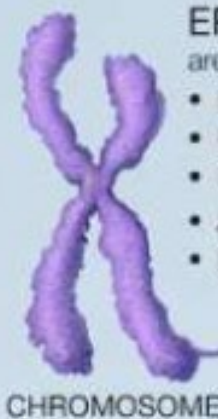


Scientific Updates February 2023

CHARLES J VELLA, PHD
FEB. 2023

Weedy Sea dragon dad glues his brood to his tail for safekeeping





CHROMOSOME

- EPIGENETIC MECHANISMS**
are affected by these factors and processes:
- **Development** (in utero, childhood)
 - **Environmental chemicals**
 - **Drugs/Pharmaceuticals**
 - **Aging**
 - **Diet**

CHROMATIN

METHYL GROUP

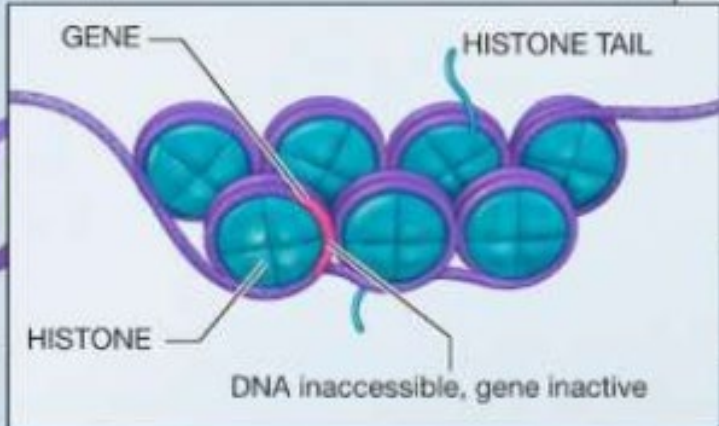
DNA

DNA methylation
Methyl group (an epigenetic factor found in some dietary sources) can tag DNA and activate or repress genes.

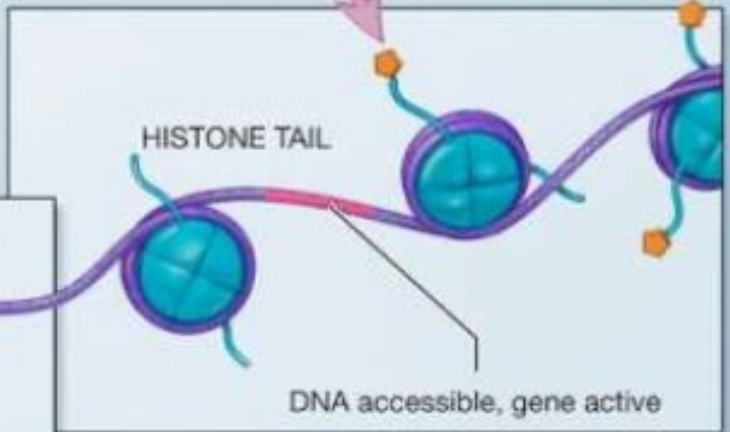
- HEALTH ENDPOINTS**
- **Cancer**
 - **Autoimmune disease**
 - **Mental disorders**
 - **Diabetes**

EPIGENETIC FACTOR

HISTONE TAIL



DNA inaccessible, gene inactive



Histone modification
The binding of epigenetic factors to histone "tails" alters the extent to which DNA is wrapped around histones and the availability of genes in the DNA to be activated.

Histones are proteins around which DNA can wind for compaction and gene regulation.

DNA Methylation: can it be transgenerationally transmitted?

- ▶ Back in the 1990s, medical scientists discovered that changes in genetic expression were not always due to changes in sequences of DNA. They found that behavioral experience and environmental factors can impact the means by which genes are turned on or off. The most common factor was found to be DNA methylation, in which a methyl group molecule attaches to a strand of DNA and from then on controls the activation of the associated gene. i.e. Dutch hunger of WWII resulted in weight characteristics of grandchildren.
- ▶ DNA methylation can be passed from parent to child despite no changes to the DNA itself—how this is possible is still a mystery.
- ▶ A team of genetic engineers at the Salk Institute for Biological Studies has demonstrated transgenerational epigenetic inheritance in a methylation-edited mammal for the first time. The group describes engineering an epigenetic mutation in test mice and tracking the change across four generations of offspring.

Answer is yes: transgenerational obesity produced via methylation change

- ▶ The work involved **adding specific methyl group molecules to two sites on the genome of test mice**. This prevented two genes associated with metabolism from activating. They then injected the engineered cells into mouse embryos that were then placed into the uterus of a surrogate mouse. The development of the mice was then followed from birth to 10 months.
- ▶ **All of those with engineered cells developed obesity**, as was expected. The research team then bred the obese mice with unmodified partners and studied their offspring. **Those offspring were then bred with other mice and so on for four generations**. All four generations had the modified allele and all developed obesity.
- ▶ The team ran the experiment several times, using engineered males in some runs with un-engineered females and sometimes with engineered females mating with un-engineered males. **It made no difference; the obesity remained**. **How such traits were passed on remains a mystery**.
- ▶ Important for understanding **non-genetically inherited human diseases**.

Gene variations for immune and metabolic conditions have persisted in humans for more than 700,000 years

- ▶ Nature can keep different genetic traits in balance as a species evolves over millions of years. These traits can be beneficial (for example, fending off disease, i.e. sickle cell) or harmful (making humans more susceptible to illness), depending on the environment.
- ▶ The theory behind these evolutionary trade-offs is called balancing selection. Sharing can be traced back to a common ancestor of Neanderthals and humans that lived about 700,000 years ago. This common ancestor bequeathed to the Neanderthals and modern humans a shared legacy in the form of genetic variation.
- ▶ Focused on deletions in DNA. Deletions are strange because they affect large segments. Some of us are missing large chunks of our genome. These deletions should have negative effects, and as a result, be eliminated from the population by natural selection. However, we observed that some deletions are older than modern humans, dating back millions of years ago.

Deletions

- ▶ Computational models to show an excess of these ancient deletions, some of which have persisted since our ancestors first learned to make tools, some 2.6 million years ago
- ▶ Deletions dating back millions of years are **more likely to play an outsized role in metabolic and autoimmune conditions**
- ▶ **Persistence of versions of genes that cause severe disease in human populations has long baffled scientists since they expect natural selection to get rid of these versions of genes.**
- ▶ **A variant may be protective against a pathogen or starvation while also underlying certain metabolic or autoimmune disorders, like Crohn's disease."**

Why genomic variation persists in a population for extended periods.

- ▶ Recent studies have identified examples of genomic deletions that have remained polymorphic in the human lineage for hundreds of millennia, ostensibly owing to balancing selection
- ▶ Demonstrate an excess of polymorphisms in present-day humans that predate the modern human-Neanderthal split (ancient polymorphisms), which cannot be explained solely by selectively neutral scenarios.
- ▶ Show that **this excess of ancient deletions is largely owing to balancing selection.**
- ▶ Ancient deletions are significantly enriched for traits related to metabolism and immunity.
- ▶ Such biological trade-offs have shaped human evolution

Monster black holes could be the source of dark energy driving the accelerating expansion of the universe



Black holes & dark energy

- ▶ The expansion of black holes alongside the cosmos could be explained if the cosmic monsters contained dark energy in their cores, the driving force behind the universe's growth.
- ▶ Supermassive black holes could be the engines driving the expansion of the universe, according to research that proposes a solution to "one of the biggest problems in cosmology."
- ▶ By comparing supermassive black holes across nine billion years of cosmic history, astronomers have discovered a clue that these black holes in most large galaxies may be the source of dark energy — the mysterious force that makes up 68% of the known universe and causes its accelerating expansion.
- ▶ The researchers published their findings Feb 2. and Feb 15. in two papers in The Astrophysical Journal and The Astrophysical Journal Letters.

Origin of dark energy

- ▶ “We thus propose that stellar remnant black holes are the astrophysical origin of dark energy, explaining the onset of accelerating expansion at $z \sim 0.7$.”
- ▶ Over the last century, astronomers discovered that the universe was expanding at an ever faster pace. This was surprising given that, acting on its own, gravity should be expected to slowly crumple the cosmos together in an event known as the Big Crunch. To explain the discrepancy, scientists proposed that something powerful enough to counteract gravity must exist, and was pushing everything in the universe further apart. They named that something **dark energy**.
- ▶ But for dark energy to reverse a cosmic collapse, it would have to be present in such enormous quantities that it makes up the vast majority of the universe. Yet, until now, it has been nowhere to be seen.

Black Holes

- ▶ The astronomers found that throughout the universe giant black holes had ballooned to be seven to 20 times larger than they once were
- ▶ The researchers **propose that black holes are growing in lockstep with the universe** — overcoming the star-crushing, light-capturing forces at their cores with a hypothetical type of dark energy called vacuum energy that makes them expand ever outwards. And, somehow, they drag the entire fabric of the cosmos out with them.
- ▶ If expansionary dark energy does lurk inside the cores of black holes, it will solve two long-standing puzzles faced by Einstein's general theory of relativity, which describes how gravity affects the universe at large scales. **Firstly**, it would explain how the universe doesn't collapse due to the large and ubiquitous force of gravitational attraction and, **secondly**, it would do away with the need for singularities (infinitesimal points where the laws of physics break down) to explain the workings of black holes' dark hearts.

Black holes

- ▶ "We're really saying two things at once: that there's evidence the typical black hole solutions don't work for you on a long, long timescale, and we have the first proposed astrophysical source for dark energy.
- ▶ Black holes in Einstein's theory of gravity are the dark energy."
- ▶ However, some leading theorists are deeply skeptical of the idea.

Cockatoos Know How to Pick the Right Tools for the Job

- ▶ Cockatoos are only the third animal, besides humans and chimpanzees, known to select varying tools based on the tasks they expect to face.
- ▶ **Chimps in northern Congo** use a short, sturdy stick to punch a hole in termite nests and then a longer, thinner stick to fish the insects out and eat them. If the chimps know that they've already left a hole-puncher near a termite mound, they won't bother bringing another one with them, showing that they think ahead of time about the tools they need for a task.



What animal kills the most humans?



11 fatalities per year world wide;
More likely to die from a falling
coconut

735,000 per year

- humans kill 475,000 other humans a year,
- Freshwater snails: 200,000 deaths per year
- Saw-scaled viper: 138,000 deaths per year
- Assassin bugs: 10,000 deaths per year
- Scorpions: 2,600 deaths per year

Your social life is as important as your medical conditions

- ▶ Eight social predictors that predicted death within four years in older individuals:
 - ▶ poor neighborhood cleanliness,
 - ▶ low perceived control over financial situation,
 - ▶ meeting with your children less than yearly,
 - ▶ not working for pay,
 - ▶ not active with children,
 - ▶ not volunteering,
 - ▶ feeling isolated,
 - ▶ being treated with less courtesy or respect.

Quality of education at age 6 of 21,000 U.S. seniors

- ▶ **Seniors who, as kids at age 6, were educated in states** that generally had shorter school years, larger classes, and lower attendance rates had a higher risk for dementia after age 65, compared with seniors raised in states offering a "high quality" education, meaning more school days, smaller classes and better attendance.
- ▶ 21% to 23% of white seniors grew up in states that offered 6-year-olds the "lowest quality" education. Among Black seniors, it was 76% to 86%
- ▶ Black seniors are much more likely to have been raised in a "low quality" educational environment than their white peers, putting them at much higher risk of dementia.

Development of Morphology of MH face

- ▶ In Africa and the Levant, morphologies and dates of several critical fossils from Herto, Omo, Jebel Irhoud, and Misliya established the emergence of early modern humans in Africa between 160 and 315 ka. Morphology expressed in the Bodo cranium suggests that speciation of *Homo heidelbergensis* or archaic *H. sapiens* may have occurred even earlier in Africa.
- ▶ Contemporaneous with the emergence of modern *H. sapiens* in Africa, hominins characterized by more archaic features still inhabited much of Eurasia, further complicating evolutionary relationships between these groups.
- ▶ It appears increasingly likely based on new fossil evidence that more hominin taxa (e.g., Denisovans and possibly additional unknown or 'ghost' hominin lineages) besides *H. heidelbergensis* and Neanderthals occupied Eurasia in the late Middle and early Late Pleistocene. Some researchers have alternatively suggested that specimens such as Dali and Jinnuishan should be classified as *H. heidelbergensis*.

Chinese hominins

- ▶ In present-day China, late Middle Pleistocene hominin craniodental fossils have been found at more than ten sites.
- ▶ Crania such as Dali, Jinniushan, and Maba. Have been regarded as archaic *H. sapiens* and positioned phylogenetically as an intermediate between *H. erectus* and anatomically modern humans.
- ▶ During the last decade, late Middle and early Late Pleistocene hominin fossils have been discovered including Huanglongdong, Zhirendong, Lunadong, Daoxian, Xuchang, and Hualongdong.
- ▶ Confirmed the notion that hominin evolution in the region was more complicated during the late Middle and early Late Pleistocene than previously hypothesized. Specifically, Zhirendong and Daoxian mandibular and dental fossils provide evidence for the emergence of modern human morphology in eastern Asia as early as 120 ka.

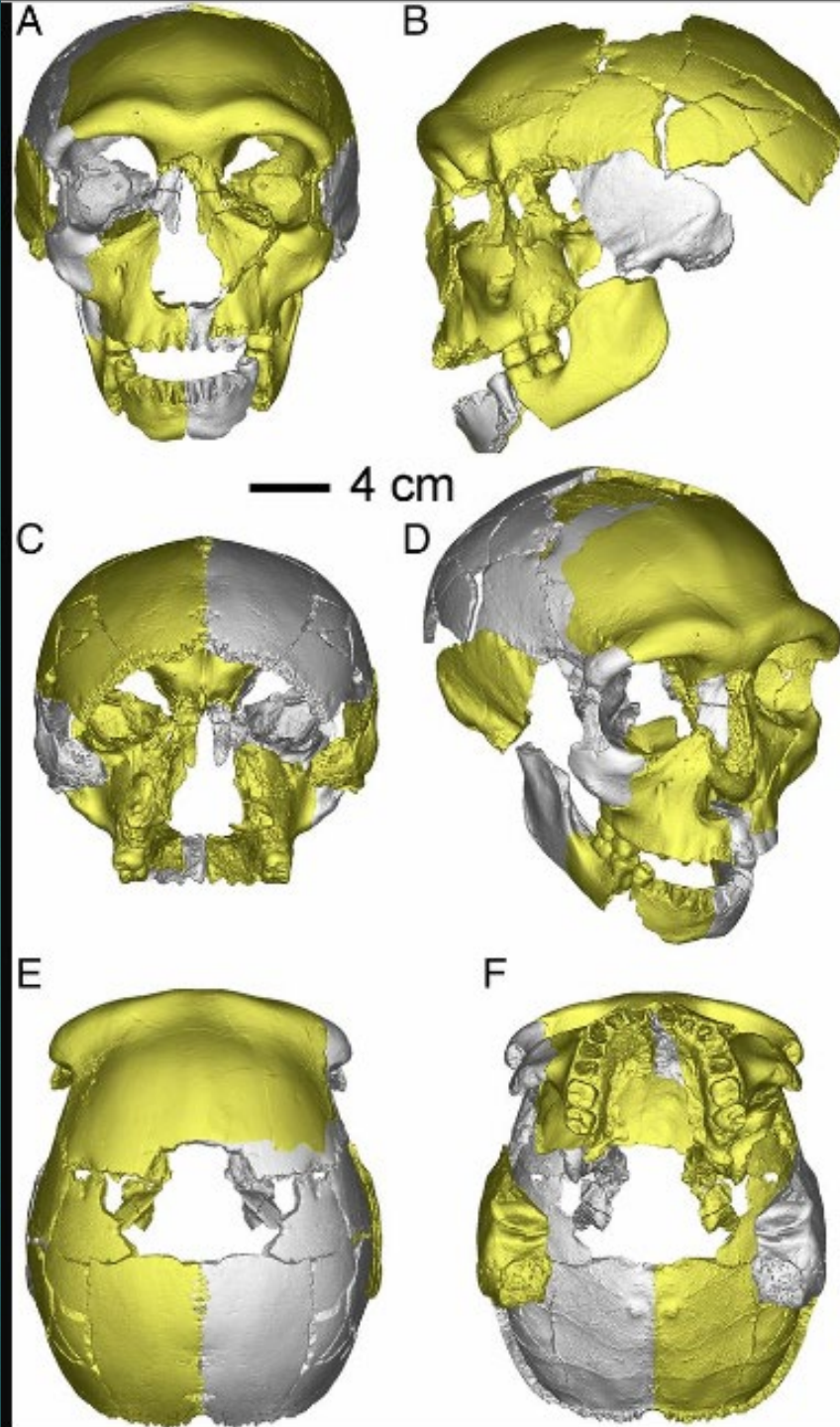
Chinese mosaics

- ▶ There has been a high degree of morphological variation in the region due to gene flow with Neanderthals and possibly the presence of a 'ghost' lineage. Lastly, reappraised dates, morphological analyses, ancient protein analysis, and mitochondrial DNA from sediments have linked the Middle Pleistocene Xiahe specimen with Denisovans.
- ▶ Recent studies of some late Middle Pleistocene humans (e.g., Dali, Panxian Dadong, and Hualongdong) emphasized their mosaic combination of derived characteristics, resembling those of modern humans, and primitive (or archaic) features (e.g., low vault, robust supraorbital structure, and a strong maxillary incisor lingual tubercle; resembling those of Early and Middle Pleistocene hominins such as Zhoukoudian, Nanjing, and Hexian).
- ▶ Comparative studies of the **Dali cranium** indicated its cranial morphological pattern is a **mosaic combination of East Asian *H. erectus* and early modern human features**. Specifically, the Dali cranium combines characteristic features of Early and Middle Pleistocene *H. erectus* (i.e., a pronounced supraorbital torus, low cranial vault, thickened cranial wall, and an angular-shaped occipital region) with modern human-like features including the broadest cranial position occurring at the posterior temporal region, a flattened face, vertical infraorbital plate, and weak prognathism.

Transition to more MH features

- ▶ Hominin teeth from the 130–300 ka site of Panxian Dadong in South China also exhibit a mosaic of archaic and derived features that align them with Middle and Late Pleistocene fossils from East and West Asia and Europe. Notably, the Panxian Dadong P³ displays derived traits falling within the range of variation exhibited by Chinese Late Pleistocene hominins, and particularly West Asian early modern humans. The preponderance of these modern human-like features suggests that the Panxian Dadong hominins are evidence of a transition in the region to modern human morphology. Thus, evolutionary timing and the dynamics of the transition from archaic to modern morphology in the late Middle and early Late Pleistocene of China are not fully elucidated by the existing fossil record.
- ▶ Detailed morphological analyses of the HLD 6 cranium confirm preliminary analyses of the cranial, mandibular, and dental morphologies in identifying a suite of derived features linking HLD 6 to modern humans.
- ▶ While it is important to be mindful of the developmental age of HLD 6, considering its date at 300 ka and the suite of modern human-like features that it exhibits, we conclude that HLD 6 represents the earliest occurrence of the modern human face in the fossil record of China.

HLD 6



Morphological description and evolutionary significance of 300 ka hominin facial bones from Hualongdong, China

- ▶ Qualitatively, facial morphology of HLD 6 resembles that of Early and Middle Pleistocene hominins from Zhoukoudian, Nanjing, Dali, and Jinniushan in China, as well as others from Java, Africa, and Europe in some of these features (e.g., supraorbital and malar regions), and Late Pleistocene hominins and modern humans from East Asia, Africa, and Europe in other features (e.g., weak prognathism, flat face and features in nasal and hard plate regions).
- ▶ Supports a **close affinities** of HLD 6 to Late Pleistocene hominins and **modern humans**. Expression of a mosaic morphological pattern in the HLD 6 facial skeleton further complicates evolutionary interpretations of regional morphological diversity in East Asia.

HLD 6

- ▶ The prevalence of modern features in HLD 6 suggests that the hominin population to which HLD 6 belonged may represent the earliest pre-modern humans in East Asia.
- ▶ Thus, the transition from archaic to modern morphology in East Asian hominins may have occurred at least by 300 ka, which is 80,000 to 100,000 years earlier than previously recognized.
- ▶ At about 300,000 years old, HLD 6 may be evidence of regional continuity, a transitional human that represents the evolution of archaic East Asian H. erectus populations into East Asian AMHs. Or, quite frankly, HLD 6 may simply be an anomaly, an archaic hominin with some quirky variation

P. boisei and *H. habilis*



2023: Oldest Oldowan tools—usually seen as a hallmark of our own genus—found with bones of *Paranthropus*



Not the first time for *Paranthropus*'s connection to stone tools

- ▶ Stone tools have been found multiple times with fossils of *Paranthropus*, a genus with several species that lived from about 2.8 million to 1.2 million years ago across Africa.
- ▶ In 1955, Louis and Mary Leakey discovered the Nutcracker Man, *Paranthropus boisei*, Zinj, in the same 1.8-million-year-old layer of sediments as Oldowan tools.
- ▶ But Mary Leakey soon found a skull of *Homo habilis* in the same layer and thought that species, in the *Homo* genus, was a better fit as the principal toolmaker.
- ▶ *Paranthropus*, with its powerful jaws and teeth, was seen as not needing tools to process tough food. *Homo* was always given credit for the tools.

Paranthropus vs habilis: new cranial rubicon

- ▶ But *Homo habilis* was something else: the teeth and jaw made it more like *Homo erectus* than *Australopithecus africanus* (the only known australopithecine species at the time), and its brain size was above the range observed in australopithecines.
- ▶ With this, the authors came to establish a minimum threshold of 600 cc for the cranial capacity of hominins capable of making tools; ruling out the australopithecines (387-550 cc) and Zinj (510 cc).
- ▶ Since then, *Homo habilis* has been regarded as the skilled tool makers, while the less brainy Nutcracker Man became just another animal in that paleoscape without such ability.

Paranthropus

- ▶ But the 2011 discovery of crude stone tools dating to 3.3 million years ago at Lomekwi in northern Kenya threw a wrench in that neat view.
- ▶ The tools predated *Homo* and showed that an earlier hominin, perhaps *Australopithecus afarensis*, already knew how to make flakes, albeit less sophisticated than those of the Oldowan.
- ▶ Ever since, researchers have been eager to find fossils and tools dating to the roughly 500,000-year gap in the fossil record between 3.3 million years and 2.8 million years ago.
- ▶ The new tools and molars from Nyayanga fall right in that gap. The ancient butchers left two hippo carcasses, many large-animal bones bearing cutmarks from tools, and 330 artifacts, including blades used to cut meat and plants. Site dated to about 2.8 Ma, with a range of 2.58 to 3.03 Ma.

Hippo fossils, 2.6 Ma, ++



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

- ▶ 60 years later, the debate resurfaces. Work at the Nyayanga site, next to Lake Victoria (Kenya) has discovered a surprising set of materials at the NY-1 level:
 - 1776 faunal remains, including three partial hippopotamus skeletons with cut marks on two of them, as well as on other antelope bones.
 - 330 Oldowan lithic artifacts.
 - 2 molars of *Paranthropus megadontia*.
- ▶ What species they would be remains to be determined: they predate the known *Paranthropus aethiopicus*, and significantly predate the earliest *Paranthropus boisei* .

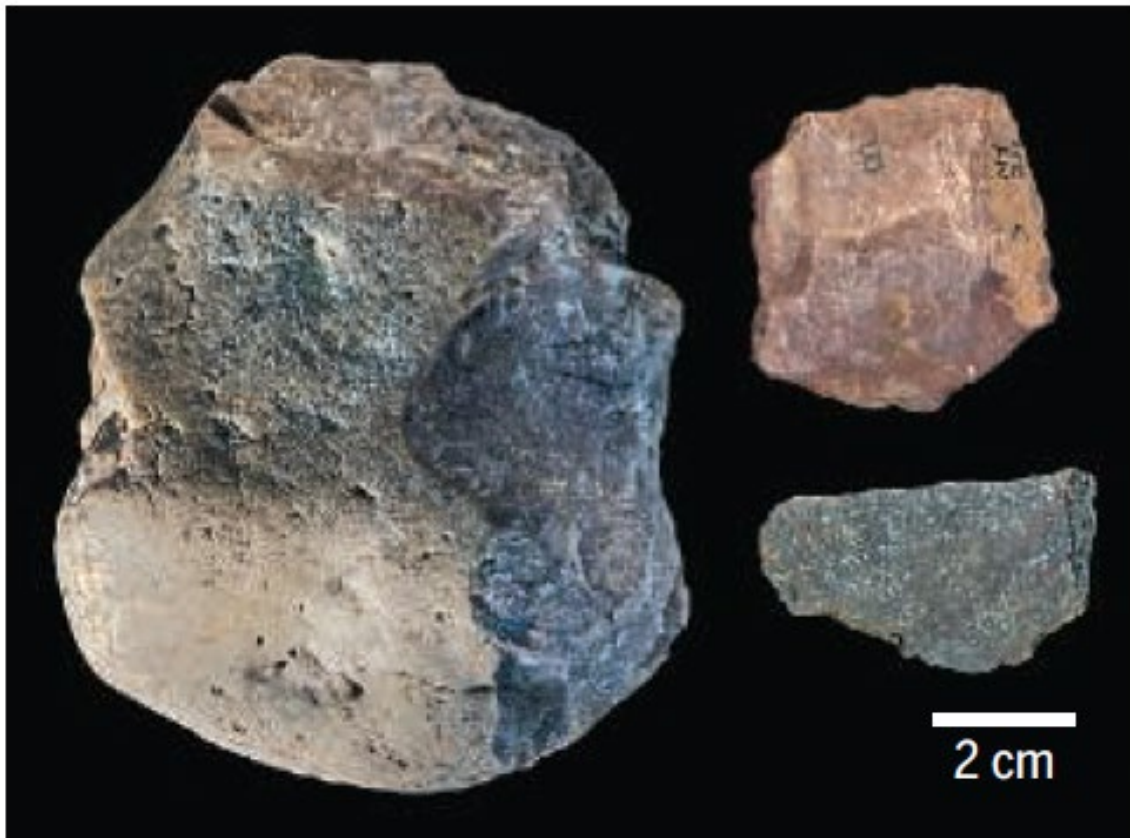
Oldowan at 3 MA

- Oldowan tools at roughly 2.9 million years ago, along the shores of Lake Victoria in Kenya
- The pair of huge hominin molars are the oldest fossilized *Paranthropus* remains ever found.
- ▶ The behaviors preserved at Nyayanga are at least 600,000 years older than prior evidence of megafaunal carcass and plant processing and substantially predate the increase in absolute brain size documented in the genus *Homo* after 2 Ma.

Paranthropus and Homo

- ▶ However, although **no *Homo* remains have been found at Nyayanga**, *Homo* members were already present in eastern Africa by 2.8 Ma (represented by the Ethiopian Ledi Geraru mandible).
- ▶ **Nor would they be the first known paranthropes to coexist with *Homo* in the same paleoscape**: 1.7 Ma ago, in Koobi Fora, paranthropuses like ER 406 and *Homo ergaster* like ER 3733 were possibly seen in the same place.
- ▶ Therefore, the Nyayanga artifacts cannot be definitively attributed to a specific genus of hominin.
- ▶ But raises the **possibility that Paranthropus made and/or co-opted stone tools.**

2023: **Oldest Oldowan tools**—seen as a hallmark of our own genus—found with bones of *Paranthropus*



An Oldowan core and flakes were among the tools found near a *Paranthropus* molar.



Whodunnit

- ▶ The real “whodunnit” now, says co-author Rick Potts is: Who was the toolmaker?
- ▶ “We’re not claiming that *Paranthropus* made the tools, but I think it could have used them,” he says.
- ▶ But there are other contenders as well. As many as a half-dozen species of *Homo*, *Australopithecus*, and *Paranthropus* lived in eastern Africa at that time.
- ▶ They might have learned directly from each other.

The human cost of America's favorite game



Update on Chronic Traumatic Encephalopathy (CTE) study discovers brain disease in 92% of ex-NFL players analyzed

- ▶ The Boston University CTE Center studied the brains of 376 deceased former NFL players and diagnosed 345 of them with chronic traumatic encephalopathy. This is 91.7% of those studied. Repeated trauma is key to developing CTE
- ▶ The NFL hasn't done anything substantial to prevent CTE or diagnose CTE, the risk is still there. The risk is high.
- ▶ In 2017, Boston University said its study diagnosed CTE in 87% of 202 football players from high school, college, semipro and the NFL. Of the 111 professional players studied, all but one of them were diagnosed with CTE.
- ▶ Boxers and football players are the athletes who have been diagnosed with CTE the most, although hockey players and soccer players have been diagnosed with it as well.

Football and CTE

- ▶ NFL are not monitoring the amount of head impacts, or intensity of head impacts, they are turning a blind eye to that.
- ▶ McKee said that the later a child starts playing tackle football, the better. She said that head contact in practice should be limited and advocated for flag football and other sports.
- ▶ 2019 study: 6% of population shows signs of chronic traumatic encephalopathy; people with CTE were about 31% more likely to develop dementia and 27% more likely to develop Alzheimer's disease than those without CTE. 9% of athletes had evidence of CTE, compared with just over 3% of nonathletes. highest rate of CTE was in football players who participated beyond high school
- ▶ Playing tackle football does increase your risk of developing CTE, and it is correlated to how many years you play,
- ▶ CJV: there is still the statistical issue of no normative database of prevalence of CTE in NFL

2023: Head trauma doesn't predict memory problems in NFL retirees

- ▶ A study of retired professional football players by researchers at UT Southwestern Medical Center has found that their cognitive abilities did not differ significantly from a control group of similarly aged men who did not play football, nor did those abilities show significant change over one to five years. The findings, published in *Brain Injury*, suggest that exposure to concussions and head injuries among National Football League (NFL) players is not a predictor of neurocognitive decline later in life.
- ▶ Included 53 former NFL players age 50 or older as well as 26 healthy controls and 83 individuals with mild cognitive impairment or dementia who did not play collegiate or professional contact sports and matched as closely as possible to the NFL retirees by age and education. The retired players in the study had an average of 5.63 concussions, 8.89 years in the NFL, and 115.12 games
- ▶ Some NFL retirees may have slightly lower memory scores is not clinically meaningful and importantly did not relate to any measure of head-injury exposure they could evaluate.

Fossil bones from the largest penguin (340 lbs) that ever lived unearthed in New Zealand: 57 Ma



Just as Deadly by Melissa Harrison: New book explores psychology of 27 female serial killers

▶ **How are male and female serial killers different?**

▶ Harrison: Let's start with **motives**.

▶ For females, the most common is financial gain, whereas for men it's often **sexual gain**.

▶ The ways in which they kill also differ. **Women's primary means are poison, and men's are asphyxiation**.

▶ Men are far more likely to target a stranger and to have stalked their victim; women are more likely to target somebody familiar to them and are more than twice as likely to have murdered a spouse or partner. They tend to target the vulnerable—elderly people, ill people or children.

▶ Females tend to have been married at least once; males tend to be single at the time of first crime. Males tend to have a high school education or less; females tend to have some college or more.

Neanderthals Were Mixing Tar 200,000 Years Ago

- ▶ **Ns used tar to produce tools long before modern humans came to Europe**
- ▶ Today's tar is distilled at temperatures between 340 and 370 °C and is done so in a ceramic vessel. Without specialist equipment, maintaining a temperature in that specific range is quite challenging.
- ▶ **Study conducted some experimental archaeology** in order to learn how these Neanderthals distilled tar. They set out to produce tar **using just the resources available to Neanderthals**.
- ▶ Fire, ash, birch bark, pointy stones, and stick-woven mesh were some of them. The group experimented with three different processes for extracting tar from birch bark while monitoring tar output, temperature, and task difficulty.

Tar production: 3 methods

1. Under a mound of ash and embers, a roll of birch bark is heated in the "ash mound" method. Tar is extruded into a bowl made of wood.
 2. The "pit roll" technique involves lighting a fire on top of a tube of birch bark that has been put into a small pit. At the bottom of the pit, tar seeps from the roll onto a rock.
 3. Last but not least, the "raised structure" technique involves setting a birch bowl in a small hole and covering it with a green willow screen. The screen is covered with a roll of birch, which is then buried in earth. The birch bark is slowly cooked by a fire that is placed on top of the ground.
- ▶ A few grams of tar were produced by each technique, which is comparable to the quantities found at Neanderthal sites in Europe. However, certain techniques—like the raised structure—were more resource- and firewood-intensive. And, other techniques, like the pit roll, were straightforward and efficient but produced little tar.
 - ▶ Researchers found that they could distill tar even when the temperature fluctuated between 200 °C and 400 °C. So, it turns out that making tar does not require ceramics or a well controlled temperature.

Tar

- ▶ Concluded that Neanderthals may have used any of these techniques. Utilizing cooking pits made them all simple to perform. In fact, it's possible that Neanderthals discovered how to create tar accidentally when a stray piece of birch bark started to seep tar next to the fire. Ns would then have found it rather easy to discover that tar was sticky and ultimately to conclude that it might be used to better secure their instruments.
- ▶ Cognitive requirements: Making tar requires complex thought, as well as the ability to combine tools and plan for the future. Study sees similarities between the technological capabilities of Neanderthals and their near-modern contemporaries in Africa.
- ▶ However, no one is certain why *Homo sapiens* did not distill tar in Africa. Most likely, there were no birch trees nearby.
- ▶ Consider for a minute the fact that you have just used one of humanity's earliest technological creations the next time you use a drop of glue. Additionally, a Neanderthal created it.

Cliffs at La Cotte de St. Brelade, Jersey: Longest N barbecue



Significance of barbecues: Neandertal cognitive ability at Jersey?

- ▶ Cliffs at La Cotte de St. Brelade, Jersey: barbecued piles of mammoth and woolly rhino bones
- ▶ Earlier Game Drive theory: Ns deliberately drove animals over the cliff in 2 separate incidents – requiring communication, planning & cooperation; klg that animals have predictable behaviors; (Native Americans used fire drive lanes to drive bison over cliffs)
- ▶ Martin Bates et al., 2014 kills that theory: Plateau was too rocky & steep for mammoths; but other studies indicate Ns used terrain klg to trap animals.

La Cotte de St. Brelade, Jersey: Ns for 140 years

- ▶ Greatest long term occupation site of N in Europe;
 - ▶ N kept returning to La Cotte for 140 K years,
 - ▶ from 180 Ka to 40 Ka; longest barbecue site in history
- ▶ **Rock shelter theory** --possibly N brought bones there to burn & for shelter; hundreds of thousands of **flint stone tools** (of “Lavallois” tradition) and **bone fragments** have been uncovered;
- ▶ **80% right-handed** at La Cotte (via tool evidence)
- ▶ Latest research there: **dental evidence of N-MH hybrids**

2023: Neanderthals hunted elephants at Neumark-Nord 1, Germany, a finding that has major implications for our understanding of social and cultural aspects of Neanderthal behavior



Ns hunting megafauna

- ▶ 2023 study by Gaudzinski-Windheuser et al. provide compelling evidence of Neanderthals hunting megafauna, specifically straight-tusked elephants (*Palaeoloxodon antiquus*) at 125 Ka in Germany.
- ▶ In the Middle Paleolithic of Europe and western Asia (home to Neanderthals, ca. 300,000 to 40,000 years ago), there are around 26 sites with evidence for megafauna exploitation. Of these, the vast majority includes the bones of megafauna found in association with stone tools but with no direct evidence of cut marks on the bones.
- ▶ The next challenge is that cut marks do not necessarily indicate hunting because they can also be caused by scavenging.
- ▶ To establish hunting, archaeologists can seek direct evidence, such as impact marks from hunting implements making contact with the bone or instances of stone tools becoming embedded in the bone.

Solitary bulls

- ▶ Neanderthals at Neumark-Nord 1 hunted straight-tusked elephants and followed a butchery strategy meant to maximize carcass exploitation
- ▶ Neumark-Nord 1: Neanderthals targeting solitary bull males.
- ▶ Further, the authors present taphonomic data (e.g., carnivore bite marks or cut marks from stone tools) for 57 different elephants. They find butchery damage on most individuals, repetitive cut marks on the left and right body parts of the same animal, and cut mark damage that indicates that hominins accessed the carcasses before carnivores.

Butchering implications

- ▶ A 10- ton modern elephant would have taken 200 to 600 person-hours to process, which, at the average, hunter-gatherer group size of 25 people would mean 3 to 5 days.
- ▶ The yield is mindboggling: more than 2500 daily portions of 4000 calories per portion. A group of 25 foragers could thus eat a straight-tusked elephant for 3 months, 100 foragers could eat for a month, and 350 people could eat for a week. It is worth noting that Neanderthals are thought to have lived in groups smaller than 25 people.
- ▶ Estimate that an elephant was killed roughly every 5 to 6 years at the site. The ramifications of having access to such a large quantity of meat on a semiregular basis goes far beyond what we know about Neanderthal behavior, and there are only two plausible explanations for how they dealt with such an influx of resources.

New N behavior

- ▶ The first is that Neanderthals had the cultural knowledge and mechanisms to store meat—drying, freezing, or caching—and they spent much more time in a single location than we typically envision (i.e., months as opposed to days).
- ▶ The second is that, in some situations, Neanderthals lived in much larger groups or participated in temporary aggregations, which would have provided important opportunities for social, cultural, and genetic exchange.
- ▶ Now also need to consider that they had preservation technologies to store food and were occasionally semisedentary or that they sometimes operated in groups larger than we ever imagined.
- ▶ It is increasingly clear that Neanderthals were not a monolith and, unsurprisingly, had a full arsenal of adaptive behaviors that allowed them to succeed in the diverse ecosystems of Eurasia for over 200,000 years.

‘What the hell are 70 elephants doing there?’

- ▶ The find comes from a trove of animal bones and stone tools uncovered in the 1980s by coal miners near the town of Neumark-Nord.
- ▶ The discoveries include the bones and tusks of more than 70 mostly adult male straight-tusked elephants (*Palaeoloxodon antiquus*), an extinct species almost twice the size of modern African elephants that stood nearly 12 feet tall at the shoulder.
- ▶ Most had been left in dozens of piles along the ancient lakeshore



Standing beside a
life-size
reconstruction of an
**adult male straight-
tusked elephant;**
(28,000 lbs).
Twice as big as
today's African
elephant

Straight-tusked elephants

- ▶ Straight-tusked elephants (*Palaeoloxodon antiquus*) were the largest terrestrial mammals of the Pleistocene, with body mass estimates of up to 6 metric tons for adult females and up to 13 metric tons for adult males, i.e., roughly three times larger than that of living Asian elephants, twice that of African ones, and also much larger than mammoth (*Mammuthus primigenius*).
- ▶ With shoulder heights of up to 12 feet and with their large tusks; present from 800 to 100 Ka
- ▶ Found cut marks at one-third of the 36 locales studied



First clear-cut evidence of elephant-hunting in human evolution at 125 Ka

- ▶ In the journal *Science Advances*. The paper focuses on 3,122 bones, tusks and teeth thought to derive from more than 70 straight-tusked elephants — some skeletons of which were virtually intact — that died at 125 Ka in a heavily forested lake basin of what would come to be east-central Germany.
- ▶ The researchers argue that, for at least 2000 years, Neanderthals hunted there for the giant, now-extinct herbivores.
- ▶ Their abundant cut marks indicated that the resident Neanderthals had used flint tools to slice off meat, and had found the remains before other carnivores such as saber-tooth tigers.
- ▶ It is the first clear-cut evidence of elephant-hunting in human evolution

Feasting on elephants

- ▶ The findings challenge the assumption that Neanderthals were basically nomads who lived in bands of no more than 25, in isolation from one another. Points to the possibility of sizable collective-subsistence events.
- ▶ Knew how to preserve meat and might have lived a settled existence in large groups.
- ▶ Hunting of elephants weighing up to 13 metric tons was part of the cultural repertoire of Last Interglacial Neanderthals there, over >2000 years, many dozens of generations.
- ▶ Suggests that Neanderthals were at times less mobile and operated within social units substantially larger than commonly envisaged.

Femur and skull of an adult male straight-tusked elephant.



Neumark-Nord

- ▶ **Classic view of Ns** as cold-adapted, steppe-tundra, big-game hunters is skewed
- ▶ **2018 investigation** that proposed that the punctured bones of two male fallow deer salvaged at Neumark-Nord were the oldest example of hunting marks in history, and that Neanderthals used sophisticated close-range hunting
- ▶ It is **now accepted** that the more typical Neanderthal was one who lived in southern Europe through the Ice Age and in central Europe during interglacial periods, as epitomized by Neumark-Nord.
- ▶ **Ns were in the Neumark-Nord 1 area** for a total duration of ~2850 years; in a lake landscape
- ▶ **Suggests some form of permanent presence of Neanderthals** and points to their dominant role as apex predator in the faunal community around this locale

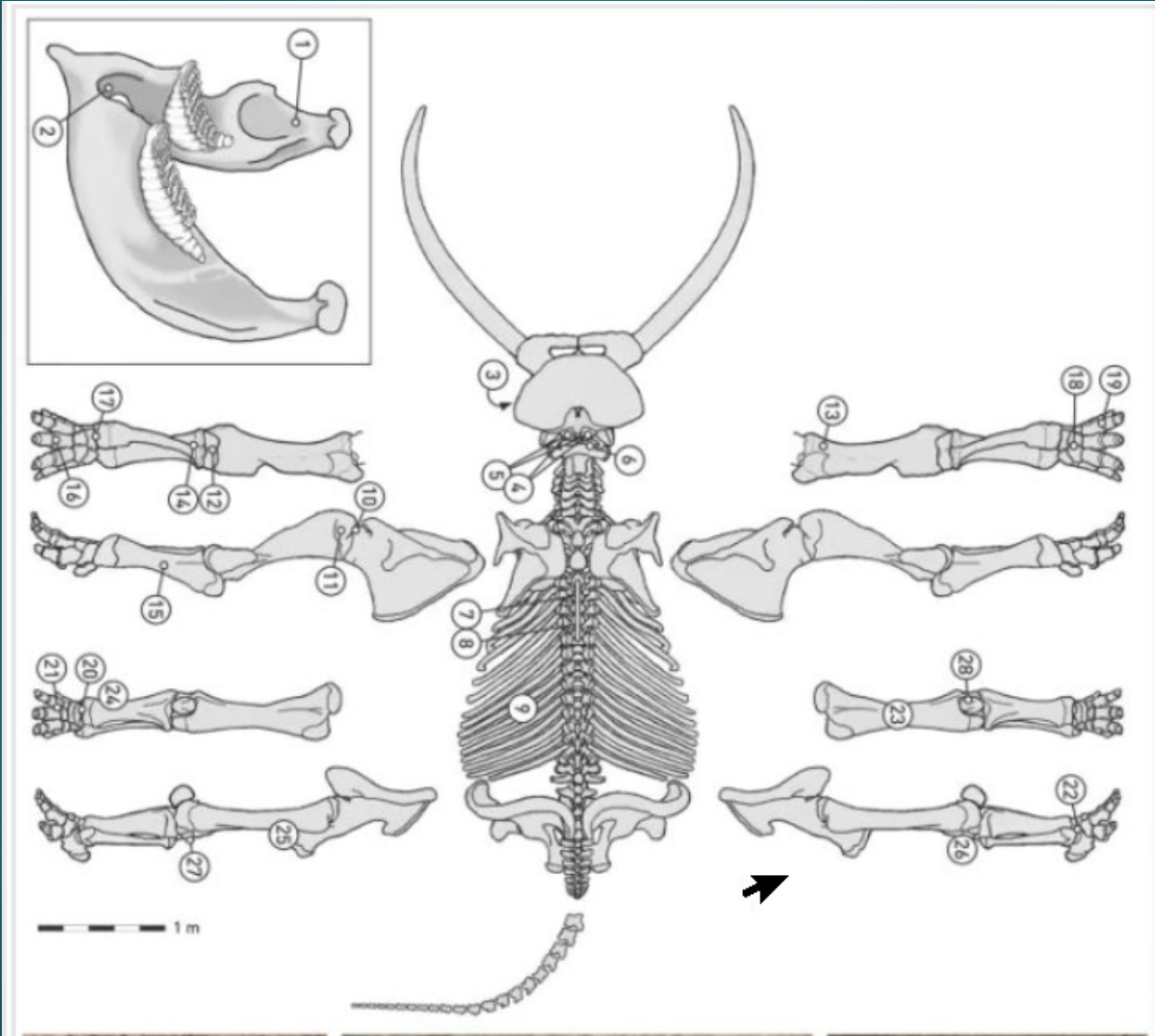
Neumark-Nord 1

- ▶ The **presence of simple flakes** suggests Neanderthal involvement in the disarticulation of the carcasses.
- ▶ Abundant **evidence for fire use at and around the excavated areas**, including heated lithics, burnt bones, charred seeds, and charcoal particles
- ▶ With an age of c. 125,000 years, Neumark-Nord provides a very early example of a hominin role in using fire for local-scale vegetation transformation caused by an archaeologically very visible and long-lasting presence of Neanderthals in this lake-land area.
- ▶ Collected 3122 elephant remains; what was left after mining destroyed parts of area; 44 elephant bone complexes from Neumark-Nord 1.

Neumark-Nord 1

- ▶ The presence of swampy/muddy areas may have acted as traps and led to burial, rapid enough to prevent development of traces of surface disintegration on the bones and, thus, fostering preservation
- ▶ For 50%, determined age at death: Unexpectedly, they found that 94% of the individuals were older than 25, and 40% were older than 40 years.
- ▶ All of the studied bone complexes display traces of human modification of elephant carcasses
- ▶ What is most notable is that cut marks occur repetitively on skeletal elements of the left and right body halves of the same individual. Although cut marks were obviously produced during the same butchering process, their morphology can differ substantially, indicating that different stone tools, possibly handled by different butchers, were used in carcass processing

How to butcher a 12-foot elephant



Cut marks



Cut mark patterns

50

- ▶ Cut marks occur repeatedly in the same positions on the bones of different animals, suggesting that the dismemberment of these animals followed a more or less standard procedure. It is also noticeable that not a single carcass element provided evidence for bone cracking.
- ▶ Infer that the Neumark-Nord evidence is indicative of rather swift and extended butchering of fresh carcasses, supported by the lack of indication that carnivores had first access to the carcasses.
- ▶ Minimum number of **57 bone complexes**; demonstrates that Neanderthals had primary access to fresh carcasses and butchered these in similar ways, involving extensive processing, during the first half of the Last Interglacial.

Neumark-Nord 1

- ▶ The largest older bulls would have roamed the lake landscape in relative isolation, without the protection of a herd, and would have been easier to approach closely, compared to females in mixed herd groups
- ▶ Used hunting strategies mostly aimed at limiting the mobility of prey, e.g., by digging pits or driving them into mud traps, and killing them with wooden thrusting spears. These weapons are well documented in the archaeological record at Schöningen and Lehringen.
- ▶ All the data presented above indicate that hunting caused the accumulation of this assemblage. It constitutes the earliest unambiguous evidence for the systematic targeting and processing of straight-tusked elephants, the largest Pleistocene terrestrial mammals that ever lived.

Need a large N group for elephant food processing

- ▶ Calculated 745 person-hours for butchery, drying, and smoking of African elephants. Regarding the amount of time a Neanderthal group of foragers would need to skin, strip meat from bones, and dry or smoke the meat from an adult male P. antiquus, we suggest, as a very rough estimate, that this could be done in 3 to 5 days, if 25 individuals were involved in the process.
- ▶ Second, The extended processing of the approximately 10–metric ton E9 individual, for example, would have yielded more than 2500 daily portions, of 4000 kcal. These minimum estimates are important: They either imply a large group of consumers and/or the presence of cultural means to preserve food and to store products over a significant period.

Larger N groups, at least periodically

- ▶ Among **contemporary low-density hunter-gatherers (San or Hadza)**, the number of people living together in a residential group varies between about 15 and 30 individuals, with an **average group size of 25**.
- ▶ Neanderthal local group (band) size is usually inferred as being smaller than that. Assuming the conventional extant hunter-gatherer local group size of 25, the values for calories and daily portions calculated would **provide food for at least 3 months**, provided the existence of cultural ways to store food over such periods.
- ▶ Dr. Roebroeks and his colleagues concluded that **at least some Neanderthals lived in substantially larger groups than is often hypothesized**.
- ▶ **Maybe it's a large, seasonal gathering, or they're storing food—or both.**
- ▶ **Indicates that Ns were more sophisticated than once assumed. "If one regional group of Neanderthals was capable of such behavior, other groups elsewhere surely would have been capable, too"**

Social N food processing

- ▶ The team calculated that an extended family of 25 could go three months before going hungry, 100 foragers could eat for a month, and 350 people could eat for a week, provided they had cultural knowledge and mechanisms to store food over that period by drying, freezing or caching.
- ▶ Traces of charcoal fires have been found at the site, suggesting that the Neanderthals may have dried meat on racks and roasted it.
- ▶ Team estimated that an elephant was killed roughly every five to six years at the site.

Other types of hunting

- ▶ These elephant hunts took place against the background of regular hunting and processing of prey animals well recorded elsewhere in the lake landscape, including fallow deer, red deer, bovids, and horses.
- ▶ The wider Neumark-Nord record, with its evidence for a year-round presence, a limited carnivore signal, and a broad diet, suggests that Neanderthals in this area were less mobile than commonly inferred.

Other locals

- ▶ At the famous site of Lehringen, a single *P. antiquus* skeleton was found with a carefully modified yew wood lance among the bones
- ▶ At first glance, the primary context associations of flint artifacts and skeletal remains at Lehringen and Gröbern do seem to fit the Neumark-Nord pattern described here.
- ▶ This may suggest that exploitation of elephants was a wider-spread phenomenon 125,000 years ago and that Neanderthal behavior at Neumark-Nord was not isolated or unusual

Where are all the hominins?

- ▶ 1 million species of insects
- ▶ 5500 species of frogs
- ▶ 2000 species of rodents
- ▶ 334 species of monkeys
- ▶ 200 species of squirrels
- ▶ Only 23 (31) species of hominins?

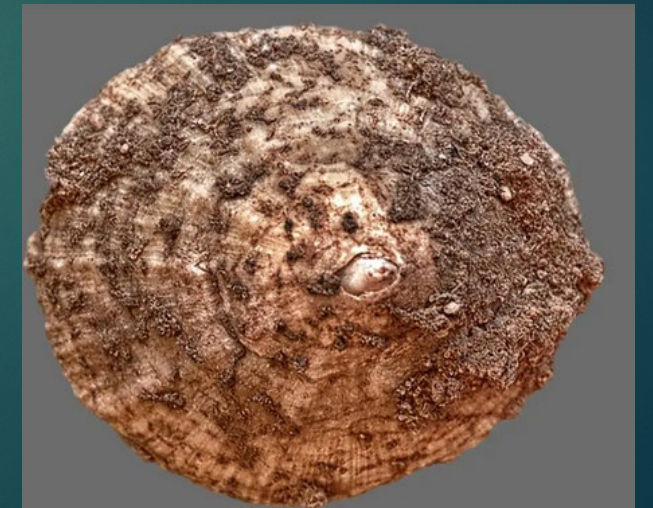
Oldest fossil mammal: this is how we started



Triassic period

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

Neandertals roasted crab and ate limpets at Gruta da Figueira Brava cave: another challenge to popular image of Neanderthals as meat-eating brutes.



The exploitation of crabs by Last Interglacial Iberian Neanderthals: The evidence from Gruta da Figueira Brava (Portugal)

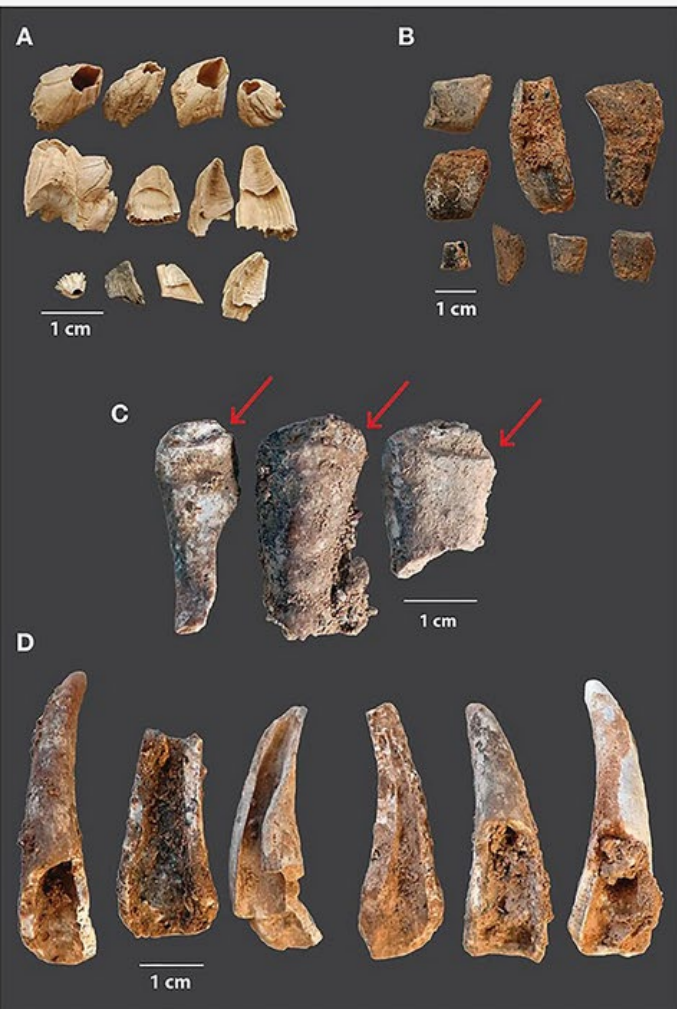
- ▶ There is growing evidence for the Neanderthals' subsistence exploitation of small terrestrial animals. This has been demonstrated by several studies of rabbits, birds, and tortoises, from southern France and the Iberian Peninsula.
- ▶ We now know that fish and shellfish harvesting played a significant role in the subsistence economy of Last Interglacial Iberian Neanderthals
- ▶ Neanderthal crab roast leftovers are found in a Portuguese cave

Neandertals liked crustaceans and sea urchins

- ▶ In a cave less than 20 miles from Lisbon, researchers discovered charred remnants of shells and claws: evidence that Neanderthals were cooking and eating crab 95,000 years ago.
- ▶ The cave site, Gruta da Figueira Brava, was about a mile from the coast when Neanderthals lived there.
- ▶ Aquatic feast: Found 560 fish bones, as well as remains from clams, mussels, crabs, waterfowl, seabirds, seals and dolphins. As well as eels, morays, conger, mullet and sea bream.
- ▶ Based on the size of the crab claws, most of the specimens were larger than average, each likely yielding around seven ounces of meat.

Surf and turf dinners

- ▶ The crab shells lacked telltale signs of being eaten by other animals, like tooth marks or shattering patterns from being dropped on rocks by birds. Instead, some of the shells were charred and blackened: a sign that they had been roasted.
- ▶ Complete animals were brought to the site, where they were roasted on coals and then cracked open to access the flesh.
- ▶ Don't know what was caught directly from the sea or scavenged from creatures that washed ashore or got trapped in tide pools
- ▶ In addition to the “surf,” they found plenty of “turf,” such as remains from red deer (20%), rabbits (17%), ibex (17%), aurochs(13%), horses (5%), cave hyena (4%) porcupine and tortoise. Plants include pine nuts.



Pieces of crustaceans from Gruta da Figueira Brava including from a barnacle, *Perforatus perforatus* (A); brown crab (B) with black burns; brown crab showing impact flakes (C); and pincers with longitudinal breaks (D).

Mariana Nabais/Catherine Dupont/João Zilhão, *Frontiers in Environmental Archaeology*, 2023

Neanderthals actively ate shellfish:

Found 635 bits of **crab shells**, representing a bare minimum of 33 individuals, along with remnants of **limpets, barnacles and sea urchins**.

Neanderthal Introgression Shaped Human Circadian Traits

- ▶ The Eurasian environments where Neanderthals and Denisovans lived for several hundred thousand years are located at higher latitudes with more variable photoperiods than the landscape where AMH evolved before leaving Africa.
- ▶ Evaluating genetic variation that arose separately in each of the archaic and AMH lineages after their split ~700 MYA, we identified lineage-specific genetic variation in circadian genes, their promoters, and flanking distal regulatory elements
- ▶ DNA of archaic ancestry integrated into the genomes of anatomically modern humans. This process potentially accelerated adaptation to Eurasian environmental factors, including reduced ultra-violet radiation and an increased variation in seasonal dynamics.

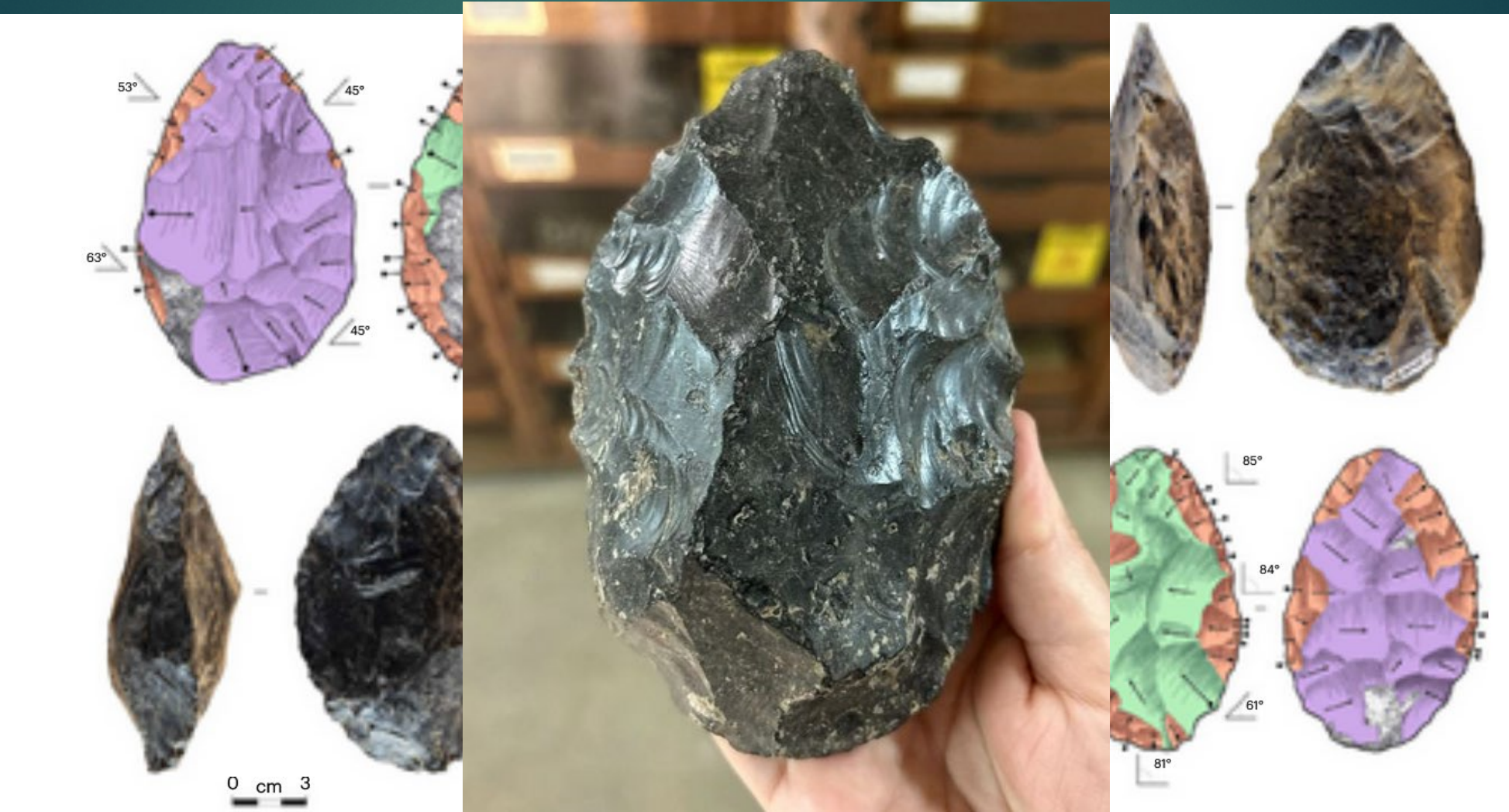
N effect on MH circadian rhythms

- ▶ Results: Here we traced the **evolution of chronotype (are you an early bird versus a night owl)** based on genomes from archaic hominin and present-day humans.
- ▶ We identified 28 circadian genes containing variants likely to alter splicing in archaics, and 16 circadian genes likely divergently regulated between present-day humans and archaic hominins.
- ▶ These differences suggest the **potential for introgression to modify circadian gene expression.**

N genes influence being a morning person in Eurasians.

- ▶ Found that many introgressed alleles have strong associations with chronotype (inclination of your body to sleep at a certain time).
- ▶ Strikingly, the strongest introgressed effects on chronotype increase morningness, which is consistent with adaptations to high latitude in other species.
- ▶ Conclusions: These findings identify differences in circadian gene regulation between modern humans and archaic hominins and support the contribution of introgression via coordinated effects on variation in human chronotype.

An unknown group of hominins crafted more than 500 obsidian hand axes more than 1.2 million years ago in what is now Ethiopia.



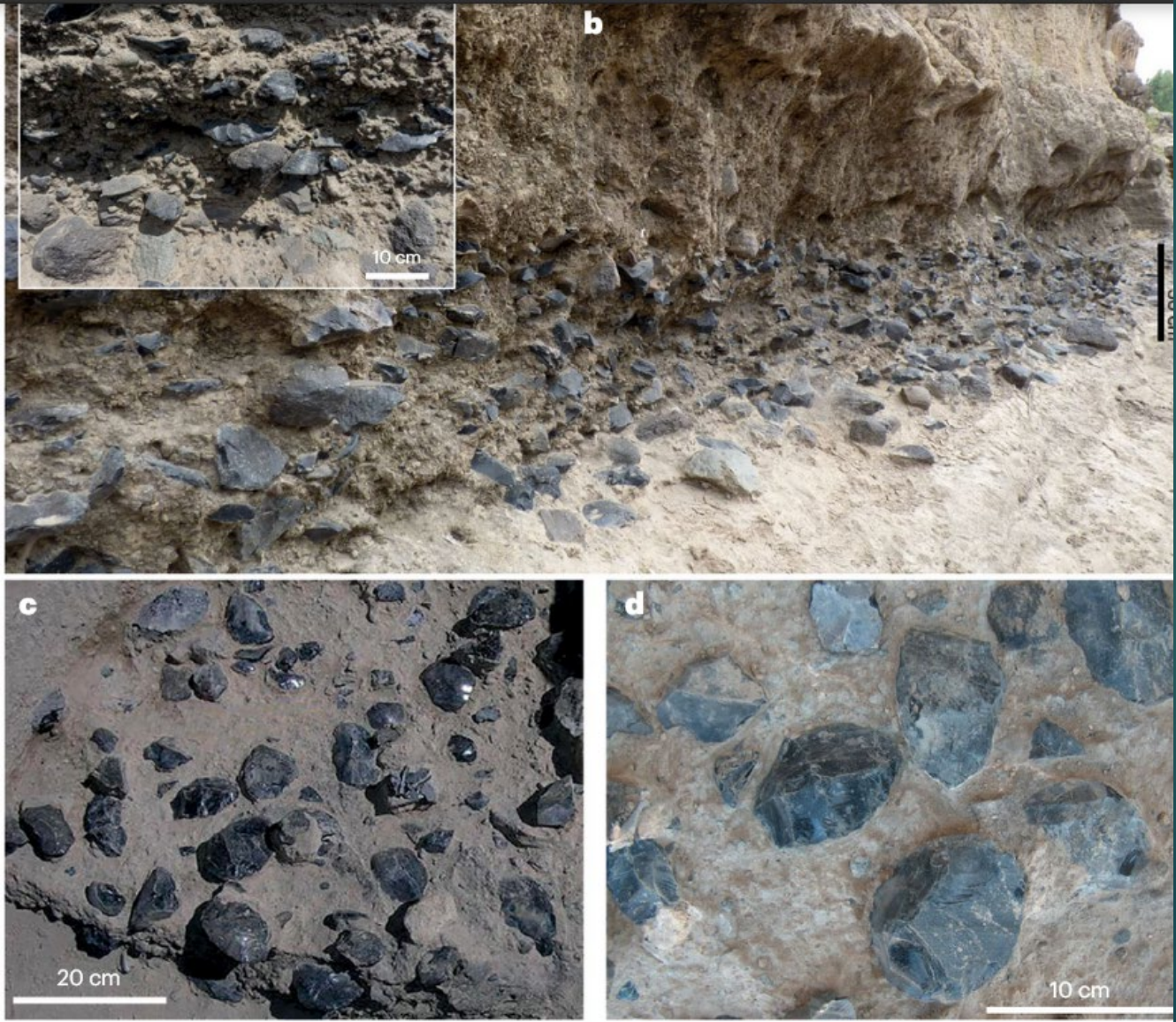
Massive, 1.2 million-year-old tool workshop in Ethiopia made by 'clever' group of unknown human relatives

- ▶ More than 1.2 million years ago, an unknown group of human relatives may have created sharp hand axes from volcanic glass in a "stone-tool workshop" in what is now Ethiopia.
- ▶ This discovery suggests that ancient human relatives may have regularly manufactured stone artifacts in a methodical way more than a half-million years earlier than the previous record, which dates to about 500 Ka in France and England.
- ▶ In the new study, the researchers investigated a cluster of sites known as Melka Kunture, located along the upper Awash River valley of Ethiopia: 575 artifacts made of obsidian at a site known as Simbiro III in Melka Kunture.

Obsidian is difficult to use

- ▶ Obsidian generally only found extensive use in stone tool manufacture beginning from the Middle Stone Age, which ranged from about 300 to 50 Ka.
- ▶ There has been evidence since the 1970s that **obsidian may have been transported across long distances as early as 1.4 million years ago**
- ▶ It remains uncertain which hominin may have created these artifacts. Discovered hominin remains about 1.66 million years old that may have been *Homo erectus*, and fossils about 1 million years old that may have been *Homo heidelbergensis*

The extensive accumulations of obsidian artefacts in Ethiopia



Obsidian workshop: seasonal activity

- ▶ It has been argued that, in earlier times, multiple activities of everyday life were all uniformly conducted at the same spot. The separation of focused activities across different localities, which indicates a degree of planning, according to this mindset characterizes later hominins only after 500 Ka.
- ▶ Simbiro III level C, in the upper Awash valley of Ethiopia, allows the test of this assumption in its assemblage of stone tools made only with obsidian, dated to more than 1.2 million years (Myr) old. The landscape was seasonally flooded. Following the deposition of an accumulation of obsidian cobbles by a meandering river, hominins began to exploit these
- ▶ We show through statistical analysis that **this was a focused activity, that very standardized handaxes were produced and that this was a stone-tool workshop.** We argue that at Simbiro III, hominins were doing much more than simply reacting to environmental changes; **they were taking advantage of new opportunities, and developing new techniques and new skills according to them.**

Behavior required planning at 1.2 Ma

- ▶ Hominins at Simbiro III had the capacity to anticipate and plan activities in a diverse and locally wooded environment. When returning to the same important spot they had to consider the seasonal flooding of the area.
- ▶ Overall, the evidence provided by MS-level C contradicts the common assumption of early hominins simply 'coping' with environmental change:
- ▶ At 1.2 Ma, they exploited a new resource when it became seasonally available.

Trees and fungi



The Overstory: now doubts about wood wide web

- ▶ **Read the novel the Overstory by Richard Powers!!** Character based on forest ecologist Suzanne Simard
- ▶ **Mycorrhizal fungi live on plants' roots.** They are thought to be beneficial to trees and to grow into vast networks beneath the forest floor. In recent years, books and documentaries have popularized the idea that these fungal networks help trees recognise related individuals – allowing them to shuttle resources to feed their own seedlings – and even send alarm calls to their kin when under threat.
- ▶ **New review of 1676 studies on the structure and function of mycorrhizal networks** and were surprised to find that **three major claims about fungi's partnership with trees are based on only a few studies that have been cited repeatedly.**
- ▶ Study conducted on only two of the world's 73,300 tree species.

Trees and fungi

- ▶ A review of studies on mycorrhizal fungi **finds there is insufficient evidence for the popular idea that trees communicate and share resources via these underground networks.**
- ▶ **Little evidence that the trees could recognise their kin or send alarm calls when threatened.**
- ▶ **What is clear** is that fungi play a significant role in the life of trees, passing them nitrogen, phosphorus and other nutrients from the soil, while the trees give the fungi sugars.

Aspen Pando



Pando

- ▶ It's ancient, it's massive, and it is faltering.
- ▶ The gargantuan aspen stand dubbed "Pando," located in south-central Utah, is more than 100 acres of quivering, genetically identical plant life, thought to be the largest living organism on earth (based on dry weight mass, 13 million pounds).
- ▶ What looks like a shimmering panorama of individual trees is actually a group of genetically identical stems with an immense shared root system.
- ▶ Now, after a lifetime that may have stretched across millennia, the "trembling giant" is beginning to break up,
- ▶ 6,615-ton (six-million-kilogram) colony of a male quaking aspen tree and his clones that covers 107 acres (43 hectares) of a Utah mountainside.

Mushrooms

- ▶ Next time you purchase white button mushrooms at the grocery store, just remember, they may be cute and bite-size but they have a **relative out west that occupies some 2,384 acres (965 hectares) of soil in Oregon's Blue Mountains**. Put another way, this humongous fungus would encompass **1,665 football fields, or nearly four square miles (10 square kilometers)** of turf.
- ▶ The **discovery of this giant *Armillaria ostoyae* in 1998** heralded a new record holder for the title of the world's largest known organism, **believed by most to be the 110-foot- (33.5-meter-) long, 200-ton blue whale**. Based on its current growth rate, the fungus is estimated to be **2,400 years old but could be as ancient as 8,650 years**, which would earn it a place among the oldest living organisms as well.

Massive fungus

- ▶ In fact the **very first massive fungus discovered in 1992**—a 37-acre (15-hectare) *Armillaria bulbosa*, which was later renamed *Armillaria gallica*—is annually celebrated at a "fungus fest" in the nearby town of Crystal Falls, **Mich.**
- ▶ Their fungus, a specimen of *Armillaria ostoyae*, **covered about 1,500 acres (600 hectares) or 2.5 square miles (6.5 square kilometers).**
- ▶ And **in 2003** Catherine Parks of the USFS in Oregon and her colleagues published **their discovery of the current behemoth 2,384-acre *Armillaria ostoyae*.**
- ▶ **New scfi series The Last of Us about a fungus apocalypse**

Epigenetic control of the symbiosis between trees and fungi

- ▶ The teams made use of existing transgenic poplar lines, whose regulatory genome DNA methylation status had been modified for scientific purposes, for their own work on the [epigenetic mechanisms](#) in trees. They compared the functional responses of the modified poplars to [mycorrhizal fungi](#) with that of an unmodified wild-type (control) line of the same species.
- ▶ The results were clear: lines whose genomic DNA methylation rates had been reduced had a lower capacity for mycorrhization (up to 40% in one instance). These results suggest a central role for DNA methylation in a host tree's capacity to form the symbiotic relationships necessary for strong development. Epigenetic modulation took place in both directions, with the fungal partner's DNA methylation also being modified by the host methylation status.
- ▶ Improve our understanding of symbiosis between two living organisms

Evolution of curly hair



What kind of Victorian gentleman would have thought that a trait he did not possess could be critical to human evolution?

Curly hair may have evolved to protect early humans from the sun

- ▶ The first humans would have had black skin and tightly curled hair. It was only relatively recently that other skin colors and hair types appeared,
- ▶ In the **first study to look at the evolution of hair types**, researchers found **tightly coiled hair provides a trade-off of shielding the head from the sun while minimizing excessive insulating effect**
- ▶ Hair that is tightly coiled offers the best protection against the sun's potentially damaging rays, which could explain why this trait evolved in early humans in Africa and straighter hair emerged as some humans moved into cooler areas.

Curly hair

- ▶ Hair's type made a big difference to how much heat the head of the manikin gained from simulated sunshine at 30°C (86°F).
- ▶ The head with a straight wig gained less than half as much heat as a control head with no wig. The head wearing the moderately curled wig gained around a quarter as much heat and the head with the tightly curled wig gained less than a tenth as much heat as the no-wig control.
- ▶ However, having any head hair more than halves the amount of sweat that is required to prevent the head from gaining heat, with tightly coiled hair reducing this more than other 2 types. Hair, particularly if tightly coiled, therefore lowers the amount of sweat that is required on the scalp to balance the sun's heat.
- ▶ When some humans left Africa and moved into cooler climes, the selective pressure for tightly coiled hair would have been lost,

Did humanity really arise in one place?

- ▶ **Historical theory of our origins in the early 2010s:** *Homo sapiens* evolved in East African savannas around 150 Ka. Then, sometime around 70,000 years ago, a mutation occurred that endowed these individuals with the capacity for complex, symbolic behavior. This set them apart from any other species and allowed them to leave Africa and take over the world, replacing all other humans they encountered.
- ▶ This “**East Side Story**” made sense, based on major finds in the 20th century.
- ▶ Evidence: The oldest fully modern *H. sapiens* skulls, dated to 233 Ka, were found in Ethiopia’s Omo Valley. “**Lucy**,” the **3.2-million-year-old *Australopithecus afarensis***, was in Ethiopia. The earliest stone tools, dated to 3.3 million years old, were discovered in Kenya.

African Origin

- ▶ The notion that humans arose in East Africa prompted ideas like the “savanna hypothesis,” which posits that human traits such as bipedalism and big brains were adaptations to living in the region’s grasslands.
- ▶ However, more recent discoveries have shaken up the East Side Story. Accumulating fossil evidence suggests that *early H. sapiens* populations were inhabiting radically different African regions, ranging from rainforests to deserts.
- ▶ Meanwhile, genetic studies and archaeological evidence are unveiling social networks connecting these ancient African societies.
- ▶ This evidence for a pan-African origin of *H. sapiens* is coalescing into a fascinating story that forces us to rethink what it means to be human.

African Origin

- ▶ Complex symbolic behaviors such as the use of shell beads, pigments, and abstract imagery in the southern corner of Africa at 70 Ka. Shell beads in N Africa.
- ▶ DNA studies have turned up even more conclusive evidence for the deep biological history of *H. sapiens* in Southern Africa.
- ▶ Researchers have sequenced the genomes of ancient and modern African populations, including the San, an Indigenous group of hunter-gatherers living in and around the Kalahari Desert in South Africa, Angola, Namibia, and Botswana.
- ▶ The San were found to have descended from the oldest distinct lineage of *H. sapiens*. This group split from all other human lineages as early as 350 Ka.

African Origin

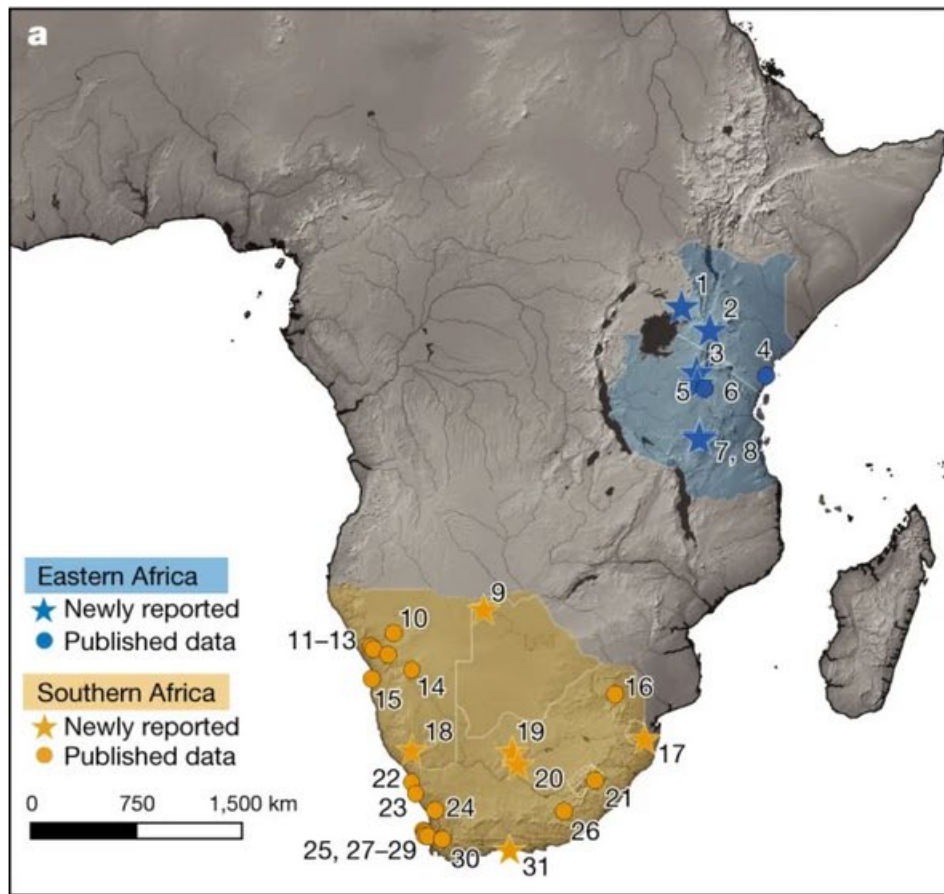
- ▶ Then Morocco: 315 Ka Jebel Irhoud *H sapiens*
- ▶ The Congo River Basin in Central Africa is home to the second-largest rainforest on the planet, after the Amazon. It covers over 178 million hectares—more than the area of Alaska. The Congo Basin is also home to the largest and most diverse group of active hunter-gatherers in the world today, comprising a total of 250,000 to 350,000 people. Yet these forested environments have been largely excluded from research into our origins.
- ▶ **Rainforests:** poor preservation of bone (number of chimp fossils!); Plus, the popular conception that our species arose on savannas has led to a mental block against investigating human origins in this tropical ecosystem.

African Origin: Central Rainforests

- ▶ In 2020, a group of researchers extracted ancient DNA from the skeletons of four hunter-gatherer children buried between 3,000 and 8,000 years ago in a cave in present-day Cameroon, which borders the Republic of the Congo. The DNA showed that the children were very closely related to today's Congo Basin hunter-gatherers but not to the farming populations inhabiting the region.
- ▶ This suggests the ancestors of contemporary hunter-gatherers inhabited Central African rainforests long before the first farming expansions.
- ▶ Confirmed that hunter-gatherers began occupying Central African rainforests at least 120,000 years ago.

Long distance networks

- ▶ **Central African hunter-gatherer populations** have been interacting with one another since at least 120,000 years ago, even when living on opposite ends of the continent. Although these groups have been geographically separated from one another for thousands of years, we found evidence that they have been interchanging genes and cultural items—particularly musical instruments—all along.
- ▶ Also in **2022**, an analysis of strontium isotopes on ostrich eggshell beads revealed a 50,000-year-old exchange network between Eastern and Southern Africa (which got interrupted about 30,000 years ago).
- ▶ Anthropologists have also noted that a similar long-distance network called *hxaro*—a system of delayed, reciprocal gift exchanges that distributes goods and strengthens social bonds.—still remains in place among contemporary San hunter-gatherers.



Ancient ostrich shell beads have been found across Africa, providing evidence for a 50,000-year-old Pan-African social network.

Jennifer M. Miller and Yiming V. Wang/Nature, CC By 4.0

Social networks

- ▶ In addition, archaeological evidence shows that, around 200,000 years ago, our ancestors were transporting obsidian for stone tools more than 160 kilometers across Eastern Africa. And around 320,000 years ago, they were transporting pigments for decorating objects and bodies across long distances.
- ▶ But in the real hunter-gatherer networks, the combination of periods of isolation and episodes of connectivity allowed new discoveries to develop in parallel in small clusters. These innovations could then be recombined, ultimately resulting in the much faster creation of complex culture.

People were diverse physically, genetically, and culturally—from the very beginning.

- ▶ Scientists are starting to realize that what researchers used to see as products of “cognitive revolutions”—such as the widespread shift some 300,000 years ago from clunky, handheld stone tools to more refined blades and projectile points—were probably instances of different populations with distinctive cultural and biological features coming together and recombining their genes and ideas.
- ▶ This mosaic evolution would explain certain seemingly unexplainable findings. For example, researchers found human fossils in the Democratic Republic of Congo that dated to around 22,000 years ago but physically resembled people living around 300,000 years ago.
- ▶ In Senegal, scientists uncovered 12,000-year-old stone toolkits that could easily be seen as 100 Ka tools.

An evolutionary paradigm shift

- ▶ These finds probably resulted from periods of isolation where different populations in different parts of the continent each developed distinctive cultural and physical adaptations to their local environments.
- ▶ At the same time, instances of connectivity allowed different populations to acquire beneficial traits, behaviors, and technologies from one another, becoming better adapted and more flexible.
- ▶ It implies that early *H. sapiens* did not, as many assumed, originate as a single, relatively large population that exchanged genes and technologies in a more or less random fashion and gradually expanded across and outside of Africa.

Recombination

- ▶ Over time, researchers do see a trend toward more sophisticated material culture, but this “modernization” didn’t originate in one region or occur at one time period. That suggests it was the product of recombination.
- ▶ DNA extracted from ancient African foragers over the past 10,000 years also tells a story of cycles of connectivity and isolation.
- ▶ Genetic analyses reveal, on the one hand, lineages that have remained distinct since almost 300,000 years ago.
- ▶ On the other hand, the DNA shows levels of genetic diversity indicating that seemingly isolated groups were actually embedded in huge social and mating networks.

African Diversity

- ▶ These interactions would have prevented the dangerous effects of inbreeding, allowing our ancestors to thrive even when tough conditions made it difficult to maintain larger populations.
- ▶ Greater genetic diversity also meant a larger reservoir of potentially beneficial mutations that could give populations a greater ability to adapt to challenges in different environments.
- ▶ Future work will help determine *why* human groups were so divided and what conditions made their confluence possible at certain times. But what is clear now is that our immediate *H. sapiens* ancestors lived across the African continent. People were diverse physically, genetically, and culturally—from the very beginning.

African Origin

- ▶ *H. sapiens* is neither a savanna nor a rainforest species. We are not wholly carnivorous or herbivorous, peaceful or war prone. We did not descend entirely from the Hadza or San lineage, because there was never one “ancestral human population.” We are a rich blend of many groups that have lived in extremely diverse environments for thousands of years.
- ▶ Perhaps, then, *H. sapiens*' quintessential adaptation is to exchange ideas, genes, and culture with one another.

Comparative analysis of genome-scale, base-resolution DNA methylation profiles across 580 animal species

- ▶ Methylation of cytosines is a prototypic epigenetic modification of the DNA. It has been implicated in various regulatory mechanisms across the animal kingdom and particularly in vertebrates.
- ▶ Mapped DNA methylation in 580 animal species (535 vertebrates, 45 invertebrates), resulting in 2443 genome-scale DNA methylation profiles of multiple organs.
- ▶ We observed a broadly conserved link with two major transitions—once in the first vertebrates and again with the emergence of reptiles.

Methylation and evolution

- ▶ Our dataset uncovered an unexpected degree of conservation in the characteristics of DNA methylation between vertebrates and invertebrates. First, while invertebrates on average showed lower genome-wide DNA methylation levels than vertebrates, many invertebrate species had genome wide DNA methylation levels well within the distribution of vertebrates
- ▶ In conclusion, **this study provides an initial account of the DNA methylation landscape associated with vertebrate evolution, both by establishing a dataset of unprecedented scale and by deriving insights into conserved and divergent aspects of DNA methylation across a wide range of animal species.** Most notably, we found that DNA sequence and DNA methylation exhibit widespread associations in both vertebrate and invertebrate species that gradually changed over the course of vertebrate evolution

Humans can recognize and understand chimpanzee and bonobo gestures

- ▶ Humans retain an understanding of gestures made by other great apes, even though we no longer use them ourselves
- ▶ The discovery of gestures used by great apes provided the first evidence of intentional communication outside human language, and more than 80 such signals have now been identified.
- ▶ Many of these gestures are shared across non-human apes, including distantly related apes such as chimpanzees and orangutans. However, despite humans being more closely related to chimpanzees and bonobos, these ape gestures are no longer thought to be present in human communication.

Gestures

- ▶ Researchers tested people's understanding of the 10 most common gestures used by chimpanzees (Pan troglodytes) and bonobos (Pan paniscus) using an online game. Over 5,500 participants were asked to view 20 short videos of ape gestures and select the meaning of the gesture from four possible answers.
- ▶ They found that subjects performed significantly better than expected by chance, correctly interpreting the meaning of chimpanzee and bonobo gestures over 50% of the time.

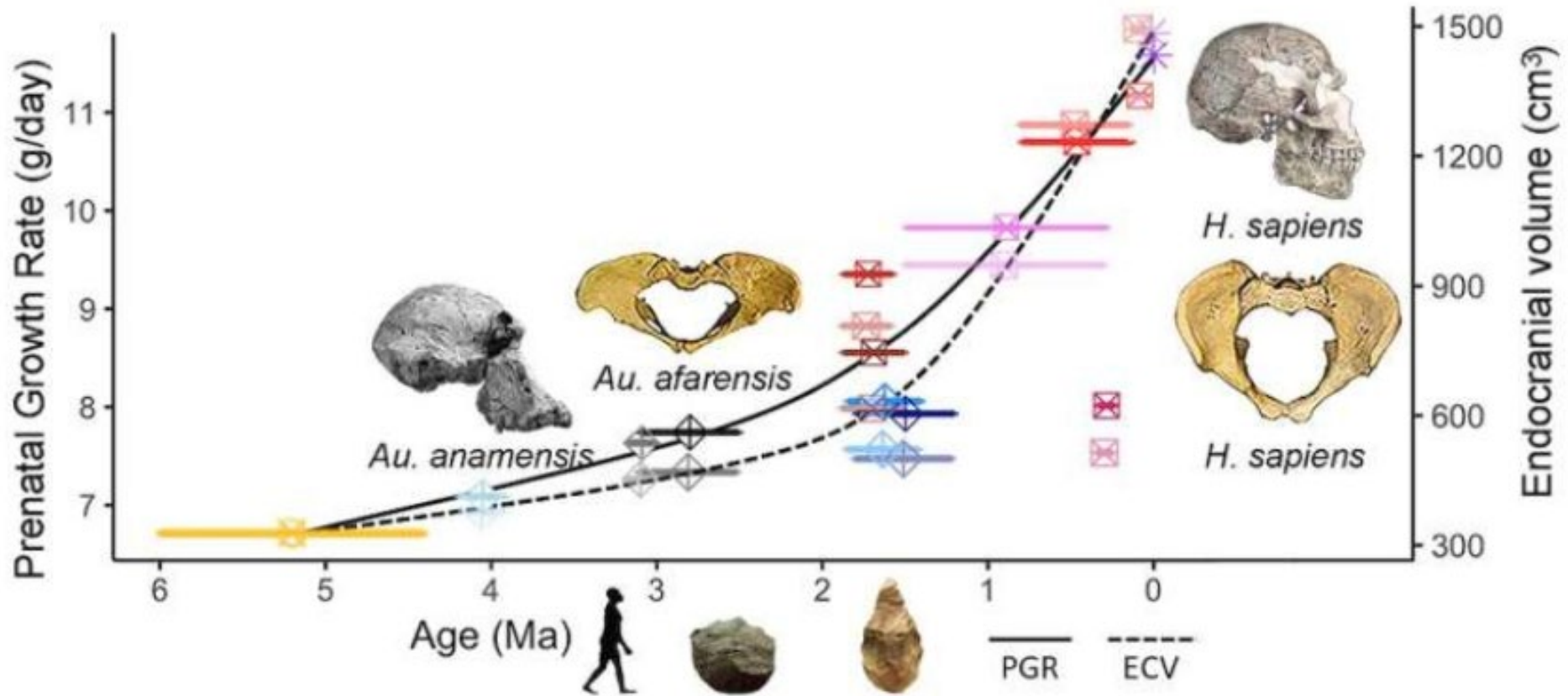
Fast evolution: island wolves switch to hunting otters



Wolves eliminate deer on Alaskan Island then quickly shift to eating sea otters

- ▶ Wolves on an Alaskan island caused a deer population to plummet and switched to primarily eating sea otters in just a few years
- ▶ In 2015 deer were the primary food of the wolves, representing 75% of their diet, while sea otters comprised 25%.
- ▶ By 2017, wolves transitioned to primarily consuming sea otters (57% of their diet) while the frequency of deer declined to 7%.

Human prenatal growth: Humans have the highest prenatal growth rate of all primates living today, (11.58 grams/day).



Using the new equation, researchers found that prenatal growth rates incr...

Molar length predicts prenatal growth

- ▶ Rate of prenatal growth is significantly correlated with both adult brain size and relative tooth lengths
- ▶ Because prenatal growth is so tightly correlated with relative molar lengths, we were able to use this statistical relationship to generate a mathematical equation that predicts prenatal growth rate from teeth alone. With this equation, we can take a few molar teeth from an extinct fossil species and reconstruct exactly how fast their offspring grew during gestation.
- ▶ Prenatal growth rates increased throughout hominid evolution, reaching a humanlike rate that exceeds what we see in all other apes less than 1 million years ago.
- ▶ A fully human prenatal growth rate appeared with the evolution of our species *Homo sapiens* only around 200,000 years ago. But other hominin species living in the past 200,000 years, such as Neanderthals, also had "human" prenatal growth rates

What teeth can tell you

- ▶ Even with only a few teeth and some of the jaw, a trained expert can tell countless things about an extinct individual—what species it was, what kind of diet it ate, whether it competed for mates through fighting, how old it was when it died, whether or not it had any serious health issues and more.
- ▶ Now, for the first time, we can add to that list knowing what pregnancy and gestation were like for that individual and other members of its species

What did ancient humans eat?

- ▶ It is axiomatic that **knowledge of the diets of extinct hominin species is central to any understanding of their ecology and our evolution.**
- ▶ When studying a recovered fossil, the traditional means for attempting to determine **what a given hominin ate is to focus on the teeth**, if present.
- ▶ By **noting their condition, coloration and how they were worn down from chewing**, scientists can infer what the individual might have eaten. But identifying the exact food has remained difficult—at least until recently. New tools now allow researchers to **study the calculus that forms on teeth.**
- ▶ **Newer techniques = analyses of dental calculus, biogeochemistry, and dental microwear.**

Teeth analysis: calculus and diet

- ▶ **Calculus** on the teeth forms due to calcification of bacteria in the plaque that adheres to teeth. Study of calculus can reveal **food particles**, which can be analyzed to isolate the plant or animal eaten by a given individual.
- ▶ One such study they highlight involved **studying the type and features of scratches in the calculus**, noting that such work is generally subject to the "last supper effect," whereby **evidence is representative of only the last few days of a subject's life.**
- ▶ Another study involved comparing isotopes found in the calculus, allowing for broadly determining **which class of plants a given individual had been eating over a period of time prior to death.**



- Fossilized El Sidrón Neandertal adolescent with dental abscess

Dietary self medication

- ▶ El Sidrón 1 may have been self-medicating a dental abscess.
 - ▶ ate poplar, which contains the natural pain-killer salicylic acid (the active ingredient in aspirin),
 - ▶ natural antibiotic producing Penicillium from the molded herbaceous material.
- ▶ Also some evidence that MHs and Ns appeared to swap mouth microbes at one point in time...through kissing or sharing food.

A lab study suggests that antidepressants may push bacteria to become antibiotic resistant

- ▶ Researcher became interested in the possible contributions of non-antibiotic drugs to antibiotic resistance in 2014, after work by his lab found more antibiotic-resistance genes circulating in domestic wastewater samples than in samples of wastewater from hospitals, where antibiotic use is higher.
- ▶ This effect was only observed in petri dishes: exposed the bacterium *Escherichia coli* to different doses of five common antidepressants: sertraline (Zoloft), duloxetine (Cymbalta), bupropion (Wellbutrin), escitalopram (Lexapro) and agomelatine (Valdoxan). Throughout **the two-month exposure period**, the team tested the bacteria's susceptibility to 13 antibiotics, representing six classes of the drugs.

Antidepressants

- ▶ All the antidepressants pushed the *E. coli* to develop antibiotic resistance within the exposure window, but sertraline and duloxetine had the most pronounced effects and generated the highest ratio of resistant bacterial cells to normal cells,
- ▶ The higher the dose of antidepressant, the faster the *E. coli* developed resistance, and the more classes of antibiotics they came to resist within the two months.
- ▶ Effect is better under aerobic conditions.
- ▶ But in healthy humans, *E. coli* is found mainly in the large intestine, where conditions are anaerobic,

The association between persistent cognitive difficulties and depression and functional outcomes in people with major depressive disorder

- ▶ The study analyzed data provided by 508 participants from the UK, Spain and the Netherlands who had completed app-based assessments of thinking, alongside measures of depression, self-esteem, and difficulties with tasks needed for everyday living (functional disability). The assessments were requested every three months and followed up for a maximum of two years. 76% = female; average age was 47 years.
- ▶ Results showed that **persistent thinking difficulties—as reported by patients—was associated with higher levels of depression and difficulties in functioning in everyday life throughout the follow up period**. Objective tests of thinking showed that those with more persistent difficulties (present at more than 75% of timepoints) reported higher levels of depression compared to those whose thinking difficulties were not so persistent (present at less than 25% of timepoints).

- ▶ Found that those with difficulties in decision-making had more problems with everyday tasks and those with poor processing speed tended to have worse symptoms of depression.
- ▶ Our study confirms that an important relationship exists between difficulties in memory, decision-making and concentration and the severity of depression.
- ▶ By using a smartphone app to assess this relationship we have also shown the potential insight that this type of remote monitoring could provide to help patients and clinicians manage symptoms of depression and their impact on their life.
- ▶ Greater persistence of cognitive difficulty with increasing severity of depression and further demonstrate that these cognitive difficulties are associated with pervasive functional disability.