

Human evolution in and out of Africa

Chris Stringer, The Natural History Museum London



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Today *Homo sapiens* is the only human on Earth



Neanderthals



Denisovans



Homo sapiens



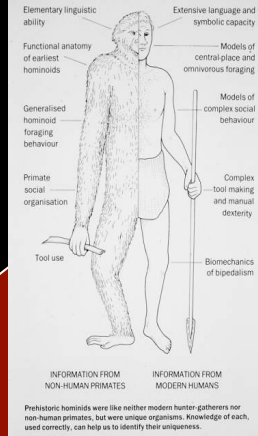
Homo floresiensis

There were at least 4 kinds of humans 60,000 years ago....

Evidence to reconstruct the past...

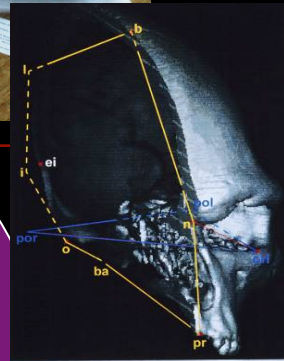


Tools



Archaeology

Behaviour



Fossils

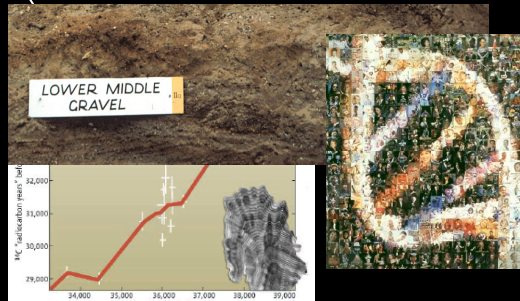
Palaeontology

History

Contextual and other data

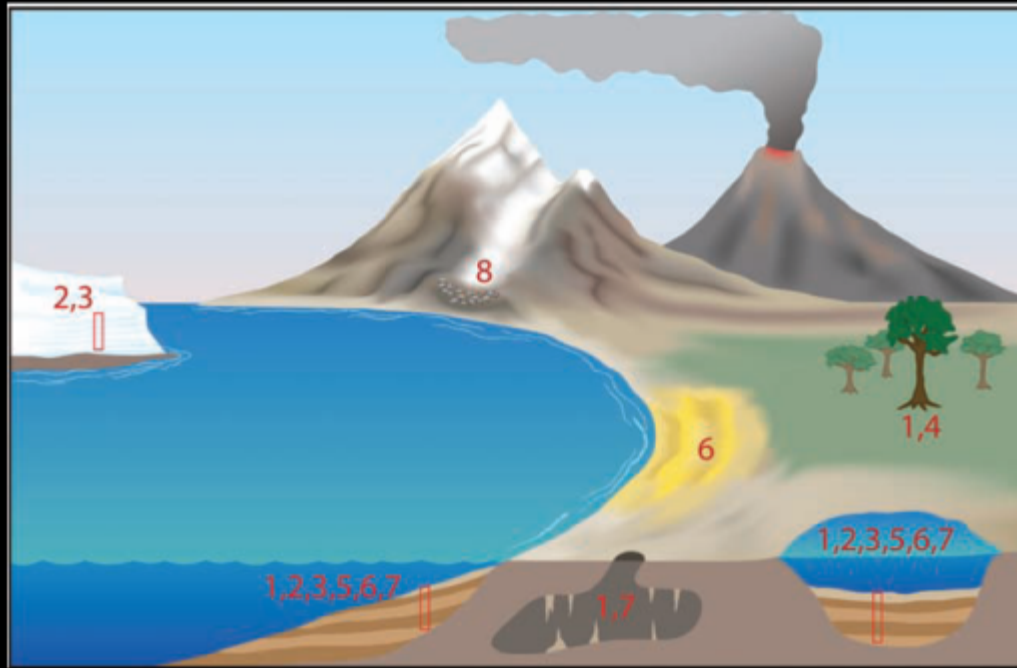
Evolution

Stratigraphy + dating

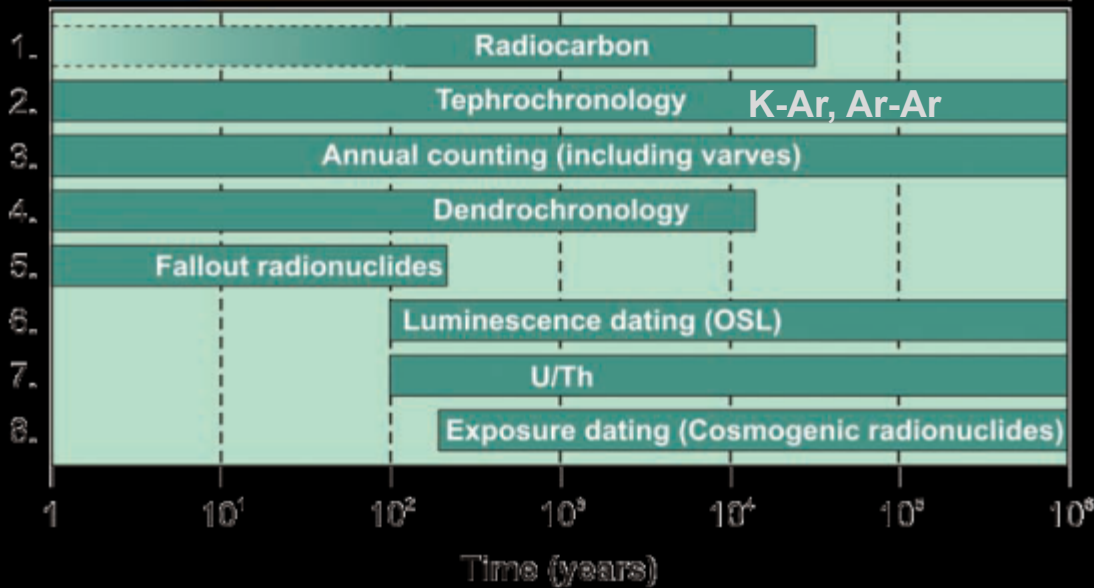


Isotopes
Calculus
DNA

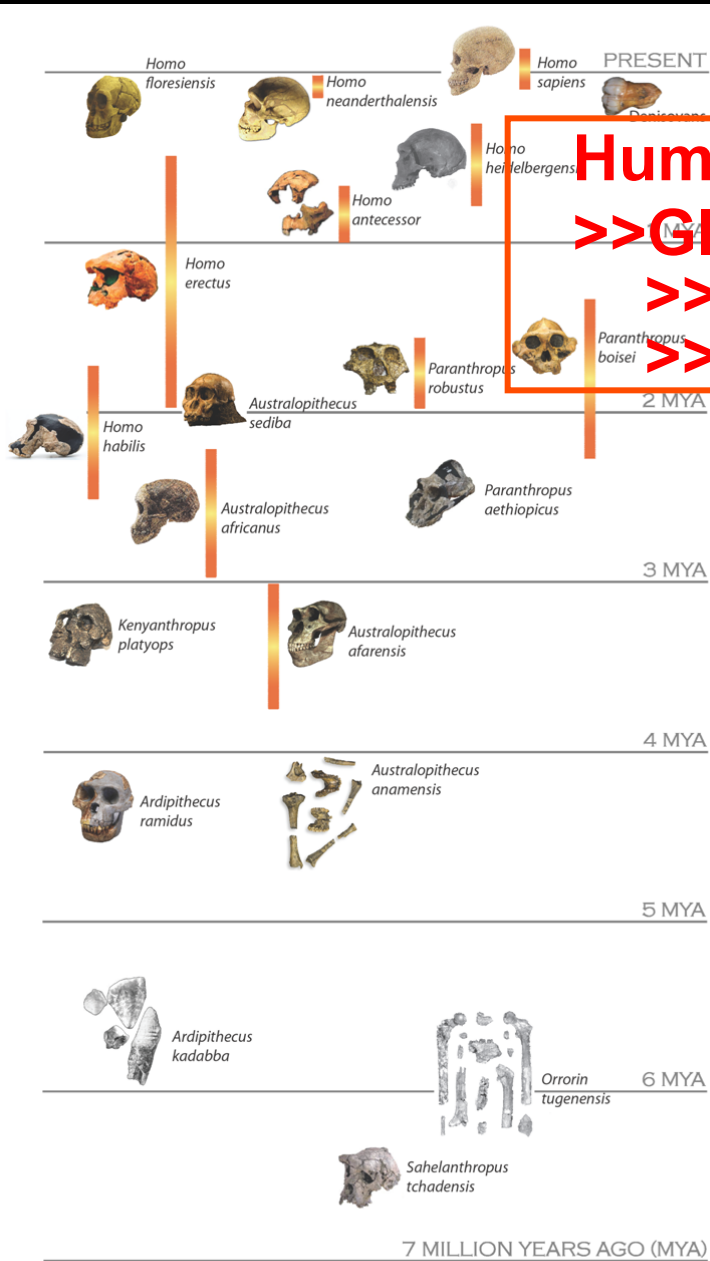
Some dating methods....



Ma = million yrs
Ka = thousand yrs



The last phase of human evolution



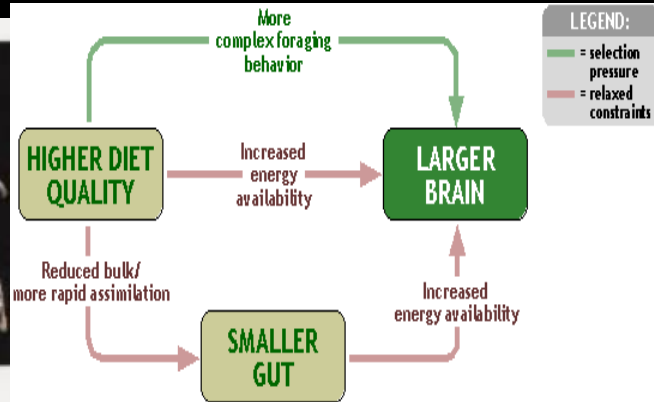
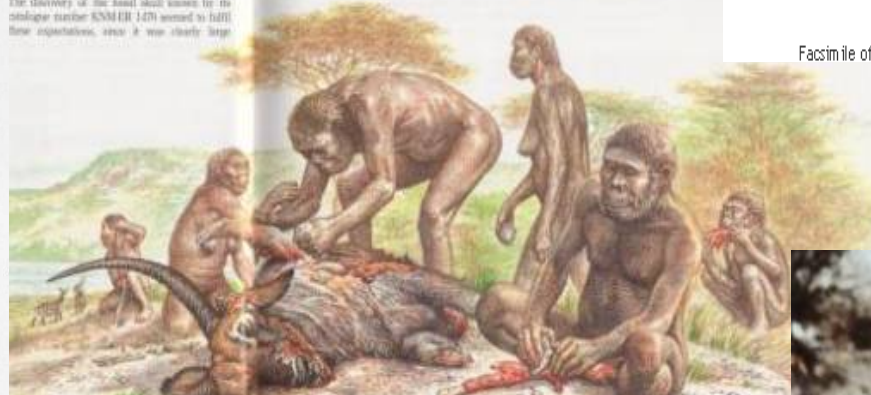
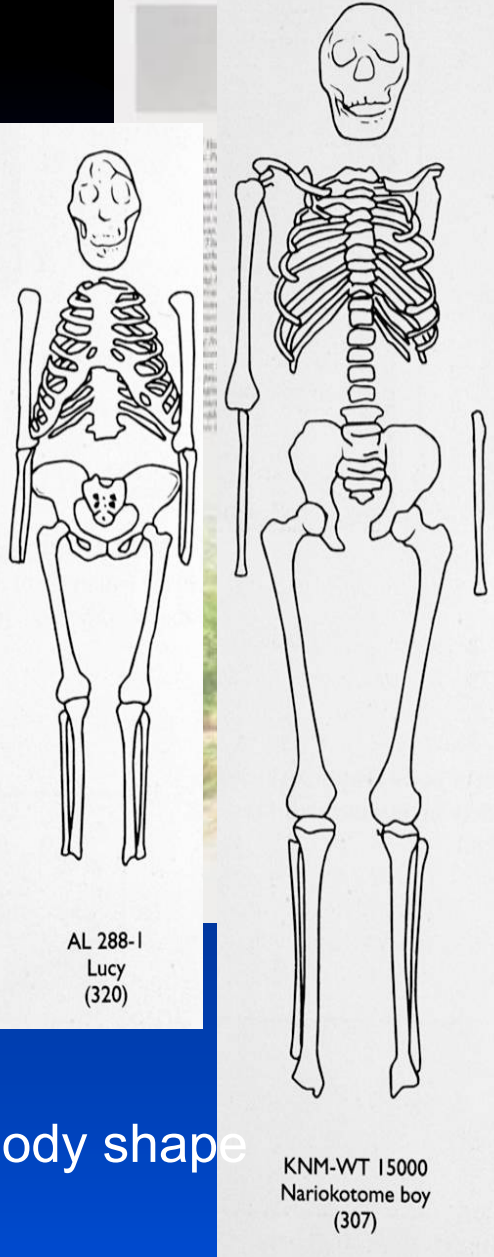
Human phase 2 – 0 Ma: several species
>> Global spread, “Human” anatomy
>> Encephalised >> Dietary range
>> Behavioural complexity

Becoming human

in a new species called *Habilis*, meaning 'handy' because of its assumed toolmaking ability. He and his collaborators believed that this species represented the most ancient and primitive of all humans.

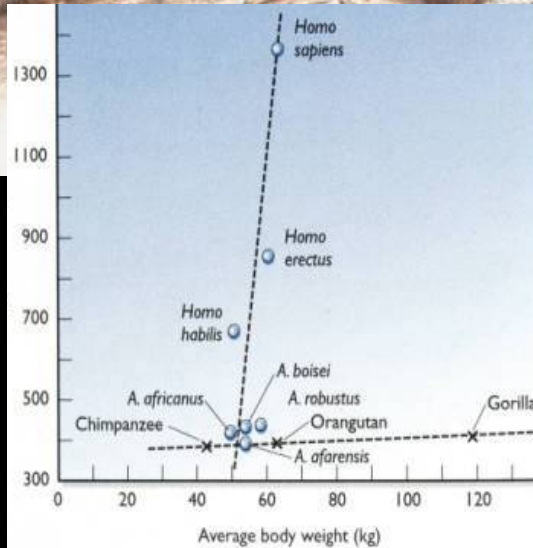
Fossil finds from Koobi Fora

Homo habilis was not well received by the scientific community. Some scientists felt that the material was not complete enough for definite opinions, others felt that it merely represented a new kind of australopithecine, while yet others felt that it consisted of a mixture of australopithecine and primitive early human fossils. Nevertheless, *Homo habilis* gradually gained scientific credence, and new fossils were found at Olduvai and elsewhere. Louis's son, Richard, initiated a new research project in northern Kenya, at Koobi Fora, on the eastern side of Lake Turkana (formerly Lake Rudolf). He was soon rewarded with finds of stone tools like those found in the earlier layers at Olduvai Gorge, as well as the remains of several australopithecines, dated at nearly 2 million years old. So there was immediate speculation about whether *Homo habilis* would also be found there. The discovery of the hand skull known by its catalogue number KNM ER 1470 seemed to fulfill these expectations, since it was clearly large.



Facsimile of Fig. 5, p. 207, Aiello and Wheeler [1995]. Copy

Meat, guts, and brains




Stone tools
 ~2.6 Ma

Body shape

Early humans 1.5-1.8 Ma: 'Out of Africa 1'

Homo erectus



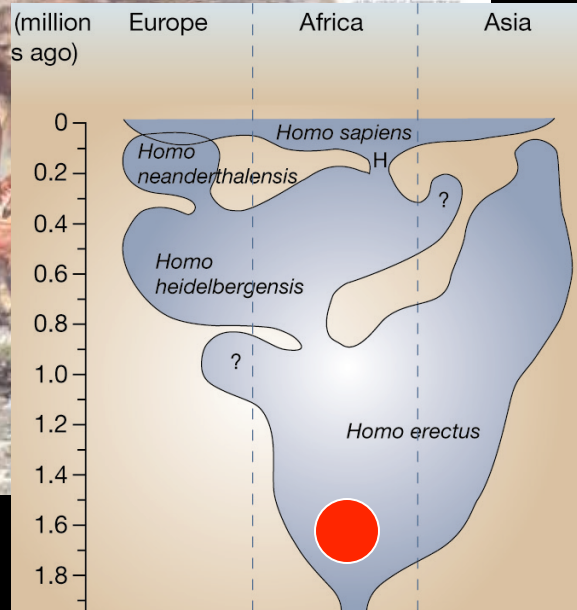
During the 19th century, a German biologist called Ernst Haeckel developed a series of hypothetical stages in human evolution, based on the belief that the gorilla represented the closest living approximation to our ancient ape ancestor. Haeckel believed that Haeckel was wrong, and Asia, rather than Africa, was our ancestral homeland. He stated one of the hypothetical pre-human stages 'Pithecanthropus alalus' (Ape man without speech), and argued that it would have lived in Southeast Asia. In 1905 a young Dutch doctor called Eugene Dubois decided to prove Haeckel right by finding actual evidence of the 'Pithecanthropus'. He discovered a jawbone in an army doctor to the island of Java in the Dutch East Indies, and subsequently within two years, he had found fossil evidence of a primitive stage in human evolution. His discovery included a thick brow and low skull cap, with a large brow ridge, and a very human-looking thigh bone. Accordingly, following Haeckel, he named his find 'Pithecanthropus', but gave it a different species name because of the upright posture he inferred from the femur — 'erectus'. We now know this species as *Homo erectus* ('erect man'), because it is generally recognized that it is indeed human.

Java and China
By 1965 more than 2000 remains of this species had been found in Java, and in new regions such as China. There, the site of Zhoukoudian, near Beijing, produced numerous erectus fossils which were initially assigned to 'Sinanthropus pekinensis' (Chinese man of Peking), but which were later re-assigned with the fossils of Java. It is also interesting that the fossils of Java Man in also representing *Homo erectus*. The characteristics of this species were now clear. The skull was relatively

Other A reconstruction of *Pithecanthropus* showing a gait including walk of hand and arm, and crouching posture. In the hypothetical diagram human are being shown under of some study the human and human equally combined both the skull and hand. More research has and still the nature of the

Other Map showing sites of *Homo erectus* fossils.

Other The fossil skull of *Homo erectus* discovered in Java, Indonesia. It is one of the earliest fossils of a hominid, and is probably made of stone from the age of *Homo erectus* skull from the African and Indonesian regions like the right to Singapore (Java, Indonesia, and on the left).





Dmanisi, Georgia

The first explorers?

Always a crossroads, the village of Dmanisi (above) once overlooked the old Silk Road through the Caucasus region. Nearly 1.8 million years ago the site lay on a peninsula between the Black and Caspian Seas (map, right), along one of several land corridors into Eurasia. Humans could have moved out of Africa—and back into it—in multiple waves, reaching Java by at least 1.6 million

years ago. By one million years ago, *Homo* had spread across Eurasia, leaving bones and tools in its wake.

~1.8 Ma



From left to right: 1. (Dmanisi,)



The emigrants

Humans weren't the only creatures leaving Africa 1.75 million years ago: Hundreds of animal bones have been unearthed at Dmanisi (select species shown below), and 10 percent of them are African species. The first wave of emigrants—including ostriches (leg bone, far left) and short-necked giraffes (foot bones, left)—was made up of species that scientists consider adaptable and opportunistic. They met Eurasians such as wolves (skull, top right), deer, and saber-toothed cats, whose fangs fit holes in one of the human skulls (left). Cats were a menace, but they may have benefited humans: Simple chopping and scraping tools found here may have been used for scavenging the animals that cats killed.



INDIVIDUAL FOSSELS SHOWN AT DIFFERENT SCALES
Nat. Geographic

of the world's great fossil hotbeds. In that decade the team unearthed several faceless skulls and mandibles—they seemed to be *Homo erectus*—along with thousands of simple stone tools in sediments the team dated at between 1.8 and 1.7 million years ago, the earliest undisputed evidence of humans outside Africa. Those dates at first surprised a skeptical scientific community. In the early 1990s most scientists thought *Homo erectus* hadn't departed Africa until around a million years ago.

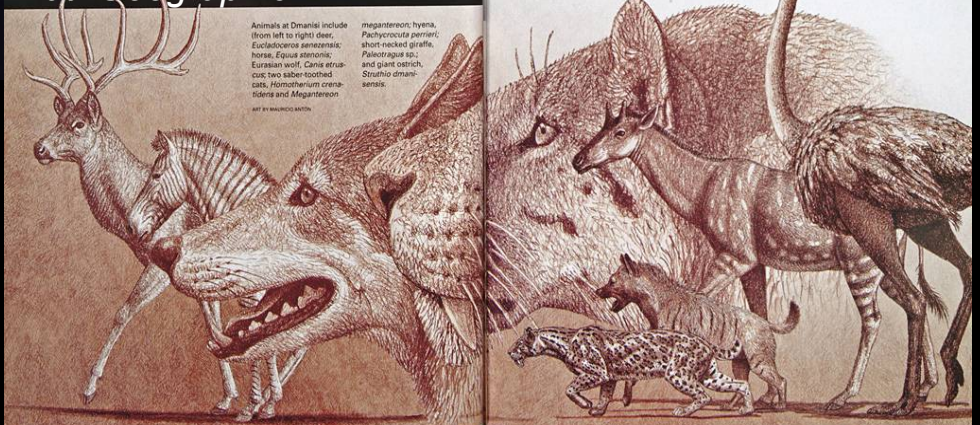
Then last season, while visiting another dig in western Georgia, Dato got a call on his cell phone from Dmanisi: Another skull was coming out of the earth. Dato rushed back. The skull he saw half-buried in the dirt astonished him.

Could it be that the **first human** intercontinental traveler wasn't a classic *Homo erectus*?

To Dato the new skull had the chimp-like face of *Homo habilis*, a small hominid with long, dangling arms who made primitive stone tools 2.4 million years ago. The implications left Dato

SOCIETY GRANT

This Research Committee project is supported by your Society membership.

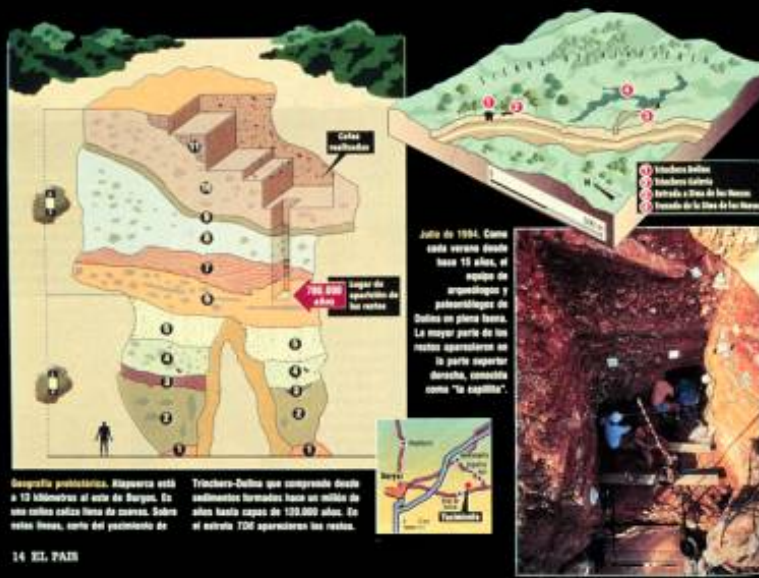


Animals at Dmanisi include (from left to right) deer, *Euchadros senensis*, horse, *Equus stenonis*, Eurasian wolf, *Canis etruscus*, two saber-toothed cats, *Homotherium cretaceridens* and *Megasterson megateron*; hyena, *Pachyocrocuta perrini*; short-necked giraffe, *Palaotragus* sp.; and giant ostrich, *Struthio dmanisensis*.

ART BY MARIO BATTI



Sima del Elefante
1.2Ma

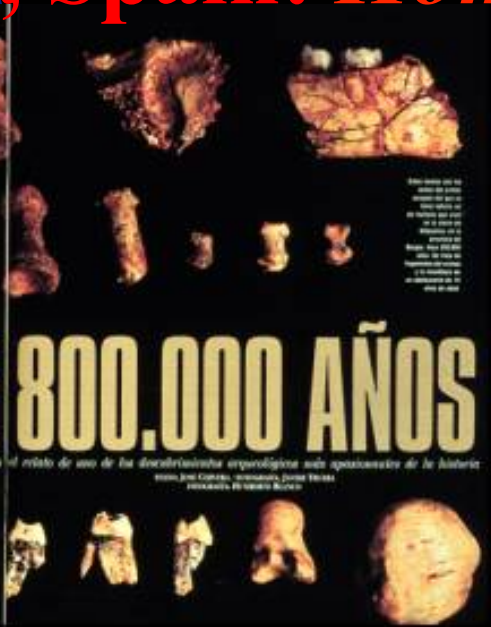
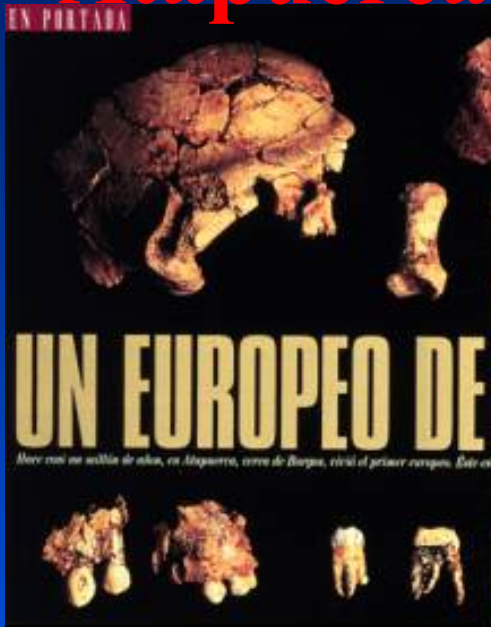


14 EL PAÍS



Gran Dolina
0.8Ma

Atapuerca, Spain: *Homo antecessor* 0.8Ma

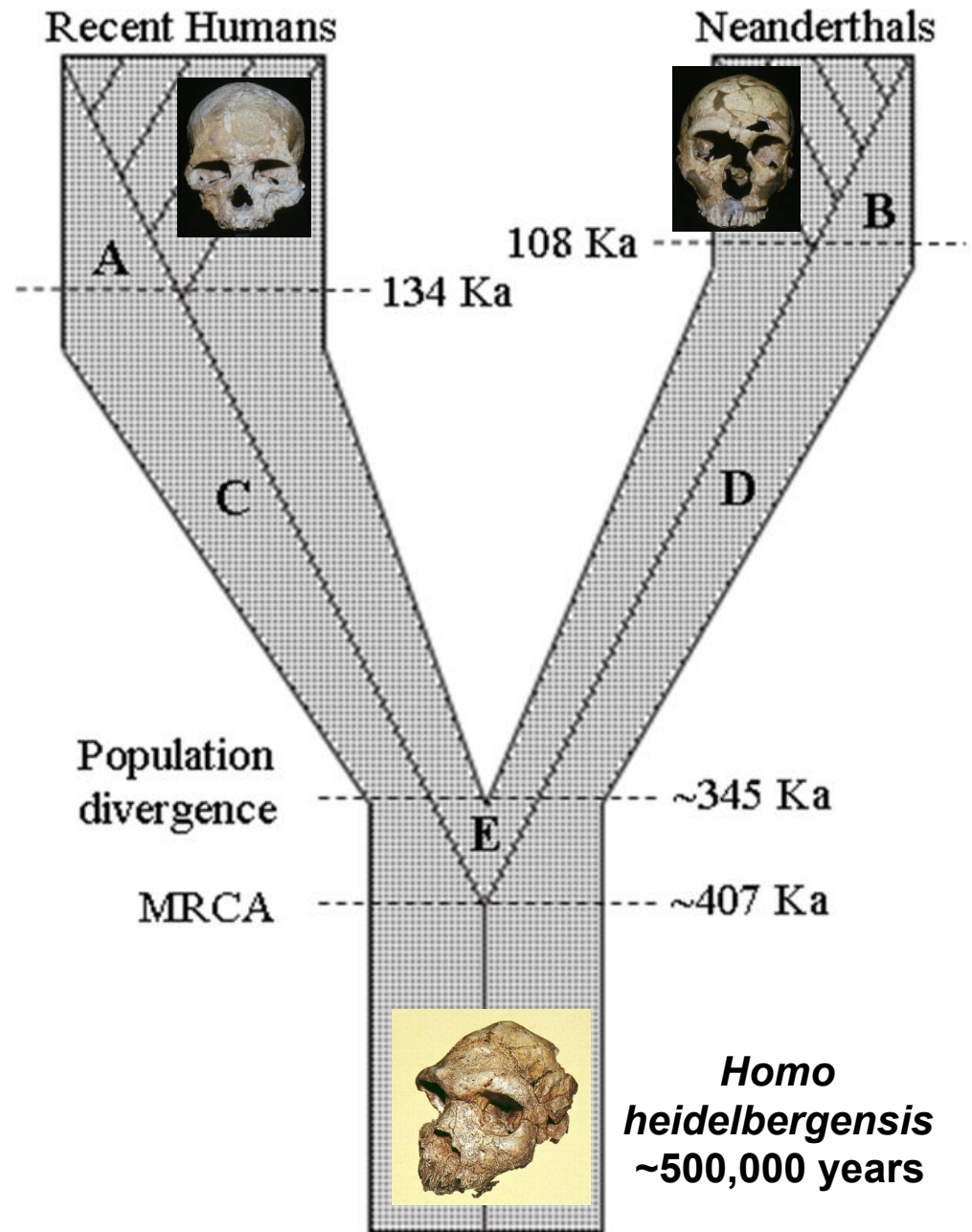


CANIBALISMO
Todos los platos aparte fermenta y que los otros humanos ballados en TDO, perteneciente a Homo y sus relaciones desde hace hasta ahora. Tanto se encuentran en aquel lugar como resultado de un acto de canibalismo, el más antiguo del que se tiene noticia.

Homo heidelbergensis Mauer ~600ka?



The evolution of Modern Humans and Neanderthals (based on fossil and genetic data)



heidelbergensis: a widespread species

Arago France



Broken Hill Zambia



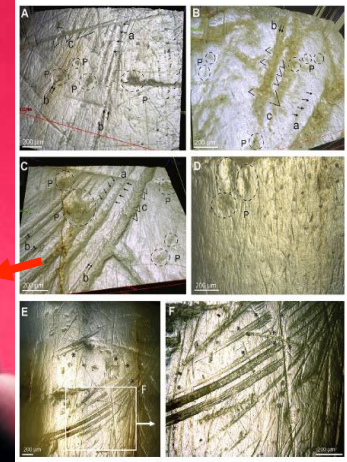
Petralona Greece



Bodo Ethiopia

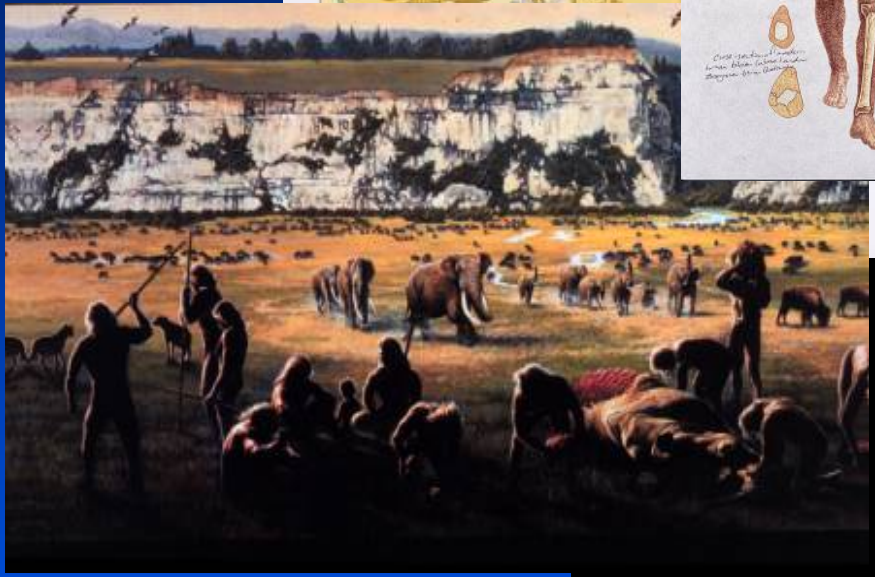


Homo heidelbergensis at Boxgrove (Sussex) ~500,000 yrs

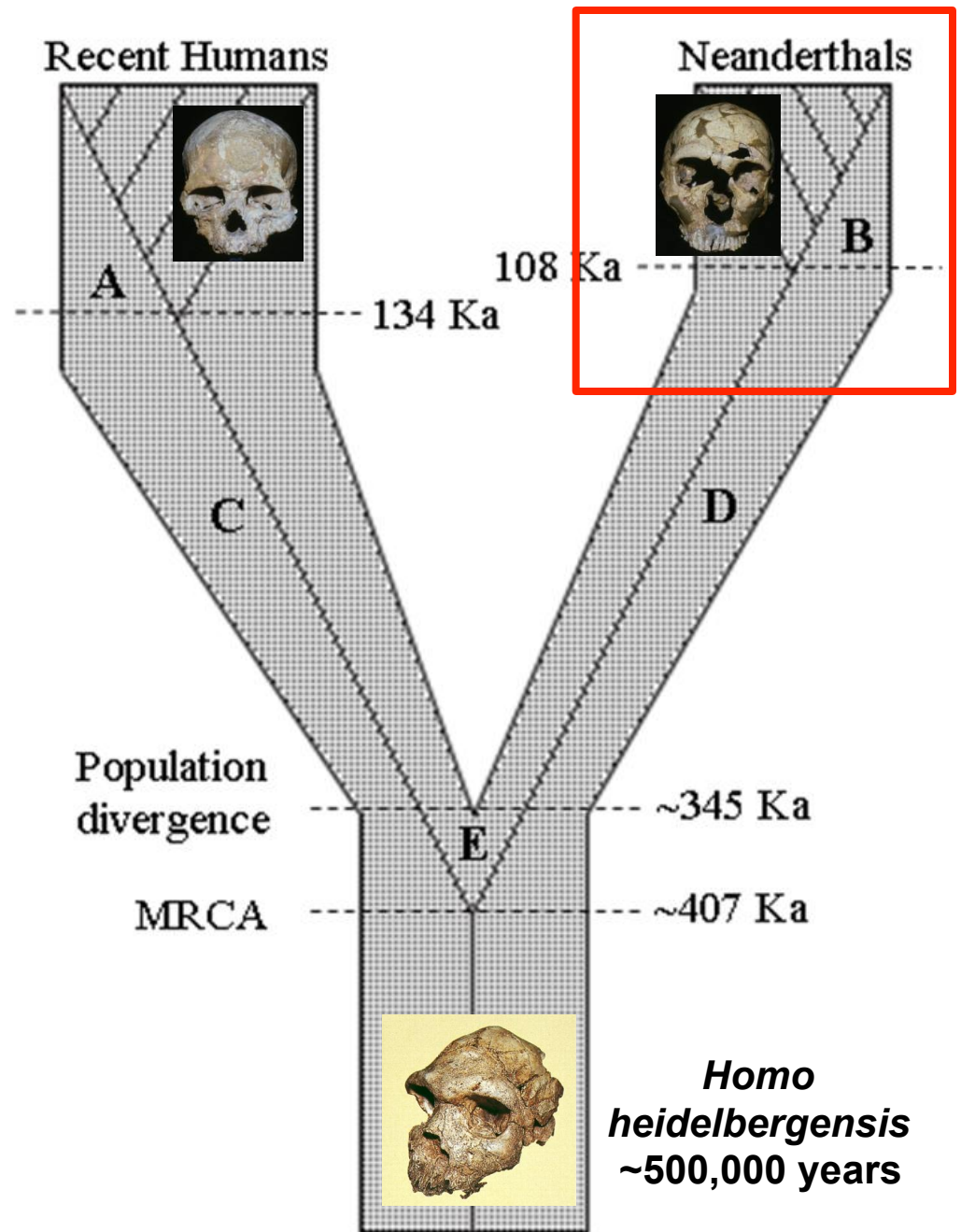


People were also drawn by the presence of flint in the chalk cliffs – an excellent source of raw material from which they could produce the most characteristic stone tool found at Boxgrove – the handaxe, of which over 300 examples have been excavated. Because the hard surfaces at Boxgrove were repeatedly covered over by gently flowing water, covering them with a fine silt, these ancient surfaces have been preserved with only minimal disturbances. The preservation is so good that the exact places where people crouched down to make their stone tools have been preserved, so every flake of flint they struck off is still lying where it fell some half a million years ago. Not only that, but the bones of the animals they ate are also there, surrounded by tools, and often covered in butchery marks.

The handaxes, which are predominantly of a certain shape, are generally well made from flint blades that were locally flinted from the chalk itself. Most have the characteristic almond or heart-like shape.



The evolution of Modern Humans and Neanderthals (based on fossil and genetic data)



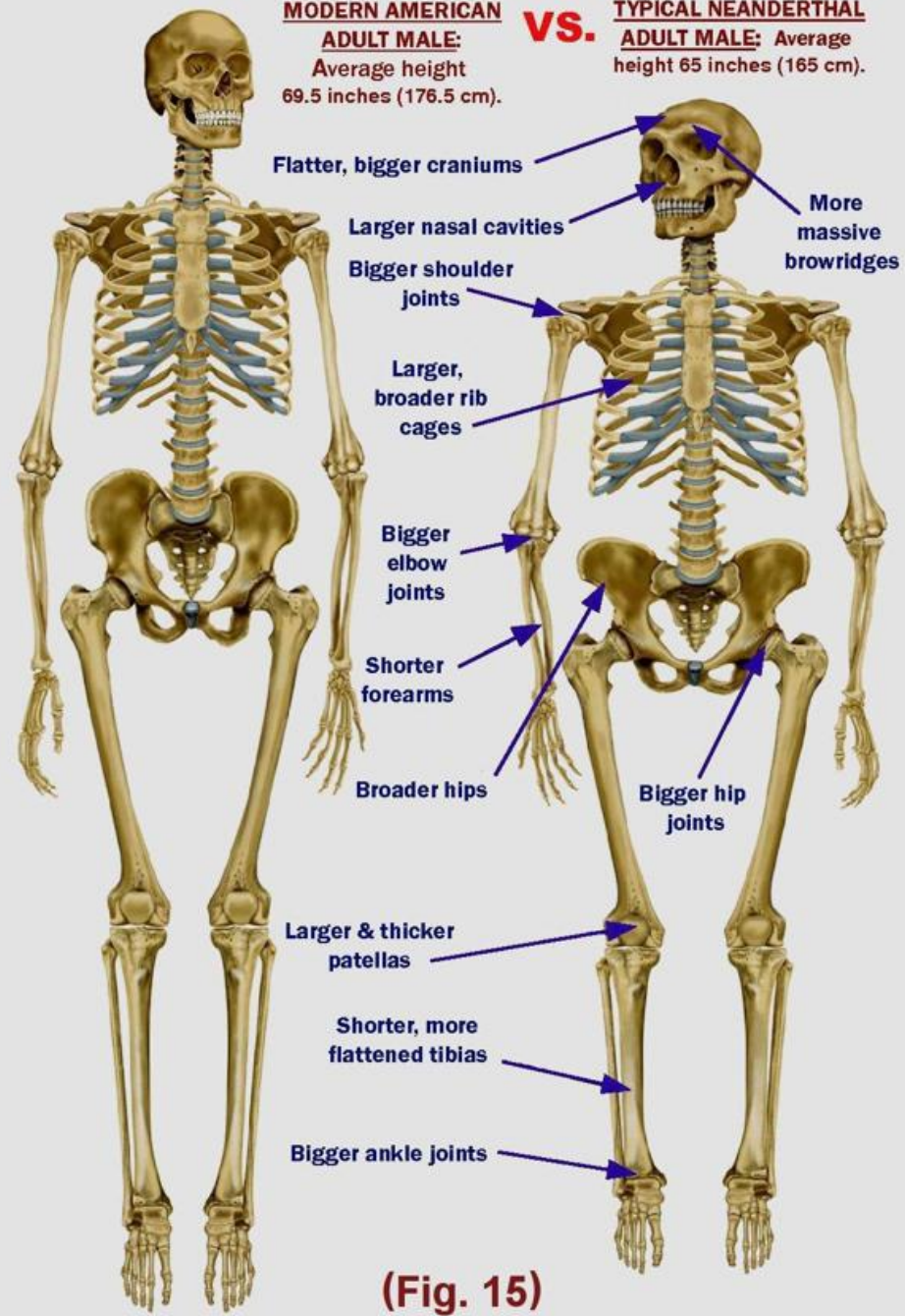
The Neanderthals



Neander Valley 1856

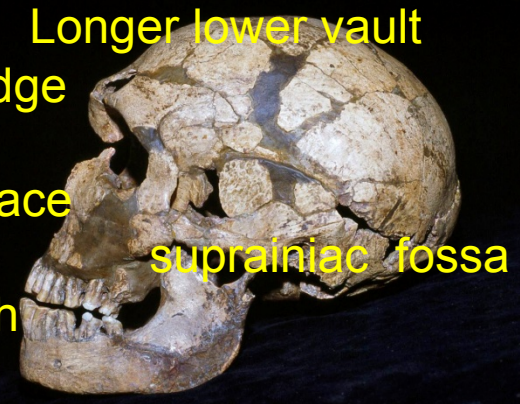
**MODERN AMERICAN
ADULT MALE:**
Average height
69.5 inches (176.5 cm).

**VS. TYPICAL NEANDERTHAL
ADULT MALE:** Average
height 65 inches (165 cm).

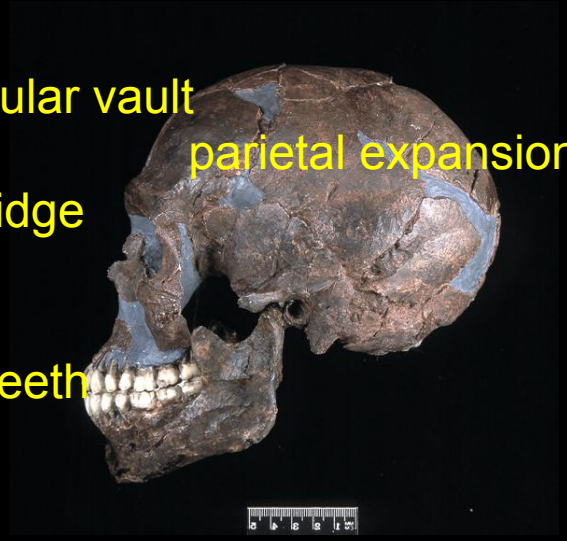


(Fig. 15)

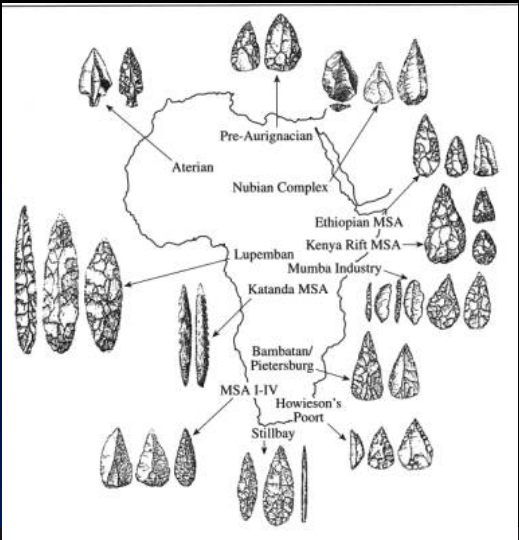
Longer lower vault
strong browridge
projecting midface
large front teeth
weak chin



globular vault
weak browridge
flat midface
small front teeth
strong chin



H. sapiens: fossils suggest an African origin for the modern pattern ~ 150-200ka?



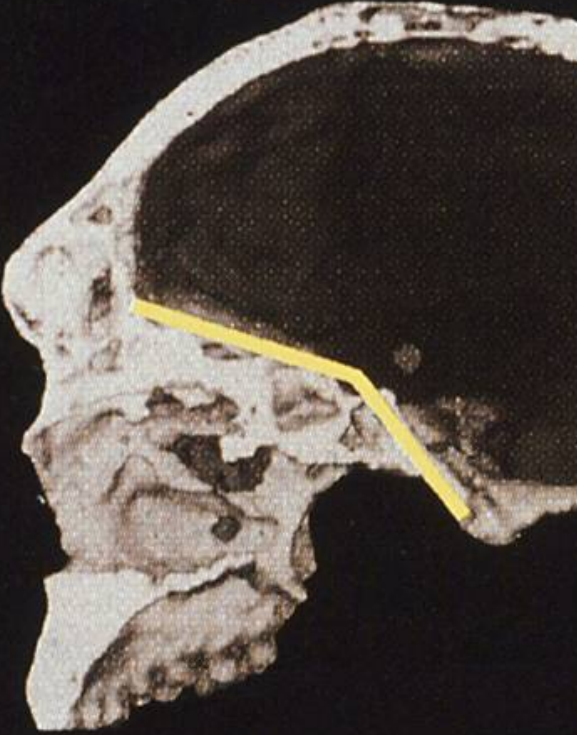
Age ka ~260

~150?

~160?

~195?

>130



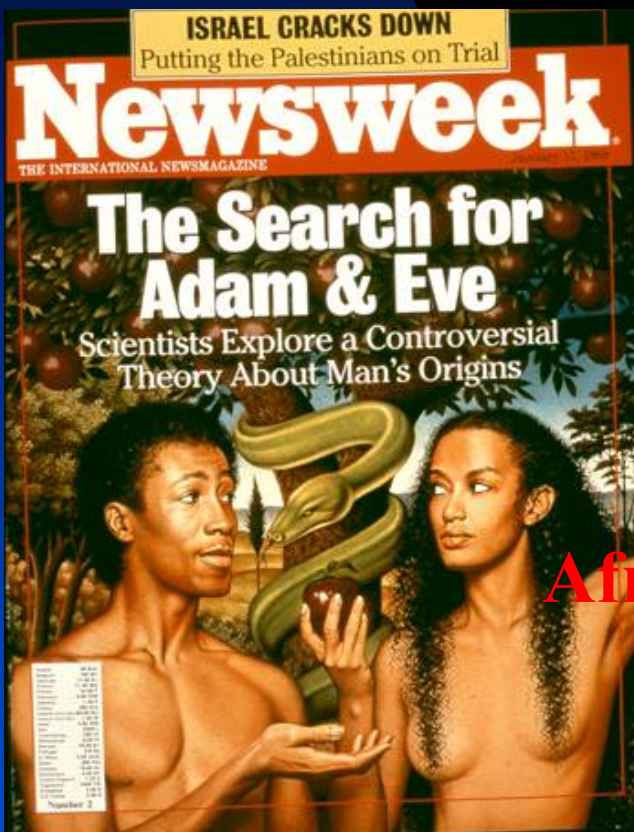
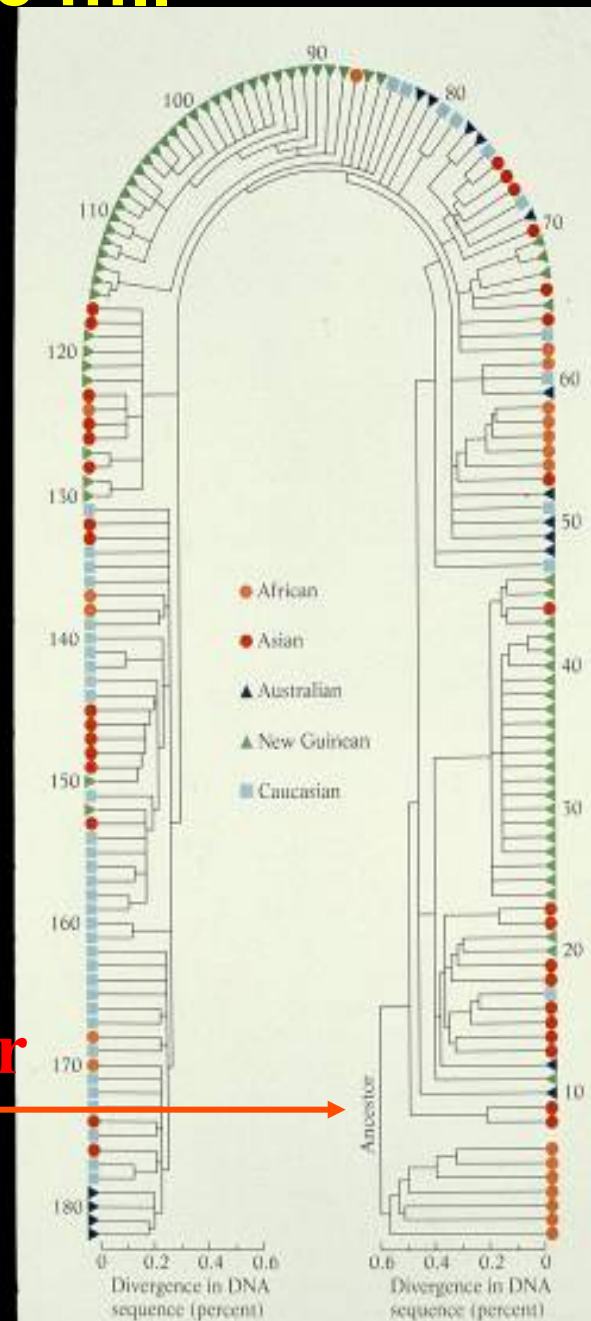
Tim White



Lieberman

1987: 'Mitochondrial Eve'.....

Mitochondrial DNA and human evolution *Nature* 325, 31-36
Rebecca L. Cann, Mark Stoneking & Allan C. Wilson (1987)

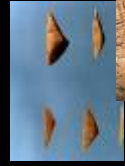


**African female ancestor
~200ka**

Microliths



Twin Rivers



Pinnacle Point

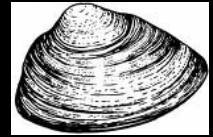
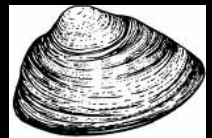


Mumba



Enkapune ya Muto

Shellfishing



Klasies

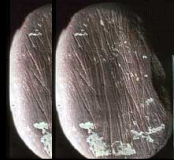
Ochre



Kaphurin



Twin Rivers



Klasies Qafzeh



Blombos

300 ka

200

150

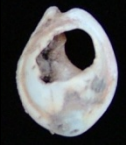
100

Taforalt

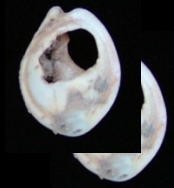
50

0

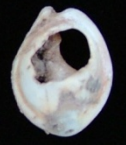
Shell beads



Skhul

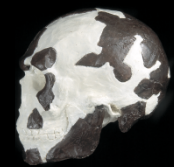


Blombos



Enkapune ya Muto

Early *H. sapiens* fossils



Omo Kibish



Herto

“Modern” anatomy and behaviour have deep roots in Africa...

Shell jewellery + red pigments ~70-100 ka

Middle Paleolithic Shell Beads in Israel and Algeria

Marian Vanhaeren,^{1*} Francesco d'Errico,^{2*} Chris Stringer,³ Sarah L. James,⁴
Jonathan A. Todd,³ Henk K. Mienis⁵

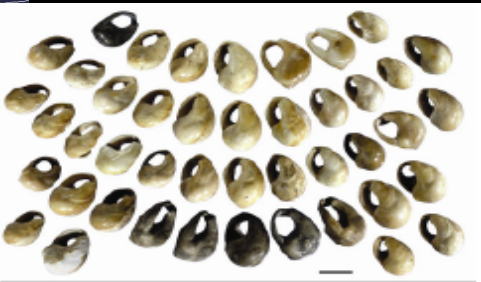
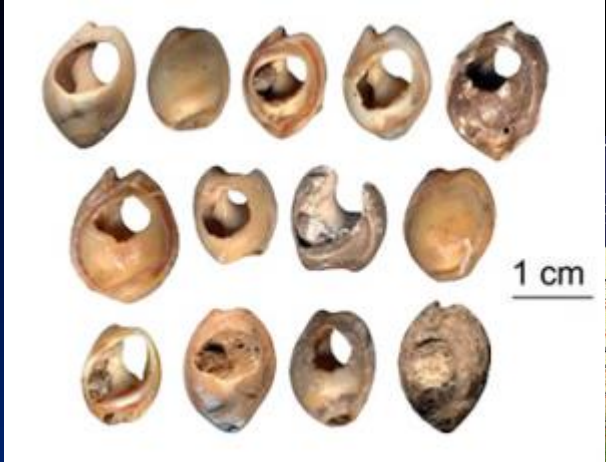
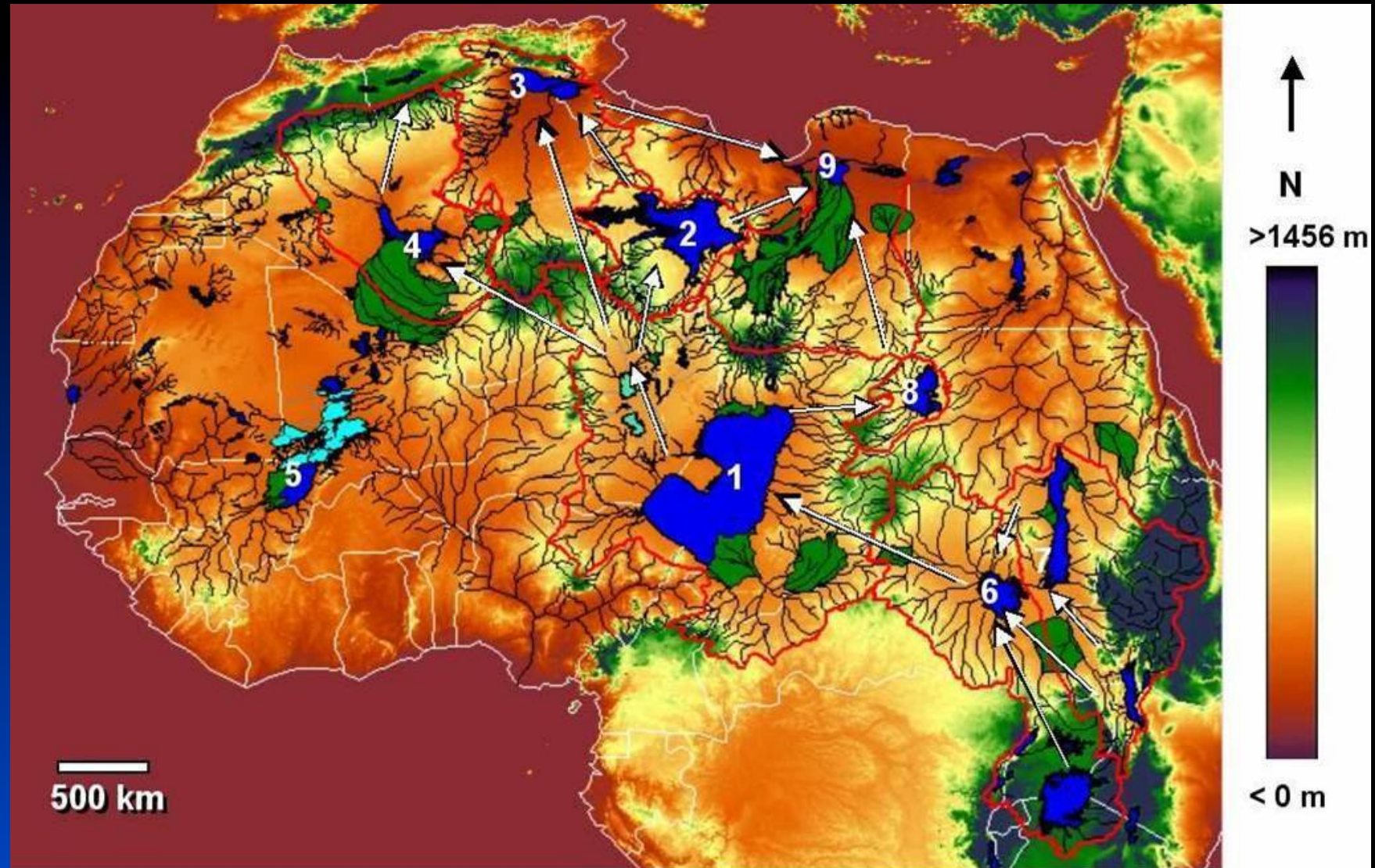


Fig. 1. Perforated *Nassarius kraussianus* beads from the Middle Stone Age of Blombos Cave. Scale bars = 5 mm.

100,000 yrs ago the Sahara was 'green' (Nick Drake *et al.*)



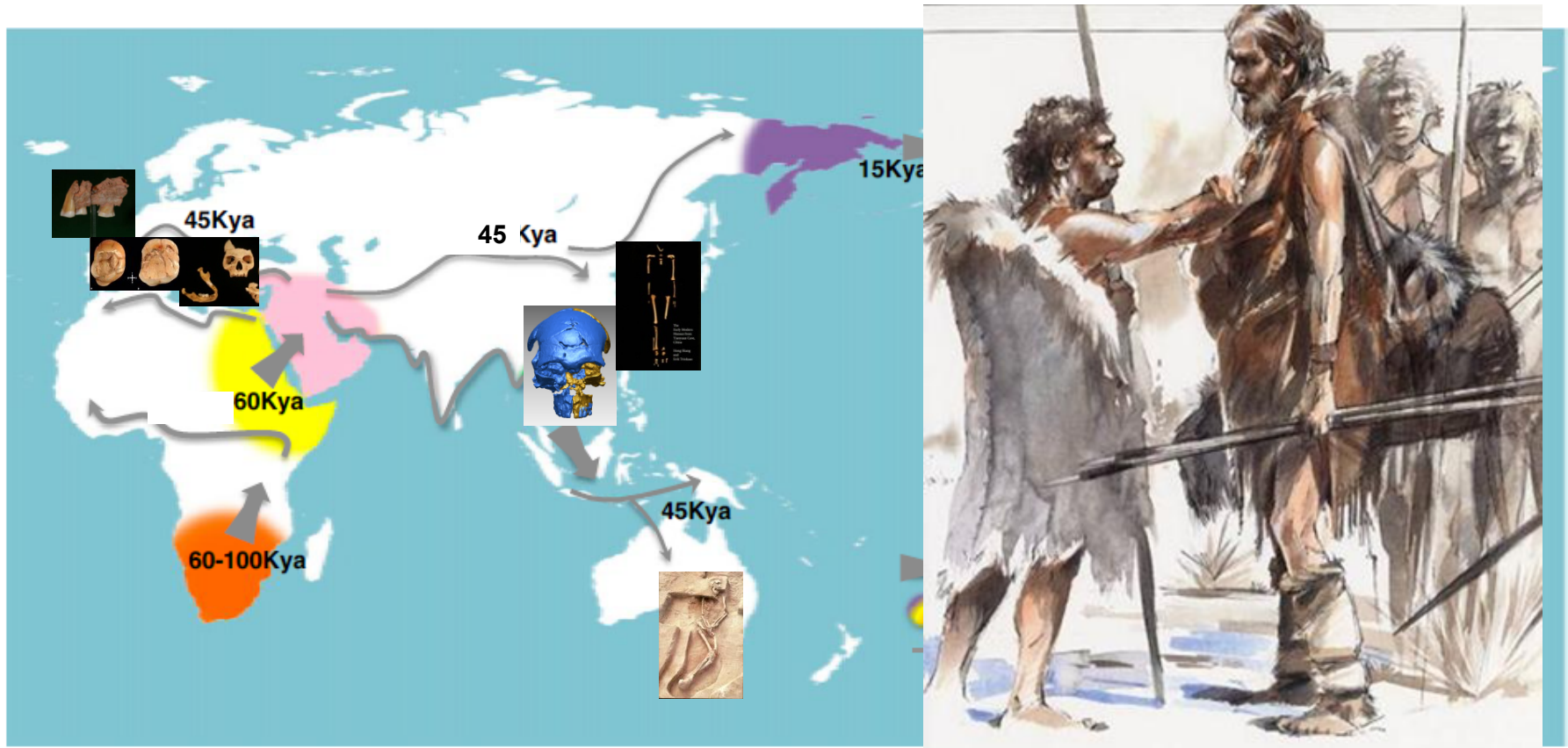


Fig. 1. Ancient dispersal patterns of modern humans during the past 100,000 y. This map highlights demic events that began with a source population in southern Africa 60 to 100 kya and conclude with the settlement of South America approximately 12 to 14 kya. Wide arrows indicate major founder events during the demographic expansion into different continental regions. Colored arcs indicate the putative source for each of these founder events. Thin arrows indicate potential migration paths. Many additional migrations occurred during the Holocene (11).

The great human expansion

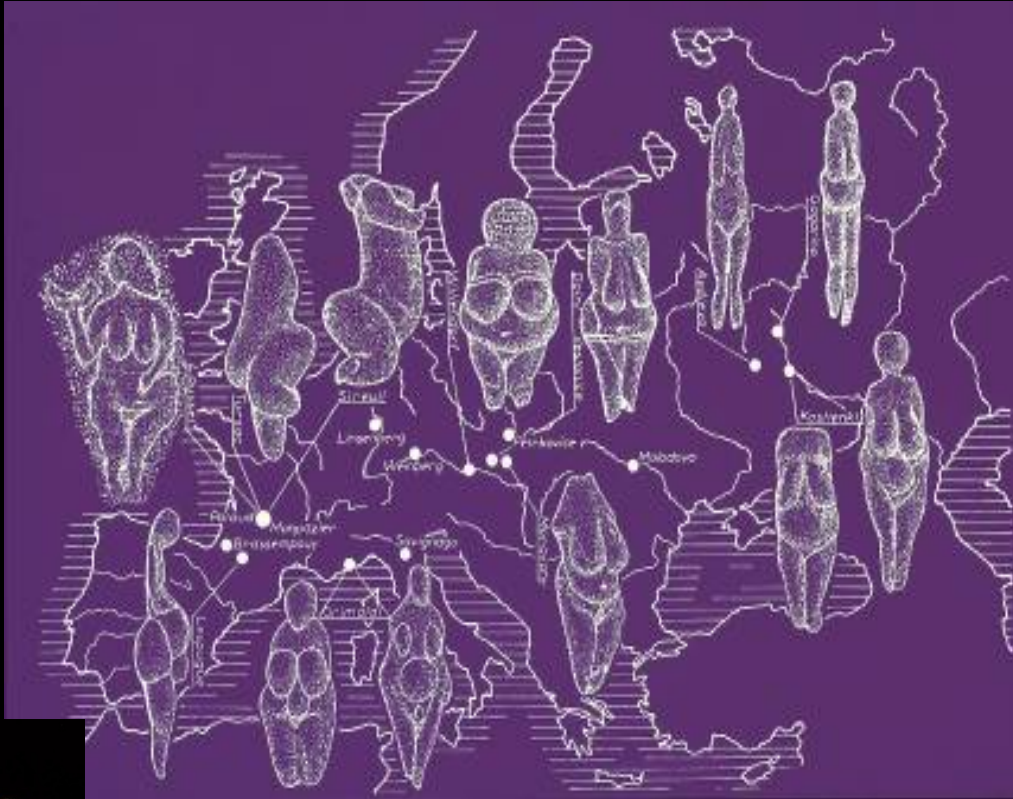
Brenna M. Henn^a, L. L. Cavalli-Sforza^{a,1}, and Marcus W. Feldman^{b,2}

PNAS 2012

Art and music 30-40 ka

Female figurines Europe and Asia

Statuettes and flutes: Hohle Fels & Vogelherd ~ 40ka



We are all the same (species), but we all look different (individuals, ♀/♂, regions, “races”).

Species
(Homo sapiens)

large brain
high round skull
small face
chin
small browridges
lightly-built skeltn

Natural Selection

Sexual Selection

Founder Effect

Drift



Individuals

body shape
skin colour
hair
nose
eyes
lips etc

The complete genome sequence of a Neanderthal from the Altai Mountains

Kay Prüfer¹, Fernando Racimo², Nick Patterson³, Flora Jay², Sriram Sankararaman^{3,4}, Susanna Sawyer¹, Anja Heinze¹,

The genomic landscape of Neanderthal ancestry in present-day humans

Sriram Sankararaman^{1,2}, Swapan Mallick^{1,2}, Michael Dannemann³, Kay Prüfer³, Janet Kelso³, Svante Pääbo³, Nick Patterson^{1,2} & David Reich^{1,2,4}

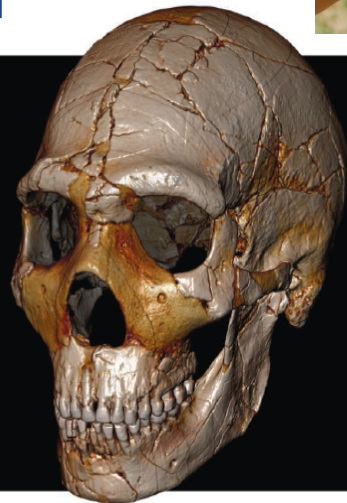
Patterns of coding variation in the complete exomes of three Neandertals

Sergi Castellano^{a,1}, Genís Parra^{a,2}, Federico A. Sánchez-Quinto^{b,2}, Fernando Racimo^{a,c,2}, Martin Kuhlwilm^{a,2},

Close Encounters Of the Prehistoric Kind

As a result, many people living outside Africa have inherited a small but significant amount of DNA from these extinct humans.

The long-awaited sequence of the Neandertal genome suggests that modern humans and Neandertals interbred tens of thousands of years ago, perhaps in the Middle East



SEPARATING THEM FROM US

Some genes that differ between modern humans and Neandertals

Gene	Significance
<i>RPTN</i>	Encodes the protein repetin, expressed in skin, sweat glands, hair roots, and tongue papilli
<i>TRPM1</i>	Encodes melastatin, a protein that helps maintain skin pigmentation
<i>THADA</i>	Associated with type 2 diabetes in humans; evolutionary changes may have affected energy metabolism
<i>DIYRK1A</i>	Found in an area critical for causing Down syndrome
<i>NRG3</i>	Mutations associated with schizophrenia
<i>CADPS2, AUTS2</i>	Mutations implicated in autism
<i>RUNX2 (CBRA1)</i>	Causes cleidocranial dysplasia, characterized by delayed closure of cranial sutures, malformed clavicles, bell-shaped rib cage, and dental abnormalities
<i>SPAG17</i>	Protein important for the beating of the sperm flagellum

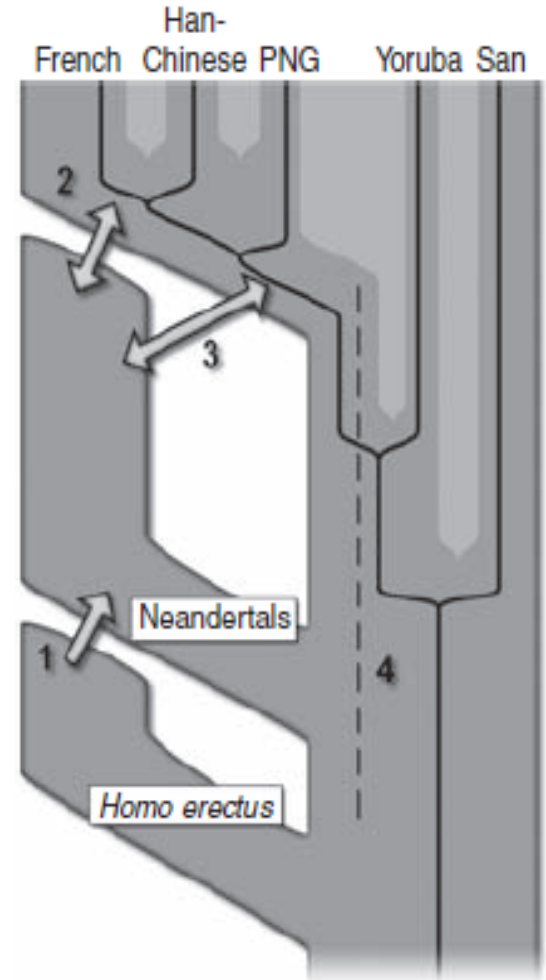
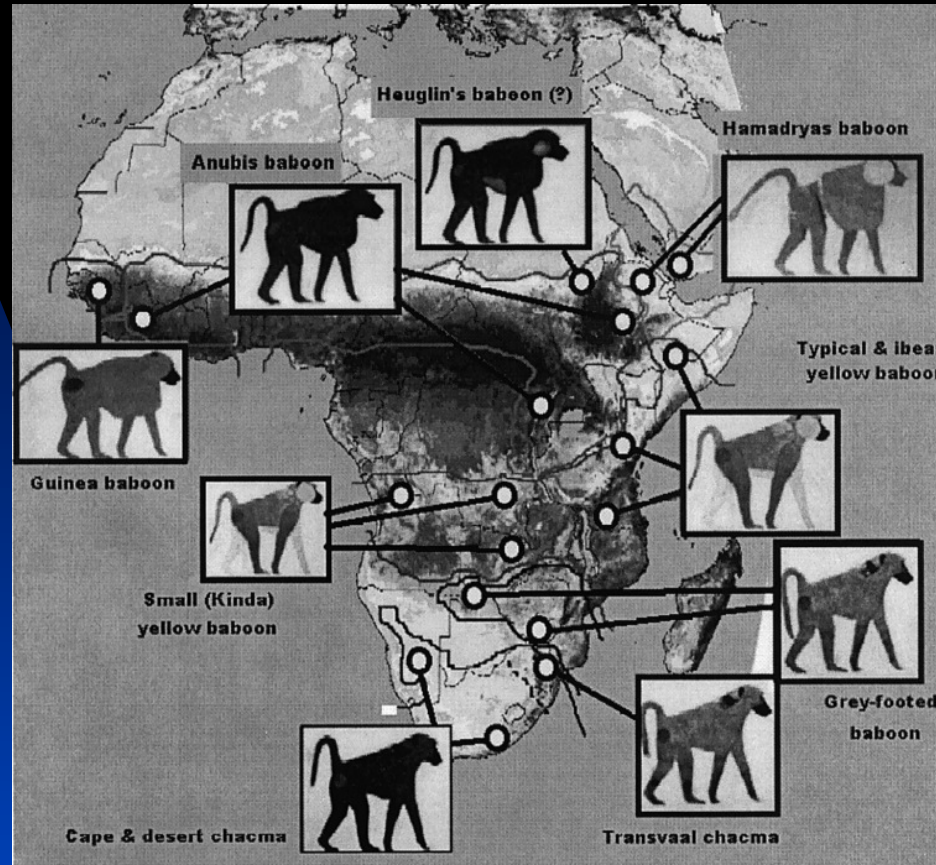


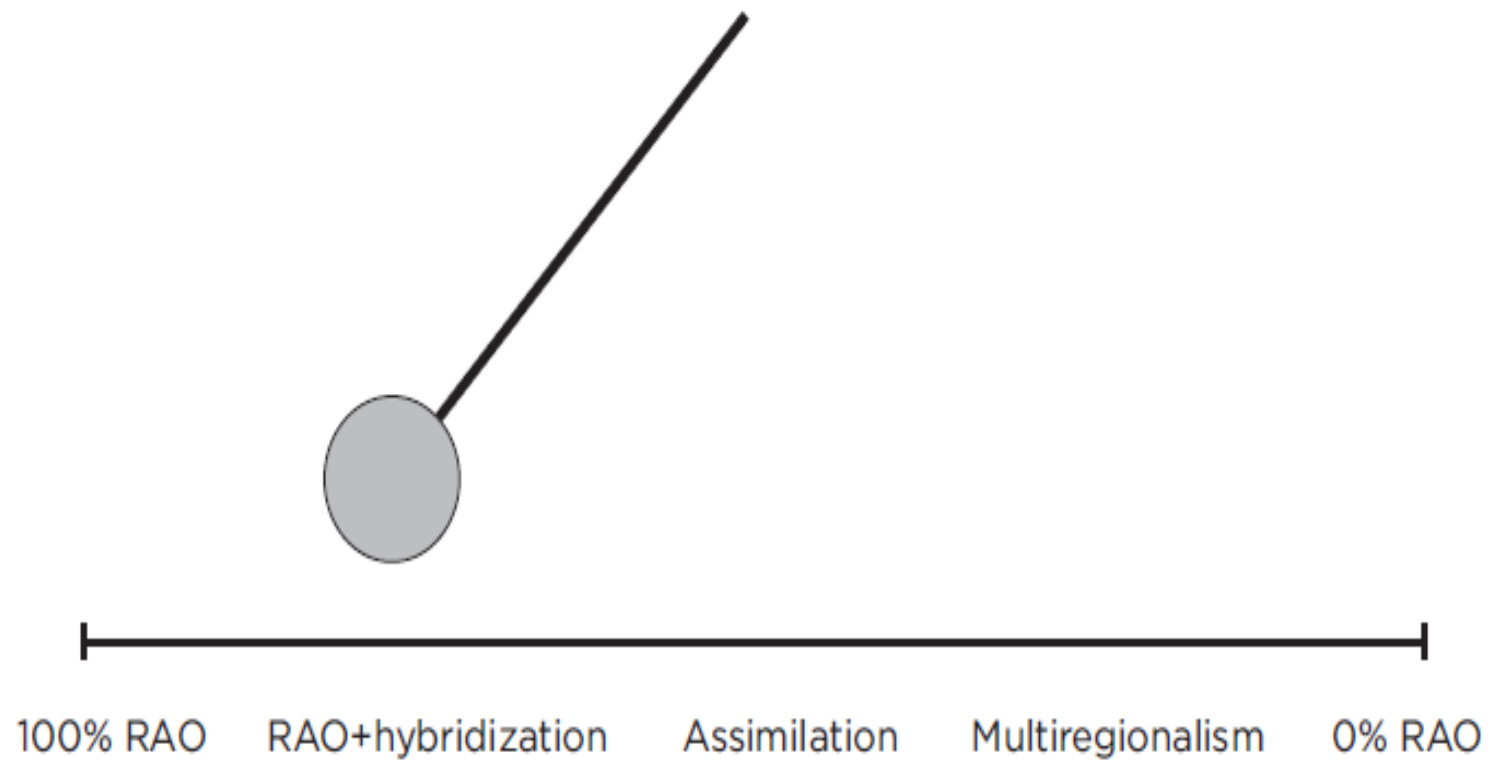
Fig. 6. Four possible scenarios of genetic mixture

Baboon-like monkeys in Africa constitute good 'species' but also interbreed (Clifford Jolly)



The message is to concentrate on biology, avoid semantic traps, and realize that any species-level taxonomy based on fossil material is going to be only an approximate reflection of real-world complexities.

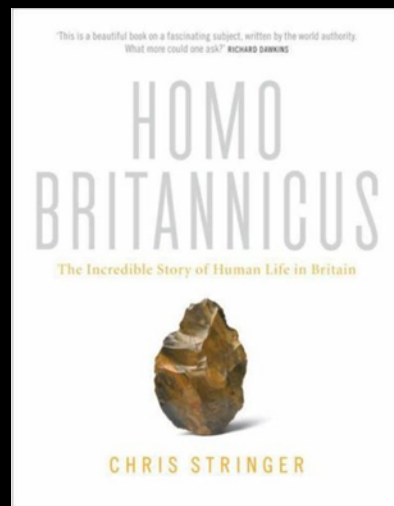
The pendulum of our species origin



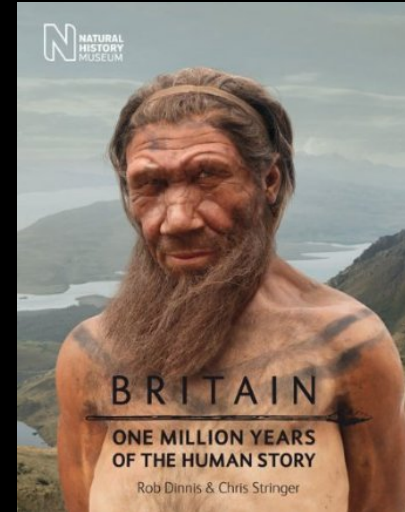
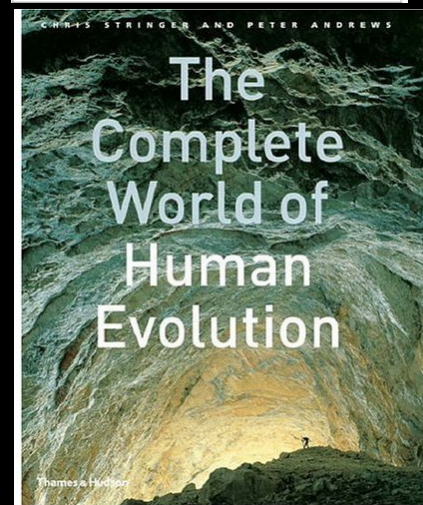
2014

“Mostly Out of Africa”

Thanks to you all for listening, and to...
The Natural History Museum London
Hum Origins Res Fund & The Calleva Foundation
and all my sources of data and illustrations..

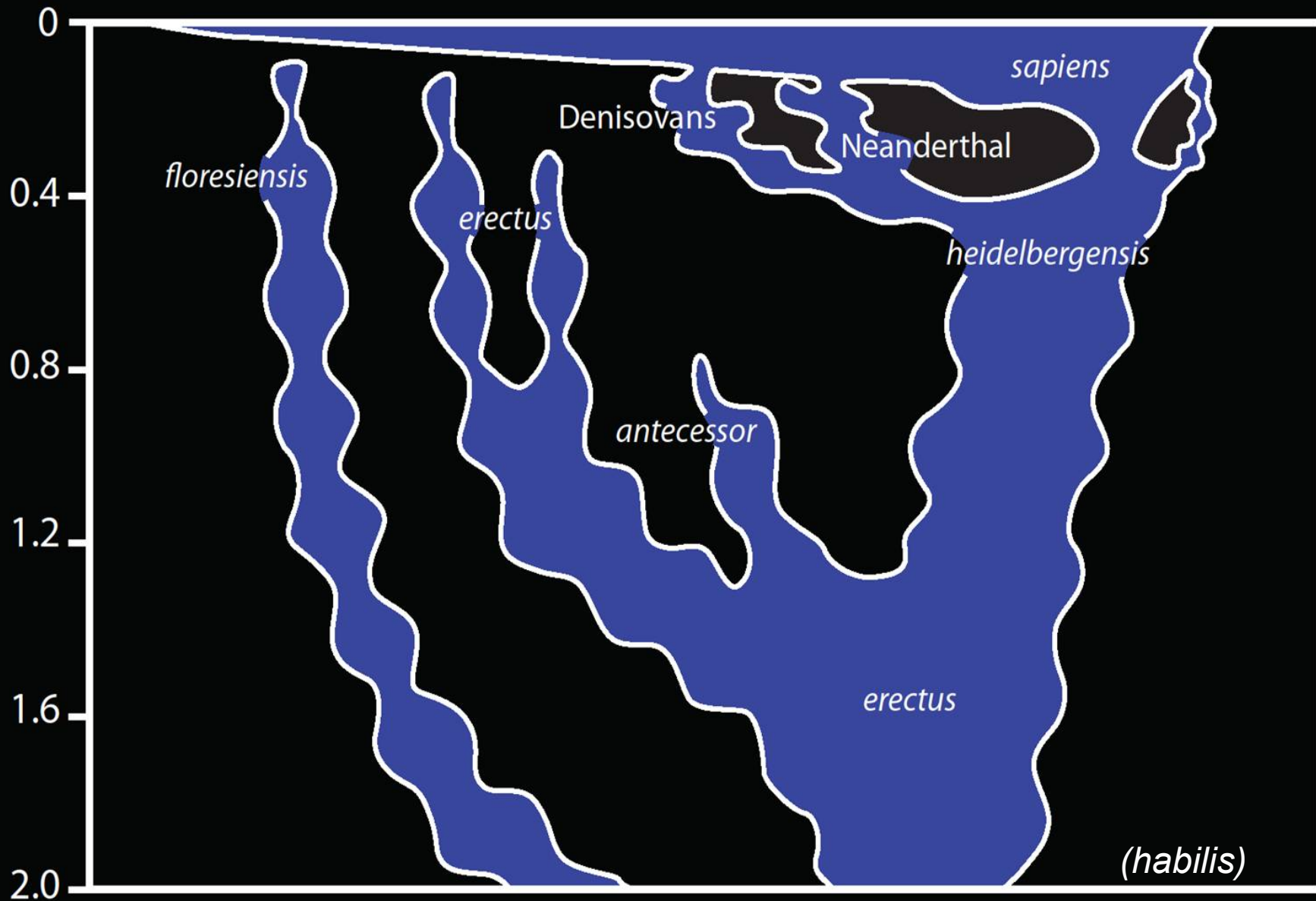


HUMAN
ORIGINS
RESEARCH
GROUP

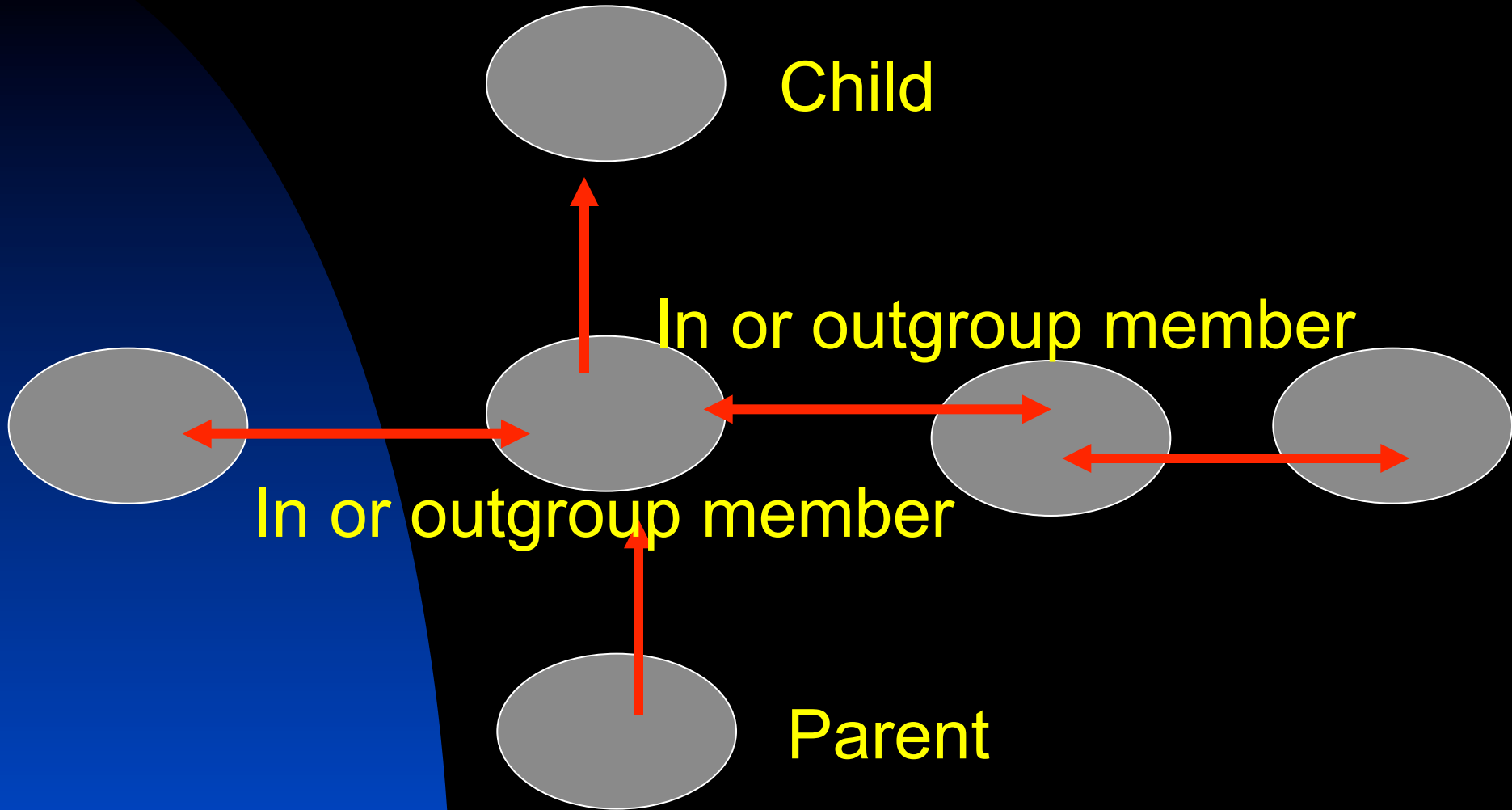


Eurasia

Africa



Transmission in archaic humans?



vis-à-vis: Explorations in Anthropology, Vol. 10: 102–125.
Style, Symboling, and Interaction
in
Middle Stone Age Societies
JAYNE WILKINS

Modern humans grow more slowly, live longer, and network more widely...

Current Anthropology
Volume 41, Number 4, 2000
The “Venus” Figurines:
Textiles, Basketry, Gender,
and
Status in the Upper
Paleolithic
by O. Soffer, J. M. Adovasio
& D. C. Hyland

Dental evidence for ontogenetic differences between modern humans and Neanderthals

Tanya M. Smith^{a,b,1}, Paul Tafforeau^{c,1}, Donald J. Reid^d, Joane Pouech^{b,c}, Vincent Lazzari^{b,c,e}, John P. Zermeno^a, Debbie Guatelli-Steinberg^f, Anthony J. Olejniczak^b, Almut Hoffman^g, Jakov Radovčić^h, Masrour Makaremiⁱ, Michel Toussaint^j, Chris Stringer^k, and Jean-Jacques Hublin^b

^aDepartment of Human Evolutionary Biology, Harvard University, Cambridge, MA 02138; ^bDepartment of Human Evolution, Max Planck Institute for Evolutionary Anthropology, 04103 Leipzig, Germany; ^cEuropean Synchrotron Radiation Facility, BP 220, 38046 Grenoble Cedex, France; ^dDepartment of Oral Biology, School of Dental Sciences, Newcastle upon Tyne NE2 4BW, United Kingdom; ^eInternational Institute of Paleoprimatology and Human Paleontology: Evolution and Paleoenvironments, Unité Mixte de Recherche Centre National de la Recherche Scientifique 6046, Université de Poitiers, 86022 Poitiers cedex, France; ^fDepartment of Anthropology, Ohio State University, Columbus, OH 43210; ^gMuseum für Vögel und Frühergeschichte, Schloss Charlottenburg–Langhansbau, D-14059 Berlin, Germany; ^hCroatian Natural History of Bordeaux II, 33000 Bordeaux, France; ⁱDirection de l’Archeologie, Service Public Natural History Museum, London SW7 5BD, United Kingdom

Edited* by Richard G. Klein, Stanford University, Stanford, CA, and approved Oct

Humans have an unusual life history, with an early weaning age, long childhood, late first reproduction, short interbirth intervals, and long lifespan. In contrast, great apes wean later, reproduce

Older age becomes common late in human evolution

Rachel Caspari^{*†} and Sang-Hee Lee[‡]

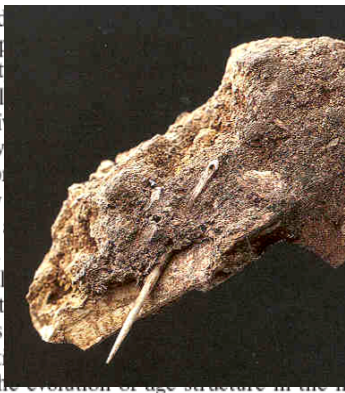
^{*}Department of Anthropology, University of Michigan, Ann Arbor, MI 48109-1092; and [†]Department of Anthropology, University of California, Riverside, CA 92521-0418

[‡]Communicated by Ward H. Goodenough, University of Pennsylvania, Philadelphia, PA, May 27, 2004 (received for review October 28, 2003)

Increased longevity, expressed as number of individuals surviving to older adulthood, represents one of the ways the human life history pattern differs from other primates. We believe it is a critical demographic factor in the development of human culture. Here, we examine when changes in longevity occurred by assessing the ratio of older to younger adults in four hominid dental samples from successive time periods, and by determining the significance of differences in these ratios. Younger and older adult status is assessed by wear seriation of each sample. Whereas there is significant increased longevity between all groups, indicating a trend of increased adult survivorship over the course of human evolution, there is a dramatic increase in longevity in the modern humans of the Early Upper Paleolithic. We believe that this great increase contributed to population expansions and cultural innovations associated with modernity.

brain size and supports the p

By longevity span attainable adults who lived individuals lived selection favored longevity. To involved with study to adult younger adult. Although this living population insight into the evolution of age structure in the human fossil record.



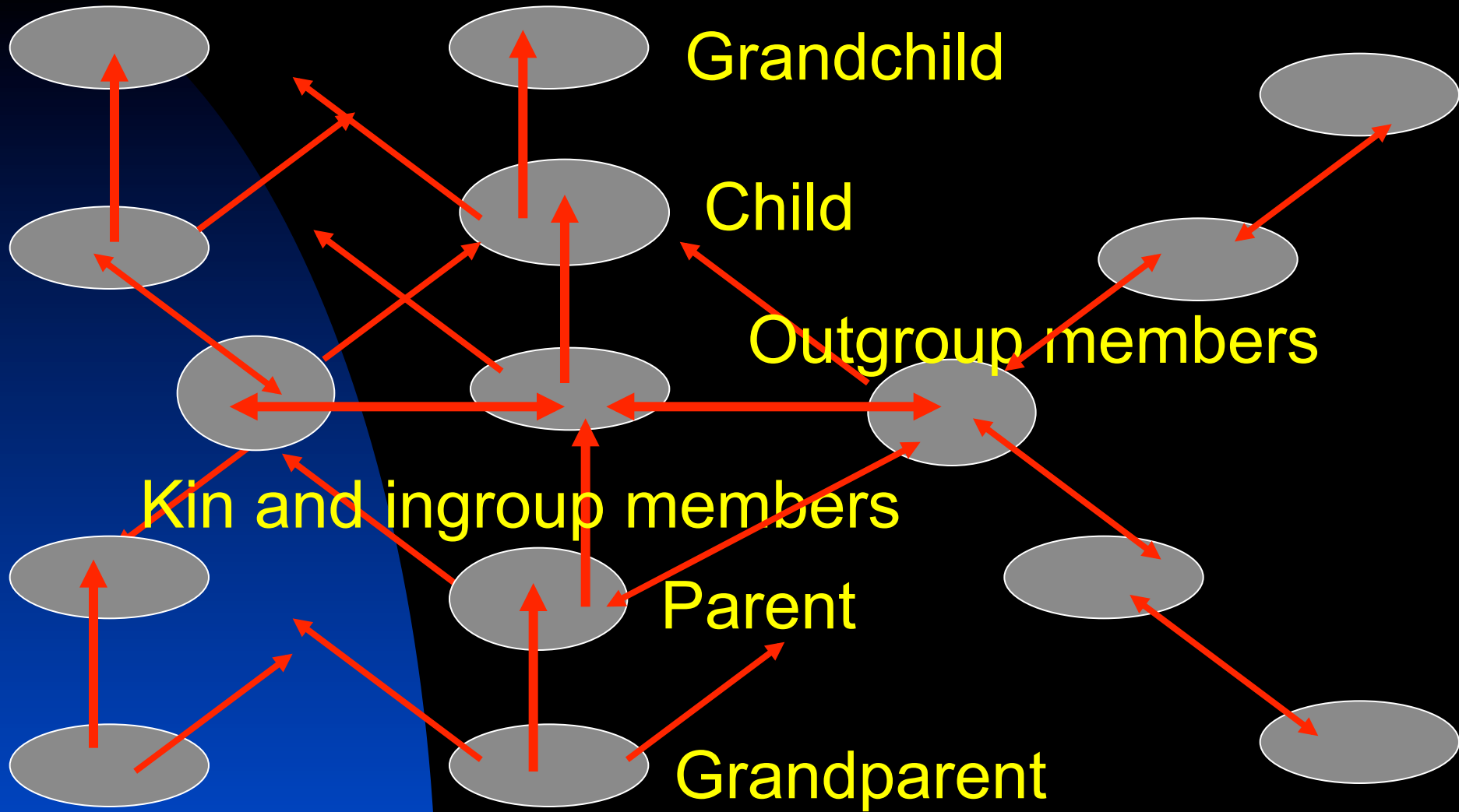
ossil record

ly *Homo*.
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ossil record.

Science 11 September 2009:
Vol. 325 no. 5946 p. 1359
DOI: 10.1126/science.
1175404

**30,000-Year-Old Wild Flax
Fibers**

Transmission in modern humans?



Variation in the Neanderthal genome appears to have been lower than in present-day humans and is among the lowest measured for any organism.

Signs of low genetic diversity in the Neanderthal woman's DNA indicate that her parents were closely related, possibly half siblings. Small population sizes encouraged inbreeding among Neanderthals, the researchers suggest.

Mating in small and isolated populations may have caused Neanderthal populations to be more differentiated from one another than what is typical for present-day humans.

The first explorers?

Always a crossroads, the village of Dmanisi (above) once overlooked the old Silk Road through the Caucasus region. Nearly 1.8 million years ago the site lay on a peninsula between the Black and Caspian Seas (map, right), along one of several land corridors into Eurasia. Humans could have moved out of Africa—and back into it—in multiple waves, reaching Java by at least 1.6 million

years ago. By one million years ago, *Homo* had spread across Eurasia, leaving bones and tools in its wake.

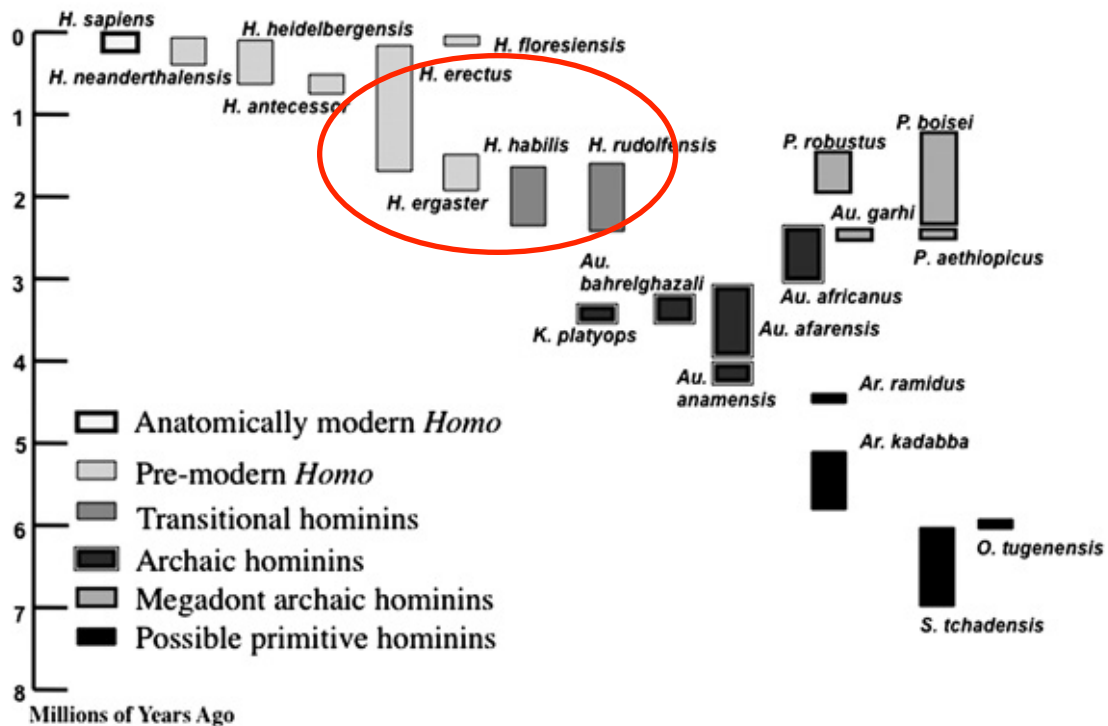


Dmanisi: humans at the gates of Europe 1.8Ma





Hominin grades - speciose taxonomy



B. Wood



Naturwissenschaften. 2007 Feb: 94(2):107-112.
Evidence of earliest human occurrence in Europe:
the site of Pirro Nord (Southern Italy).

1.5
Ma?

Arzarello M, Marcolini F, Pavia G, Pavia M,
Petronio C, Petrucci M, Rook L, Sardella R.



1.4
Ma?

1.2 Million year old jawbone
found in Sima del Elefante
Atapuerca, Spain



1.2
Ma?

El mapa de los yacimientos

REGISTRO CRONOLÓGICO PRINCIPALES HALLAZGOS

VISTA AÉREA

GALERÍA

ENTRE 400.000 Y 200.000 AÑOS

'Homo heidelbergensis' y herramientas de Modo 2 (Achelense).

GRAN DOLINA

ENTRE 1.000.000 Y 200.000 AÑOS

Principales restos de 'Homo antecessor'. Huesos de grandes carnívoros

TRINCHERA DEL FERROCARRIL

Los yacimientos afloraron durante la construcción de una línea de ferrocarril (1896-1901) hoy abandonada

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SIMA DEL ELEFANTE

ENTRE 1,3 MILLONES Y 150.000 AÑOS

Lascas de Modo 1 (Olduvayense)

SIMA DE LOS HUESOS

400.000 AÑOS

'Homo heidelbergensis'. Es el yacimiento más rico en fósiles humanos

PORTALÓN

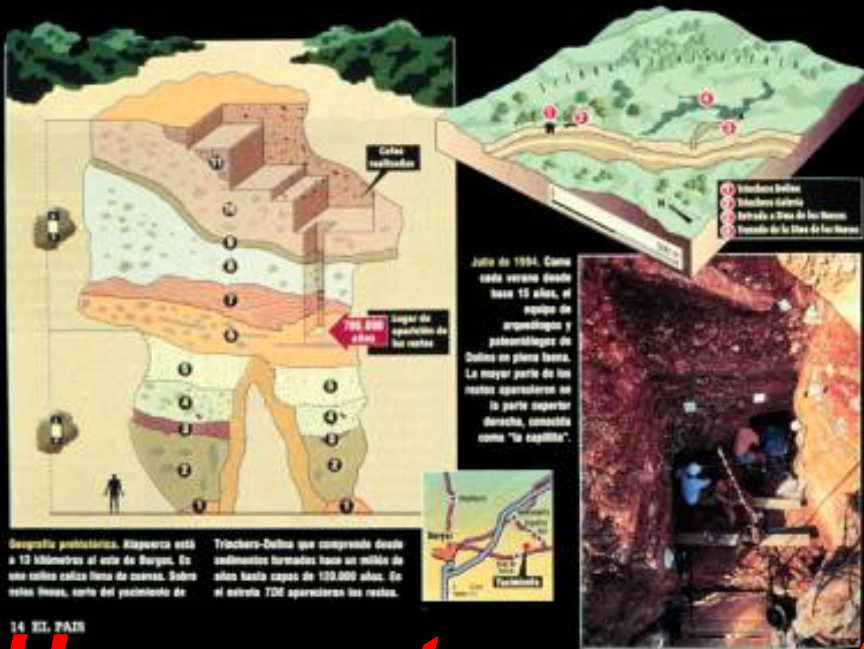
3.000 AÑOS (EDAD DEL BRONCE)

Adornos de hueso y marfil

0 50M

Atapuerca

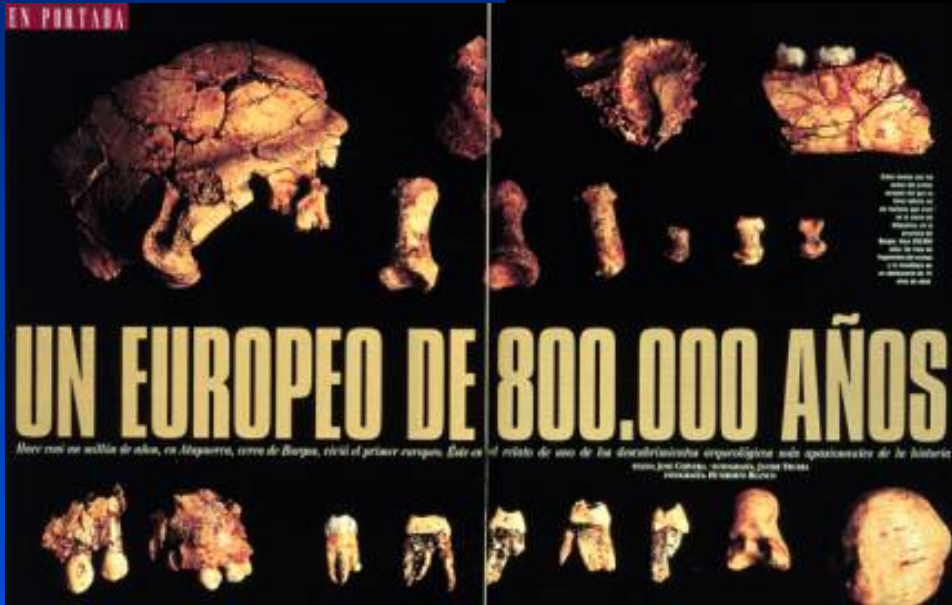




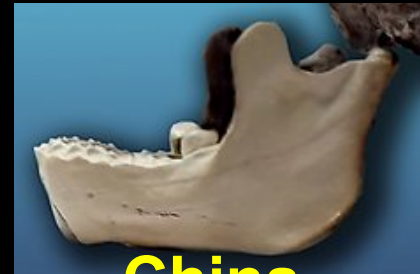
14 EL PAÍS

Homo antecessor 0.8Ma

Atapuerca Spain: Gran Dolina

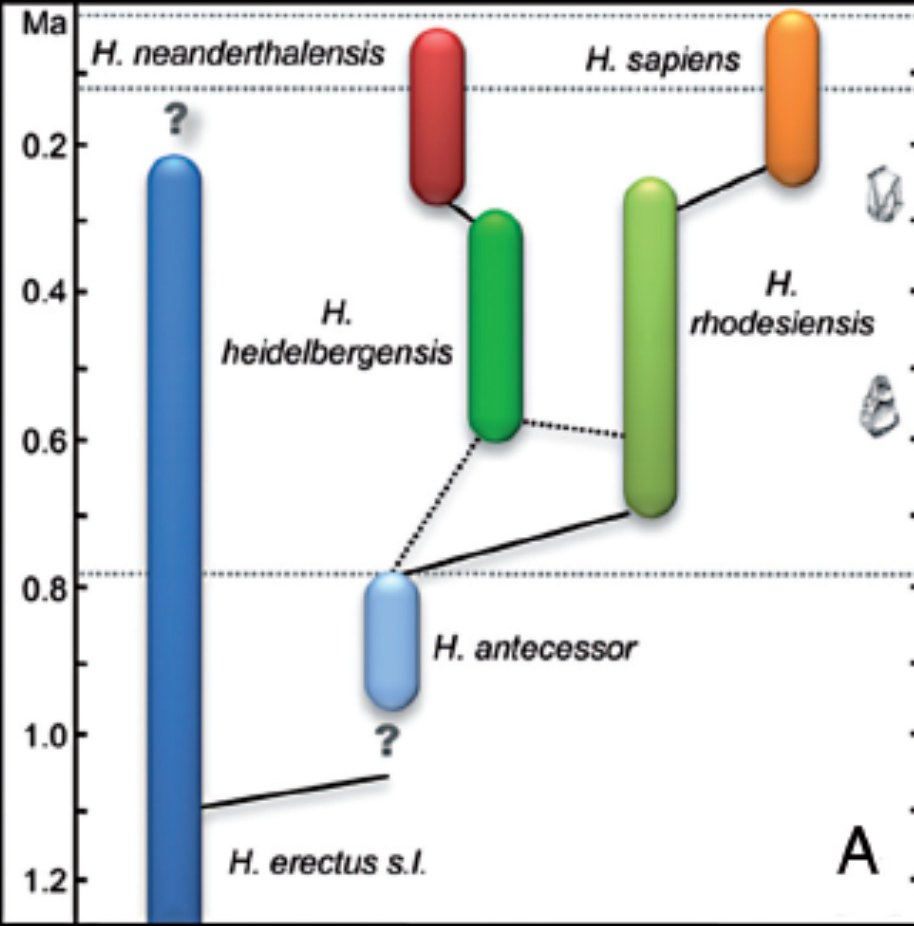
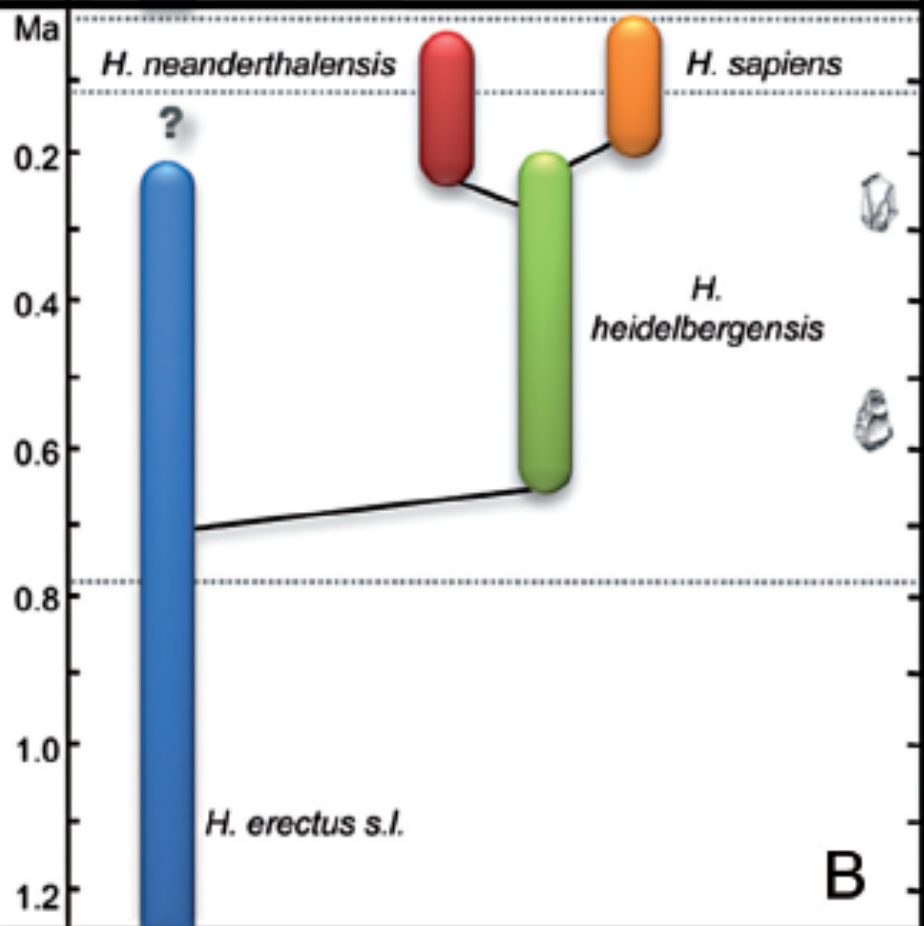


Ceprano Italy



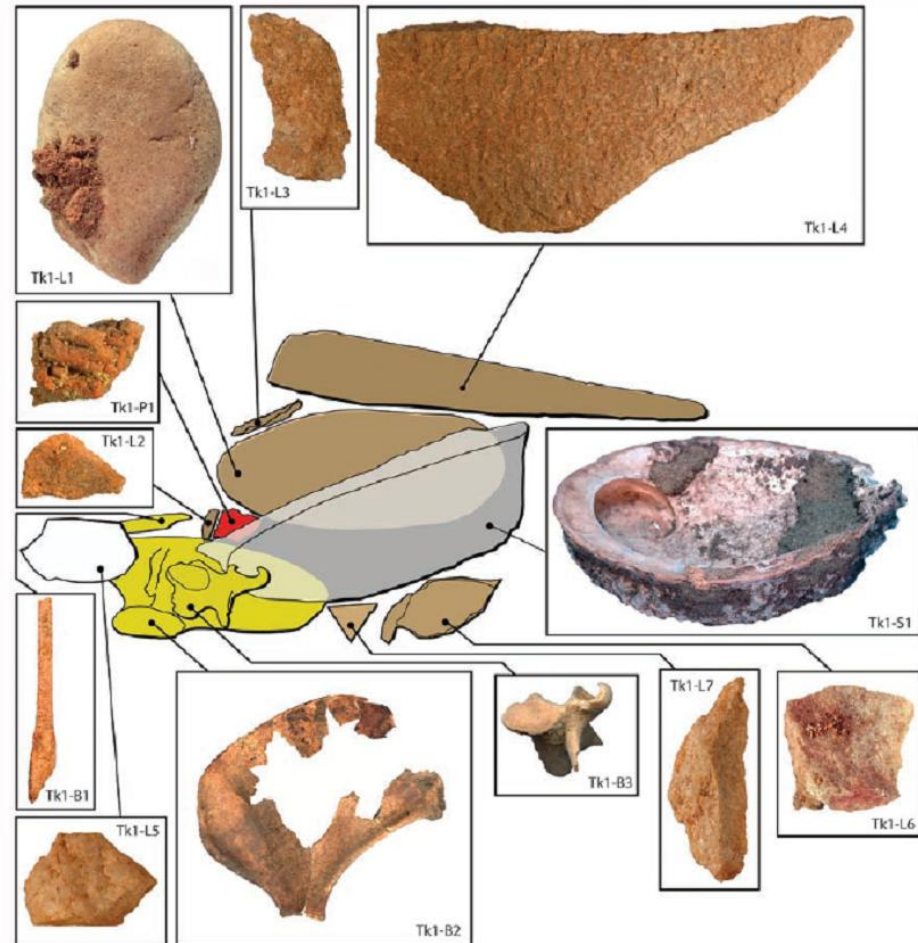
China





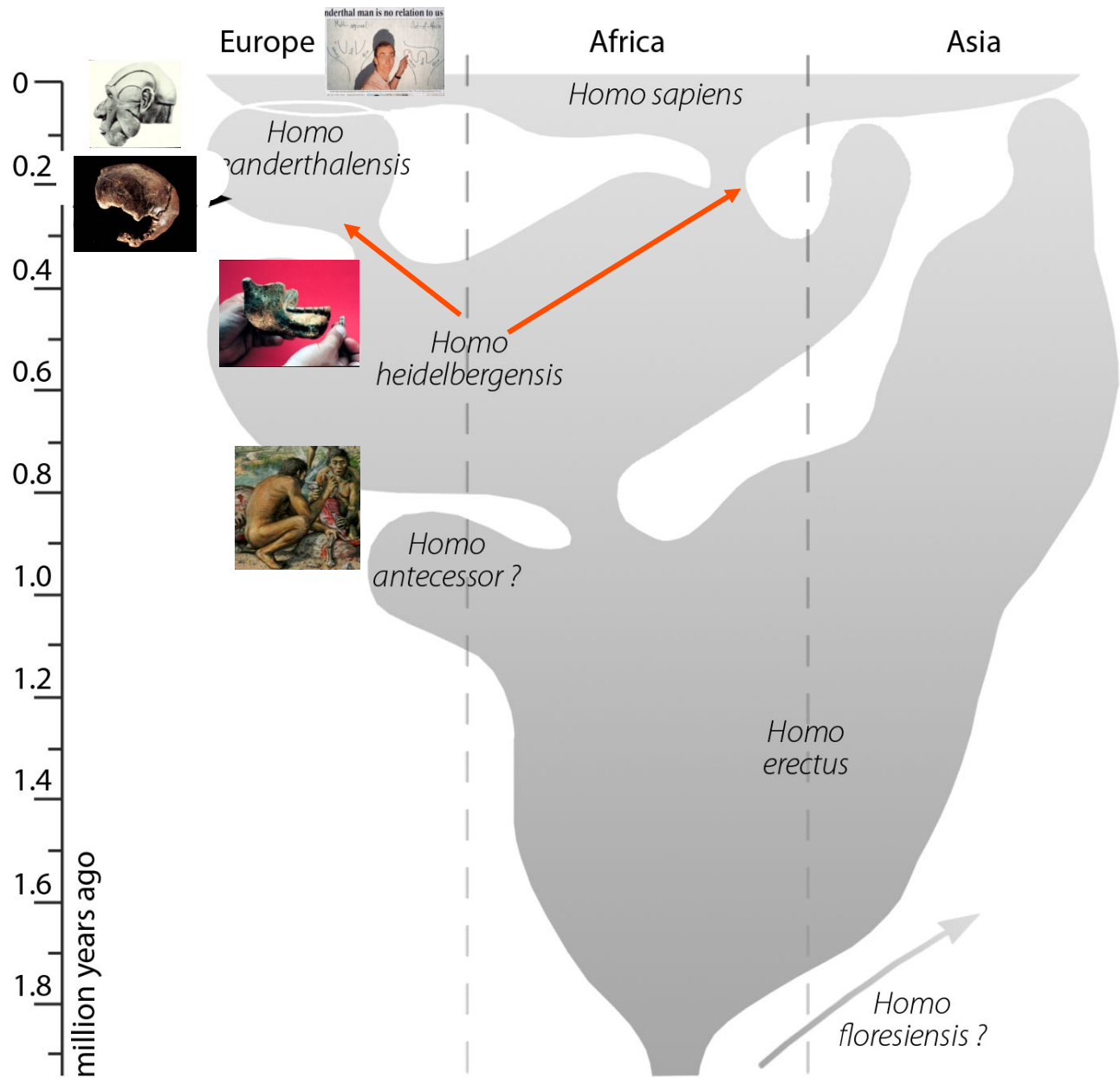
A 100,000-Year-Old Ochre-Processing Workshop at Blombos Cave, South Africa

Christopher S. Henshilwood,^{1,2*} Francesco d'Errico,^{3,1} Karen L. van Niekerk,¹ Yvan Coquinot,⁴ Zenobia Jacobs,⁵ Stein-Erik Lauritzen,⁶ Michel Menu,⁴ Renata García-Moreno³



Artifacts making up Tk1 and their relative spatial locations. [Image: C. Henshilwood and F. d'Errico]

Ochre-processing toolkits in situ showing Tk1 (A) and Tk2 (B). [Images



Human behavioural evolution: gains + losses

In the past, small populations would have been prone to extinction, or forced into relatively rapid movement or adaptation to survive, and this could have led to the regular loss of innovations that might have been useful in the longer term. Thus without the networking we find in modern humans, repeated 'bottlenecking' did not just remove genetic diversity, but also discoveries and inventions associated with the human populations concerned..

The Status of *Homo heidelbergensis* (Schoetensack 1908)

Chris Stringer

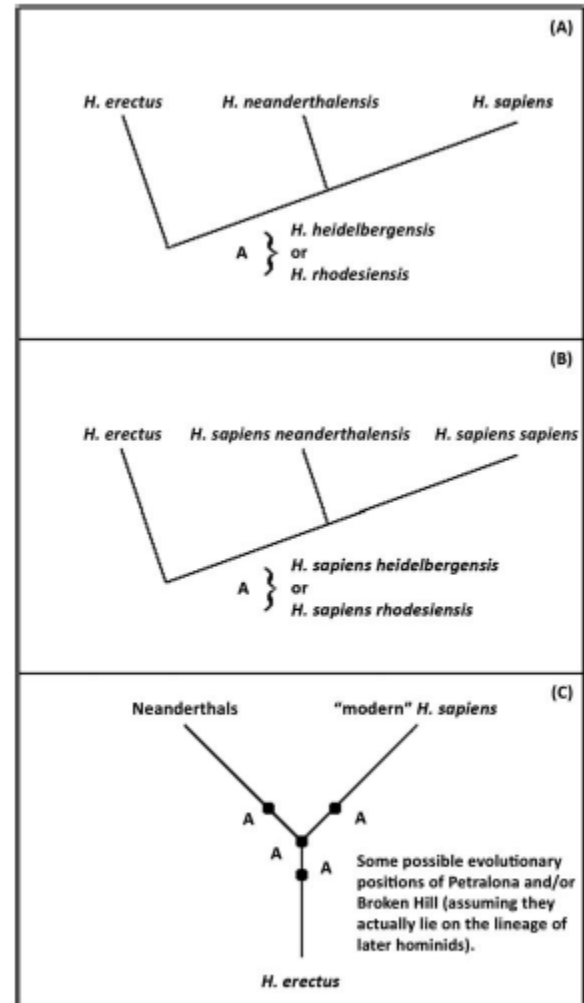
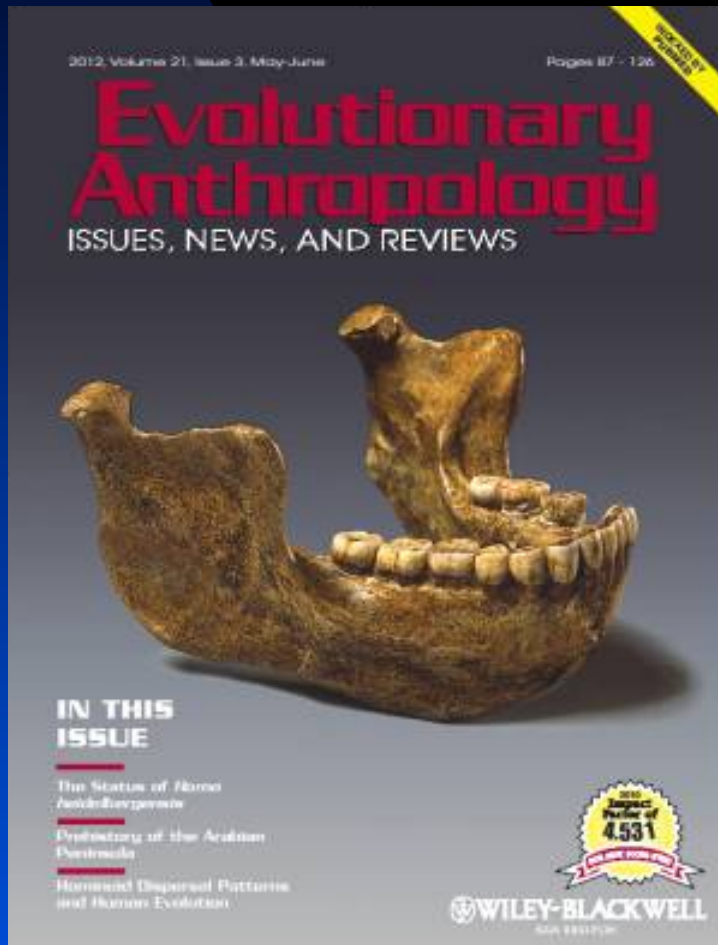
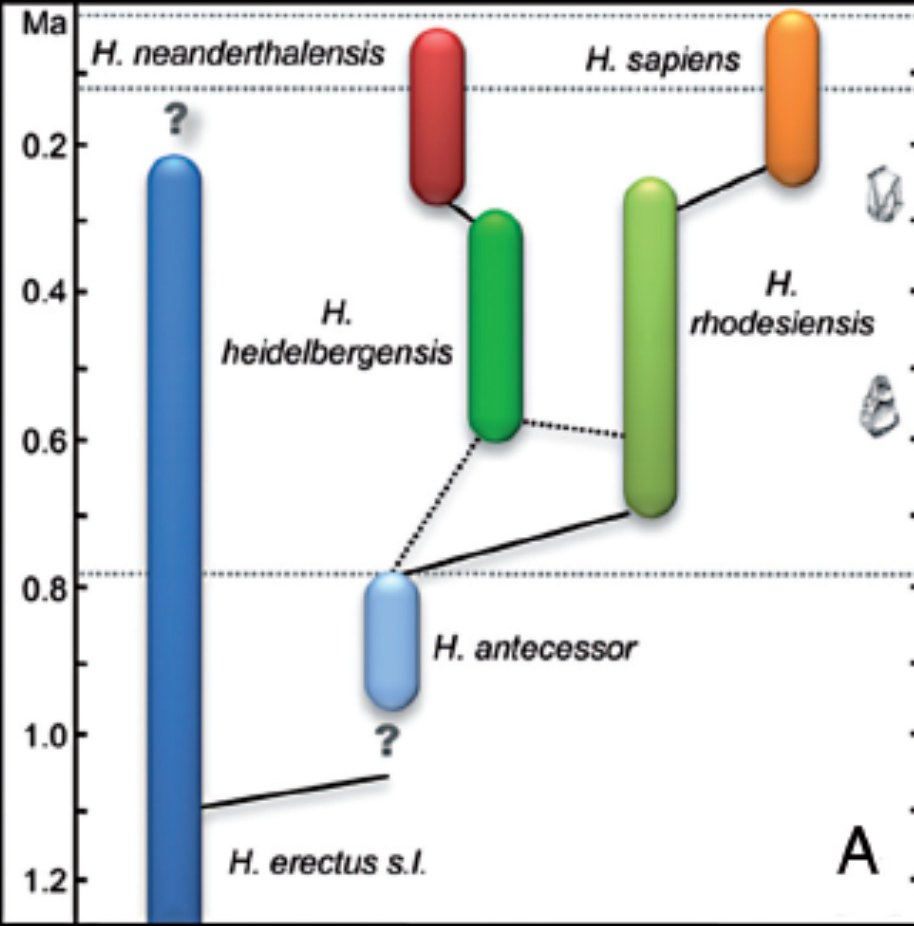
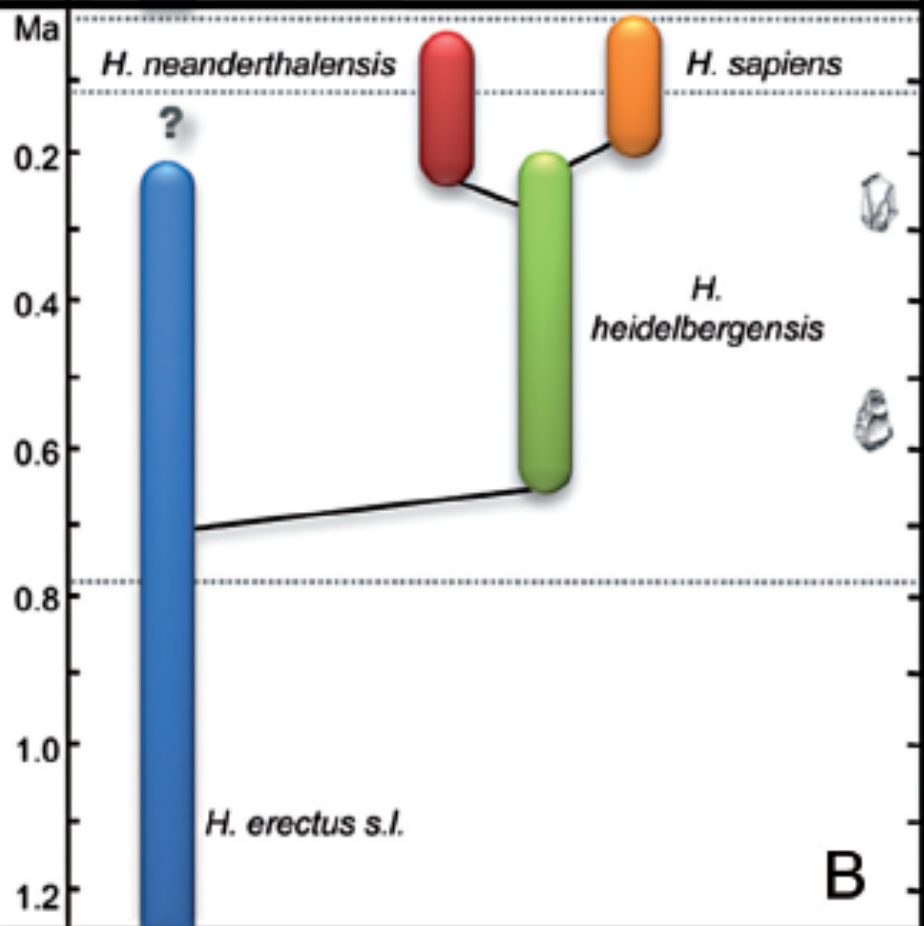


Figure 1. Illustration of the possible phylogenetic relationships of the Petralona and Broken Hill fossils. Redrawn, with permission, from Stringer.⁹



PALEOANTHROPOLOGY

RIP for a key Homo species?

Researchers consider killing off a claimed common ancestor of Neandertals and modern humans

By Michael Balter, in Tautavel, France

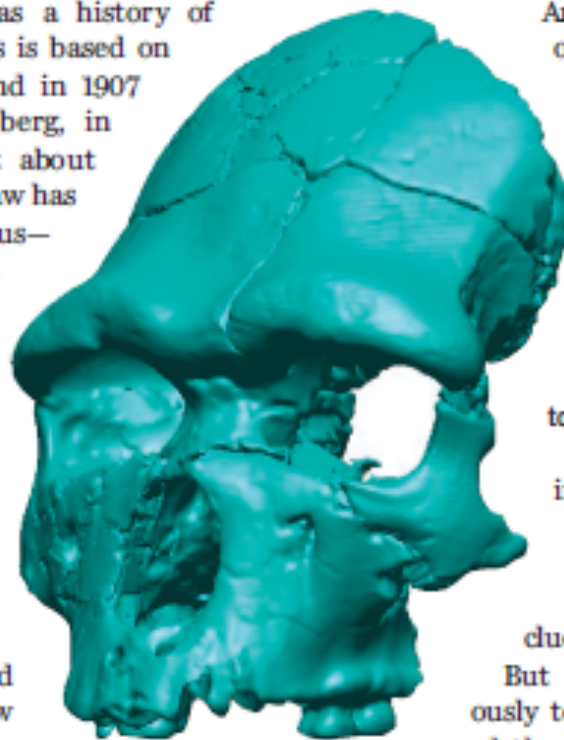
“If someone kills one person they go to jail,” anthropologist Zeresenay Alemseged of the California Academy of Sciences in San Francisco noted last month at a meeting here in France’s deep south. “But what happens if you kill off a whole species?” The answer soon became apparent: anguished debate. In the balance was *Homo heidelbergensis*, a big-brained human ancestor generally seen as a pivotal figure during a murky period of evolution. At the invitation of the meeting, researchers generally was a paleo-



ensis has
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many as
humans

H. heidelbergensis has a history of controversy. The species is based on a single lower jaw found in 1907 at Mauer, near Heidelberg, in Germany. Estimated at about 600,000 years old, the jaw has an unusually thick ramus—the vertical projection that hinges to the skull—and nothing quite like it has been found since. For decades, the name failed to catch on, until anthropologists including Rightmire and Chris Stringer of the Natural History Museum in London noted distinctive thick brow ridges and large faces in skulls of roughly similar

species is based, cannot be closely matched with any other fossil, in part because few other jaws are preserved. To keep the species alive, researchers need to find and designate a new type specimen that has both a jaw and skull, but such a specimen would surely spark new debates, Arsuaga said. The better course “would be to let the species die.”



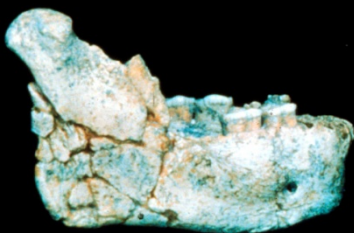
Anthropologist Yoel Rak of Tel Aviv University in Israel supported this argument by comparing the Mauer jaw with the few jaws claimed to be *H. heidelbergensis* fossils,

This new reconstruction ties France’s Arago skull to *Homo heidelbergensis*.

including three partial jaws from Arago. “The Mauer specimen is one of a kind,” Rak concluded in his talk.

But others fought vigorously to save both the species and the simpler, more straightforward view of human evolu-

heidelbergensis: moving beyond Mauer



Asian *H. heidelbergensis*?



El mapa de los yacimientos

REGISTRO CRONOLÓGICO

PRINCIPALES HALLAZGOS

VISTA AÉREA

GALERÍA

ENTRE 400.000 Y 200.000 AÑOS

'Homo heidelbergensis' y herramientas de Modo 2 (Achelense).

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Los yacimientos afloraron durante la construcción de una línea de ferrocarril (1896-1901) hoy abandonada

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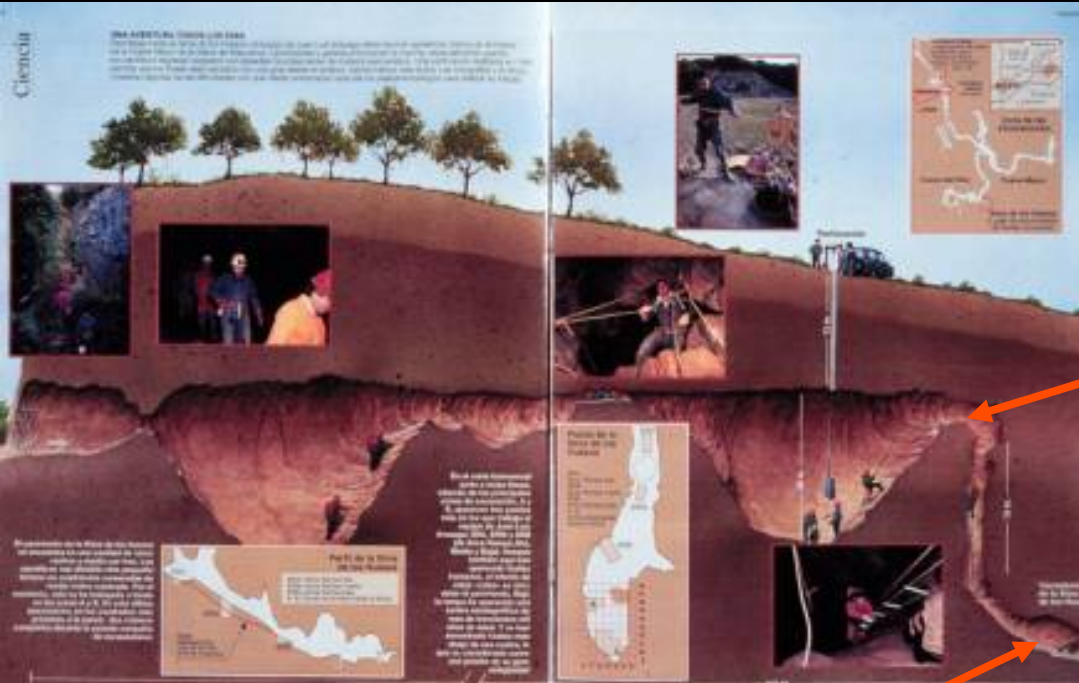
Adornos de hueso y marfil

0 50M

Atapuerca



Into "The Pit of the Bones" Atapuerca

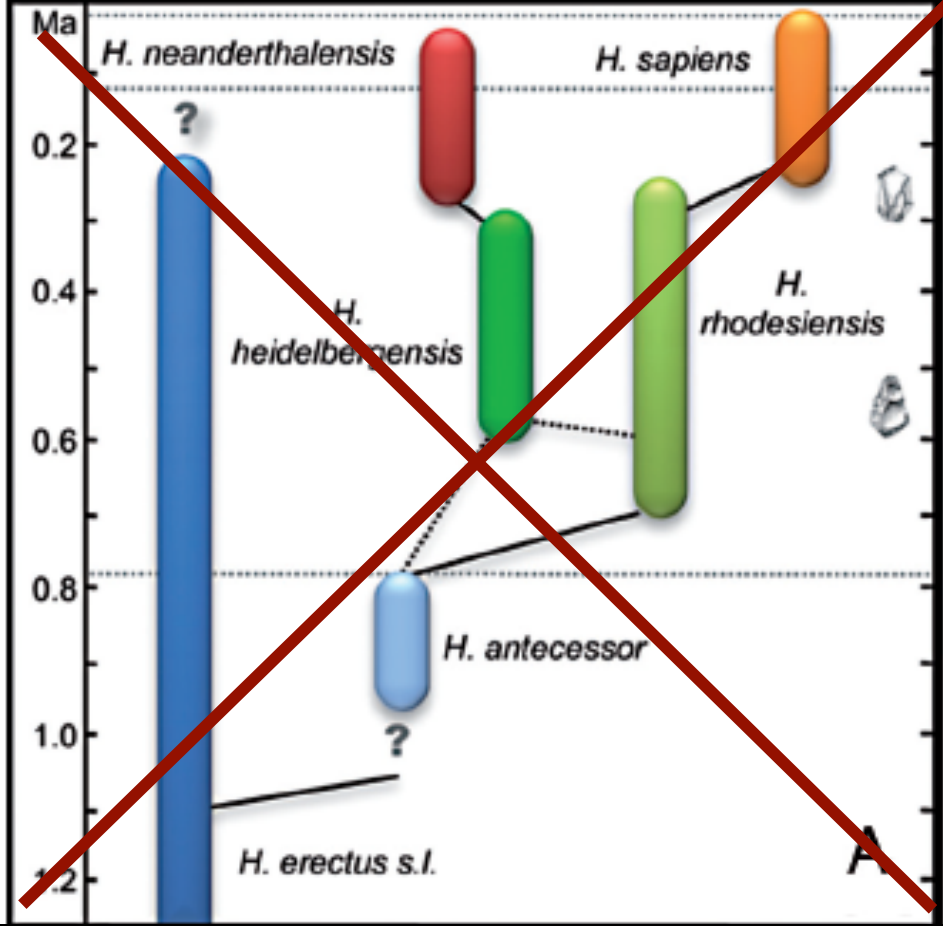
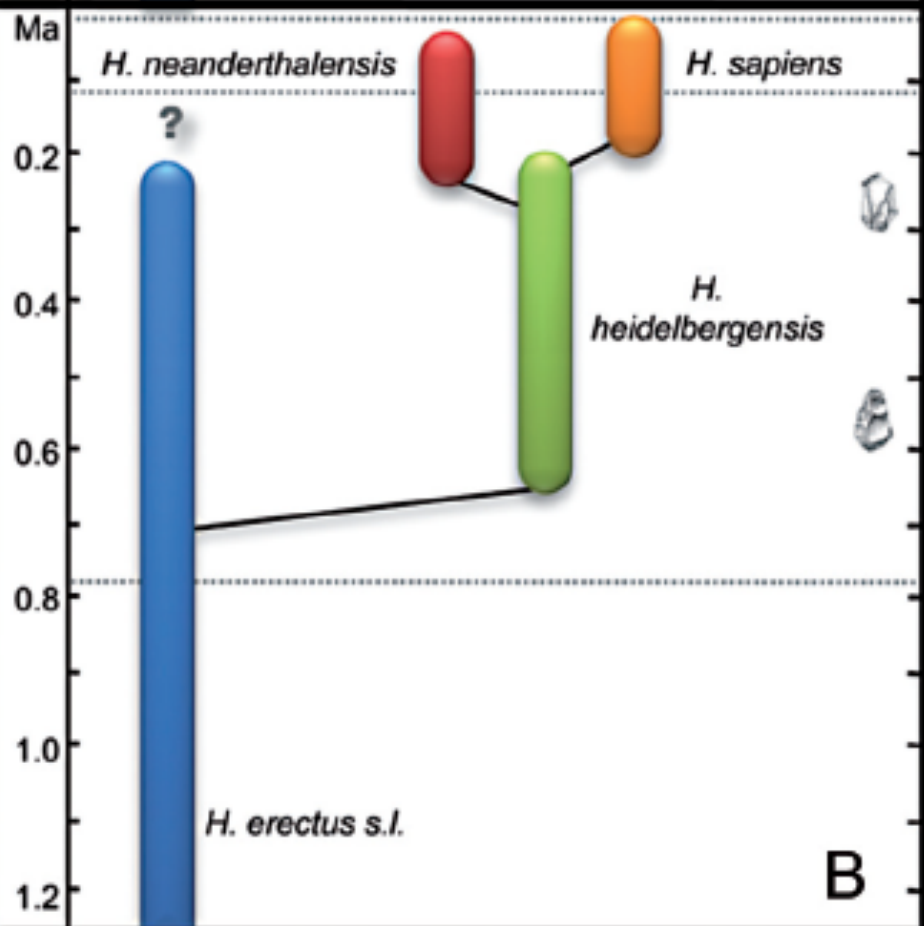


The Sima de los Huesos, Atapuerca ~400 ka and early Neanderthal

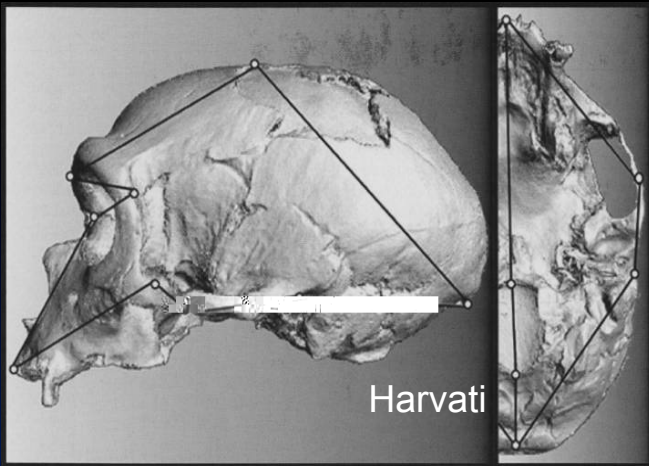


En la colección de la Sima de los Huesos están representadas todas las regiones del esqueleto lo que hace que *Homo heidelbergensis* sea la especie humana fósil mejor conocida. A partir de restos de diferentes individuos adultos es posible componer un esqueleto prácticamente completo. Muchos de los fósiles de la Sima de los Huesos, como el fémur de la derecha, son excepcionales en yacimientos de esa antigüedad.





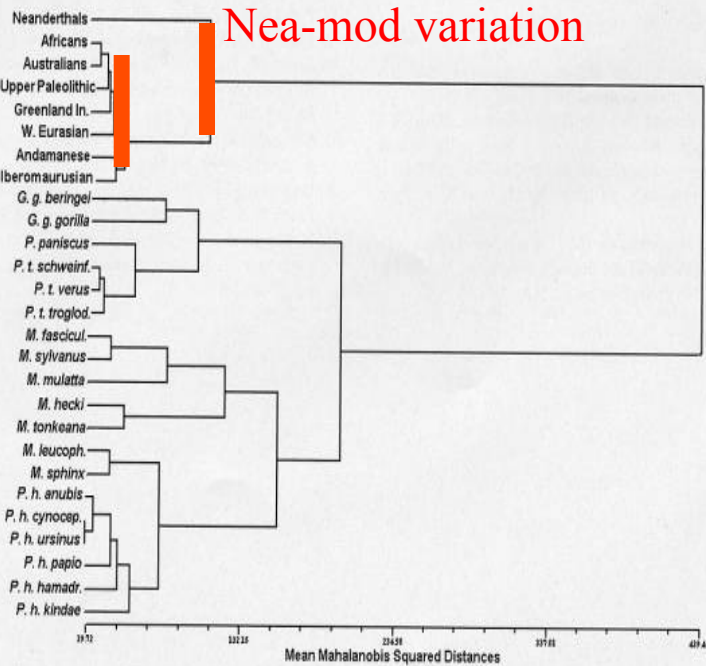
Neanderthals:



a different species?



Mod
var.

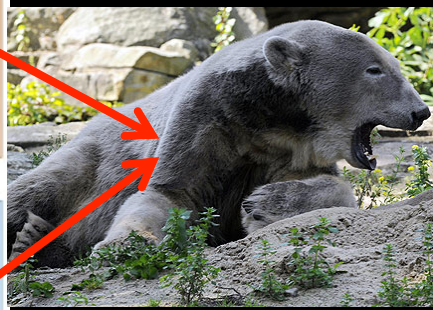
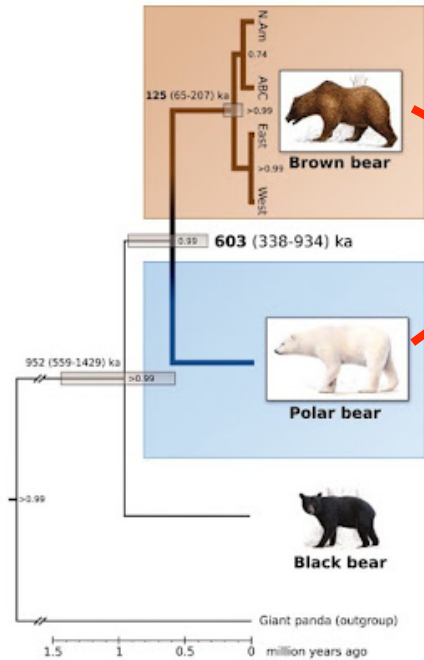


Cluster diagram (unweighted pair-group method, arithmetic average) of studied populations based on the mean D^2 among samples.

Harvati



Interbreeding?



Life 21

I'm a Neanderthal man

Despite what the scientists say, it explains why men have been behaving badly for the past 100,000 years

SO now it's official. Neanderthal man is extinct. According to new research in the *American Journal of Human Genetics*, modern Europeans show no trace whatever of any Neanderthal genes.

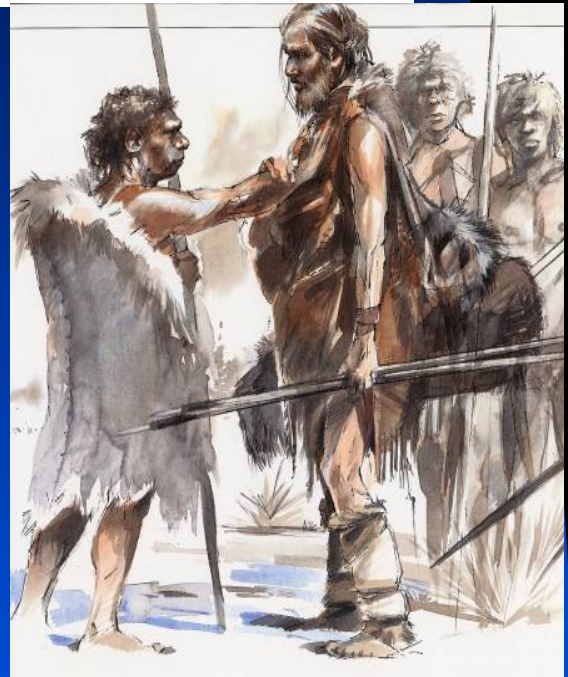
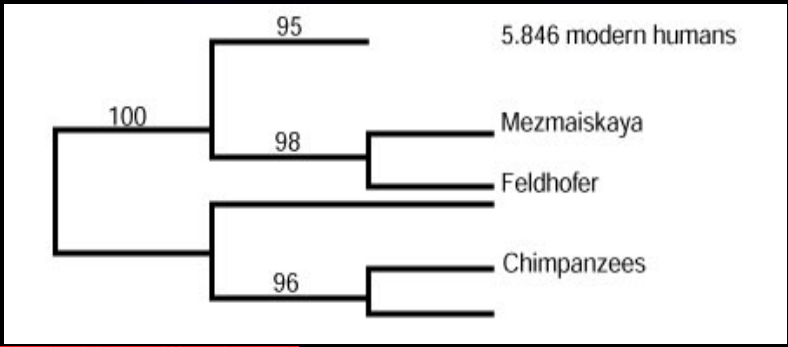
Scientists, led by the Hays Center of the University of Oklahoma, examined samples of DNA from across Europe and discovered that pygmy (Dutch) men had a large amount of Neanderthal genes. The same genes of Neanderthal genes were found in modern European men.

The Neanderthals had already been living in Europe for 100,000 years. They were bigger, stronger and taller than the men who lived there. They had larger brains, but not to the modern, neanderthal man.

Interestingly, Neanderthals are a perfect example of the way animals — the more becoming human — and often become smaller and more dexterous as they evolve.

MISSING LINK: Pygmy men and their Neanderthal genes — could one be losing the other?

EVOLUTION'S SURVIVORS: A young Neanderthal and a modern man.



nature

Ancient DNA

NEANDERTHAL GENOMICS

A million DNA base pairs sequenced

BIOTECHNOLOGY Sequencing the past

EARTHQUAKE RUPTURE Where will it end?

AVIAN INFLUENZA VIRUS A test for pandemic potential

NATUREJOBS Spotlight on Ireland



Neanderthal fashion

THE Sun **NEANDERTHALS DEAD OFFICIAL**

This species is no more.. it has ceased to be.. this is an EX species

DEAD & BURIED

PAGE ONE OPINION

The Sun today, as always, offers its readers the best of the news. It is the only newspaper in the world that is free to read and free to use. It is the only newspaper in the world that is free to read and free to use. It is the only newspaper in the world that is free to read and free to use.

What happened to the Neanderthals?

Continuity?

~~Evoived into the Cro-Magnons~~

Genetically absorbed

Extinction?

Interpopulation conflict

Demographic disadvantage

Competitive exclusion

Infectious diseases

Distinct physiologies/diets

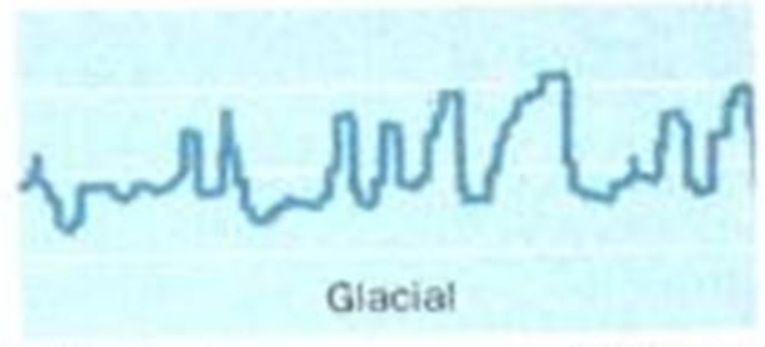
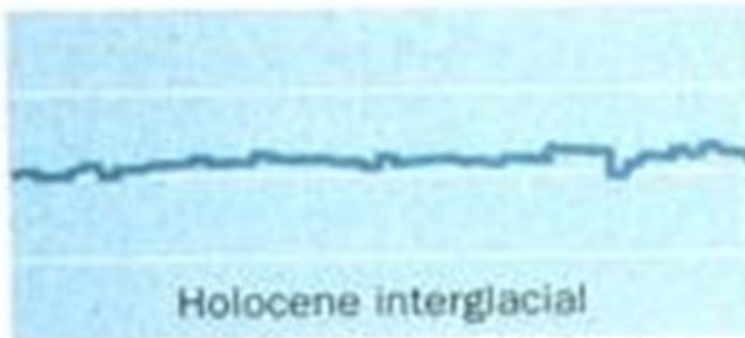
Competition/fluctuating climates

Climate change

Part of megafaunal extinctions



Rapid climate change 20-70 ka

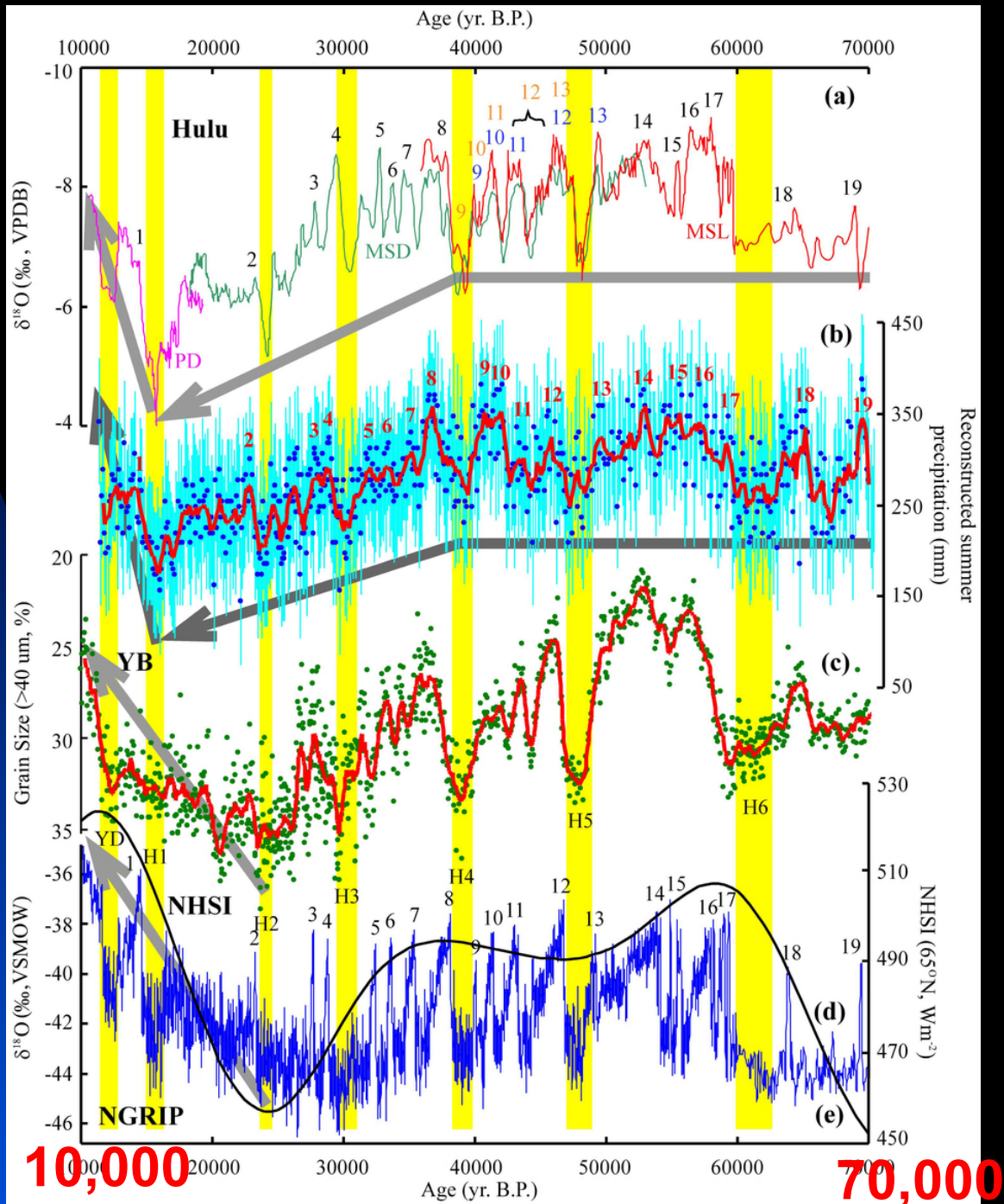


Modern

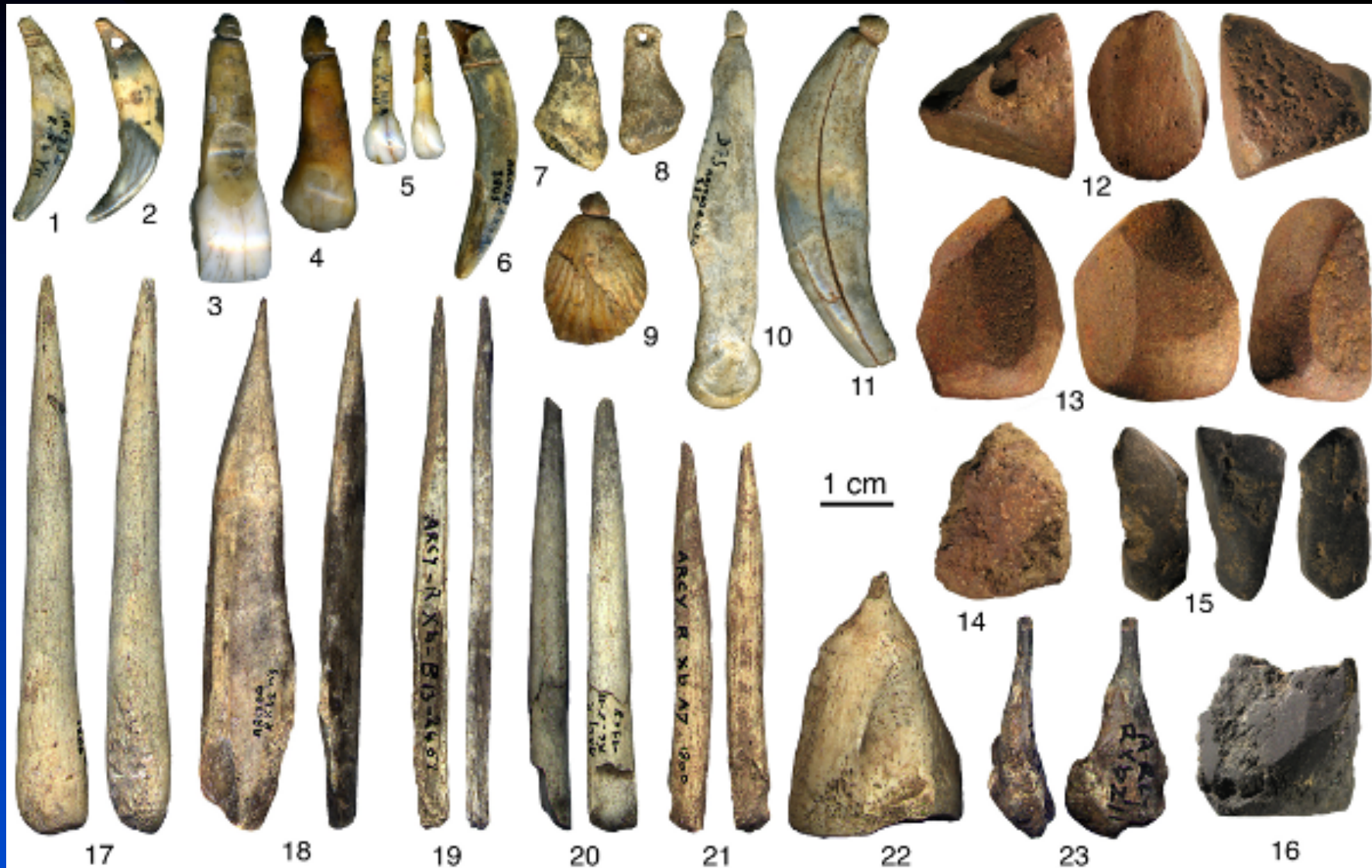
10,000 yr BP

20,000 yr BP

40,000 yr BP

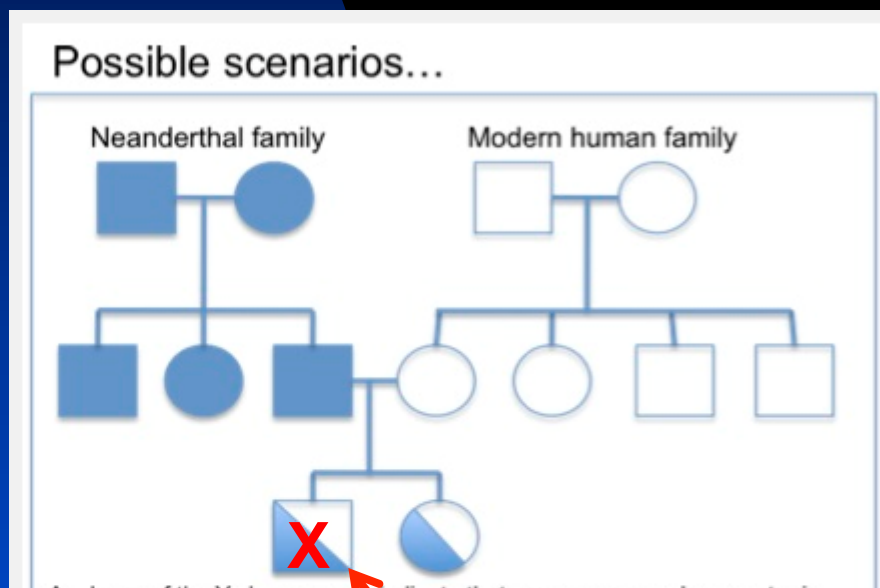


Châtelperronian material: the product of Neanderthals ~42,000 years ago?



These results suggest that part of the explanation for reduced Neanderthal ancestry near certain genes is that Neanderthal alleles caused decreased fertility in males when moved to a modern human genetic background.

This suggests that when ancient humans met and mixed with Neanderthals, the two species were at the edge of biological incompatibility



Sterility of male offspring – Haldane's rule operating?

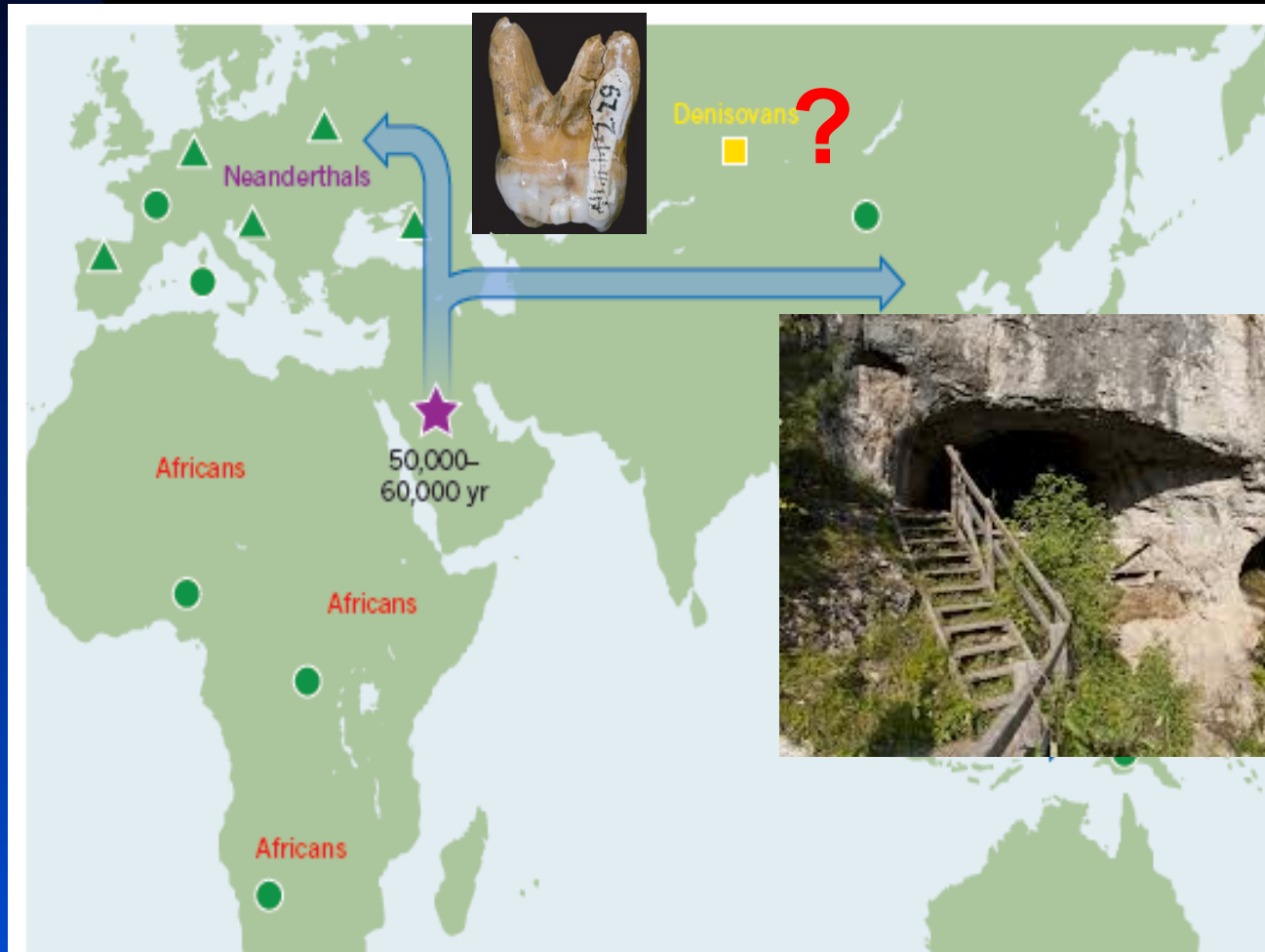
Extended Data Table 2 | Neanderthal-derived alleles that have are associated with phenotypes in genome-wide association studies

rs id	Coordinates	Derived allele	Derived allele frequency (%)		Phenotype
			Europeans	East Asians	
rs12531711	7:128,617,466	G	10.03	0.17	Systemic lupus erythematosus, Primary biliary cirrhosis
rs3025343	9:136,478,355	A	8.44	0.00	Smoking behavior
rs7076156	10:64,415,184	A	26.52	8.74	Crohn's disease
rs12571093	10:70,019,371	A	16.35	14.86	Optic disc size
rs1834481	11:112,023,827	G	21.50	0.35	Interleukin-18 levels
rs11175593	12:40,601,940	T	1.98	3.32	Crohn's disease
rs75493593	17:6,945,087	T	1.85	12.06	Type-2 Diabetes
rs75418188	17:6,945,483	T	1.85	11.54	
rs117767867	17:6,946,330	T	1.85	11.54	

We identified alleles that are likely to have been introduced by Neanderthal gene flow (Supplementary Information section 10) and intersected these alleles with SNPs that have been shown to be associated with phenotypes (from the NHGRI GWAS catalogue¹⁹ as well from a recent GWAS for type 2 diabetes²⁰).

Remnants of Neanderthal DNA in modern humans are associated with genes affecting type 2 diabetes, Crohn's disease, lupus, biliary cirrhosis, and smoking behavior. They also concentrate in genes that influence skin and hair characteristics.

Enter the Denisovans...



Genetic history of an archaic hominin group from Denisova Cave in Siberia



ILLUSTRATION BY CHRISTINA MORRIS



What makes a modern human

PATCHWORK PLANET

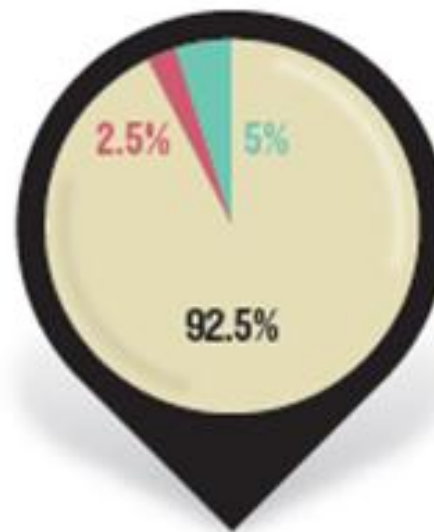
Most people's genomes contain remnants of archaic DNA from ancient interbreeding³⁻⁶.



Sub-Saharan Africa



Eurasia and Americas



Australia and New Guinea


Genes*

- African
- Unknown archaic African source
- Neanderthal
- Denisovan

*Figures are approximate, and for Africa, based on limited data⁶.

Early humans 1.5-1.8 Ma: 'Out of Africa 1'

Homo erectus



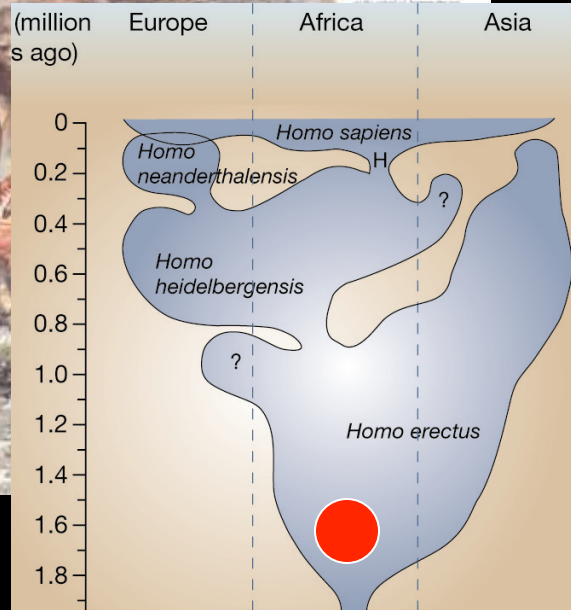
During the 19th century, a German biologist called Ernst Haeckel developed a series of hypothetical stages in human evolution, based on the belief that the gorilla represented the closest living approximation to our ancient ape ancestor. Haeckel believed that Darwin was wrong, and Asia, rather than Africa, was our ancestral homeland. He stated one of the hypothetical pre-human stages (Pithecanthropus alalus (Ape man without speech)), and argued that it would have lived in Southeast Asia. In 1865 a young Dutch doctor called Eugene Dubois decided to prove Haeckel right by finding actual evidence of the Pithecanthropus. He showed a drawing of an arm bone to the island of Java in the Dutch East Indies, and subsequently within two years, he had found hard evidence of a primitive stage in human evolution. His discovery included a thick brow and low skull cap, with a large brain ridge, and a very human-looking thigh. Interestingly, following Haeckel, he named his find

Pithecanthropus, but gave it a different species name because of the upright posture he inferred from the femur — *erectus*. We now know this species as *Homo erectus* ('Upright man'), because it is generally recognized that it is indeed human.

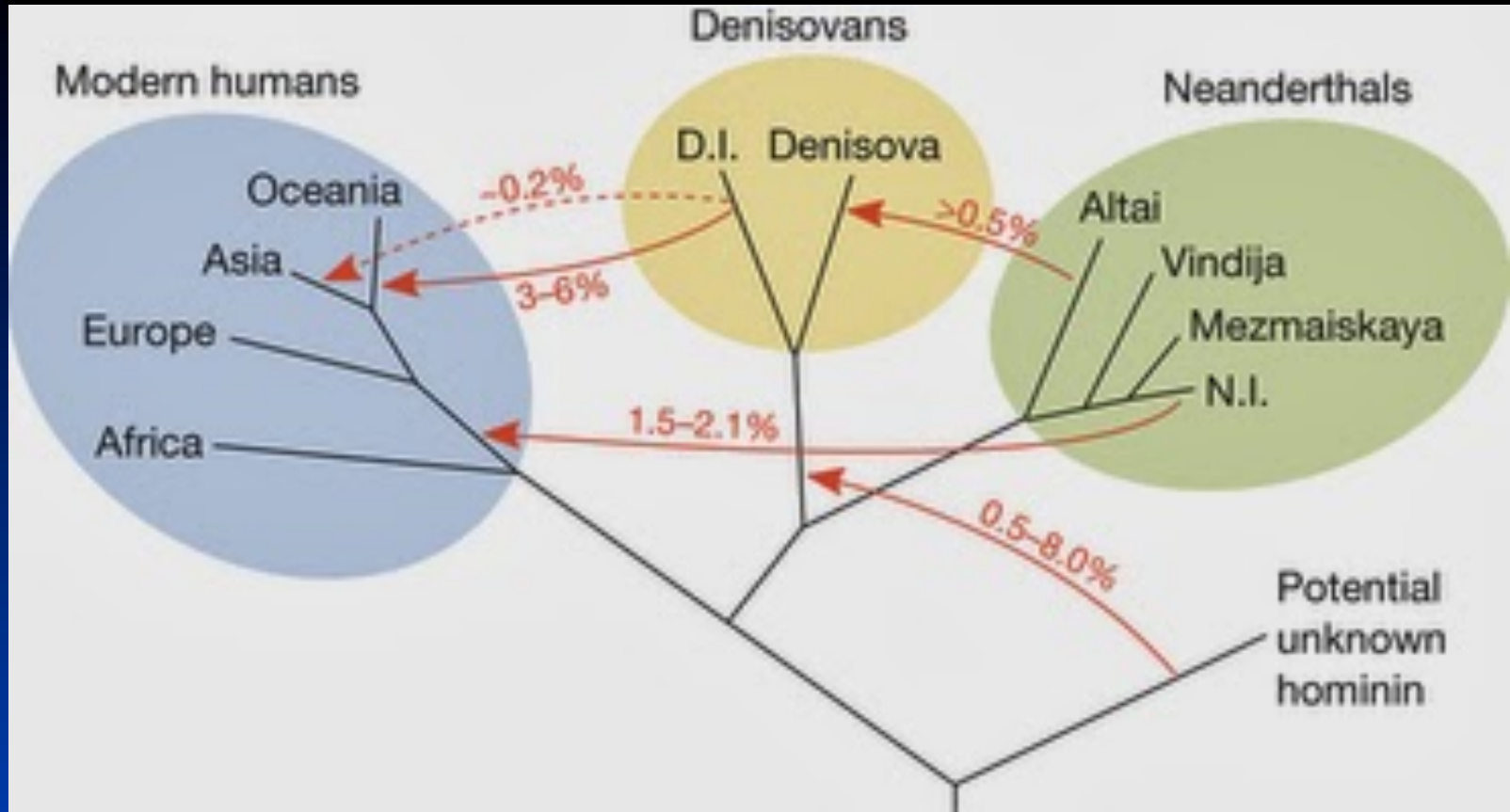
Java and China
By 1965 more than 2000 remains of this species had been found in Java, and in new regions such as China. There, the site of Zhoukoudian, near Beijing, produced numerous erectus fossils which were initially assigned to 'Sinanthropus pekinensis' (Chinese man of Peking), but which were later re-assigned with the fossils of Java. It is also interesting that the fossils of Java had been discovered with the fossils of 'Java Man' in the 1930s, but the characteristics of this species were not clear. The skull was relatively

Homo Erectus that lives Asia might resemble an ape more. Erectus had teeth like assigned to it, and the jaw bone. Erectus had teeth like modern chimpanzees and had similar characteristics to H. habilis/ergaster.

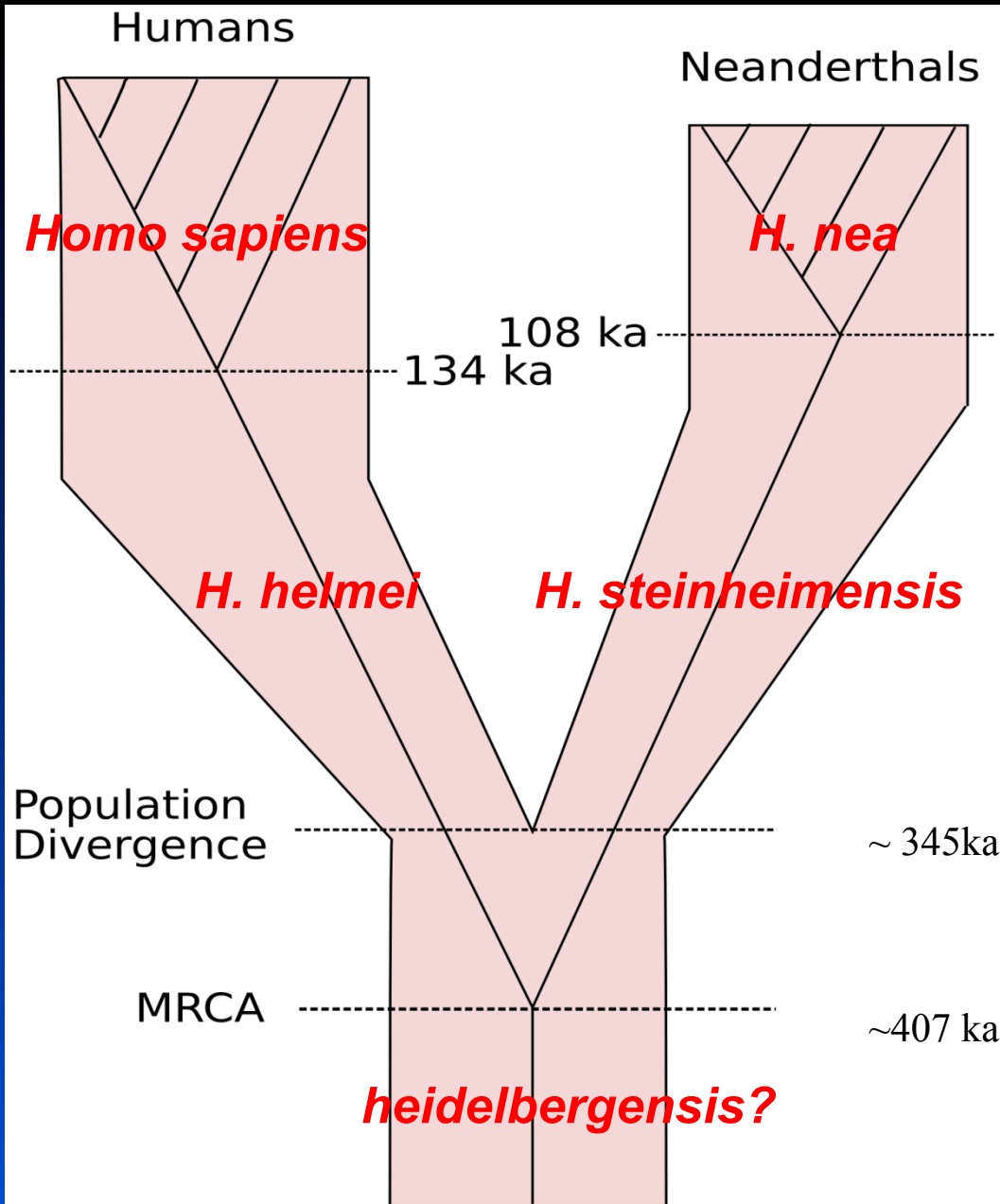
Homo Erectus is a member of the Hominidae family, a group including both of hominids and apes, and sharing many of the same traits. In the Hominidae group, humans are being shown as a member of the group that shares and shares equally, whether both the other and had. More research has and still the Hominidae.



Ancient interbreeding: common but at a low level?

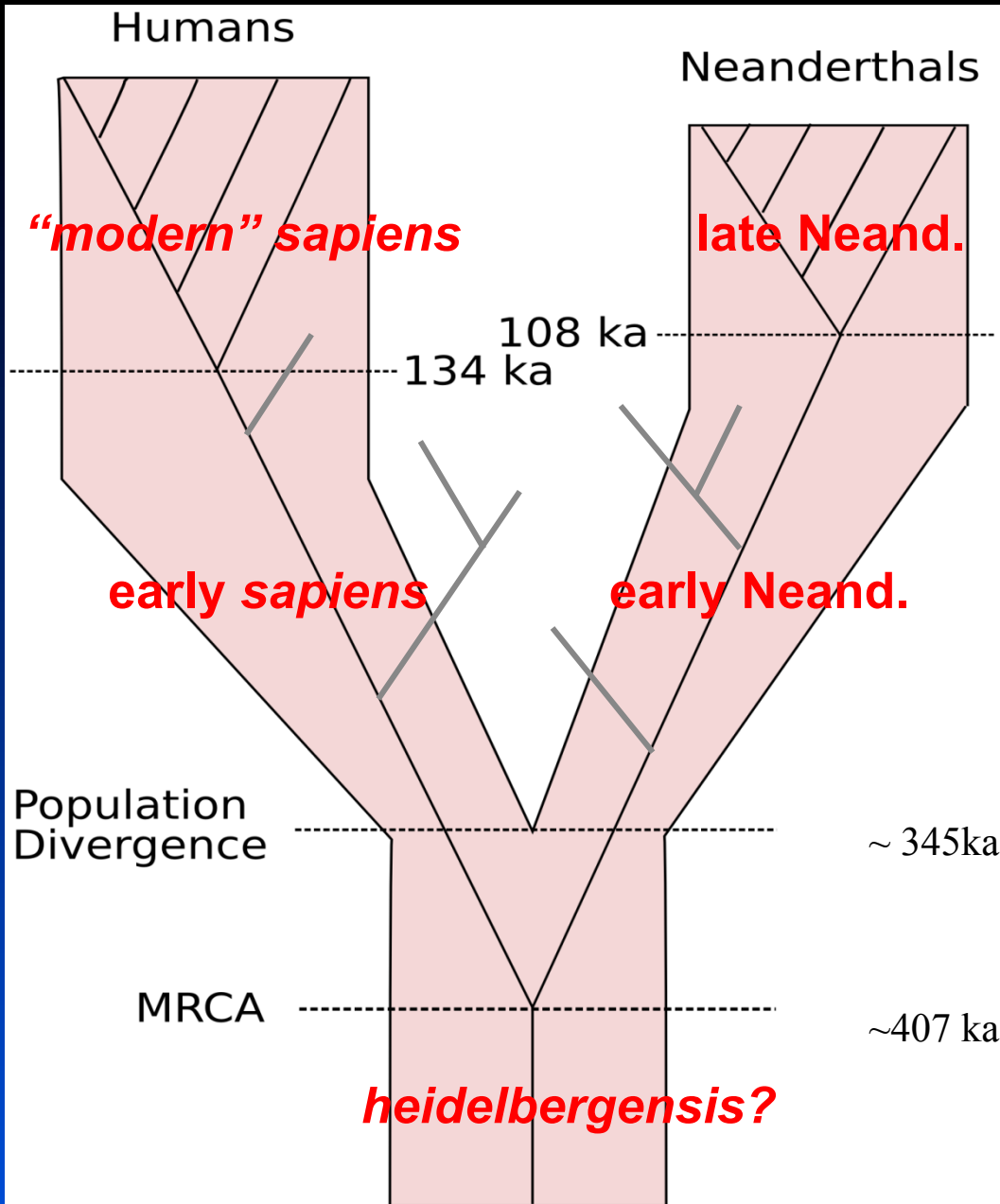


Latest genetic calibration (5 complete Nea, 54 complete modern mtDNA sequences)



The Neanderthal and modern humans lines began to split about 400,000 years ago

Latest genetic calibration (5 complete Nea, 54 complete modern mtDNA sequences)



The Neanderthal and modern humans lines began to split about 400,000 years ago

Variation in the European Middle Pleistocene MIS 7-11: *heidelbergensis* vs *neanderthalensis*?

Bilz 9 or 11?



Swanscombe 11

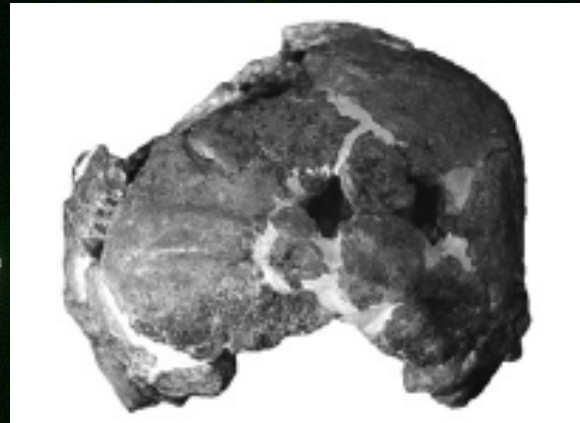


Petralona 7-15?

Grün 1995: an age of
150–250 ka for the
speleothems bracketing
the cranium.

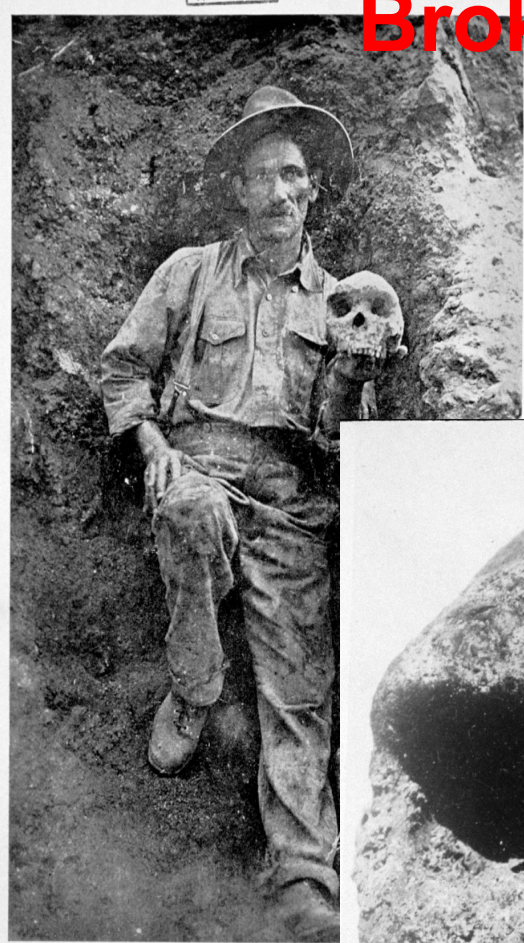


Vertsz 7 or 9?

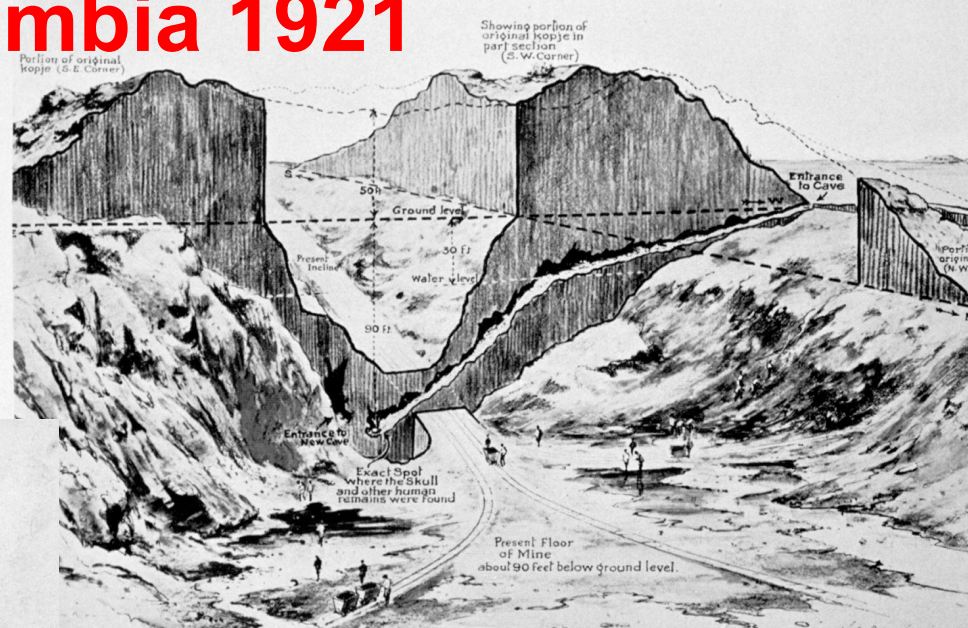
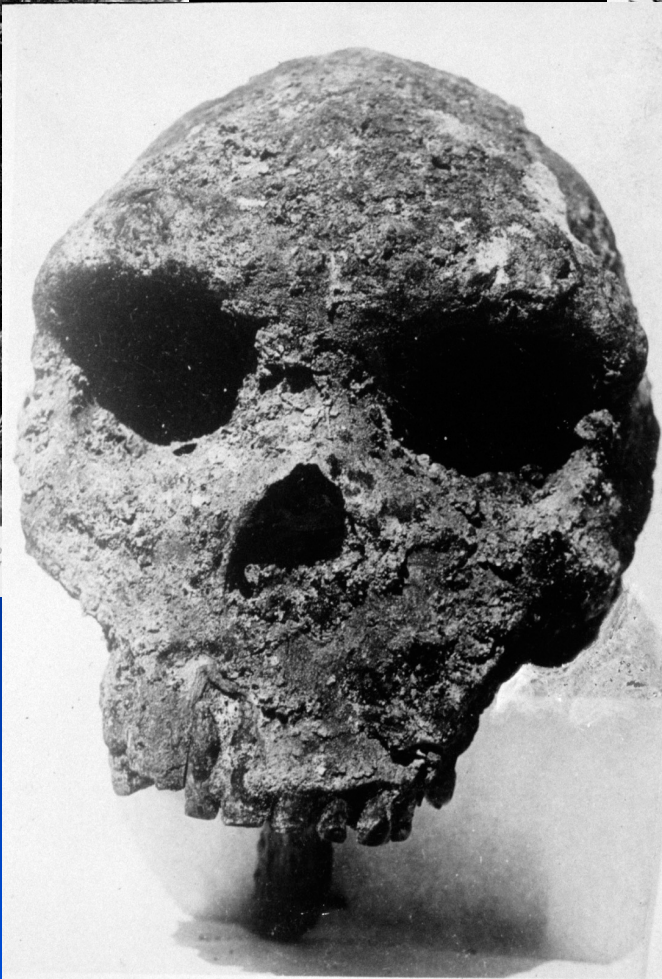


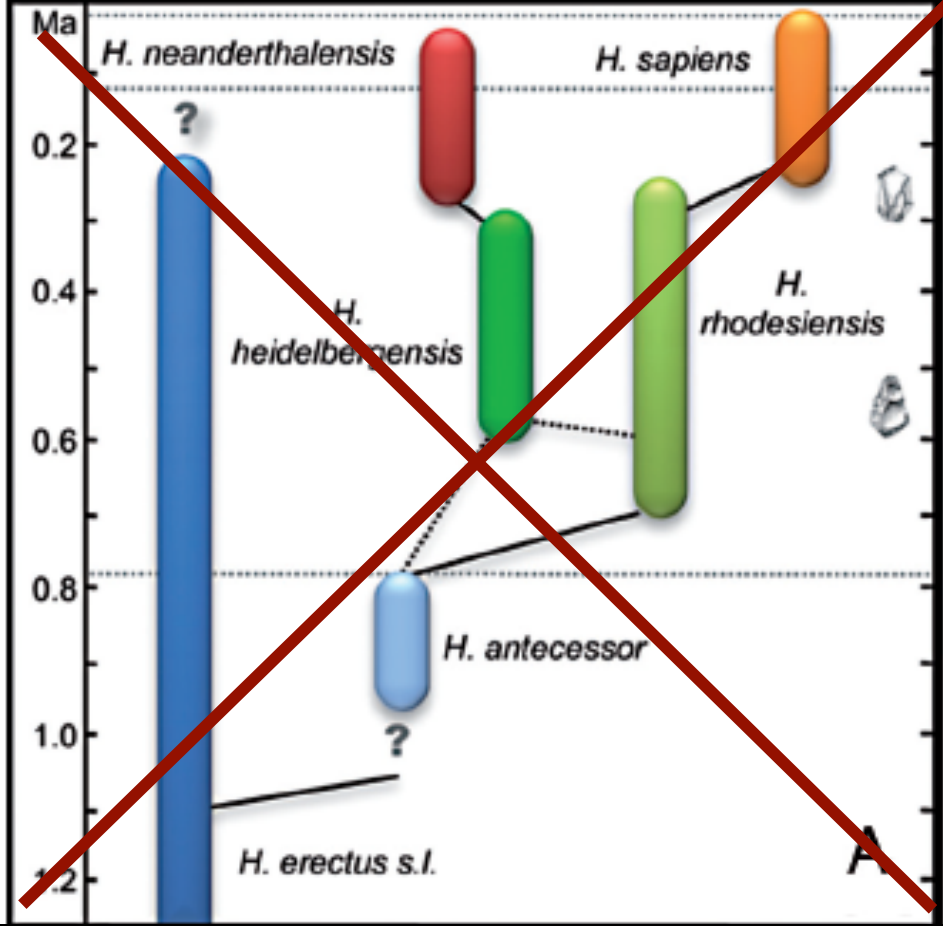
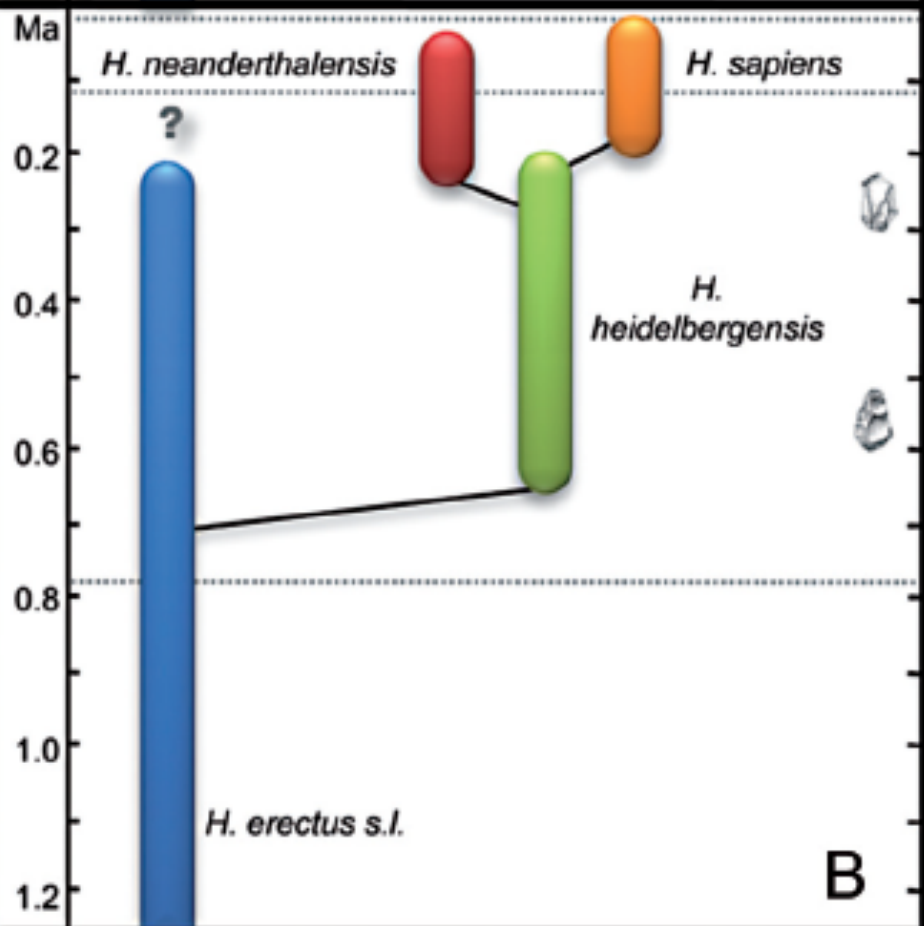
Ceprano 11?

Broken Hill, Zambia 1921



Mr. Zwigelaar, the discoverer of the Rhodesian skull, shown with the skull. (Photograph given Hrdlička by Mr. Zwigelaar.)





heidelbergensis: Broken Hill

enamel frag right M2

os coxa E 719

proximal femur E 907

femoral midshaft EM 793

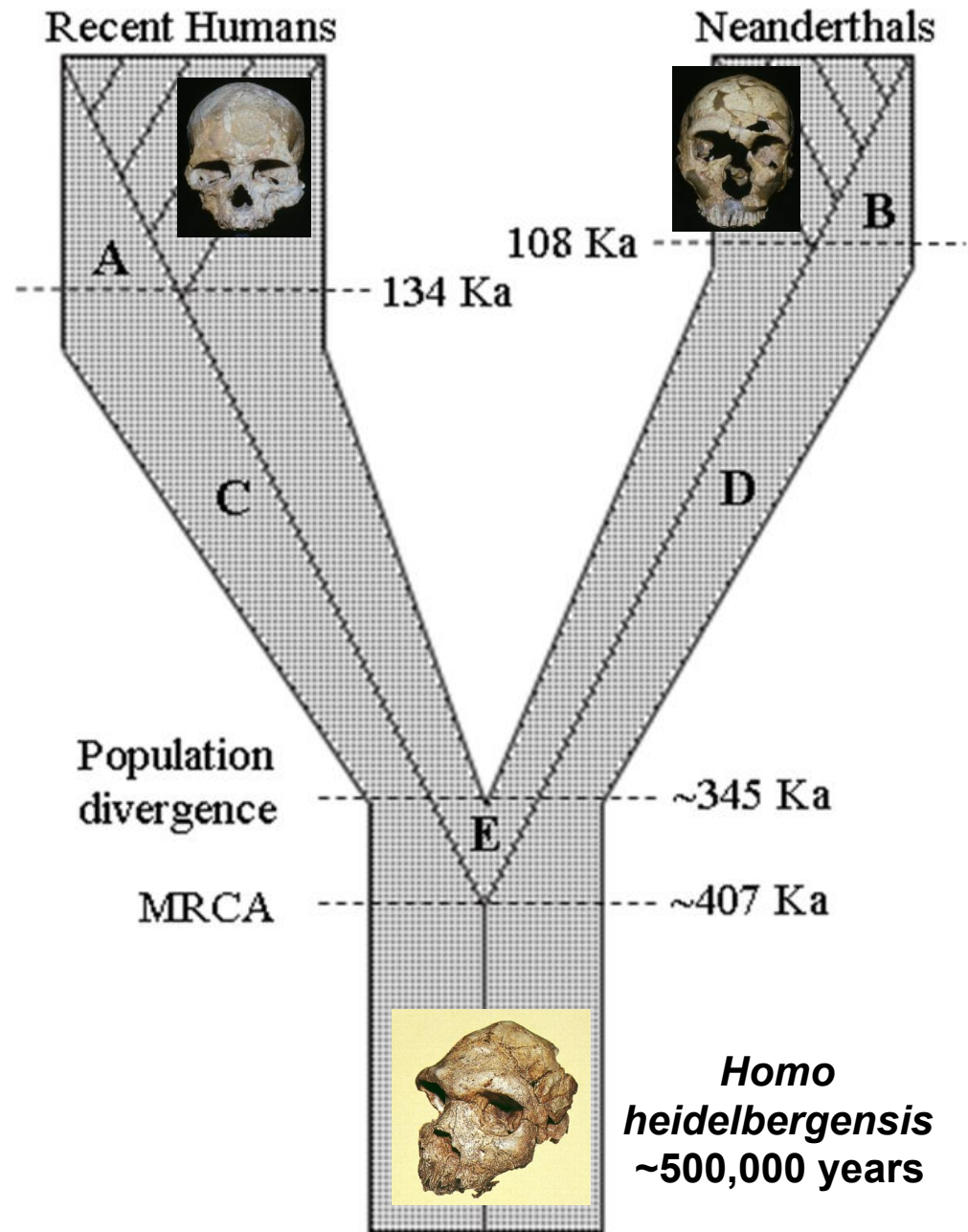
mineralised silty 'skin'

Samples
ESR and/or
U-S
dated

Results range
from 175-300ka:
analyses
ongoing....



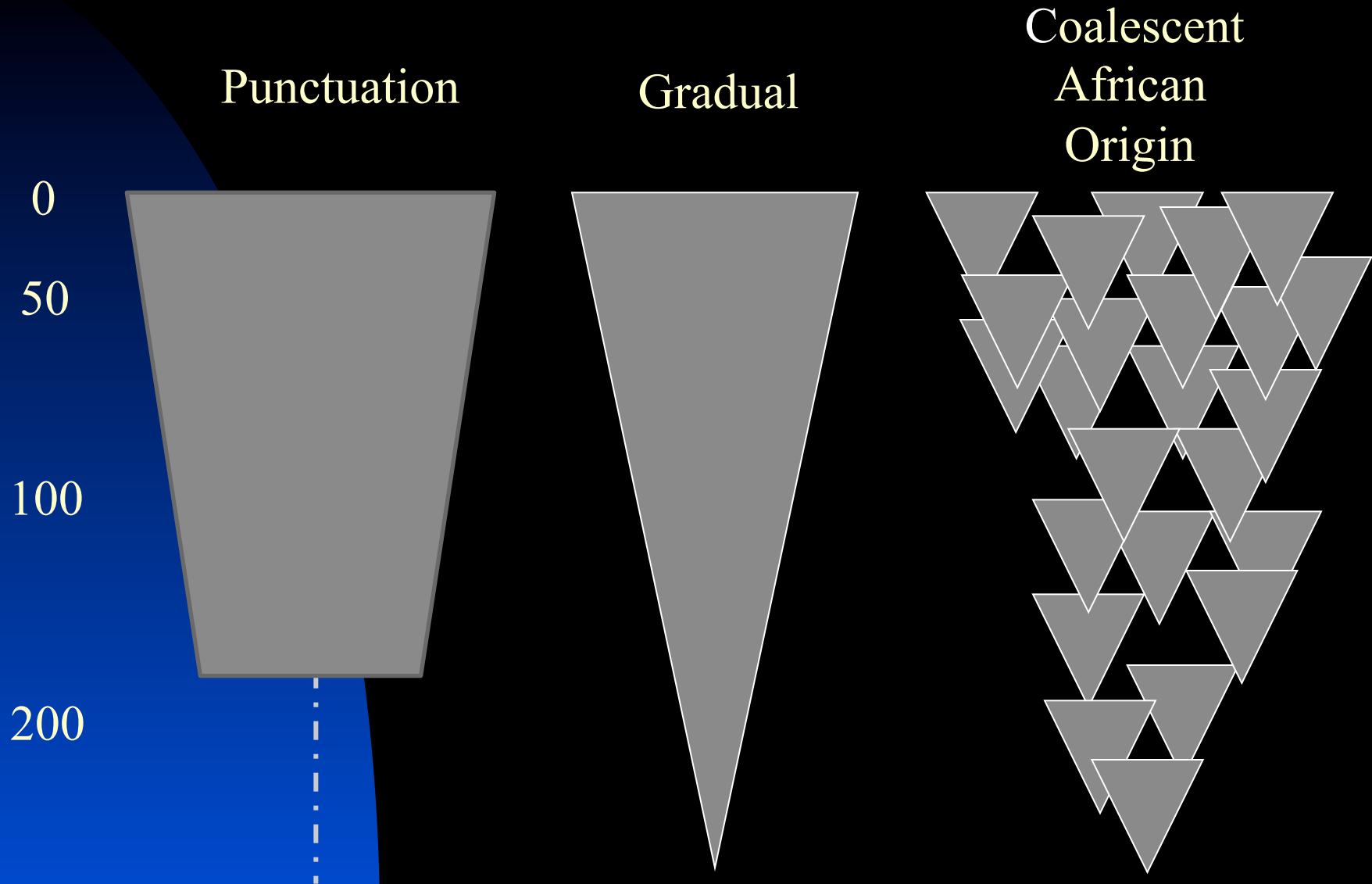
The evolution of Modern Humans and Neanderthals (based on fossil and genetic data)

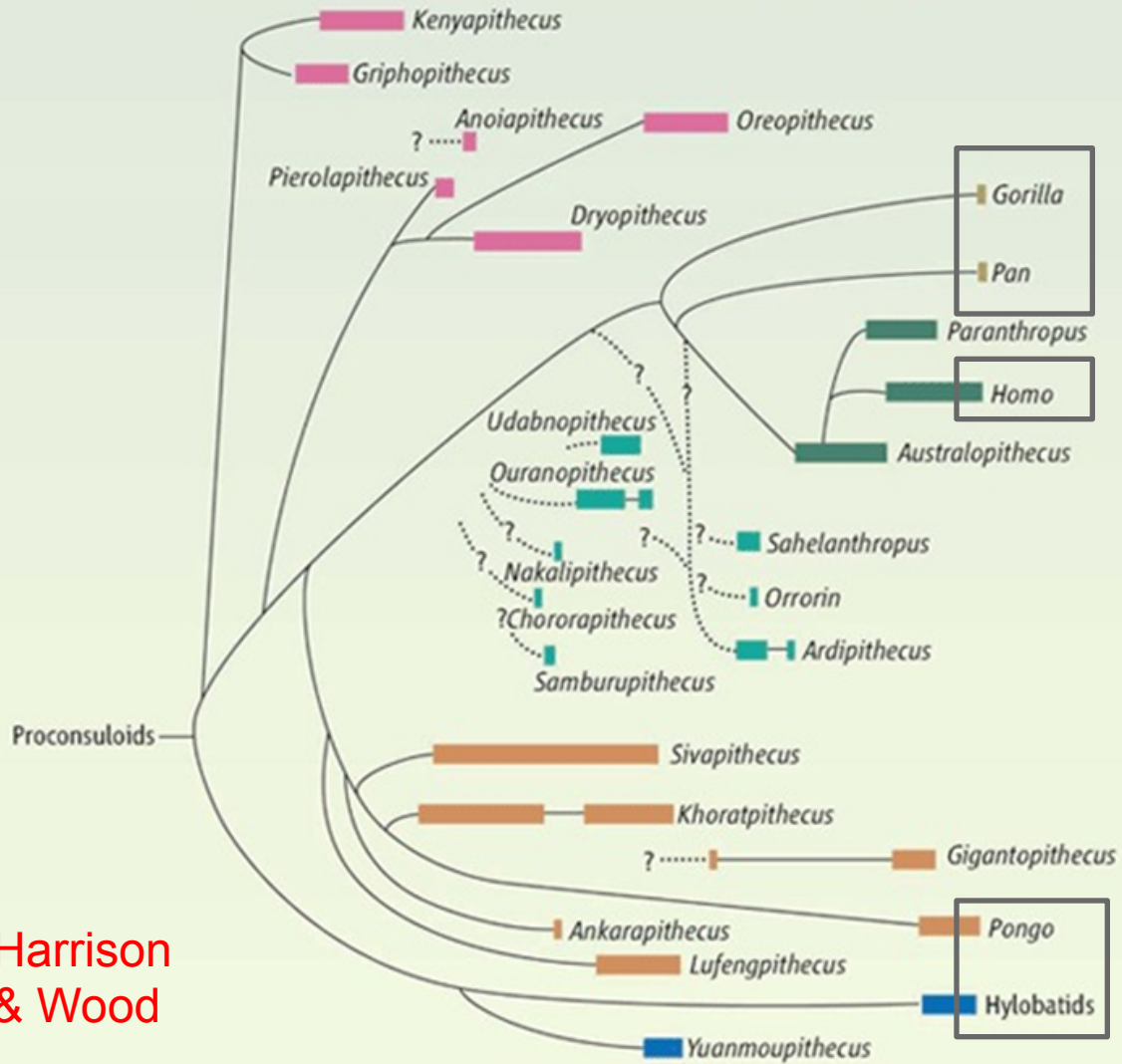


Neanderthals and Us



Patterns of Physical and Behavioural Evolution?

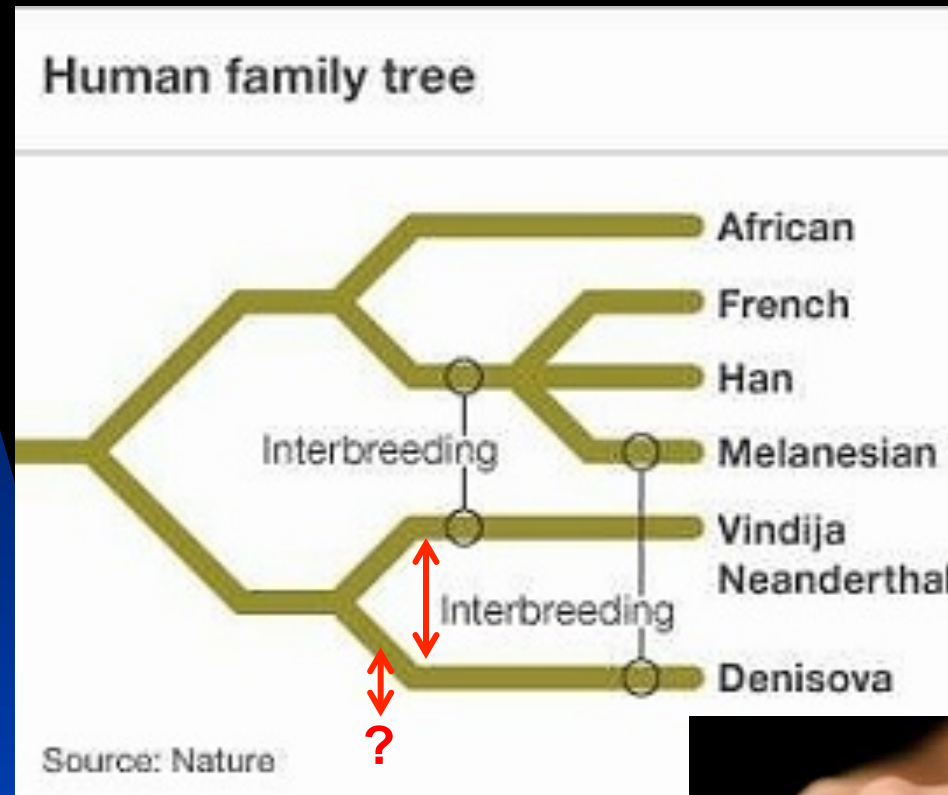




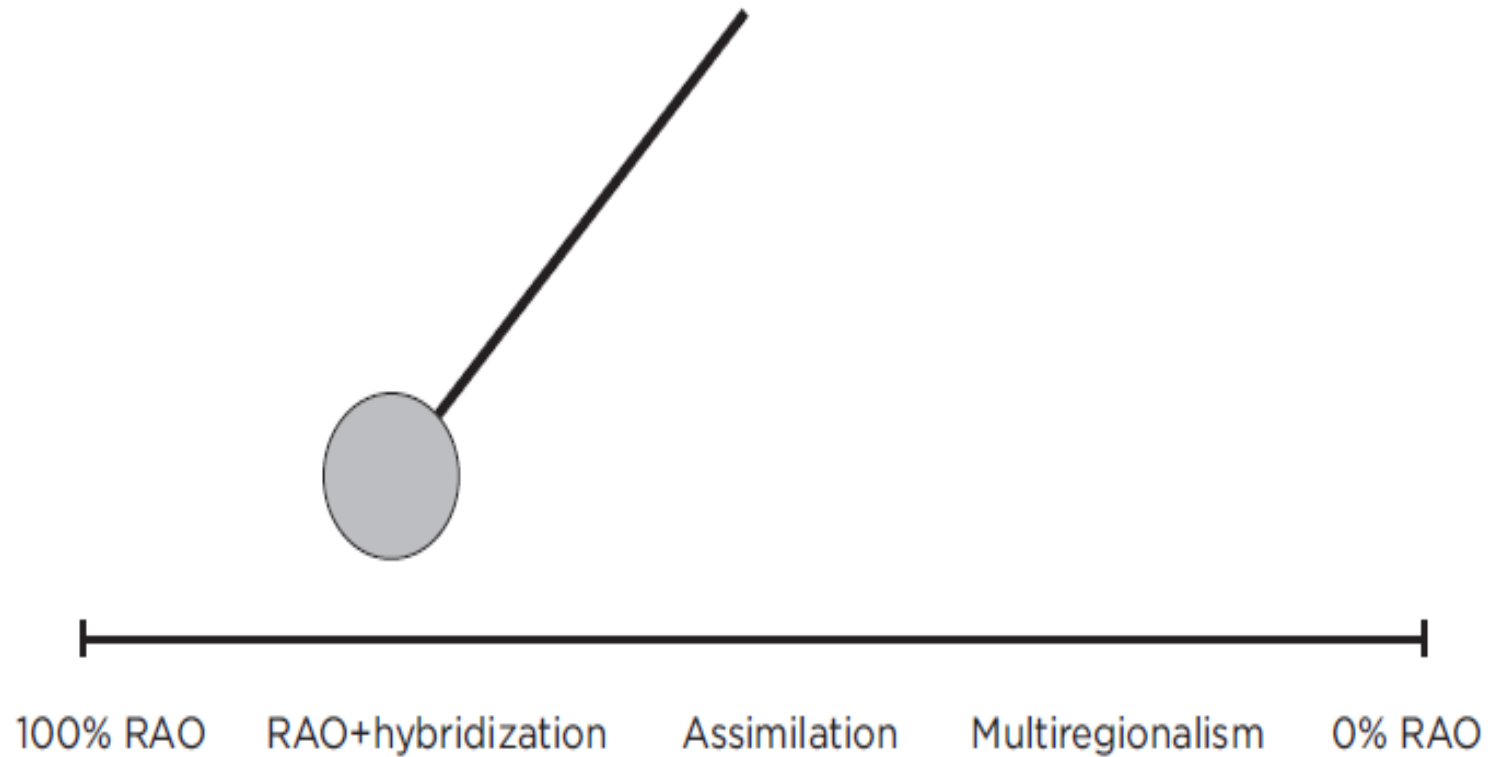
- Stem hominids
- Hominins
- Pongines
- Extant African great apes
- Stem hominines or stem hominins
- Hylobatids

Harrison
& Wood

Genetic history of an archaic hominin group from Denisova Cave in Siberia



Models of modern human origins



1984

1970

New techniques of investigation

Scanning and morphometrics

New Techniques for Studying Fossils

Scientists investigating fossil remains have an ever-growing battery of techniques to help them study their finds in greater detail. They can now potentially directly date a fossil using a range of techniques (see pp. 30-33). These include radiocarbon dating if the specimen is probably no older than about 50,000 years, uranium series dating by placing it in a gamma ray source, or electron spin resonance (ESR) dating by using a fragment of its tooth enamel. Computers have allowed the compilation and rapid analysis of large quantities of data obtained from fossils. The slow and methodical use of traditional metal measuring instruments, similar to engineering calipers, is now giving way to the rapid recording of data by electronic, sonic or laser light sensors, which can relate points on surfaces very precisely in three dimensions, and insert them directly into computers for recall. The resulting network of points can essentially reconstruct the shape of the object, such as a fossil skull, and compare it on screen

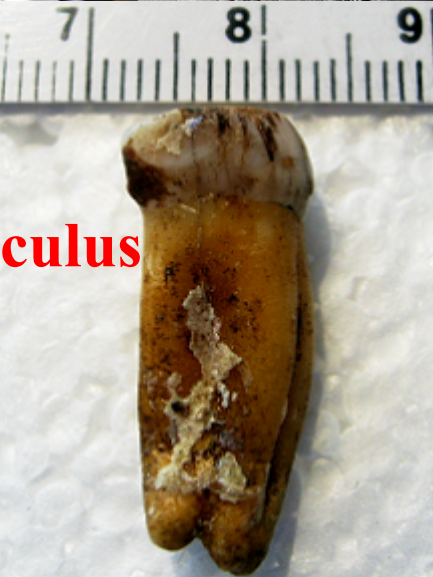
with others. Morphing techniques can be used to illustrate the amount of change in shape required to vary, involve one specimen into another, or to grow a series of specimens through their life cycle.

Scanning fossils

Once the techniques of X-raying or radiographing objects became widespread, hidden internal information about fossils could be studied for the first time - for example, the shape of sinus chambers within skulls, or the form of tooth roots within jawbones. Now, a powerful new X-ray technique has become available from medicine, called computerized tomography. The resultant images are called CT scans, and these can be processed on computer systems, printed, or even transformed into solid replicas by a technique called stereolithography. They are providing unprecedentedly detailed internal images of fossils, and the images can be manipulated to 'remove' rock that is still obscuring a fossil, or to reconstruct an incomplete fossil.

For example, in 1976, Neanderthal fossil remains were found in Gibraltar, at a site called Devil's Tower. They consisted of parts of the upper and lower jaws and braincase of a child. The teeth of the child matched those of a modern five-year-old of their stage of development. However, the original assumption that they represented a single child about five was challenged in 1982 by the suggestion that these bones might represent the remains of two

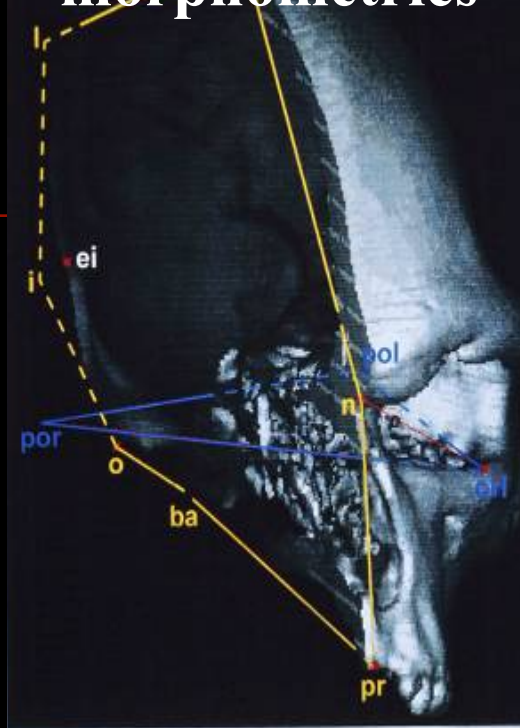
SEM, MicroCT, Synchrotron



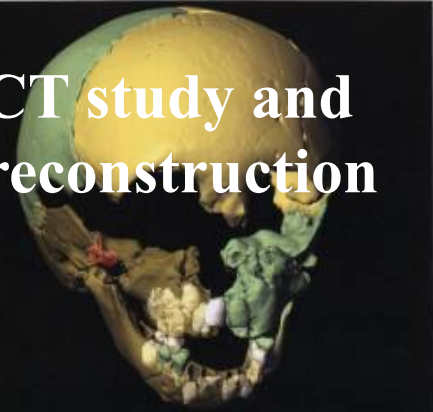
Calculus

In 1976, the bones of a child's skull were excavated from deposits below the surface of the rock of Gibraltar near Devil's Tower. They were recognized as a very good example of a young Neanderthal. Later research raised the possibility that the bones of two children of different maturity had been mixed up. However, attached slabs of the lower and the teeth within the jaws suggested that they all came from a child aged about 4 years of age. This was further confirmed when computerized tomography (CT) was used to reconstruct the whole skull, showing that the lower and upper jaws

been involved in the 1976 Prince Neanderthal skull, as a basis on which to reconstruct the child's anatomy. Using moulding clay, marks, set and also can show the full up over the skull before right. For some Neanderthal skulls are available from a separate occasion, but the others, such as the shape of the nose and lips, and the colour of the skin and eye, indicated passage must be used. Unless a sketch of reconstruction gives us a Neanderthal head to see in a past age, some of the details will remain constant. However, the relative depth of hair can and the lines through the detailed reconstruction to life.

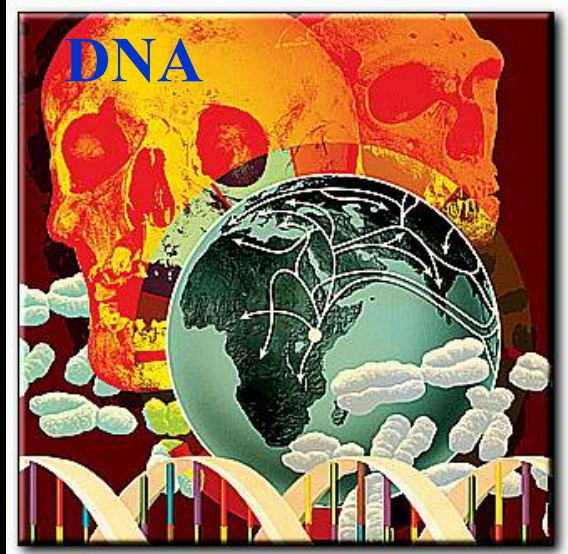
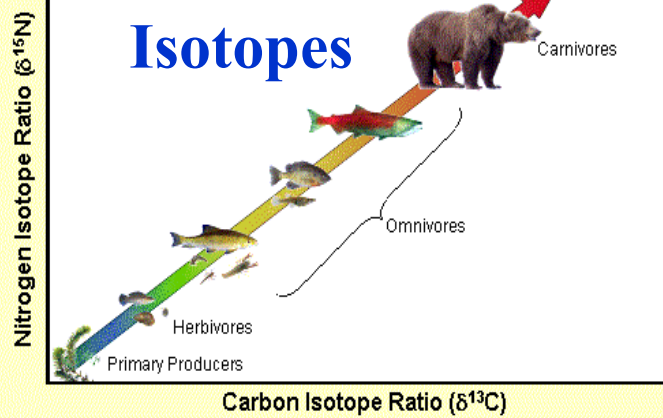


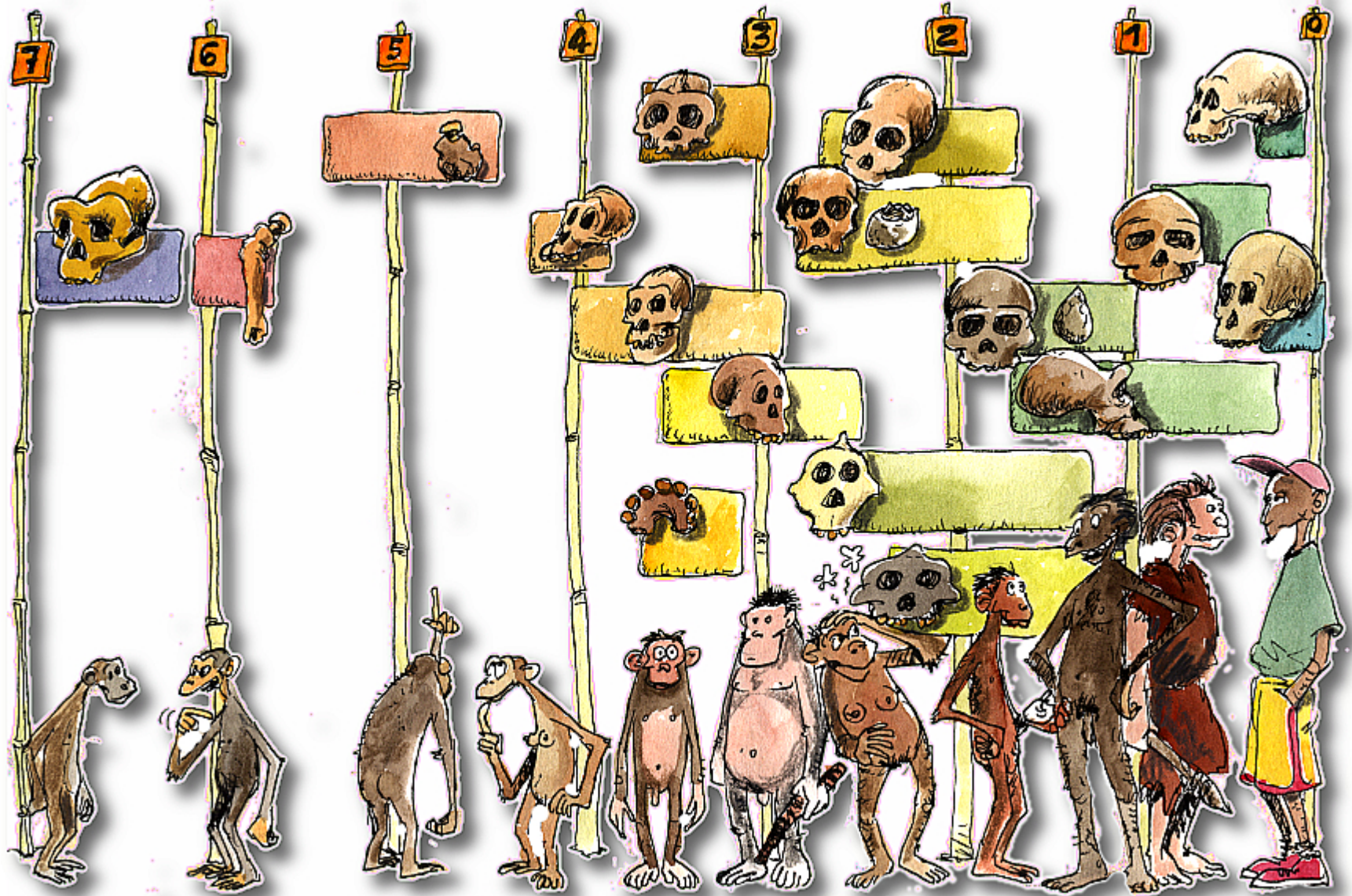
CT study and reconstruction

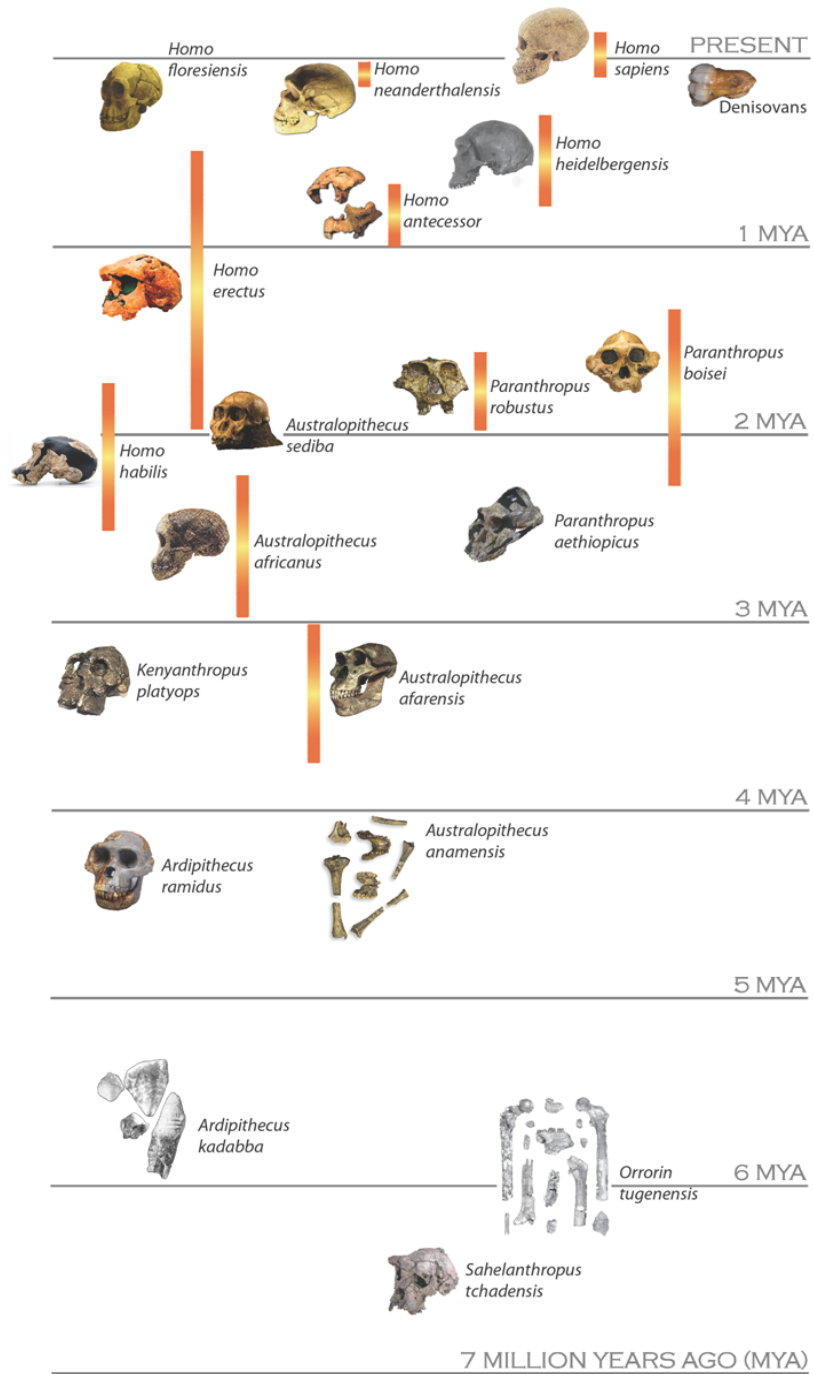


Direct dating

~259 ka



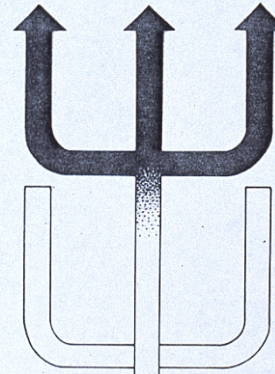




7 MILLION YEARS AGO (MYA)

How did modern humans evolve? Models of the 1990s

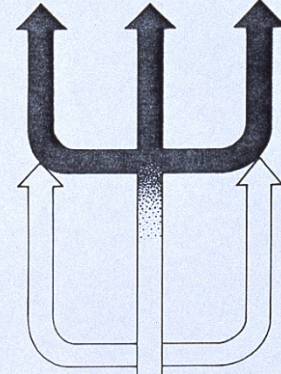
EUROPE AFRICA ASIA



a

Recent African Origin

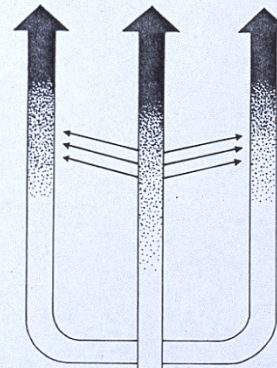
EUROPE AFRICA ASIA



b

RAO+hybridization

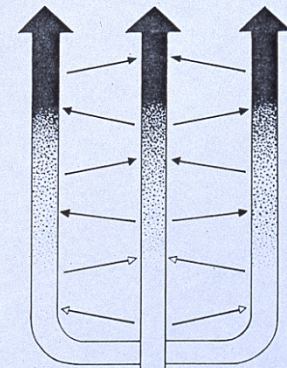
EUROPE AFRICA ASIA



c

Assimilation

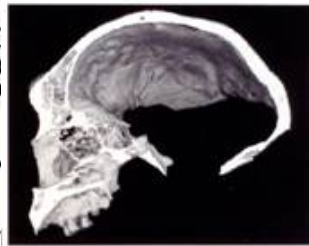
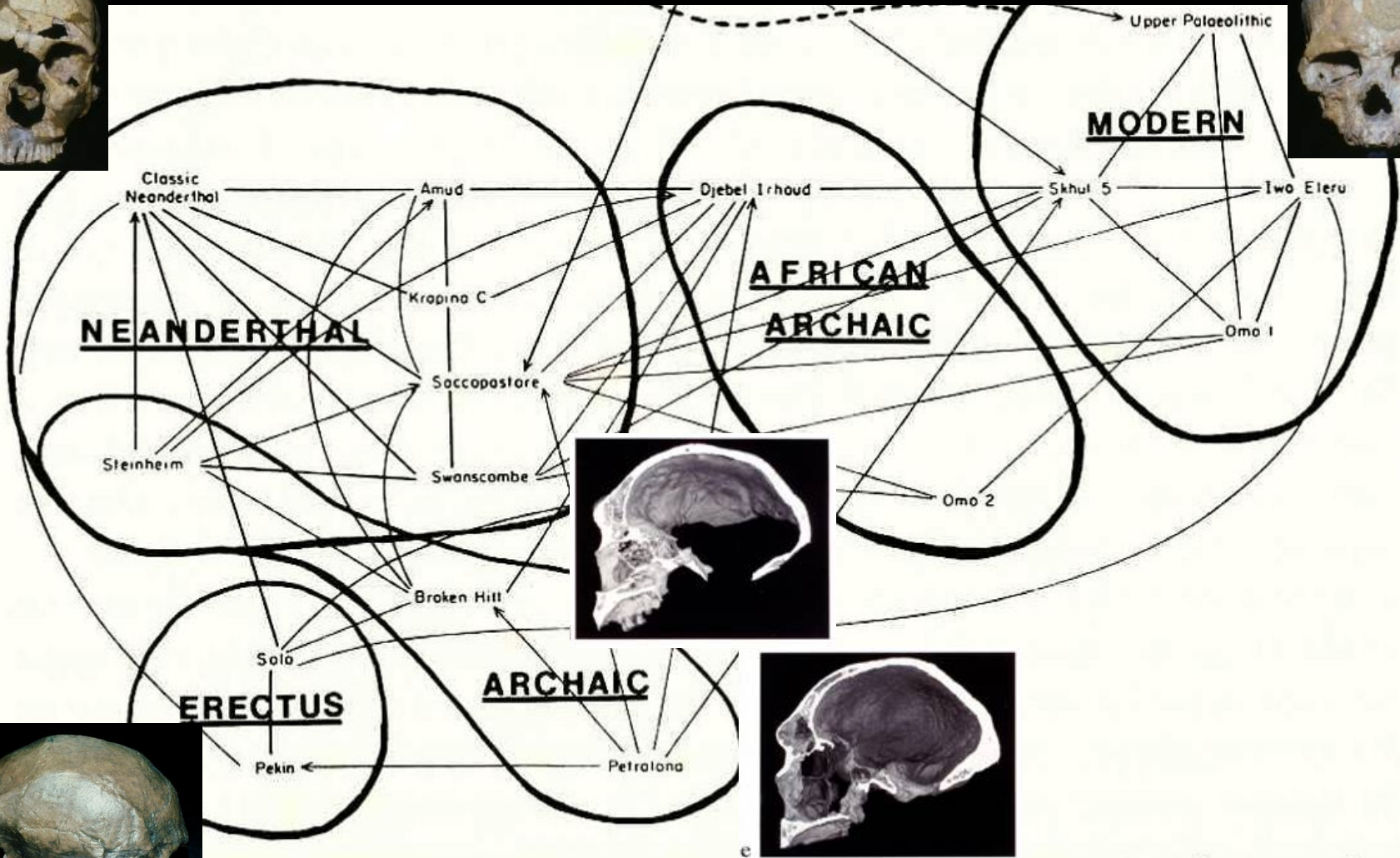
EUROPE AFRICA ASIA

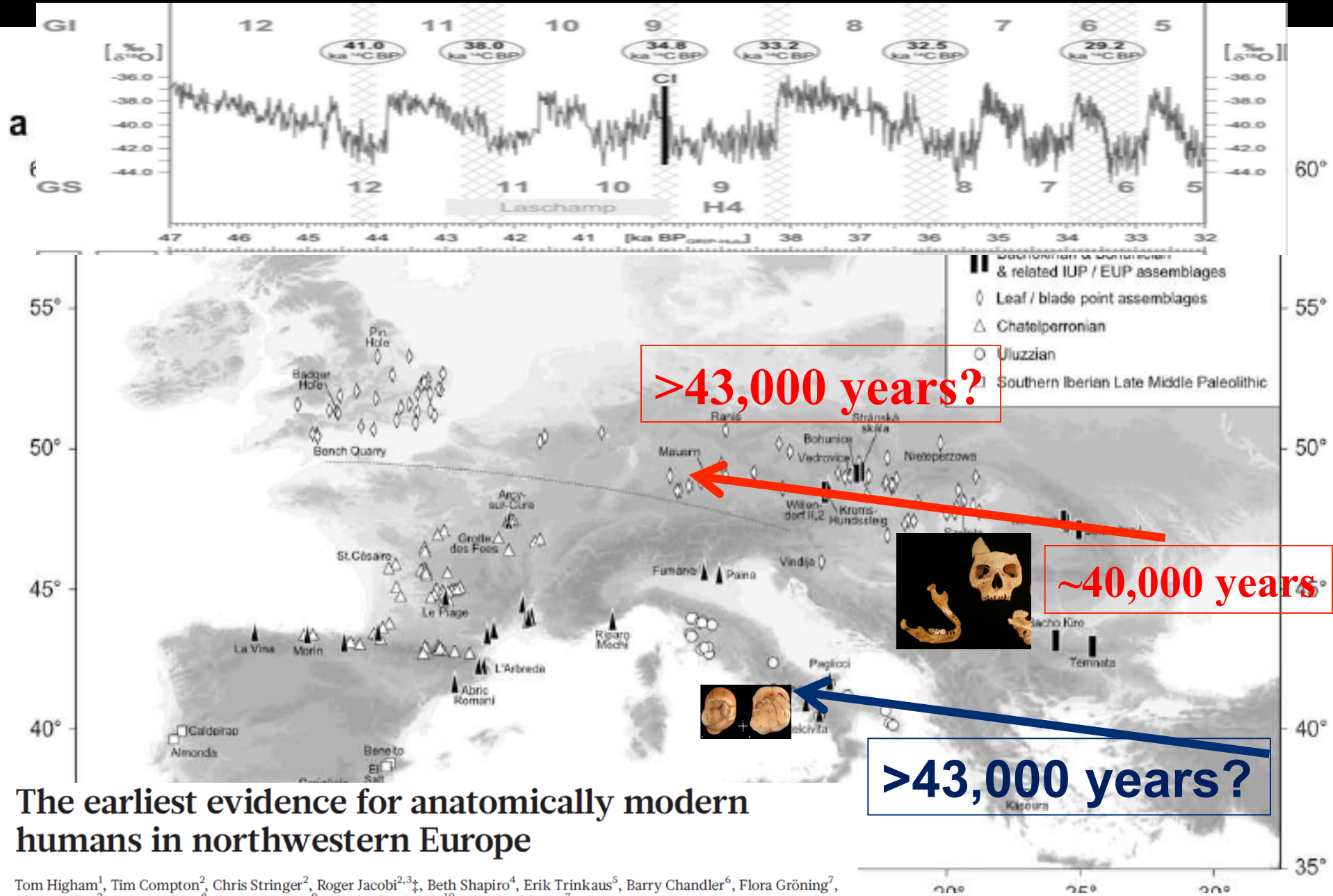


d

Multiregionalism

Stringer 1974: cranial metrics suggest Neanderthals are not good ancestors for modern humans



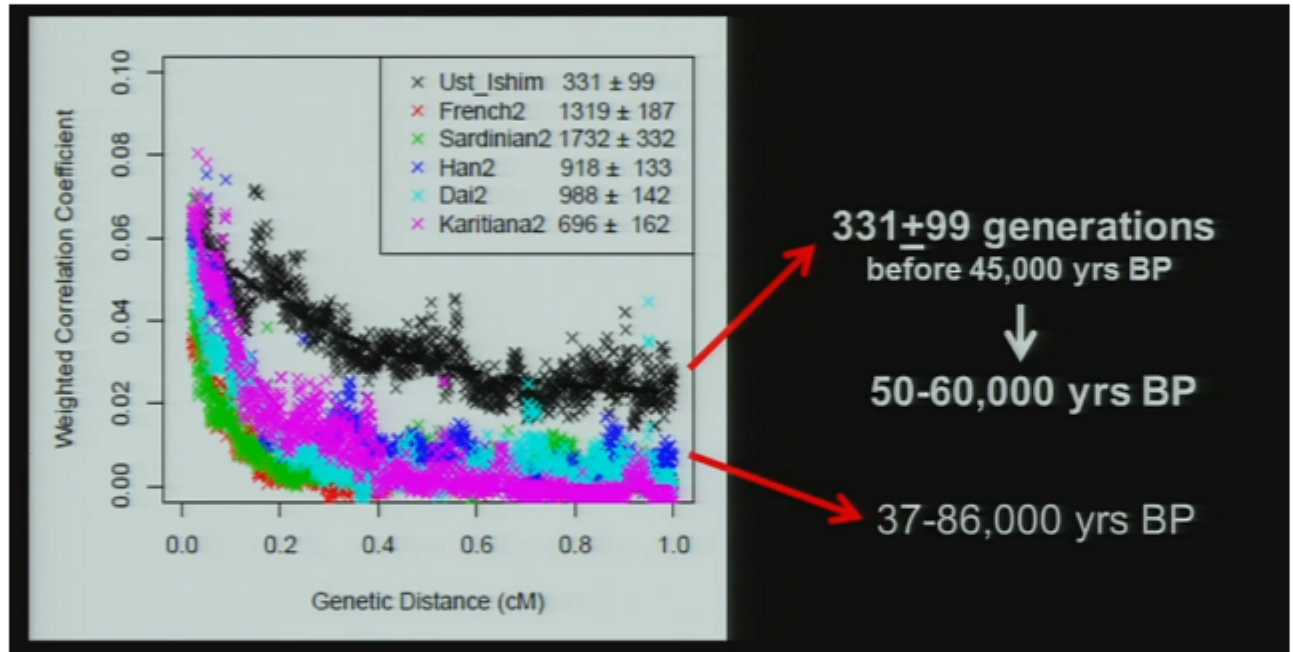


The earliest evidence for anatomically modern humans in northwestern Europe

Early dispersal of modern humans in Europe and implications for Neanderthal behaviour

Stefano Benazzi¹, Katerina Douka², Cinzia Fornai¹, Catherine C. Bauer³, Ottmar Kullmer⁴, Jiří Svoboda^{5,6}, Ildikó Pap⁷, et al.

Ust-Ishim femur DNA constrains time of Nea-modern interbreeding



According to Dr. Paabo, Ust-Ishim has longer Neandertal chunks than modern humans and this can be used to estimate that the admixture with Neandertals happened 331±99 generations before its time of 45,000y BP, or around 50-60,000y BP.

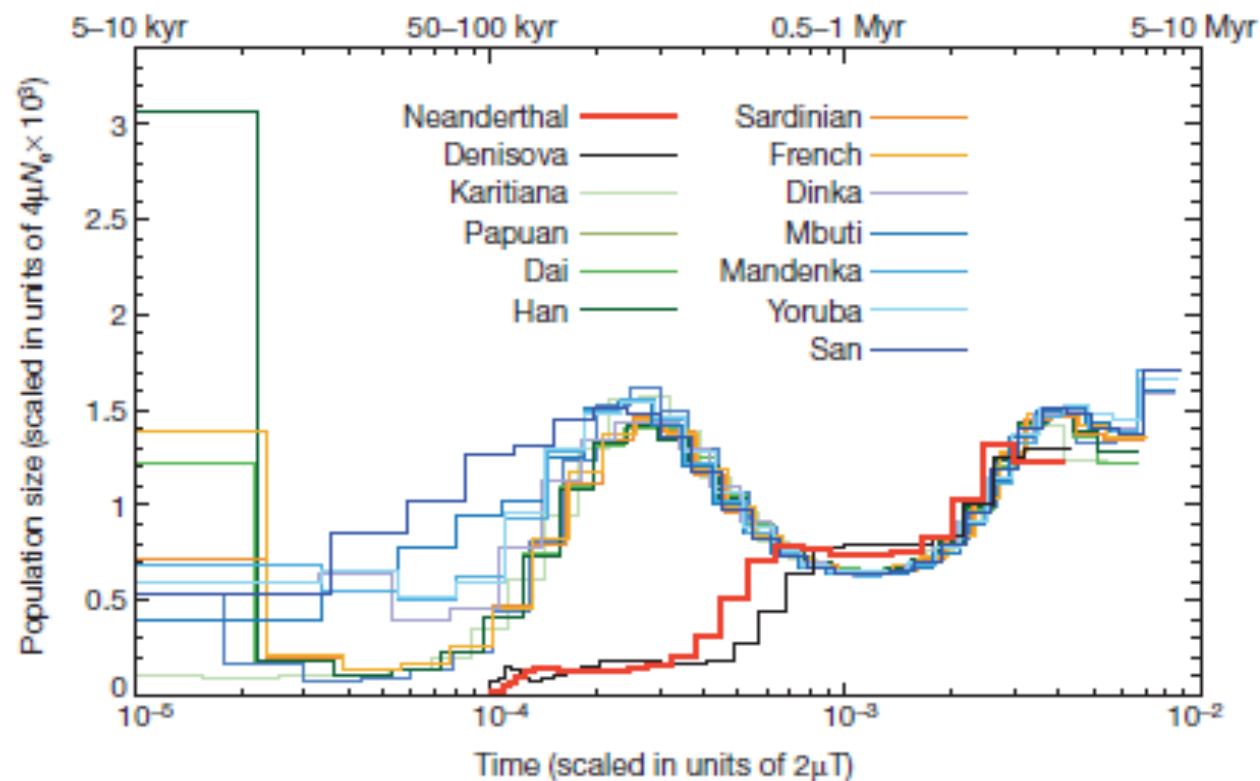
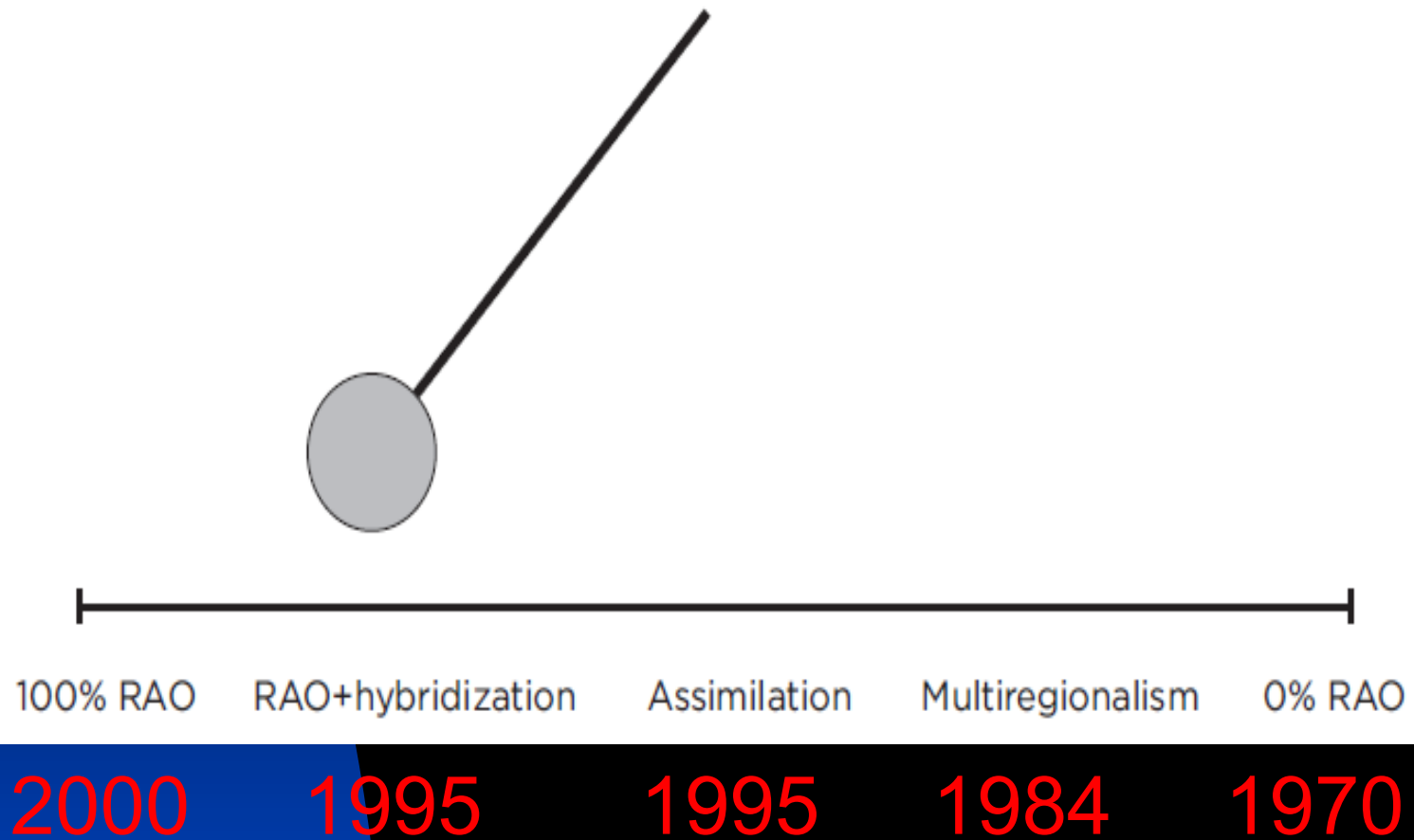


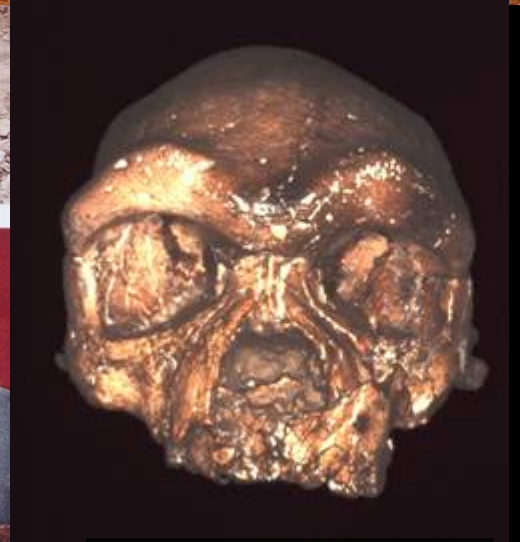
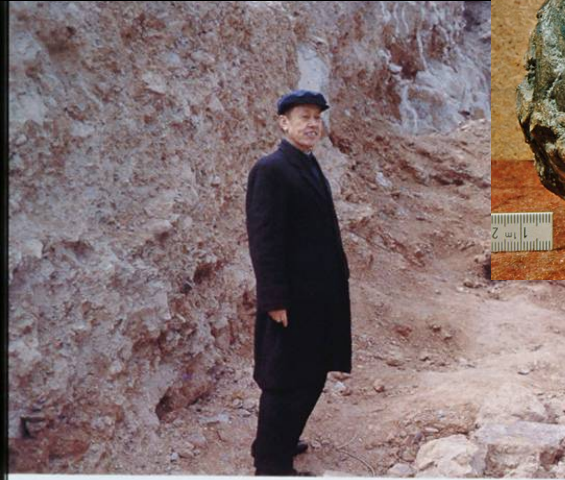
Figure 4 | Inference of population size change over time. The y axis specifies a number proportional to the population size N_e . The x axis specifies time in units of divergence per base pair (along the top in years for mutation rates of 0.5×10^{-9} to 1.0×10^{-9} per site per year). The analysis assumes that the Neanderthal and Denisova remains are of the same age, whereas archaeological evidence and the branch shortening indicate that the Neanderthal bone is older than the Denisovan bone. However, because the exact difference in ages is not known, it is not possible to determine whether the reduction in population size experienced by both archaic groups (but not by modern humans) coincided in time.

It is thus clear that the demographic histories of both archaic populations differ substantially from that of present-day humans.

The pendulum starts swinging...



The Asian story...



El mapa de los yacimientos

REGISTRO CRONOLÓGICO PRINCIPALES HALLAZGOS

VISTA AÉREA

GALERÍA

ENTRE 400.000 Y 200.000 AÑOS

'Homo heidelbergensis' y herramientas de Modo 2 (Achelense).

GRAN DOLINA

ENTRE 1.000.000 Y 200.000 AÑOS

Principales restos de 'Homo antecessor'. Huesos de grandes carnívoros

TRINCHERA DEL FERROCARRIL

Los yacimientos afloraron durante la construcción de una línea de ferrocarril (1896-1901) hoy abandonada

HALLAZGO DE LA MANDÍBULA

SIMA DEL ELEFANTE

ENTRE 1,3 MILLONES Y 150.000 AÑOS

Lascas de Modo 1 (Olduvayense)

SIMA DE LOS HUESOS

400.000 AÑOS

'Homo heidelbergensis'. Es el yacimiento más rico en fósiles humanos

PORTALÓN

3.000 AÑOS (EDAD DEL BRONCE)

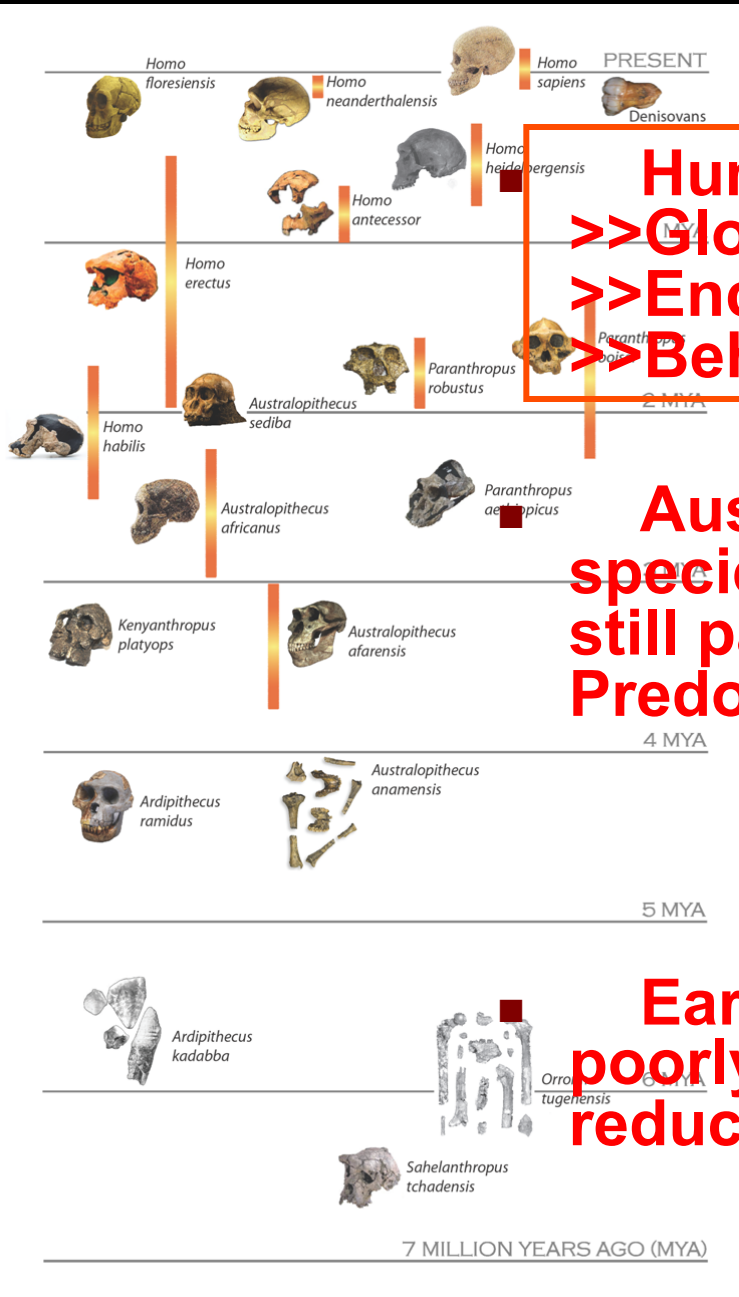
Adornos de hueso y marfil

0 50M

Atapuerca



“Phases” of human evolution



Human phase 2 – 0 Ma: several species
>> Global spread, “Human” anatomy
>> Encephalised >> Dietary range
>> Behavioural complexity

Australopithecine phase 4 – 2 Ma: Many species, widespread in Africa. Bipedal but still partly arboreal? Early tool-use? Predom. still ape-like?

Early phase 7 – 4 Ma: C+E. Africa. Still poorly known. Earliest bipeds? Canines reduced. Largely ape-like?

7 MILLION YEARS AGO (MYA)

Neanderthals and “Hobbit” extinct
Homo sapiens “Out of Africa 2”

Homo sapiens in Africa
Early Neanderthals in Europe

Homo heidelbergensis appears
Changes in glacial intensity

First humans in N. Europe/Britain?

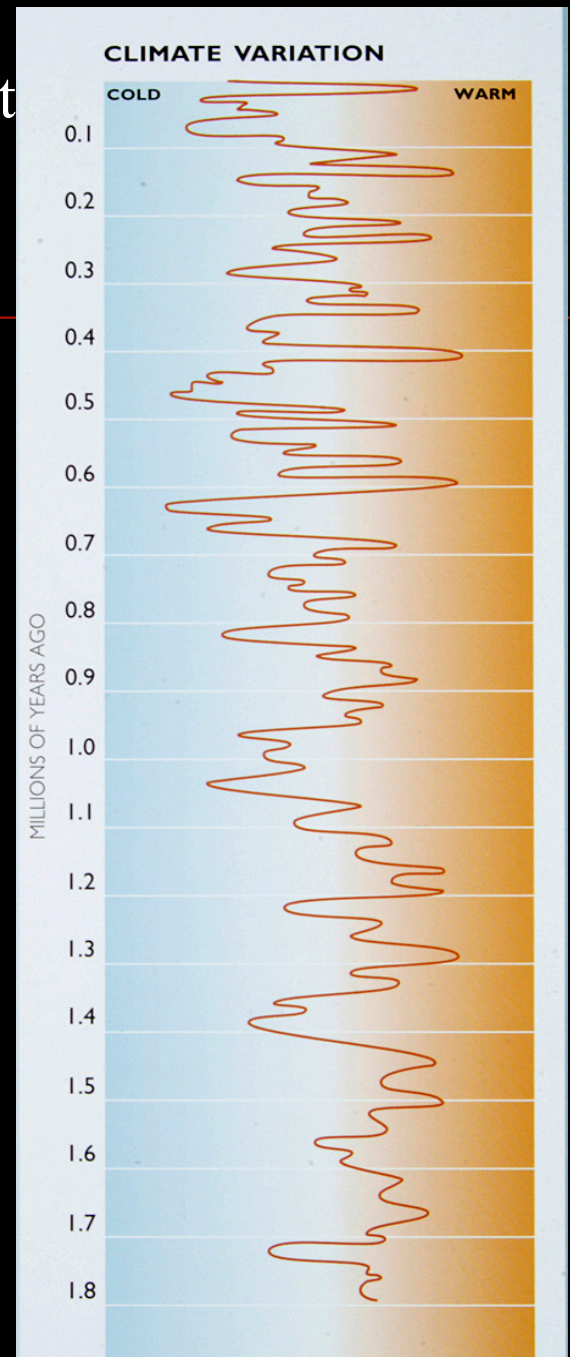
Some “recent” events in human evolution

First humans in S. Europe?

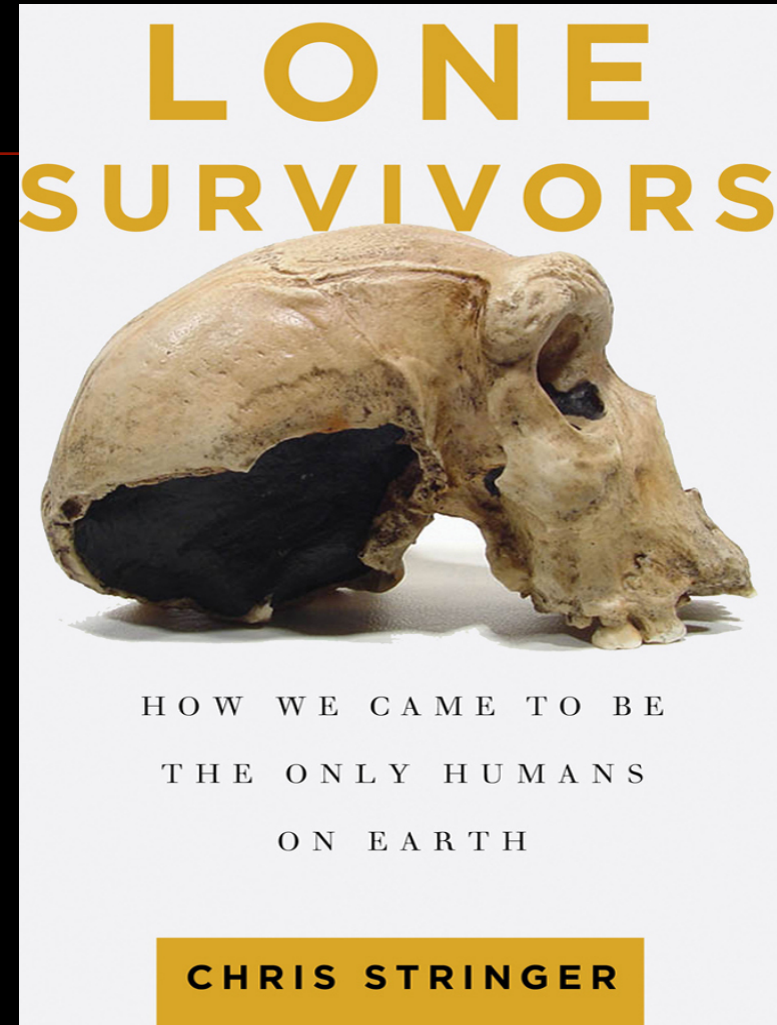
Homo erectus in Java & China

‘Out of Africa 1’?

Homo erectus in Africa



The Origin of our Species



Chris Stringer, The Natural History Museum London

The Enigma of the Handaxe

Africa 1.5Ma



Britain 0.4Ma



If they were talking to each other, they were saying the same thing, over and over and over...

Desmond Clark

Today innovations spread and take hold.....

NOKIA
Connecting People

Know our past. Create the future...

