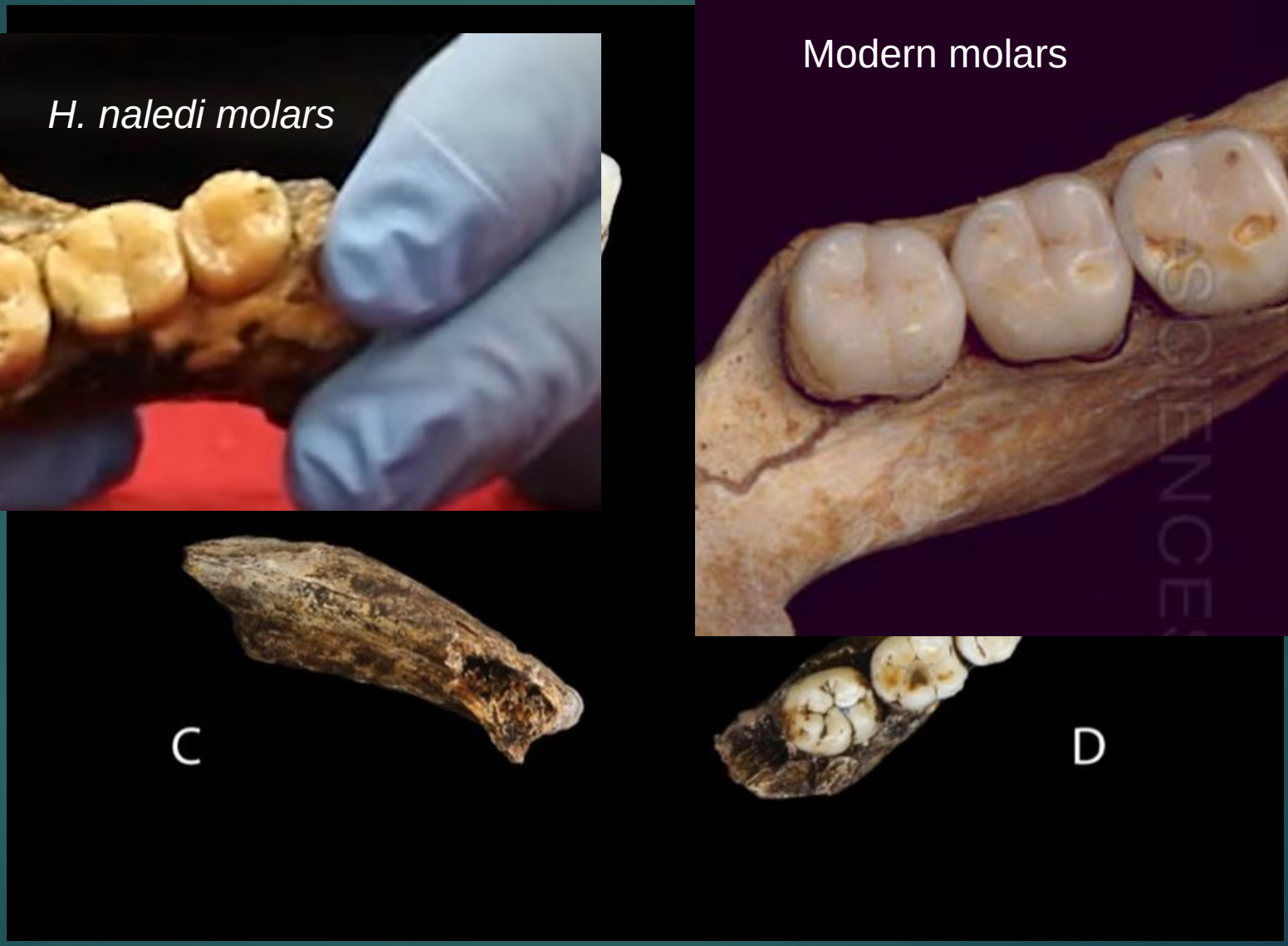
All 6 were larger than largest *H naledi* males.

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. All worked for free.

They brought out the largest assemblage of fossil human relatives ever discovered in the history of the continent of Africa.

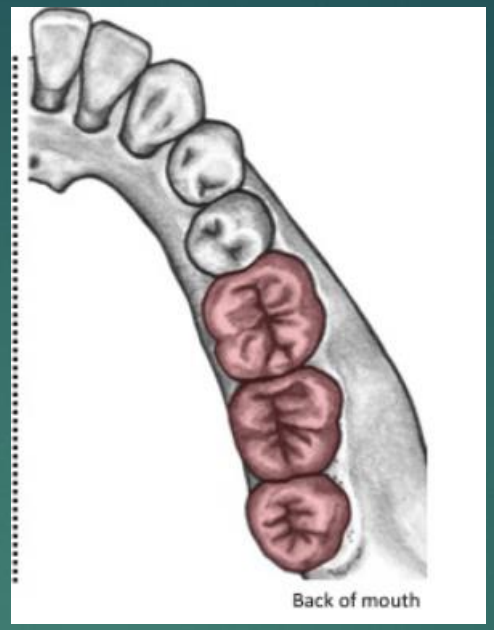
Lee Berger (& J. Hawks) were too big to fit in cavern; so supervised it all on HD TV monitor.

Molar progression was clue



Teeth

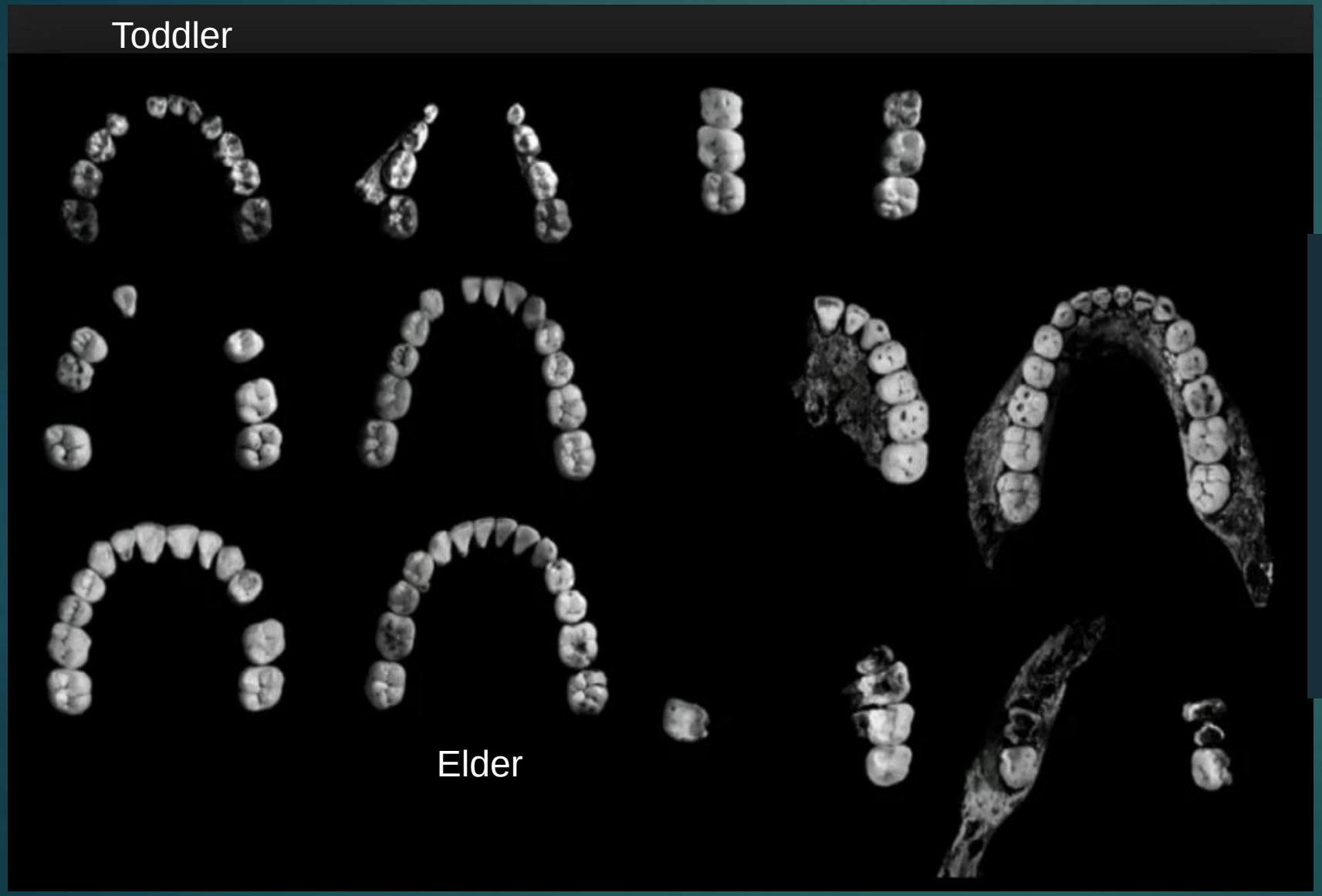
- In MHs: 3rd molar is smallest and 1st molar is biggest



- *Homo naledi* has ancestral condition, 3rd molar is largest and 1st molar is smallest

- Anterior teeth are small in genus *Homo*

190 Teeth: multiple complete sets



Infants (top left) to very old (30s) (bottom right)

Chipped teeth

CHIPPED OFF: Tooth damage sustained by *Homo naledi,* resulted from a diet heavy on hard or gritty objects.
One likely chip culprit: dirt-covered, nutritious underground plants such as tubers.
Similar to baboon chip pattern

Silt, not concrete like breccia: Toothpicks, not pneumatic hammers

Climbing in and out twice a day resulted in…

Majority of analysis team were early career paleontologists

September, 2015 – The Big Announcement

The New York Times

Thursday, September 10, 2015 Today's Paper Video 75°F CAC 40 -0.71%

World U.S. Politics N.Y. Business Opinion Tech Science Health Sports Arts Style Food Travel Magazine T Magazine Real

Afghans See U.S. General as Crucial to Their Defense

By ROD NORDLAND and MUJIB MASHAL 5:00 AM ET

Although Afghanistan's forces and officials are supposed to be running the war, Gen. John F. Campbell's prominent role is being widely taken as a sign that the fight against the Taliban is not going well.

Justice Dept. to Put Focus on White-Collar Criminals

By MATT APUZZO and BEN PROTESS

New policies prioritize the prosecution of individual employees and put pressure on corporations to turn over evidence against their

A reconstruction of the skull and hand of Homo naledi, a human ancestor discovered in South Africa.
Naashon Zalk for The New York Times

A New Species of Human Ancestor Is Found

By JOHN NOBLE WILFORD 5:02 AM ET

A cave in South Africa yielded the discovery of a previously unidentified member of the early human lineage — Homo naledi, a new hominin species who seem to have buried their dead.

Your Thursday Briefing

By ADEEL HASSAN 59 minutes ago

Here's what you need to know to start your day

The Opinion Pages

A Senseless Delay on the Iran Deal

By THE EDITORIAL BOARD

Republicans seem determined to drag out the fight, even it means neglecting other business.

- Blow: Hillary Is Hobbling, for Now
- Obama's Syrian Nightmare
- Collins: A Presidential Primary Cheat Sheet

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- Kristof: Com
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- Op-Ed: A Sm
Raise Psych
- Join us on F

Watching

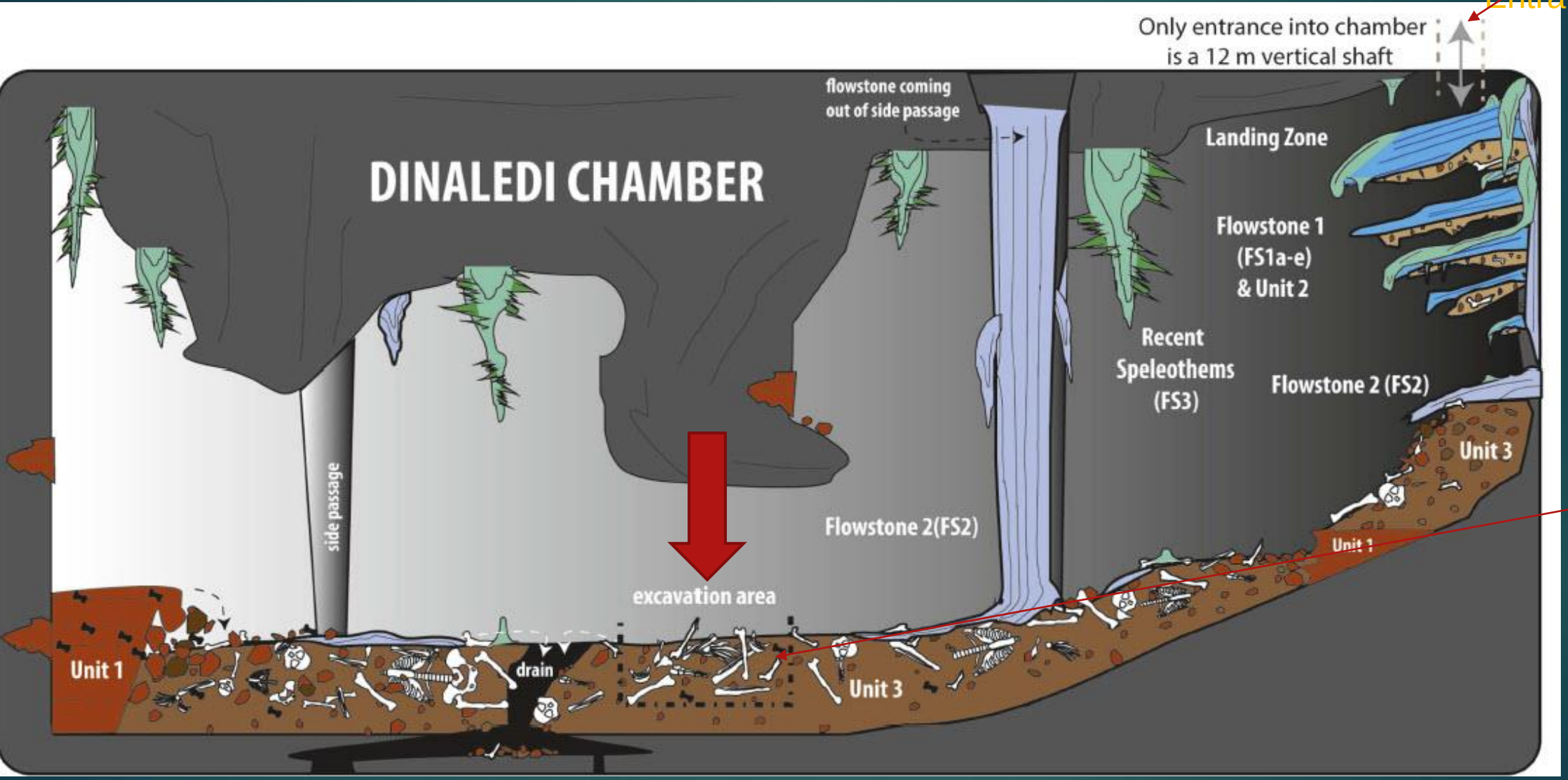
7h BMI, the music licensing agency, plans to an
exceeded **$1 billion** in annual revenue for th
The New York Times

8h A 21-year-old New Jersey man pleaded guilty
court to planning to travel abroad with other
York and New Jersey to **join the Islamic Sta**
The New York Times

You can 3D Print your own 96 bones from *H. naledi*

- http://morphosource.org/index.php
- Anyone can sign up for a free login and download the shape files, and print them out
- To 3D print other hominin fossils, files at: http://africanfossils.org/

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



Only Entrance

Red unit 1 is Oldest; no bones

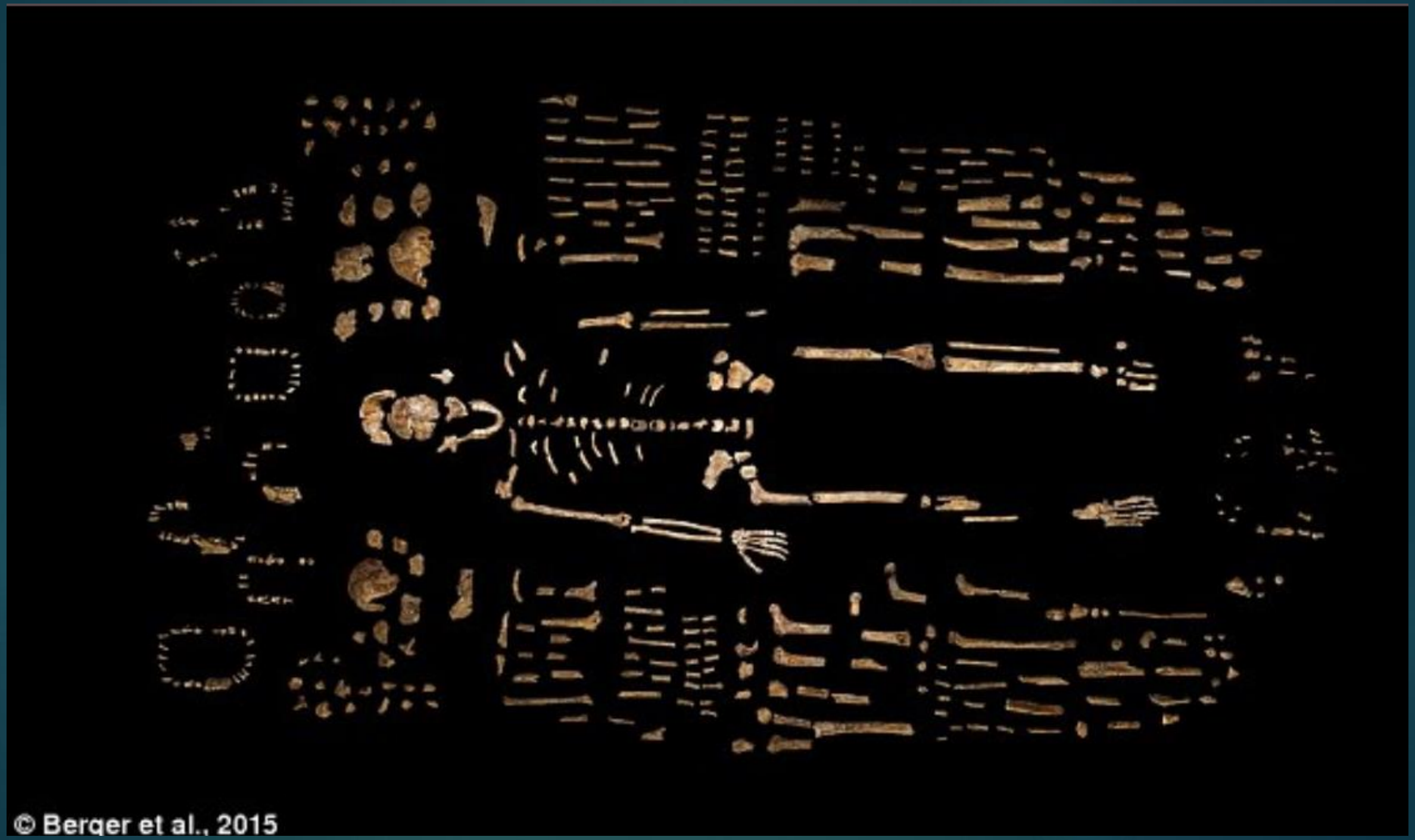
1 square meter excavation area

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

3D lasered the entire chamber; 30,000 photos of location of bones

2014: *Homo naledi:*

- 15 separate individuals in1550 bones:
  - collected in first sweep of surface (400 bones)
  - an excavation of 1 square meter x half a foot (1150 bones)
- 737 partial or complete anatomical elements
- As of 2022, 25 individuals; 2000 bones
- Sterkfontein: 700 bones in 70 years


© Berger et al., 2015

Homo naledi: Multiple samples of same bone

Parts of 5 Skulls. Jaws.

150 hand bones
48 rib bones
40 pelvic bones

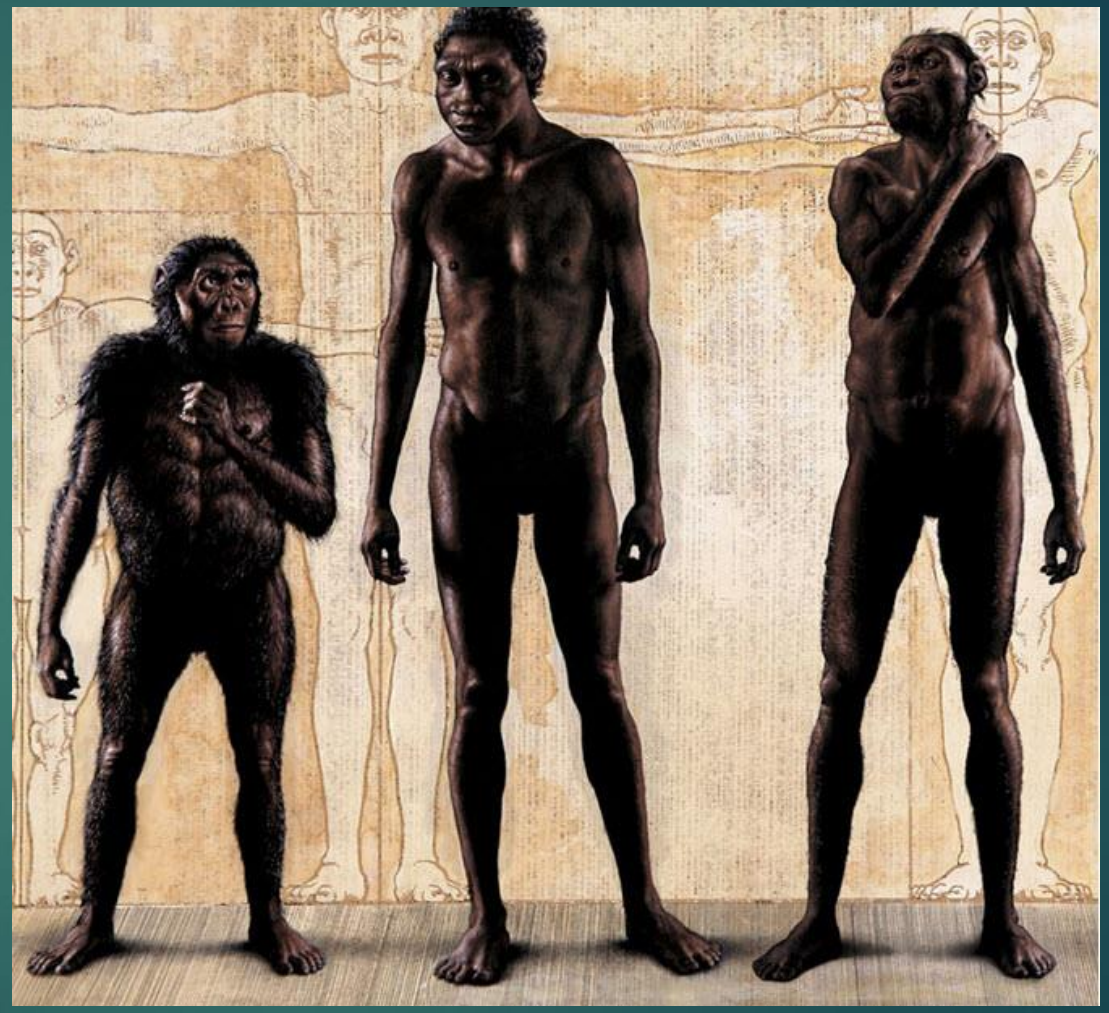
190 teeth = 15 (now 25) individuals.

100 foot bones: A nearly complete foot.

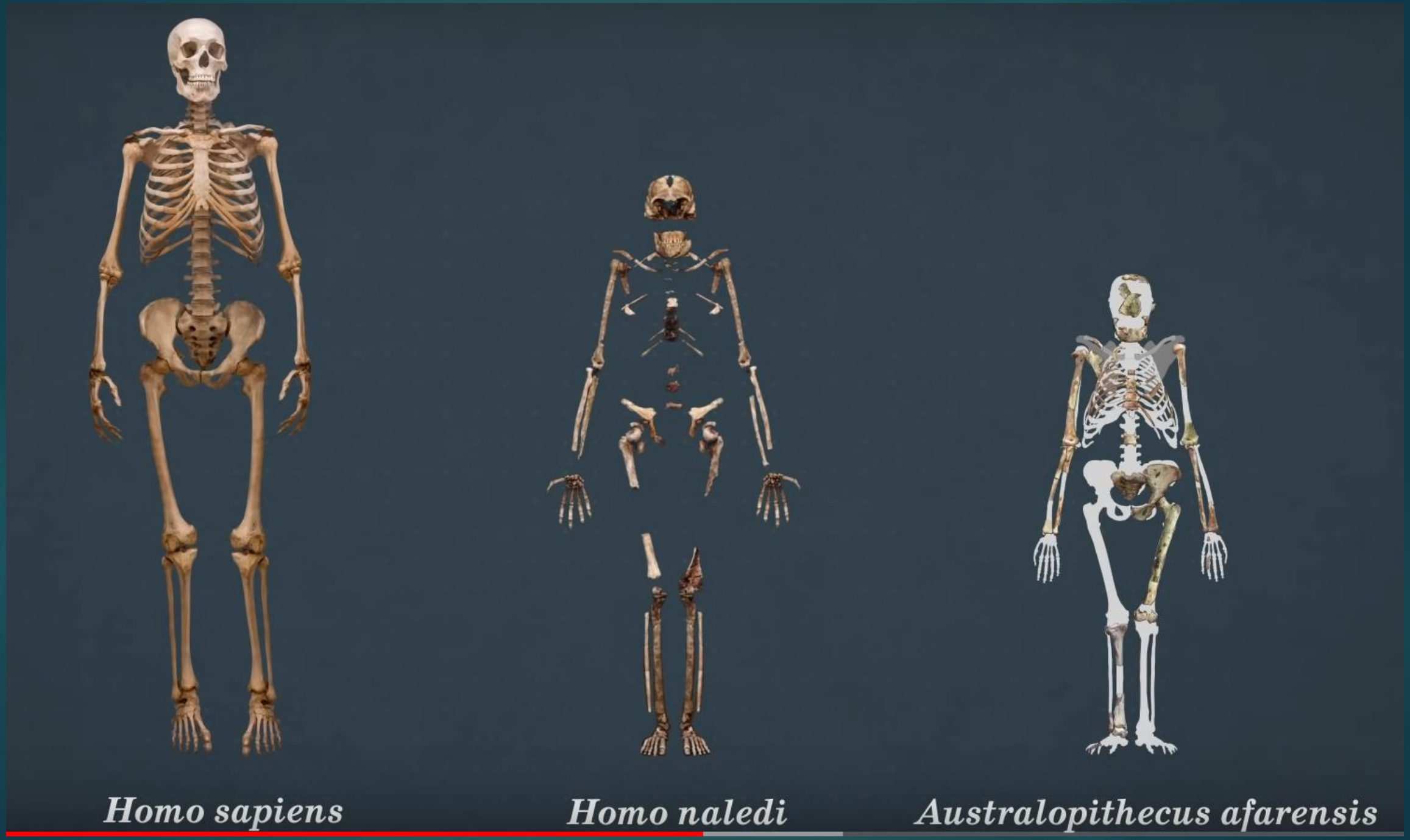
3 bones of the inner ear.

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

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



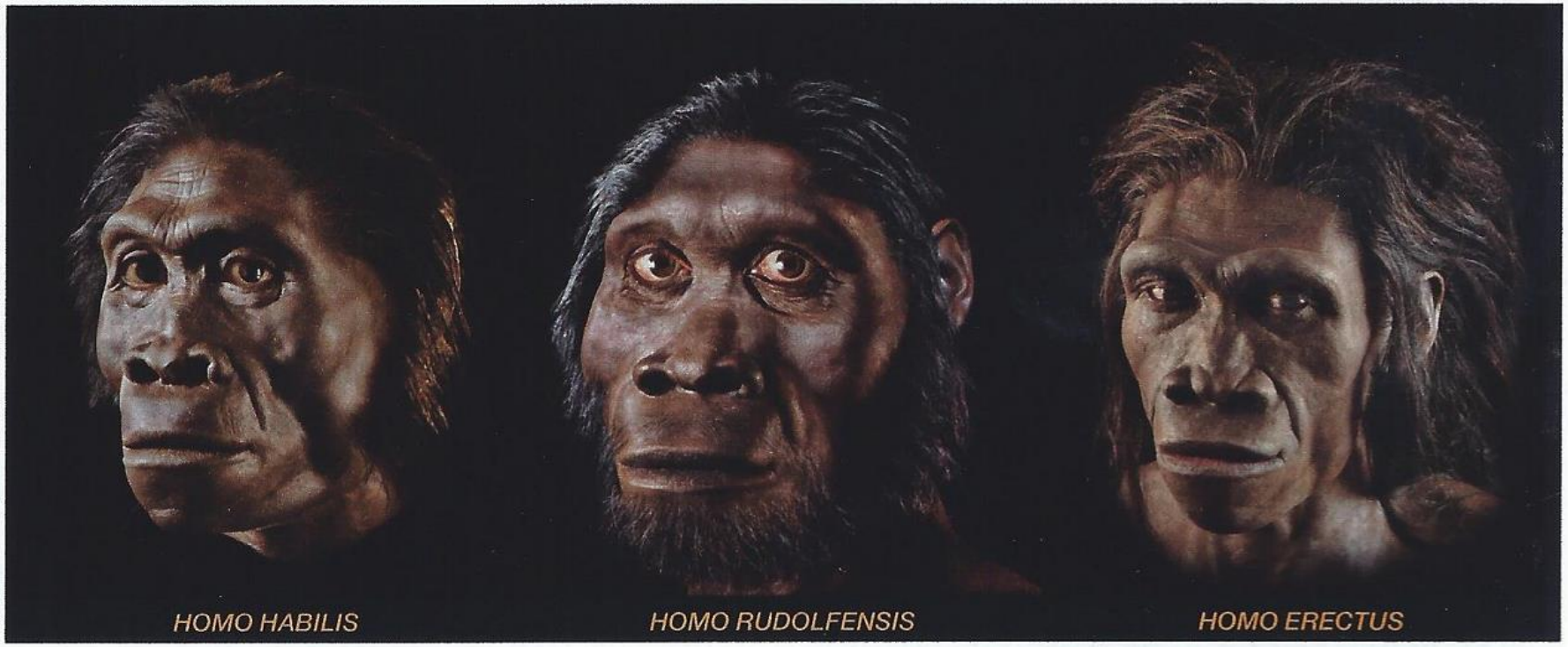
"Lucy"	"Turkana Boy"	"Rising Star Hominin"
Australopithecus afarensis	*Homo erectus*	*Homo naledi*
3.2 million years ago	1.6 million years ago	Date Unknown
Adult Female	Adolescent Male	Adult Male
3 ft 8 in	5 ft	4 ft 10 in
60-65 lbs	110-115 lbs	100-110 lbs


Homo sapiens
Homo naledi
Australopithecus afarensis

Age distribution:

- Originally 13 (now 25) individuals of practically every developmental age, from neonate to elderly:
  - 3 infants (1 fetus; Infants were identified by their thimble-size vertebrae),
  - 3 young juveniles,
  - 1 older juvenile,
  - 1 sub-adult,
  - 4 young adults
  - 1 old female adult
- 8 of 13 were not adult (implication: not repeated cave exploration by socially isolated adult males)

A bush of 3 different *Homo* species appear circa 2 Ma: no “linear” progression toward modern humanness



A trio of other *Homo* species, all first appearing in the fossil record around two million years ago, argues against a linear progression toward humanness—a message underscored by *H. naledi*’s unique blend of primitive and advanced traits.

IMAGES NOT TO SCALE

No march of progress in human evolution

- The existence of such anatomical mosaics is not a problem; they are an expected result of evolution.

- Anthropologists once assumed that the species of *Homo* could be placed in a rough order of increasing brain size. But this ‘march of progress’ assumption is false.

- Species with small brains lived both early and late in the evolution of *Homo: H. habilis, H. naledi,* and *H. floresie*nsis,

No march of progress in human evolution

- Smaller teeth in our genus: developed as higher-quality foods and tool use became more important.

- Historical theory: tooth size had a similar trend as brain size in human evolution.
  - *Australopithecus africanus* had small brains and large premolar/molar teeth.
  - Succession of *Homo* species followed an opposite trend toward smaller tooth size and larger brain size, from *H. habilis* to modern humans.

No march of progress in human evolution

- *H. naledi* violates this theory. It had small teeth, but also a small brain
- It shared a similar ecological niche as archaic and modern humans.
- The traditional view would predict that *H. naledi* should have been "outcompeted" by larger-brained humans.
- Be wary of idea of evolutionary "competition" between species.

H. naledi: a mosaic

- *H. naledi* exhibits mosaic traits:
  - Ancestral anatomical features shared with *Australopithecus*,
  - Derived features shared with *Homo*,

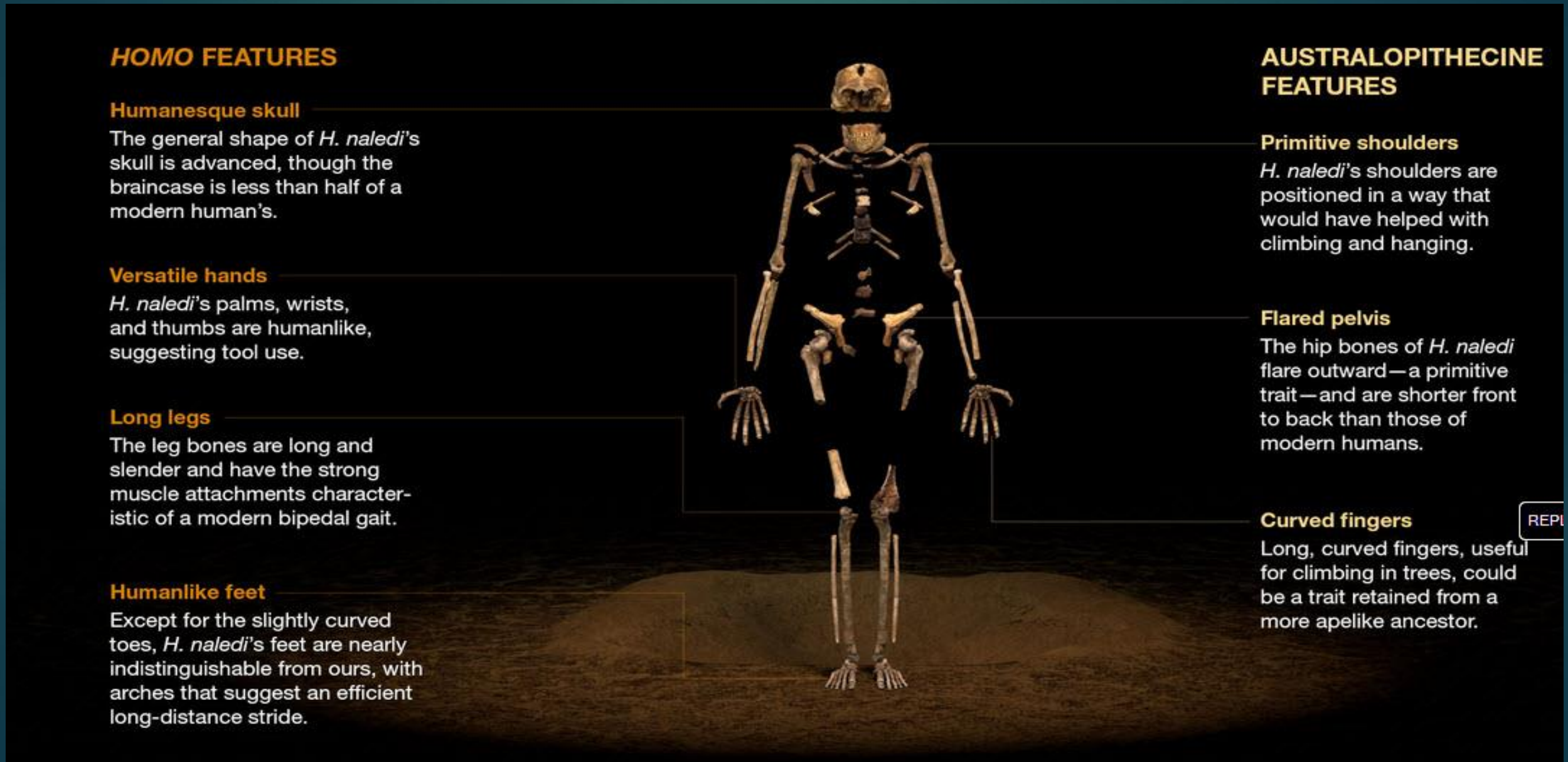
- This anatomical mosaic is reflected in different regions of the skeleton.

- The overall morphology of *H. naledi* places it within the genus *Homo.*

H. naledi is humanlike: Feet, hands, teeth: anything that interacts with environment is *Homo,* derived

Like Australopithecine: Everything that is central (the trunk, architecture of vertebral column, & small brain) is ancestral; as if evolution was crafting it from the outside in.

Homo naledi: an anatomical mosaic

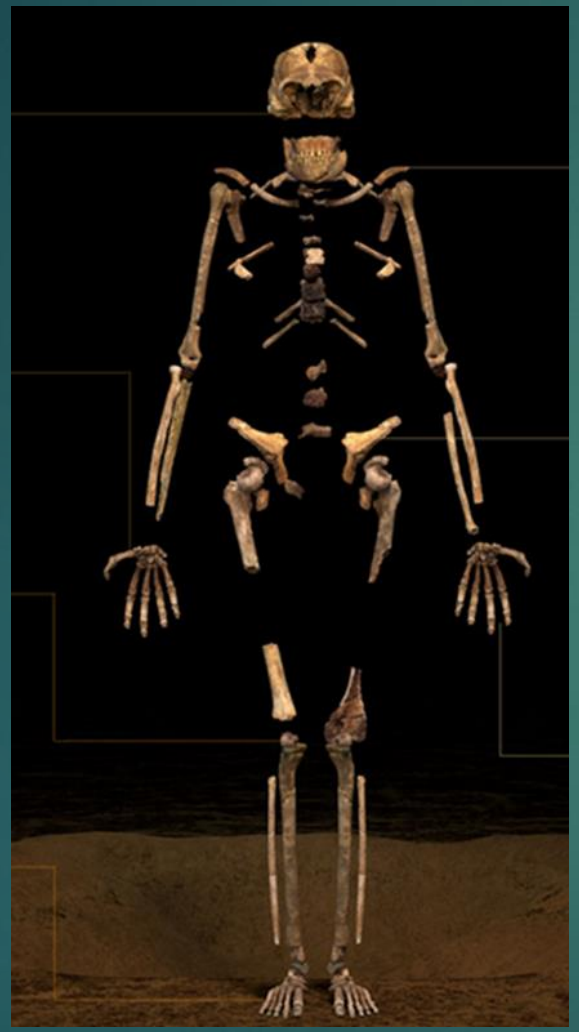


Skeleton: *H. naledi* vs. *A. sediba*: mirror reversal mosaics

H. naledi:

Derived:
skull,
teeth
legs
feet,
hands

Ancestral;
shoulders
thorax,
pelvis
curved
fingers
small brain



A. sediba:

Derived:
skull,
pelvis

Ancestral:
Feet
hands

A. sediba vs *H. naledi*: Another challenge to traditional concepts

- *A. sediba* was found a few kilometers away:
- *Naledi* is almost the mirror of *sediba*.
  - Where you see ancestral features in *sediba*, in *naledi* you see derived;
  - Everywhere that *sediba* is derived, *naledi* is ancestral.

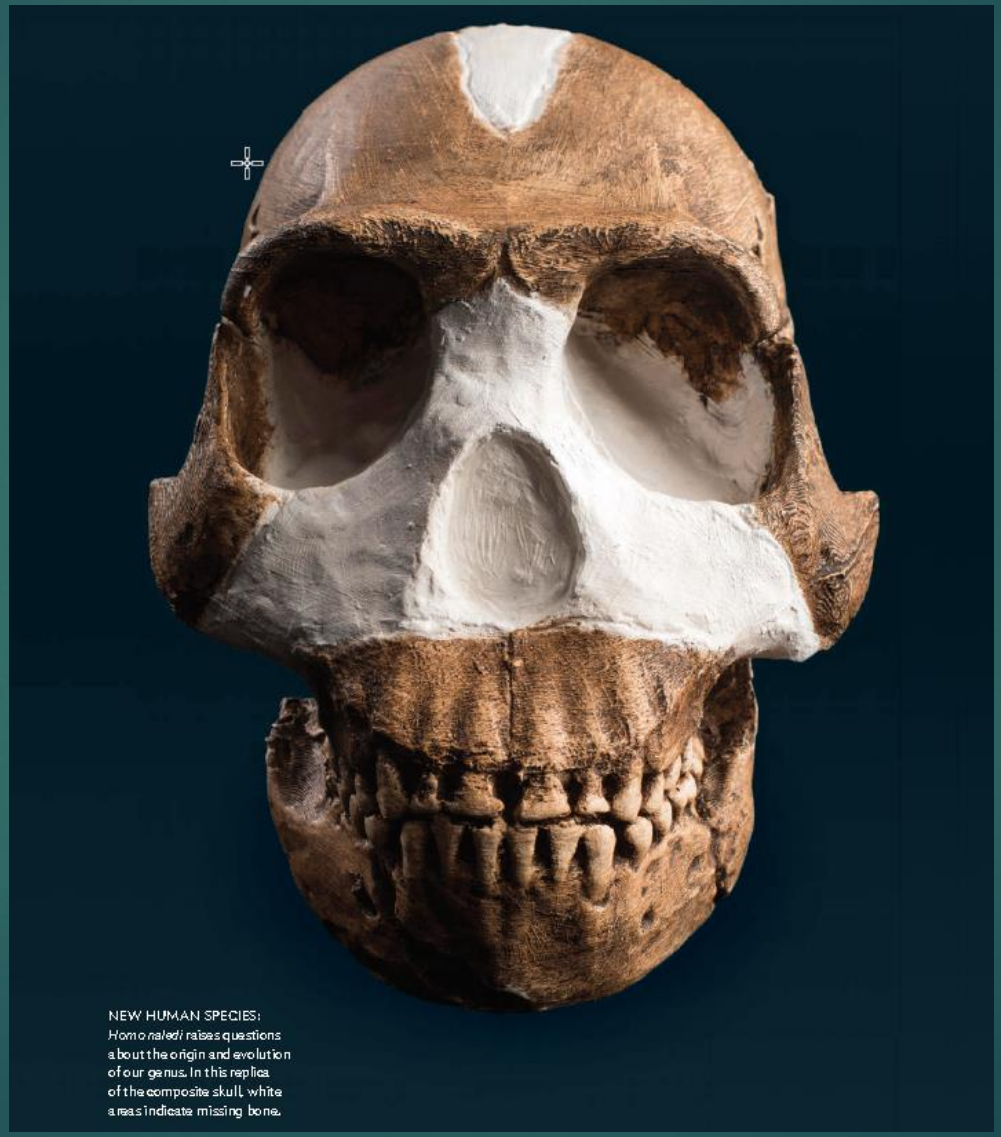
- Researchers have been operating under the assumption that the signature features of Homo— such as a toolmaking hand, big brain and small teeth— evolved in concert.

- *A. sediba and H. naledi* show that things we thought evolved together did not.

Movement: bipedal and arboreal

- *H. naledi* anatomy indicates that:
  - though they had a humanlike stride and gait,
  - they were more arboreal than other *Homo;*
  - better adapted to climbing and suspensory behavior in trees than endurance running.

Homo naledi cranium



NEW HUMAN SPECIES:
Homo naledi raises questions about the origin and evolution of our genus. In this replica of the composite skull, white areas indicate missing bone.

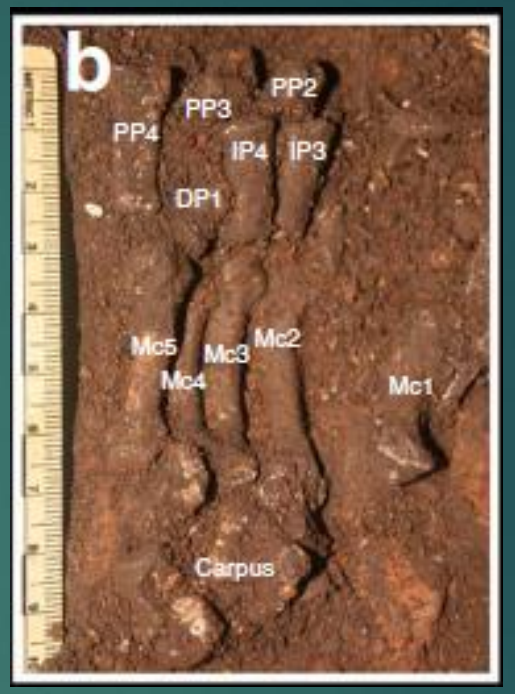
DH1: Holotype of *Homo naledi*

Holotype: original specimen used to describe a new species for the first time.

Homo naledi: Cranium 465-610 cc compared to *H. sapiens*

- Five partial skulls had been found—two male, two female.
- Cranial morphology is advanced enough to be called *Homo*.
- But the braincases were tiny—610 cc for the males and 465 cc for the females. Size of an orange.
- Only the smallest specimens of *H. habilis*, one single *H. erectus* specimen, and no *H. floresiensis* overlap with these values.

Homo naledi: most complete hand in fossil history



Found in situ in semi-articulation with the palm up and fingers flexed.

Australopithecine-like arboreal climbing capable, extremely curved fingers (joints are curved; more curved than almost any other species of early hominin; but longer thumb and wrist are stiffer like Homo, suggesting tool-using capabilities

Foot of *Homo naledi:* meant for walking - upright biped; the feet were "Nike-ready," as *National Geographic* put it; most complete foot in history of paleoanthropology; 1 of 6

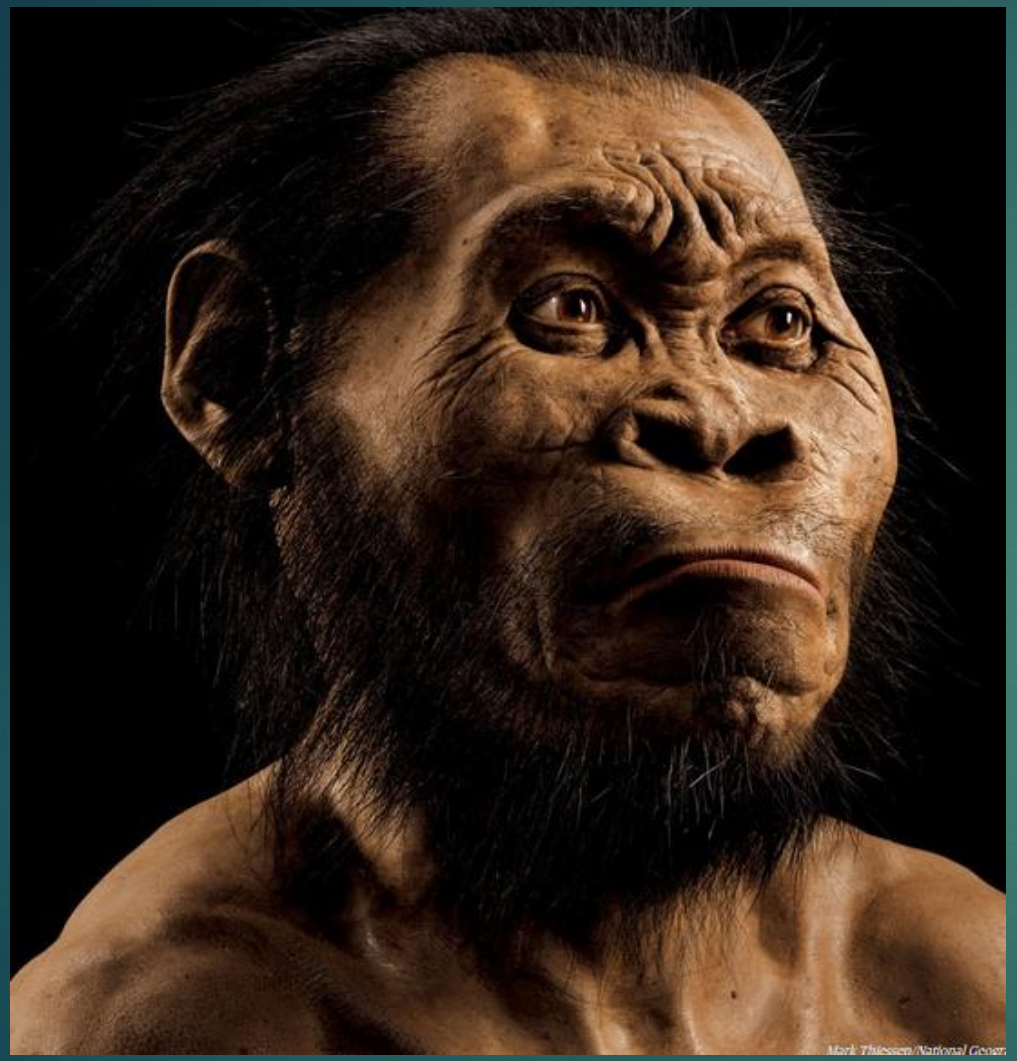
10 cm = 4 in
Woman's
Size 4

Found articulated as seen here

Foot very similar to *H. sapiens.*

It possessed some ancestral features: a flatter arch, curved toes and a heel less robust than ours

Homo naledi by John Gurche



A reconstruction of Homo naledi's head by paleoartist John Gurche, who spent some 700 hours recreating the head from bone scans

Image is from the 10/2015 issue of National Geographic

Big Controversy --Berger:
Bodies were “deliberately disposed”: Burial?

Reasons for deliberate body deposition conclusion.

- Only *H. naledi* fossils found in chamber (only a small number of leg bones of a bird, and teeth and isolated bones of rodents).
- Exceptional preservation of bones
- Bones are lightly mineralized
- Sediments in chamber are not from external source
- Bodies were intact on arrival/ no green fxs.
- No evidence of some catastrophe which killed all the individuals inside the chamber

Why conclusion for deliberate body deposition.

- No evidence of predation on bones.
- No evidence of living occupation of chamber.
- No evidence of flooding/water transport (being introduced by water flow).
- The bodies were not all deposited at the same time = Site was used repeatedly for burials

Alternative theory: Death trap

- The remains of *H. naledi* could have accumulated as a result of a classic catastrophic event during which a large group of animals is trapped in the cave:
  - during a single event when a large number of hominin individuals were in the chamber,
  - or in a death trap scenario over a period of time as individuals repeatedly entered the Dinaledi Chamber and died.

- Neither hypotheses cannot be ruled out.

Bones of Contention: *H. naledi* contrarians

- A number of scientists are advising caution.
- They're not denying the importance of the find; the fossils, they say, are invaluable. But they contend that the bones may not represent a new species.
- Berger submitted twelve papers to *Nature*. Asserted that the cave fossils represented another new species—*Homo naledi*, or Star Man.
- After an anonymous peer-review process, the papers were not accepted. The editors asked Berger to heavily revise them. After several back-and-forths, he withdrew them.
- Published in *eLife* which is peer reviewed; open journals accept around 25 percent, compared to the 7 percent acceptance rate of *Science. eLife* charges $2,500 to publish a paper.

Alternative explanations

- Briana Pobiner:
  - “Dead people smell bad and attract predators. A cave would be a good place to keep them far away from where you hang out, too, so I can see chucking bodies into the cave so you wouldn’t be the next one eaten for dinner.”
- Tegobo Makhubela, UJ lecturer: ***
  - "I think they went into the cave running away from danger of veld fires, heavy rainfalls with thunder or being chased away by predators and they were trapped down there unable to leave the place and ended up dying in the cave. I think they were alive because they do not have any indications of being attacked or killed.“
- CJV: Group got lost and trapped in chamber.

Bones of Contention

- Questions raised:
- How old are the fossils? Failure to date the find in 2015
- Rush to publish; research done hastily
- Is it a new species? Or *Homo erectus*
- Controversial theory that species might have disposed of its dead
- Untrained eyes of early researchers
- Too much media
- Was there damage done to fossils?

Bones of Contention 2

- In 2000, four months after Berger's "Footsteps of Eve" was published, the *American Journal of Physical Anthropology* published a piece, by Tim White, of UC Berkeley, about the state of paleoanthropology.

- White drew a distinction between "the scientist versus the careerist," warning that "irresponsible proclamations momentarily seize the public's attention in popular news and go straight into textbooks. The retractions rarely do."

Tim White vs Lee Berger

- Tim White, UCB, took 15 years to publish his findings on “Ardi”.
- He believes *H. naledi* might be a variant of *H. erectus.*
- The fossils come not from a single specimen, but from as many as 15 different individuals; it is therefore difficult to identify which bone came from which individual, and even whether they lived in the same period.

Tim White

- Photos taken of the find demonstrate to White that many of the fossils were “very disturbed, perhaps by earlier cavers, in the geologically recent past.”
- “One tibia, for example, was white on one end, a clear indication it had been snapped off in the recent past,”
- White on Berger’s burial theory: “The only evidence seems to be ‘We can’t think of anything else.’ This is not evidence.”
- Berger’s response: This is White’s opinion. Let him publish a scientific rebuttal.

Bones of Contention 4:

- John Hawks counters*:* body is unlike *H. erectus*; form of skull looks like early *erectus*, but premolar teeth unlike *erectus*; only 1 *erectus* brain is as small as *naledi*

- The field is split, largely between those who consider Berger
  - a visionary for publicly sharing data vs.
  - those who consider him a hype artist.
  - “Intentional corpse disposal is a nice sound bite, but it’s more spin than substance,” the paleoanthropologist William Jungers,

Zeray Alemseged' s Opinion

Unprecedented, landmark find.

Help understand variation within one species.

Supports hominin species diversity (like other animal species)

2016: Zeray believed it is derived from *Homo erectus;* isolated in South Africa; an isolated, dead-end species; like *A. sediba, H. floresiensis*

x

No phylogeny & Proteinomics

- Problem with recent hominin phylogeny studies:
- Three different methods of looking at the phylogenetic placement of *Homo naledi* have led to three very different results, and similar problems have emerged with *Australopithecus sediba*, *Homo floresiensis*, and other species.
- These are some of the most complete skeletal samples of any hominin species, and yet they cannot reliably place them on a tree.
- Need Proteomics to help with phylogeny.

2015: Just scratched the surface: Unanswered questions

- Only 1 meter of 12 meters excavated so far.
- Provisionally assigned to the genus *Homo*
- 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?*

New dating surprise: Late Middle Pleistocene = H. naledi, 300 Ka

Jebel Irhoud, Morocco
6800 miles

Broken Hill, Zambia
800 miles away

Naledi, South Africa

New dating: 235-336 Ka

- Based on geological analysis, new dating: 235-336 Ka
- Late for such a small brained hominin
- Raises issues of nature of genus *Homo:* A lot of morphological variation in *Homo* – too much?
- Correlation of large brain and hip or teeth morphology no longer valid
- Evidence of coexistence of 3 *Homo* species at 300 Ka
- Did they interbreed, compete with each other?
- Hand and wrist morphology compatible with stone tool use

2017: *Homo naledi* dated to 236-335 kya

- New dating doesn't, however, answer questions about how long ago the species first appeared and when it died out.

- Attempts to extract DNA from Dinaledi fossils have so far failed.

2013-2017: New discoveries: Lesedi Chamber

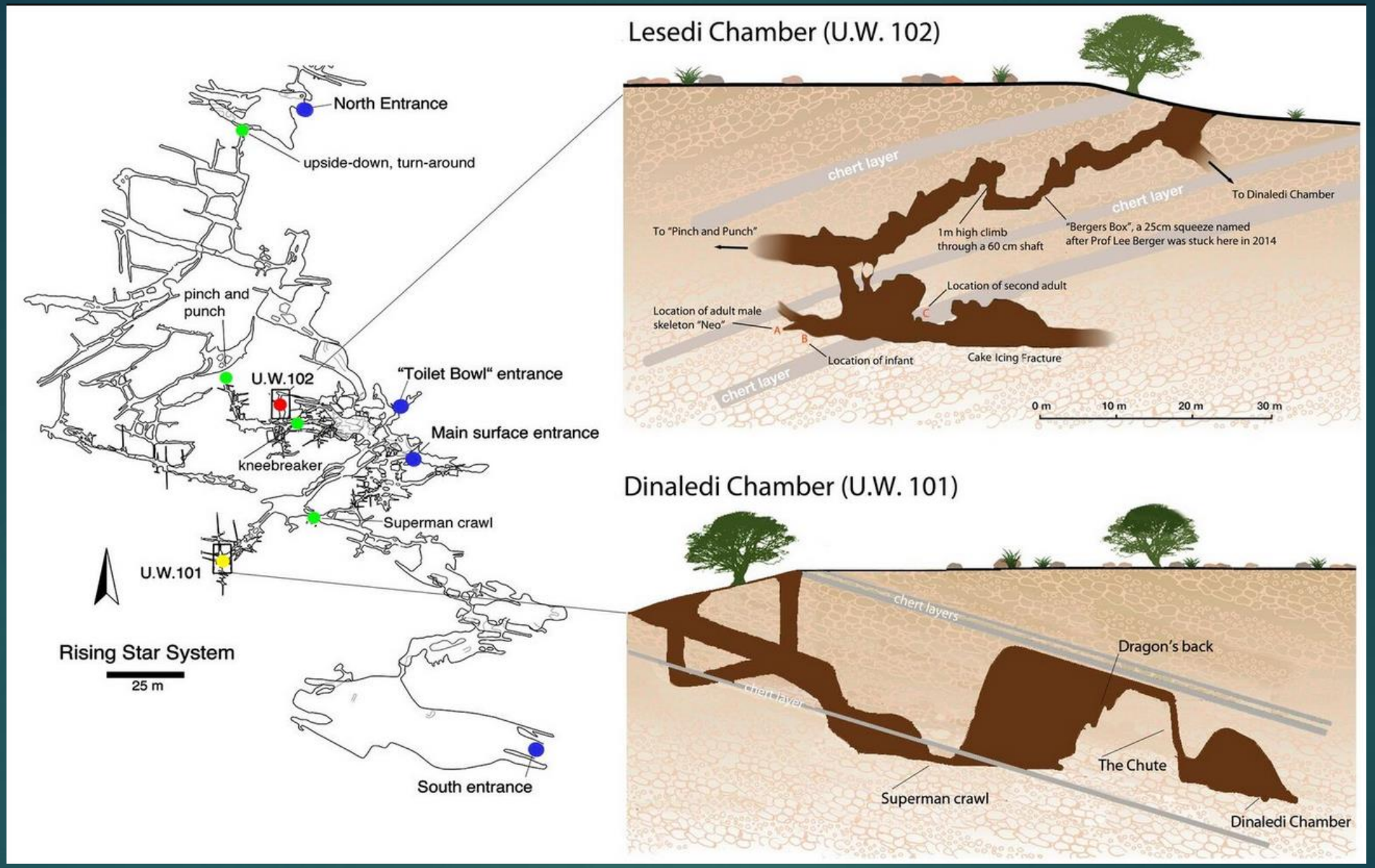
- Additional fossil hominin material was subsequently discovered in the Lesedi Chamber of the cave system in November 2013 by Rick Hunter and Steven Tucker. Only published in 2017.

- The second cavern, called the Lesedi chamber, is a mere 80 lateral meters from the now-famous Dinaledi chamber,

- No direct geological connection to the Dinaledi Chamber.

New Lesedi chamber: 3 more individuals

- 2000 bones in both chambers; Of the 206 bones in the human body, only about 20 are not represented in the cave.
- "[The second] chamber has the remains of an additional three individuals at least as of 2017; 131 fossil bones in 3 collection sites
- Includes a partial (40%) skeleton with a skull. Named "Neo ("nay-oh")" which means *gift* in Sesotho, a language spoken in South Africa.
- Lesedi fossils are notably similar to the Dinaledi fossils in shape and morphology.
- 2020: 25 individuals total (via number of same teeth) in both chambers



Lesedi Chamber is located about 80 meters from the Dinaledi Chamber.
Both chambers are extremely difficult to access

Challenges to conventional theory: issue of variation

- The persistence of small-brained humans for so long in the midst of bigger-brained contemporaries revises the previous conception that a larger brain would necessarily lead to an evolutionary advantage,

- Their mosaic anatomy greatly expands the known range of variation for the *Homo* genus.

- Evolution depends on adaptation to ecological variation and not to larger brains:
- Remember the discovery of the temporal simultaneity of larger brained *H. erectus* and smaller brained *P. robustus* in same area

Leti

Lee Berger holds a reconstruction of Leti's skull. Wits University

New child skull of *Homo naledi*

- Child “Leti” skull on a limestone shelf: teeth and fragments of skull belonging to a *Homo naledi* child, age 4 to 6.
- Lee Berger argues that the remote location of the finding implies it was a burial.
- The researchers named the child "Leti,“ meaning "the lost one.“ consisting of six teeth and 28 skull fragments in 2017.

Leti, the “Lost One”

Fragmented skull discovered by itself in a tight crevice.
(20 cm by 80 cm tall

DH7: Juvenile *H. naledi:* ~8–11 years old

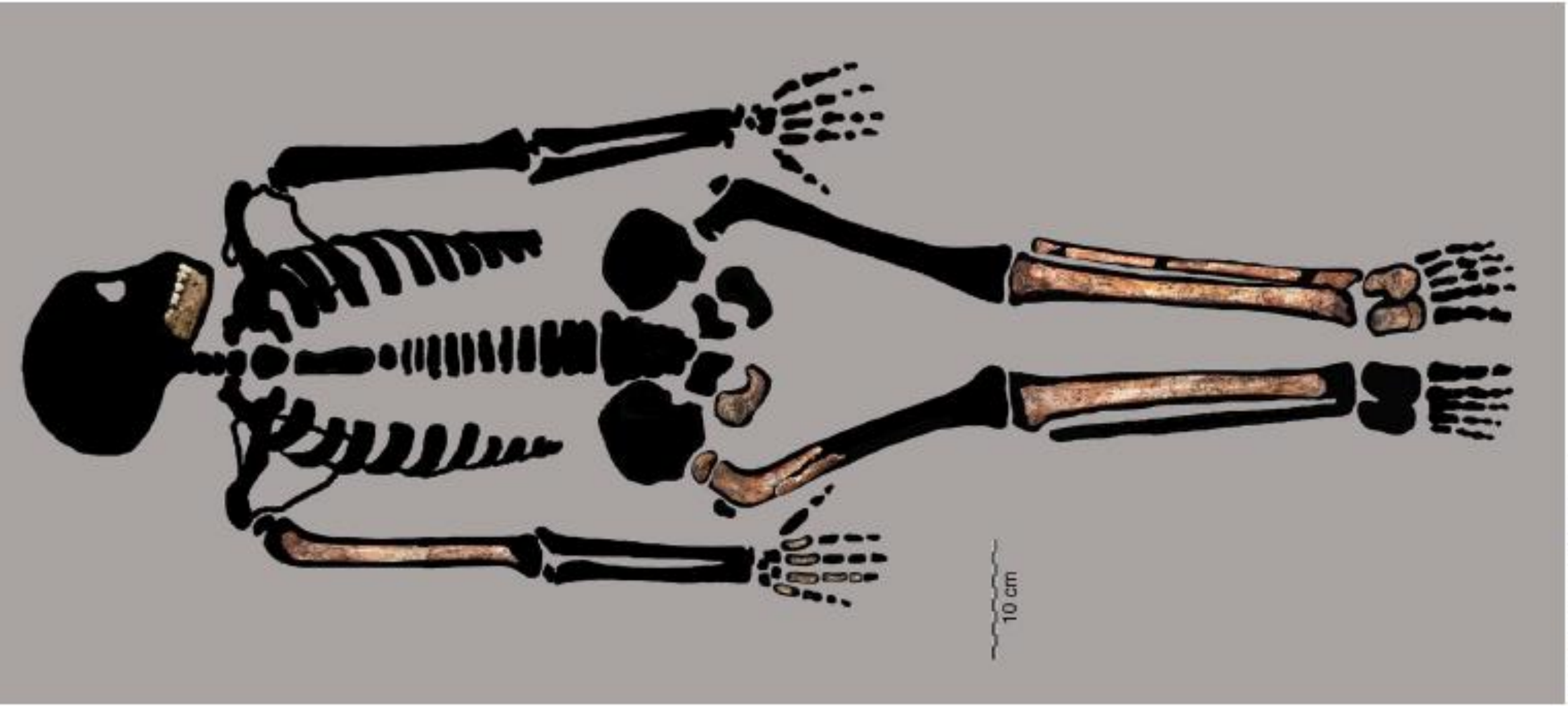


Fig 8. DH7 partial skeleton.

Neo

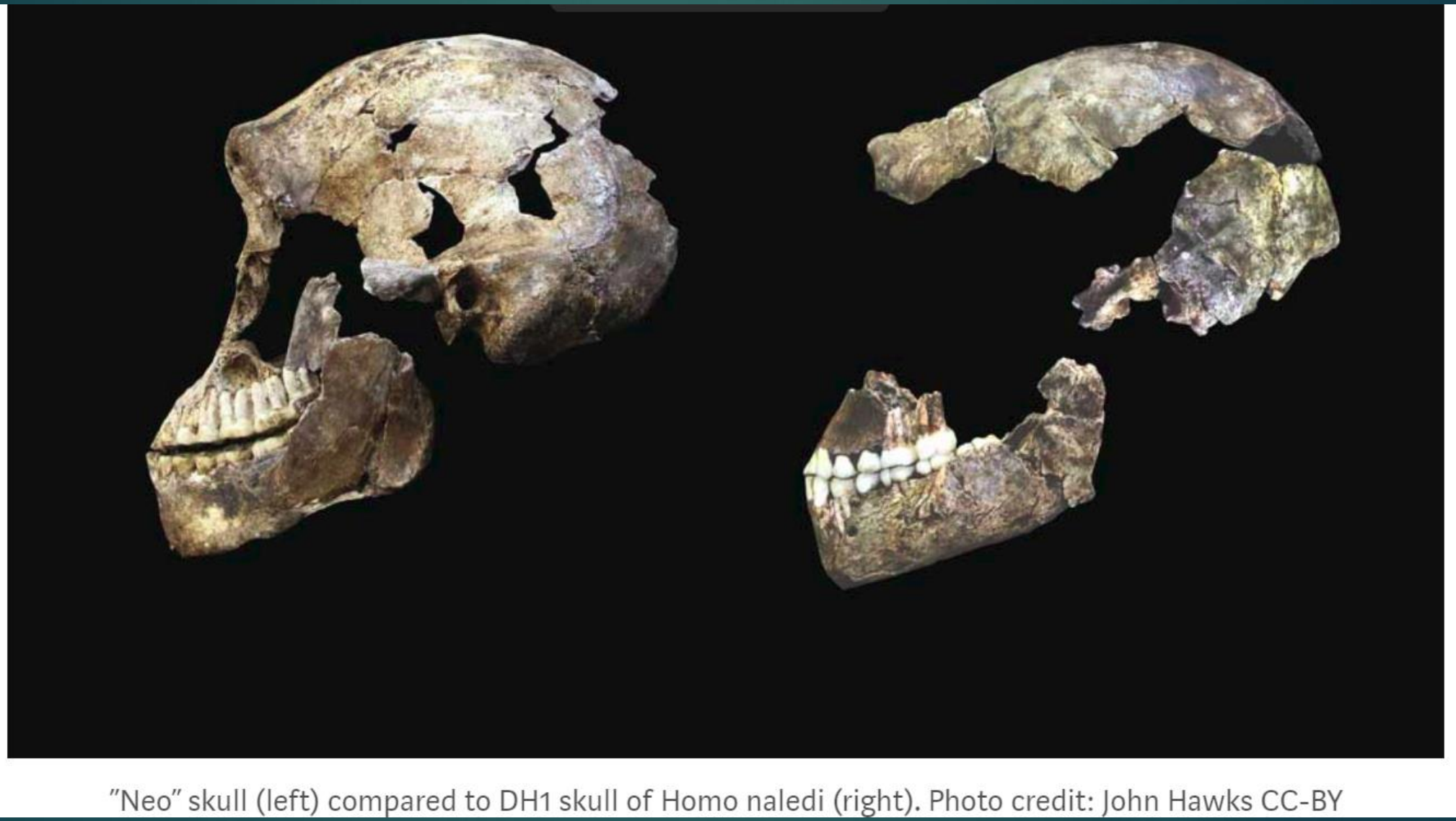
LES1 Cranium – Neo: 610 cc

LES1, with an endocranial volume of ~ 610 cc; 9 percent larger than the brain size estimates for the previously discovered Dinaledi fossils

LES1 Cranium

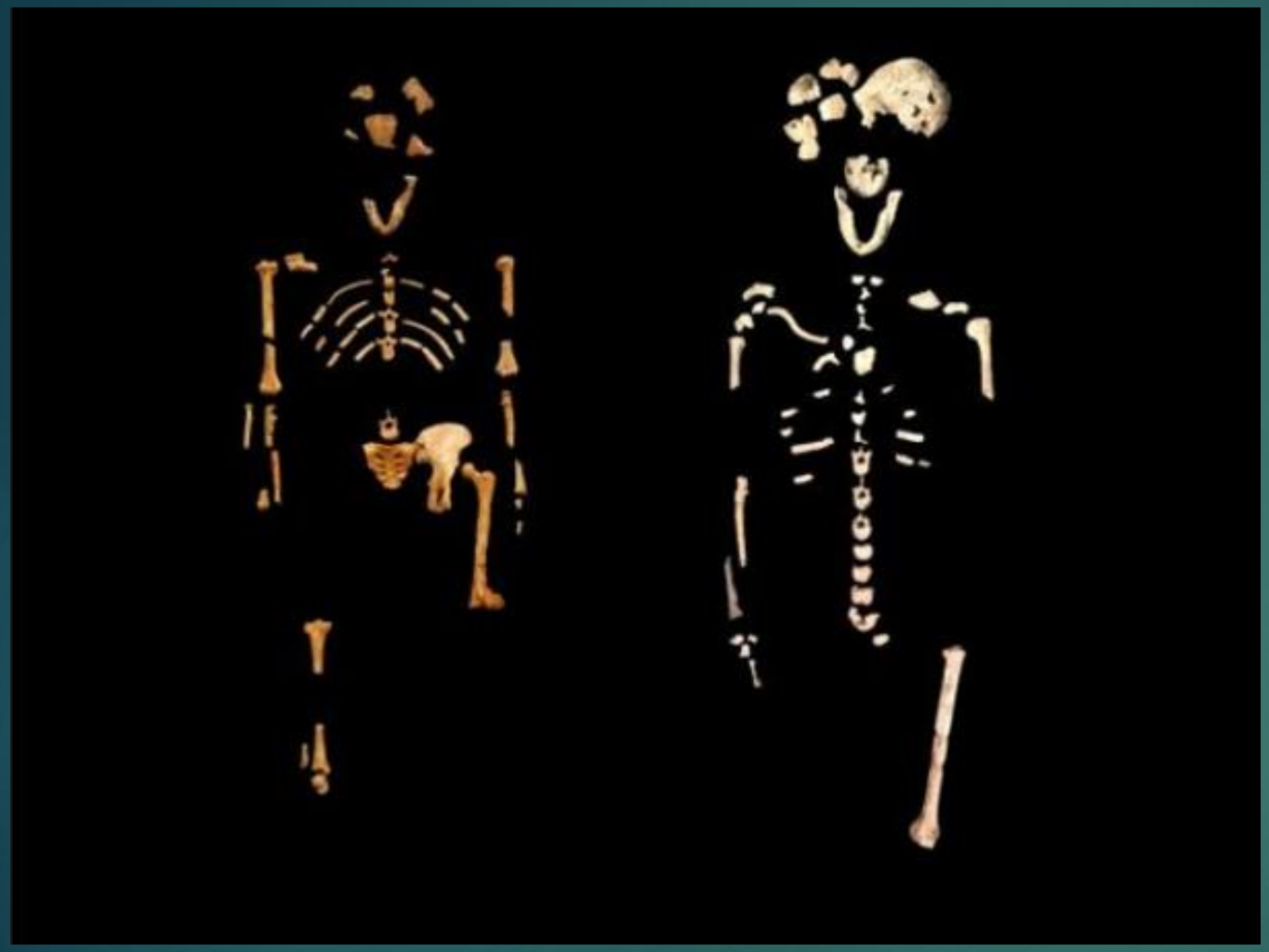
Neo from Lesedi

DH1 from Dinaledi

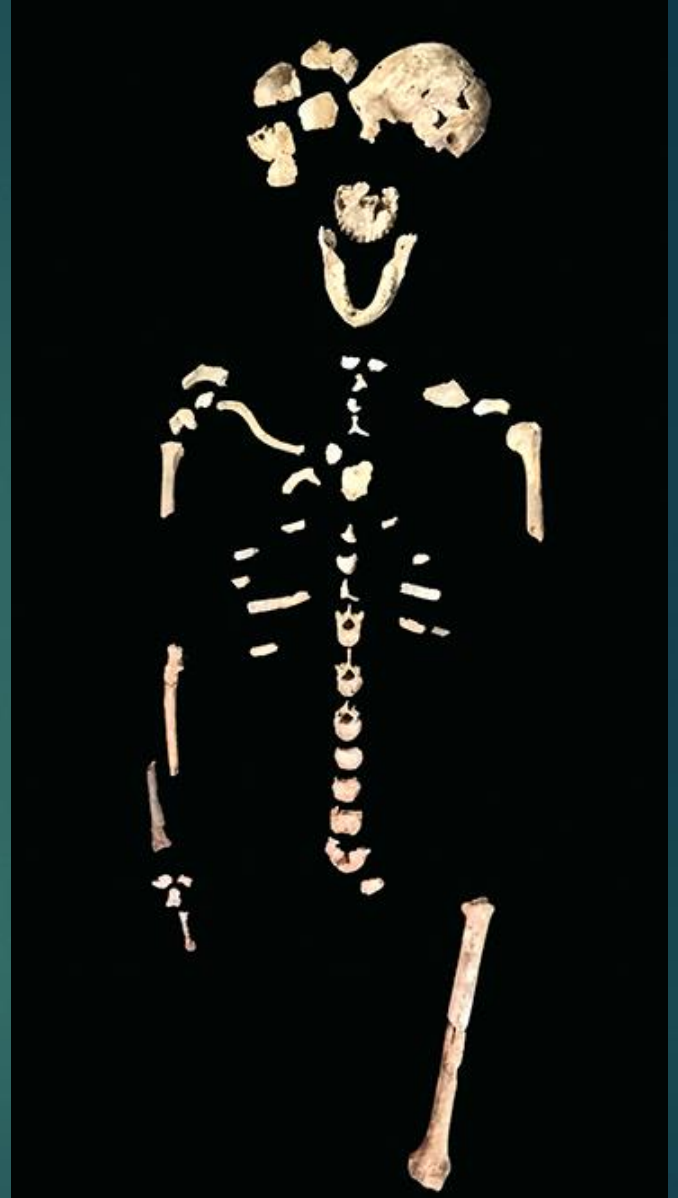


"Neo" skull (left) compared to DH1 skull of Homo naledi (right). Photo credit: John Hawks CC-BY

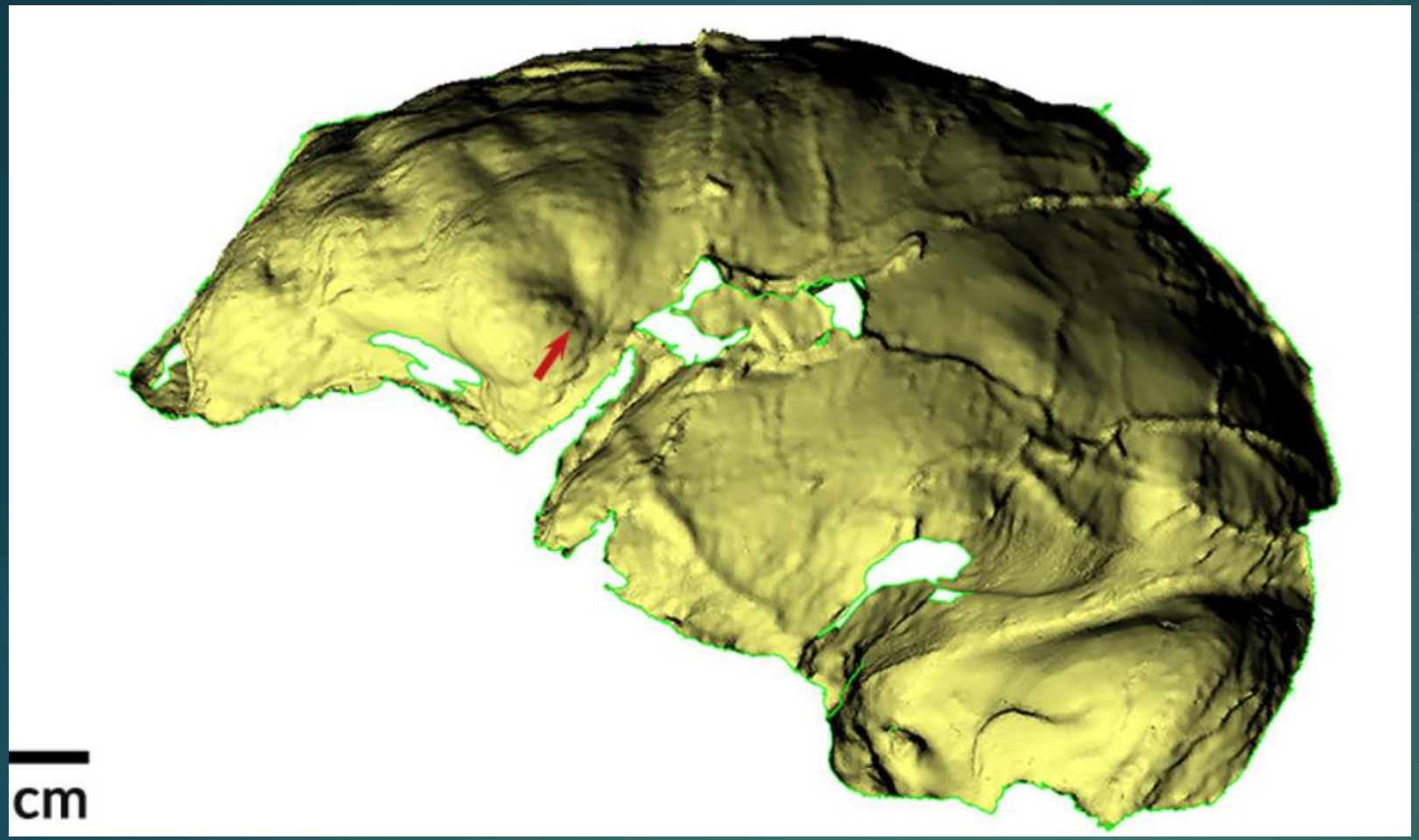
Lucy and Neo



Neo is one of the most complete skeletons ever found.



BODY PLAN A partial *Homo naledi* skeleton unearthed in South Africa is about as complete as Lucy's famous partial skeleton. Lucy, an *Australopithecus afarensis*, lived in East Africa about 3.2 million years ago. H. naledi lived perhaps 300,000 years ago, scientists say, although this new partial skeleton remains undated.



DH3: inferior frontal gyrus that was more human-like than primate-like.

Hurst & Hollowell: GO FOR BROCA A virtual cast of *Homo naledi*'s brain surface contains clues to the presence of a region (pointed to by red arrow) that may correspond to Broca's area in present-day people. This language-related neural region enhanced social emotions and communication, researchers contend. Falk disagrees. Also left posterior hemisphere longer = right handedness

Shawn Hurst & Ralph Hollowell

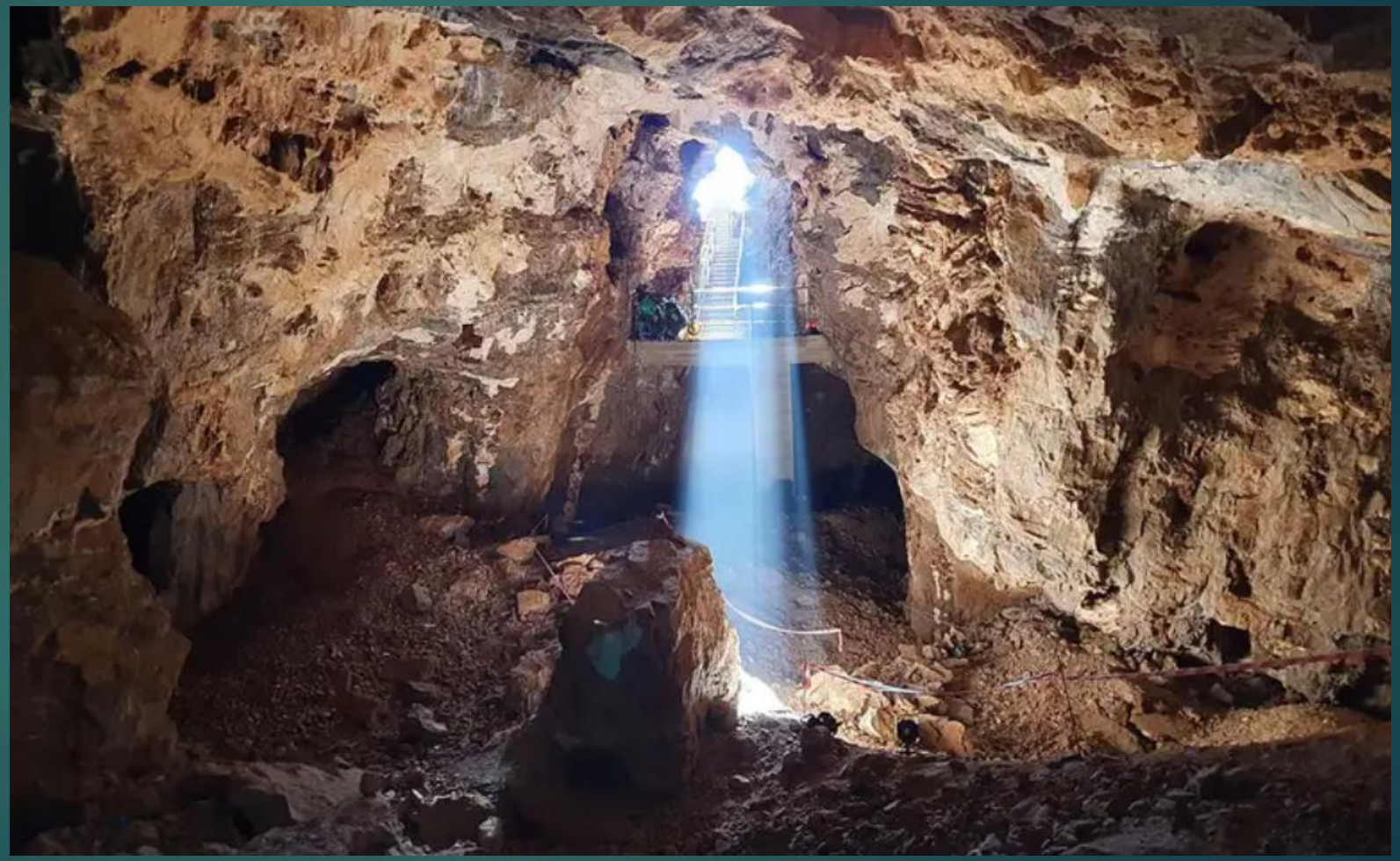
Neo reconstruction

Puzzles

- Two caves. There is no connection between the two.
- There are no stone tools.
- Did they fall in? Were they pushed? Why are they in two different chambers so difficult to access?
- The authors of the new articles would like us to believe they were put there by others of their kind, but there is a long way to go before we can be certain of that.

New Third Cave: UW105: 3 main chambers, all with fossils

Fossils in breccia;
not *H. naledi*



Potential Implications of *Homo naledi*

- The effect on the field is transformative.
- Evolution produced different types of humanlike creatures originating in parallel in different parts of Africa.
- Was there multiple early hybridizations?
- Is this a relic population that may have evolved in near isolation in South Africa? A dead end?
- Is there a point at which we became human or are there many ways to be human?

*** Potential Implications of *Homo naledi*

- Apart from our language capacity, no modern human uniqueness claim has survived unmodified for more than a recent decade since it was made:
  - Tool use, tool making, culture, food sharing, theory of mind, planning, empathy, inferential reasoning —
  - All have now been observed in wild primates.
- Frans de Waal: "It is an odd coincidence that "*naledi*" is an anagram of "denial."
- "We are trying way too hard to deny that we are modified apes…We are one rich collection of mosaics, not only genetically and anatomically, but also mentally."

Lessons to learn from *H. naledi*

- Some of the hallmarks of "being human" such as efficient bipedalism and fine motor skills are not dependent on a big brain.

- *Homo naledi* reaffirms that human evolution — like the evolution of all groups — is not patterned like a ladder, but rather like a very deeply pruned bush, with many branching lineages, most of which have died out.

- We should never expect a new fossil find to have a predicted set of traits that perfectly "links" it between two other species.

- Nor should we use value-laden terms such as "primitive" to describe species, most of which successfully made their way on Earth for far longer than our own species has existed.

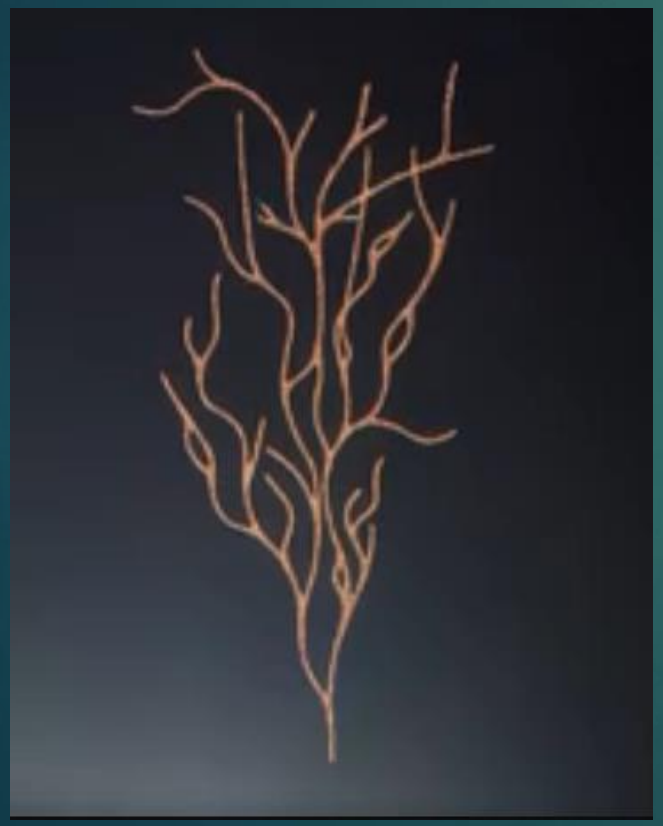
H. naledi: challenges to traditional concepts

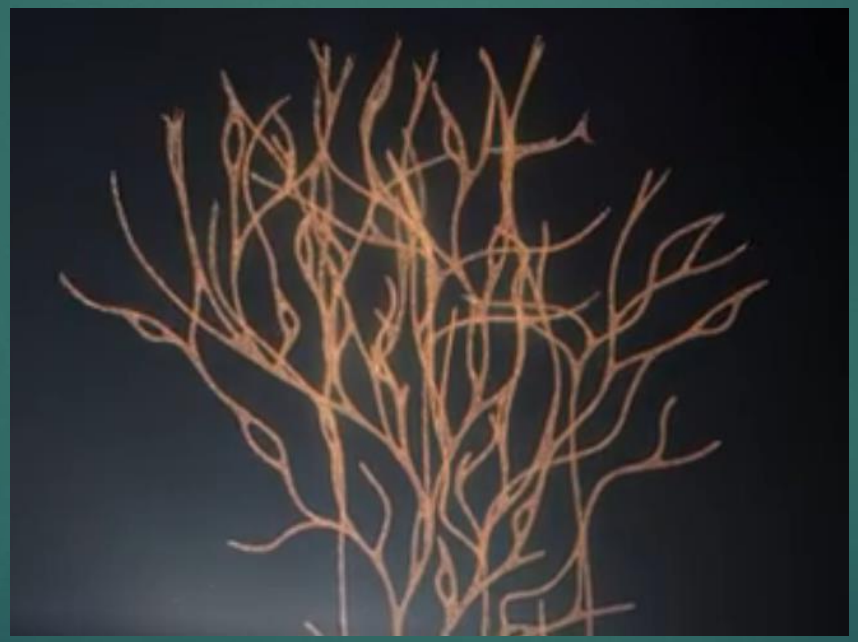
- Relationship of ancestral and derived traits; all recent finds are mosaics
- Cannot predict a new whole skeleton pattern from a fossil part of that skeleton, given mosaic blends in *A. sediba*, *H. floresiensis* and *H. naledi*
- Things we thought evolved together don’t:
  - Teeth and brain do not evolve in parallel
  - Nor smaller teeth and bigger brain

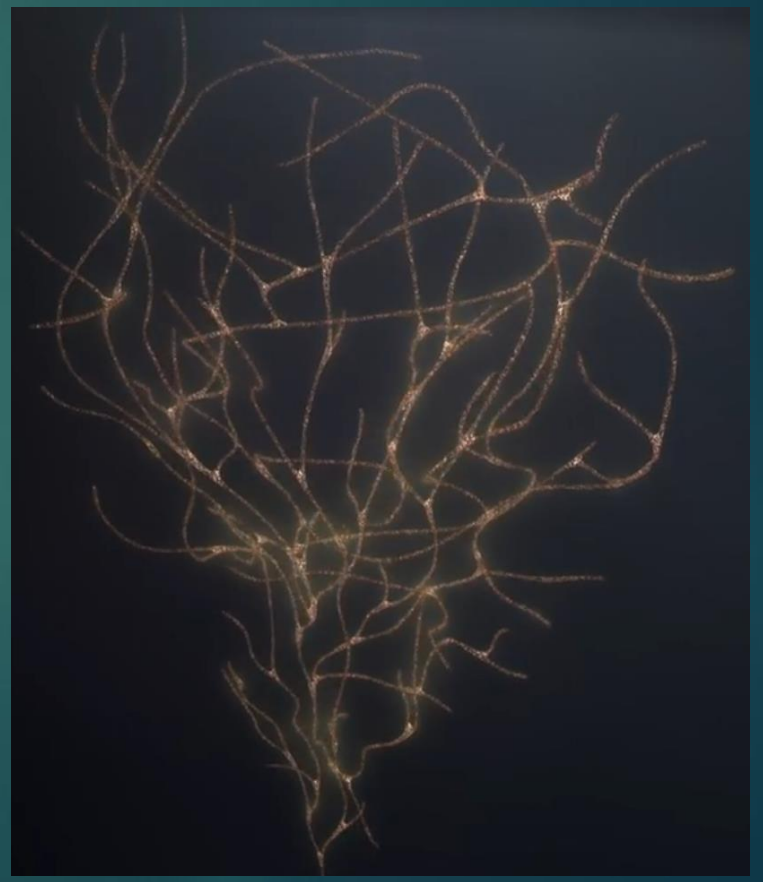
Unanswered questions

- We do not know when *H. naledi* arose
- We do not know when *H. naledi* went extinct
- We do not know if *H. naledi* intermixed with other African hominin species
- Origin of African Middle Stone Age tools: who first made them at 300 Ka?
- If Naledi could just be discovered right next to Cradle of Humanity, what of other 90% of Africa that has not been explored paleontologically

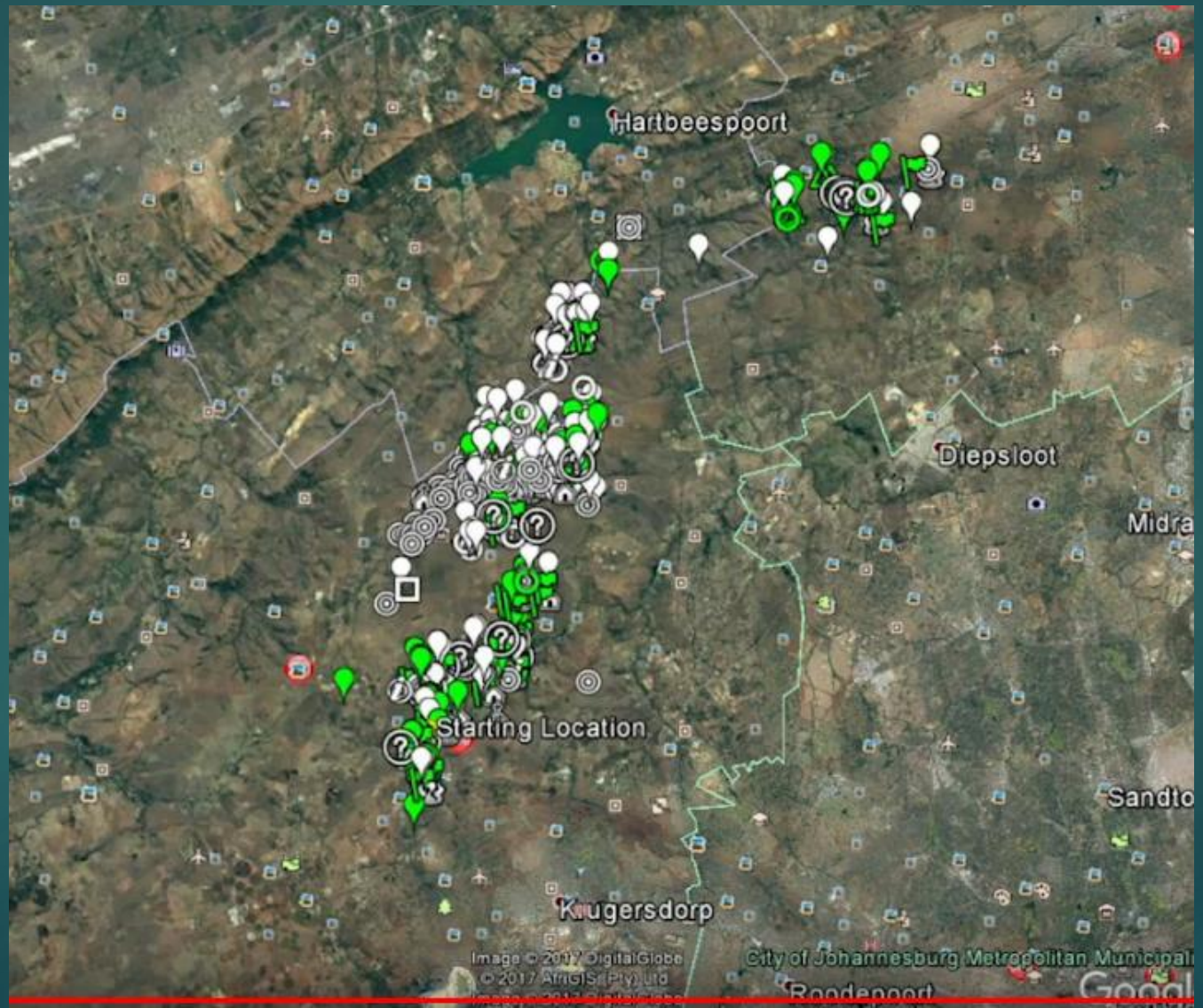
Lee Berger’s new metaphor for hominin evolution: Braided Stream – glacier produces a river that divides into rivulets which all merge again downstream in a lake; divergence from common ancestor, then coalesced again; difficult to tell which branch was responsible for us being here today







Things to come: Remember Berger's use of Google Earth for fossil hunting: 800 caves with at least 250 other fossil sites



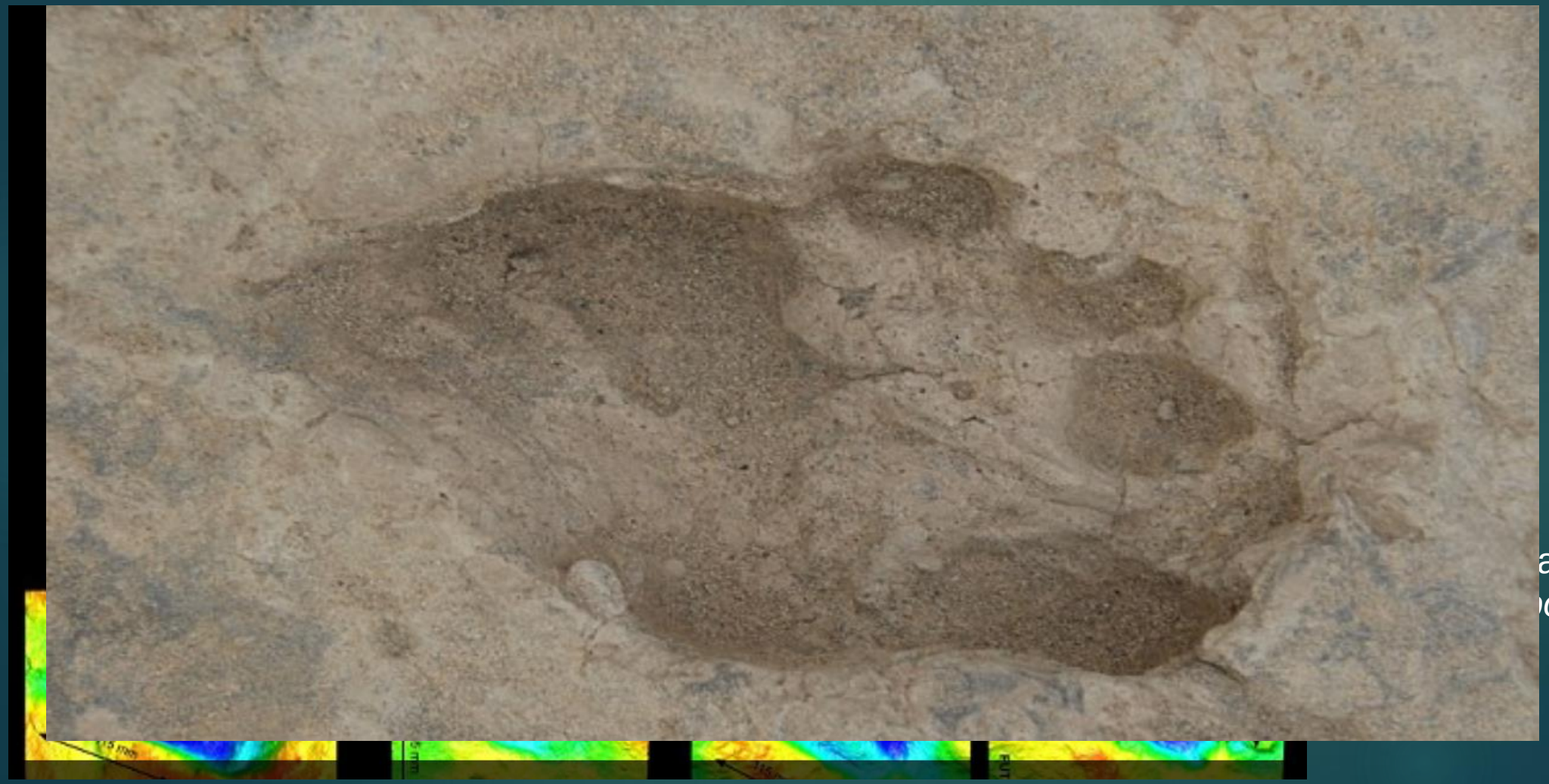
2022: New Lee Berger claim: Homo naledi exhibited controlled use of fire in Dinaledi cavern

- A decade of work has been done in Dinaledi cavern where H. naledi was discovered and no evidence of fire was found. Only 47 people have been there.
- In August 2022: Lee Berger lost over 50 pounds and finally gets to Dinaledi cave for the very first time, and suddenly declares that *H. naledi* controlled fire.
- He said: “I looked up. And I realized the ceiling was black. It was burnt. It was covered in soot. It had been right above our heads the entire time.“ Also “Huge lumps of charcoal, thousands of burned bones, giant hearths and baked clay.”

Fire use at Dinaledi?

- The same day, lead investigator and paleoanthropologist Keneiloe Molopyane was making another find nearby: "Pieces of bone ... burnt bone," she said, which indicated they were eating there.
- Claims that remnants of small fireplaces and sooty wall and ceiling smudges were found.
- No peer reviewed publication yet.

2016: Ninety-seven, 1.5-million-year-old footprints made by at least 20 different *Homo erectus* individuals at multiple sites near Ileret, Kenya



ala, et al.,
orts, 2016

5-million-year-old *Homo erectus* footprints hint at prehistoric hunting parties

- 99 footprints that appear to have been left by male Homo erectus

- The footprints - the oldest human tracks in the world, found in in Ileret, Kenya - may have been left by group hunting antelope or wildebeest

- Stalking some of the other animals whose prints are also preserved in the mud.

Ron Clarke and “Little Foot” *Australopithecus*

Ron Clarke and the Sterkfontein hominid

12/6/2017: 'Little Foot' makes public debut 20 years after discovery

“Little Foot”: a near-complete fossil hominin skeleton dating back 3.67 Ma; oldest fossil hominin skeleton ever found in South Africa per Ron Clarke; *Australopithecus prometheus*, which was named back in 1948 from fragmentary fossils.

December 7, 2017: Exhibition of Little Foot

- **The most complete skeleton of an *Australopithecus*;** StW 573 nicknamed ***Little Foot*** , with about 90% recovered (Lucy: only 40% of its skeleton).

- Others debate both dating (2.2 to 3.6 Ma) and species designation

2017: Microstratigraphic preservation of ancient faunal and hominin DNA in Pleistocene cave sediments

- DNA preserved in sediments has emerged as an important source of information about past ecosystems, independent of the discovery of skeletal remains.

- Little is known about
  - the sources of sediment DNA,
  - the factors affecting its long-term preservation,
  - and the extent to which it may be translocated after deposition.

2017: New archeological technique: DNA in sediments

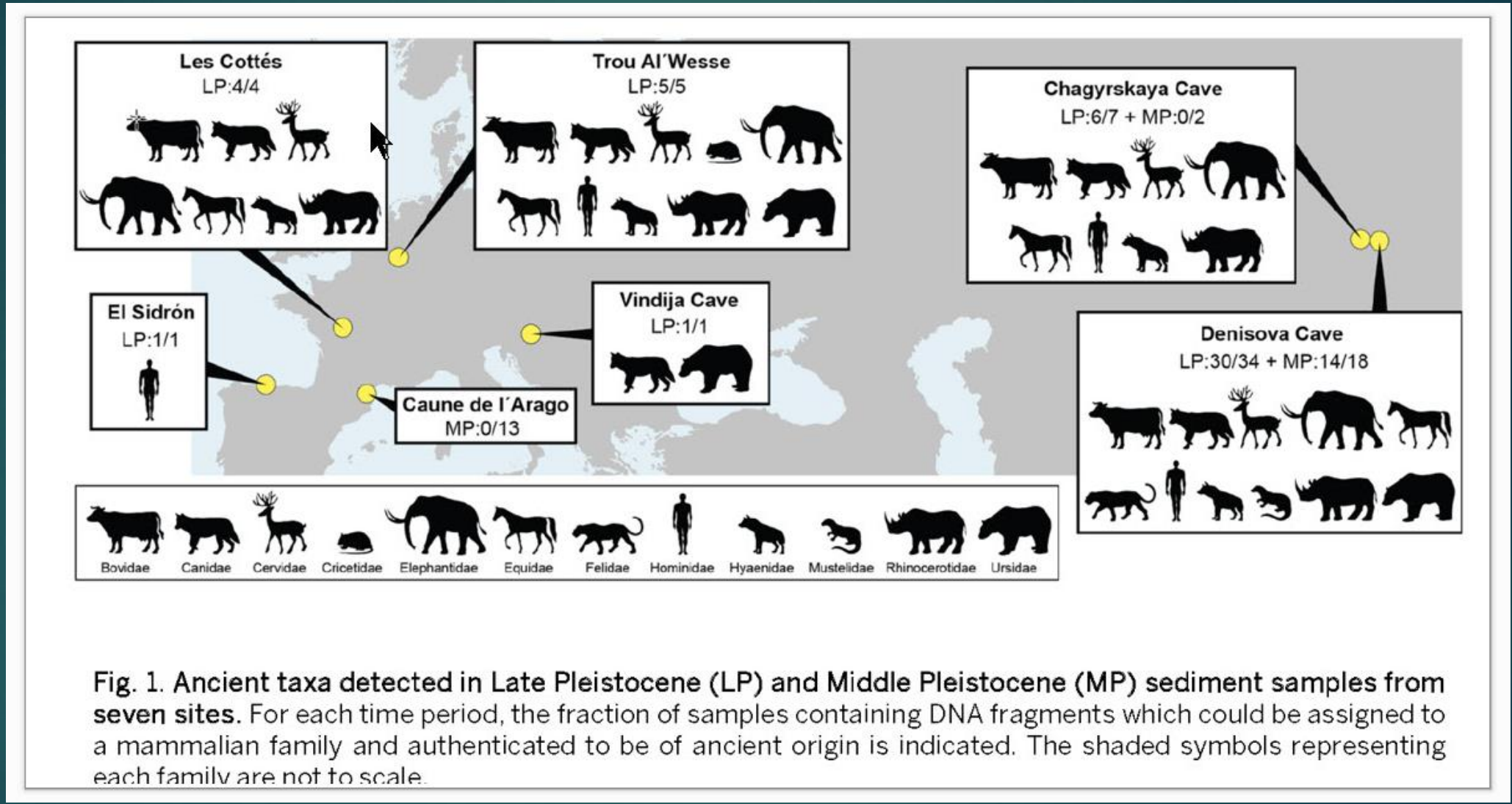


Fig. 1. Ancient taxa detected in Late Pleistocene (LP) and Middle Pleistocene (MP) sediment samples from seven sites. For each time period, the fraction of samples containing DNA fragments which could be assigned to a mammalian family and authenticated to be of ancient origin is indicated. The shaded symbols representing each family are not to scale.

Viviane Slon et al., 2017

2017: New sediment DNA retrieval

- Ancient DNA from mammals in sediments from 7 caves in Europe and Asia;
- without fossils;
- 14 to 550 Ka;

- Small particles, especially in fragments of bone and feces (coprolites),

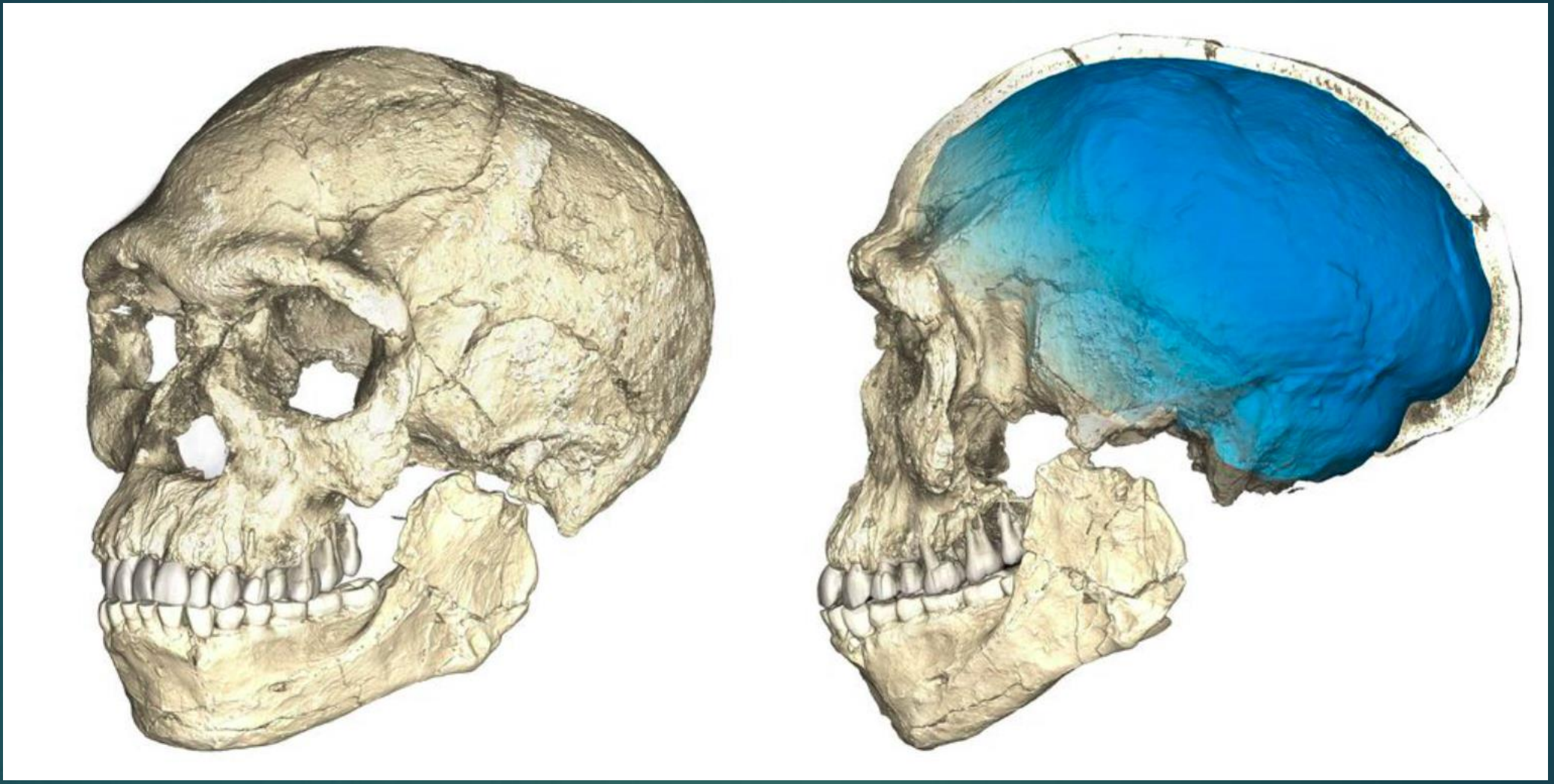
- human DNA in nine of those 85 samples from four of the sites:
  - 9 hominin samples – 8 Ns & 1 D

2017: Morocco, Jebel Irhoud, 315 Ka *H. sapiens*

- Re-excavation of a cave in Morocco where a group of miners found skulls in 1961. Then thought they were Neandertals.
- Oldest *H. sapiens* skull: *Homo sapiens* fossils from Jebel Irhoud, Morocco
- Cranial capacity 1305-1480 cc

Hublin, J.-J. et al. *Nature*(2017).

We’re older than we thought



Reconstructions of the earliest known Homo sapiens fossils based on CT scans of multiple original fossils. (Philipp Gunz, MPI EVA Leipzig, License: CC-BYSA 2.0)

2017: New Jebel Irhoud dating

- The remains dated to 315 ± 34 Ka, which means that our species originated 100,000 years earlier than we thought.
- The previously known oldest *Homo sapiens* fossils from Omo Kibish, Ethiopia, dated at about 233 Ka
- A mosaic: the faces, teeth, and lower jaws of these Moroccan fossils look more modern or specialized, while their braincases have more ancestral features like an elongated shape, of Neanderthals
- Disputes the popular notion that there's an East African 'Eden' or cradle of humanity

Simultaneous hominins

- At 300 Ka, a bush of *Homo* species coexisted:
  - *Homo erectus* in Asia
  - *Homo sapiens* in Europe and Africa
  - *Homo neanderthalensis* in Europe
  - Homo rhodenensis (Broken Hill) in Africa
  - *Denisovans* in Asia
  - *Homo floresiensis* in Flores
  - *Homo luzonensis* in Luzon, Philippines
  - *Homo naledi* in South Africa
  - Thus eight hominin species roamed the planet simultaneously.
- Given that the fossil record always underestimates the number of species, we should expect that our current count is an underestimate

2017: Hominid Findings and Controversies

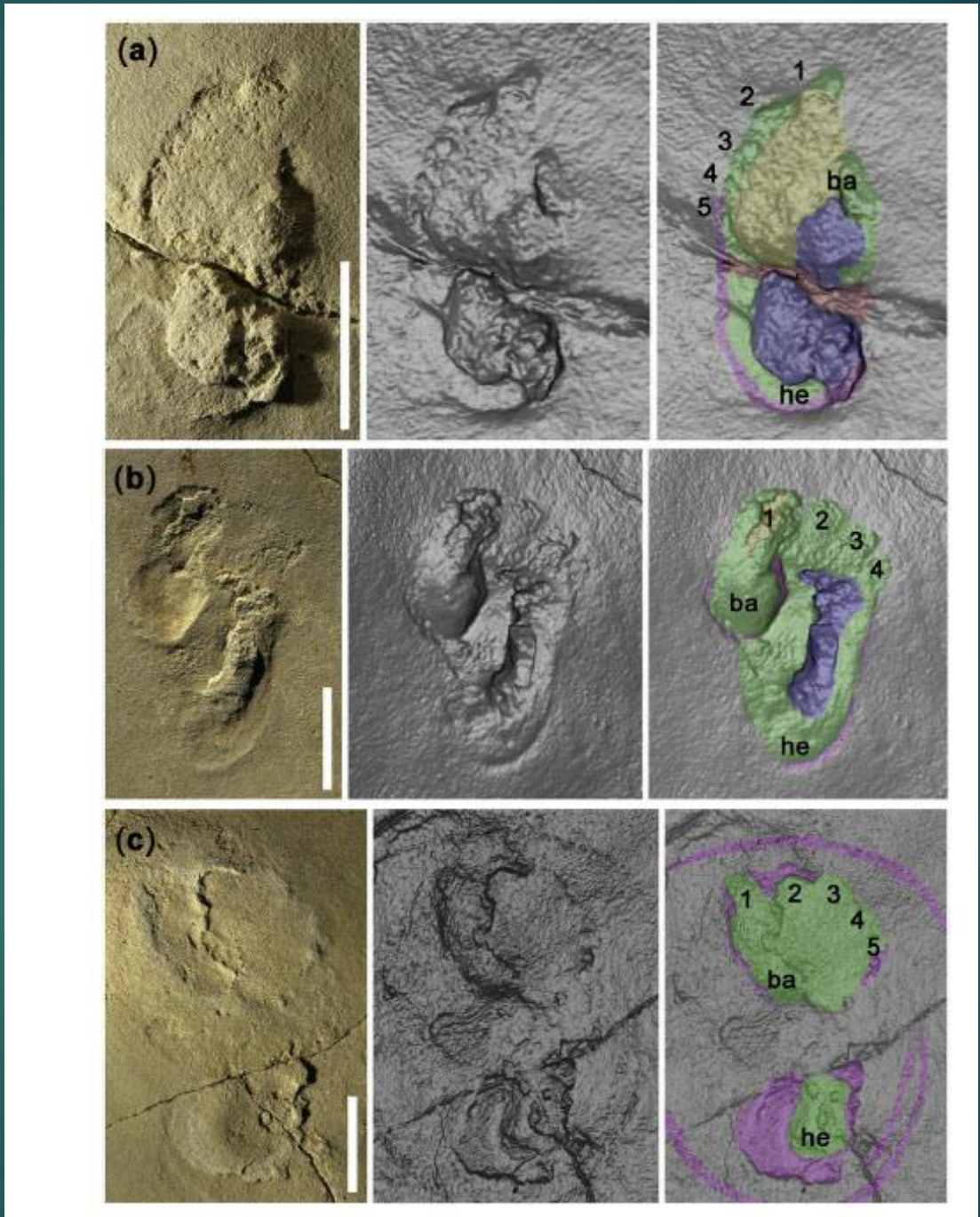
- A single *Graecopithecus* tooth from Bulgaria dating to around 7 Ma might be from the earliest known hominid, and if so, it could suggest that hominids originated in Europe, not Africa.
- 5.7 Ma footprints on Crete: Gierliński et al. (2017) describes fossil footprints from Trachilos in western Crete that are reliably dated to a Late Miocene age of about 5.7 million years. These footprints are from a large bipedal primate with human-like feet.
- The oldest hominin fossils, *Sahelanthropus, Orrorin, & Ar. Kadabba*, do not have fossil feet. All of the early hominins that are older than 1.8 million years have only been found in Africa

2017: 5.7 Mya footprints on Crete

5.7 Mya footprints

Similar to Ardi:
But may indicate how apelike Ardi's feet were.

Bernard Wood:
Miocene ape



2017: Findings and Controversies

- Does this refute the “Out of Africa” story? These footprints differ from those of all other land animals, including the more ape-like feet (without ball and with the big toe sticking out sideways) of the much younger *Ardipithecus ramidus* (prior earliest known feet).
- Or are they made by an European Miocene ape, which convergently evolved a bipedal locomotion. Remember similar claims made about two other fossil apes: *Ramapithecus* (14 Mya, member of *Sivapithecus,* an orangutan fossil) and *Oreopithecus* (9 Mya, parallel evolution of bipedalism).
- Tim White: “tries to resurrect Begun’s tired argument with a long-known crappy fossil, newly scanned”.

MHs arrive in Australia at 65 Ka

- **Humans arrived in Australia 65,000 years ago:** a new excavation at an aboriginal rock shelter called Madjedbebe in northern Australia; stone tools

- This find overturns the hypothesis that *Homo sapiens* drove the megafauna of Australia to extinction soon after they arrive; they died off circa 45 Ka;

- More evidence of earlier out of Africa migrations

Southern California in 130 Ka??

- Holen et al. (2017) in the journal *Nature:* Damaged mastodon bones in southern California dated to about 130,000 years ago are argued to be the result of humans smashing them with stones in an effort to extract the bone marrow.
- If shown to be the case, this finding would radically change the current archaeological consensus about the peopling of the Americas approximately 15,000–20,000 years ago.

- A highly controversial finding.

New DNA discoveries in 2017

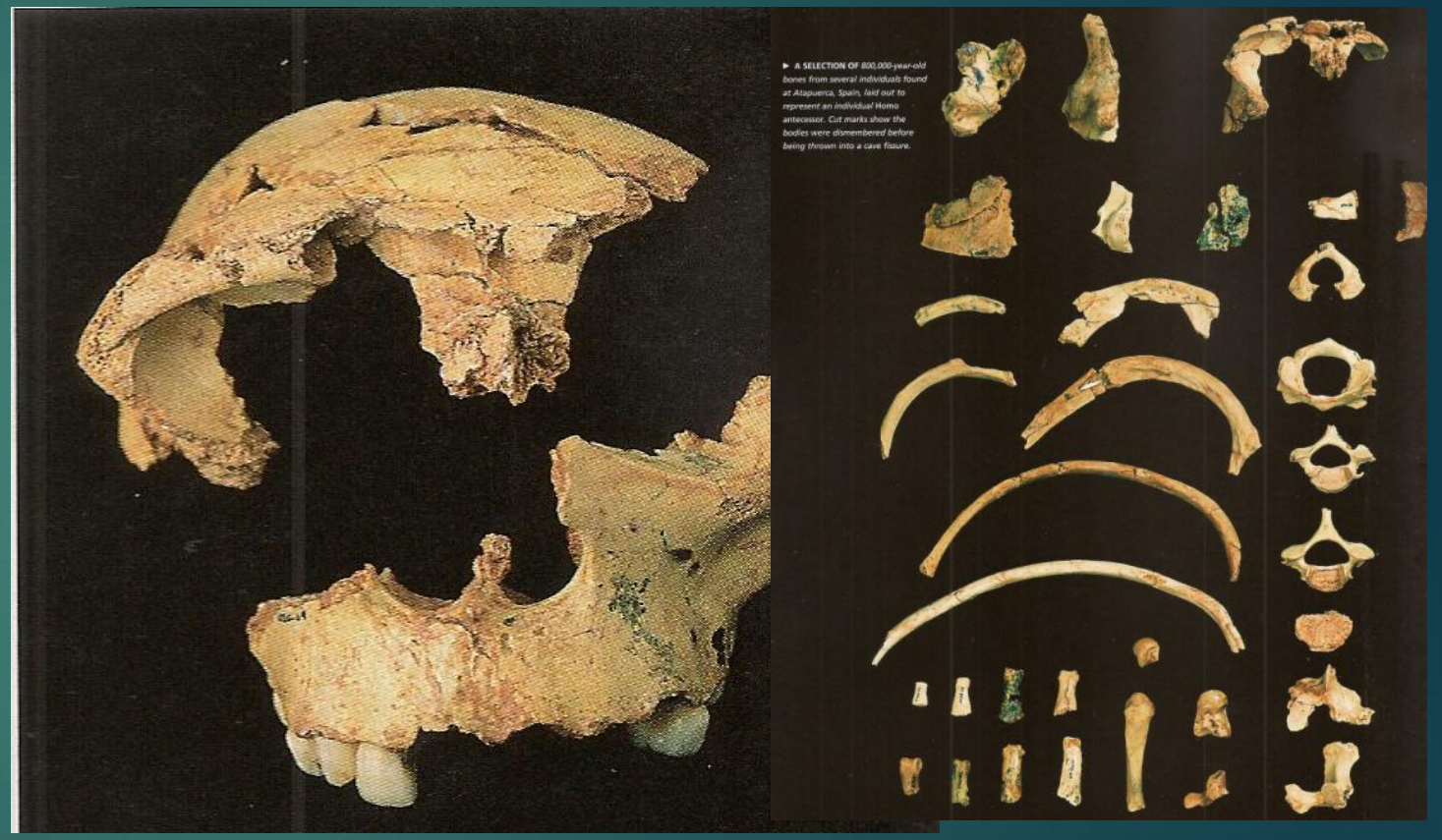
- African Modern humans interbred with Neanderthals in the Hohlenstein-Stadel cave (HST) in Germany more than 270,000 years ago.
- The mtDNA from the Hohlenstein-Stadel sample was highly divergent from those of other coexisting Neanderthal groups.
- Implication of this interbreeding is that Late Pleistocene Neandertal mtDNA may have been replaced by more fit African MH mtDNA

Cosimo Posth,, et al., 2017

Homo antecessor

Homo antecessor: oldest direct fossil record of the presence of *Homo* in Europe in 1994

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



1994: *Homo antecessor*

Homo antecessor

Gran Dolina: Homo antecessor

Teeth were pr of the nasal region and the presence of a facial depression above the canine tooth called the canine fossa—were modern

Homo antecessor

- On July 8, 1994, discovery of Homo antecessor (“Progenitor”), at Gran Dolina; 80 fossils belonging to six hominid individuals; incomplete skull of a juvenile from Gran Dolina, in Atapuerca, Spain.

- *H. antecessor* may have evolved from a population of *H. erectus* living in Africa more than 1.5 million years ago and then migrated to Europe

- Antecessor had a modern face; robust torso

- Originally researchers claimed they were the ancestors of both the Neanderthals and *Homo sapiens*

Homo antecessor

- Species name was highly debated with many considering the remains to be *Homo heidelbergensis*.
- 200 Oldowan stone tools
- 160 hominin fossil remains, all attributed to a single species, *H. antecessor*.
- 15 individuals, ages 3 to 20, share many physical similarities with *Homo erectus*
- Recent analysis: *H. antecessor* is sister group of LCA of Ns and MHs

Homo antecessor

- Atapuerca, Gran Dolina, Spain: 2nd oldest site in Europe
- Homo antecessor male would have stood approximately 5”2”- 5’9” (1.6-1.8 meters) tall, weighing around 90 kg.
- Cranial capacity: 1,000-1,150 cc

2018 First Direct Dating of *Homo antecessor:* ~860 Ka

- Direct dating of a fossil tooth of *Homo antecessor* from the unit TD6 of the archaeological site of Gran Dolina in the Sierra de Atapuerca (Burgos, Spain).
- In the work, a time range of between 772 and 949 Ka was found for this species of the Lower Pleistocene,
- Makes it the oldest known fossil human species in Western Europe

Mathieu Duval, et al., 2018

Homo antecessor: 170 fossils, 8-11 individuals

Crédito: Roberto Sáez (izd y ctr), Mario Modesto, en Martinón-Torres M et al, 2019 (dch arr) y Emiliano Bruner et al, 2017 (dch abj)

Homo antecessor

- The Gran Dolina site is the oldest temporary camp in Europe.
- Now 8-11 individuals; Mostly children and teenagers; most of the features tying *H. antecessor* to modern people were found in juveniles
- Oldest evidence of human cannibalism: evidence of butchering (cutmarks, dismembering, skinning, defleshing); hominin fossils mixed in with food debris

Dental enamel proteome of *H. antecessor*

Tooth ATD6-92 of Homo antecessor (Gran Dolina). Credit: Welker F, Ramos-Madrigal J, Gutenbrunner P et al (2020). The dental proteome of Homo antecessor. Nature

Dental enamel proteome of *H. antecessor*

- Dental enamel proteomes of *H. antecessor* from Atapuerca (Spain) and *Homo erectus* from Dmanisi (Georgia),

- Evidence that, including modern humans, Neanderthals and Denisovans. *H. antecessor* is a close sister lineage, and not the LCA, to subsequent Middle and Late Pleistocene hominins

- This placement implies that the modern-like face of *H. antecessor*—that is, similar to that of modern humans—may have a considerably deep ancestry in the genus *Homo*, and that the cranial morphology of Neanderthals represents a derived form

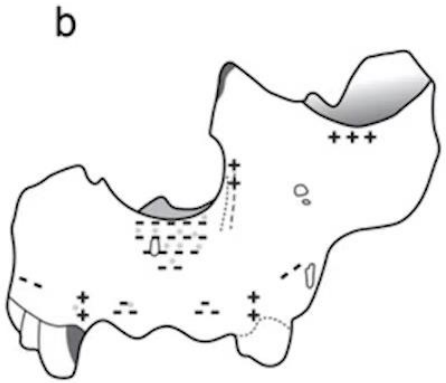
2022: 1.4 Ma jawbone

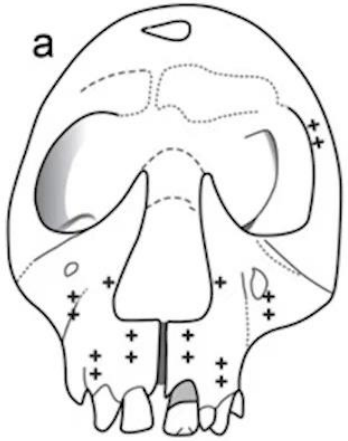
- 1.4 Ma: Oldest known human fossil in Europe
- Sima del Elefante, Atapuerca: maxilla & 1 tooth
- Prior 2008 mandible at same site = 1.2 Ma
- Both considered H. antecessor; both with modern flat face

Homo antecessor: The oldest modern face

Homo antecessor

Homo sapiens

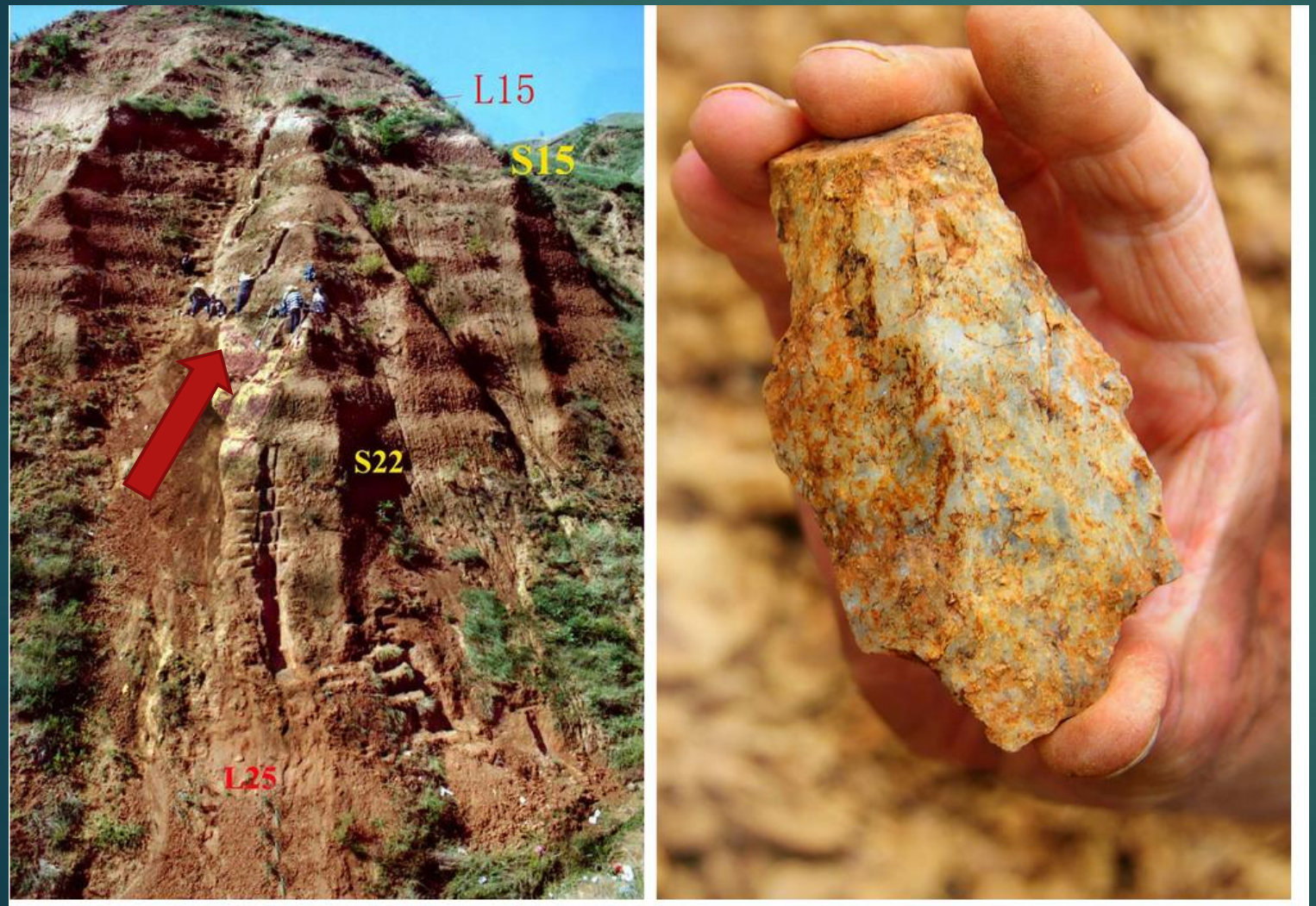




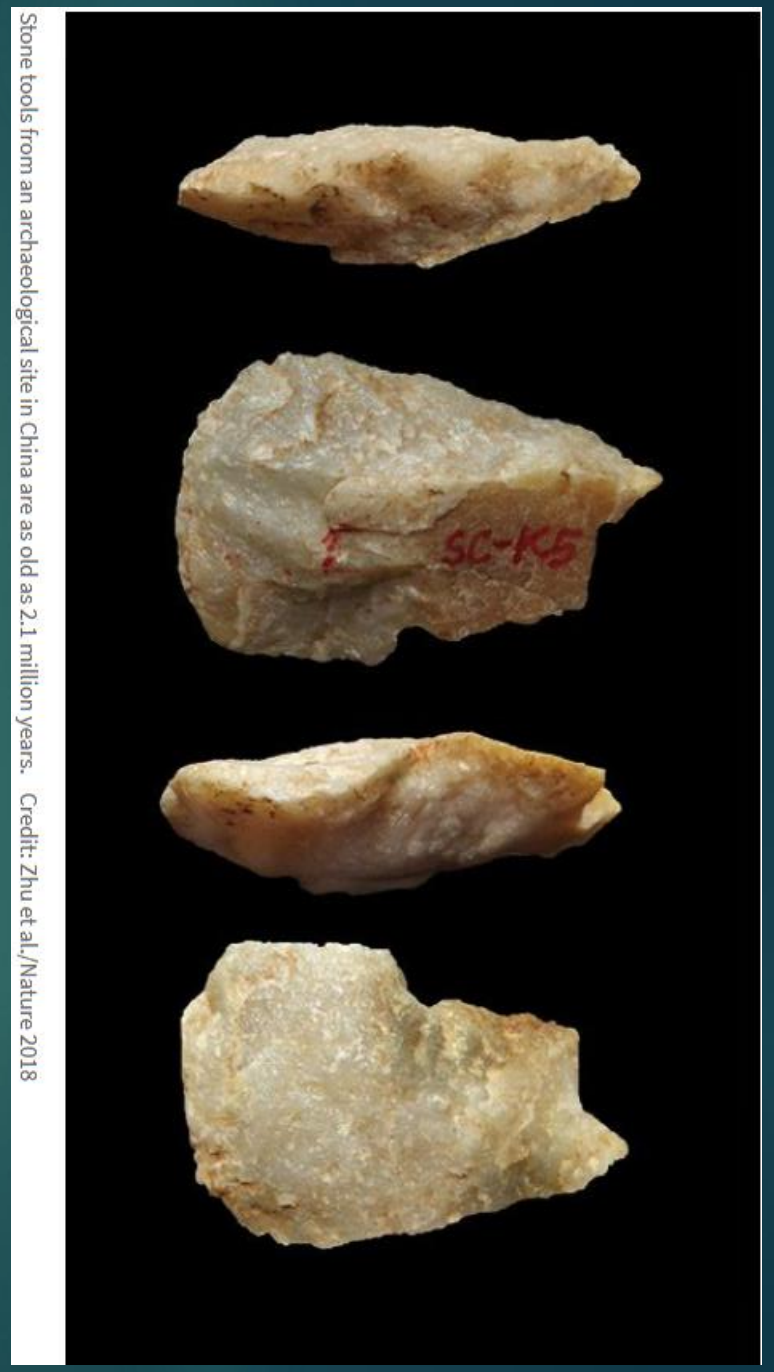
Homo ergaster

Its delicate cheekbones and flattened features are similar to those seen in living humans and are unlike the heavily built faces of Neanderthals. “Our so-called modern face is an ancient face,” says Chris Stringer

July 2018: Chinese stone tools dated to 2.1 Ma; Shangchen, Lantian region, China



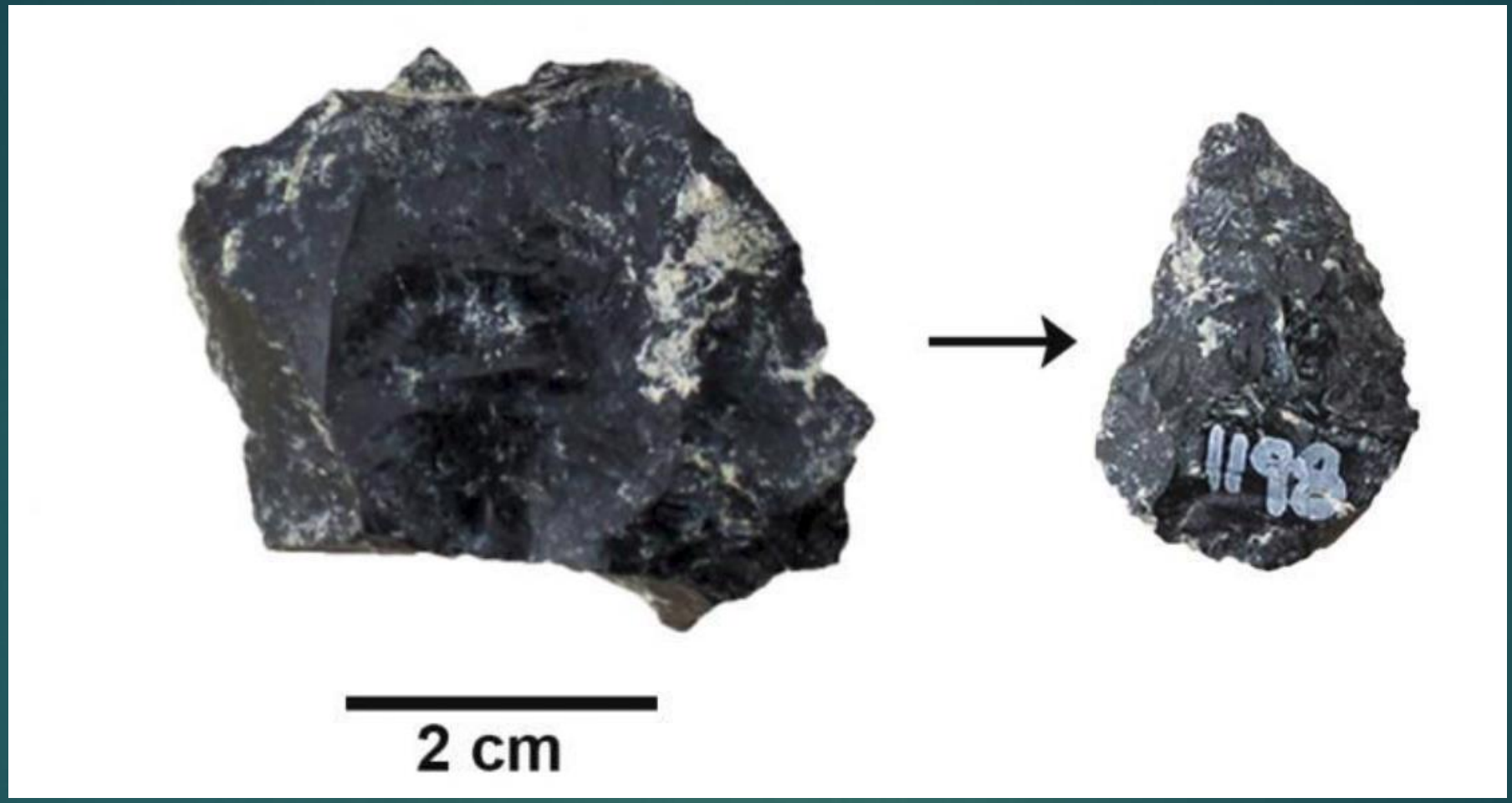
One of the 2.1 million-year-old artifacts, right, recovered from a gully in western China, left, suggest that hominins may have left Africa far earlier than previously believed. Zhaoyu Zhu



Stone tools from an archaeological site in China are as old as 2.1 million years. Credit: Zhu et al./Nature 2018

July 2018: Chinese stone tools dated to 2.1 Ma; Shangchen, Lantian region, China; only identified as unspecified *Homo*

African obsidian: Social Networking Isn't New



Obsidian from Olorgesailie, Kenya revealed that social networks existed long before we thought.

2018: Social networking of tool sources

- In 2018, scientists discovered that social networks were used to trade obsidian, valuable for its sharp edges, by around 300 Ka.

- Stone tools from southern Kenya: the stones chemically matched to obsidian sources in multiple directions of up to 55 miles away.

- There was a shift from the larger and clunkier tools of the Acheulean, to the more sophisticated and specialized tools of the Middle Stone Age (MSA). The MSA tools were dated to 320 Ka, the earliest evidence of this kind of technology in Africa.

2018 study of Olorgesailie site in southern Kenya

- Study concluded the obsidian was traded in social networks; team found red and black rocks (pigments) used for coloring material in the MSA sites, indicating symbolic communication;

- All of these innovations occurred during a time of great climate and landscape instability and unpredictability, with a major change in mammal species (about 85%).

2018: Misliya-1, Israel, 177-194 Ka, early modern *H. sapiens*

- One of oldest fossils of modern humans outside Africa have been discovered in Mt. Carmel, Israel: MH mandible, dubbed Misliya-1, revealing that its owner lived between 177 to 194 Ka

- With fire hearths; stone tools of Levallois technique; large animals

- Migration out of Africa via Nile Valley and the eastern Mediterranean coast — and not through the southern route — the Bab el Mandeb Strait, the southern coast of Saudi Arabia, the Indian subcontinent, East Asia

Israel Hershkovitz, et al., Science, 2018

Oldest known human fossil outside Africa discovered in Israel

177-194 Ka

2018: Al Wusta-1 *Homo sapiens* phalanx. The oldest directly dated fossil at 85 Ka of our species in Arabia: beyond Africa and the Levant/adjacent Mediterranean basin.

2018 discoveries: New dating system for South African caves

- South African record has often been considered undatable compared to East Africa where volcanic ash layers allow for high resolution dating.
- Cradle of Humanity in South Africa has produced 40% of all known human ancestor fossils
- The flowstones in the caves can act almost like the volcanic layers of East Africa, forming in different caves at the same time, allowing us to directly relate their sequences and fossils into a regional sequence
- South Africa's hominin record is a fair-weather friend: The fossil record of early hominins in South Africa is biased towards periods of drier climate

Robyn Pickering, et al., 2018

2019 Flowstone dating of Cradle caves

- 2019: U–Pb-dated flowstones restrict South African early hominin record to dry climate phases, between 3.2 and 1.3 Ma

- 29 flowstones, from eight caves, and found that the flowstones all date to the same six narrow time windows. For example, 2 million years ago, all the important cave sites across the Cradle were closed – nothing was being washed into them – with flowstone forming inside them. This represents wetter periods and correspond to predominantly closed caves.

Robyn Pickering, et al., 2019

2018 discoveries: New dating system for South African caves

- Fossils in these caves date to six narrow time-windows between 3.2 and 1.3 million years ago;
- Cradle experienced big changes in local climate, from wetter to drier conditions, at least six times between 3 and 1 million years ago.
- Flowstones can only grow in caves during wet times, with more rain outside. Flowstones formed only in times of increased rainfall.
- We therefore know that during the times in between, when the caves were open & fossils were deposited, the climate was drier. Skewing our interpretation.

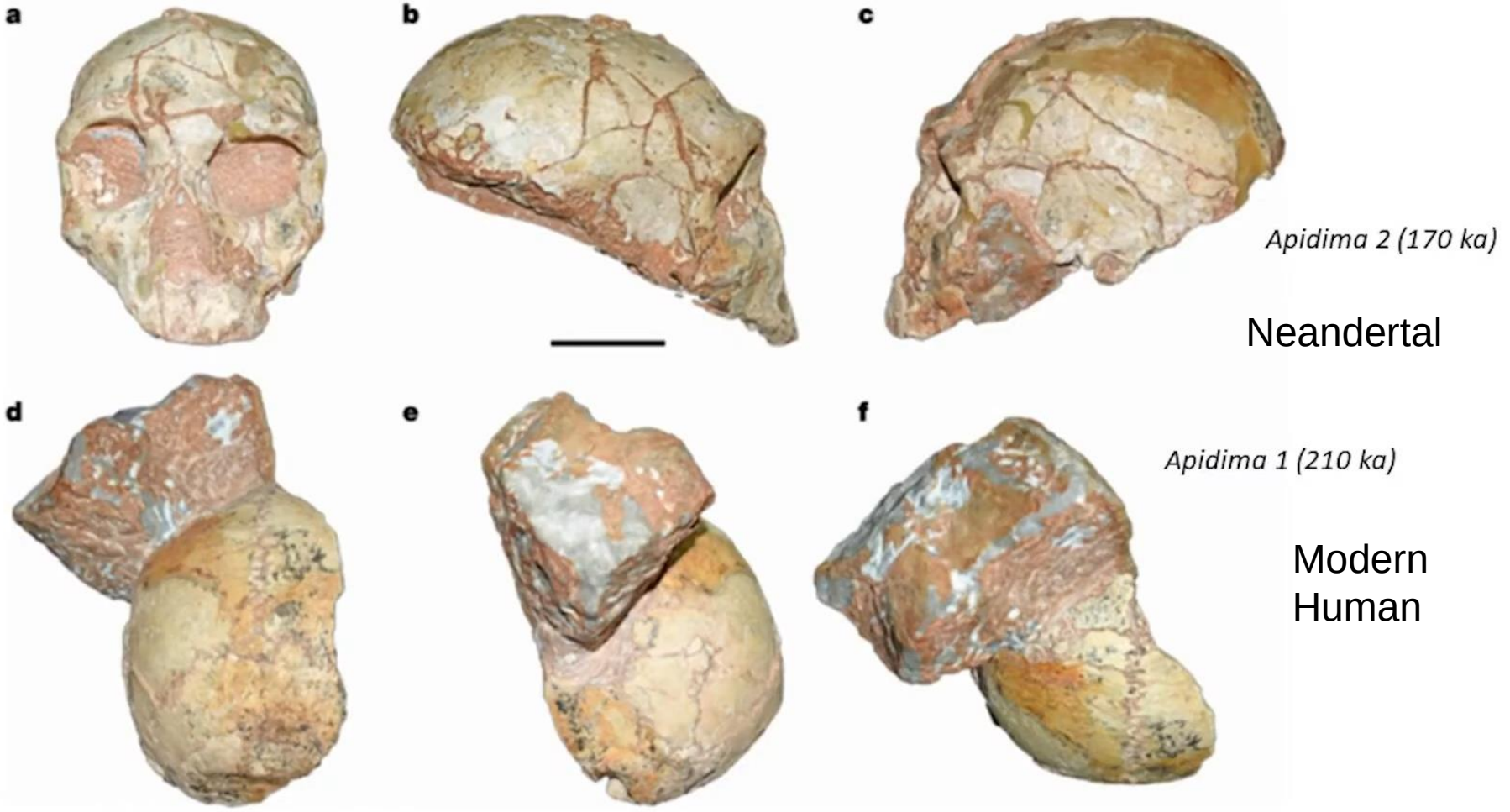
Apidima, Greece: Found centimeters close, but different species & dates: H. sapiens (210 Ka) & H. neanderthalensis (170 Ka)

MH

N

Apidima 1 (left) is a modern human; Apidima 2 (right) is a Neanderthal.Katerina Harvati / Eberhard Karls

When did H. sapiens really arrive in Europe?



Crédito: Harvati K et al (2019)

2019: Adipima 1 = *H. sapiens*, 210 Ka

- 3D reconstructions:
  - They digitally reconstructed Apidima 2 – a Neandertal. 170 Ka.
  - For Apidima 1, half of the rear of a skull case, *H. sapiens*, 210 Ka.

- The range of ages could be explained by the skulls mixing together in a mudflow that later solidified in the cave.

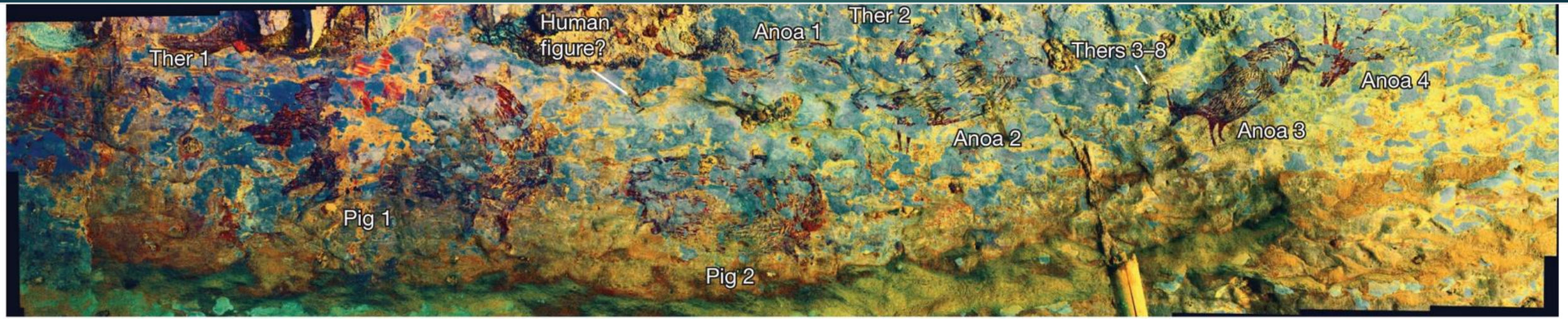
- But W. Sharp of UCB: samples actually returned dates ranging from more than 300 to less than 40 Ka

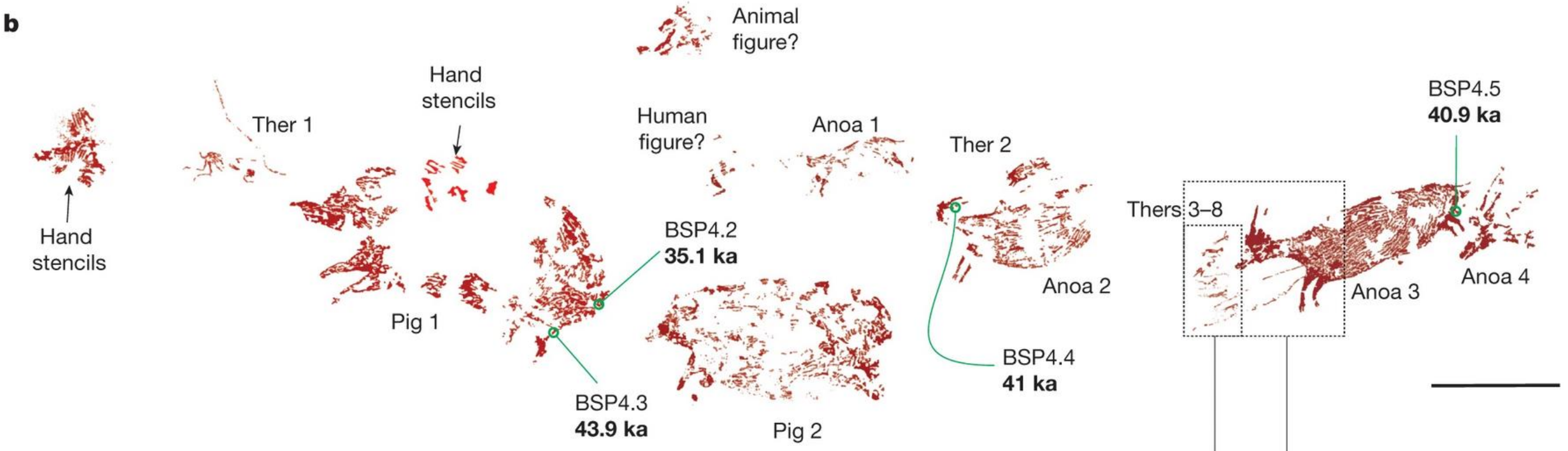
2019 - Chimpanzees: tool use – cracking nuts – anvil method

2019: Tool use and hunting in chimpanzees

- Chimps use tools:
  - use tree roots as anvils for cracking hard nuts with stone or wood hammers;
  - some hammers brought from 100 meters away;
  - females engage in such tool use more frequently than males;
  - if females hunt, share more than males
- Male chimps hunt red colobus monkeys; chaotic male bands, not really cooperative; although meat is shared; and no meat exchange for sex
- 2019: Bonobos hunt Weyn's duikers in female-led groups; female control of carcasses is frequent but not exclusive, and meat sharing in bonobos is primarily passive but not without aggression.

43,900 years old 4.5-meter-long panel: in southern Sulawesi, Leang Bulu'Sipong 4 cave



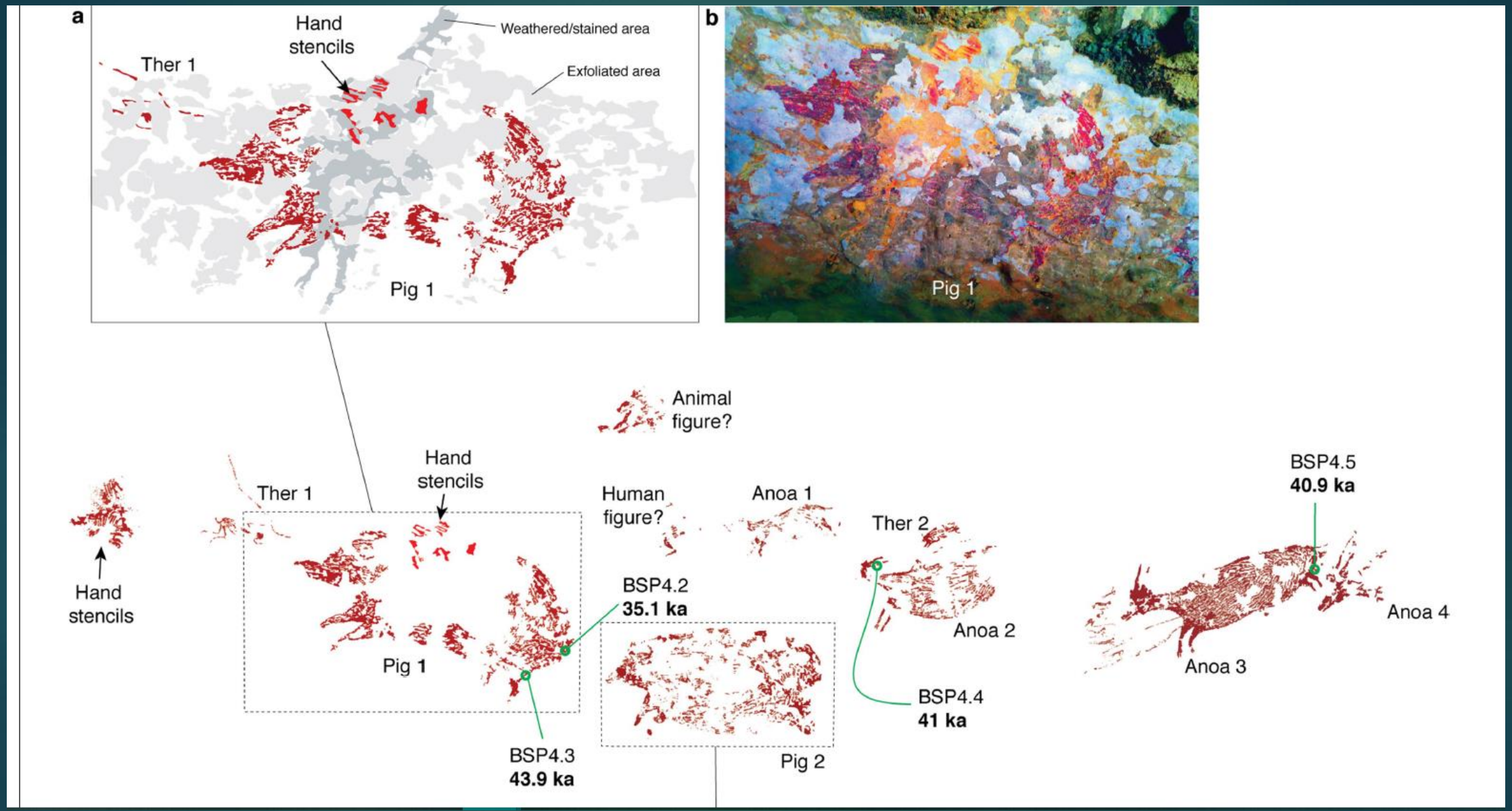


Oldest figurative artworks

- A cave-wall depiction of a pig and buffalo hunt is the world's oldest recorded story, on the Indonesian island Sulawesi. The scene is more than 43,900 years old.

- 4.5-metre-long panel features reddish-brown forms that seem to depict human-like figures hunting local animal species

- The panel seems to depict wild pigs found on Sulawesi and a species of small-bodied buffalo, called an anoa. These appear alongside smaller figures that look human but also have animal traits such as tails and snouts.

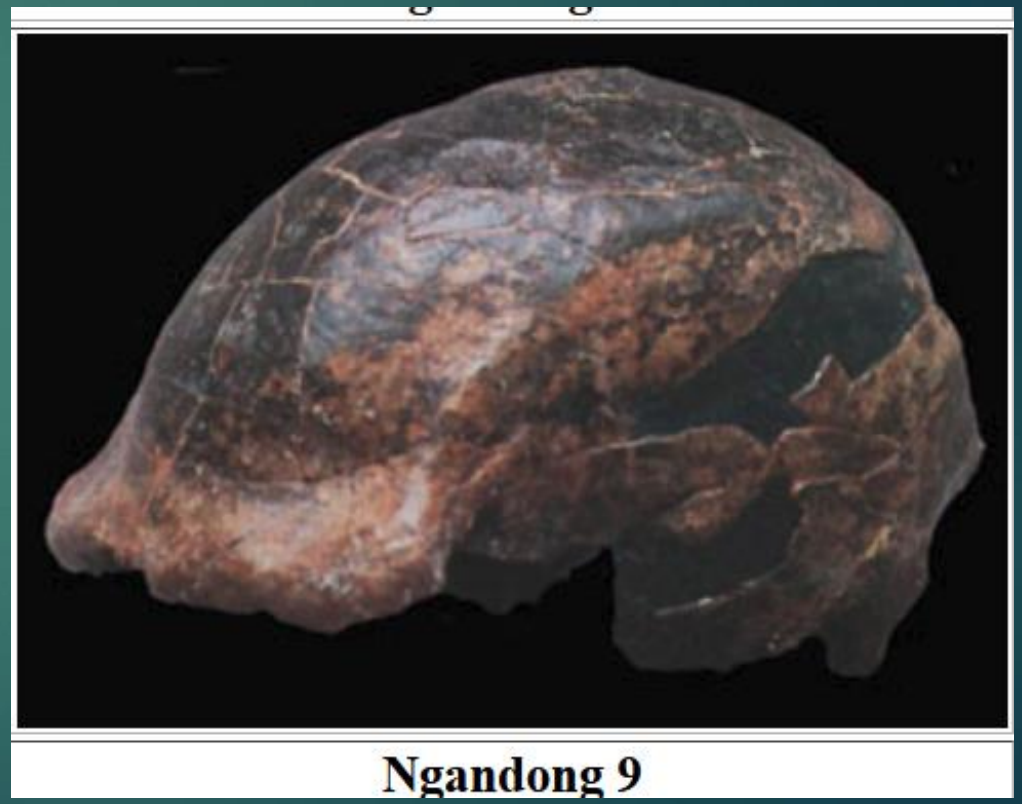

a
Hand stencils
Ther 1
Weathered/stained area
Exfoliated area
Pig 1
b
Pig 1
Animal figure?
Hand stencils
Ther 1
Hand stencils
Human figure?
Anoa 1
Ther 2
BSP4.5
40.9 ka
Hand stencils
BSP4.2
35.1 ka
Anoa 2
Anoa 4
Pig 1
Anoa 3
BSP4.4
41 ka
BSP4.3
43.9 ka
Pig 2

Oldest artwork: 44 Ka, cave in southern Sulawesi called Leang Bulu’Sipong 4

A section of the ancient cave art discovered in Indonesia that depicts a type of buffalo called an anoa, at right, facing several smaller human–animal figures. Credit: Ratno Sardi

2019: Dating Ngandong *Homo erectus*

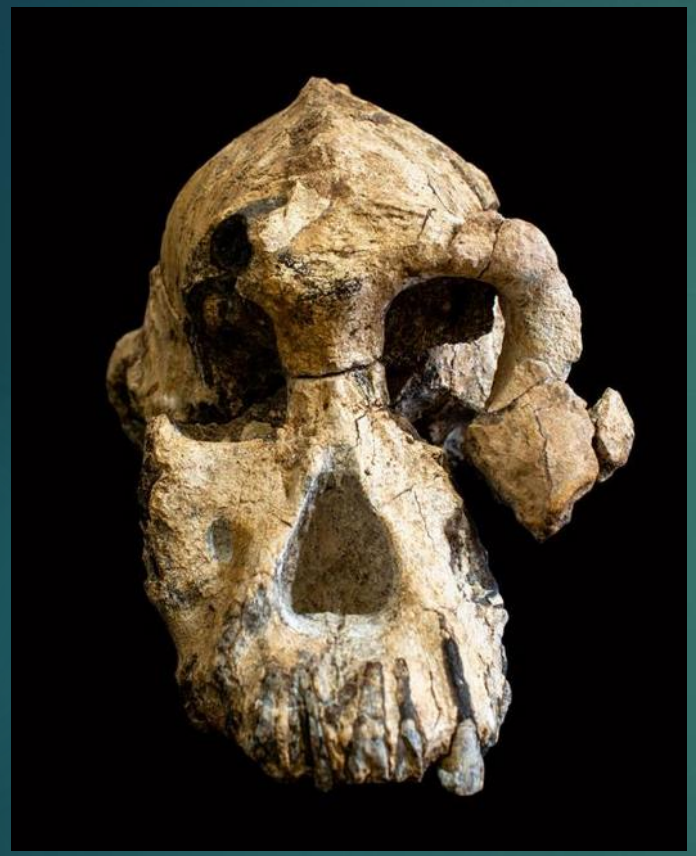
- Ngandong and Sambungmacan, the last surviving *H. erecti*.
- Newly dated to ~143 ka.



Indriati et al. (2011)

2019: MRD Cranium (MRD-VP-1/1): An *eureka* moment, finding a cranium for *Australopithecus anamensis:* 3.9 Ma

2019: *A. anamensis*, MRD-VP-1/1



- Yohannes Haile-Selassie, et al., 2019
- Beverly Z. Saylor, et al., 2019

- The first complete skull of a male *Australopithecus anamensis* surfaced at Miro Dora (MRD), Woranso-Mille, in Ethiopia's Afar region, in 2016; 35 miles from where Lucy was found.
- It is oldest skull ever found of an *australopithecine*, at 4.2-3.9 Ma
- MRD is the first specimen to shed light on the full cranial anatomy of the earliest known australopiths

2019: Australopithecus anamensis

- Until this find was announced in 2019, researchers had only found bits and pieces of this species from various sites across Ethiopia and Kenya.

- It challenges the previous assumption that *A. anamensis* was the direct ancestor of the species *Australopithecus afarensis*—to which the famous fossil “Lucy” belongs.

- Thanks to this skull, we now know that the two species overlapped in time.

Found in 2 separate pieces

Contemporaries: *A. africanus*, *Paranthropus and H. erectus*

- 2020: fossils of both *Paranthropus robustus* (DNH 152) and *Homo erectus* (DNH 134) dating to between ~2.04 and 1.95 Ma, making these the oldest fossils of both of these hominin species. Earlier origin of *Homo erectus* by 150-200 Ka

- These finds demonstrate the contemporaneity of these two species at this site with *Australopithecus africanus*

- Another example of multiple contemporaneous African hominin species

2021: New archaic MH fossil:
120-130 Ka: More muddle in middle

Conventional thinking is that only *H. sapiens* lived in the Levant at 130 Ka; the earliest conclusive evidence of Neanderthals being there is from 70 Ka

New Nesher Ramla *Homo*: The look of a primitive Neanderthal, with a modern Levallois stone toolkit.

Controversial theory: Was it the earliest known Neanderthal in the Middle East, or a late remnant of a previously unknown Neanderthal ancestor? Too young to be N ancestor

I. Herskovitz *et al., 2021*

Very large teeth; No chin

- Mix of Neanderthal-like and archaic features (*H. erectus*);; does not look like early or late Neanderthals in the Middle East or Europe.

2022: Surgical amputation of a limb 31,000 years ago in Borneo:

Distal third of their left lower leg surgically amputated, probably as a child; lived for 6-9 years in East Kalimantan, Borneo

T. Maloney, et al., 2022

2022: Modern human incursion into Neanderthal territories 54,000 years ago at Mandrin, France

- Hominin fossils from Grotte Mandrin in France that reveal the earliest known presence of modern humans in Europe between 57 Ka and 52 Ka. 852 stone artifacts; 196 nanopoints with high impact damage
- The first alternating occupation of Neanderthals and modern humans, with a modern human fossil and associated Neronian lithic industry found stratigraphically between layers containing Neanderthal remains associated with Mousterian industries.
- At least four alternating phases of replacement, with Neanderthals occupying the area
- Up to ~54 ka, a modern human incursion at around 54 ka, Mandrin E (based on type of stone tools & 1 MH molar), followed by Neanderthal reoccupations and a second modern human phase from ~44 to 42 ka. (Mandrin B1) onward. This succession also represents the first known archeological evidence in Europe for the interstratification of a modern human occupation between those of Neanderthals (Mandrin E versus Mandrin F and Mandrin D).

Ludovic Slimak, et al., 2022

Earliest MHs in Europe: 54-40 Ka

2023 Mandrin study: bows and arrows were first used in Europe by *Homo sapiens* when they arrived there at ~54 Ka

.At Mandrin, France, level E: According to experiments, ancient stone points found in Mandrin E level were so little that they could only be used as arrowheads when shot from bows

CJV: another Châtelperronian controversy?

Metz, L., Lewis, J. E., & Slimak, L. (2023). Bow-and-arrow, technology of the first modern humans in Europe 54,000 years ago at Mandrin, France. *Science Advances*, *9*(8),


IX
11
12
13
14
IX
Châtelperronian
1
2
3
4
5
6
7
8
9
10
X
1 cm
11
12
13
14
15
16
17
18
19
21
22
20
1
2
3
4
5
X
6
7
8
9
10
11
12
15
13
14
16
1 cm
X
White-tailed eagle,
Pygargue à queue blanche
Haliaeetus albicilla

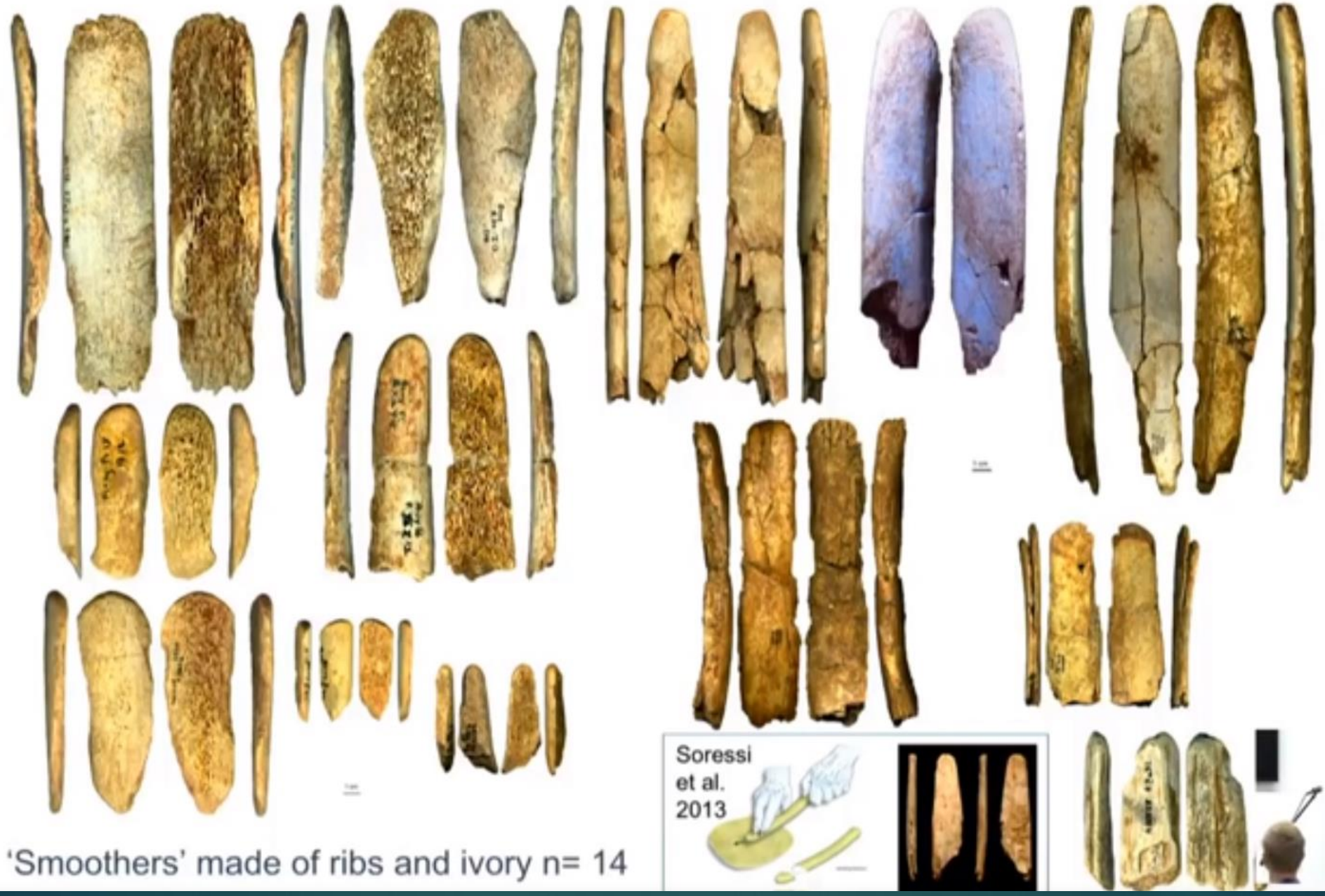
Châtelperronian Tool debate x 20 years

- 20-year debate as to whether last Neandertals or AMHs created the tools & jewelry at Grotte du Renne at Arcy-sur-Cure, France. Long assumption that Ns were incapable of producing UP tools.
- At this site the Châtelperronian is stratigraphically associated with Neandertals.
- Hypotheses explaining this association range from “acculturation” by AMHs, to independent development of such artifacts by Neandertals, to movement of pendants and bone artifacts from the overlying Aurignacian into the Châtelperronian layers, or to movement of the hominin specimens from the underlying Mousterian into the Châtelperronian layers.
- 2016 study using proteinomic analysis and mtDNA definitively prove that hominins in same layer are Ns.


1 cm


a
b
c
d

Grotte du Renne, Levels VIII-X, Châtelperronian



'Smoothers' made of ribs and ivory n= 14

2022 No sustained increase in zooarchaeological evidence for meat eating after the appearance of *Homo erectus*

- The evolution of larger brain is commonly linked to a major dietary shift involving increased consumption of meat.
- Early archaeological sites preserving evidence of carnivory predate the appearance of *H. erectus*, but larger, well-preserved sites of meat consumption only appear after the arrival of *H. erectus*.
- This qualitative pattern is a key tenet of the "meat made us human" viewpoint,
- New analysis shows no sustained increase in the relative amount of evidence for carnivory after the appearance of *H. erectus*, calling into question the primacy of carnivory in shaping its evolutionary history.

W. Andrew Barr, et al. 2022

Carnivory sampling error

- New Analysis: a quantitative synthesis of the zooarchaeological record of eastern Africa from 2.6 to 1.2 Ma.
- Sampling error: The prevalence of hominin carnivory are all strongly related to how well the fossil record has been sampled
- *** When correcting for sampling effort, there is no sustained increase in the amount of evidence for hominin carnivory between 2.6 and 1.2 Ma.
- These findings undercut evolutionary narratives linking anatomical and behavioral traits to increased meat consumption in *H. erectus*, suggesting that other factors are likely responsible for the appearance of its human-like traits.

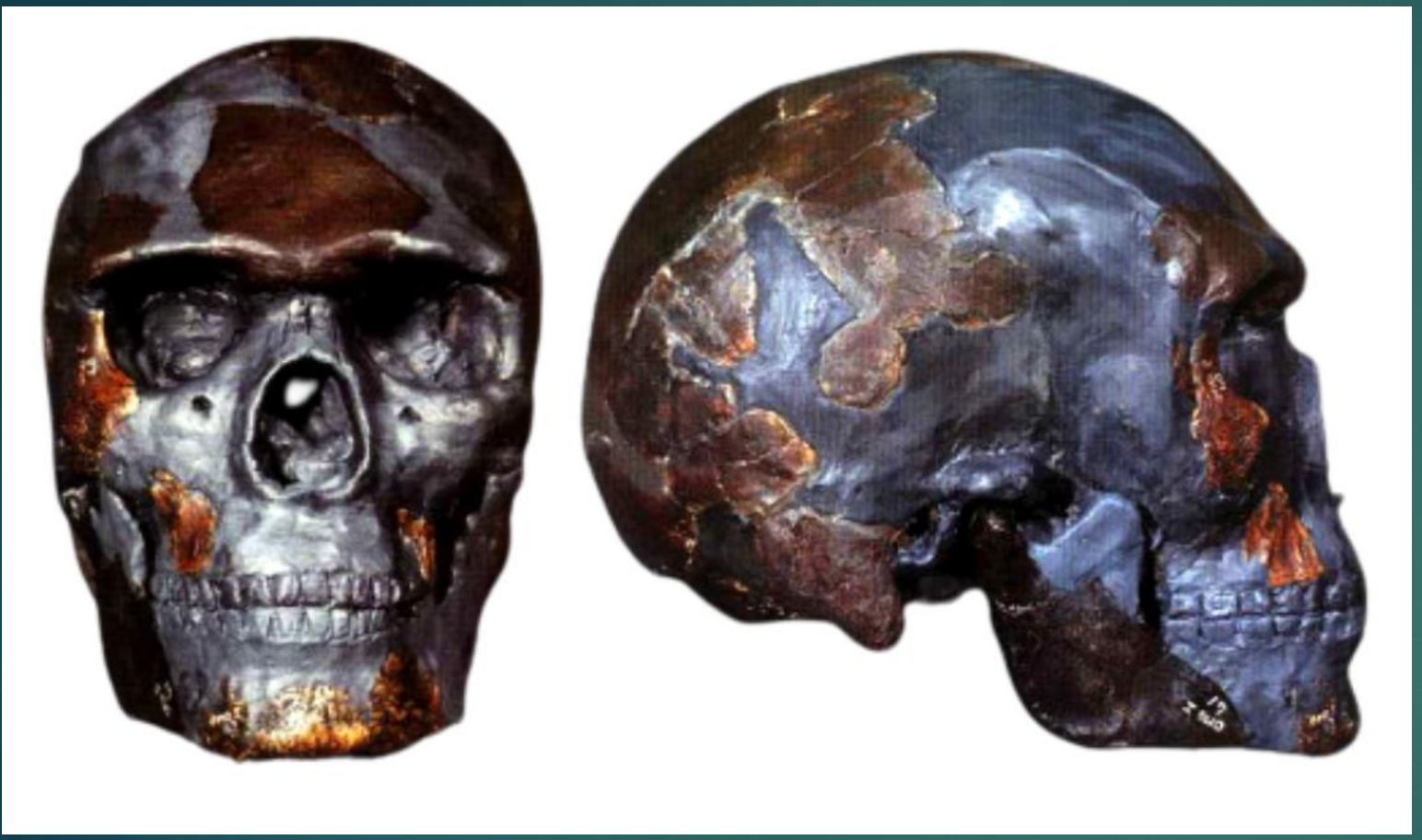
2022: New dating of the oldest known *Homo sapiens* from eastern Africa: Omo = 233 Ka

- Traditional dating: Omo-Kibish and Herto in Ethiopia: 197 Ka for the Kibish Omo I, and around 160–155 Ka for the Herto hominins.

- New dating: geochemical analyses that link the Kamoya's Hominid Site (KHS) Tuff, which conclusively overlies the member of the Omo-Kibish Formation that contains Omo I, obtained a new minimum age for the Omo fossils of 233 ± 22 ka..

Céline M. Vidal, et al., 2022

The dating of the Omo 1 skull (Ethiopia), the 2nd oldest Homo sapiens fossils, has been revised. It is now at least 233 ka (previously 197 ka),



Four different Australopithecus crania from the Sterkfontein caves, South Africa.

- 2022: two studies: dueling dates

New dating: The Sterkfontein cave fill and fossils was dated to 3.4 to 3.6 million years ago, far older than previously thought.

The new date would have overturned the long-held concept that South African Australopithecus is a younger offshoot of East African Australopithecus afarensis.

But more recent study, using faunal dating (size of the teeth of *Theropithecus oswaldi*), determined that there is no evidence that any of the South African cave sites are older than about 2.8 million years. Lucy is still older than Mrs. Ples

Svante Pääbo: Nobel Laureate in Physiology & Medicine, 2022

Arctic Desert: Kap Kobenhavn Formation in northern Greenland today

This region today is barren and home to moss, lichen, and muskox.

Today preserves sediments from both land and a shallow ocean-side estuary.

2023: Greenland at 2 Ma: New study “A tour de force. Simply astounding”

An illustration of the Kap Kobenhavn Formation in northern Greenland two million years ago, when it was covered with poplar and birch forests and populated with mastodons.

Mineral surfaces adsorbs and preserve aDNA

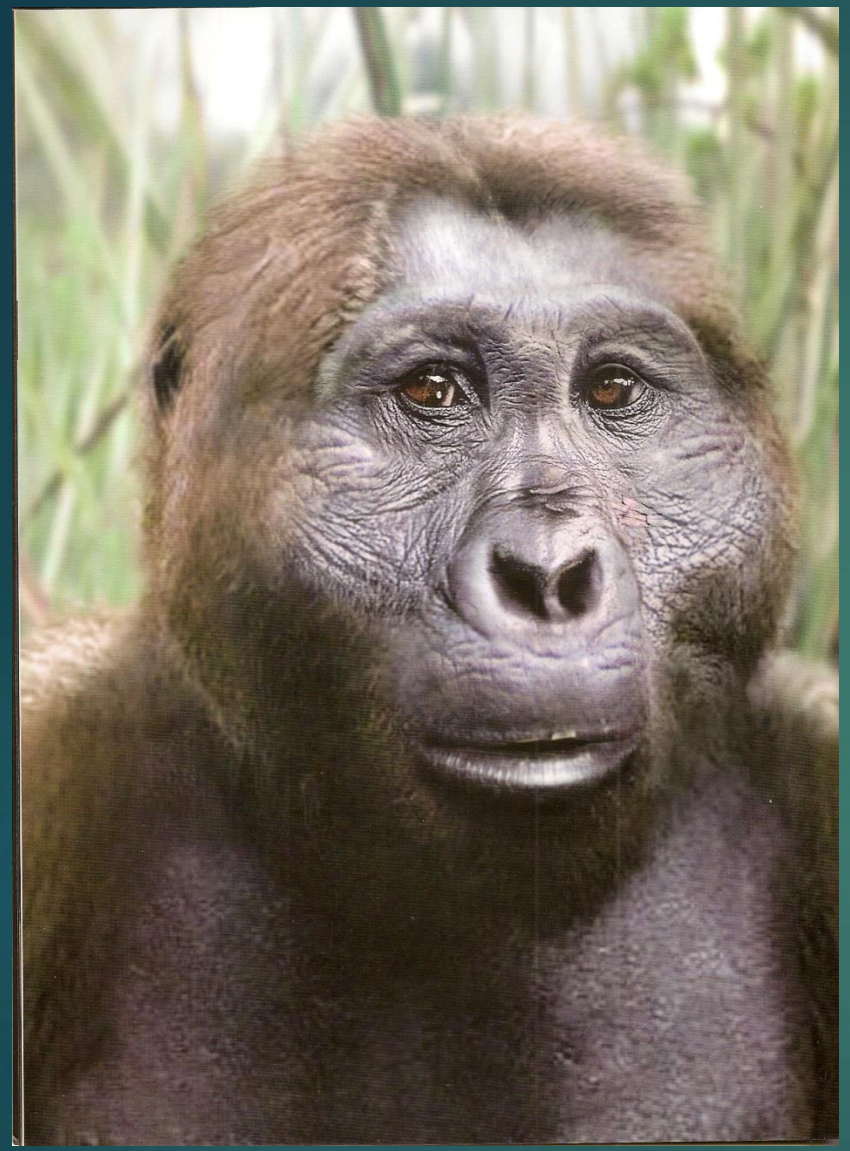
- Extracted DNA from 41 organic-rich sediment samples at five different sites within the Kap København Formation, Greenland. Screened nearly 3 billion of these “reads” against libraries of living species.

- The marine depositional environment favored adsorption of DNA on the mineral surfaces (clay minerals, the mineral smectite, and quartz).

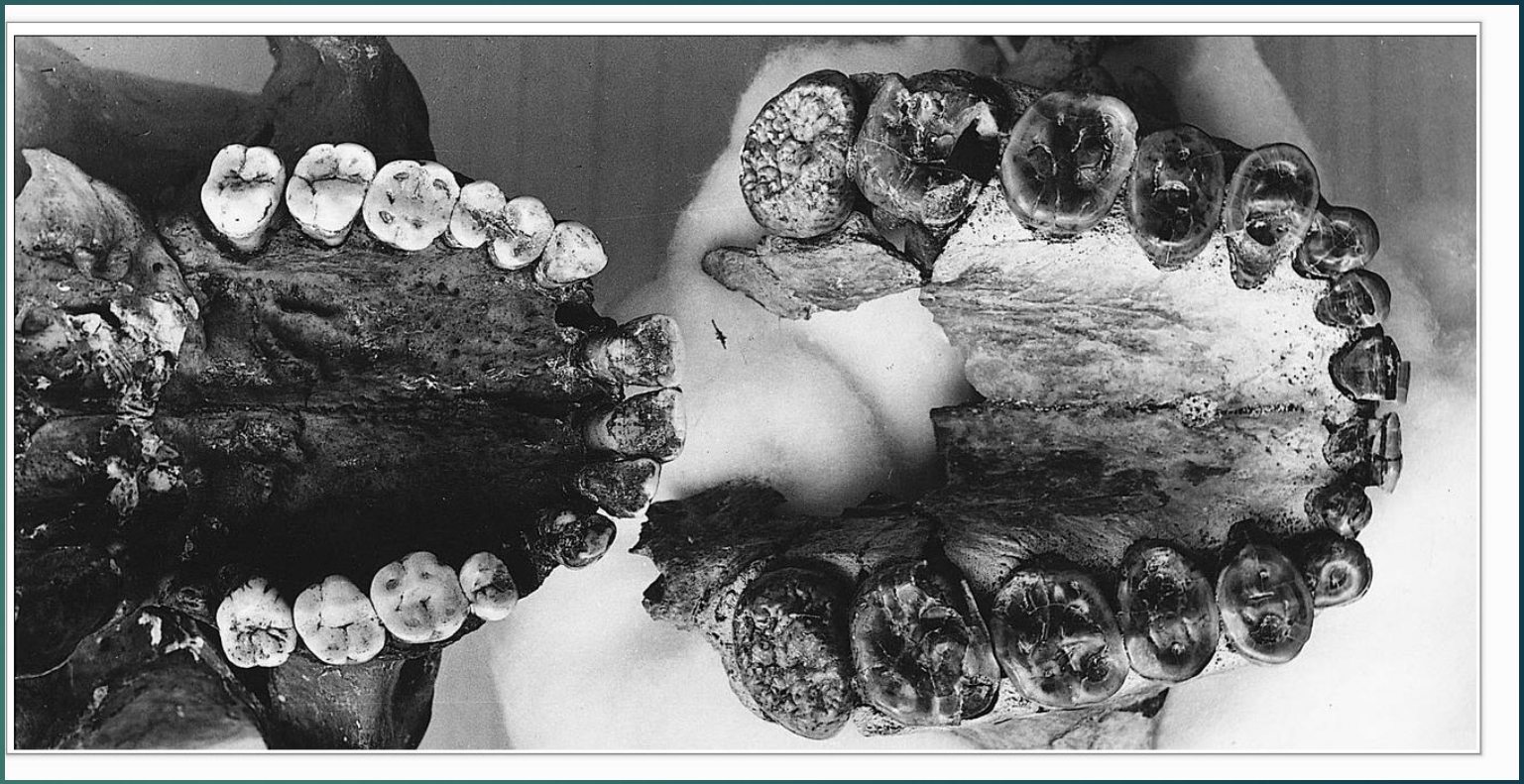
- Chemical bond with minerals reduced the rate of spontaneous chemical degradation of aDNA

Greenland at 2 Ma: a treasury of species

- Extracted DNA from more than 135 different species:
  - 102 different plant genera
  - 9 different animal taxa: mastodons, caribou, Arctic hares, lemmings,, rodents, geese, fleas and ants. Also snippets of horseshoe crab and coral DNA, which generally live today in warmer waters.
  - Now working on 4 Ma sediment



Paranthropus bosei, 2.3 M
by V. Deak



P. Bosei = Largest molars of any hominin

Paranthropus boisei, Olduvai gorge, 1959

- Remember: Not “Nutcracker Man”
- Evidence from chipping patterns and tooth structure of living primates suggest Paranthropus rarely ate hard foods (low chipping frequency)
- Their enormous back teeth evolved for other purposes, likely for chewing large quantities of very tough leafy material

I. Towle, et al., 2021

2023: Oldest Oldowan tools—seen as a hallmark of our own genus—found with oldest *Paranthropus* molars, at 2.8 Ma

Thomas Plummer et al 2023

Paranthropus and stone tools

- It's not the first time stone tools have been found with *Paranthropus*

- In 1955, Louis and Mary Leakey discovered the Nutcracker Man, *Paranthropus boisei*, in the same 1.8-million-year-old layer of sediments as Oldowan tools.

- But Mary Leakey soon found a skull of *Homo habilis* in the same layer and thought that species, in our own genus, was a better fit as the principal toolmaker.

- *Paranthropus*, with its powerful jaws and teeth, was seen as not needing tools to process tough food.

Paranthropus vs habilis: a cranial rubicon

- *Homo habilis* had teeth and jaw more like *Homo erectus*, and its brain size was above the range observed in australopithecines.

- With this, the authors came to establish a minimum threshold of 600 cc for the cranial capacity of hominins capable of making tools, in comparison with that of australopithecines (387-550 cc) and that of Zinj (510 cc).

- Since then, *Homo habilis* has been regarded as the skilled tool maker, while the less brainy *Paranthropus* became just another animal in that region without such ability.

Non-*Homo* tool use

- The 2011 discovery of crude stone tools dating to 3.3 million years ago at Lomekwi in northern Kenya threw a wrench in that neat view.
- These tools predated *Homo* and showed that an earlier hominin, perhaps *Australopithecus afarensis*, already knew how to make flakes, albeit less sophisticated than those of the Oldowan.
- In 2023, 60 years after the Olduvai toolmaker controversy, the debate resurfaces. Work at the Nyayanga site, dated to 2.8 Ma, next to Lake Victoria (Kenya) has discovered a surprising set of materials at the NY-1 level:

3 Hippo fossils, 2.8 Ma

Nyayanga, Kenya: oldest Oldowan tools and oldest *Paranthropus*

- 1776 faunal remains (mosaic vegetation and a C4 grazer–dominated fauna), including three partial hippopotamus skeletons with cut marks on two of them, as well as on other antelope bones.

- 330 lithic Oldowan artifacts: oldest ever found

- 2 characteristic molars of *Paranthropus* megadontia: oldest ever found

- What specific species they are remains to be determined: they predate the known *Paranthropus aethiopicus*, and much predate the earliest *Paranthropus boisei* .

Hold your judgment…

- However, although no *Homo* remains have been found at Nyayanga, *Homo* members were already present in eastern Africa by 2.8 Ma (Ethiopian Ledi Geraru mandible).

- Nor would they be the first known paranthropes to coexist with *Homo* in the same region: 1.7 Ma ago, in Koobi Fora, paranthropuses and *Homo ergaster* were possibly seen in the same place.

- Therefore, the Nyayanga artifacts cannot yet be definitively attributed to a specific genus of hominin.

Homo erectus -- Out of Africa

- Earliest in Africa = 2.0 Ma (*H. ergaster*)
- 2.1 Ma, hominin to Shangchen, China
- Dmanisi, Georgia = 1.8 Ma (*H. erectus*)
- Continental Asia = 1.4 Ma
- Island of Java, SE Asia = 1.0 Ma
- Spain = 800 Ka (*H. antecessor*)
- Philippines = 700 Ka
- Flores = 700 Ka (dwarf into *H. floresiensis*?)
- Ngandong = last erecti at 143 Ka

Multiple African Migrations that are currently known

- Migrations out of Africa:
  - 1 Ma, *H. antecessor* in Spain
  - 640 Ka, *H. heidelbergensis* develop into Neandertals & Denisovans in Europe & Asia
  - *H. floresiensis* in Flores, 600 Ka
  - MHs in Germany, 270 Ka
  - MHs in Greece, 201 Ka
  - MHs in India, 170 Ka

Multiple Migrations 2

- MHs, prior to 100 Ka in South China (MH teeth, 80-120 Ka)
- MHs, 90-70 Ka to Levant
- Australia, c 65 Ka
- MHs, 54 Ka, in France
- Then successful AMH migration out of Africa at 50-60 Ka
- MHs to Europe, c 47 Ka
- MHs to Americas, c 20 Ka

Morphological evidence of multiple Out of Africa migrations: 210 to 50 Ka, but left no descendants

- Apidima Cave, Greece (dated to more than 210 ka): skull
- Misliya Cave, Israel (180 ka): mandible
- Israeli caves of Skhul and Qafzeh (90–130 ka): skulls[1]
- Al Wusta in Saudi Arabia (90 ka): finger
- Chinese fossils (113 - 80 ka): teeth
- Teeth from Sumatra (70 ka)
- Artefacts from northern Australia (65 ka)
- Cranial and mandibular fossils from Laos (50 Ka)

Simultaneous hominins

- At 300Ka, a bush of *Homo* species coexisted:
  - *Homo erectus* in Java
  - *Homo sapiens* in Africa
  - *Homo neanderthalensis* in Eurasia
  - Homo rhodenensis in Africa
  - *Denisovans* in Asia
  - *Homo floresiensis* in Flores
  - *Homo luzonensis* in Philippines
  - *Homo naledi* in South Africa
  - Variety of MP *Homo* (Levant, Africa: NB Homo, J Irhoud, etc.)
  - Thus 8+ hominin species roamed the planet simultaneously.
- Given that the fossil record always underestimates the number of species, we should expect that our current count is an underestimate

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