OLLI Science Update on Human Evolution

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Mice do CPR: mouse tries to pull out the tongue of an unconscious social partner, perhaps to clear its airway in an attempt to revive; released hormone oxytocin plays a key role

Flower name?

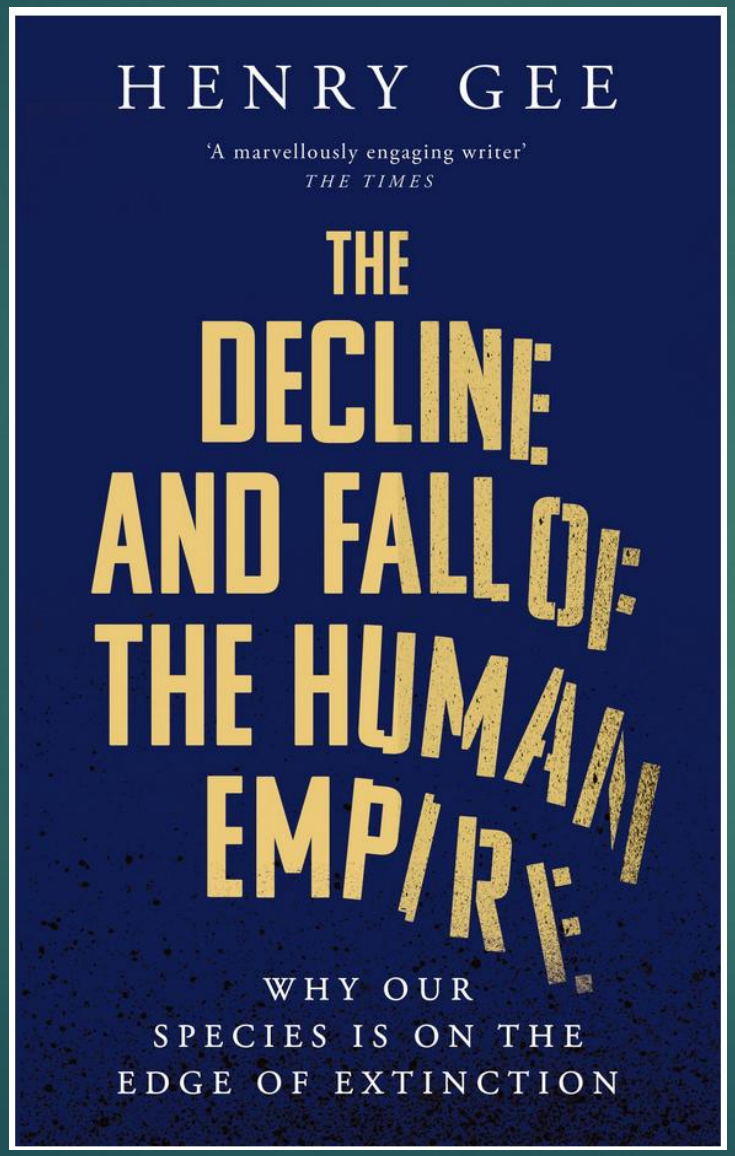
There’s a new sunflower in town. But it isn’t your stereotypical sunflower with cheery yellow petals.

The so-called “woolly devil” is tiny, pale and well camouflaged amid limestone-rich rocks and look-alike plants in Texas’s Big Bend National Park, where it was discovered.

New March of Regression

Sparklemuffin peacock spider: Males also do a sexy shimmy to dazzle the ladies.

Extinction in 10,000 years writes NATURE editor

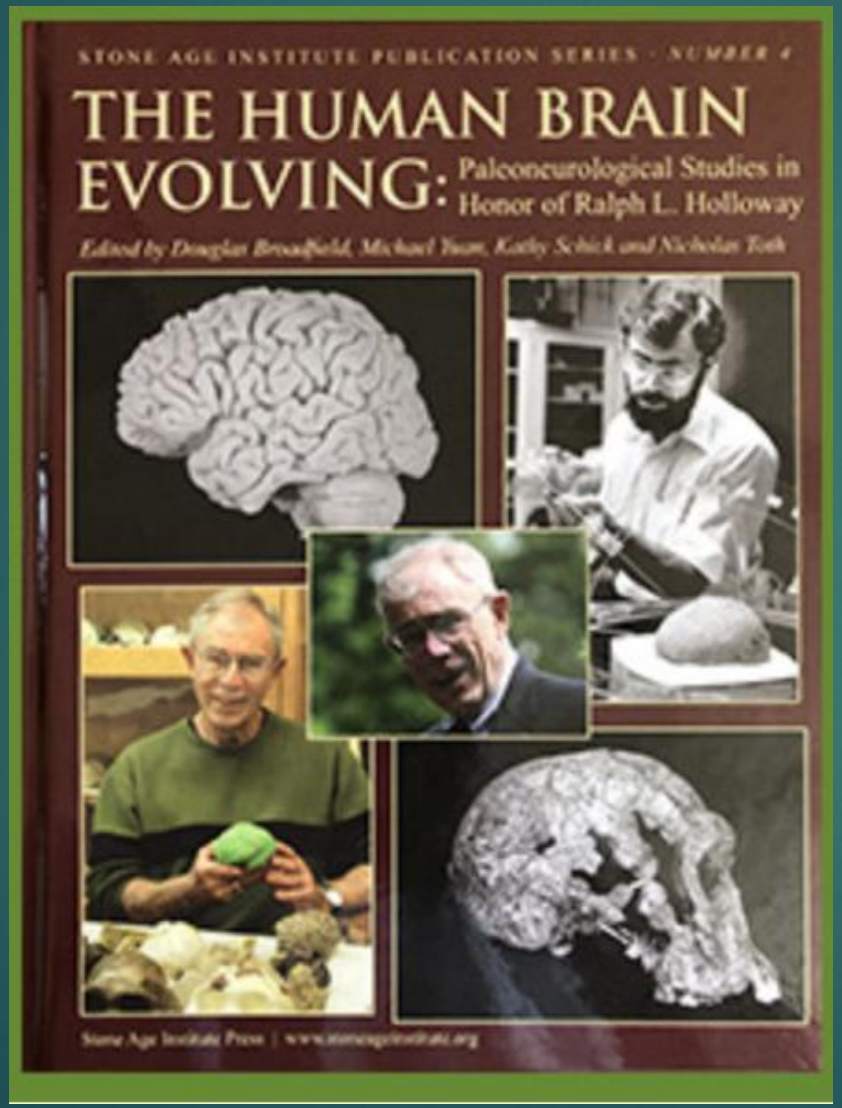


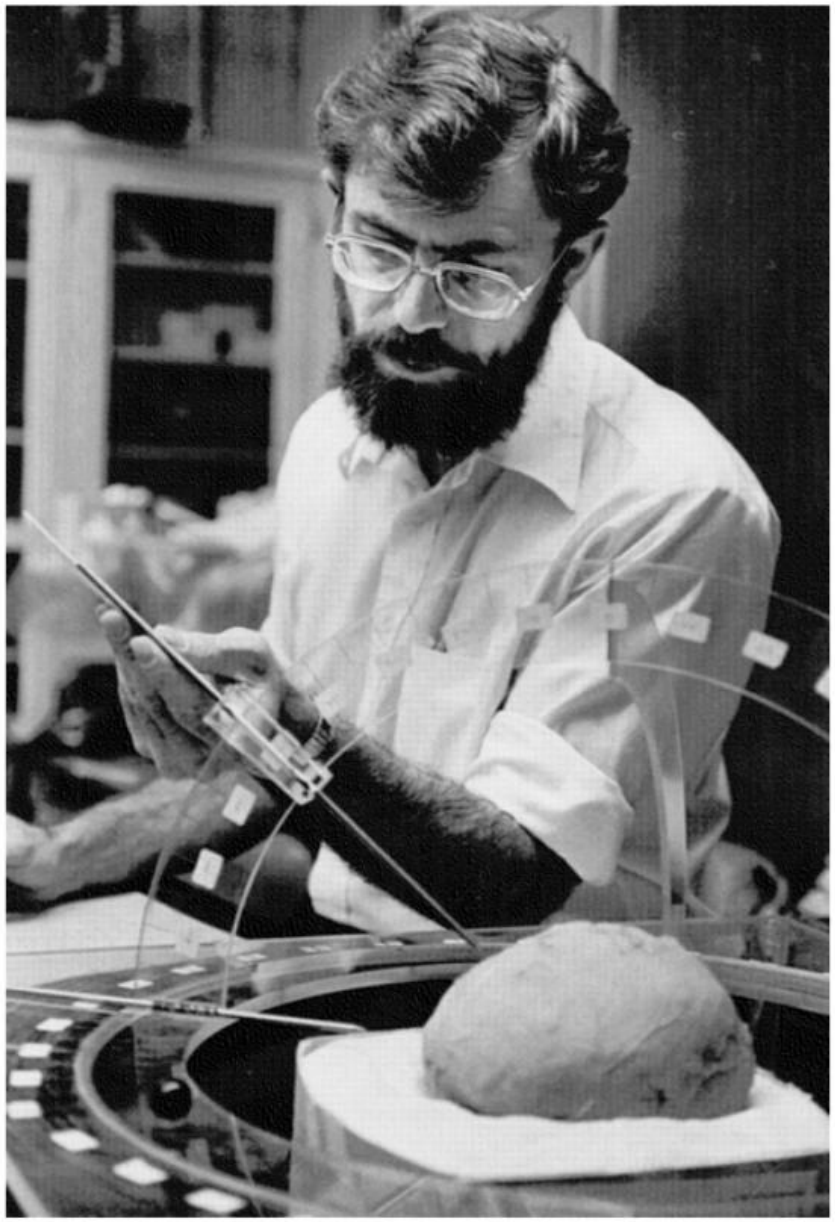
But he is a great believer in human ingenuity.

Imagine it: our descendants could live on a Space X asteroid city ruled by an Elon Musk clone.

See, there are worse things than extinction.

Ralph Holloway, RIP at 90: greatest paleoneurologist, Columbia U.; lunate sulcus





RIP: Elizabeth Vrba

- The biologist's theories about how environments prompt rapid species evolution and extinction propelled her onto the world stage.
- Instead of a process of slow, continuous adaptive changes driven by natural selection, she linked episodes of rapid species extinction and formation to cataclysmic events in the environment.
- She is best known as a rigorous and creative contributor to the development of macroevolutionary theory — the origin and evolutionary fates of species and higher groups

Elizabeth Vrba

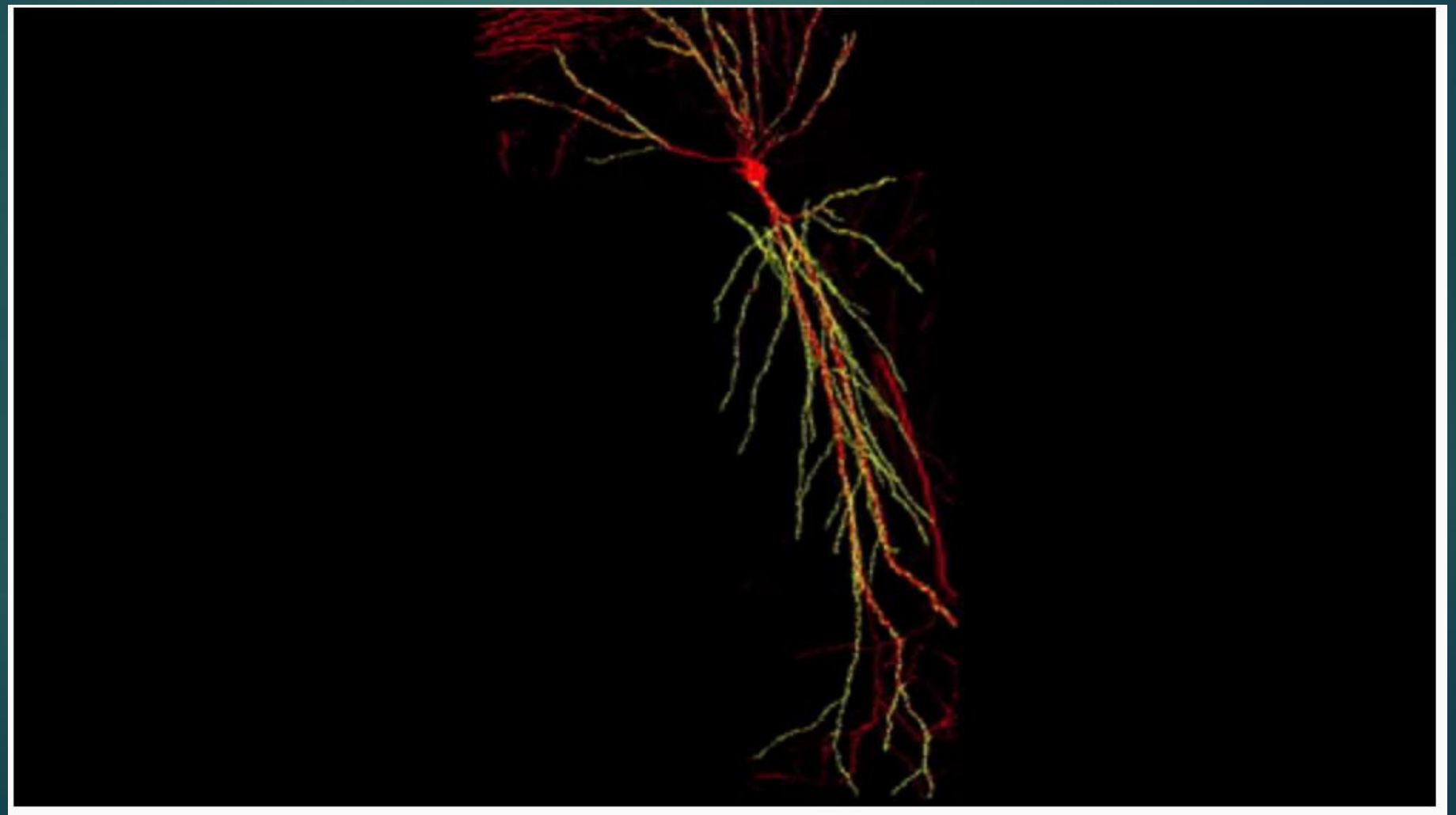
- Vrba exploded onto the scientific world stage at a macroevolution meeting in Chicago, Illinois, in 1980. Helped prove theory of punctuated evolution: in which most species in the fossil record remain unchanged for long periods, with occasional branching events involving rapid change during which new species evolve.

- 'Exaptation' is another original Vrba concept. An exaptation is a trait that has been co-opted to serve an extra function unrelated to that for which it originally evolved

- Vrba solved a problem that had vexed Darwin throughout his entire career: how could the great diversity of species over vast stretches on continental areas have occurred in the absence of obvious barriers that would cause reproductive isolation? Elisabeth's answer was that environmental change not only drives species extinct, but also through the fragmentation and rearrangement of habitats, can cause isolation and create opportunity for rapid speciation.

Kanzi the bonobo, who learned how to communicate with humans using hundreds of symbols and made stone tools, died last week at the age of 44. Kanzi taught researchers a lot about ape cognition.

First look of memory forming: Neuronal plasticity in action – Hebb's rule: neurons that fire together, wire together,: 3D reconstruction of a single CA1 pyramidal neuron in the mouse brain. The dendritic arbor is in red and each yellow dot is a mapped excitatory synapse received by this neuron. Each CA1 pyramidal neuron in the mouse receives between 10 to 15,000 excitatory synapses.



Hippocampal encoding of memories in human infants -- Tristan S. Yates, et al., 2025

- Why grown humans have a years-long blind spot in their episodic memory for the period of infancy remains a puzzle.
- It had been unclear which stage(s) in the life of a memory are responsible for this infantile amnesia: encoding, consolidation, storage, and/or retrieval.
- By showing that the hippocampus has at least some capacity to encode individual experiences beginning around 1 year of age, this study establishes a boundary condition for accounts of infantile amnesia that assume broad failures of encoding from hippocampal immaturity.
- Our findings are consistent with recent studies in rodents showing that memory engrams formed during infancy in the dorsal hippocampus, homologous to the posterior hippocampus in humans, can persist into adulthood but remain inaccessible at retrieval without direct stimulation or reminders.

We Make Memories as Babies—So Why Do We Forget Them?

- MRI scans show that the brains of infants and toddlers can encode memories, even if we don't remember them as adults.

- Babies as young as one year old can form memories, according to the results of a brain-scanning study published today in *Science*. The findings suggest that infantile amnesia — the inability to remember the first few years of life — is probably caused by difficulties in recalling memories, rather than creating them.

- Try as they might, adults can't remember events from their earliest months or years. But whether this is because a baby's hippocampus, a key brain region in storing such memories, is not sufficiently developed or because adults cannot recall these memories has long been an open question.

Proof of concept that the encoding capability exists

- Used fMRI to scan the brains of 26 young children, aged 4 months to 2 years, who were performing a task involving memory.
- The team measured hippocampal activity as the children viewed an image of a new face, object or scene for 2 seconds, and when they were shown the same image again about a minute later.
- They found that the greater the hippocampal activity when a baby was looking at a new image, the longer they looked at that image when shown it again. Because babies tend to spend more time looking at familiar things, this result suggests that they were remembering what they had seen.
- The researchers saw the strongest encoding activity in the posterior part of the hippocampus — the area most associated with memory recall in adults.

Forgotten, but not gone

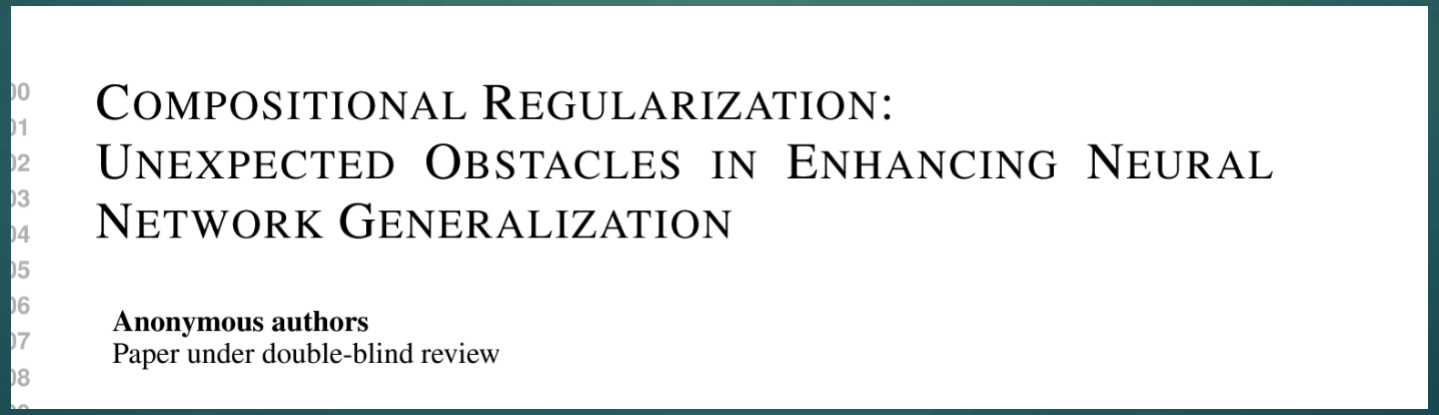
- Signal was stronger in those older than 12 months of age, suggesting a kind of developmental trajectory for the ability of the hippocampus to encode individual memories.

- Supports this idea that the immature hippocampus is capable of doing at least some kind of episodic memory encoding.

- The inability of adults to remember their earliest years therefore seems to be a recall problem, which could be caused by a “mismatch between how the memory was initially stored and the retrieval cues or the search terms that your brain is using to try to get back to the memory

First peer-reviewed scientific publication by AI

- Sakana: The AI Scientist generates its first peer-reviewed scientific publication (12/Mar/2025)
- The AI Scientist-v2 has achieved a milestone by generating a fully AI-created paper that passed the peer-review process. This marks the first instance of an AI-generated paper meeting the standard peer-review criteria typically applied to human-authored submissions. Then withdrawn.



COMPOSITIONAL REGULARIZATION:
UNEXPECTED OBSTACLES IN ENHANCING NEURAL
NETWORK GENERALIZATION

Anonymous authors
Paper under double-blind review

Colossal Biosciences genetically altered a mouse (right) to express traits reminiscent of the long-extinct woolly mammoth, including a long, coarsely textured coat, to create the woolly mouse (left) – 7 genes changed

The mammoth that squeaked; Company Seeking to Resurrect the Woolly Mammoth Creates a 'Woolly Mouse'

Ancient hunters may have used throwing spears 300,000 years ago

Wooden spears from Schöningen, Germany, dated to 300,000 years ago. could be thrown over medium distances of 19 meters, as well as used for thrusting.
Point of balance: Throwing spears have their point of balance in the front half.
On this measurement, those from Schöningen were suitable for throwing.

*** The Evolution of Long-Range Hunting with Stone-Tipped Weapons During the Afrotropic Middle Stone Age - Yonatan Sahle, et al., 2024

- Long-range hunting with stone-tipped weapons (throwing spears):
- (a) was probably not practiced in the Afrotropics before or during MIS 8 before ~243 ka;
- (b) experimentation with long-range javelins—similar to those used by current Ethiopian hunters—may have started during MIS 6 after ~191 ka;
- (c) such hunting probably became part of the everyday hunting arsenal by the end of MIS 5 at ~85 ka.
- Each hunting range and weapon-delivery system comes with its own adaptive advantages. Thus, the human ability to hunt over long- or maximum-range distances with stone-tipped weapons did not necessarily always replace shorter distance weapons.

Africa weapon use: 3 weapon types

- 1) ≥MIS 8 glacial (≥243 ka): Hunters before ~464 ka used contact weapons whilst starting to experiment with throwing them over short distances of up to ~10 m. These weapons became part of mainstream hunting behavior by MIS 8 (~300–243 ka). By that time, hunters started to experiment with medium-range hunting by throwing their weapons over distances of up to ~19 m. Did not use long-range stone-tipped weapons (effective at distances of ~20–30 m).

- 2) MIS 6 glacial (~191–130 ka): Short-range hunting is relatively consistently paired with both contact- and medium-range hunting. These hunters may have used two or three spear/javelin types according to circumstance. In some instances, they started to experiment with long-range javelins; but this was not mainstream.

130-71 Ka – start of long-range weapons, esp. ~82 ka

- 3) MIS 5 (~130–71 ka): Was characterized by alternating interglacial and glacial sub-stages.
- Continued with the three-weapon arsenal wherein up to the MIS 5c interglacial sub-stage (peaking at ~96 ka), short-range hunting was often mainstream.
- Subsequently, there is a shift at several sites towards medium-range hunting becoming a mainstream strategy.
- During the final MIS 5a interglacial substage (peaking at ~82 ka), long-range hunting becomes mainstream in tandem with medium-range hunting at some sites.
- *** 130-71 ka is therefore the first time during which long-range hunting weapons became part of the everyday Afrotropic hunting arsenal.

~71–57 ka: bow and arrow in South Africa

- 4) MIS 4 glacial (~71–57 ka): long-range javelin hunting becomes regularly paired with hunting at maximum distance (e.g., bow hunting) in southern Africa.

- MIS 4 Afrotropic hunters were able to hunt effectively across all the effective ranges to fit their respective needs, ecologies, and socio-cultural traditions.

57-29 Ka: decline of long distance javelin, increase in arrow use

- ** 5) MIS 3 interstadial (~57–29 ka): Hunting at maximum distance with stone-tipped weaponry becomes rare during this stage.
- Instead, there is a general return to mainstream hunting with a combination of long-, medium- and short-range spears/javelins, especially in southern Africa.
- ** After ~40 ka bone points similar to those used by southern African San hunters as arrowheads appear in greater numbers at several sites.
- The seeming reversion in stone-tipped hunting weaponry may thus in part reflect a shift in the use of arrow-tip materials.

Current theory

- ** Current hypothesis that experimentation with long-range weapons became feasible (physically, cognitively, and technologically) since MIS 6 (190 Ka), but that it was the variable climatic conditions of MIS 5 (130-71 Ka) that pushed it into a mainstream hunting behavior.
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- Being thus prepared, the challenges of the MIS 4 glacial then stimulated the development of bimanual, mechanically projected weapons that are effective at distances of >30 m.

- Once this stage was reached, Afrotropic hunters had the capacity to invent, reinvent, produce, and use the full stone-tipped weapon arsenal across all hunting ranges according to their respective socio-ecological contexts.

*** South American Capuchin monkeys use stone tools

Critically endangered golden-bellied capuchins are more widespread than researchers previously thought, and stone tools might be the secret to their success.

Stone tool use by Capuchins

- They have now discovered golden-bellied capuchins are present at several sites in the dry forest south of their usual habitat.
- New evidence that their populations in the dry forest use stone tools to split open tough palm tree fruits. That is a significant discovery because the species doesn't seem to use stone tools in the Atlantic Forest, even when it has access to suitable stones.
- Stone tools allowed the monkeys to move into new territory. Easily accessible food is harder to find in the dry forest, so the capuchins may only be able to survive there because tools allow them to eat the less accessible flesh of palm tree fruits.
- Like early African hominins.

*** Biological memories from your father: changes in the activity of our genes wrought by the experiences of those who came before us.

- To uncover the lasting influence of stress, the Marlin lab taught male mice to associate the smell of almonds with a light shock to the paw. These mice grew more neurons in their noses for the almond smell, indicating a great sensitivity to the smell, compared to animals that were not trained to make this smell association.
- Even more remarkably, offspring of the conditioned mice also had a greater sensitivity to the smell.
- “These mice are born with a change in their brain based on a 10-minute experience that their dad had before they were ever conceived,” Dr. Marlin said. “How incredible is that?”

Transgenerational epigenetic inheritance

- This field, transgenerational epigenetic inheritance, is a whole new way of thinking about genetics.

- It could influence how we think about post-traumatic stress disorder and other conditions connected to malnutrition, neglect and trauma.

- It also aligns with what people say they feel in their bones: that their family members' lives, even before they were born, matter.

- *** Profound ignorance of T's understanding of science = Difference between transgender vs transgenic mice. Transgenic mice (mice injected with human genes) are workhorse of biological research.

*** We’re going to need a bigger boat! Megalodon had longer, slimmer body. Less chunky than this picture. 16 m vs old 9 m; between 54 and 80 feet long and weighed about 94 tons. Blue whale = 79 feet

52-foot Otodus megalodon shark predating on a 26-foot Balaenoptera whale

No megalodon jaw fossils have ever been discovered.

*** Less pain if you swear

- Swearing correlates with an increase in pain tolerance.
- Swearing is “a drug-free, calorie-neutral, cost-free means of self-help”

- First study linking swearing with hypoalgesia — a reduced sensitivity to pain. Subjects were asked to participate in a cold pressor task, in which they held their hands in ice water for as long as possible while repeating either a swear word of their choosing or a non-swear word.

- Swearing was associated with not only increased pain tolerance but also decreased perceived pain.

- Regardless of language, swearing was linked with greater pain tolerance

Pain – physical and social

- In addition to pain tolerance, swearing has been linked to bolstered social bonds, improved memory, and even an alleviation of the social pain of exclusion or rejection.

- Neurologically, the pathways for physical pain and emotional pain are the same.

- Studies show that the same brain areas light up when someone feels physical pain or experiences social rejection, highlighting the interconnectedness of physical and emotional pain.

- Take 1000 mg Tylenol after social breakup

*** Belief in Evolution in America

- Eight in 10 Americans accept human evolution, according to the latest (2023-2024) iteration of Pew Research Center's Religious Landscape Survey.
- Asked "Which of these statements about the development of human life on Earth comes closest to your view?“:
  - 33% of respondents preferred "Humans have evolved over time due to processes such as natural selection; God or a higher power had no role in this process,"
  - 47% preferred "Humans have evolved over time due to processes that were guided or allowed by God or a higher power," and
  - 17% preferred "Humans have existed in their present form since the beginning of time."
- Most U.S. Muslims and Christians say that human evolution was guided by God

***Neanderthal gene in 25% of East Asians gave them Lactose Persistence

- Lactase persistence (LP), or lactose tolerance, refers to the ability to digest the sugars in milk beyond infancy, and is thought to have evolved once humans started raising cattle for dairy between 5,000 and 10,000 years ago.
- But LP genes increased in human populations many millennia before the advent of animal husbandry.
- In Europeans, coding area −13838*T accounts for LP. This gene is almost unknown in East Asians.
- New study indicates 25% of East Asians have Lactose persistence (ability to drink milk as adults). Produced by introgression of N immunity gene.

More about disease than milk: N gene for immunity results ultimately in LP

- The weirdest detail of the study is that the introgressed haplotype came under selection before 25,000 years ago in the ancestors of East Asian people via N introgression

- That date is far earlier than any evidence of dairy animal domestication. It's also far earlier than the evidence of strong selection on the European −13838*T allele.

- Ma and coworkers considered it unlikely that lactase persistence was itself the target of selection at this date. Target was immunity to pathogens.

LP or immunity gene

- Inherited N gene in East Asians underwent positive selection between 25,000 and 28,000 years ago, thousands of years before they began drinking milk.

- Originally enhanced immunity system functioning with lactose tolerance just a happy side-effect of its existence.

- *LCT* region in Europeans may also not be associated with LP phenotype alone but be associated with an ancient adaptation to famine or increased pathogen exposure. Improved gut nutritional absorption?

*** The evidence for *Homo erectus* and related hominin existence before one million years ago.

Earliest archeological evidence in Eurasia

- The earliest archaeological evidence of any kind in Eurasia is more than two million years old—found in places like
  - Shangchen, China, and the Dawqara Formation of Jordan.
  - Just this year Grăunceanu, Romania, dating to an estimated 1.97 million years ago.

- In western Europe there may be only two such sites, both in Spain: Sima del Elefante and Barranco Léon.

- Sima del Elefante: a mandible in 2008

ATE9-1 partial mandible described in 2008: The calculus sample contained wood fibers. These are the earliest evidence of toothpicks. The calculus also contained starch granules from plants, including some from a grass which may have come from seed consumption. Dated 1.1-1.4 Ma

Homo antecessor: ATD6-15 (frontal bone) & ATD6-69 (maxilla) -- 1.2 to 0.8 million years, Sierra de Atapuerca

Known for it's modern-like flat face.

*** The earliest human face of Western Europe -- Rosa Huguet, et al., 2025

- Who the first inhabitants of Western Europe were, what their physical characteristics were, and when and where they lived are some of the pending questions in the study of the settlement of Eurasia during the Early Pleistocene epoch, prior to 1 Ma.

- The available paleoanthropological evidence from Western Europe is limited and confined to the Iberian Peninsula.

- Study presents most of the midface of a hominin found at the TE7 level of the Sima del Elefante site (Sierra de Atapuerca, Spain), dated to between 1.4 million and 1.1 million years ago.

Earliest face, ATE7-1: unlike H. antecessor

- This fossil (ATE7-1, nicknamed Pink, after Pink Floyd) represents the earliest human face of Western Europe identified thus far.

- Most of the morphological features of the midface of this hominin are primitive for the Homo clade and they do not display the modern-like aspect exhibited by Homo antecessor found at the neighboring Gran Dolina site, also in the Sierra de Atapuerca, and dated to between 900,000 and 800,000 years ago.

ATE7-1: First European H. erectus

- The discovery suggests that an ancient *Homo* population—previously unknown—roamed Western Europe long before *Homo antecessor*, a species found at the nearby Gran Dolina site that lived roughly 900,000 years ago.

- The jaw and cheekbone bear similarities to *H. erectus* fossils found at Dmanisi in Georgia, a site dated to about 1.8 million years ago.

H. aff. erectus

- ATE7-1 is more derived in the nasoalveolar region than the Dmanisi and other roughly contemporaneous hominins.

- On the basis of the available evidence, it is reasonable to assign the new human remains from TE7 level to Homo aff. erectus. If confirmed, this fossil would become the first known representative of this species in western Eurasia.

- From the archaeological, palaeontological and paleoanthropological information obtained in the lower levels of the Sima del Elefante and Gran Dolina sites, we suggest a turnover in the human population in Europe at the end of the Early Pleistocene

Earliest European fossils

- It is assumed that Eurasia was settled after the first expansion of hominins out of Africa, at least 1.8 Ma, as attested by hominins recovered from the Dmanisi site in the Republic of Georgia.

- In Western Europe, fossil evidence of the first human dispersal is limited to the Iberian Peninsula and dated between 1.4 Ma and 1.1 Ma:
  - a deciduous molar from Barranco Leon site (Orce, Spain), and
  - a phalanx and a mandibular fragment from Sima del Elefante site.

Modern face of H. antecessor

- The TD6 assemblage has been dated to the end of the Early Pleistocene and the hominins assigned to the species H. antecessor, with its modern-like morphology of the midface.

- This finding has prompted debate about the emergence of modern midfacial morphological features.

Sima del Elefante

- New discovery of the midfacial fossil remains of a hominin found in the TE7 level of the Sima del Elefante cave site, dated to at least 1.1 Ma.

- This finding enables us to not only learn about the facial morphology of early Europeans, but also increase our knowledge of the evolutionary history of our ancestors in Europe and the roots of H. antecessor.

- The Sima del Elefante site, located in Sierra de Atapuerca (Burgos, Spain), is a major cave with a visible sedimentary thickness of 25 m, filling a 15-m-wide conduit, divided into 16 lithostratigraphic units, TE7 to TE21, from bottom to top.

Sima del Elefante levels

- Sima del Elefante presents the longest stratigraphic sequence within the archaeological record for the European Early Pleistocene.

- Along this sequence, we have recovered evidence of human presence, such as stone tools and bones with anthropogenic modifications at almost all stratigraphic levels, whereas only the TE9 and TE7 levels have provided human remains thus far

Sima del Elefante T9 and T7

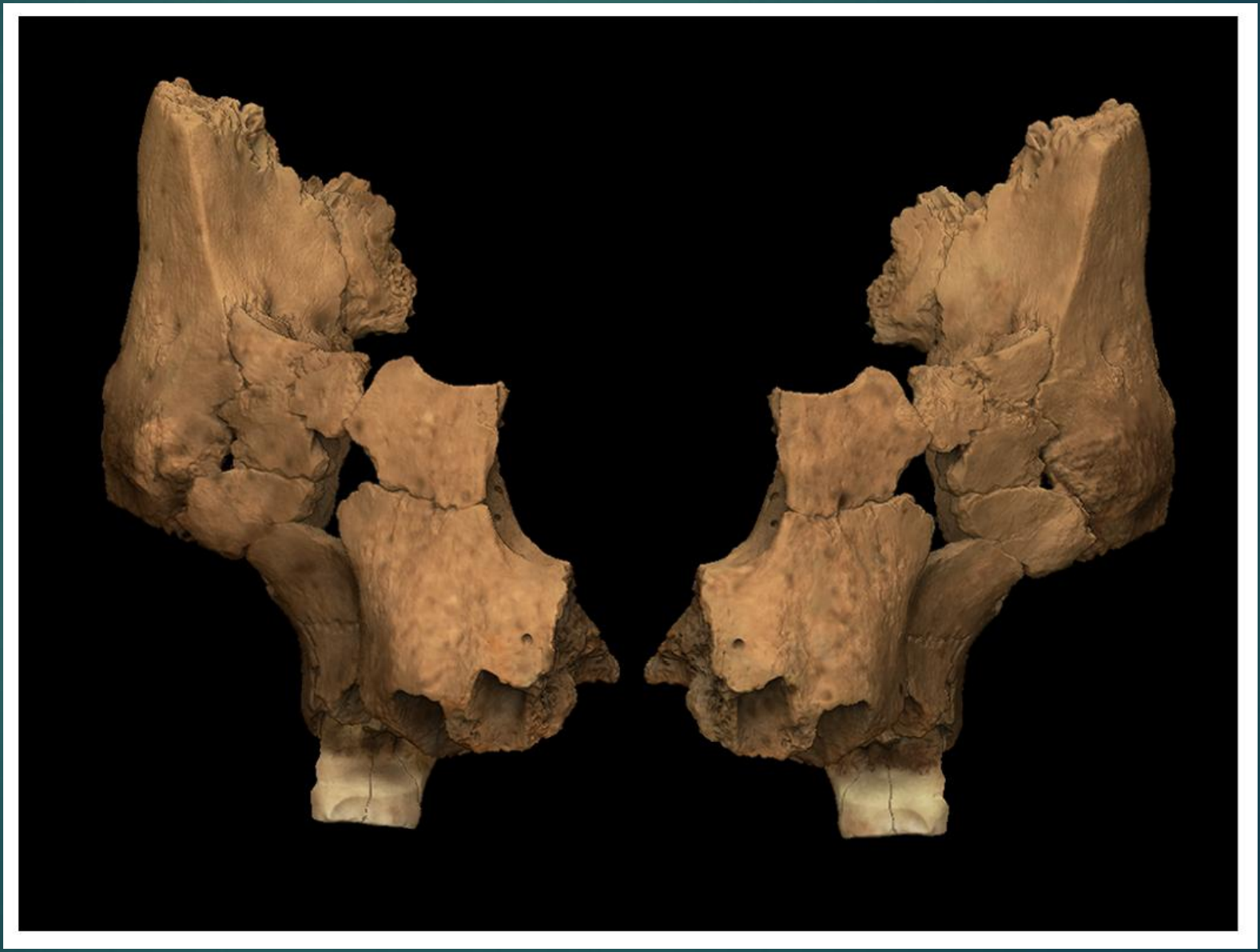
- TE9 level was dated on the basis of a combination of paleomagnetism, cosmogenic nuclides and biostratigraphy to around 1.2 Ma.

- In 2022, the hominin fossil record from the Sima del Elefante site was significantly enriched with the discovery of a hominin midface (ATE7-1) in the TE7 level.

- ATE7-1 was found 2 m below the TE9 level in the stratigraphic succession.

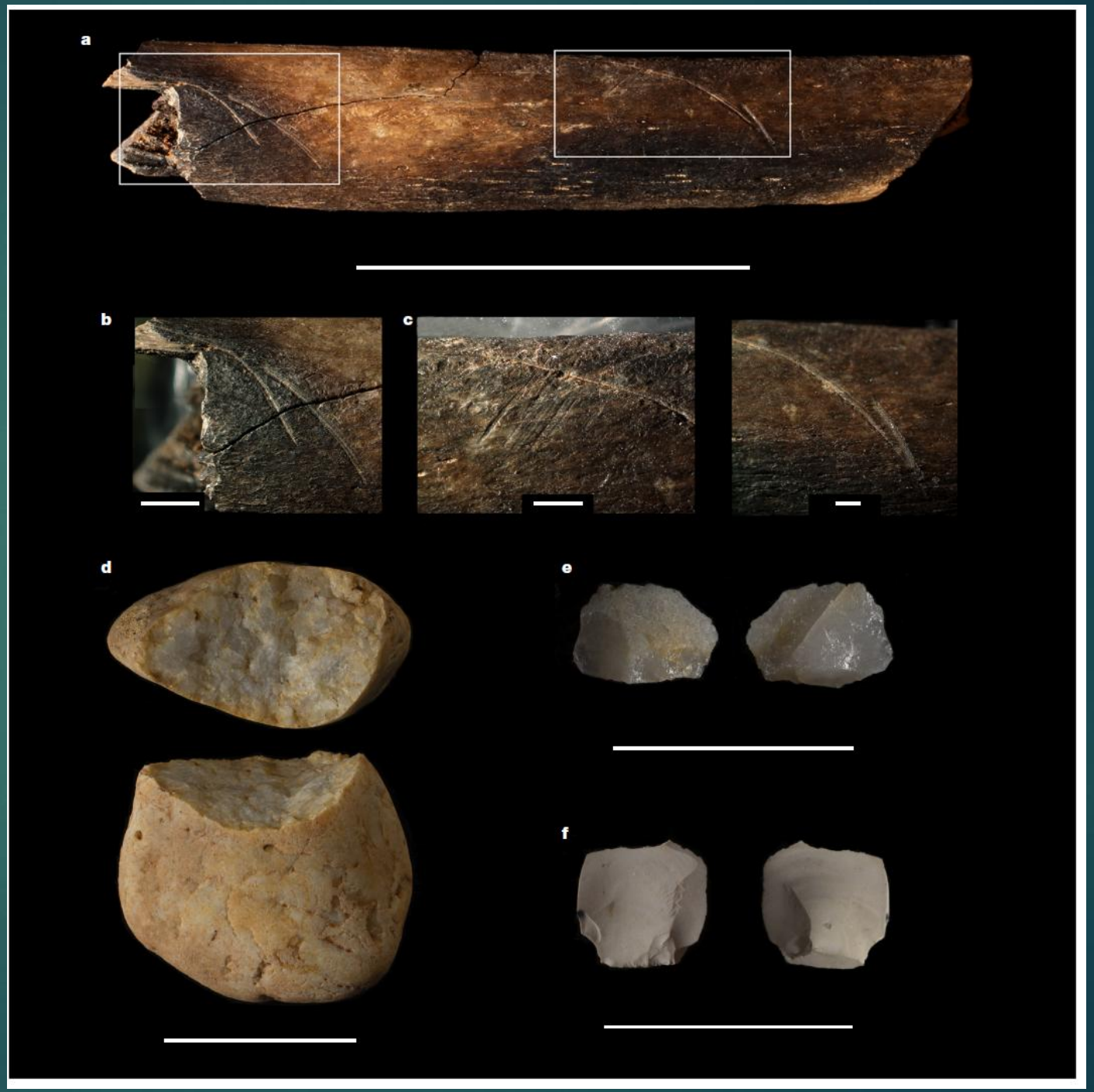
ATE7-1 partial face

Frontal view of the virtual reconstruction of ATE7-1. Right side mirror imaged.



Faunal remains (w/ cutmarks) and lithic artefacts from level TE7 of Sima del Elefante.

Evidence of eating meat.



Age via rat species

- From the biochronological point of view, the rodent assemblages that appear at TE7 and TE9 are the same and can be placed within the lower part of the Calabrian stage (Early Pleistocene), with an approximate age of 1.5–1.1 Ma

- Landscape: a humid forest, roamed by horses, ancient cattle, monkeys and even some hippos.

ATE7-1: differences from H. antecessor, H. erectus

- Specimen ATE7-1 consists of a substantial part of the maxilla and the zygomatic bone from the left side of an adult individual.
- No signs of taurodontism are present. Each root has one canal.
- ATE7-1 does not exhibit the modern-like midface of H. antecessor, and they concluded that this specimen belonged to a different species than that recovered from the TD6 level of the Gran Dolina cave site.

Assignment of ATE7-1 to H. aff. erectus

- Also differs from Dmanisi hominins:
- ATE7-1 front stands out as a very narrow in contrast to the broad midfaces of African and Asian H. erectus specimens, where the robust zygomatic bones are strongly projected laterally.
- They propose the provisional assignment of ATE7-1 to H. aff. erectus.

Similarities and differences

- Features that resemble ATE7-1 to *Homo erectus:* their overall robustness, a poorly developed and somewhat sunken nasal region, and the midface projection. However, it's face is shorter and narrower not usual for H. erectus.

- Difference from *Homo antecessor*: *Homo antecessor* has a modern appearance of (a flat, short, and vertical face); ATE7-1 has a more primitive midface morphology, but with a greater derivation in the nasoalveolar region than the Dmanisi *erectus* and other contemporary hominins.

- The mandible of TE9 could belong to the same species, although this has not been confirmed.

First settlement of Western Europe = 1.4 Ma

- The fossil record recovered at Sima del Elefante strengthens the evidence for the first settlement of Western Europe around 1.4 Ma.

- European sites with chronologies between 1.4 Ma and 1.1 Ma,: Fuente-Nueva, Barranco Leon, Le Vallonnet, Pont-de-Lavaud, Kocabas or Pirro Nord.

- Hypothesize that the first settlement occurred from Eastern to Western Europe at least 1.4 Ma.

A depopulation event circa 900 Ka

- There is a discontinuity between the Gran Dolina-TD6 and the Sima del Elefante hominin and faunal populations, implying a potential a depopulation of Europe during MIS3 (900 Ka), due to the extreme climatic conditions.

- Could still have favored a demographic decline in the H. aff. erectus population.

- This scenario would be in accordance with the severe human bottleneck around 900,000 years ago proposed previously.

What happened to them? Climate-caused extinction circa 1 Ma

- This discovery suggests that two distinct groups of early humans existed in Western Europe around one million years ago.

- However, it is unlikely that these species coexisted, as extreme climatic conditions would have caused the extinction of hominin populations in Europe by 1.1 million years ago, before the arrival of *Homo antecessor*.

- Harvard anthropologist G. Philip Rightmire believes the Sima del Elefante individual was likely part of a long-lasting regional *H. erectus* population. “I would put my money on a long-lasting regional *H. erectus* population occupying Dmanisi around 1.8 million years ago, with later populations moving into Europe”.

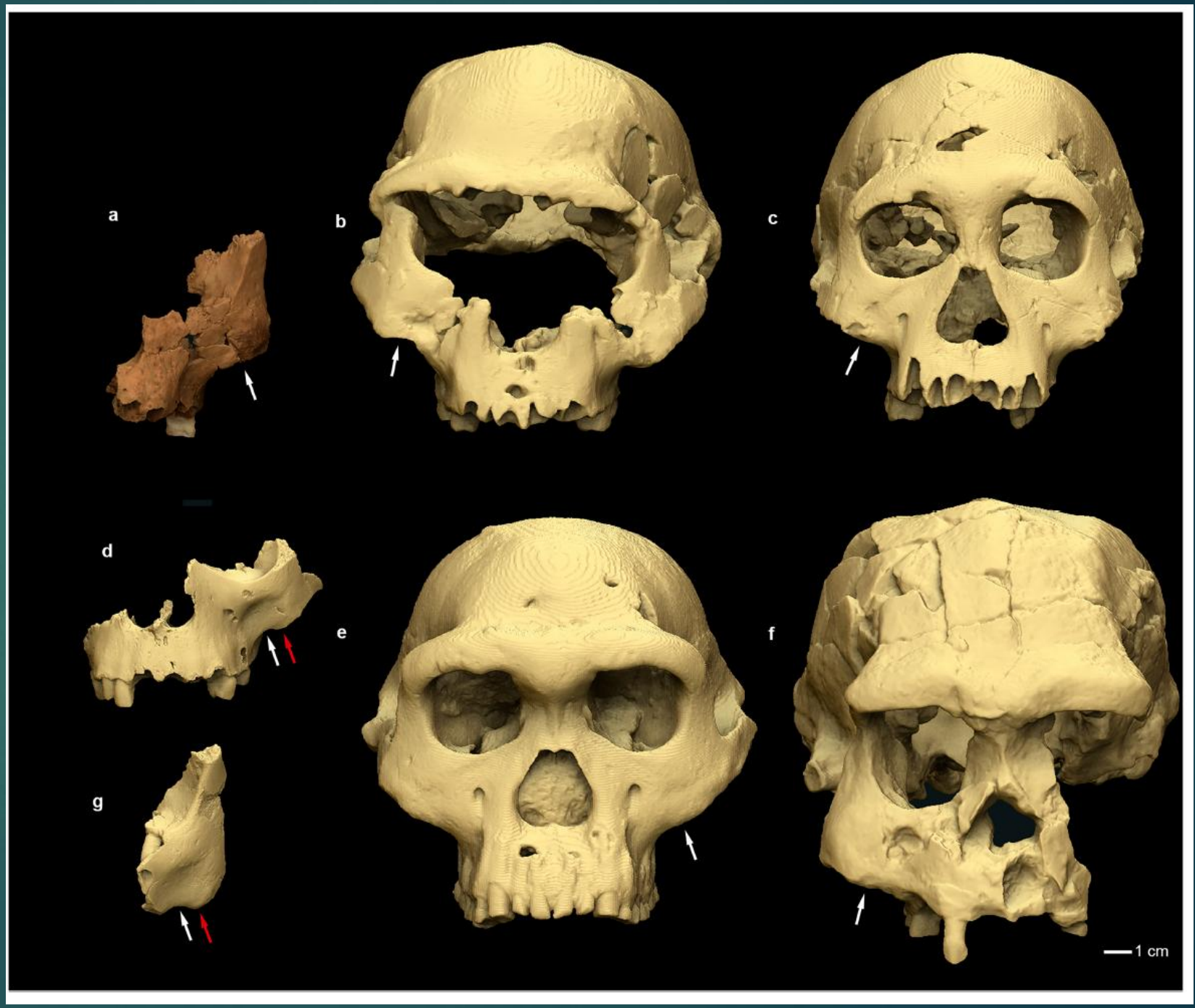
Conclusion

- Strong evidence here to suggest that Western Europe was populated by at least two different Homo species during the Early Pleistocene: H. aff. erectus, represented at TE7 and possibly TE9; and, later, H. antecessor.

- There is possibility that a residual population of H. aff. erectus coincided for a short time with H. antecessor, if climatic conditions at Sierra de Atapuerca were not as dramatic as suggested previously.

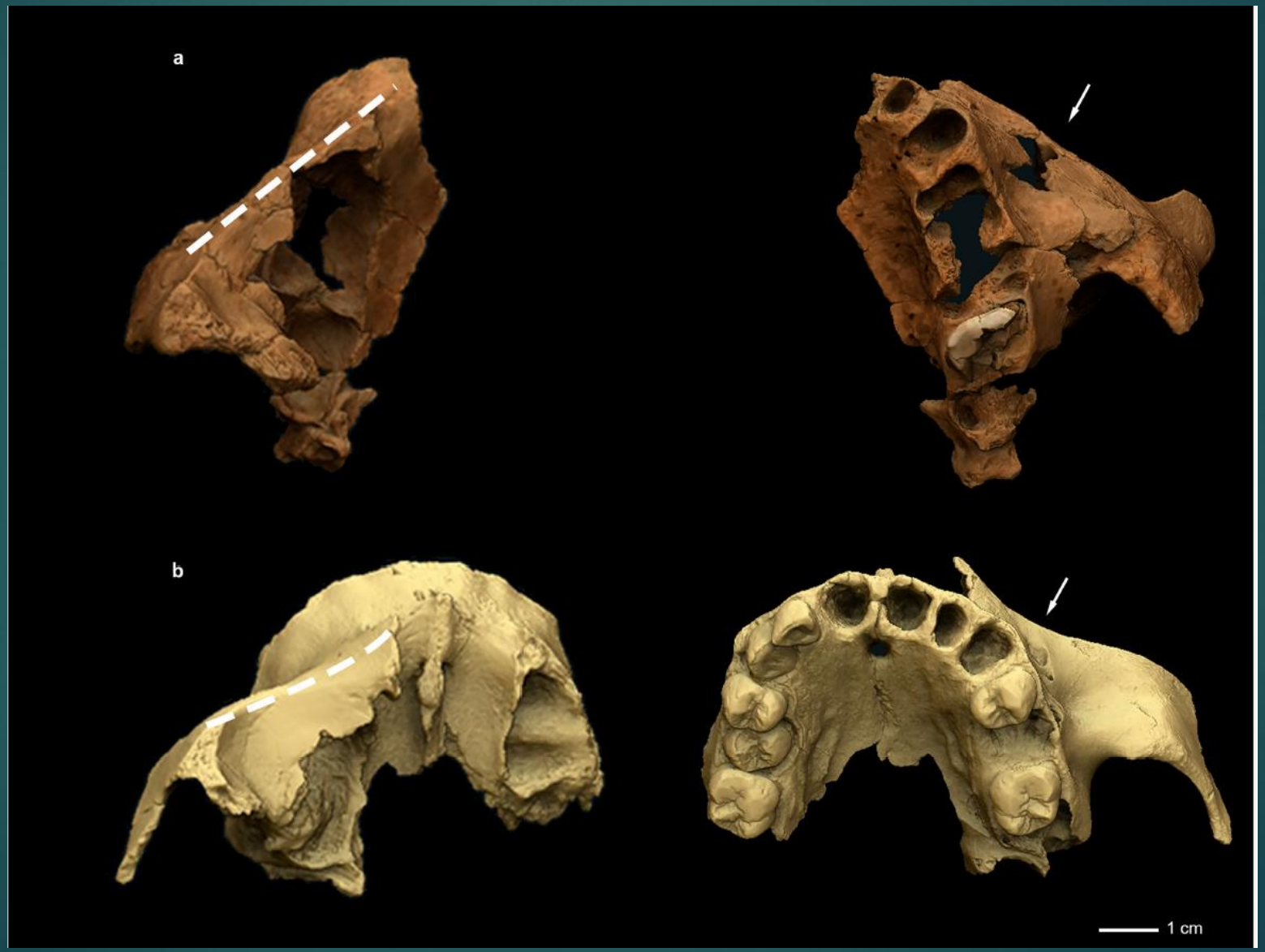
- However, we cannot rule out the complete disappearance of the new species represented at the lower levels of the Sima del Elefante before the arrival of H. antecessor.

Comparison of the zygomaxillary border and the zygomaxillary tubercle.
Frontal view of the virtual reconstruction of a) ATE7-1,
b) D2282, c) D2700, d) ATD6−69, e) D4500, f) Sangiran 17 and g) ATD6−58.

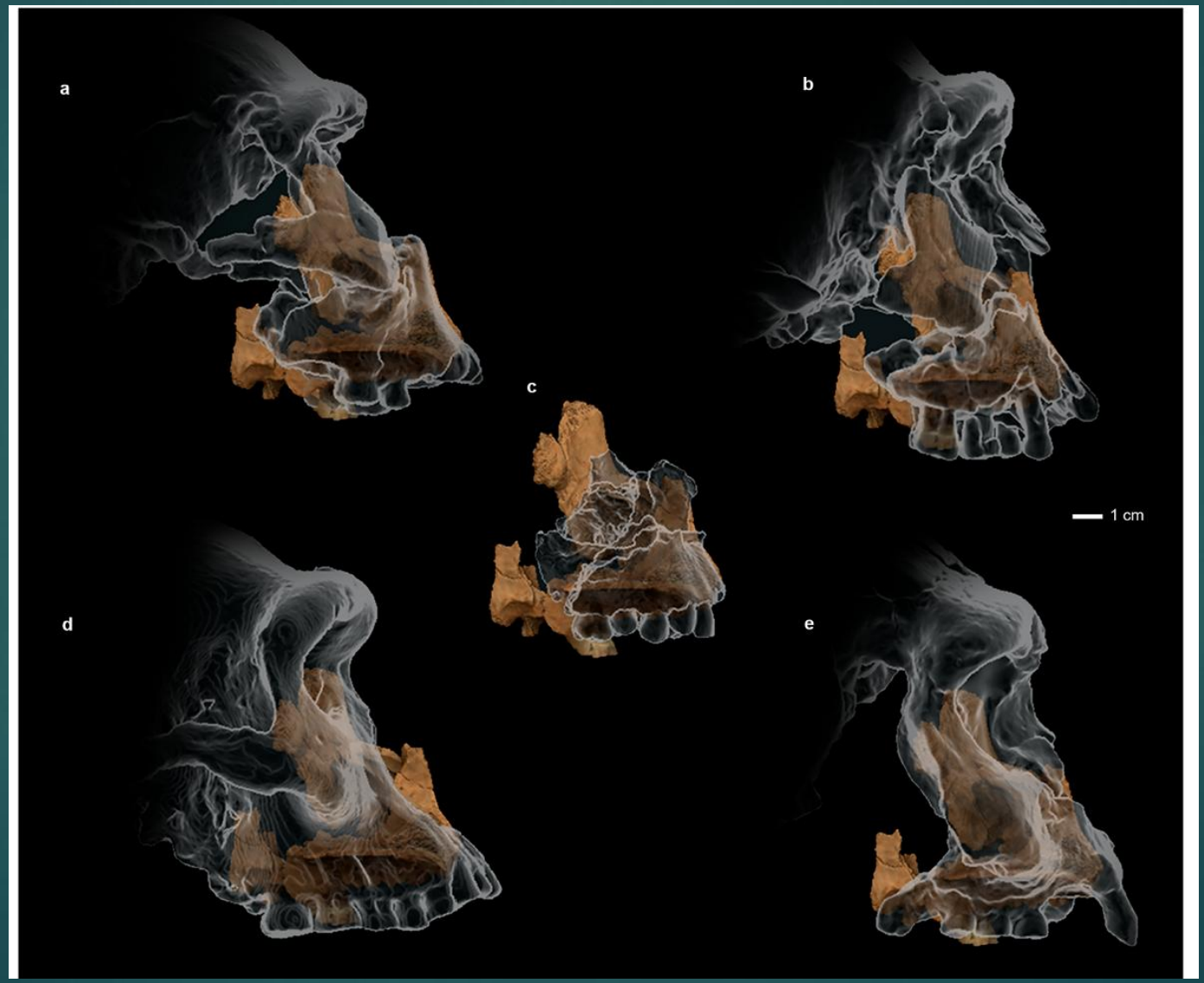


Lateral view of the virtual reconstruction of a) ATE7−1, b) D2282, c) KNM-ER-3733, d) ATD6-69, e) D4500 and f) Sangiran 17.

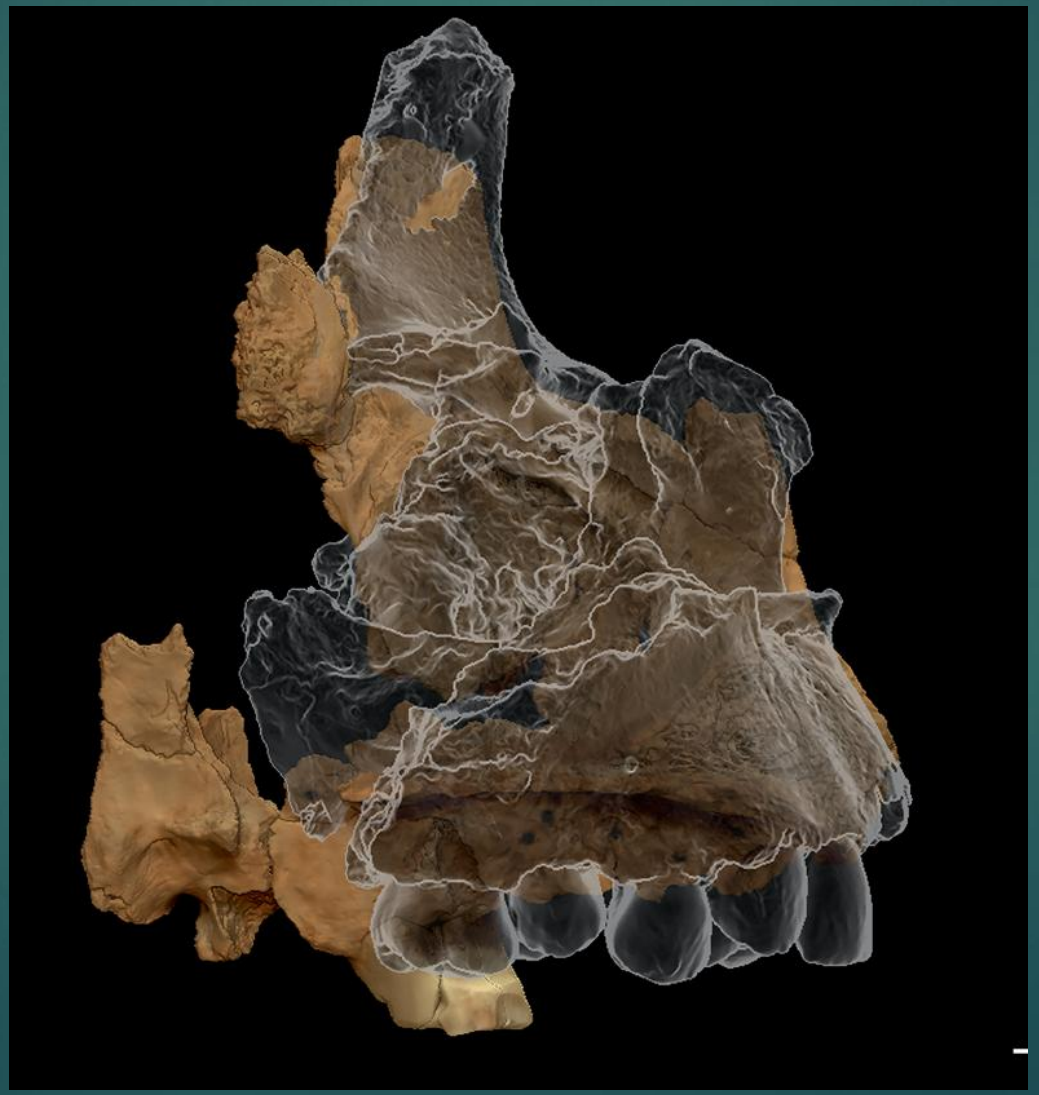
Comparison of the maxillary flexion. Virtual reconstruction of ATE7−1 and ATD6-69 (Homo antecessor).



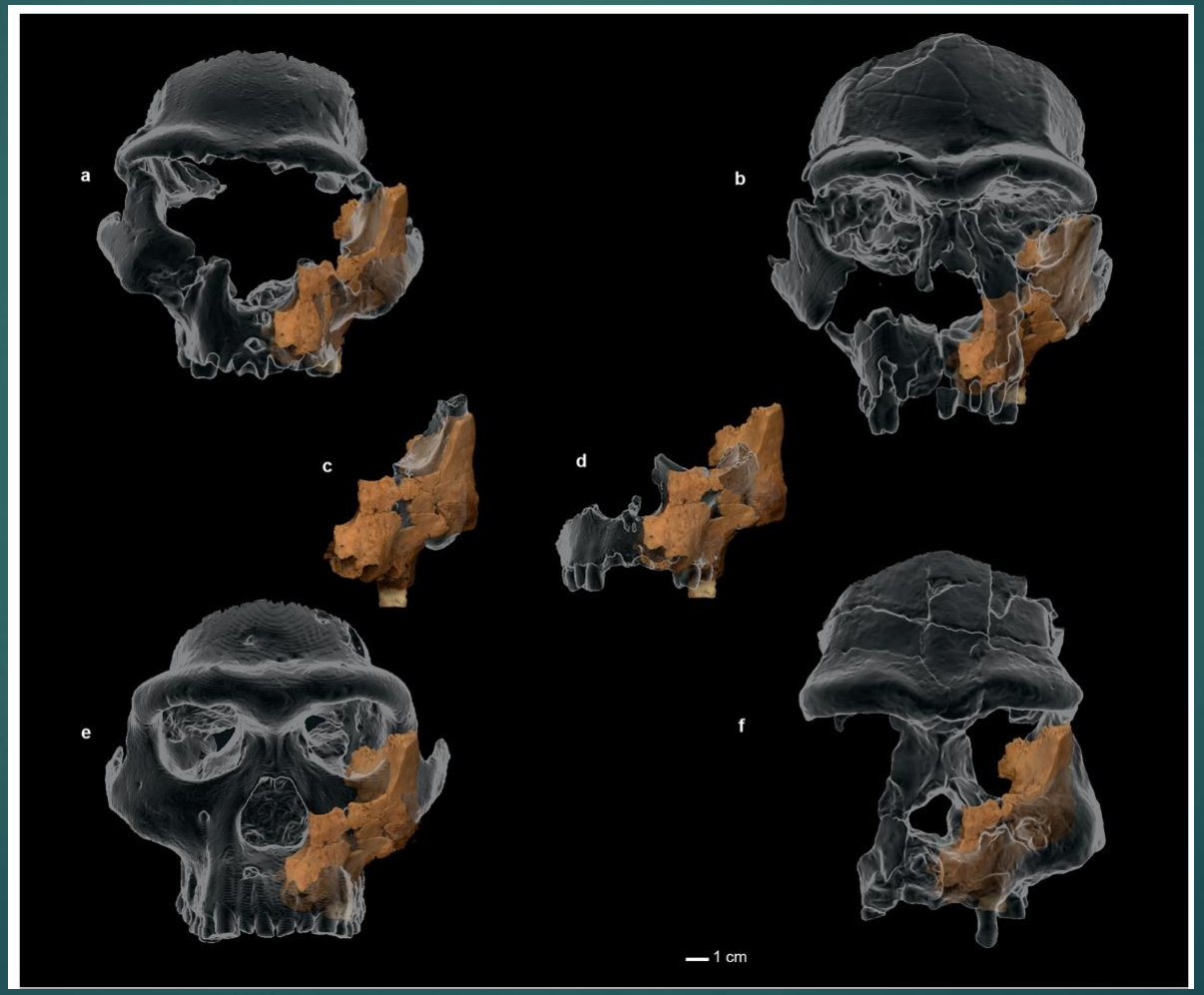
General comparison of ATE7-1 with Early Pleistocene specimens from Africa and Eurasia in lateral view: Lateral view of the superimposition of the virtual reconstruction of ATE7-1 with a) D2282, b) KNM-ER-3733, c) ATD6-69, d) D4500 and e) Sangiran 17.



Comparison of the nasal lateral margin in ATE7-1 and ATD6-69. Lateral view of the superimposition of the virtual reconstruction of ATE7-1 (opaque texture) and ATD6-69 (ghost texture).



General comparison of ATE7-1 with Early Pleistocene specimens from Africa and Eurasia in frontal view. Frontal view of the superimposition of the virtual reconstruction of ATE7-1 with a) D2282, b) KNM-ER-3733, c) ATD6-58, d) ATD6-69, e) D4500 and f) Sangiran 17 (mirror reconstruction).



*** Where do the Dmanisi hominins fit on the human evolutionary tree? Debbie Argue, José María Bermúdez de Castro, Michael S. Y. Lee, Maria Martinón-Torres. 2025

- Archeological excavations at the site of Dmanisi in the Republic of Georgia have yielded a rich assemblage of hominin fossil remains, as well as lithic artefacts and bones of fossil fauna.

- The site is considered to be between 1.95 Ma and 1.77 Ma and presents us with the first skeletal evidence of hominins to emerge from Africa, a key event in human evolution.

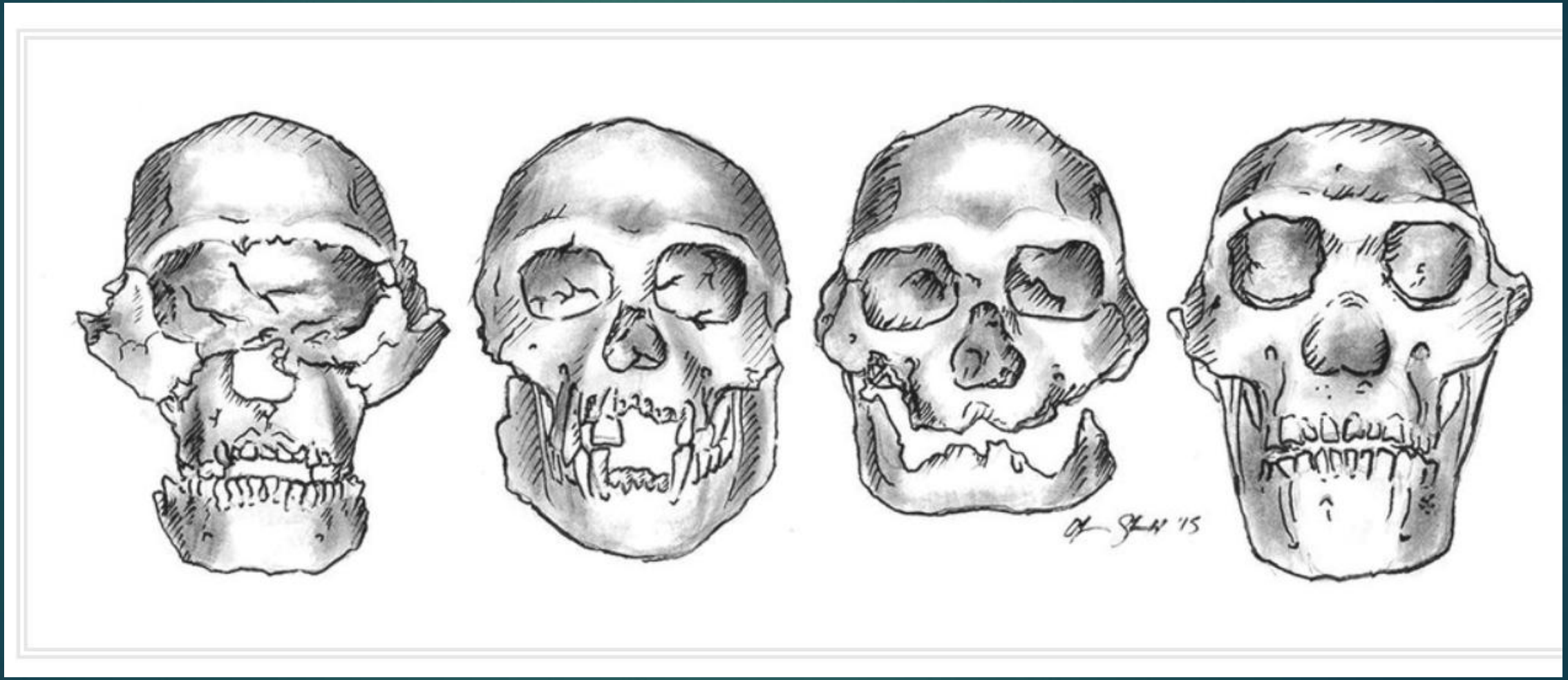
- Their morphology, and the degree of morphological variation observed among the assemblage, has generated considerable controversy about their affinities and heterogeneity.

- Used parsimony analyses to test the competing hypotheses for Dmanisi hominins employing characters from the cranium, mandible, dentition, and postcranium

The D2600 mandible (later associated with Skull 5): designated as the type specimen of *Homo georgicus* in 2002

Are these Dmanisi fossils H. erectus? Skulls 1-5

Sketch of Skulls 2-5



Skulls 1-5

Computer reconstruction, Skulls 1-5

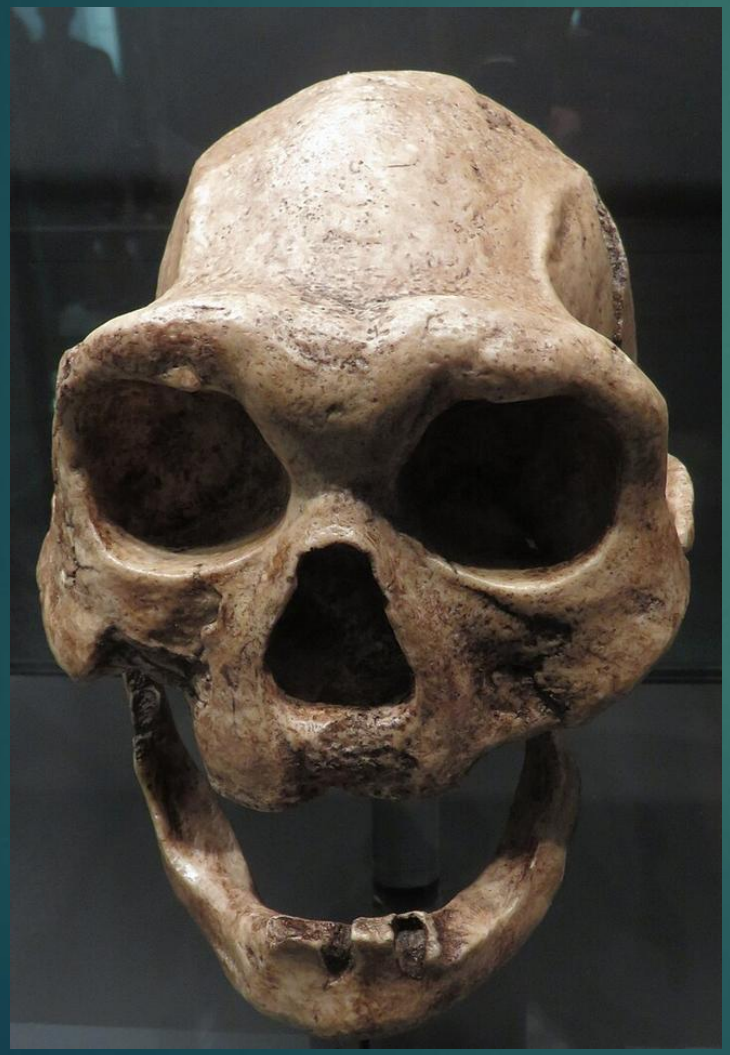
Dmanisi mandibles: D211 first found, (1.95-1.77 Myr)

Partial cranium, Dmanisi, Georgia. D2280, Skull, 1, 775 cc, adult male

Dmanisi cranium D 2282 + lower jaw D 211 (= Skull 2 replica), 650 cc, adol. female

D2700, D2735 (mandible), Skull 3, 600 cc, young male

Dmanisi cranium D 3444 + lower jaw D 3900 (= Skull 4, replica), 625 cc, elder male, lost all but 1 tooth; extensive bone loss on the maxillae and the mandible due to resorption = caregiving



Dmanisi cranium Skull 5, D4500 + lower jaw D2600 (Original mandible), 546 cc, male

Early descriptions of Dmanisi fossils

- The hominin remains recovered from the Dmanisi site comprise five crania, four of which have associated mandibles. Three of the mandibles include their teeth and postcranial remains have been recovered for two of the individuals.

- Designated as H. georgicus, with D2600 as the holotype.

- However, other taxonomic attributions have been proposed: Homo erectus; H. sp. indet (aff ergaster); H. ex gr. ergaster; Homo georgicus; and H. erectus ergaster georgicus

Skull 5, D4500, has smallest endocranial capacity = 546 cc

- Skull 5, D4500, as a very robust male based upon its massive midface, prominent canines, and its high mandibular corpus. Its endocranial capacity is 546 cc, within the range of Au. afarensis (387 cc-550 cc, Au. africanus (435 cc-560 cc, and Homo habilis (509 cc – 687 cc).

- The D4500 endocranial capacity is 30% - 33% smaller than one of the other males in the group, D2280 (730 cc), while a third adult male, D3444, has a brain size of 625 cc.

Male brain smaller than the females

- There is one assumed female in the assemblage: D2282 = 650-660 cc, 19% larger than D4500. The subadult among the Dmanisi hominins has an endocranial capacity of between 600 cc and 612 cc, again, larger than D4500.

- This pattern of sexual dimorphism (in which some males in a species may have considerably smaller brains than females, and males, in that species) is not normal in other Homo, or in non-human primates

Dmanisi hominins are not H. erectus

- *** We propose that
  - the Dmanisi hominins are not Homo erectus, and
  - that two species are represented among the assemblage:
  - one comprises Homo georgicus and the other an as yet unnamed species.
- Our review of the dating of the Dmanisi site leads us to propose that:
  - Homo georgicus was probably present by 1.8 Ma and
  - that the other hominins recovered from the Dmanisi excavations accumulated at some time or times during the reverse polarity of 1.07 Ma and 1.77 Ma. The specific, individual, ages of these hominins remain unknown.

High variation in Dmanisi fossils

- Vekua et al. (2012) deem the Dmanisi specimens to be the most primitive and small-brained fossils to be grouped with H. erectus, or any taxon linked unequivocally with genus Homo, and also the ones most similar to the presumed habilis-like stem.
- The range of variation observed among the Dmanisi crania, mandibles and dentition is significant. Two potential explanations for the variability have been advanced: that the species exhibits an unusually large degree of sexual dimorphism; or that more than one species is contained among the sample.
- Here we present parsimony analyses to assess the potential attributions of the Dmanisi hominins and assess whether the assemblage represents one or more species.

Different species or intrapopulation differences

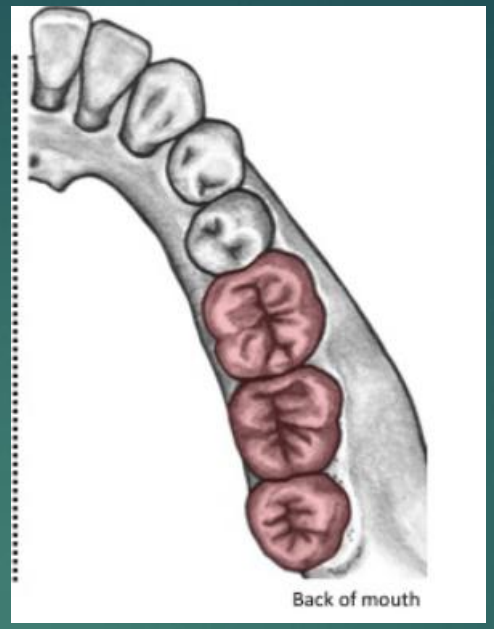
- Original D211 mandible assigned to H. erectus; has primitive and derived traits; early analysis concluded Homo sp. indet. (aff. ergaster).
- Issue of heterogenity in this group: variation in cranial capacities in the fossil sample, D2280 (775 cc); D2282 (650 cc); D2700 (600 cc), exceeds that within modern humans, chimpanzees, and gorillas
- Is it sexual dimorphism?
- Definition of a new species, Homo georgicus, sp. nov., that expresses a marked degree of sexual dimorphism
- One theory: group the Dmanisi hominins together as one paleodeme (species), that is close to the stem from which H. erectus evolved; but reservation, however, as to whether D2600 should be included

Teeth

- From a primitive pattern of M1 smallest < M2 < M3, largest to a derived pattern of M1 largest > M2 > M3, smallest, most posterior

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

- Primitive condition, 3rd molar is largest and 1st molar is smallest



Modern, derived

Primitive – H. naledi

Evidence opposed to single species theory

- Van Arsdale: The amount of variation among the Dmanisi hominins exceeds that found among H. sapiens and Pan and is inconsistent with a single species hypothesis for the Dmanisi hominins.

- Variation in the dental remains in Dmanisi mandibles has also generated discussion. Martinón-Torres et al. (2008) found that Skull 5's D2600 retains a number of primitive conditions, including the primitive molar sequence M1 < M2 < M3, also observed in Australopithecus, Paranthropus, and the majority of H. habilis, H. rudolfensis, and the early Homo dental remains.

- In contrast, D211 and D2735, exhibit the first occurrence of M1 > M2.

2 species theory

- In all, Bermúdez de Castro et al. (2014) observe 10 features on Skull 5's D2600 mandible that are not shared with the other two Dmanisi individuals, suggesting that two species are present among the Dmanisi hominins:
  - H. georgicus, represented by D2600 mandible; and a separate paleodeme (species) represented by D211 and D2735 that has a completely different craniofacial growth pattern to Skull 5, D4500.
  - Skull 5, D4500: Its muzzle-like face is similar to Au. afarensis and is among the largest and most prognathic known from early Homo

Parsimony analyses

- Used parsimony analyses to test the competing hypotheses for Dmanisi hominins employing characters from the cranium, mandible, dentition, and postcranium

- Original Geological analysis: Oldowan, or Mode 1 lithic assemblage, and, in particular, the age of the majority of the associated vertebrate fauna, indicate a latest Pliocene, Olduvai Subchron age of 1.95 to 1.77 Ma.; more likely 1.77 Ma; newer data ranges between 1.78 and 1.07 Ma.

- Compared 105 cranial and post cranial character data of Au. afarensis, Au. africanus, Au. sediba, H. floresiensis, H. erectus, H. habilis, H. naledi, H. sapiens, Pan, Gorilla, Pongo, and Dmanisi fossils

Data: two species

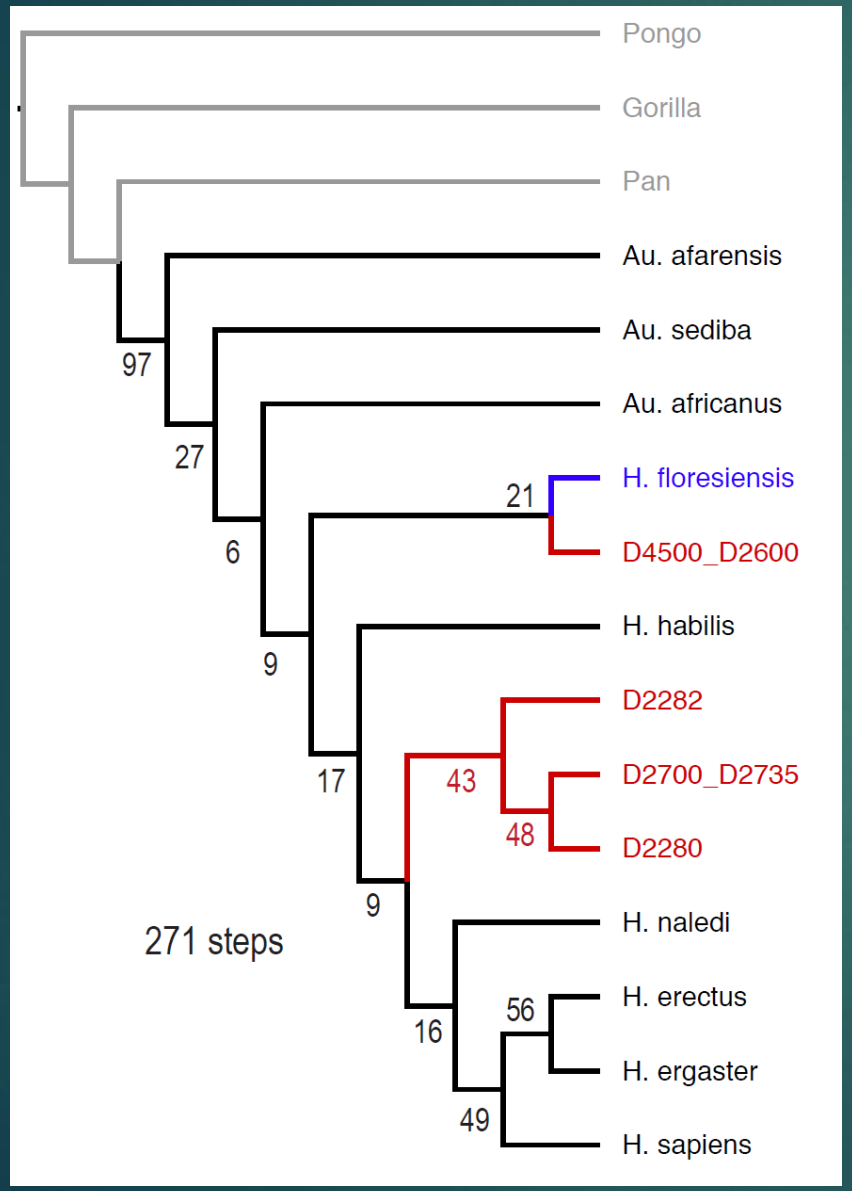
- Evaluated the support for all Dmanisi taxa forming a single clade, consistent with the single-species hypothesis. Vs two clades

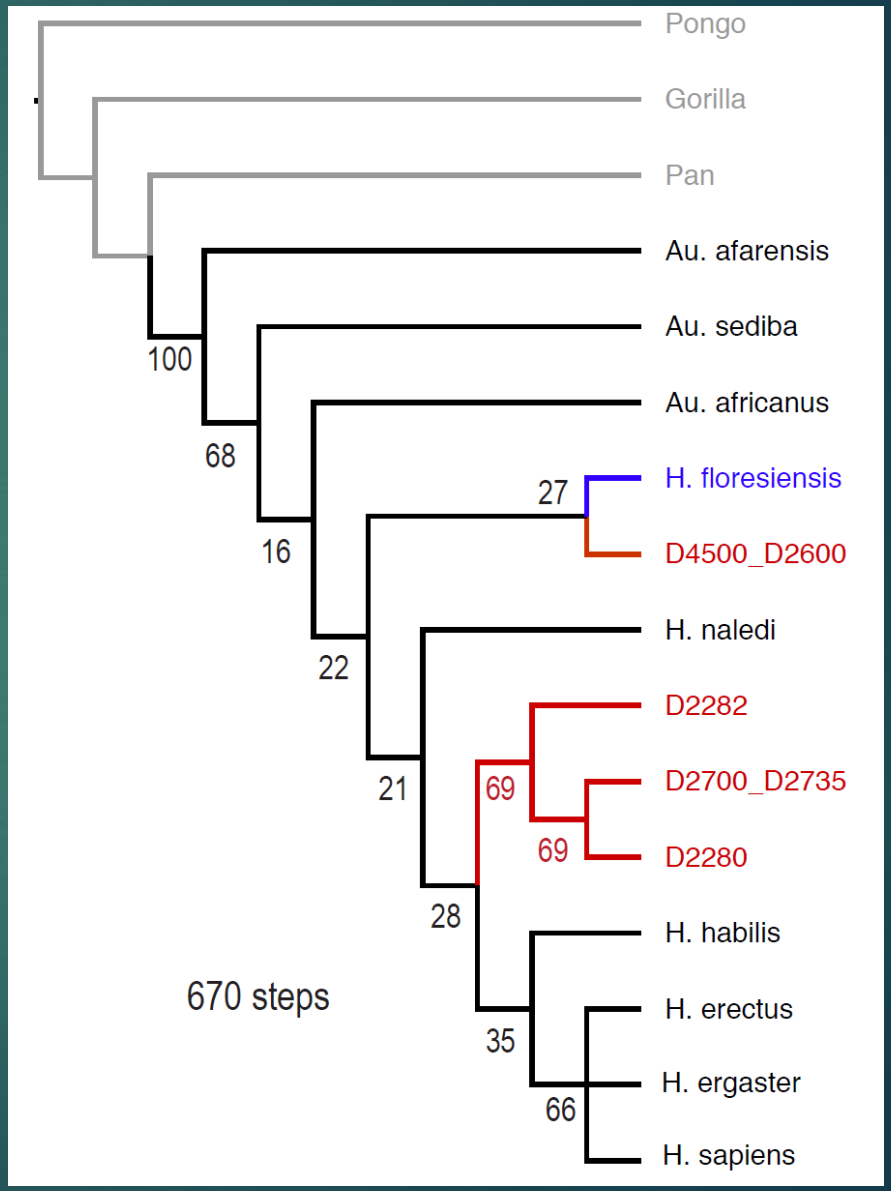
- In our main analyses, the Dmanisi individuals consistently separated into two groups: Skull 5, D4500, which often appears near Homo floresiensis, vs. D2282, D2700_2735 and D2280, which often appear near H. erectus, H. ergaster and H. sapiens.

- Three Dmanisi individuals (D2280, D2282, D2700_D2735) grouped together within this second clade. This Dmanisi clade weakly clustered as sister to hominins (H. habilis, H. erectus, H. ergaster, and H. sapiens).

- Dmanisi individual D4500 again grouped with Homo floresiensis.

2 of 4 phylogenetic trees





2 species – Not H. erectus

- New parsimony conclusions: hypotheses that should be tested with additional data and new fossils.

- Although the Dmanisi hominins have been variously assigned to H. erectus or H. ergaster, the Dmanisi hominins do not form sister taxa to H. erectus (senso stricto) or H. ergaster in our analyses.

- There is thus no support in our dataset for the idea that any of the Dmanisi hominins are most closely related to (or conspecific) with H. erectus or H. ergaster.

2 Clades

- Three of the four Dmanisi individuals form a clade (D2280, D2282, D2700), consistent with them being a single species.
- However, it is less certain that Dmanisi individual D4500 also belongs to this clade.
- In unconstrained phylogenetic analyses, the four Dmanisi individuals are separated into two clades.
- D2280, D2280 and D2700 group with H. habilis, H. erectus, H. ergaster, and H. sapiens).

Problems with single species theory

- Skull 5, D4500, groups with H. floresiensis.
- There are also much larger character distances between D4500, and the other three Dmanisi individuals
- D4500 small brain size is inconsistent with single species theory.
- Under the single species model for the Dmanisi hominins we would need to accommodate a novel characteristic in Homo, in which Australopith/early Homo molar sequences and Middle-Pleistocene Homo molar sequences occur concurrently.
- Similar issues in mandibles.

Conclusions

- The Dmanisi hominins are often included in H. erectus or H. erectus s. l. H. ergaster, notwithstanding that they are formally designated as Homo georgicus with Skull 5's D2600 mandible as the holotype.

- In our phylogenetic analyses, none of the Dmanisi hominins form a sister taxon to either H. erectus or H. ergaster.

- We hypothesize that the Dmanisi hominins did not share a unique common ancestor with H. erectus or H. ergaster, and we cannot support their attribution to either of those species.

Skull , D4500, represents a separate species

- Although all the Dmanisi hominins are attributed to a single species, the morphological variation evident among them has prompted questions about their heterogeneity with discussion focusing on whether one species or two are represented.

- While their phylogenetic analyses did not lead us to propose two species among the Dmanisi hominins, there are nevertheless morphologically significant differences in the cranium, mandible and dentition of the individual represented by D4500 and the other Dmanisi hominins that are consistent with the view that Skull 5, D4500, represents a separate species.

Skull 5 a separate species? More like H. floresiensis

- These are the unique and perplexing pattern of sexual dimorphism evident in the endocranial capacities of the assemblage when considered as one species:

- The dichotomy in mandibular molar size sequences; and in the presence of both a primitive and a derived form in the mandibular structures among the assemblage.

- We also note that D4500, in terms of character distances, is more similar to other hominins, including H. floresiensis, than it is to the other Dmanisi individuals.

Two species

- We propose that the most parsimonious hypothesis for the Dmanisi hominins is that two species are present among the assemblage: Homo georgicus comprising Skull 5, D4500, and an un-named species comprising the other Dmanisi hominins: D2280, D2282, D2700 and D3444.
- The alternative hypothesis, that the assemblage comprises a single species, requires substantial paradigm shifts in our definition of Homo.
- We surmise that the first hominin species at Dmanisi was H. georgicus (Skull 5, D4500), and that the species was probably present by 1.8 Ma.
- The other hominins, D2280, D2282, D2700 and D3444, accumulated at some time or times during the reverse polarity of 1.07 Ma and 1.77 Ma.

Specific ages unknown

- The specific ages of D2280, D2282_D211, D2700_D2735 and D3444_D3900, however, remain unknown.

- Needed: Dating of the volcanic ashes in which each hominin was recovered, together with dating the ashes in the overlying strata to find the minimum date for the hominins, would likely produce a more refined understanding of the chronology for the Dmanisi hominins.

*** 22,000-Year-Old Footprints Reveal the Earliest Evidence of Human Transport Technology

- In the shifting gypsum sands of White Sands National Park in New Mexico, a series of fossilized human footprints have surfaced, casting a striking new light on the ingenuity of Ice Age inhabitants. These tracks, dated to ~22,000 years ago, provide the oldest known evidence of human transport technology—suggesting that long before the invention of the wheel, prehistoric peoples were building and using travois-like devices to move heavy loads across vast landscapes.
- Study focuses on linear traces found alongside human footprints in the park's Alkali Flat region—traces that appear to be drag marks made by wooden poles in contact with the ground. The researchers propose that these markings, found in association with human footprints, may represent the earliest known use of a human-drawn transport system.

Footprints at White Sands, New Mexico, at multiple time periods; seeds & pollen data showed that the locality 2 footprints had been made between 23,000 and 21,000 years ago.

The ichnology of White Sands (New Mexico): Linear traces and human footprints, evidence of transport technology? – M. Bennett, et al., 2025

- A travois is crafted from one or more wooden poles and is one of the simplest prehistoric vehicles. A travois—a simple sled-like structure made from wooden poles tied in an A-frame—has long been documented in Native American cultures. These devices likely played vital roles in the lives of ancient peoples, they have low preservation.
- Here we report linear features associated with human footprints, some of which are dated to ~22,000 years old, preserved in fine-grained sediments at White Sands National Park (New Mexico, USA).
- Using a range of examples, we identify three morphological types of trace in late Pleistocene sediments.
- Type I features occur as single, or bifurcating, narrow (depth > width) grooves which extend in planform from 2 to 50 m in length and trace either straight, gently curved or more irregular lines. They are associated with human footprints, which are truncated longitudinally by the groove and are not associated with other animal tracks.

Study of tracks

- Type II examples are broader (width > depth) and form shallow runnels that typically have straight planforms and may truncate human footprints to one side.
- Type III examples consist of two parallel, equidistant grooves between 250 and 350 mm apart. They trace gently curving lines that can extend for 30+ m. Human footprints are associated with these features and may occur between, and to the side of, the parallel grooves.
- We review a range of possible interpretations including both human and non-human explanations and conclude that the most parsimonious explanation is that they represent drag marks formed by travois consisting of a single pole or crossed poles pulled by humans, presumably during the transport of resources. As such this unique footprint record may represent one of the earliest pieces of evidence for the use of transport technology.

Travois

- The term ‘travois’ broadly to include any form of vehicle fashioned from a single wooden pole with a load, as well as more complex vehicles consisting of two or more crossed poles. Ancient travois were most likely made of wood, so are not usually preserved in the archaeological record. Here we describe linear features associated with human footprints preserved in fine-grained sediments at White Sands

- Conclude that they were likely made by humans dragging either single or multiple poles potentially as improvised travois although we cannot exclude the possibility that some of the traces observed were made by the transport of firewood.

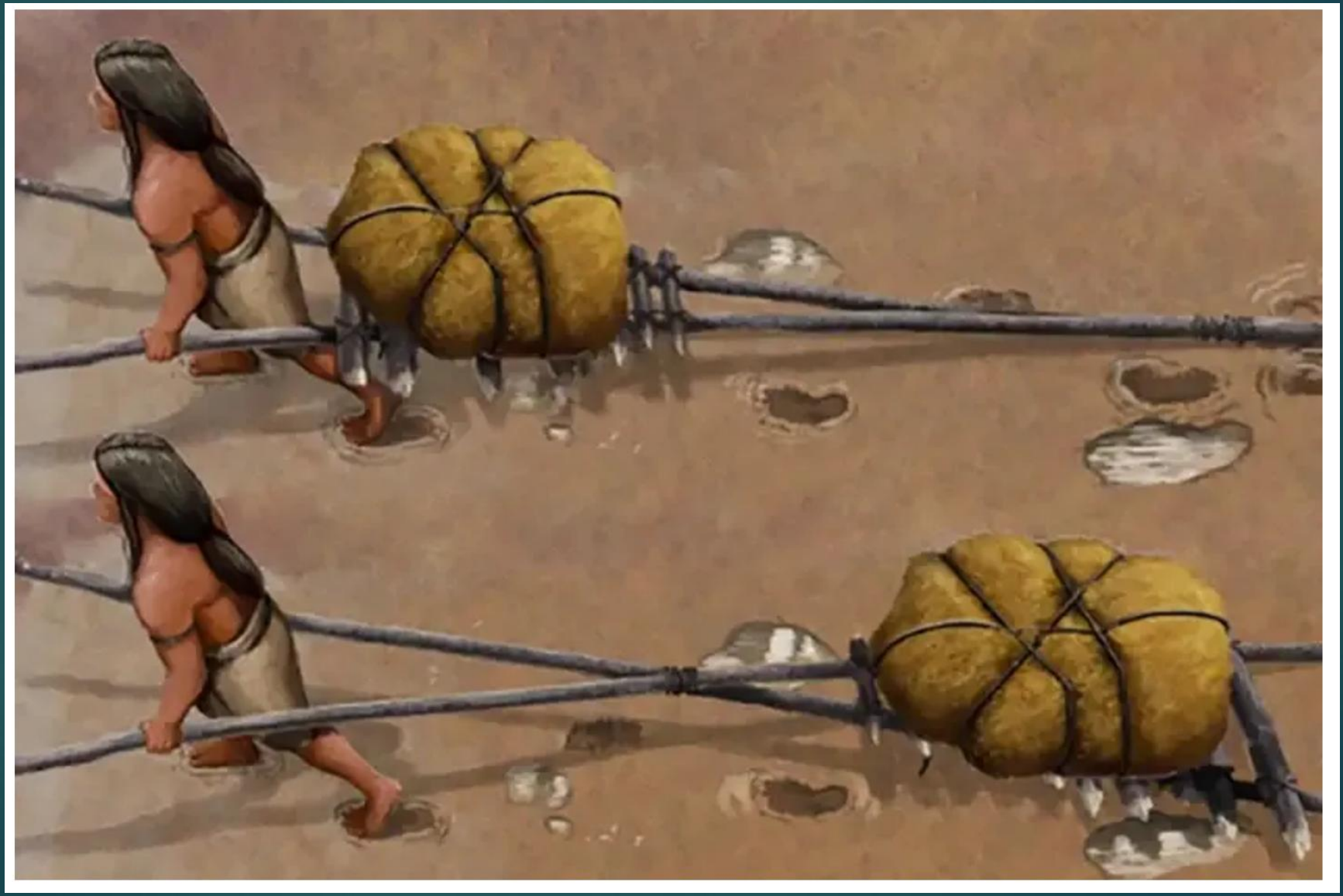
Other tracks

- Tracks and trackways of Proboscidea (mammoth/mastodon), Folivora (giant ground sloth), Carnivora (canid and felid), and Cetartiodactyla (bovid and camelid) occur on Alkali Flat along with humans.

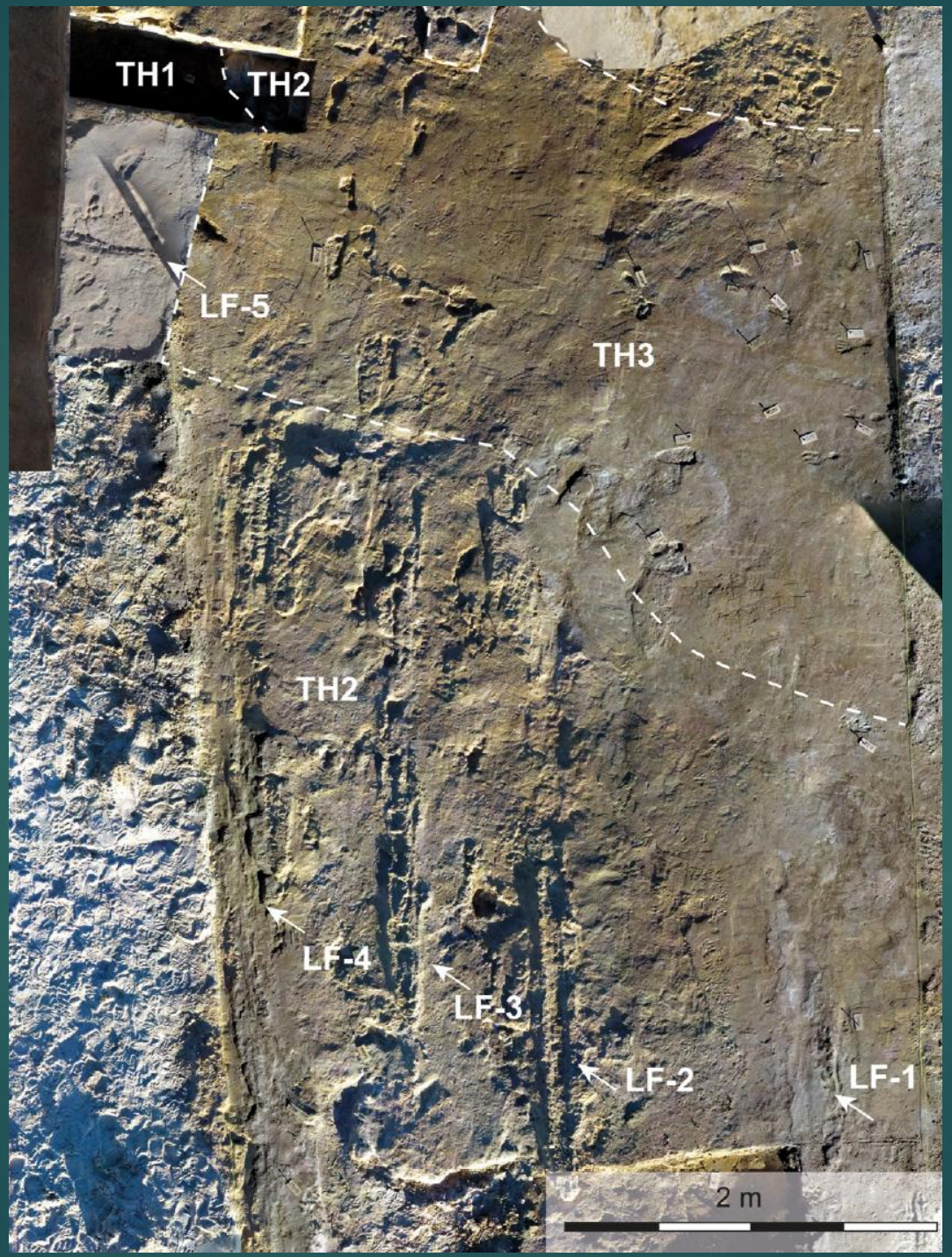
- Not only do the tracks occur in large concentrations, but they occur over a wide spatial area allowing individual trackways to be followed for extended distances.

- Lines created by travois are called “linear features”

Illustration of two types of travois, or sledge, that may have been used by ancient people in North America. No wheels. Pre draft animals.



Drag marks made by ancient vehicles in White Sands National Park, New Mexico


TH1
TH2
LF-5
TH3
TH2
LF-4
LF-3
LF-2
LF-1
2 m

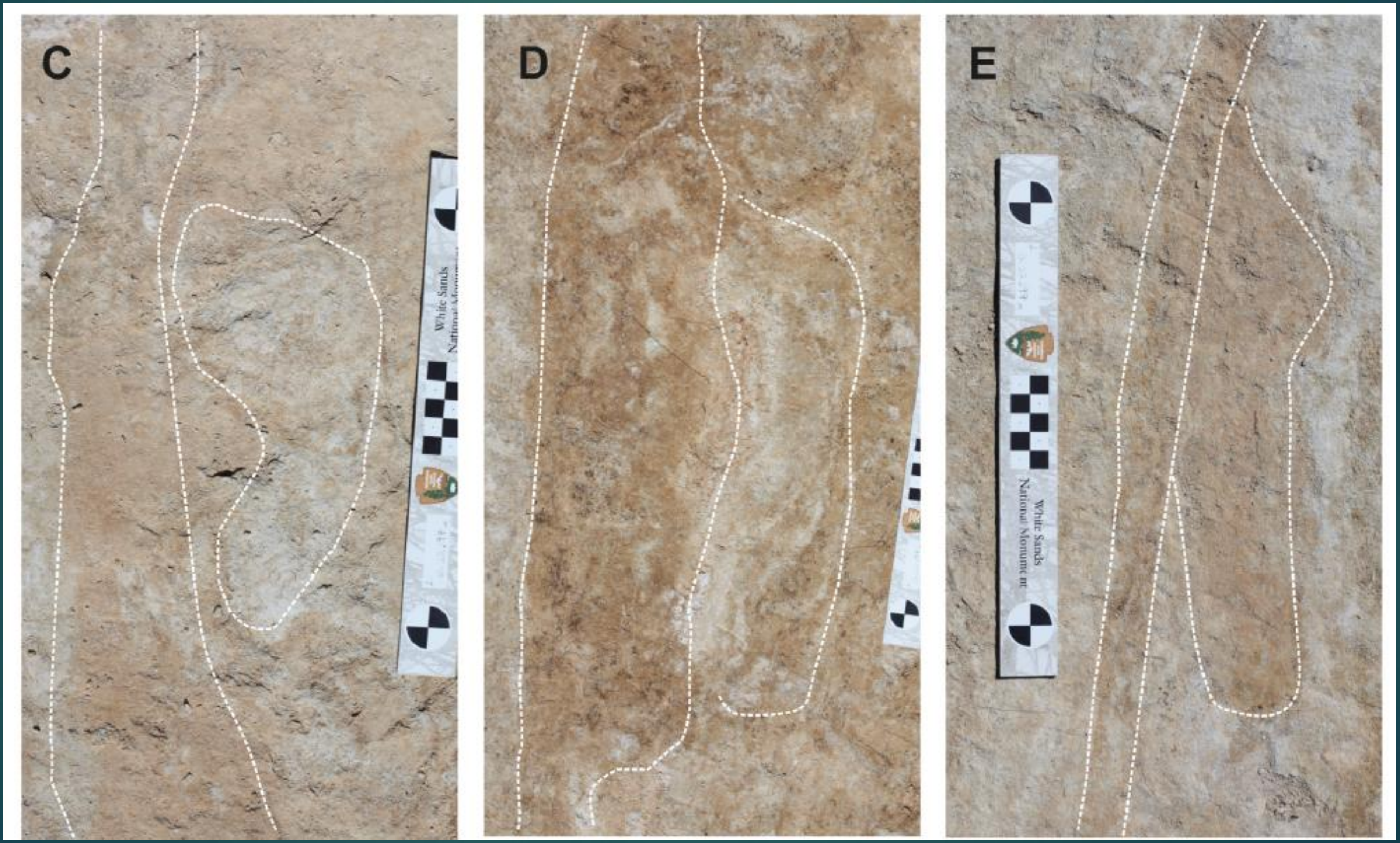
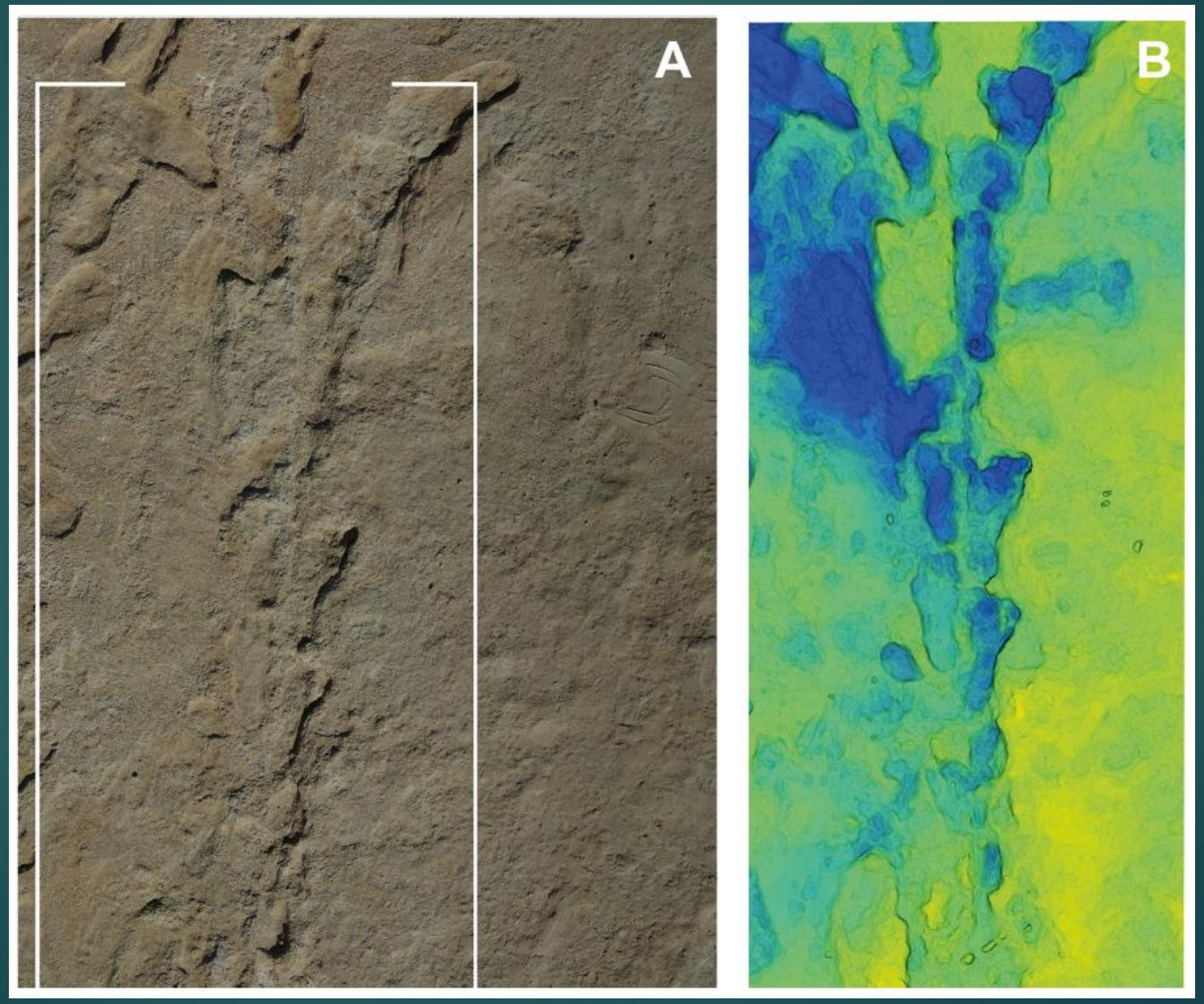
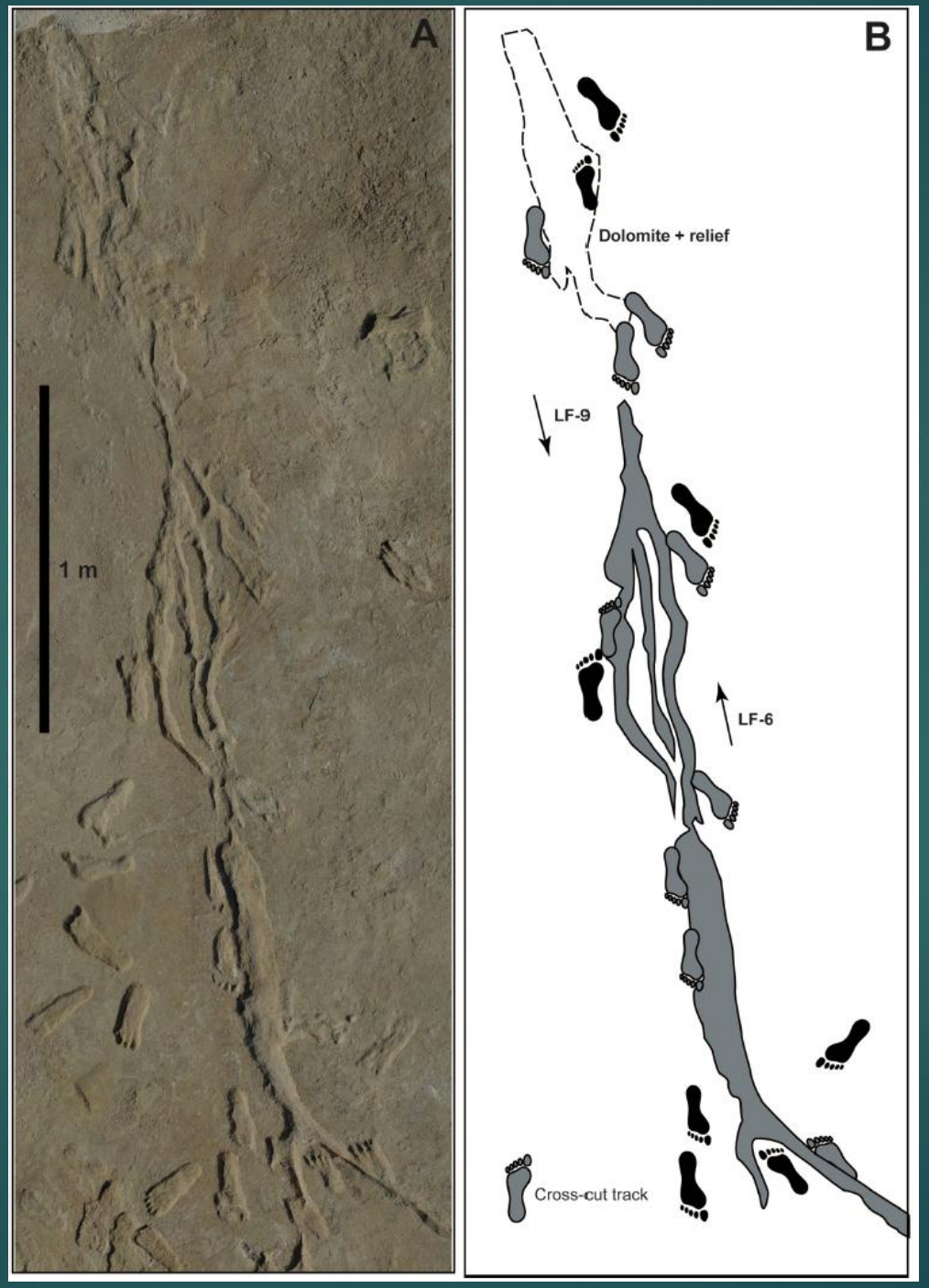
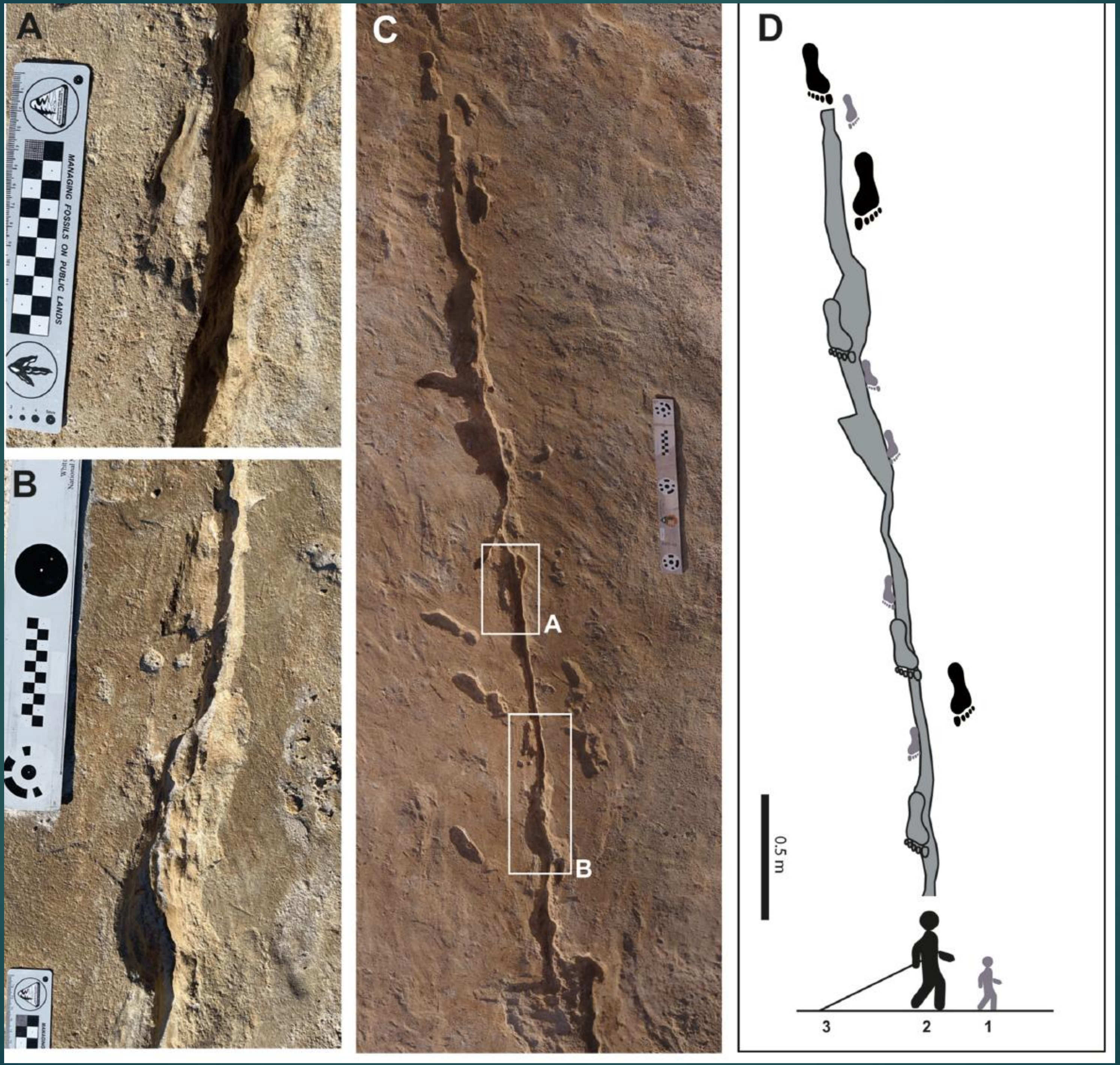

C
D
E
White Sands
National Monument


Figure 7
LF-6
LF-9
Figure 6
LF-6
N
LF-9
LF-7/8
0.0
0.5
1.0
(m)


A
B


A
1 m
B
Dolomite + relief
LF-9
LF-6
Cross-cut track


0.6 m
Figure 10

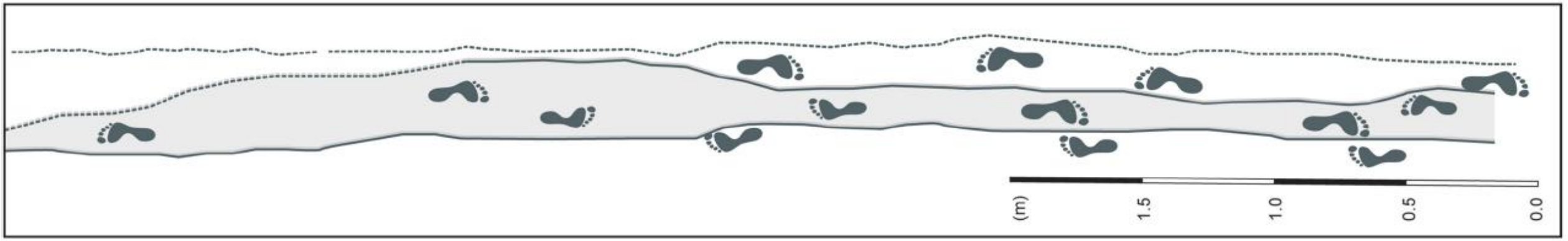

A
MANAGING FOSSILS ON PUBLIC LANDS
B
C
A
B
D
0.5 m
3
2
1

Reminder of wood technology

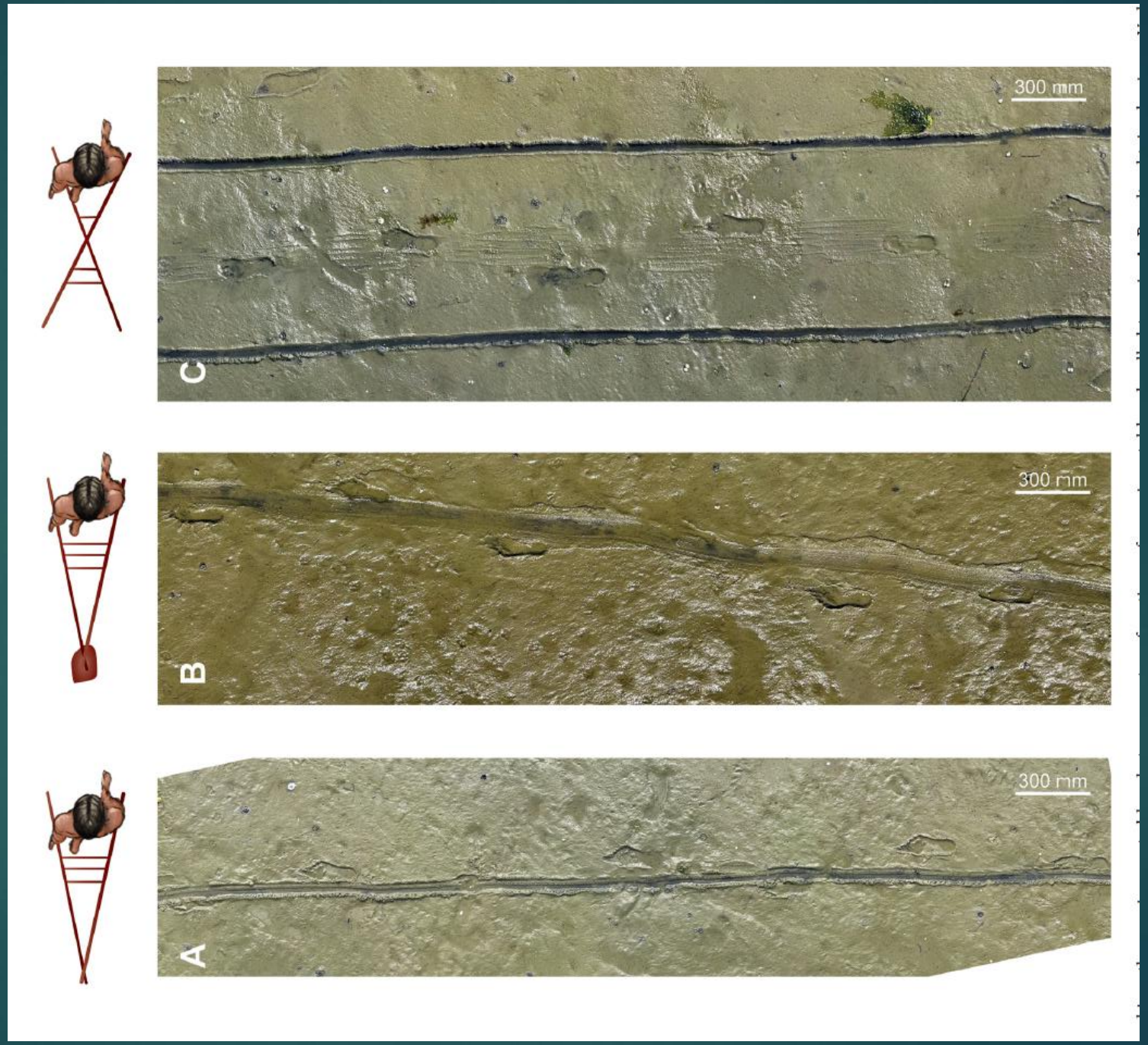
- The linear features at last provide some connection with technology. But the connection is not lithic.

- The use of travois tells us a great deal about the social organization and logistics of these people, and emphasize—if we needed reminding once more—that ancient people interacted with wood and other perishable materials in their lives more than with stone.

- Our traditional search strategies when looking for evidence of early human or hominin activities must in many cases fail because these strategies rely on stone artifacts, and ignore wooden ones.


(m)
1.5
1.0
0.5
0.0

Experiments



Conclusions

- Linear features, in the form of single or parallel grooves, associated with human footprints, are prominent of the trace and track record at White Sands National Park.
- There are three basic morphological types of features, namely single, often deeply cut, grooves that may bifurcate or jump between parallel lines (Type I). Secondly, there are broader grooves that form runnels with either single or multiple lines. Finally, there is a third type, in which two parallel grooves move across the surface. These features occur across Alkali Flat, both in potential former shoreline locations, and out on the playa floor.

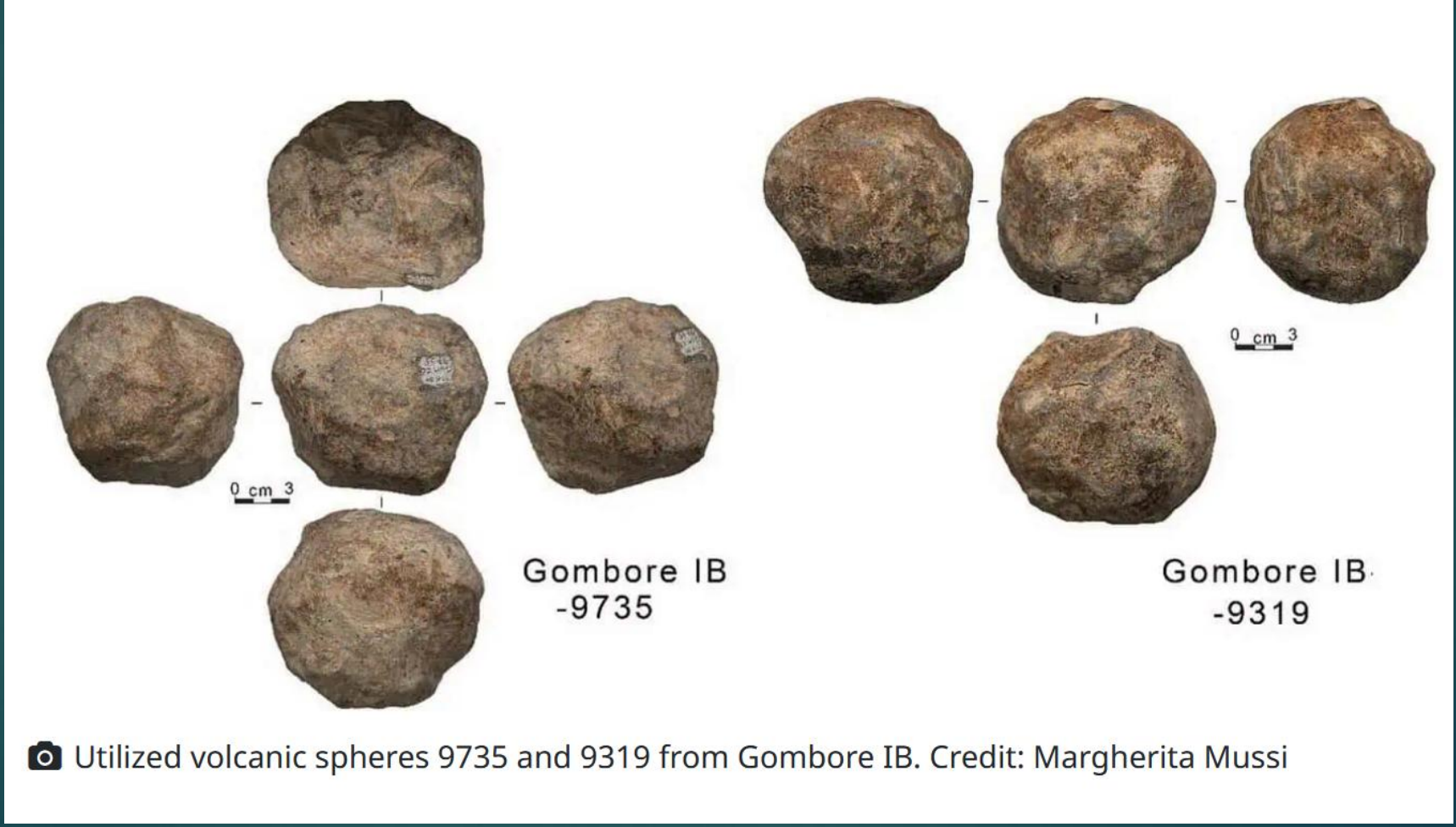
Dating

- In all cases, they crosscut human footprints and are not associated with other animal tracks, which implies a human agency in the formation of these traces.
- While some of the simpler traces may be formed by the movement of firewood, or simply the idle dragging of spears or tent poles, we suggest that those that involve the movement of two parallel grooves are likely produced by an improvised travois dragged by people.

- These surfaces date from ~22,000 years ago at the height of the Last Glacial Maximum, as such the linear features on these surfaces would therefore provide the oldest known evidence of vehicle transport.

Early Humans May Have Collected Round Stones for Over 1 Million Years

- Early humans may have prized volcanic balls for over a million years.



Utilized volcanic spheres 9735 and 9319 from Gombore IB. Credit: Margherita Mussi

Round stone balls

- In the highlands of Melka Kunture, Ethiopia, archaeologists have found dozens of remarkably round stones—dark, dense balls of volcanic rock. These are not sculpted artifacts; no hands chipped them into shape. They were born of fire and geology, not craftsmanship. And yet, a new study suggests, early hominins may have used them with purpose.
- The spheres, made from volcanic basalt and lapilli, were discovered across eight archaeological sites in Melka Kunture, dated between 1.7 million and 600,000 years ago. That range spans three different human ancestors: *Homo erectus*, *Homo heidelbergensis*, and early *Homo sapiens*.
- This is possibly the first evidence of the use of natural shapes for varied activities. And this happened repeatedly over more than 1 million years of human evolution at Melka Kunture.

Use of round stones

- They came from sites with tens of thousands of other tools—flakes, scrapers, and core stones used for hunting and survival.

- *** Many of the spherical rocks showed wear marks, chipped edges, and smoothed faces, as if they'd been hammered, rubbed, or pounded into service.

- ** "I am convinced that the hard volcanic ones were used to knap or retouch lithic tools," Mussi explained. "While the rather soft lapilli ones were used for rubbing vegetables, hides, or other stuff."

Stones

- We may never know exactly what our ancestors did with these spheres. They may have served as hammerstones, grinding tools, or even primitive game pieces. But the behavior behind them—the attention to shape, the act of selection, the testing of function—offers an important clue into our ancetors' evolution.

- It tells us that long before the first painting on a cave wall or the first arrow loosed from a bow, early humans were watching the world closely. They were noticing. They were experimenting.

- And maybe, just maybe, they saw beauty in a sphere.

** The Levant: Ns later than MHs

- East Mediterranean Levant. AMH were present in that region between 80 and 130 ka, and created the Skhul and Qafzeh record with its burials, pigments and personal ornaments, associated with a Middle Paleolithic lithic technology.
- Between 80 and 47 ka however, only Neandertals are known from the fossil record of the Levant.
- If the absence of fossil AMH in the record represents a true absence from the region, this could indicate that the Skhul/Qafzeh hominins and their immediate descendants indeed may have "lacked the behavioral capacities that enabled subsequent modern humans to compete successfully against the Neanderthals"

CJV: Levant

- Late Pleistocene Israel is the region in which issues of population mixture or competition at the time of the emergence of modern humans are most likely to be solved.

- For those who believe that modern humans first arose in Africa and subsequently spread throughout the world replacing archaic populations, the Levant would be the first region where such archaic populations were encountered.

- For those who regard the Levantine Neandertal populations as late émigrés from a glaciated and inhospitable Europe, the Levant is the place where it is most likely that Neandertals encountered other human populations

- Results suggest that the traditional “Neandertal” versus “modern human” groupings in the Levant may not be as distinct as often thought.

- This would imply that as populations left Africa, they interbred with the Late Pleistocene inhabitants of the Levant, and suggest that as different populations moved or expanded their range, subsequent human evolution be viewed as a consequence of the continued mixing of ideas and genes

*** Evidence from Tinshemet Cave in Israel suggests behavioral uniformity across Homo groups in the Levantine mid-Middle Palaeolithic circa 130,000–80,000 years ago -- Yossi Zaidner, et al., 2025

- The south Levantine mid-Middle Palaeolithic (mid-MP; ~130–80 ka) is remarkable for its exceptional evidence of human morphological variability, with contemporaneous fossils of Homo sapiens and Neanderthal-like hominins.

- Yet, it remains unclear whether these hominins adhered to discrete behavioral sets or whether regional-scale intergroup interactions could have homogenized mid-MP behaviors.

Interactions among Levantine Homo groups

- New study reports on discoveries at Tinshemet Cave, Israel. The site yielded articulated Homo remains in association with rich assemblages of ocher, fauna and stone tools dated to ~100 ka.

- Based on findings from other key regional sites of this period, findings indicate consolidation of a uniform behavioral set in the Levantine mid-MP, consisting of:
  - similar lithic technology,
  - an increased reliance on large-game hunting and
  - a range of socially elaborated behaviors, comprising intentional human burial and the use of ocher in burial contexts.
- Suggest that the development of this behavioral uniformity is due to intensified inter-population interactions and admixture between Homo groups ~130–80 ka.

Morphological variability

- Growing body of evidence indicates that southwest Asia was the stepping stone for an Asia-wide expansion of Homo sapiens. The Levant during this period is marked by exceptional evidence of synchronous human morphological variability within the region, including fossil evidence of highly variable populations.

- This variability is expressed on the inter-site level with
  - archaic Neanderthal-like fossils reported at Nesher Ramla and
  - H. sapiens-like fossils at Skhul and Qafzeh caves,
  - between the Skhul and Qafzeh fossils, and the
  - use of Mousterian tools within the Qafzeh MH fossil assemblage.

Variability

- This variability has been a source of major debate about the anatomical affinities of Levantine mid-MP hominins.

- Skhul and Qafzeh hominins have been variously seen as variable populations of archaic H. sapiens, distinct human types or hybrids.

Four Levant Sites

- High human morphological diversity in the Levantine mid-MP is accompanied by abundant evidence of complex social behavior such as intentional burial of the dead, the interment of grave goods and ocher use in burial sites.

- The four key Levantine sites that include human-fossil-bearing deposits and are broadly assigned to the mid-MP—namely, Qafzeh, Skhul, Tabun and Nesher Ramla—are currently characterized by a lack of coherence.

Qafzeh 0 and Skhul V

Qafzeh

- To date, the most complete package of material markers of technological and symbolic human behaviors derives from Qafzeh Cave.

- Excavations in this site have uncovered seven burials, associated with grave goods and abundant ocher pieces, and large lithic assemblages that demonstrate the technological dominance of the centripetal Levallois method.

- The Levallois knapping technology is considered a defining characteristic of mid-MP lithic technology in southwest Asia.

Nesher Ramia: Neandertal like skull pieces, 140-120 Ka

Tabun 1 Neandertal

Nesher Ramia, Israel

- Additionally, the recently uncovered, large lithic assemblage of Nesher Ramla reveals that the Levallois centripetal reduction system was the primary technology employed at this site.

- While mid-MP Nesher Ramla may closely align with Skhul and Qafzeh chronologically, its human fossils belong to a palaeodeme associated with archaic Neanderthal-like hominins.

Tinshemet Cave: evidence of cultural traditions

- Here we report on the recent discoveries at Tinshemet Cave, Israel, which is located only 10 km from the open-air site of Nesher Ramla.

- They systematically evaluated the likelihood that these sites, together with Qafzeh, Skhul and Tabun C, belonged to a coherent regional cultural tradition widely shared among hominin groups of diverse anatomical affiliations.

- Tinshemet Cave has yielded large lithic assemblages dominated by centripetal Levallois technology associated with numerous Homo spp. remains, including fully articulated skeletons, and abundant ocher chunks.

Levant

- **Homo sapiens Presence:** Fossil evidence suggests that Homo sapiens were present in the Levant as early as 130,000 years ago.
- **Neanderthal Presence:** Fossil evidence suggests Neanderthals occupied the southern Levant between approximately 80,000 and 55,000 years ago.
- **Coexistence and Interaction:** The archaeological record suggests that Homo sapiens and Neanderthals coexisted in the Levant for a significant period, potentially interacting and sharing cultural practices.

Levant

- **Ongoing Debate:** The exact timing and nature of the interactions between these two groups, as well as the broader question of their relationship, continue to be subjects of scientific debate and research.

- **Material Culture:** The material culture of both groups in the Levant, including tools and burial practices, shows similarities, suggesting possible cultural exchange or adaptation.

CJV:

- By integrating data from four key fields—stone tool production, hunting strategies, symbolic behavior, and social complexity—the study argues that different human groups, including Neanderthals, pre-Neanderthals, and Homo sapiens, engaged in meaningful interactions.

- It's here in the Levant that the world's oldest human burials have been discovered, with graves at sites in what is now modern-day Israel such as Qafzeh, Skhul, Tabun, and Nesher Ramla dated to between 100,000 and 110,000 years ago.

- Disagreements persist over which species occupied each site, although the Qafzeh and Skhul specimens are generally seen as being more Homo sapiens than Neanderthal while the Nesher Ramla remains show a mix of traits from both lineages.

Ns and MHs and Levallois tradition

- The Tabun skeletons, meanwhile, represent a Neanderthal or pre-Neanderthal population,

- The newly discovered Tinshemet individuals have been tentatively characterized as Homo sapiens-ish pending further analysis.

- Tellingly, the new study reveals that the stone technologies found at Tinshemet conform to the centripetal (moving toward the center) Levallois industry, thus matching the lithic traditions at all of the other nearby sites.

Cultural transmission of tech & hunting focus

- What's more the centripetal Levallois technology refers to "a process of production" rather than just the nature of the finished tools, which means the sequence itself had to be learned via cultural transmission.

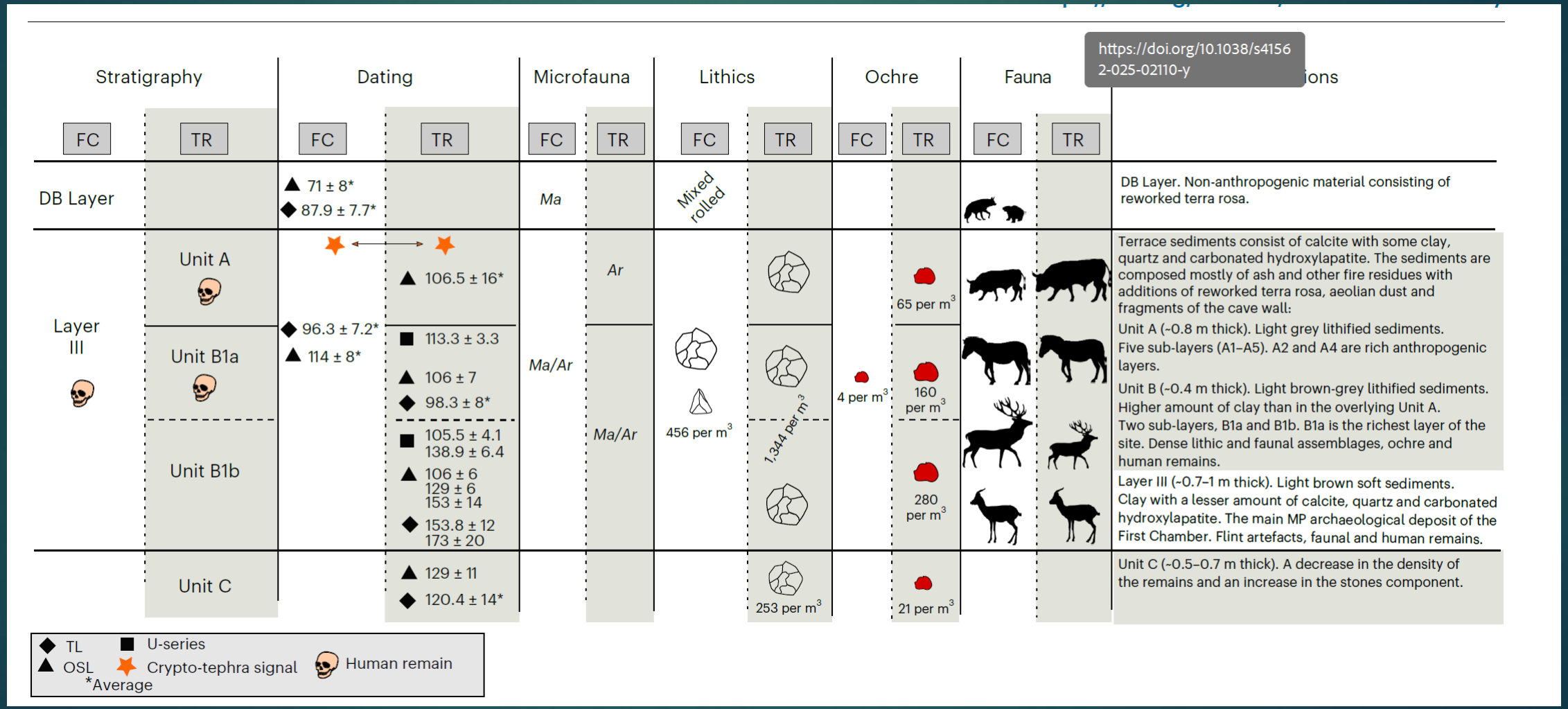
- Animal remains from all of the sites suggest that the Levantine hominins of the mid-Middle Palaeolithic differed from earlier and later humans in that they focused specifically on hunting large herbivores such as aurochs and horses.

Symbolic thought and shared traditions

- Given that funerary practices and the use of ocher are both seen as proxies for the development of symbolic thought in prehistoric humans, the presence of these elements at the various caves suggests that interactions between the different populations may have driven the emergence of complex social behaviors and customs.

- It's important that [these practices] occur only in the Levant and only during this period of time. We don't have it before and we don't have it later. So taking together all these four aspects, we see a clear behavioral uniformity [across all the sites]. Suggests that they not only co-existed but actively shared ideas, technologies, and practices.

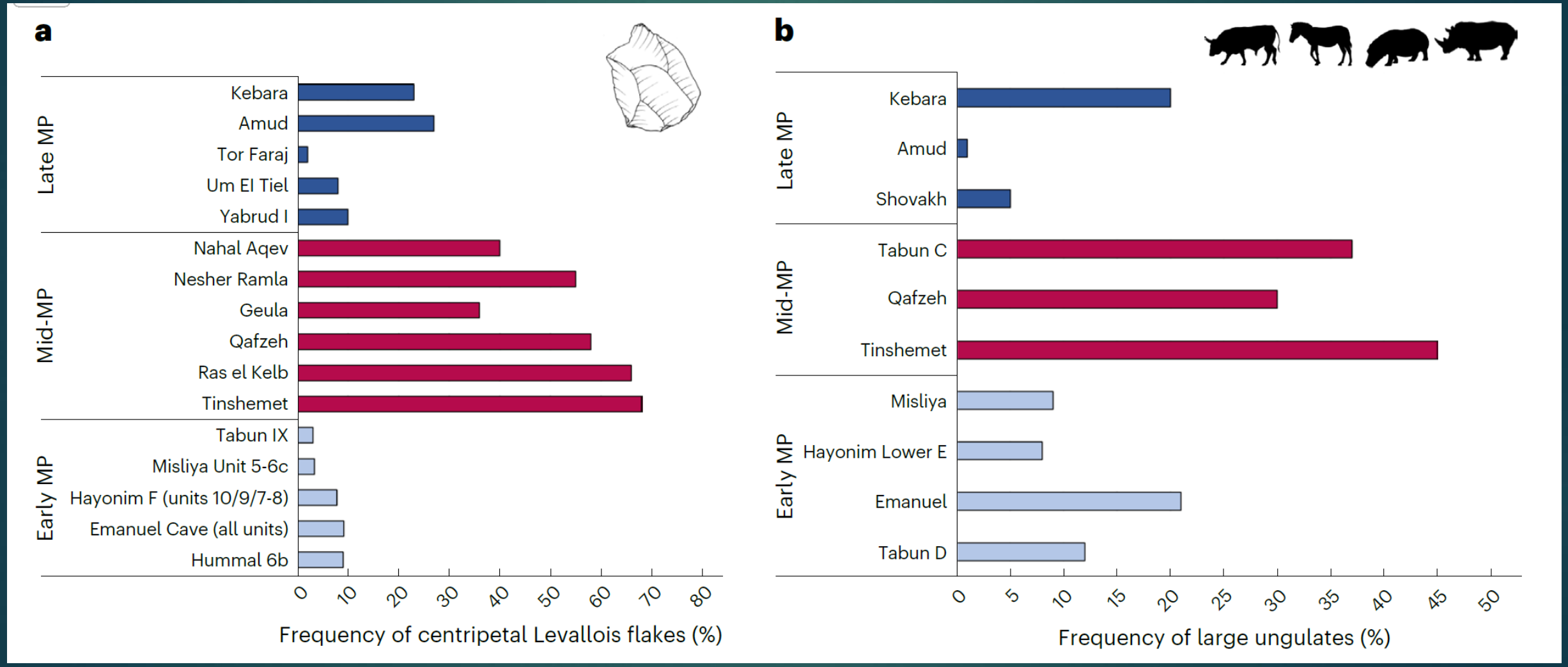
Tinshemet Cave: major characteristics. Archaeological and environmental characteristics (stratigraphy, dating, microfauna, lithics, ocher and fauna) of the Terrace and the First Chamber.



Tinshemet Cave

- Tinshemet Cave was inhabited during the MIS 5 (130–80 ka)
- Stone tech: Levallois - The results show close technological similarity between these assemblages, suggesting that they are likely to represent the same cultural unit.
- Ocher: 7,500 ocher fragments of different sizes, shapes, textures and colors
- Fauna: ungulate remains = 88%
- Human remains, totaling five individuals, were discovered in different layers of Tinshemet Cave. Notable findings include two fully articulated skeletons, three isolated skulls in varying states of preservation, assorted appendicular bones and isolated teeth. Characterized as Homo spp.
- One non-N skeleton was removed as a one-ton block of rock and brought to Hershkovitz's lab,

Centripetal Levallois method and large-game hunting in the Levantine



Human burials at Tinshemet, Qafzeh and Skhul Caves. Note that in all three caves the body was deposited on their right side

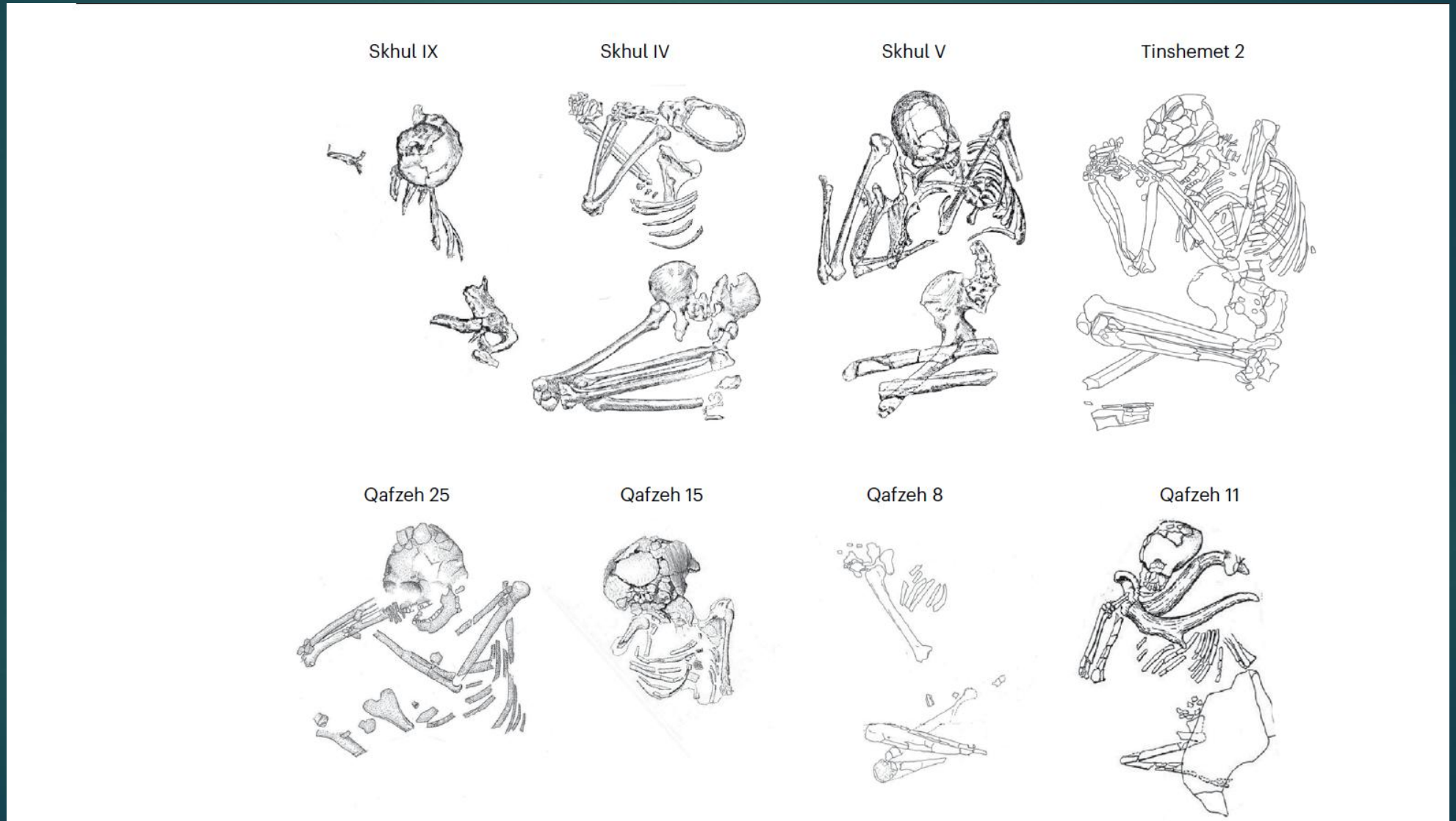


Fig. 5 | Human burials at Tinshemet, Qafzeh and Skhul Caves. Note that in all three caves the body was deposited on their right side (Qafzeh 9 excluded) in a f

Funerary practices

- Funerary practices and interment processes at Tinshemet Cave: These include formal inhumation of both adults and children, and the fetal or sleeping position of the dead (bodies lying on their sides with highly flexed legs, arms bent towards the chest and face, and the head facing down).

- The dominance of primary burials (on the basis of the fully or partial articulated skeletons) suggests immediate burial after death.

- Additional insights into the burial practices at Tinshemet Cave suggest grave inclusions—that is, large pieces of ocher.

Lithic technologies as a measure of inter-population connectivity

- The centripetal Levallois technology is the dominant lithic reduction method used at Tinshemet Cave, as at all other mid-MP sites.

- The neighboring northern part of the Arabian Peninsula shows similar technological features and is probably part of the same techno-complex.

- Precursor early MP (~250–140 ka) lithic industries of the Levant exhibit an entirely different technological set than that of the Levantine mid-MP, with the dominance of blades produced by non-Levallois laminar methods and the production of Levallois blanks employing convergent unidirectional and bidirectional methods. The Levantine early MP industries display no evidence of the systematic use of the centripetal Levallois method, which became dominant in the Levant in the mid-MP.

Levallois

- The centripetal Levallois method persisted into the late MP (80–45 ka), where it occurs alongside other Levallois as well as non-Levallois and laminar methods, but rarely dominates the lithic assemblages.

- The Levantine mid-MP lithic technological homogeneity differs from the neighboring regions, such as the technologically heterogeneous East Africa during the Middle Stone Age.

- The technological homogeneity that occurs across Homo groups in southwest Asia suggests high inter-population connectivity within this region during the mid-MP.

Ocher—a marker of socially mediated activities

- During the mid-MP, ocher emerged as an important cultural substance whose exploitation is likely to have involved trips to distant sources and heat treatment.
- The use of ocher in the Levantine MP was reported only in mid-MP sites roughly contemporaneous with Tinshemet Cave. Its use has been linked to funerary practices and has been taken as evidence of a human behavioral mode probably undergirded by the emergence of symbolic thought.
- Heating of the ocher to obtain red color, reported at Skhul, Qafzeh and Tinshemet, is likely to be related to the importance of red in symbolic communication.
- Ocher stain was also found on perforated marine shells from Qafzeh, which are likely to have been used as personal ornaments. An additional aspect of ocher use is the long-distance trips involved in its acquisition.

Exploitation of large ungulates

- Large ungulates: increased reliance on large-bodied ungulates in the mid-MP compared with the early and late stages of the Levantine MP.

- The proportion of the largest ungulate prey taxa, aurochs and equids, at Qafzeh, Skhul, Tabun C, Tinshemet Cave and the open-air site of Nesher Ramla is consistently greater than during the earlier and later stages of the MP

Behavioral uniformity across Homo groups

- The consolidation of a unified behavioral package during the ~50,000-year-long Levantine mid-MP deserves particular attention as it stands in stark contrast to the heterogenous morphology of the local hominin population. The MP Levant was inhabited by three hominin groups: archaic Neanderthal-like Homo, Neanderthals and H. sapiens. The evidence suggests that some of these hominins coexisted.

- The site of Nesher Ramla yielded Homo remains that bear a combination of Neanderthal and archaic Homo features, which chronologically overlap with the Qafzeh and Skhul fossils.

Skhul and Qafzeh

- The identification of the Skhul specimens as modern humans was supported by some scholars while others identified them as a separate morphological group or as hybrids, emphasizing their peculiar characteristics in the morphology of the chin and the brow ridges, and the morphological differences between the Skhul and Qafzeh fossils.

- The morphological variability of the Qafzeh hominins is also notable including fossils that show characteristics that do not align with H. sapiens.

Similar death rituals

- The Tinshemet burials present an exceptional opportunity for comparative analysis of burial customs across prominent mid-MP Levantine sites.

- All three major Levantine mid-MP sites with skeletal remains, Tinshemet Cave (MNI = 5), Skhul Cave (MNI = 10) and Qafzeh Cave (MNI = 25), fall within the multiple-burials site category, signifying that a major activity at these sites involved the deliberate treatment and deposition of the deceased.

- The cultural responses to death were similar in all three sites.

Earliest Burial practices

- All three sites show remarkable similarities in how people disposed of their dead.

- These characteristics include the highly flexed position of the deceased and the placement of various objects inside the grave, including animal remains and chunks of ocher, which demonstrate similarities in symbolically mediated behavior across these sites and suggest that the intricacy of funerary rites in the mid-MP surpasses that of late MP burials of Levantine Neanderthals exposed at Amud and Kebara Caves, dating to 70–50 ka.

- The mid-MP burials at Tinshemet, Qafzeh and Skhul caves represent the earliest instances of intentional Homo burials, predating the formalized burial practices in Europe and Africa by tens of thousands of years.

Inter-population connectivity

- The morphological variability of the Levantine MP hominins has become a source of heated debate on their taxonomic identity and on the question of H. sapiens and Neanderthal interactions in the region.

- The hypotheses raised include
  - coexistence with no interactions
  - alternating occupations,
  - brief episodes of engagement followed by extinction, and
  - interactions that facilitated cultural transmission and assimilation across species.

Lots of interaction

- The final interactional scenario is supported by recent studies of the facial and dental morphology of the Qafzeh and Skhul fossils that show that the Qafzeh and Skhul hominins fall well within the expected morphology of hybrid populations supporting previous similar views.

- A recent study based on the lithic technological behavior of the Nesher Ramla hominins demonstrated that Nesher Ramla, Skhul and Qafzeh shared core reduction technologies, suggesting that cultural diffusion and interaction across Homo populations is the most likely reason for the close cultural similarity between these sites.
- The behavioral evidence from Tinshemet Cave further supports a high level of inter-population connectivity in the Levantine mid-MP.

Genetic and social admixtures

- The summary of the MP human behavioral features in the Levant reveals a well-defined mid-MP entity with a widely shared behavioral repertoire found across the four major Levantine sites (Qafzeh, Skhul, Nesher Ramla and Tinshemet) with chronological overlaps.
-
- These strata broadly share:
  - a uniform lithic technology,
  - the use of ocher,
  - a large-ungulate hunting pattern,
  - the presence of articulated human remains and
  - the presence of grave goods or non-utilitarian artefacts.

Genetic and social admixtures.

- We suggest that the association between behavioral uniformity and high human biological variability could be a result of intensifying social interactions and admixture among African H. sapiens and Eurasian Neanderthal-like hominins in the mid-MP Levant.

- It is now increasingly understood that several taxa provided population sources for the Levantine MP and that population influxes from different sources chronologically overlapped in a way that created opportunities for genetic and social admixtures.

Hershkovitz comment: Cooperation, not war

- "We tend to think of our evolutionary history as a kind of Cold War: two superpowers, the Neanderthals and Homo sapiens, vying for control of land and resources for tens of thousands of years, until finally modern humans 'capture' the heart of Neanderthal lands in Western Europe," Hershkovitz says.
- "But here in Israel, at the point of longest contact between these two groups, the paradigm doesn't hold out: the arrival of sapiens in this region brought new technologies, new genetic diversity in both gene pools and both sides benefited. In distant prehistory at least it seems that the standard approach between different groups of humans was cooperation, not war."

*** Next study: MHs = not a single continuous ancestral lineage

- For the last two decades, the prevailing view in human evolutionary genetics has been that Homo sapiens first appeared in Africa around 200,000 to 300,000 years ago, and descended from a single lineage.
- Using a new method of modeling genomic data, called "cobraa," which is an advanced analysis of modern human DNA based on full genome sequences from 1000 genome project, researchers from the University of Cambridge in *Nature Genetics.*
- The team developed a computational algorithm called cobraa that models how ancient human populations split apart and later merged back together. They tested the algorithm using simulated data and applied it to real human genetic data from the 1000 Genomes Project.

Mixing events

- Study found evidence that modern humans are the result of a genetic mixing event between two ancient populations that diverged around 1.5 million years ago.
- Then at about 300,000 years ago, these groups came back together, with one group contributing 80% of the genetic makeup of modern humans and the other contributing 20%.
- Long before interactions of MHs and Ns and Ds—around 300,000 years ago—a much more substantial genetic mixing took place.
- Unlike Neanderthal DNA, which makes up roughly 2% of the genome of non-African modern humans, this ancient mixing event contributed as much as 20% and is found in all modern humans.

Split, then bottleneck, then long growth

- Immediately after the two ancestral populations split, we see a severe bottleneck in one of them—suggesting it shrank to a very small size before slowly growing over a period of one million years.

- This originally smaller population (A) would later contribute about 80% of the genetic material of modern humans, and also seems to have been the ancestral population from which Neanderthals and Denisovans diverged.

- However, some of the genes from the population which contributed a minority of our genetic material, particularly those related to brain function and neural processing, may have played a crucial role in human evolution.

Purifying selection

- The study also found that genes inherited from the second population were often located away from regions of the genome linked to gene functions, suggesting that they may have been less compatible with the majority genetic background.

- This hints at a process known as purifying selection, where natural selection removes harmful mutations over time.

*** A structured coalescent model reveals deep ancestral structure shared by all modern humans -- Trevor Cousins, et al., 2025

- Understanding the history of admixture events and population size changes leading to modern humans is central to human evolutionary genetics.

- Here we introduce a coalescence-based hidden Markov model, cobraa, that explicitly represents an ancestral population split and rejoin, and demonstrate its application on simulated and real data across multiple species

Two ancestral populations

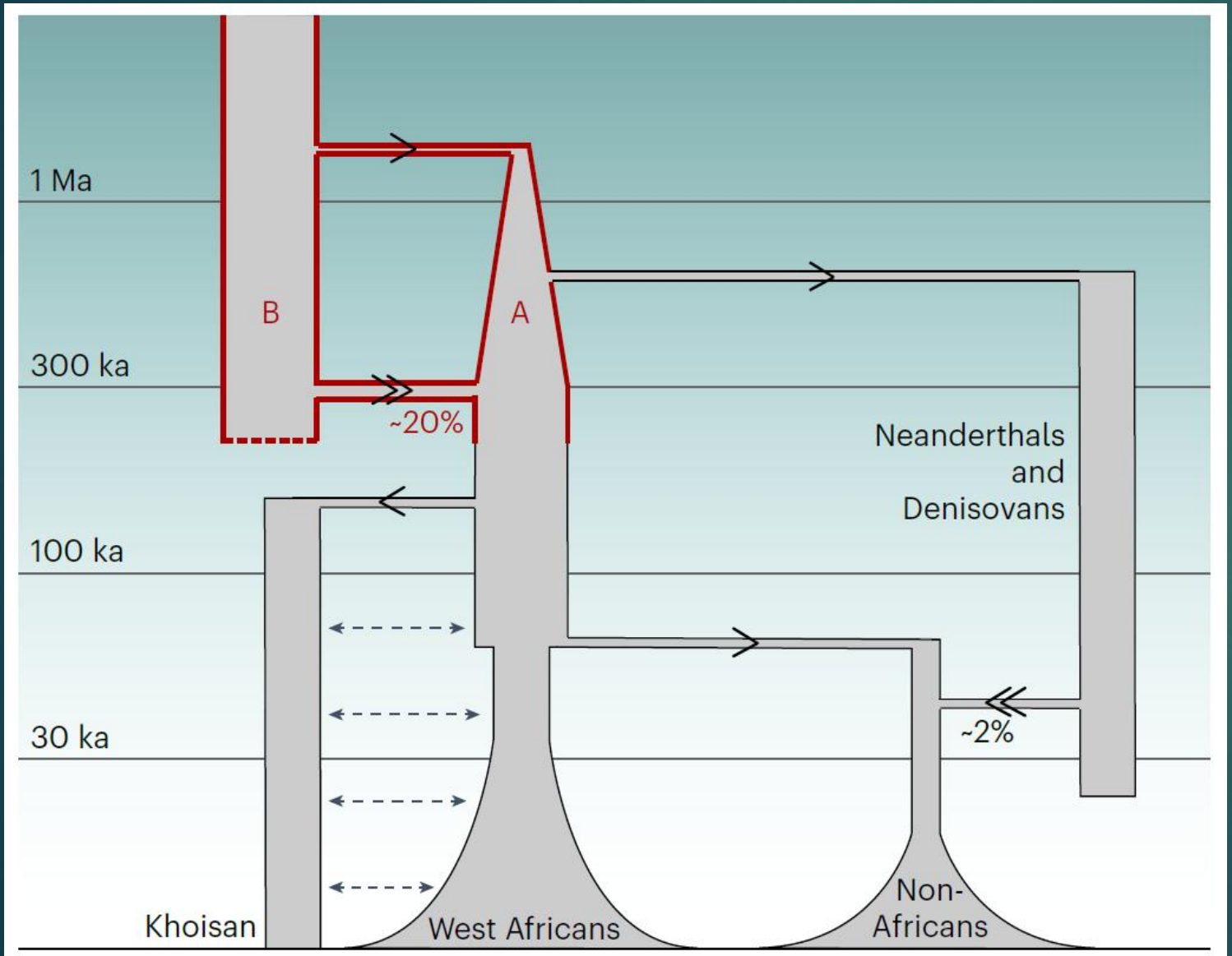
- Using cobraa, we present evidence for:
  - an extended period of structure in the history of all modern humans,
  - in which two ancestral populations that diverged ~1.5 million years ago
  - came together in an admixture event ~300 thousand years ago,
  - in a ratio of ~80:20%.
  - Immediately after their divergence, we detect a strong bottleneck in the major ancestral population.

2 ancestral populations – 1 deleterious

- We inferred regions of the present-day genome derived from each ancestral population, finding that material from the minority correlates strongly with distance to coding sequence, suggesting it was deleterious against the majority background.

- Moreover, we found a strong correlation between regions of majority ancestry and human–Neanderthal or human–Denisovan divergence, suggesting the majority population was also ancestral to those archaic humans.

A simplified model of human demographic history, as inferred by cobraa.



Deep population structure ~1.5 Ma to ~300 ka ago shared by all present-day humans, (red). Arrows indicate the direction of gene flow, with admixture events (double arrows) labeled by their percentage genetic contribution to the recipient population.

Of the two ancestral branches A and B, **A** represents 80% of subsequent ancestry and features a sharp bottleneck immediately after its founding.

Dashed arrows between Khoisan and other African populations reflect the fact that this divergence, the deepest among present-day human populations, has involved ongoing or intermittent gene flow.

Deep split

- Introduce here a coalescent-based method to infer a structured ancestry from a diploid genome sequence, which we have used to infer a deep split in human ancestry ~1.5 Ma, rejoining ~300 ka, around the time of the earliest anatomically modern human fossils.

- The admixture percentage of ~20% is much higher than the fraction of Neanderthal or Denisovan admixture into present-day non-African populations

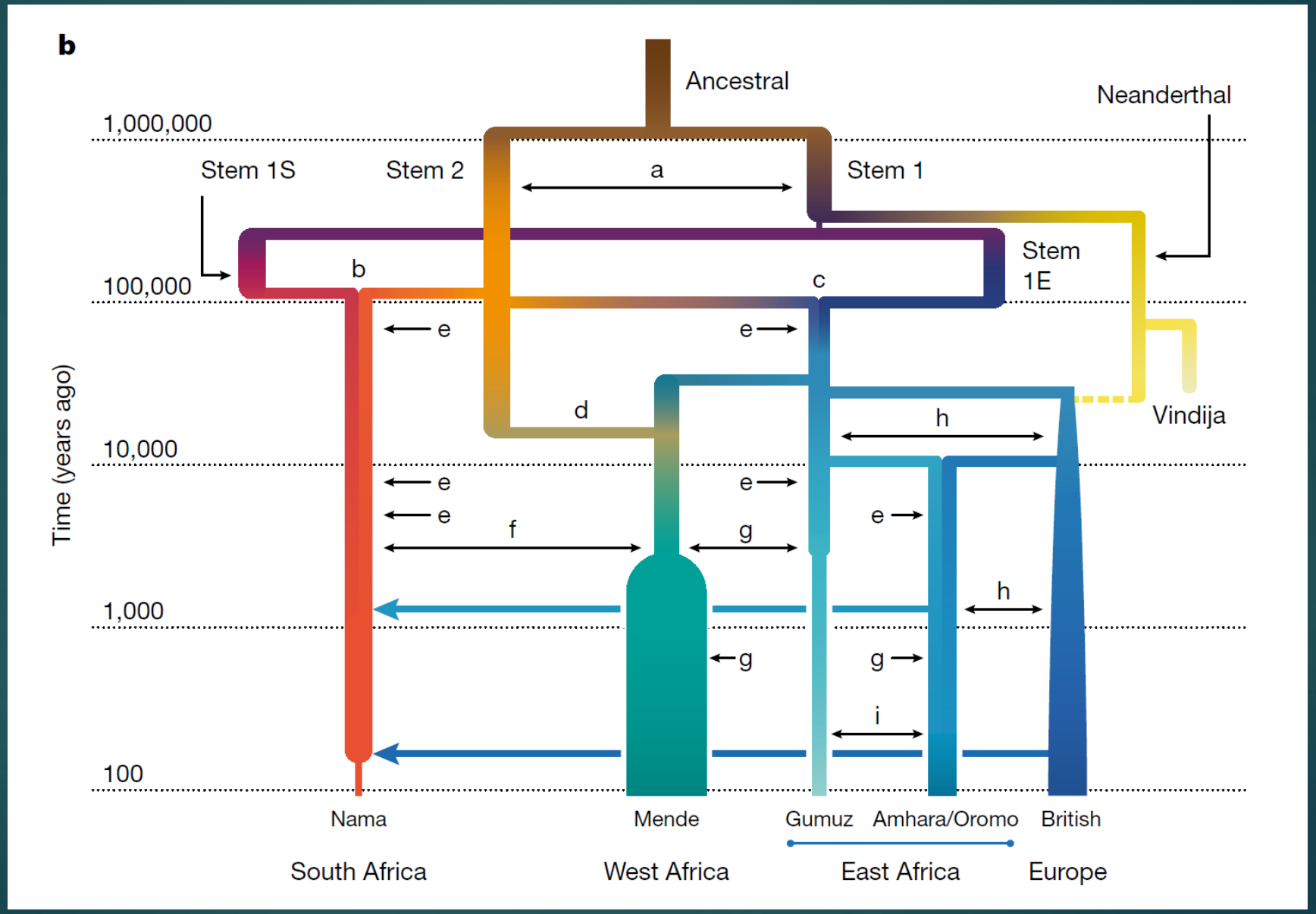
Comparison with recent Ragsdale study

- Recently, Ragsdale et al. 2023 also proposed deep ancestral structure in the ancestors of modern humans.

- Their best-fitting model suggested an initial divergence ~1.7 Ma into two populations, ‘stem 1’ and ‘stem 2’, with continuous gene flow between them until ~500 ka, at which point, stem 1 split into populations—1S ancestral to Khoisan and 1E ancestral to all other modern human subpopulations.

- Stem 2 is estimated to have contributed 70% of ancestry into the Khoisan lineage ~120 ka, and 50% of ancestry into stem 1E ~100 ka.

Ragsdale et al. 2023: two weakly structured stem



Ragsdale

- The initial split time of ~1.7 Ma is similar to ~1.5 Ma estimated by cobraa. In contrast, cobraa estimates a single admixture event ~300 ka, substantially more ancient than the earliest admixture reported in Ragsdale.

- The differences could be due to the space of models. For example, cobraa requires populations A and B to be in isolation after they split, contrasting with the inferred continuous gene flow between stem 1 and 2 in Ragsdale.

Relation to hominin record

- The model of ancestral structure we propose raises intriguing questions about the relationship of lineages A and B to previously identified hominins.

- Archeological evidence suggests numerous forms of archaic hominins with it unclear which, if any, contributed directly to the ancestry of modern humans.
  - Various Homo erectus and Homo heidelbergensis populations that are potential candidates for lineages A and B existed both in Africa and elsewhere in the relevant period.

Founder event lead to bottleneck

- It is tempting to ascribe the sharp bottleneck that we infer in lineage A after separation from lineage B to a founder event potentially involved with migration and physical separation.

- Furthermore, the ancestors of Neanderthals and Denisovans were in Eurasia before modern humans expanded there, and we can ask whether the gene flow from the ancestors of modern humans into Neanderthals came from A or B, and also how the proposed archaic gene flow event into Denisovans was related to these populations.

Where?

- Dr Cousins said it's 'likely' that groups A and B both originated and stayed in Africa, but there are other possibilities regarding location. Either A or B could also have migrated to Eurasia.

- But one of the drawbacks to the new model, according to John Hawks, is that it is based on the 1000 Genomes Project, which has a low representation of African populations.

- "So I see this as more a proof of principle than a real guide to what ancient humans were doing," Hawks said.

** When Did Humans First Make Stone Tools? New Research Suggests They Didn’t—At First

- For decades, archaeologists have puzzled over one of humanity’s most crucial technological leaps—when and how early humans began making sharp stone tools.

- A new study proposes an unexpected answer: before hominins ever struck two rocks together, they may have been using naturally occurring sharp stones to butcher meat and process plants.

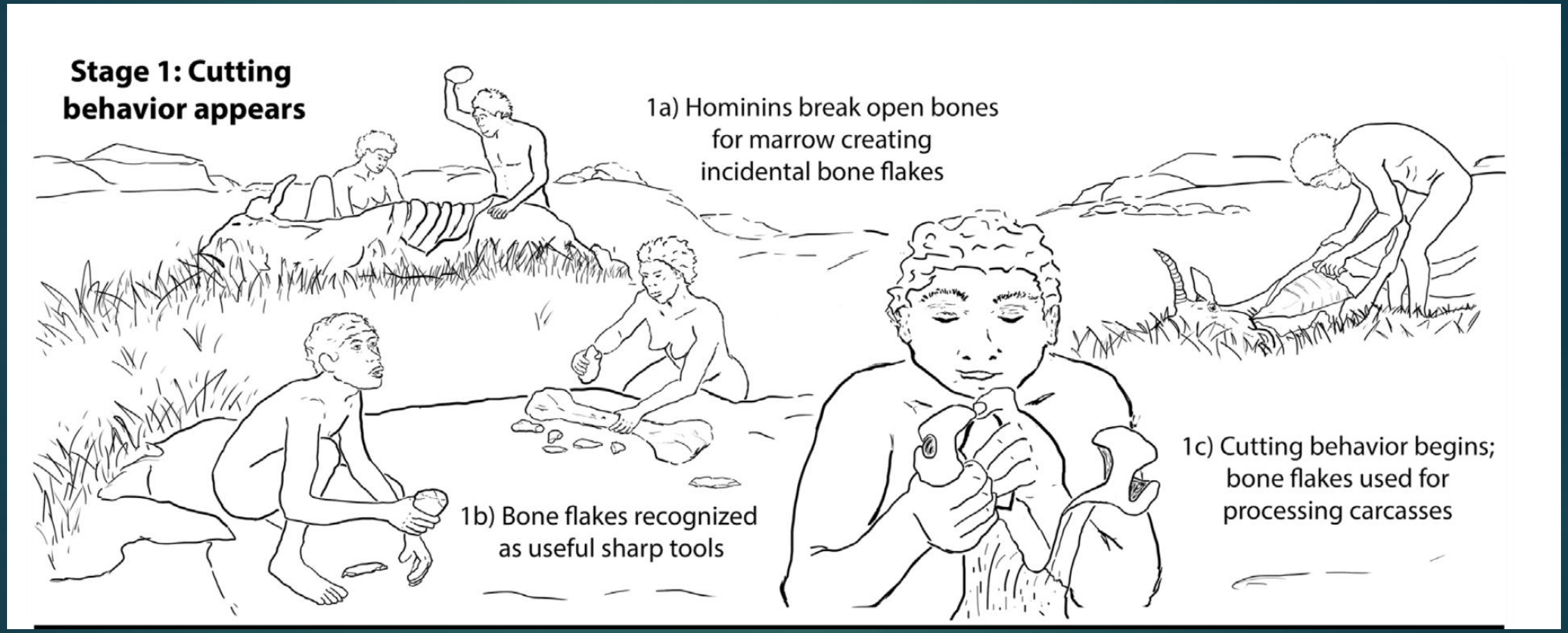
Naturally formed sharp stones are everywhere

Naturaliths

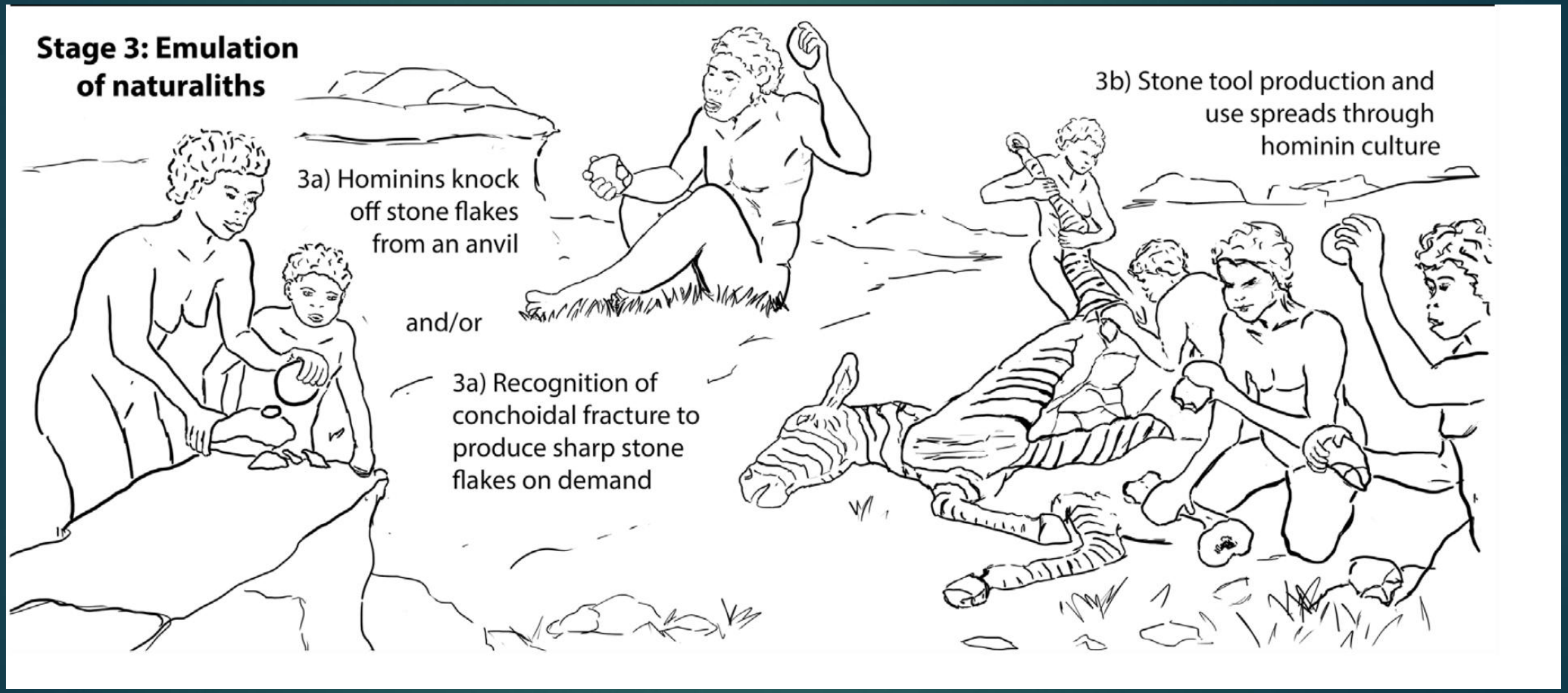
- Before the first intentional toolmakers, hominins may have relied on "naturaliths"—sharp rock fragments created by natural geological or biological processes. These early humans may have used these naturally occurring cutting tools long before they figured out how to produce them deliberately.

- For hundreds of thousands of years before hominins learned to manufacture stone flakes, they simply collected and used ones already lying around. These naturaliths may have been produced in a variety of ways—rockfalls, erosion, wave action, glacial activity, and even trampling by large animals like elephants.

A schematic of the origin of knapping




Stage 2: Naturalith use begins
2a) Scavenging/butchering carcass in area near naturaliths
2b) Observe naturalith utility for cutting
2c) Naturalith use spreads through hominin culture


Stage 3: Emulation of naturaliths
3a) Hominins knock off stone flakes from an anvil
and/or
3a) Recognition of conchoidal fracture to produce sharp stone flakes on demand
3b) Stone tool production and use spreads through hominin culture

*** Neanderthals may have eaten maggots as part of their diet – Ann Gibbons, 2025

High nitrogen (= high meat) in Neanderthal bones doesn’t mean they were uber-carnivores

Ns as hypercarnivores

- Neanderthals were hypercarnivores at the top of the food chain, eating as much meat as hyenas and cave lions. Or at least many researchers have assumed.

- But meat wasn't the only thing on their menu, according to a presentation last week at the annual meeting of the American Association of Biological Anthropologists: Our close cousins may have consumed lots of maggots.

- If Neanderthals were balancing their diets with maggots, they weren't eating as much meat as previously thought—and long-standing notions that our close cousins were uber-hunters may be exaggerated.

Nitrogen 15 level = meat consumption predictor

- In 1991, researchers first revealed that the fossilized bones of Neanderthals had high ratios of nitrogen 15 compared with nitrogen 14—usually the signature of a high-meat diet. The values suggested Neanderthals were bigger meat eaters than even hypercarnivorous hyenas and lions.

- Melanie Beasley of Purdue University began to question this assumption when she read a report a few years ago by archaeologist John Speth of the University of Michigan. Speth's article described accounts by missionaries and Arctic explorers of people who fell sick with "rabbit starvation"—an illness that afflicts those who eat mainly lean, high-protein game meat and too little fat.

Processing meat

- Humans can’t eat as much meat as a lion because as primates, our digestive and metabolic systems evolved to process a mostly vegetarian diet.

- When we eat protein, our bodies break it down into amino acids that contain nitrogen, which is converted into ammonia and excreted in urine.

- Too much protein floods the liver with ammonia, which can be toxic—even deadly—as the liver can’t convert it all to urea, causing it to build up in the bloodstream.

Casu marzu, a traditional Sardinian cheese

Casu marzu, a traditional Sardinian cheese teeming with the live larvae of cheese flies.

This posed a conundrum: How could Neanderthals stomach so much more meat than modern humans?

- Speth's paper offered a clue—he quoted Arctic explorers who described Indigenous people eating "thoroughly putrefied, maggot-infested animal foods as highly desirable fare, not starvation rations."
- In his article, Speth proposed that rotten meat might be higher in nitrogen than fresh tissue—and thus may have boosted nitrogen levels in Neanderthals' bones. It wasn't that they were eating so much more meat, but they were sometimes scavenging or storing meat that was putrefied and, therefore, higher in nitrogen.

Higher nitrogen in rotting flesh

- The longer the insects fed on rotting tissue, the higher the nitrogen values of the larvae. The nitrogen values in the larvae of black soldier flies that feed on rotting tissue are about eight times higher than the modest increases in the rotting tissue. This was far higher than the modest increases in nitrogen in the rotting tissue, and significantly higher than the nitrogen values found in animals and fish that humans hunt and eat.
- But were Neanderthals actually eating maggots? Almost certainly, Beasley says. For one thing, they're practically unavoidable when processing game outside. They are also easy to scoop from the soil beneath a carcass, she notes. And they're a salty tasting food full of fat and protein enjoyed by many modern foraging groups.
- From a nitrogen stable isotope perspective, the consumption of such an [isotopically] enriched food source would certainly offer an explanation for the extremely high values we observe in Neanderthals.

*** Rapid change in red cell blood group systems after the main Out of Africa of Homo sapiens -- Mazières, S, et al., 2025

- We show that Neanderthal and Denisova were polymorphic for ABO and shared blood group alleles recurrent in modern Sub-Saharan populations.

- ABO-related alleles currently prevent viral gut infection and Neanderthal RHD and RHCE alleles nowadays are associated with a high risk of hemolytic disease of the fetus and newborn.

- Such a common blood group pattern across time and space is coherent with a Neanderthal population of low genetic diversity exposed to low reproductive success and with their inevitable demise.

N blood types

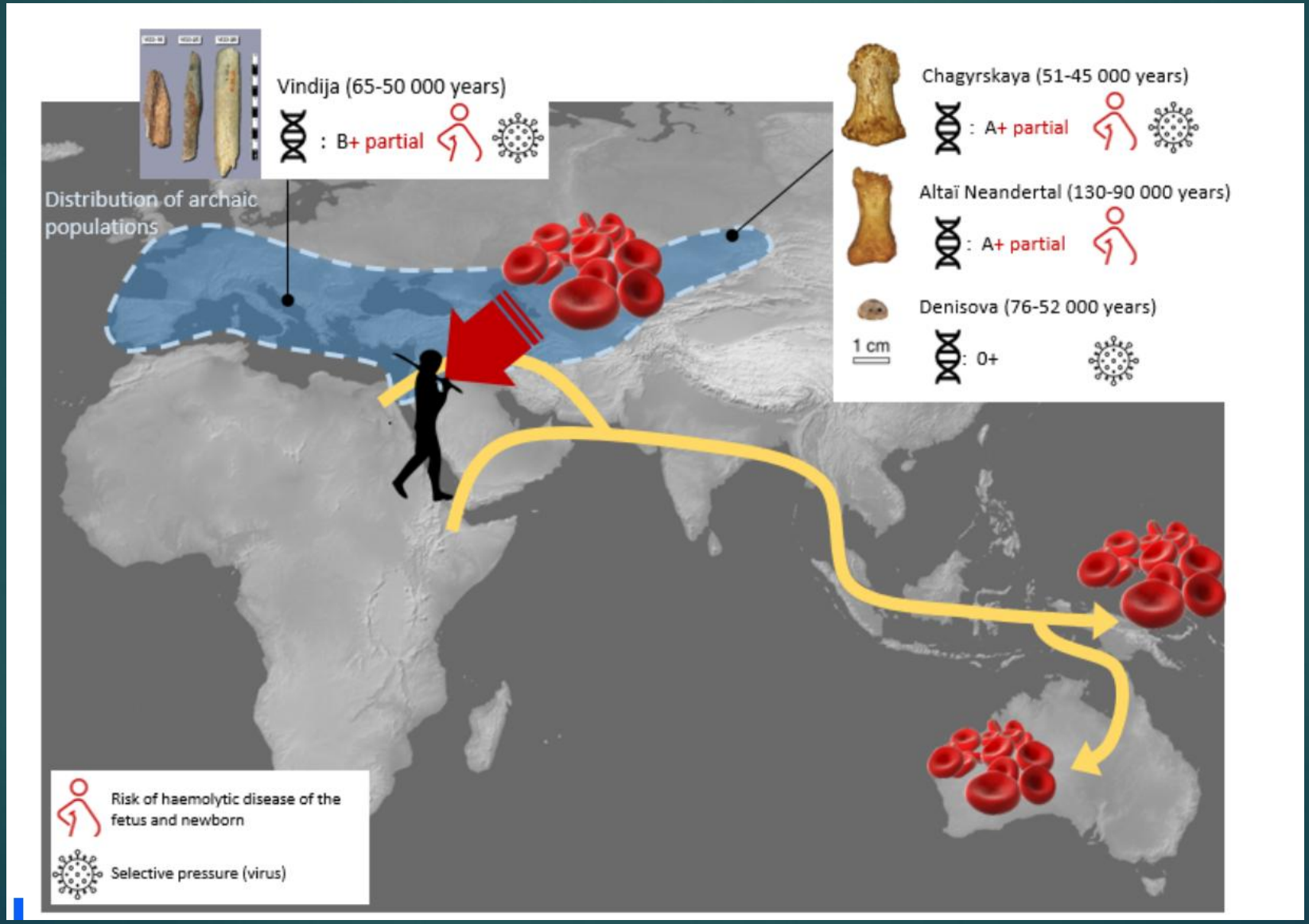
- Lastly, we connect a Neanderthal RHD allele to two present-day Aboriginal Australian and one Papuan individuals, suggesting that a segment of archaic genome was introgressed in this gene in non-Eurasian populations.

- Research suggests that a rare N blood group (RHD DIII type 4 variant) is linked to potential fatal complications in newborns, might have contributed to their disappearance.

N rare blood type

- Found 10 blood groups that can cause fatal complications during blood transfusions if they aren’t compatible with the recipient’s type. They found that blood groups in Neanderthals remained mostly unchanged during their last 80,000 years of existence,
- Incompatibility between a mother's and fetus's blood types, like Rh incompatibility, can have serious consequences. This occurs when an Rh-negative mother carries an Rh-positive fetus. While potentially life-threatening for the baby, this phenomenon might have also played a role in the decline of Neanderthals, highlighting the impact of blood type differences beyond modern human populations

Only 3 MHs: Australian and Papua New Guinea have rare N RH factor



Unique RH variant in Ns

- Neanderthals possessed a unique Rh variant that is almost unheard of in modern humans.

- This rare RhD variant was incompatible with the Rh types found in Denisovans and early *Homo sapiens*.

- For any case of inbreeding of a Neanderthal female with a *Homo sapiens* or Denisovan male, there is a high risk of hemolytic (abnormal breakdown of red blood cells) disease of the newborn.

Ns had lack of similar diversity of blood types

- Ns = Originally thought that Neandertals were all type O—just as chimpanzees are all type A and gorillas all type B—prior research demonstrated that N had the full range of ABO variability observed in modern humans.

- Early *Homo sapiens* developed diverse Rh gene variants while living on the Persian Plateau. These variations likely provided resilience to environmental pressures and diseases.

- Neanderthals, on the other hand, remained largely isolated, which may explain why their blood types showed little evolution over tens of thousands of years.

Rh incompatibility possibility

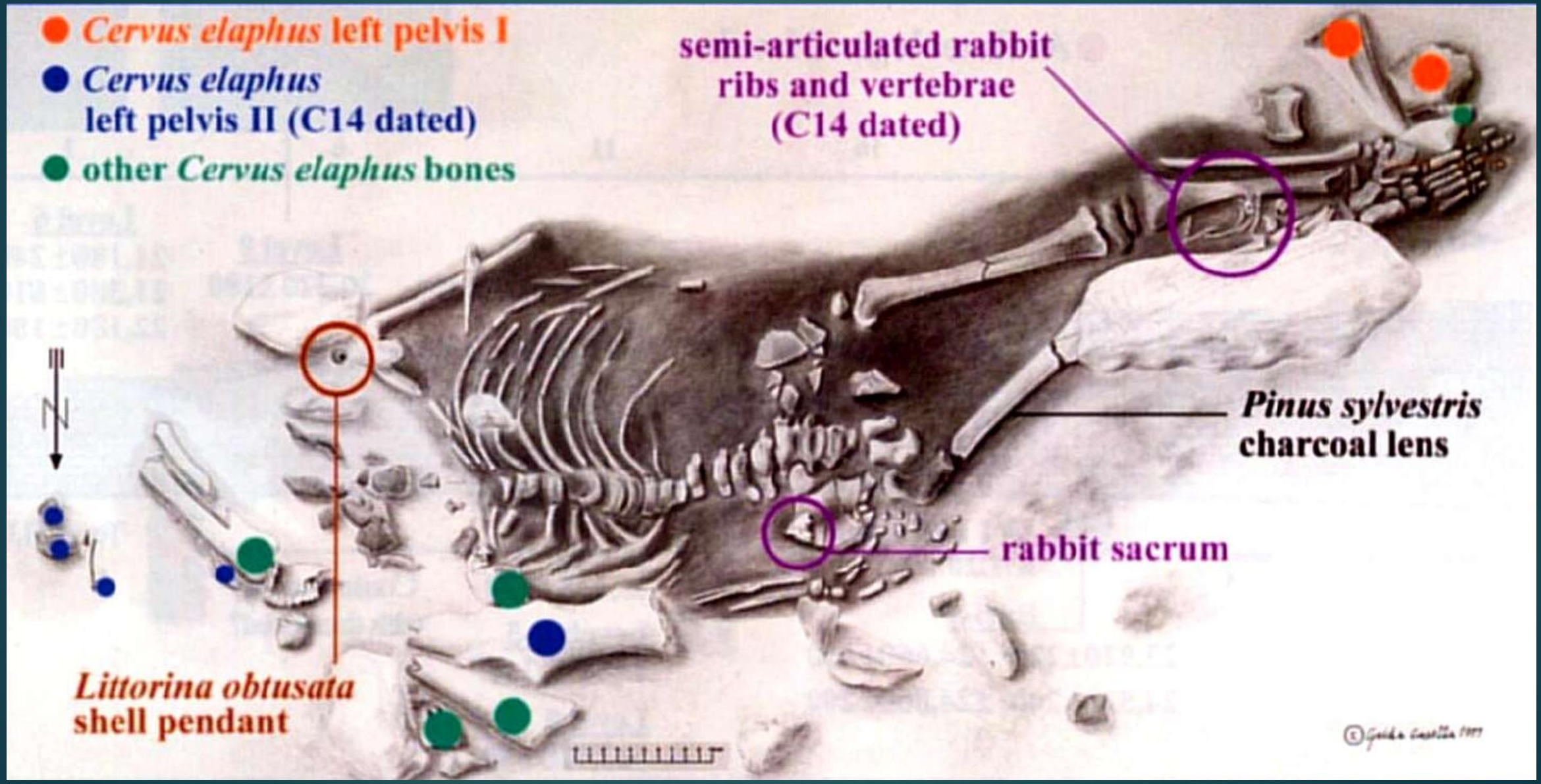
- Ns exhibited very little genetic diversity, and that they may have been susceptible to hemolytic disease of the fetus and newborn (erythroblastosis fetalis)—due to maternofetal Rh incompatibility—in cases where Neandertal mothers were carrying the children of *Homo sapiens* or Denisovan mates.

Conclusion

- Blood group profiles revealed polymorphism at the ABO locus, ancestral and African-origin alleles, and a RH haplotype presently secluded in Oceania, plausible relic of introgression events into modern humans prior to their expansion towards Southeast Asia.

- An additional contribution is the reduced variability of many alleles and the possible presence of hemolytic disease of the fetus and new-born, which reinforces the notion of high inbreeding, weak demography and endangered reproductive success of the late Neanderthals,.

1998 Lagar Velho child – MH-N hybrid or not?



1998 Lagar Velho child from Portugal: modern human with Neanderthal ancestry

Forearm bone fragments belonging to an ancient child that appeared to have features from both humans and Neanderthals.

Dating of Lagar Velho child, a hybrid

- The child's remains were discovered 27 years ago in a rock shelter called Lagar Velho in central Portugal. The nearly complete skeleton was stained red, and scientists think it may have been wrapped in a painted animal skin before burial.
- The child's robust limb proportions and stocky build resembled those of a Neanderthal, yet their chin and other cranial features were unmistakably Homo sapiens. This mosaic anatomy reignited debates about the extent of interbreeding between Neanderthals and early modern humans.
- The researchers suggested that the child was descended from populations in which humans and Neanderthals mated and mixed. That was a radical notion at the time, but advances in genetics have since proven it correct.

Direct hydroxyproline radiocarbon dating of the Lapedo child (Abrigo do Lagar Velho, Leiria, Portugal).

- Small roots had grown through the bones and contamination — from plants or other sources — made it impossible for scientists to use traditional carbon dating to measure the child's age. They instead dated the charcoal and animal bones around the skeleton to between 27,700 and 29,700 years ago.
- Now able to date the skeleton by measuring part of a protein (hydroxyproline) that's found primarily in human bones.
- Examining part of a crushed arm, they revealed that the earlier estimate was in the ballpark: the skeleton was from between 27,700 and 28,600 years ago.

Not so ritualized: ocher but no grave goods

- Redating these associated materials revealed an unexpected result—**the red deer bones were actually older than the child's burial**. This means they were not placed in the grave as ritual offerings, as previously thought, but were likely already present in the sediment. Similarly, the charcoal under the child's legs, once hypothesized to be evidence of a ritual fire, turned out to be at least **150 years older** than the burial itself.
- These findings force a reassessment of the symbolic elements of the burial. While ocher staining—commonly associated with Upper Paleolithic funerary rites—remains a strong indicator of ritualized treatment, the absence of directly associated grave goods weakens the case for an elaborate burial ceremony.