



Education and Culture

Erasmus Mundus

Laurea Magistrale in QUATERNARIO, PREISTORIA E ARCHEOLOGIA

Master in PREISTORIA E QUATERNARIO

Homo sapiens



Julie Arnaud

Julie.arnaud@unife.it

Slides (Marta Arzarello & Florent Detroit)

Out of Africa 1
Homo ergaster

Map illustrating the migration of *Homo ergaster* out of Africa, showing the path of migration and the distribution of other hominid species.

Key sites and species labeled on the map include:

- Africa:** STERKPOINTEIN, SWARTKRANS, OLDUVI GORGE, *Homo habilis*, *Homo ergaster*, HERTO BOORT, BULI, KESHER BENOT YAKOV, VUJEDINA, TERMIFFINE, SIERRA DE ATAPUERCA, *Homo antecessor*.
- Europe:** *Homo georgicus*, DMANISI.
- Asia:** ZHOUKOUZHUAN, LANTIAN, BENZIDONG, *Homo erectus*, YUAKMOU, BUNAT, SANGIRAN, INDOKERTO, TRONOL.

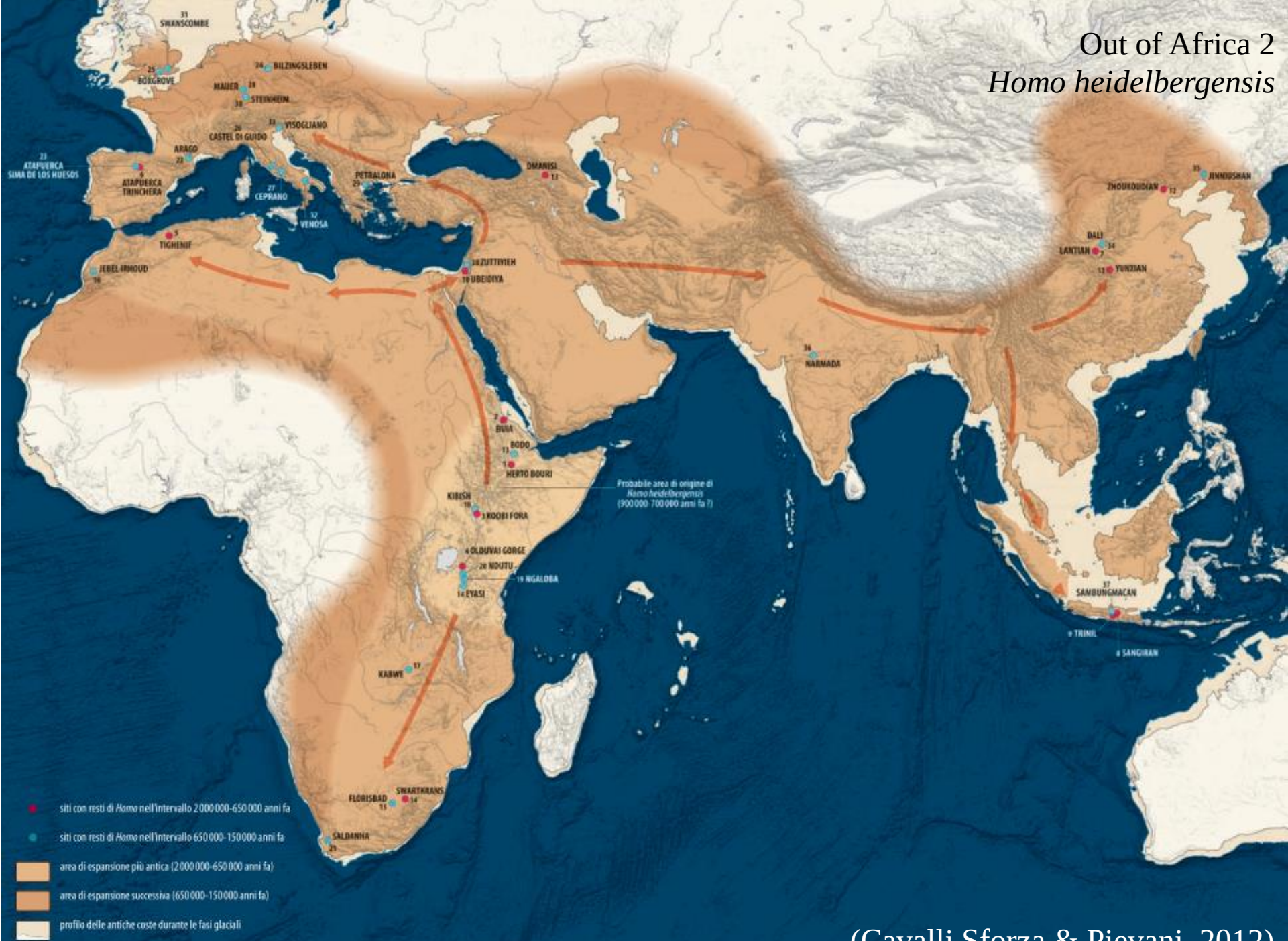
Legend: profilo delle antiche coste durante le fasi glaciali

(Cavalli Sforza & Pievani, 2012)

(Cavalli Sforza & Pievani, 2012)

 profilo delle antiche coste durante le fasi glaciali

Out of Africa 2 *Homo heidelbergensis*



(Cavalli Sforza & Pievani, 2012)

Out of Africa 3
Homo sapiens

Senzi Cave
140,000-130,000 anni fa

Qafzeh Cave
100,000 anni fa

Abu Hureira
130,000-110,000 anni fa

Kharijeh Cave
100,000 anni fa

Klasies River Cave
120,000-60,000 anni fa

Pinnacle Point
170,000-160,000 anni fa

Blombos Cave
140,000-130,000 anni fa

Nertis Bone
140,000-130,000 anni fa

Enlène Valley
100,000 anni fa

Erudone del Toba
17,000-17,000 anni fa

Sarawak
10,000-10,000 anni fa

Lijiang
10,000-10,000 anni fa

Zhoukoudian
67,000-67,000 anni fa

espansioni da 195.000 a 85.000 anni fa

espansioni da 85.000 a 45.000 anni fa

profilo delle antiche coste durante le fasi glaciali

(Cavalli Sforza & Pievani, 2012)

(Cavalli Sforza & Pievani, 2012)

Definizione della specie *Homo sapiens* basata sui criteri morfologici (Definizione paleontologica della specie)

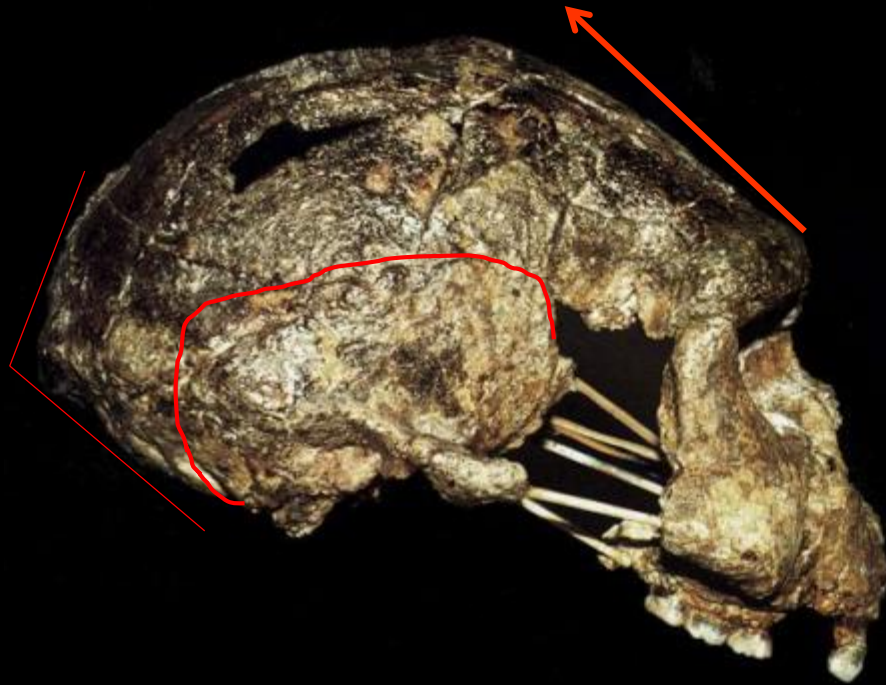


Day & Stringer (1982)

- Volta cranica corta ed elevata
- Ossa parietali nel piano sagittale lunghi e curvi
- Volta parietale nel piano coronale alta e larga
- Osso occipitale lungo e stretto, senza proiezione
- Osso frontale elevato
- Complesso sopra-orbitale non continuo
- Presenza di una fossa canina

Vandermeersch (1981, 2005)

- Forma arrotondata del cranio
- Capacità cranica elevata
- Diminuzione della robustezza (riduzione / scomparsa delle superstrutture)
- Volta cranica elevata, con le pareti laterali parallele o divergenti (verso l'alto)
- Osso occipitale regolarmente arrotondato
- Faccia corta
- Tendenza ad una riduzione delle dimensioni dentarie

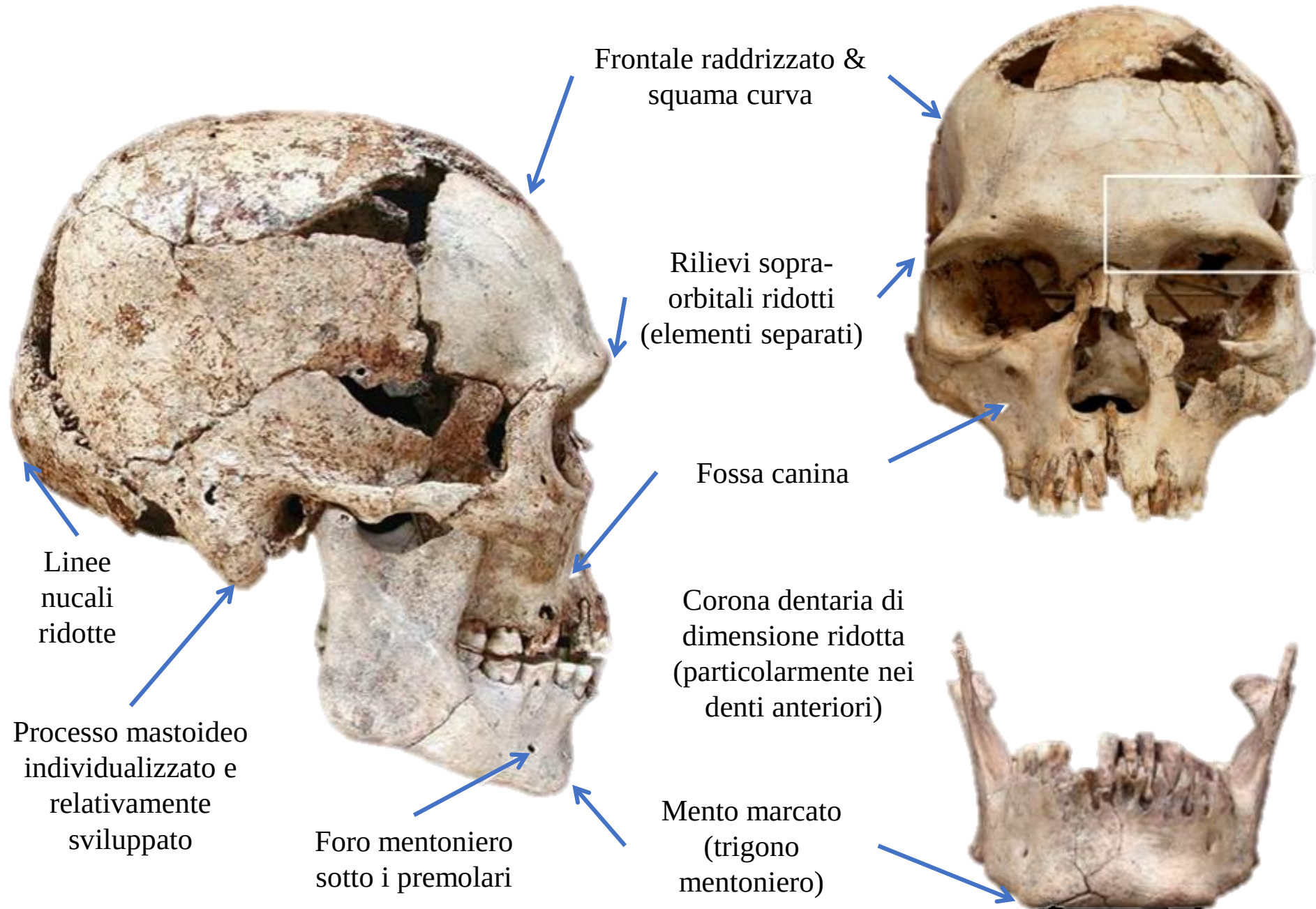


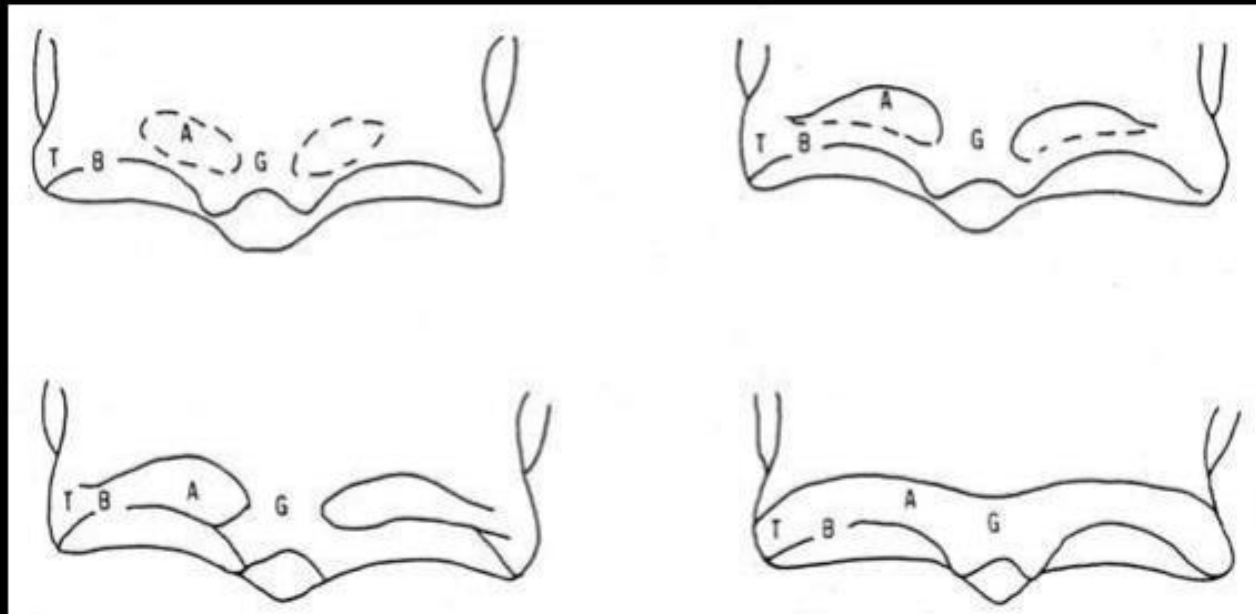
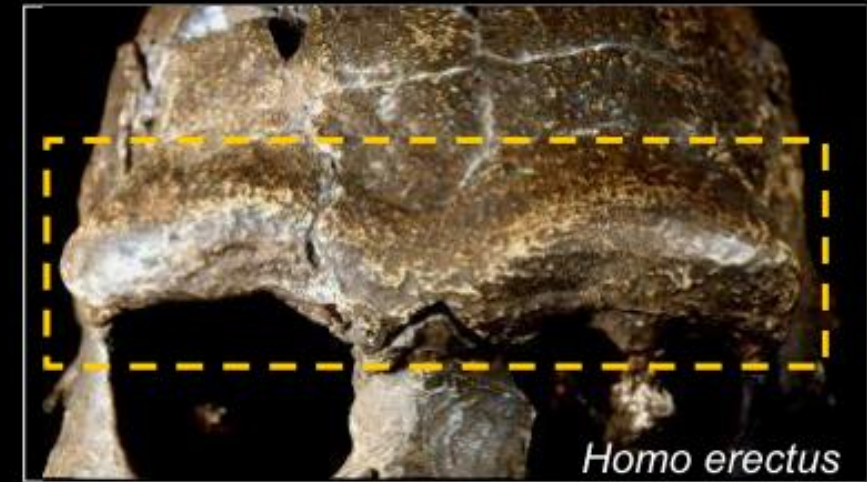
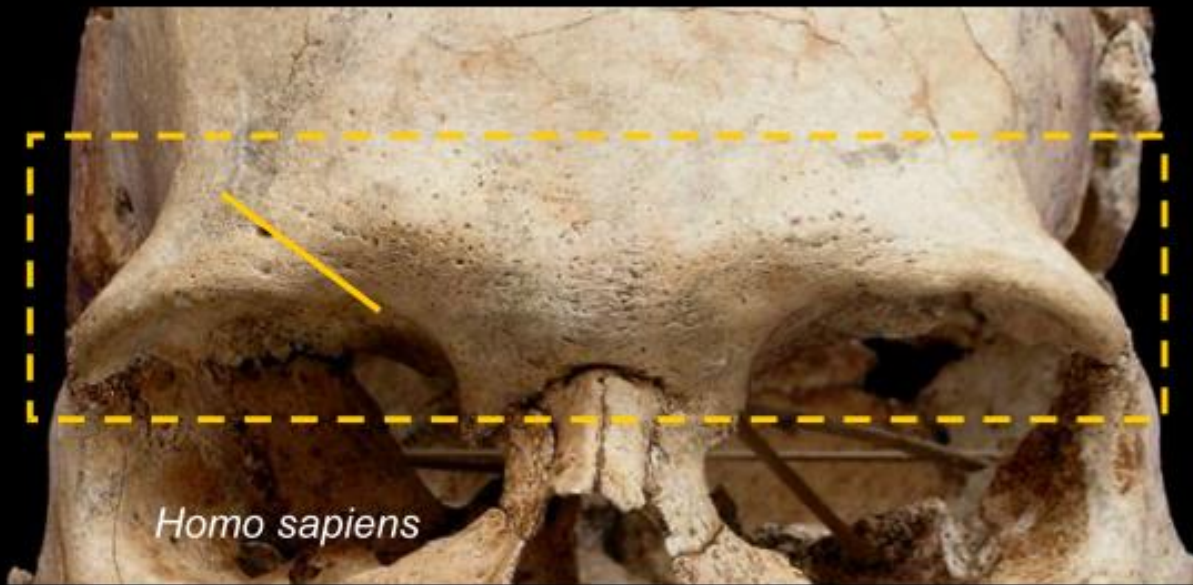
1. Short & rounded vault
2. Elevated frontal & convexity of the scala
3. Rounded ("open") occipital bone
4. Reduced face, placed under the braincase

1. Volta cranica corta e arrotondata
2. Frontale elevato & squama convessa
3. Occipitale arrotondato (« aperto »)
4. Faccia ridotta, situata sotto la scatola cranica



Riduzione globale della robustezza

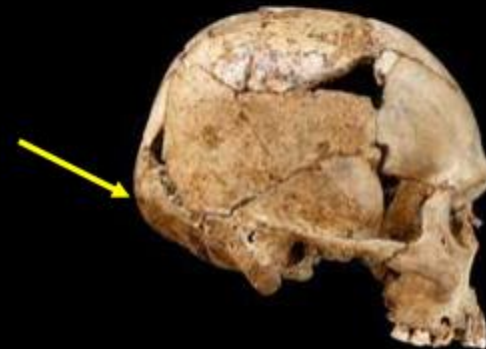
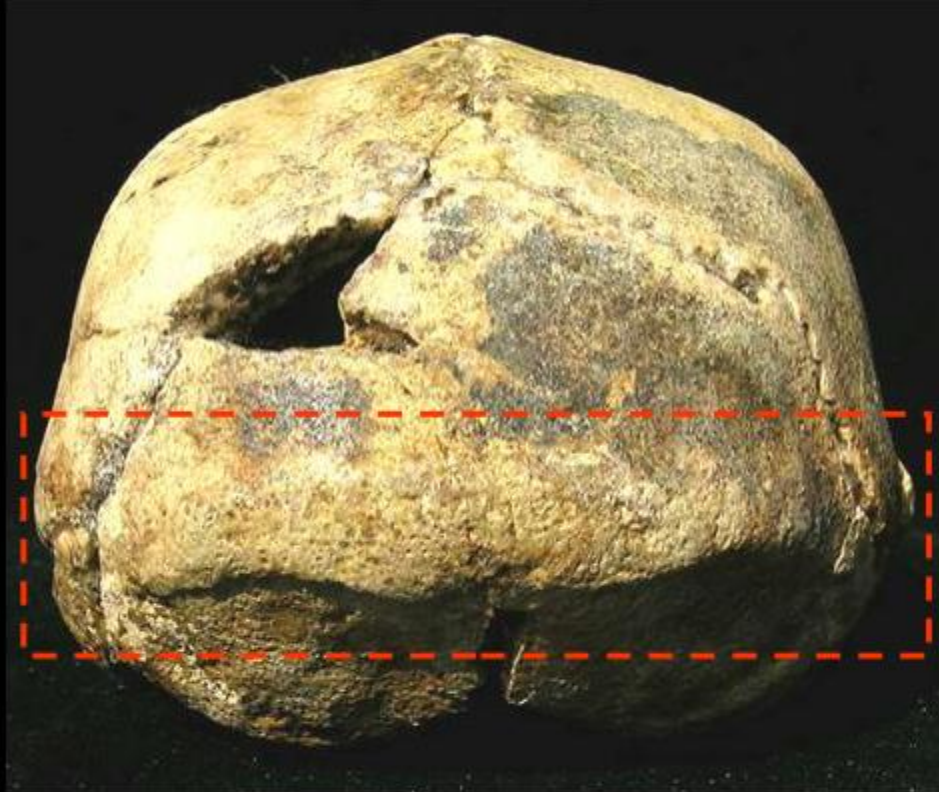




G : Glabella
 A : superciliary arch
 B : upper border of the orbit
 T : lateral trigone

G: Glabella
 A: Arcata sopraciliare
 B: Bordo orbitale superiore
 T: Trigone

Transverse occipital torus





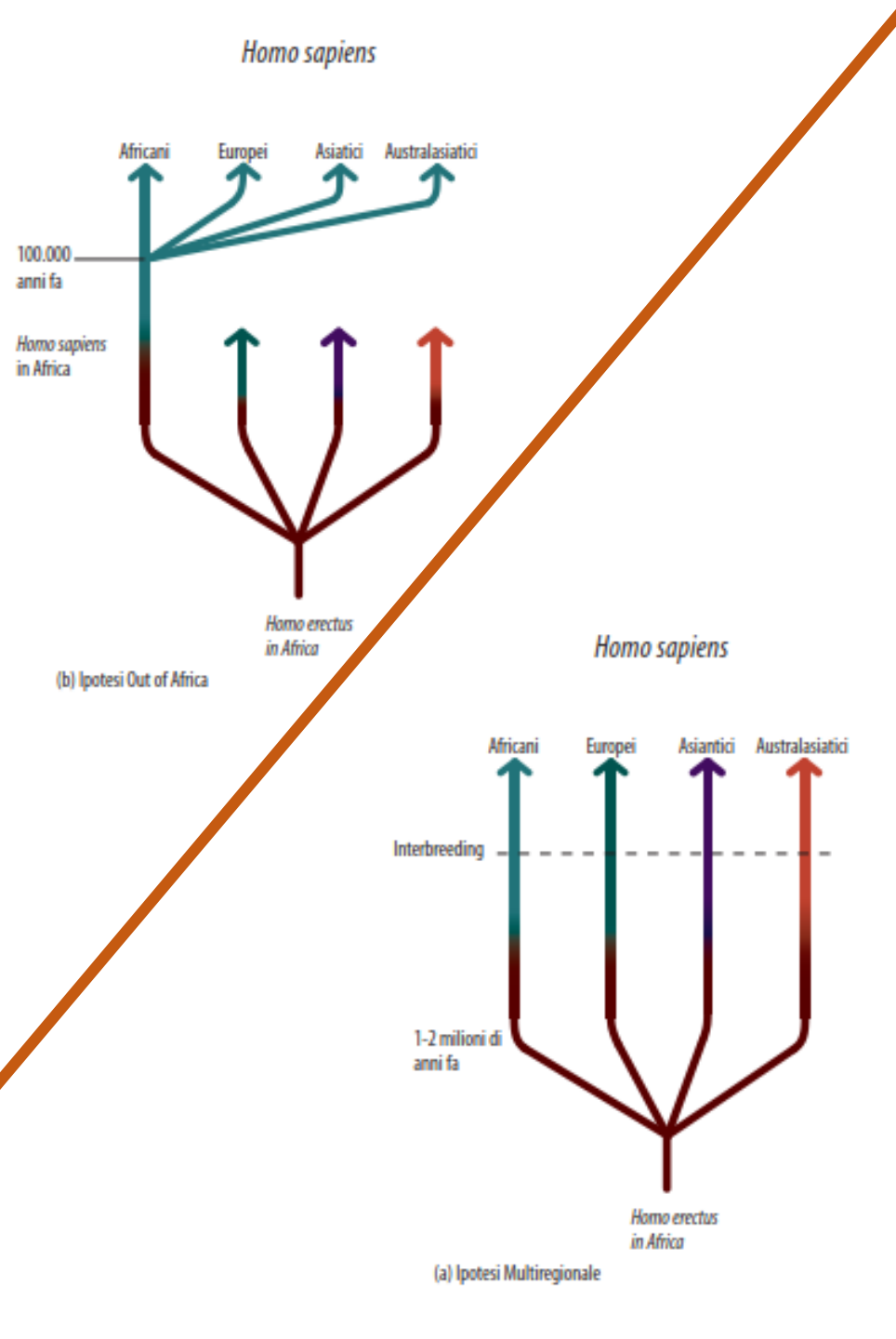
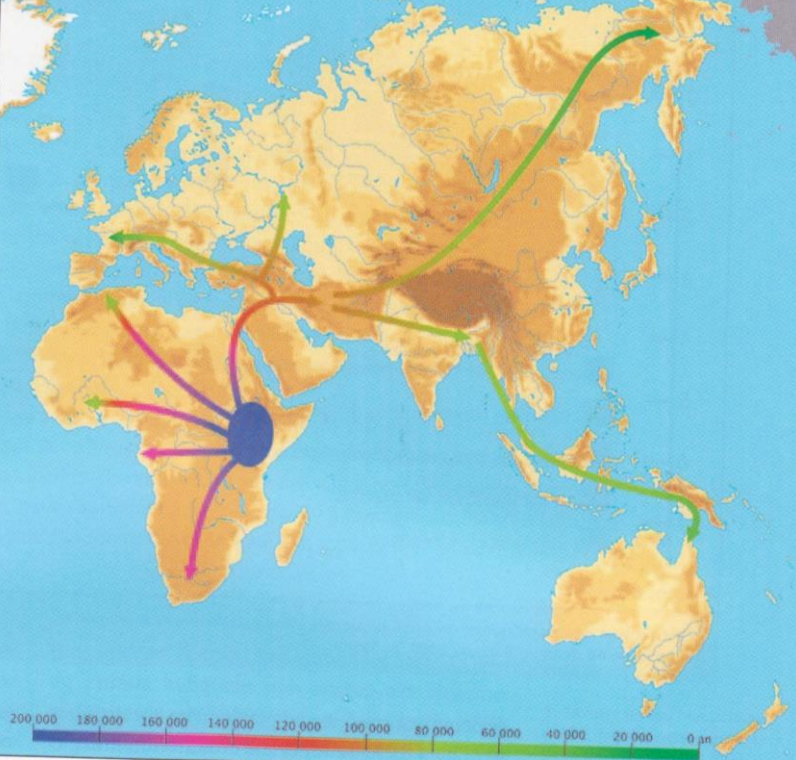
- Tronco e bacino stretti
- Massa corporea poco elevata in confronto alla statura
- Centro di gravità situato al livello della seconda vertebra sacra
- Colonna vertebrale a convessità secondarie (verso l'avanti) marcate
- Arti lunghi in confronto al tronco
- Arti inferiori robusti ed allungati
- Allungamento delle porzione distale dei arti
- Spessore ridotto dell'osso corticale ed allargamento delle cavità midollari in confronto a *Homo erectus*

Umanità
Verso il 2000
Feb. 03

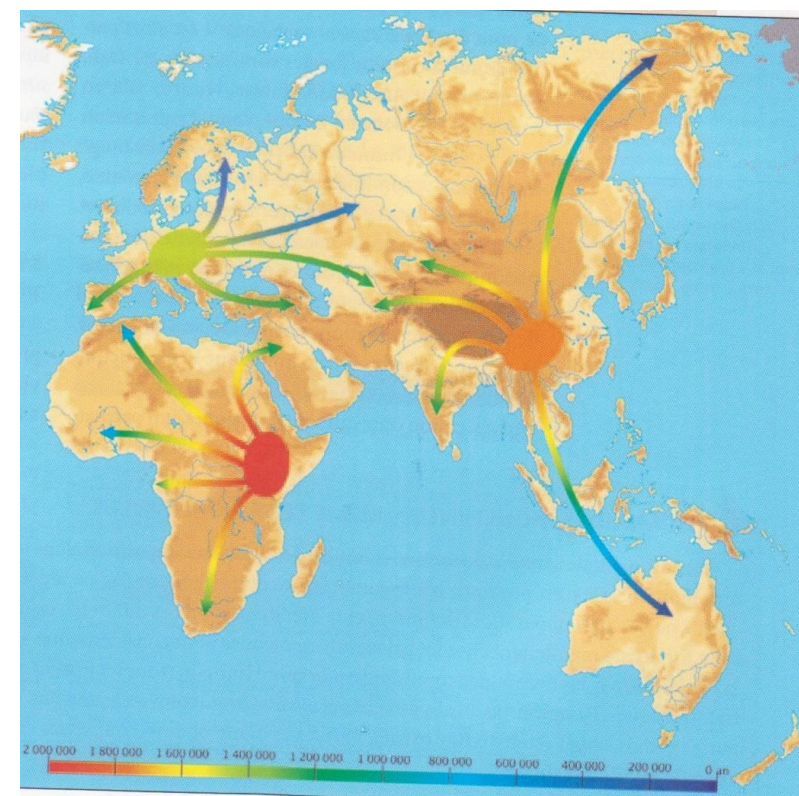




Le origine ed ipotesi evolutive

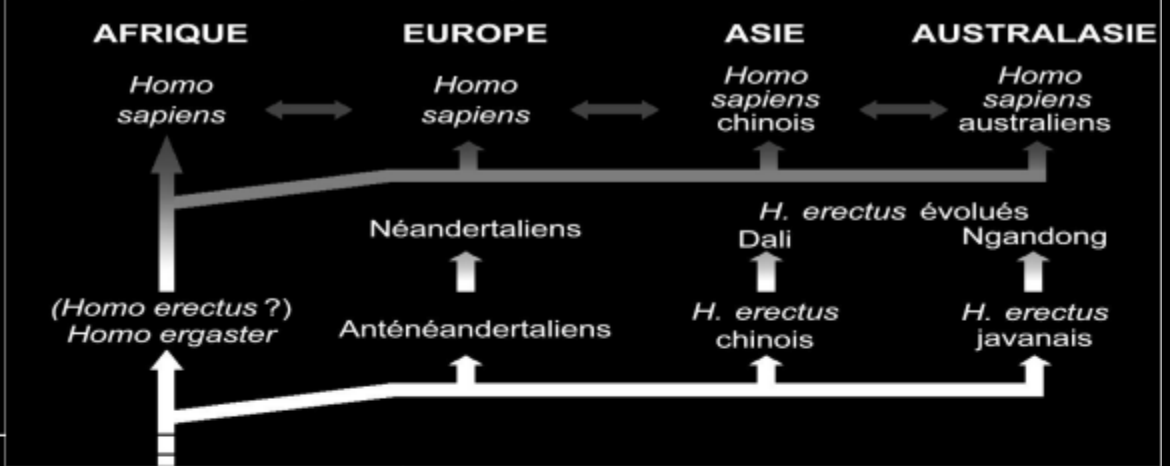


Modello multiregionale
Modello a candelabro

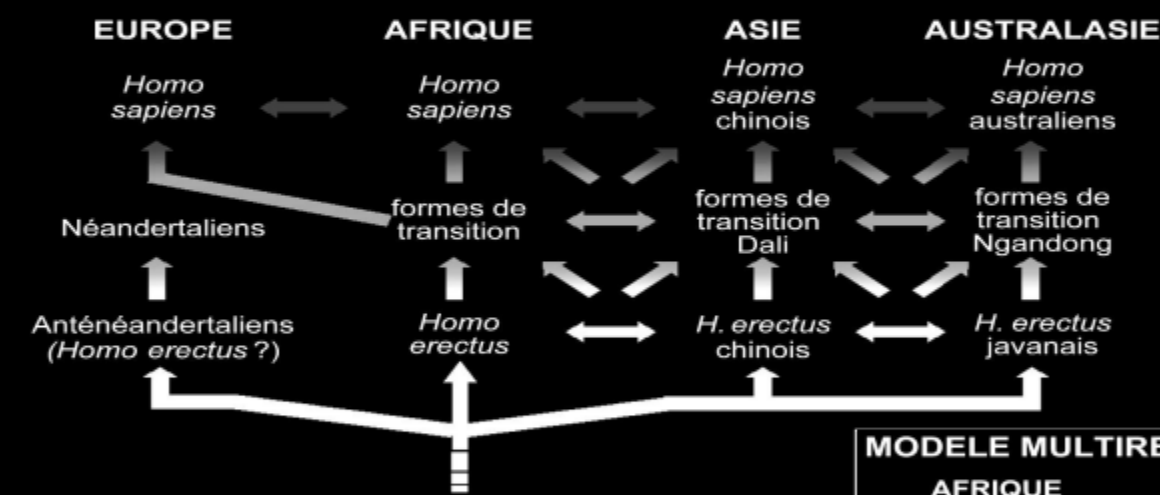


Modello « Out of Africa » o modello di sostituzione

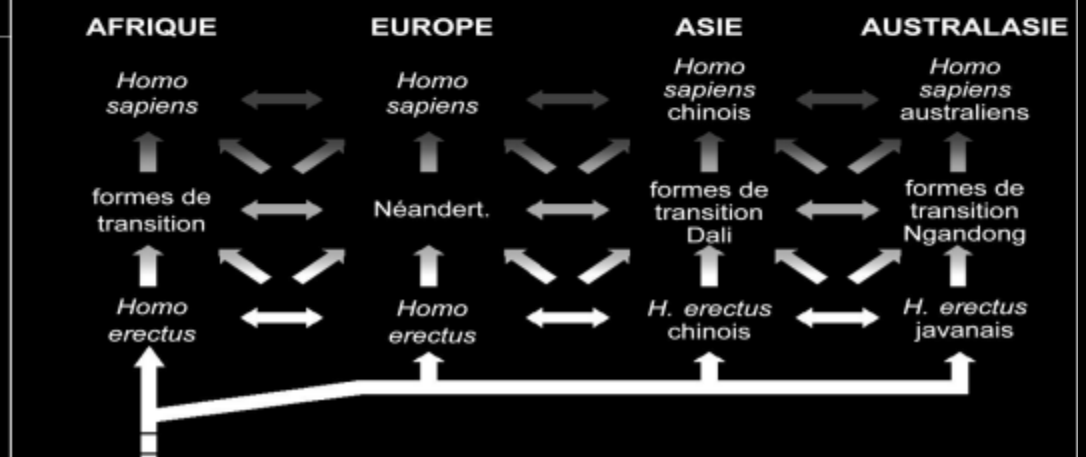
MODELE AVEC REMPLACEMENT



MODELE INTERMEDIAIRE



MODELE MULTIREGIONAL



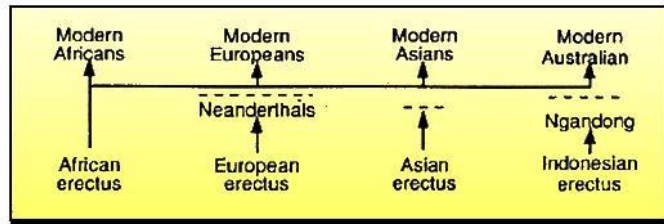
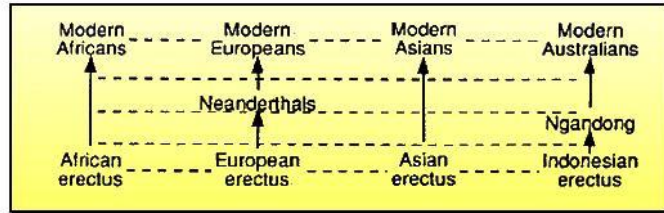
Modello del Multiregionalismo

Le principali basi della teoria multiregionalista sono:

- Specifiche similitudini regionali tra le forme arcaiche di *Homo sapiens* e quelle moderne;

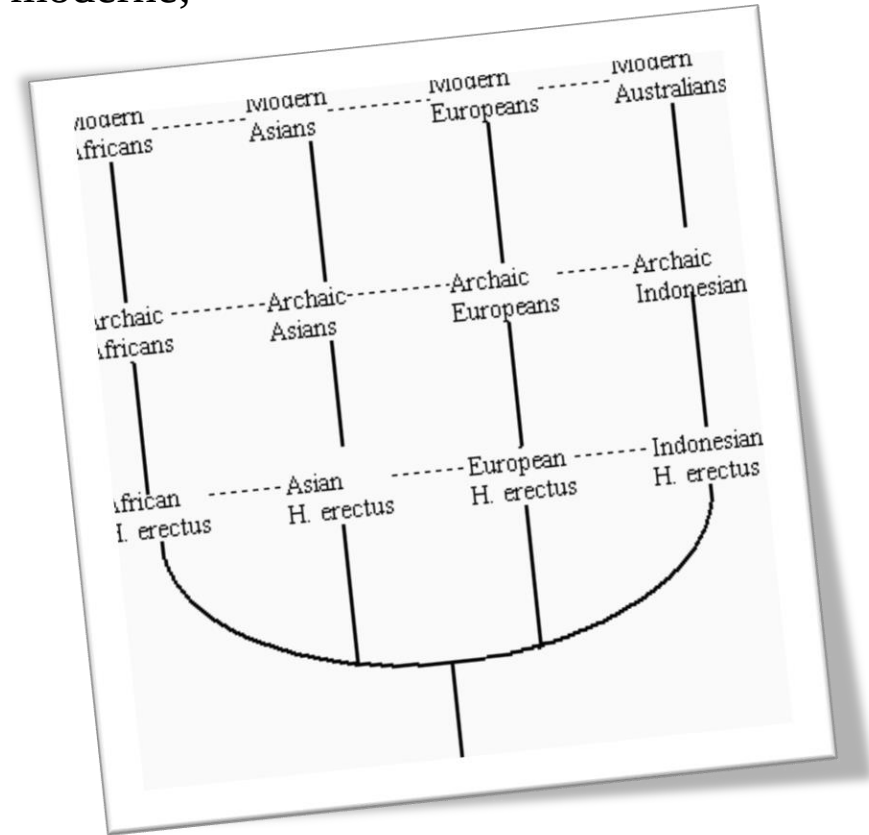
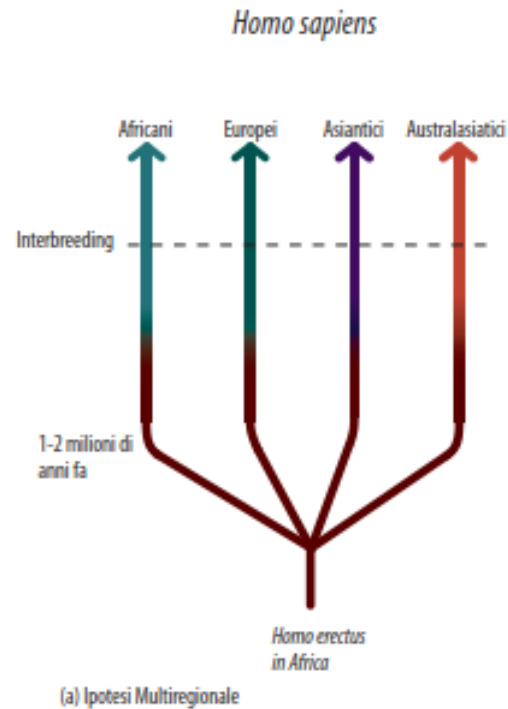
Le principali critiche al multiregionalismo sono:

- Assenza di forme di transizione in Asia e Europa
- Prove genetiche
- La teoria richiede un continuo *gene flow* tra le popolazioni regionali



Two views of the origins of modern humans: the multiregional model (top) and the "Out of Africa" model. Each interprets the same fossil evidence in a radically different way

Stringer, 1990

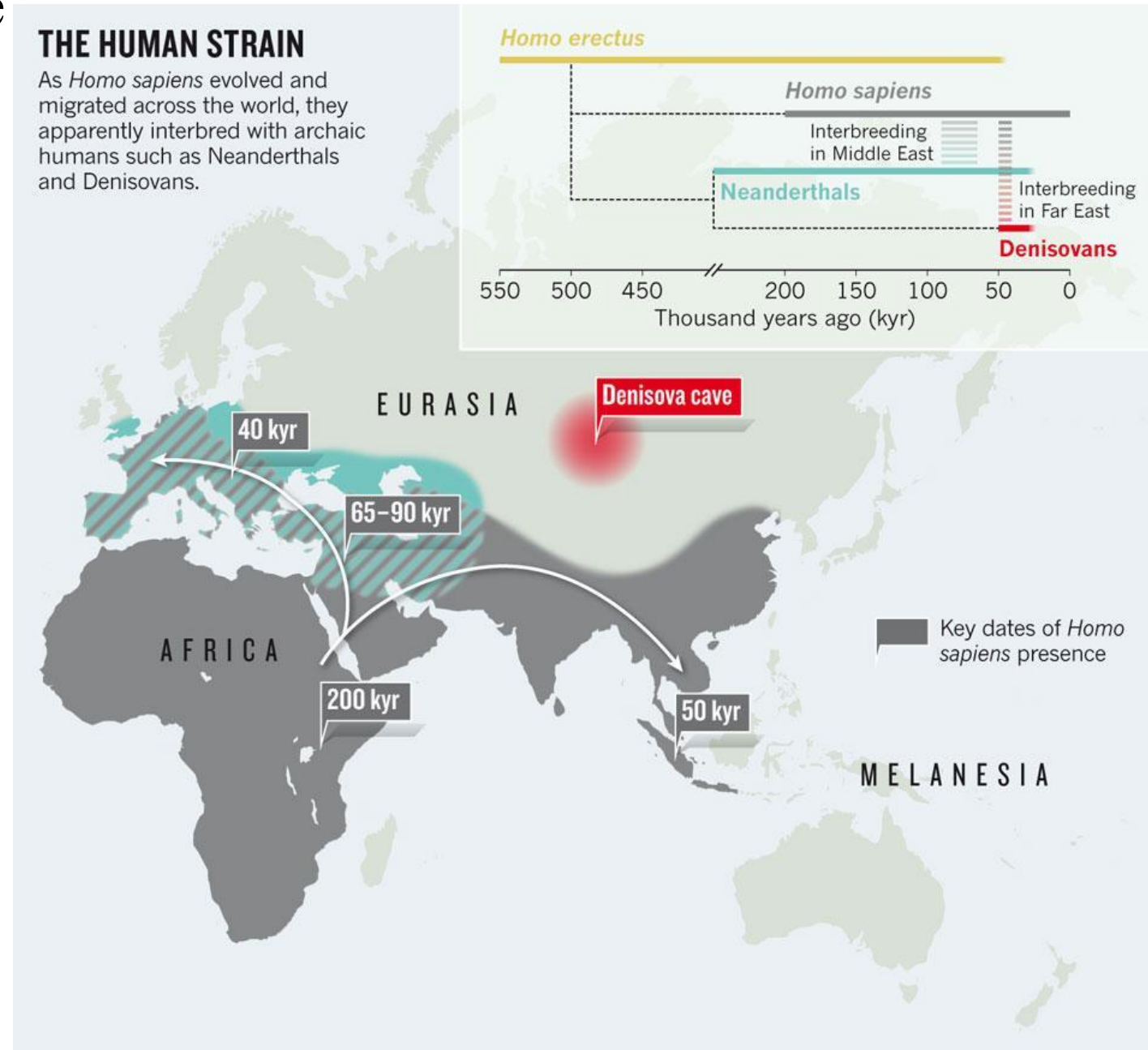


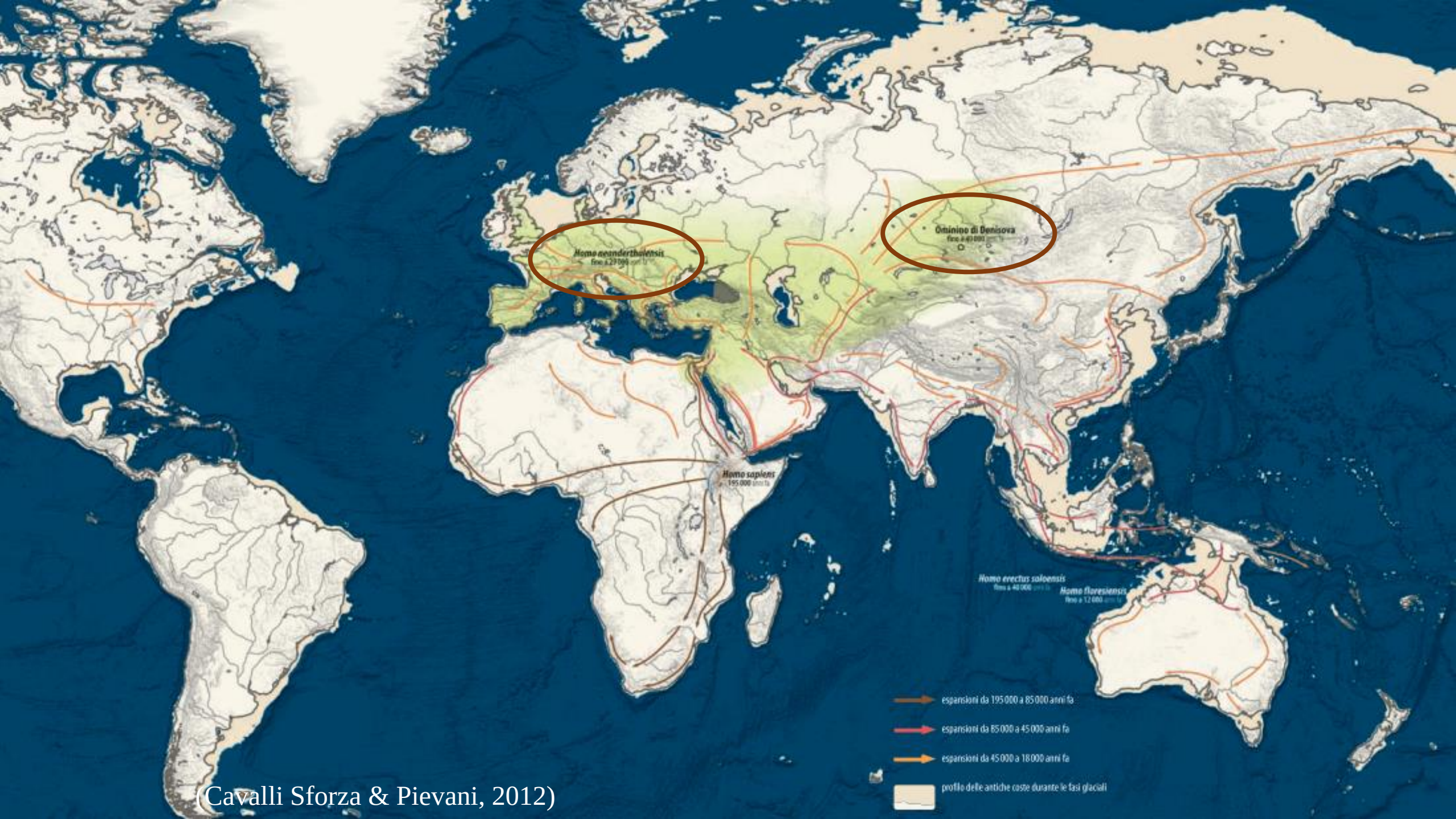
Modello della “sostituzione parziale”

Teoria dell’assimilazione (Smith 1987) o del parziale rimpiazzo: assimilazione da parte delle popolazioni europee del patrimonio genetico dell’uomo moderno, per flusso genico*. Prove paleontologiche: fossili dell’Europa orientale (Vindija)

Teoria dell’ibridazione (Trinkaus): incrocio nelle varie aree geografiche dell’umanità moderna con le popolazioni preesistenti.

*Il **flusso genico** è la diffusione dei geni fra popolazioni, per migrazioni di individui in età riproduttiva. Il flusso genico può introdurre in una popolazione nuovi alleli o può cambiare le frequenze alleliche. L'effetto globale del flusso genico è quello di ridurre le differenze genetiche medie tra le popolazioni e quindi di limitarne l'evoluzione. D'altra parte, il flusso genico può aumentare la variabilità interna di una popolazione, aumentandone il polimorfismo.



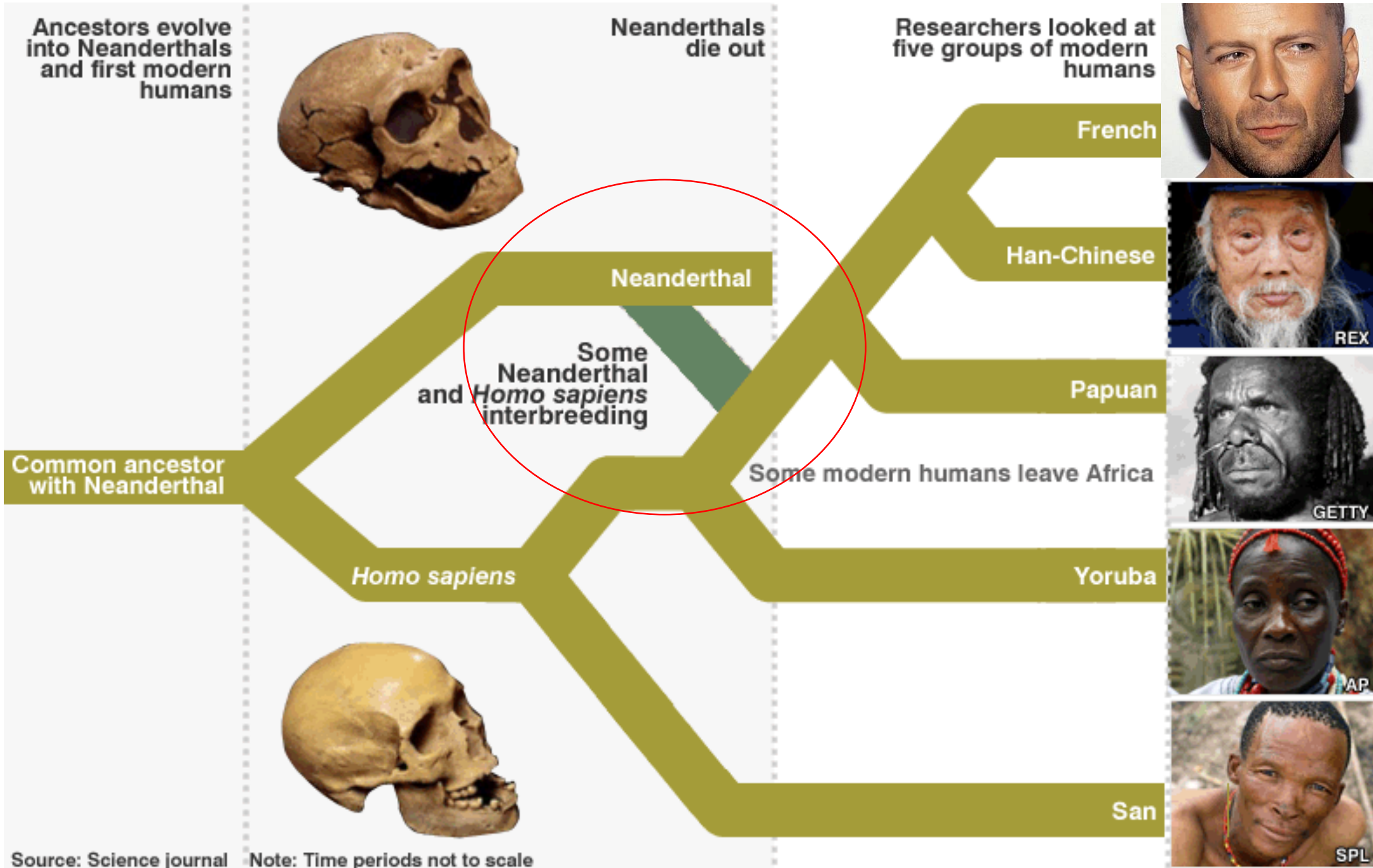


(Cavalli Sforza & Pievani, 2012)

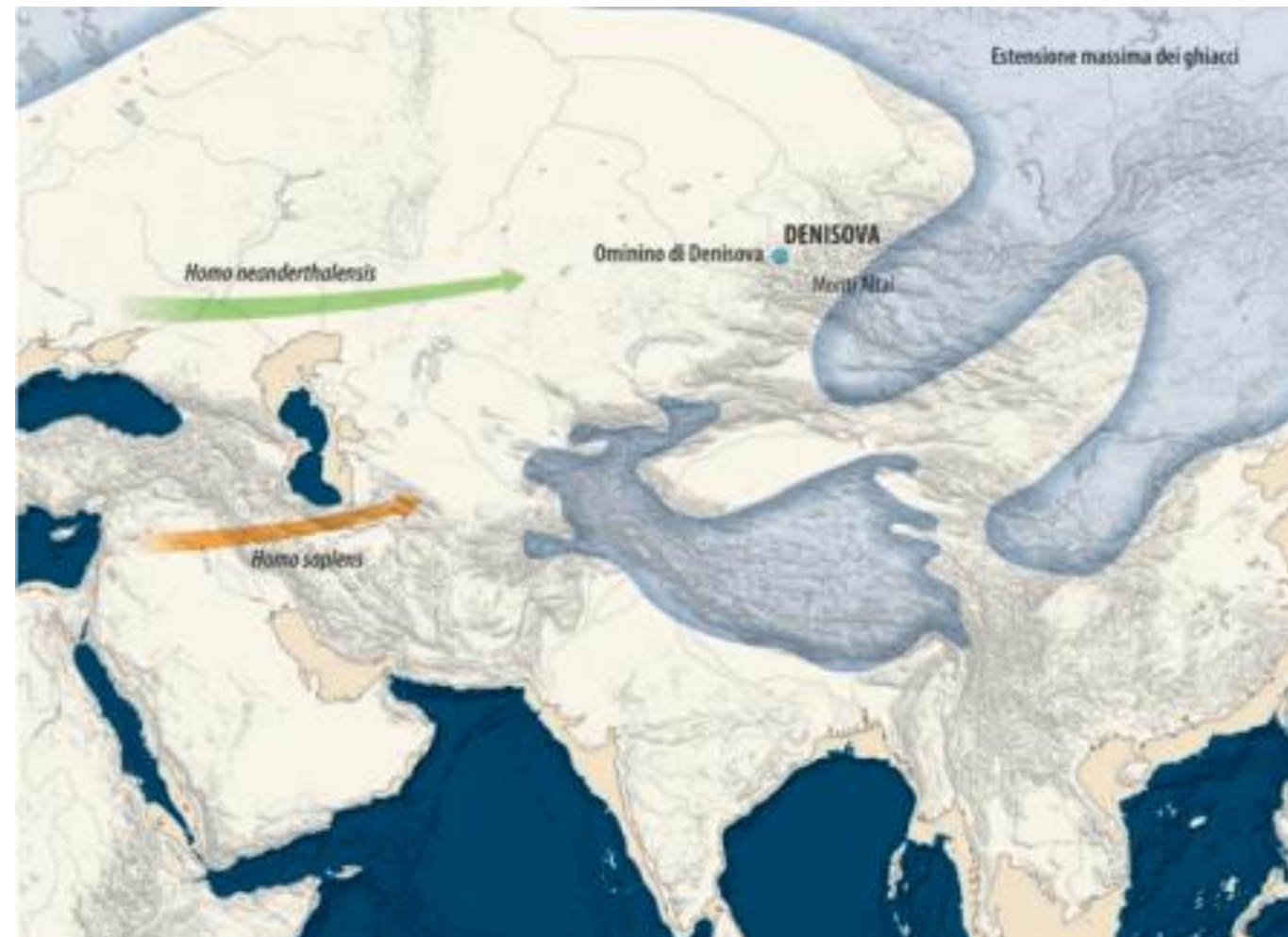
Ancestors evolve into Neanderthals and first modern humans

Neanderthals die out

Researchers looked at five groups of modern humans



Area di possibili incroci



An early modern human from Romania with a recent Neanderthal ancestor

Qiaomei Fu^{1,2,3*}, Mateja Hajdinjak^{3*}, Oana Teodora Moldovan⁴, Silviu Constantin⁵, Swapan Mallick^{2,6,7}, Pontus Skoglund², Nick Patterson⁶, Nadin Rohland², Iosif Lazaridis², Birgit Nickel³, Bence Viola^{3,7,8}, Kay Prüfer³, Matthias Meyer³, Janet Kelso³, David Reich^{2,6,9} & Svante Pääbo³

Neanderthals are thought to have disappeared in Europe approximately 39,000–41,000 years ago but they have contributed 1–3% of the DNA of present-day people in Eurasia¹. Here we analyse DNA from a 37,000–42,000-year-old² modern human from Peștera cu Oase, Romania. Although the specimen contains small amounts of human DNA, we use an enrichment strategy to isolate sites that are informative about its relationship to Neanderthals and present-day humans. We find that on the order of 6–9% of the genome of the Oase individual is derived from Neanderthals, more than any other modern human sequenced to date. Three chromosomal segments of Neanderthal ancestry are over 50 centimorgans in size, indicating that this individual had a Neanderthal ancestor as recently as four to six generations back. However, the Oase individual does not share more alleles with later Europeans than with East Asians, suggesting that the Oase population did not contribute substantially to later humans in Europe.

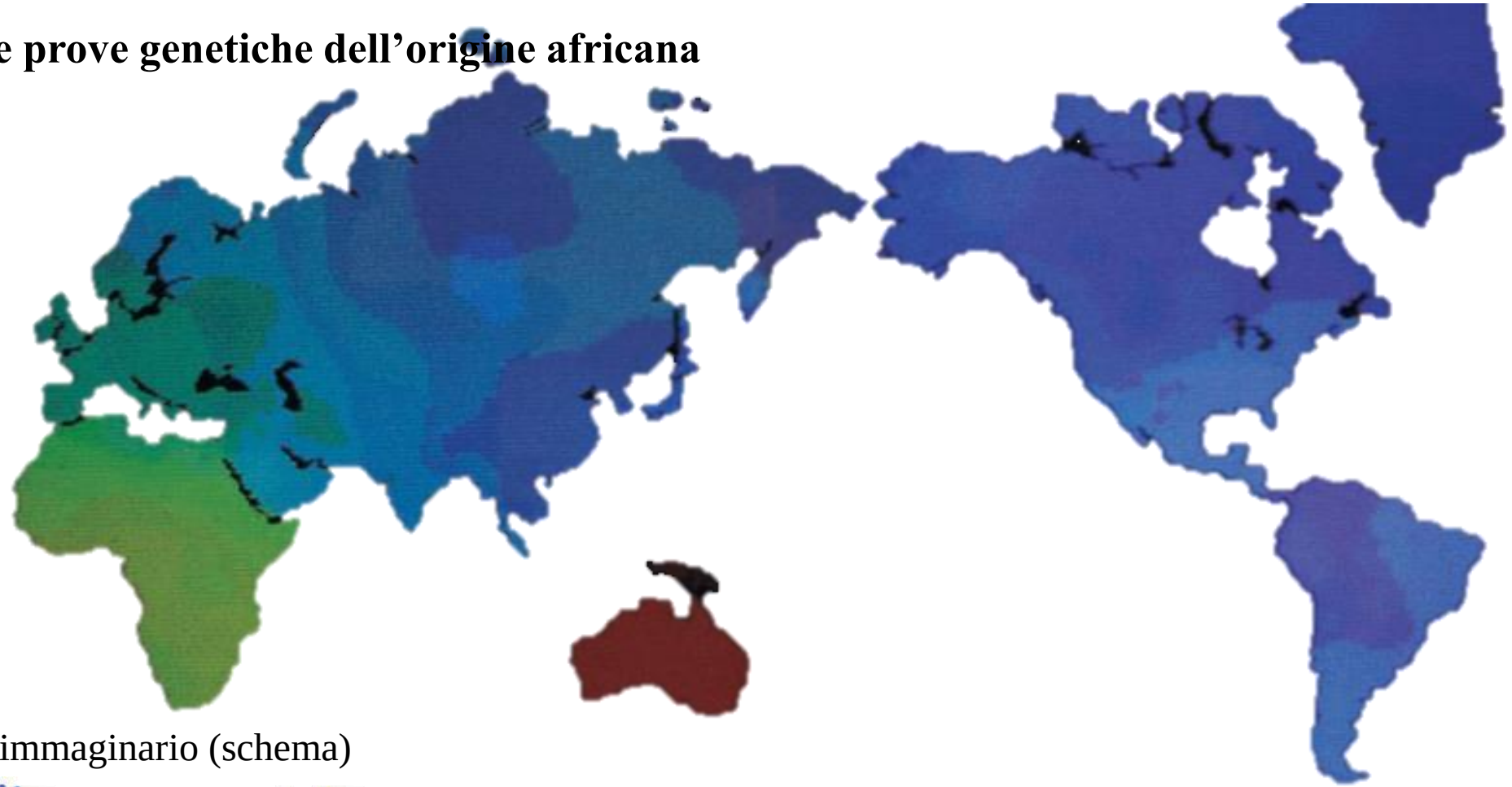


Putative recent Neanderthal ancestry

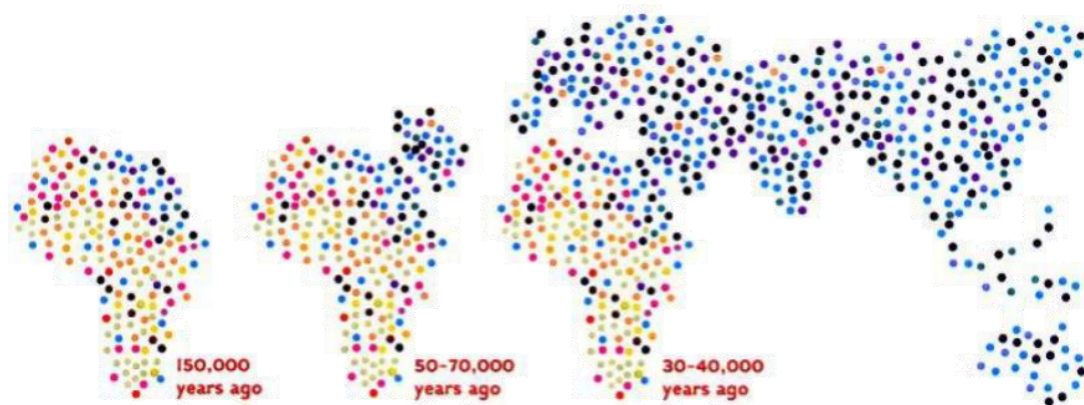


Modello «Out of Africa» - Le prove genetiche dell'origine africana

L'origine africana dell'uomo moderno desunta dallo studio del DNA mitocondriale attuale



Diversità di un segnale genetico immaginario (schema)

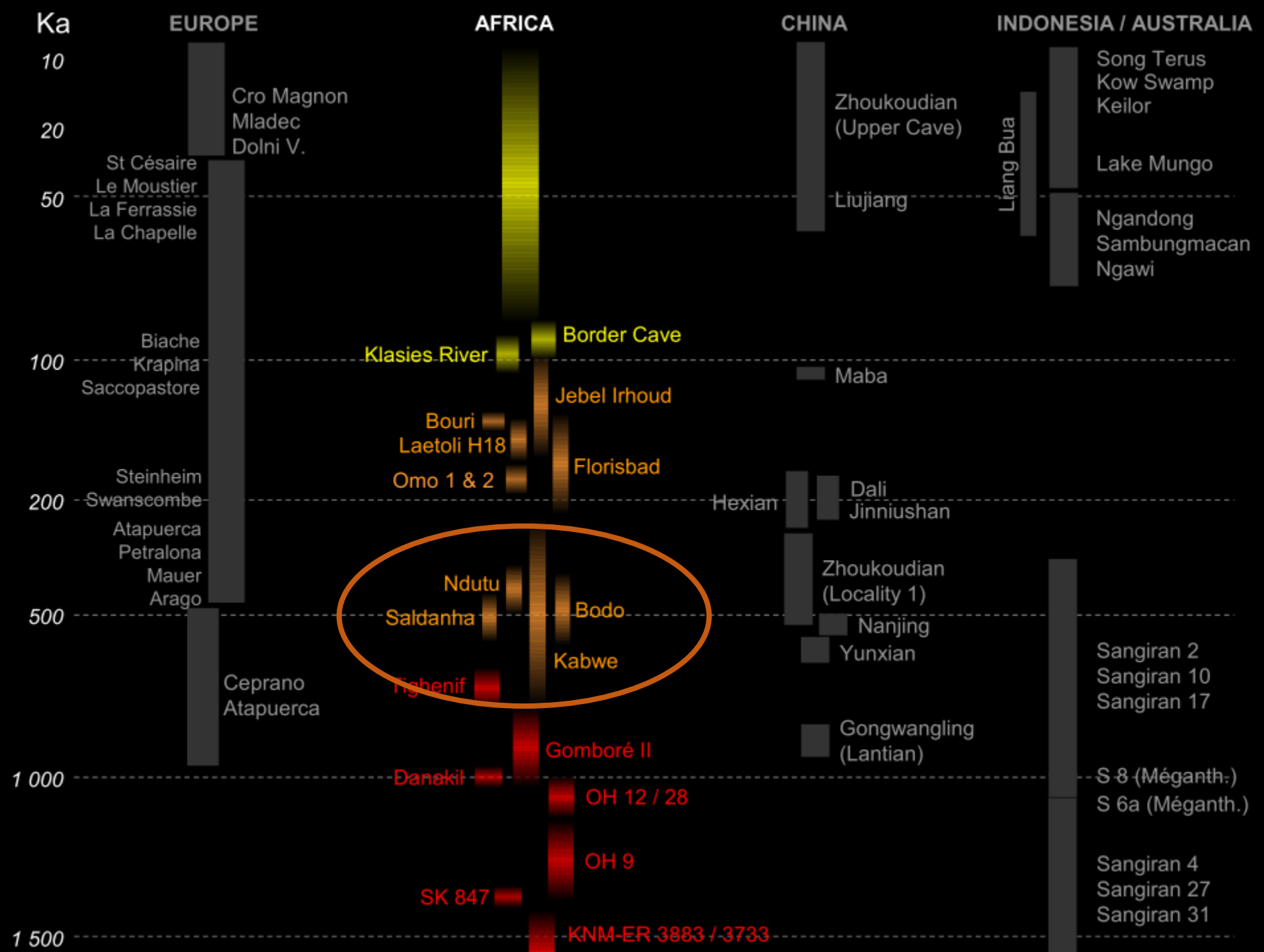


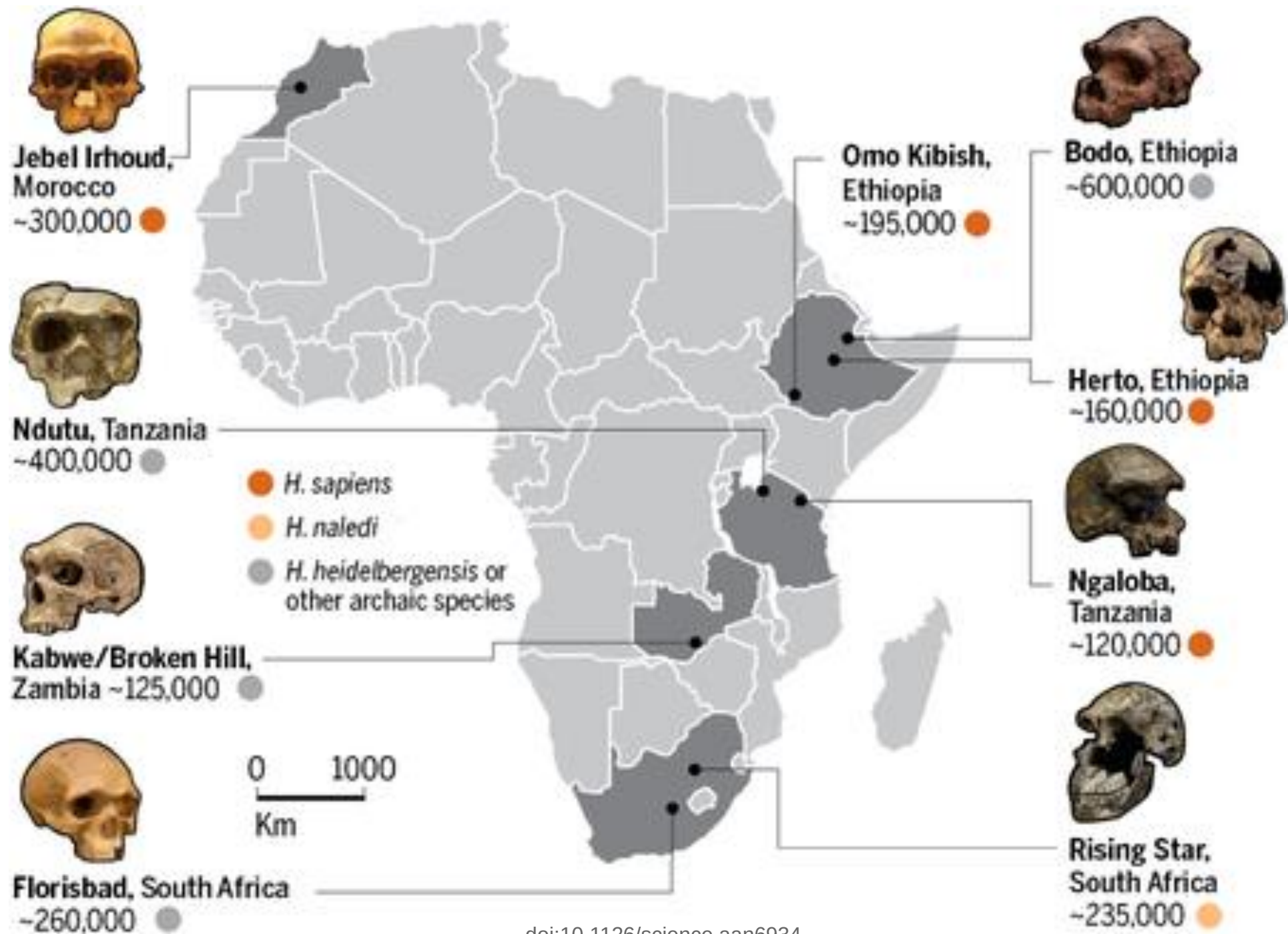
Variabilità del mtDNA attuale

« Tutta la variabilità del mtDNA umano attuale e mondiale è anche presente in Africa (Africa dell'Est), quindi sarebbe il posto più probabile dell'origine della specie *Homo sapiens*. »



Le testimonianze fossile

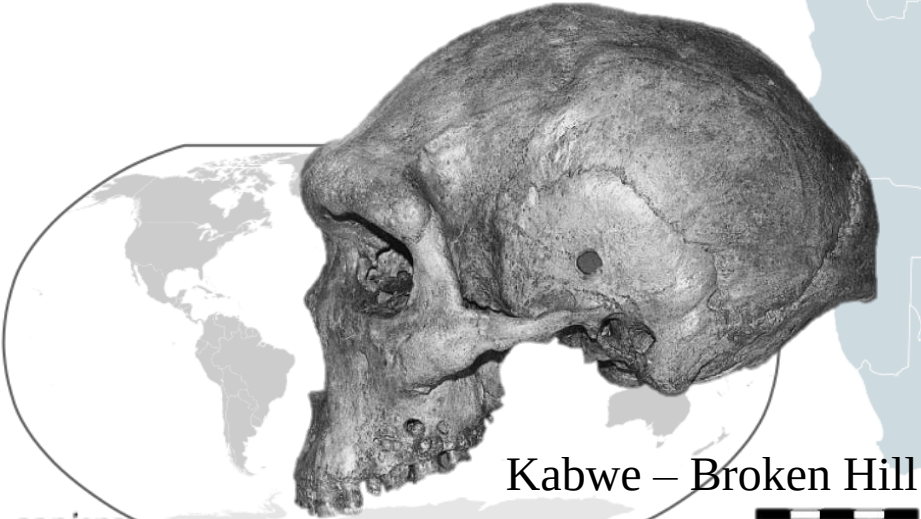
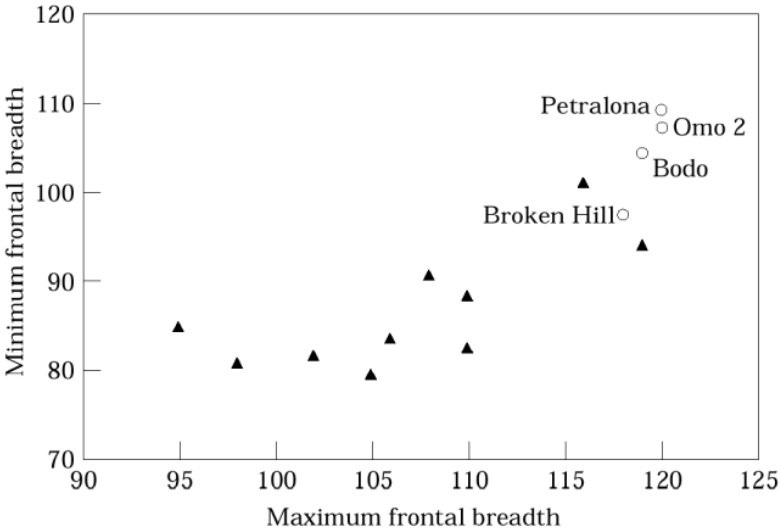




Bodo, Etiopia and Kabwe (Broken Hill, Zambia) 600 000 y B.P.?



Bodo (Rightmire, 1995)



Kabwe – Broken Hill



(▲), *Homo erectus* (Africa and Asia); (○), "archaic" *Homo sapiens*.

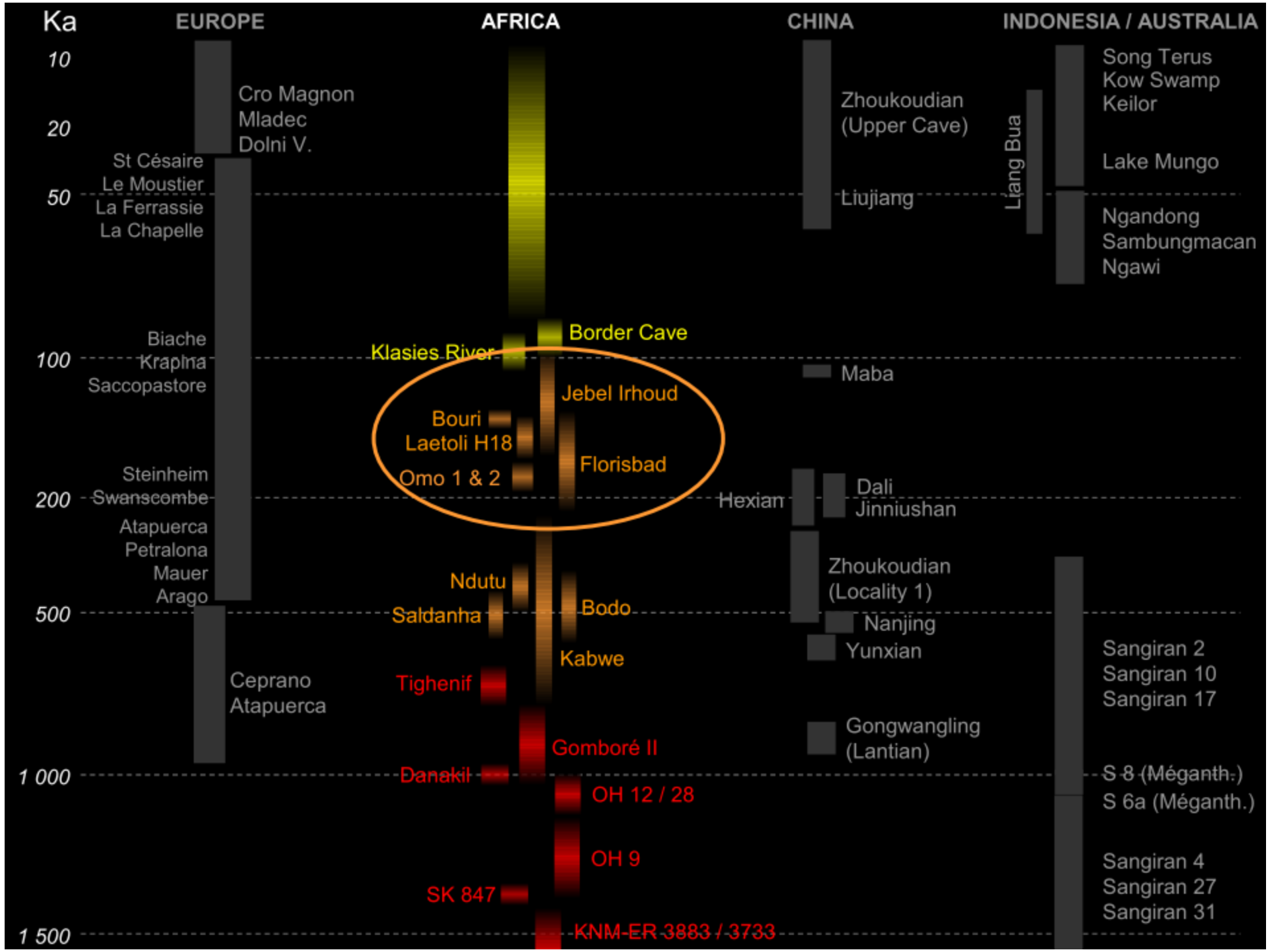


Ndutu, Tanzania
 • 400 000 y BP

H. erectus: Dimensions of the cranium, thickness of the vault bones.

Archaic *H. sapiens*: Occipital and mastoid morphology

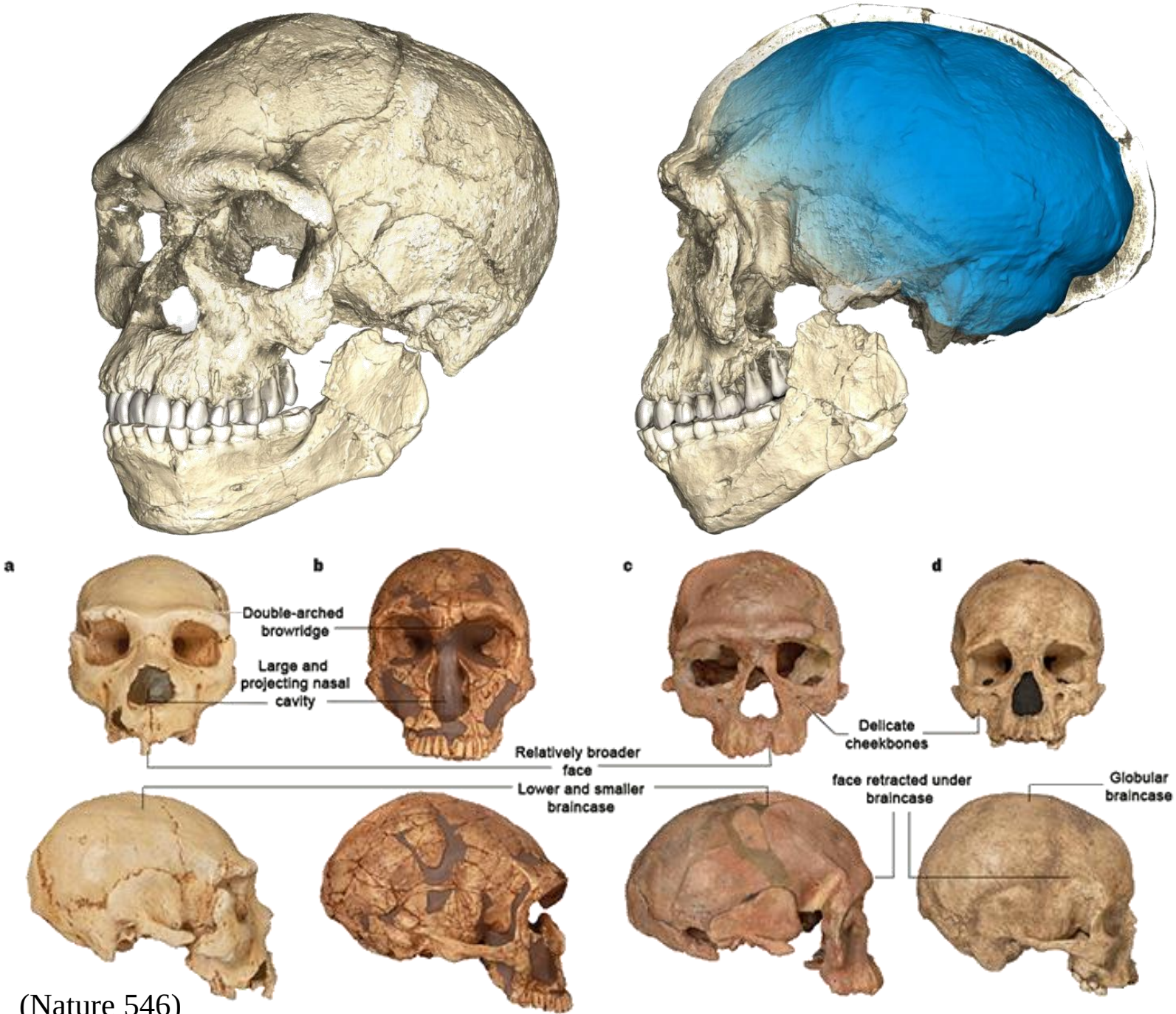




New fossils from Jebel Irhoud, Morocco and the pan-African origin of *Homo sapiens*

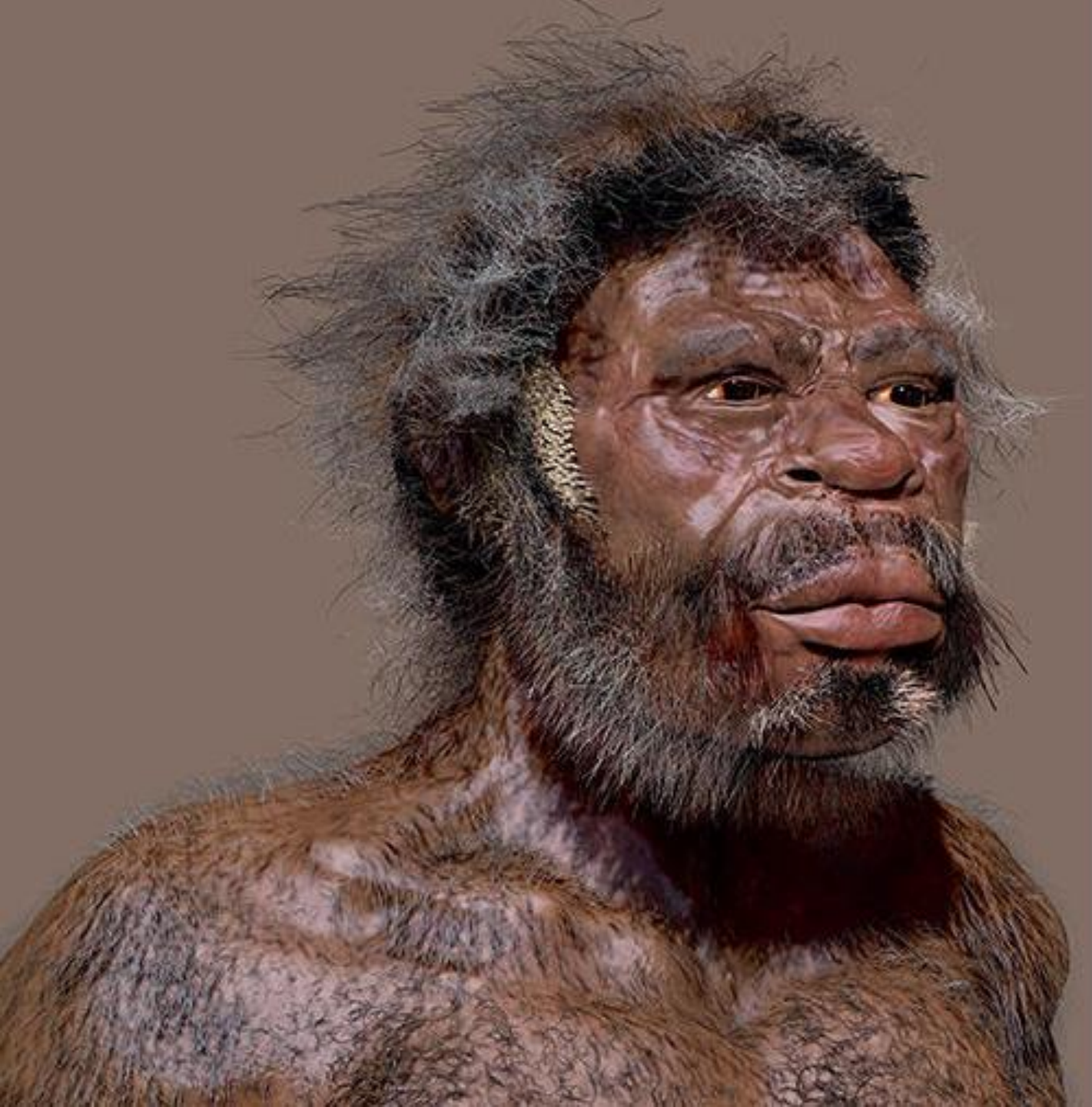
Jean-Jacques Hublin^{1,2}, Abdelouahed Ben-Ncer³, Shara E. Bailey⁴, Sarah E. Freidline¹, Simon Neubauer¹, Matthew M. Skinner⁵, Inga Bergmann¹, Adeline Le Cabec¹, Stefano Benazzi⁶, Katerina Harvati⁷ & Philipp Gunz²

Fossil evidence points to an African origin of *Homo sapiens* from a group called either *H. heidelbergensis* or *H. rhodesiensis*. However, the exact place and time of emergence of *H. sapiens* remain obscure because the fossil record is scarce and the chronological age of many key specimens remains uncertain. In particular, it is unclear whether the present day ‘modern’ morphology rapidly emerged approximately 200 thousand years ago (ka) among earlier representatives of *H. sapiens*¹ or evolved gradually over the last 400 thousand years². Here we report newly discovered human fossils from Jebel Irhoud, Morocco, and interpret the affinities of the hominins from this site with other archaic and recent human groups. We identified a mosaic of features including facial, mandibular and dental morphology that aligns the Jebel Irhoud material with early or recent anatomically modern humans and more primitive neurocranial and endocranial morphology. In combination with an age of **315 ± 34 thousand years** (as determined by thermoluminescence dating)³, this evidence makes Jebel Irhoud the oldest and richest African Middle Stone Age hominin site that documents early stages of the *H. sapiens* clade in which key features of modern morphology were established. Furthermore, it shows that the evolutionary processes behind the emergence of *H. sapiens* involved the whole African continent.



(Nature 546)

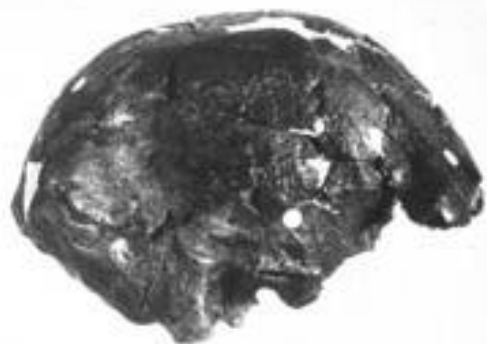
Faccia moderna ma cranio arcaico



Omo Kibish, Ethiopia
195 000 - 130 000 y BP



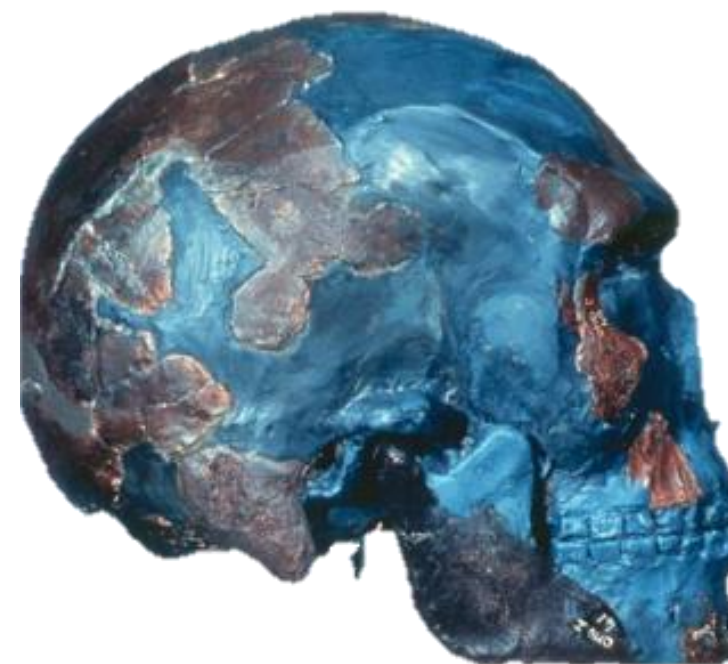
Omo 1



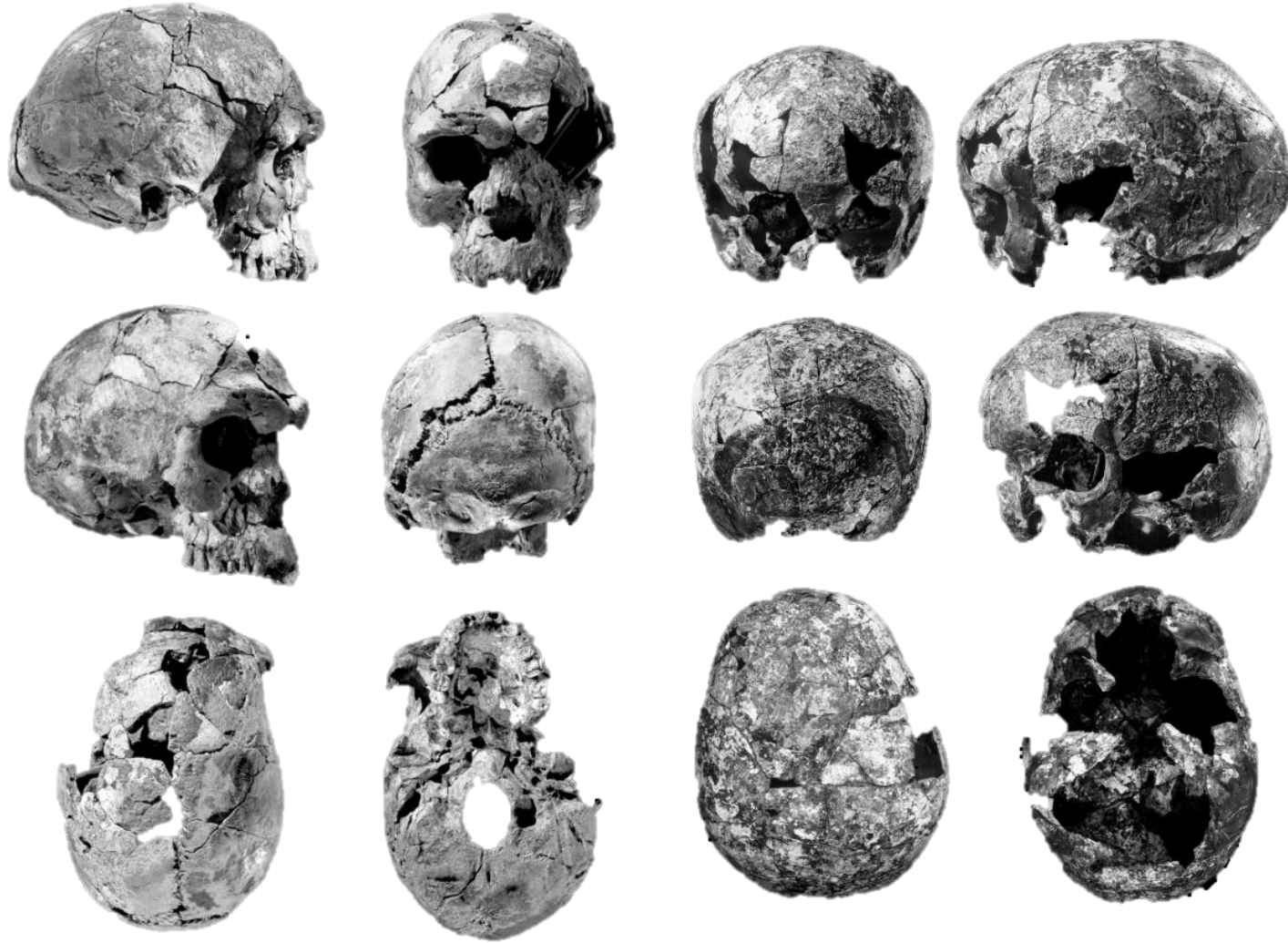
Omo 2



Stretto di Bab El-Mandeb, il punto in cui Africa
e Arabia Saudita si toccano quasi



Herto Bouri, Middle Awash, Ethiopia
154-160 000 y BP



(White, 2003)



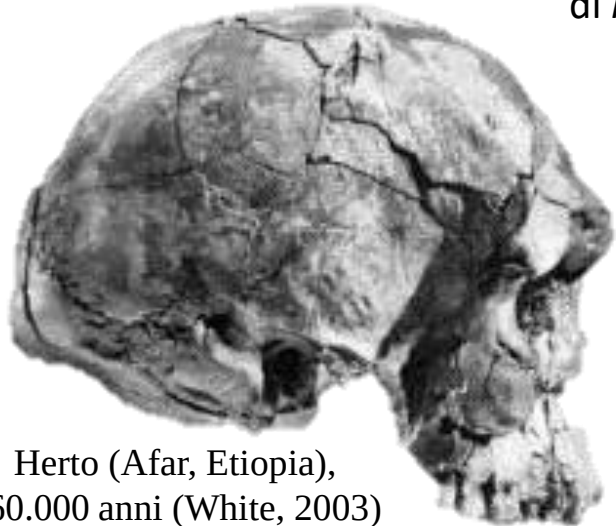
Stretto di Bab El-Mandeb, il punto in cui Africa
e Arabia Saudita si toccano quasi

Homo sapiens idaltu

I resti sono stati scoperti per la prima volta nel sito di Herto Bouri (Etiopia) e sono datati a circa 160 ka anni BP.



“Perché I ominidi di Herto sono morfologicamente appena sotto la variabilità dei AMHS [Anatomically Modern *Homo sapiens*] e perché sono differenti degli altri ominidi fossili conosciuti, le riconosciamo come *Homo sapiens idaltu*, una nuova paleosubspecie di *Homo sapiens*.”



Herto (Afar, Etiopia),
160.000 anni (White, 2003)

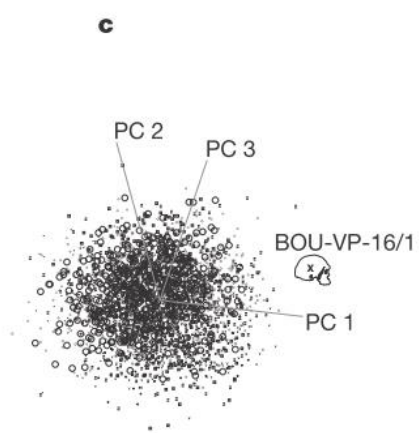
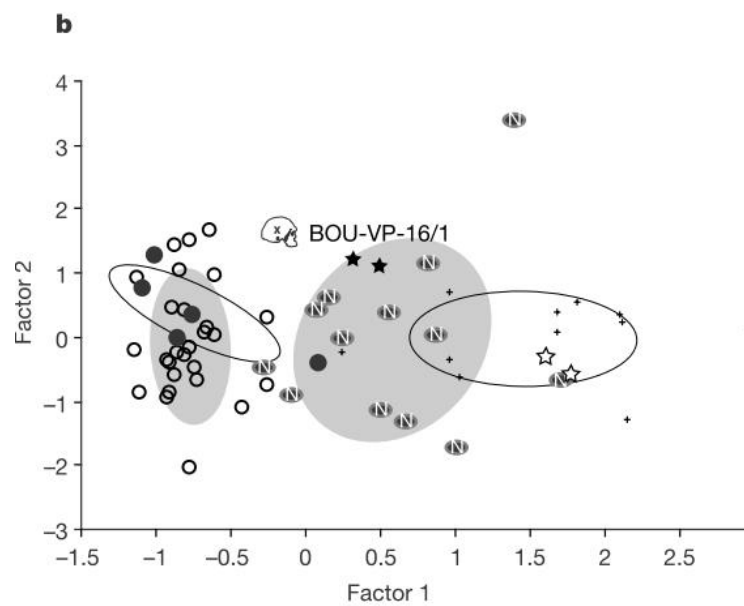
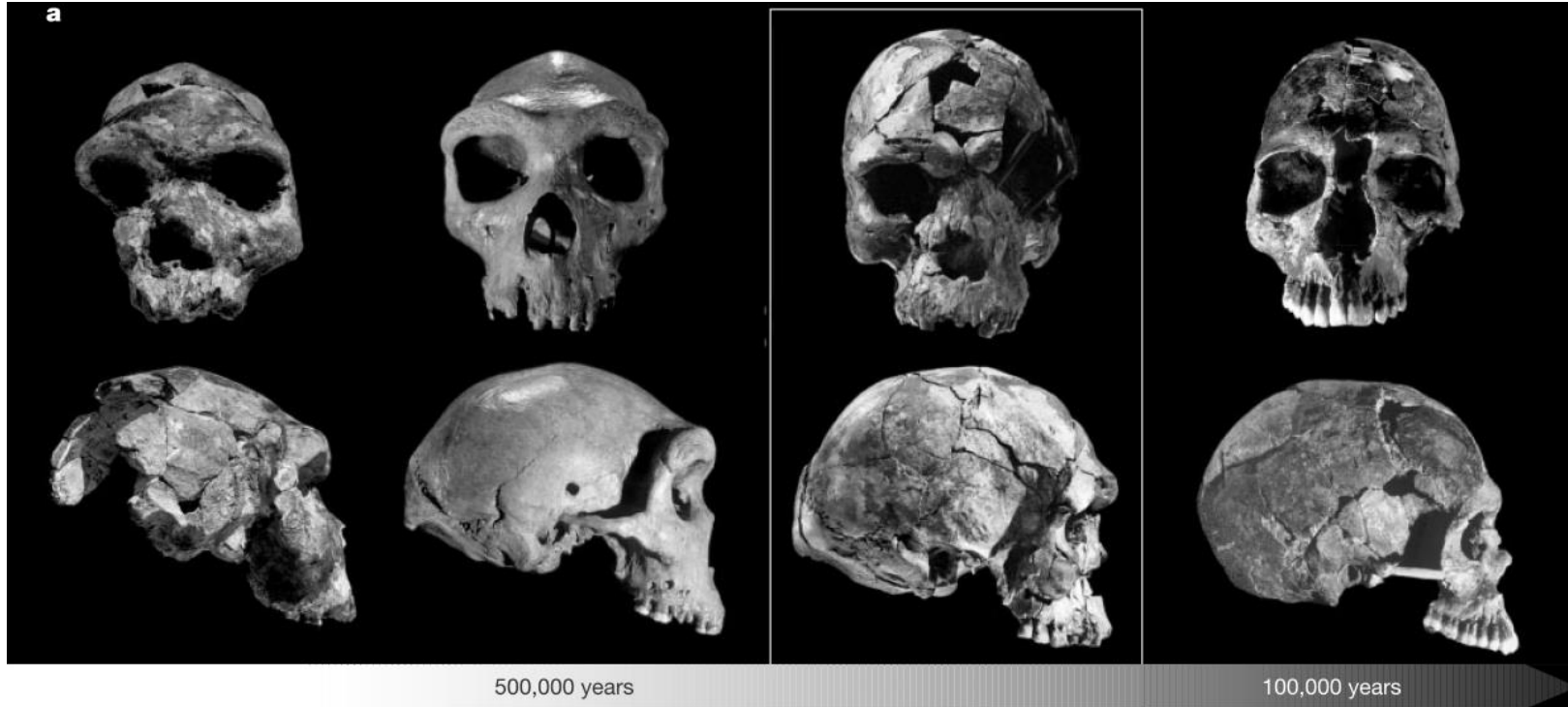
Order Primates L., 1758
Suborder Anthropoidea Mivart, 1864
Superfamily Hominoidea Gray, 1825
Family Hominidae Gray, 1825
Homo sapiens idaltu subsp. nov.

Etymology. The subspecies name ‘idaltu’ is taken from the Afar language. It means ‘elder’.
Holotype. BOU-VP-16/1 (Fig. 1), an adult cranium with partial dentition. Holotype and referred material are housed at the National Museum of Ethiopia, Addis Ababa. Holotype from Bouri Vertebrate Paleontology Locality 16 (BOU-VP 16); differentially corrected GPS coordinates: 10° 15.5484’ N and 40° 33.3834’ E.

Referred material. BOU-VP-16/2 cranial fragments; BOU-VP-16/3 parietal fragment; BOU-VP-16/4 parietal fragment; BOU-VP-16/5 child’s cranium; BOU-VP-16/6 R. upper molar; BOU-VP-16/7 parietal fragment, BOU-VP-16/18 parietal fragments; BOU-VP-16/42 upper premolar, BOU-VP-16/43 parietal fragment.

Stratigraphy and age. Bouri Formation, Upper Herto Member. Dated by ⁴⁰Ar/³⁹Ar to between 160,000 and 154,000 years ago (ref. 6).

Diagnosis. On the limited available evidence, a subspecies of *Homo sapiens* distinguished from Holocene anatomically modern humans (*Homo sapiens sapiens*) by greater craniofacial robusticity, greater anterior–posterior cranial length, and large glenoid-to-occlusal plane distance. *Homo sapiens idaltu* is distinguished from the holotype of *Homo rhodesiensis* (Woodward, 1921) by a larger cranial capacity, a more vertical frontal with smaller face, and more marked midfacial topography (for example, canine fossa). We consider the holotypes of *H. helmei* and *H. njarasensis* too fragmentary for appropriate comparisons.

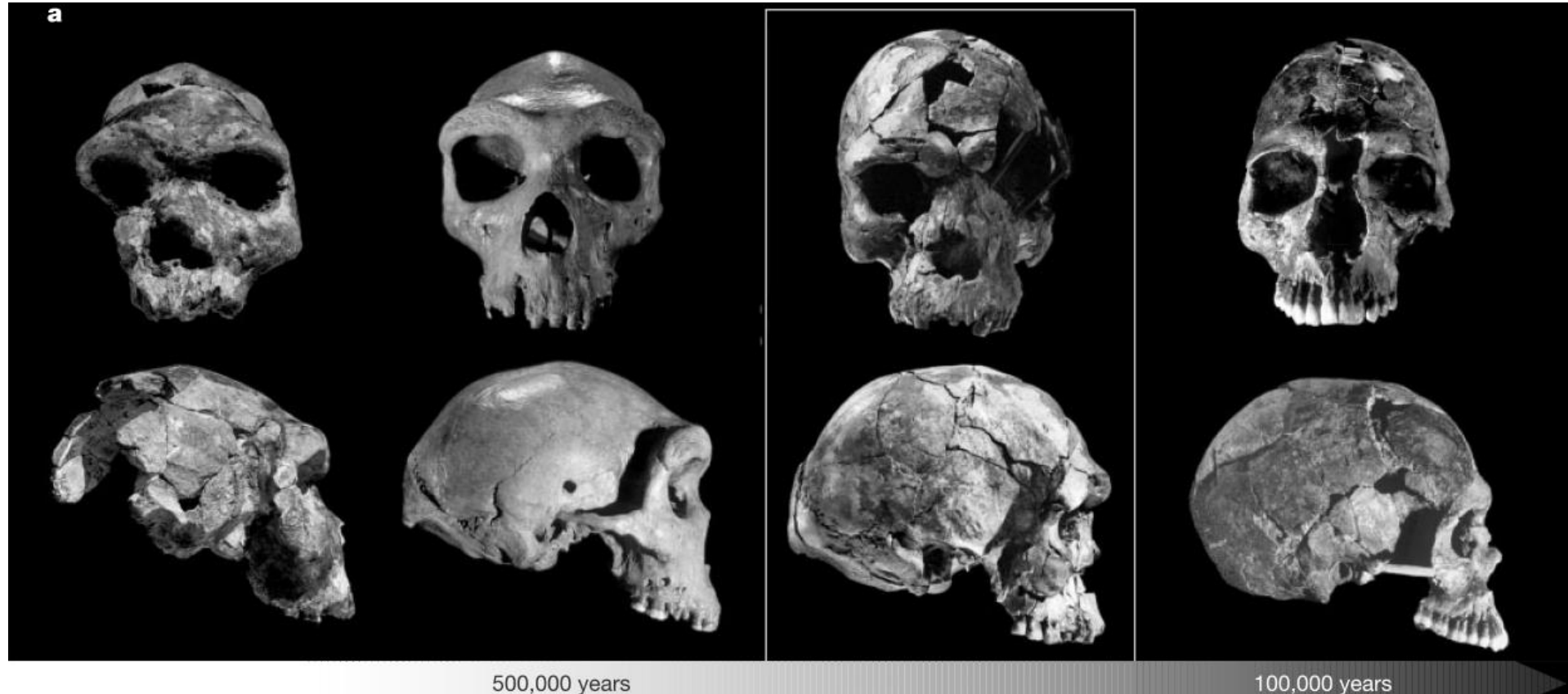


The african « evolutionary sequence » for *Homo sapiens*

Archaic *Homo sapiens*
Homo rhodesiensis?
Homo heidelbergensis?



Anat. modern
Homo sapiens

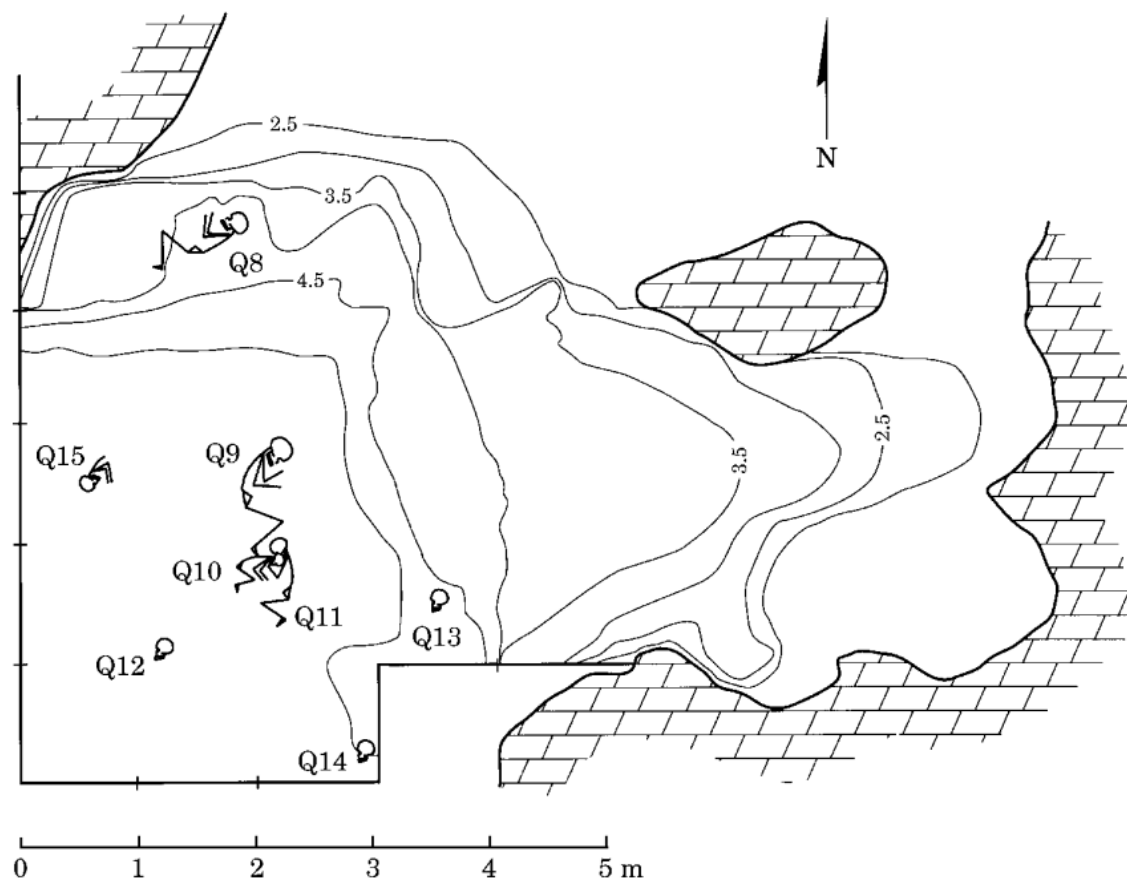


Homo sapiens idaltu



Qafzeh, Israele
90-100 000 y BP

Resti umani (NMI 25 individui)
Industrie musteriane



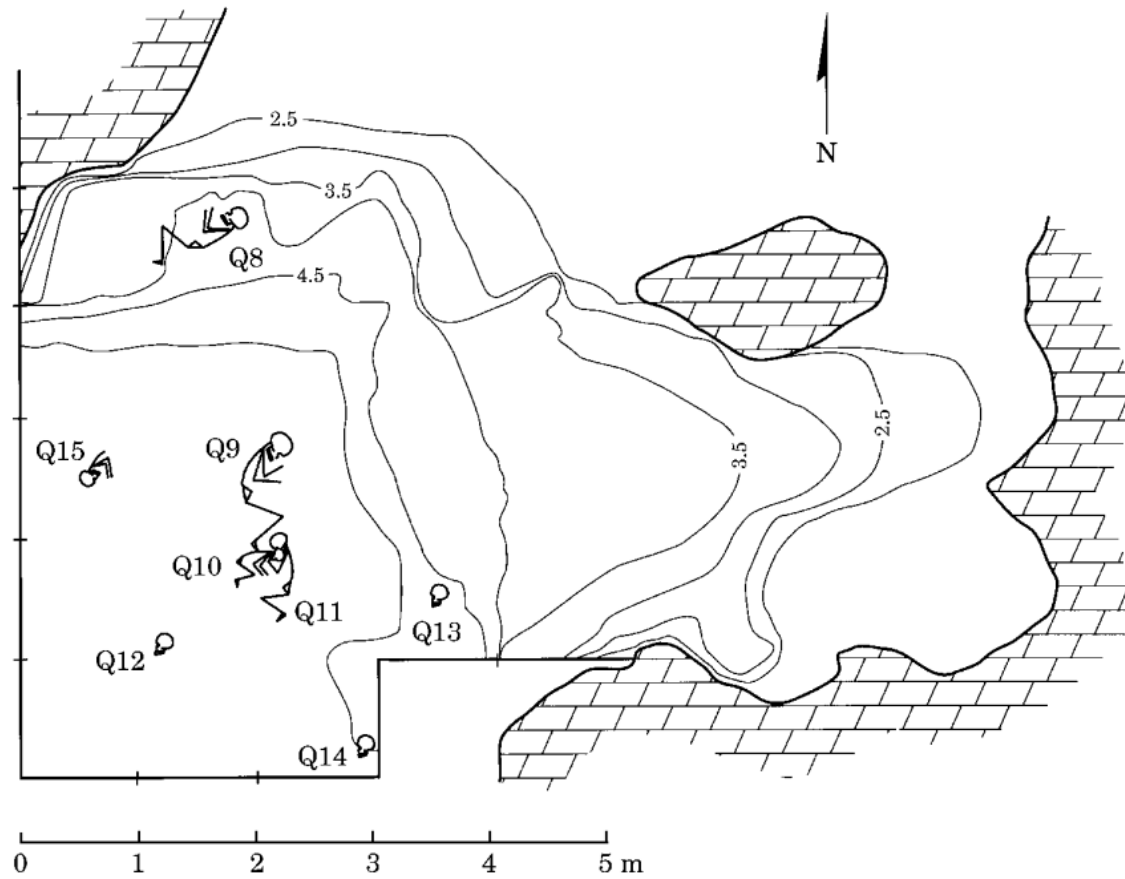
(Vandermeersch, 1981)



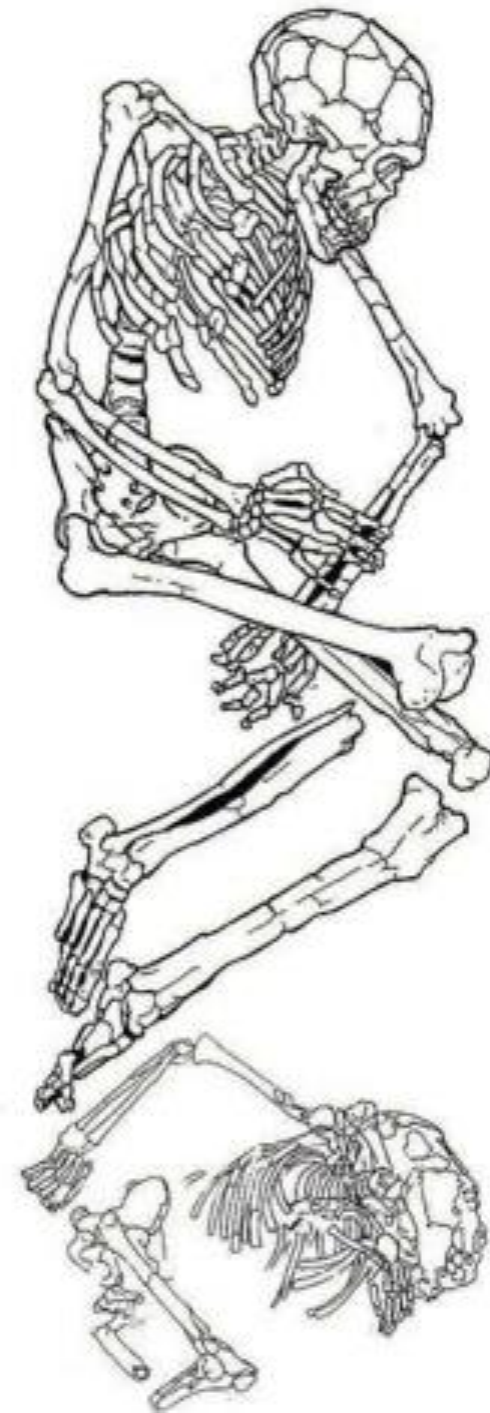
Qafzeh 9

Qafzeh, Israele
90-100 000 y BP

Sepoltura doppia



(Vandermeersch, 1981)



I primi *Homo sapiens* nel Vicino Oriente

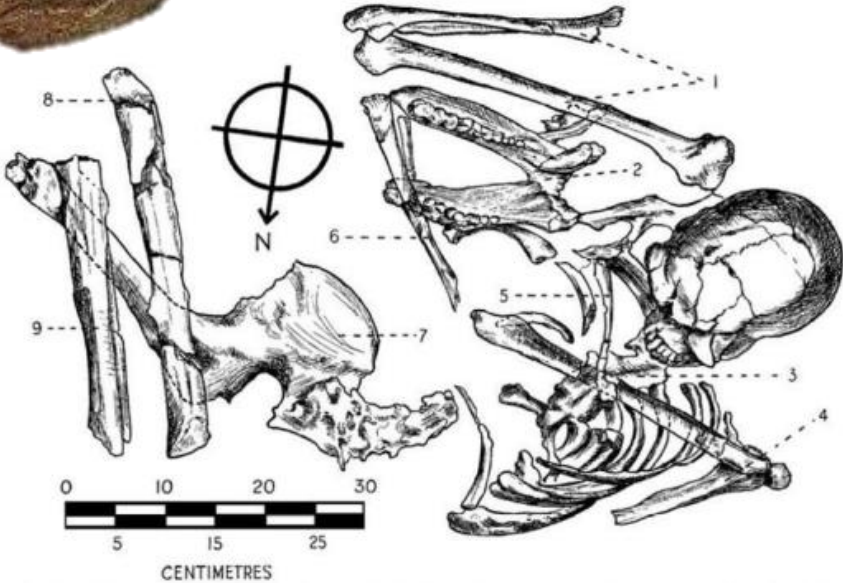
Skhul - Israele (100.000 BP)

- Industria musteriana / *Mousterian industries*
- 10 scheletri completi / *10 complete skeleton*
- morfologia arcaica (inizialmente attribuiti a *Homo neanderthalensis*) / *Archaic morphology (attributed at the beginning to Homo neanderthalensis)*



Skhul IV

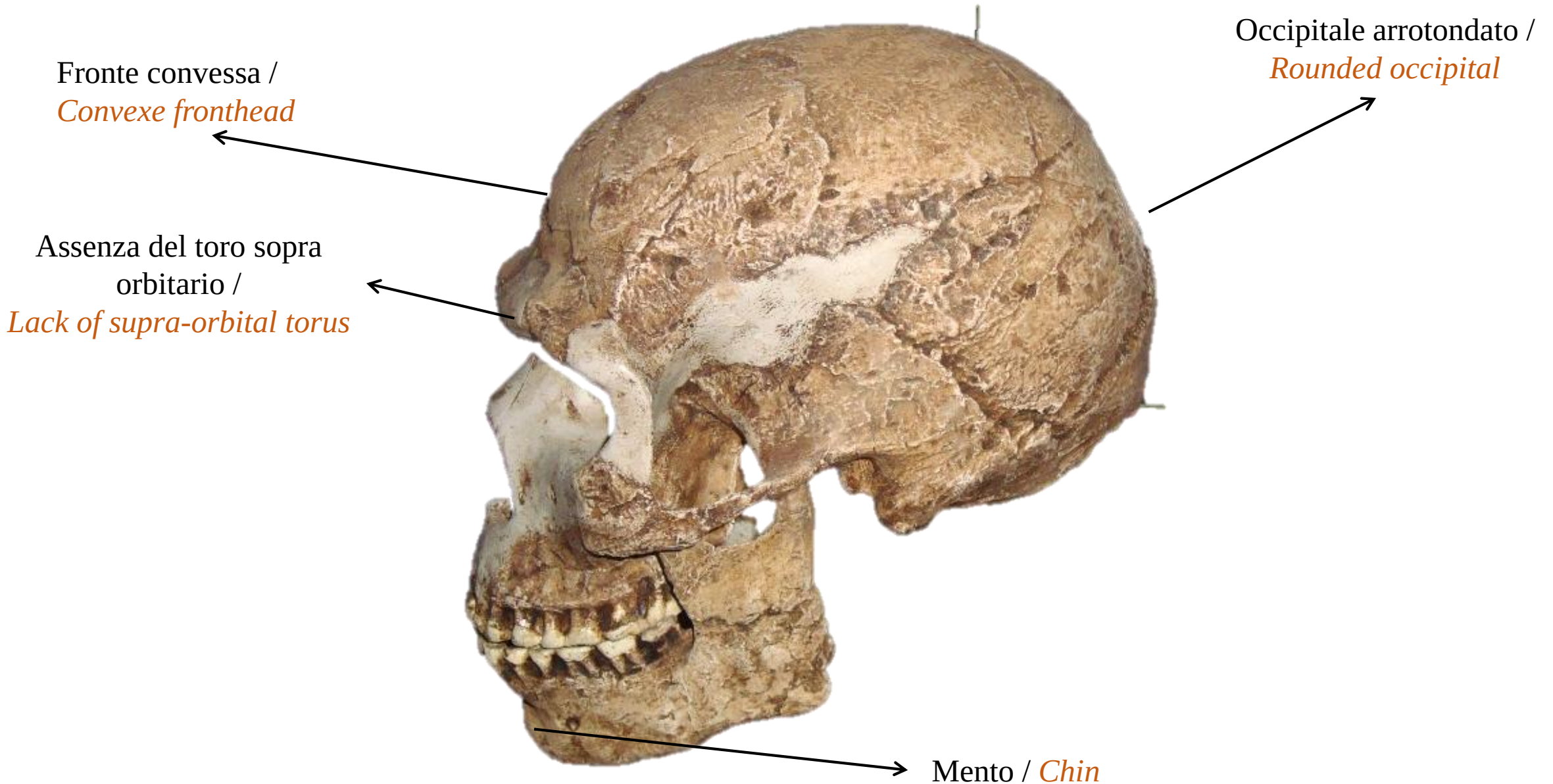
Skhul V, Israel
100 000 y BP

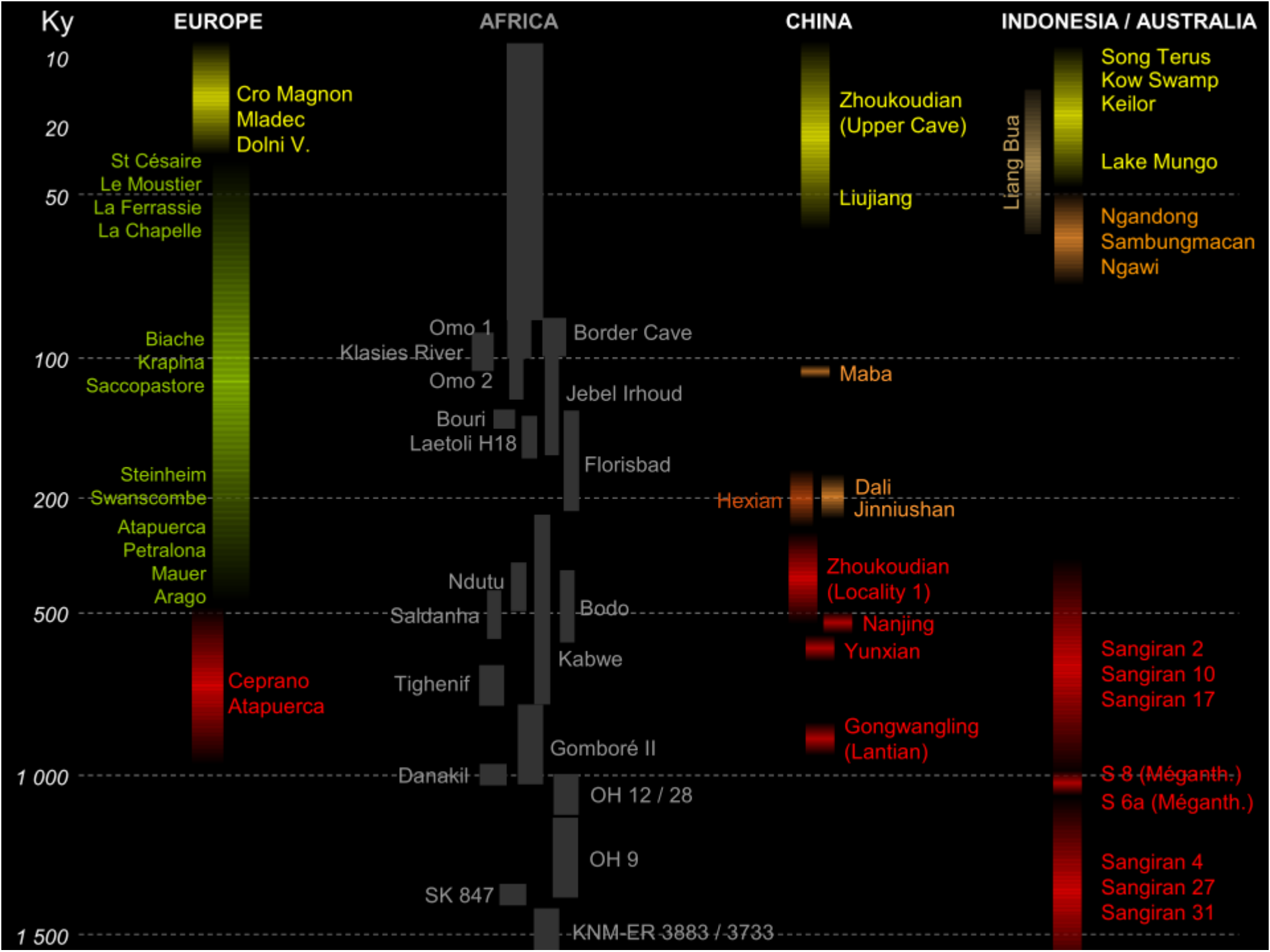


2. Plan of the contracted burial of a tall male, Skhul V. 1, right arm; 2, Pig's mandible; 3, dorsal vertebrae; 4, left scapula and humerus; 5, left clavicle; 6, left radius; 7, right ilium; 8, left femur; 9, left tibia and fibula.

(Garod & Bate, 1937)

I primi *Homo sapiens* nel Vicino Oriente
First Homo sapiens in the Near-East





Fossil record

Homo erectus

East Asia (China)

Southeast Asia

mainland

insular (Java)

H. erectus /archaic *H. sapiens*

East Asia (China)

Southeast Asia

insular (Java)

fossil *Homo sapiens*

East Asia

Southeast Asia

Australia

Pacific

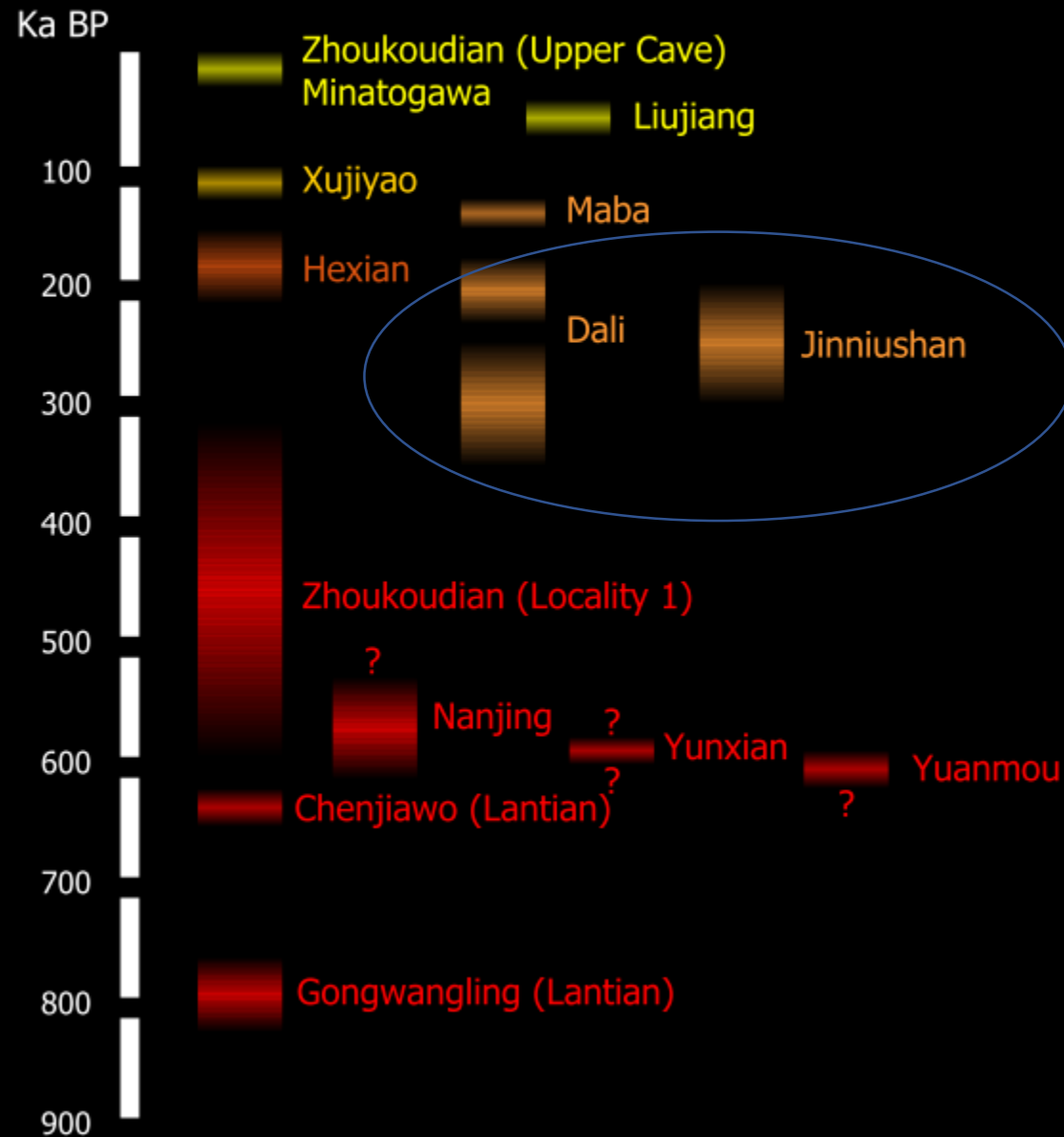


Chronology of Chinese human fossils

Anatomically modern
Homo sapiens

“Archaic” *Homo sapiens*
transition forms?

Homo erectus



Narmada Valley, India
Pleistocene medio – 230 ka?

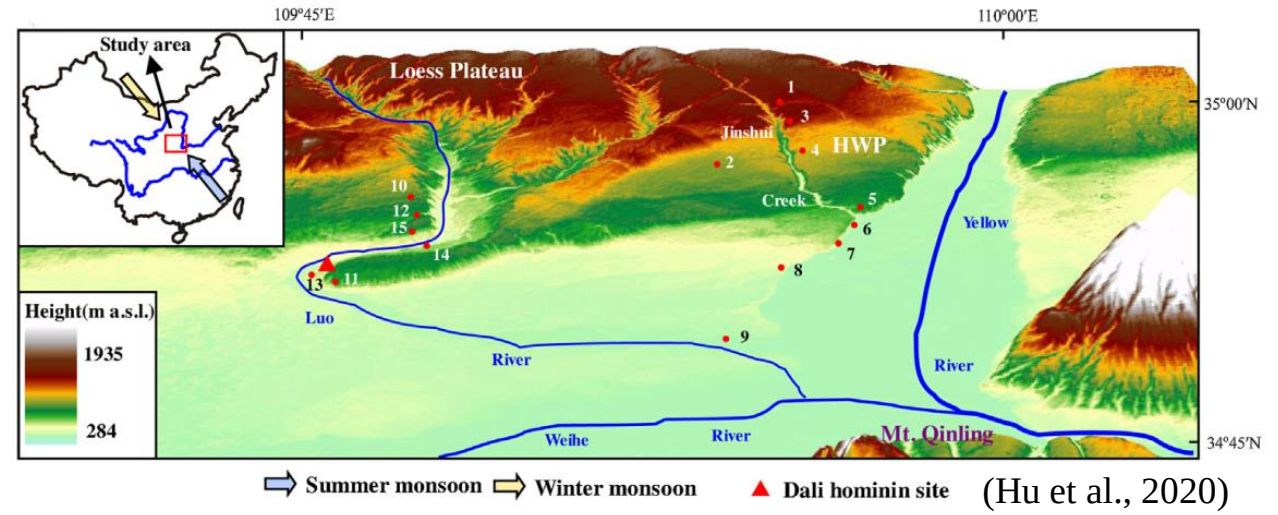


Dali, China

180 – 230 ky BP (U-Th on tooth)

250-350 ky BP (ESR – U-Th on tooth)

~550 ky BP (Geomorphology, Hu et al., 2020)

Mosaic of *H. erectus* and *H. sapiens* features« archaic » *H. sapiens* = *H. rhodesiensis*, *H. heidelbergensis*?

Jinniushan, China
260 000 y B.P.

« archaic » *H. sapiens* = *Homo rhodesiensis* / *Homo heidelbergensis*?



(Rosenberg et al., 2006)



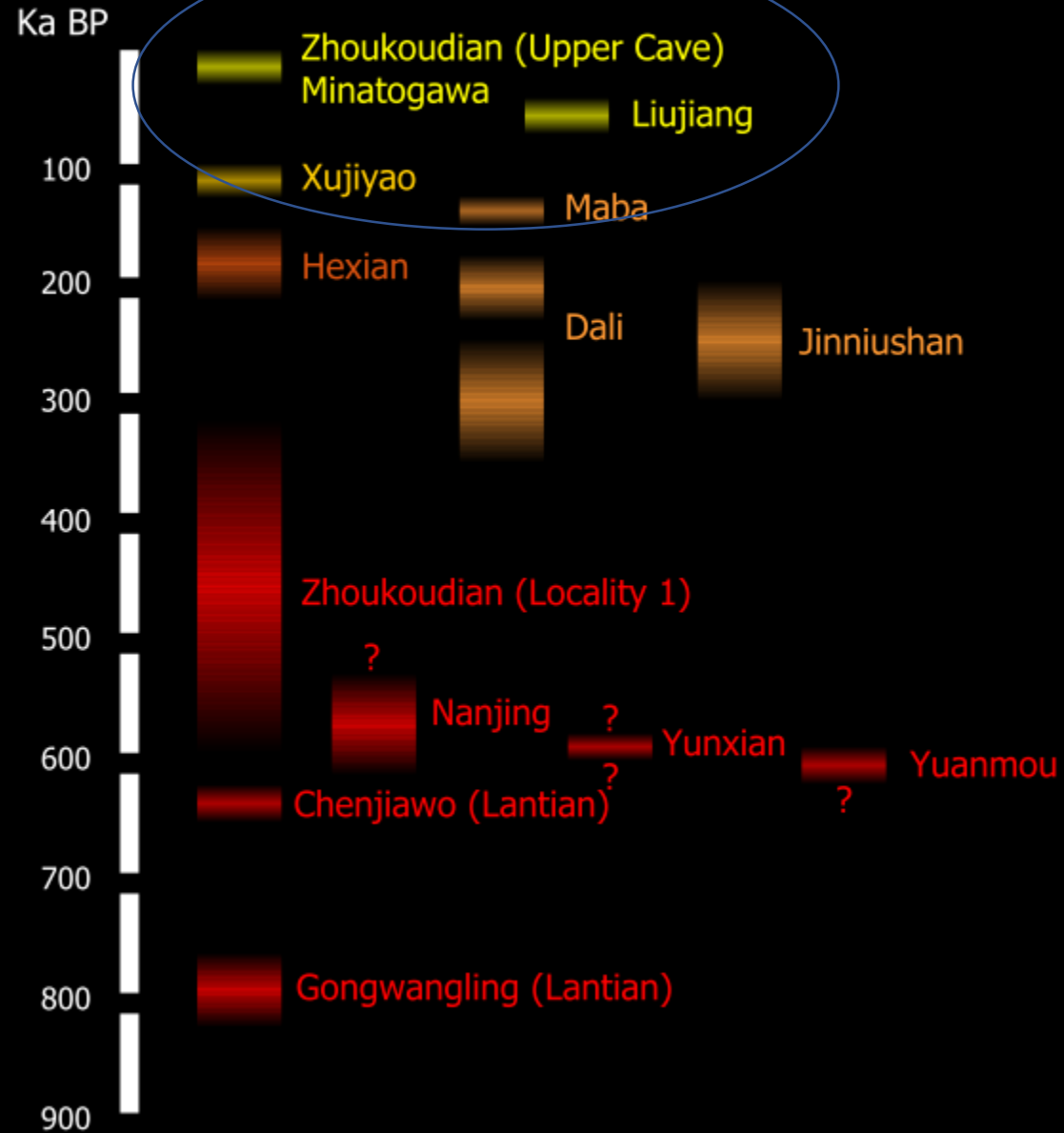
Chronology of Chinese human fossils

Anatomically modern
Homo sapiens

“Archaic” *Homo sapiens*
transition forms?

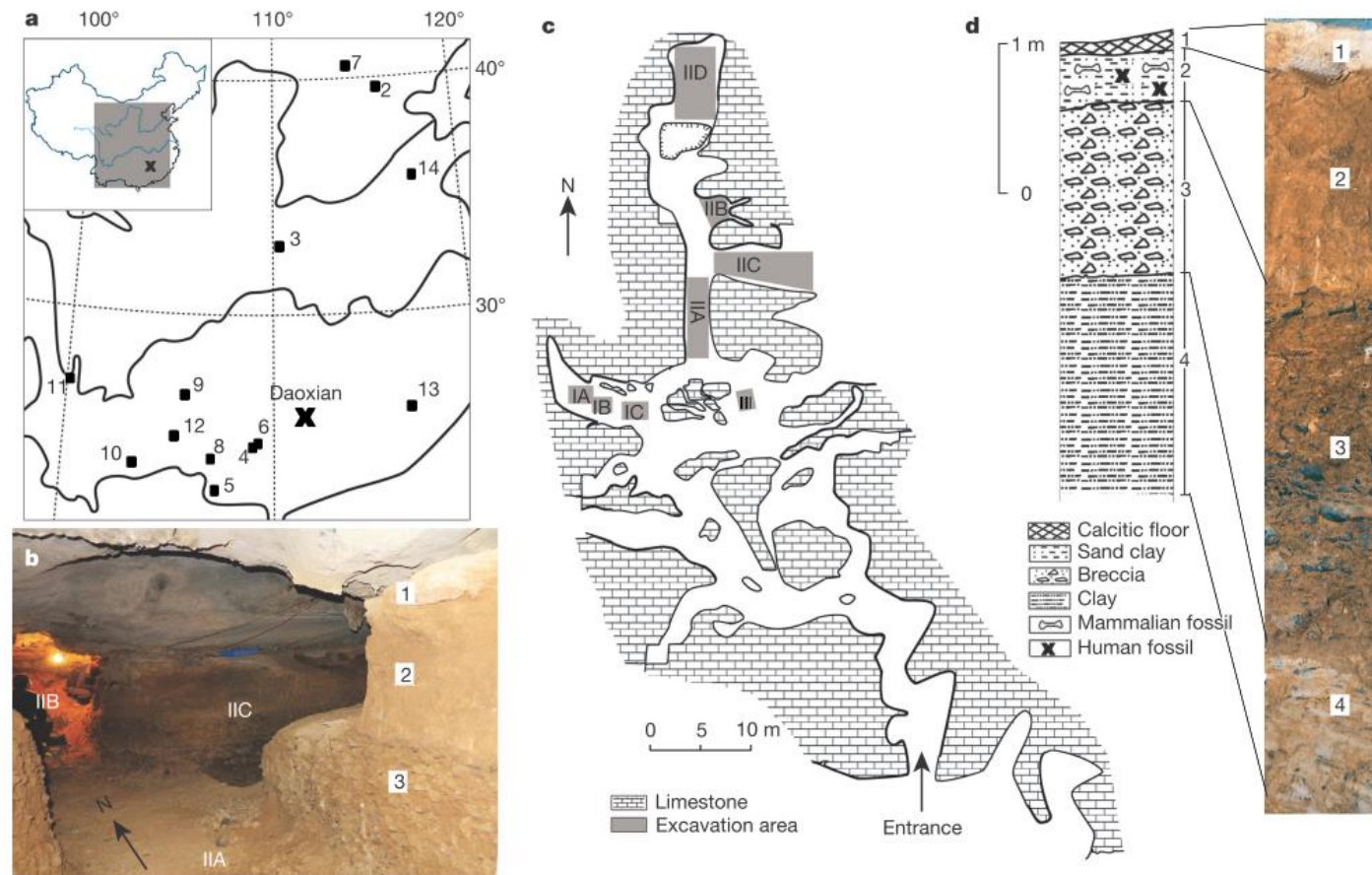
~*Homo heidelbergensis*?

Homo erectus



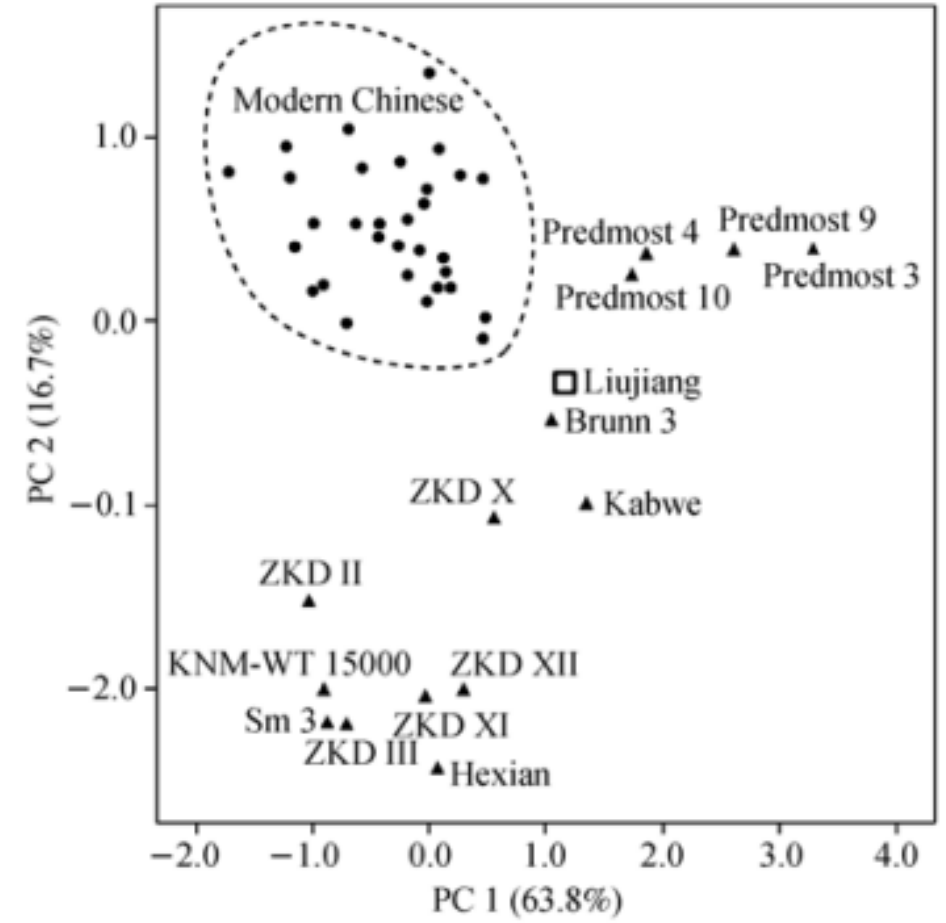
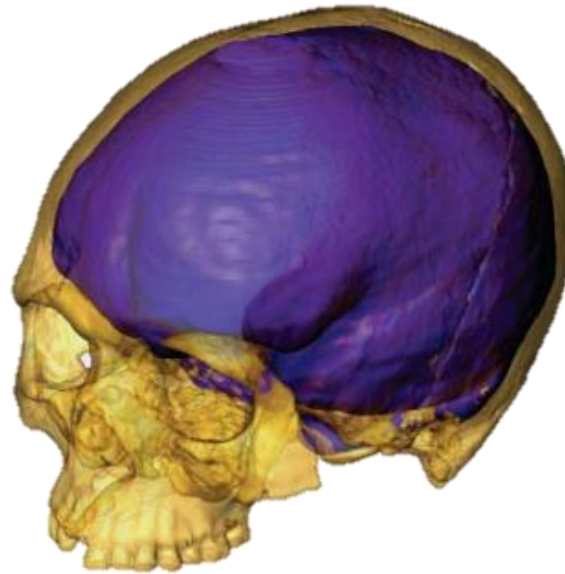
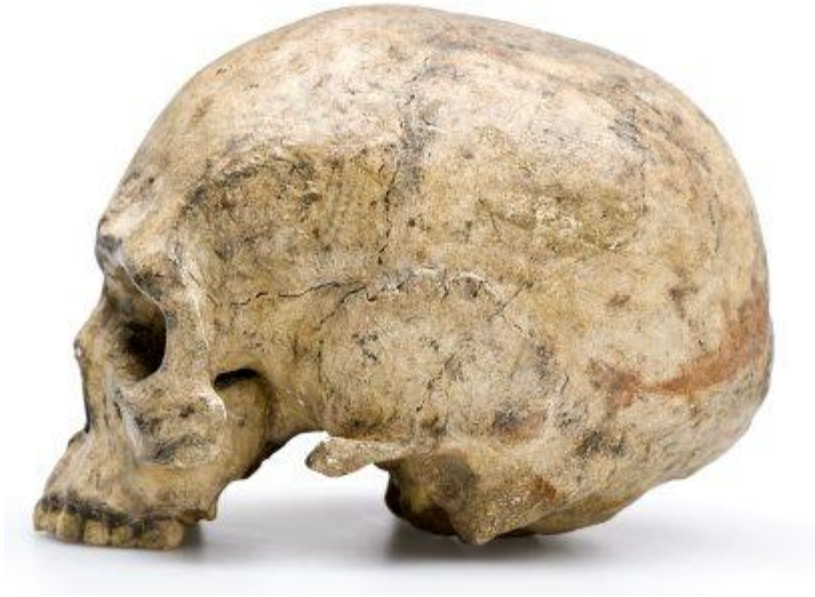
Wu Liu^{1*}, María Martínón-Torres^{2,3,4*}, Yan-jun Cai⁵, Song Xing¹, Hao-wen Tong¹, Shu-wen Pei¹, Mark Jan Sier^{4,6,7}, Xiao-hong Wu⁸, R. Lawrence Edwards⁹, Hai Cheng¹⁰, Yi-yuan Li¹¹, Xiong-xin Yang¹², José María Bermúdez de Castro^{2,4} & Xiu-jie Wu^{1*}

Più derivati che tutti i altri umani anatomicamente moderni, similarietà con il umani del Pleistocene medio, superiore e anche di tempi moderni.



“I risultati sono rilevanti per l’indagine sulle ragioni della relativamente tardiva entrata di *H. sapiens* in Europa. Degli umani moderni “completi” erano già presenti in Cina almeno 80.000 anni fa, non ci sono però evidenze dell’entrata in Europa prima di 45.000 anni fa. Questo potrebbe indicare che *H. neanderthalensis* fosse stato un’ulteriore **barriera ecologica** per gli uomini moderni, che sono potuti entrare in Europa solo quando la scomparsa dei Neanderthals era già iniziata”.

Liujiang, China
60 – 100 000 y BP?



Zhoukoudian Upper Cave, China
20 – 30 000 y BP





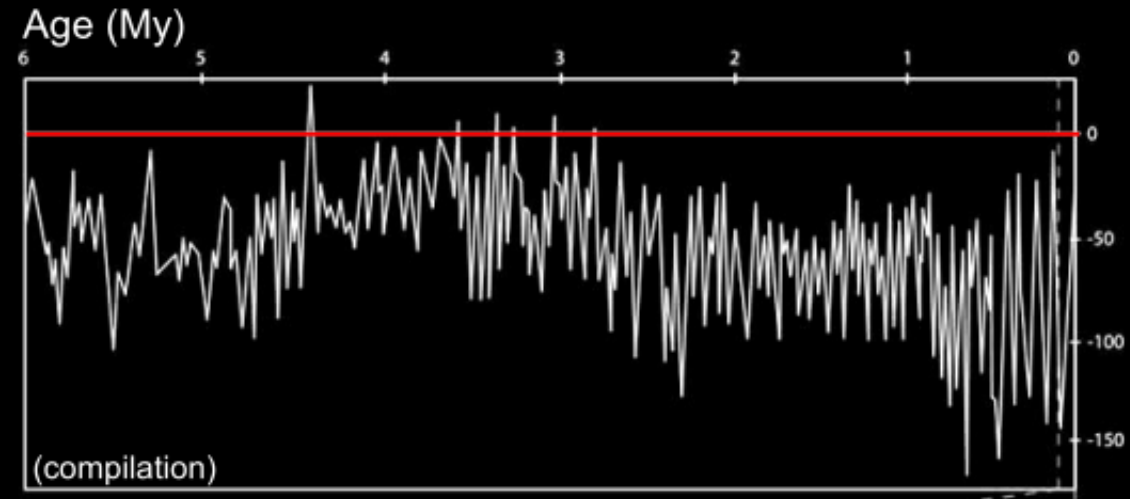
Toward Southeast Asia and
Australia

How did they arrive ?

Homo erectus

Glacial / interglacial
=> Sea level changes

- insular periods



How did they arrive ?

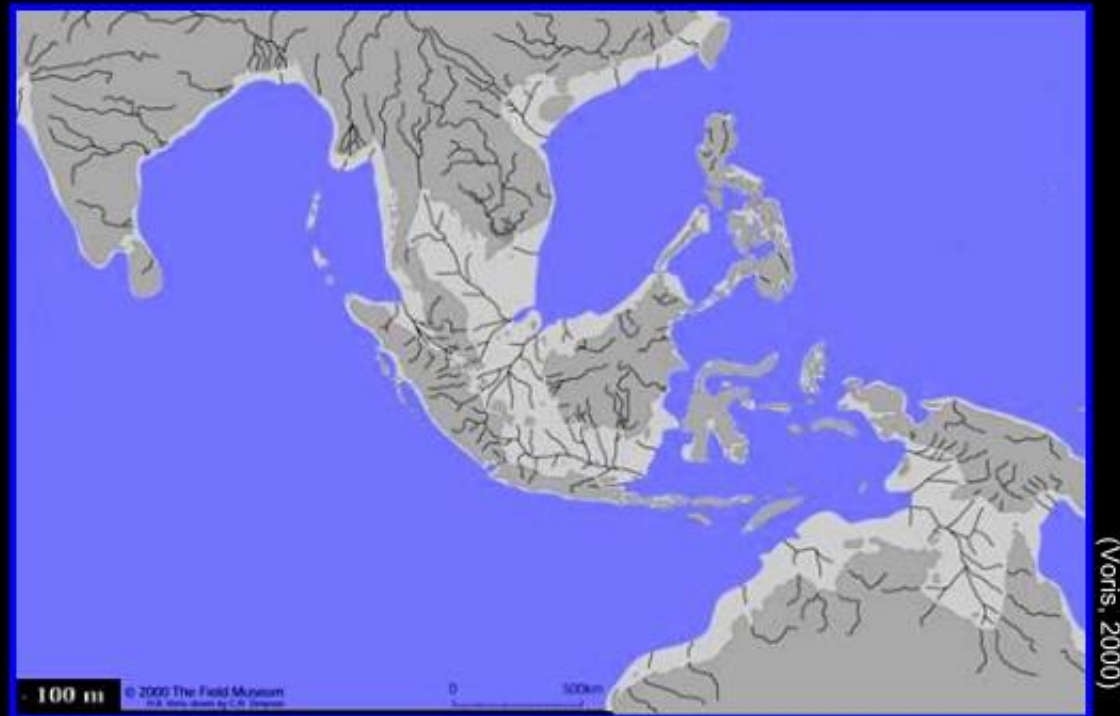
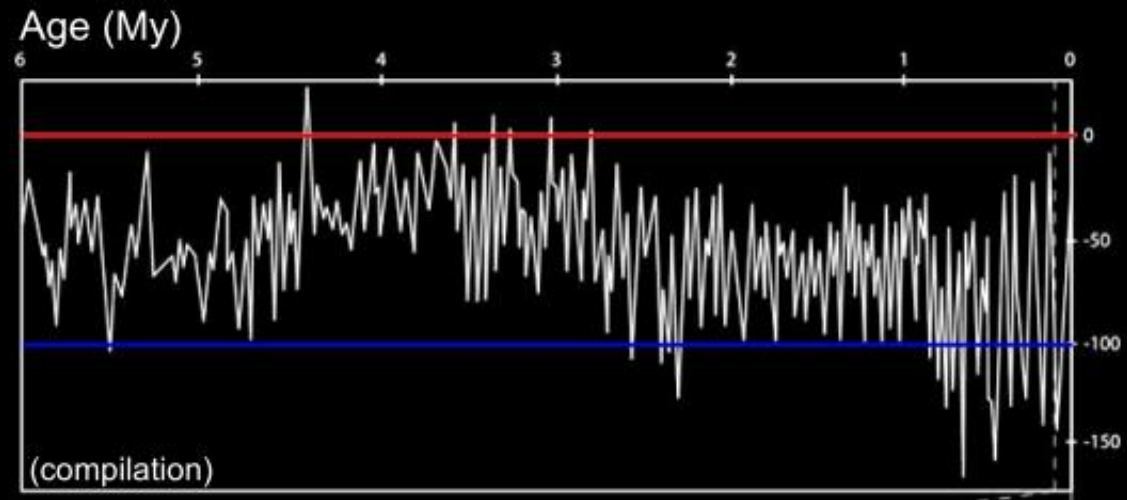
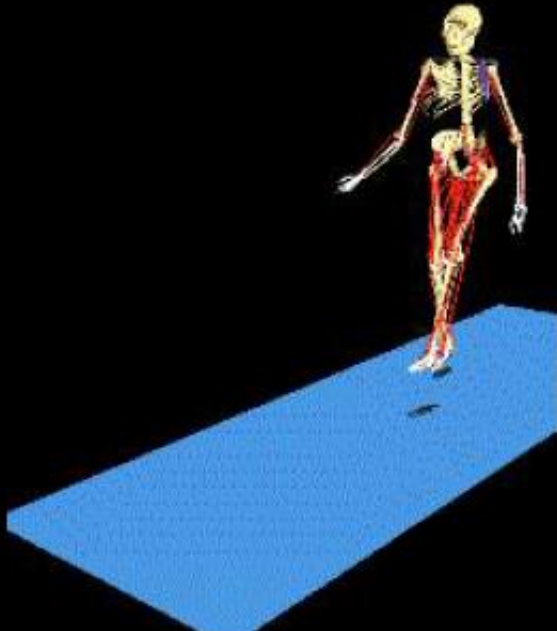
Homo erectus

Glacial / interglacial

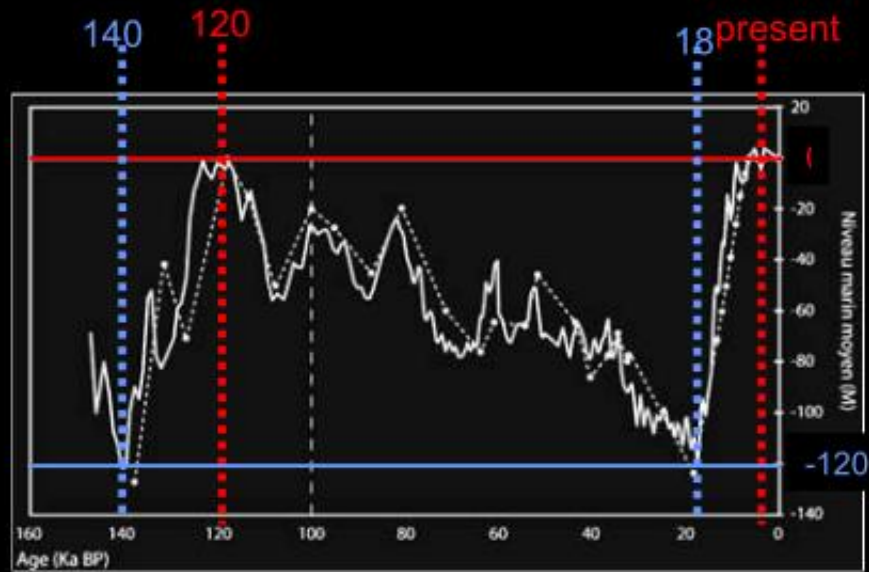
=> Sea level changes

- insular periods

- continental periods



Homo sapiens is able to navigate for at least 60 000 years



d'après Chappell *et al.* (1996) ; Pillans *et al.* (1998) et Voris (2002)

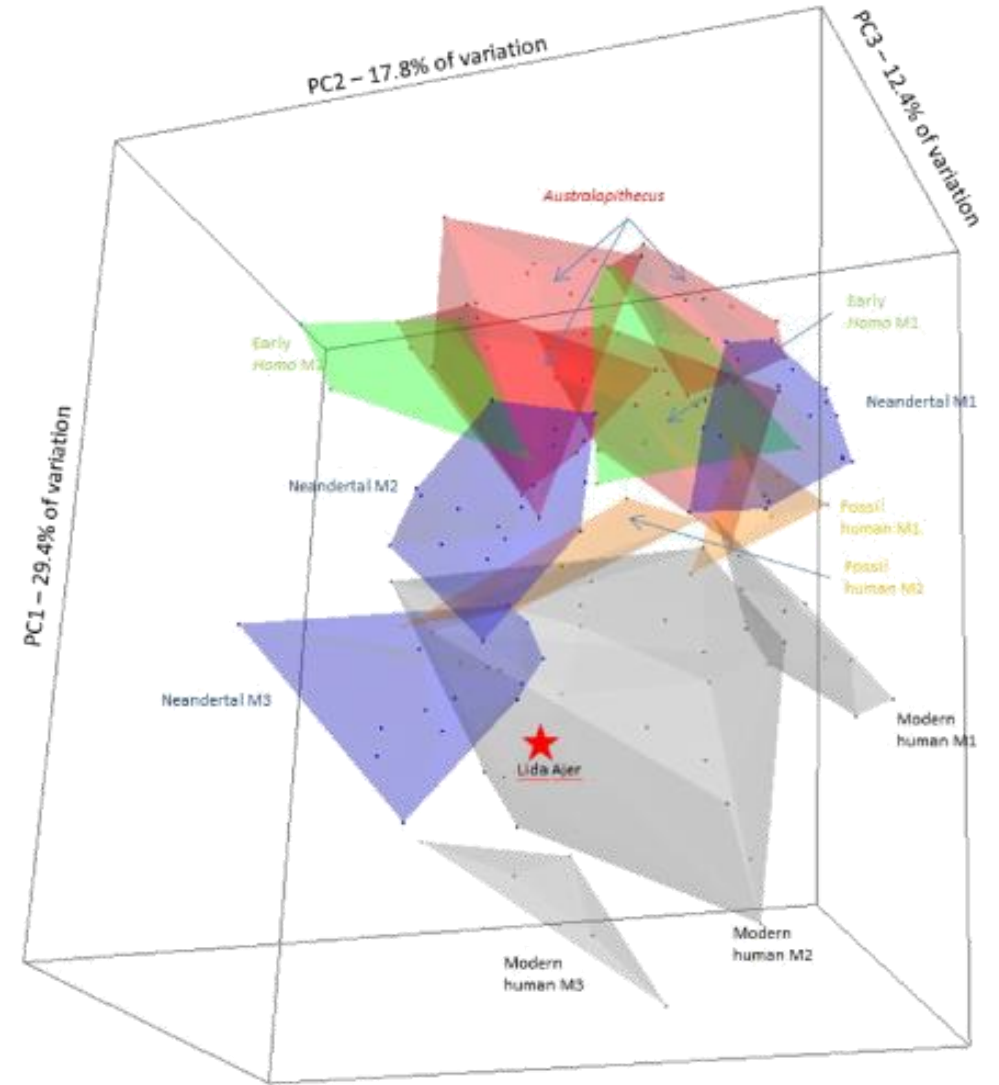
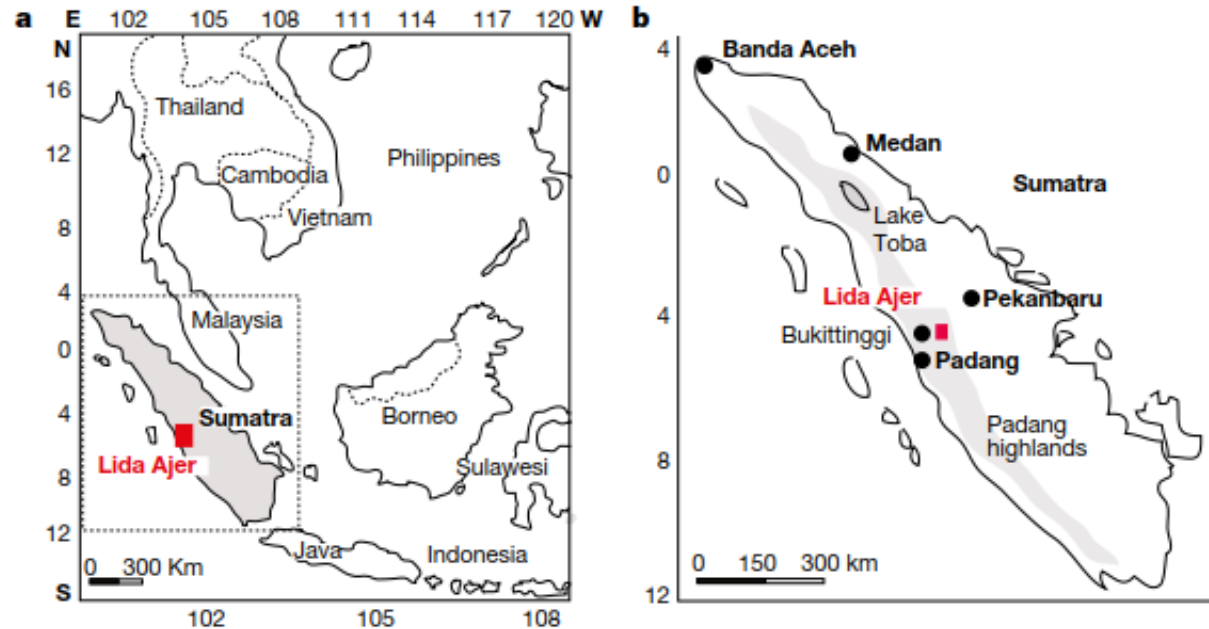
Localizzazione in indonesia della comparsa di
Homo floresiensis e *soloensis*

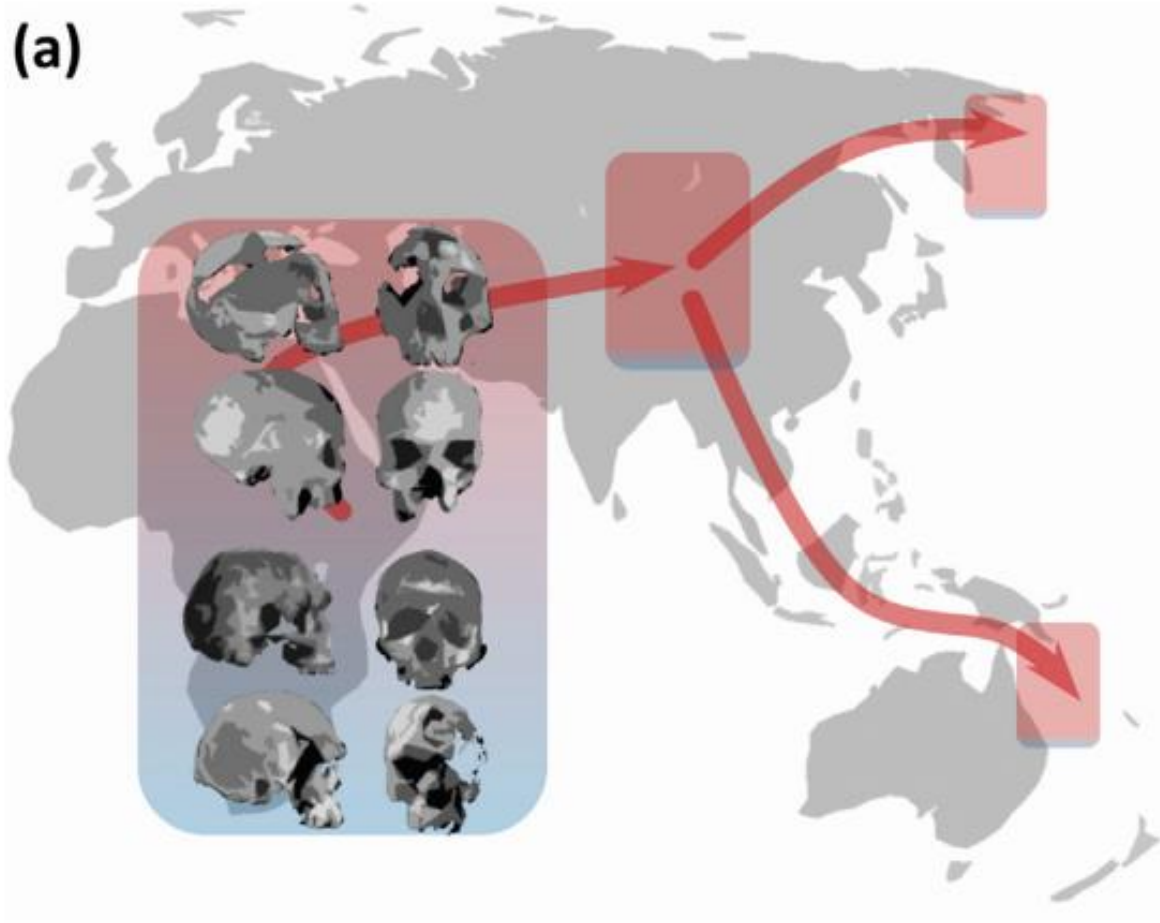


(Cavalli Sforza & Pievani, 2012)

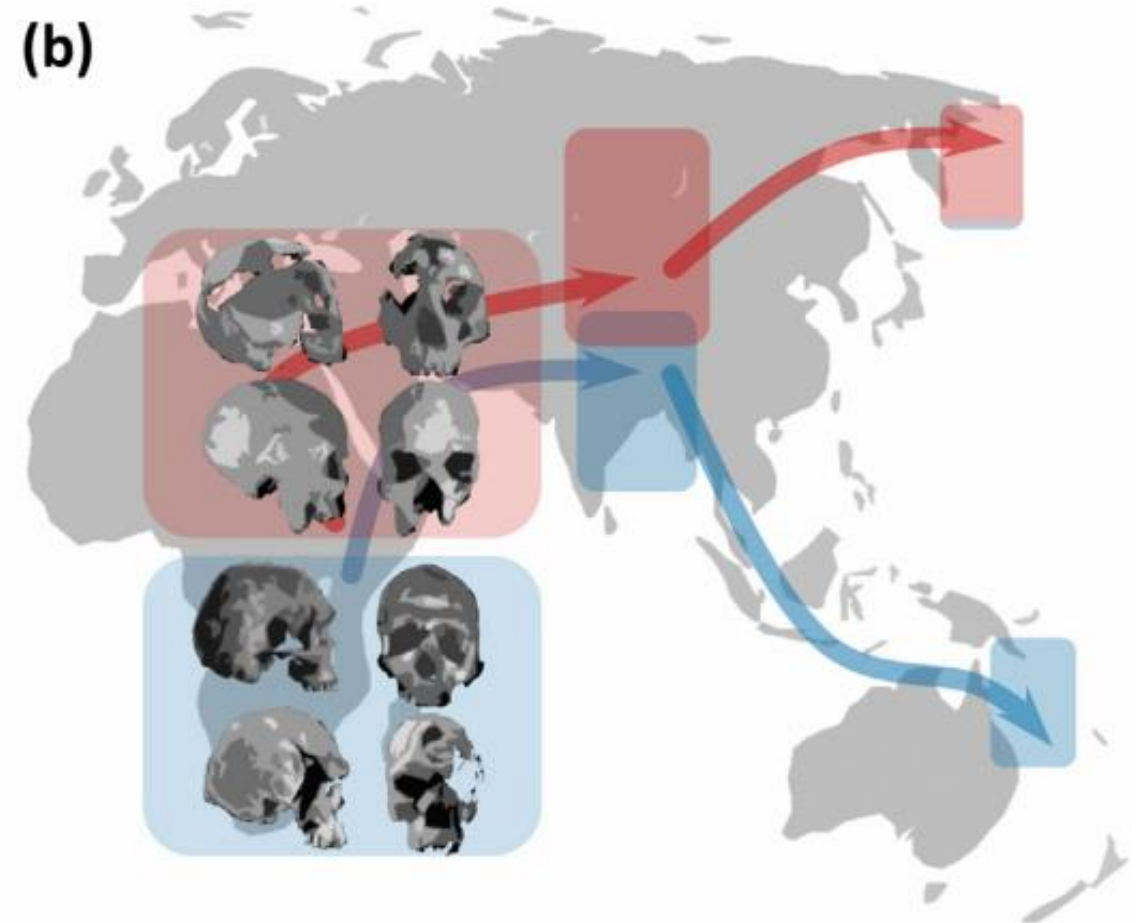
An early modern human presence in Sumatra 73,000–63,000 years ago

K. E. Westaway¹, J. Louys², R. Due Awe^{3,†}, M. J. Morwood^{4,‡}, G. J. Price⁵, J.-x. Zhao⁵, M. Aubert⁶, R. Joannes-Boyau⁷, T. M. Smith^{8,9}, M. M. Skinner^{10,11}, T. Compton¹², R. M. Bailey¹³, G. D. van den Bergh⁴, J. de Vos¹⁴, A. W. G. Pike¹⁵, C. Stringer¹², E. W. Saptomo³, Y. Rizal¹⁶, J. Zaim¹⁶, W. D. Santoso¹⁶, A. Trihascaryo¹⁶, L. Kinsley¹⁷ & B. Sulistyanto³





Single dispersal

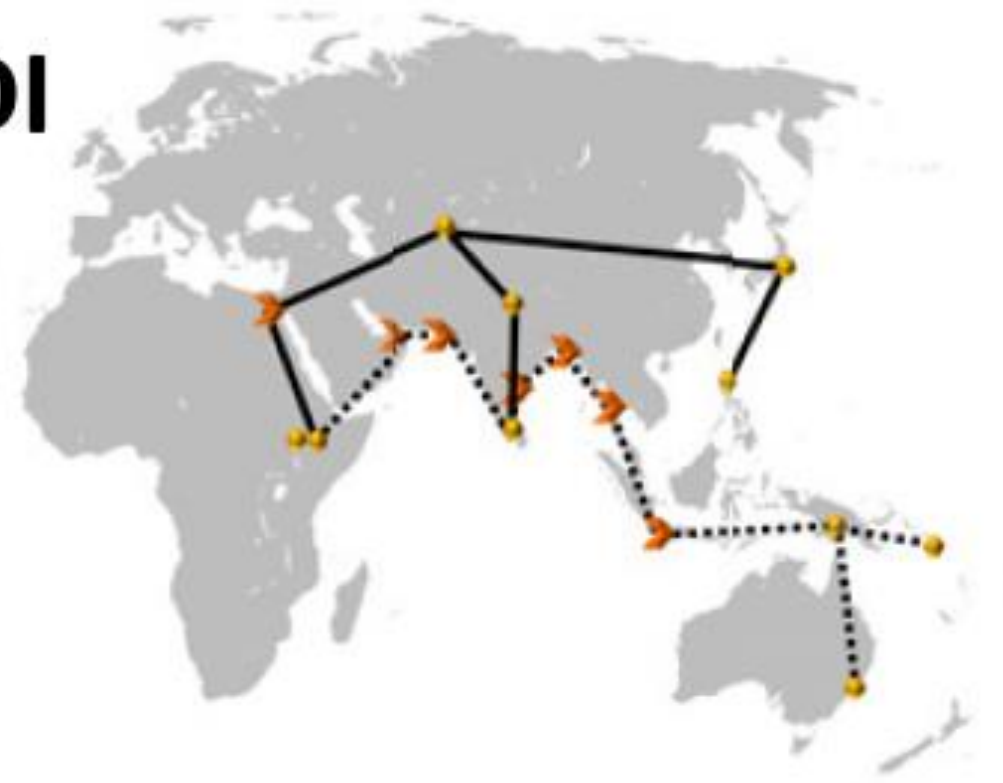


Multiple dispersal

MD



MDI

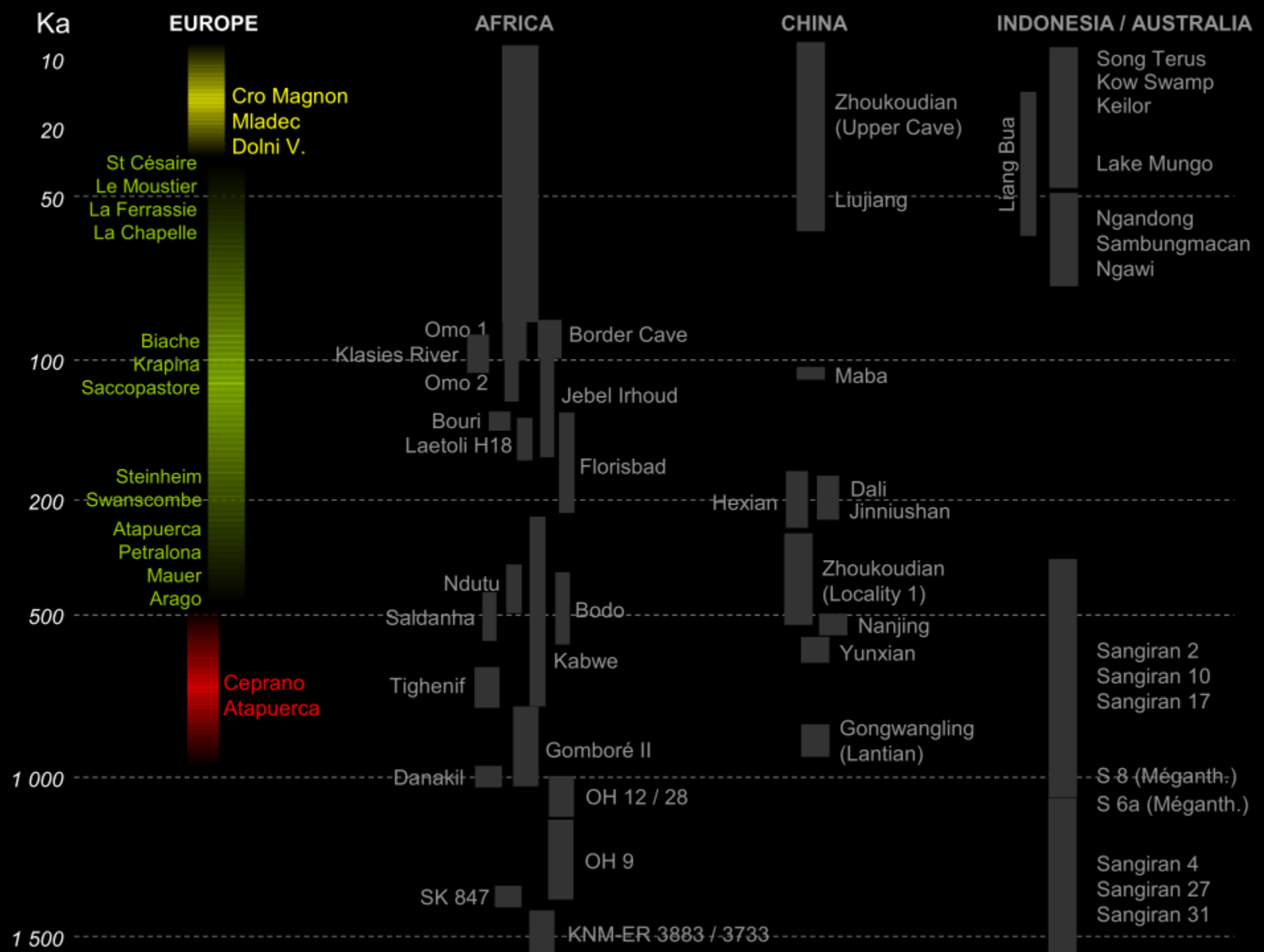


Recent genetic studies and accumulating archaeological and paleontological evidence suggest a « southern route » dispersal into Asia in the late Middle Pleistocene, followed by a separate dispersal into northern Eurasia.

Australo-Melanesian populations are descendants of an early dispersal whereas other Asian populations are descended from, or highly admixed with, members of a subsequent migration event.

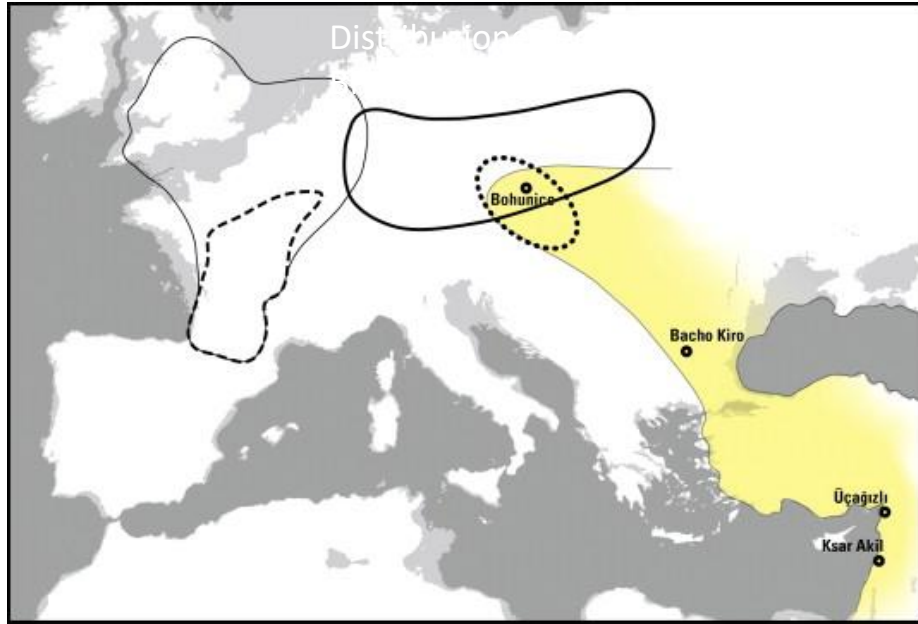


(Cavalli Sforza & Pievani, 2012)





I primi uomini moderni in Europa



Bacho Kiro (Bulgaria) (Aurignaziano antico), 43.000 anni

Grotta del Cavallo (Italia) (Uluzziano), 45.000-43.000 anni

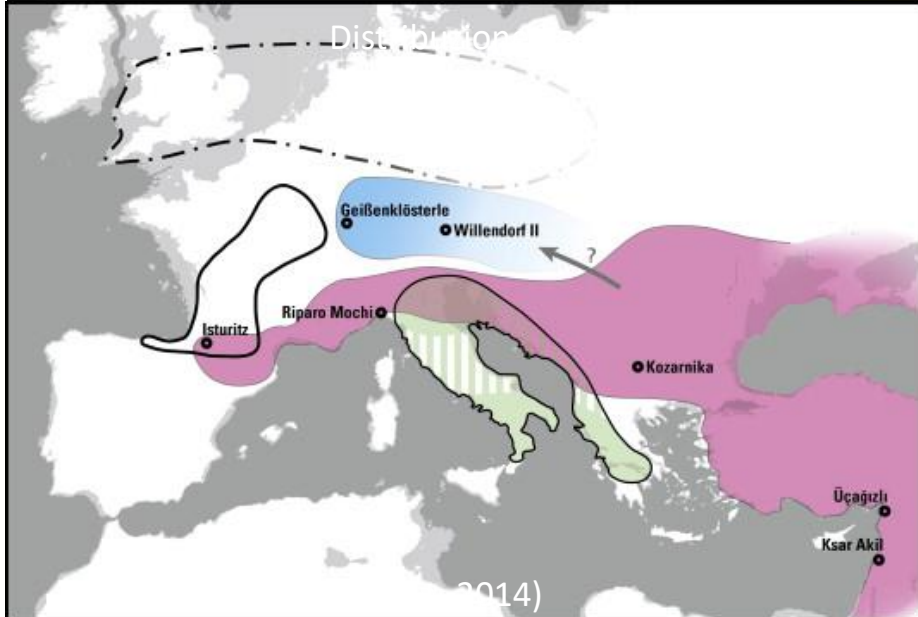
El Castillo (Spagna) (Aurignaziano antico) 37.000- 34.000 anni

Mladec (Repubblica Ceca) (32.000 anni)

Dolni Vestonice, Pavlov (Repubblica Ceca) (25.000 anni)

Cro Magnon (Francia) (30.000 anni)

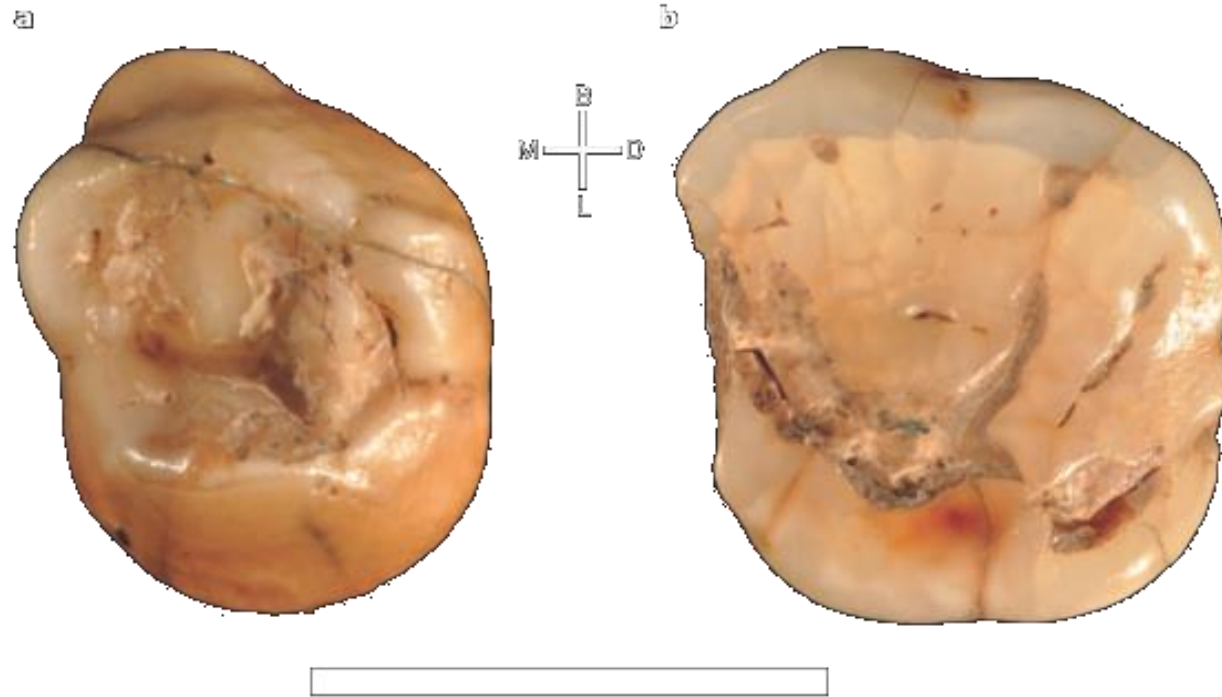
Pestera cu Oase (Grotta degli orsi, Romania) 34-36.000 anni



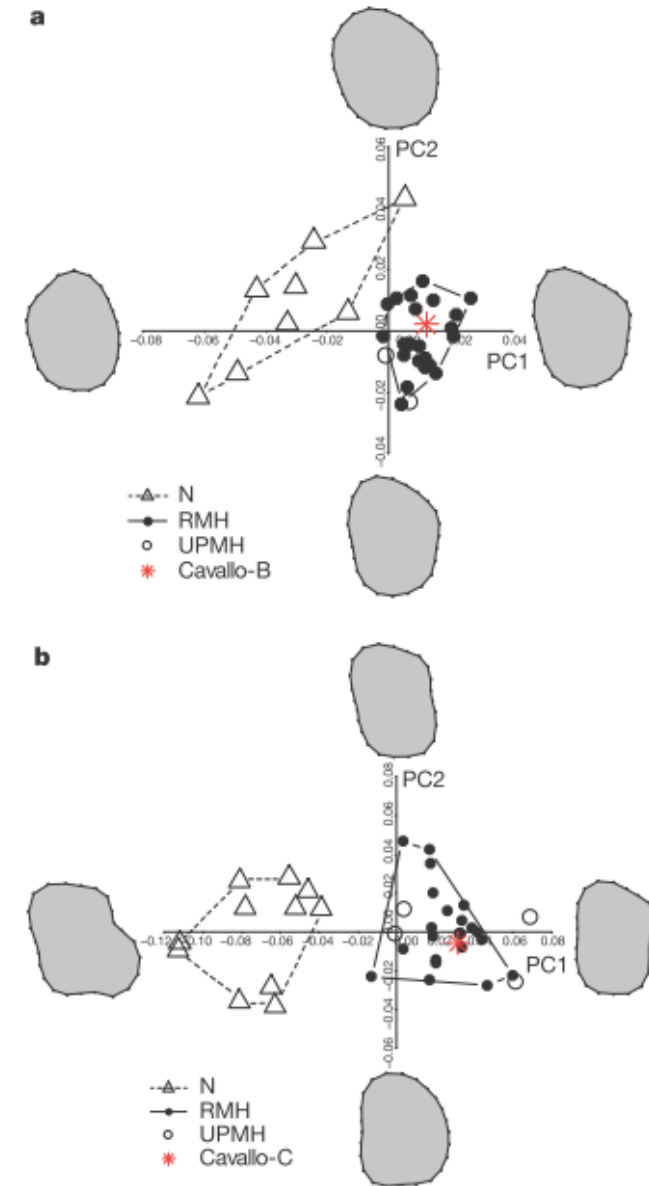


Early dispersal of modern humans in Europe and implications for Neanderthal behaviour

Stefano Benazzi¹, Katerina Douka², Cinzia Fornai¹, Catherine C. Bauer³, Ottmar Kullmer⁴, Jiří Svoboda^{5,6}, Ildikó Pap⁷, Francesco Mallegni⁸, Priscilla Bayle⁹, Michael Coquerelle¹⁰, Silvana Condemi¹¹, Annamaria Ronchitelli¹², Katerina Harvati^{3,13} & Gerhard W. Weber¹



Grotta del Cavallo, Italia (45 000 – 43 000 y BP)



Cro-Magnon, Francia

27 680 +/- 270 BP (Henry-Gambier et al, 2002)



Cro-Magnon 1



Cro-Magnon 2

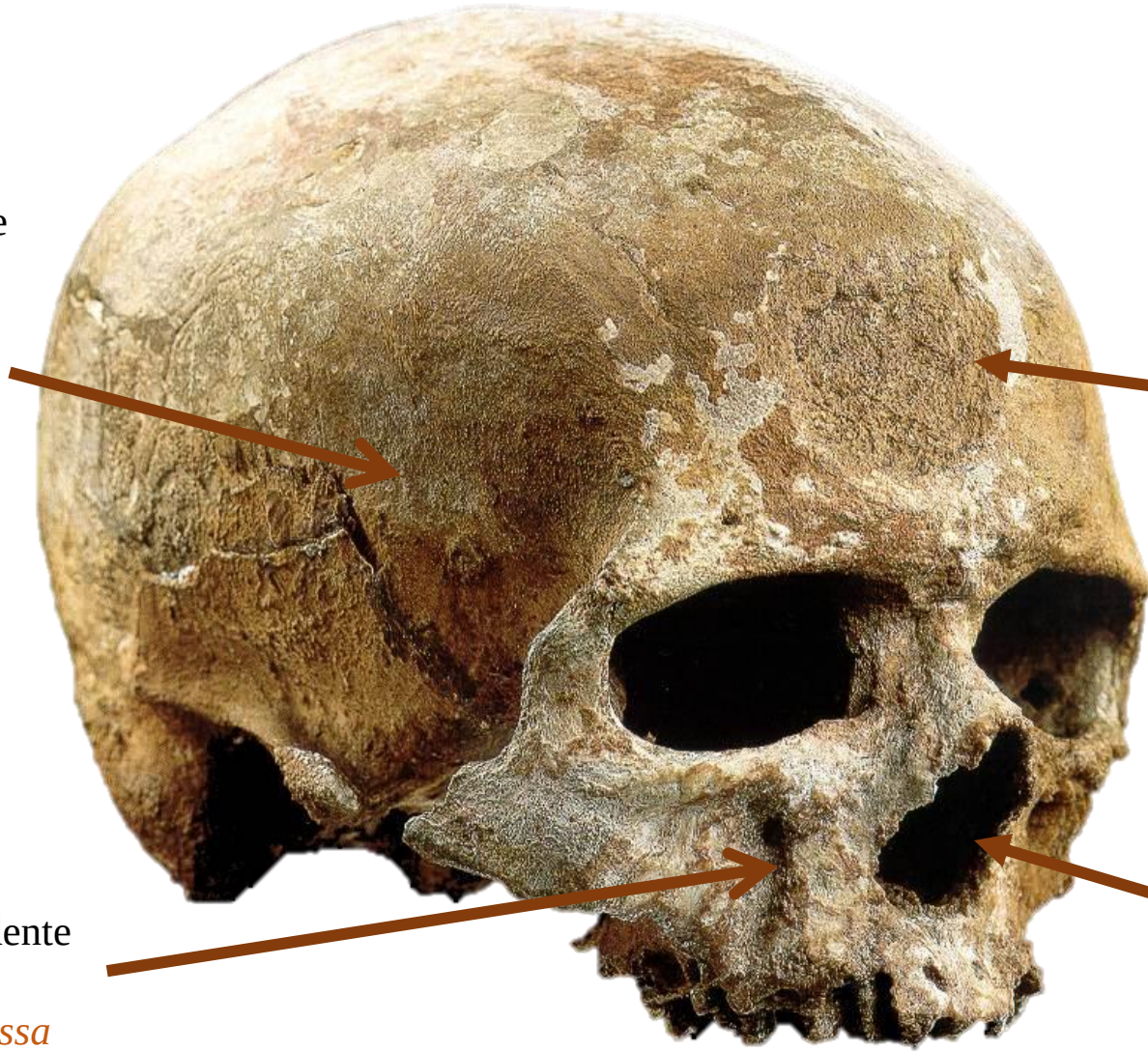


Parietali espansi e
occipitale
arrotondato /
*Parietals
expanded and
rounded
occipitals*

Fronte verticale /
*Vertical frontal
bone*

Fossa canina evidente
/
Evident canine fossa

Faccia piccola e
piatta / *Short and flat
face*



H. sapiens, Cro-Magnon



Mladec V, Czech Republic
34-35 000 y BP?

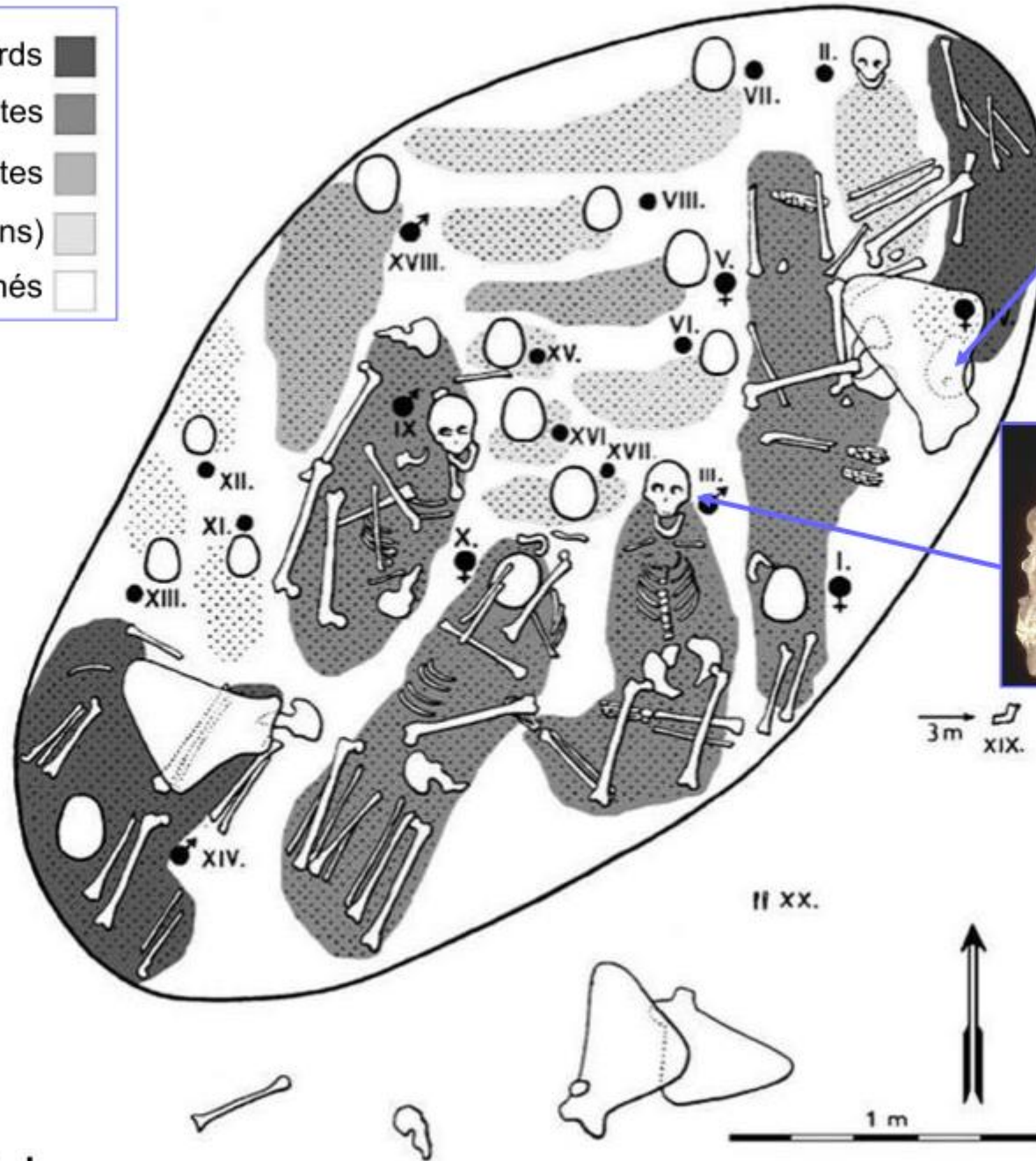


Triple burial (Mladec 5, 6 and 46)

Predmost III, Czech Republic
28 – 20 000 y BP



- 2 vieillards ■
- 2 "couples" adultes ■
- 2 jeunes adultes ■
- 7 enfants (2-14 ans) ■
- 3 nouveaux nés ■



Predmost
Multiple burial



Peștera cu Oase, Romania 34 290 +/- 900 BP



Available online at www.sciencedirect.com

SCIENCE @ DIRECT®



Journal of Human Evolution 45 (2003) 245–253

News and Views

Early modern human cranial remains from the Peștera cu Oase, Romania

Erik Trinkaus^{a*}, Ștefan Milota^b, Ricardo Rodrigo^c, Gherase Mircea^b,
Oana Moldovan^d

^aDepartment of Anthropology, Campus Box 1114, Washington University, St. Louis, MO 63130, USA

^bPRO ACVA GRUP, Str. Surduc 1, 1900 Timișoara, Romania

^cCentro Nacional da Arqueologia Náutica e Subaquática, Instituto Português de Arqueologia, Avenida da Índia 136,
1300 Lisboa, Portugal

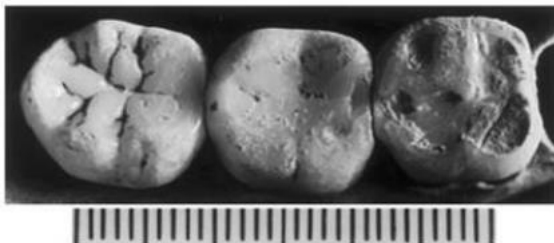
^dInstitutul de Speologie “Emil Racoviță,” Clinicilor 5, P.O. Box 58, 3400 Cluj, Romania

Keywords: Human paleontology; Early modern humans; Europe; Late Pleistocene



Conclusion

The 2002 discovery of a human mandible at the Peștera cu Oase in southwestern Romania indicates that the earliest “modern” Europeans combined a variety of archaic *Homo*, derived early modern human, and possibly Neandertal features in their cranio-facial skeletal and dental morphology. Although compatible with some degree of admixture between regional Neandertal populations and in-dispersing early modern humans, the Oase 1 mandible is particularly relevant for emphasizing the degree to which early modern humans were not particularly modern.



(Trinkaus, 2003)

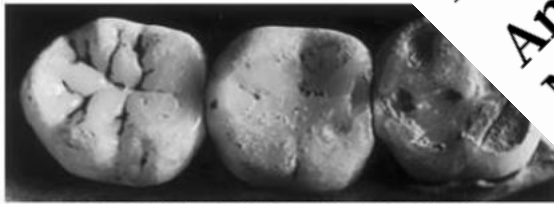


Pestera cu Oase, Romania
34 290 +/- 900 BP



Conclusion

The 2002 discovery of a human mandible in southwestern Romania indicates that Europeans combined a variety of modern human, and possibly, facial skeletal and dental features with some degree of archaic populations and individuals. The mandible is particularly significant in which early modern



LETTER

An early modern human from Romania with a recent Neanderthal ancestor

Qiaomei Fu^{1,2,3,*}, Mateja Hajdinjak^{3,*}, Oana Teodora Moldovan⁴, Silviu Constantin⁵, Swapan Mallick^{2,6,7}, Pontus Skoglund², Nick Patterson⁶, Nadin Rohland², Iosif Lazaridis², Birgit Nickel³, Bence Viola^{3,7,8}, Kay Prüfer³, Matthias Meyer³, Janet Kelso³, David Reich^{2,6,9} & Svante Pääbo³

Early r

doi:10.1038/nature14558

Availab'

www.sciencedirect.com

DIRECT

245–253

the Peștera cu

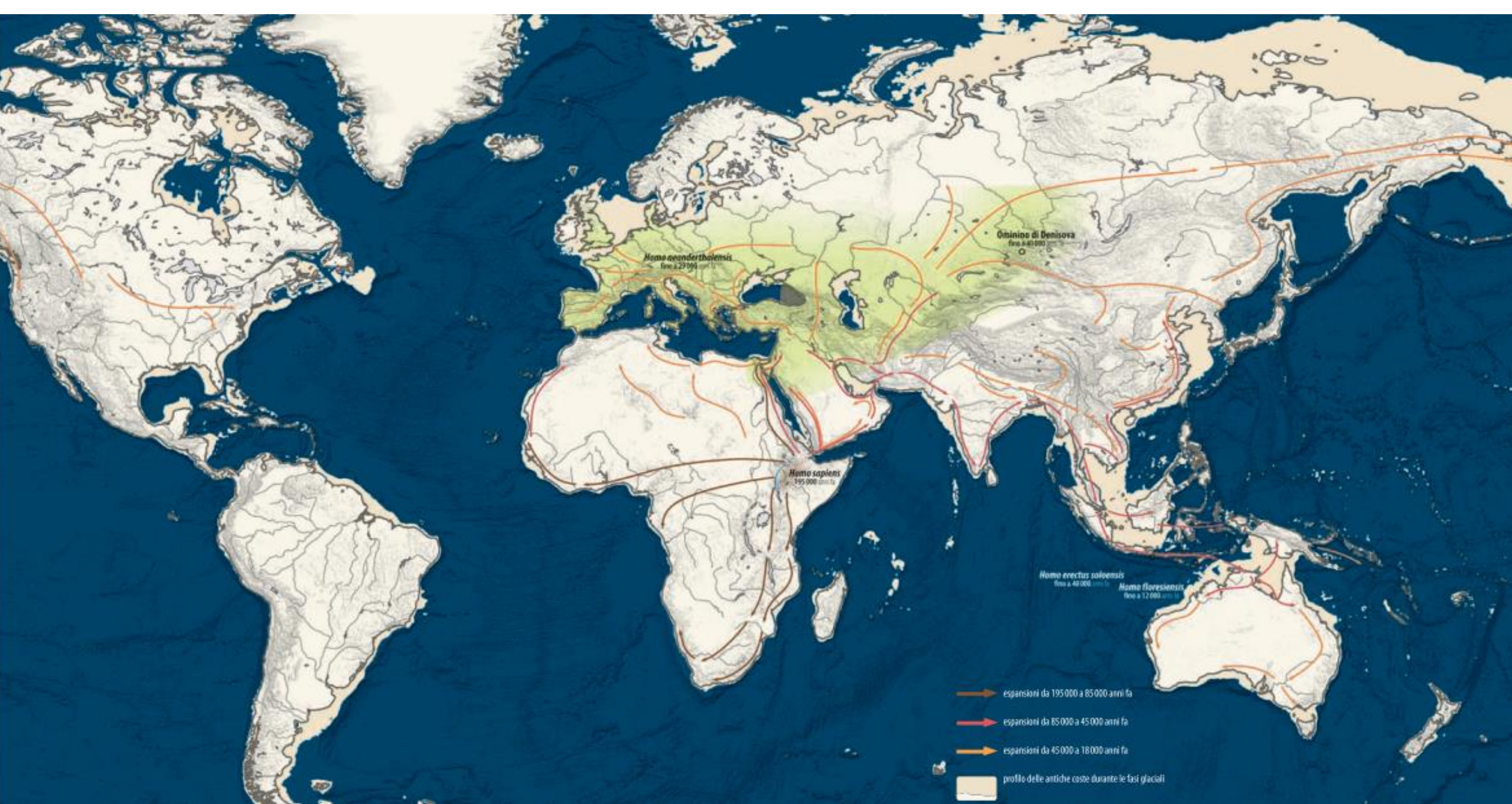
se Mircea^b,

Louis, MO 63130, USA
mania
Arqueologia, Avenida da Índia 136,

Box 58, 3400 Cluj, Romania

scene







Modern human dispersal routes in Europe (47,000–41,000 BP)



