

Climate and Human History

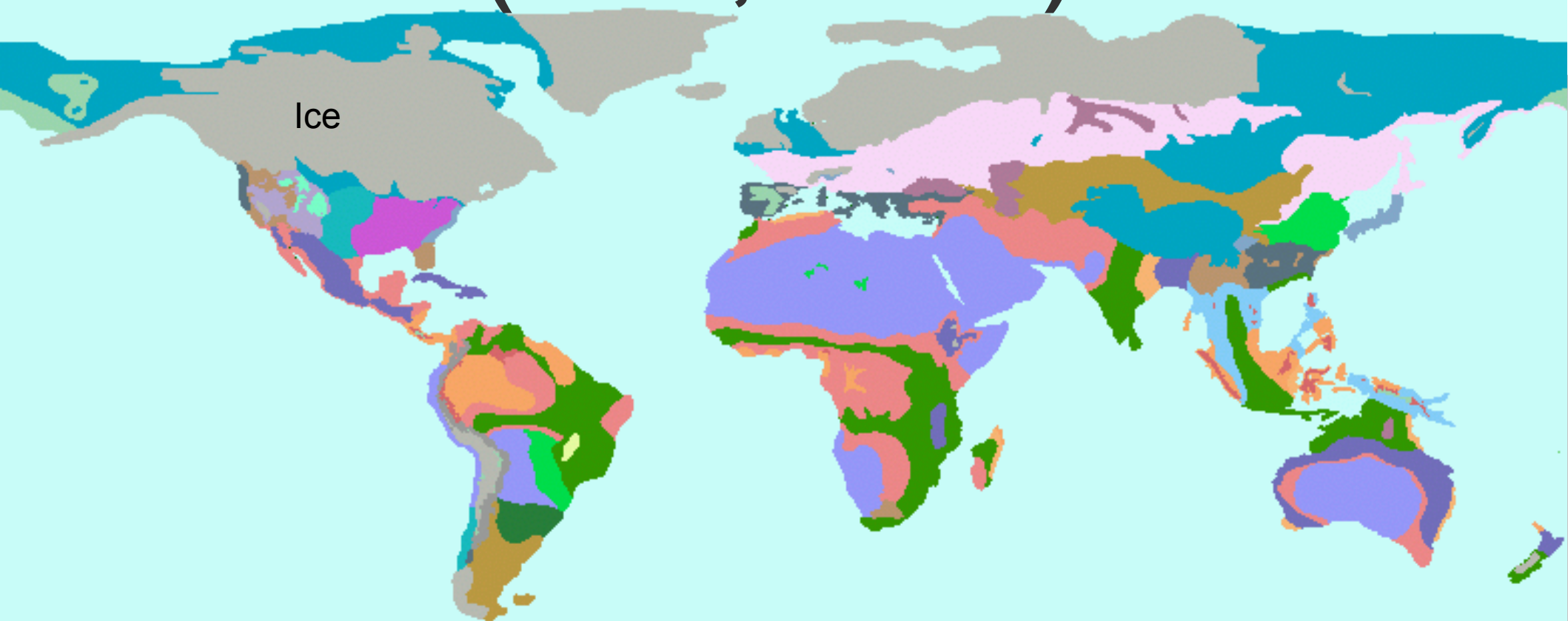
Stephan Matthiesen

1. Climate and climate history
2. The Ice Age
3. Farming and City States
4. Rise and Fall of the Roman Empire
5. Tang and Maya in the 10th century
6. Mediaeval Optimum and Little Ice Age
7. El Niño through the ages
8. Miscellaneous topics
9. Current and future changes
10. Summary and re-cap





Last Glacial Maximum (LGM; 18 ka)



Map Generated by the National Geophysical Data Center

0 4961mi

http://en.wikipedia.org/wiki/Last_Glacial_Maximum

Legend Last Glacial Maximum Vegetation

Alpine tundra
Broadleaved temperate evergreen fores
Dry steppe
Forest steppe

ice sheet or other permanent ice
Lakes and open water
Main Taiga
Monsoon or dry forest
Montane Mosaic
Montane tropical forest
Open boreal woodlands

Polar and alpine desert
Savanna
Semi-arid temperate woodland or scrub
Steppe-tundra
Subalpine parkland
Temperate desert
Temperate semi-desert

Temperate steppe grassland
Tropical extreme desert
Tropical grassland
Tropical rainforest
Tropical semi-desert
Tropical thorn scrub and scrub woodla
Tropical woodland

Tundra
Lakes
Continents

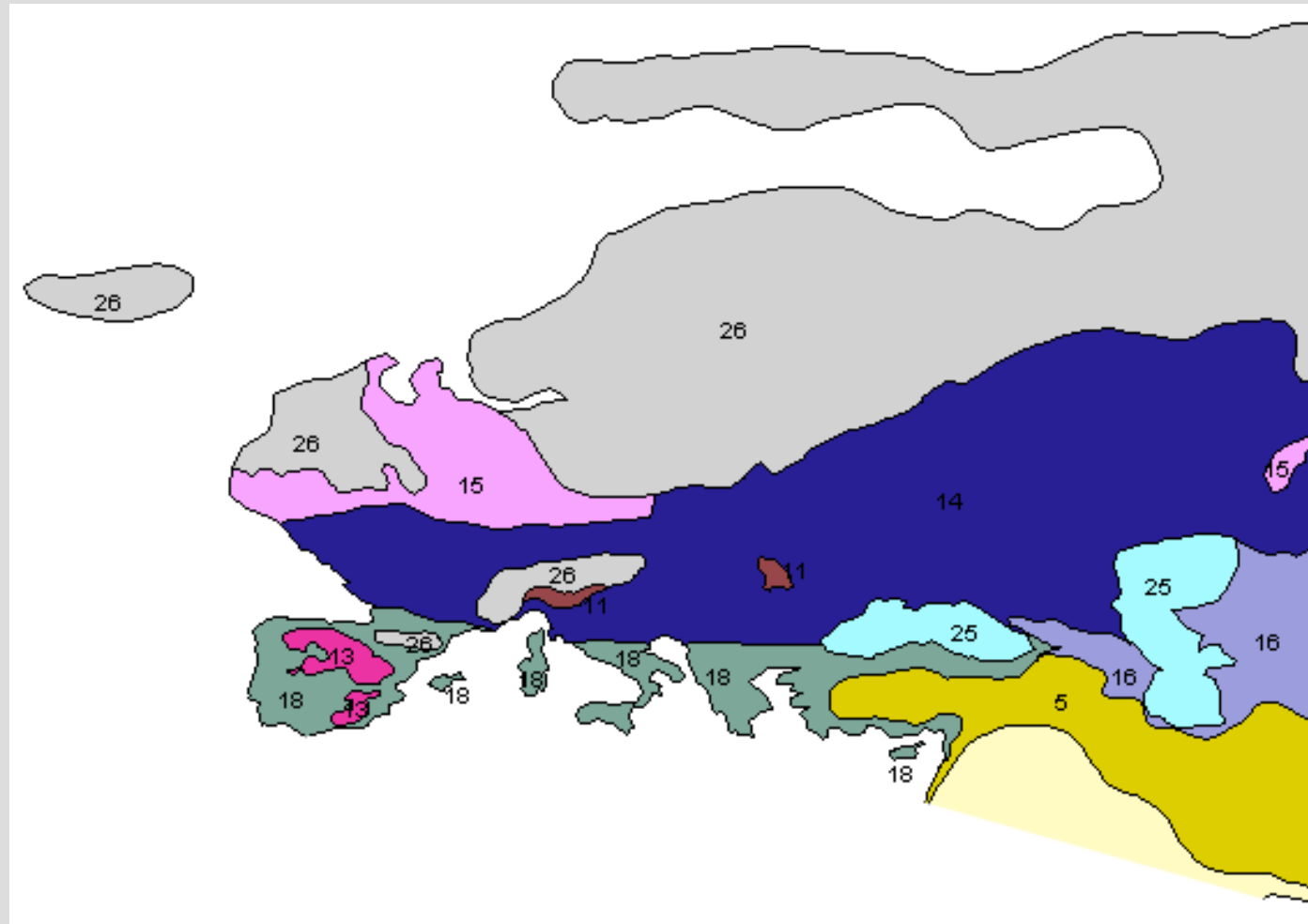
Europe in the LGM

26: Permanent ice

15: Polar and alpine desert
desert (less than 2%
covered by vascular plants)

14: Steppe-tundra (probably
around 50% ground cover)

18: Forest steppe (5-20%
tree cover)



The Ice Age was not (always) cold

Forest elephant fauna

Mammoth fauna

Waldelefanten - Fauna



Dama dama



Bubalus murrens



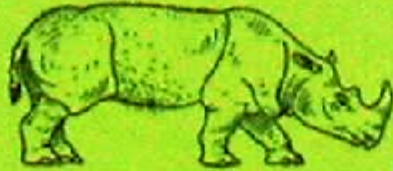
Capreolus capreolus



Bos primigenius



Hippopotamus amphibius



Stephanorhinus kirchbergensis



Sus scrofa



Elephas antiquus



Crocuta c. spelaea



Panthera leo spelaea



Ursus spelaeus



Cervus elaphus



Equus ferus

Mammut - Fauna



Rangifer tarandus



Bison priscus



Ovibos moschatus



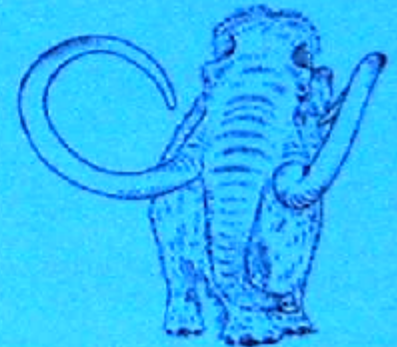
Coelodonta antiquitatis



Saiga tatarica



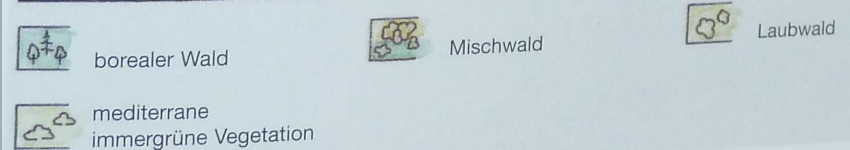
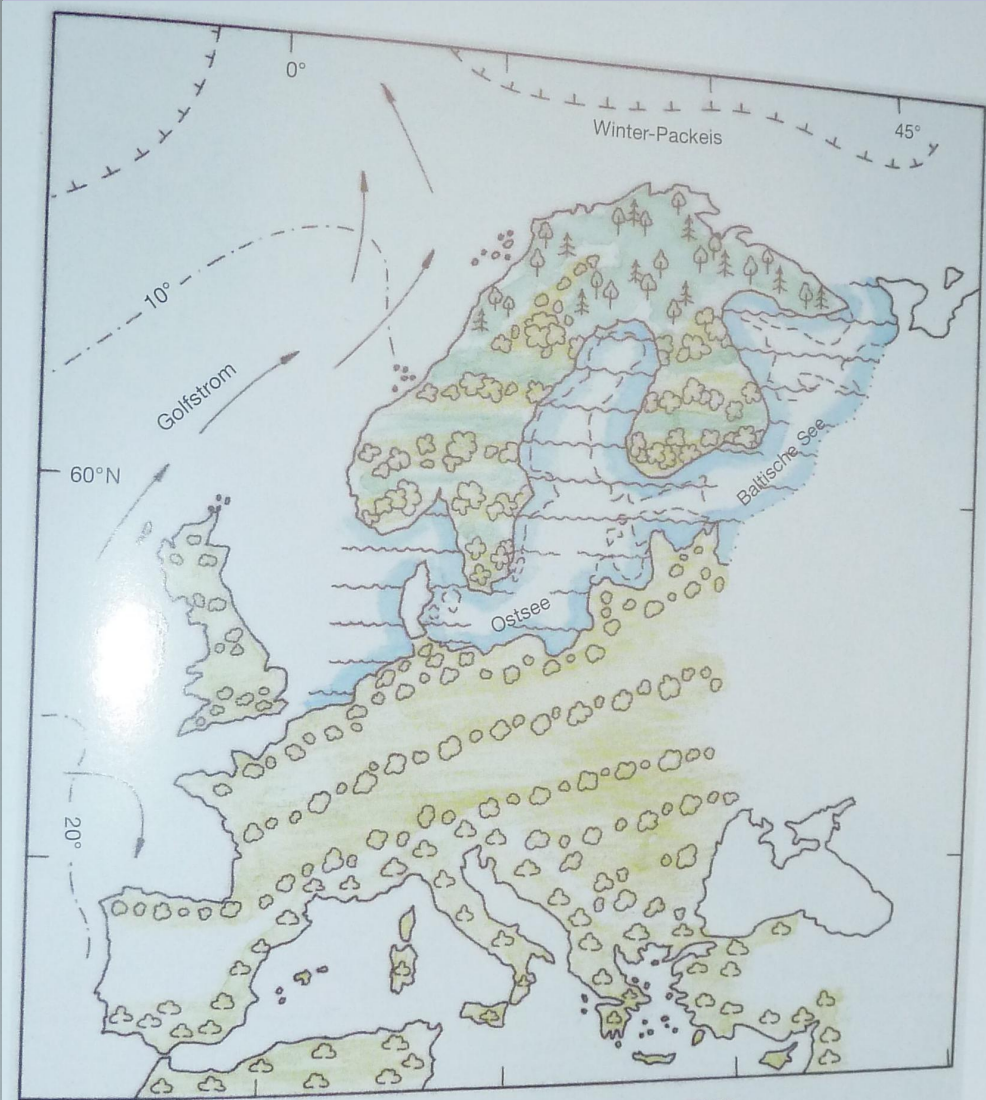
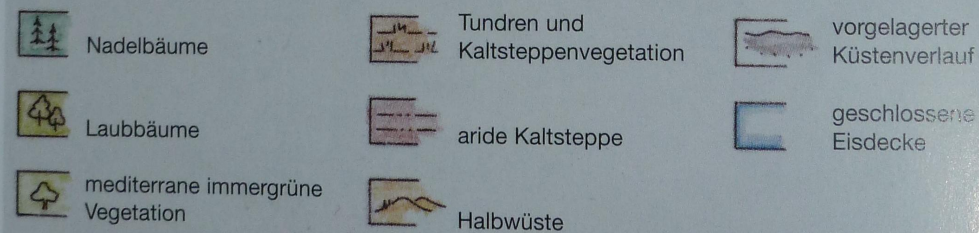
Megaloceros giganteus



Mammuthus primigenius

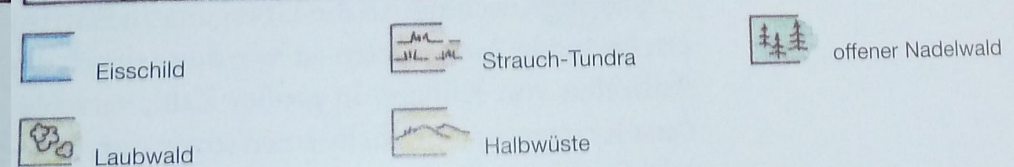
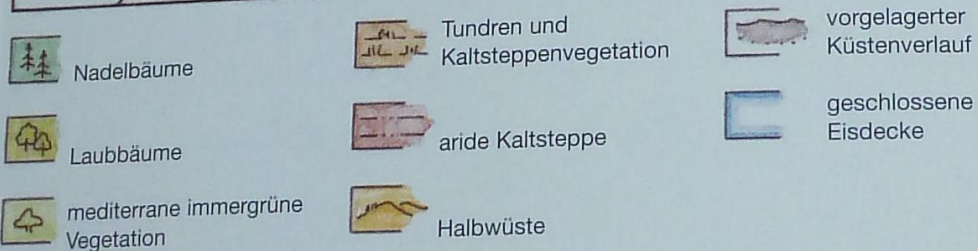
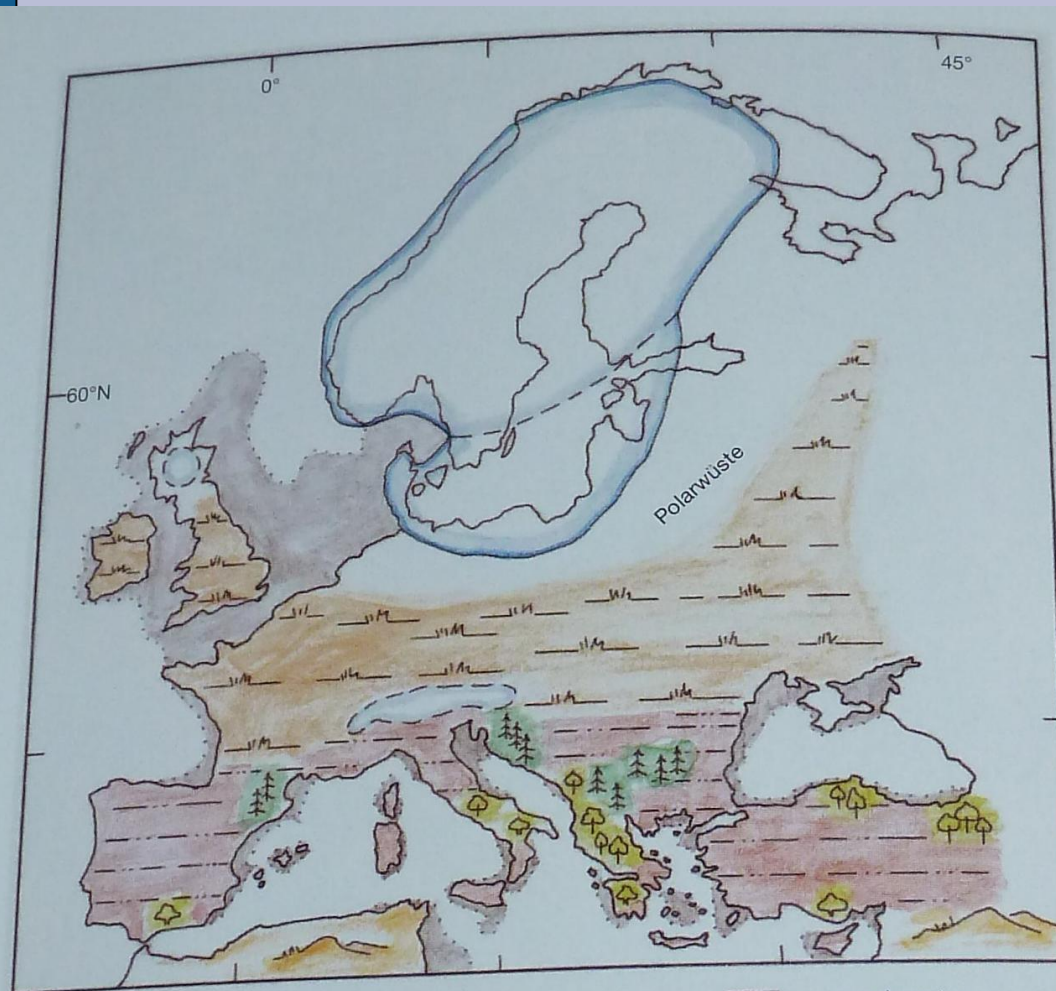
150,000 BP

120,000 BP

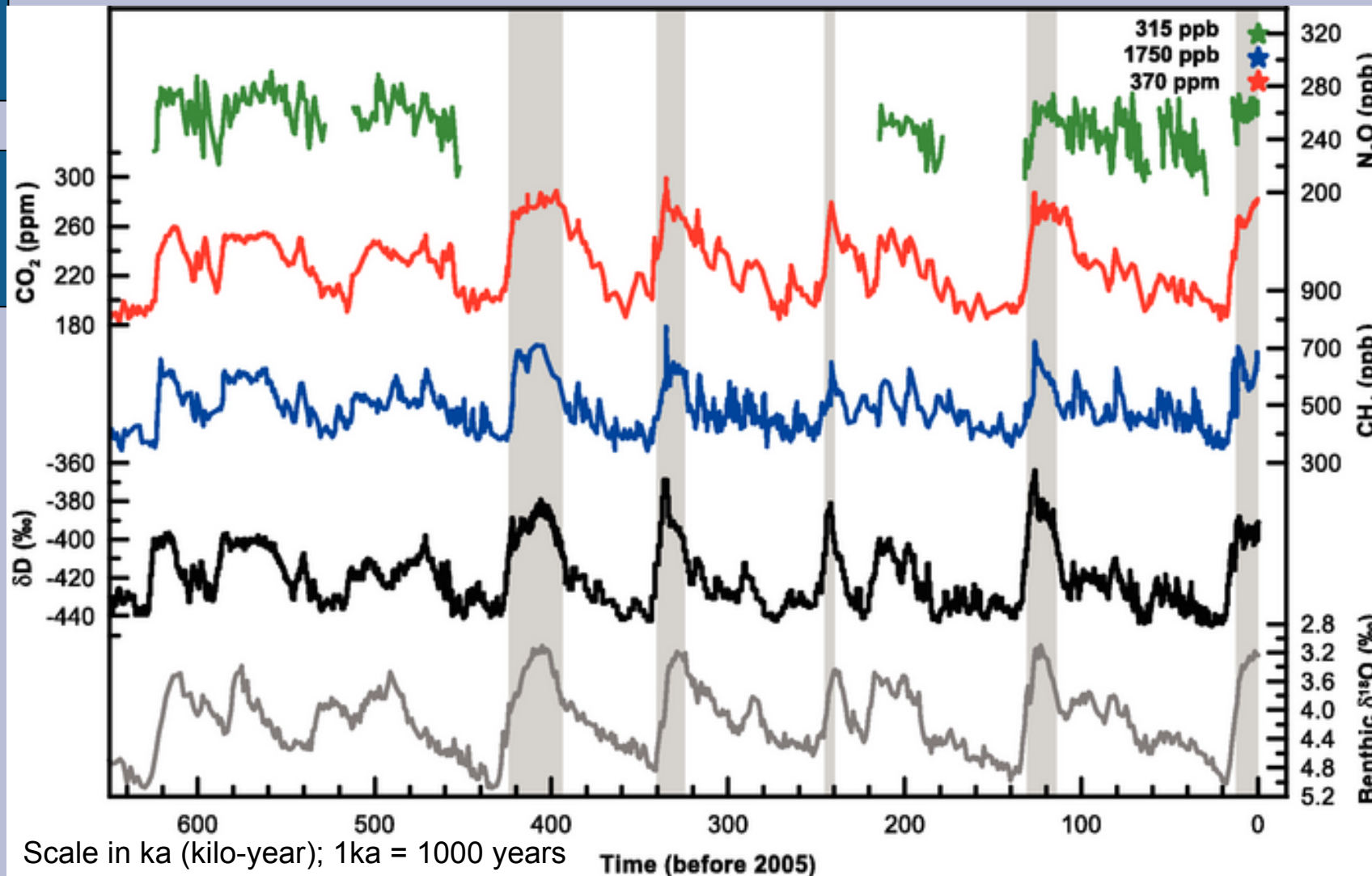


65,000 BP

38,000 BP



Ice Cores



Greenhouse
gases

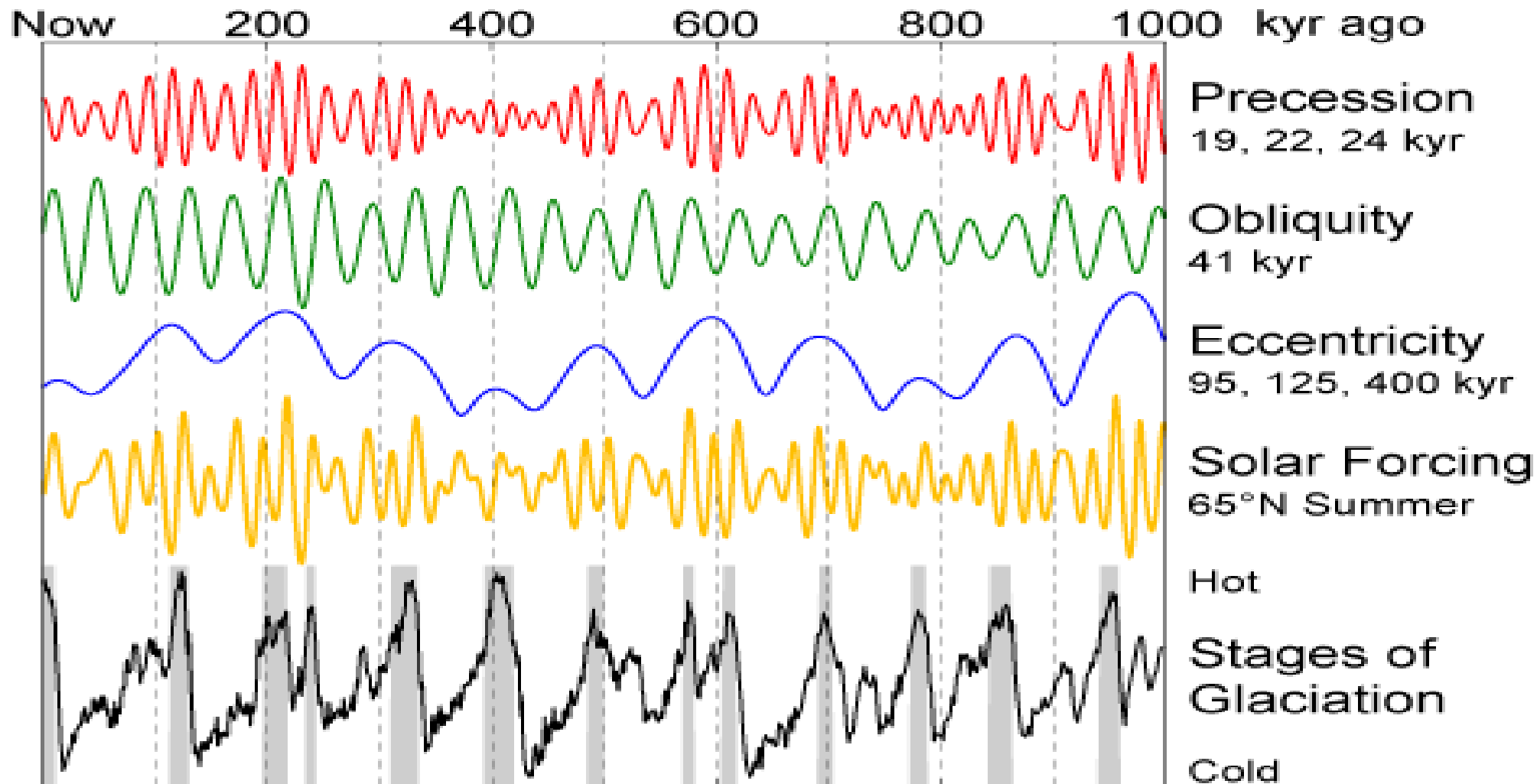
proxy for
temperature

from sediment
cores: Proxy for
ice volume

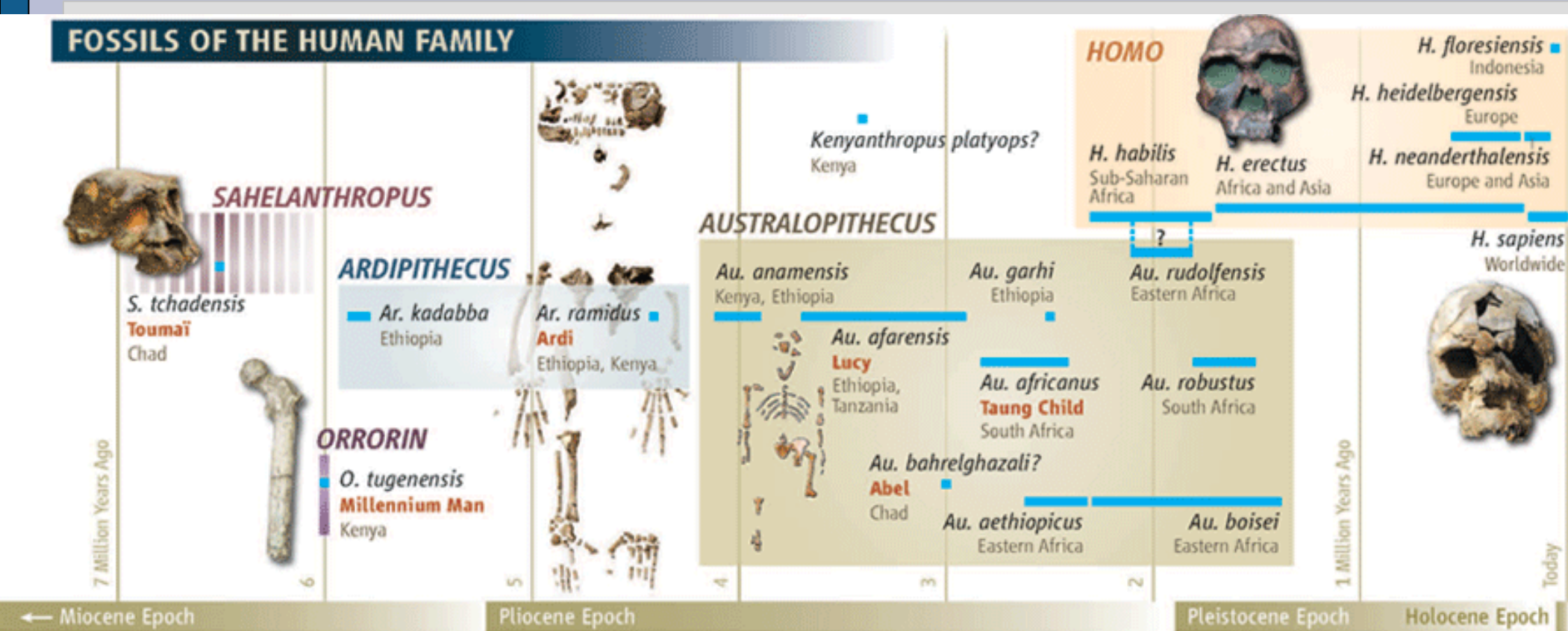
Note: „High-resolution ice core records of temperature proxies and CO₂ during deglaciation indicates that antarctic temperature starts to rise several hundred years before CO₂.“

(IPCC)

Milankovitch cycles



Fossils of the human family



Gibbons: A New Kind of Ancestor: Ardipithecus Unveiled.
 Science 2 October 2009, Vol. 326. no. 5949, pp. 36-40

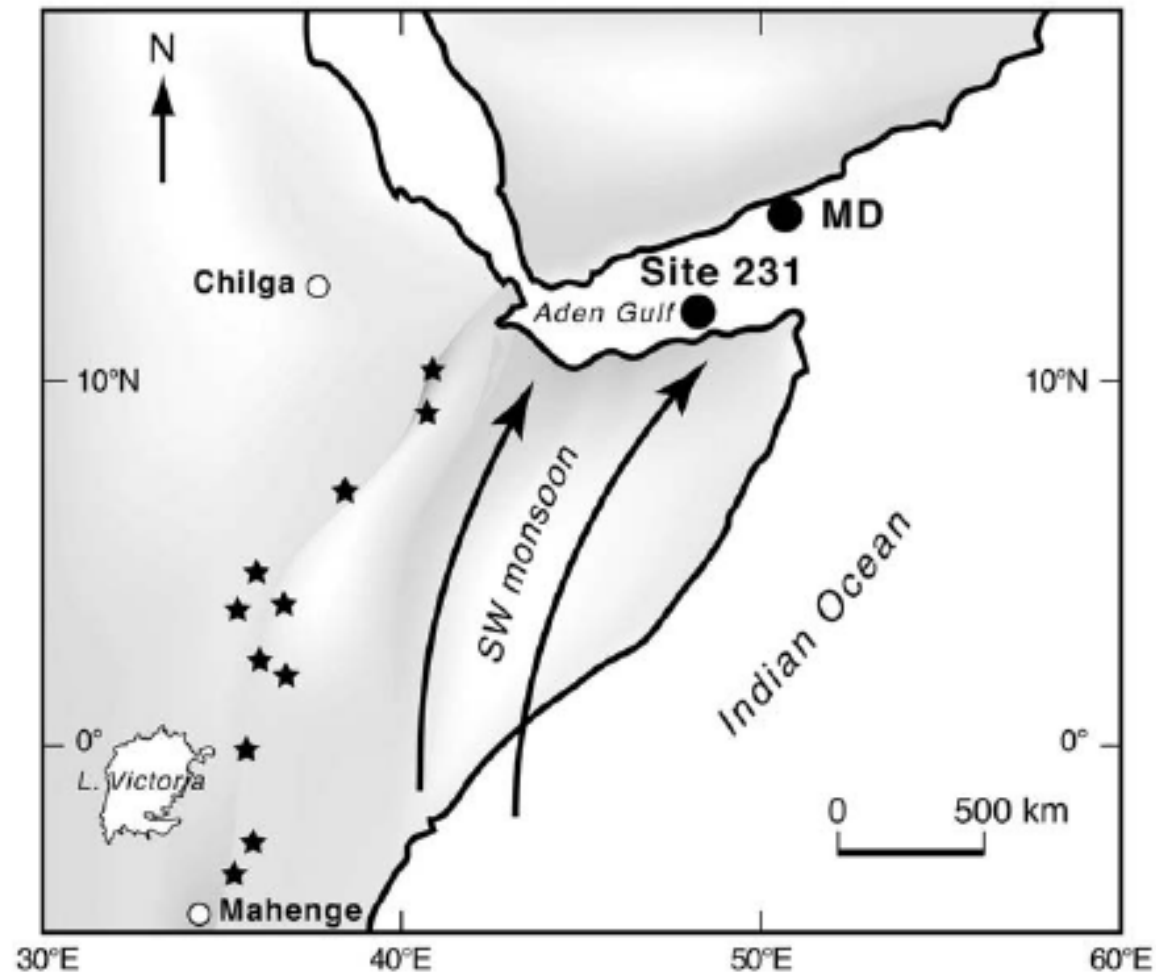


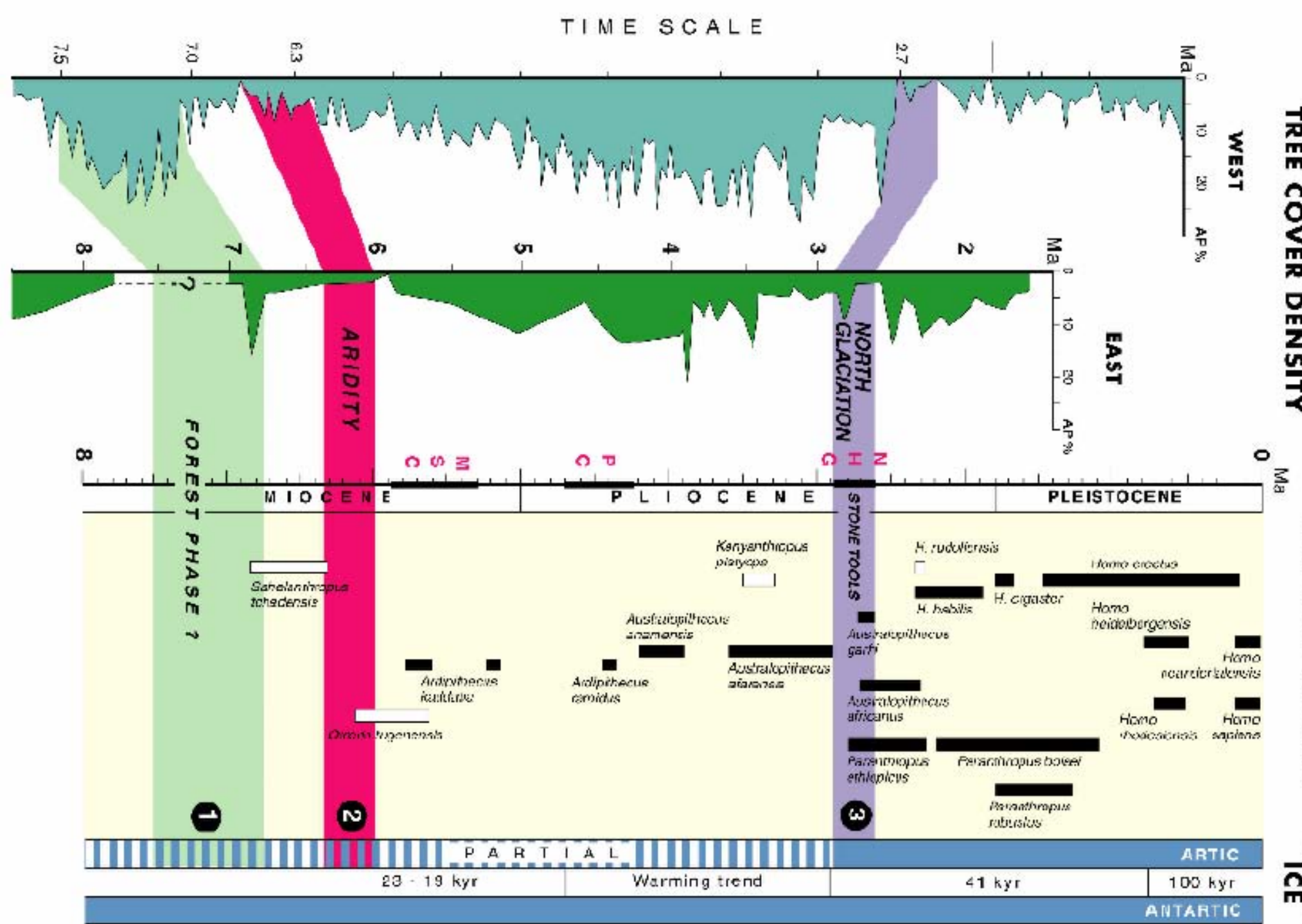
Fig. 5. Location of marine cores DSDP 231, MD76-135 and East African terrestrial hominid sites in the East African Rift, with respect to SW summer monsoon winds direction.

Bonnefille (2010): Cenozoic vegetation, climate changes and hominid evolution in tropical Africa. *Global and Planetary Change*, Vol. 72, No. 4. (18 July 2010), pp. 390-411.
doi:10.1016/j.gloplacha.2010.01.015

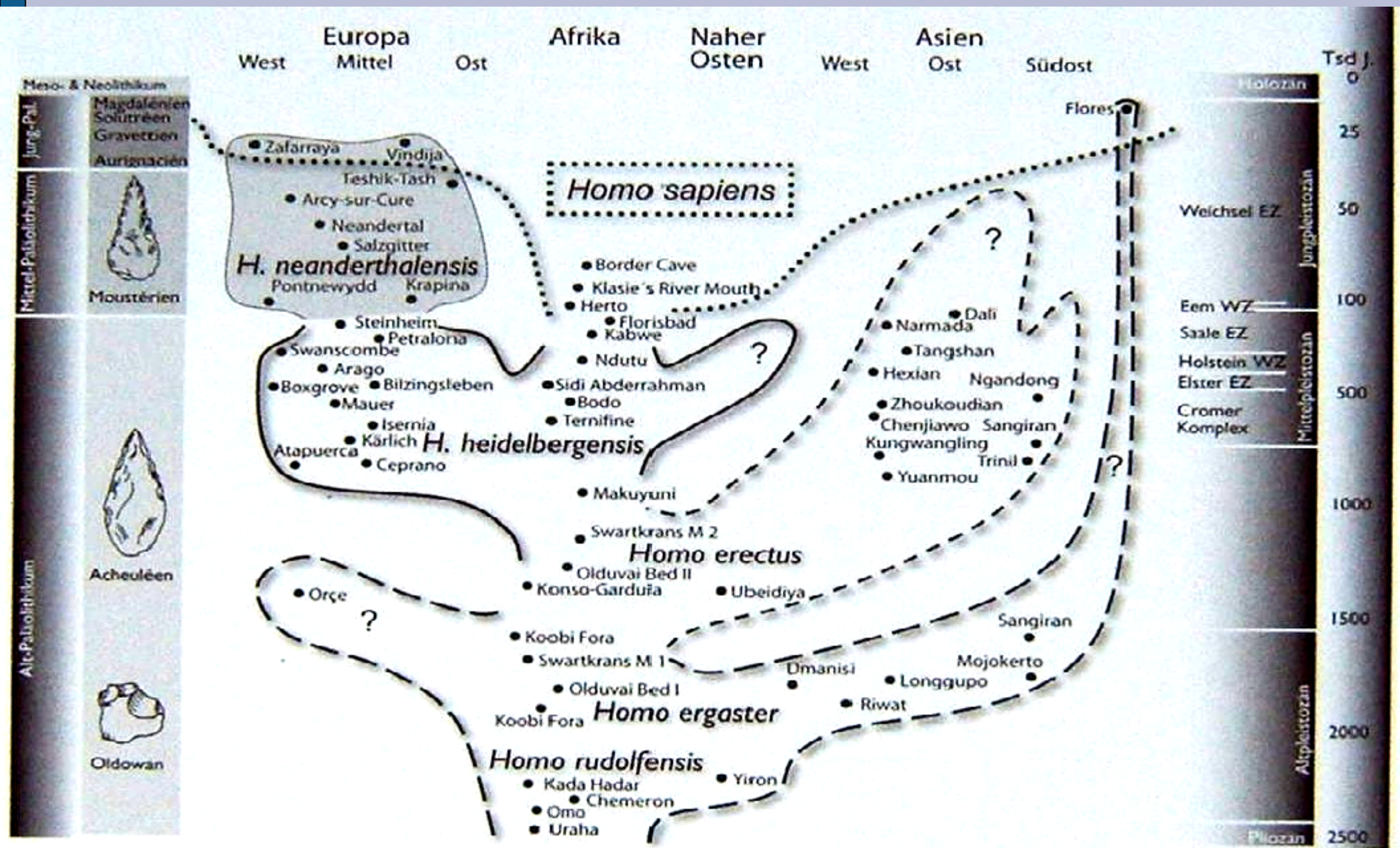
TROPICAL AFRICA TREE COVER DENSITY

HOMINID RECORD

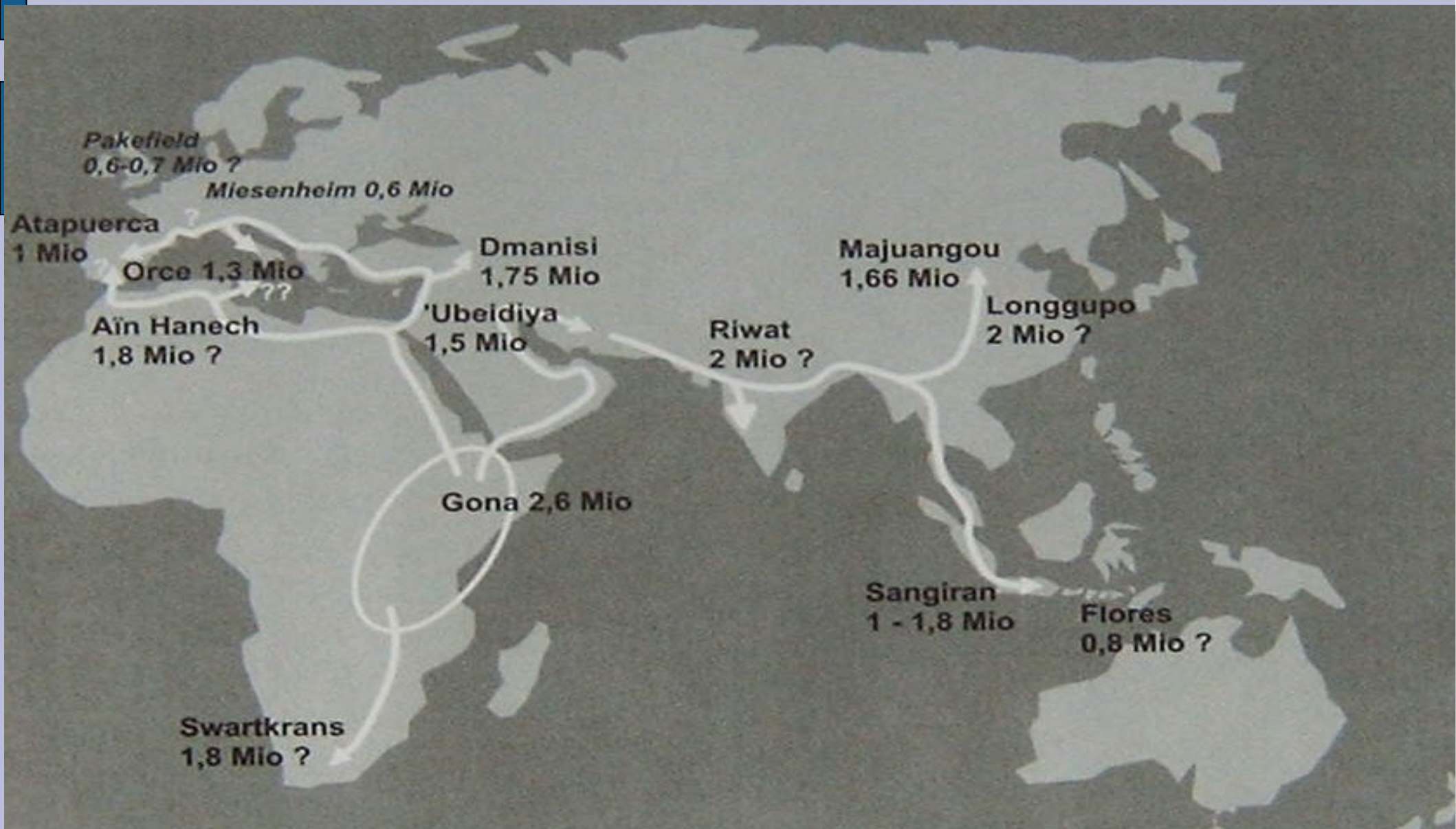
POLAR ICE



Human evolution



First Human Migration



The first Europeans

Bilzingsleben excavation site



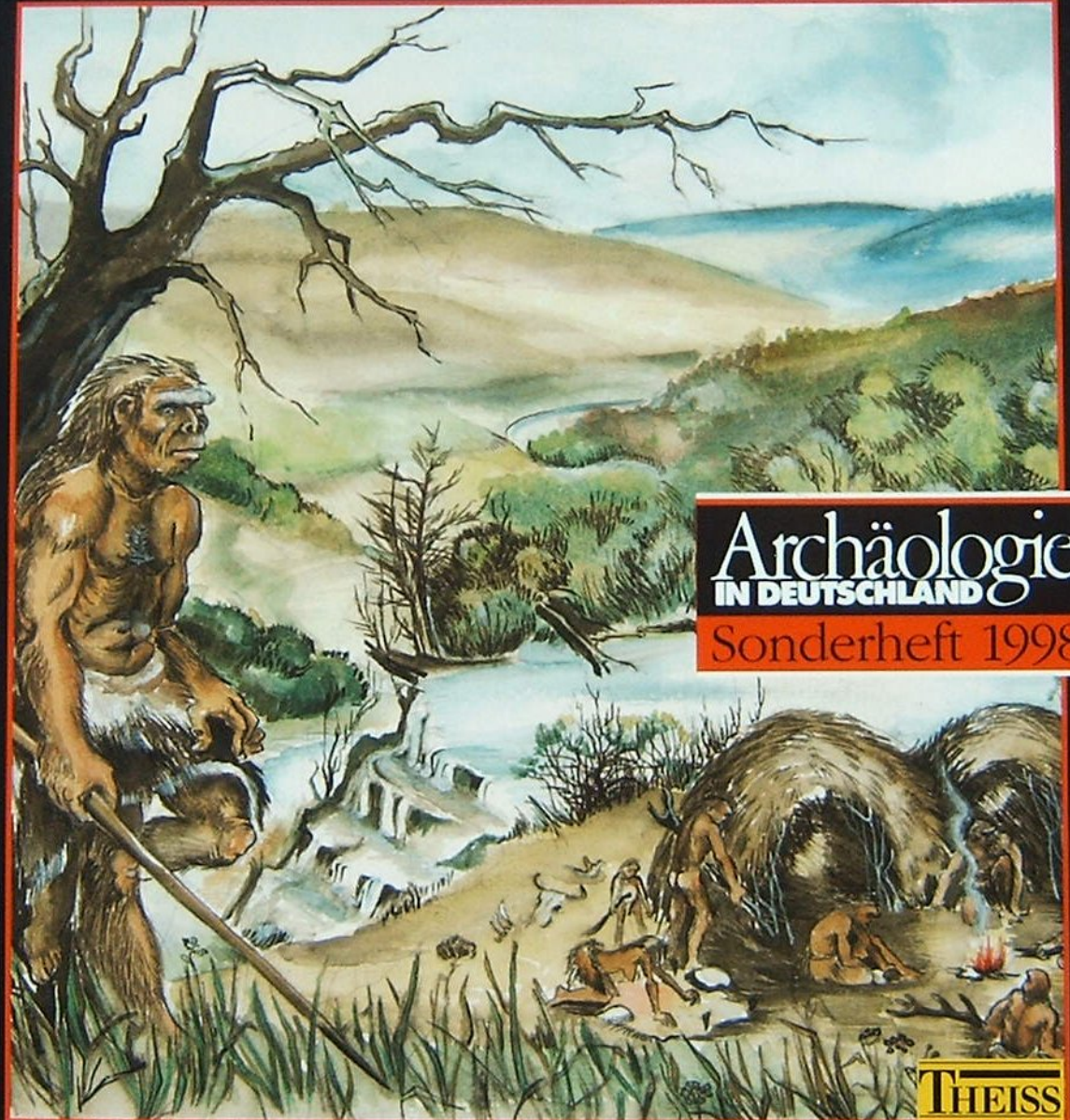


Bilzingsleben 400,000 years ago



Antler tools from Bilzingsleben

DIE ERSTEN MENSCHEN IN EUROPA



Archäologie
IN DEUTSCHLAND
Sonderheft 1998

THEISS

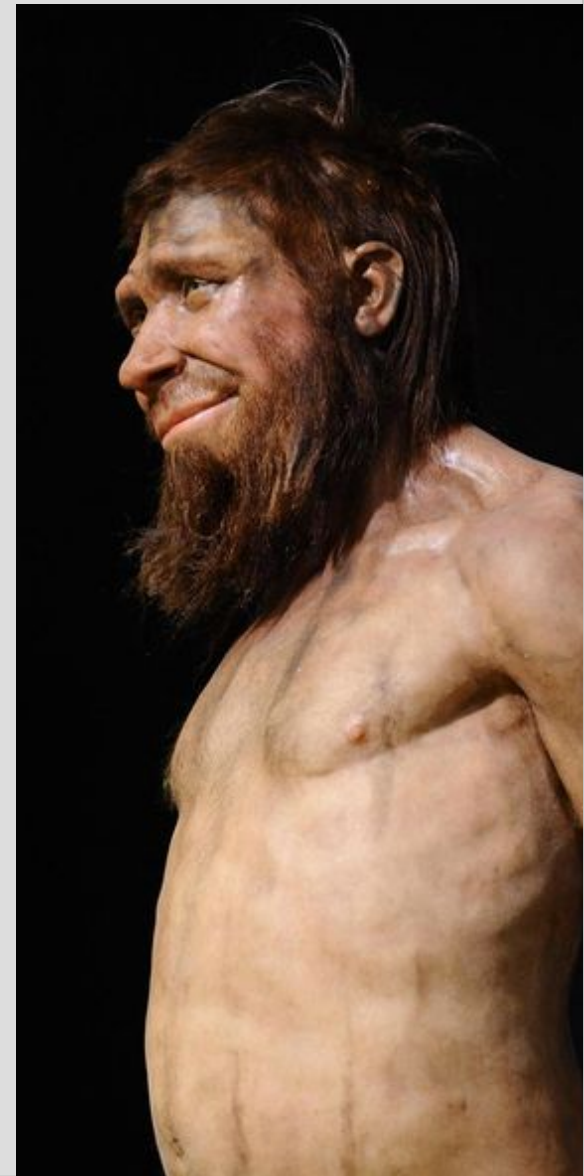
Beware of reconstructions..



Reconstructed Neanderthal man (left),
based on skull Shanidar 5 (Belgium)

„looks like Abraham Lincoln“

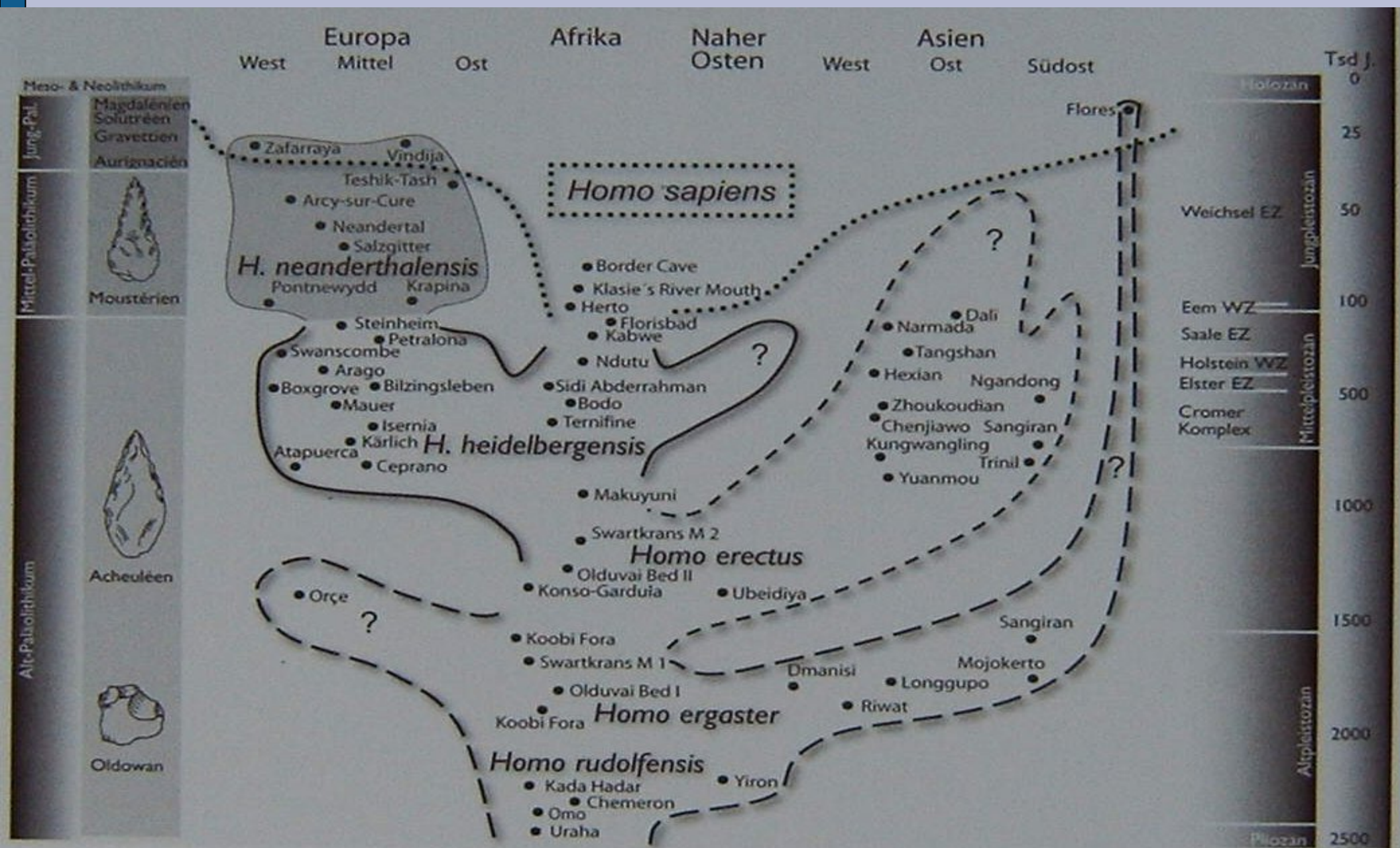
„Somebody please put some more hair and much more fat and muscle on this guy. It was damned cold in the Late Pleistocene!“ (Rob Gargett)



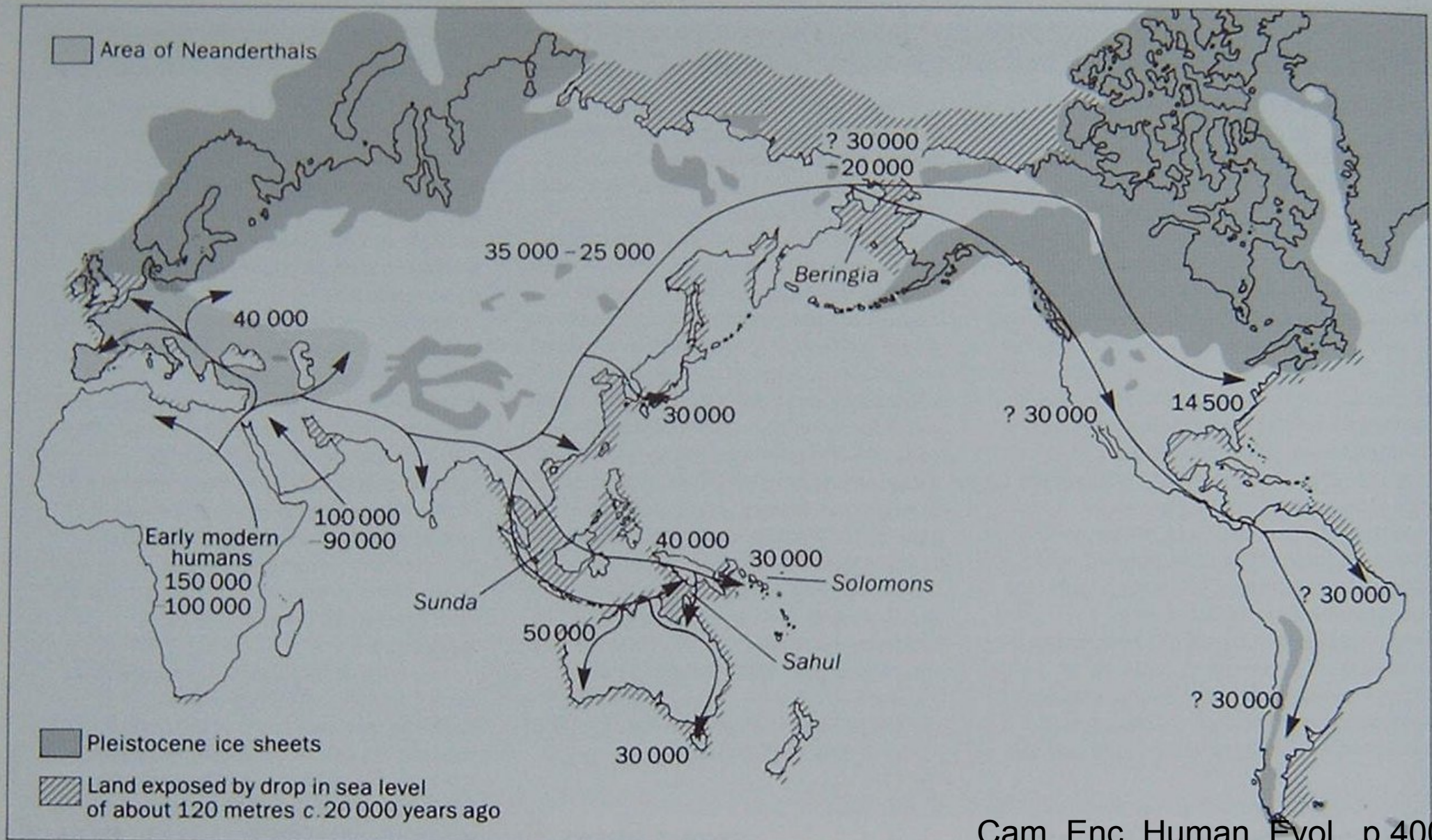
Rob Gargett, „The
subversive archaeologist“

<http://thesubversivearchaeologist.blogspot.com>

Human evolution



“Out of Africa” Second Human Migration



A catastrophe?

East African megadroughts between 135 and 75 thousand years ago and bearing on early-modern human origins

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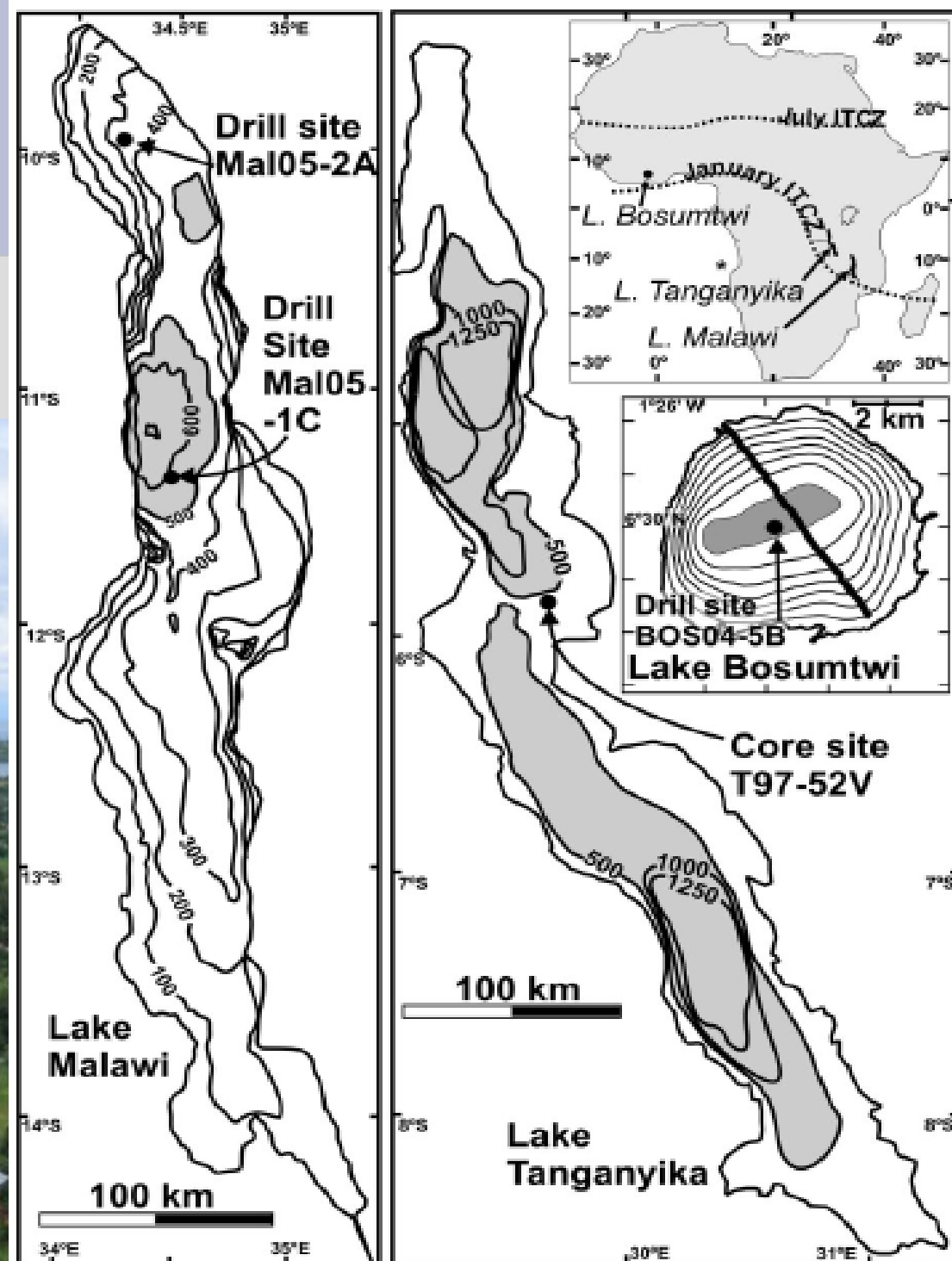
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Edited by William F. Ruddiman, University of Virginia, Charlottesville, VA, and accepted by the Editorial Board July 27, 2007 (received for review April 30, 2007)

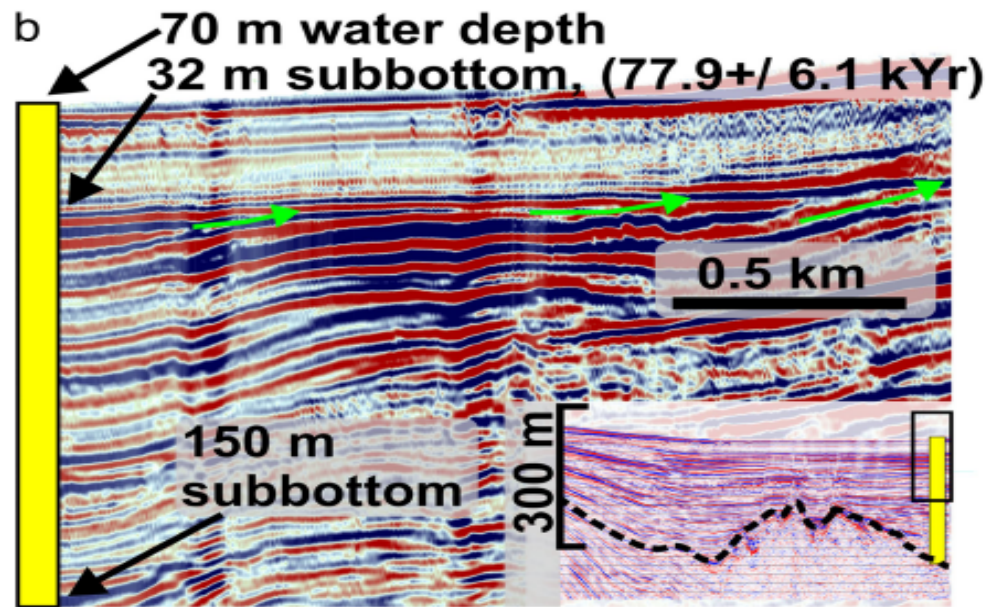
The environmental backdrop to the evolution and spread of early *Homo sapiens* in East Africa is known mainly from isolated outcrops and distant marine sediment cores. Here we present results from new scientific drill cores from Lake Malawi, the first long and continuous, high-fidelity records of tropical climate change from the continent itself. Our record shows periods of severe aridity between 135 and 75 thousand years (kyr) ago, when the lake's water volume was reduced by at least 95%. Surprisingly, these intervals of pronounced tropical African aridity in the early late-Pleistocene were much more severe than the Last Glacial Maximum (LGM), the period previously recognized as one of the most arid of the Quaternary. From these cores and from records from Lakes Tanganyika (East Africa) and Bosumtwi (West Africa), we document a major rise in water levels and a shift to more humid conditions over much of tropical Africa after ~70 kyr ago. This transition to wetter, more stable conditions coincides with diminished orbital eccentricity, and a reduction in precession-dominated climatic extremes. The observed climate mode switch to decreased

and the seasonal migration of the Intertropical Convergence Zone. In West Africa, the monsoon transfers moisture to the continental interior from the equatorial Atlantic, whereas East African moisture is obtained mainly from the Indian Ocean (18). Orbital precession has induced 19- to 23-thousand-year (kyr) fluctuations in insolation at the top of the atmosphere, and has prompted changes in tropical African climate during the Pleistocene (9–11, 19, 20). However, this forcing is moderated at times by tropical sea-surface temperatures (SSTs), which may be linked to high-latitude climate processes (21, 22). The variability of tropical African continental climate is documented over the past 25 kyr in lake and ocean sediment cores, as is the orbital forcing of North African climate (23). The modern precipitation of East Africa is linked to Indian and Pacific Ocean SSTs and the El Niño Southern Oscillation (ENSO) (18, 24), whereas the long-term forcing of equatorial East African climate has been attributed both to orbital processes (e.g., precession) (25) and to

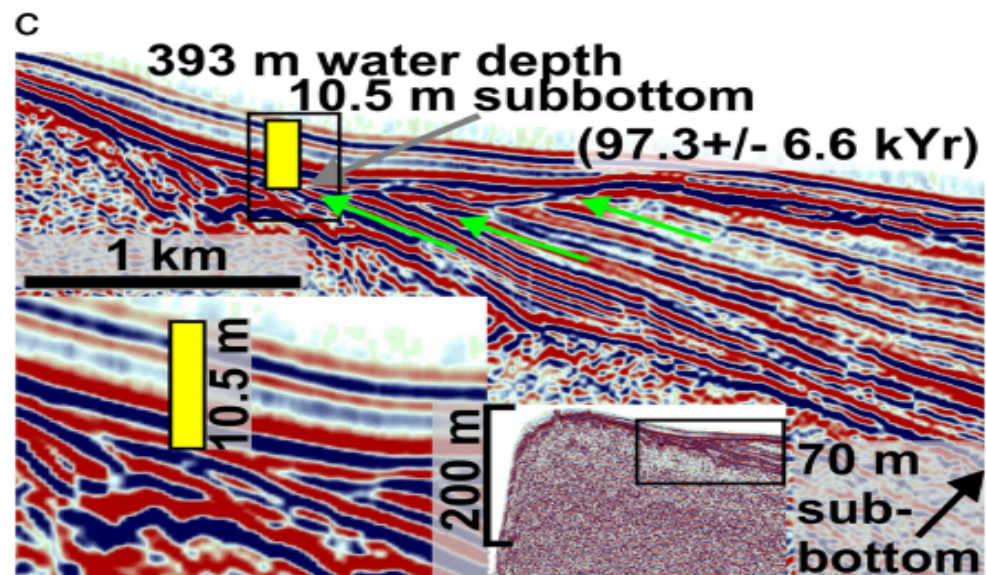
Lake Malawi



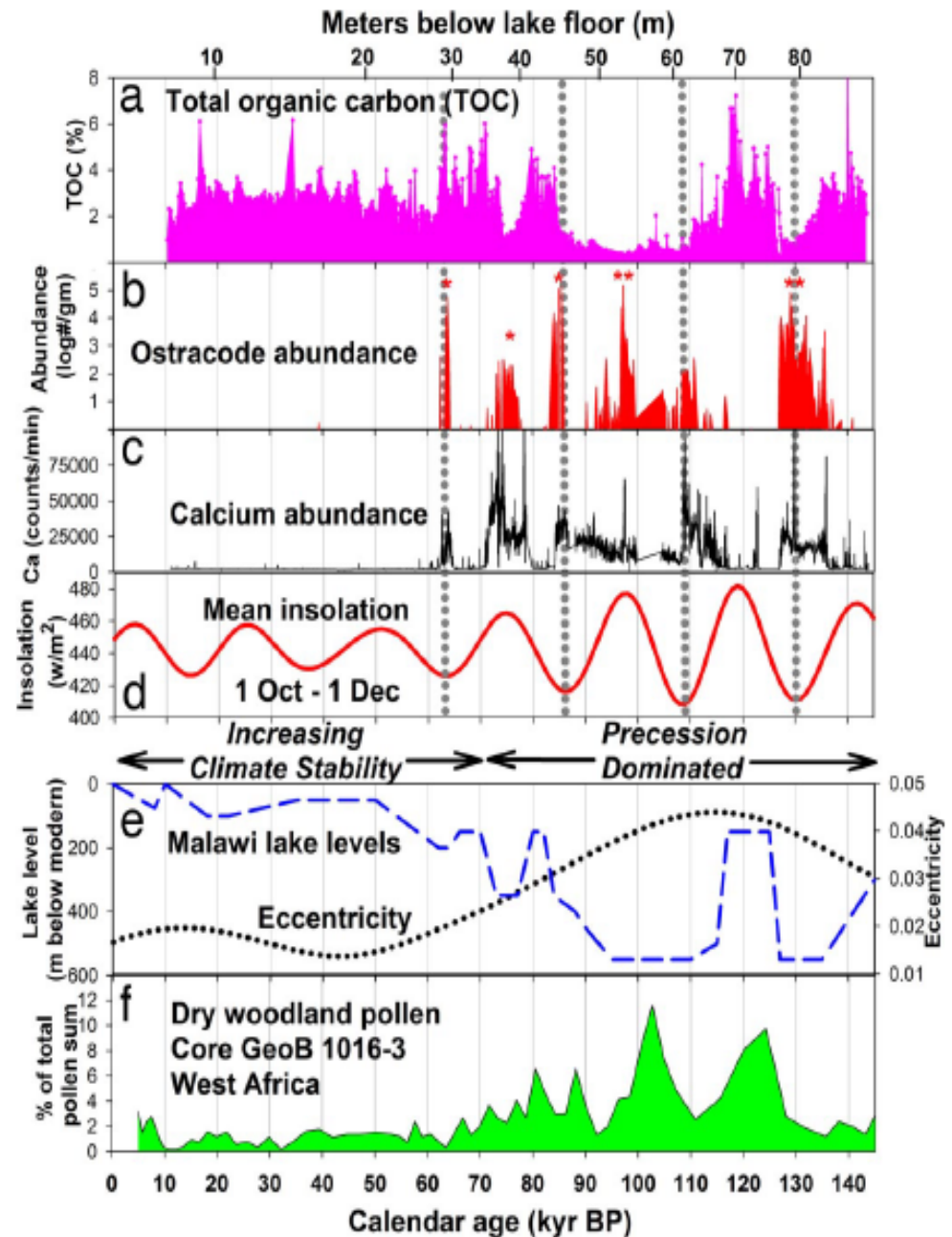
Lake level indicators



Lake Bosumtwi Drill Site BOS04-5B



Lake Tanganyika Core Site T97-52V



And humans?

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coincides with the marked expansion of early modern human populations, suggested from studies of modern mtDNA inherent in maternal lineages (12) and Y-chromosome analyses (13). Although still controversial, several early studies of mtDNA deduced that modern human ancestry is traceable to a single individual who lived in South or East Africa before 130 kyr ago (14). Similar studies demonstrate the importance of the founder effect, in that all modern-day non-Africans are descended from a small group of individuals who departed northeast Africa after the early Late Pleistocene (12). Coincident with the expansion of the African lineages is the expansion of early modern human populations that apparently experienced orders-of-magnitude increases by ≈ 50 kyr ago (46).

Before 70 kyr ago, the tropical lake data sets indicate a period of heightened climate variability, when tropical refugia expanded and collapsed repeatedly. Whether a series of climatic crises before 70 kyr ago produced a true human population bottleneck is still uncertain (47). The question arises as to whether the observed change to a more hospitable climate after 70 kyr ago, the dramatic late-Pleistocene population expansion, and the only successful early-modern human African exodus are mere coincidence.

We thank the University of Rhode Island and Lengeek Vessel Engineering, Inc., for general contracting and barge modifications; the marine operations and drilling crews of the drilling vessel, *Vipha*,

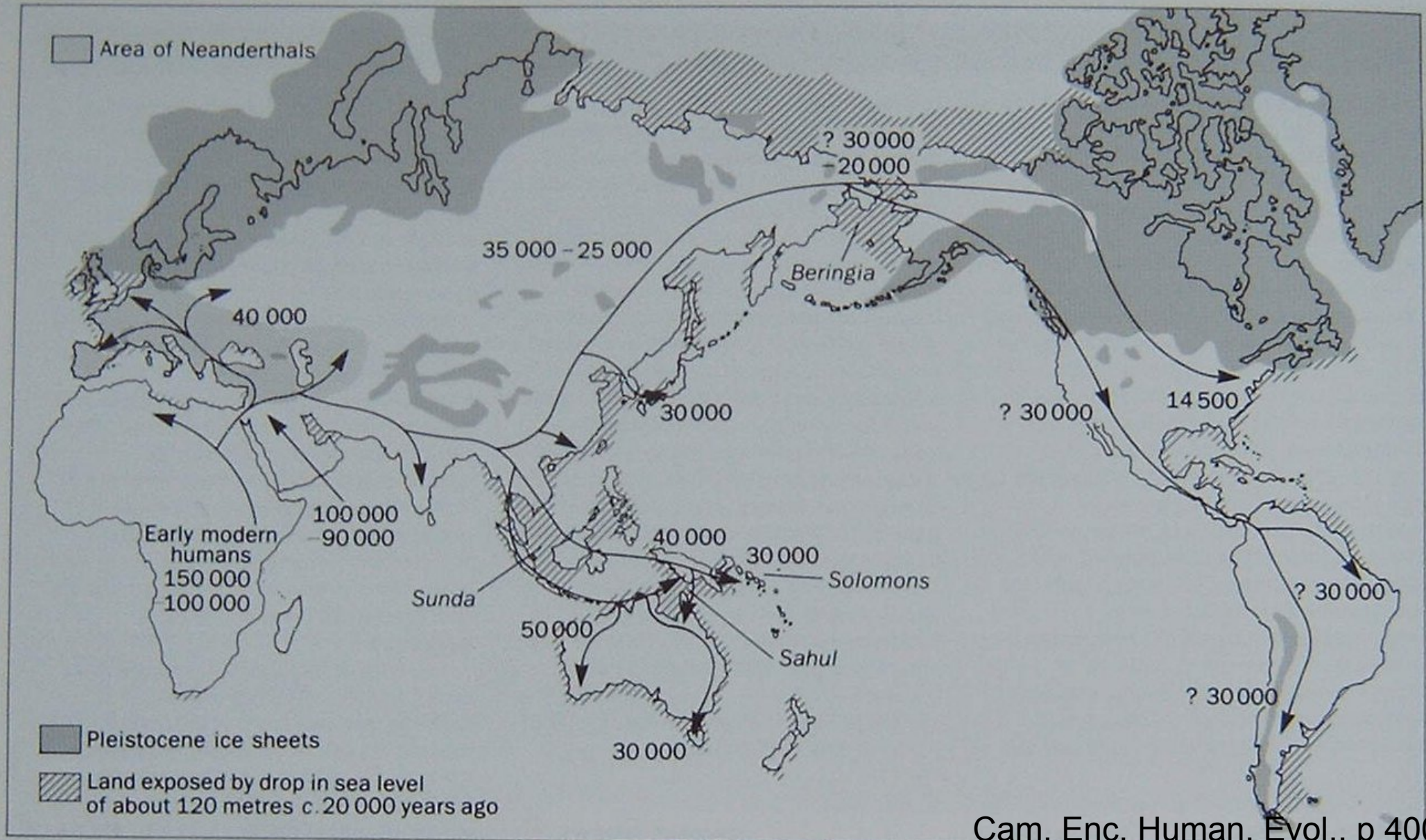
Another catastrophe?

Lake Toba
(Indonesia)
74000 BP

Supervolcano
eruption



Possible dispersal routes



Summary

- Climate of the Pleistocene (“Ice Age”): very variable and unstable
- Evolution of anatomically modern humans
- Several migration waves
- (“Out of Africa”)

Literature

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