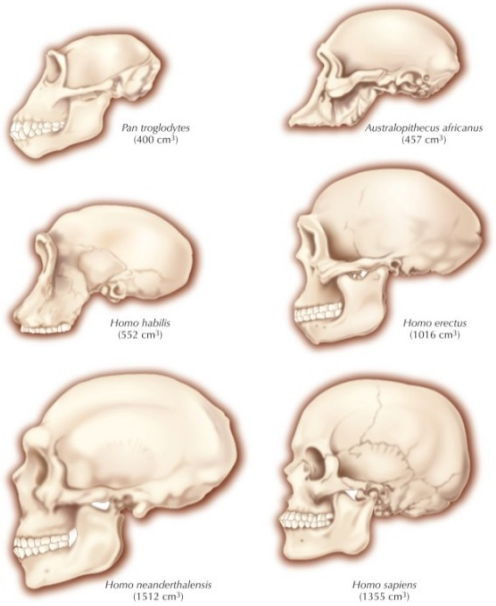
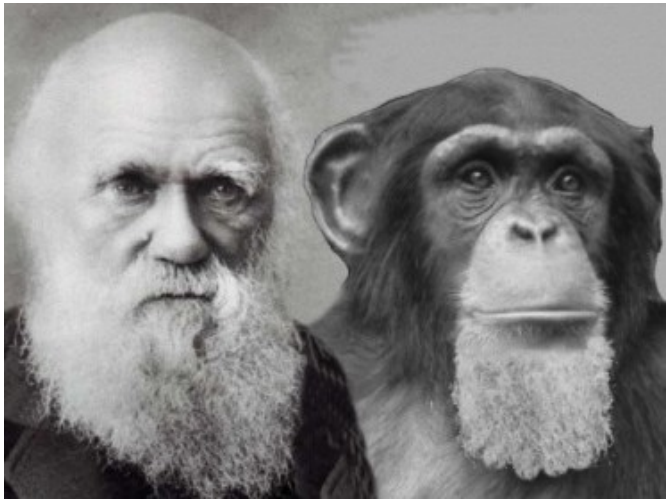
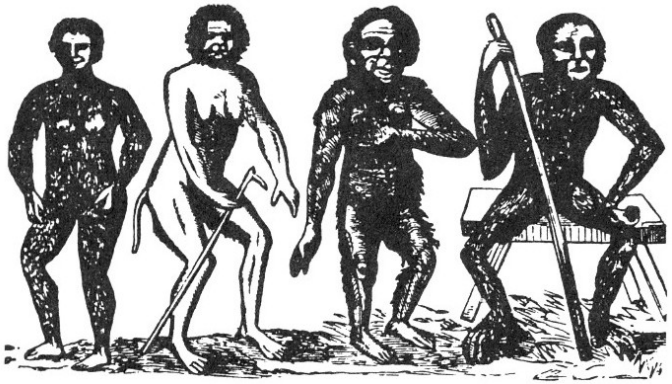
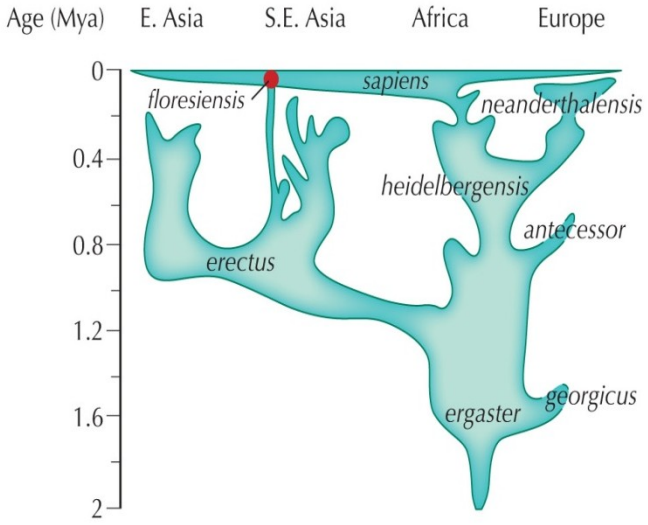
HUMAN EVOLUTION
CULTURAL EVOLUTION

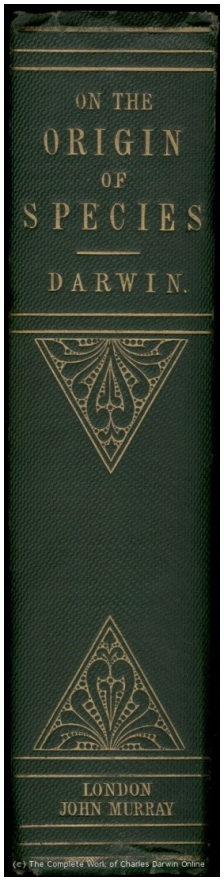


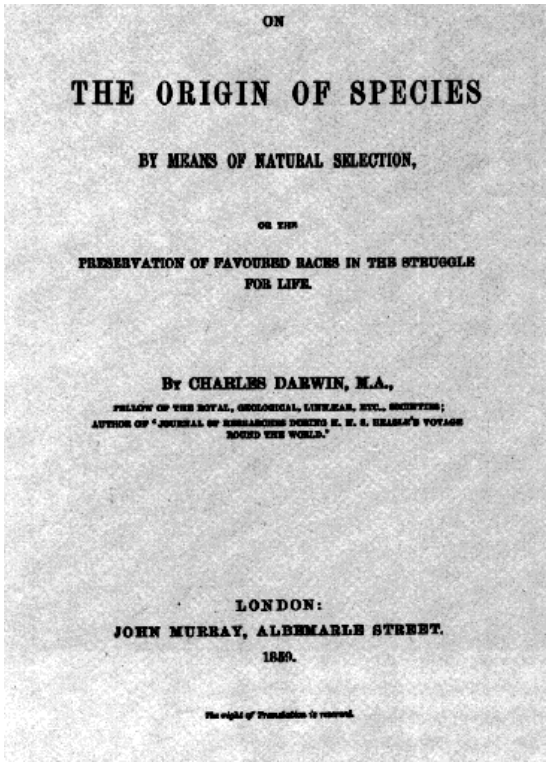






Light will be thrown on the origin of man and his history.




ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

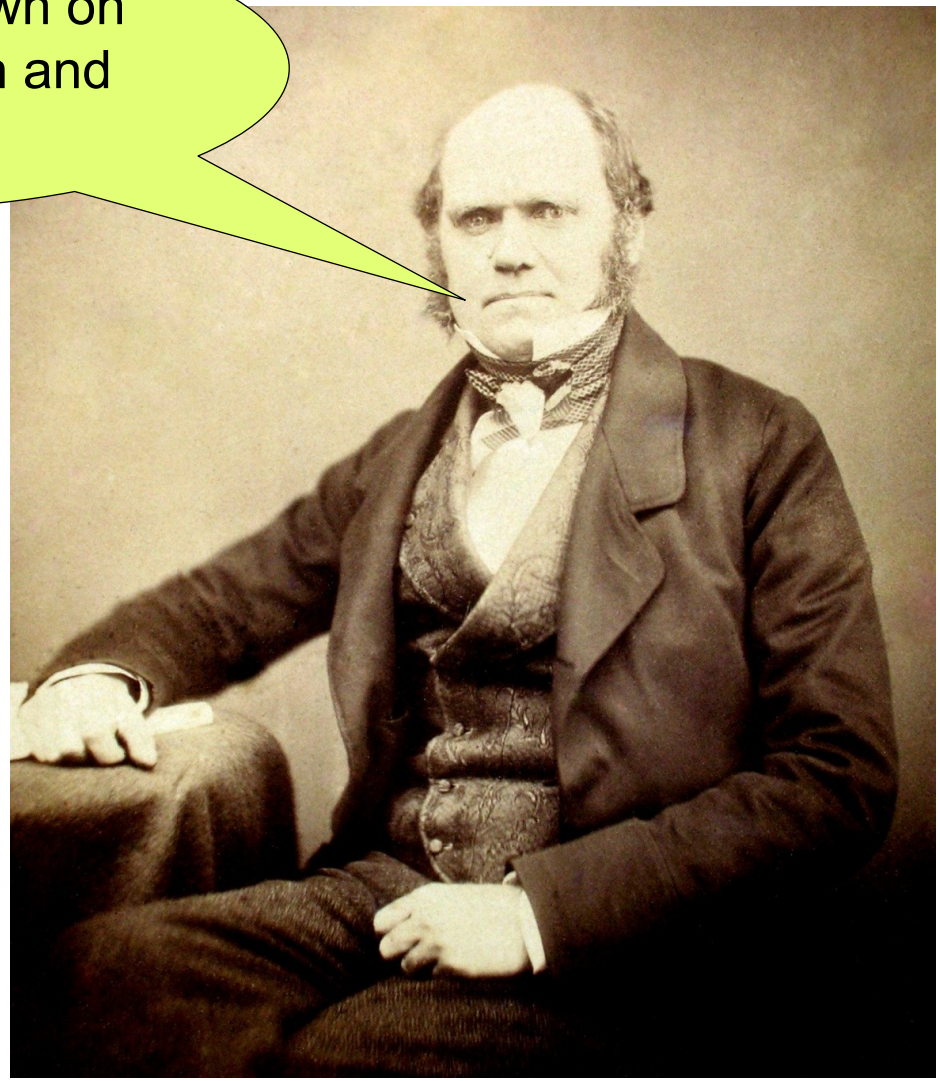
OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNEAN, ETC., SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD.'

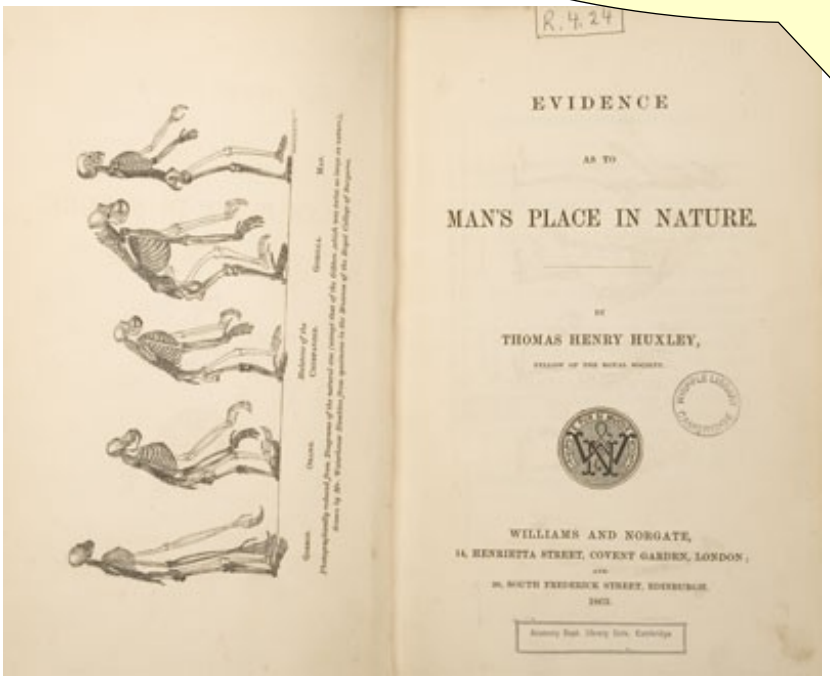
LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

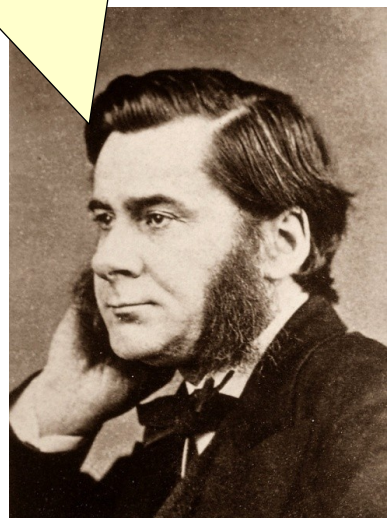


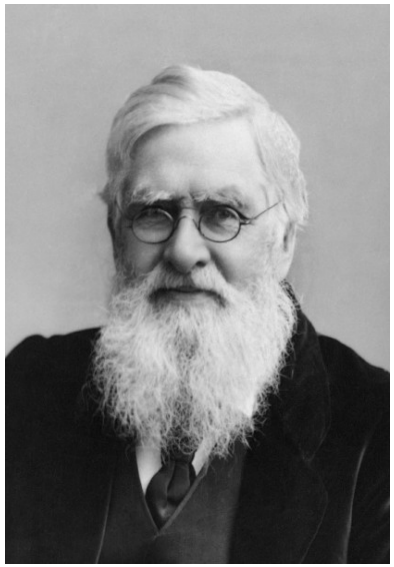
T. H. Huxley (1863):

Evidence as to Man's place in Nature

Humans differ from apes in all parts of their bodies less than apes from other monkeys.



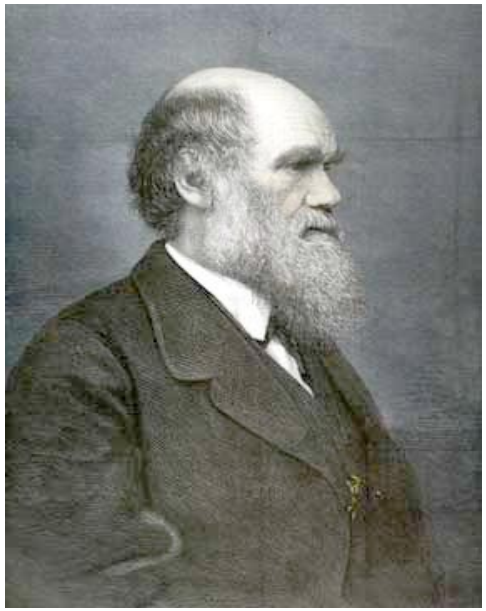


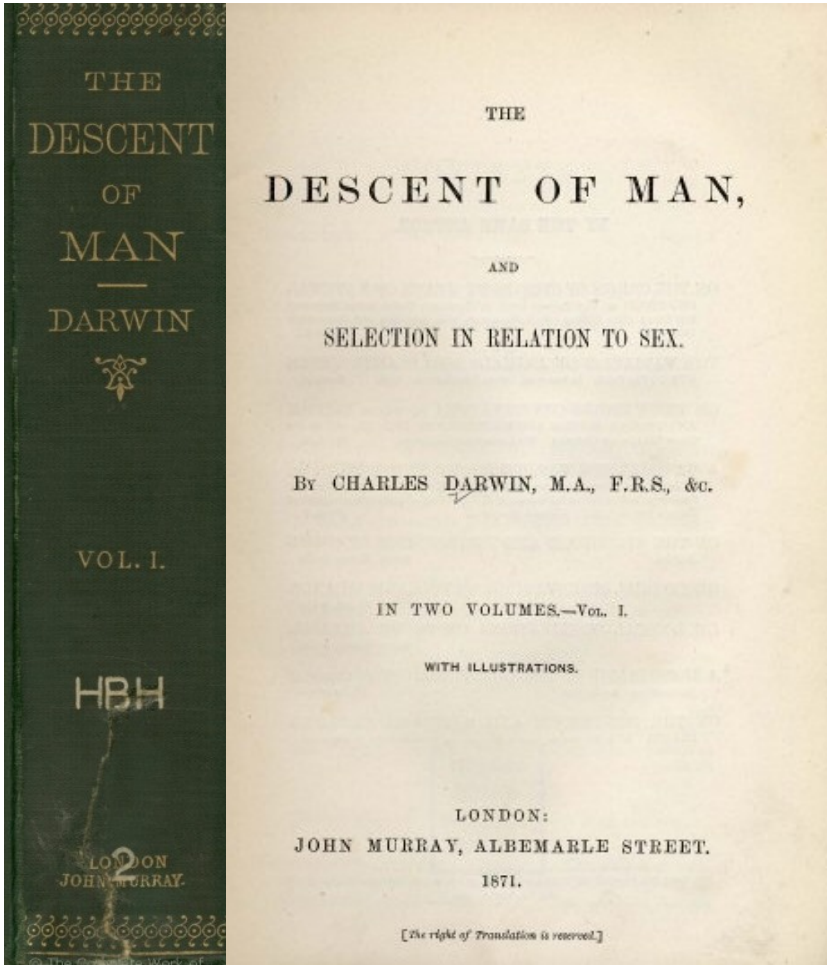


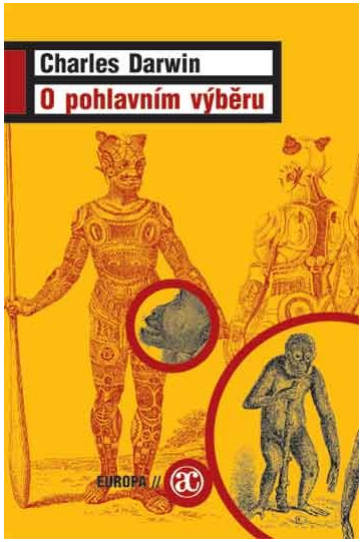
A. R. Wallace (1864):

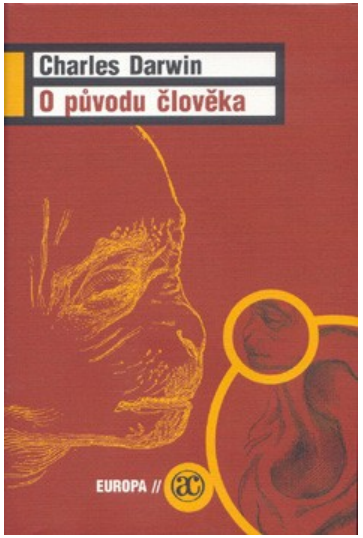
The origin of human races and the antiquity of Man deduced from the theory of ‚Natural Selection'

1871: The descent of man, and selection in relation to sex

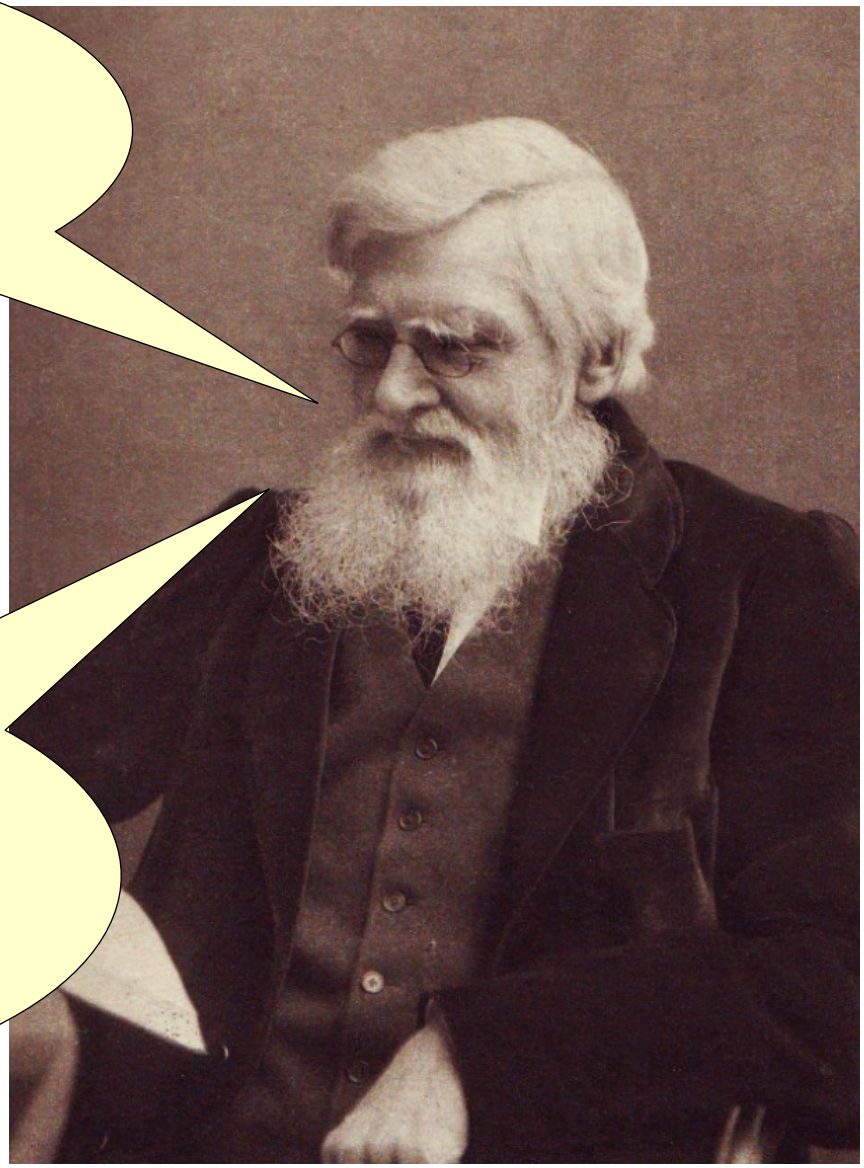




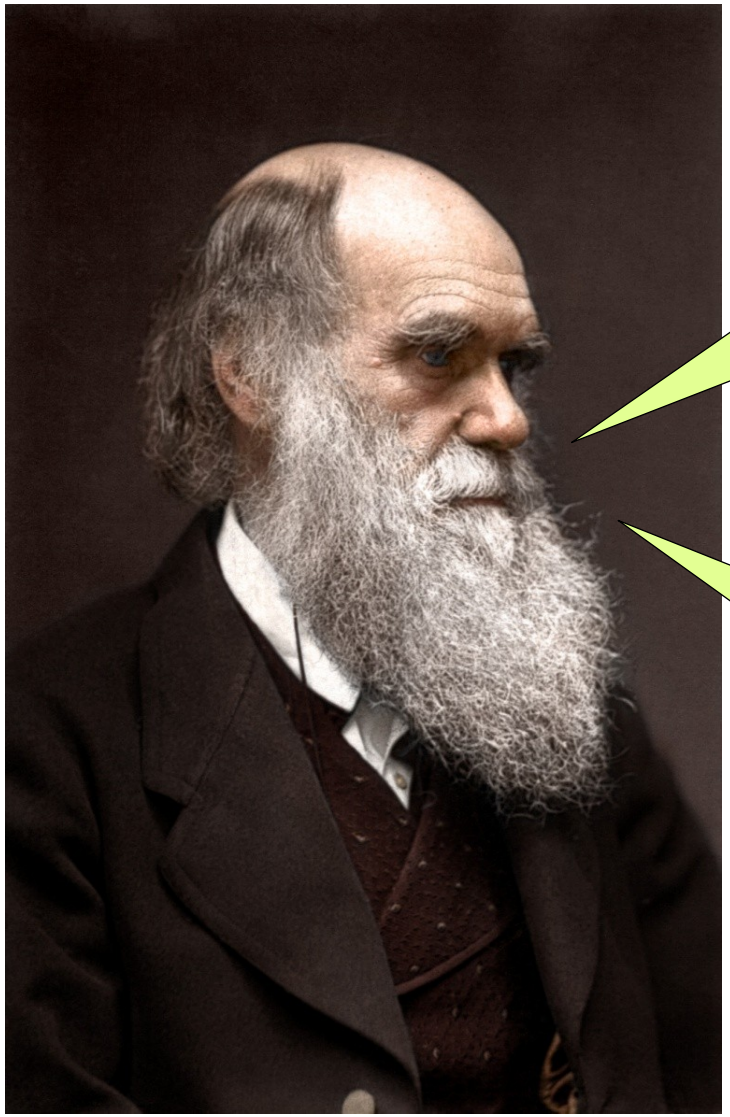




The break between apes and humans is too big, ‘savages’ do not at all fill it.



Selection cannot explain the sense of humour, ingenuity, talent for mathematics, philosophy, arts, or music.



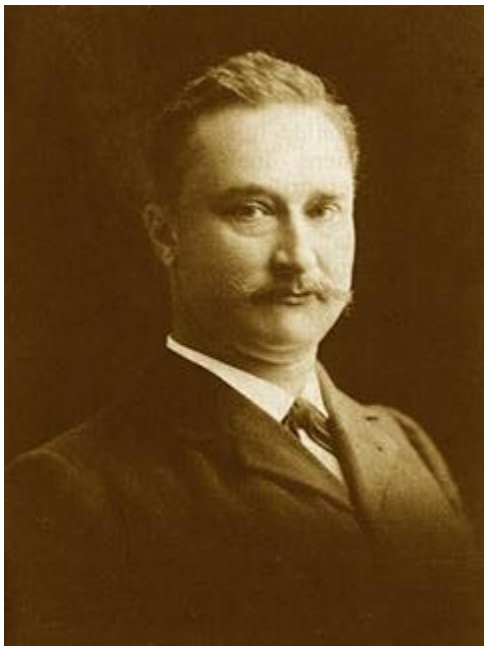
The difference between animals and humans are only quantitative. Morals, sympathy, sense of beauty also exist in animals.

In animals, we can see behaviour analogous to love, kindness, religion, or altruism.

Neanderthals: 1829 Engis (Liège), 1848 Gibraltar, 1856 Neandertal

Looking for missing link:

1891 Eugène Dubois: *Anthropopithecus* (*Pithecanthropus, Homo*) *erectus*, Trinil, Java; 700 000 – 1 mil. let

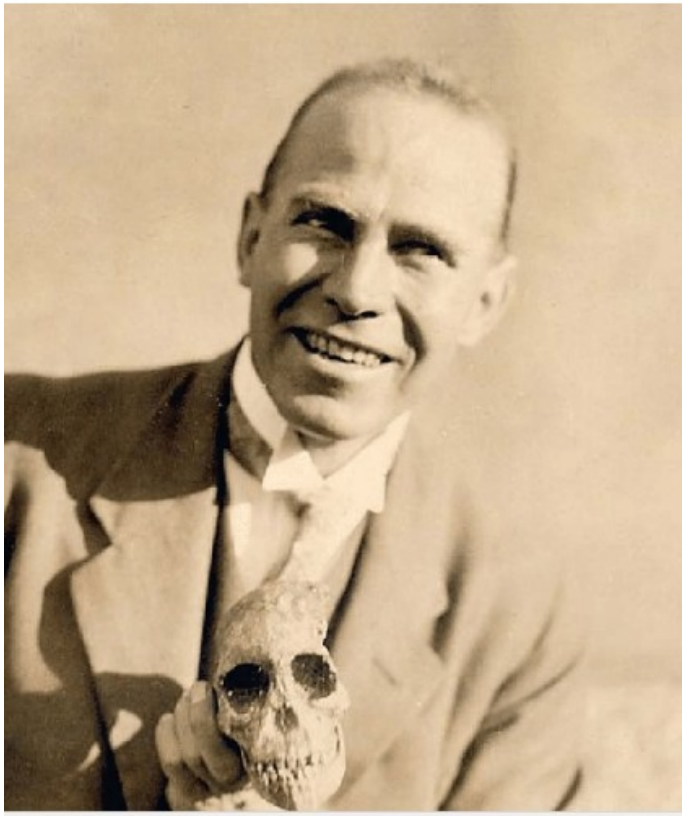


E. Dubois
(1858–1940)

Trinil 2

Looking for missing link:

1924 Raymond Dart: *Australopithecus africanus*, Taung, South Africa; 2.5 mil.



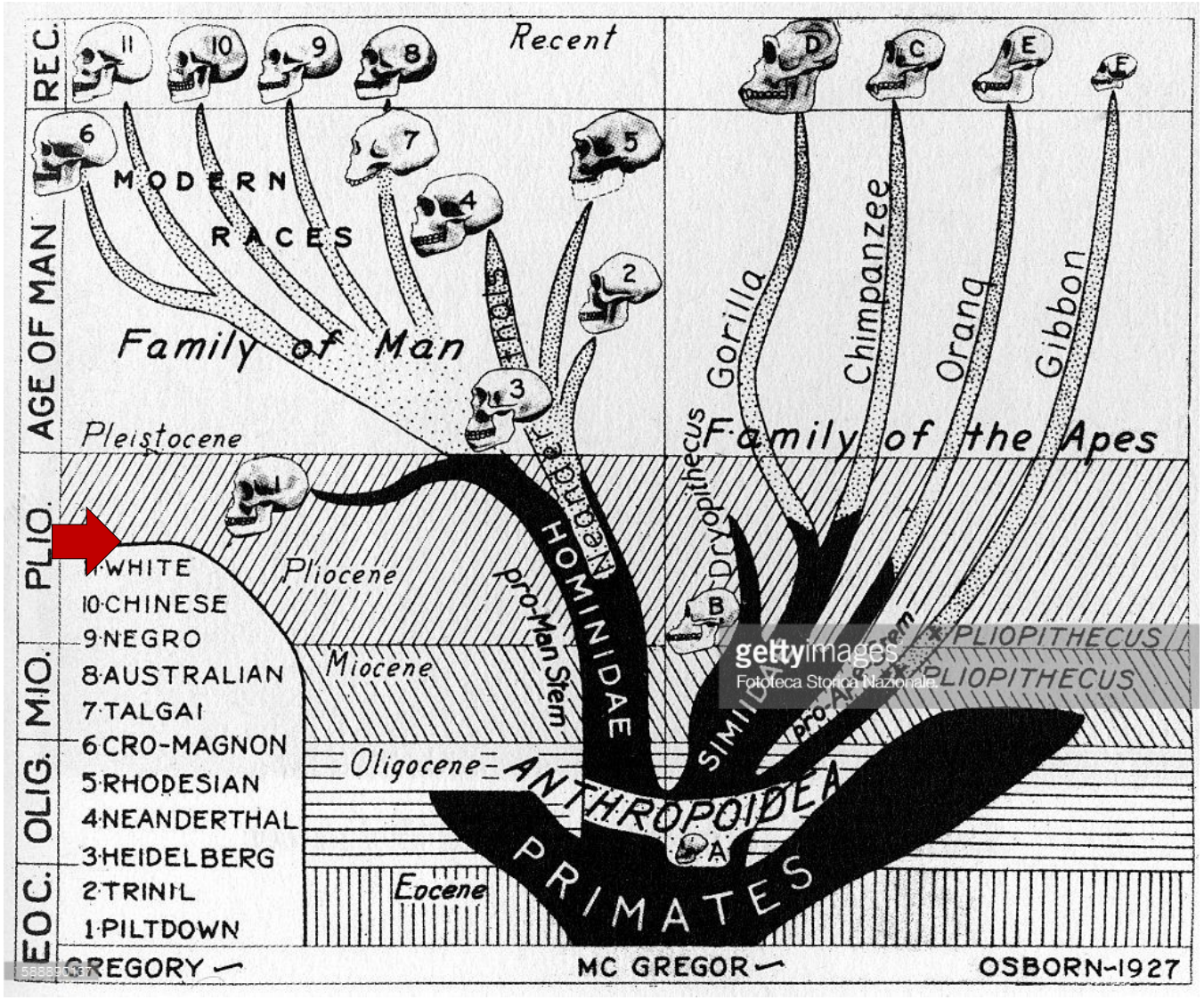
R. Dart
(1893–1988)

Looking for missing link:

1912: Piltdown – *Eoanthropus dawsoni* (‘Piltdown Man’)

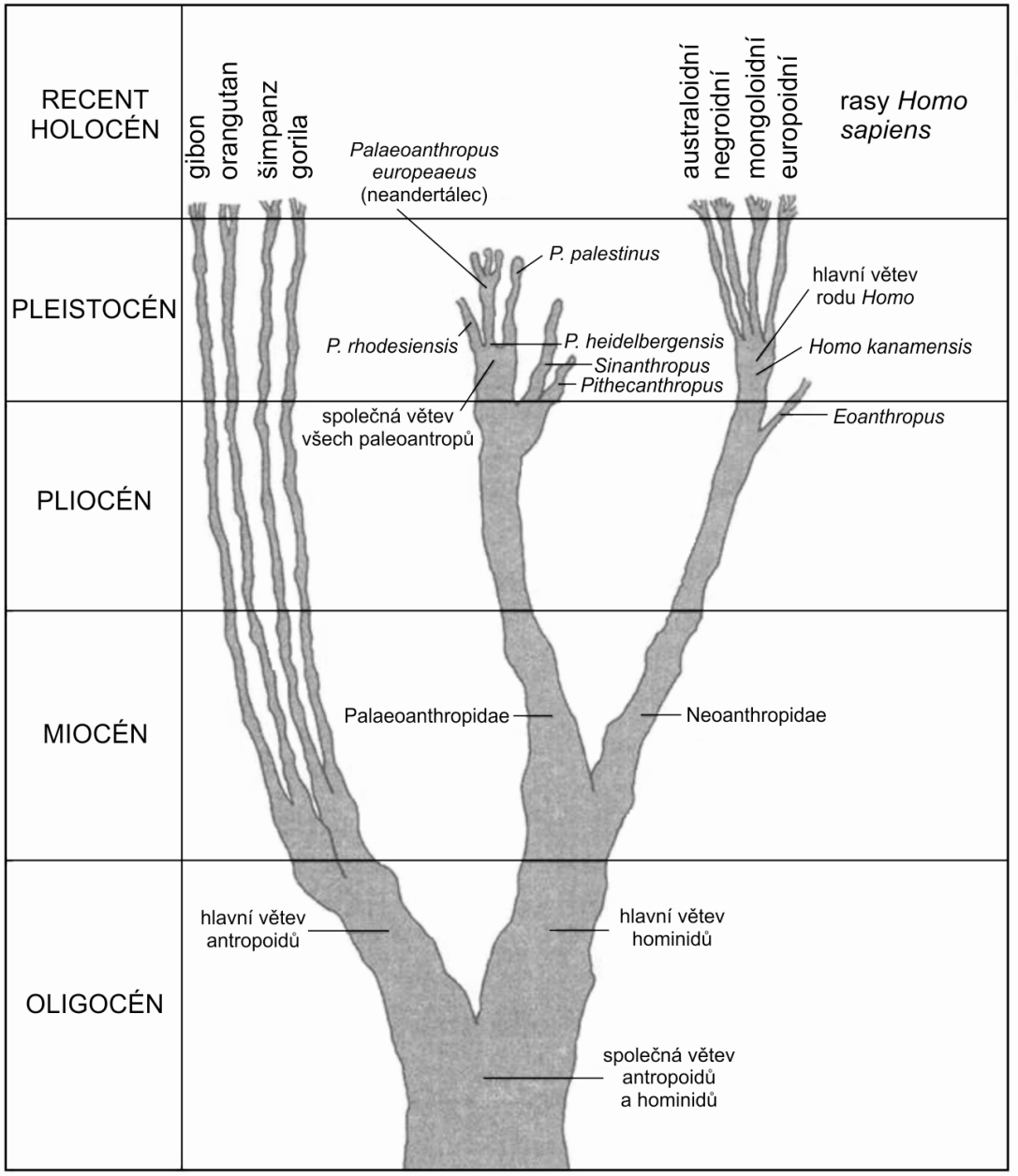
Charles Dawson

H. F. Osborn
(1927)

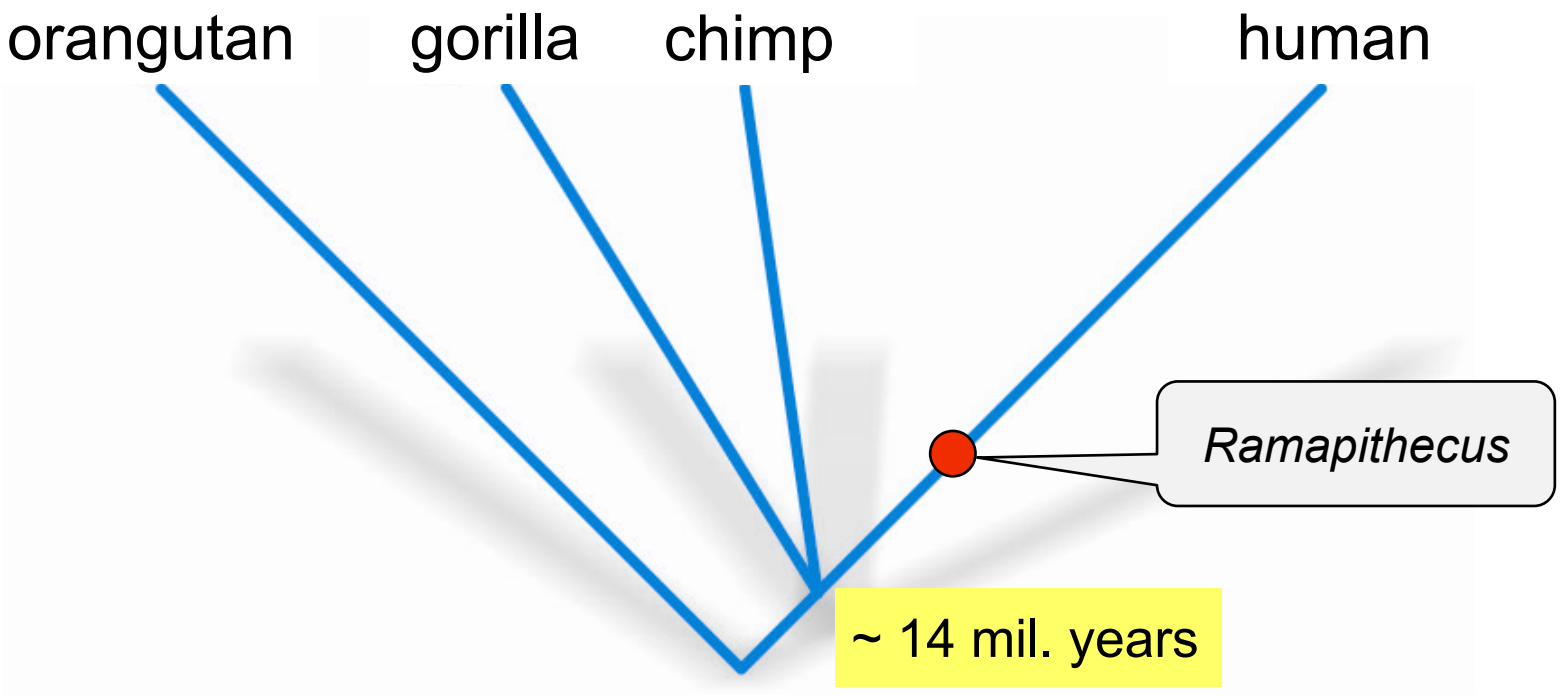


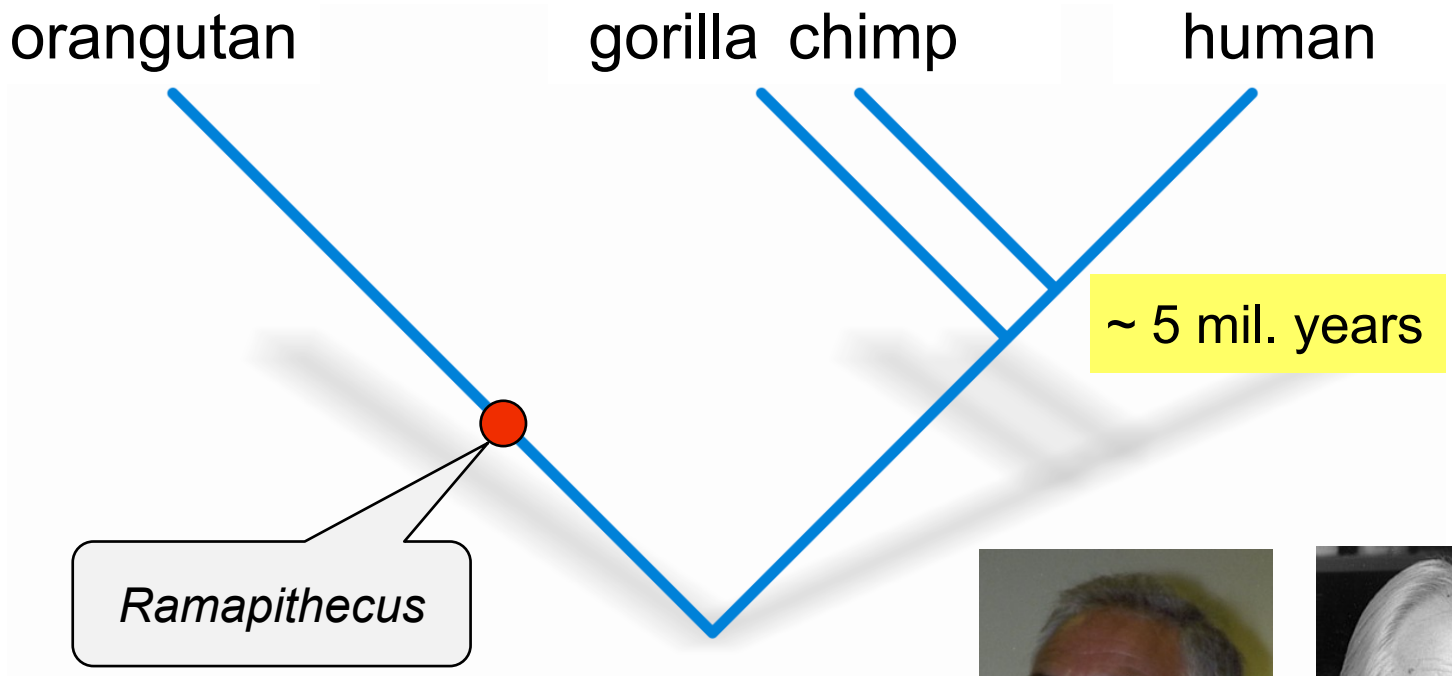
Divergence between humans and other fossil hominins very ancient

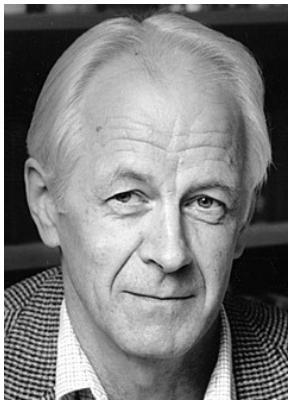
Arthur Keith
(1935)



Divergence between humans and other fossil hominins very ancient

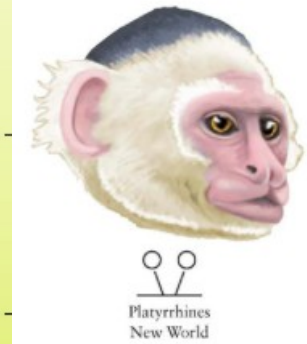

orangutan
gorilla
chimp
human
Ramapithecus
~ 14 mil. years





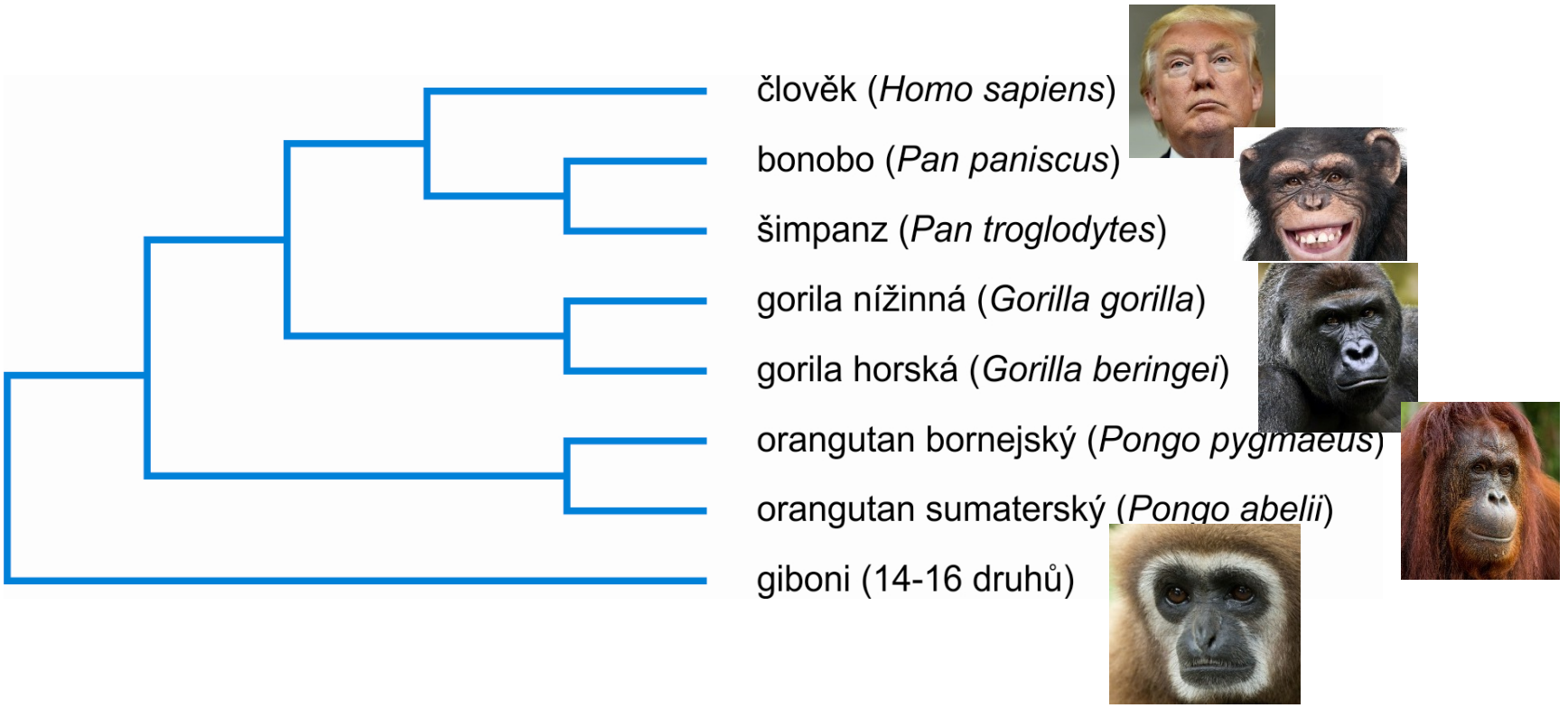
1967: Vincent Sarich, Allan C. Wilson
serum albumin, immunological distances
human-chimp ≈ 4-5 mil.

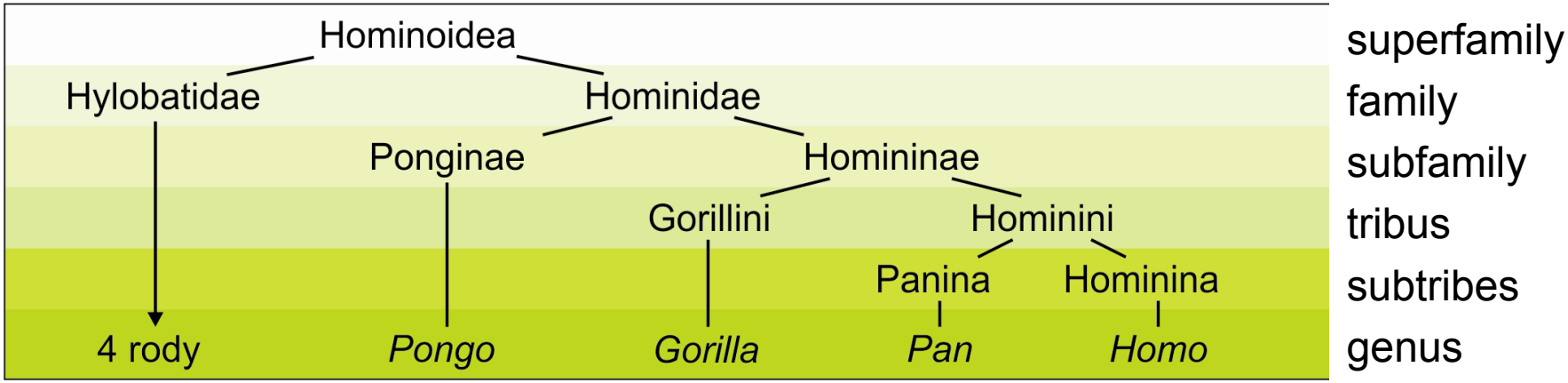
now: *Ramapithecus* = *Sivapithecus;* orangutan's ancestor
human-chimp ≈ 7.5 M


Platyrrhines
New World


Catarrhines
Old World

Miliony let
0
10
20
30
40
50
60
70
poloopice (Strepsirrhini)
ploskonosí (Platyrrhini)
Cercopithecidae
Hominoidea
úzkonosí (Catarrhini)
Simiiformes
Haplorrhini
Primates


člověk (*Homo sapiens*)
bonobo (*Pan paniscus*)
šimpanz (*Pan troglodytes*)
gorila nížinná (*Gorilla gorilla*)
gorila horská (*Gorilla beringei*)
orangutan bornejský (*Pongo pygmaeus*)
orangutan sumaterský (*Pongo abelii*)
giboni (14-16 druhů)


Hominoidea
Hylobatidae
Hominidae
Ponginae
Homininae
Gorillini
Hominini
Panina
Hominina
4 rody
Pongo
Gorilla
Pan
Homo
superfamily
family
subfamily
tribus
subtribes
genus

Fossils:

1924 Raymond Dart: Taung, South Africa
Australopithecus africanus ('Taung Child')

1959 Louis S.B. Leakey, Mary Leakey:
Olduvai, Tanzania, East Africa –
Australopithecus (Paranthropus) boisei

P. boisei

A. africanus

Lucy

1974 Donald Johanson:
Hadar, Awash, Afar Depression, Ethiopia
Australopithecus afarensis ('Lucy')

Oldest hominins:

1994: *Ardipithecus ramidus* (‘Ardi’), Awash, Ethiopia – 4.4 mil. (2004: *Ar. kadabba* – 5.6 mil.)

2001: *Orrorin tugenensis*, Tugen Hills, Kenya – 6 mil.

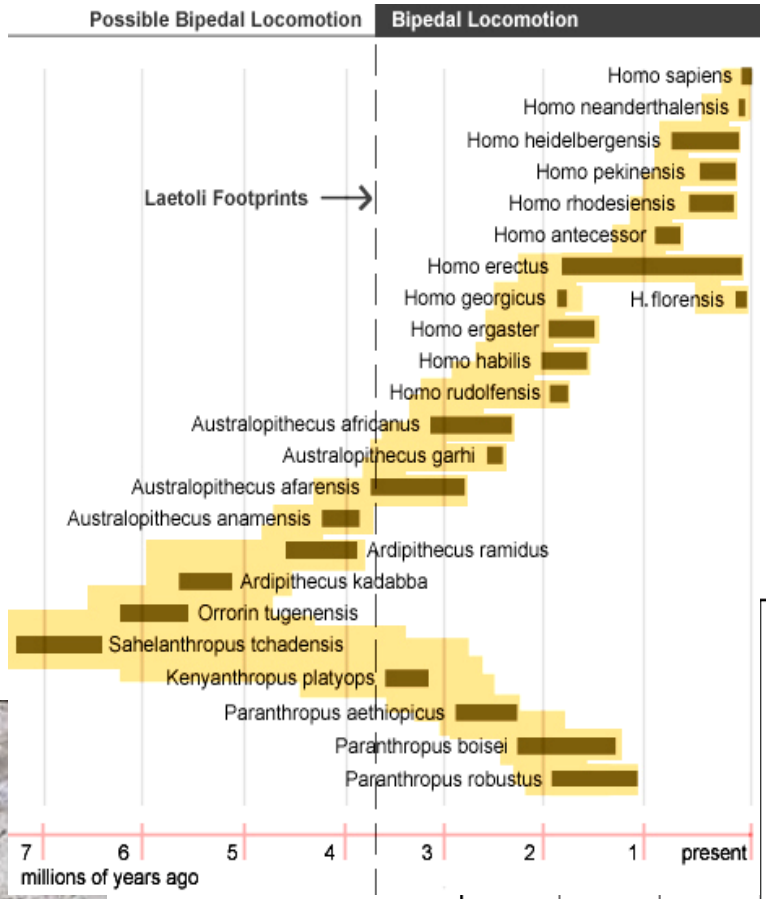
2002: *Sahelanthropus tchadensis* (‘Toumai’), S Chad – 6-7 mil.

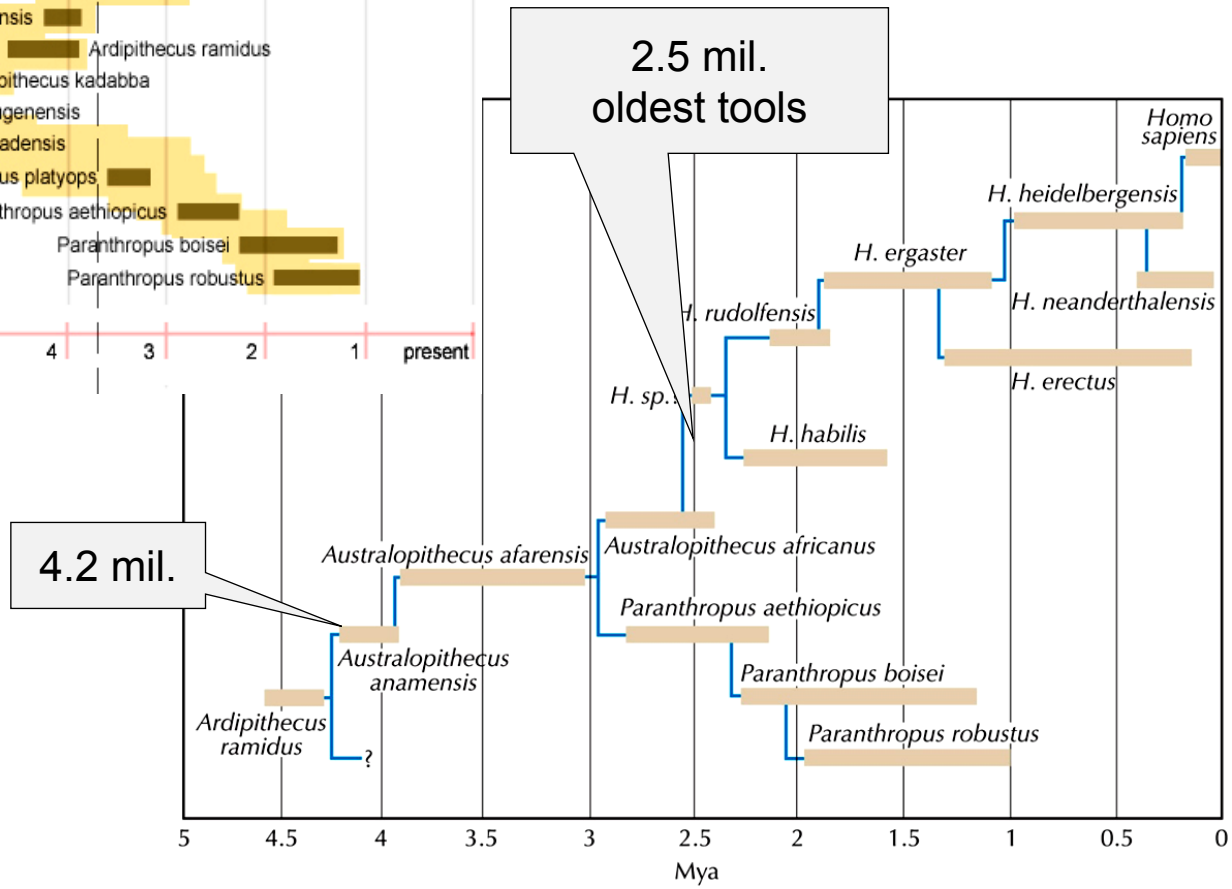
Ar. ramidus

Orrorin tugenensis

Sahelanthropus tchadensis

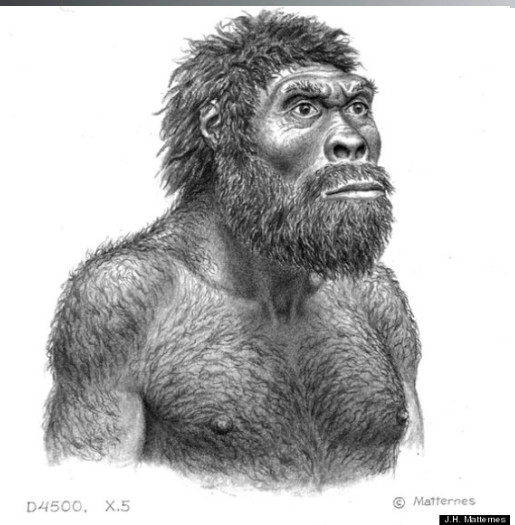
A. afarensis footprints
Laetoli, Tanzania, 3.6 M





Complication: Dmanisi

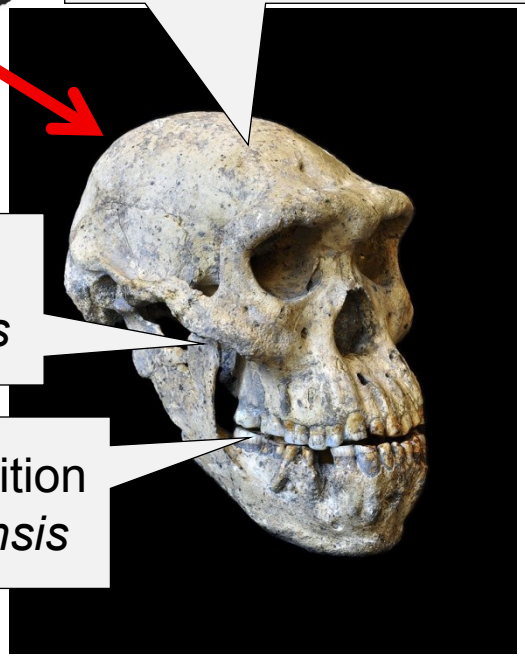
„*Homo georgicus*“
~ 1.8 mil.
~ early *H. erectus*
great variation
individual D4500



braincase 546 cm^3
~ *H. habilis*

face
~ *H. erectus*

massive dentition
~ *H. rudolfensis*



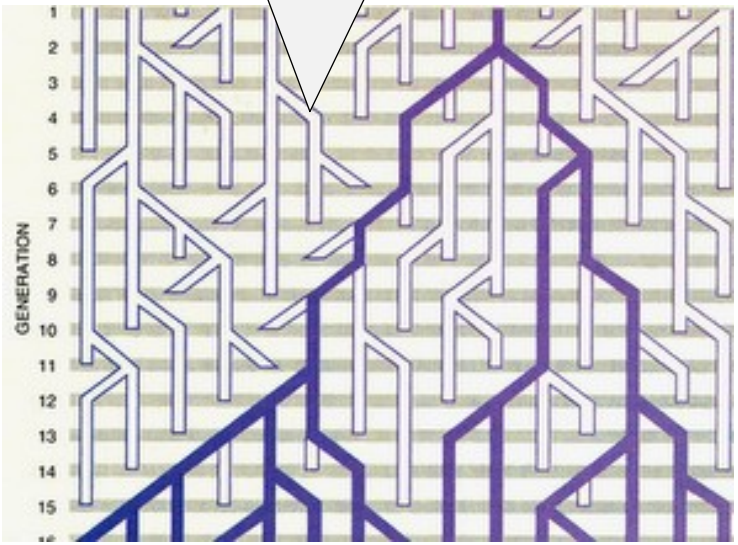
„Rozdělovači“ (splitters)	„Slučovači“ (lumpers)
Sahelanthropus tchadensis	*Ardipithecus ramidus s. lato*
Orrorin tugenensis	
Ardipithecus ramidus s. str.	
Ardipithecus kadabba	
Australopithecus anamensis	*Australopithecus afarensis s. lato*
Australopithecus afarensis s. str.	
Kenyanthropus platyops	
Australopithecus bahrelghazali	
Australopithecus africanus	*Australopithecus africanus*
Australopithecus garhi	
Australopithecus sediba	
Paranthropus aethiopicus	*Paranthropus boisei s. lato*
Paranthropus boisei s. str.	
Paranthropus robustus	*Paranthropus robustus*
Homo habilis s. str.	*Homo habilis s. lato*
Homo rudolfensis	
Homo gautengensis	
Homo ergaster	*Homo erectus s. lato*
Homo erectus s. str.	
Homo georgicus	
Homo pekinensis	
Homo floresiensis	
Homo soloensis	
Homo antecessor	
Homo heidelbergensis	*Homo sapiens s. lato*
Homo rhodesiensis	
Homo helmei	
Homo neanderthalensis	
Homo denisoviensis	
Homo sapiens s. str.	

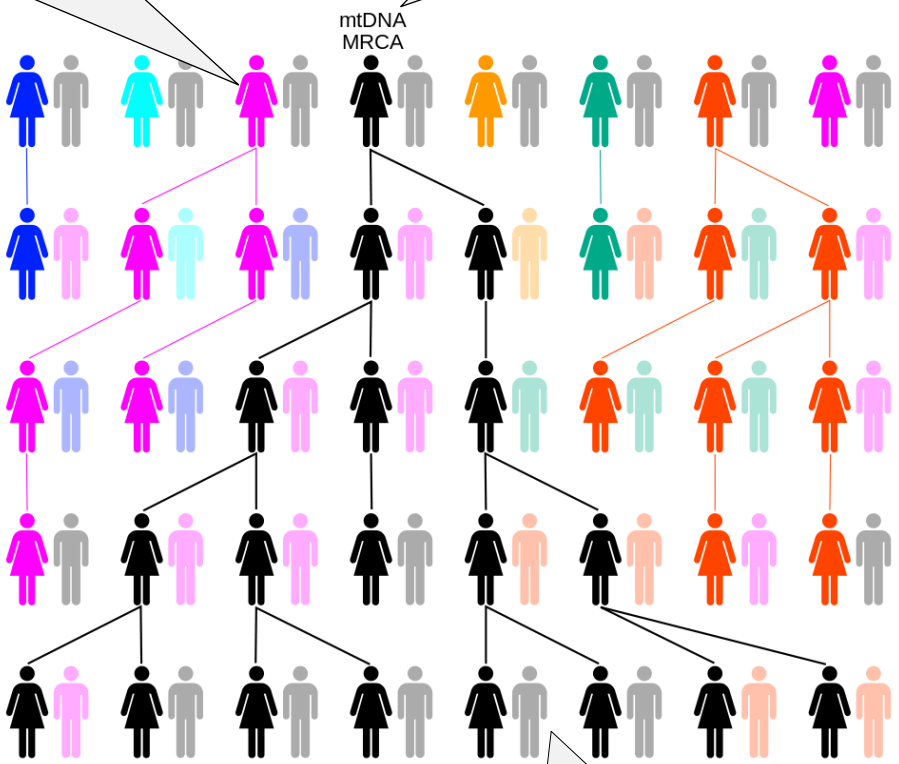
1987: Rebecca Cann, Mark Stoneking, A. C. Wilson
147 women

mtDNA is inherited only maternally

most recent common ancestor (MRCA)

random sorting of mitochondrial lineages

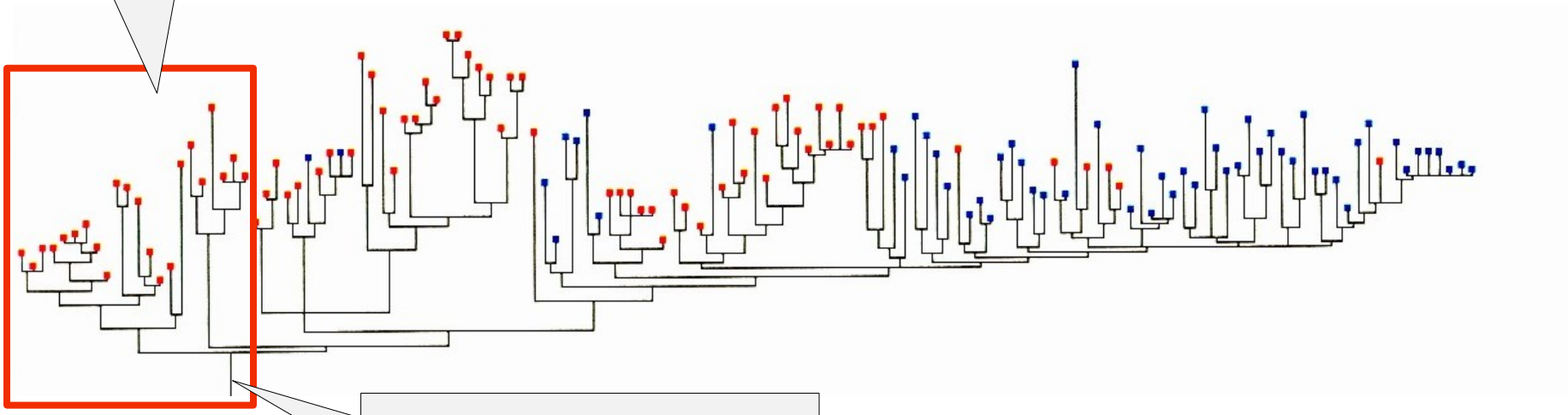




sample of contemporary women

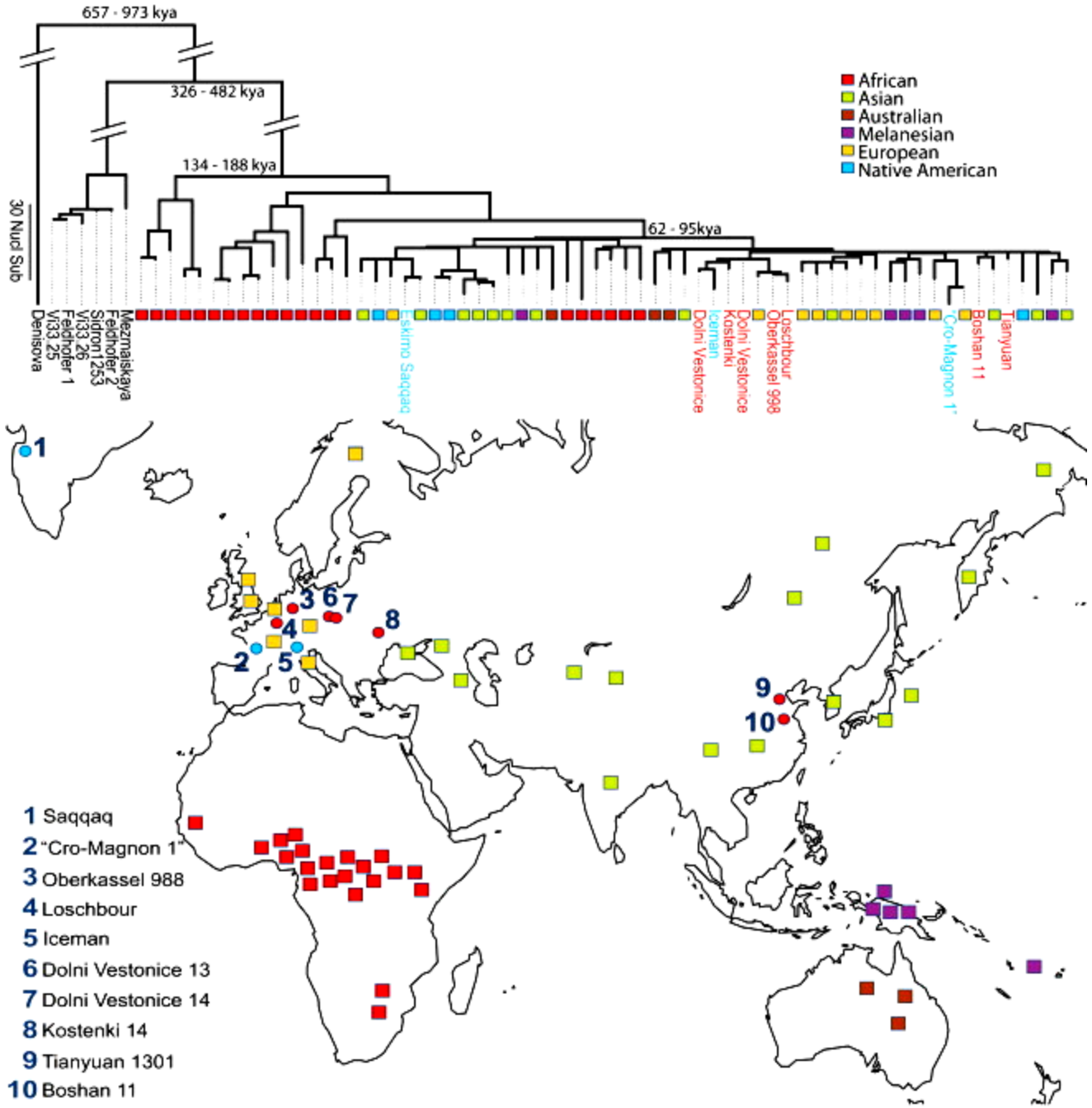
1987: Rebecca Cann, Mark Stoneking, A. C. Wilson
147 women

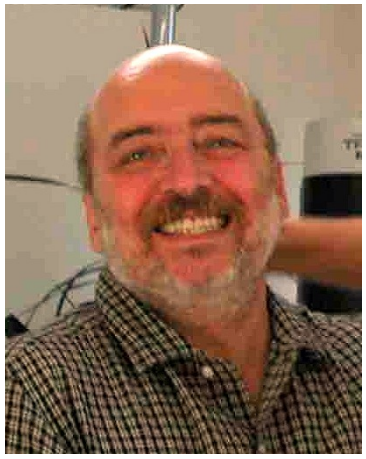
oldest lineages are of African origin



‘Mitochondrial Eve’: ca. 200 000 years*)

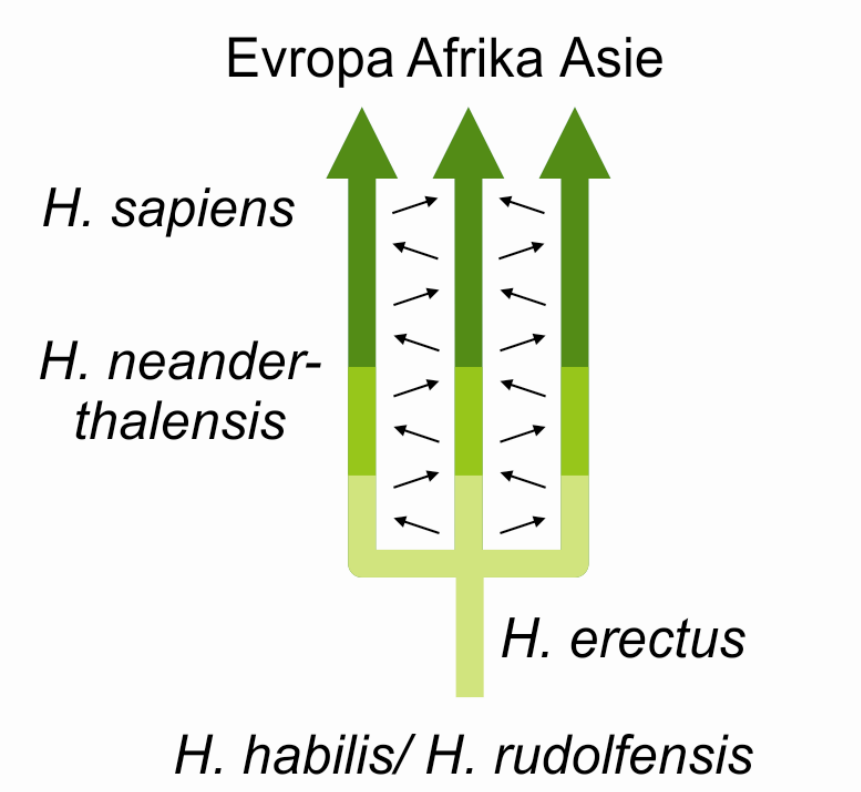
*) today ca. 160 000


657 - 973 kya
326 - 482 kya
134 - 188 kya
62 - 95kya
30 Nucl Sub
African
Asian
Australian
Melanesian
European
Native American
Denisova
Vi33.25
Feldhofer 1
Vi33.26
Sidron1253
Feldhofer 2
Mezmaiskaya
Eskimo Saqqaq
Dolni Vestonice
Iceman
Kostenki
Dolni Vestonice
Oberkassel 998
Loschbour
Cro-Magnon 1*
Boshan 11
Tianyuan
1 Saqqaq
2 "Cro-Magnon 1"
3 Oberkassel 988
4 Loschbour
5 Iceman
6 Dolni Vestonice 13
7 Dolni Vestonice 14
8 Kostenki 14
9 Tianyuan 1301
10 Boshan 11

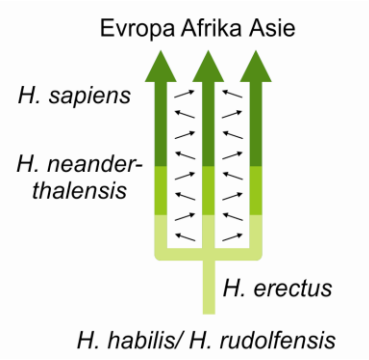


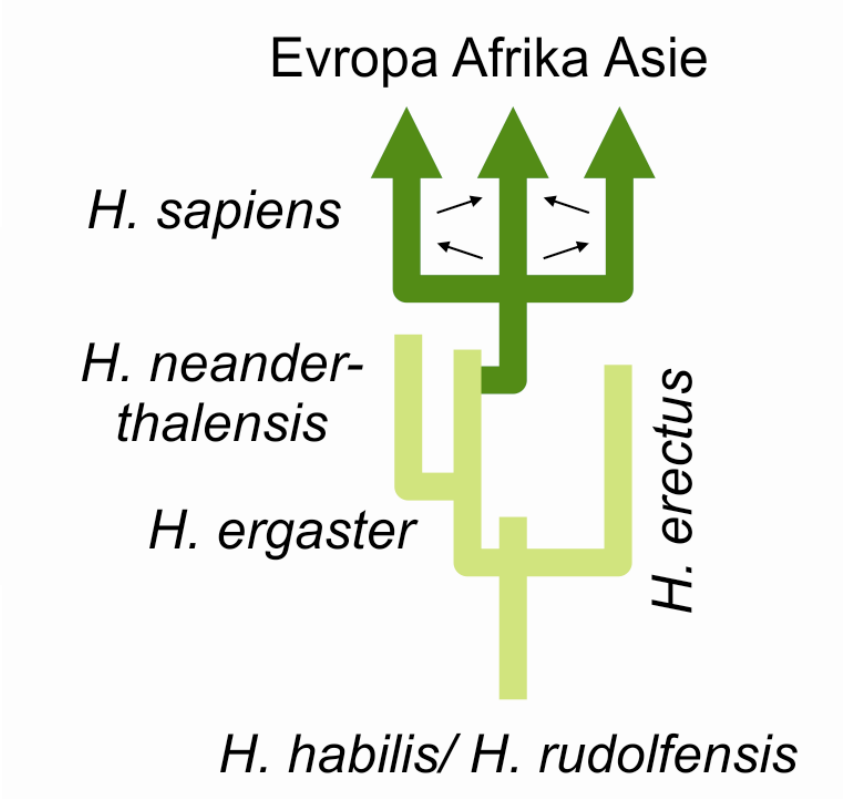
Milford H. Wolpoff

multiregional model

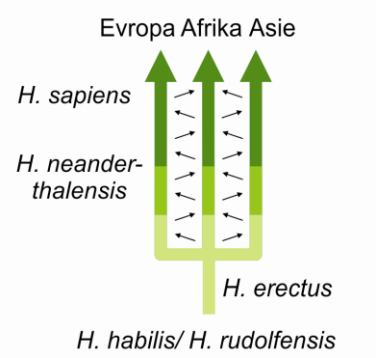


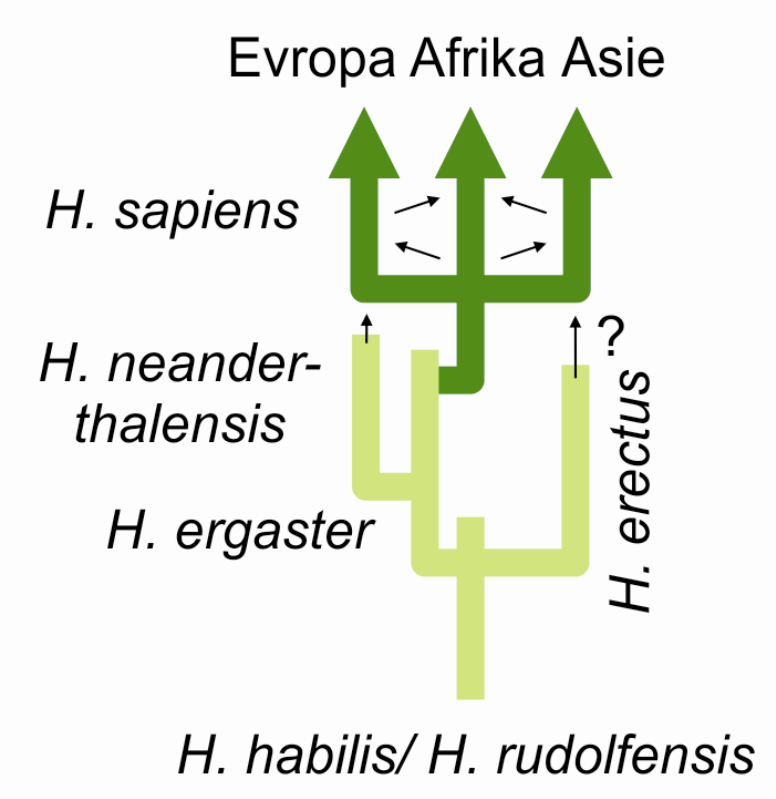
‘out-of-Africa’

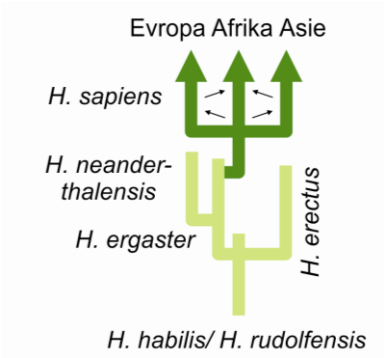




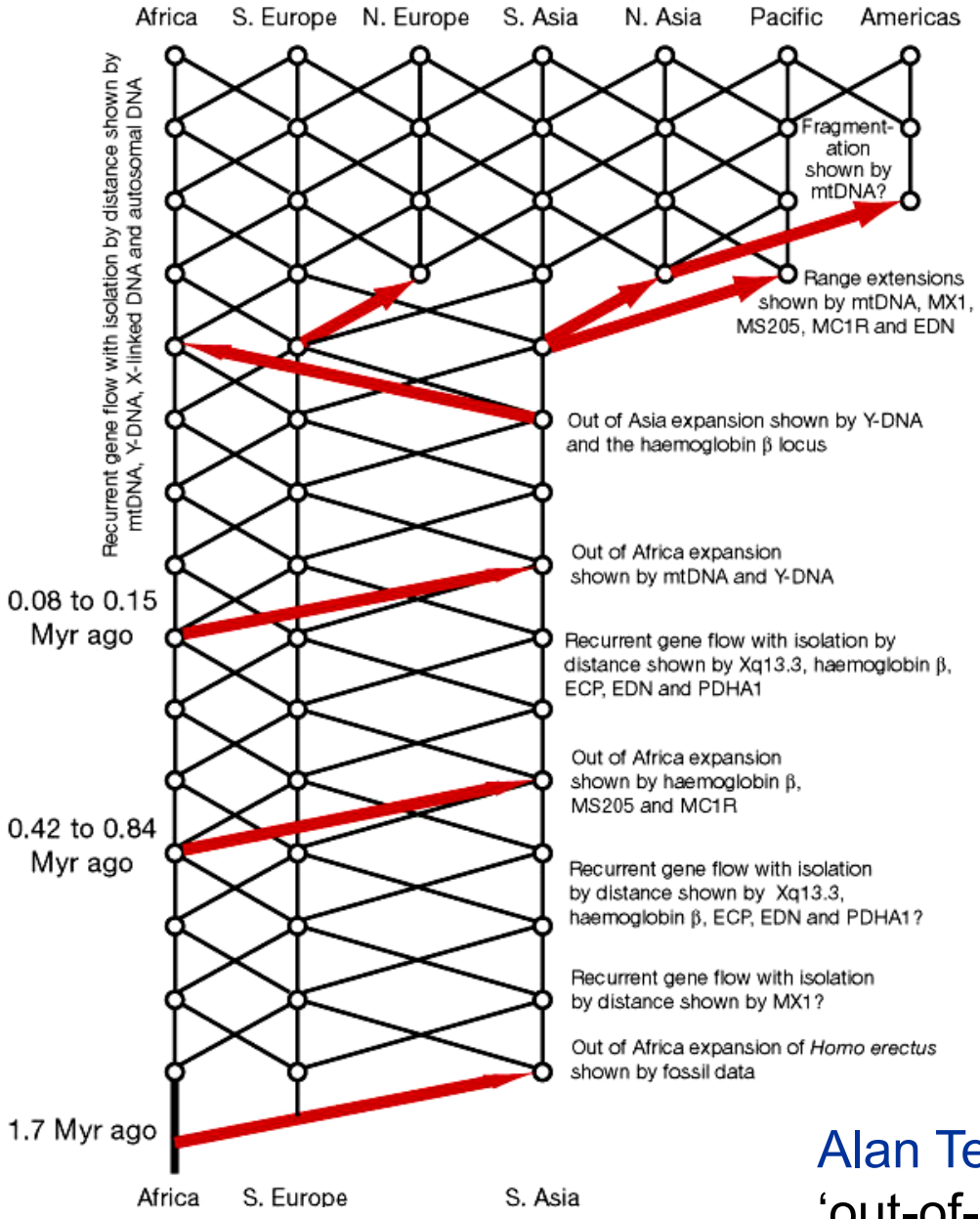
‘out-of-Africa’ with hybridization





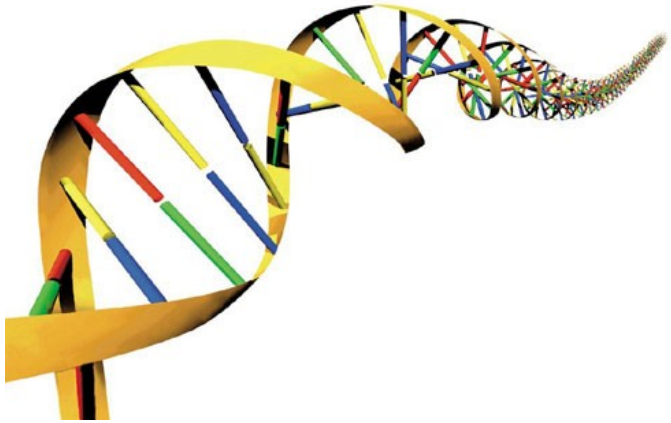


Problem: also multiregional hyp. assumes African origin!

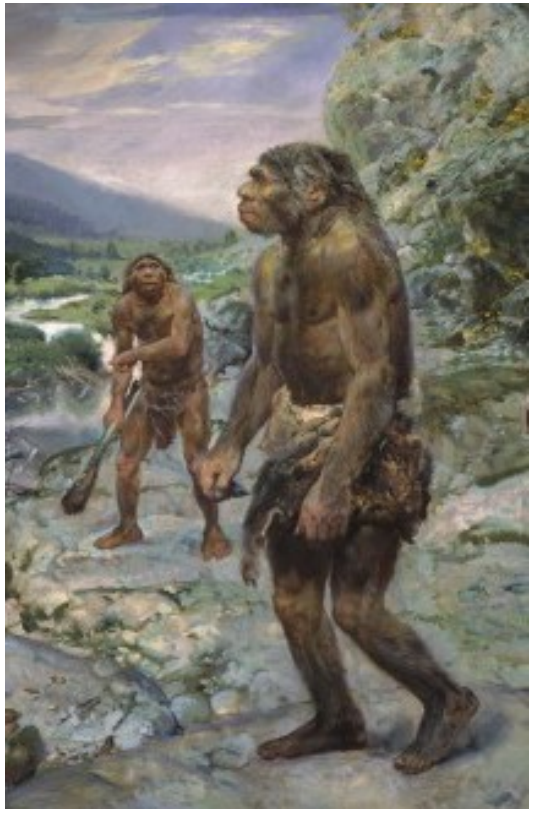


Alan Templeton (2002):
'out-of-Africa again and again'

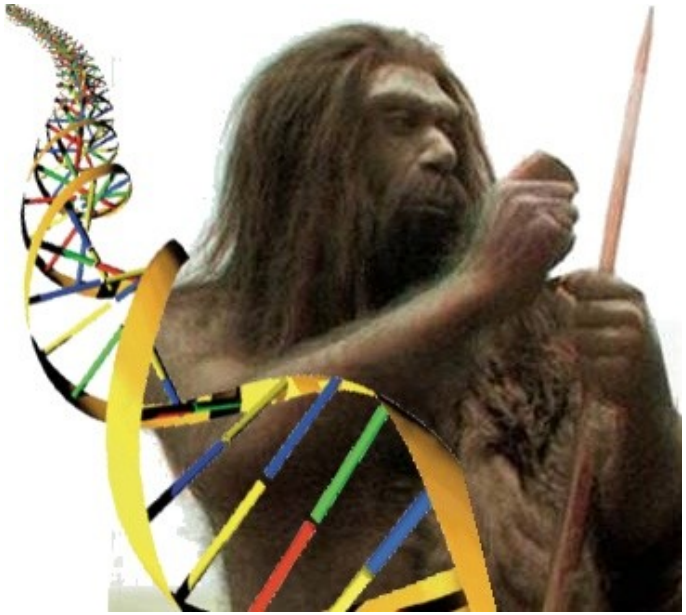
Egyptian mummy, 2400 years
Pääbo et al. (1985)



Before...



... now:



sequences of Neanderthal mtDNA:

outside variation of recent humans

not closer to ancient than to recent *Homo sapiens*

sequences of nuclear genome →

~1.5-2% Neanderthal DNA in human genome

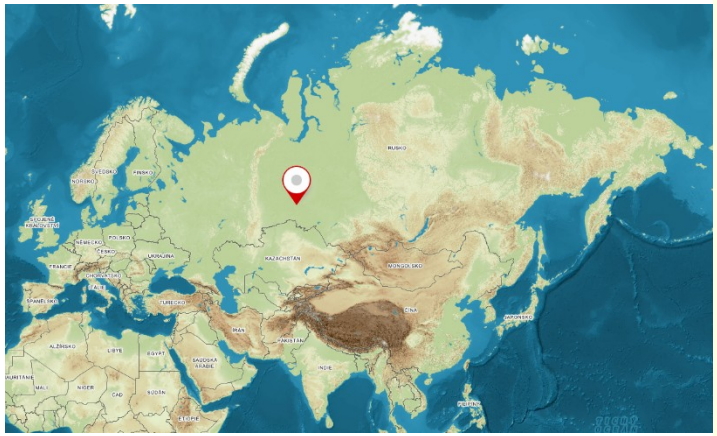
Europe, Asia (ca. by 20% more)

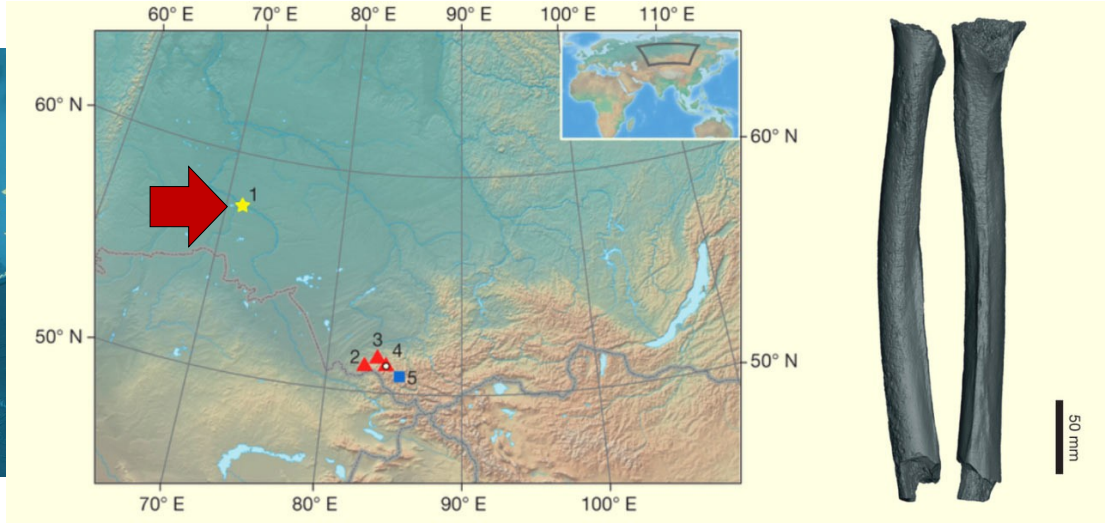
not sub-Saharan Africa

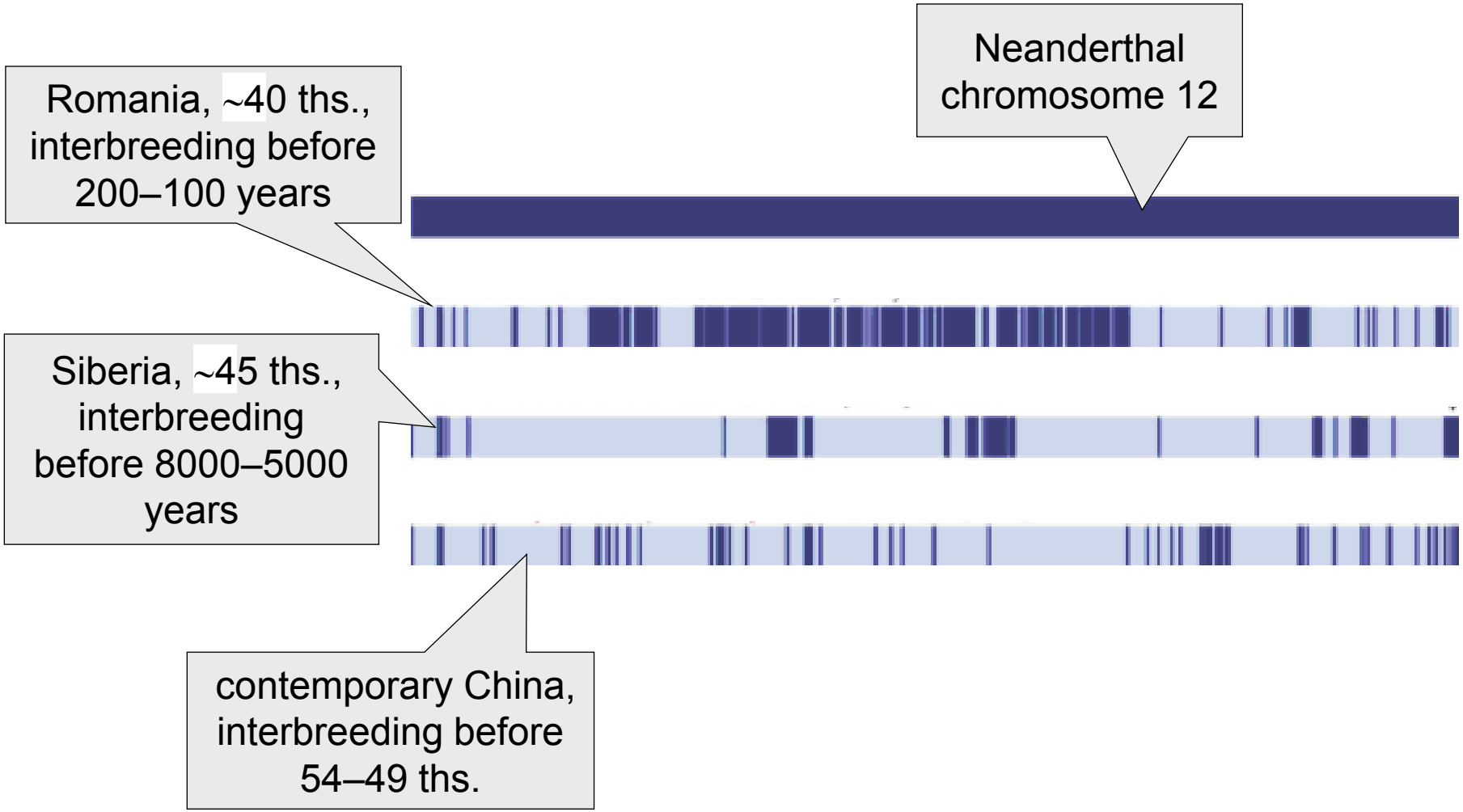
54-49 ths. years, likely Near East

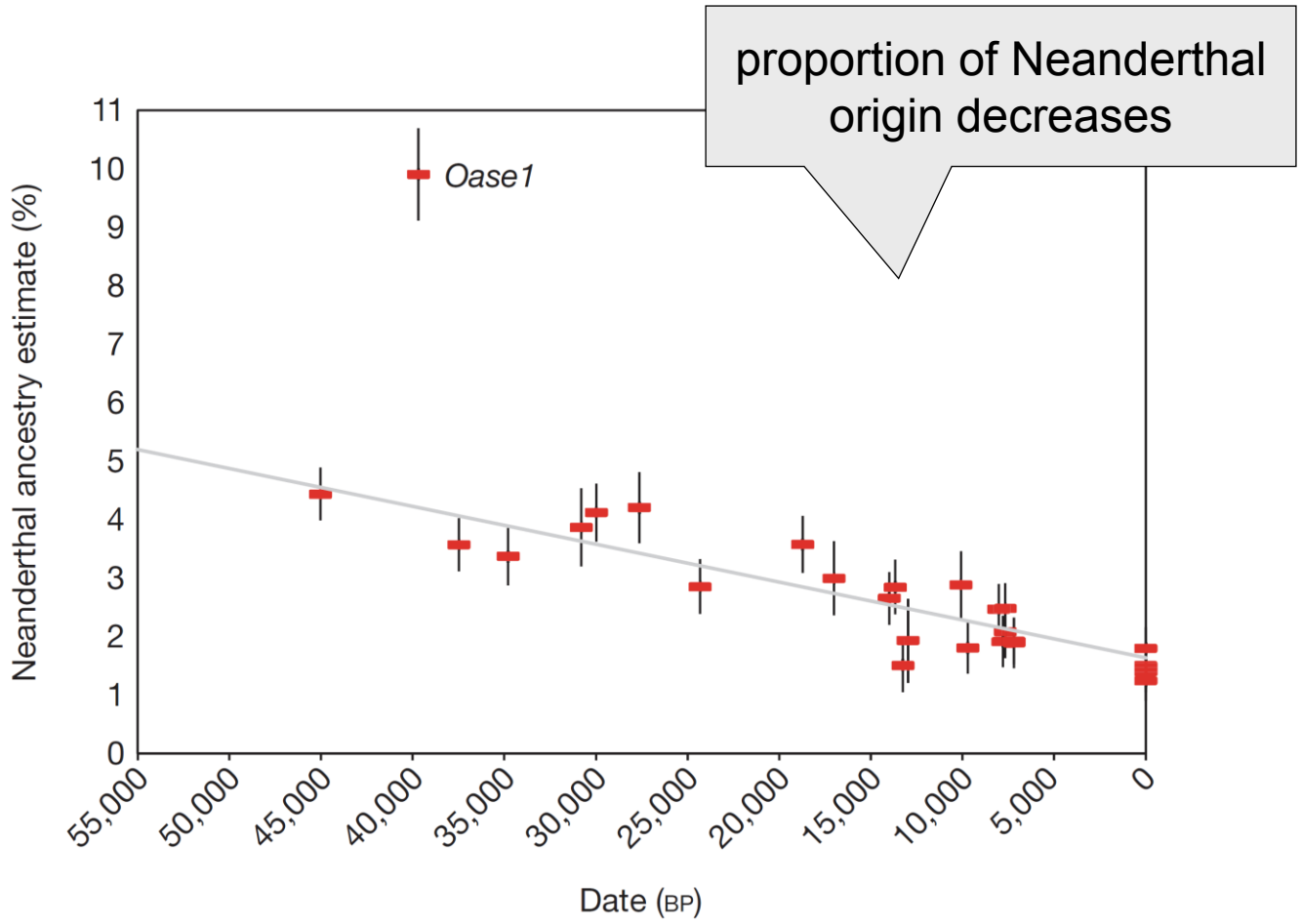
Oase cave, Romania (42–37 ths.): interbreeding 4–6 generations (100–200 years) before death; but this population hasn't leave genetical traces in modern Europeans

Ust'-Ishim, Irtysh (Omsk, W Siberia; ~45 ths.): 5–8 ths. (180–290 gens.) before death






Neanderthal chromosome 12
Romania, ~40 ths., interbreeding before 200–100 years
Siberia, ~45 ths., interbreeding before 8000–5000 years
contemporary China, interbreeding before 54–49 ths.


proportion of Neanderthal origin decreases
Oase1
Neanderthal ancestry estimate (%)
0
1
2
3
4
5
6
7
8
9
10
11
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Date (BP)

What have Neanderthals given us?

⊕

Neanderthal keratin (adaptation to a cold climate?)

interleukin 18 (cytokines)

gene *MC1R*: El Sidrón, Spain (43 ths.), Monti Lessini, Italy (50 ths.)
→ 'Celtic type' min. in 1% (in recent humans 1-2%)

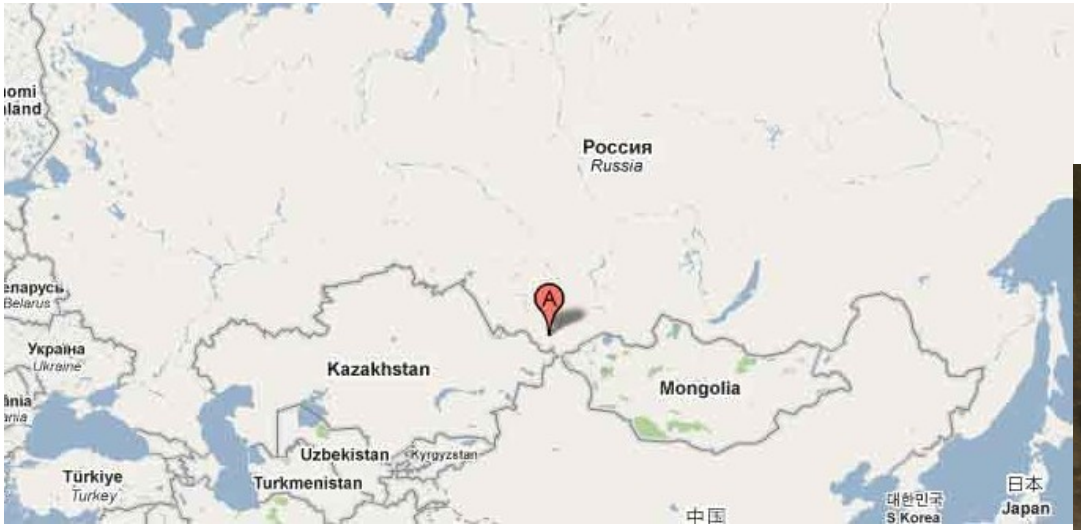
⊗

systemic lupus erythematosus, primary biliary cirrhosis, Crohn's disease, Diabetes Type 2

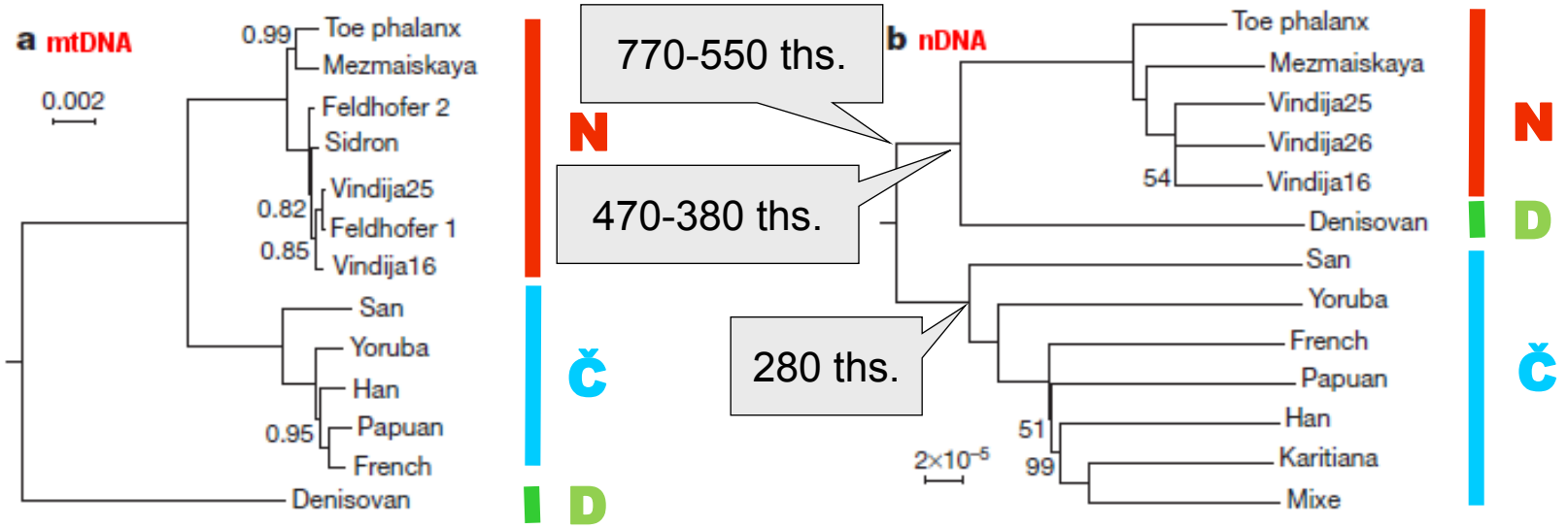
addiction to nicotine

absence of Neanderthal genes on X chromosome → Haldane's rule!

Denisovans


Россия
Russia
Kazakhstan
Mongolia
Uzbekistan
Kyrgyzstan
Turkmenistan
Türkiye
Turkey
Україна
Ukraine
Belarus
中国
대한민국
S Korea
日本
Japan

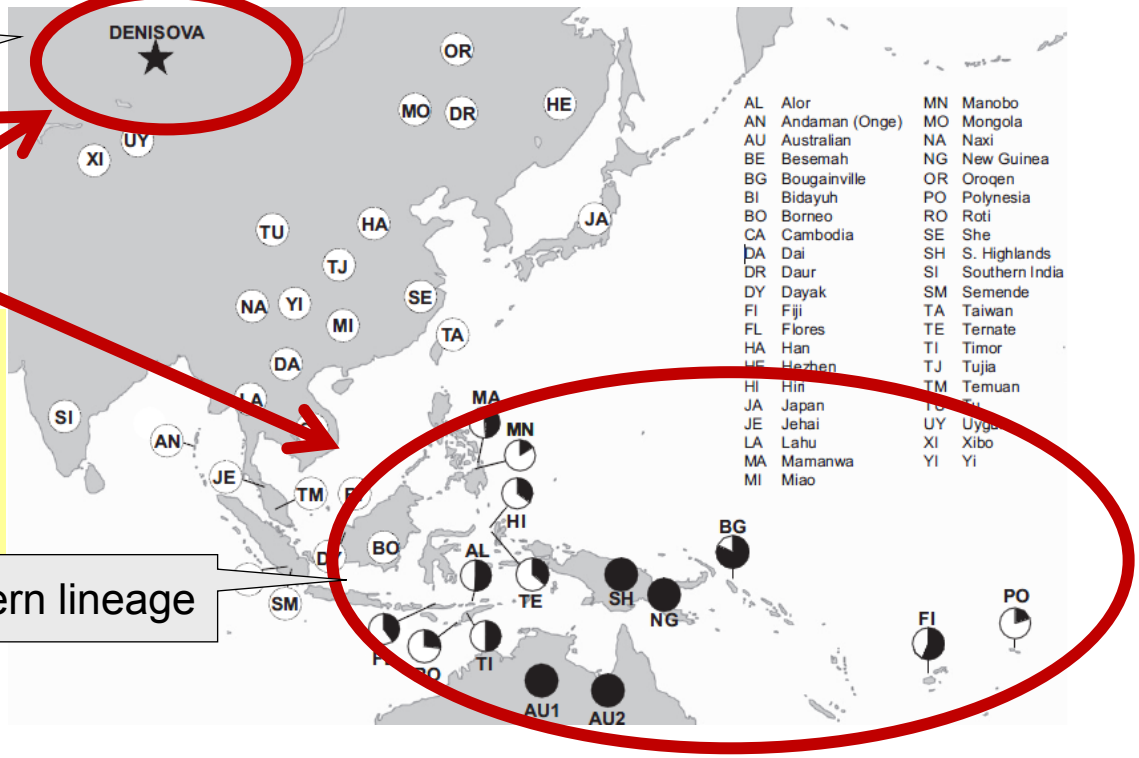

10 mm



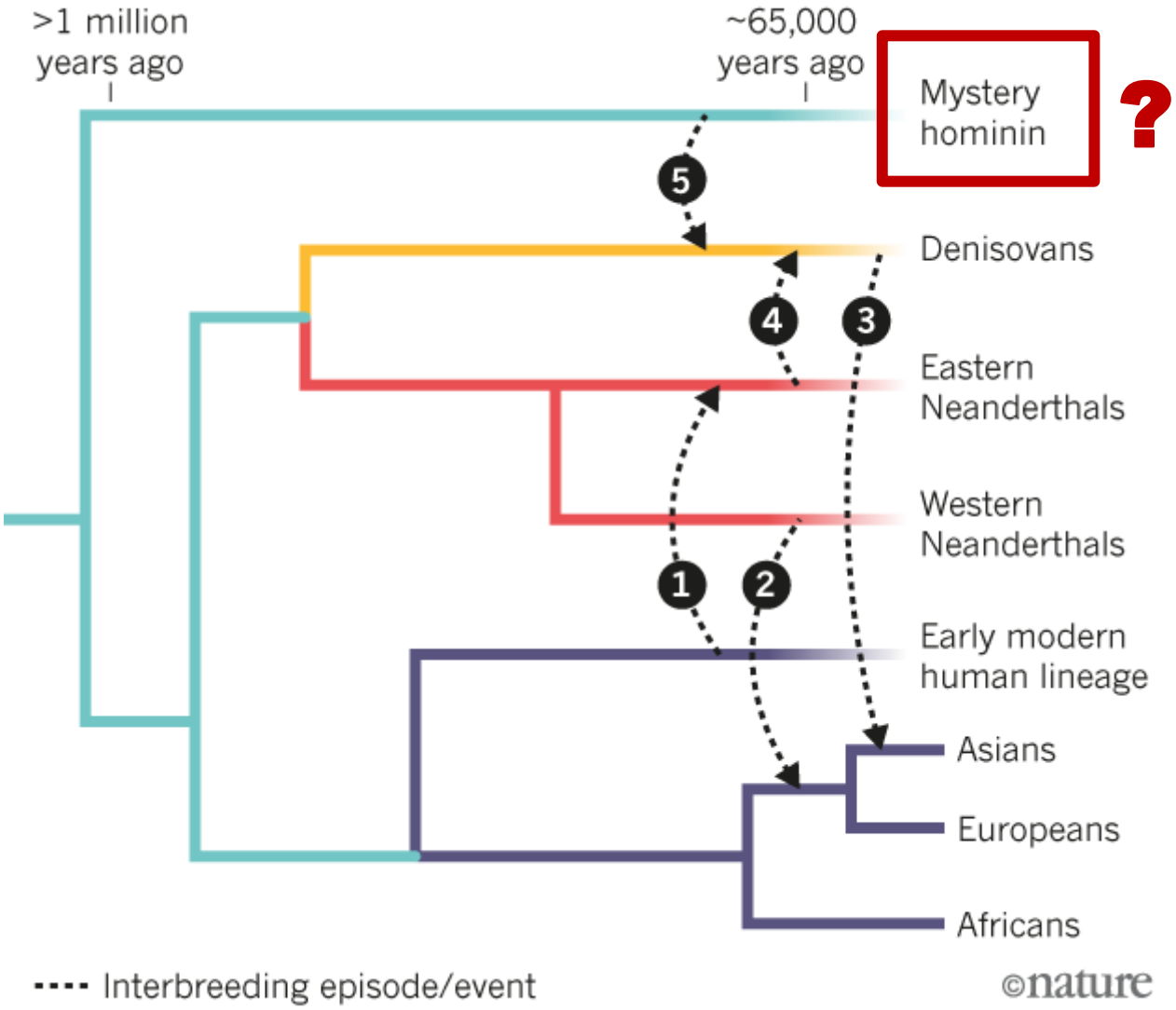
Siberian lineage

split 400-270 ths.

up to 6% Denisovan DNA
49–44 ths.
not Europe, Africa and
continental Asia

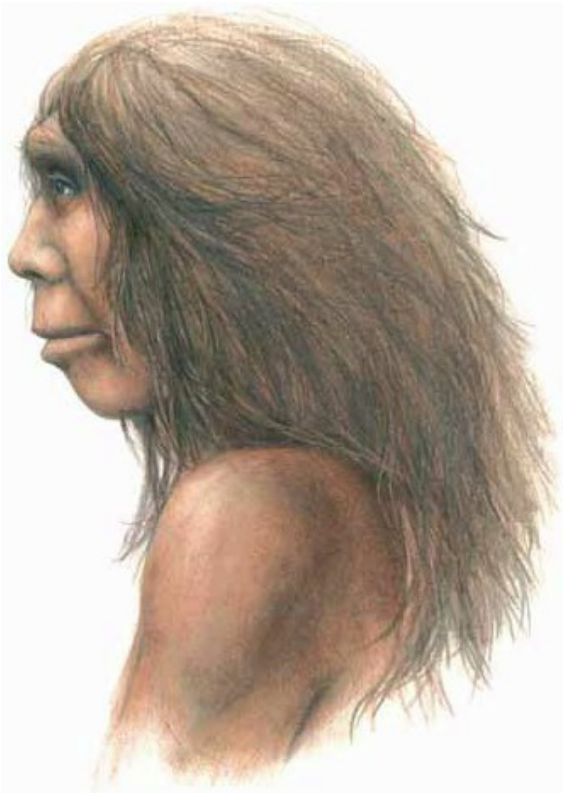


southern lineage


>1 million years ago
~65,000 years ago
Mystery hominin
?
5
Denisovans
4
3
Eastern Neanderthals
Western Neanderthals
1
2
Early modern human lineage
Asians
Europeans
Africans
Interbreeding episode/event
©nature

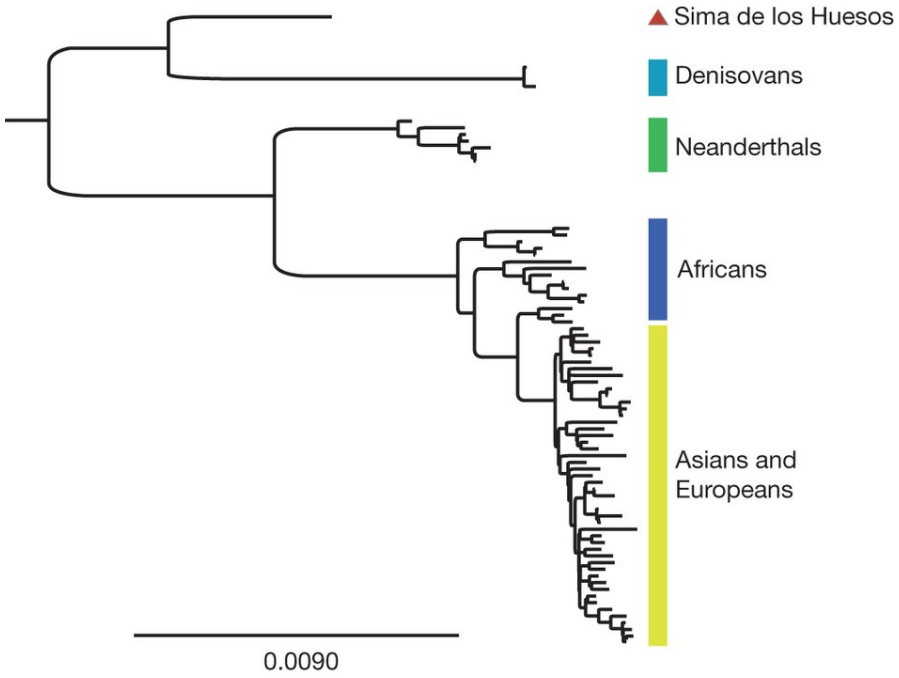
Sima de los Huesos, Cueva Mayor (Sierra de Atapuerca, N Spain)

Homo heidelbergensis

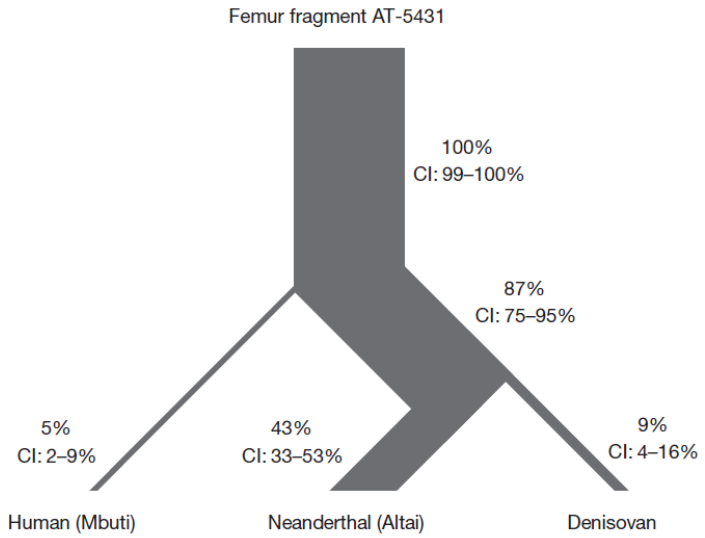


300 – 530 ths.

mtDNA:

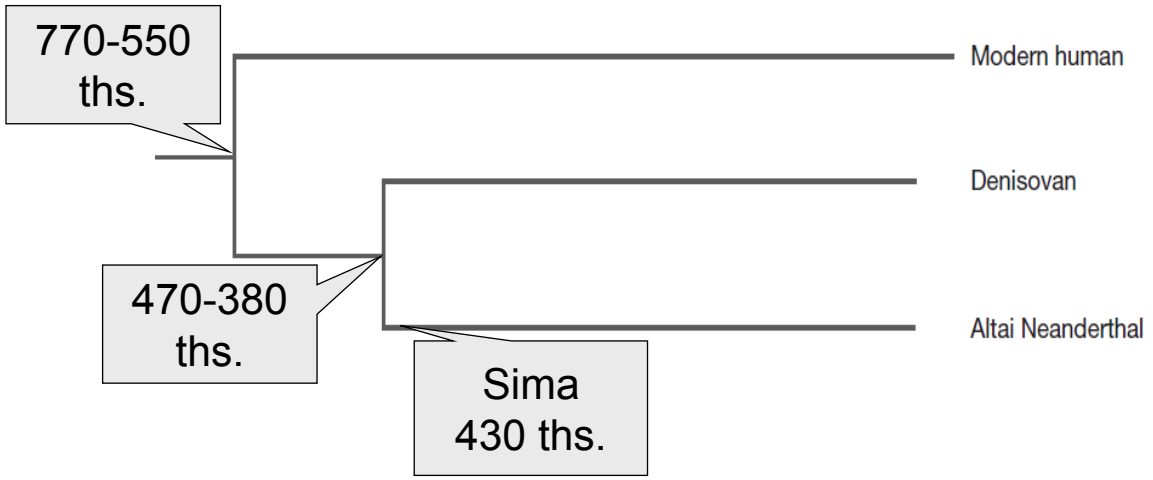


nuclear DNA:

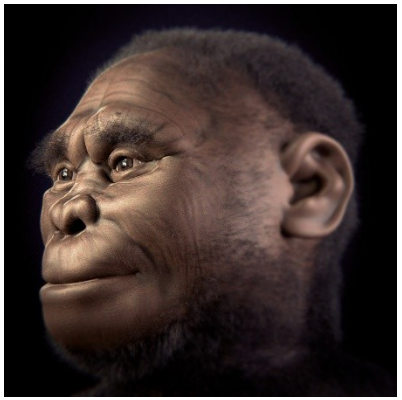


~ 430 000 years

split ca. 800 ths.

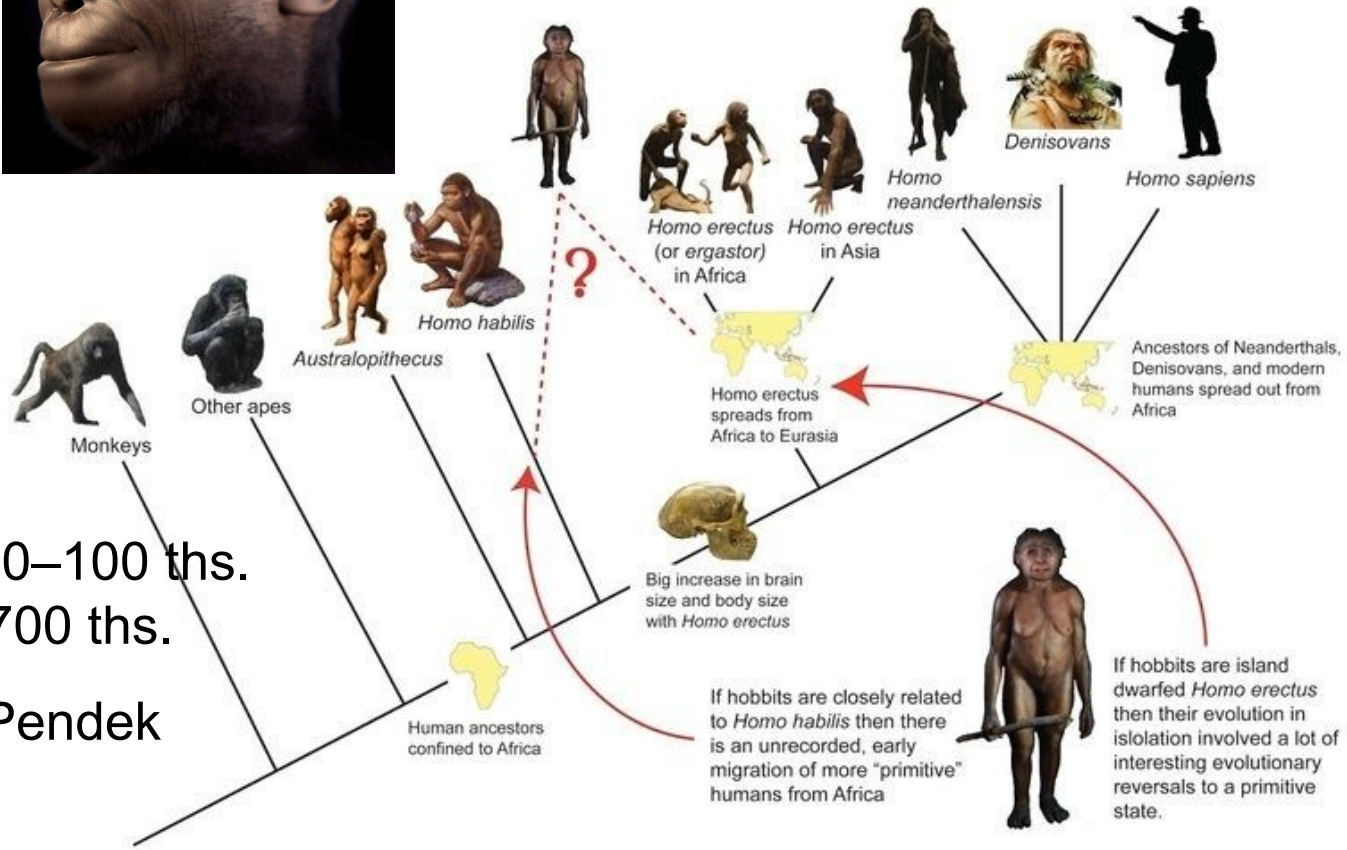


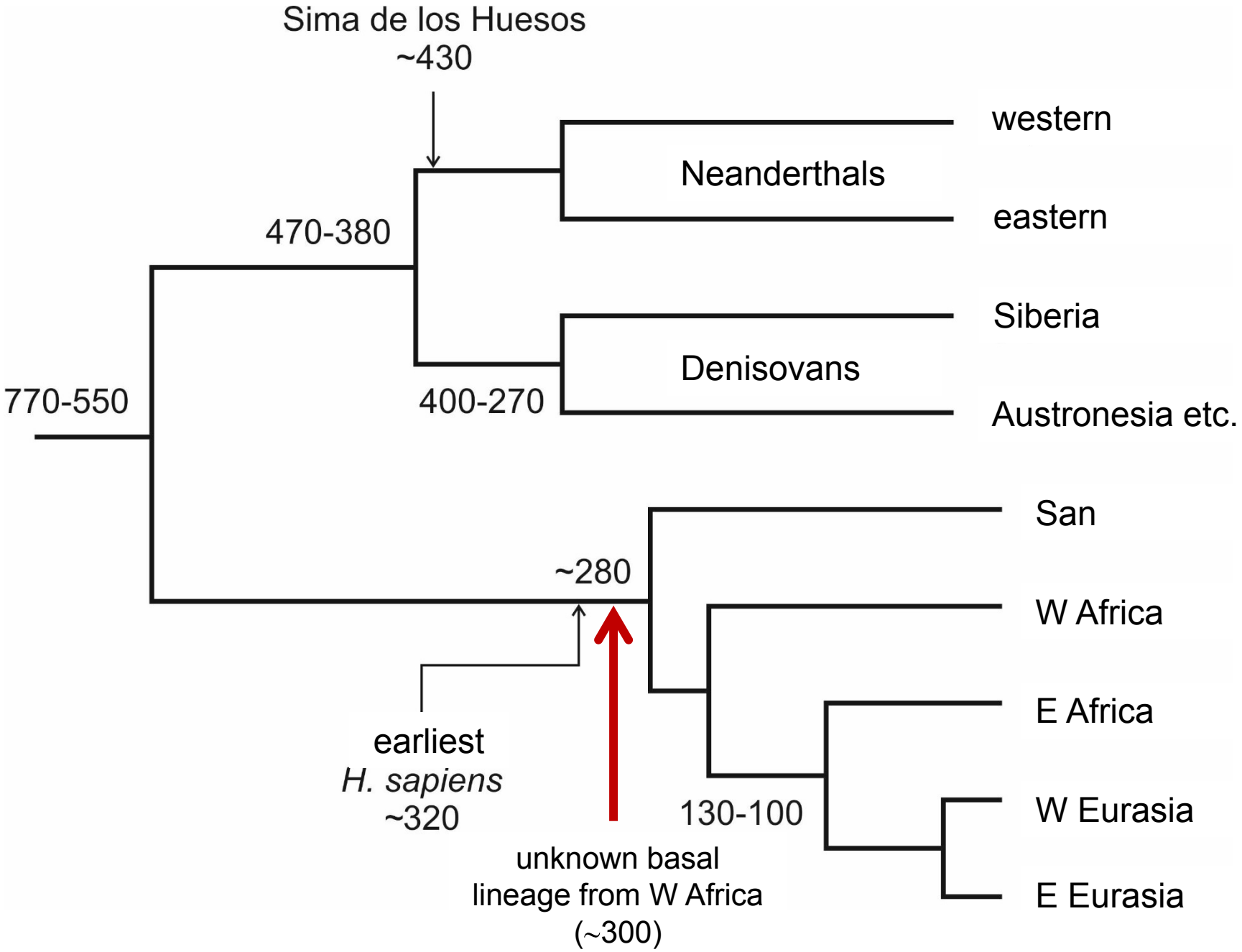
Flores' Hobit



younger estimate 60–100 ths.
older estimate ca. 700 ths.

Ebu Gogo, Orang Pendek




Sima de los Huesos
~430
western
Neanderthals
eastern
470-380
Siberia
Denisovans
770-550
400-270
Austronesia etc.
San
~280
W Africa
E Africa
earliest
H. sapiens
~320
130-100
W Eurasia
unknown basal
lineage from W Africa
(~300)
E Eurasia

~315
Jebel Irhoud
(Morocco)

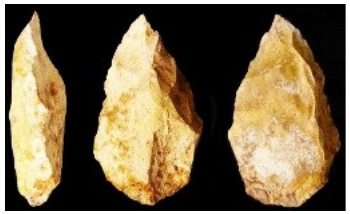
~160
Mitochondrial Eve

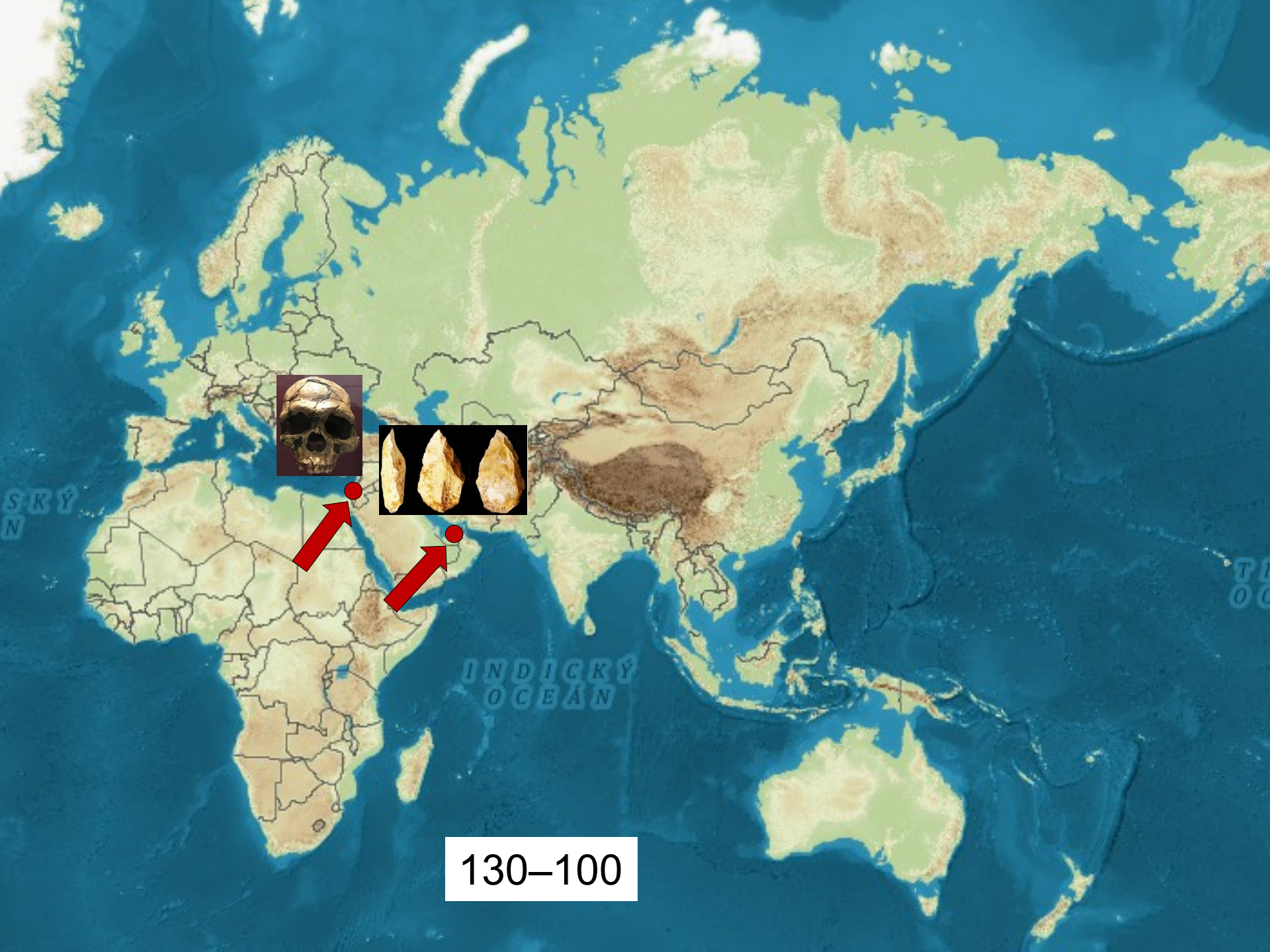
350

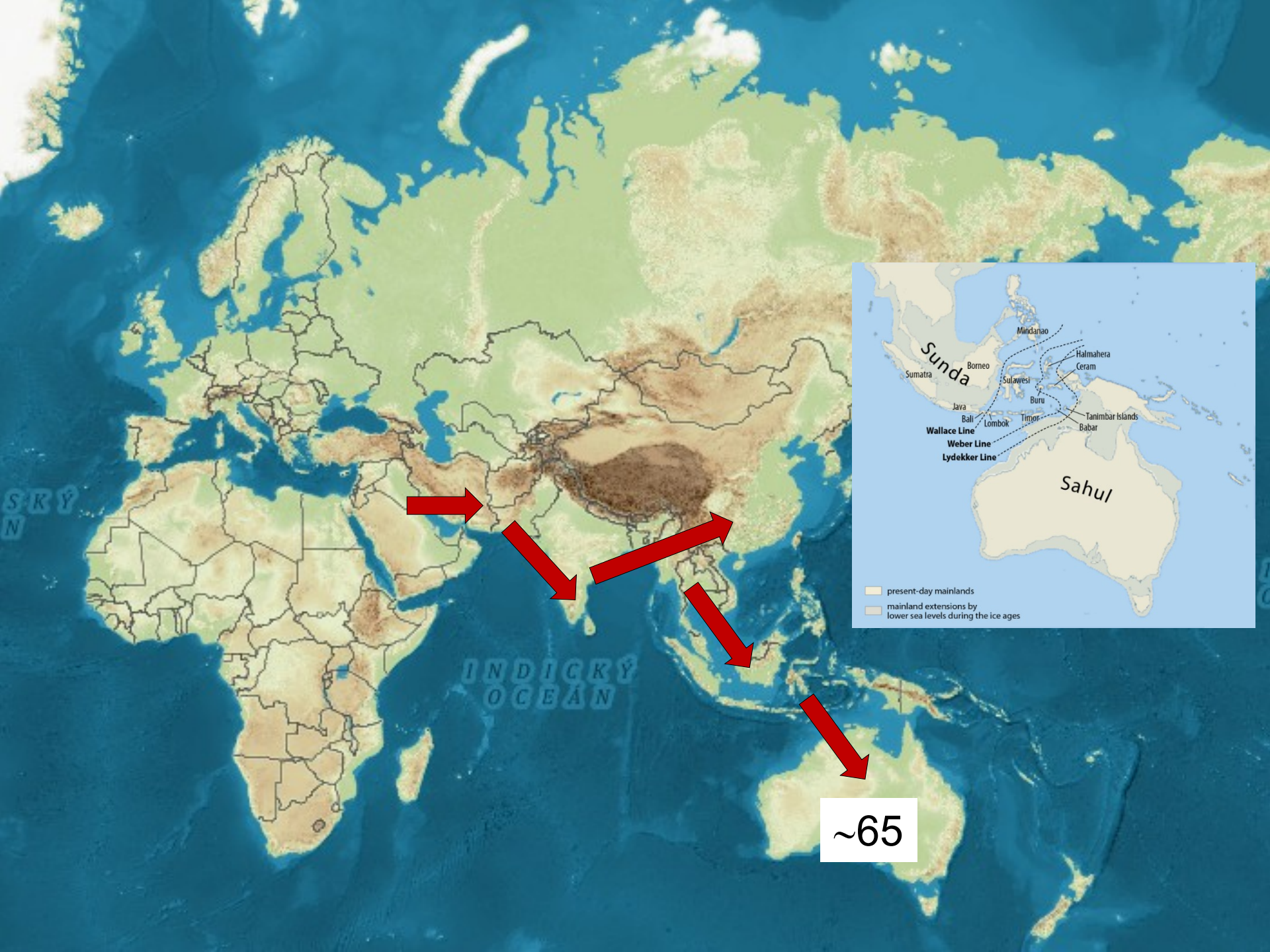
0

130-100
1st migration from Africa:
Qafzeh, Shkul
(Israel),
Jebel Faya (UAE)

~280
San + ‘Pygmies’



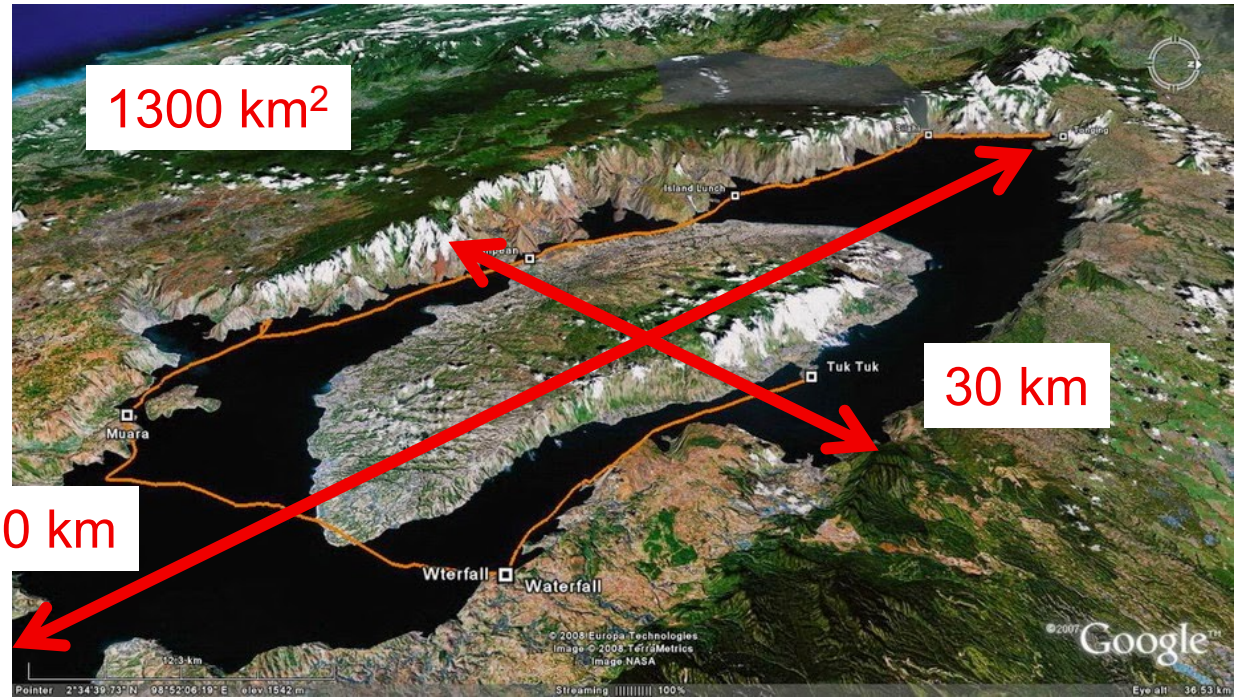

INDICKÝ
OCEÁN
130–100


INDICKÝ OCEÁN
~65
Sunda
Sahul
Mindanao
Halmahera
Ceram
Borneo
Sumatra
Sulawesi
Buru
Java
Bali
Lombok
Timor
Tanimbar Islands
Babar
Wallace Line
Weber Line
Lydekker Line
present-day mainlands
mainland extensions by lower sea levels during the ice ages

Mt. Toba:

northern Sumatra

~74 000 years

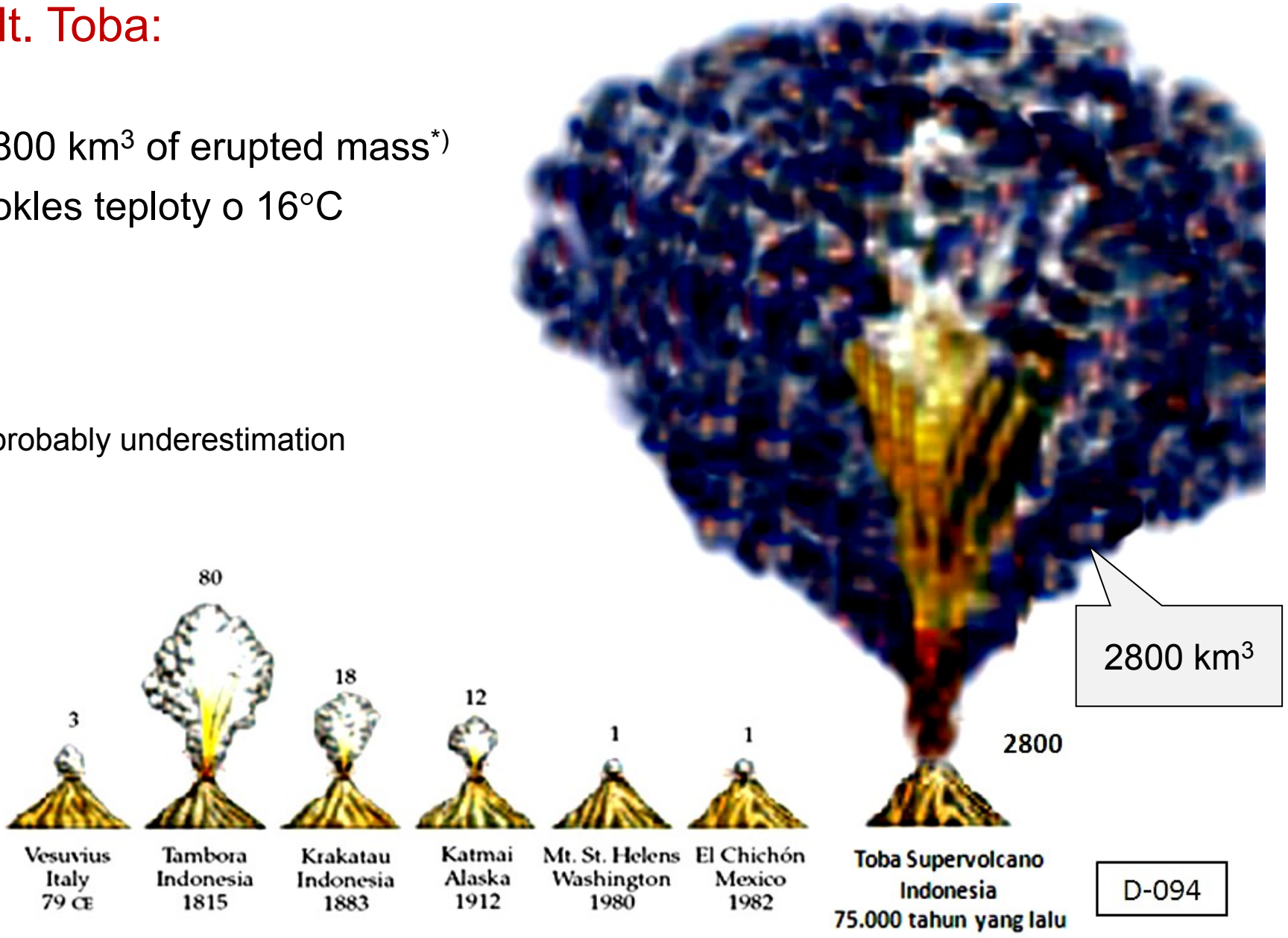


Mt. Toba:

2800 km^3 of erupted mass*)

pokles teploty o 16°C

*) probably underestimation



~315
Jebel Irhoud
(Morocco)

~ 160
Mitochondrial Eve

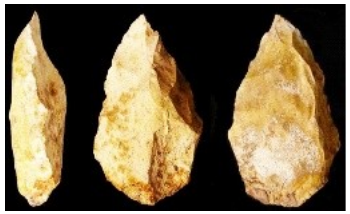
41–39
last
Neanderthals

50
2nd migration
from Africa

350

0

130-100
1st migration from Africa:
Qafzeh, Shkul
(Israel),
Jebel Faya (UAE)



~ 280
San + ‘Pygmies’

~45
colonisation
of Europe

54–49

INDICKÝ OCEÁN

50 ago


Oase cave ~40
Ust'-Ishim ~45
~45
49–44
INDICKÝ OCEÁN

AMH

Neanderthals

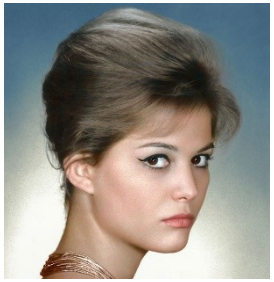
Denisovans

54–49 tis.

49–44 tis.

5000 years!

Europe

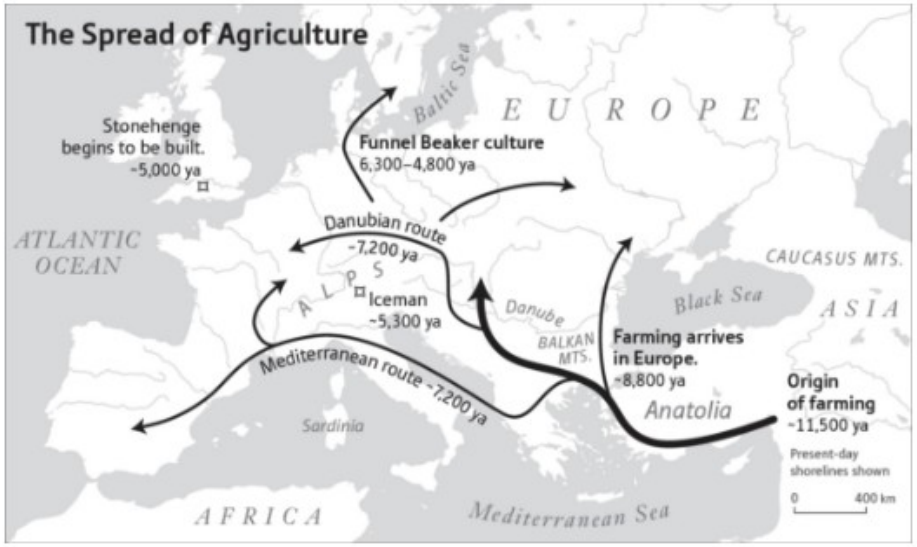


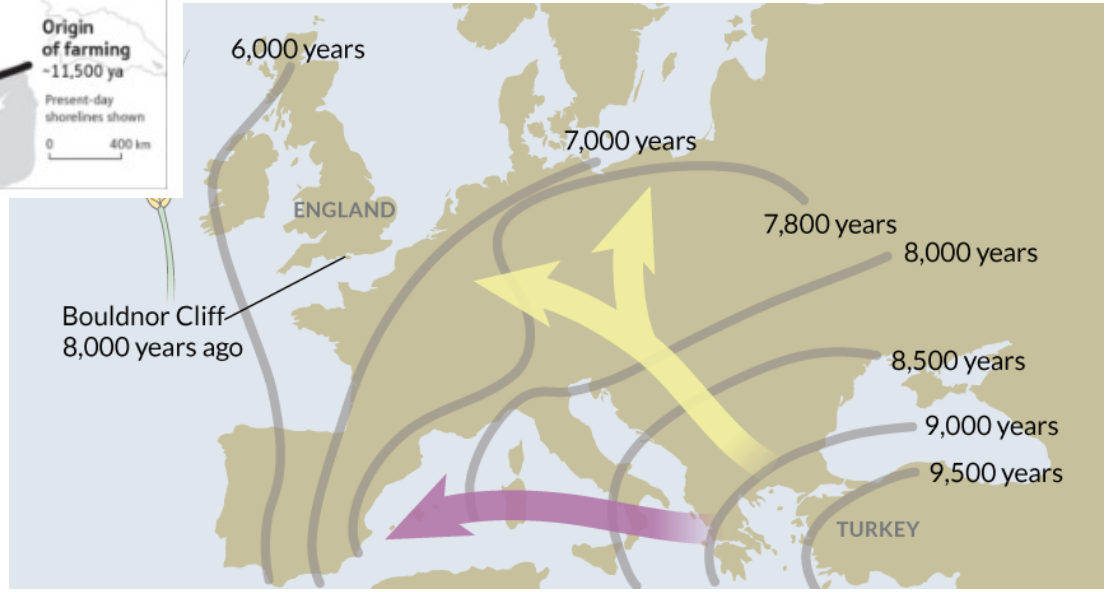
E Asia

Papua, Australis

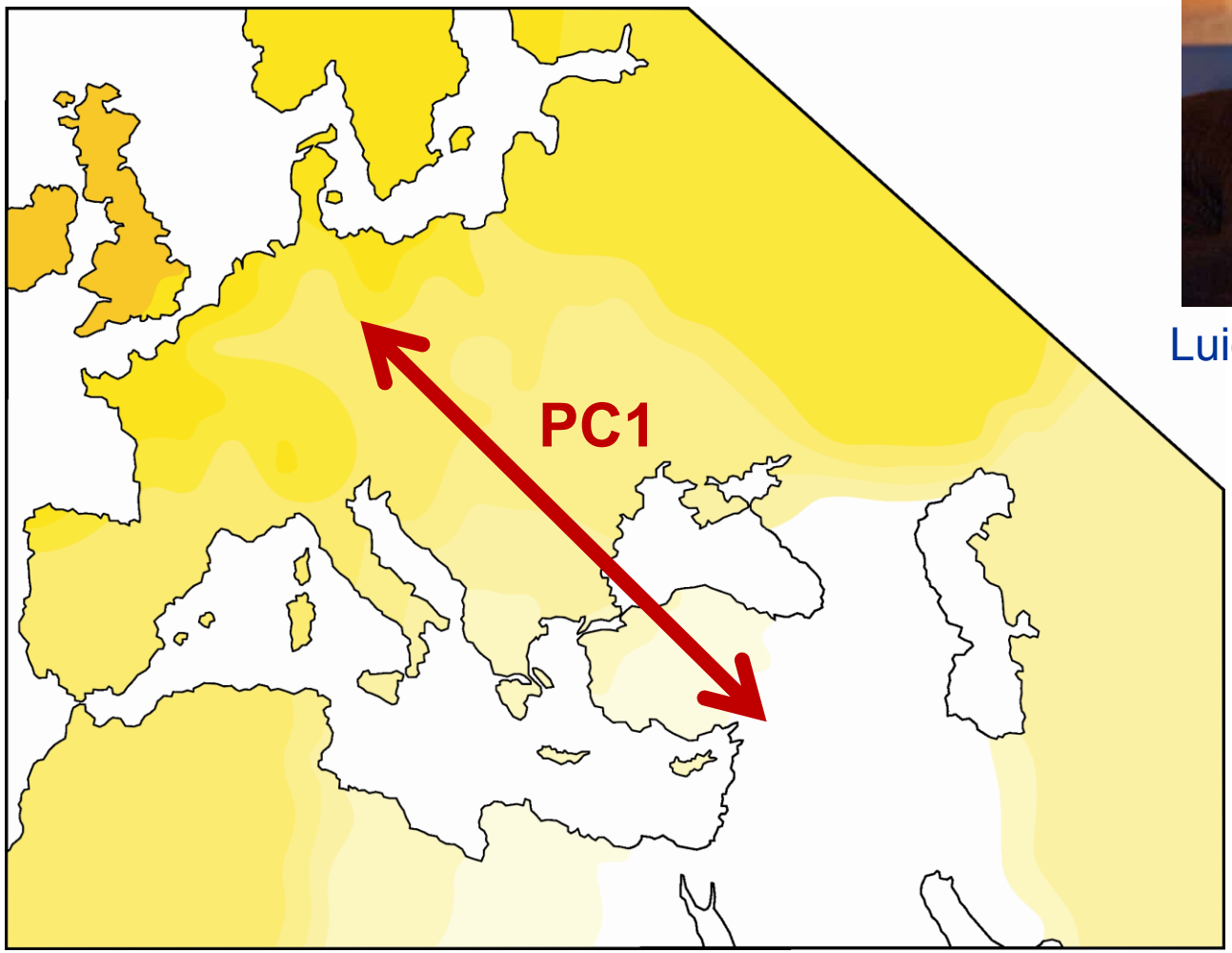
Neolithic onset in Europe – acculturation or demic diffusion?

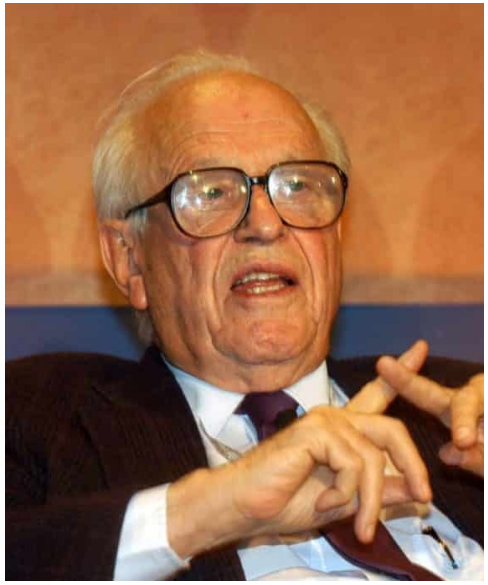
Min. 8 centres:
Fertile Crescent, N and S China, Sahel, Papua-New Guinea, central Mexico, Peruan Andes, and E Northern America





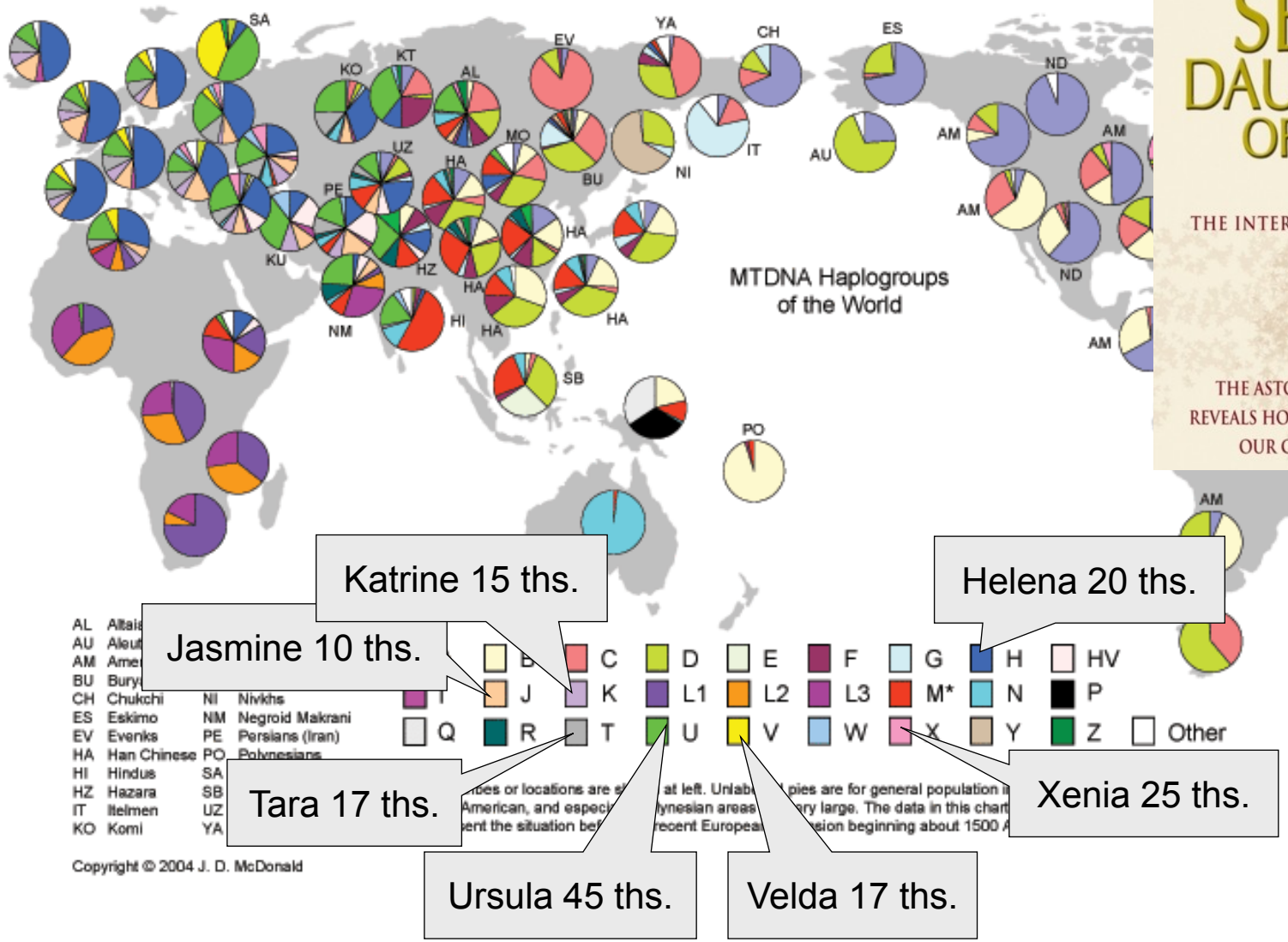
blood groups

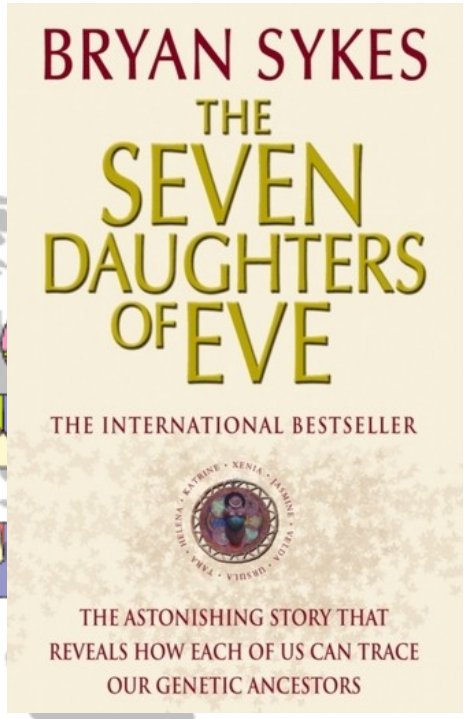




Luigi Luca Cavalli-Sforza
(1922–2018)

mtDNA





Katrine 15 ths.

Jasmine 10 ths.

Helena 20 ths.

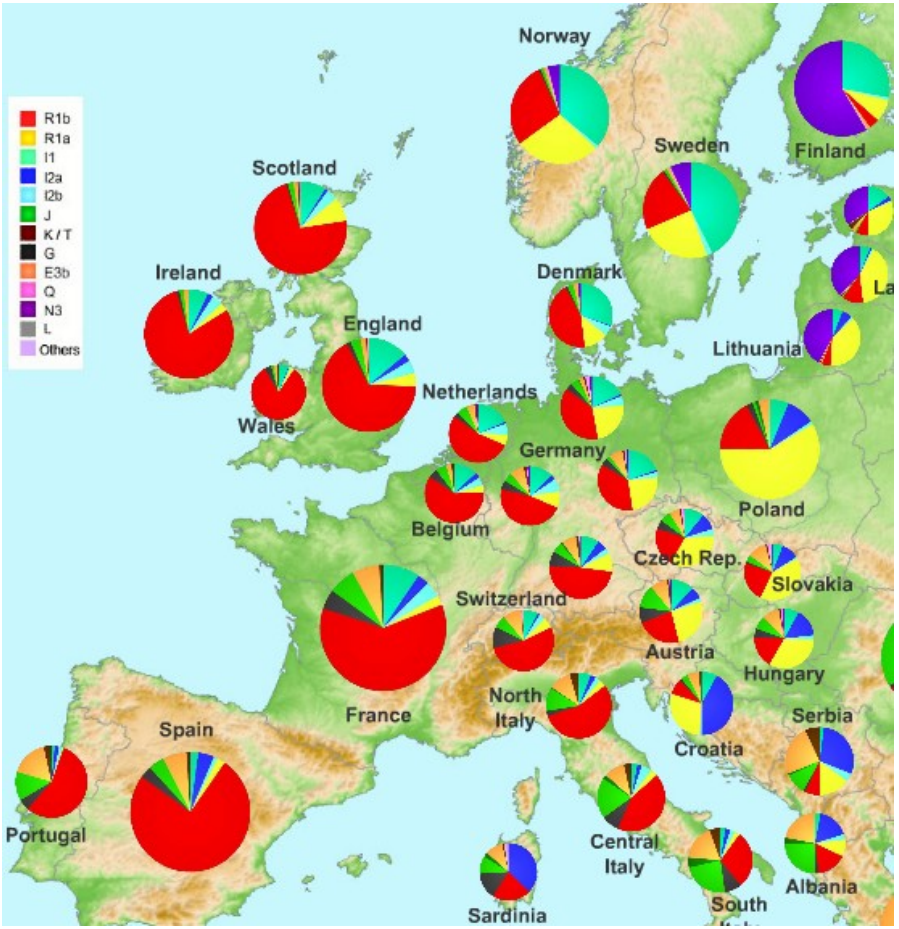
Tara 17 ths.

Xenia 25 ths.

Ursula 45 ths.

Velda 17 ths.

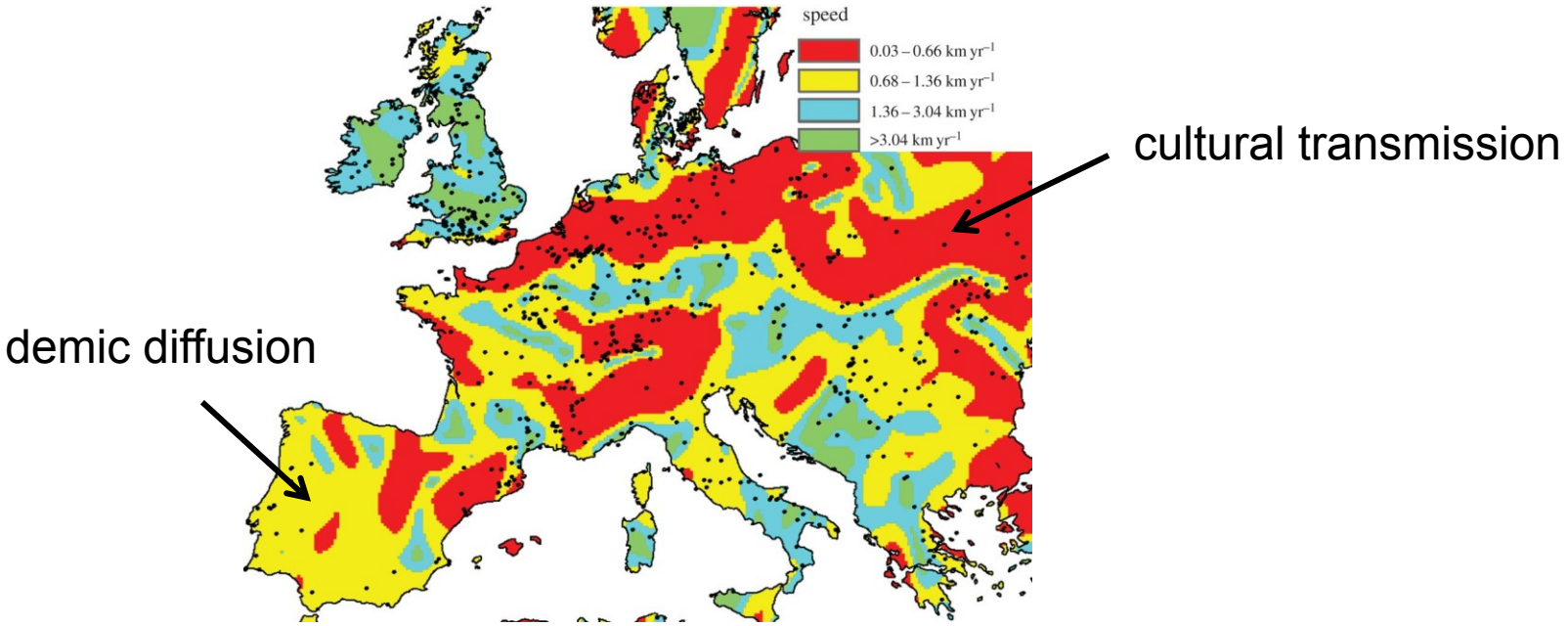
Y chromosome

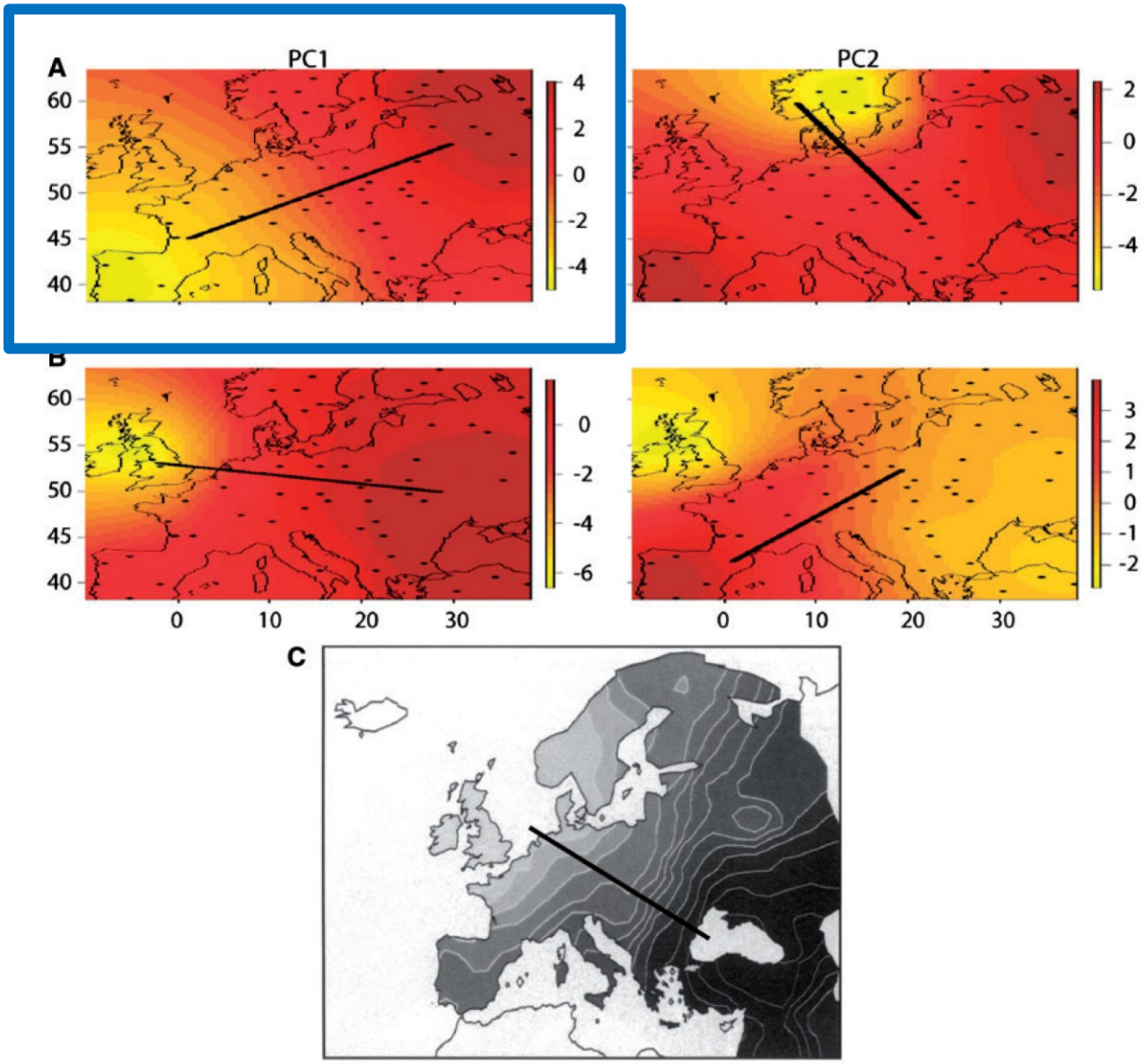


mtDNA: only ~20% palaeolithic origin → more acculturation?

craniometry, nuclear genes (*NR4*): demic diffusion

→ corresponds to male migration



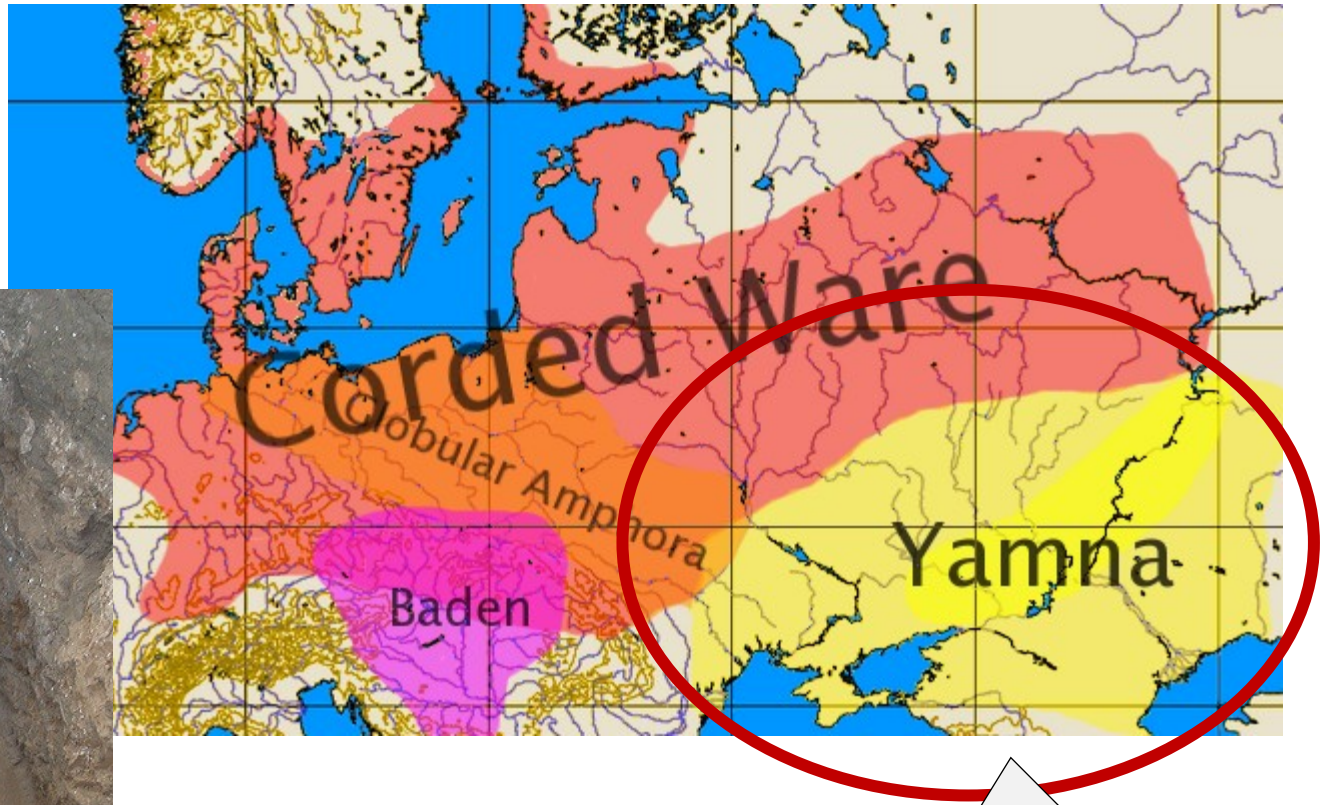


Arenas et al.: Mol. Biol. Evol. (2012)

10 ths.: 4 large populations: hunters-gatherers of W and C+E Europe ...

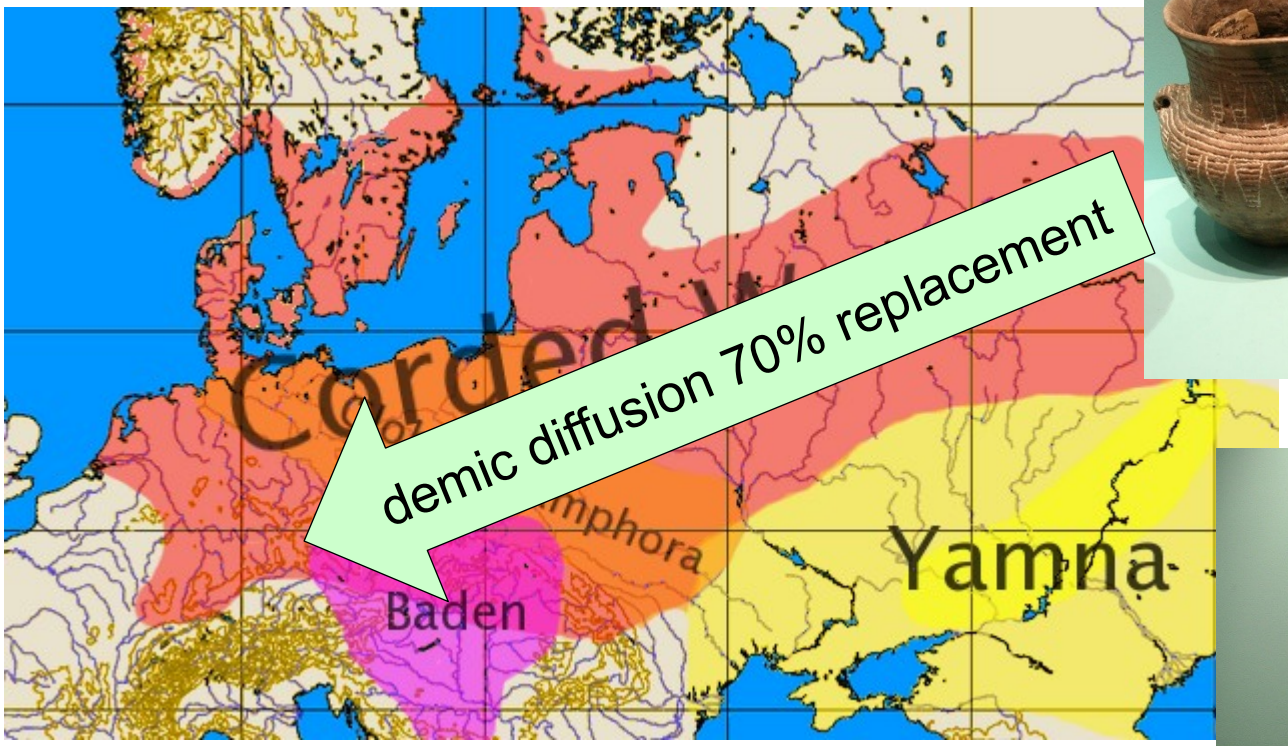
... farmers of Fertile Crescent + E Iran

ca. 5000 ago: Yamna culture expansion
admixture of populations of Armenia and Iran (1 : 1)



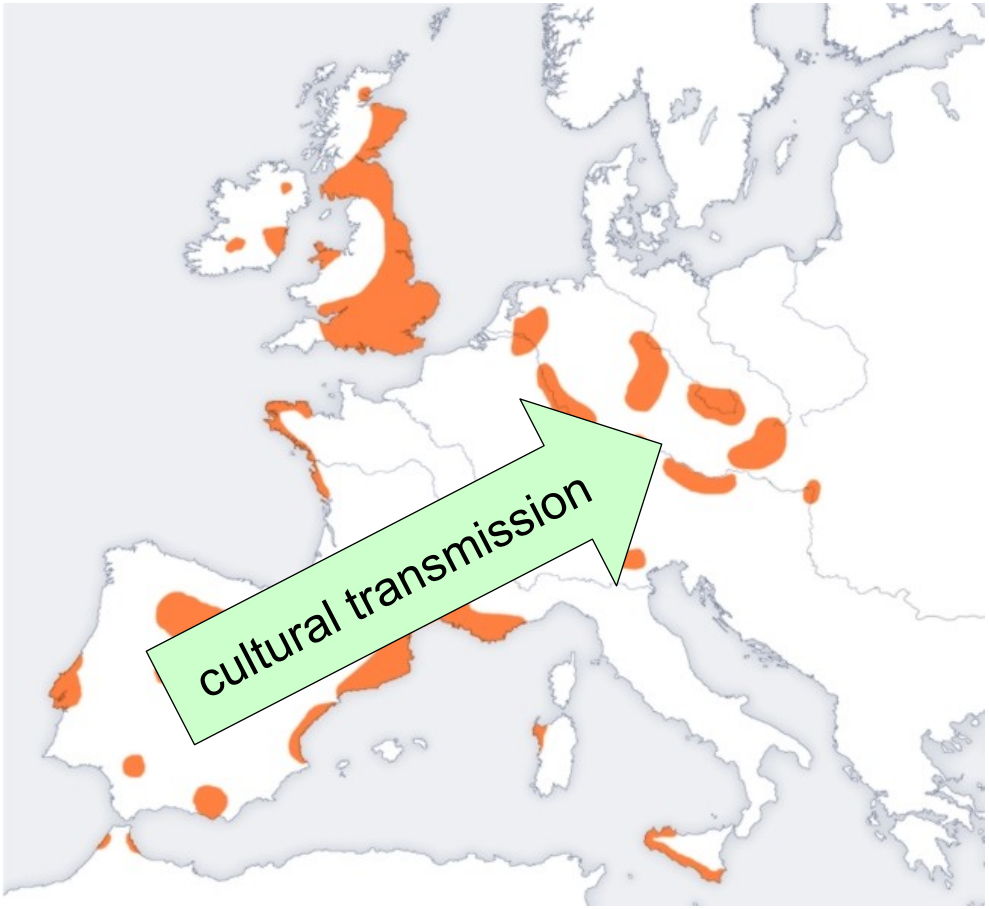
probably spread of Indo-European languages!

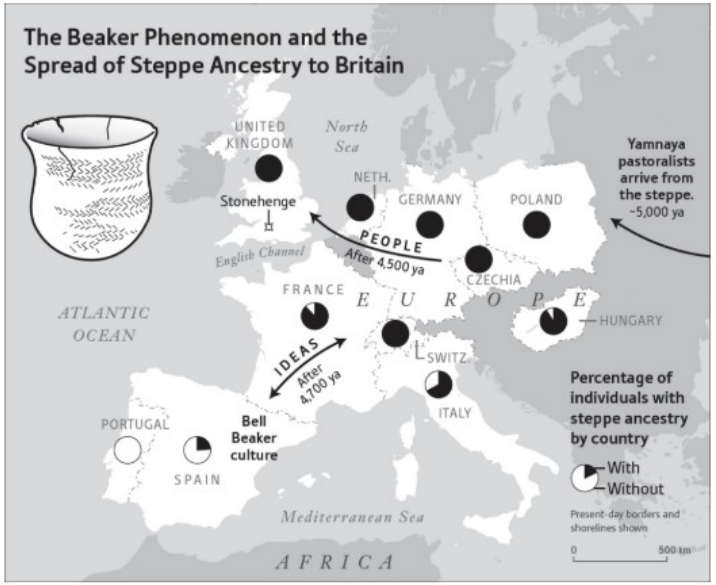
ca. 4 900: Corded Ware culture



4900-1800: Bell Beaker culture, originally Iberian peninsula

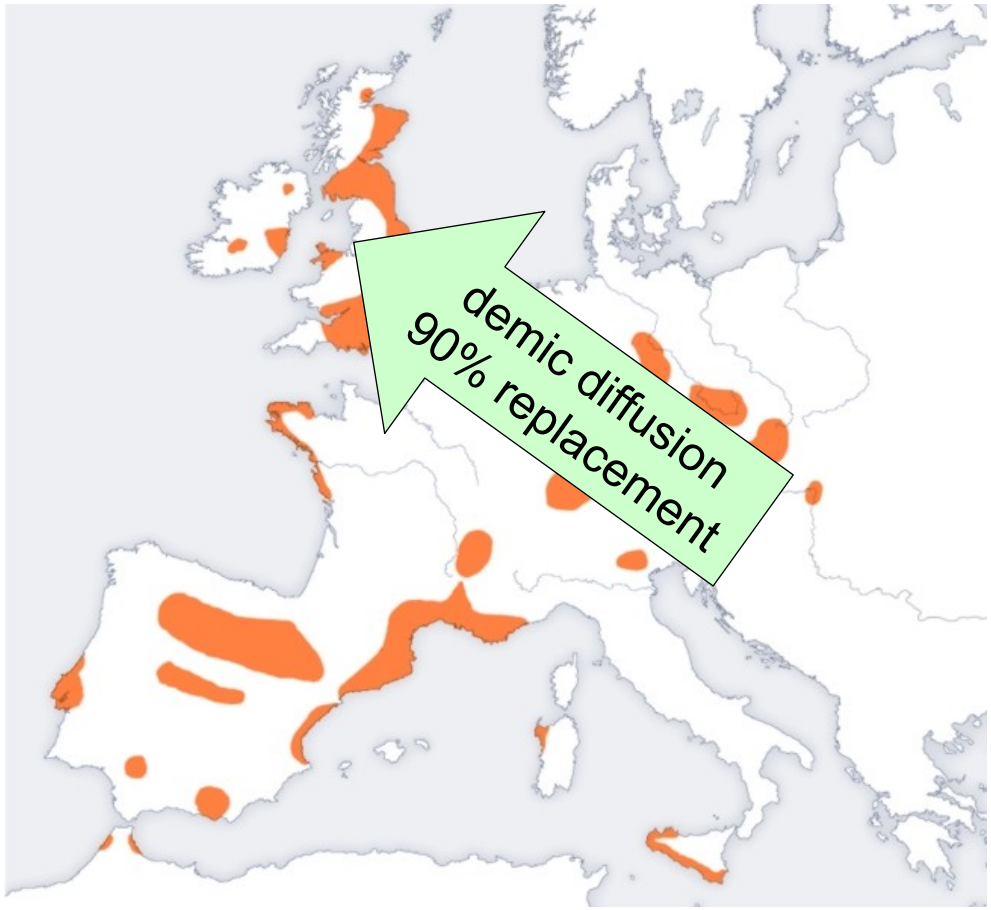
4900-1800: Bell Beaker culture

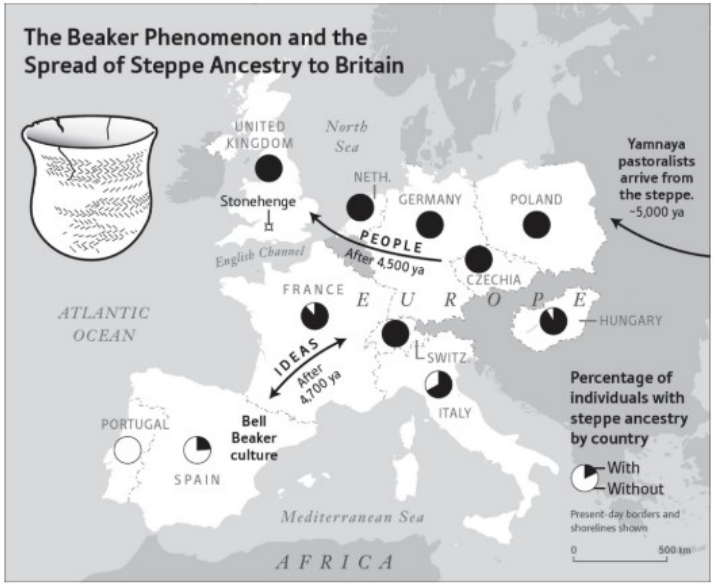




after 4700

4900-1800: Bell Beaker culture





after 4500

What defines humans?

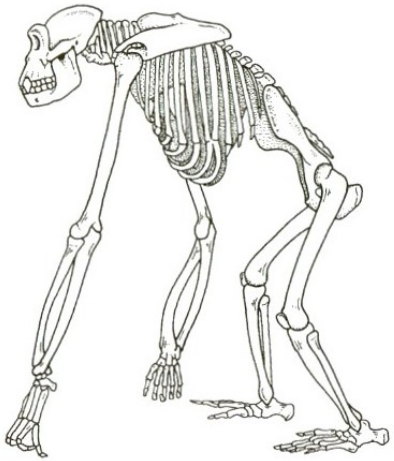
upright posture?

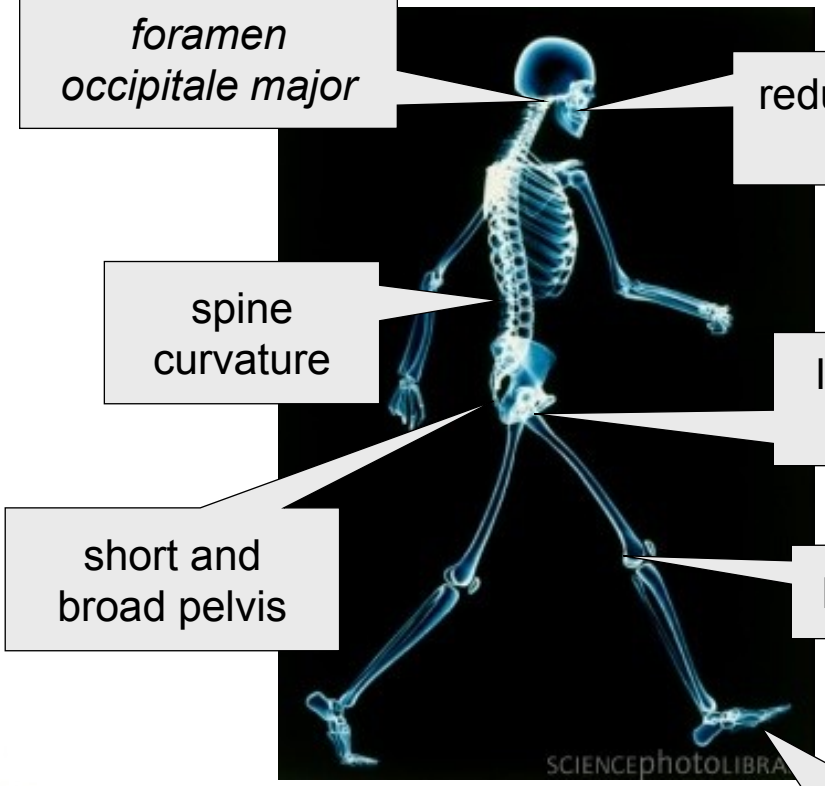
tools?

brain?

speech?

Typical skeleton traits:





foramen occipitale major

reduction of face and teeth

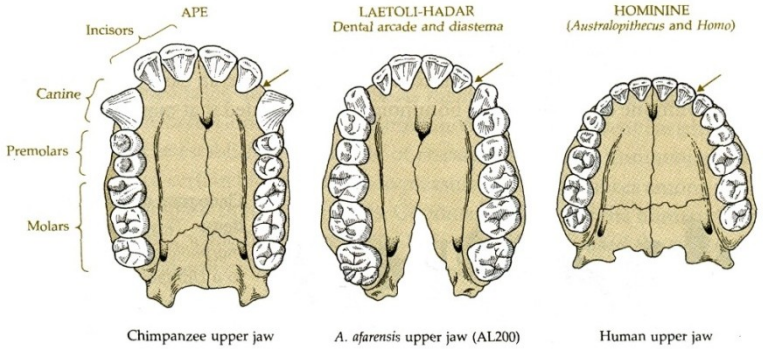
spine curvature

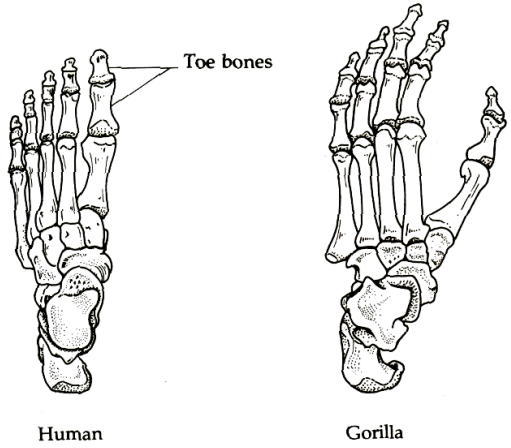
large head of femur

short and broad pelvis

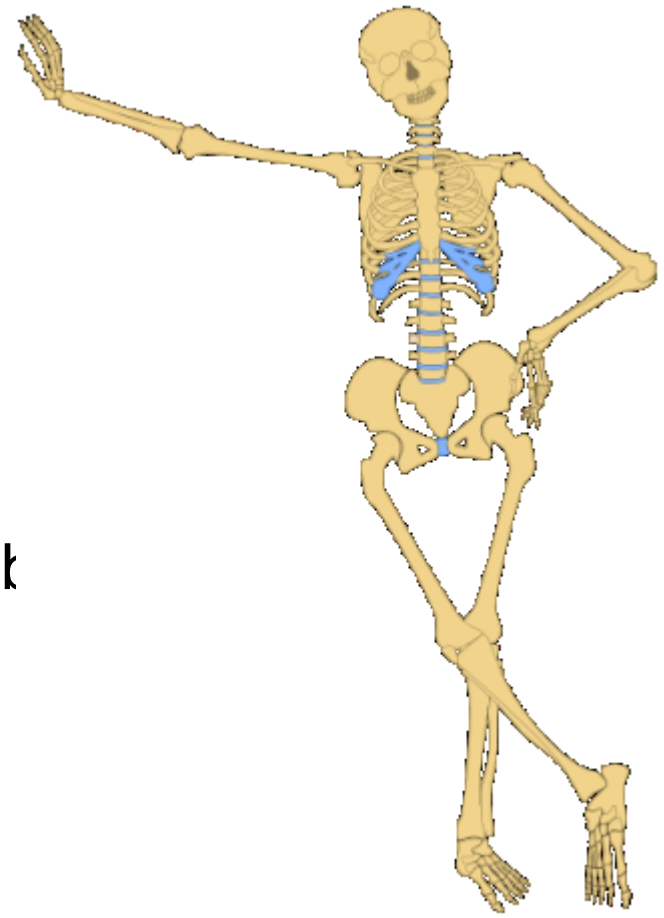
knee shape

short toes, foot curvature





Upright posture drawbacks:



painful parturition

spine pain

hernia

varicose veins, circulation prob

haemorrhoids

flatulence during pregnancy

flat feet, corns, legs pain

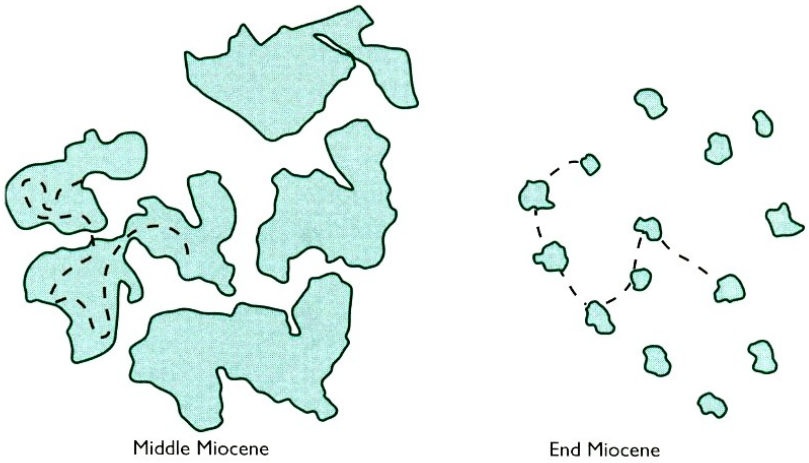
necessity to learn walking

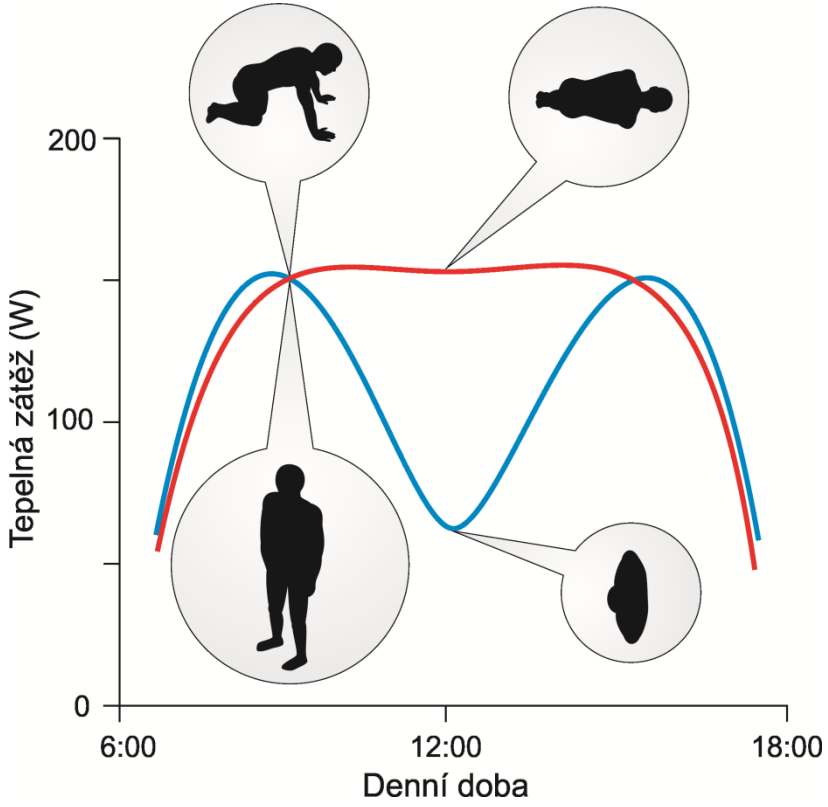
end of Miocene: climatic changes

forest → savanna

getting upright posture:

better view (predators, prey? food gathering? using tools?
thermoregulation? migrations for food?





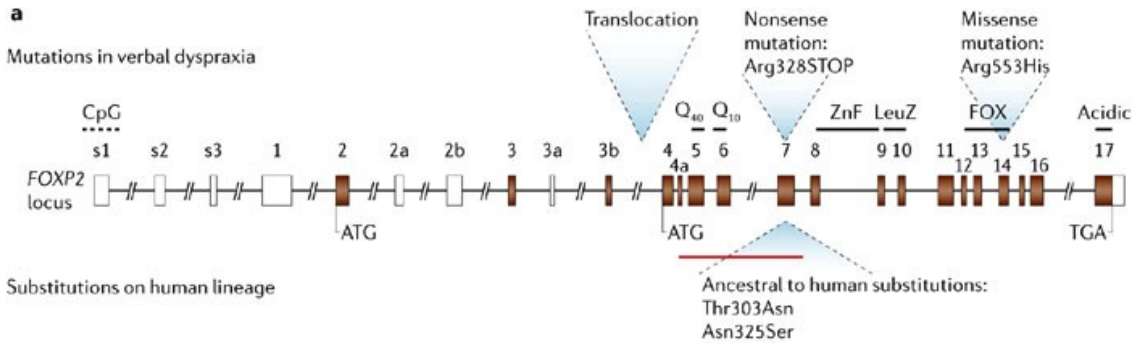
What defines humans?

upright posture?

tools?

brain?

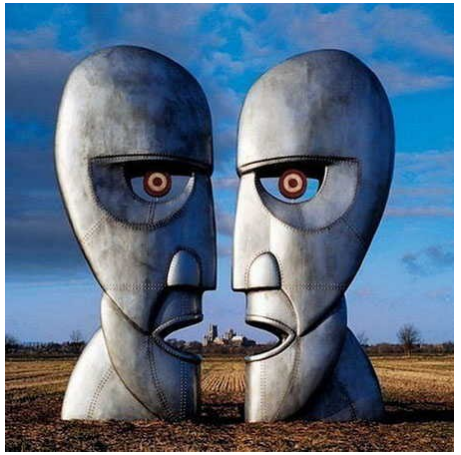
speech?

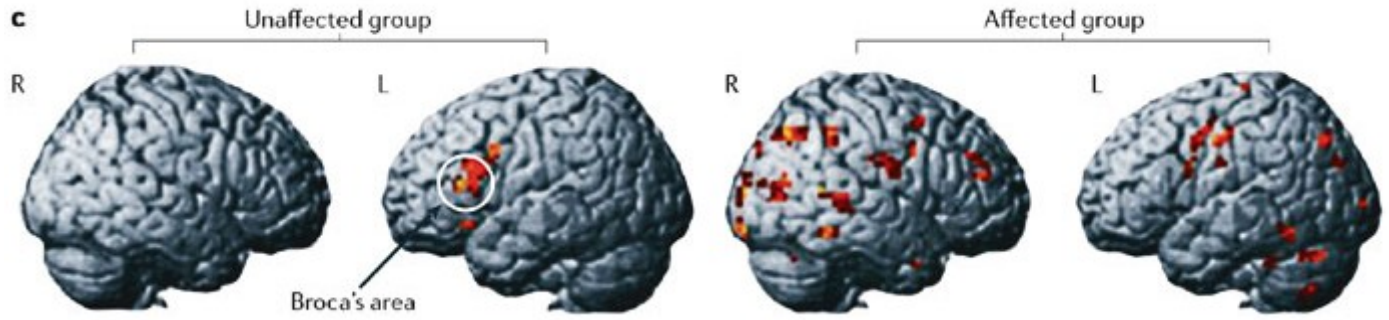


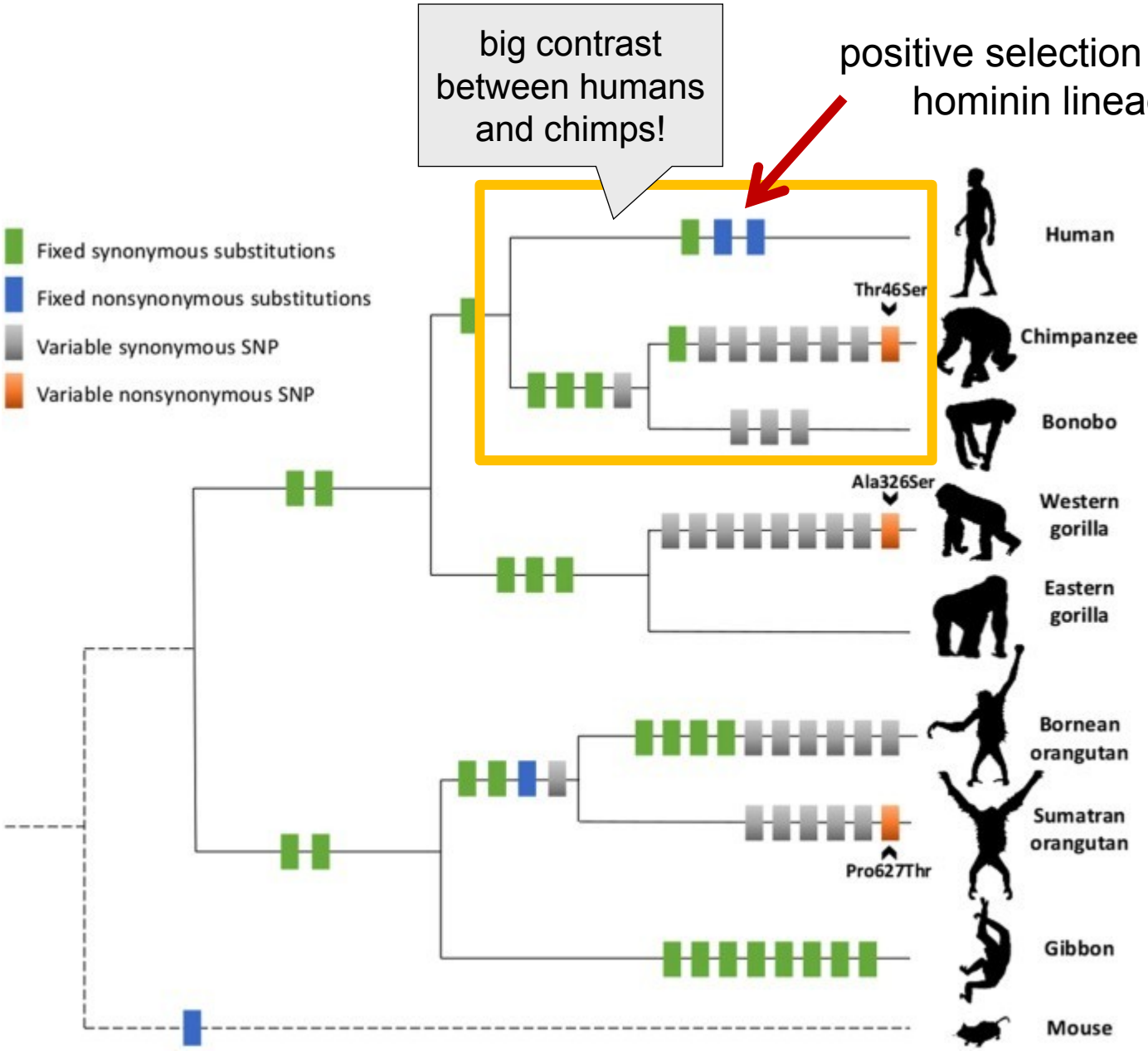
gene *FOXP2* (*Forkhead box 2*):

very conservative

in humans ability of speech






big contrast between humans and chimps!
positive selection on the hominin lineage
Fixed synonymous substitutions
Fixed nonsynonymous substitutions
Variable synonymous SNP
Variable nonsynonymous SNP
Thr46Ser
Ala326Ser
Pro627Thr
Human
Chimpanzee
Bonobo
Western gorilla
Eastern gorilla
Bornean orangutan
Sumatran orangutan
Gibbon
Mouse

Uniqueness of human evolution

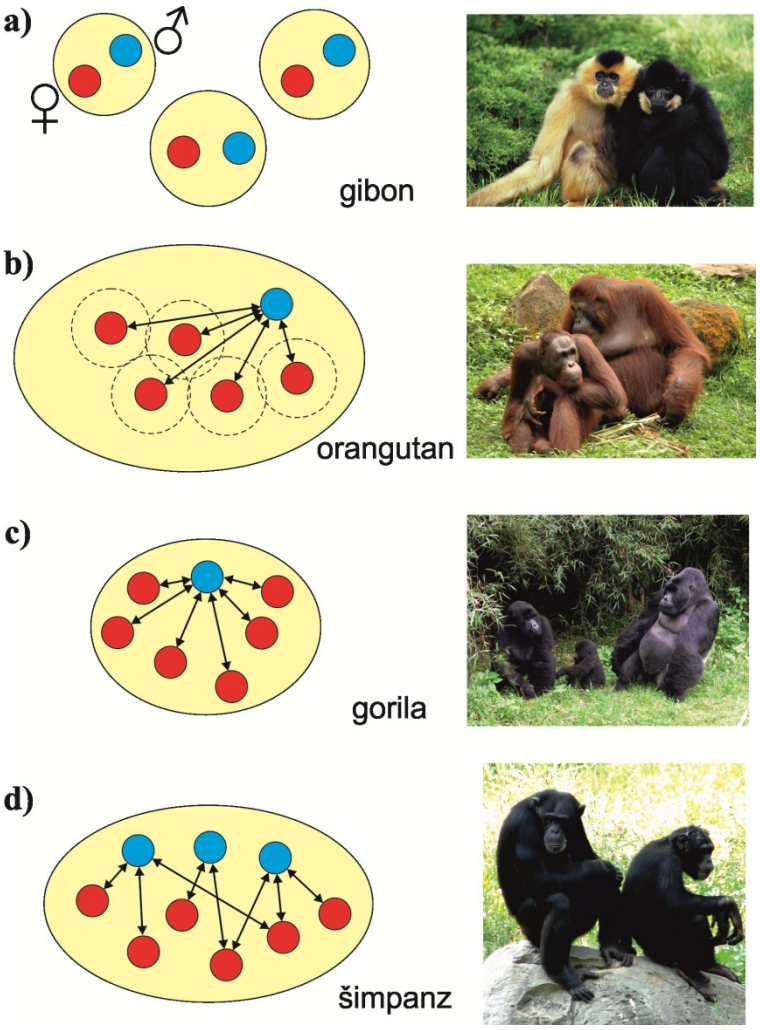
social system: group life,
monogamy but tendency to polygamy

paradox: fast evolution but only a single species

typical 2 processes:

ecological dominance: external environment → humans are 'hostile force of nature' for themselves

cooperative competition: cooperation to compete (runaway social selection)



Why menopause?

group selection – avoid delivery of defected children and deterioration of the gene pool?

lifespan increase, menopause as a consequence of senescence?

today: help with childcare

Why hidden ovulation?

commodity mining (‘prostitution’)?

raising doubts, avoiding infanticide?

continuous sexuality, paternal care?

Why ‘hairlessness’?

sexual selection?

defence of parasites?

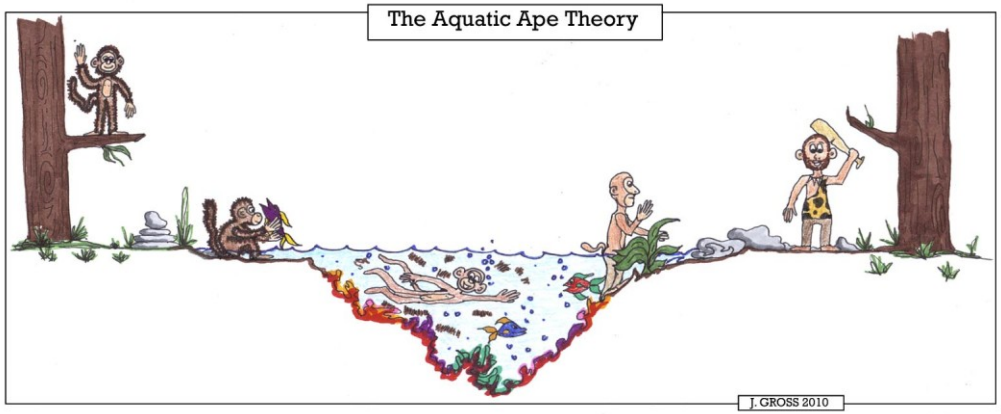
clothes, fire and shelter (uselessness of fur)?

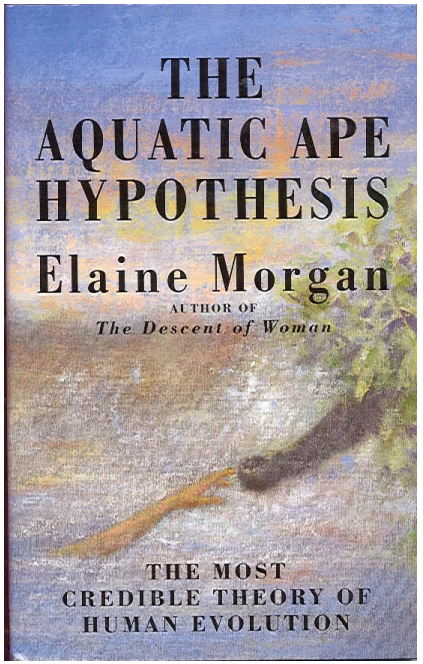
species identification?

neoteny?

aquatic life of ancestors (Alistair Hardy, Elaine Morgan)?

thermoregulation!





CULTURAL EVOLUTION

chimpanzees, great tits, brown rats, Japanese makaque (*Macaca fuscata*)

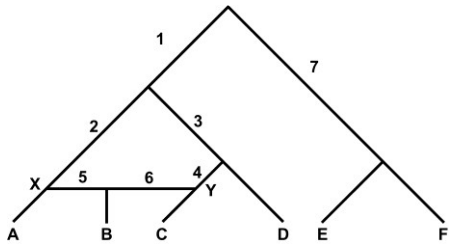
Cultural evolution characteristics:

both vertical and horizontal

Lamarckian

fast

reticulate



selection of cultural traits (memes)

group selection

not only cultural transmission but also population growth (demic diffusion)

culture can affect genetic factors

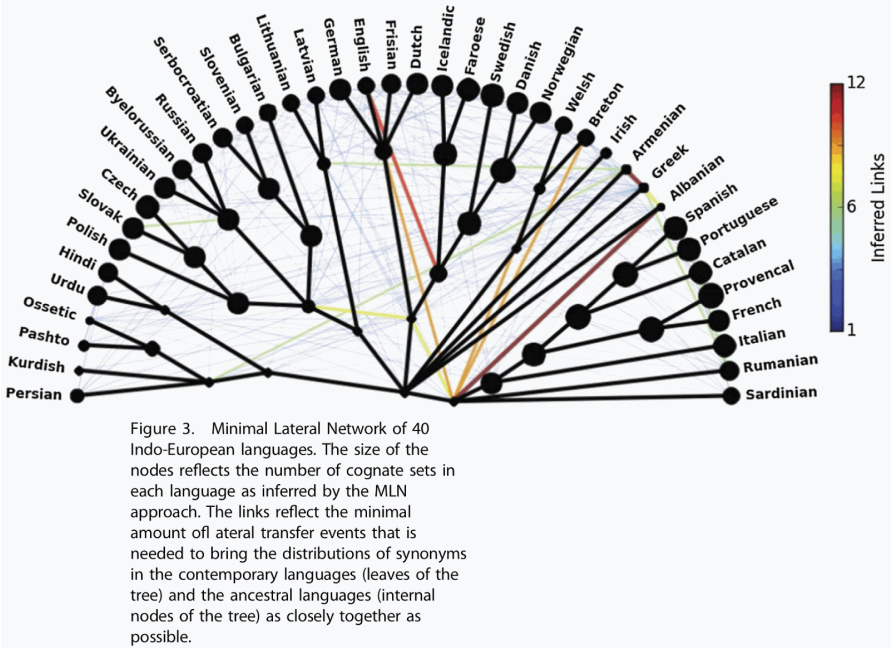


Figure 3. Minimal Lateral Network of 40 Indo-European languages. The size of the nodes reflects the number of cognate sets in each language as inferred by the MLN approach. The links reflect the minimal amount ofl ateral transfer events that is needed to bring the distributions of synonyms in the contemporary languages (leaves of the tree) and the ancestral languages (internal nodes of the tree) as closely together as possible.