Science Updates
June 2023

Charles J Vella, PhD

Discuss future human evolution topics

- Only 2 more chapters of David Reich's *Who We Are* which has underpinned our lectures for the last year. Need recommendations for next set of talks.
- My series of lectures on Pre-Homo hominins and on Evolution of the Brain?
- Or tell me or send me your suggestions for potential other science books to focus talks around
- Possibles:
  - *Behave* by Robert Sapolsky
  - Evolutionary psychology topic
  - *50 Great Myths Of Human Evolution* by John H Relethford
  - *Code Breaker* by Jennifer Doudna or a *Crack in Creation* (CRISPR)
  - Other books?

A time-lapse image of lightning bolts from a thunderstorm near Mudanya in Turkey on June 16.

Each dolphin has its own signature "whistle" that functions like a name.

Laela S. Sayigh, et al., 2023

Dolphin moms use ‘baby talk’ with their calves, a first among non-human species

- Only a handful of other species have been shown to change their calls when addressing their young, including zebra finches, rhesus macaques, and squirrel monkeys. But none used motherese. New study, based on three decades of data in Florida, reveals common bottlenose dolphins use motherese—the first time it’s been documented in a species other than humans.

- Bottlenose mothers nurse their young for two years, and the animals generally stay with her until they’re between three to six years old, learning how to hunt, navigate, and stay safe in the ocean.

- “Motherese,” or, more formally, “infant-directed speech”: Sentences become shorter, sounds are exaggerated, and the overall pattern of speech is more singsong and musical.

Baby talk

- Dolphins, however, don’t use another animal’s signature whistle to direct communication. Instead, they repeat their own signature whistle and listen for another dolphin to respond with their own.

- By analyzing recordings of 19 different female dolphins over 34 years, found that the signature whistles of dolphin mothers had a greater range of frequencies—the high pitches were higher and the lows were lower—when their calves were nearby. These two pitches are only used with calves. Higher pitch is central to baby talk.

Humans' evolutionary relatives butchered one another 1.45 million years ago

- Oldest decisive evidence of humans' close evolutionary relatives butchering and likely eating one another.

- National Museum of Natural History paleoanthropologist Briana Pobiner and her co-authors describe nine cut marks on a 1.45 million-year-old left shin bone from a relative of Homo sapiens found in northern Kenya.
- Analysis of 3D models of the fossil's surface revealed that the cut marks were dead ringers for the damage inflicted by stone tools. This is the oldest instance of this behavior

- Proof of the value of museum collections.

View of the hominin tibia and magnified area that shows cut marks.

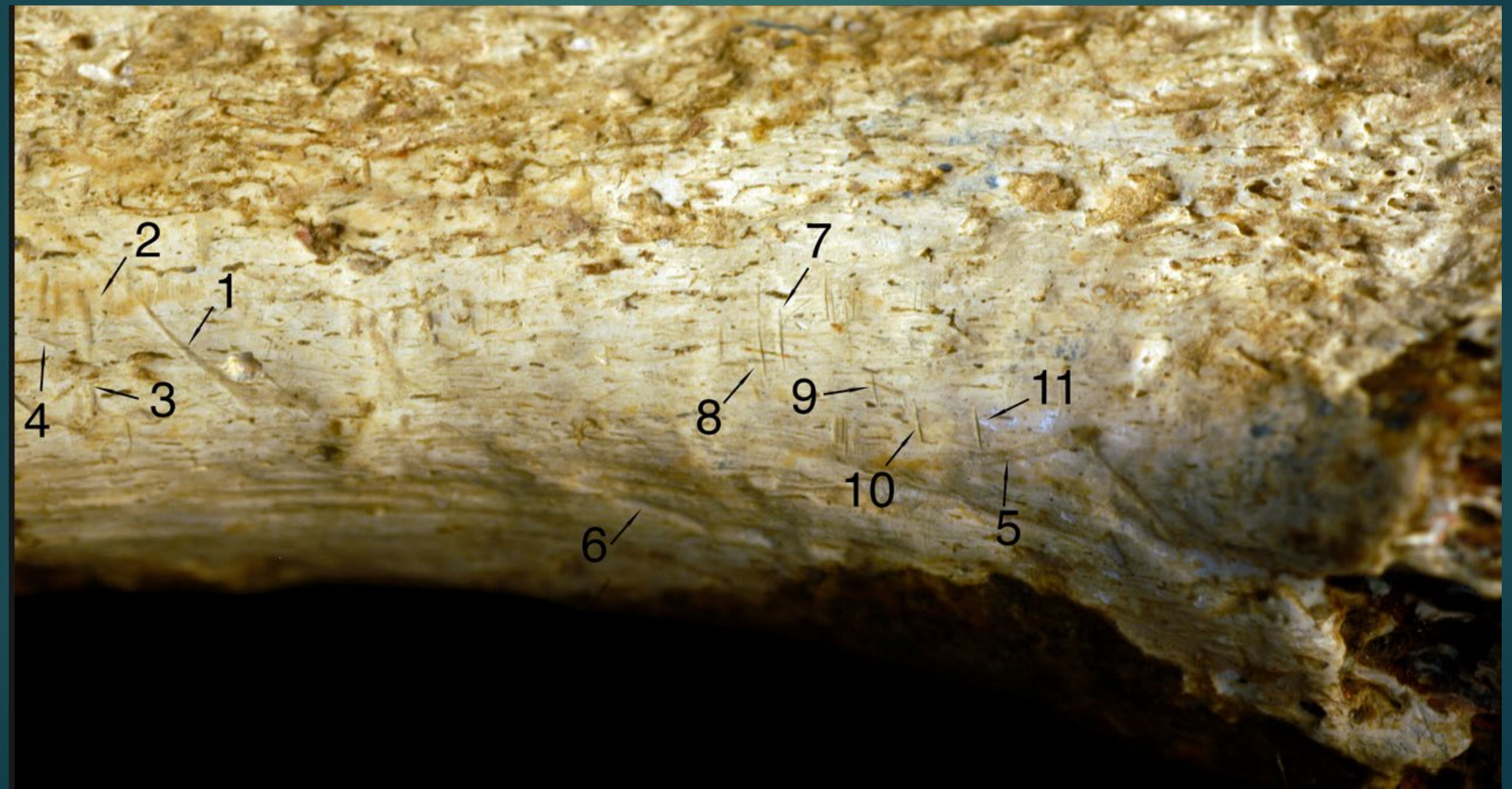
Early Pleistocene cut marked hominin fossil from Koobi Fora, Kenya -- Briana Pobiner, et al., 2023

- Identification of butchery marks on hominin fossils from the early Pleistocene is rare. Our taphonomic investigation of published hominin fossils from the Turkana region of Kenya revealed likely cut marks on KNM-ER 741, a ~ 1.45 Ma proximal hominin left tibia shaft found in the Okote Member of the Koobi Fora Formation.
- An impression of the marks was created with dental molding material and scanned with a Nanovea white-light confocal profilometer, and the resulting 3-D models were measured and compared with an actualistic database of 898 individual tooth, butchery, and trample marks created through controlled experiments.
- This comparison confirms the presence of multiple ancient cut marks that are consistent with those produced experimentally. These are to our knowledge the first (and to date only) cut marks identified on an early Pleistocene postcranial hominin fossil.

A Search for hominin predation

- In July 2017, Pobiner undertook a pilot study of the taphonomy of published hominin postcranial fossils from the Turkana region of Kenya dated to ~ 1.8 to 1.5 Ma, with an expectation of potentially finding some carnivore damage on these fossils.
- However, she unexpectedly observed potential butchery marks on a single fossil: KNM-ER 741, discovered by Mary Leaky.
- This observation was unexpected because while butchery marks left by hominins on animal fossils beginning by at least the early Pleistocene point to increased meat and marrow acquisition during the evolution of the genus Homo and hundreds of cut marked fossils of other animals have been identified from the Okote Member of the Koobi Fora Formation, no cut marks on hominin fossils from this temporal and geographic area have been reported.

Nine marks identified as cut marks (mark numbers 1–4 and 7–11) and two identified as tooth marks (mark numbers 5 and 6) based on comparison with 898 known bone surface modifications. Scale = 1 cm



Analysis of cutmarks

- The analysis positively identified nine of the 11 marks as clear matches for the type of damage inflicted by stone tools.
- The other two marks were likely bite marks from a big cat
- Cut marks are located where a calf muscle would have attached to the bone—a good place to cut if the goal is to remove a chunk of flesh.
- The cut marks are also all oriented the same way, such that a hand wielding a stone tool could have made them all in succession without changing grip or adjusting the angle of attack.

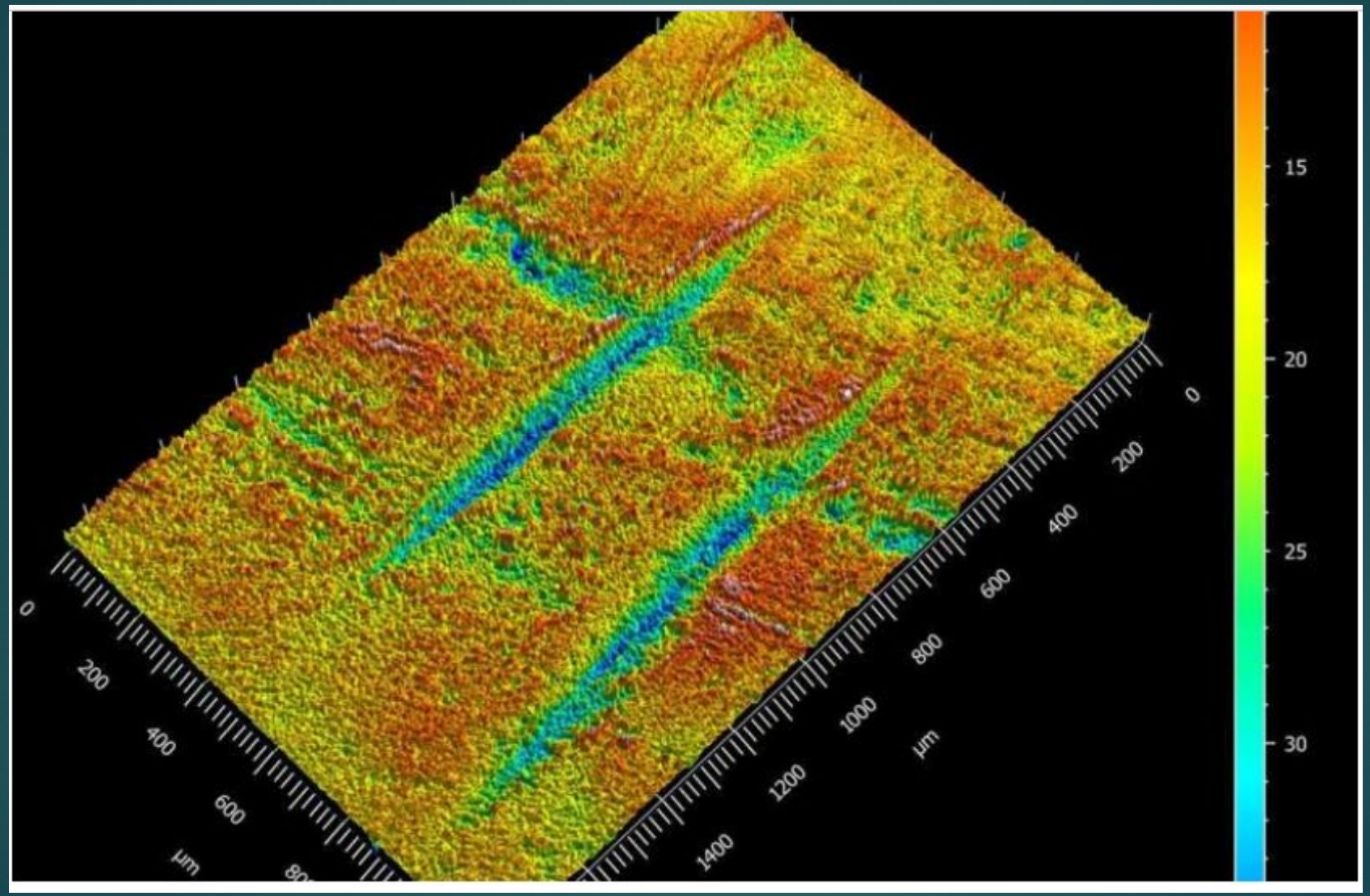
Cutmarks from stone tool

- While this case may appear to be cannibalism to a casual observer, Pobiner said there is not enough evidence to make that determination because cannibalism requires that the eater and the eaten hail from the same species.

- Unknown hominin: The fossil shin bone was initially identified as Australopithecus boisei and then in 1990 as Homo erectus, but today, experts agree that there is not enough information to assign the specimen to a particular species of hominin.

- The use of stone tools also does not narrow down which species might have been doing the cutting. There were multiple stone tool users at 1.5 Ma.

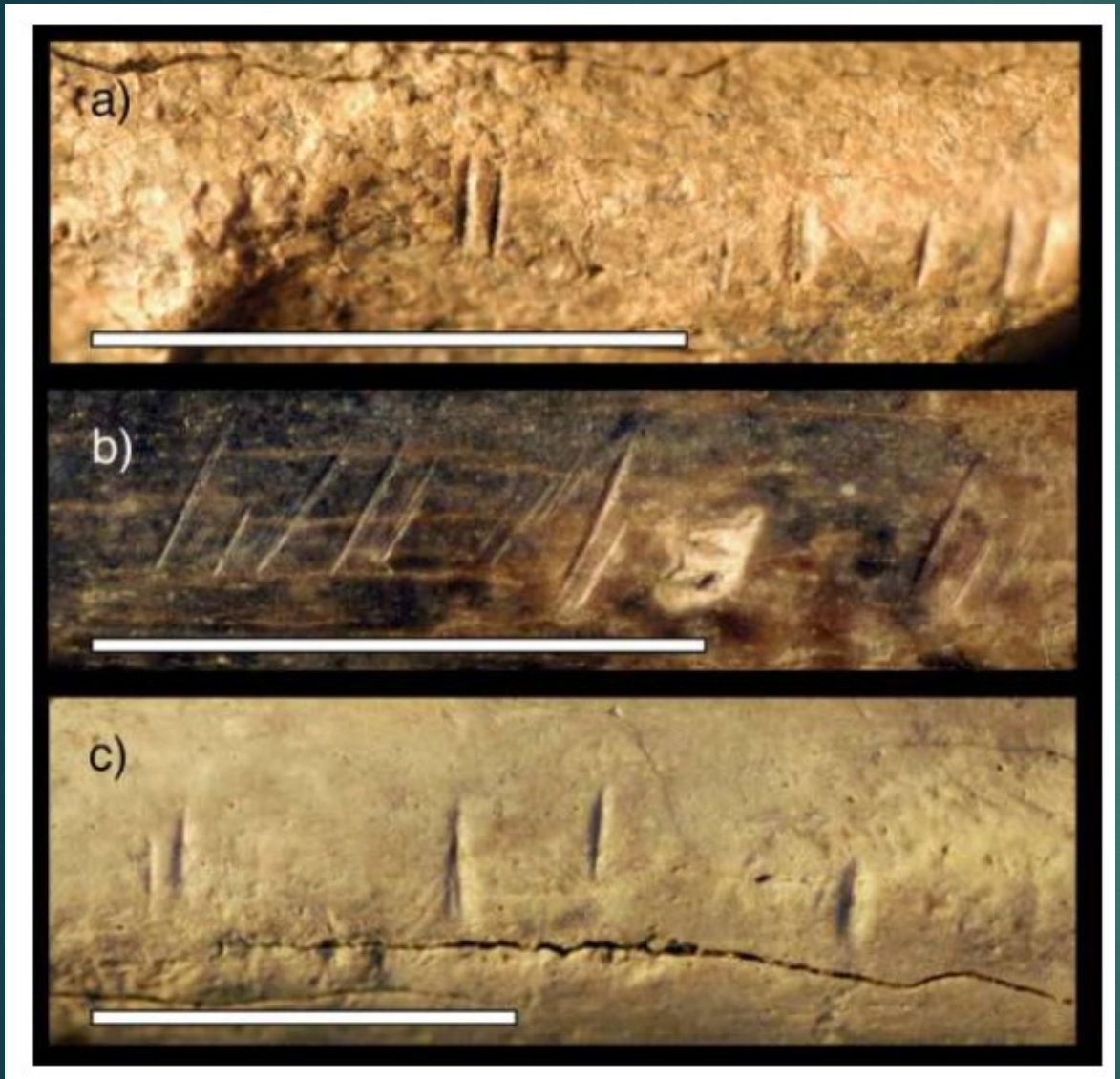
3D model of marks 7 and 8 identified as cut marks



Prehistoric cannibalism

- So, this fossil could be a trace of prehistoric cannibalism (if same species), but it is also possible this was a case of one related species chowing down on its evolutionary cousin.

- None of the stone-tool cut marks overlap with the two bite marks, which makes it hard to infer anything about the order of events that took place. A big cat may have scavenged the remains after hominins removed most of the meat from the leg bone; or equally possible that a big cat killed an unlucky hominin and then was chased off before opportunistic hominins took over the kill.



Close-up photos of three fossil animal specimens from the same area and time horizon as the fossil hominin tibia studied by the research team.
These fossils show similar cut marks to those found on the hominin tibia studied. The photos show (a) an antelope mandible, (b) an antelope radius (lower front leg bone) and (c) a large mammal scapula (shoulder blade)

Variety of Cannibalism

- Various motivations or contexts for human cannibalism: survival; gastronomic or dietary; aggressive; psychotic or criminal; warfare; affectionate funerary, ritual, spiritual, or magical; and medicinal.
- These types of cannibalism have also sometimes been subdivided into social divisions that include
  - aggressive (consuming enemies) versus
  - affectionate (consuming friends or relatives), or
  - endocannibalism (consumption of individuals within the group, usually associated with sacred beliefs and spiritual regeneration of the deceased) versus
  - exocannibalism (consumption of outsiders, usually associated with hostility and violence).

Cannibalism

- Current taphonomic criteria for different kinds of cannibalism to better understand the intent of anthropogenic modification of hominin skeletal remains. These include:
- abundant anthropogenic modifications on more than 20% of human remains
- intensive processing of bodies
- greater abundance of cut marks related to defleshing and filleting than dismembering;
- the presence of human tooth marks or chewing damage;
- similar treatment of human and animal remains.

Cannibalism criteria

- Differentiating between nutritional and ritual cannibalism is primarily based on a comparison of the taphonomic traces on and post-processing discard patterns of hominin and non-hominin remains.

- Evidence for marrow and brain extraction are additional indications of nutritional cannibalism, while ritual cannibalism might be inferred in instances of defleshing without marrow extraction.

- High levels of anthropogenic modifications (> 30%) are common after an intensive butchering process intended to prepare a hominin body for consumption in different contexts, contradicting previously held assumptions about cut mark intensity.

Cannibalism

- Nutritional cannibalism occurs for the sole purpose of obtaining food and can be divided into two categories:
  - (1) incidental cannibalism, which is focused on survival; this occurs in periods of food scarcity or due to catastrophes, i.e., is starvation-induced
  - (2) long duration cannibalism, which is also called gastronomic or dietary cannibalism; humans are simply part of the diet of other humans

- Evidence for Pleistocene hominin butchery marks on hominins.
- There is uncontested evidence for cannibalism in European Neanderthals from sites in Belgium (Troisieme Caverne of Goyet), France (Moula-Guercy and Padrelles), Spain (Cueva del Sidrón and Cueva del Boquete de Zafarraya), and Croatia (Krapina).

Butchery marks on hominins

- There is also evidence for both anthropogenic defleshing and cannibalism in Homo sapiens from sites in Ethiopia (Herto), Poland (Maszycka Cave), the UK (Gough's Cave), and possibly Germany (Brillenhöhle).

- Yet there are still only a handful of Pleistocene sites with evidence for hominin cannibalism, and only four published examples of postmortem defleshing on hominin fossils other than Neanderthals and Homo sapiens.

- 1 = At ~ 600 Ka, the first observation of cut marks on an early hominin was made on the Bodo cranium from the Middle Awash Valley of Ethiopia; White concluded it was an intentional postmortem defleshing of this specimen by a hominin with a stone tool

Butchery marks on hominins

- 2 - Evidence for processing on some of the at least 30 Homo heidelbergensis or Homo erectus individuals from Caune de l 'Argo (also known as Arago Cave) in Tautavel, France, most dated to the ~ 680 Ka
- 3 - Butchery marks among the ~ 772 to 949 Ka, Homo antecessor remains from Gran Dolina; The patterning of butchery damage on the Homo antecessor remains was generally similar to the patterning of damage on the non-human animal remains and was consistent with those bones that held the most nutritional value; human meat consumption by Homo antecessor at this site as "frequent and habitual" and concluded that this nutritional cannibalism was accepted and included in their social system; Gran Dolina hominins periodically hunted and consumed individuals from another group. With evidence for processing of 11 individuals—2 adults, 3 adolescents, and 6 children—this is arguably the earliest firm evidence of systematic cannibalism in the hominin fossil record, and the only such evidence from the Early Pleistocene.

Butchery marks on hominins

- 4 - Oldest cut marks on a hominin fossil: cut marks inflicted by a stone tool on the right maxilla of Stw 53, a partial skull from Sterkfontein Member 5 in South Africa; attributed to Homo habilis but is also sometimes argued to represent Australopithecus; age between 2.6 and 2.0 Ma, or between 2.0 and 1.5 Ma; but date contested

- KNM-ER 741 is now at least among the oldest hominin fossils with evidence of hominin butchery marks, and currently is the oldest known hominin butchery marked postcranial fossil. Conclude that if anthropophagy occurred after the defleshing of KNM-ER 741, it was an opportunistic, practical, and functional activity which occurred simply in the context of obtaining food, rather than one imbued with ritual meaning.

The earliest unambiguous Neanderthal engravings on cave walls: La Roche-Cotard, Loire Valley, France

- Report on Neanderthal engravings on a cave wall at La Roche-Cotard in central France, made more than 57±3 Ka ago.
- Following human occupation, the cave was completely sealed by cold-period sediments, which prevented access until its discovery in the 19th century and first excavation in the early 20th century.
- The timing of the closure of the cave is based on 50 optically stimulated luminescence ages derived from sediment collected inside and from around the cave.

Jean-Claude Marquet, et al., 2023

La Roche-Cotard Neandertal engravings

- The anthropogenic origin of the spatially-structured, non-figurative marks found within the cave is confirmed using taphonomic, traceological and experimental evidence.

- Cave closure occurred significantly before the regional arrival of *H. sapiens*, and all artefacts from within the cave are typical Mousterian lithics; in Western Europe these are uniquely attributed to *H. neanderthalensis*.

- We conclude that the LRC engravings are unambiguous examples of Neanderthal abstract design.

History of La Roche-Cotard excavations

- In 1846, La Roche-Cotard cave entrance was exposed during quarrying and in 1912, the site owner Francois d'Achon excavated almost all the inner sedimentary deposits.

- Only Mousterian lithic artefacts were discovered within the cave; no later-period material was found.

- Subsequent excavation, in the 1970s and from 2008 onwards, identified three additional loci close to the cave.

The walls of LRCL: finger flutings

- On the walls of LRC, the first observations of seemingly organized digital traces (finger flutings) were made during field campaigns from 1976 to 1978, and then again from 2008 (all directed by the lead author).

- In addition, sparsely occurring red ochre spots were identified.

- Other types of marks are also present: (i) traces left by animal claws, (ii) the smoothing of the very fragile wall surface presumably through repeated contact with animal fur, and (iii) numerous easily recognizable traces caused by the percussion of metal tools, from the excavation in 1912.

Neandertal Engravings

- Use the term “engravings” for the finger-flutings, as an “engraving” is generally defined as the deliberate removal of material carried out with a tool or a finger.

- We will show that this removal of material is neither accidental nor utilitarian, but rather that it is intentional and meticulous. In 2008, the digital traces were recognized as ancient traces.

- They were made by Neanderthals

The cave

- Today, the cave of La Roche-Cotard comprises four main chambers extending ESE-WNW for 33 m: the Mousterian Gallery, the Lemmings Chamber, the Pillar Chamber and the Hyena Chamber.

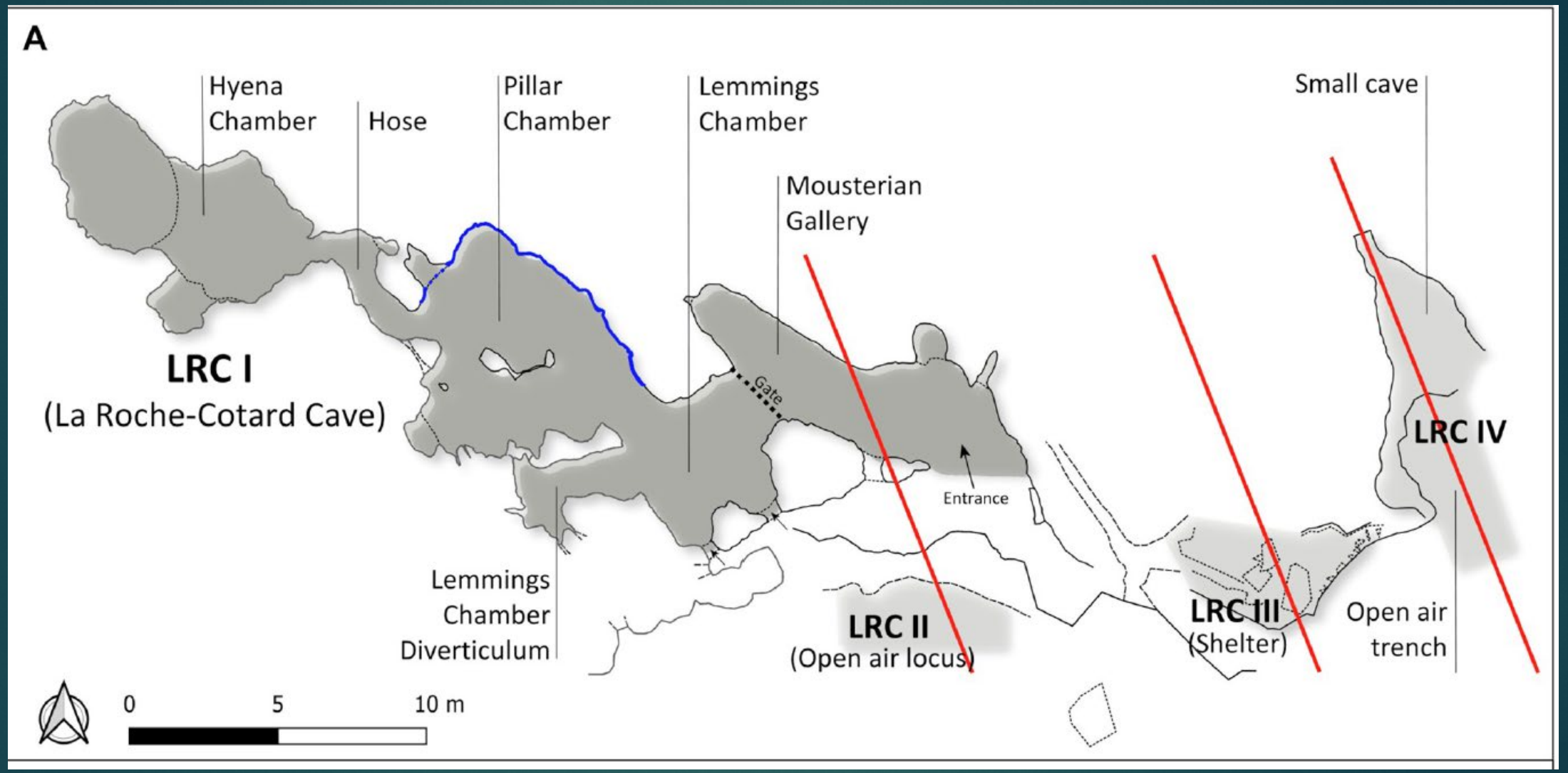
- Only Mousterian lithic artefacts were discovered, either within or outside the cave; no later period material was found. Bifaces and Levallois flakes were found in the cave (LRC I).

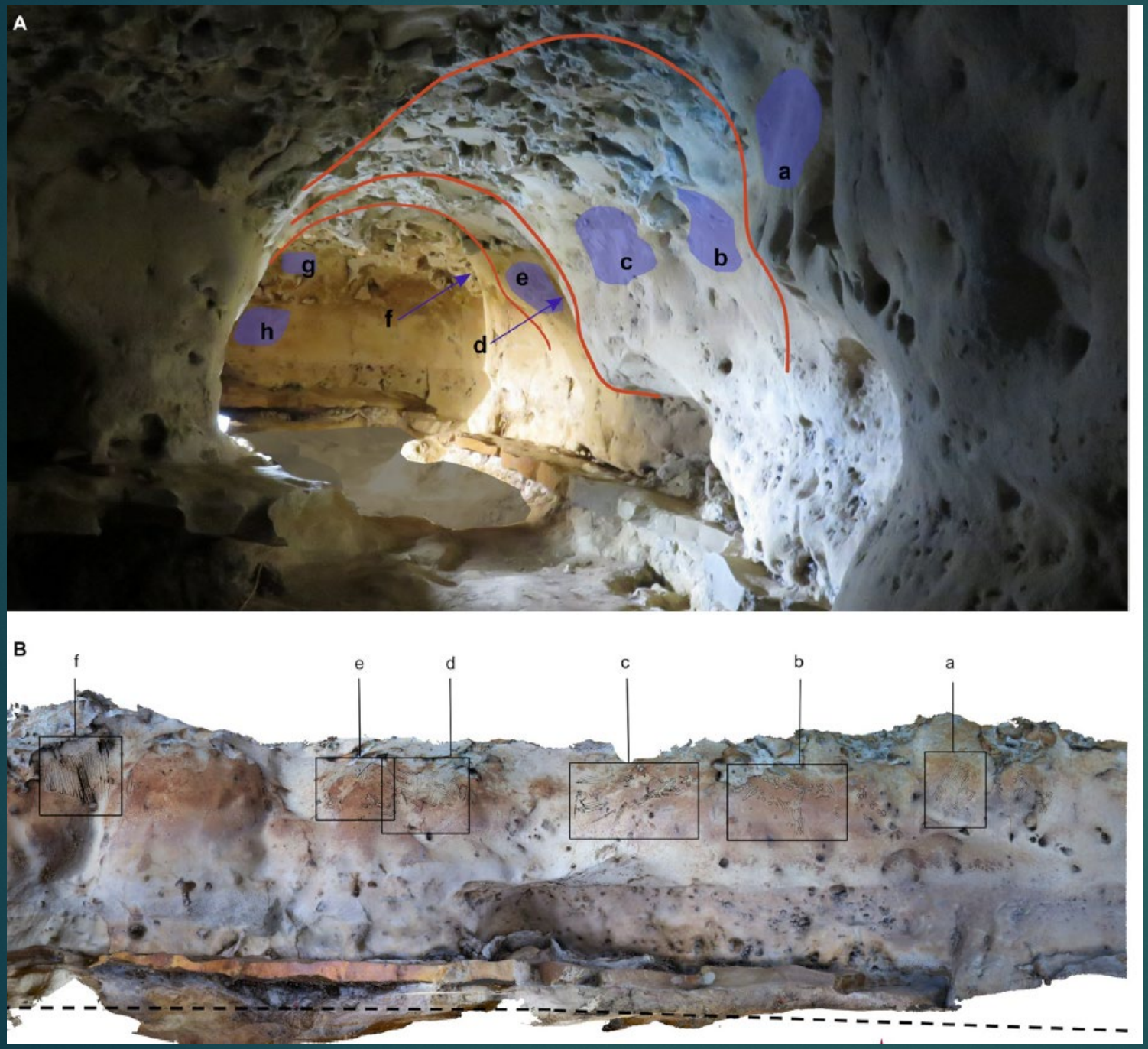
- In addition, engravings were made on the walls of the Pillar Chamber at LRC I. No other, more recent occupations (until the 19th century) have left traces in the cave,

6 panels

- First six panels (a to f) are at an average height of 1.50 to 1.70 m above the Neanderthal floor.

- The majority of the traces on these panels were made by fingers laid flat, while a few rare traces appear to have been made by a finger on edge (on the side).


A
Hyena Chamber
Hose
Pillar Chamber
Lemmings Chamber
Mousterian Gallery
Small cave
LRC I
(La Roche-Cotard Cave)
Gate
Entrance
LRC IV
Lemmings Chamber Diverticulum
LRC II
(Open air locus)
LRC III
(Shelter)
Open air trench
0
5
10 m



Spatial organization of the marked panels in the Pillar Chamber.

A. View of the Pillar Chamber from the entrance, showing the location of panels with markings.

Sections and ridges of the ceiling are indicated by red lines.

Numbered panels are indicated by blue areas or arrows

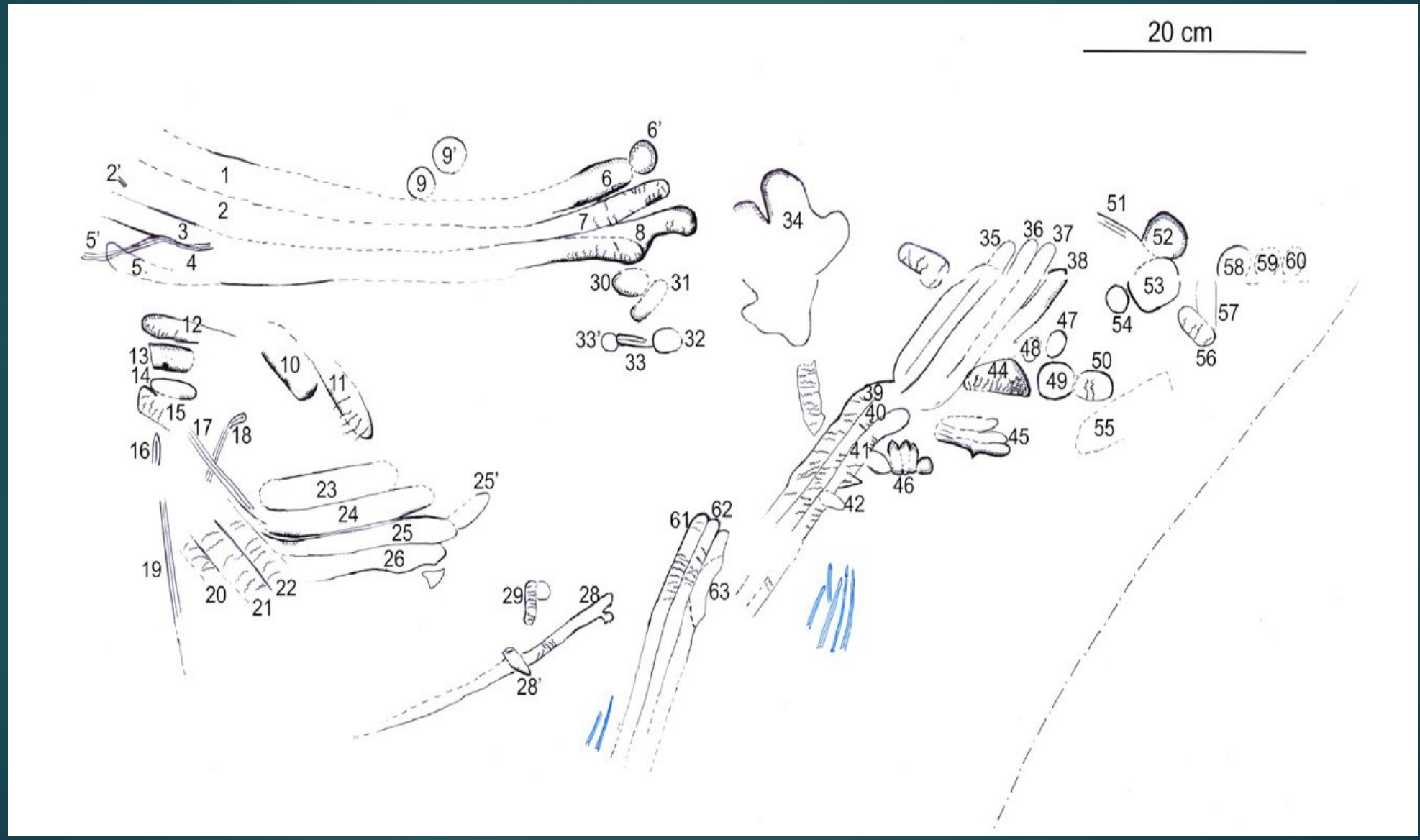
Neanderthal cave engravings identified as oldest known, more than 57,000 years old

- Markings on a cave wall in France are the oldest known engravings made by Neanderthals

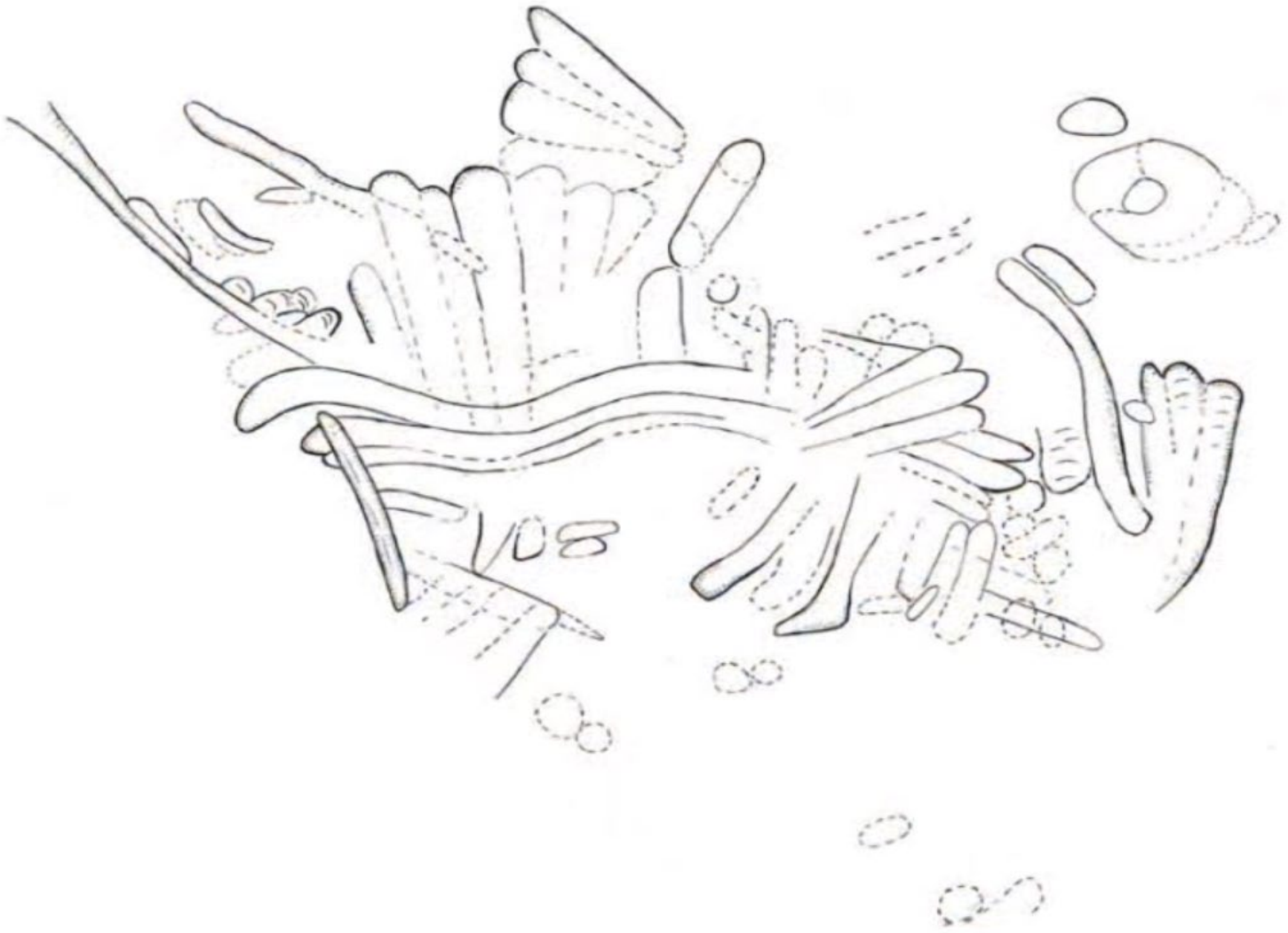
- The cave is La Roche-Cotard in the Center-Val de Loire of France, where a series of non-figurative markings on the wall are interpreted as finger-flutings, marks made by human hands.

- The researchers made a plotting analysis and used photogrammetry to create 3D models of these markings, comparing them with known and experimental human markings. Based on the shape, spacing, and arrangement of these engravings, the team concluded that they are deliberate, organized and intentional shapes created by human hands.

Linear Panel: 1.50 m long and 0.50 m high, is made up of 63 ancient anthropogenic traces



Undulated Panel

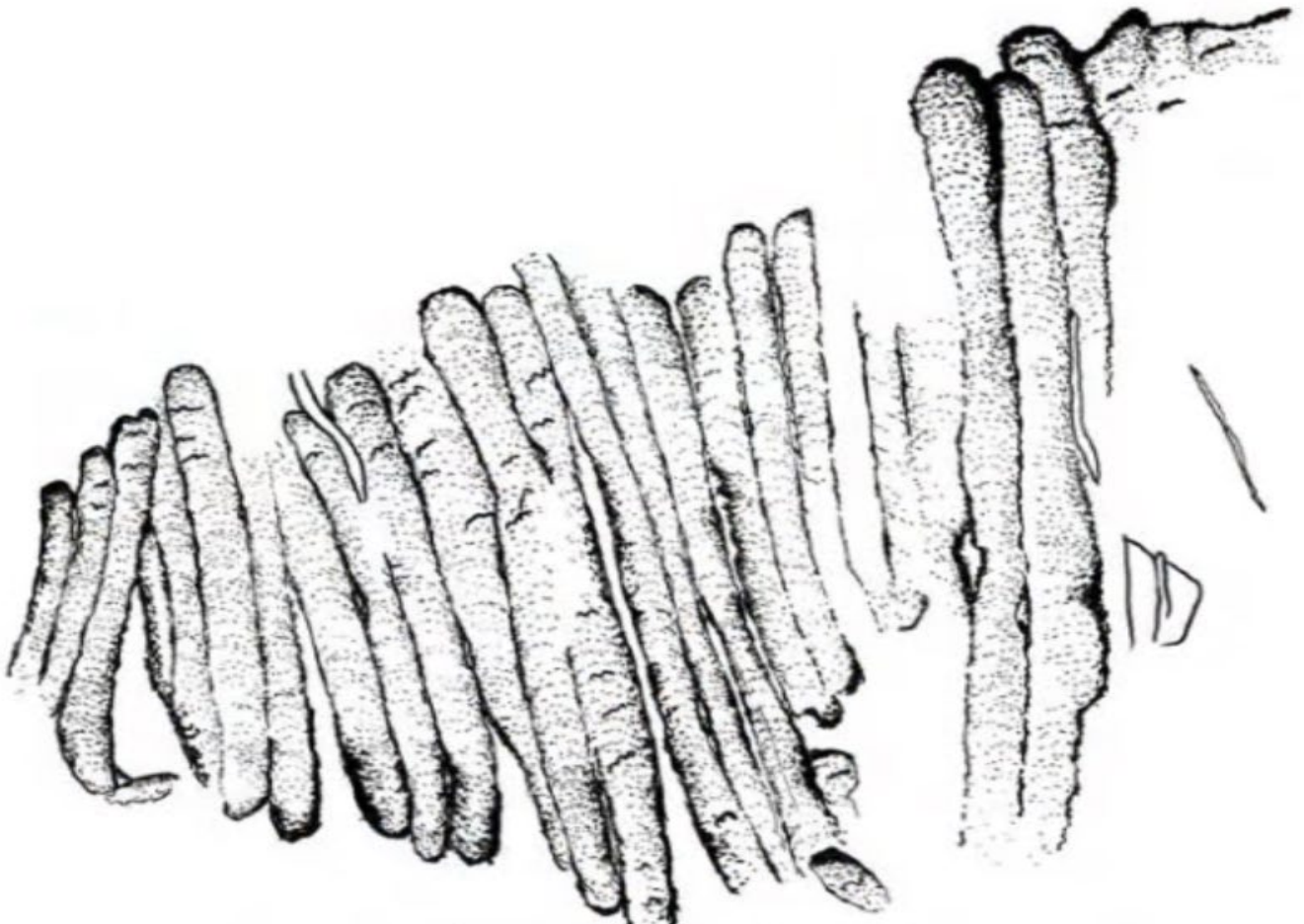


Undulated Panel

Circular Panel

Circular Panel

Triangular Panel



Triangular Panel

Dotted Panel

Dotted Panel

Dating: 57 to 75 Ka

- The team also dated cave sediments with optically-stimulated luminescence dating, determining that the cave became closed off by infilling sediment around 57,000 years ago, well before Homo sapiens became established in the region.

- This, combined with the fact that stone tools within the cave are only Mousterian, a technology associated with Neanderthals, is strong evidence that these engravings are the work of Neanderthals.

- The engravings have been dated to over 57,000 years ago and, thanks to stratigraphy, probably to around 75,000 years ago, making this the oldest decorated cave in France, if not Europe.

The main decorated wall of La Roche-Cotard cave

Dating

- OSL dating indicates that the sediment deposition closed the cave > 51 ka (95% CI) ago, or at 57 ± 3 ka (68% CI).

- This age makes access to the cave interior by anatomically modern humans (AMH) highly unlikely; MHs at 45 ka (Bacho-Kiro)

- The non-figurative engraved marks at La Roche-Cotard are necessarily older than 57 ± 3 ka, and can be, therefore, confidently stated to be of Neanderthal origin.

A creative process

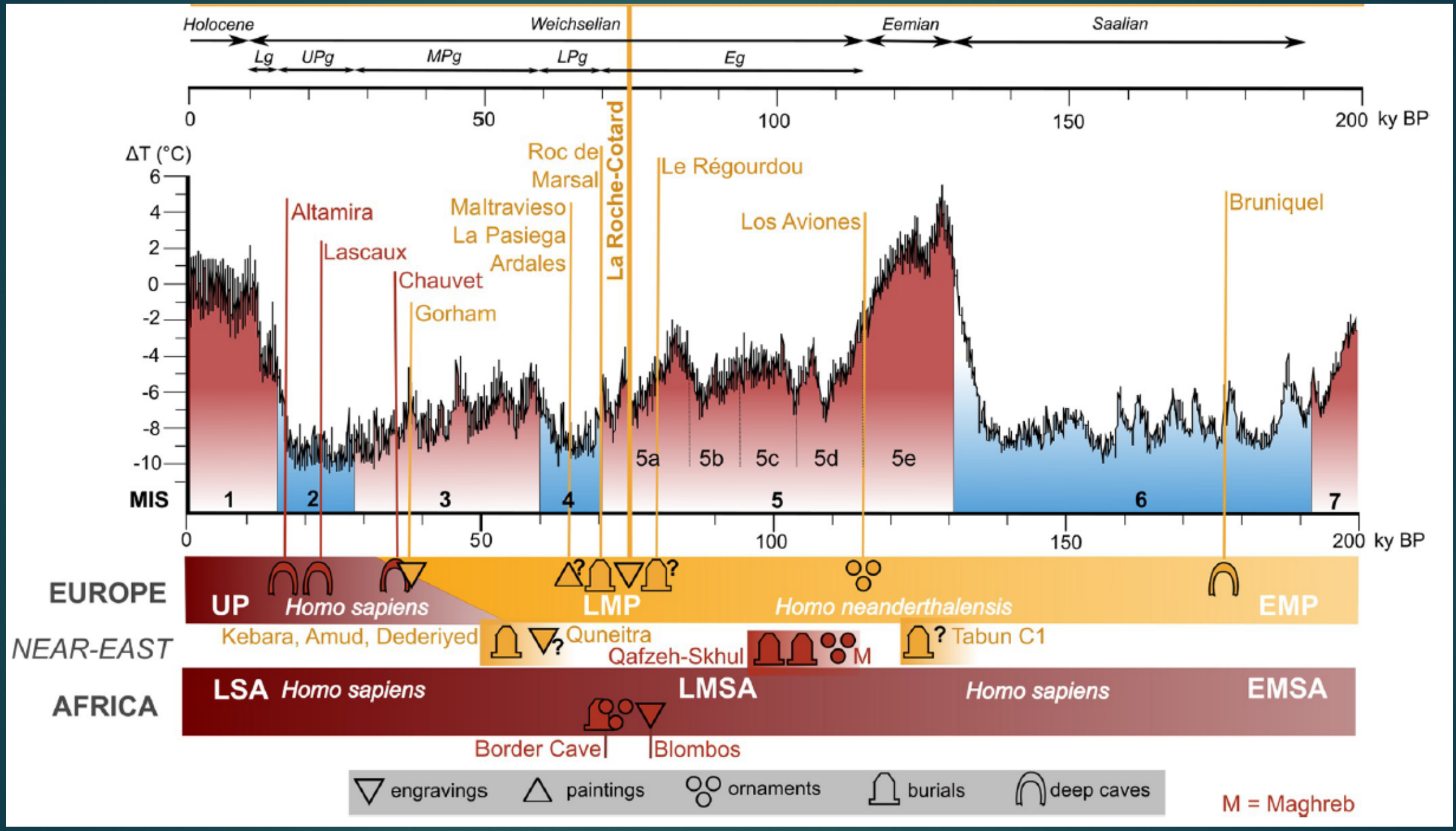
- The graphic productions identified on the walls of La Roche-Cotard demonstrate a deliberate creative process visible in the spatial arrangement of the engraved marks on the cave wall.
- There is little graphic evidence associated with Neanderthals, and that is mainly on mobile objects (pebbles, slabs, bones...), rather than walls.
- In contrast, the walls of La Roche-Cotard testify to something different: the frequent repetition of thoughtful gestures, organized in space both on the wall surfaces and with respect to the cave as a whole.
- There even seems to be a progression in the complexity of these graphic entities, particularly from the first to the sixth panel.

Original panels

- These traces were meticulously made only on selected surfaces and most often exploiting the shape of the cave wall.

- The spatially close Circular and Undulated Panels also demonstrate the care taken in making these engravings: the former is composed of deep (forcefully made) digital traces of a slightly oblong circular shape, and the latter is composed of wavy axial traces around which numerous other traces have been added. These two entities could be considered as one. The Triangular Panel has a shape that exploits the shape of the surface used.

- These figures are clearly intentional. The layout of these non-figurative graphic entities is an organized, deliberate composition, and is the result of a thought process giving rise to conscious design and intent.


Holocene
Weichselian
Eemian
Saalian
Lg
UPg
MPg
LPg
Eg
0
50
100
150
200 ky BP
ΔT (°C)
6
4
2
0
-2
-4
-6
-8
-10
MIS
1
2
3
4
5
5a
5b
5c
5d
5e
6
7
Altamira
Lascaux
Chauvet
Gorham
Maltravieso
La Pasiega
Ardales
Roc de Marsal
La Roche-Cotard
Le Régourdou
Los Aviones
Bruniquel
EUROPE
UP
Homo sapiens
LMP
Homo neanderthalensis
EMP
NEAR-EAST
Kebara, Amud, Dederiyed
Quneitra
Qafzeh-Skhul
M
Tabun C1
AFRICA
LSA
Homo sapiens
LMSA
Homo sapiens
EMSA
Border Cave
Blombos
engravings
paintings
ornaments
burials
deep caves
M = Maghreb

Homo naledi: 465–610 cc:
Was a small-brained hominin the world's first gravedigger—and artist?

Homo naledi

- History of *H. naledi* discovery:
- Lee Berger's team made its first discovery in Rising Star in 2013: the bones of at least 21 individuals at the bottom of a chute 50 kilometers northwest of Johannesburg.

- The team named it a new species because it had a surprising mix of traits, such as a small brain and a globular skull.

- First claimed that they were two million years old, they were finally dated to 241 to 335 Ka years ago, based on radiometric dates on sediments above and below the remains.

- As more bones emerged, Berger claims they had been intentionally buried.

Lee Berger's bonanza of non-peer-reviewed publicity

- 3 non-peer reviewed preprint papers published Jun 1, 2023
- Then Netflix's "Unknown: Cave of Bones" on July 17
- And then a book coauthored by Berger and Hawks called "*Cave of Bones: A True Story of Discovery, Adventure, and Human Origins*," available August 8.
- Berger claims all peer reviews for publication will become public.

3 non-peer-reviewed Preprints on bioRviv

- L.R. Berger et al. "Evidence for deliberate burial of the dead by *Homo naledi*" (2023). 10.1101/2023.06.01.543127
- L.R. Berger et al. "241,000 to 335,000 years old rock engravings made by *Homo naledi* in the Rising Star cave system, South Africa" (2023). 10.1101/2023.06.01.543133
- A. Fuentes et al. "Burials and engravings in a small-brained hominin, *Homo naledi*, from the late Pleistocene: contexts and evolutionary implications" (2023). 10.1101/2023.06.01.543135

New controversial claims about *H. naledi*

- A trio of papers posted online and recently presented at a meeting laid out an astonishing scenario.

- Claim that ~240,000 years ago, small-brained hominins carried their dead through a labyrinth of tight passageways into the dark depths of the vast limestone Rising Star cave system in South Africa. Working by firelight, these diminutive hominins dug shallow graves, sometimes arranging bodies in fetal positions and placing a stone tool near a child's hand.

H. naledi

- Some etched cave walls with crosshatches and others made fires in what amounted to a subterranean funeral, more than 100,000 years before such behaviors emerged in modern humans.`

- If true, this scenario, based on some new fossil finds in South Africa's Rising Star cave system, would have major implications for the dawn of human behavior as well as the abilities of the hominin *Homo naledi*.

Berger claims

- In 2018, they identified depressions deep in the chambers of the cave system, in which the bodies of *H. naledi* adults and several young children had been deposited in a fetal position, suggesting that the intent was to bury the dead.

- Berger claim: "This burial has depth, demonstrating it's not a body that died in a depression or hole," he said. "It was a whole body that was covered in dirt and then decayed within the gravel itself, not by some dramatic collapse or being washed in. We feel they've met the litmus test of the most ancient human burials."

Immediate skepticism

- However, other researchers are overwhelmingly skeptical of the papers, which are in review at the online journal *eLife* and have been posted on bioRxiv.
- Researchers say they are wowed by the original fossil finds, but the new skeletal finds could have simply fallen or been dumped into existing depressions and been buried slowly by natural processes.
- Much later humans could have made the etchings, which are undated.

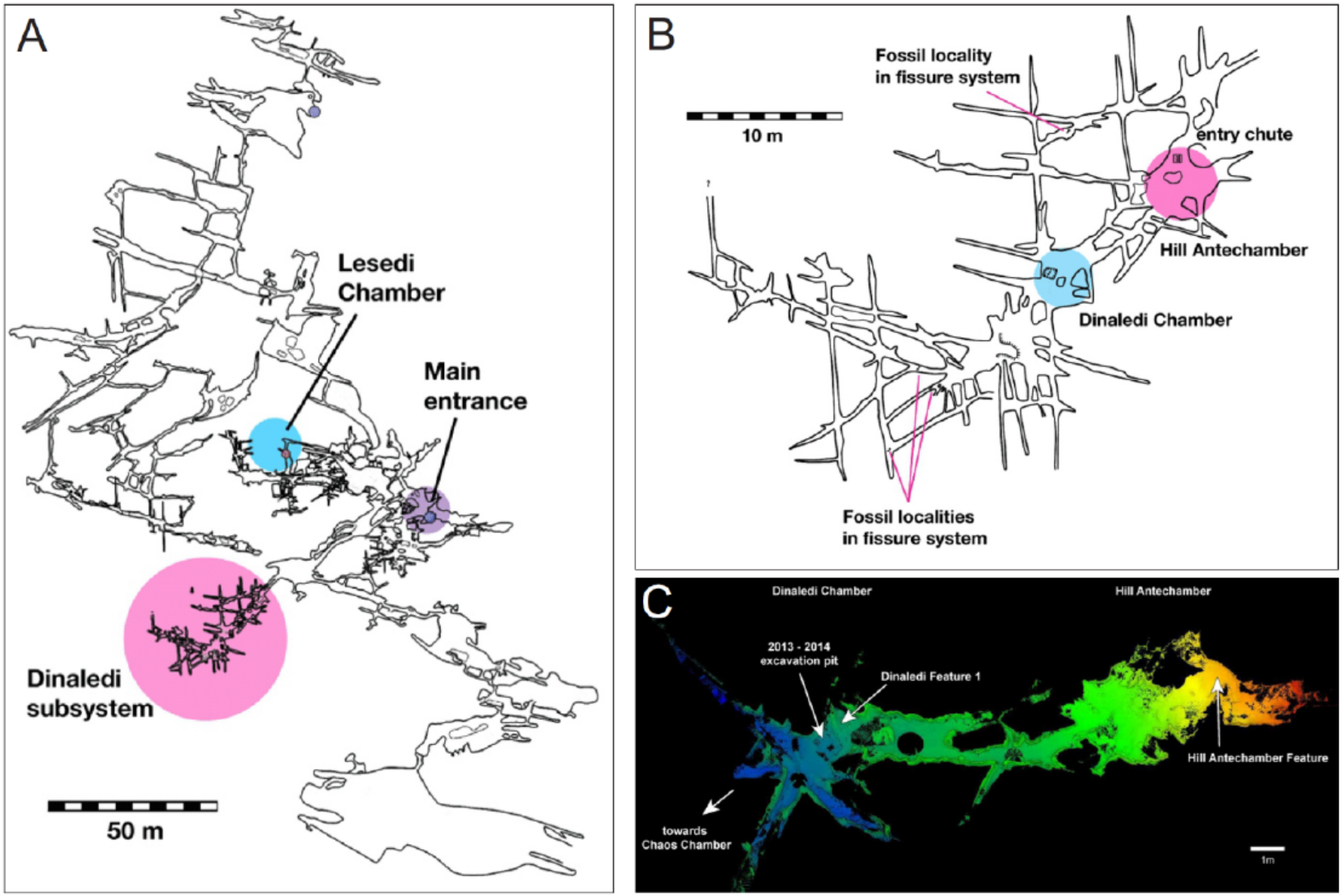


Figure 1. Maps of the study locality. (A) Rising Star cave system. The locations of the Dinaledi

“Burial features” = 4 individuals + a stone object

- The Rising Star cave's Hill Antechamber feature contains the remains of at least four *H. naledi* children

- One oval pit (8 centimeters deep and 50 by 25 centimeters in size) filled with 83 bone fragments and teeth from one *H. naledi* individual as well as a few fragments from other individuals.

- Elsewhere in the cave, the team found another set of very fragile bones.

New discoveries

- They removed two big chunks of sediment with bones inside, encased them in plaster, and took them to their lab.

- There, CT scans revealed 90 skeletal pieces and 51 dental pieces from three *H. naledi* individuals, including a child. The scans also revealed a tool-like stone object next to the child's hand.

- The researchers argue that the arrangement of the bones suggests the bodies were carefully buried in a fetal or seated position.

Homo naledi were burying their dead at least 100,000 years before humans

- Three new preprints posted to BioRxiv which will be published later this year in the journal eLife.
- Lee Berger: has announced the discovery of *H. naledi* bodies deposited in fetal positions, indicating intentional burials.
- This would predate the earliest known burials by *Homo sapiens* by at least 100,000 years, suggesting that brain size might not be the definitive factor behind such complex behavior.
- The team also found crosshatched symbols engraved on the walls of the cave that could date as far back as 241,000–335,000 years, but currently undated.

Paper 1: Evidence for deliberate burial of the dead by Homo naledi

- "Recent excavations in the Rising Star Cave System of South Africa have revealed burials of the extinct hominin species Homo naledi. A combination of geological and anatomical evidence shows that hominins dug holes that disrupted the subsurface stratigraphy and interred the remains of H. naledi individuals, resulting in at least two discrete features within the Dinaledi Chamber and the Hill Antechamber.

- These are the most ancient interments yet recorded in the hominin record, earlier than evidence of Homo sapiens interments by at least 100,000 years. These interments along with other evidence suggest that diverse mortuary practices may have been conducted by H. naledi within the cave system. These discoveries show that mortuary practices were not limited to H. sapiens or other hominins with large brain sizes. Two burials occur in pits that were intentionally dug.

- The oldest known H. sapiens burial in Africa was at Panga ya Saidi cave in Kenya, dating back to 78.3 ka

Lee Berger, et al., 2023

Dinaledi Feature 1

- The Dinaledi “Feature 1” was uncovered in 2018 in an excavation unit within the Dinaledi Chamber immediately to the north of our 2013–2014 excavation area that produced abundant skeletal remains of H. naledi.

- A combination of stratigraphic, anatomical, and taphonomic evidence supports this feature as a burial. The key observations are
  - (1) the difference in sediment composition within the feature compared to surrounding sediment;
  - (2) the disruption of stratigraphy;
  - (3) the anatomical coherence of the skeletal remains;
  - (4) the matrix-supported position of some skeletal elements; and
  - (5) the compatibility of non-articulated material with decomposition and subsequent collapse..

Dinaledi Feature 1

- The skeletal representation and spatial relationship of elements indicate that Feature 1 contains predominantly the remains of a single body including the 83 identifiable bone fragments and teeth that were recovered above and within the exposed circumference of the feature

- The spatial arrangement of the skeletal remains is consistent with primary burial of a fleshed body, covered in sediment, followed by decomposition and post-depositional collapse

Hill Antechamber Feature 1 + a stone

- The Hill Antechamber feature was uncovered during excavations conducted in 2017.

- Feature 1 contains 4 children

- The configuration of the skeletal remains in this feature is consistent with the body of Individual 1 being in a flexed position at the time of interment, with the right foot and right hand near or at their current spatial positions

Hill antechamber

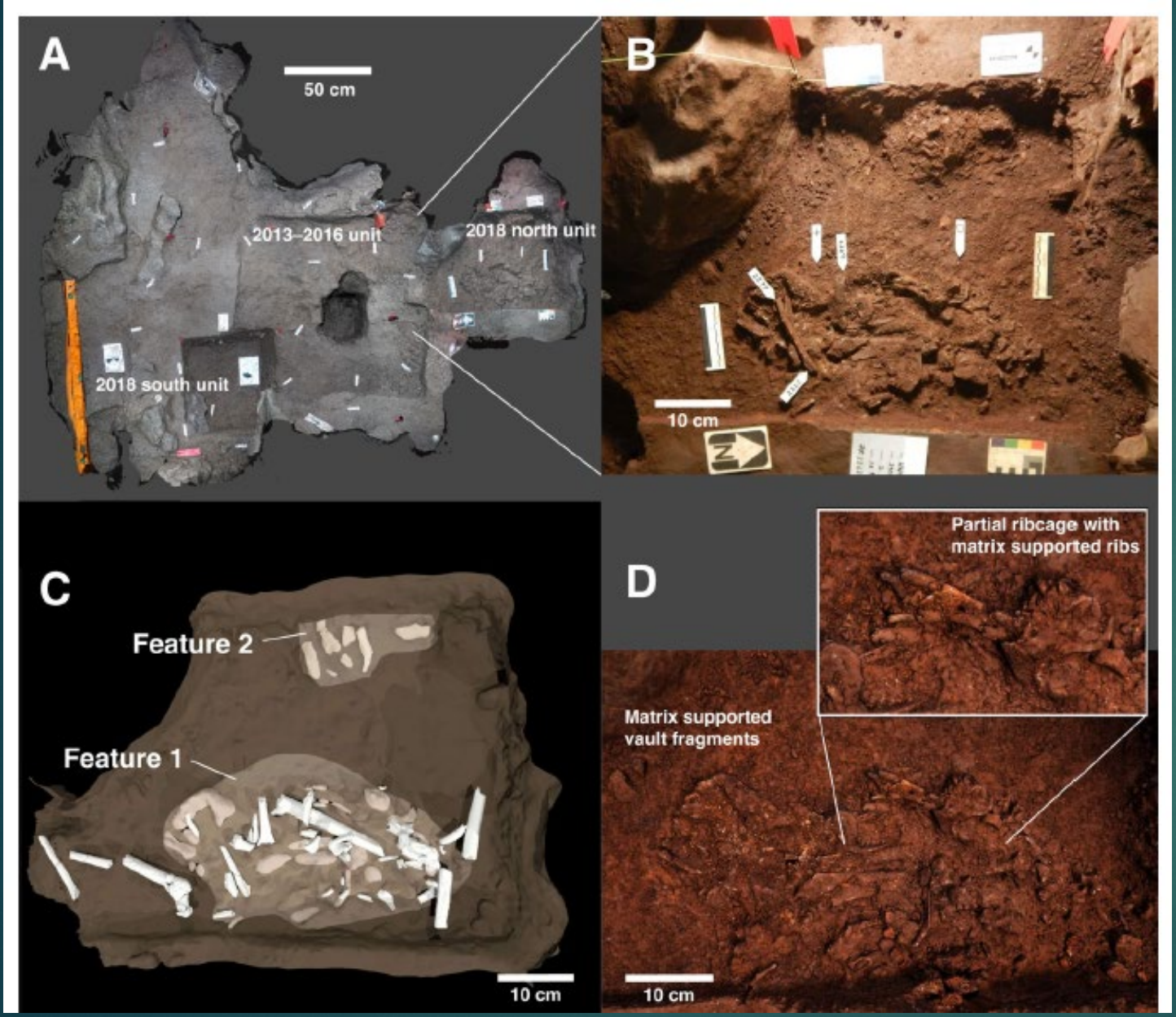
- In 2017, the scientists also removed fragile *H. naledi* remains encased in three blocks of sediment from the Hill Antechamber.

- CT scans of the blocks have identified partial skeletal remains of a roughly 13-year-old *H. naledi* whose body, curled in a fetal position, was placed in a shallow, dug-out depression and covered with dirt, per Berger.

- Scattered teeth of two other *H. naledi* individuals were also detected in this block, possibly entering via sediment disturbances or as *H. naledi* buried others in the Hill Antechamber, the team suspects.

Announcements without analysis

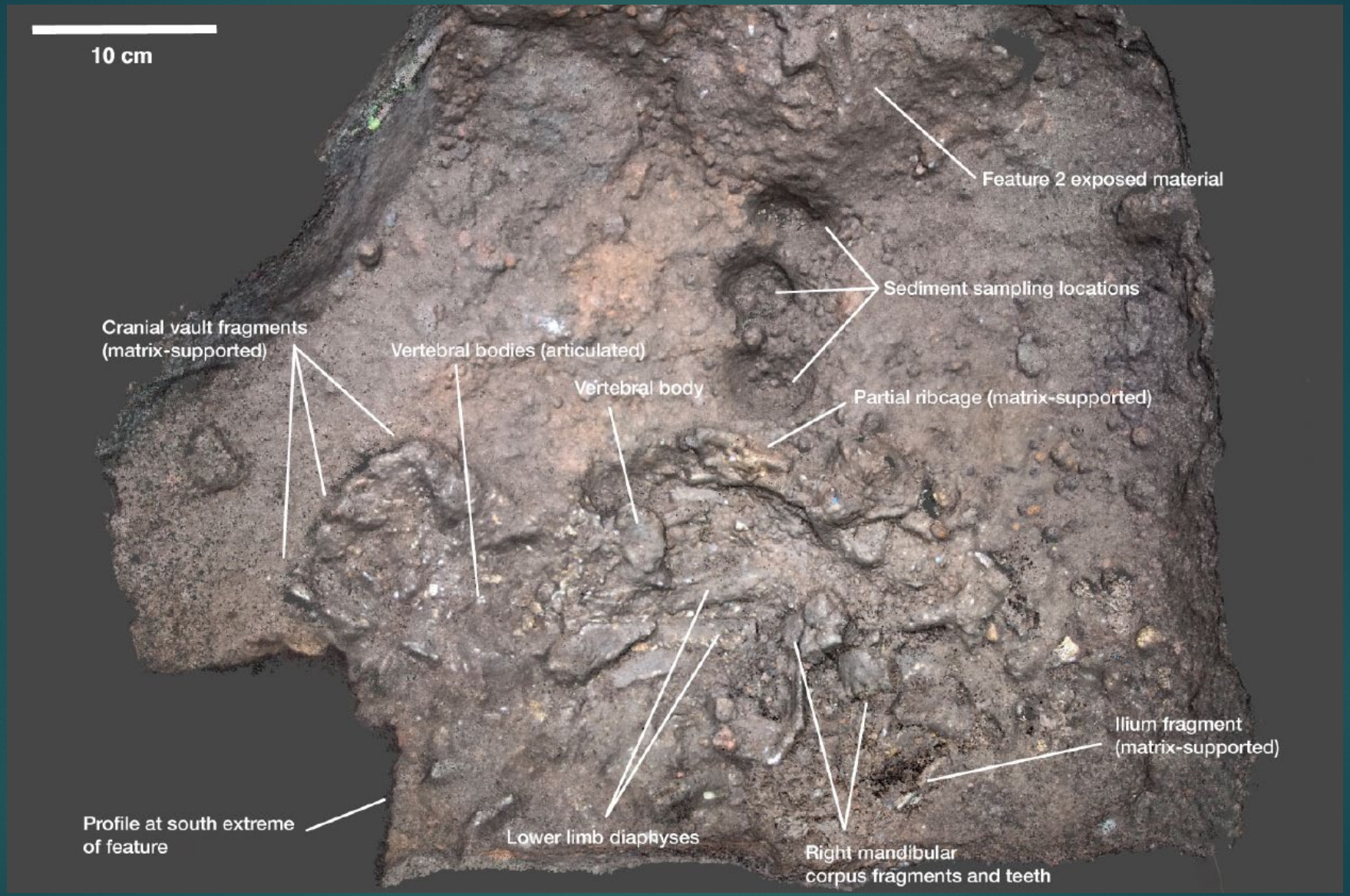
- The 3 removed blocks with remains have not been internally investigated and are unpublished.
- The teen's remains included a “tool-shaped rock” artifact near the hand.
- Berger: "We believe it's a chert or dolomite substance, and it may have characteristics of being a manufactured lithic artifact," and it's something that will be investigated once the artifact is extracted for further testing.



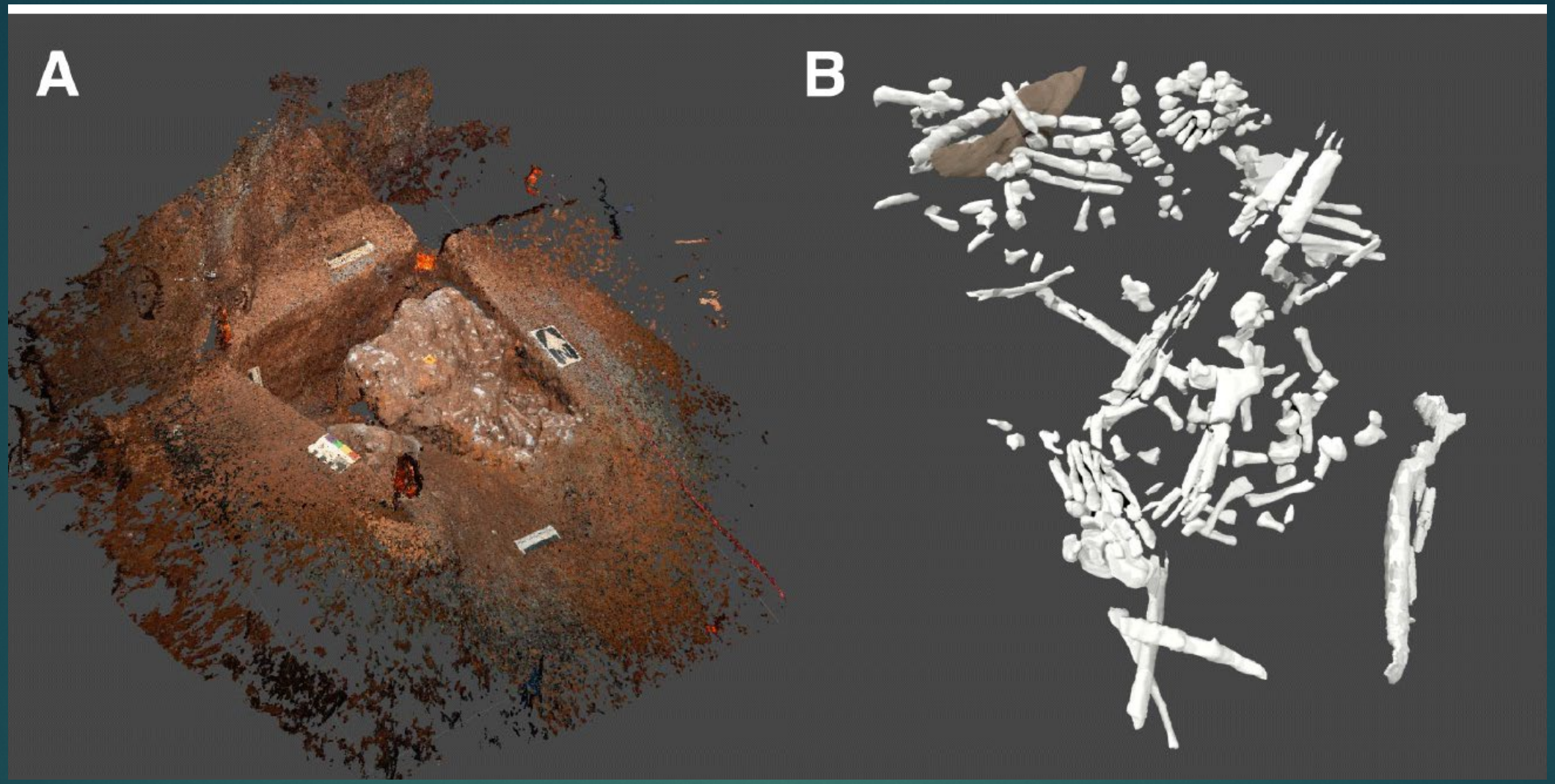
Dinaledi Chamber burial features. (A) Photogrammetry model of the Dinaledi Chamber floor and excavation areas. Locations of 2013–2016 excavation area and two 2018 excavation units are labelled.

(B) (D) Photograph of excavation area including Feature 1 and Feature 2.

(C) Three-dimensional reconstruction of excavation area including both the excavated skeletal material and the unexcavated material in spatial position. The oval area of Feature 1 corresponds to the sediment contrast and outline of skeletal material remaining in situ.



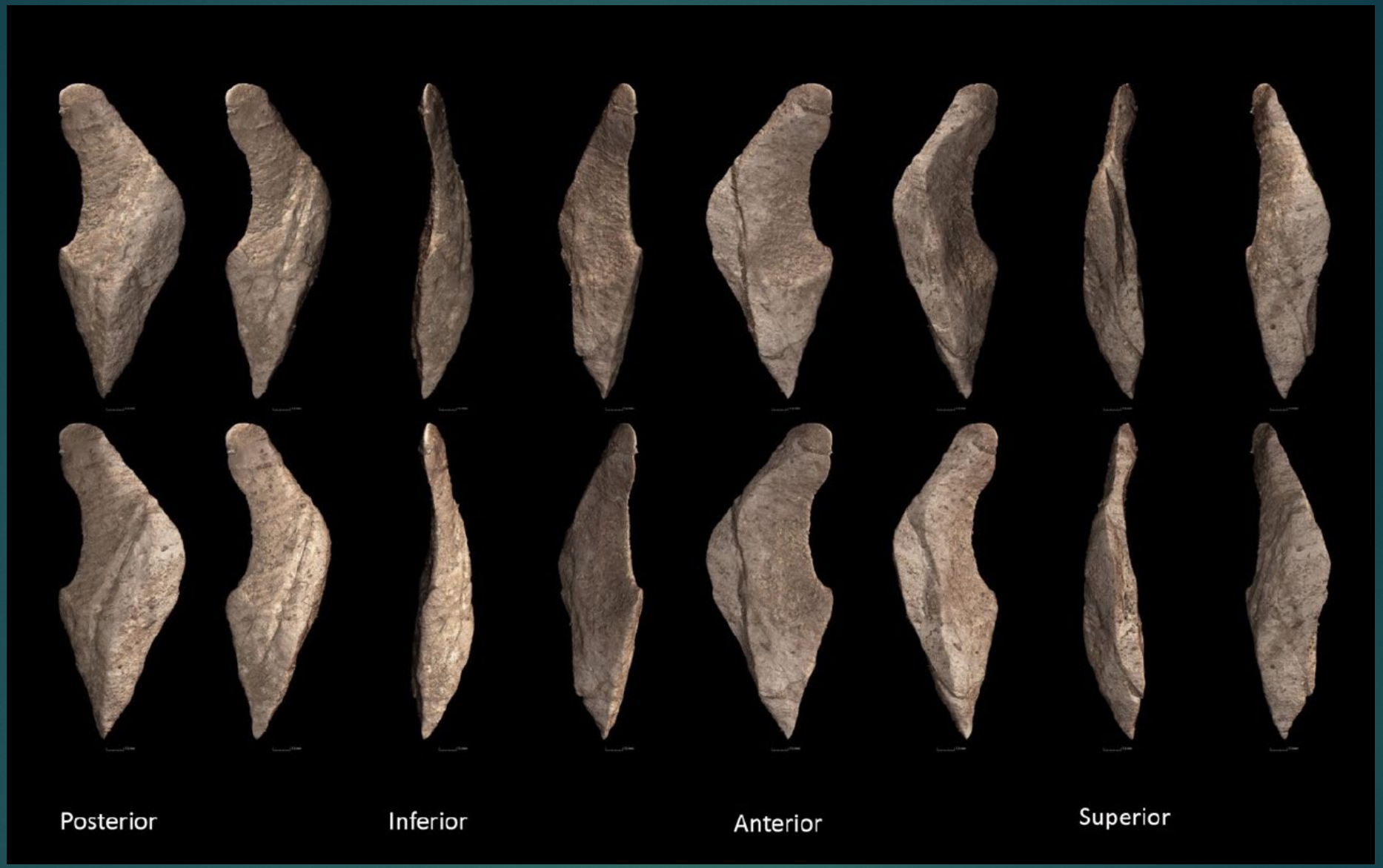
Surface of Dinaledi Feature 1 remaining in situ with identifiable elements indicated.



Hill Antechamber feature:

(A) Hill Antechamber feature in situ prior to jacketing and extraction from the cave

(B) Overhead view of segmented skeletal material and teeth within the feature.



Hill Antechamber Artifact 1 (HAA1) showing surface from 8 different angles with 2 different lighting directions.

Burger theories

- “These burial features meet evidentiary standards used for recognizing burials of H. sapiens. The recognition of burials in these chambers within the cave system prompts us to evaluate the broader array of H. naledi remains for evidence of mortuary activities.

- Our 2013–2014 excavation was localized between 1 and 2 meters to the southwest of Dinaledi Feature 1. Within an excavation area of 80 cm by 80 cm we recovered remains attributable to a minimum of 5 individuals

- A parsimonious explanation for this configuration of skeletal remains is that these remains may be a palimpsest of burials that have sequentially disrupted each other. In this hypothesis, early burials were disturbed when pits were dug for subsequent burials.

Berger theories

- Other occurrences of remains outside of the Dinaledi Chamber and Hill Antechamber are discussed as possible evidence of mortuary practices.

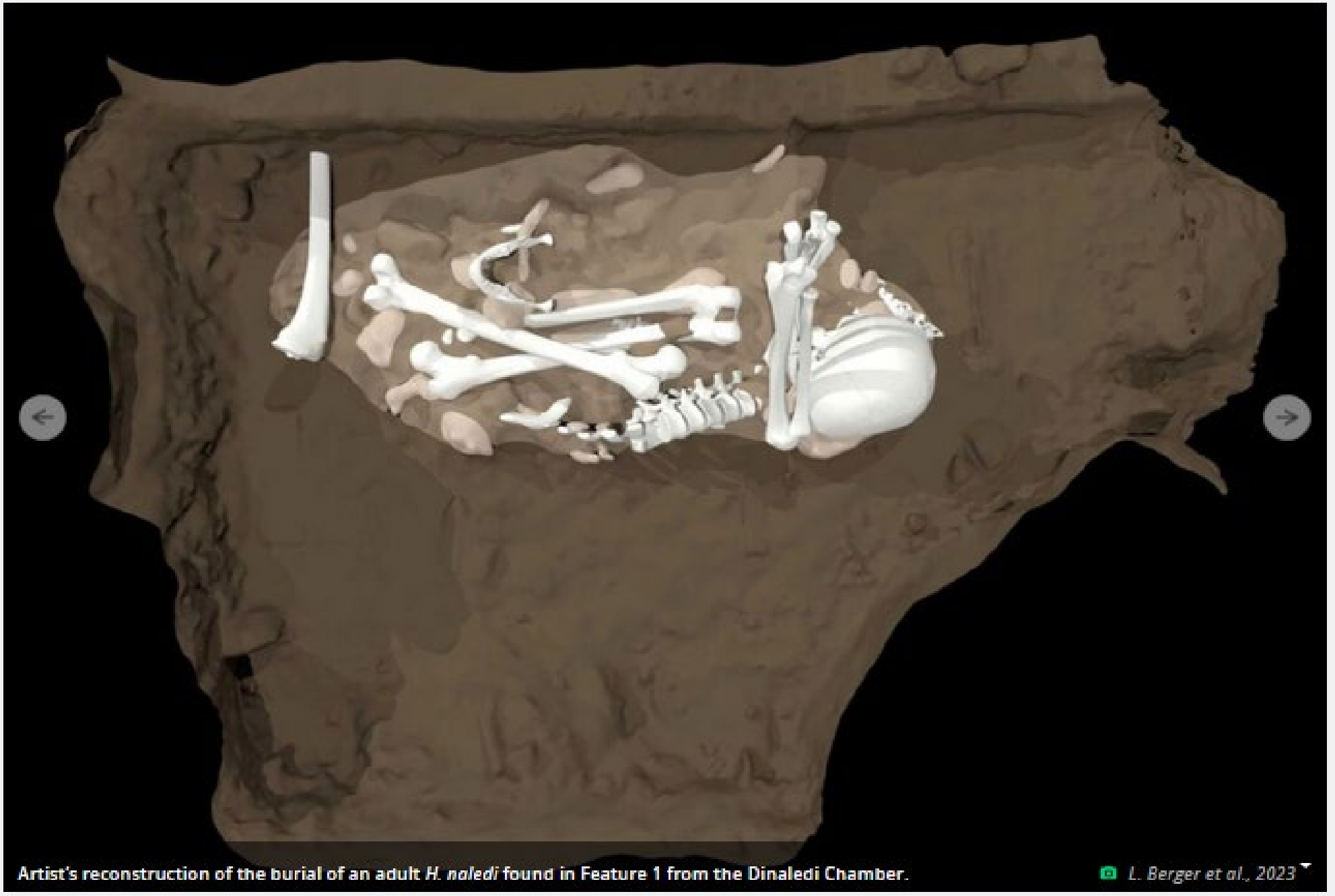
- Instances where parts of individuals occur in remote narrow passages cannot be explained as a result of carnivore or water transport, making it necessary to consider that H. naledi may have placed these partial remains in these locations, possibly representing a form of funerary caching (intentional placement of bodies in caves).

- It is possible that H. naledi used certain parts of the cave system for burials and other mortuary practices in contrast to other kinds of behaviors, and further exploration of the cave system may assess that hypothesis.

Berger Conclusions

- The complex treatment of the dead of H. naledi may pre-date the earliest evidence of burials by H. sapiens in Africa by as much 160,000 thousand years or more.

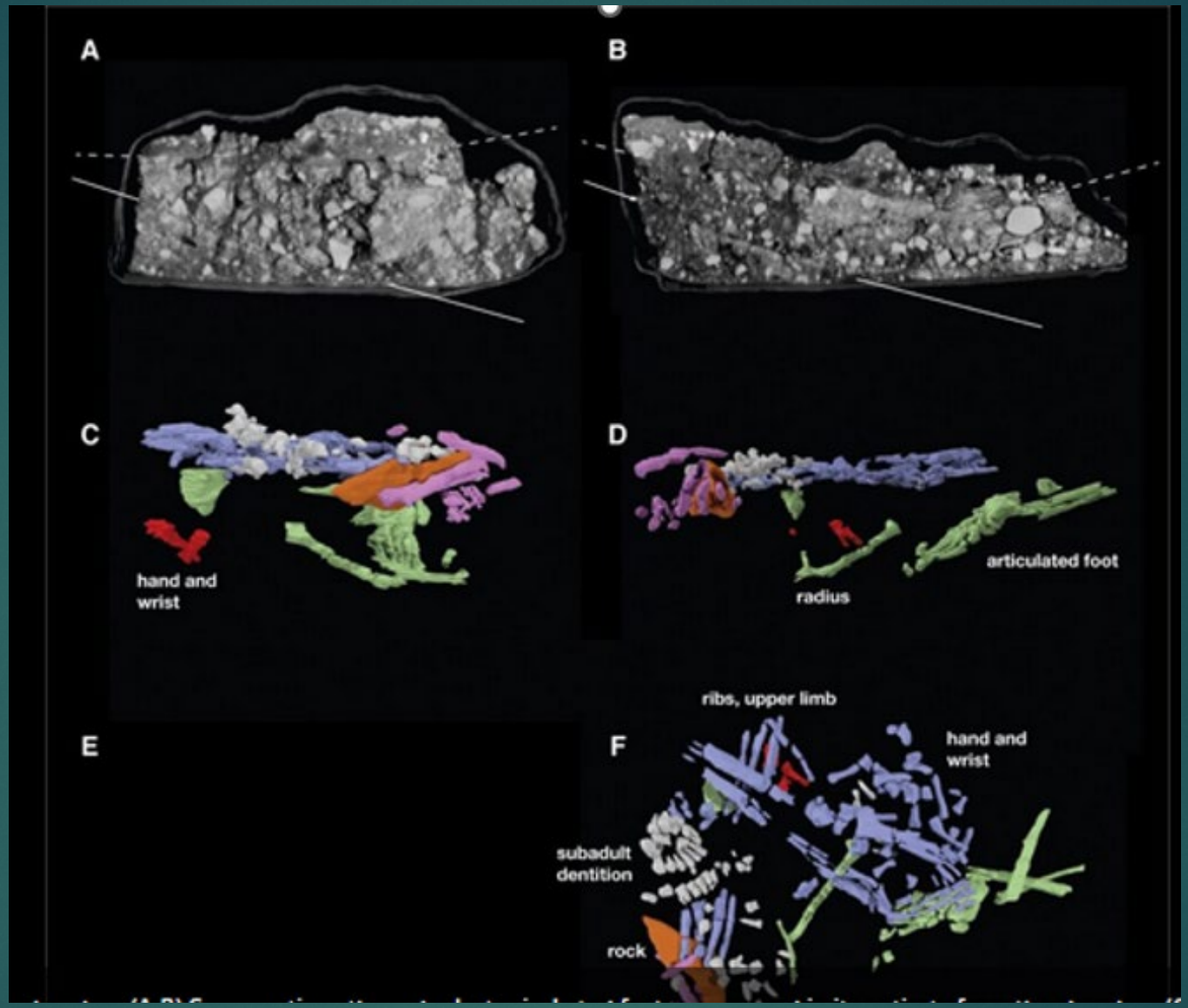
- This raises the possibility that burial or other mortuary behavior may have arisen much earlier than present evidence for them, or that such behaviors evolved convergently in minds different from our own.



Artist's reconstruction of the burial of an adult *H. naledi* found in Feature 1 from the Dinaledi Chamber.

L. Berger et al., 2023

Hill Antechamber feature with remains of at least four *H. naledi* children. One child (right) is approximately 13 years old in human terms.



CT scans of Hill Antechamber. (A-B) Cross sections through plaster jacketed feature removed in its entirety from the chamber. (C-F) Digital 3D reconstructions of bones in the burial including the tool-shaped rock (orange) visible near the hand of the nearly 13-year-old child upper limb

A crescent-shaped stone identified among scanned H. naledi fossils includes a point, sharp edges and other signs of having been an implement of some kind.

Hill Antechamber Artifact 1 (HAA1) close-up from the previous figure with detail showing striations visible on both faces and intersection of these striations with sharp edge of artifact showing appearance of serrations.

Criticism: Scans of that stone reveal no clear indications of intentional modifications, Pettitt says. This find should be examined more closely after it's removed from surrounding sediment.

Claims of fire use and crosshatchings

- They also discovered crosshatchings and other geometric shapes engraved on the cave walls; some were carved on top of others, indicating they were etched at different times.
- Berger claims that in order to work in the dark, *H. naledi* had fire, although the papers include no evidence for this.
- *H. naledi* had a brain of about 410 to 600 cubic centimeters, the size of a chimpanzee or *Australopithecus* brain.
- Taken together, the team's scenario suggests "that those of us that teach and write about the evolution of social behavior … need to step back and take humans off the pedestal," says co-author Agustín Fuentes of Princeton University. "Much of what we assumed was distinctly human, and distinctively caused by having a large brain, may not be [due to] either of those things."

Etchings

- On July 28, 2022, Berger and his team found etchings engraved in a crosshatch pattern on Panel B in the Hill Antechamber.

- The patterns include geometric figures like squares, ladders, triangles, crosses, and X's. More crosshatch etchings were found on a second Panel A, which also showed evidence of earlier etchings behind it, obscured by covering the surface with cave dirt.

- The surface also showed signs of having been prepared by hammerstones prior to the engraving.

- Dating rock engravings is a complex and challenging process. But Berger *et al*. argue that contextual evidence rules out these etchings having been made by natural forces, given the fossil algal stromatolite rock found at the bottom of the Panel A engraving.

Etchings

- Add in prior evidence (unpublished) found of fire in the Rising Star cave system—charcoal, silt, burnt bone—and there is a solid case to be made that the engravings were made by *H. naledi*.

- Berger: "These are not the kind of graffiti or engravings that humans do." "There's no evidence of humans in the proximal spaces other than our entry into this space. There are burials of this species directly below, graves they dug. The engravings were not done in one sitting, they're done over time, and there's [evidence of] erasure. They actually put material or sand over it and carved through at a later period."

Hash marks

Engravings remain undated

Unpublished claim of fire use

- Berger lost 50 lbs to enter the Dinaledi chamber. Immediately claimed to have discovered fire usage (despite 40 prior researchers entering the cave and not noticing this!)
- At a lecture last fall, Berger described finding fragments of charcoal, burned antelope bones, rocks arranged as hearths and soot marks on the cave walls, all indicating that the ancient hominins were using fire for light and cooking.
- These discoveries, however, have not been published, and Berger said efforts to date the soot marks will be difficult, because the radiocarbon method can only be applied to organic materials up to 60,000 years old.

Paper 2 - 241,000 to 335,000 Years Old Rock Engravings Made by Homo naledi in the Rising Star Cave system, South Africa.

- The production of painted, etched or engraved designs on cave walls or other surfaces is recognized as a major cognitive step in human evolution. Such intentional designs, which are widely interpreted as signifying, recording, and transmitting information in a durable manner were once considered exclusive to Late Pleistocene Homo sapiens.

- Recent work has demonstrated that other hominin groups also made such marks, including Neanderthals, and possibly Middle-Pleistocene Homo erectus. Such durable signs indicate an intentionality characteristic of meaning-making which has been argued to require significant levels of cognitive abilities not found in species with smaller brain sizes.

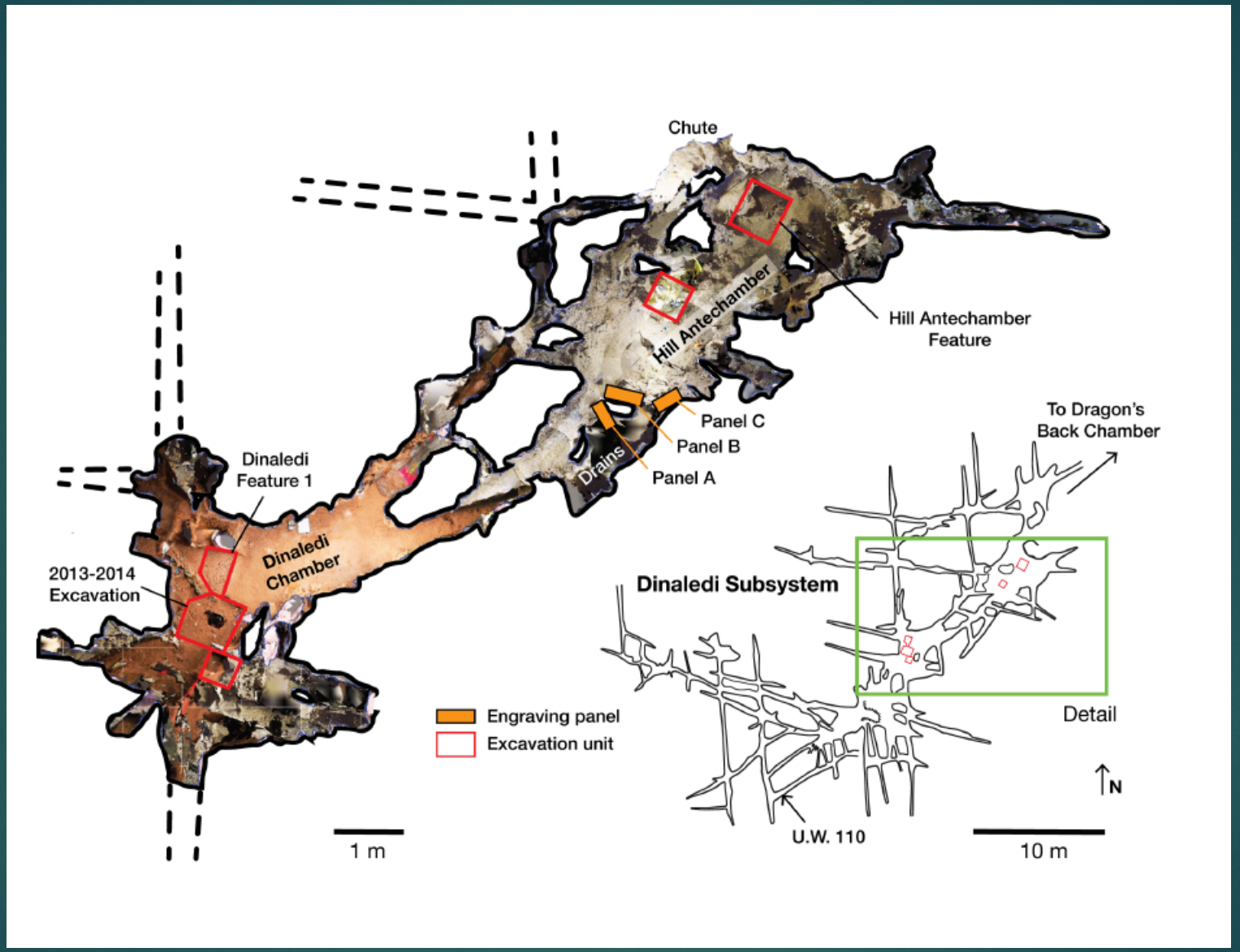
Lee Berger, et al., 2023

Engravings

- In fact, the evolution of such meaning-making symbols is thought to be a core aspect of what it means to be “human”.

- Present the first known example of abstract patterns and shapes engraved within the Dinaledi subsystem of the Rising Star Cave in South Africa.

- We identified markings incised into the dolomitic limestone walls of the cave. The engravings described here are deeply impressed cross-hatchings and other geometric shapes


Chute
Hill Antechamber
Hill Antechamber Feature
Panel C
Panel B
Panel A
Drains
Dinaledi Feature 1
Dinaledi Chamber
2013-2014 Excavation
To Dragon's Back Chamber
Dinaledi Subsystem
Detail
Engraving panel
Excavation unit
N
U.W. 110
1 m
10 m

sideways


L6
L4
L11
L7
L8
L3
L3
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Rock Engravings

- The surfaces bearing these engravings appear to have been prepared and smoothed. In some areas there is residue that creates a sheen on the surface possibly indicating repeated handling or rubbing of the rock, and there is evidence of the application of dirt or sand to the surface by non-natural processes.

- Homo naledi entered this part of the cave system and buried bodies within the both the Dinaledi Chamber and adjacent Hill Antechamber between 241 and 335 ka.

- The engravings described here are found on a pillar in the Hill Antechamber that extends into the natural fissure corridor that links the two chambers and we associate them with H. naledi.

Rock engravings

- On July 28, 2022, during a survey of the Dinaledi Subsystem, we identified what appear to be engraved markings on the southern and northern faces of a natural pillar that forms the entrance and exit of a passage connecting the Hill Antechamber with the Dinaledi Chamber.
- Most of these marks are linear features between ~5 and ~15 cm in length. Many of these intersect to form geometric patterns such as squares, triangles, crosses, and X's, while some are isolated lines. The engravings are located on three dolomitic panels, which we have labelled A, B and C.
- Seen as a triptych, these engravings are in a location where they can be viewed during access and egress to the Dinaledi Chamber when entering the system from the Hill Antechamber. The Hill Antechamber is the likely point of access by Homo naledi to the entire subsystem, and the passage is the natural linkage between the two main chambers of the subsystem

Rock engravings

- At present we have no evidence limiting the time period across which H. naledi was active in the cave system.

- The maximum age constraint reported by Dirks et al. (2017) on H. naledi skeletal material (335 kyr BP) in Dinaledi is limit of a direct ESR-US date on H. naledi teeth; while the minimum age constraint (241 kyr BP) is based on U-Th on a flowstone that formed in part around a bone fragment (Wiersma et al. 2020).

- These dates do not necessarily pertain to skeletal material from other parts of the cave system, nor do they exclude earlier or later access to the cave system by H. naledi individuals. The duration of H. naledi cultural activity within the cave system is therefore not presently known.

Claim that H naledi were the engravers

- It is unlikely that any other hominin population made these engravings. No evidence that recent humans or earlier hominins ever entered any adjacent area of the cave until surveys by human cave explorers during the last 40 years.
- The number of modern cavers and archaeologists who have entered the Dinaledi subsystem is extremely limited. There is no evidence of modern cavers altering cave walls in such a manner in the Dinaledi subsystem, or elsewhere in Rising Star system.
- The evidence that these engravings were created in multiple events over time further makes it unlikely that historic humans were involved in their creation. The available evidence is most compatible with the extinct species Homo naledi as the creator of these markings
- The engravings in panel A give the impression of overlapping crosses and lines and are remarkably similar in appearance to the engraving from Gorham's Cave, Gibraltar.

Paper 3 - Burials and engravings in a small-brained hominin, Homo naledi, from the Pleistocene: contexts and evolutionary implications – A. Fuentes

- A theoretical paper: Data from recent explorations in the Dinaledi subsystem illustrates one of the earliest examples of a mortuary practice in hominins and offers the earliest evidence of multiple interments and funerary actions, as well as evidence of the early creation of meaning making by a hominin.
- The hominin undertaking these behaviors was the small-brained Homo naledi. These data call into question several key assumptions about behavioral and cognitive evolution in Pleistocene hominins. The evidence from Dinaledi push back the temporal origins of mortuary and funerary behaviors and associate the creation of meaning making with a small-brained species and thus challenge key assumptions about the role and importance of encephalization in human evolution.

- This suggests that the hominin socio-cognitive niche and its relation to meaning-making activities is more diverse than previously thought. The association of these activities in subterranean spaces accessed and modified by the small brained species Homo naledi impacts assertations that technological and cognitive advances in human evolution are associated solely with the evolution of larger brains.

A. Fuentes, et al., 2023

Emotional and Cognitive capacities of *H. naledi*

- The recent finds from the Dinaledi chamber, Rising Star Cave, South Africa indicate that large-brain-only model for complex hominin behavior no longer holds.

- Fire use, mortuary behavior, and the evidence of engravings attributed to H. naledi falsify the hypothesis that only a large-brained hominin was capable of cognitively complex cultural, possibly symbolic, behavior.

- This suggests that neurobiological organization rather than overall brain size, may have been one part of an early key transition within hominin evolution

- We suggest that a distinctive cultural, empathetic, collaborative niche dependent on increasingly complex and robust relationships between individuals has also been a primary driver in the development of key aspects of human, or human-like, behavior

Erases the idea of human exceptionalism -- that humans are different than animals and special due to their big brains.

- Regardless of what one terms the underlying cognitive processes associated with the burial activities of H. naledi, they indicate a level of conscious emotional awareness that enables and is associated with extensive shared intentionality, forward planning, and repeated cultural behavior involving bodily risk.

- Thus, it is clear that the hominins in the later Pleistocene are typified by a range of brain sizes and cranial and post-cranial morphologies and that the material record in that same time period offers increased evidence for shared meaning-making. This demonstrates that such behavior is neither “modern” nor exclusive to *Homo sapiens* (sensu latu).

- Neither absolute brain size nor encephalization quotient are necessarily correlated with the meaning-making capacities and emotional-cognition complexity associated with mortuary and funerary behavior.

Don’t need a large brain

- It has been assumed that a large brain was an essential step towards a uniquely human cognition, social relationships and culture. However, small-brained hominins were responsible for many key changes in human evolution.

- Planning and forethought in stone tool production predates the origins of Homo and by 1.76 million years ago multiple taxa/populations of relatively small-brained hominins were likely developing separate bifacial tool traditions.

- It is also evident that small-brained hominins (under 800-1000cc) were those who initially expanded around, and out of Africa, crossing into eastern and Southeastern Asia. Additionally, the use of fire emerges in excess of 1.5 million years ago conspecific only with small-brained hominins.

Chris Stringer's supportive reaction

- Chris Stringer: New findings cannot be dismissed.

- "I would certainly like to see attempts at dating the evidence for the engravings and for the fire, but if these huge claims turn out to be well-founded, they have profound implications for our reconstructions of human evolution."
- "If the research team demonstrates complexity of behavior I think it will certainly put a nail in the coffin of the idea that a small hominin brain can't accomplish complex things."

Scientists Are Skeptical that Intelligence in *Homo naledi* "Erases Human Exceptionalism"

- "I think the evidence for deliberate burial is interesting," said Bernard Wood, of George Washington University, "but I don't think it's decisive."
- "In theory, those rock engravings could have been made by cavers in the 1930s," Wood said. "They have jumped to the assumption that they were made by H. naledi."
- Petraglia wrote in an email, "I think it's entirely possible that *Homo sapiens* was in these caves."

Criticism: not yet vetted by peer review

- Researchers agree that by finding so many individuals of *H. naledi*, Berger and his team have uncovered a remarkable death scene.

- Criticism: María Martinón-Torres:, said that such speculations were premature based on the evidence presented so far. “Hypotheses need to be built on what we have, not what we guess.”

- María Martinón-Torres: 'funerary caching’ (intentional placement of bodies in caves) rather than burial. She pointed out that the oval depressions did not contain full skeletons in complete alignment.

- If *Homo naledi* brought the bodies into the cave and left them on the cave floor, the bones could have become separated as the bodies decomposed. “Still, I think the possibility of having funerary caching with this antiquity is already stunning.”

Criticisms

- Martinón-Torres: suspects that disconnected skeletal parts described in the new papers accumulated either after bodies of the dead that had been placed in cave shafts later fell through or had been left at the back of underground caves.

- Trampling or other *H. naledi* activities in caves could eventually have produced fragmentary sets of fossils uncovered by Berger's group. . Geologic movement and sedimentation, common in caves, could have moved the bones and covered them with dirt

Burials?

- Burials?: Is there actually evidence for funerary behavior at Rising Star Cave? According to standards set by the paleoanthropology community, the evidence presented so far indicates no.

- Not one of the burials provides compelling evidence of a deliberately excavated pit. Indeed, the shallow cavities could be natural depressions where the bodies accumulated and were later disturbed by trampling, or partial cave collapse.

- But perhaps the biggest barrier to confirming the status of the findings is that so far none of the alleged burials have been fully excavated. It's therefore impossible to assess the completeness of the bodies, their original position, and the limits of the purported pits.

Criticism: ignore speculation

- "I'm highly optimistic that they have burials, but the jury is still out," said Michael Petraglia. He wanted to see more detailed analysis of the sediment and other kinds of evidence before judging whether the ovals were burials. "The problem is that they're ahead of the science."

- At the moment, the data "sadly do not present a clear and unambiguous demonstration of a deliberate burial," says Paul Pettitt, who is the expert on ancient burials. Said it was possible that *Homo naledi* did not bring the bodies in, either for caching or burying. "I'm not convinced that the team have demonstrated that this was deliberate burial."

- Meaning-making?: "We can and really should ignore speculation about *Homo naledi*'s apparent complex emotional intelligence and cognition"

Insufficient Evidence

- However, not one of the burials provides compelling evidence of a deliberately excavated pit. Indeed, the shallow cavities may not be dug pits at all, but natural depressions where the bodies accumulated and were later disturbed by trampling, or partial cave collapse.

- The alleged burials also fail to meet another fundamental criteria for deliberate burials: anatomical alignment of the body and articulation of skeletal remains.

- In a deliberate burial, the body is generally intact and any minimal displacement can be explained by decomposition. That's because burial involves immediately covering the body with soil, which protects the anatomical integrity of the skeleton.

Insufficient Evidence for burials

- Rising Star Cave so far hasn't produced evidence for anything other than the general spatial association of some skeletal elements. At most, it provides evidence for the in-situ decomposition of particular body parts, such as an ankle, and partial hand and foot articulations.

- Moreover, confirming intentional burial in the past has required the presentation of human remains in an arrangement that can't have been achieved by chance.

- However, the scattered distribution of the remains at Rising Star prevents reconstruction of their original positions.

- A stone artefact supposedly included in the burial as a "grave good" is said to have scratches and edge serrations from use. But this so-called artefact's shape suggests it may be natural. It's still encased in sediment and has only been studied through synchrotron X-ray.

Issues: Did prior cavers visit these caves

- There was a 1985 map of Rising Star Cave system used by Rick Hunter and Steven Hunter
- The cave system was explored in the 1980s by the Speleological Exploration Club (SEC), a local branch of the South African Speleological Association (SASA).
- Many initially thought bones in Dinaledi cave exhibited fresh breaks
- The arrangement of bones, as well as several survey pegs, suggested "someone had already been there" as recently as a few decades earlier.

Critics on engravings

- Most experts interviewed were not persuaded by claims that engravings found on the cave walls were made by H. naledi between 241 to 335 Ka years ago, which would make them among the oldest symbols ever discovered.

- The problem with the rock art at Rising Star Cave is that it's undated. To imply any link with Homo naledi requires firm dates.

- In the absence of dating, it's simply spurious to claim the engravings were made by Homo naledi, rather than by another species (and potentially at a much later date).

Fire use - Any proof?

- Fire use: In public lectures and on social media they clarify they have found new evidence for hearths, including charcoal, ash, discolored clay and burned animal bones.

- Yet none of the scientific research needed to confirm the use of fire has been carried out. Or if it has, it hasn't been published.

- Previously acquired radiocarbon dates obtained at the site on the apparent hearth material provided very late dates that distanced the hearths from the remains of Homo naledi by several hundred thousand years.

- Claims of Homo naledi's fire use seem totally unestablished.

Morality and evolution: only survival and reproduction matter

- The animal kingdom is full of cheats, and it could be a driving force in evolution
- New Book: *The Liars of Nature and the Nature of Liars* – Lixing Sun
- Cheating is found in all domains of life, at every level of the biological hierarchy, from the most complex organisms to the least sophisticated, even incomplete, forms of life. It is found among animals, plants, fungi, bacteria, viruses, chromosomes, genes, and snippets of DNA
- Evolution = is an unmoral, heartless process that proceeds pragmatically without any concern over ethical preferences, honor codes, or value systems. It certainly makes no distinction between prosocial cooperation and antisocial manipulation, because all that matters is what works to enhance survival and reproduction.

Morality and evolution

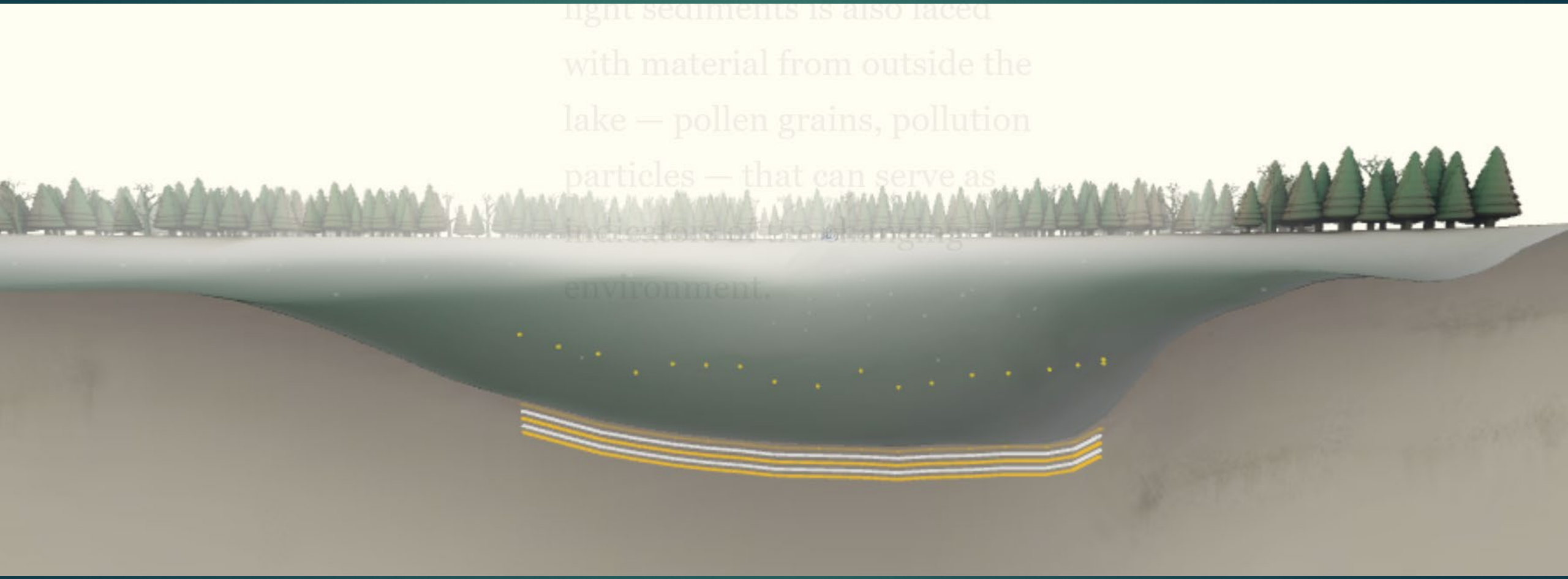
- Any trait — be it morphological, physiological, behavioral, or genetic — can prevail as long as it can boost its owner's Darwinian fitness, defined and measured as the number of offspring born and raised to adulthood. Furthermore, while freeing cheating from our moral consideration, evolution punishes those who forgo it as a strategic option when using it can increase their fitness.
- So, cheating flourishes in nature as a direct result of natural selection. Less well-known, however, is that cheating also serves as a potent selective force that drives evolution on its own. The reason is simple in concept: cheating favors the cheater and hurts the cheated. As such, it spurs the emergence of counter-cheating tactics, which in turn beget counter-counter-cheating strategies, ad infinitum.

Morality and evolution

- Rhizobia, soil bacteria that live in the roots of plants — specifically legumes. Some cheat by not fixing Nitrogen; get free housing

- It's easy to see natural selection in terms of unrelenting, cutthroat competition for resources between rivals, or in terms of surviving the onslaughts of predators, parasites, and pathogens. Because of this, evolution has been popularly stereotyped as "survival of the fittest" and "nature red in tooth and claw."
- Such a one-dimensional impression tends to divert our attention from the soft power of cooperative behaviors that are fully as effective for enhancing fitness in numerous situations and contexts, a point made clear by many scientists during recent decades. In some animals, social intelligence is significantly more important than physical strength.

Clifford Lake, Ontario and its layers of evidence

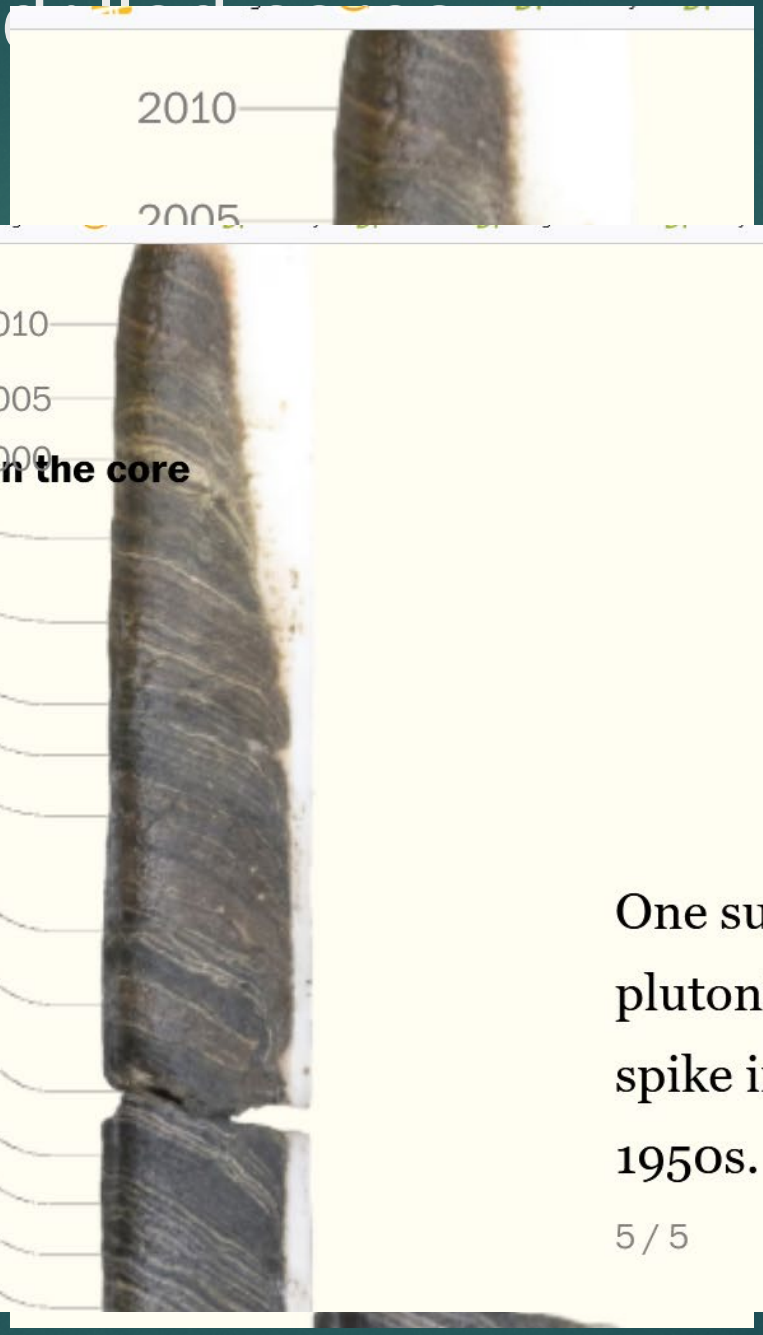


Sarah Kaplan, et al., 2023

The Anthropocene

- Hydrogen molecules uncovered in Greenland's ice denote the start of the Holocene — the 11,700-year stretch of stable temperatures that encompasses all of human civilization, up to and including the present day.
- Crawford Lake, Ontario, Canada, developed thousands of years ago, as water filled a sinkhole in the limestone cliffs of Southern Ontario. Crawford Lake is a unique bellwether of global change. A thermometer of the planet.
- Each year during the summer calcite particles cover the previous layer of debris.

Crawford Lake bottom c



One such marker is radioactive plutonium, which began to spike in the core in the early 1950s.

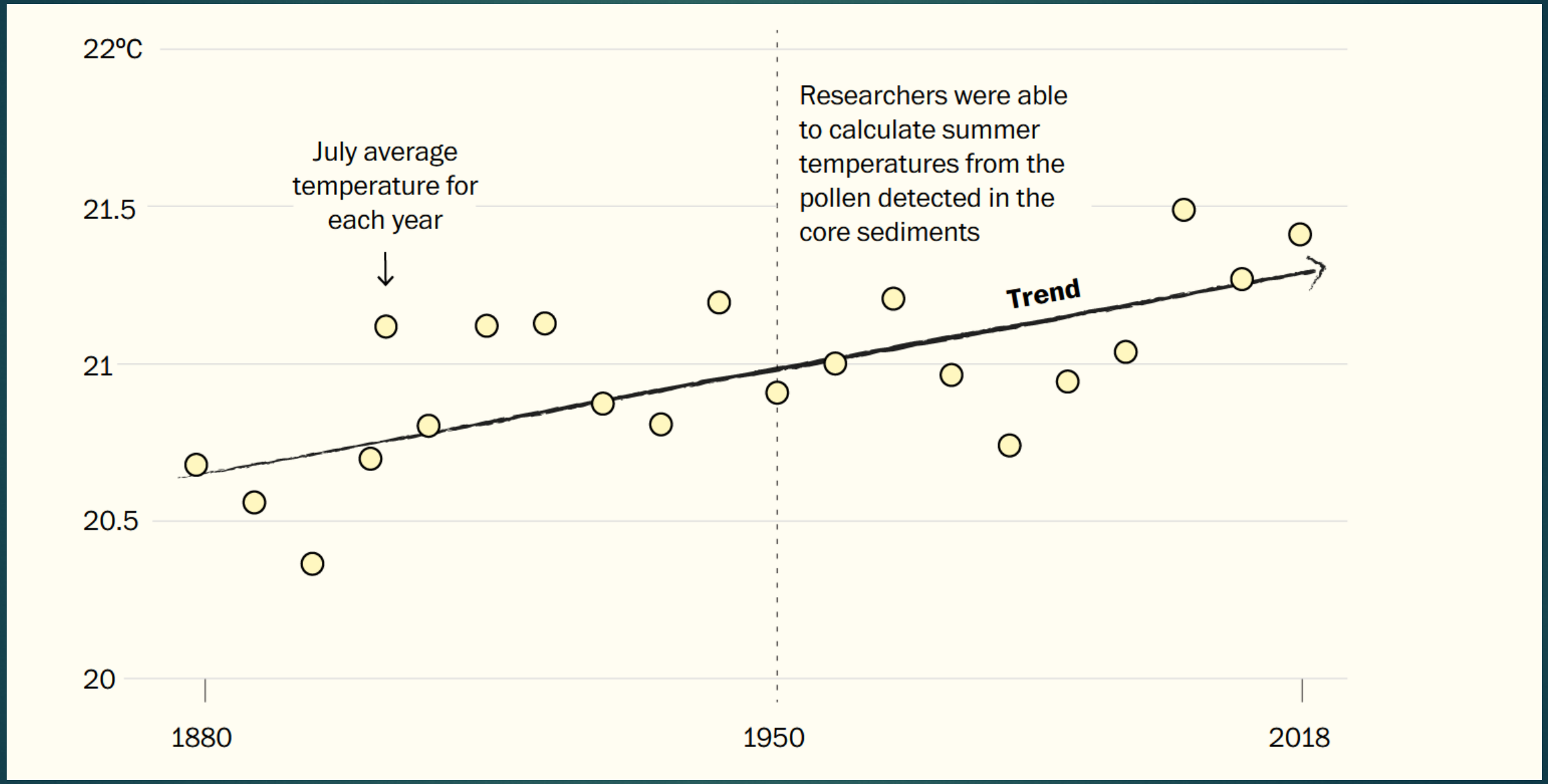
5 / 5

Golden Spike candidate

- The impacts piled up throughout the 19th and 20th centuries. Tiny black bits of fly ash — a byproduct of burning coal and oil — drifted into the lake from rapidly industrializing cities. Heavy metals like copper and lead increased in the mud.
- And then, around 1950, the world reached a tipping point.
- "This is when humans essentially overwhelmed the Earth as a functioning system". Crawford Lake — and the rest of the planet — were fundamentally, irrevocably transformed.
- The sharpest sign of change was a surge in radioactive plutonium that started in Crawford Lake's mud around 1950. The element rarely occurs naturally on this planet; it could only have come from nuclear weapon tests happening thousands of miles away.

Climate Change

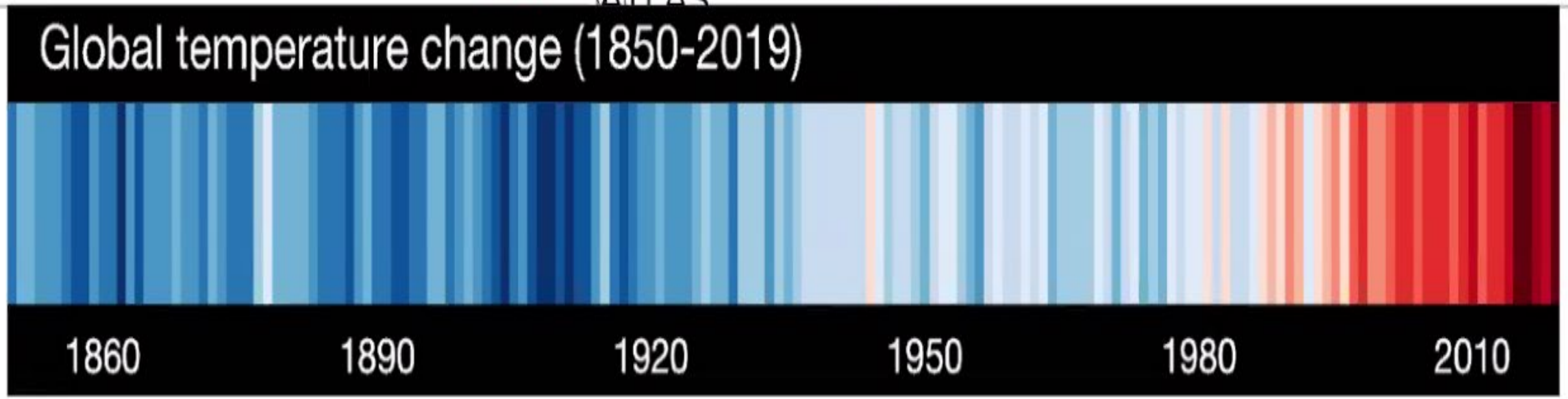
- Still more sediments recorded irreversible losses. Certain microbe species were eliminated locally. The amount of elm pollen plummeted — a consequence of the invasive fungus that was decimating North America's tree populations at the time.
- All the while, greenhouse gas pollution made the planet inexorably hotter. The lake's calcite layers became thicker during warm years; pollen grains show how the forest composition shifted to include more heat-loving tree species.
- Average temperatures in southern Canada have increased about 1.5 degrees Celsius (2.7 degrees Fahrenheit) in this time. The globe as a whole is now warmer than it's been at almost any point since the end of the last ice age.

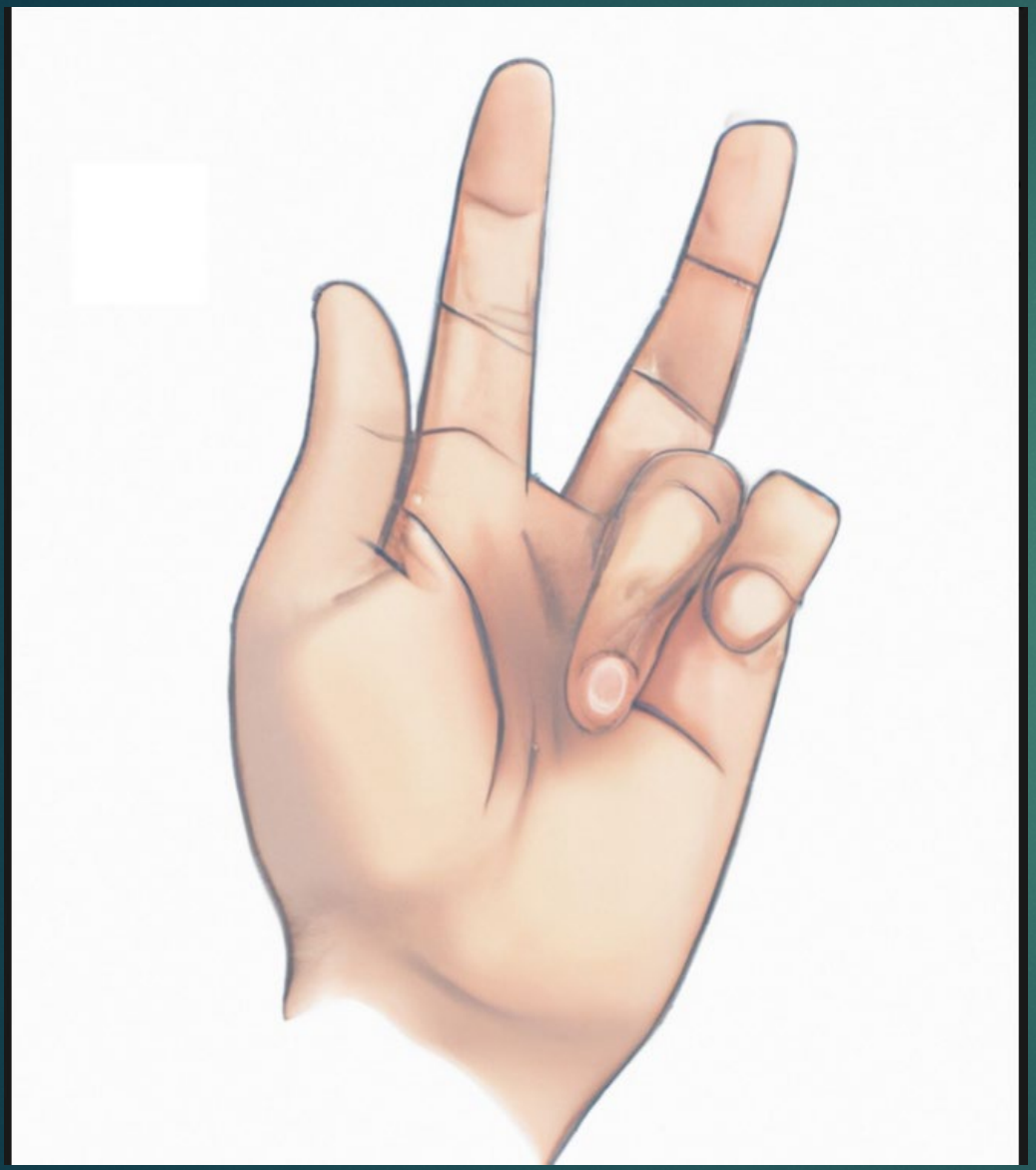

22°C
21.5
21
20.5
20
July average temperature for each year
Researchers were able to calculate summer temperatures from the pollen detected in the core sediments
Trend
1880
1950
2018

Great Acceleration

- These changes all are the result of what scientists call “the Great Acceleration” — the dramatic, simultaneous surge in almost every measure of human activity that started in the mid-20th century and continues through today. “The Earth is, in fact, fundamentally different.”
- Scientists warn that the planet is getting dangerously close to climate “tipping points,” where ice melt will accelerate and major weather systems could collapse.
- Change is possible. Reduction of plutonium and the revitalization of the lake’s distinctive calcite bands during the 1980s is a sign of successful efforts to combat acid rain.
- Atmospheric carbon dioxide concentrations will remain elevated for tens of thousands of years. It will take at least as long, and a dramatic drop in temperature, for the polar ice sheets to return to their preindustrial majesty.

Global climate change: temperatures 1860-2010





- “Viking disease” hand disorder may come from Neandertal genes
- A condition known as Dupuytren’s disease is partly of Neandertal origin.
- Researchers have long known that the disease was much more common in Northern Europeans than in those of African ancestry.

Viking disease genetic risks = Neandertal

- Dupuytren's disease is a disorder affecting the hand. Those who suffer from the condition eventually see their hands become bent permanently in a flexed position. Although the condition can affect any finger, the ring and middle fingers are most often afflicted.

- A 1999 Danish study reported 80% heritability for the condition, indicating a strong genetic influence. The condition is much more common in people of Northern European ancestry. One study estimated the prevalence of Dupuytren's disease among Norwegians over 60 years to be as much as 30%. This apparent geographic distribution has given Dupuytren's disease the nickname "Viking disease."

Viking disease

- UK Biobank + n = 651 K: They found 61 genome-wide significant variants associated with Dupuytren's disease.

- Further analysis showed that three of these variants are of Neandertal origin, including the second and third most strongly associated ones.

- The finding that two of the most important genetic risk factors for Dupuytren's disease are of Neandertal origin leads the scientists to conclude that Neandertal ancestry is a significant factor in explaining the prevalence of the disease in Europe today.

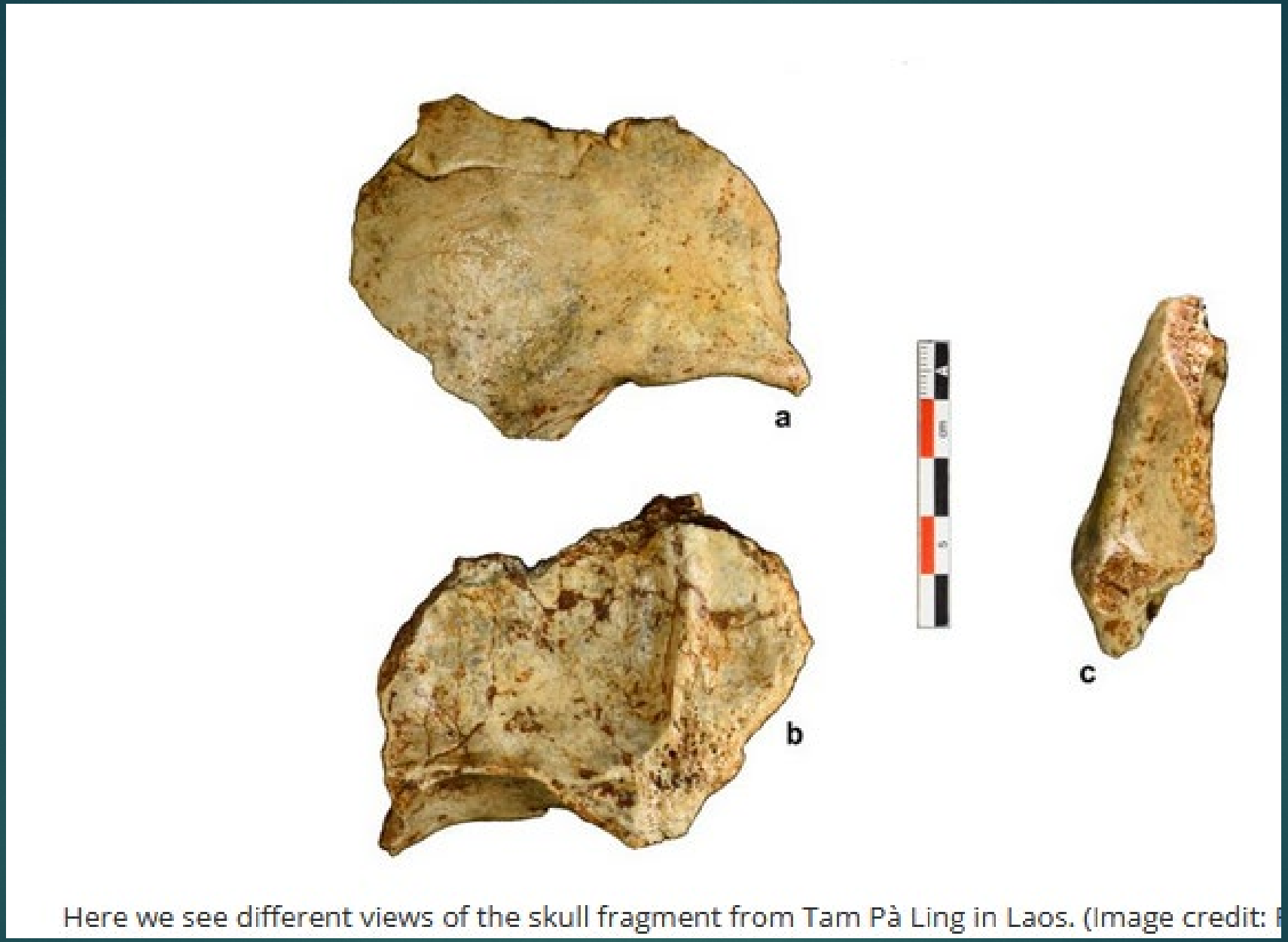
Earlier, disputed, dates of several OoA migrations

- Earlier hints of very ancient human presence in Southeast Asia and Australia:
- Stone tools and charcoal from a shallow cave in northern Australia called Madjedbebe, dated to 65,000 years ago by optically stimulated luminescence (OSL= how long it's been since bits of sediment were last exposed to light, if artifact is undisturbed.) Some scientists argue that burrowing termites may have shuffled Madjedbebe's ground, and question its date.
- In 2017, Sumatra's Lida Ajer Cave yielded teeth identified as *Homo sapiens* and dated to between 70,000 and 46,000 years ago.
- Scientists have also identified stone tools in central India as humanmade and dated them to about 74,000 years ago. But in each of these cases, other researchers have questioned the evidence.

Tam Pà Ling cave in Laos

86,000-year-old human bone found in Laos cave hints at 'failed population' from prehistory

- The discovery of a skull and shin bone fragment in a cave in Laos pushes back the earliest known date of Homo sapiens in Southeast Asia.
- *Homo sapiens* arrived in Southeast Asia as early as 86,000 years ago, a human shin bone fragment found deep within a cave in Laos reveals. An earlier, unsuccessful migration of modern humans into Asia that left no descendants,
- The finding comes from the cave of Tam Pà Ling, or Cave of the Monkeys, which sits at around 3,840 feet above sea level on a mountain in northern Laos.
- Researchers in 2010 found most of a *H. sapiens* skull and jawbone, which they dated by OSL to about 46,000 years old. Human bone fragments previously found in the cave were 70,000 years old, making them some of the earliest evidence of humans in this area of the world.
- Found two new bones — fragments of the front of a skull and a shin bone from H. sapiens — were likely washed into the Tam Pà Ling cave during a monsoon. No stone tools or other clues about these humans' lifestyles have been found in Tam Pà Ling.



Here we see different views of the skull fragment from Tam Pà Ling in Laos. (Image credit:

The skull, they estimated, was up to 73,000 years old, and the shin bone dates back as far as 86,000 years ago.

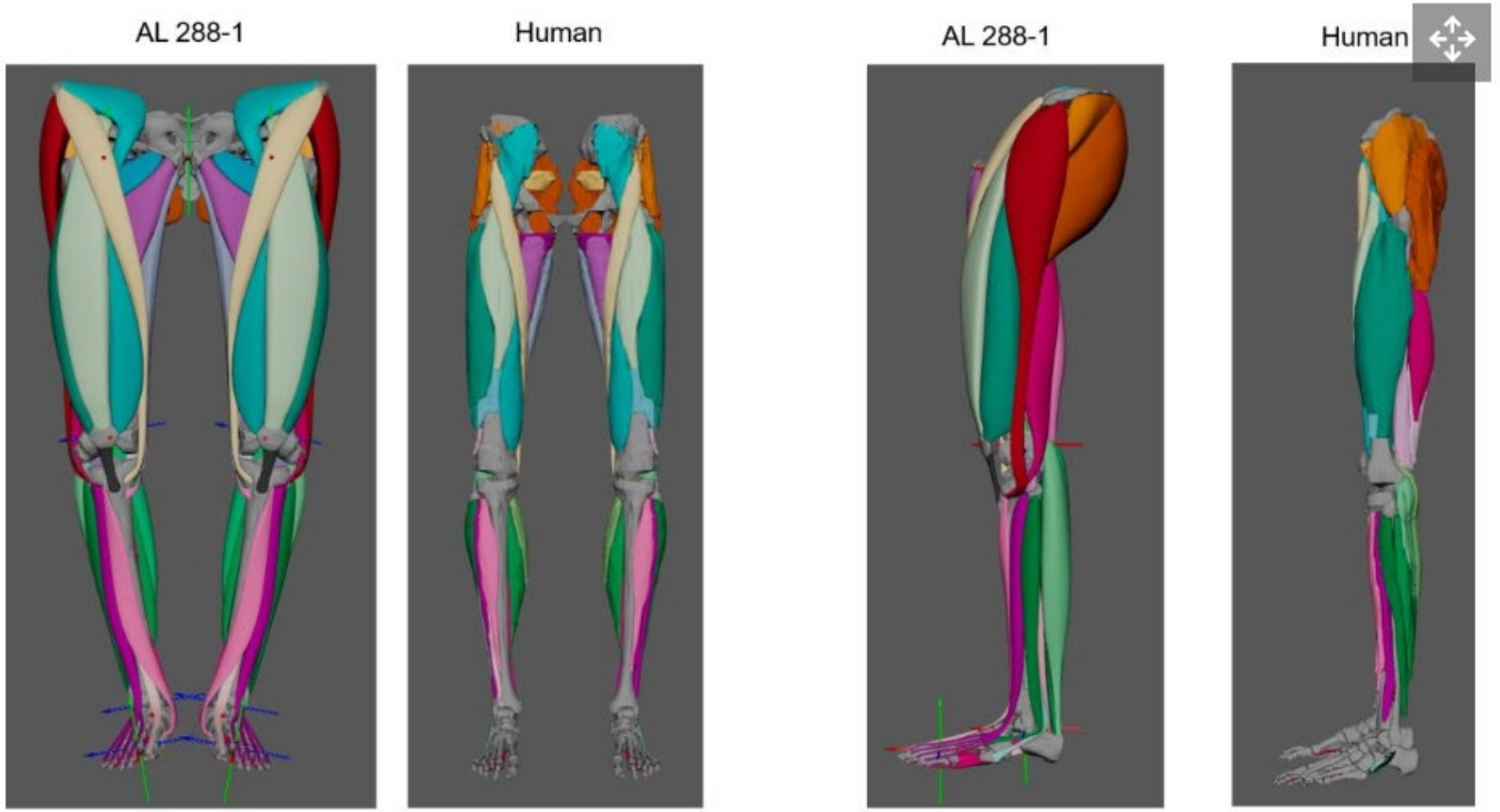
3.2 Ma *A. afarensis* 'Lucy' had massive leg muscles to stand up straight and climb trees

- *Australopithecus afarensis*, the extinct species to which Lucy belongs, could probably straighten its knee joints, extend its hips and stand up straight like modern humans. She walked erect.

- "Lucy" could stand and walk upright just like modern humans do, new 3D muscle modeling reveals. Used a digital modeling approach to recreate 36 muscles in each of Lucy's legs

- The hominin's reconstructed pelvis and leg muscles also suggest that she could climb trees, meaning the species likely thrived in both forest and grassland habitats in East Africa 3 million to 4 million years ago.

Virtual model of Lucy’s muscles



The model revealed that Lucy's legs were far more muscular than a modern human's and more similar in composition to a bonobo's. (Image credit: Dr Ashleigh Wiseman)

Lucy’s muscles

- The model also reveals the proportions of fat and muscle in Lucy's legs, showing they were far more muscular than a modern human's and similar in composition to a bonobo's (*Pan paniscus*).

- While a human thigh is about 50% muscle, Lucy's were likely 74% and less fatty. Some of her calf and thigh muscles occupied twice as much space in her legs as they do in human legs today.

- Lucy's knees demonstrated a wider range of motion in the extension-flexion axis than a human's. This, combined with her muscle mass, suggests that *A. afarensis* could utilize a wide range of habitats, from dense forests to grassy savannas.

Stone tool discovery pushes back paleo history of Greece

- ATHENS — Deep in an open coal mine in southern Greece, discovery of the oldest archaeological site, dated to 700 Ka
  - Stone tools from the Lower Palaeolithic period — about 3.3 million to 300,000 years ago — and
  - remains of an extinct species of giant deer, elephants, hippopotamus, rhinoceros and a macaque monkey.
- The artifacts are simple tools, like sharp stone flakes, belonging to the Lower Paleolithic stone tool industry
- Speculate that the lithics were produced by *Homo antecessor*

Nicholas Paphitis, 2023

The lingering effects of Neanderthal introgression on human complex traits

- Some Neanderthal genes are responsible for certain traits in modern humans, including several with a significant influence on the immune system. However, modern human genes are winning out over successive generations.

- Using a vast dataset from the UK Biobank consisting of genetic and trait information of nearly 300,000 white Brits, the researchers analyzed more than 235,000 N genetic variants. They found that 4,303 of those differences in DNA are playing a substantial role in modern humans and influencing 47 distinct genetic traits.

Xinzhu Wei, et al., 2023

348 important N variants have phenotypic effect

- Introgressed Neanderthal variants make a significant contribution to trait variation (explaining 0.12% of trait variation on average).

- However, the contribution of introgressed variants tends to be significantly depleted relative to modern human variants matched for allele frequency and linkage disequilibrium (about 59% depletion on average), consistent with purifying selection on introgressed variants. Different from previous studies, we find no evidence for elevated heritability across the phenotypes examined.

- Identified 348 independent significant associations of introgressed Neanderthal variants with 64 phenotypes.

Genes that impact immunity, development & metabolism

- Examination of these variants reveals their substantial impact on genes that are important for the immune system, development, and metabolism.

- Skov et al., 2020 has suggested that a majority of such associations are likely driven by statistical association with nearby modern human variants that are the true causal variants. They suggested that these associations at Neanderthal introgressed SNPs were driven by the associations at linked non-archaic variants, indicating a limited contribution to modern human phenotypes from Neanderthal introgression.

Better methodology to id effective N variants

- Depletion in heritability likely reflects selection against Neanderthal alleles
- Our analysis demonstrates the complex influence of Neanderthal introgression on complex human phenotypes. These N alleles tend to be depleted in their impact on phenotypic variation (with about a third of the studied phenotypes showing evidence of depletion).
- This pattern is consistent with these alleles having entered the modern human population roughly 50,000 y ago and being subject to purifying selection.
- Introgressed heritability depletion = the remaining introgressed variants in present-day humans tend to have smaller phenotypic effects compared to other modern human variants

Brain circuits for maternal infanticide and infant protection

- Study pinpoints for the first time the brain mechanisms that encourage and discourage infanticide in females; found in both rodents and humans alike

- Chemically blocking the principal nucleus of the bed nucleus of stria terminalis (BNSTpr), prevented infanticide nearly 100% of the time.

- By contrast, when the study team artificially activated the brain region, both mothers and females without offspring killed pups in nearly all trials, attacking within a second of the stimulation. The mice rarely attacked other adults, suggesting that the structure specifically controls aggression toward young animals.

Dayu Lin, 2023

Maternal infanticide: opposing brain systems

- Revealed that the BNSTpr appears to work in opposition to a brain region called the medial preoptic area (MPOA), itself known to promote mothering behavior.

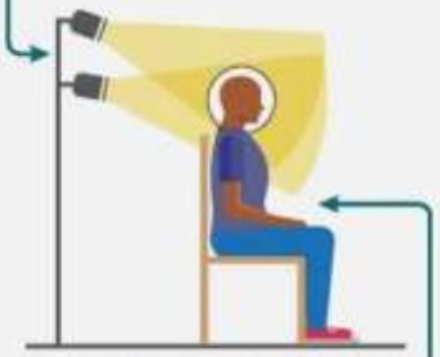
- Mice that had not yet reached motherhood showed high BNSTpr activity, which dampened activity in the MPOA. After the mice gave birth, however, MPOA activity ramped up, likely suppressing the infanticidal system in the process. The new mothers tended to avoid infanticide regardless of whether the pup was theirs or not

Curls keep you cool!

Tightly curled hair offers greater protection from solar radiation heat

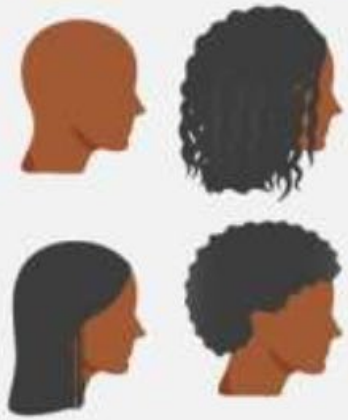
We came to this conclusion by running a series of experiments

We used lamps to **simulate solar radiation**



We used a thermal manikin to **measure heat transfer**

We put **wigs with different textures** on the manikin

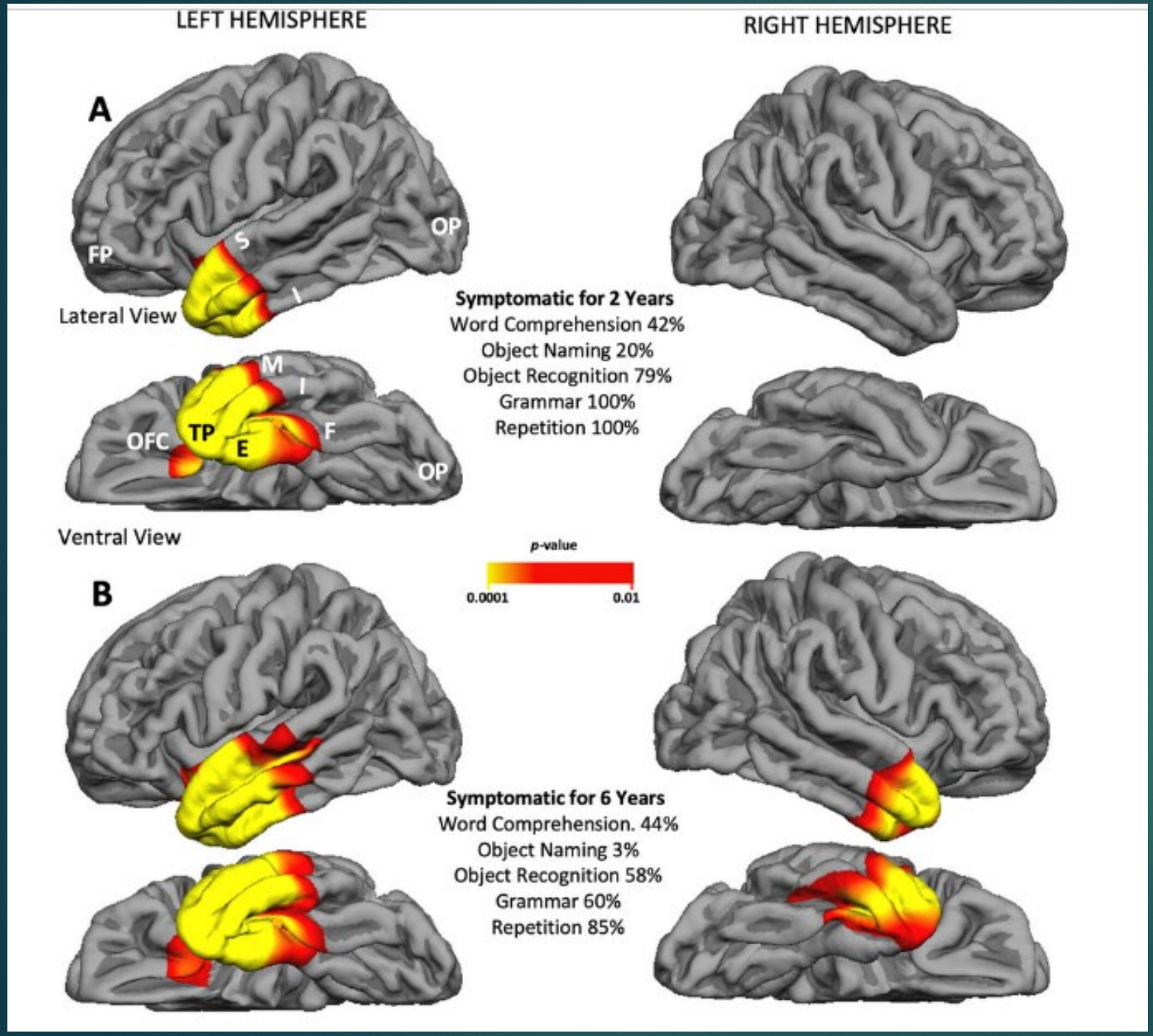


We ran the experiments with **different wind speeds and with dry and wet scalps** (to simulate sweat)

For each combination of factors **we measured heat transfer from the scalp**

Our results likely reflect the fact that tightly curled hair creates more distance between the scalp and the top of the hair.

Lasisi et al., 2023 **Human scalp hair as a thermoregulatory adaptation**. PNAS



- **Functions of Temporal Pole**
- Frontotemporal Degeneration with Transactive Response DNA-Binding Protein Type C at the Anterior Temporal Lobe:
- Semantic progressive aphasia patient (right-handed woman) with symptom onset at the age of 59
- Atrophy is initially confined to left ATL, and is sufficient to cause severe and isolated impairment of word comprehension and object naming.
- Later right ATL atrophy

Temporal Pole functions

- Semantic PPA of ATL atrophy is unique.
- It differs from Wernicke's aphasia because of intact language repetition, and from posterior transcortical aphasia because of the much greater severity of the word comprehension impairment with otherwise preserved grammar and basic neurological function
- Deficits: word comprehension, naming, object recognition, face recognition, social conduct, person identification

153,000-year-old footprints from South Africa are the oldest *Homo sapiens* tracks on record

The role of genetic selection and climatic factors in the dispersal of anatomically modern humans out of Africa

- We analyze the functional and spatiotemporal properties of 57 hard sweeps inferred in ancient human genomes to reconstruct human evolution during the poorly understood Out of Africa migration.

- Evidence for extended period of genetic adaptation lasting ~30,000 y, potentially in Arabia or surrounding regions, prior to a rapid dispersal across the rest of Eurasia as far as Australia.

R. Tobler, et al., 2023

Arabia

- Functional genetic targets include multiple interacting loci involved in fat storage, neural development, skin physiology, and cilia function, with associations with multiple modern Western diseases.

- Similar adaptive signatures are also evident in introgressed archaic hominin loci and modern Arctic human groups, indicating that cold environments were a prominent historical selection pressure that potentially facilitated the successful peopling of Eurasia.

Ancient humans may have paused in Arabia for 30,000 years on their way out of Africa

- There may have been a previously unknown phase of humanity's great migration: an "Arabian standstill" of up to 30,000 years in which humans settled in and around the Arabian Peninsula. These humans slowly adapted to life in the region's colder climate before venturing to Eurasia and beyond.

- Arabian peninsula experienced multiple wet and dry periods since 400 Ka.

- The legacy of these adaptations still lingers. Under modern conditions, many genetic changes from this period are linked to diseases including obesity, diabetes, and cardiovascular disorders.

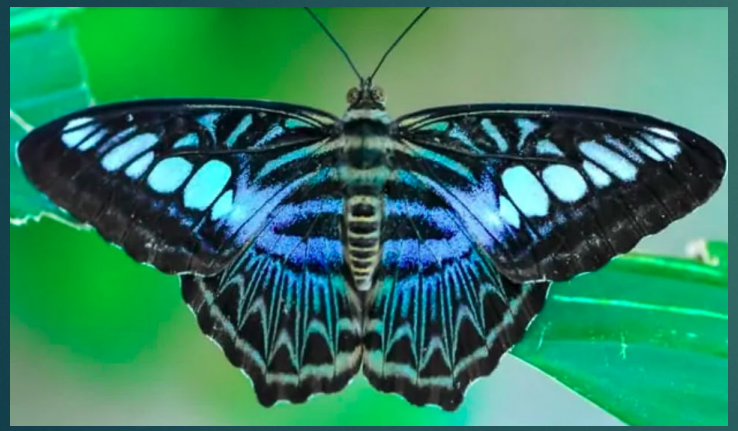
Raymond Tobler, et al., 2023

Arabian standstill

- Our findings suggest early humans went through a period of extensive adaptation, lasting up to 30,000 years, before the big diaspora between 60,000 and 50,000 years ago. This period of adaptation was followed by rapid dispersal across Eurasia and as far as Australia.
- They name this period the "Arabian standstill." Genetic, archaeological and climatic evidence all suggest these ancient humans were most likely living in and around the Arabian Peninsula.
- The genetic adaptations involved parts of the genome related to fat storage, nerve development, skin physiology, and tiny hair-like fibers in our airways called cilia. These adaptations share striking functional similarities with those found in humans and other mammals living in the Arctic today.

The role of genetic selection and Arabian climatic factors

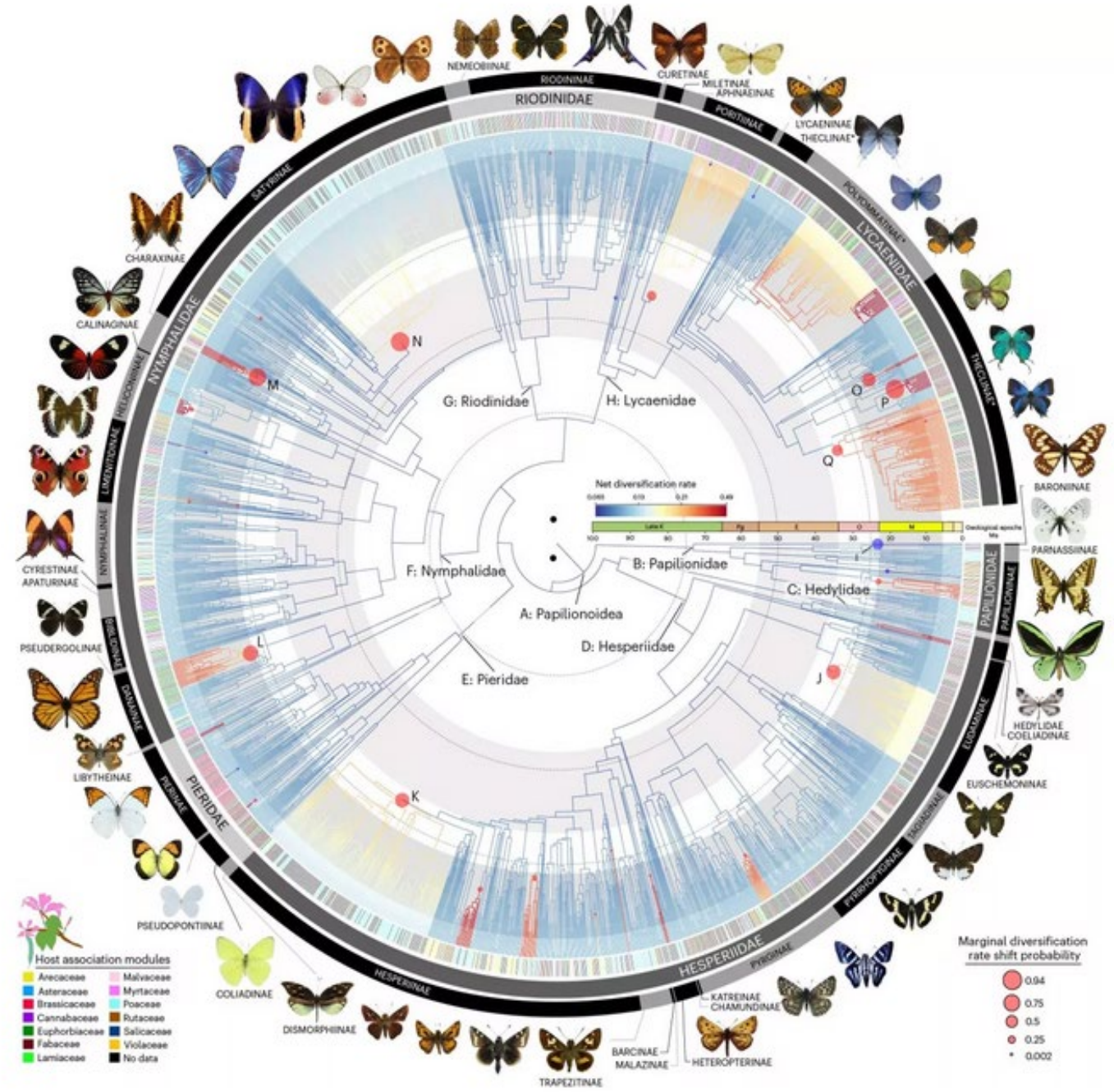
- Functional similarities with previously identified human adaptive genes derived from historical mixing events with Neanderthals and Denisovans. These distant relatives of humans are also thought to have adapted to cold Eurasian climates
- Overall, these changes seem likely to have been driven by adaptation to the cool and dry climates in and around prehistoric Arabia between 80,000 and 50,000 years ago. The changes would also have prepared the ancient humans for the cold Eurasian climates they would eventually encounter.
- Many of these adaptive genes have links to modern diseases, including obesity, diabetes, and cardiovascular disorders.



Lepidoptera: **20,000 species of butterflies** in the world, and around 750 species in the United States

All butterflies evolved from ancient moths in North America 100 million years ago in what is now Central and North America,

- There are now an estimated 20,000 species of butterflies, and they are found on every continent except Antarctica. They arose 100 M years ago before the rise of flowers.
- Constructed the new butterfly tree of life by sequencing 391 genes from nearly 2,300 butterfly species from 90 countries — representing 92% of recognized geniuses
- Originated in what is present-day western North America or Central America, butterflies spread to what is now South America. Some migrated to Antarctica, which was much warmer at the time and still connected to Australia. They had reached the northern edge of Australia when the two landmasses split — a process that began around 85 million years ago.



Butterfly tree of life traced back to North America 100 million years ago. (Image credit: Kawahara et al)

Butterfly Spread

- Next the butterflies crossed the Bering Land Bridge and reached what is now Russia 75-60 million years ago.
- They then spread out to Southeast Asia, the Middle East and the Horn of Africa. They even reached the then-isolated island of India around 60 million years ago.
- Surprisingly, due to unknown reasons, the spread of butterflies paused at the edge of the Middle East for 45 million years before finally spreading into Europe around 45-30 million years ago.

Butterfly food

- First butterflies fed on plants from the legume family. Legumes are found in almost every ecosystem and most lack potent defensive chemicals against insect feeding. Scientists believe these traits might have caused the butterflies to stick with a legume diet for millions of years.

- Today, butterflies have diversified to eating other plant families but most stick to a single plant family. Around two-thirds of the existing species feed on a single plant family, mostly wheat family and legume family. Interestingly, the most recent common ancestor of legumes is around 98 million years old —which largely coincides with the origin of butterflies.

Study identifies brain network connections associated with anosognosia

- Anosognosia is a condition in which a patient is unaware of their neurological deficit or psychiatric condition. Visual anosognosia is associated with complete cortical blindness and unawareness of vision loss
- Identified distinct network connections associated with visual anosognosia and motor anosognosia as well as a shared network for awareness of these deficits. Defined by connectivity to visual and metacognitive processing regions while the shared network for awareness converged on the hippocampus and precuneus—brain structures that are associated with memory.
- Results are the first to identify the role of the hippocampus in a systematic analysis of visual anosognosia.

Isaiah Kletenik et al., 2023

Anosognosia

- Memory-associated structures are necessary to recognize a deficit by comparing visual inputs to prior information stored in memory while updating self-knowledge about performance compared to previous abilities.

- Connectivity to visual association cortex and posterior cingulate in visual agnosia while motor anosognosia was defined by insula, supplementary motor area, and anterior cingulate connectivity.

- A cross-modal anosognosia network was defined by connectivity to the hippocampus and precuneus

Clinical study: Medicinal cannabis is a 'life-changing treatment' for people with Tourette syndrome

- First robust clinical study proving that medicinal cannabis effectively treats the debilitating effects of Tourette syndrome. The findings—which show a statistically and clinically significant reduction in motor and vocal tics in just six weeks.

- Found a significant association between levels of cannabis in the bloodstream and the response to active treatment. Careful dosing with THC/CBD in an oral formulation is very well tolerated in a relatively young patient group.
- 22 adult patients with severe Tourette symptoms. In the double-blind study, participants received both medicinal cannabis oil and a placebo over two six-week blocks.
- This is the first rigorous and methodical trial of medicinal cannabis to be undertaken in a sufficiently large group of people to make definitive conclusions about its effectiveness,

‘Behavioral modernity’ as a process, not an event, in the human niche

- Both popular books and scientific articles attempt to discern the key moments in evolutionary history that indicate the true appearance of our species.

- Summarize the available data used to indicate behavioral modernity and suggest that
  - (1) key factors traditionally seen as indicative of ‘behaviorally modern’ humans had their origin across the Middle Pleistocene and
  - (2) were not lumped into one cohesive package until more recently.

- Fossil, genetic, and archaeological datasets indicate that members of our genus (Homo) have been engaging in complex cognitive thought and semiosis since circa 400–300 ka, and perhaps earlier. These data point to a more complex, but more accurate and realistic, depiction of the braided steam of human evolution.

Marc Kissel & Agustín Fuentes, 2018

Behavioral modernity

- Behavioral modernity models revolve around the concept of a 'human revolution,' wherein a significant, adaptive, and specific cognitive expansion occurred, creating a disjuncture between Homo sapiens and our closest hominin relatives (usually classed as Neanderthals, Homo heidelbergensis, and other 'archaic' species of Homo)
- Often, this disjuncture is associated with the appearance of 'symbolic' artifacts in the archeological record or specific morphological suites (e.g. 'anatomically modern' Homo sapiens) as indicators of this adaptive cognitive shift.
- The timing of these events have been variously pegged to the appearance of cave art and carved figures (~50 ka), specific types of microlith and blade technologies (~75 ka), and, more recently, ochre engravings and use (~80–110 ka)

Human niche

- The cause of this proposed cognitive adaptive shift in behavior is not known, though it is often associated with
  - possible adaptive genetic mutations (Klein 1992),
  - brain reorganization (Bruner 2010), or
  - ecological expansion scenarios (d'Errico et al. 2017).

- There is an emerging case to be made that contemporary Homo sapiens' success relative to other members of the genus Homo was not due to a set of specific morphological and/or material adaptations but rather a suite of changes and coalescences in behavioral practices, patterns, and densities; in other words, an expansion of the human niche (structural ecologies, social partners and the larger local groups/population)

More complex causation of Behavioral Modernity

- However, over the past decade multiple investigators have demonstrated more complexity in, and a deeper time record of, the appearance of most of the material remains associated with the proposed human cognitive advance

- Collectively, these data demonstrate older, and noncontiguous, dates for the first appearances of most of the material evidence used to represent 'cognitively complex' behavior and for the appearance of 'anatomically modern' Homo sapiens fossils.

- High likelihoods of complex admixture patterns in, and a significant impact of genetic drift across, terminal Pleistocene Homo populations

Behavioral Modernity

- Most likely that contemporary human behavior evolved, probably in a nonuniform manner, across the middle and later Pleistocene, as various populations created and exchanged new technologies while modifying and co-adapting preexisting behaviors.

- For example, ochre use was evidence for modern human behavior until seen in the Middle Stone Age (MSA), after which it no longer had salience for the question because there were (at the time) no anatomically ‘modern’ humans in that time period.

- We need to assess the available data without preassigning cognitive and manufacturing capacities to specific taxa.

Complex origins

- Earliest data that may reflect meaning making in our genus,
- Multiple lines of evidence that
  - (a) contradict the 'key' moment of transition (human revolution/behavioral modernity) models and
  - (b) support a model suggesting a process of expansion on the human niche across the late Pleistocene.
- Contemporary behavior evolved over time, such that we should not expect to find earlier members of our genus, or even early H. sapiens, producing the exact types of materials that we today associate with modern behavior and symbolic thought.
- Ours is an argument for multiple, interacting factors affecting the evolution of complex behavioral capacities.

Multiple processes

- As an example of this approach, consider the following:
- Forkhead Box Protein P2 (FOXP2) changes did not produce language, but changes in this gene system in concert with changes to auditory canals, communication behavior, frontal and parietal lobe cortical expansion and enhanced neural density/connectivity, and increasing complexity of tool creation and manufacture, in the context of increasingly complex social structures/actions, all interacted to facilitate the emergence of linguistic processes/components, setting the stage for the eventual emergence of language.

- We suggest that the capacities for 'symbolic' expression arose via similar processes.

Fire

- The use, encouragement, control, domestication, and creation of fire have been the subject of intense scrutiny. It seems evident that hominins were interacting using fire by 1 Ma, and different populations used it across much of the middle Pleistocene.

- Evidence for the use of fire ranges from
  - Gesher Benot Ya'aqov in Israel, at ~790 Ka years ago, to
  - Beeches Pit in England,
  - Schoningen in Germany, and
  - Zhoukudien in China (both about sites date to 400 Ka
  - and to a much wider range of sites more recent than 300,000 years ago.
  - The evidence from Qesem Cave, Israel, at 420–200 Ka suggests that fire use was essential to hominin's survival in the region.

Social network complexity

- Such signals of cognitive complexity, rather than pointing to symbolic thought, can be used to see the evolution of new social practices and the formation of complex social networks.

- ‘One way of phrasing this perspective is that there is not an “origin” of fire but, rather, a long prehistory of fire”.

- The control and creation of fire most likely had multiple origins and various proximate causes. Ultimately, firelight allows not simply for increased digestibility but also for more time for information transfer and discussion.

Burials

- As with fire, the origins of intentional burial are contested and debated.
- One of the earliest claims is the AL 333 fossil assemblage, which dates to 3.2 Ma and may have been reburied, but there appears to be no direct evidence in support of this. Now considered due to possible big cat predation.
- The Sima de los Huesos assemblage may also represent an intentional burial, or at least the intentional movement and common deposition of bodies post-mortem.
- Recent support for the assertion of burial activity before (or in addition to) that of contemporary humans comes from the recent work on Homo naledi..

Burials

- As reported by Dirks and colleagues the 101 chamber (the location of the H. naledi find) dates to between 236–335 ka, placing the species within the timeframe of the Middle Stone Age.
- The remains found in chamber 101 are asserted to have been intentionally deposited there by living members of their species.
- While the authors of the H. naledi burial claim are clear to note that mortuary behavior does not necessarily imply symbolic thought, it does suggest it.

Nonmodern humans

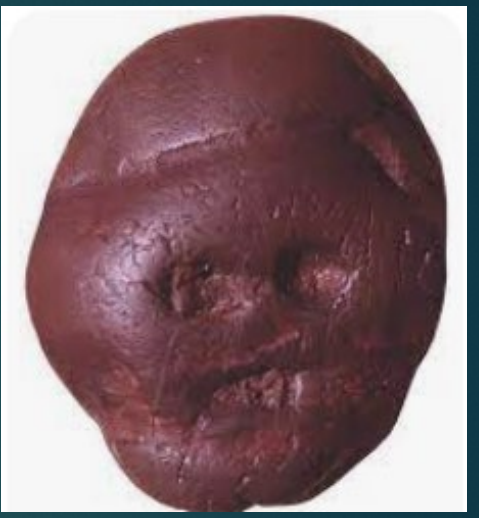
- From a behavioral standpoint, if one accepts the species designation, these dates imply that the African Middle Stone Age, and its possible examples of symbolic thought and action, may in part be the product of nonmodern humans. Such an assertion is not without support from the archaeological record, but it calls into question the notion that there was a single lineage of hominins exhibiting ‘human-like behavior in the Later Middle Pleistocene.

- As noted by Berger et al. (2017) Pleistocene Africa was home to a diverse array of hominin populations, though scholars argue about how many species exist at this time period.

‘Symbolic’ items pre-1 million years ago to 200 ka

- Claims of pre-1 Ma symbolic artifacts have been met with intense scrutiny.
- Part of this is due to the fragmentary nature of the early archaeological record, but there is also a deeply held assumption that only Homo sapiens produce such artifacts.
- If symboíc-like behavior is seen in such early populations it has been argued that that behavior must not be indicative of symbolic thought since such early populations did not have the cognitive capacities/complexity associated with such behaviors.
- We propose as a starting point that such objects that were created, modified by horn may or may not be symbols, but can be seen as glimmerings of the capacity to engage in complex semiosis (meaning-making) by the hominins that produced them (Kissel and Fuentes 2017a).

Symbolic?



- Perhaps the best known of these is the Makapansgat Pebble, which, though not modified by hominins. has been argued to have been curated and brought to the site by an australopith.
- The stone has three depressions on its flattened surface. These depressions, formed through erosion, are said to resemble two eyes and a mouth.
- The ability to link objects based on resemblance, is not solely the purview of humans. Indeed, we can almost see it as the absence of seeing more complex connections.

1 Ma to 200 Ka

- Sightly more common, and certainly more accepted, are objects that date to after 1 Ma but before 200 Ka. the often-given origin of H. sapiens.
- In this period, we see an increase in the number and type of artifacts. Interestingly, this pre-modem human sample bone and wood tools, engraved artifacts, art and the potential use of beads.
- It may not require too much of a cognitive leap to apply methods of producing chipped stone tools to the bone fragments left over from a meal.
- The presence of bone tools from Swartkrans and Drimolen at ~2 Ma have been accepted by some scholars, though their association with australopithecines have led to some skepticism as to their legitimacy. While not symbolic in the strict definition, it may indicate a more complex way of interacting with the world.

Bone and wooden tools

- Bone tools have been reported from the site of Broken Hill (also known as Kabwe), Zambia -- three bone tools at ~300 ka. The site is best known for a hominin skull, often suggested to be H. heidelbergensis.
- While the association between the tools and the skull is not definitive, it suggests that this population is the creator of these tools. While the dating and excavation of these remains are of low quality, the taphonomic study indicates they are legitimate tools. We thus suggest this as plausible data for pre-sapiens hominin creating bone tools.
- The other site with potential to inform on early bone tool use is Schöningen, Germany, which has 88 bone tools from the well-known 'spear horizon'. It is suggested to be a ~300 ka butchery site.

Bone tools

- Bone tools have been recovered from Schöningen 12 II as well, about 800 m from the ‘Spear Horizon’ locality. Thus, hominins at 300 ka were using bone for a range of activities, such as bone retouchers, precussors, and anvils. These latter categories may reflect different functions.

- Moreover, reports of elephant ivory from Schöningen may indicate use of yet another material, but it is unclear whether the ivory was used by the hominins or if the modifications on its surface were due to natural processes (Julien et al. 2015).

Wooden artifacts

- It is also in this time period that we find the first preserved wooden artifacts, including the Clacton spear, found in England; 400 Ka,
-
- Similarly, the famous wooden spears from Schöningen stand as a testament to what can be found under good contexts of preservation.
- To be clear, one could argue that the presence of bone tools in Australopithecine sites negates the importance of all of these finds as indicators of some distinctive cognitive capacities potentially associated with meaning- making.

Small brained hominins

- After all, if a small-brained hominin could do it, perhaps that means that it is not sufficient evidence of the capacity for symbolic thought.

- Scholars have also long argued that hominins in East Asia were using bamboo, rather than stone, to create tools. Perhaps the use of these kinds of materials per se does not imply that hominins were capable of meaning-making.
- However, such an approach risks privileging the identifiably 'symbolic' and missing other aspects of Homo trends that reflect a common pool of cognitive and behavioral capacities implicated (even if a later date) in the creation and use of symbolic materials.

Engravings

- The prime examples of what most consider to be indicative of the key moment when hominins displayed what are considered to be human cognitive processes can be found in engraved objects.
- Purposeful marking of one object with another, even in an abstract form, suggests a desire to recreate the same feeling in either yourself or another person in the future.
- One early example is a clam shell from Trinil, which has a minimum date of 380 Ka via 40 Ar/39 Ar and luminescence dating of sediments in the shells. A Pseudodon shell from an excavation from the 1890s has an engraved geometric pattern.
- Experimental work suggests, but does not prove, it was engraved by a hominin with a shark tooth and would have required effort to produce (e.g. that it was intentionally produced and not scratched as a by-product).

Engravings

- The whole pattern was most likely made in a single engraving session. Trinil is the type site for Homo erectus, which would suggest that this species was creating engravings well before the origin of H. sapiens.

- More controversial are the engravings from Bilzingsleben, Germany, with five bone and one stone artifact reported as being engraved. The site dates to a minimum of 230 Ka and is associated with a Homo erectus skull. Some have argued that the taphonomic details are not sufficient to indicate that these are intentionally engraved objects.

Art

- Various researchers have suggested that the art instinct is a key part of being human. While the majority of this research focuses on paintings, the recognition of other forms of art is important.
- There are two examples of artistic expression that predate the ~200 Ka rubicon: The Tan-Tan and the Berekhat Ram figurines.
- Moreover, the examples of engraved objects mentioned above may also be a form of art. Tan-Tan is a Moroccan town south of the River Draa. The figurine itself comes from a sequence of alluvial sands and gravels that has a Middle Acheulean industry. It is thus not dated directly but is suggested to be 300–500 ka.

Art

- The Tan-Tan figurine is made of quartzite and the overall form of the artifact is natural. According to Bednarik, ‘The object is entirely the result of random natural processes’. However, Bednarik notes that some of the grooves have been artificially emphasized. The details on the archaeological survey are unclear.

- The other potential *early art object is the* Berekhat Ram figurine from Israel. The status of this artifact has been debated; however, work by D’Errico and Nowell (2001) suggests that it was naturally anthropomorphic and then modified by hominins.

Art objects

- It is not clear what material the object is made from but seems to be a basaltic lapillus tuff. Others have questioned the anthropogenic nature of the grooves. It is also well-dated, found between two volcanic tuffs dated using Ar40/Ar39 to between 470–233 Ka.

- Another interesting find is a brownish rock from Krapina, Croatia, which, while not modified by humans, was transported to the site. The rock has many dark dendritic structures and, ‘of more than 1000 lithic items at Krapina, none resemble this specimen and we propose it was collected and not further processed by the Neandertals because of its aesthetic attributes’.

Brownish rock from Krapina, Croatia

Ochre

- What ochre was used for, and whether its use is indeed a shared derived trait of humanity, has been subject to much debate.
- Watts, Chazan, and Wilkins (2016) recently provided an overview of some of the early evidence of ochre use in South Africa. For these scholars, there is no compelling data to support ochre use in South Africa significantly older than ~500 ka, but they do suggest that by 300 ka it was widely used in the Fauresmith culture.
- The c. 200 Ka ochres from a Neandertal site called Maastricht- Belvédère C, Netherlands, are significant in that they demonstrate the use of this material by nonmodern humans. As Neandertals were at the time a distinct population from what is termed anatomically modern humans, the use of ochre at this site suggests independent invention (or some form of substantive information exchange between populations). At this site, a small concentration of red material was excavated and various methods confirm that the material is hematite and most likely nonlocal.

Ochre

- More recent finds support the use of Neandertals using pigments.
- Reports of early ochre use also come from Becov 1, Czech Republic. There has not been much study of these ochres, though the initial analyses suggest that 'tablets' were found that served as palettes for mixing of pigments, and that some of the samples were heat-treated. The minimum date of 200 Ka would suggest that Neandertals were the occupants of this site and it is well outside of the biogeographic range of early H. sapiens.

Beads

- Ornamentation is often seen as a marker of the cognitive complexity characteristic of ‘modern’ humanity, though this has been challenged.
- Most report that the earliest beads were found in South Africa, southwest Asia, or northern Africa, and are associated with modern humans around 135–100,000 years ago.
- The use of eagle claws to form a necklace or bracelet is also reported from the Neandertal site of Krapina at ~130,000 years ago.
- However, the earliest beads described in the literature come from the Acheulean site of Biddenham, in Bedfordshire, England.

Shells

- Bednarik reports on a series of shells, supposedly collected by H. erectus, that were chosen based on specific criteria to be used as beads.
- About two dozen of these beads were examined microscopically, and some show wear facets around the opening of the ‘tunnels’ that were created by parasites. The beads are not well-dated, and they were collected in 1910 along with lithics from a quarry, making the age of these finds suspect.
- Other scholars have suggested that the ‘beads’ are natural and do not meet stringent criteria necessary to be considered artifacts. For now, we would place this in the low likelihood category, but include it as a reminder that there are many collections that remain understudied.

Data

Table 2. Overview of data used in this paper.

Type	Sites and date
Bone	Broken Hill, Zambia, 300 ka, pre-*sapiens*; Schöningen, Germany, 300 ka, *H. erectus/H. heidelbergensis*
Art	Tan Tan, Morocco, 500–200 ka, Acheulian/*H. erectus*Berekhat Ram, Israel. 470–233 ka, Krapina, Croatia, 130 ka, Neandertal
Ornamentation	Biddenham, UK, Acheulean, *H. erectus* Krapina, Germany, Neandertal
Engraved	Kozarnika, Bulgaria, ~1.4 ma, *H. erectus*; Trinil, Java, 380 ka, *H. erectus*; Bilzingsleben, Germany, 230 ka, *H. erectus*
Ochre	Bizat Ruhama, Israel, 780 ka, *H. erectus*; Maastricht-Belvédère, Netherlands, 200 ka, Neandertal; Becov 1, Czech Republic, 200 ka, Neandertal
Burial	Dinaledi chamber, 250 ka, *H. naledi*

Dates of artifacts

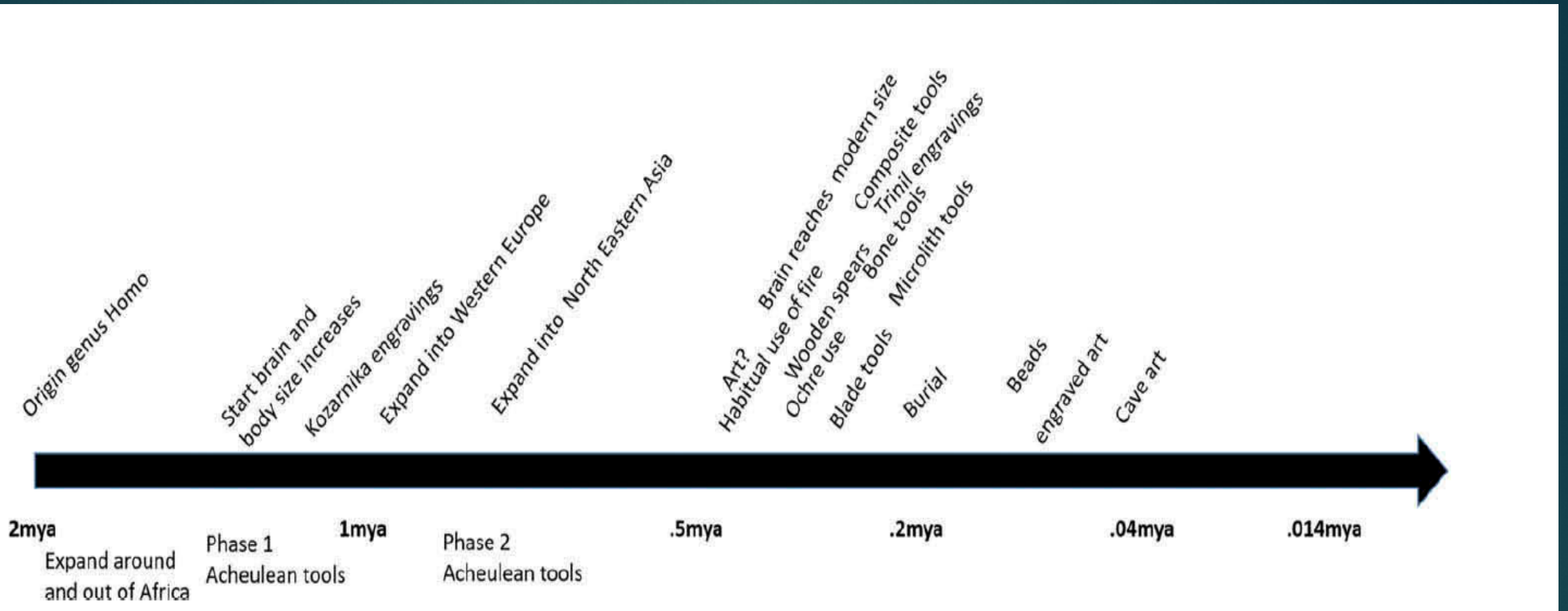


Figure 1. Timeline of first appearance dates of various artifact types. (Modified from Fuentes 2017b).

Conclusions

- Since at least Leslie White's (1940) work, paleoanthropologists have seen symbol-making as a, if not the, definitive behavior that makes us human.
- The creation of some of the artifacts discussed here might not strike readers as particularly important, especially given that there are not many instances and that some of the instances are debatable as to whether they represent complex cognitive behavior.
- Chimpanzees use a wide range of tools and even use sticks as spears to hunt bush babies, and macaques are known to use shells and stones as hammers in order to open marine bivalves and snails. One might argue that these early examples we have described are not anything more than is reflected in the capacities of other primates.

Conclusions

- However, we suggest that the range of items we report here represents a different type of engagement with the material world than the functional manipulation of items by other primates; that such elements might indicate the initial capacities for a particular kind of creativity, one that forms an infrastructural basis for the later development of cognition capable of symbol production and use
- Creative behaviors, once the purview of only humans, are in fact more common than once believed across not just primates, but many complex social mammals and some birds.
- We are not suggesting that the artifacts discussed in this text prove that early hominins were capable of symbolic thought as expressed today, nor that fire or intentional burial or etchings on shells made us human.

Creative behaviors

- Rather, we want to problematize the idea that searching for symbolic artifacts will allow anthropologists to discern when we became human.
- Many of the behaviors/abilities thought to have originated with, or subsequent to, H. sapiens are seen in earlier populations.
- For example, *H. erectus* populations are associated with engraved objects, bone tools, art, and ochre use; behaviors that, at one point, were the sine qua non of modernity.

Alternative terminology

- Instead of deciding that the production of these elements before 200 Ka means that they cannot represent modernity, we suggest the null hypothesis that the ability to create and modify objects of significance was a shared trait across many populations of Pleistocene Homo.

- The codification of these traits in the Middle Pleistocene was just one of many events that show increased reliance on meaning-making as a salient aspect of the human niche.

- The recent publication of dates that suggest Neandertals created some of the earliest known cave paintings (Hoffmann et al. 2018) reinforces the idea that we need to search for clues to the origins of being human in a diverse set of hominin populations.

Archeological MHs

- Whitley and Whitley (2015) argue that part of the problem with the attempt to link specific traits to modernity is that all those that have been proposed from an archaeological standpoint are necessary, but not sufficient, to identify this behavior.
- What makes us human, they argue, is something that ‘cannot be assayed by a mean, or even a mean and a standard deviation’ (Whitley and Whitley 2015: 232).
- They further suggest replacing the term ‘behavioral’ or ‘cognitive’ modernity with the phrase ‘archaeological modernity’, as this makes it clear that the first archaeologically modern humans differ from contemporary humans. Furthermore, we note that tracing the appearance of various indicators of modernity is a separate inquiry from when we, as human beings, first appeared.

Becoming human is a process

- It would be difficult to prove that any object was symbolic without detailed knowledge of the cultural system that crafted it..

- The processes of developing contemporary capacities for symbolic expression had to have developed over time and there is no reason to think that the development proceeded at particularly even or nonsaltatory modes without multiple instances of dead-ends/extinctions.

- The archaeological, genetic, and fossil record may be too equivocal, sparse, or equifinal to allow us to pinpoint behavioral modernity, nor should we expect there to be a moment in time when Homo became sapiens, but we rather expect to see a long-term process by which this occurs.

Becoming human

- We suggest that it is not that the creation of ornamentation or the engraving of signs on rocks that is the pivotal step that made us human. These are part of the complex process of becoming human across the Pleistocene.

- Becoming human, and being human, is not demarcated by a single episode.

- By 200 to 400 Ka, Homo brain size was the same as in modern humans, and its functional capacity close to ours if not nearly identical. At this same time, the inner ear and vocal apparatus for language had developed, and the neurobiology for speech was likely in place

Human niche

- In this time period we see evidence for a substantial uptick in the complexity of tools and lifeways in Homo populations across Africa and Eurasia.
- Fire use become ubiquitous, and there is evidence for at least a few ‘symbolic’ materials being produced/used, the manufacture and use of more and more complex tools, and even the first possible burials of the dead.
- The human niche was changing. More complex information was being exchanged, more types of tools and uses for them were being created, more learning and teaching were needed to successfully be a member of the genus Homo.

Creating meaning – first glimmerings

- The possible examples of meaning making in Homo groups prior to ~200 Ka are few and far apart.

- However, we proposed that these are glimmerings – rare and potentially isolated occurrences in early human groups that demonstrate that those early humans had the capacity to create meaning; though the context, the right set of circumstances and abilities, for shared and sustained meaning making was not yet present, they were just around the corner.

J. Shea: Human evolution follows progressive trajectory = Wrong

- The idea that the earliest humans were significantly different from us is a myth.
- The idea that human evolution follows a progressive trajectory is one of the most deeply entrenched assumptions about *Homo sapiens* evolution.
- In fact, archaeologists have long believed that modern human behaviors emerged tens of thousands of years after our species first evolved. The underlying theoretical framework remains teleological.
- Is it because we are thinking of human evolution teleologically, as a process by which these "something other than modern" humans become "fully" modern humans? This idea of a significant evolutionary division between earlier H. sapiens and later "modern" ones, between us and an ancestral "them," has now spread well beyond Paleolithic archaeology into mainstream anthropology.

J. Shea, 2011

Behavior modernity

- Behavior modernity = The European Upper Paleolithic archaeological record has long been the standard against which the behavior of earlier and non-European humans is compared.

- During the Upper Paleolithic (45,000 to 12,000 years ago), *Homo sapiens* fossils first appeared, together with complex tool technology, carved bone tools, complex projectile weapons, advanced techniques for using fire, cave art, beads, and other personal adornments.

- As an analytical construct, behavioral modernity is deeply flawed at all epistemological levels.

Homo sapiens Is as *Homo sapiens* Was: Behavioral Variability vs. 'Behavioral Modernity' in Paleolithic Archaeology – J. Shea, 2011

- Shea tested the hypothesis that there were differences in behavioral variability between earlier and later *Homo sapiens* using stone tool evidence dating to between 250,000 to 6,000 years ago in eastern Africa

- A systematic comparison of variability in stone tool making strategies over the last quarter-million years shows no single behavioral revolution in our species' evolutionary history. Instead, the evidence shows wide variability in stone tool making strategies over the last quarter-million years and no single behavioral revolution. Particular changes in stone tool technology are explicable in terms of principles of behavioral ecology and the costs and benefits of different tool making strategies.

Behavioral variability

- There are no such things as modern humans, just *Homo sapiens* populations with the capacity for a wide range of behavioral variability.

- Shea: Using data from later Middle Pleistocene archaeological sites in East Africa, this paper tests and falsifies the core assumption of the behavioral-modernity concept—the belief that there were significant differences in behavioral variability between the oldest H. sapiens and populations younger than 50 kya.

- It concludes that behavioral modernity and allied concepts have no further value to human origins research. Research focused on the strategic underpinnings of human behavioral variability will move Paleolithic archaeology closer to a more productive integration with other behavioral sciences.

“Behavioral modernity”

- Though some researchers see the achievement of human “behavioral modernity” as an abrupt evolutionary change event, a prehistoric “revolution” (Klein 2008), others envision it as a more gradual, sometimes even recursive process of cumulative behavior change (McBrearty and Brooks 2000).

- All living humans, extinct humans, and extinct hominins are assumed to have possessed a capacity for behavioral variability at least comparable in scale to living African apes.

- We do not know the antiquity of our species’ current degree of behavioral variability, but there are only three possibilities:
  - (1) it evolved after our species’ origin and is a characteristic of only some H. sapiens,
  - (2) it evolved at the same time our species split from ancestral hominins and is a species-specific characteristic, and
  - (3) it evolved before H. sapiens’ origin and is a characteristic shared by more than one hominin species.

No significant differences

- Shea argues that the hypothetical evolutionary trend (we become MHs) that is the core assumption of the behavioral modernity model in Paleolithic archaeology is wrong.
- All living humans are capable of wide behavioral variability. There is no evidence that such skeletal contrasts as exist between the earliest H. sapiens and those living today indicate significant differences in the capacity for behavioral variability.
- Yet current models for the evolution of modern human behavior assume that the earliest H. sapiens were less capable of behavioral variability than we are today.
- Archaeological evidence associated with later Middle Pleistocene H. sapiens in East Africa indicates a capacity for behavioral variability equivalent to that associated with Late Pleistocene and Early Holocene humans.

Klein's neural mutation theory

- R. Klein (1992, 2008) argues that differences between the behavior of African Middle Stone Age humans on the one hand and both African Later Stone Age and Eurasian Upper Paleolithic humans on the other resulted from the spread of a neural mutation linked to fully facultative language and cultural behavior around 50 kya.

- The main evidence for this change is improvements in foraging efficiency and technological complexity inferred from the zooarchaeological and lithic records. The main weakness of the "neural mutation" hypothesis is that the hypothetical neural mutation does not leave a clearly detectable signal in the fossil record.

Human revolution that wasn't – McBrearty & Brooks

- The fate of Klein's neural mutation hypothesis:
  - Is untestable
  - FOXP2 gene in Ns,
  - McBrearty data,
  - new genetic data about MRCA

- McBrearty and Brooks (2000; McBrearty 2007) have proposed a model in which modern behaviors developed cumulatively in Africa over the course of the last 280 kya.

Human revolution that wasn't – McBrearty & Brooks

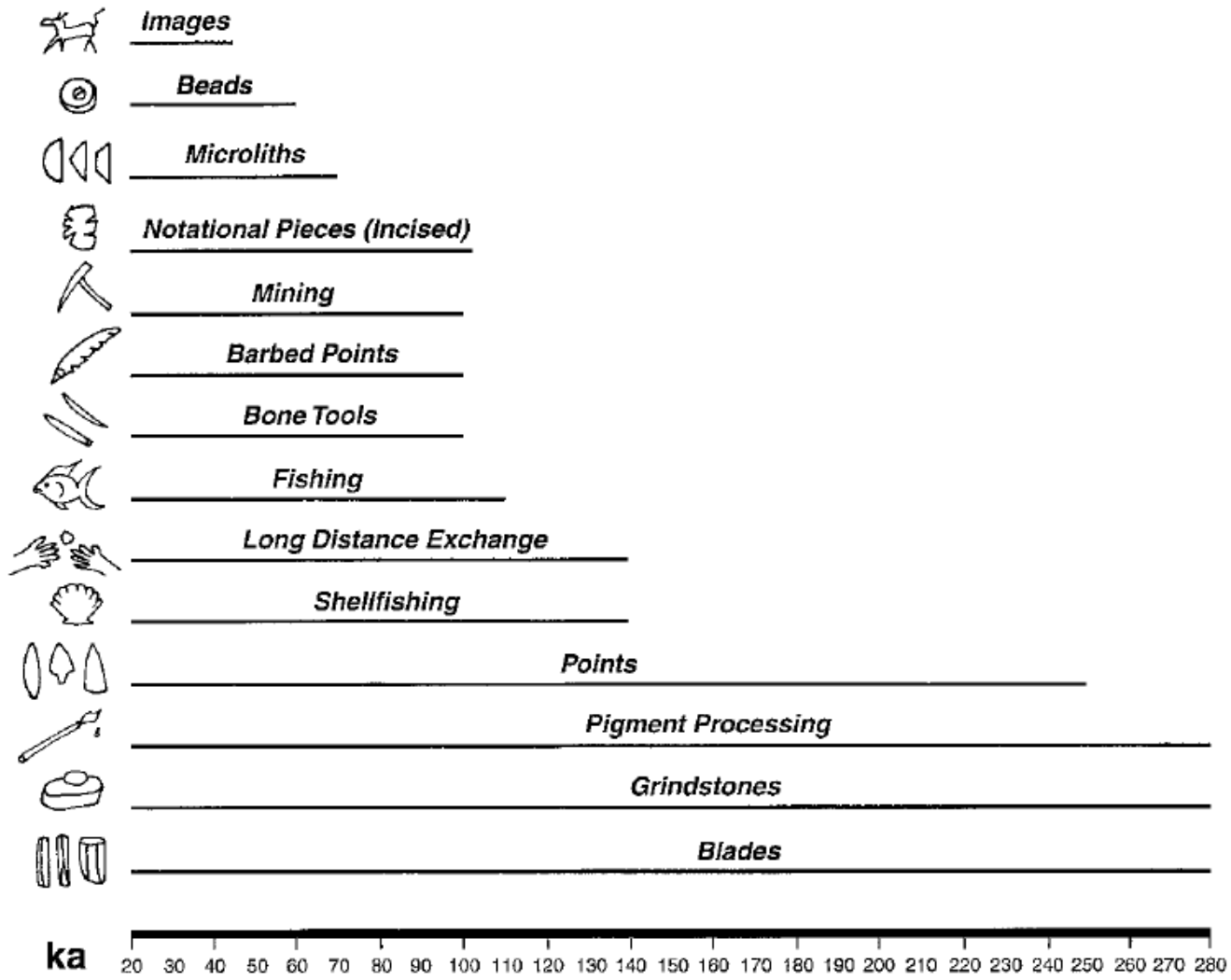
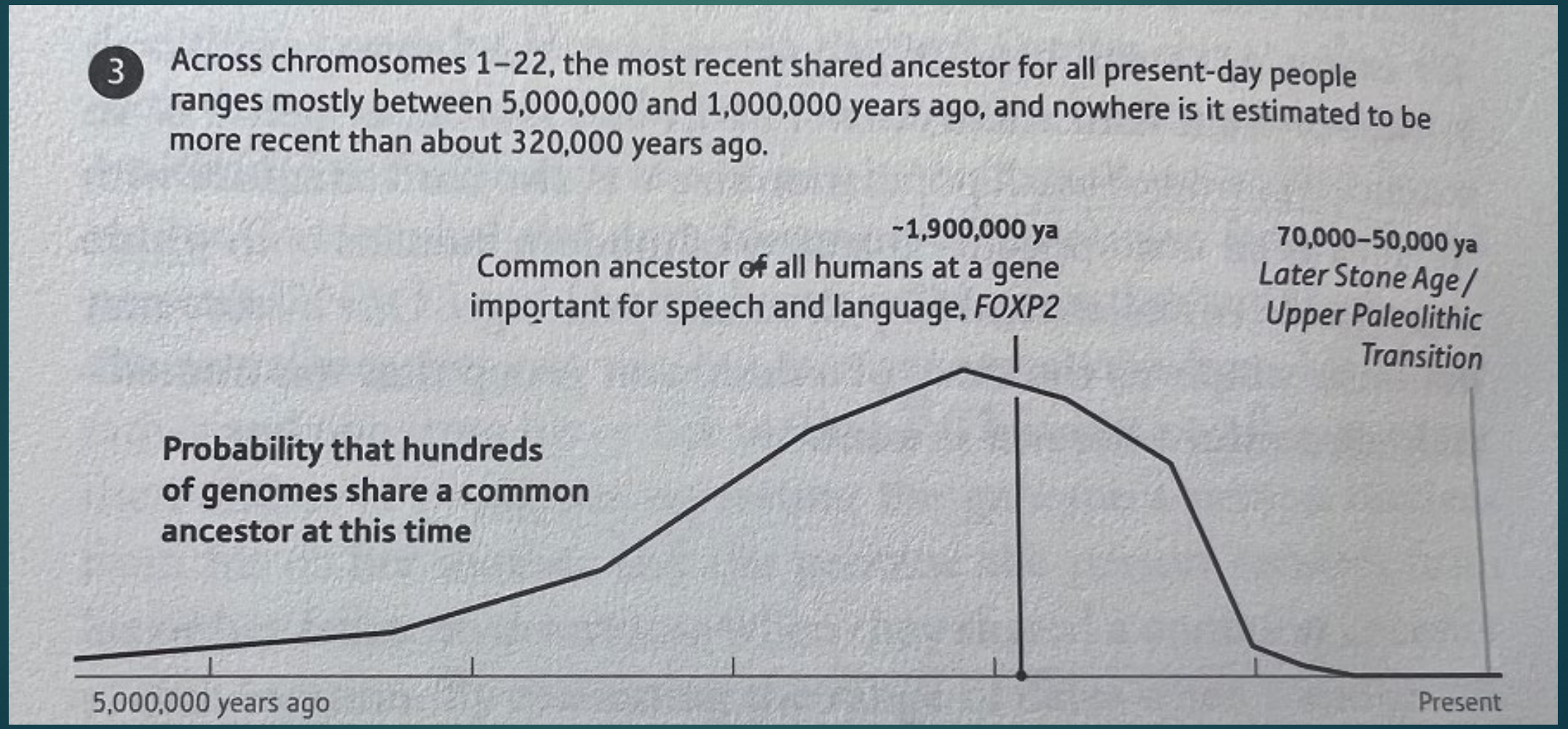


Figure 13. Modern behaviors and their time depths in Africa. © Sally McBrearty & Alison S. Brooks.

This view of events stems from a profound Eurocentric bias and a failure to appreciate the depth and breadth of the African archaeological record.

In fact, many of the components of the "human revolution" claimed to appear at 40–50 ka are found in the African Middle Stone Age tens of thousands of years earlier

How We Can Tell How Long It Has Been Since Our Genes Shared Common Ancestor: Most recent shared ancestor is ~320 ya -- MRCA for all present-day people: between 1-5 Ma to 320 Ka; for FOXP2, 1.9 MA



Most recent shared ancestor of MHs is ~320 ya

- MH genome: there is no gene location where all people living today share a common ancestor earlier than ~320 K ya; in effect, the approximate origin date of MHs

- This is far older time than required by Richard Klein's theory of genetic switch that made us MH ~50 Ka; disproves his theory; if he was right, would find genetic variants that were shared within last 100 Ka; but there are none

Table 2. Presence/absence contrasts for behaviors indicated for Middle Paleolithic (MP) and Upper Paleolithic (UP) periods in Europe and Southwest Asia and the African Middle and Later Stone Ages (MSA, LSA)

Behavior	Europe MP	Europe UP	SW Asia MP	SW Asia UP	Africa MSA	Africa LSA
Persistent occupation of harsh environments	. . .	+	+?	+	+	+
Seasonal mobility strategies	+?	+	+	+	+	+
Effective hunting of large mammals	+	+	+	+	+	+
Systematic fishing and exploitation of shellfish and aquatic mammals and birds	+?	+	. . .	+?	+	+
Organized use of domestic space	. . .	+	+	+	?	+
Patterned artifact diversity/standardization of artifact types	. . .	+	. . .	+	+	+
Systematic prismatic blade production	. . .	+	+	+	+	+
Carved bone, antler, ivory, and stone artifacts	. . .	+	. . .	+	+	+
Symbolic use of mineral pigments	+?	+	+	+	+	+
Personal adornments	. . .	+	+	+	+	+
Representative and abstract art	. . .	+	. . .	+	. . .	+
Ritualized symbolic behaviors (mortuary practices)	+?	+	+	+	+?	+
Musical instruments	. . .	+	. . .	. . .	. . .	+
Long-distance exchange networks	. . .	+	. . .	+?	+	+

FOXP2

- The presence of FOXP2 in Neanderthal DNA suggests there was strong selective pressure for speech and, by implication, for language too among the Middle Pleistocene hominin populations ancestral to both Neanderthals and H. sapiens.

- Finding ochre-stained tools, perforated shells, or rock art is clear and convincing evidence for human symbolic behavior.

- But the absence of such evidence does not necessarily mean the originating symbolic capacity was absent. Recent humans make extensive use of perishable media as well.

Eurocentric bias

- Africanist prehistorians are acutely aware of the European origins of these working definitions of behavioral modernity, and most agree that they are inappropriate, yet these definitions have neither been abandoned nor replaced by substantively different ones.

- The absence of modern behaviors unique to Pleistocene Africa is even more odd. For at least 195,000 years, H. sapiens was an African hominin, and for much of that period (>50-60 kya), it was exclusively African. There must have been behaviors derived uniquely among African H. sapiens. And yet, to read much of what has been written recently about H. sapiens evolution on that continent, the only such uniquely African pattern of human behavior appears to be the capacity to persist successfully for long periods of geological time without acting like Upper Paleolithic Europeans.

Consensus about behavioral modernity

- Nothing in recent paleoanthropological research challenges the belief that all living humans are equally divergent from hominin ancestors and therefore equally behaviorally modern. There is also a consensus that all humans (i.e., H. sapiens) who have lived since Pleistocene times have been behaviorally modern. The archaeological consensus on human behavioral modernity deteriorates as one looks farther back into the Late Pleistocene record, beyond 40-50 kya.
- Some components of modern human behavior appear before the oldest-known dates for H. sapiens fossils, but there appears to be a consensus that behavioral modernity evolved during the course of H. sapiens' evolution.
- Evidence presented in this paper will show this consensus is wrong and that the capacities for behavioral variability underwriting what we call behavioral modernity or modern human behavior are at least as old as the oldest skeletally modern-looking H. sapiens.

Bladelets = UP

- Assumption = Bladelets as only UP tool:

- Yet it has never been shown that blade production calls for any greater measure of manual skill or intelligence than any of the other flint-knapping strategies practiced by Middle Pleistocene Homo.

- Blades do not, as commonly supposed, necessarily yield more cutting edge per unit mass of stone than other core-reduction methods.

- To paraphrase Freud on cigars, sometimes a blade is iust a blade.

Hero stories

- As Landau (1991) demonstrated many modern-day explanations of human origins ("anthropogenic narratives") retain the same structural elements as hero stories, folktales, and other mythological traditions.
- In all such anthropogenic narratives, the protagonist undergoes a fundamental change or "transformation" from an inferior earlier state to a subsequent superior one. This transformation is caused by a "donor."
- In prescientific narratives this donor was often a supernatural being or an object with magical powers. Early scientific accounts of human evolution identified such behavioral qualities as sociality, encephalization, terrestriality, and bipedalism as crucial donors in the early phases of human evolution. Much recent archaeological debate about modern human origins is a debate about the nature of this donor.

Narrative explanations

- Those previously discussed—neural mutations, population pressure, socio-ecological change, and symbolic behavior)—have been joined by age/sex-based division of labor, expanded social networks, and a broadened ecological niche. None of these phenomena are necessarily mutually exclusive, and thus much of the debate surrounding them concerns their relative importance for explaining particular archaeological evidence.
- Narrative explanatory frameworks are satisfying ways of explaining complex phenomena, but their simple linear structure constrains the kinds of explanations we can propose about human origins. The most severe of these constraints is that narrative explanations require us to define "behavioral modernity" in terms of a list of discrete traits. Trait lists are a good starting point for defining anything, but there is a growing consensus that the trait lists most commonly used to define modern human behavior are critically flawed.

Lithic study results

- The archaeological assemblages found with the oldest H. sapiens in East Africa and those from roughly contemporary sites preserve evidence for mode 1-4 lithic technologies. This amounts to four-fifths (80%) of the range of lithic technological modes with which H. sapiens is associated throughout Africa and most of Eurasia after 50 kya.
- At least insofar as stone tool production is concerned, the earliest H. sapiens in East Africa were capable of as great a range of behavioral variability as humans associated with mode 4 assemblages but not mode 5 ones, that is, Upper Paleolithic Europeans. There are differences among the range of lithic technological modes represented in individual samples, but few recent archaeological sites feature evidence for the full range of modern human behavior either.

No differences found in lithic variability

- Stone tool assemblages made by Late Pleistocene and Holocene Africans who lived in the same region as the earliest H. sapiens differ from these earlier ones mainly in preserving evidence for microlithic mode 5 or microlithic technology.
- Microlithic technologies occur in African contexts sporadically between 50 and 100 kya. They become common and widespread after 20 kya, not just in Africa but also in Eurasia. However, one ought not read too much into this difference. Small retouched stone tools are known from many Eurasian Lower and Middle Paleolithic. Small geometric-backed pieces are known from Last Interglacial (presumably Neanderthal) contexts in Germany. Whatever cognitive capacities mode 5 microlithic technologies require were plainly ones that were either evolutionarily primitive or evolved convergently in the genus Homo.
- These observations challenge the assumption that there were significant differences in the capacity for behavioral variability between the oldest-known H. sapiens and recent humans. In other words, the evidence is insufficient to reject the null hypothesis of “no difference” between the earliest H. sapiens and behaviorally modern Late Pleistocene ones in term of their measurable behavioral variability.

Behaviorally modern Neanderthals

- Some of the particular lines of evidence cited as proof of African Middle Stone Age humans' and Eurasian Upper Paleolithic humans' behavioral modernity also occur in European contexts associated with Neanderthals.
- Much of this evidence is concentrated in Europe during the millennia immediately preceding Neanderthals' last appearances in the fossil record, a time when H. sapiens populations were dispersing into Europe.. Thus, there is some question of whether such modern behavior is an entirely independent development among Neanderthals. Allowing that it was would require us to reconsider much of what we think we know about Neanderthal—H. sapiens evolutionary relationships. Neanderthals are, for better or worse, the quintessential evolutionary "other."

Neandertals

- A strategic perspective parsimoniously explains similarities between Neanderthals and H. sapiens' archaeological records in terms of convergence, a well-known evolutionary phenomenon. Similar selective pressures can elicit similar strategic solutions among morphologically similar organisms. Neanderthals and H. sapiens were hominin species with a recent last common ancestor. They lived at more or less the same time in similar habitats and with similar needs for food, shelter, and tools.
- In some parts of Europe, they lived in exactly the same environments within a few thousand years of one another. It would be astonishing if there were not superficial similarities in their archaeological records arising from evolutionary convergence in some of their archaeologically visible adaptive strategies. Europe is not unique in this respect; the much longer (45-130 kya) Middle Paleolithic archaeological record of the East Mediterranean Levant preserves abundant evidence for behavioral convergence between Neanderthals and H. sapiens in settlement patterns, technology, and subsistence.

Evolution is not teleological

- The idea that behavioral modernity is a derived evolutionary state, one not shared by all morphologically modern looking H. sapiens and one that can be reliably diagnosed from behavioral characteristics, is rich with potential for abuse. It fits well with racist arguments that there are meaningful grade-level evolutionary differences among living humans.
- Creationists do not mock paleoanthropologists for using the terms “modern human behavior” or “behavioral modernity,” but they would be justified in doing so. These terms imply that our evolutionary history is teleological, that it follows a trend or predetermined trajectory. As with the evolution of all living things, human evolution was a complex and contingent process.
- Need to focus attention on behavioral variability, assessing the cost and benefits associated with specific behaviors without reference to other hominins,

Lithic evidence of behavioral variability

- Using evidence from stone tool variation, this article has shown that the earliest Homo sapiens populations who lived in East Africa around 200 kya possessed a capacity for behavioral variability identical to “behaviorally modern” Upper Paleolithic humans.
- The long-standing assumption that there are vast behavioral differences between these earliest humans and so-called modern humans like ourselves is almost certainly wrong. How much farther back in time this capacity for behavioral variability extends remains unknown.
- R. Potts: More than one reader will be surprised, then, that Shea’s principal analysis invokes Clark’s system of technological modes to show that East African lithic assemblages from roughly 300 to 100 kya possess the “type artifacts” of modes 1 through 4. Shea takes this as a measure of wide behavioral variability in H. sapiens from its onset. This is surprising, because Clark’s system typifies the linear evolutionary paradigm that Shea decries.

Lynn Wadley: Compound adhesive use requires advanced cognition

- Compound adhesives were made in southern Africa at least 70,000 years ago, where they were used to attach similarly shaped stone segments to hafts. Mental rotation, a capacity implying advanced working-memory capacity, was required to place the segments in various positions to create novel weapons and tools. The compound glues used to fix the segments to shafts are made from disparate ingredients, using an irreversible process. The steps required for compound-adhesive manufacture demonstrate multitasking and the use of abstraction and recursion. As is the case in recursive language, the artisan needed to hold in mind what was previously done in order to carry out what was still needed. Cognitive fluidity enabled people to do and think several things at the same time, for example, mix glue from disparate ingredients, mentally rotate segments, talk, and maintain fire temperature. Thus, there is a case for attributing advanced mental abilities to people who lived 70,000 years ago in Africa without necessarily invoking symbolic behavior.

L. Wadley: complex cognition

- Through replications, it is sometimes possible to trace the cognitive steps involved in the manufacture or use of items of material culture. Now and again these steps (such as those required for the manufacture and use of compound glues that combine several ingredients, procedures, and complicated pyrotechnology) cannot be executed without recourse to abilities such as abstract thought and multitasking.
- In my view, this suggests overlap between the cognitive abilities of people living today and people who made compound adhesives in the Middle Stone Age or the Middle Paleolithic. The concept of remote capture involved in the creation and use of snares and traps seems to be another indicator of enhanced working memory and complex cognition. Equipment designed to function out of sight of its maker and not immediately, but at a future time, provides evidence for an ability to integrate action across space and through time.

Wadley: enhanced working memory

- This ability engages modern executive functions of the brain that in turn characterize enhanced working memory and hence complex cognition. The central executive is the decision-making component of working memory, and its functions include paying attention to the goals of a task at hand and inhibiting extraneous thought and action. Can link technology such as snaring with modern executive functions of the brain.

- For example, traces of red ochre were found in old stone tools, where it was used in an adhesive to attach the handle.

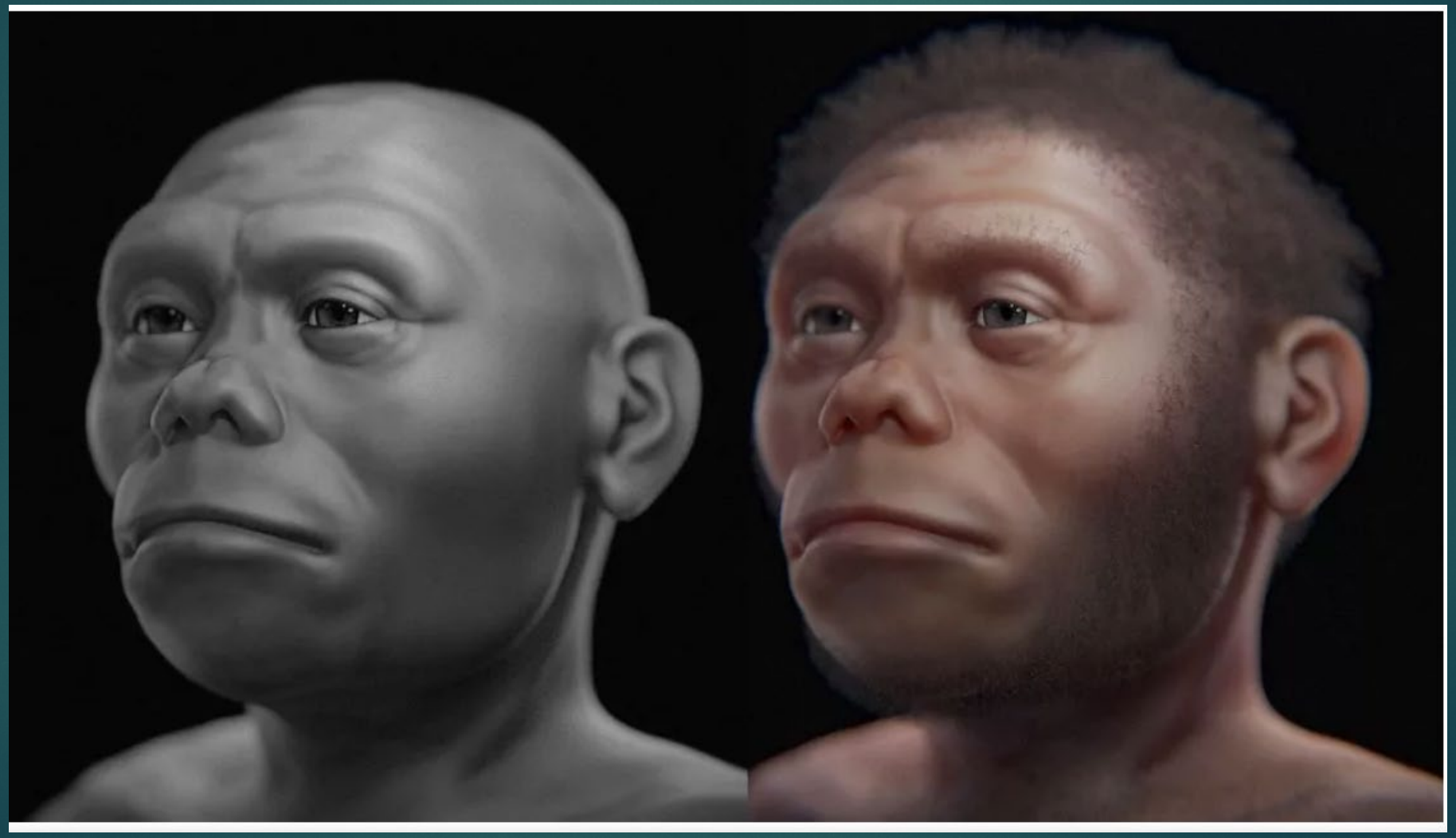
- Wadley conducted experiments and mixed Acacia tree gum, beeswax and red ochre, and the result was the identical adhesive

L. Wadley: multitasking at 77 Ka

- This experiment showed that modern humans 77,000 years ago were able to multi-task. “Looking at how red ochre was used, I initially thought this was simple technology implemented in a functional way, but when I began my test I realized it was a highly complicated process involving manipulating fire, and heating the materials that have different qualities at different temperatures.”

- For example, traces of red ochre were found in old stone tools, where it was used in an adhesive to attach the handle.

2023: Latest reimaging of H. floresiensis, the Hobbit woman



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