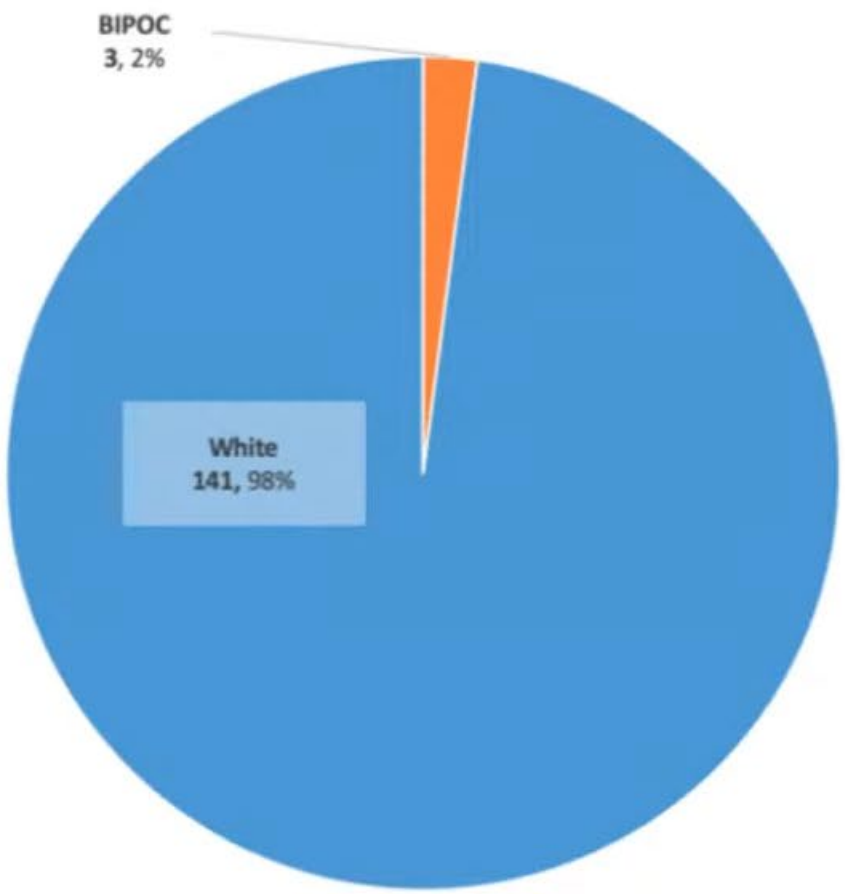
Paleogenetics, Part 12
Peopling of Europe

CHARLES J VELLA, PHD, 2022

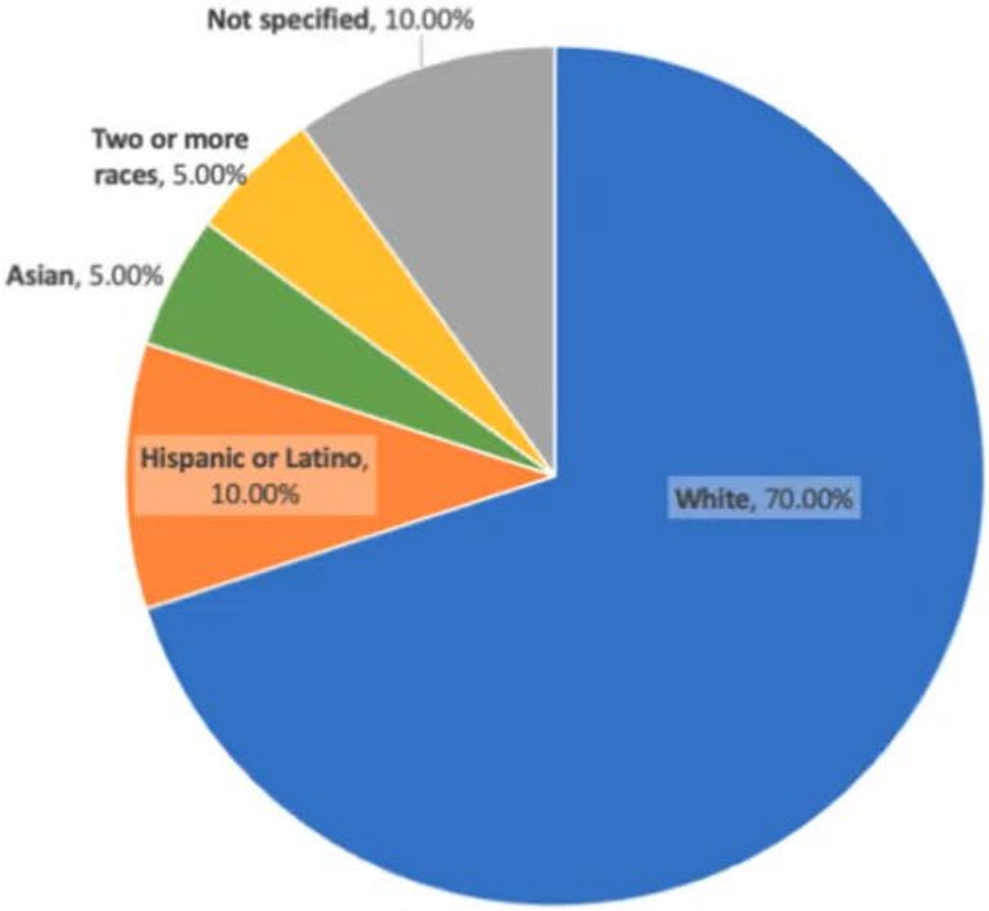
October 2022
Science Update

Colonial History of the Academy
by Rebekah Kim, the Academy's Head Librarian

Does Racism Shape Who Is A Scientist?



Past Academy Curator demographics
(1853-2019)

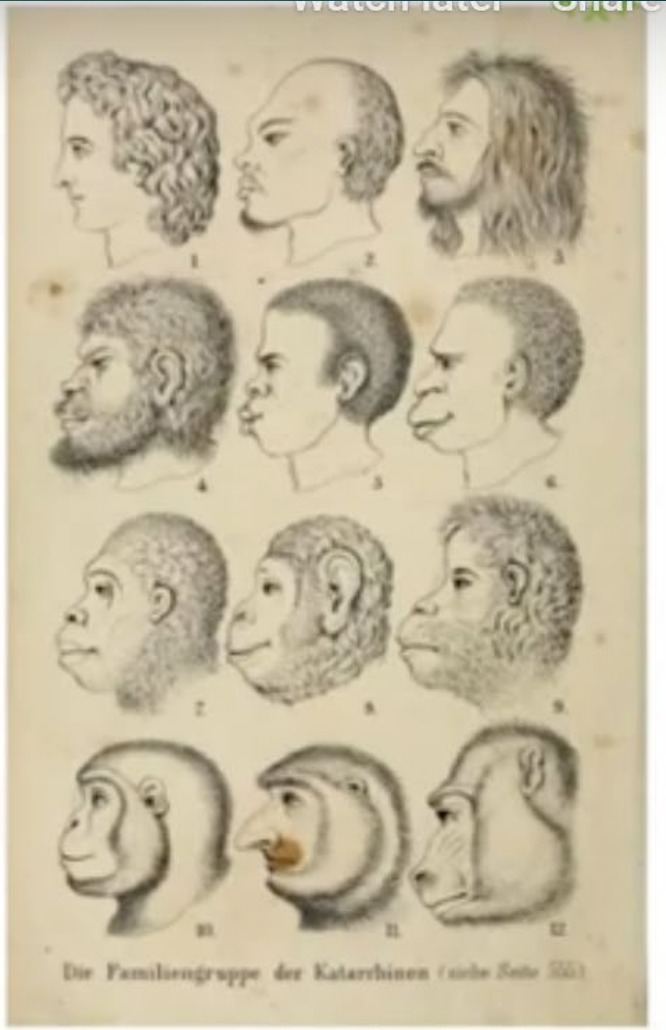


Current Academy Curator demographics

What Is Race?

"Race is a worldview and social classification that divides humans into groups based on their appearance and assumed ancestry, and that has been used to establish social hierarchies."

- Joseph L. Graves Jr. and Alan H. Goodman
  Racism, Not Race: Answers to Frequently Asked Questions



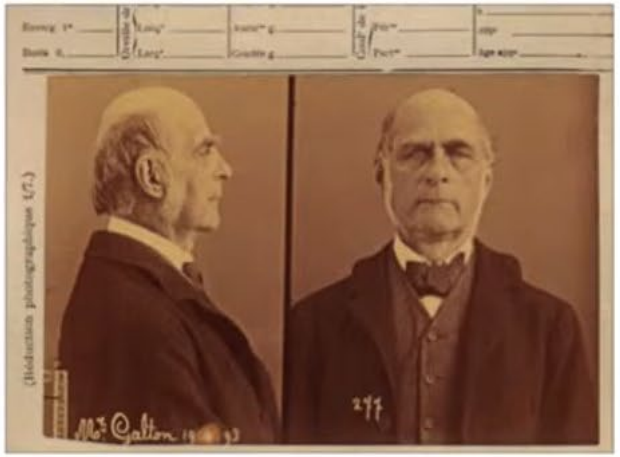
From *Natürliche Schöpfungsgeschichte* (1868) by Ernst Haeckel

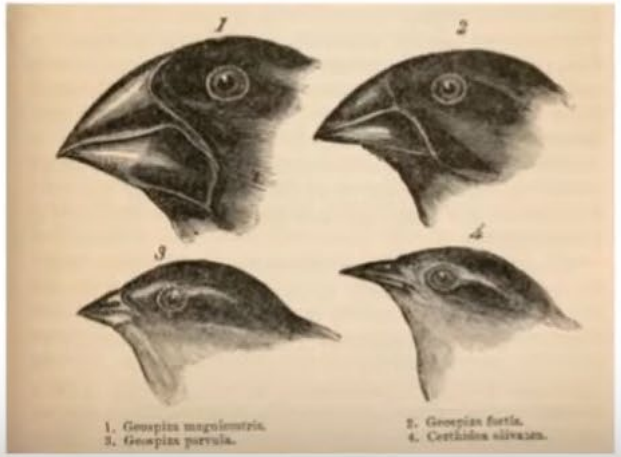
Carl Linnaeus

1701-1778

Species	Skin colour, medical temperament (corresponding to the four medieval humours), and body posture	Physical traits relating to hair colour and form, eye colour, and distinctive facial traits	Behavior	Manner of clothing	Form of government
Americanus	Red, choleric and straight	Straight, black and thick hair; gaping nostrils; [freckled] face; beardless chin	Unyielding, cheerful, free	Paints himself in a maze of red lines	Governed by customary right
Europaeus	White, sanguine, muscular	Plenty of yellow hair; blue eyes	Light, wise, inventor	Protected by tight clothing	Governed by rites
Asiaticus	Sallow, melancholic, stiff	Blackish hair, dark eyes	Stern, haughty, greedy	Protected by loose garments	Governed by opinions
Africanus	Black, phlegmatic, lazy	Dark hair, with many twisting braids; silky skin; flat nose; swollen lips; Women [with] elongated labia; breasts lactating profusely.	Sly, sluggish, neglectful	Anoints himself with fat	Governed by choice [caprice]

Natural Selection & Eugenics





Francis Galton (1822 - 1911)

A **statistician**, sociologist, psychologist, **anthropologist**, tropical explorer, geographer, inventor, meteorologist, proto-geneticist, psychometrician and a **proponent of social Darwinism, eugenics and scientific racism**

Eugenics (pseudoscience): a set of beliefs and practices that aim to improve the genetic quality of a human population (OED)

Continuing Legacies

EO Wilson (1929-2021)

- American biologist, speciality was study of ants
- Best selling author and won two Pulitzer Prizes.
- Considered "the father of sociobiology"
- Conservationist who championed Half-Earth Project
- Wilson's archive revealed a close relationship with Jean-Philippe Rushton.
- Rushton's academic work was connecting intelligence to race, and in his later life headed the Pioneer Fund (hate group).

Rushton: Psychologist – claimed Blacks have larger genitals and buttocks which correlate with smaller br

"Museums are Eurocentric institutions, created in Europe on the basis of Enlightenment ideas that manifest in quite a racist way to the rest of the world. Their DNA is problematic, but that doesn't mean they shouldn't exist."

– Ngaire Blankenberg

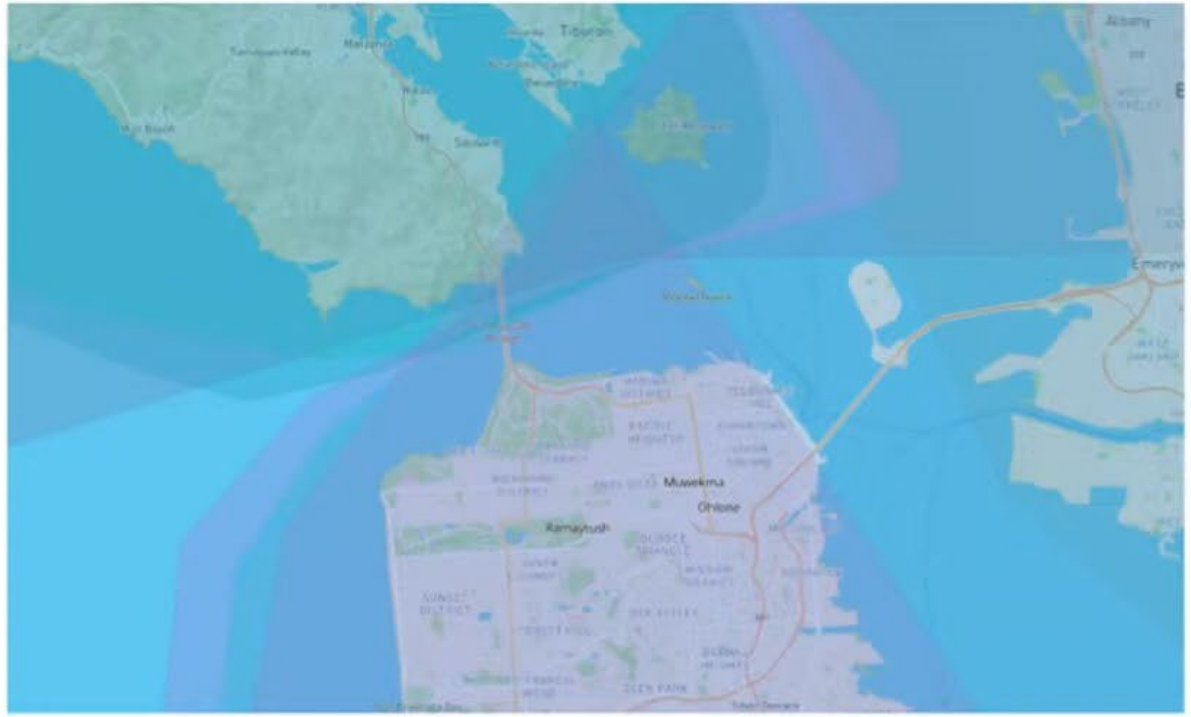
Director of the National Museum of African Art

CAS was founded in 1853

The Academy's Early History

» We are on the unceded, ancestral land of the Ramaytush Ohlone

» "We have on this coast a virgin soil with new characteristics and attributes, which have not been subjected to a critical scientific examination"



native-land.ca

David Starr Jordan

1851-1931

- President of the Academy intermittently between 1896 and 1912
- Founding President of Stanford University (1891-1913)
- Curator of Ichthyology, 1892-1896
- Proponent of Eugenics

Discovered 1900 type specimens by himself; sterilization proponent; a pacificist because war is a way to get rid of fittest; many eugenics groups = norm at the time

Jordan's Sphere of Influence

Influence at the Academy and beyond

Carl & Rosa Smith Eigenmann
Ichthyologists at the Academy (1884-1891), Indiana & San Diego

Barton Warren Evermann
Academy Executive Director (1914-1932)

Eric Knight Jordan
Academy Geology Curator (1924-1926)

Charles Henry Gilbert
Ichthyology Curator, (1892-1898) and professor at Stanford (1891-1925)

Frank Mace MacFarland
Director of Hopkins Marine Station, 1910-1913, 1915-1917 and Academy Director of the 1934-1938

Paul Popenoe
Editor of *Journal of Heredity*, worked with Human Betterment Foundation

Alvin Seale
Ichthyologist & first Superintendent of Steinhart Aquarium (1921-1941)

Leo Stanley
Chief Surgeon of San Quentin (1913-1951)

Leo Stanley: unethical experimentation and sterilizations of prisoners

CAS Collections Data Online* (via GBIF)

1.6 million out of 46 million specimens

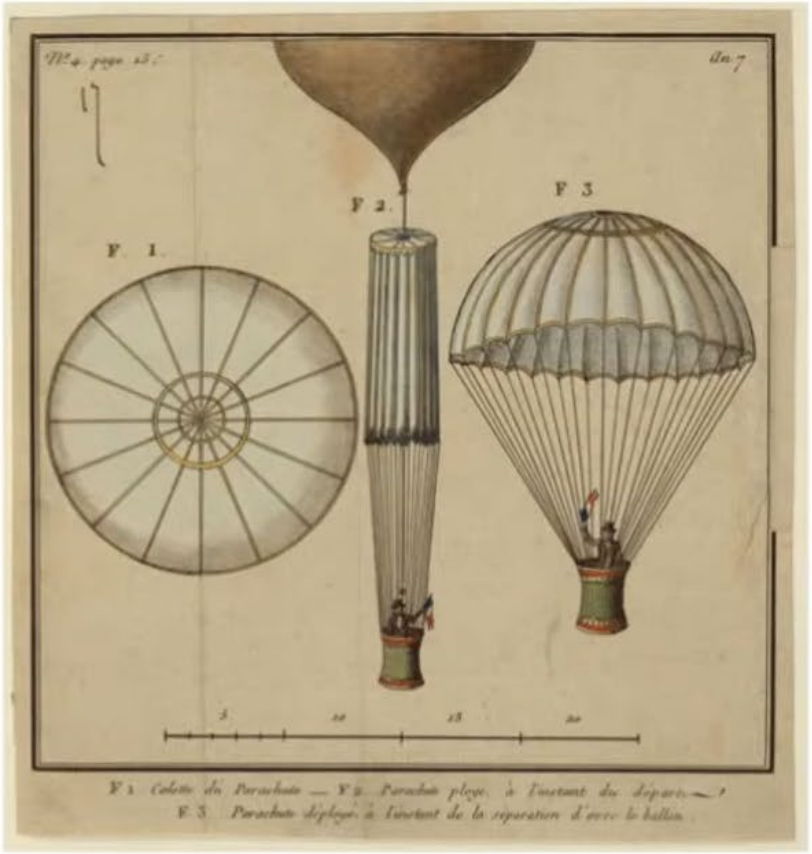
Collecting around the globe

Galapagos expedition crew (1905)

Zaca off Tahaa Island (circa 1930)

Early collections were colonial in nature; paternalistic, no permissions for collec

Parachute Science: What is it?



Library of Congress, Tissandier Collection

Scientists with access to funding "drop in" on a **resource deprived community** to take whatever is needed to further their research without any further effective communication and engagement with others from the host community.

Does not credit local knowledge; esp. in South

Linnaeus color coding was used on 100s of thousands of CAS specimens

Collections

Colonial and imperial collections made by others, stewarded by us

***Micrognathus brachyrhinus* collected from San Miguel Harbor, Philippines, 1908**
CAS Ichthyology collections

Details | Map | Comments | Linked Resources

Ichthyology (CAS-CASC:CASC)

Catalog #: 24763
Occurrence ID: urn:catalog:CAS:ICH:24763
Secondary Catalog #: USNM 137269
Taxon: *Micrognathus brachyrhinus* Herald in Schultz, Herald, Lachner, Welander and Woods, 1953
Family: Syngnathidae
Determiner: Herald, E. S. (1953-01-01)
Type Status: paratype
Collector: U.S. Fish Commission
Date: 1908-04-21
Verbatim Date: 1908-4-21
Locality: Philippines, Ticao, San Miguel Harbor, Philippines
13.942281 123.178822 +-25004m.
Verbatim Coordinates: 13.942281°, 123.178822°
Georeference Remarks: Error covers area around San Miguel Bay.
Individual Count: 1
Preparations: alc-75% EtOH
Usage Rights: http://creativecommons.org/publicdomain/zero/1.0/
Rights Holder: California Academy of Sciences
Record ID: b7d6cf41-a9c4-4d5b-be4b-7335a30c314c

Color-coded geographic regions inventory system
CAS Entomology collections

Collections

Harmful content

» Other examples
  - Colonial place names
  - Racist scientific and common names
  - Species named after problematic people

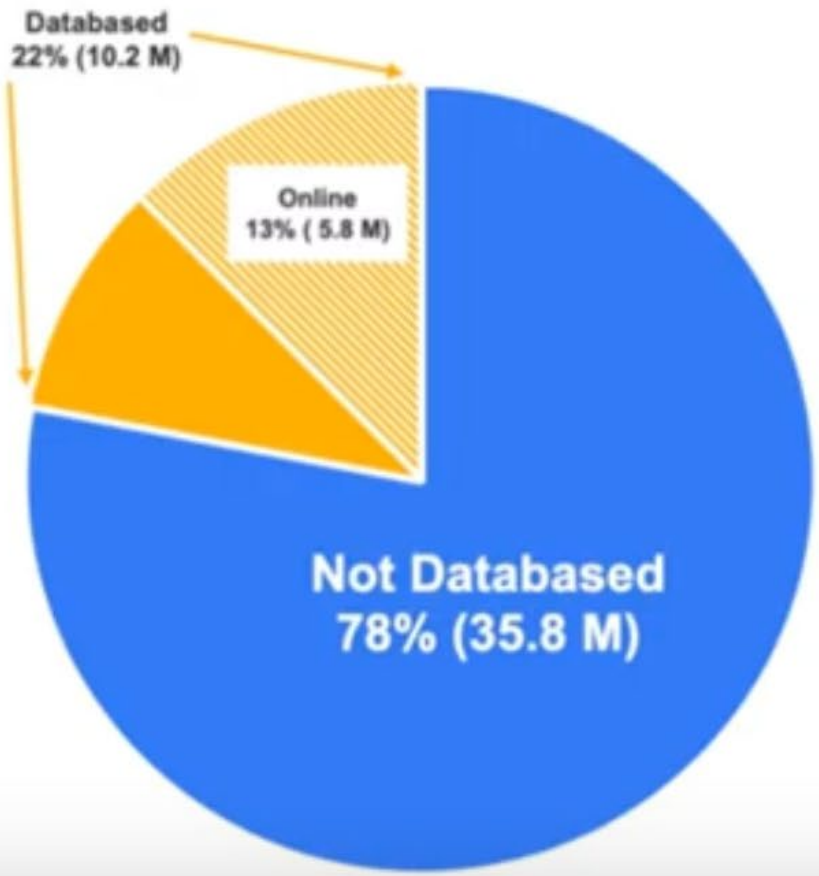
» Missing information
  - Who gets credit and who does not?
  - What we still don't know. What we are yet to uncover…

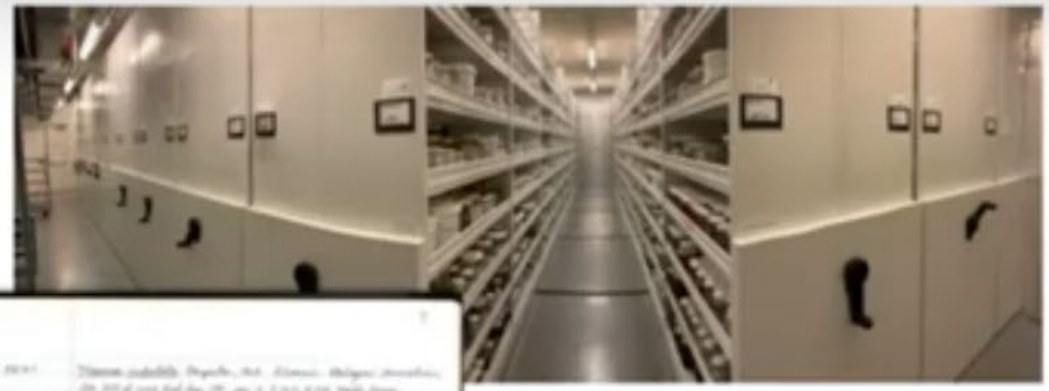
Anophthalmus hitleri Scheibel, 1937

Cave beetle named after Adolph Hitler

Barriers to Accessibility

Who has access?





46 million specimens

Science is based in culture of the time

- Craniology
- Phrenology
- Race as biological

- CAS has a repatriation program

Wattis Hall of Man (1973-1993)

Displaying Culture

Wattis Hall of Man

Cultures as primitive, etc. Othering of non-Western cultures

What Are We Doing Now?

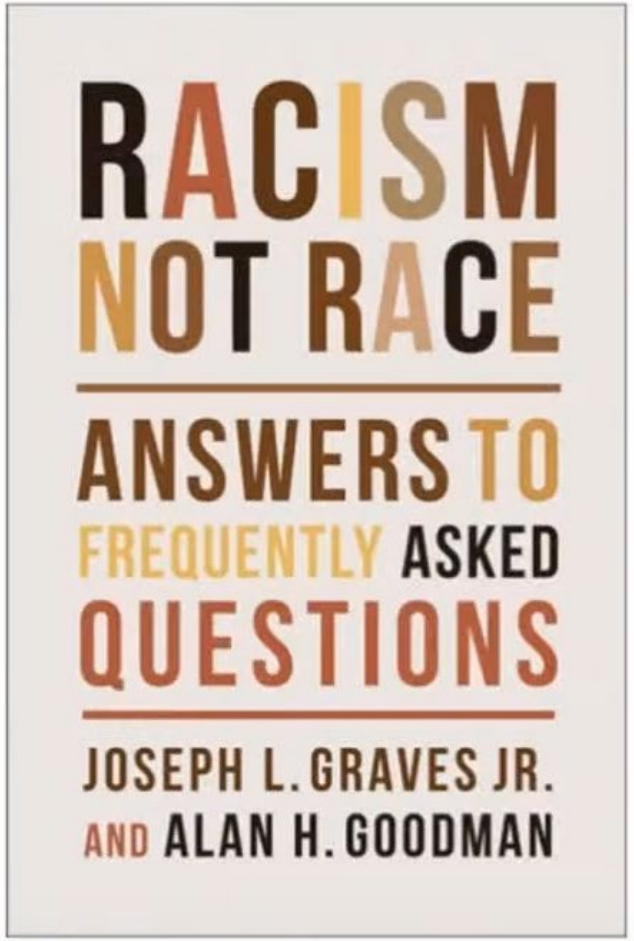
- # 1: Acknowledge our history
- Address parachute science
- Prioritize democratizing collections data
- Address racism and colonialism in our collections
- Indigenous Solidarity group
- IBSS Summer Seminar Series
- Library & Archives project: Untold Stories







Additional Resources



A Burmese Python

A Burmese python weighing 31.5 pounds regurgitating a white tailed deer weighing 35 pounds in southwestern Florida. (Image credit: Ian Bartoszek)

Finally!!

Svante Pääbo: Nobel Laureate in Physiology & Medicine, 2022

Nobel Prize in Physiology or Medicine Is Awarded to Svante Pääbo

- The Nobel Prize in Physiology or Medicine (+$900 K) was awarded to Svante Pääbo, a Swedish-born scientist whose three decades spent trying to extract aDNA and for his technical achievement of extracting genomes of Neandertals and Denisovans in 2010. Svante Pääbo has made stunning discoveries about human evolution using ancient DNA — and his work helped to spawn the competitive field of paleogenomics.
- Elizabeth Kolbert: likened aDNA extraction process to reassembling a "Manhattan telephone book from pages that have been put through a shredder, mixed with yesterday's trash, and left to rot in a landfill."
- Son of Sune Bergstrom, a well-known biochemist who had shared the Nobel Prize in Chemistry in 1982

Congratulations

Traditional dunk at Leipzig

N genetic contribution to current MHs

- Analyzed Neandertal DNA associations with a large variety of more than a hundred brain disorders and traits such as sleep, smoking or alcohol use in the U.K. Biobank with the aim to narrow down the specific contribution of Neandertal DNA to variation in behavioral features in people today.
- While Neandertal DNA showed over-proportional numbers of associations with several traits that are associated with central nervous system diseases, the diseases themselves did not show any significant numbers of Neandertal DNA associations.
- Among the traits with the strongest Neandertal DNA contribution were smoking habits, alcohol consumption and sleeping patterns.
- Results suggest that Neandertals carried multiple variants that substantially increase the smoking risk in people today

Quantum 'spooky action at a distance' lands scientists Nobel prize in physics

- They designed experiments that proved atomic particles could affect each other instantaneously over vast distances.
- The 2022 Nobel Prize in Physics has been awarded to three scientists whose work pioneered one of the most fascinating tests in the world of quantum mechanics, contradicting Einstein and discovering the strange phenomenon of quantum teleportation.
- John F. Clauser, Alain Aspect, and Anton Zeilinger won the 10 million Swedish krona ($915,000) prize for "experiments with entangled photons, establishing the violation of Bell inequalities and pioneering quantum information science"
- Albert Einstein dubbed the phenomenon "spooky action at a distance“

Entanglement

- Quantum entanglement, a process in which two or more quantum particles are coupled so that any change in one particle will lead to a simultaneous change in the other, even if they are separated by vast, even infinite, distances. This effect gives quantum computers the ability to perform multiple calculations simultaneously, exponentially boosting their processing power over those of conventional devices.
- The physical world is best described not by the discrete billiard ball model of Newtonian physics, but rather by a model of wave-like particles that affect each other instantaneously across enormous distances.
- Anton Zeilinger, of the University of Vienna, built upon these foundations, using a more sophisticated experimental design to entangle multiple photons and even demonstrating that it is possible to move all of the information about one particle to another. Zeilinger also showed that the effect still took place across enormous distances, with entangled particles 89 miles (143 kilometers) apart still behaving according to quantum predictions.

Quantum

- China's quantum satellite sent secure messages over 1200 km
- China launched its Micius quantum satellite in 2016. It produces pairs of photons that are quantum entangled, meaning the measured state of one photon is linked to the measured state of the other, regardless of the distance between them.
- Entanglement can’t directly transfer information, because that would mean data is travelling faster than light. But entangled particles can be used to create secret “keys” that enable extraordinarily secure communication.
- This kind of communication could eventually be used to build a secure, unhackable internet of quantum information

Rapid evolutionary change: genetic mutation in 1819 – a transposon change: these extra 9,000 bases landed in its *cortex* gene,

- In an iconic evolutionary case study, a black form of the peppered moth rapidly took over in industrial parts of the UK during the 1800s, as soot blackened the tree trunks and walls of its habitat.

Dark colouring helped the moths escape being picked off by birds as their habitat changed

Chernobyl frog evolution: frogs with darker skin survived

A colored gradient shows how Eastern tree frogs in Chernobyl have adapted to radiation by evolving to have darker skin. (Image credit: Germán Orizaola and Pablo Burraco)

Eastern tree frogs (*Hyla orientalis*) with more skin-darkening melanin pigment were more likely to survive the 1986 nuclear accident in Ukraine than frogs with lighter skin, leading to populations today that are dominated by darker frogs.

Neurons in a dish learn to play Pong —

Cortical Labs company calls its neuron system DishBrain.

The work is a proof of principle that neurons in a dish can learn and exhibit basic signs of intelligence.

Each DishBrain has thousands of attached electrodes. Use neurons to develop “biological processing units” for use in computing.

Pong

- Hundreds of thousands of human neurons growing in a dish coated with electrodes have been taught to play a version of the classic computer game *Pong*.
- In doing so, the cells join a growing pantheon of *Pong* players, including pigs taught to manipulate joysticks with their snouts[2] and monkeys wired to control the game with their minds.
- The gamer cells respond not to visual cues on a screen but to electrical signals from the electrodes in the dish. These electrodes both stimulate the cells and record changes in neuronal activity. Researchers then converted the stimulation signals and the cellular responses into a visual depiction of the game. The results are reported today in *Neuron*.

A series of hominoid crania (counterclockwise from the L): juvenile Australopithecus, adult Australopithecus, adult chimpanzee, juvenile chimpanzee, adult Homo erectus (center).

Hominid prenatal growth rates found to have increased after lineage split from chimps

- Humans are characterized by having very large brains relative to body size. Because gestation is critically linked to brain size, pregnancy is an important but elusive aspect of hominid evolution.

- High Prenatal growth rate results in human infants that are quite large at birth relative to their time of gestation, with both large neonatal body mass and brain mass compared to other primates.

- Yet, despite this large body and brain mass, at birth the human infant brain is still only 30% of the size of the adult brain, a developmental characteristic that leads to a helpless infant that is highly reliant on parents and other social group members for survival

Tesla A. Monson, et al., 2022

Prenatal growth rate

- The human linage that split from chimps underwent an increase in prenatal growth rate soon after the split.

- Prior research has shown that the prenatal growth rate for humans is faster than for all of the other primates—a human fetus, for example, grows by approximately 11.6 grams a day, while gorillas grow by just 8.2 grams per day. It has been suggested by some researchers that the faster prenatal growth rate led to the relatively speedy evolution of a larger brain.
- Study: measurement of the first and third molar provided a good correlation ratio for prenatal growth for 13 hominid species.

Prenatal growth rate

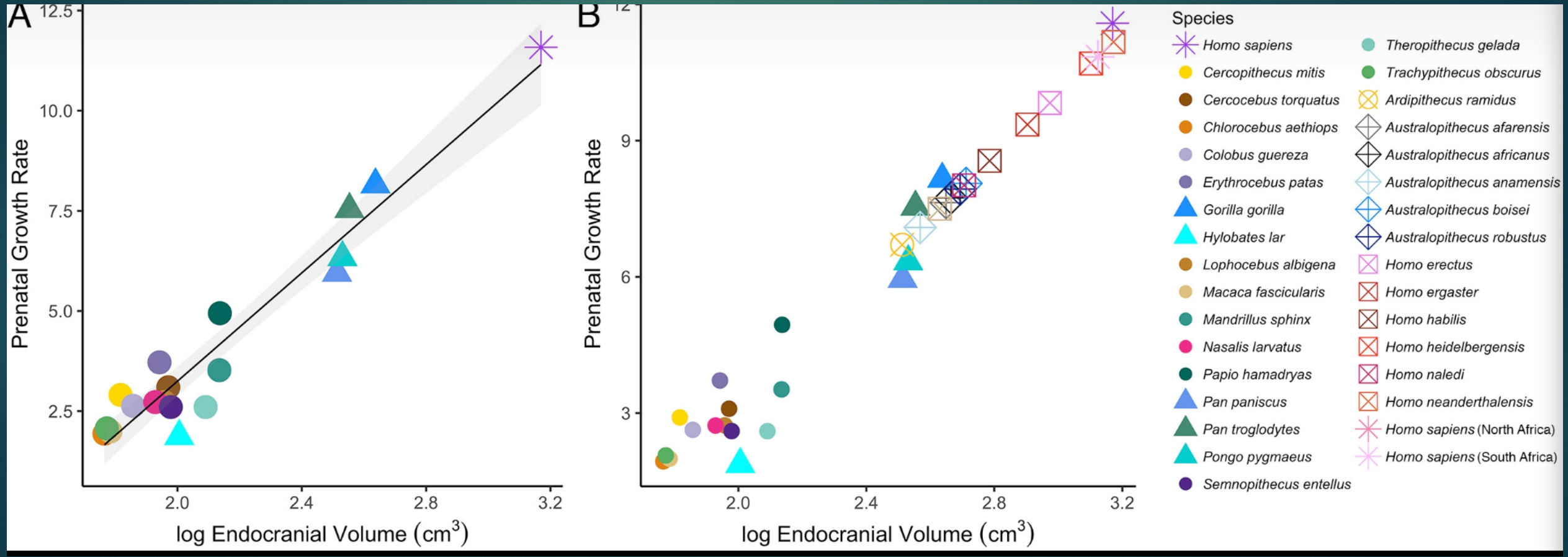
- Found that prenatal growth rate in the linage that developed into humans began to speed up after diverging from chimpanzees approximately 5 to 6 million years ago.
- The increased rate matched that of modern humans as far back as 1 million years ago; a human-like PGR evolved less than 1 million years ago in later *Homo*
- Rise in prenatal growth rate they calculated does coincide with similar estimates made by other teams using measurements of brain and pelvis size increases.
- Support the evolution of human-like pregnancy in the Pleistocene and open up possibilities for novel ways to explore the evolution of hominid gestation via dental variation.

Prenatal teeth and brain growth correlated

- We demonstrate that dentition provides a window into the life of neonates. Teeth begin to form in utero and are intimately associated with gestational development. Calculated as the ratio of birth weight (mass in grams) to gestation length (days), mammalian species that have high rates of prenatal growth have infants that are larger at birth relative to other species with comparable lengths of gestation.
- We measured the molar dentition for 608 catarrhine primates and collected data on prenatal dental growth rate (PGR) and endocranial (brain) volume (ECV) for 19 primate genera .
- Found that PGR and ECV are highly correlated (R^2 = 0.93); ECV predicts increasing prenatal growth rates in the hominid fossil record. ECV is a strong indicator of PGR and, in turn, maternal physiological investment during gestation. molar proportions are ALSO significantly correlated with PGR

- Together with pelvic and endocranial morphology, reconstructed PGRs indicate the need for increasing maternal energetics during pregnancy over the last 6 million years, reaching a human-like PGR (i.e., more similar to humans than to other extant apes) and ECV in later *Homo* less than 1 million years ago.

Prenatal dental growth rate (PGR) (g/day) is significantly correlated with endocranial (brain) volume (ECV) in extant catarrhines (R^2 = 0.93)

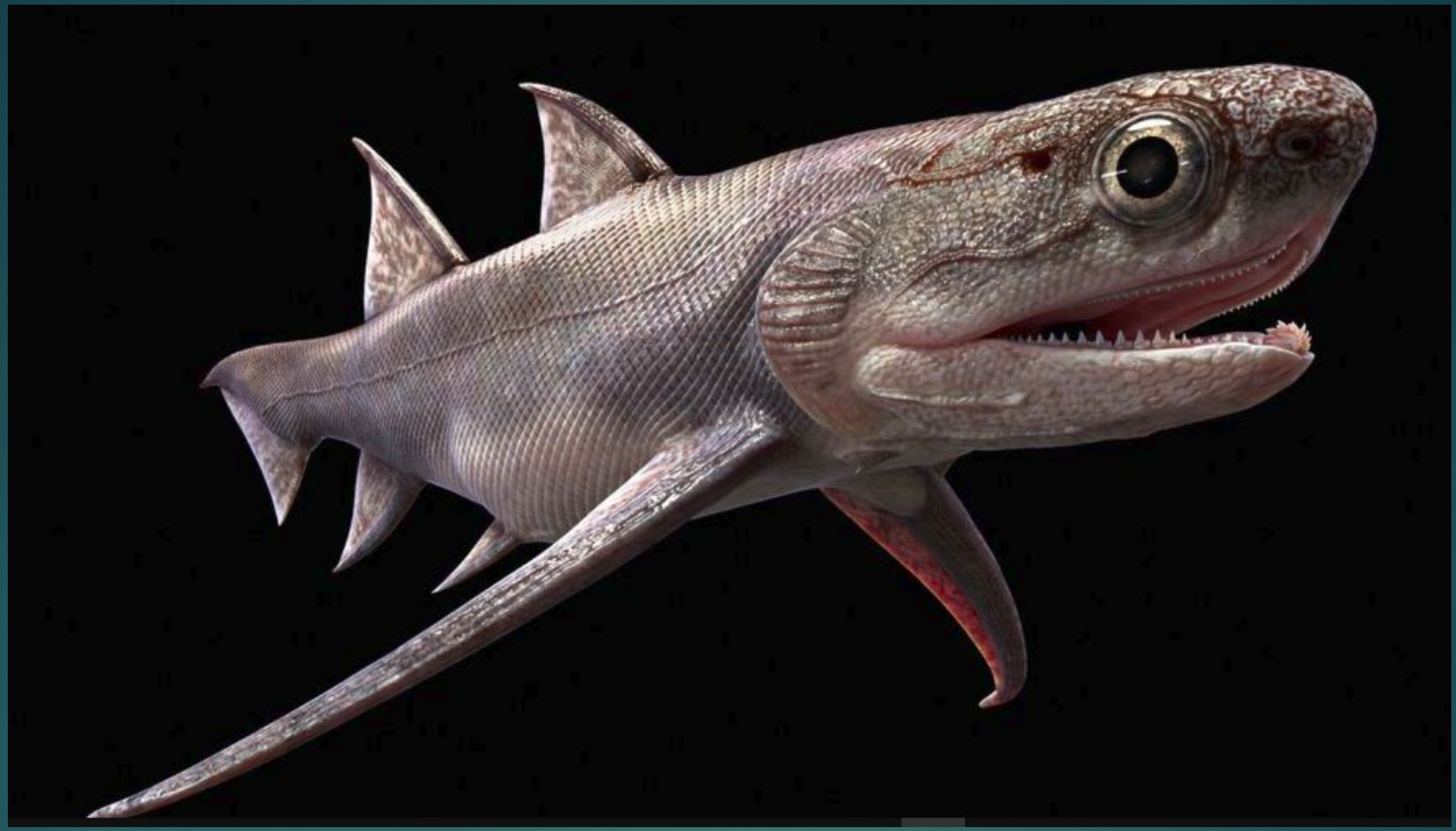


H. naledi had the lowest PGR of all species in genus Homo

Fossils reveal the deep roots of jawed vertebrates

Fanjingshania, ***a 439-million-year-old 'shark' that forces us to rethink the timeline of vertebrate evolution***

Establish unequivocally an ancient origin for jawed vertebrates: Dating to between 439 million and 436 million years ago



The fossil discoveries all come from new fossil sites in the Guizhou and Chongqing Provinces in China. The Chongqing site was found in 2019, when three young Chinese palaeontologists were play fighting, and one was kung-fu kicked into the outcrop. Rocks tumbled down, revealing a spectacular fossil inside.

Increasing evidence that bears are not carnivores

What do you want to eat? Bears = omnivores, not carnivores

- Bears evolved early and continuously to be low-protein macronutrient omnivores
- Bears are not cats or dogs, and feeding them like they are likely shortens their lives.
- A new study in *Scientific Reports* on the diets of giant pandas and sloth bears adds more evidence that bears are omnivores like humans and need a lot less protein than they are typically fed in zoos.
- Bears are not carnivores in the strictest sense like a cat where they consume a high-protein diet

Bears

- Giant Pandas prefer a high-carbohydrate, low-protein diet
- Sloth bears: chose the fat-rich avocados almost exclusively, eating roughly 88% avocadoes to 12% yams; typically live only around 17 years in U.S. zoos, almost 20 years less than the maximum lifespan
- Grizzly bears in the wild eat salmon, but then wander off and spend hours finding and eating small berries

Evidence of dinosaur-killing asteroid impact found on the moon

Asteroid strikes on the Moon at 66 Ma

- Asteroid impacts on the moon millions of years ago correspond with large space rock strikes here on Earth — including the massive impact that wiped out the nonavian dinosaurs.
- The finding reveals that major impacts during Earth's prehistory were not isolated events. Instead, these asteroid strikes were accompanied by a series of smaller hits both here and on the moon, whose surface is littered with over 9,000 craters left by space rock impacts.
- Results by studying microscopic glass beads within lunar soil samples returned to Earth by China's Chang'e-5 lunar mission in 2020.
- These tiny glass beads were created by the intense heat and pressure generated by meteor strikes.

Chicxulub impactor

- The ages of some of the lunar glass beads indicated they were created around 66 million years ago, around the time the dinosaur-killing asteroid, known as the Chicxulub impactor, struck Earth in what is now the Gulf of Mexico, near Mexico's Yucatán Peninsula.
- The impact led to what is known as the Cretaceous-Paleogene extinction event, which ultimately killed three-quarters of all life on Earth, including the nonavian dinosaurs.
- The roughly 6.2-mile-wide (10 kilometers) Chicxulub impactor struck Earth at around 12 miles per second (19.3 kilometers per second), or 43,200 mph (69,524 kph), leaving an impact crater measuring about 93 miles (150 km) wide and 12 miles (19 km) deep. Aside from the shock waves generated by the initial impact, the asteroid hit caused a series of life-altering knock-on effects, including throwing up thick clouds of dust that blocked out the sun.

1 Km asteroid = earth killer

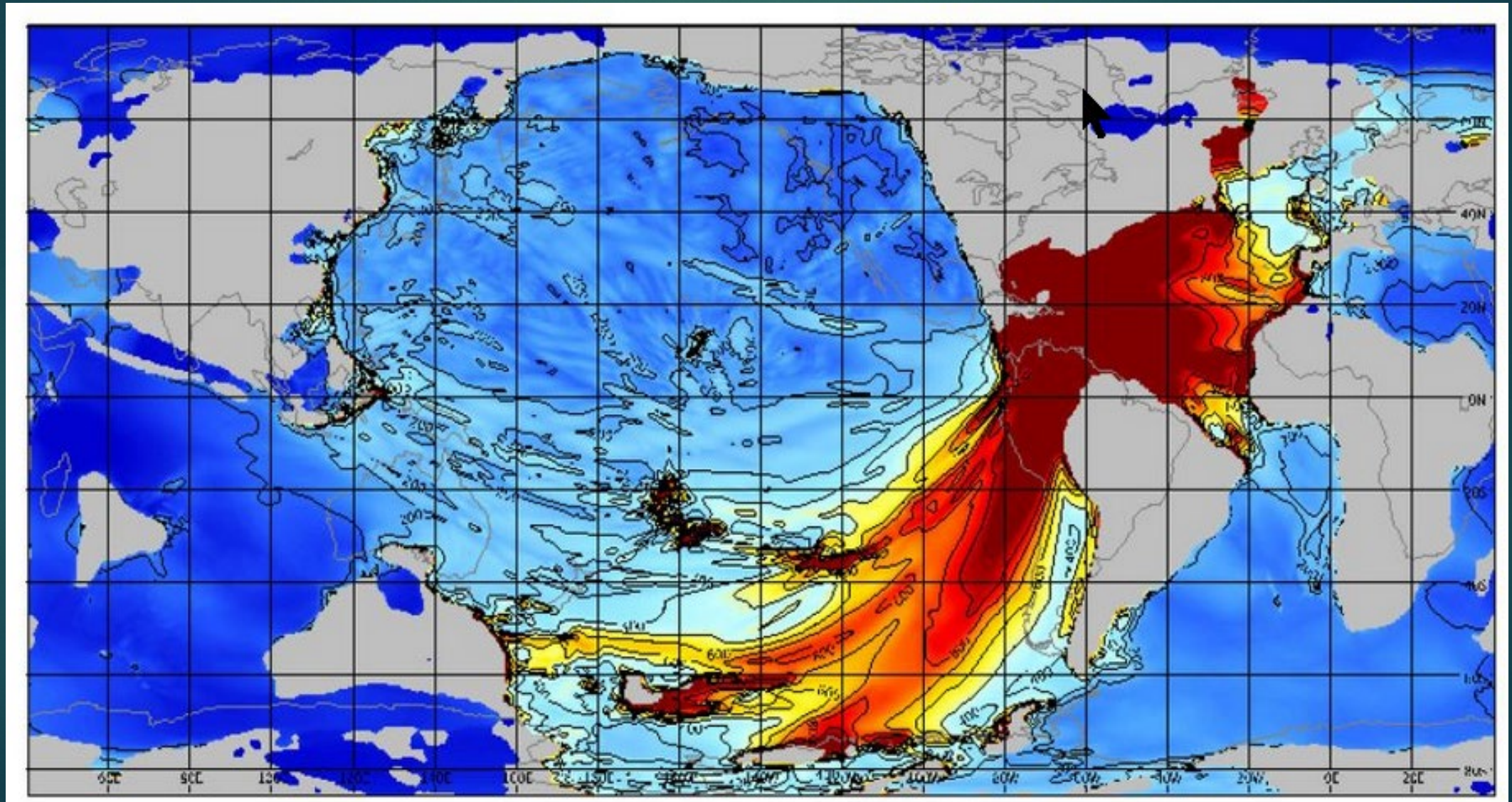
- The initial impact creates a vast fireball that kills anyone who can see it. Then dust from the impact and smoke from the fires girdles the Earth, led to lethal acid rain and extended global cooling. plunging our planet into a so-called impact winter
- During this season of suffering, so much dust and noxious gas would cloud the sky that plants could no longer turn sunlight into energy via photosynthesis. Plant life would perish around the world, and animals would soon follow suit. Only very small and ground-dwelling animals (like our early mammal ancestors) would have a shot at survival.
- The good news is, there is no threat of any potentially hazardous asteroid reaching our planet for at least the next 100 years.

Asteroid = tsunami

- The dinosaur-killing asteroid that slammed into Earth 66 million years ago also triggered a jumbo-size tsunami with mile-high waves in the Gulf of Mexico whose waters traveled halfway around the world.

- Researchers discovered evidence of this monumental tsunami after analyzing cores from more than 100 sites worldwide and creating digital models of the monstrous waves after the asteroid's impact in Mexico's Yucatán Peninsula.

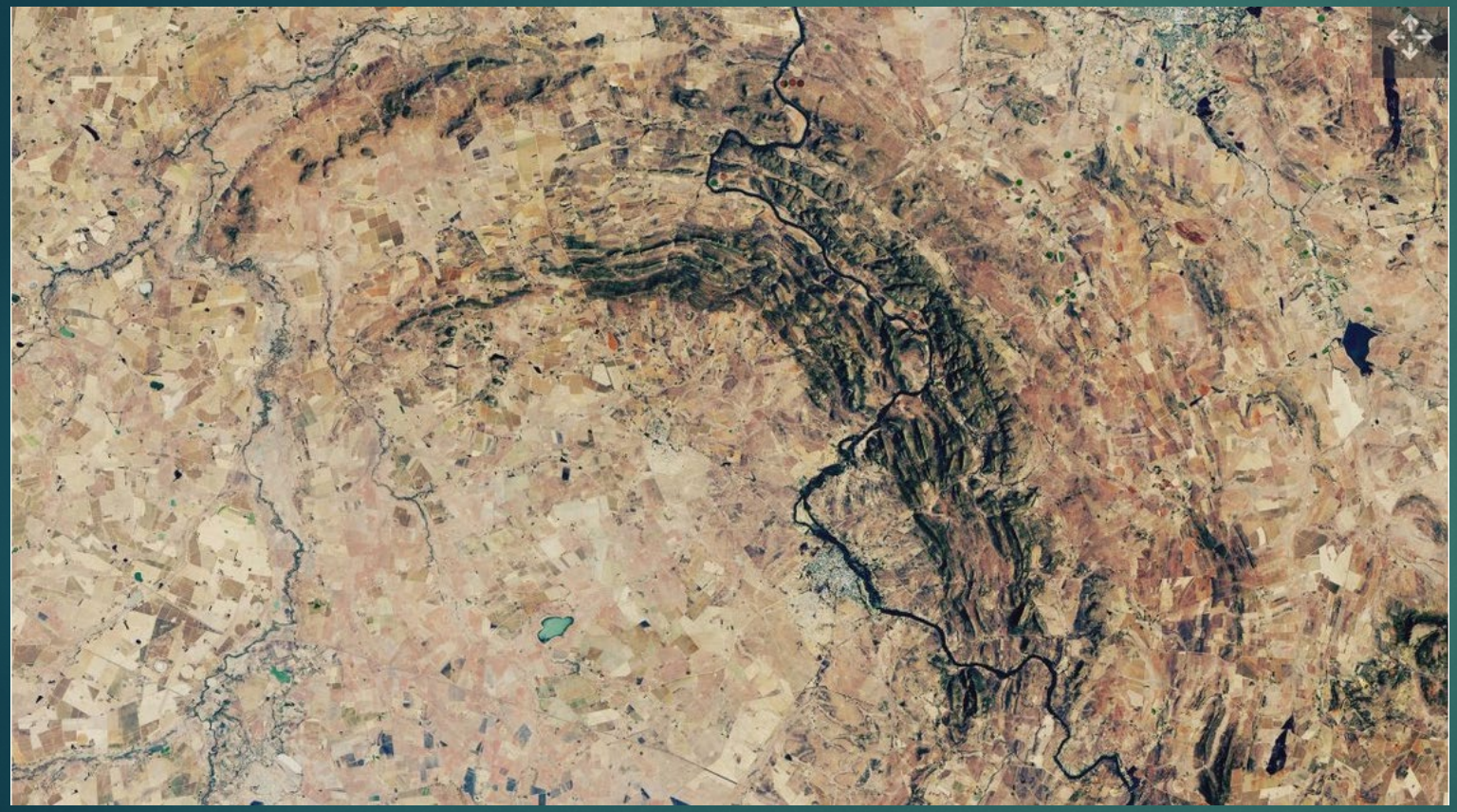
The modeled tsunami sea-surface height perturbation (in meters) 24 hours after the dinosaur-killing asteroid hit Earth



Chicxulub

- Once the asteroid struck Earth, it created a 62-mile-wide (100 km) crater and kicked up a dense cloud of dust and soot into the atmosphere. Just 2.5 minutes after the strike, a curtain of ejected material pushed a wall of water outward, briefly making a 2.8-mile-tall (4.5 km) wave that crashed down as the ejecta plummeted back to Earth, according to the simulation.
- At the 10 minute mark, a 0.93-mile-high (1.5 km) tsunami wave about 137 miles (220 km) away from the impact site swept through the gulf in all directions.
- An hour after the impact, the tsunami had left the Gulf of Mexico and rushed into the North Atlantic. Four hours following the impact, the tsunami passed through the Central American Seaway — a passage that separated North from South America at the time — and into the Pacific.
- A full day after the asteroid's collision, the waves had traveled through most of the Pacific and the Atlantic, entering the Indian Ocean from both sides, and touching most of the globe's coastlines 48 hours after the strike.

Largest asteroid ever to hit Earth was twice as big as the rock that killed off the dinosaurs



- The Vredefort crater was birthed 2 billion years ago when the largest asteroid ever to hit Earth impacted the planet.
- Rock was somewhere between 12.4 and 15.5 miles wide.
- 75 miles (120 kilometers) southwest of Johannesburg,
- Currently measures about 99 miles (159 km) in diameter, making it the biggest visible crater on Earth; originally 155 to 174 miles
- Chicxulub crater = 112 miles

Biggest impact: The simulation shows the moon forming from the shattered remains of Theia and parts of Earth's ejected mantle.

Creation of the moon

- The moon could have formed immediately after a cataclysmic impact that tore off a chunk of Earth and hurled it into space
- Since the mid-1970s, astronomers have thought that the moon could have been made by a collision between Earth and an ancient Mars-size protoplanet called Theia; the colossal impact would have created an enormous debris field from which our lunar companion slowly formed over thousands of years.
- But a new hypothesis, based on supercomputer simulations made at a higher resolution than ever before, suggests that the moon's formation might not have been a slow and gradual process after all, but one that instead took place within just a few hours.

Creation of moon

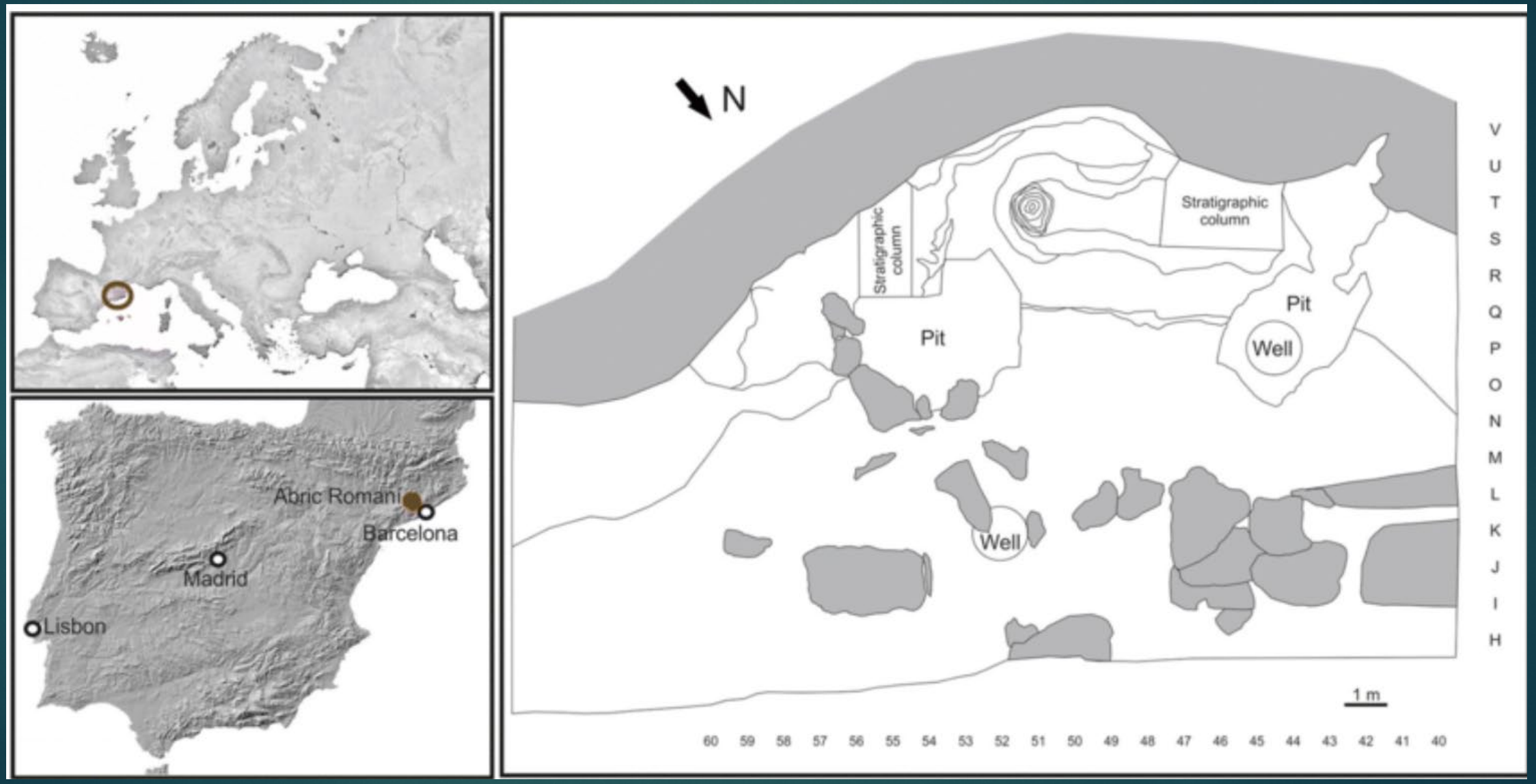
- Scientists got their first clues about the moon's creation after the return of the Apollo 11 mission in July 1969, when NASA astronauts Neil Armstrong and Buzz Aldrin brought 47.6 pounds (21.6 kilograms) of lunar rock and dust back to Earth. The samples dated to around 4.5 billion years ago, placing the moon's creation in the turbulent period roughly 150 million years after the formation of the solar system.
- Other clues point to our largest natural satellite being birthed by a violent collision between Earth and a hypothetical planet, which scientists named after the mythic Greek titan Theia — the mother of Selene, goddess of the moon. This evidence includes similarities in the composition of lunar and Earth rocks; Earth's spin and the moon's orbit having similar orientations; the high combined angular momentum of the two bodies; and the existence of debris disks elsewhere in our solar system.


norton
Denied webcam access to Sn

A modest molar found at the new site of Qvemo Orozmani, about 20 km from Dmanisi (Georgia) constitutes the oldest human remains in Eurasia outside of Dmanisi, since a similar dating of 1.77-1.84 Ma is estimated.

Orozmani: molar found in 2022 (photo: REUTERS/David Chkhikvishvili).

Neanderthal site of Abric Romaní (Barcelona, Spain); 300 sqm



Neanderthal site of Abric Romaní (Barcelona, Spain)

- More N remains have been discovered in the magnificent Neanderthal site of Abric Romaní, after more than 40 years of continuous research, which has revealed much information about Neandertal's way of life (group size between 6 and 12 individuals, organization of spaces, multiple bonfires, use of wood, lithic industry and the fauna hunted and consumed there).
- In the 2022 campaign, four N parietal, temporal and zygomatic fragments are added to this great collection. The estimated dating is 60 ka.
- 12,000 archaeological remains have been found including fauna and stone tools, and more than thirty hearths. .

Neanderthal remains of Abric Romaní

Neanderthal remains of Abric Romaní. Credit: María D. Guillén IPHES-CERC

Neandertal domestic living spaces

- The inner part of the rock shelter located close to the wall was used as a sleeping area as showed by many small fireplaces.

- In the central part of the site we found large domestic areas were Neanderthals developed different activities, such as the tools production and food cooking.

- Finally, the external part of the campsite was used as waste dump. There abundant fauna, stone tools and charcoals remains have been recovered.

Condors do virgin birth!

No mating needed

- Female California condors don't need males to have offspring—joining sharks, rays, reticulated pythons, and lizards on the list of creatures that can reproduce without mating.
- For decades, scientists have been trying to coax the California condor back from the edge of extinction. The entire population of these birds crashed to just 22 animals in 1982. By 2019, captive breeding and release efforts had slowly built the total population up over 500.
- Discovered that two male birds—known only by their studbook numbers, SB260 and SB517—showed no genetic contribution from the birds that should have been their fathers.
- In other words, the birds came into the world by facultative parthenogenesis—or virgin birth. What's particularly bizarre about the condors, says Ryder, is that SB260 and SB517 had different mothers, each of them housed with males. What's more, both mothers had successfully reproduced with those males before and after. neither of the offspring produced by parthenogenesis survived to reproduce itself.

Parthenogenesis

- Such asexual reproduction in normally sexually reproducing species occurs when certain cells produced with a female animal's egg behave like sperm and fuse with the egg.
- Recorded self-fertilization in some captive bird species, such as turkeys, chickens, and Chinese painted quail, usually only when females are housed without access to a male. But this is the first time it's been recorded in California condors.
- Also in komodo dragons
- The critically endangered smalltooth sawfish may be turning to parthenogenesis as mates become increasingly difficult to find in the wild.

Chimpanzee ranges and eastern Rift Valleys

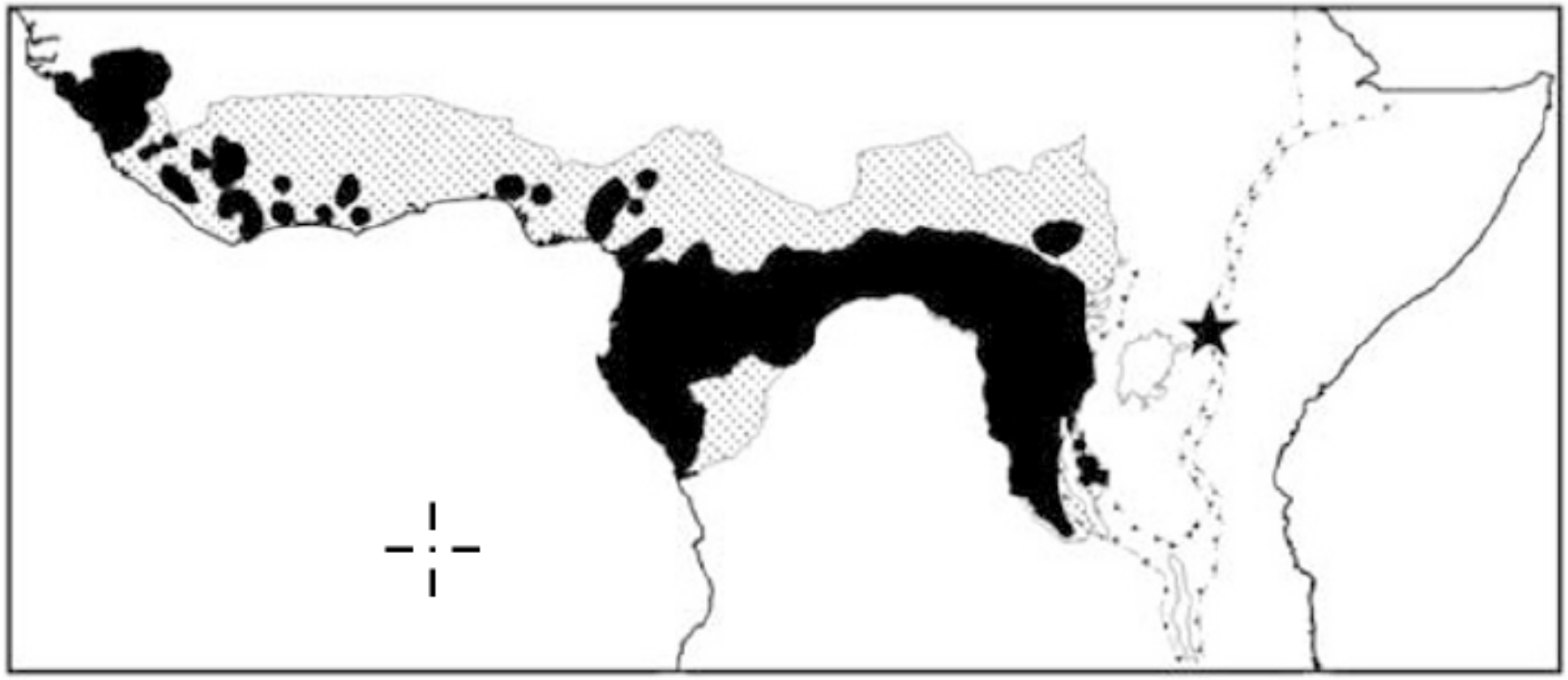


Figure 1 | Map showing current (solid black) and historical (stippled) ranges of *Pan* in equatorial Africa relative to major features of the eastern and western Rift Valleys. The Kapthurin Formation, Kenya, in the Eastern Rift Valley is marked by a star.

KNM-TH 45519 fossil chimp tooth

How many chimpanzee fossils are there?

- There are no chimp bone fossils! Why?
- First fossil chimpanzee - Sally McBrearty, Nina G Jablonski, Nature 2005.
- In 2005, in a sediment of the Kapthurin Formation in the Eastern Rift Valley, Sally McBrearty of the Univ. of CT and Nina Jablonski of the California Academy of Sciences discovered 5 chimp fossil teeth, dated to 500 Ka. In basalt outcrop in Kenya near Lake Bogoria and Lake Baringo.
- They were found in sediments that include fossils of two early humans – *Homo erecti* (within 1 mile; a mandible, Acheulean tools)– suggesting that these chimps and human ancestors were contemporaries.
- Suggested that chimp ancestors were more capable of adapting to a broader range environments than previously thought; not just rain forest.
- No bones: rain forest soil is wet and acidic

Nearby to chimp teeth: *H. erectus* mandible: sediment of the Kapthurin Formation in the Eastern Rift Valley

Only Gorilla fossils:

2007: 8 gorilla fossil teeth in Ethiopia

- Because of the dearth of fossil hominoid remains in sub-Saharan Africa spanning the period 12–7 Myr ago, nothing is known of the actual timing and mode of divergence of the African ape and hominid lineages.
- Most genomic-based studies suggest a late divergence date—5–6 Myr ago and 6–8 Myr ago for the human–chimp and human–gorilla splits, respectively—and some palaeontological and molecular analyses hypothesize a Eurasian origin of the African ape and hominid clade.
- Discovery and recognition of a new species of great ape, *Chororapithecus abyssinicus*, from the 10–10.5-Myr-old deposits of the Chorora Formation at the southern margin of the Afar rift. To the best of our knowledge, these are the first fossils of a large-bodied Miocene ape from the African continent north of Kenya.
- Evidence suggests that *Chororapithecus* may be a basal member of the gorilla clade, and that the latter exhibited some amount of adaptive and phyletic diversity at around 10–11 Myr ago.

Climate change and deforestation may drive tree-dwelling primates to the ground

Unlike our evolution down from trees…

- Data on 15 lemur species and 32 monkey species at 68 sites in the Americas and Madagascar. 118 co-authors from 124 unique institutions.
- A large-scale study of 47 species of monkeys and lemurs has found that climate change and deforestation are driving these tree-dwelling animals to the ground, where they are at higher risk due to lack of preferred food and shelter, and may experience more negative interaction with humans and domestic animals.
- The study found that primates that consume less fruit and live in large social groups were more likely to descend to the ground. The authors suggest that these traits act as a potential "pre-adaptation" to terrestriality.
- Furthermore, primates living in hotter environments, and with less canopy cover, were more likely to adapt to these changes by shifting toward more extensive ground use.

Scientists discover 1 million-year-old DNA sample lurking beneath Antarctic seafloor

- DNA from ancient microorganisms, some of which dates back to roughly 1 million years ago, has been discovered beneath the seafloor in Antarctica.

- The DNA is the oldest ever discovered from seafloor sediments.

- Sedimentary ancient DNA or sedaDNA, up to 584 feet (178 meters) beneath the seafloor as part of a 2019 survey

- Scientists aren't certain which species the oldest sedaDNA belongs to, although it is definitely from a eukaryote

Human Brain Cells Grow in Rats

- Human brain “organoids” wired themselves into rats’ nervous systems, influencing the animals’ sensations and behaviors.

- Scientists have successfully transplanted clusters of human neurons into the brains of newborn rats, a striking feat of biological engineering

- In 2018, the neuroscientist Fred Gage and his colleagues at the Salk Institute for Biological Studies transplanted human brain organoids into the brains of adult mice. The human neurons continued to mature as the mouse brain supplied them with blood vessels.

Human neurons in rat brain

- Another study: Organoid of human neurons placed in a rat's brain. The human neurons multiplied in the rat brain until they numbered about three million, making up about a third of the cortex on one side of the rat brain.
- Each cell in the organoid grew six times longer than it would have in a petri dish. The cells also became about as active as neurons in human brains.
- Even more strikingly, the human organoids spontaneously wired themselves into the rat brain. They connected not just to nearby neurons, but to distant ones as well.
- Those connections made the human neurons sensitive to the rat's senses.
- These species-blending experiments raise provocative ethical questions.
- On learning tests, for example, they scored no better than other rats.

Are animals ticklish?

You can not tickle yourself

- Humans are not the only creatures to experience tickling—dolphins, chimps, dogs and rats have a tickle response.
- In all groups, the response is nearly the same—there is a moment of perception followed by a smile and then a laugh.
- Suspect there is a neural inhibition to touching yourself activating tickle response, otherwise you would laugh when putting on socks.

Alzheimer's drug slows mental decline in trial — but is it a breakthrough?

- Lecanemab by Eisai and Biogen - monoclonal antibody: If the results stand up, the treatment would be the first of its kind to show a strong signal of cognitive benefit in a robust trial.
- Slowed the rate of cognitive decline for people in a clinical trial by 27%.
- 18-point scale called the Clinical Dementia Rating–Sum of Boxes (CDR–SB).
- Lecanemab decreased amyloid in people's brains, but those receiving treatment scored, on average, 0.45 points better on the CDR-SB than those in the placebo group at the 18-month mark.
- A clinically important result would be, they give a range of 0.5 to 2 points.
- Amyloid is "associated with the problem, but it isn't 'the' problem

Risks

- The question will be whether the benefit it brings is worth the risks.
- During the trial, about 20% of participants who received lecanemab showed abnormalities on their brain scans that indicated swelling or bleeding, although less than 3% of those in the treatment group experienced symptoms of these side effects.
- By contrast, during the phase III trials for Aducanumab, 40% of participants showed signs of brain swelling on their scans.

Use olive oil.

- Researchers reported in the *Journal of the American College of Cardiology* that people who ate more than half a tablespoon per day had lower rates of premature death from cardiovascular disease, Alzheimer's disease and other causes compared to people who never or rarely consumed olive oil.
- Among all edible plant oils, olive oil has the highest percentage of monounsaturated fat, which lowers "bad" LDL cholesterol and increases "good" HDL. It's been shown to lower blood pressure and contains plant-based compounds that offer anti-inflammatory and antioxidant properties known to reduce the disease process, including heart disease. Best = extra virgin olive oil—commonly known as EVOO
- Strong evidence demonstrates the heart-healthy benefits of soybean, canola, corn, safflower, sunflower and other plant oils.

Adverse health outcomes associated with long-term antidepressant use

- British study of 200 K patients: Long-term antidepressant use may double the risk of heart disease
- One of the most widely prescribed drugs in England. In 2018, more than 70-million antidepressant prescriptions were dispensed.
- The researchers found that, once pre-existing risk factors had been taken into account, long-term antidepressant use was associated with an increased risk of coronary heart disease, and an increased risk of death from cardiovascular disease and from any cause. The risks were greater for non-SSRI antidepressants (mirtazapine, venlafaxine, duloxetine, trazodone), with the use of such drugs associated with a two-fold increased risk of coronary heart disease, cardiovascular mortality, and all-cause mortality at ten years.
- There was also some evidence that antidepressants, and particularly SSRI's, were associated with a reduced risk (23% to 32% lower risk) of developing high blood pressure and diabetes.
- Emphasize the importance of proactive cardiovascular monitoring and prevention in patients who have depression and are on antidepressants given that both have been associated with higher risks.

A new route to evolution: Nuclear-embedded mitochondrial DNA

- Billions of years ago, a primitive animal cell took in a bacterium that became what we now call mitochondria. These supply energy to the cell to allow it to function normally, while removing oxygen, which is toxic at high levels.
- This was all thought to have happened a very long time ago, mostly before we had even formed as a species, but that's not true. It happens routinely, with bits of our mitochondrial genetic code transferring into the nuclear genome.
- Mitochondrial DNA appears in some cancer DNA, suggesting that it acts as a sticking plaster to try and repair damage to our genetic code.
- It is therefore conceivable that a symbiosis that began around 1.45 billion years ago is not yet complete.

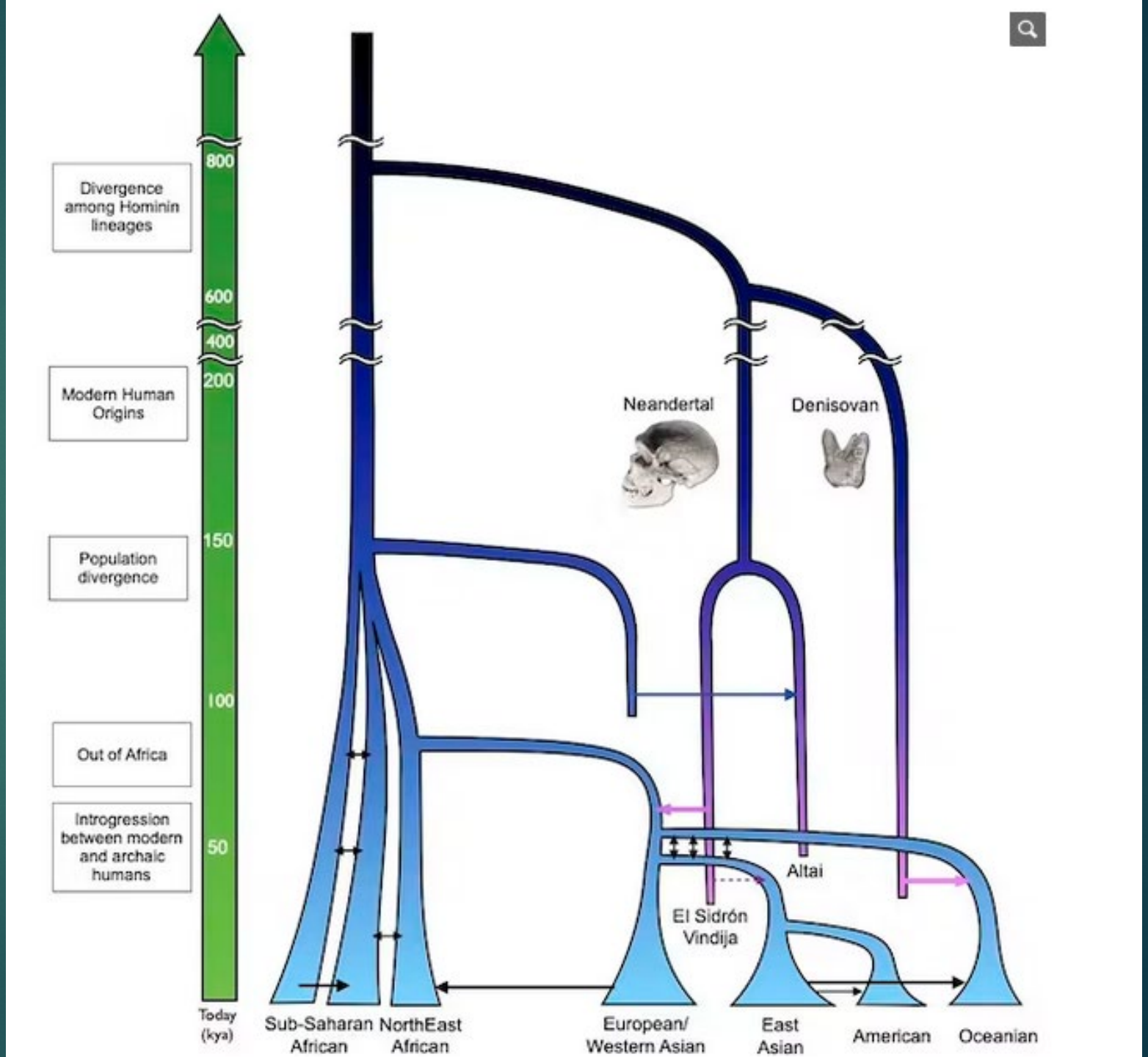
Mitochondrial inserts in nuclear DNA

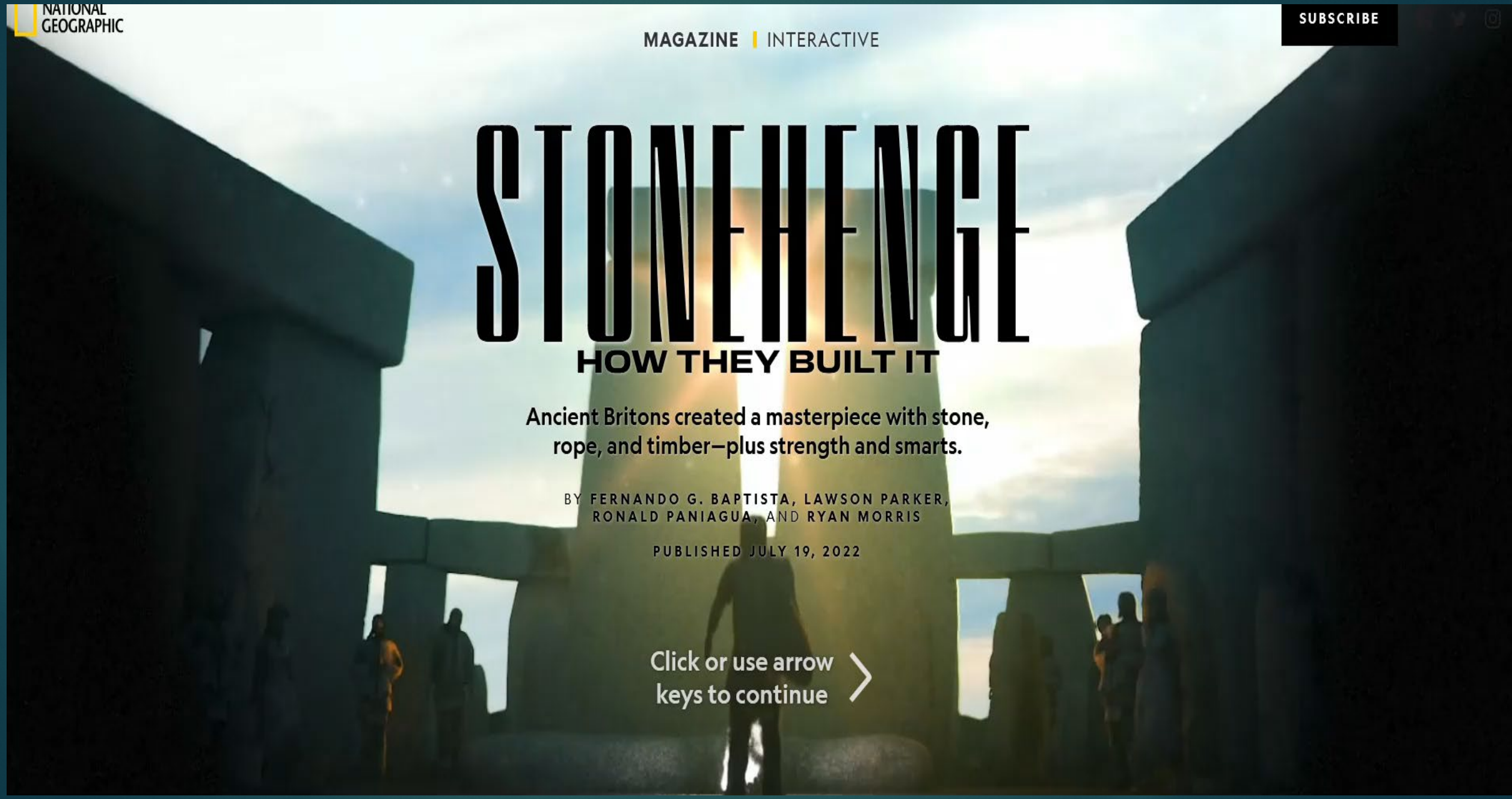
- Mitochondrial DNA is normally passed down the maternal line; but in study of 66,000 people, showed that the new mitochondrial inserts in nuclear code are actually happing all the time, showing a new way our genome evolves. More than 99% of individuals had at least one insert.
- Estimate that mitochondrial DNA transfers to nuclear DNA in around one in every 4,000 births. If that individual has children of their own, they will pass these inserts on—the team found that most of us carry five of the new inserts, and one in seven of us (14%) carry very recent ones.
- Once in place, the inserts can occasionally lead to very rare diseases, including a rare genetic form of cancer. De novo inserts were observed in the germline once in every 104 births and once in every 103 cancers. Inserts preferentially involved non-coding mitochondrial DNA
- It isn't clear exactly how the mitochondrial DNA inserts itself—whether it does so directly or via an intermediary, such as RNA—it is likely to occur within the mother's egg cells.

Mitochondrial inserts in nuclear DNA

- When the team looked at sequences taken from 12,500 tumor samples, they found that mitochondrial DNA was even more common in tumor DNA, arising in around one in 1,000 cancers, and in some cases, the mitochondrial DNA inserts actually *causes* the cancer.
- Mitochondrial DNA appears to act almost like a Band-Aid, a sticking plaster to help the nuclear genetic code repair itself. And sometimes this works, but on rare occasions if might make things worse or even trigger the development of tumors
- More than half (58%) of the insertions were in regions of the genome that code for proteins.
- In the majority of cases, the body recognizes the invading mitochondrial DNA and silences it in a process known as methylation. However, this method of silencing is not perfect, as some of the mitochondrial DNA inserts go on to be copied and move around the nucleus itself.
- A selective process counter-balancing inserts, maintaining genome size and removing inserts that influence gene expression.

Showing how humans are related to Neanderthals and Denisovans.

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STONEHENGE
HOW THEY BUILT IT
Ancient Britons created a masterpiece with stone, rope, and timber—plus strength and smarts.
BY FERNANDO G. BAPTISTA, LAWSON PARKER, RONALD PANIAGUA, AND RYAN MORRIS
PUBLISHED JULY 19, 2022
Click or use arrow keys to continue

Paleogenetics, Pt. 12:
Peopling of Europe
October 2022

Europe is a continent of immigrants

- Three major movements of people shaped the course of European prehistory.

- Europe is a continent of immigrants and always has been.

- "The people who live in a place today are not the descendants of people who lived there long ago," says David Reich. "There are no indigenous people—anyone who hearkens back to racial purity is confronted with the meaninglessness of the concept."

First Europeans

- All people outside Africa descend from African ancestors who left that continent 60,000 years ago.

- 1 -Those first modern human hunter gatherers (HG) ventured into Europe about 45,000 years ago, having made their way up through the Middle East. Their own DNA suggests they had dark skin and light eyes. These early settlers were widely scattered. They kept their distance when Neolithic farmers first arrived.

- The first modern Europeans lived as hunters and gatherers in small, nomadic bands. They followed the rivers, edging along the Danube from its mouth on the Black Sea deep into western and central Europe.

First Europeans

- As Europe was gripped by the Ice Age, the modern humans hung on in the ice-free south, adapting to the cold climate.

- Around 27,000 years ago, there may have been as few as a 1000 of them, according to some population estimates.

- 2 - From 9500-4000 B.C. Neolithic farmers from present-day Turkey had joined HGs in southern Europe before pushing deeper into the continent. Brought wheat, sheep, cattle—and their own DNA—to rest of Europe by 4000 B.C.

Prehistoric Melting Pot

- 3 - Yamnaya from Russia arrive ca 3300-2200 B.C. Their mastery of horses and wagons introduced a new mobile lifestyle to Europe.

- Most Europeans today have DNA from all three groups. Yamnaya bloodlines are strongest in the north, those of Neolithic farmers in the south.

- DNA Legacy: Before the arrival of the Yamnaya, Neolithic farmer DNA had largely replaced that of hunter-gatherers. By 1000 B.C. Yamnaya DNA could be found all across Europe

1 Hunter-Gatherers (white)

2 Neolithic Farmers' DNA (blue) became slightly less dominant by 4500 B.C. as they began to mix with hunter-gatherers.

3 Yamnaya (orange)

First immigrants

- 1 - Post Ice Age: About 14,500 years ago, as Europe began to warm, HGs followed the retreating glaciers north. In the ensuing millennia, they developed more sophisticated stone tools and settled in small villages. Archaeologists call this period the Mesolithic, or Middle Stone Age.
- 2 - Second wave: Out of Anatolia
- Farming: People began planting small plots of emmer and einkorn, two ancient forms of wheat, and probably herding small flocks of sheep and goats, some 10,300 years ago, near the dawn of the Neolithic period.
- Within a thousand years the Neolithic farming revolution spread north through Anatolia and into southeastern Europe.
- By about 6,000 years ago, there were farmers and herders all across Europe.

Demic and cultural diffusion propagated the Neolithic transition across different regions of Europe

- It has long been clear that Europe acquired the practice of farming from Turkey or the Levant, but did it acquire farmers from the same places?

- The Neolithic transition is the shift from hunting-gathering into farming. About 9000 years ago, the Neolithic transition began to spread from the Near East into Europe, until it reached Northern Europe about 5500 years ago.

- There are two main models of this spread.
  - The cultural model assumes that European hunter-gatherers become farmers by acquiring domestic plants and animals, as well as knowledge, from neighboring farmers.
  - The demic model assumes that it was mainly due to the migration of farmers

Demic vs Cultural

- The answer isn't obvious.

- For decades, many archaeologists thought a whole suite of innovations—farming, but also ceramic pottery, polished stone axes capable of clearing forests, and complicated settlements—was carried into Europe not by migrants but by trade and word of mouth, from one valley to the next, as hunter-gatherers who already lived there adopted the new tools and way of life.

- But DNA evidence from Boncuklu (Anatolia, Turkey) has helped show that migration had a lot more to do with it.

Migration, not cultural exchange

- Early Anatolian farmers had migrated, spreading their genes as well as their lifestyle. DNA of Europe's first farmers still dominates the genes of modern Sardinians.
- They didn't stop in southeastern Europe. Over the centuries their descendants pushed along the Danube and deep into the heart of the continent.
- Others traveled along the Mediterranean by boat, colonizing islands such as Sardinia and Sicily and settling southern Europe as far as Portugal. From Boncuklu to Britain, the Anatolian genetic signature is found wherever farming first appears.
- Those Neolithic farmers mostly had light skin and dark eyes—the opposite of many of the hunter-gatherers with whom they now lived side by side.

Hunter gatherer-Farmer mix; then change

- Across Europe, this creeping first contact was standoffish, sometimes for centuries. There's little evidence of one group taking up the tools or traditions of the other. Even where the two populations did mingle, intermarriage was rare. There's no question they were in contact with each other, but they weren't exchanging wives or husbands.

- About 5,400 years ago, everything changed. All across Europe, thriving Neolithic settlements shrank or disappeared altogether. The dramatic decline has puzzled archaeologists for decades. There's less stuff, less material, less people, less sites

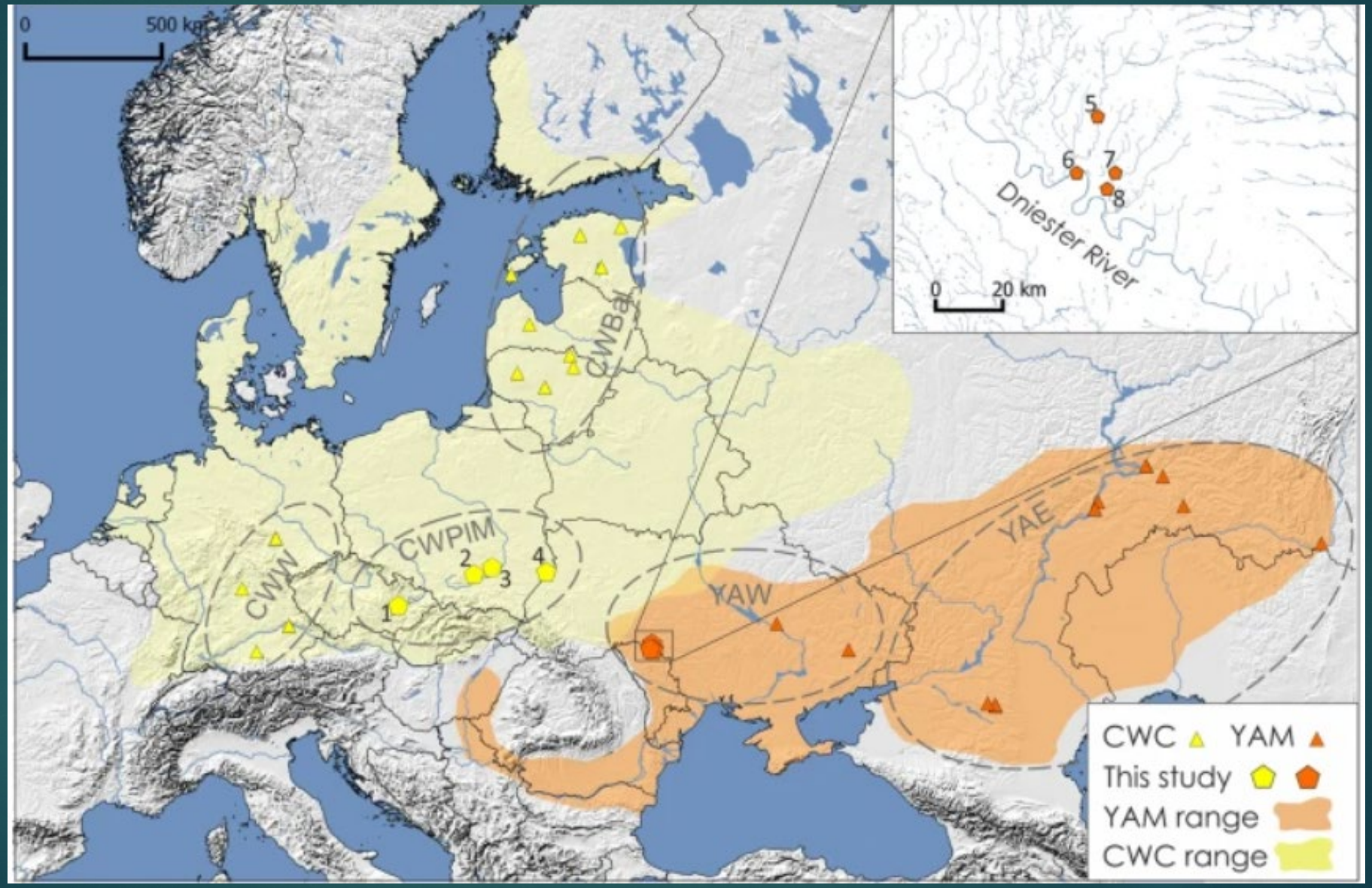
Corded Ware culture

- After a 500-year gap, the population seemed to grow again, but something was very different. In southeastern Europe, the villages and egalitarian cemeteries of the Neolithic were replaced by imposing grave mounds covering lone adult men.

- Farther north, from Russia to the Rhine, a new culture sprang up, called Corded Ware after its pottery, which was decorated by pressing string into wet clay.

- Corded Ware burials are so recognizable, archaeologists rarely need to bother with radiocarbon dating. Almost invariably, men were buried lying on their right side and women lying on their left, both with their legs curled up and their faces pointed south. In some of the Halle warehouse's graves, women clutch purses and bags hung with canine teeth from dozens of dogs; men have stone battle-axes.

CWC and Yamnaya locations



Corded Ware

- When researchers first analyzed the DNA from some of these graves, they expected the Corded Ware folk would be closely related to Neolithic farmers.

- Instead, their DNA contained distinctive genes that were new to Europe at the time—but are detectable now in just about every modern European population.

- Many Corded Ware people turned out to be more closely related to Native Americans than to Neolithic European farmers. That deepened the mystery of who they were.

Third wave: Out of the Steppe

- There was a change of burial customs around 2800 B.C. People erected mounds on a massive scale, accenting the individuality of people, accenting the role of men, accenting weapons. That was something new in Europe.

- But it was not new 800 miles to the east, however. On what are now the steppes of southern Russia and eastern Ukraine, a group of nomads called the Yamnaya, some of the first people in the world to ride horses, had mastered the wheel and were building wagons and following herds of cattle across the grasslands.

- They built few permanent settlements. But they buried their most prominent men with bronze and silver ornaments in mighty grave mounds that still dot the steppes.

Corded Ware people

- But, in 2015, teams led independently by David Reich and Eske Willerslev announced that occupants of Corded Ware graves in Germany could trace ~75% of their genetic ancestry to the Yamnaya.
- It seemed that Corded Ware people weren't simply copying the Yamnaya; to a large degree they actually were Yamnayan in origin.
- How could steppe pastoralists figure out how to live in forested Europe?
- Archaeologists have concluded that populations in northern and central Europe began shrinking about 5300 years ago.
- Plague disease began spreading across Europe perhaps as early as 5700 years ago. Large farmer mega communities disappear at about 5400.
- How violent their entry into Europe was is controversial.

Yamnaya

- By 2800 B.C, Yamnaya had begun moving west, probably looking for greener pastures. Włodarczak's mound near Žabalj, Serbia, is the westernmost Yamnaya grave found so far.

- Genetic evidence shows that many Corded Ware people were their descendants. Like those Corded Ware skeletons, the Yamnaya shared distant kinship with Native Americans—whose ancestors hailed from farther east, in Siberia.

- Within a few centuries, other people with a significant amount of Yamnaya DNA had spread as far as the British Isles. In Britain and some other places, hardly any of the farmers who already lived in Europe survived the onslaught from the east.

- In what is now Germany, there's a 70 to 100 % replacement of the local population. Something very dramatic happens 4,500 years ago.

Farmers

- Until then, farmers had been thriving in Europe for millennia. They had settled from Bulgaria all the way to Ireland, often in complex villages that housed hundreds or even thousands of people. There are estimates there were as many as seven million people in Europe in 3000 B.C. In Britain, Neolithic people were constructing Stonehenge

- A clue comes from the teeth of 101 people living on the steppes and farther west in Europe around the time that the Yamnaya's westward migration began. In seven of the samples, alongside the human DNA, geneticists found the DNA of an early form of *Yersinia pestis*—the plague microbe that killed 60% of all Europeans in the 14th century.

Yersinia pestis

- Unlike that flea-borne Black Death, this early variant had to be passed from person to person.

- The steppe nomads apparently had lived with the disease for centuries, perhaps building up immunity—much as the Europeans who colonized the Americas carried smallpox without succumbing to it wholesale.

- And just as smallpox and other diseases ravaged Native American populations, the plague, once introduced by the first Yamnaya, might have spread rapidly through crowded Neolithic villages. That could explain both their surprising collapse and the rapid spread of Yamnaya DNA from Russia to Britain.

Plague?

- But this theory has a major question:

- Evidence of plague has only just recently been documented in ancient Neolithic skeletons, and so far, no one has found anything like the plague pits full of diseased skeletons left behind after the Black Death. If a plague wiped out Europe's Neolithic farmers, it left little trace.

- When construction of Stonehenge began about 3000 B.C., Britain was inhabited by Neolithic farmers. When it was finished in 4000 B.C., the Neolithic population had been replaced by descendants of the Yamnaya—perhaps because the latter carried plague.

Plague?

- Whether or not they brought plague, the Yamnaya did bring domesticated horses and a mobile lifestyle based on wagons into Stone Age Europe.

- And in bringing innovative metal weapons and tools, they may have helped nudge Europe toward the Bronze Age.

- In Finland, milk use appears with the arrival of Corded Ware pottery in the early third millennium BC,

All Europeans today are a genetic mix

- The genetic recipe for a typical current European would be roughly equal parts Yamnaya and Anatolian farmer, with a much smaller dollop of African hunter-gatherer.

- But the average conceals large regional variations: more “eastern cowboy” genes in Scandinavia, more farmer ones in Spain and Italy, and significant chunks of hunter-gatherer DNA in the Baltics and eastern Europe.

- The new genetic results undermine the nationalist paradigm that we have always lived here and not mixed with other people. There’s no such thing as a Dane or a Swede or a German. Instead, we’re all “Russians”, all Africans.

Ancestral European Population conclusions

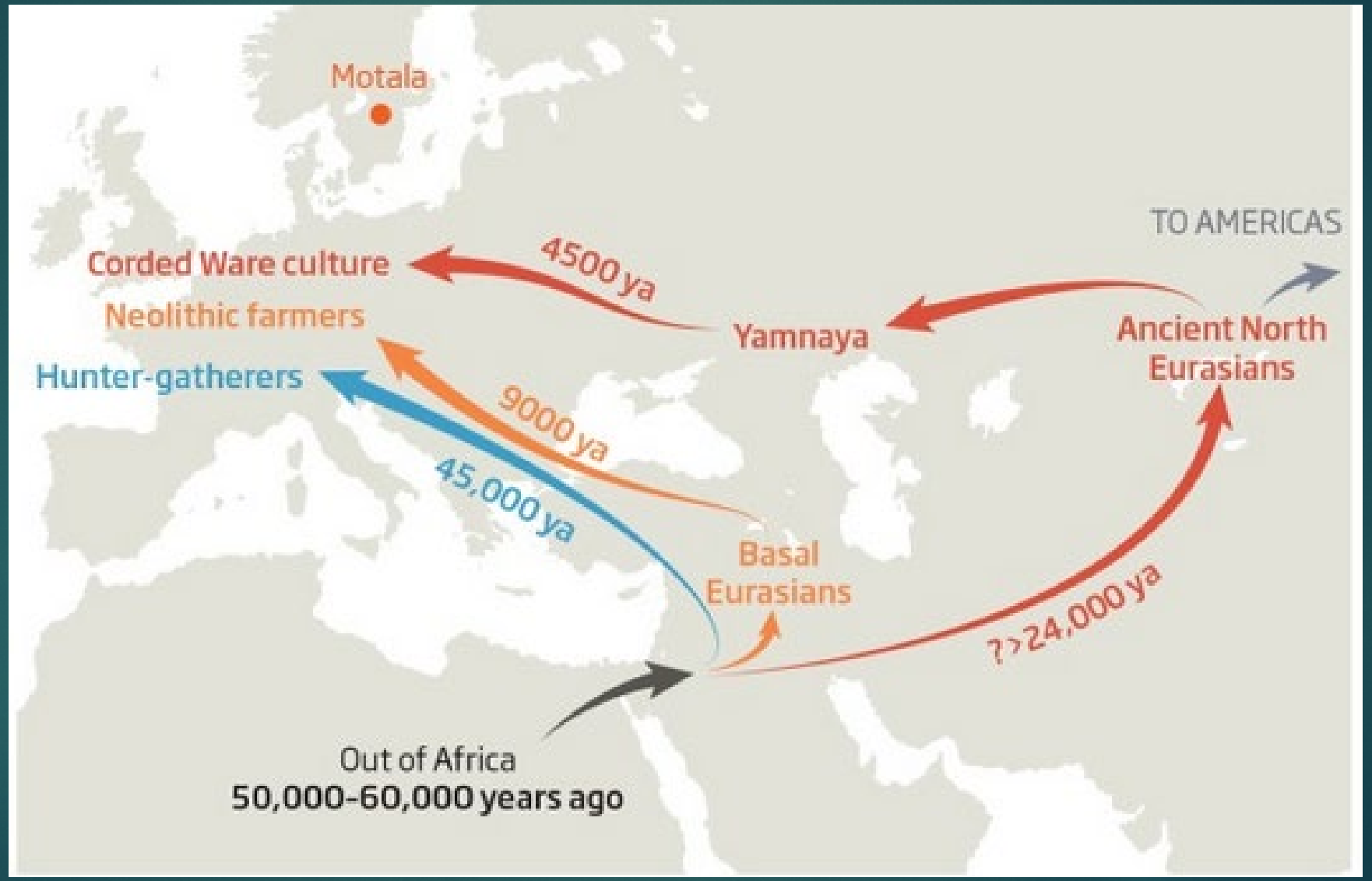
- Modem Europeans are a mixture of at least three larger ancestral populations: WHG (Western HGs) & EEF (early farmers) & ANE (Northern Eurasians)
- EEF have their roots in the Near East but are already genetically admixed
- ANE arrived with Corded Ware culture from Eastern Europe 4500 BP – links Europeans with Native Americans
- Corded Ware is genetically highly similar to Yamnaya Culture

Ancestral European Population conclusions

- At least two mass migrations to Europe during Neolithic period– first the farmers at 7000 ya, then the Corded Ware/Yamnaya at 4500 ya

- Influx of Indo-European languages during late Neolithic

3 Groups: Hunter gatherers, Neolithic farmers, & Yamnaya



Who We Are and How We Got Here

- Chapter 5, "The Making of Modern Europe"
  - explains how Europeans today descend from three highly divergent populations,
  - which came together over the last nine thousand years in a way that archaeologists never anticipated before ancient DNA became available.

Timeline of European population changes

- > 5500 Ka Hunter Gatherers
- 5500-4000 Ka Near East Farmer Migration
- 4000-3000 Ka Hunter-Farmer mixture
- 4000-3000 Ka Yamnaya steppe pastoralism
- < 3000 Ka Formation of modern Europe

Reich's basic message

- The overriding lesson ancient DNA teaches is that the
  - population in any one place has changed dramatically many times since the great human post-ice age expansion, and that
  - recognition of the essentially mongrel nature of humanity should override any notion of some mystical, longstanding connection between people and place.

- Per Reich, we are all, to use British PM Theresa May's anti-liberal derisive label, "citizens of nowhere". (CJV: Hitler said something similar about liberal Germans who lived abroad)

Population replacements

- Between 41 and 39 Ka in western Europe, the Neanderthals were replaced by modern human populations. The first modern human samples we have in Europe are about 45 Ka and are genetically not at all related to present-day Europeans. They seem to be from extinct, dead-end groups

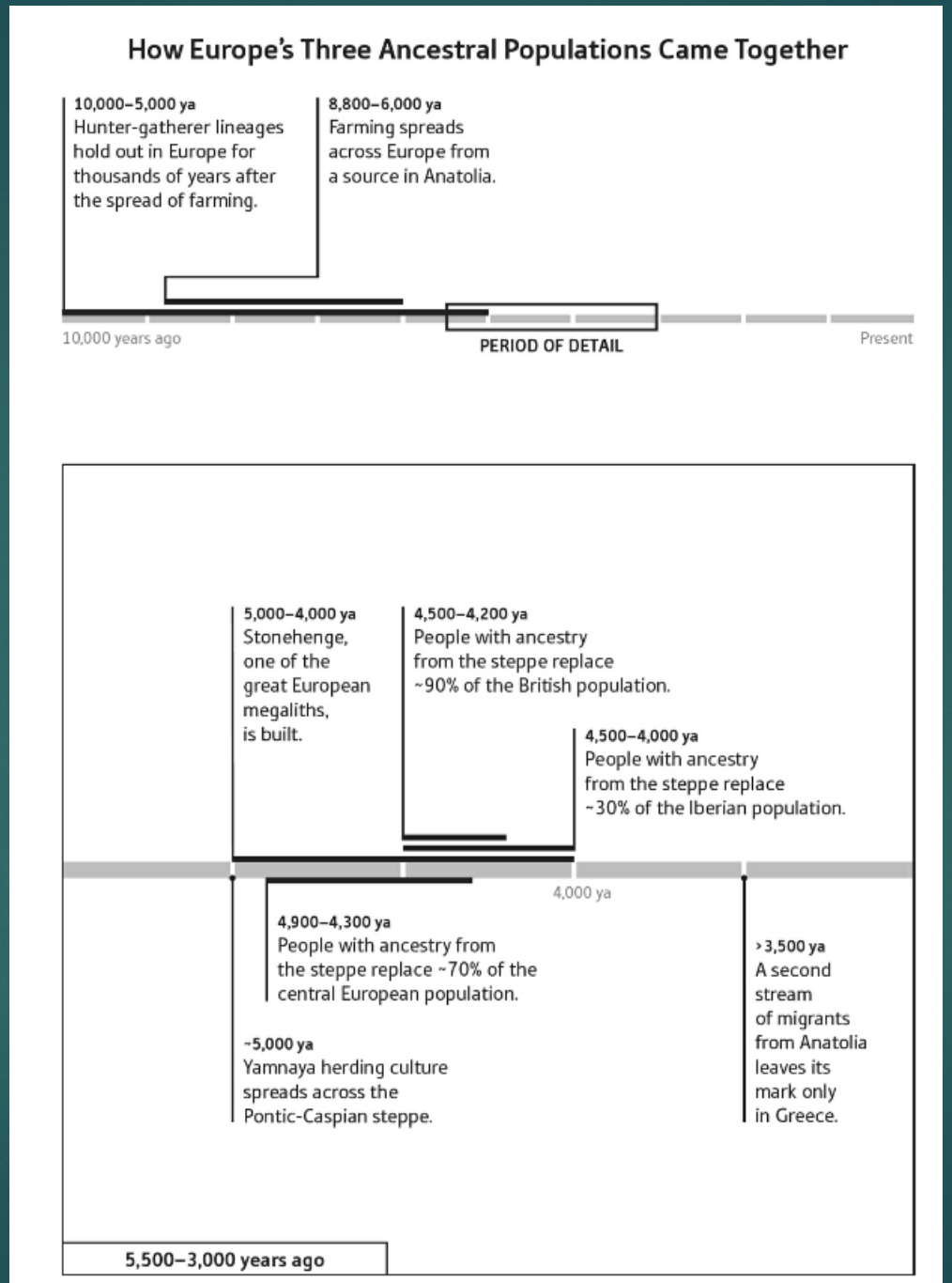
- After that, you see for the first time people related to later European hunter-gatherers who have contributed a little bit to present-day Europeans. That happens beginning 37 to 35 Ka.

- Then the ice sheets descend across northern Europe and a lot of these populations are chased into refuges in the southern peninsulas of Europe.

Population replacements

- After the Ice Age, there's a repeopling of northern Europe from the southwest, probably from Spain, and then also from the southeast, probably from Greece and maybe even from Anatolia, Turkey.
  - Again, after 9,000 years ago,
  - there's a mass movement of farmers into the region which
  - almost completely replaces the hunter-gatherers
  - with a small amount of mixture.
- And then *again*, after 5,000 years ago, there's this mass movement at the beginning of the Bronze Age of people from the Eastern flat grassland steppe, the Yamnaya.

How Europe's Three Ancestral Populations Came Together



How Europe's Three Ancestral Populations Came Together

- 10 to 5 Ka: Hunter-gatherer lineages hold out in Europe for thousands of years after the spread of farming.
- 8.8 to 6 Ka: Farming spreads across Europe from a source in Anatolia.
- -5 Ka: Yamnaya herding culture spreads across the Pontic-Caspian steppe.
- 3 Ka: Stonehenge, one of the great European megaliths, is built by farmers.

How Europe's Three Ancestral Populations Came Together

- 4.9 to 4.3 Ka: People with ancestry from the steppe replace ~90% of the British population.
- 4.5 to 4.2 Ka: People with Yamnaya ancestry replace ~30% of the Iberian population.
- > 3.5 Ka: A second stream of migrants from Anatolia leaves its mark only in Greece.

Strange Sardinia

- In 2009, first mitochondrial DNA from ancient European hunter-gatherers and some of the earliest farmers of Europe.

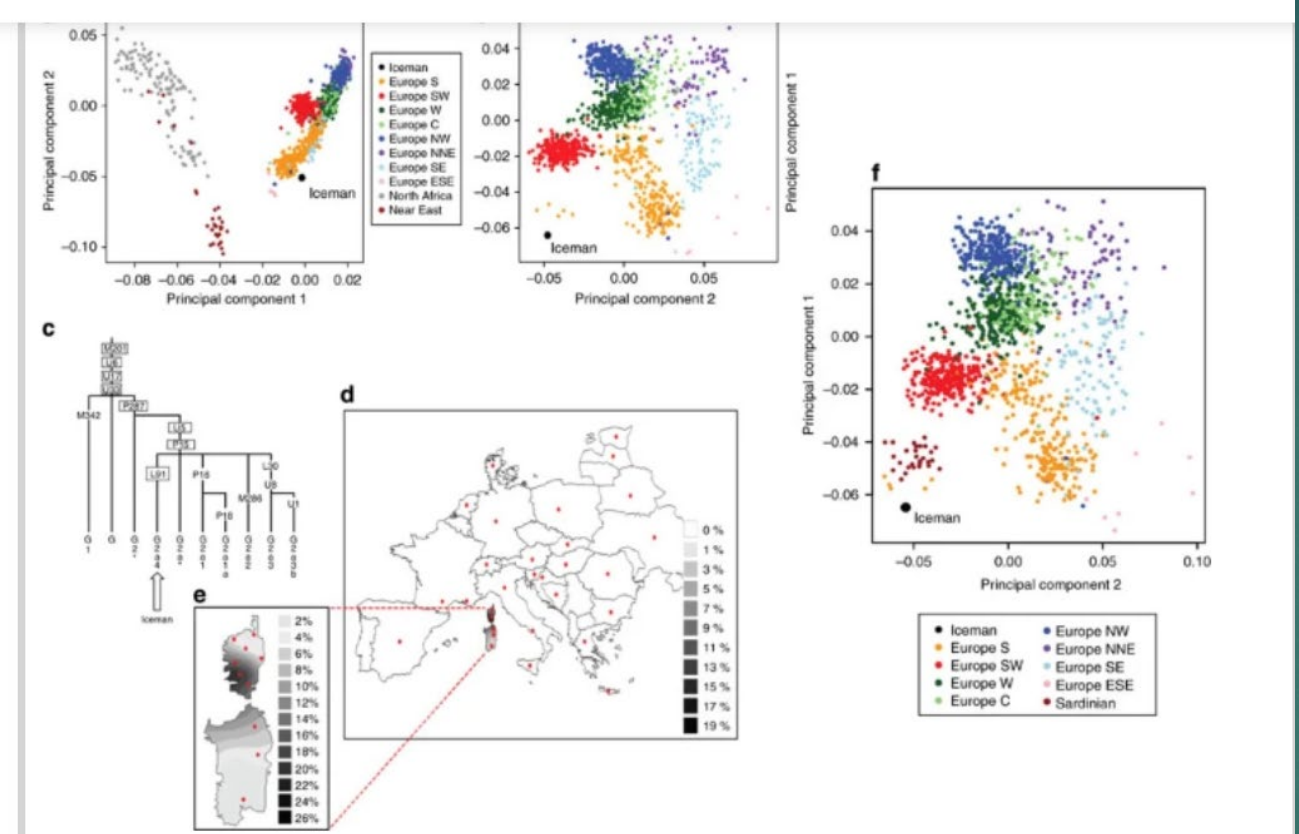
- Nearly all ancient hunter-gatherers carried the U haplotype of mtDNA.

- But the farmers who succeeded them carried no more than a few percent of those types, and their DNA was more similar to that seen today in southern Europe and the Near East. It was clear that the farmers came from a population that did not descend from European hunter-gatherers.

Sardinia and the Iceman

- Genome of "Iceman' a natural mummy dating to ~5.3 Ka that was discovered in 1991 on a melting glacier in the Alps -- his closest genetic relatives are the people of Sardinia.

Genome of Iceman, 2012: closest to Sardinia/Corsica DNA



(a) Principal component analysis (PCA) of the Iceman genome and SNP array data for European, North African and Near Eastern populations. Population samples were as follows: Europe S (for

Brown eyes, blood group O, lactose intolerant.

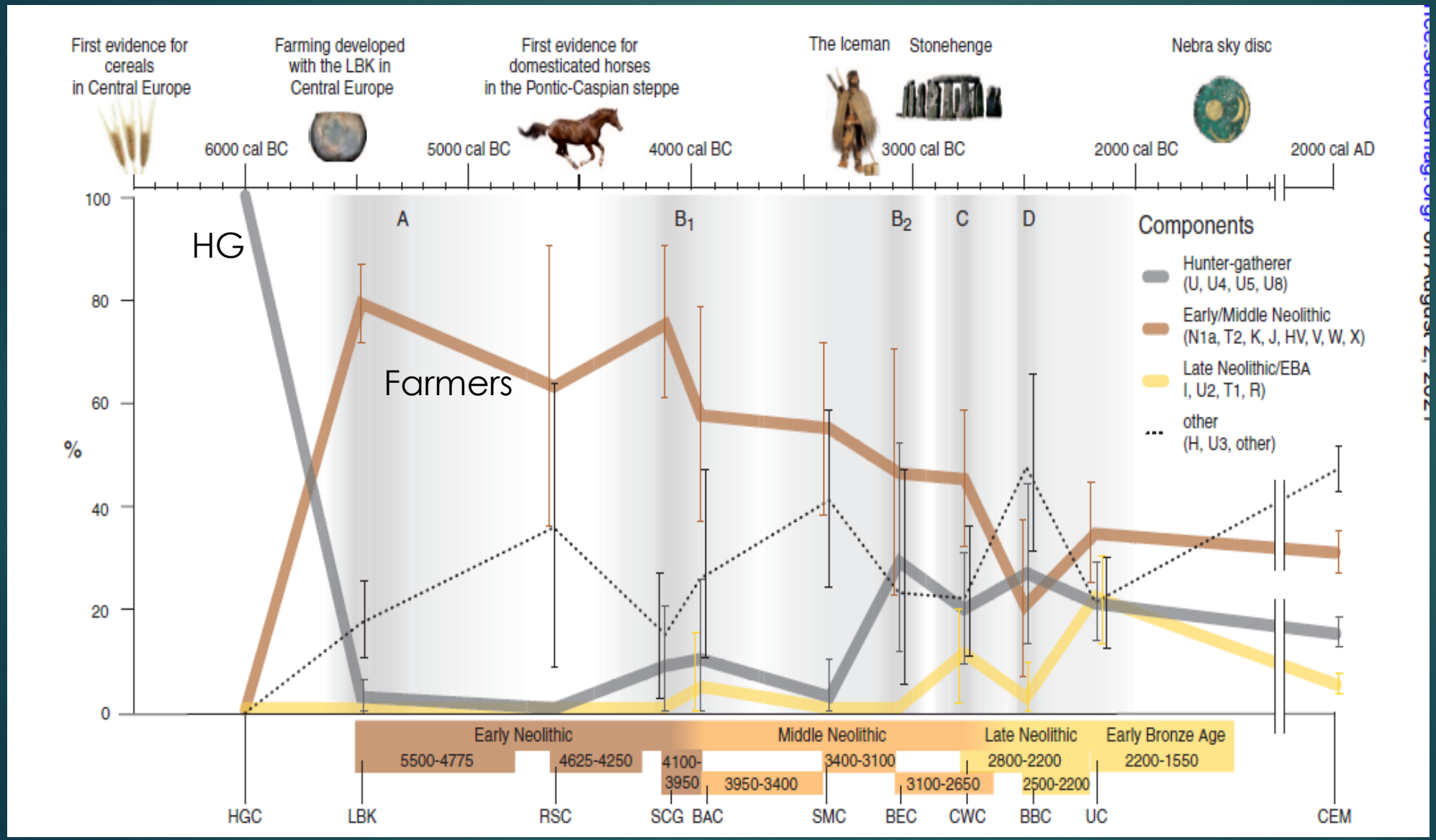
Sequences corresponding to ~60% of the genome of *Borrelia burgdorferi* are indicative of the earliest human case of infection with the pathogen for Lyme borreliosis.

A. Keller, et al., 2012

MtDNA types

- In hunter-gatherer populations the dominating mitochondrial lineage has been type U, especially its subgroups U4, U5a and U5b.
- In the advent of the Neolithic revolution, these U subgroups were largely supplanted by farmer-associated haplogroups H, HV, J, K, N1a, T2 and W.
- The subsequent spread of Yamnaya-related people and Corded Ware Culture in the late Neolithic and Bronze Age were accompanied with the increase of haplogroups I, U2 and T1 in Europe

MtDNA evidence: demic diffusion = new populations in Europe



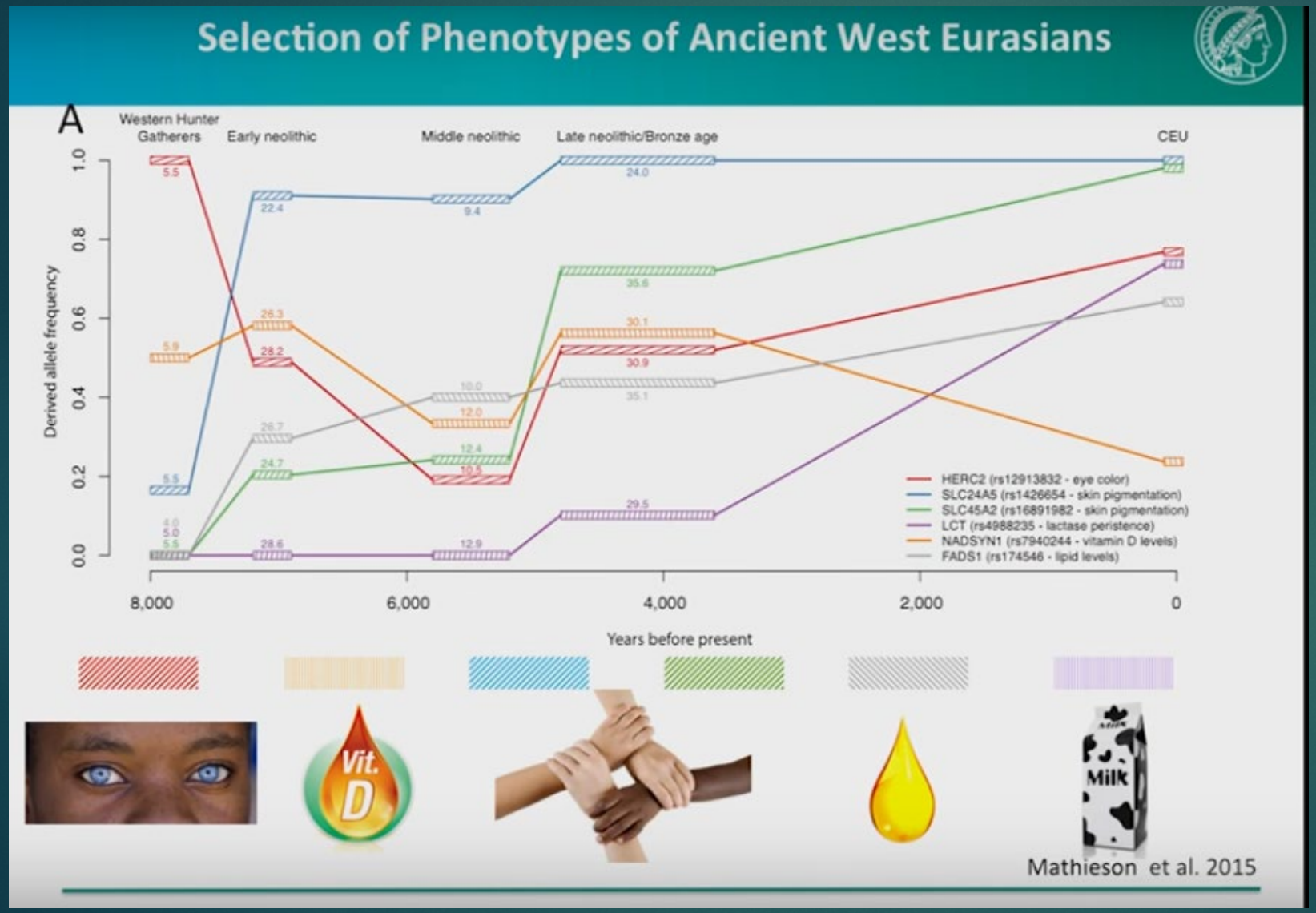
A - 6000 BC: only U haplotypes, hunter-gathers

B – With arrival of farmers & LBK (Linear Band culture), U haplotypes drop to zero

C – changes at 2500 BC

Brandt, et al., 2013

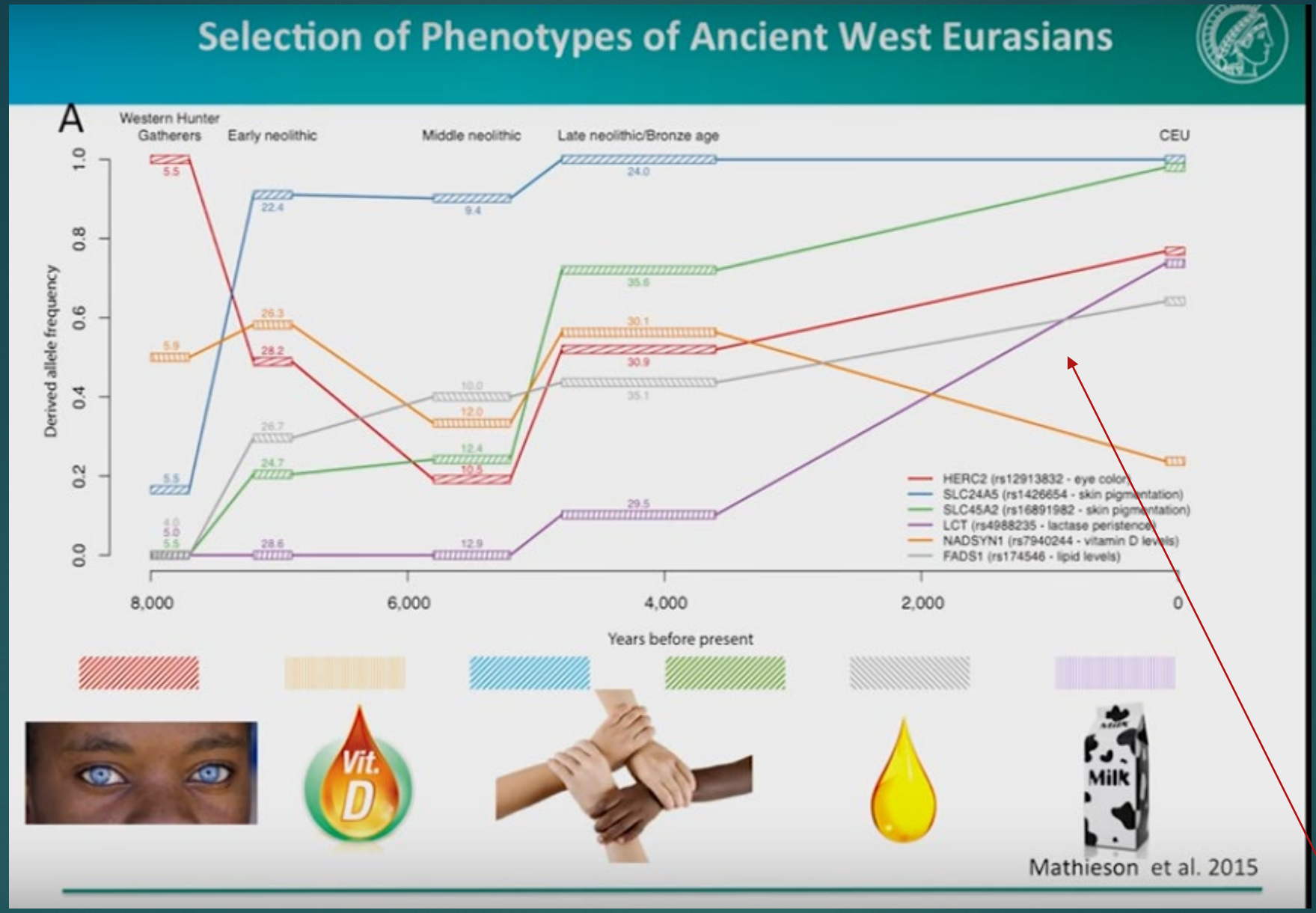
Genetic Selection of European phenotypes



A - Blue eyes & skin color in HG, down by 5500 ya, via influx of farmers, then resurge with Yamnaya

B – Vitamin D related to skin color; early farmers had darker skin; today both genes for lighter skin color abound

C – Lactose tolerance not in early farmers; increased post Pontic step people arrival at 4500 ya; today 60%

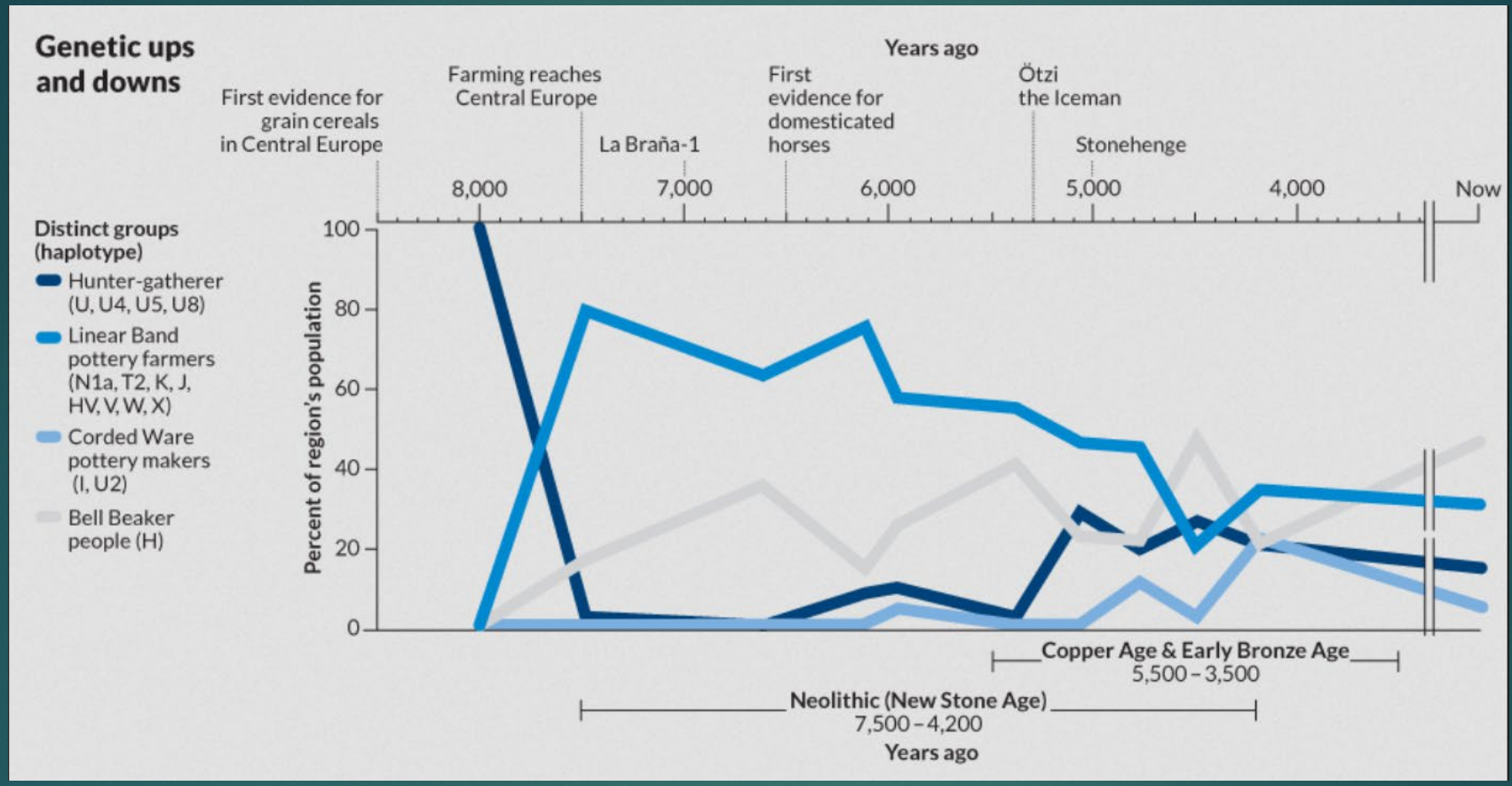


8K: Brown skin, blue eyes

4K: light skin

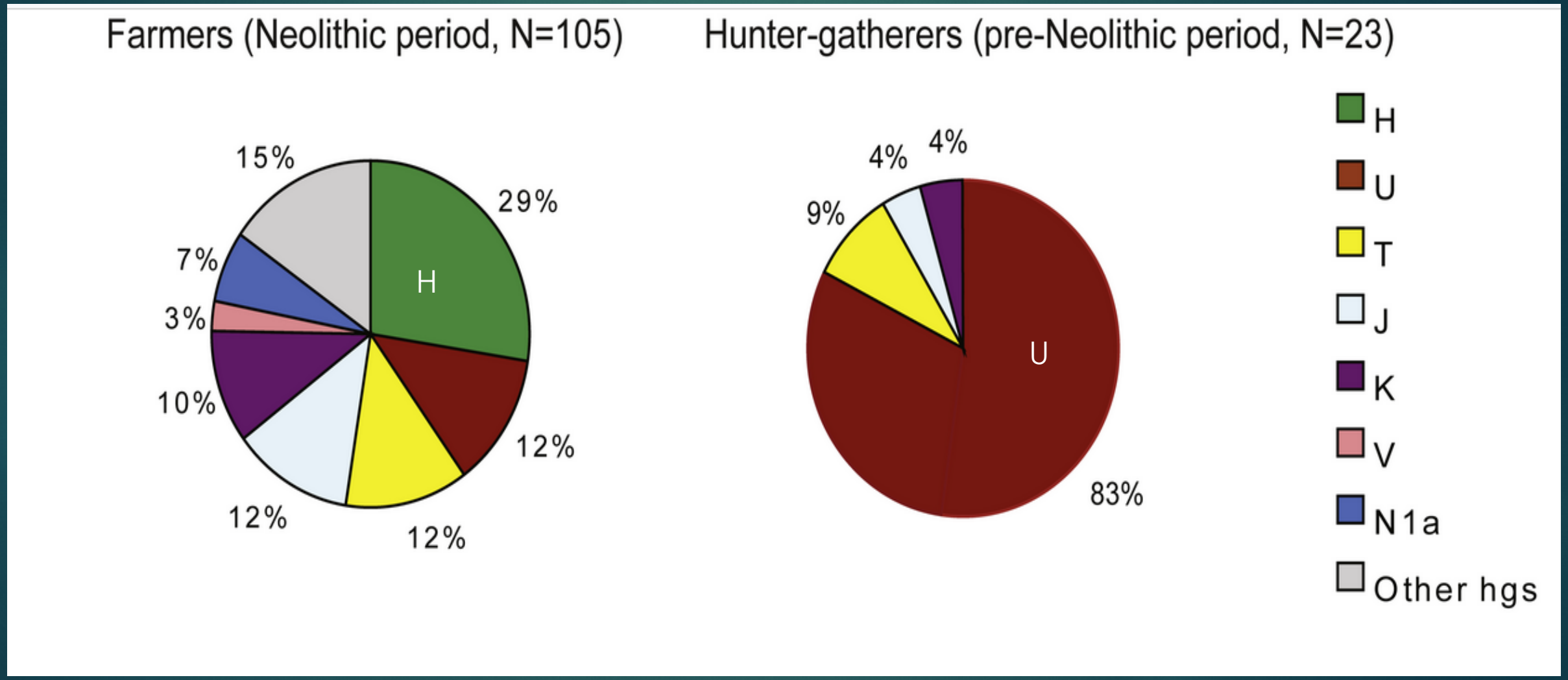
Milk tolerance only in last 3K

Genetic ups and downs

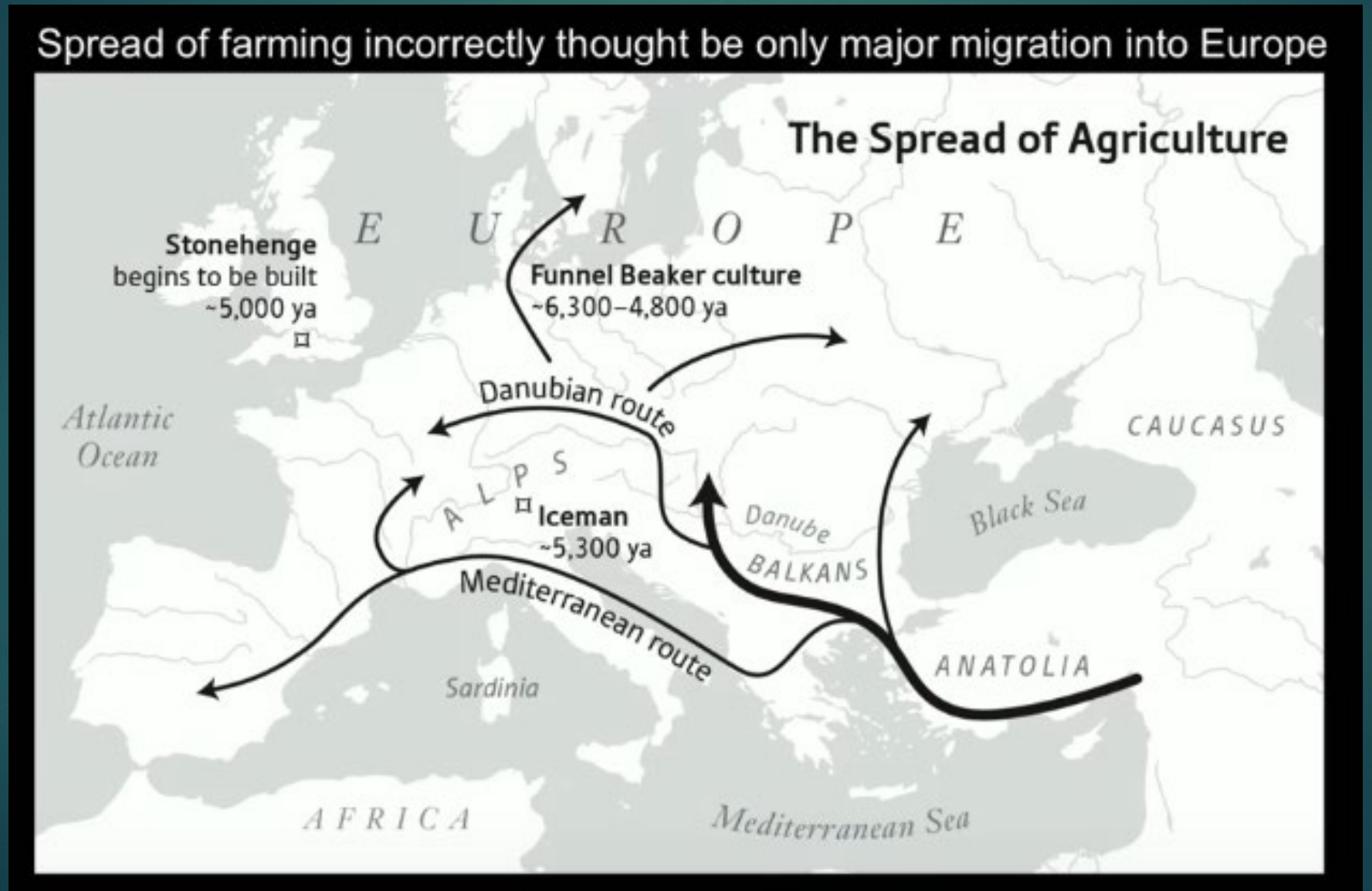


- Only about 0.2 percent of modern Europeans carry haplotype N1a (25% of early farmers); People who made different types of pottery in ancient Europe also tended to be genetically different (mitochondrial haplotypes) from each other.

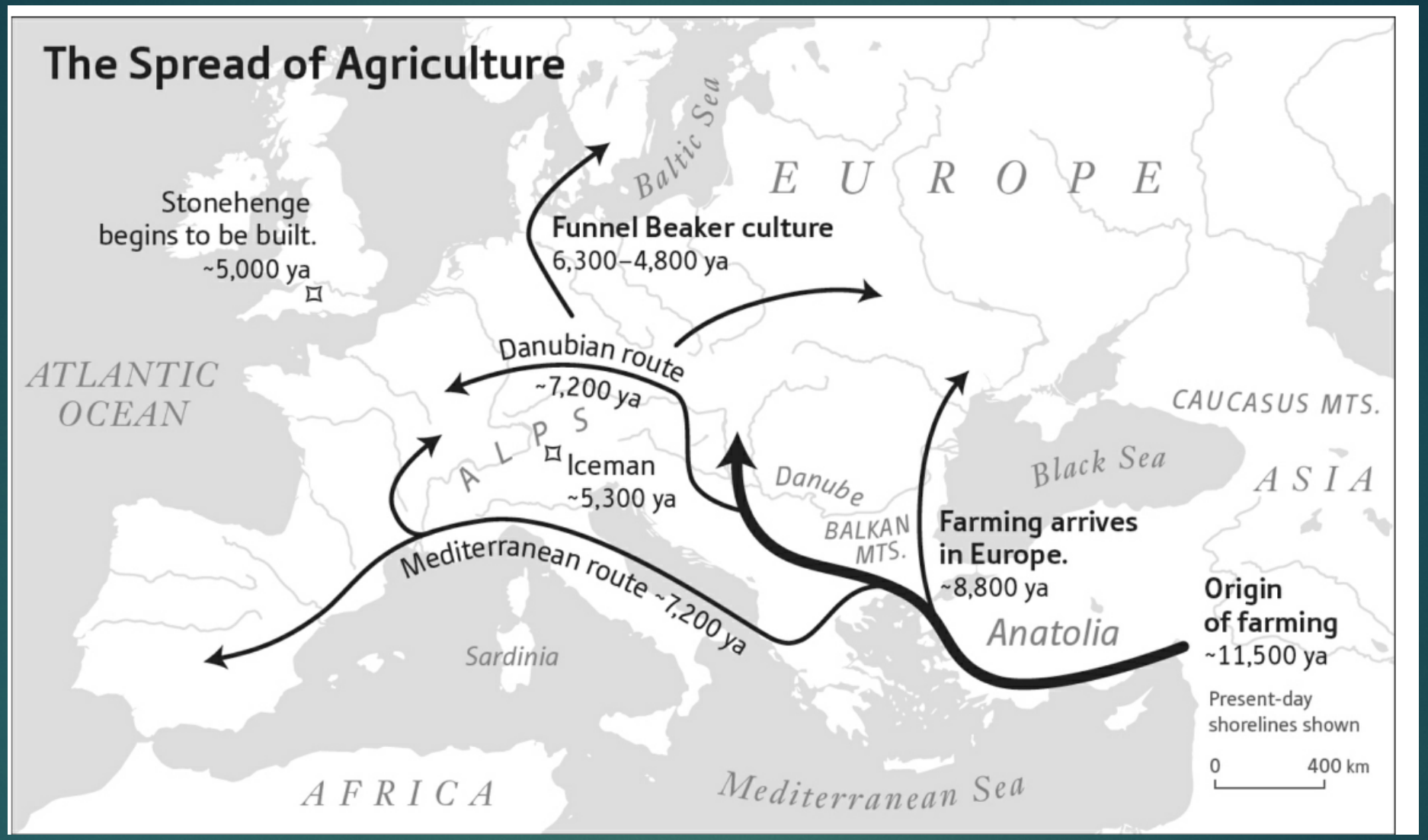
mtDNA of Neolithic farmers and pre-Neolithic HGs



3rd lesson in humility:
Large scale migration was common in our past



Agriculture arrives in Europe ~6500 Ka



Farming expanded from the Near East to the far northwest of Europe between about 11.5 and 5.5 Ka, transforming economies across this region.

Sardinia

- The strange genetic link to present-day Sardinians kept turning up.

- In the same year that the Iceman's genome was published, Pontus Skoglund, et al. at the University of Uppsala published four genome sequences from individuals who lived about five thousand years ago in Sweden.

- A leading theory up until their study was that the Swedish hunter-gatherers who lived at that time descended from farmers who had adapted a hunter-gatherer lifestyle to exploit the rich fisheries of the Baltic Sea, and were not directly descended from the hunter gatherers who had lived in Northern Europe (incl. Sweden) several thousand years earlier.

Sardinia

- Ancient DNA disproved this theory.
- Instead of being genetically close to each other, the farmers and hunter-gatherers were almost as different from each other as Europeans are from East Asians today.
- And the farmers once again had that strange link to Sardinians.

Sardinia

- Skoglund and Jakobsson proposed a new model to explain these findings—that
  - migrating farmers whose ancestors originated in the Near East spread over Europe with little mixture with the hunter-gatherers they encountered along the way,
  - a sharp contrast to Luca Cavalli-Sforza's model for the farming expansion into Europe that emphasized extensive mixture and interaction with the local hunter-gatherers during the expansion.
- Would explain why the ancient farmers were genetically similar to present-day Sardinians, who plausibly descend from an earlier migration of farmers to that island around 8 Ka that largely displaced the previous hunter-gatherers.

Sardinia

- Isolated on Sardinia, the descendants of these farmers were minimally affected by demographic events that later transformed the populations of mainland Europe.
- But their model was wrong in claiming these 2 groups were primary source of DNA of modern Europeans
- In 2012, it seemed that the big question of the ancestral sources of present-day European populations might be solved.
- But there was an observation that didn't fit.

Chapter 3: The transformation of Europe after the Neolithic Revolution

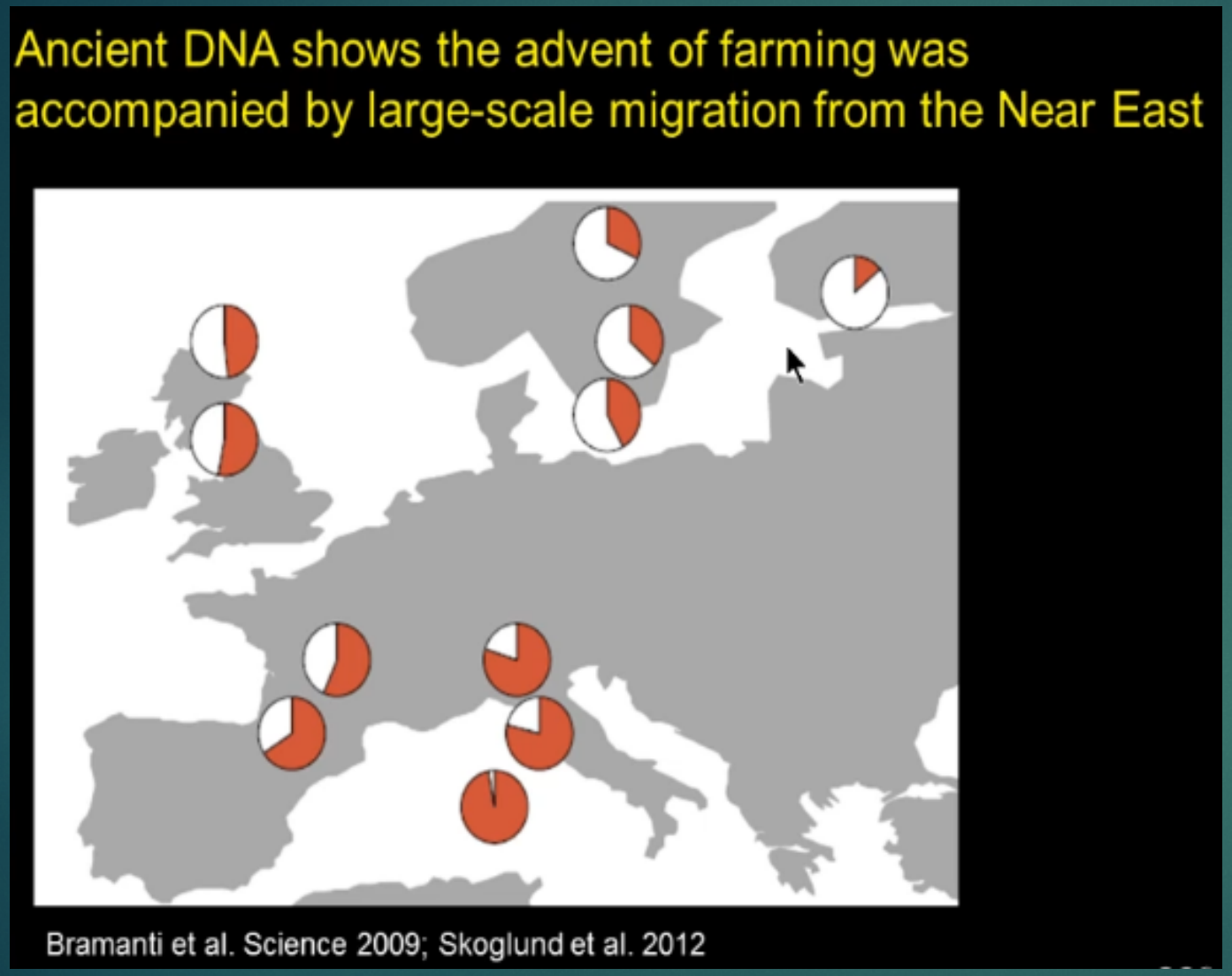
>800 samples with genome-wide data

Great patterns evident in archaeology and language

Archaeology

Linguistics

8500 years ago Neolithic Revolution:
farmers arrive from Anatolia thru Greece; to Britain by 6000 years ago

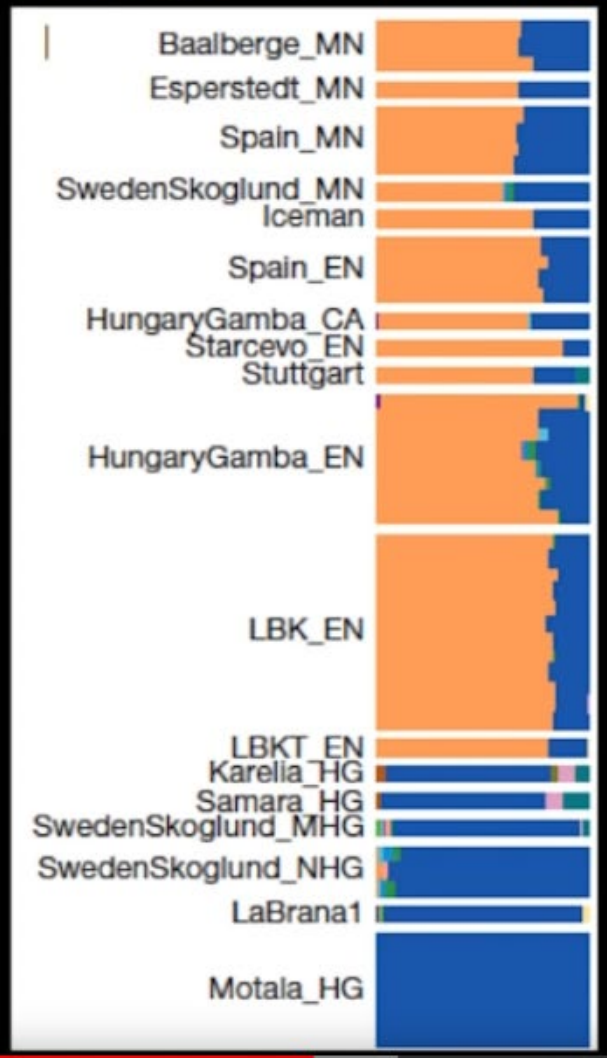


Farmers eventually swamp the indigenous hunter gathers

Before 4500 years ago Europeans were a mix of two ancestries

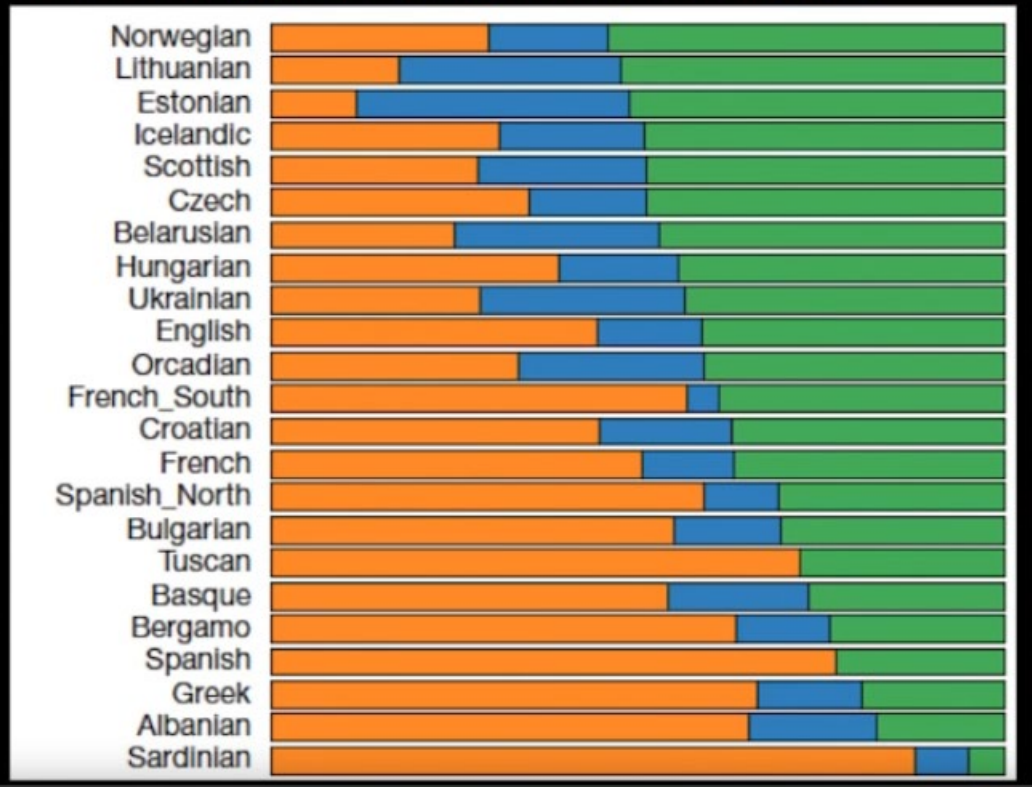
Blue = Local hunter-gatherers

Orange = Anatolian farmers



But today, there is green ancestry too

What happened after 4500 BCE?



ANE – Ancient North Eurasians

- Used the 3 Populations test on 50 current European groups and discovered a strong signal of mixtures from Sardinians…
- And Native Americans – not Siberians, or East Asians
- Concluded that there was an Ancient North Eurasian population before 15 Ka
- ANE contributed to the group that crossed the Beringian land bridge and also went to Europe

Ancestors of Europeans: ANE – Ancient North Eurasians

- Nick Patterson published a perplexing result showing that the frequencies of mutations in northern Europeans today tend to be intermediate between those of southern Europeans and Native Americans.

- He hypothesized that these findings could be explained by the existence of a "ghost population"—the Ancient North Eurasians—who were distributed across northern Eurasia more than 15 Ka and who contributed both to Native Americans and to northern Europeans.

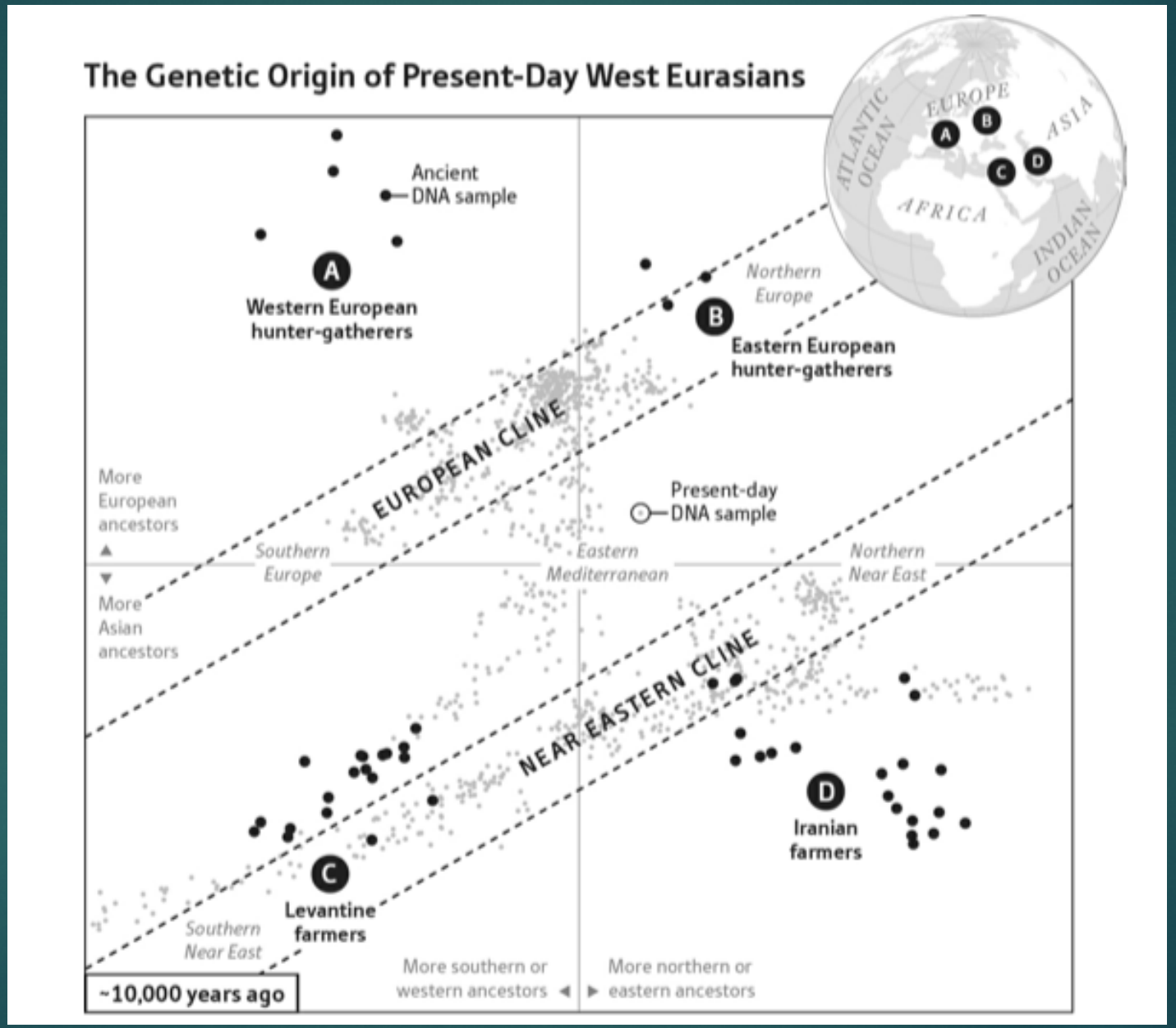
- A year later, Eske Willerslev obtained a sample of ancient DNA from Siberia that matched the predicted Ancient North Eurasians—the 24 Ka Mal'ta child.

The Genetic Origin of Present-Day West Eurasians

- Iosif Lazaridis was able to figure out how it was that the Ancient North Eurasian ancestry entered Europe within the last five thousand years.

- Using a principal component analysis, plotted a single dot for each individual depending on where he or she fell relative to the two principal components.

- On the scatterplot obtained for close to 800 current West Eurasians, two parallel lines appeared: the left containing almost all Europeans, and the right containing almost all Near Easterners, with a striking gap in between.


The Genetic Origin of Present-Day West Eurasians
ATLANTIC OCEAN
EUROPE
ASIA
AFRICA
INDIAN OCEAN
A
B
C
D
Ancient DNA sample
A
Western European hunter-gatherers
Northern Europe
B
Eastern European hunter-gatherers
EUROPEAN CLINE
Present-day DNA sample
More European ancestors
More Asian ancestors
Southern Europe
Eastern Mediterranean
Northern Near East
NEAR EASTERN CLINE
D
Iranian farmers
C
Levantine farmers
Southern Near East
~10,000 years ago
More southern or western ancestors
More northern or eastern ancestors

The Genetic Origin of Present-Day West Eurasians

- Ten thousand years ago, West Eurasia was home to four populations.

- The farmers of Europe and western Anatolia from 9 to 5 Ka were a mixture of
  - western European hunter-gatherers (A in above PCA).
  - Levantine farmers (C) and
  - Iranian farmers (D).

The Genetic Origin of Present-Day West Eurasians

- Meanwhile, the pastoralists of the steppe north of the Black and Caspian seas ~5000 years ago were a mixture of
  - eastern European hunter- gatherers (B) and
  - Iranian farmers (D).

- In the Bronze Age (3300-1200 BC), these mixed populations mixed further to form populations with ancestry similar to people today.

The Genetic Origin of Present-Day West Eurasians

- First came the hunter-gatherers,
  - who themselves were the product of a series of population transformations over the previous thirty-five thousand years,
  - the most recent of which was a massive expansion of people out of southeastern Europe by ~14 Ka that displaced much of the previously established population.

- They have contributed ancestry to present-day Europeans but not to present-day Near Easterners.

The Genetic Origin of Present-Day West Eurasians

- Second came the first farmers, who lived between about 8.8 to 4.5 Ka in Germany, Spain, Hungary, and Anatolia.
- Ancient farmers from all these places were genetically similar to present-day Sardinians,
  - showing that a pioneer farmer population had landed in Greece probably from Anatolia,
  - and then spread to Iberia in the west and Germany in the north,
  - retaining at least 90 percent of their DNA from that immigrant source,
  - which meant that they mixed minimally with the hunter-gatherers they encountered along the way.

The Genetic Origin of Present-Day West Eurasians

- Further investigation showed that it was not quite so simple.

- Found that farmers from the Peloponnese in southern Greece who lived around 6 Ka may have derived part of their ancestry from a different source population in Anatolia—a population that descended more from Iranian-related populations than was the case in the northwestern Anatolian farmers who were a likely source population for the rest of Europe's farmers.

The Genetic Origin of Present-Day West Eurasians

- The first farming in Europe was practiced in the Peloponnese of S Greece and the nearby island of Crete by people who did not use pottery.
- This has led some archaeologists to wonder if they were from a different migration.
- Our ancient DNA is consistent with this idea, and suggests the possibility that this population held on for thousands of years.

The Genetic Origin of Present-Day West Eurasians

- Third, we identified a new development in farmers living between 6 and 4.5 Ka.

- In many of these later farmers, we observed a shift toward approximately 20 percent extra hunter-gatherer ancestry, not present in the early farmers, implying that genetic mixing between the previously established people and new arrivals had begun, albeit after a couple of thousand years' delay.

The Genetic Origin of Present-Day West Eurasians

- How did the farming and hunter-gatherer cultures coexist?
- Hints come from the Funnel Beaker culture, which is named for decorated clay vessels in graves dated after about 6.3 Ka.
- The Funnel Beaker culture arose in a belt of land a few hundred kilometers from the Baltic Sea, which was not reached by the first wave of farmers, probably because their methods were not optimized for the heavy soils of northern Europe.

The Genetic Origin of Present-Day West Eurasians

- Protected by the stronghold of their difficult-to-farm environment, and sustained by the fish and game resources of Baltic Europe, the northern hunter-gatherers had more than a thousand years to adapt to the challenge of farming.

- They adopted domesticated animals, and later crops, from their southern neighbors, but kept many elements of their hunter-gathering ways.

The Genetic Origin of Present-Day West Eurasians

- The people of the Funnel Beaker culture were among those who built the megaliths, the collective burial tombs made of stones so large it would have taken dozens of people to move them.

- The archaeologist Colin Renfrew suggested that megalith building might be a direct reflection of this boundary between southern farmers and hunter-gatherers turned farmers—a way of laying claim to territory, of distinguishing one people and culture from others.

The Genetic Origin of Present-Day West Eurasians

- The genetic data may bear witness to this interaction, as there was clearly a stream of new migrants into the mixed population.

- Between 6 and 5 Ka, most of the northern gene pool was overtaken by farmer ancestry.

- This mixture of a modest amount of hunter-gatherer-related ancestry and a large amount of Anatolian farmer-related ancestry—in a population that retained key elements of hunter-gatherer culture—that characterized the Funnel Beaker potters and many other contemporary Europeans.

The Genetic Origin of Present-Day West Eurasians

- Europe had reached a new equilibrium.

- The unmixed hunter-gatherers were disappearing, persisting only in isolated pockets like the islands off southern Sweden.

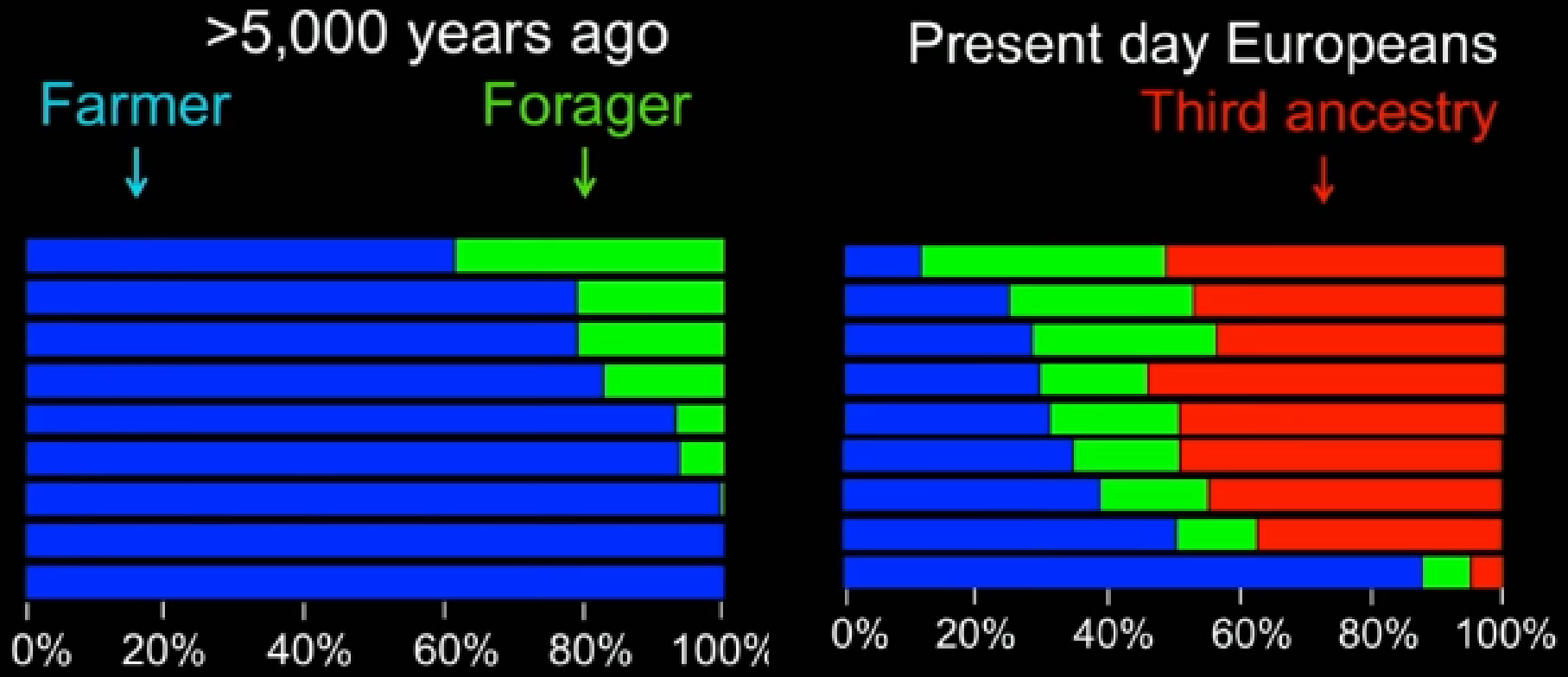
- In southeastern Europe, a settled farmer population had developed the most socially stratified societies known up until that time, and rituals that as the archaeologist Marija Gimbutas showed featured women in a central way—a far cry from the male-centered rituals that followed.

The Genetic Origin of Present-Day West Eurasians

- In remote Britain, the megalith builders were hard at work on building Stonehenge.
- Within a few hundred years their descendants would be gone and their lands overrun.
- The extraordinary fact that emerges from ancient DNA is that just five thousand years ago, the people who are now the primary ancestors of all extant northern Europeans had not yet arrived.

Before 5,000 years ago Europeans were a mixture of two ancestries but today there is a third

Lazaridis et al. *Nature* 2014; Haak et al. *Nature* 2015



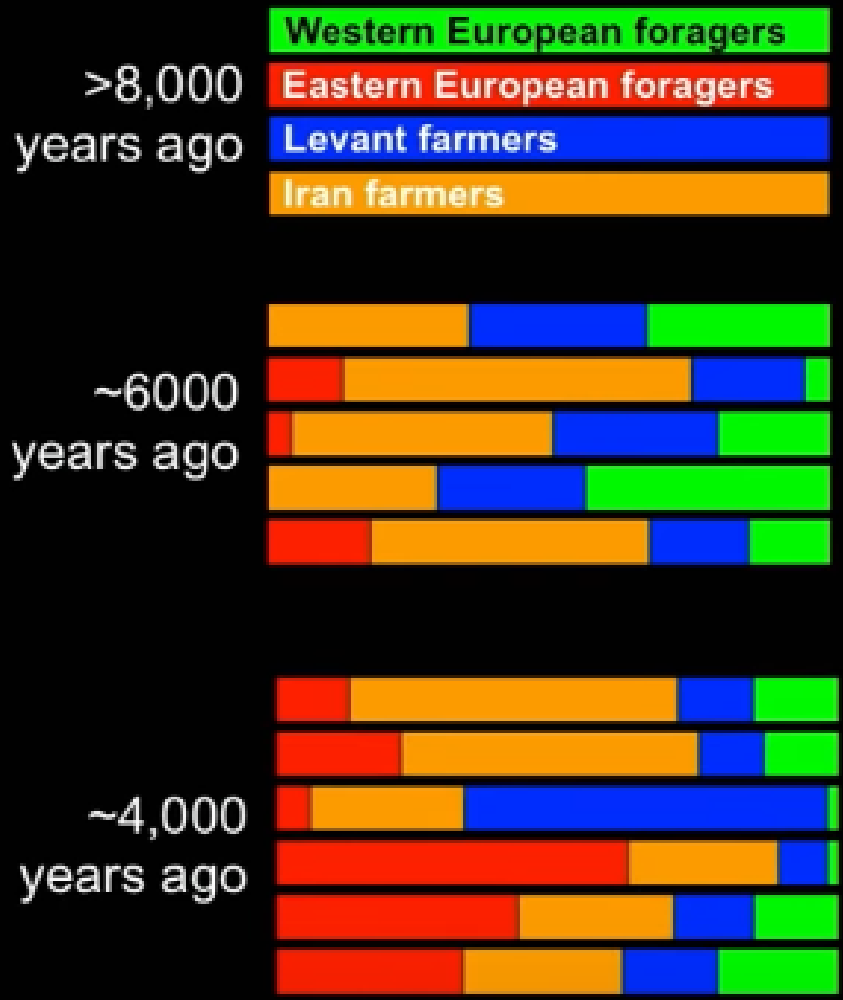
Blue = Anatolian farmers

50% of later population ancestry (red) did not exist at 5 Ka

20% was forager in later population

2nd lesson in humility: "White" people are a recent phenomenon

Derived from 4 sources as different from each other as Europeans / East Asians

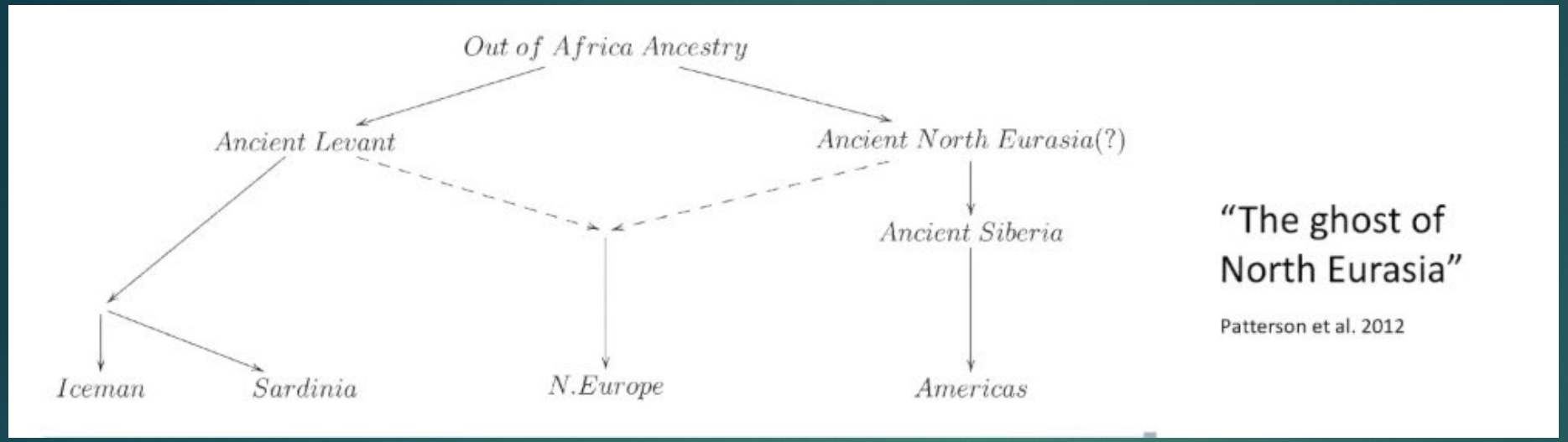


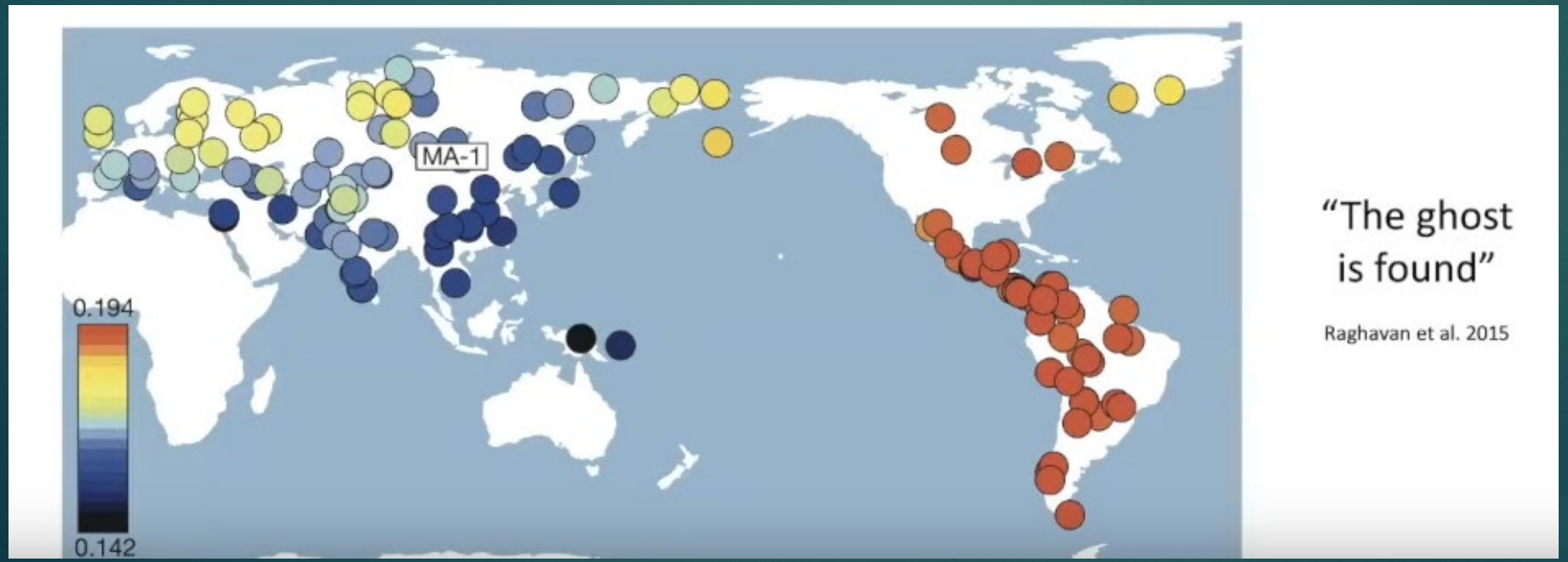
By 4,000 years ago we observe present-day low population differentiation

Homogenization of Europe:

"White" West Eurasian people are recent phenomenon

Discovery of Europe's Third Ancestral Population

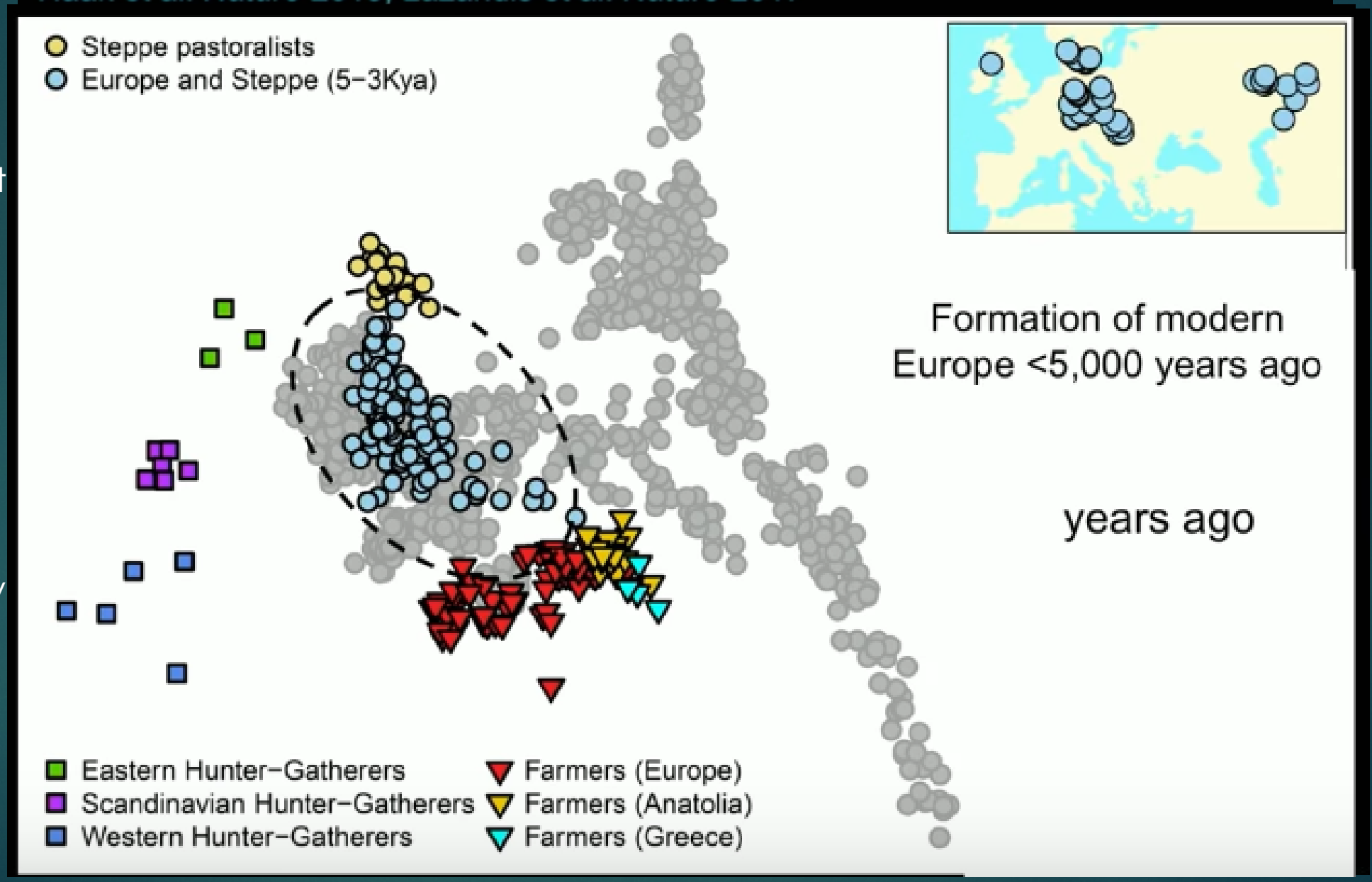




- Current Europeans are descendants of Levant farmers and a North Eurasian "ghost" population, who before 15 Ka were ancestral to Siberians & Native Americans & some N Europeans
  - 2015: Willerslev found N Eurasian group = Mal'ta child, 24 Ka

The third population arrives after 5,000 years ago

Haak et al. *Nature* 2015; Lazaridis et al. *Nature* 2017



Principle Component Analysis = Table of 600 K genetic locales vs 1000 people

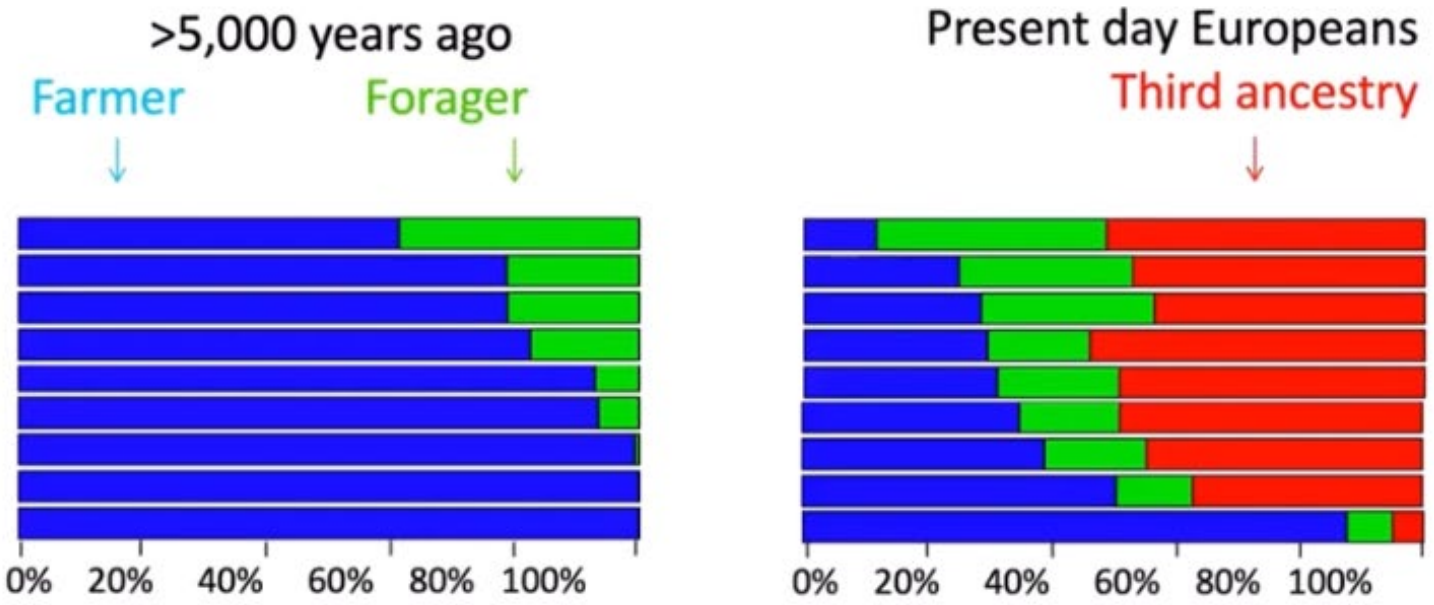
How closely related they are

3rd Population:

Yamnaya, Descend From N Asians

Before 5,000 years ago Europeans a mixture of two ancestries / Today there is a third

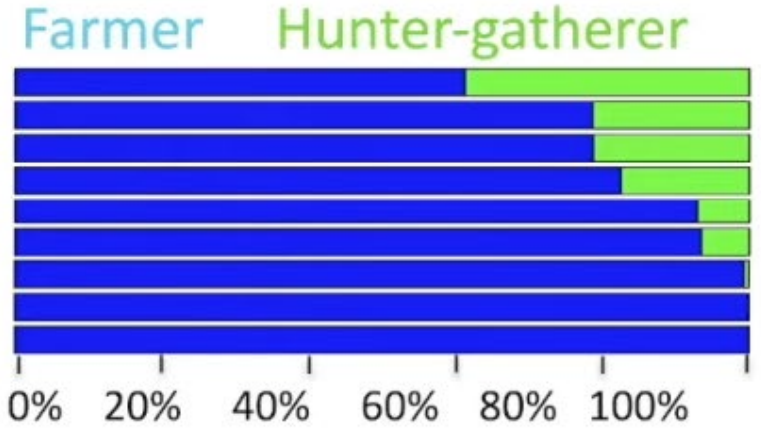
Lazaridis et al. 2014; Haak et al. 2015



Iosif Lazaridis

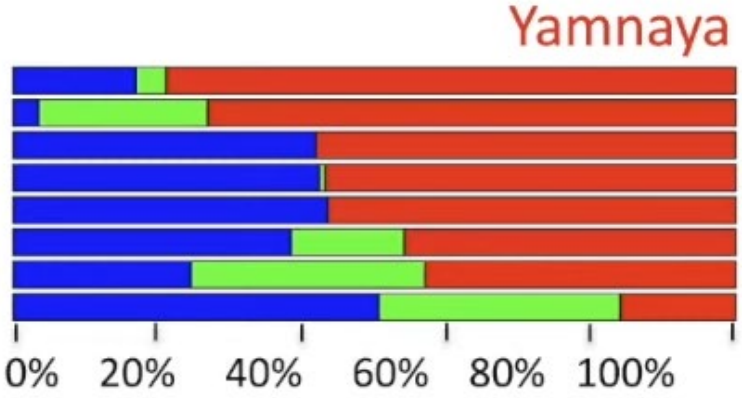
When did third ancestry arrive?

Migration 1



Farmers arrive, mix with local hunter-gatherers 8,500-5,000 years ago

Migration 2



Yamnaya-farmer mix <5,000 years ago

Summary: Europe massively transformed by 2 migrations

Yamnaya are the single largest source of ancestry in many current European

Yamnaya: replaced 70% of population in some areas: mobile homes, without settlements

European farmers

- Before about 5000 years ago, Neolithic Europe was inhabited by people much like those who raised Stonehenge.
- They were farmers with an urge to work together and build large stone structures. It looks like these people were quite communal. Living in groups of up to 15,000.
- Patterns of wear on ancient cattle bones suggest they had worked out how to use livestock to pull heavy loads. They probably had wheeled vehicles and there may even have been proto-roads connecting communities.
- In other words, Neolithic Europe appears to have been prosperous, community-minded and relatively peaceful. Then everything changed.

Yamnaya: Kurgan burials

- Starting about 5000 years ago in south-east Europe – a region bounded today by Ukraine in the east and Hungary in the west – a new style of burial custom appeared.

- The dead were interred alone in what archaeologists call “pit graves” rather than in communal structures. The body was decorated with a red pigment called ochre, and the grave chamber covered with wooden beams and marked by a mound of earth a few meters tall, dubbed a kurgan. This distinctive burial custom originated on the Eurasian steppe where it was associated in particular with the Yamnaya

- By 4900 years ago, the Corded Ware people – named after their distinctive pottery and adopting many Yamnaya customs – began to appear in central and northern Europe. The big question is: how and why did Yamnaya practices spread so far and so fast?

Yamnaya

- New group: Also known as the Yamnaya Culture, Pit Grave Culture or Ochre Grave Culture.
- Generally considered by linguists as the homeland of the Proto-Indo-European language.
- Probably originated between the Lower Don, the Lower Volga and North Caucasus during the Chalcolithic, around what became the Novotitorovka culture (3300-2700 Ka) within the Yamna culture.
- Highly mobile steppe culture of pastoral nomads relying heavily on cattle (dairy farming). Sheep were also kept for their wool. Hunting, fishing and sporadic agriculture was practiced near rivers.

Yamnaya

- First culture (along with Maykop) to make regular use of ox-drawn wheeled carts.
- Metal artefacts (tools, axes, tanged daggers) were mostly made of copper, with some arsenical bronze.
- Domesticated horses used as pack animal and ridden to manage cattle herds.
- Coarse, flat-bottomed, egg-shaped pottery decorated with comb stamps and cord impressions.

Yamnaya burials

- The dead were inhumed in pit graves inside kurgans (burial mounds).
- Bodies were placed in a supine position with bent knees and covered in ochre.
- Wagons/carts and sacrificed animals (cattle, horse, sheep) were present in graves, a trait typical of later Indo-European cultures.

Who were the Yamna people genetically?

- Genetic analysis of Yamnayan genomes revealed that Yamnayans were a blend of three ancestral HG populations.

- 1- The dominant element (55 to 85%) was the Mesolithic Eastern Hunter-Gatherer (EHG), associated with Y-haplogroups R1a and R1b.

- 2 - Then came the Caucasian Hunter-Gatherer (CHG) admixture, making up about 15-25% of their genomes.

Yamnaya

- 3 - The third admixture was the Western Hunter-Gatherer (WHG), representing about 6% of Yamna genomes. The WHG admixture is derived from Mesolithic Western Europeans descended from Late Cro-Magnons (Gravettian) and is mainly linked with Y-haplogroup I.

- The Yamnaya DNA samples recovered from elite Kurgan graves in southern Russia = haplogroup R1b-Z2103, the essentially eastern branch of Indo-European R1b.

Yamnaya

- Per Reich, the Yamnaya =
  - monoculture spread; into Europe,
  - more than 50% of current Europeans now have this genetic ancestry;
  - not an invasion;
  - not an empire,
  - they were decentralized;
  - no war like events; some raiding

- There is an alternative interpretation of the Yamnaya

Yamnaya

- Steppe pastoralists from north of Caspian and Black Sea
- Left large tombs
- Used horses and wheeled carts
- Exploited the steppe grasslands with larger herds
- Moved from Mongolia to Hungary

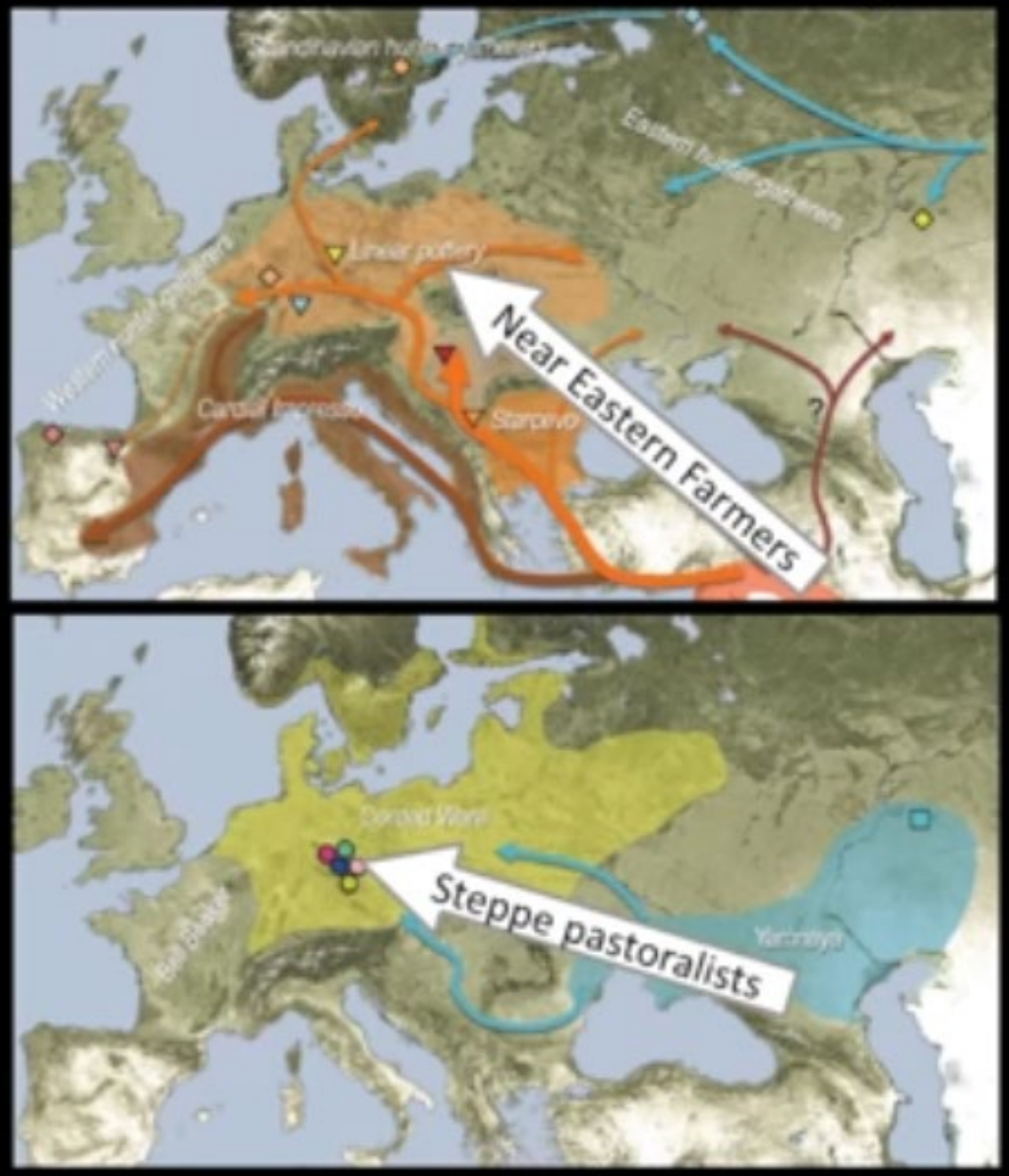
Summary: two major migrations into Europe

These are the only two major migrations into Western and Central Europe in the last 10,000 years

MIGRATION 1
6500 BCE
Near Eastern farmers
60-100% replacement

MIGRATION 2
~2500 BCE
Steppe pastoralists
60-80% replacement

RESURGENCE
Each followed by resurgence of local ancestry over thousands of years



The Tide from the East: The Yamnaya

- The grasslands of the steppe stretch 8,000 kilometers from central Europe to China.

- Prior to 5000 years ago, the archaeological evidence indicates that almost no one lived far from the steppe river valleys,
  because in between these areas there was too little rain to support agriculture, and too few watering holes to support livestock.

- The European third of the steppe was a hodgepodge of local cultures, each with its own pottery style, spread thinly over the landscape in places where water could be founds

The Tide from the East

- All this changed with the emergence of the Yamnaya culture 5000 years ago, whose economy was based on sheep and cattle herding.
- These people were pastoral nomads who drove wheeled vehicles, rode domesticated horses and began to use dairy products – a package that was to guarantee their dominance wherever they went.
- Their migrations were the engine that powered the bronze age.
- Homer described a society in which warlords gained prestige and wealth through plunder and rape. It is not pretty, but is highly congruent with what we now know of the Yamnaya (the Beaker people represented the far western wave of Yamnaya migrations).

Yamnaya

- Of theirs and other such male-dominant migrations, Reich drily comments: “Males from populations with more power tend to pair with females from populations with less.”

- The Yamnaya emerged from previous cultures of the steppe and its periphery and exploited the steppe resources far more effectively than their predecessors.

- They spread over a vast region, from Hungary in Europe to the foothills of the Altai Mountains in central Asia, and in many places replaced the disparate cultures that had preceded them with a more homogeneous way of life.

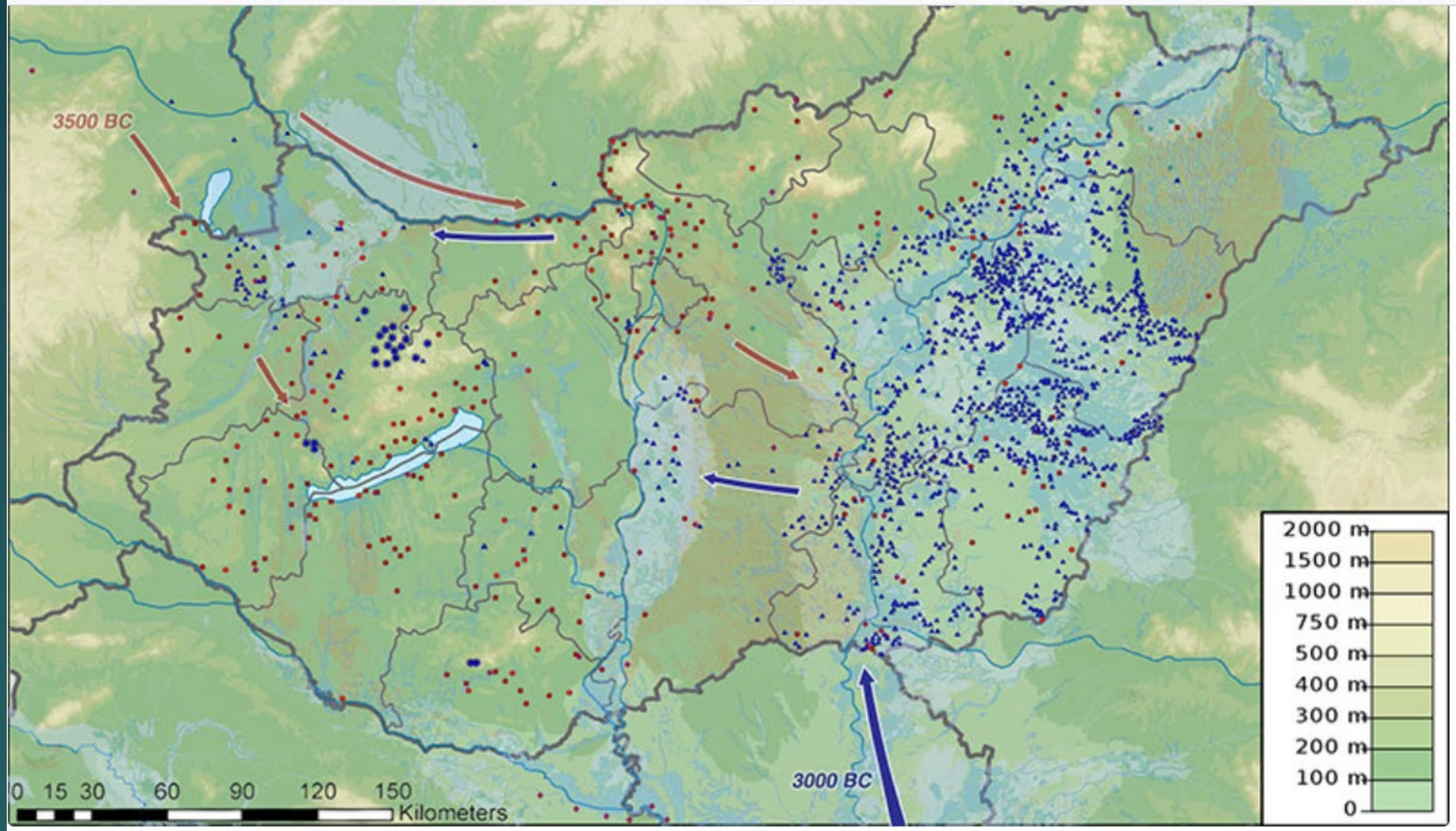
- Most people of European descent have close genetic and linguistic ties with near eastern and north Indian peoples,

Yamnaya and the wheel

- One of the inventions that drove the spread of the Yamnaya was the wheel.
- Wagons using wheels may have been adopted by the Yamnaya from their neighbors to the south: the Maikop culture in the Caucasus region between the Black and Caspian seas.
- By hitching their animals to wagons, the Yamnaya could take water and supplies with them into the open steppe and exploit the vast lands that had previously been inaccessible.

The Tide from the East: wagons and horses

- By taking advantage of another innovation—the horse, which had recently been domesticated in a more eastern part of the steppe, and which made cattle herding possible—the Yamnaya also became vastly more productive.
- A profound transformation in culture began with the Yamnaya: The increase in the intensity of the human use of the steppe lands coincided with a nearly complete disappearance of permanent settlements—almost all the structures that the Yamnaya left behind were graves, huge mounds of earth called kurgans. Sometimes people were buried in kurgans with wagons and horses, highlighting the importance of horses to their lifestyle.



10. A. *Map of Yamnaya kurgans in Hungary, and contemporary settlements of Baden-Boleráz.*

Yamnaya: mass migration vs cultural exchange

- The wheel and horse so profoundly altered the economy that they led to the abandonment of village life. People lived on the move, in ancient versions of mobile homes.

- Archaeologist David Anthony, a leading proponent of the idea that the spread of Yamnaya culture was transformative in the history of Eurasia, could not bring himself to suggest that its spread was driven by mass migration. Instead, he proposed that most aspects of Yamnaya culture spread through imitation and proselytization.

- But the genetics showed otherwise. The Yamnaya carried exactly the type of genetic ancestry that needed to be added to early European farmers and hunter-gatherers to produce populations with the mixture of ancestries observed in Europe todays

Yamnaya's ancestors

- Yamnaya themselves had formed from earlier populations.
- From 7 to 5 Ka, there was a steady influx into the steppe of a population whose ancestors traced their origin to the south—to the people of Armenia and Iran—eventually crystallizing in the Yamnaya, who were about a *one-to-one ratio of ancestry from these two sources.*
- A good guess is that the migration proceeded via the Caucasus isthmus between the Black and Caspian seas.
- The evidence that people of the Maikop culture or the people who proceeded them in the Caucasus made a genetic contribution to the Yamnaya is not surprising in light of the cultural influence the Maikop had on the Yamnaya.

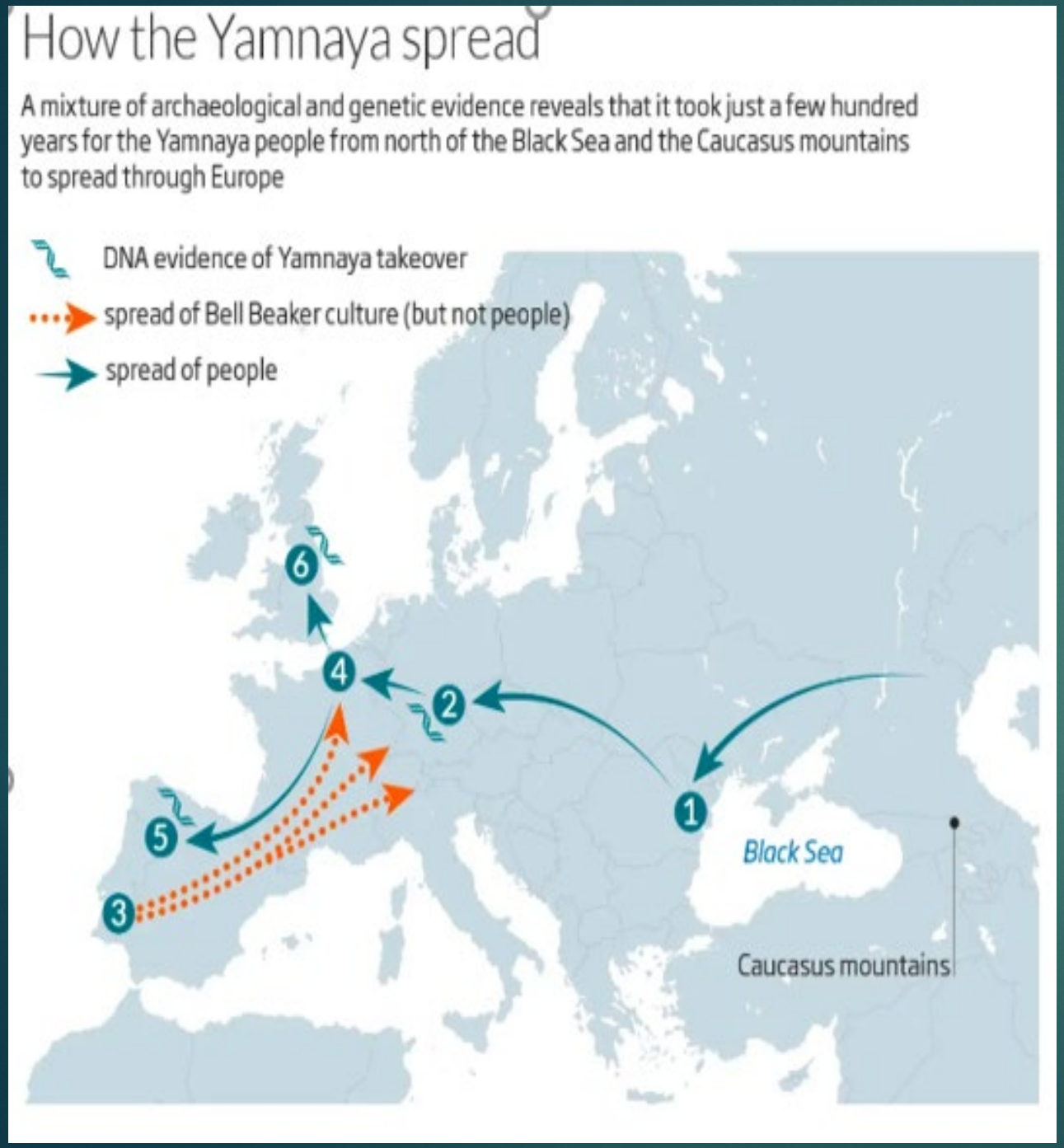
Yamnaya: a mixture of Maikop, Iranian, & Armenian groups

- Not only did the Maikop pass on to the Yamnaya their technology of carts, but Maikop were the first to build the kurgans.

- The penetration of Maikop lands by Iranian- and Armenian-related ancestry from the south is also plausible in light of studies showing that Maikop goods were heavily influenced by elements of the Uruk civilization of Mesopotamia to the south.

- Whatever cultural process allowed the people from the south to have such a demographic impact, once the Yamnaya formed, their descendants expanded in all directions.

Individual graves containing a body decorated with ochre are a hallmark of Yamnayan culture.



- **1** Yamnaya arrive in south-east Europe-5000 years BP
- **2** Some Corded Ware people have substantial Yamnaya ancestry-4900 BP
- **3** First Bell Beaker people appear-4700 BP
- **4** Bell Beaker culture spreads eastwards, and some Yamnaya-descended Corded Ware people become Beakers -4600-4500 BP
- **5** Yamnaya Beakers reach Iberia-4500 BP
- **6** Yamnaya Beakers reach Britain-4400 BP

Pottery and Mitochondrial DNA

First farmers
Linear Band Pottery
Central Europe
7,500–6,500 years ago

Linear Band pottery farmers (N1a, T2, K, J, HV, V, W, X)

Farmers
Funnel Beaker
Sweden
6,300–4,800 ya

Hunter-gatherers
Pitted Ware
Southern Scandinavia
5,200–4,300 ya

Farmers
Corded Ware
Central Europe
4,900–4,350 ya

Corded Ware pottery makers (I, U2)

Farmers
Bell Beaker
Iberia, Central Europe, Britain
4,800–3,800 ya

Bell Beaker people (H)

How the Steppe Came to Central Europe

- On the eve of the arrival of steppe ancestry in central Europe around 5000 years ago, the genetic ancestry of the people who lived there was largely derived from the first farmers who had come into Europe from Anatolia beginning after 9000 years ago, with a minority contribution from the indigenous European hunter-gatherers who mixed with them.

- In far eastern Europe also around 5000 years ago, the genetic structure of the Yamnaya reflected a different mixture of ancestries: an Iranian-related population along with an eastern European hunter-gatherer population, in approximately equal proportions.

Corded Ware: Battle Axe Culture, 2.8 K

Originally hunter gatherers; then agriculturists from N East to Anatolia arrive in central Europe, 7-8K; then in late Neolithic, 4-5K, + languages; immigration of

Plague comes to Europe, circa 4 Ka

Plague opened up locale for new immigration

Corded Ware culture

- The genetic impact of steppe ancestry on central Europe came in the form of peoples who were part of the ancient culture known as the Corded Ware, so named after its pots decorated by the impressing of twine into soft clay.

- Beginning around 4900 years ago, artifacts characteristic of the Corded Ware culture started spreading over a vast region, from Switzerland to European Russia.

- The ancient DNA data showed that beginning with the Corded Ware culture, individuals with ancestry similar to present-day Europeans first appeared in Europe.

Yamnaya = Corded Ware culture

- In Germany, people buried with Corded Ware pots derive about three-quarters of their ancestry from groups related to the Yamnaya and the rest from people related to the farmers who had been the previous inhabitants of that region.

- Steppe ancestry has endured, as we also found it in all subsequent archaeological cultures of northern Europe as well as in all present-day northern Europeans.

- The genetic data thus settled a long-standing debate in archaeology about linkages between the Corded Ware and the Yamnaya cultures.

Corded Ware

- The two had many striking parallels, such as the construction of large burial mounds, the intensive exploitation of horses and herding, and a strikingly male-centered culture that celebrated violence, as reflected in the great maces (or hammer-axes) buried in some graves.

- At the same time, there were profound differences between the two cultures, notably the entirely different types of pottery that they made, with important elements of the Corded Ware style adapted from previous central European pottery styles.

Corded Ware Culture and Yamnaya

- The people of the Corded Ware culture share significant levels of genetic ancestry with Yamnaya, and the people of both cultures may be directly descended from a genetically similar pre-Yamnaya population

- The genetics showed that the connection between the Corded Ware culture and the Yamnaya culture reflected major movements of people.

- The makers of the Corded Ware culture were, at least in a genetic sense, a westward extension of the Yamnaya.

Corded Ware culture = Yamnaya

- The Corded Ware culture is thought to have originated from the westward migration of Yamnaya-related people from the steppe-forest zone into the territory of late Neolithic European cultures such as the Globular Amphora and Funnelbeaker cultures, and is considered to be a likely vector for the spread of many of the Indo-European languages in Europe and Asia.

- Wikipedia gives a far more complex interpretation of the Corded Ware culture.

Corded Ware culture: Gustaf Kossinna

- The discovery that the Corded Ware culture reflected a mass migration of people into central Europe from the steppe was not just a sterile academic finding.

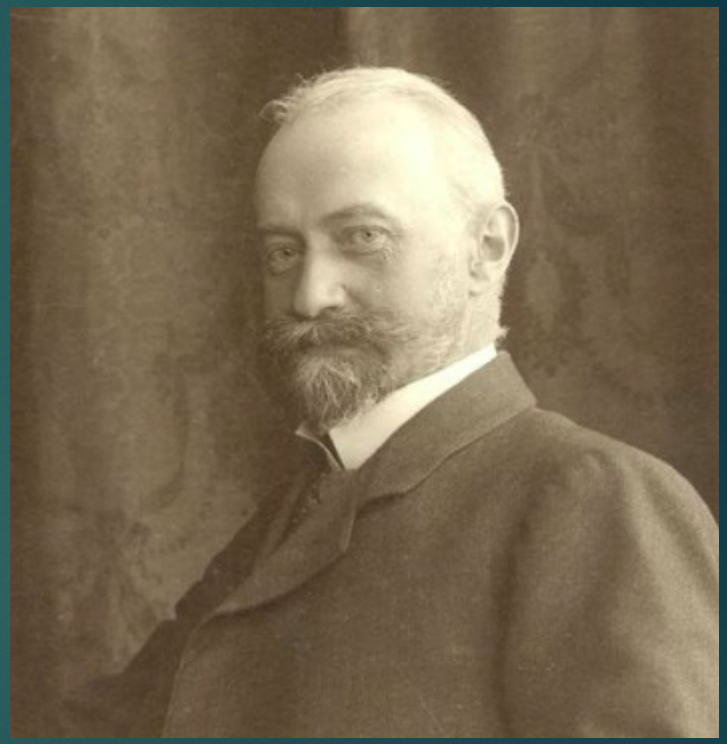
- It had political and historical resonance. Reich had not been in the habit of consulting archeologists who had previously worked on these European Cultures before he published his data on same topics.

- Reich's kind of migration theory leads back to old archeological demons of blond, blue-eyed guys coming back somehow out of the hell where they were sent after World War II.

- At the beginning of the twentieth century, the German archaeologist Gustaf Kossinna was among the first to articulate the idea that cultures of the past that were spread across large geographic regions could be recognized through similarities in style of the artifacts they left behind.

Gustaf Kossinna

- **Gustaf Kossinna** (1858 –1931) was a German philologist and archaeologist who was Professor of German Archaeology at the University of Berlin.
- He was the most influential German prehistorian of his day, and was creator of the techniques of settlement archaeology.
- His nationalistic theories about the migratory origins of the Germanic peoples and Indo-Europeans influenced aspects of Nazi ideology.



Corded Ware culture: Gustaf Kossinna

- He viewed archaeologically identified cultures as synonymous with "peoples", and he originated the idea that the spread of material culture could be used to trace ancient migrations, an approach he called the *siedlungsarchäologische Methode*, or "Settlement Archaeology."

- Based on the overlap of the geographic distribution of the Corded Ware culture with the places where German is spoken, Kossinna suggested that the cultural roots of the Germans and of Germanic languages today lay in the Corded Ware culture.

Kossinna

- In his essay "The Borderland of Eastern Germany: Home Territory of the Germans" he argued that because the Corded Ware culture included the territories of Poland, Czechoslovakia, and western Russia of his day, it gave Germans the moral birthright to claim those regions as their own.
- Kossinna's ideas were embraced by the Nazis, and although he died in 1931, before they came to power, his scholarship was used as a basis for their propaganda and a justification for their claims to territories to the east. (See Burns "The US and the Holocaust")
- Kossinna's suggestion that migration was the primary explanation for changes in the archaeological record was also attractive to the Nazis because it played into their racist worldview, as it was easy to imagine that migrations had been propelled by innate biological superiority of some peoples (blue eyed, blond, Aryans) over others.

Kossinna lead to Nazi “Aryan Race” theory

- The north German tribe of proto-Indo-Europeans, Kossinna argued, had moved outward and dominated an area that stretched most of the way to Moscow.
- Nazi propagandists later used that as an intellectual justification for the modern Aryan “master race” to invade eastern Europe.
- Partly as a result, for decades after World War II the whole idea that ancient cultural shifts might be explained by migrations fell into ill repute in many archaeological circles.
- Even today it makes some archaeologists uncomfortable when geneticists draw bold arrows across maps of Europe.

Reaction to Kossinna

- Following the Second World War, European archaeologists reacting to the politicization of their field began picking apart the arguments of Kossinna and his colleagues, documenting cases in which changes in material culture were brought about through local invention or imitation and not thru migrations of people.

- They urged extreme caution about invoking migration to explain changes in the archaeological record.

- Today, a common view among archaeologists is that migrations are only one of many explanations for past cultural change.

Reaction to Kossinna: cultural vs demic changes

- Many archaeologists still argue that when there is evidence for major cultural change at a site, the working assumption should be that the changes reflect communication of ideas or local invention, not necessarily movements of people.

- Discussions of the Corded Ware culture and migration in the same breath ring particularly loud alarm bells because of Kossinna's and the Nazis' attempt to use the Corded Ware culture to construct a basis for national German identity

Reaction to Reich's data of Yamnaya migration

- The correct theory that the Corded Ware culture spread through a migration from the east had already been proposed in the 1920s by Kossinna's contemporary, the archaeologist V. Gordon Childe, although this idea too fell out of favor in the wake of the Second World War and the reaction to the abuse of archaeology by the Nazis, a reaction that took the form of extreme skepticism about any claims of migration.
- Reich: Finding about the genetic link between the Yamnaya and the Corded Ware culture demonstrates the disruptive power of ancient DNA.
- It can prove past movements of people, and in this case has documented a magnitude of population replacement that no modern archaeologist, even the most ardent supporter of migrations, had dared to propose.

Reaction to Reich's data of Yamnaya migration

- Reich: While we were in the final stages of preparing a paper for submission in 2015, one of the German archaeologists who contributed skeletal samples wrote a letter to all coauthors: "We must (!) avoid...being compared with the so called '*siedlungsarchäologische Methode*' from Gustaf Kossinna!"
- He and several contributors then resigned as authors before we modified our paper to highlight differences between Kossinna's thesis and our findings, namely that the Corded Ware culture came from the east and that the people associated with it had not been previously established in central Europe.

aDNA argues against Kossinna's theory

- Reich argues that ancient DNA has become a strong argument against Kossinna's theory.

- First, in documenting the spread of the Yamnaya and their descendants deeper and deeper into Europe at just the right time, the DNA evidence supports the favored theory among linguists: that proto-Indo-Europeans migrated into Europe from the Russian steppe, not the other way around.

-

- Second, together with archaeology it amounts to a rejection of Kossinna's claim that some kind of pure race exists in Europe, one that can be identified from its cultural artifacts.

Yamnaya migration = Corded Ware culture

- Reich: The association between steppe genetic ancestry and people assigned to the Corded Ware archaeological culture through graves and artifacts is not simply a hypothesis. It is now a proven fact.

- How was it that the low-population-density shepherds from the steppe were able to displace the densely settled farmers of central and western Europe?

- The archaeologist Peter Bellwood has argued that once densely settled farming populations were established in Europe, it would have been practically impossible for other groups coming in to make a demographic dent, as their numbers would have been dwarfed by the already established population.

Theories of Yamnaya takeover of Europe

- As an analogy, consider the effect of the British or Mughal occupations of India. Both powers controlled the subcontinent for hundreds of years, but left little trace in the people there today.
- But ancient DNA shows definitively that major population replacement happened in Europe after around 4500 years ago.
- How were people with steppe ancestry able to have such an impact on an already settled region?
- One theory is that the farmers who preceded them may not have occupied every available economic niche in central Europe, giving the steppe peoples an opportunity to expand.

Yamnaya

- Although it is difficult to estimate population sizes from archaeological evidence, the number of people in northern Europe before 2000 years ago has been estimated to be around one hundred times less than today or even smaller.

- When the Corded Ware culture arrived, many tilled fields in central Europe were surrounded by virgin forests.

- But studies of pollen records in Denmark and elsewhere show that around this time, large parts of northern Europe were transformed from partial forest to grasslands, suggesting that the Corded Ware newcomers may have cut down forests, reengineered parts of the landscape to be more like the steppe, and carved out a niche for themselves that previous peoples of the region had never fully claimed.

Yamnaya migration: Yersinia pestis

- There is also a second possible explanation for why the steppe peoples were able to become established in Europe—one that no one would have thought plausible without ancient DNA.
- Eske Willerslev and Simon Rasmussen had the idea of testing 101 ancient DNA samples from Europe and the steppe for evidence of pathogens.
- In seven samples, they found DNA from *Yersinia pestis*, the bacterium responsible for the Black Death, estimated to have wiped out around one-third of the populations of Europe, India, and China around seven hundred years ago.

Yamnaya migration: Yersinia pestis

- Traces of plague in a person's teeth are almost a sure sign that he or she died of it.
- The earliest bacterial genomes that they sequenced lacked a few key genes necessary for the disease to spread via fleas, which is necessary to cause bubonic plague.
- But the bacterial genomes did carry the genes necessary to cause pneumonie plague, which is spread by sneezing and coughing just like the flu.
- That a substantial fraction of random graves analyzed carried *Y. pestis* shows that this disease was endemic on the steppe.

Yamnaya: immunity?

- Is it possible that the steppe people had picked up the plague and built up an immunity to it, and then transmitted it to the immunologically susceptible central European farmers, causing their numbers to collapse and thereby clearing the way for the Corded Ware culture expansion?
- Prior example: collapse of Native American populations after 1492 was infectious diseases spread by Europeans who had built up some immunity to these diseases after living in close proximity to their farm animals.
- Was it possible that, in a similar way, northern European farmers after five thousand years ago were decimated by plagues brought from the east, paving the way for the spread of steppe ancestry through Europe?

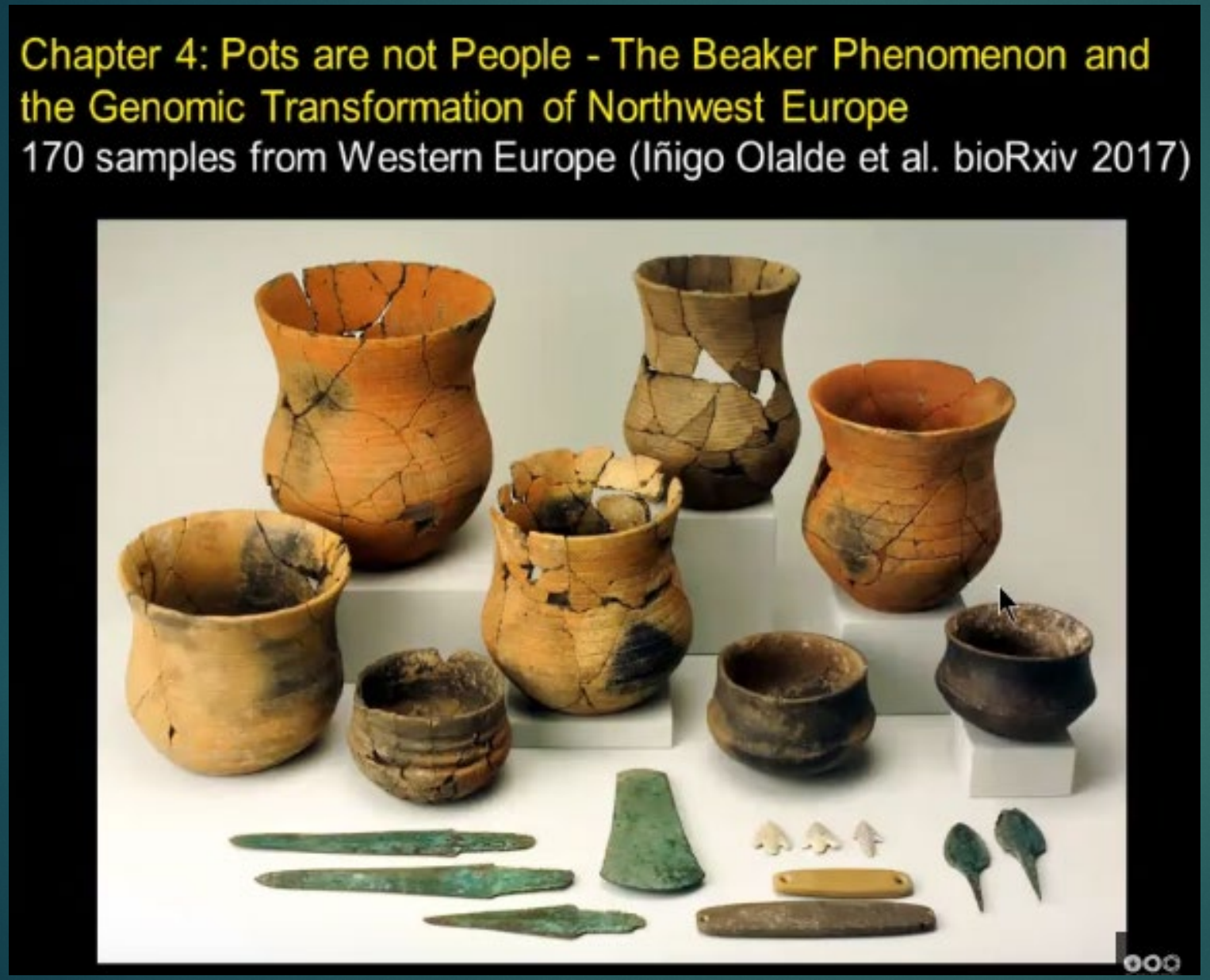
How Britain Succumbed

- Beginning ~4700 years ago, a couple of centuries after the Corded Ware culture swept into central Europe, there was an equally dramatic expansion of the Bell Beaker culture, probably from the region of present-day Spain.

- The Bell Beaker culture is named for its bell-shaped drinking vessels that rapidly spread over a vast expanse of western Europe alongside other artifacts including decorative buttons and archers' wristguards.

- By studying the isotopic composition of teeth, archaeologists have shown that some people of the Bell Beaker culture moved hundreds of kilometers from their places of birth. Bell Beaker culture spread to Britain after 4500 years ago and stayed until 1800 bc.

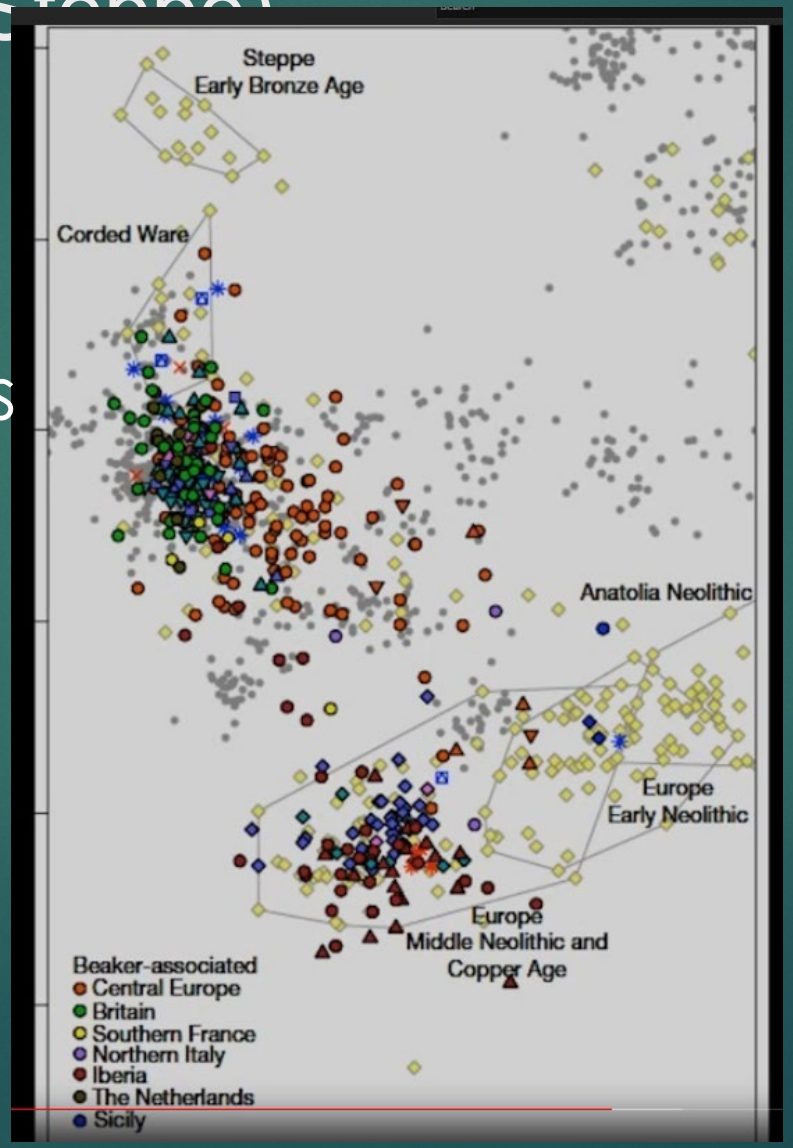
Bell Beaker Culture

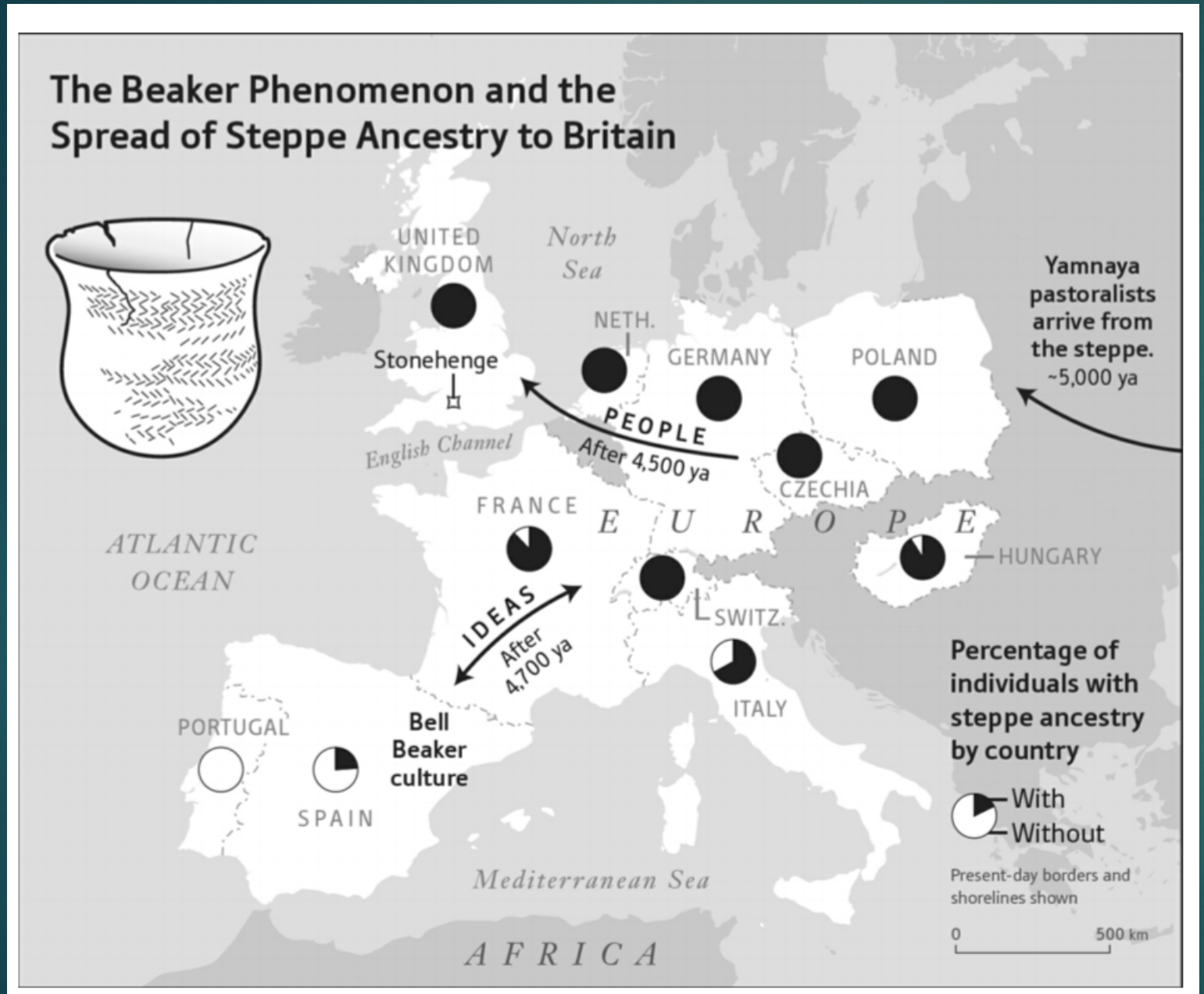


- Pots are not People
- What does archeological different material cultures mean, i.e. type of clay pots;
- Recent theory that it was spread of ideas not movement of people
- Bell Beaker culture, starting in Iberia, 4800 ya; to Britain by 4400 ya
- Spread of cultural style or of movement of peoples bringing new culture

Bell Beaker group is genetically heterogeneous – Corded Ware from Central Europe group (Steppe ancestry) and Bell Beaker Iberian group (without Steppe)

Bell Beaker group:
Initially spread by ideas between 2 genetically unrelated groups





2 ways to spread:

Genetic spread of Steppe ancestry in Europe
but by ideas
Into Spain

Bell Beaker

- In 2017, whole-genome ancient DNA data from more than 200 skeletons associated with the Beaker culture from across Europe.

- Bell Beaker Individuals in Iberia were genetically indistinguishable from the people who had preceded them and who were not buried in a Bell Beaker culture style.

- But Bell Beaker-associated individuals in central Europe were extremely different, with most of their ancestry of steppe origin, and little if any ancestry in common with individuals from Iberia associated with the Bell Beaker culture.

Bell Beaker culture in Europe

- In contrast to what happened with the spread of the Corded Ware culture from the east, the initial spread of the Bell Beaker culture across Europe was mediated by the movement of ideas, not by migration.

- Once the Bell Beaker culture reached central Europe through the dispersal of ideas, though, it spread further through migration.

- But after 4500 years ago, all ancient British samples we analyzed had large amounts of steppe ancestry and no affinity to Iberians at all.

Yamnaya spread the Bell Beaker culture

- Steppe ancestry in dozens of Bell Beaker skeletons in Britain closely matches that of skeletons from Bell Beaker culture graves in central Europe.
- The genetic impact of the spread of peoples from the continent into the British Isles in this period was permanent.
- British and Irish skeletons from the Bronze Age that followed the Beaker period had:
  - at most around 10 percent ancestry from the first farmers of these islands,
  - with the other 90 percent from people like those associated with the Bell Beaker culture in the Netherlands.
- This was a population replacement at least as dramatic as the one that accompanied the spread of the Corded Ware culture

Bell Beaker Culture

- Prompted by the ancient DNA results, several archaeologists speculated to Reich that the Bell Beaker culture could be viewed as a kind of ancient religion that converted peoples of different backgrounds to a new way of viewing the world, thus serving as an ideological solvent that facilitated the integration and spread of steppe ancestry and culture into central and western Europe.
- At a Hungarian Bell Beaker site, there was direct evidence that this culture was open to people of diverse ancestries, with individuals buried in a Bell Beaker cultural context having the full range of steppe ancestry from zero to 75 percent (as high as in people associated with the Corded Ware culture).

Beaker Folk

- What made it possible for people practicing the Beaker culture to spread so dramatically into northwestern Europe and outcompete the established and highly sophisticated populations previously established there?

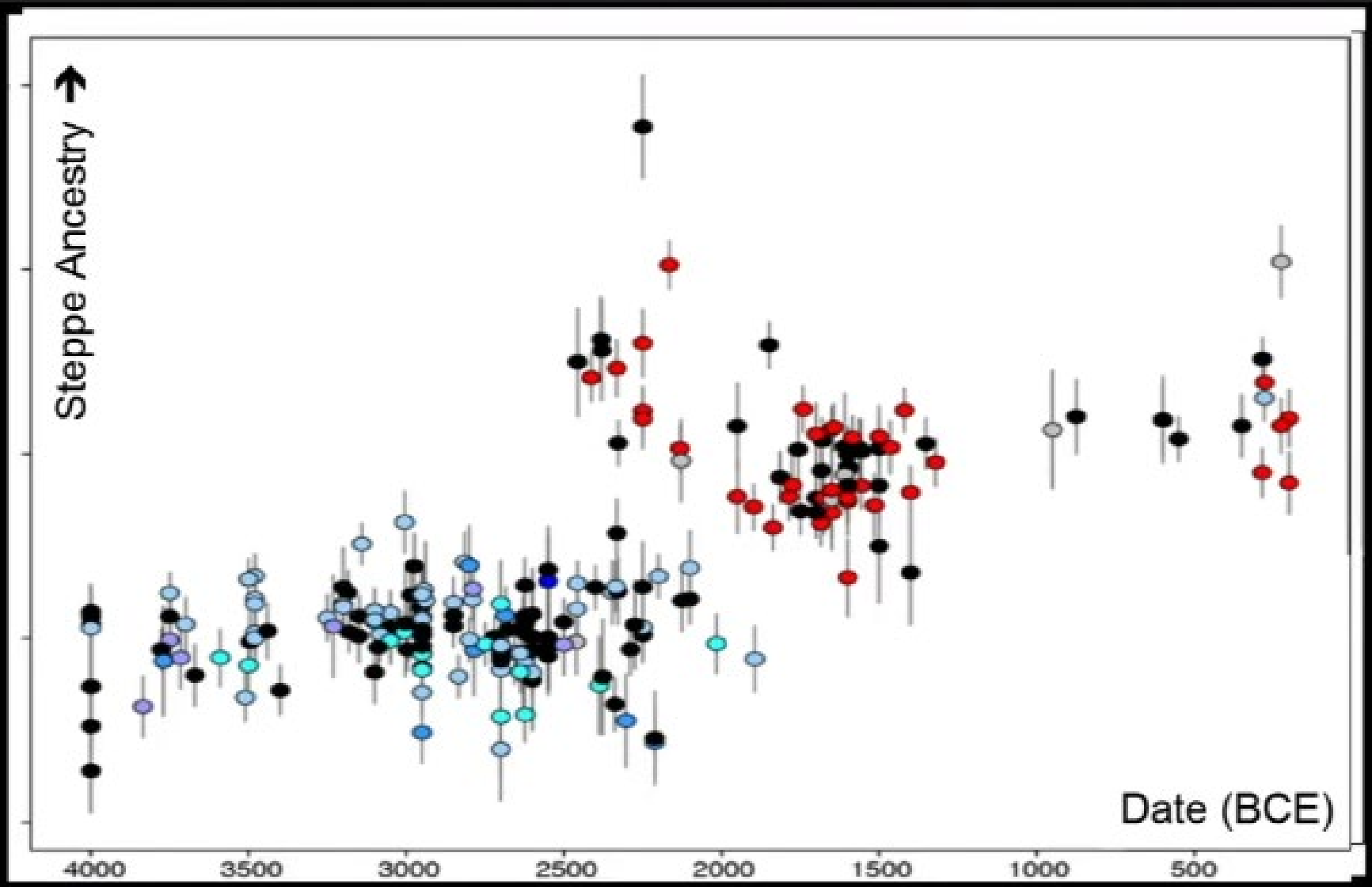
- Archaeologists view the Bell Beaker culture as extremely different from the Corded Ware culture, which was in turn extremely different from the Yamnaya culture. Yet all three participated in the massive spread of steppe genetic ancestry from east to west, and perhaps they shared some elements of an ideology despite their very different features.

Spread of Beaker pottery in Spain

- The spread of Beaker pottery between present-day Spain and Portugal and central Europe was due to a movement of ideas, not people, as reflected in their different ancestry patterns.

- However, the spread of Beaker pottery to the British Isles was accompanied by mass migration.

- 90 percent of the population that built Stonehenge-people with no Yamnaya ancestry-was replaced by people from continental Europe who had such ancestry.



40% whole genome replacement,
~100% Y chromosome replacement

Spain:

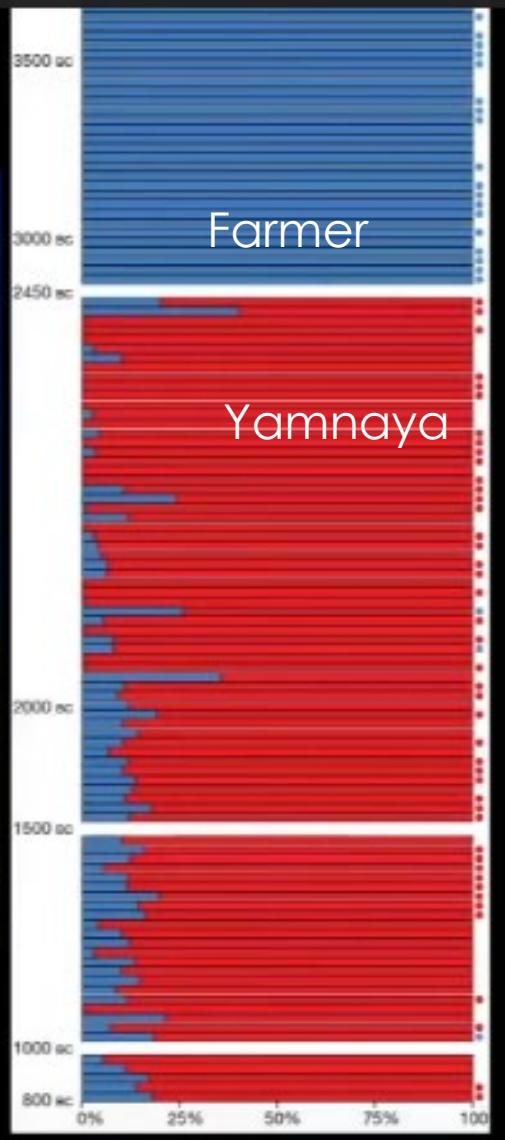
100% Y DNA replacement of farming males Y-DNA by Yamnaya males

Yamnaya males replaced local males

replacement in Britain

90% whole genome replacement,
~100% Y chromosome replacement

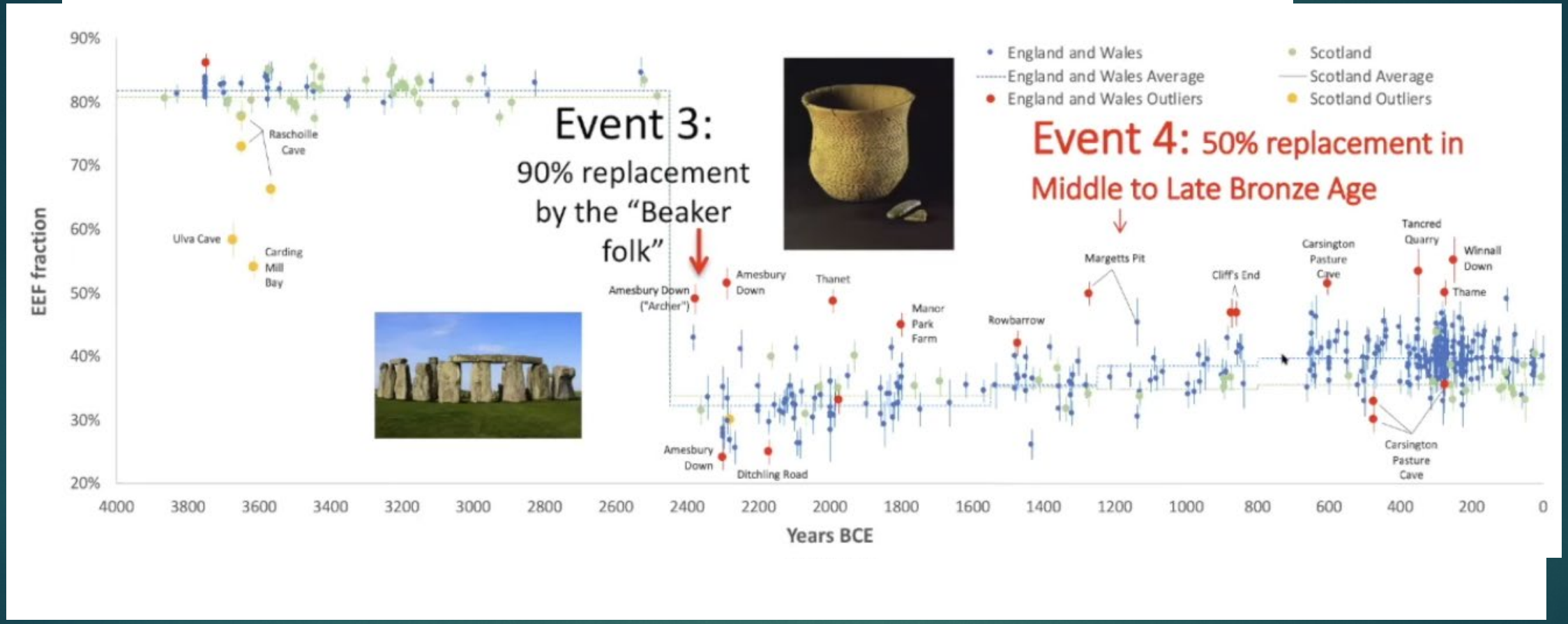
Olalde et al. 2018



What happened in Britain

What we can do with >800 genomes from a single place (Britain)

Patterson et al. in revision



Recolonization after ice age: HGs from 11 Ka (brown skin, blue eyes); less than 5% of today's DNA

Smaller 4th event of farmers in southern England

Summary: Population turnovers in Western Eurasia

- Modern day Europeans from 3 groups: early hunter gathers, early farmers, and then the steppe pastoralist Yamnaya
- Yamnaya: from Mongolia to Hungary; brought wheel, carts and newly domesticated horses (ancient version of mobile homes) out into grassland steppes at 5300 bp; big graves; Corded Ware culture
- Bell beaker culture from Iberia to Western Europe, spread through communication of ideas, not movement of people (Iberia vs Germany difference genetically)
- Britain: Stonehenge by early farmers at 3000 y ago; but then Bell beaker Yamnaya replacement
- Spain: no change from 6000 to 4000 early farmers, then 40% Yamnaya, but 100% of Y chromosome from latter

An alternate theory: Disease, warfare and Yamnaya

- Teams led by David Reich and Eske Willerslev announced, independently, that occupants of Corded Ware graves in Germany could trace about three-quarters of their genetic ancestry to the Yamnaya. It seemed that Corded Ware people weren't simply copying the Yamnaya; to a large degree they actually were Yamnaya in origin.
- A new model that involves disease, warfare and death by Kristian Kristiansen, Univ. of Sweden differs from Reich model of Yamnaya.
- Neolithic Europe was in crisis just before the Yamnaya's arrival. Using the pollen record from archaeological sites as a proxy for levels of agricultural activity, archaeologists have concluded that populations in northern and central Europe began shrinking about 5300 years ago.
- Examining the teeth of Neolithic people who lived in what is now Sweden about 5000 years ago, they found plague-causing bacteria – the earliest known relative of the Black Death. Further analysis suggested the disease began spreading across Europe perhaps as early as 5700 years ago. this is also when the settlements of south-east Europe reached their greatest size

European settlements

- Within those settlements, thousands of people lived in unhygienic conditions and in close contact with livestock, providing a perfect environment for plague to emerge.
- From there, the disease could have spread rapidly into central and northern Europe via the wheeled vehicles and proto-roads appearing at this time.
- These mega-settlements were beginning to be abandoned and burned down a little after 5700 years ago, which would make sense if they were becoming centers of death and disease. By 5400 years ago, they were gone.
- Corded Ware site called Eulau in Germany. Here, a handful of unusual graves each contain between two and four bodies – mostly women and their children. Analysis of isotopes in the women's teeth reveals that they did not grow up locally. And injuries on five of the 13 bodies indicate that they met a violent end.

Yamnaya

- This means that when the Yamnaya arrived a few centuries later, they were entering a Europe with a small and weakened indigenous population that could offer little resistance. Even so, says Kristiansen, this on its own cannot explain why the Yamnaya spread so rapidly, morphing to become the Corded Ware people.
- He thinks the sheer speed of this change hints that the Yamnaya migrants were dynamic and aggressive. This might suggest they were mainly young male warriors, riding into new territory. Most Yamnaya women don't seem to have joined the migration until later.
- In line with this idea, a controversial 2017 genetics study concluded that the DNA signal left in ancient European bones from the time is easiest to explain if there were between five and 14 male migrants for every female migrant. Archaeological evidence also points to most immigrants being men. Male migrants with a shared sense of identity having children with Neolithic women who still retained some local traditions.

Yamnaya

- A rather high number of skull trepanations [holes drilled in skulls] – people may have undergone this procedure as a therapeutic measure after bad head injuries.
- However, if Eulau is an example of the violence that accompanied an influx of Yamnaya and their descendants, it is arguably not particularly representative. Kristiansen suspects it was the migrants who usually came out on top, judging by the fact that Corded Ware groups quickly multiplied and spread.
- Yamnaya were accomplished horse riders. Even before they left the Eurasian steppe, some had become axe-wielding warriors – as depicted on ancient standing stones in the steppe landscape. They were also probably in better shape to fight too. Ancient DNA suggests they were unusually tall for the time. And they had a highly nutritious diet. “It looks like they lived mostly on meat and milk products,” says Kristiansen.

Critique

- Indeed, many archaeologists think the wider narrative emerging from genetic studies oversimplifies things.
- The trouble, according to Martin Furholt at the University of Oslo, Norway, is that geneticists divide prehistoric Europe into a series of large cultural blocks – Yamnaya in the south-east, Corded Ware in the north and so on – each of which represents a population with a shared sense of self.
- "The idea that archaeological units of classification represent human groups of a shared social, or ethnic identity has been proven wrong many times during the history of research," says Furholt.
- Ethnicity is founded on shared ancestry, whereas identity is more about culture. "Geneticists are basically looking at ethnicity. But archaeologists are foremost looking at identity," says Heyd.

Enigmatic Bell Beaker people, who emerged in Europe slightly later than the Corded Ware people

- In some ways, they were similar to the Yamnaya: they buried their dead in single graves, had recognizable warriors and celebrated these warriors by occasionally carving their images on standing stones. As a result, the geneticists suspected that Bell Beaker people descended from the Yamnaya. However, the archaeologists convinced them this was only partially true.
- Origin and initial spread of Bell Beaker culture had little to do – at least genetically – with the expansion of the Yamnaya or Corded Ware people into central Europe.
- It started in western Iberia. It is in that region that the earliest Bell Beaker objects – including arrowheads, copper daggers and distinctive Bell-shaped pots – have been found, in archaeological sites carbon-dated to 4700 years ago.

Bell Beaker people

- Then, Bell Beaker culture began to spread east, although the people more or less stayed put.
- By about 4600 years ago, it reached the most westerly Corded Ware people around where the Netherlands now lies. For reasons still unclear, the Corded Ware people fully embraced it. “They simply take on part of the Bell Beaker package and become Beaker people,” says Kristiansen.
- In other words, there were now two types of Bell Beaker people: one with roots in Iberia and one with Corded Ware (and ultimately Yamnaya) roots.
- Kristiansen thinks the Yamnaya Beakers then took advantage of the maritime know-how of their Iberian friends and voyaged to Britain some 4400 years ago. The fact that the genetic analysis showed the Britons then all-but disappeared within a couple of generations might be significant

Yamnaya

- It suggests the capacity for violence that emerged when the Yamnaya lived on the Eurasia steppe remained even as these people moved into Europe, switched identity from Yamnaya to Corded Ware, and then switched again from Corded Ware to Bell Beaker.
- In fact, there is much stronger evidence that these Yamnaya Beakers were ruthless. By about 4500 years ago, they had pushed westwards into the Iberian Peninsula, where the Bell Beaker culture originated a few centuries earlier. Within a few generations, about 40 per cent of the DNA of people in Iberia could be traced back to the incoming Yamnaya Beakers,
- The genetic analysis showed that the Britons who built Stonehenge all-but disappeared within a few generations of the Yamnaya's arrival.

Ancestor of horse

- Archaeologists have used ancient DNA samples to identify the genetic homeland of modern horses, where the animals were first domesticated around 4,200 years ago.

- Modern domestic horses probably originated on the steppes around the Volga and Don rivers, now part of Russia, before spreading across Eurasia, ultimately replacing all pre-existing horse lineages.

- They found that until around 4,200 years ago, many distinct horse populations inhabited various regions of Eurasia.

- Modern domestic horses ultimately replaced almost all other local populations as they expanded rapidly across Eurasia from about 4000 ya, synchronously with equestrian material culture, including Sintashta spoke-wheeled chariots.

Librado, P. *et al., 2021*

Horses

- Horses with the modern domestic DNA profile lived in the Western Eurasian steppes, especially the Volga–Don region, from 8000 to 5000 ya.

- By around 4200–4000 Ka, these horses had appeared outside the Western Eurasian steppes — first reaching Anatolia, the lower Danube, Bohemia and Central Asia, and then spreading across Eurasia, replacing all other local horse populations by about 3500 to 3000 ya.

- The findings also challenge previously held ideas about the role of horses in some early human migrations.