

# Climate and Human History

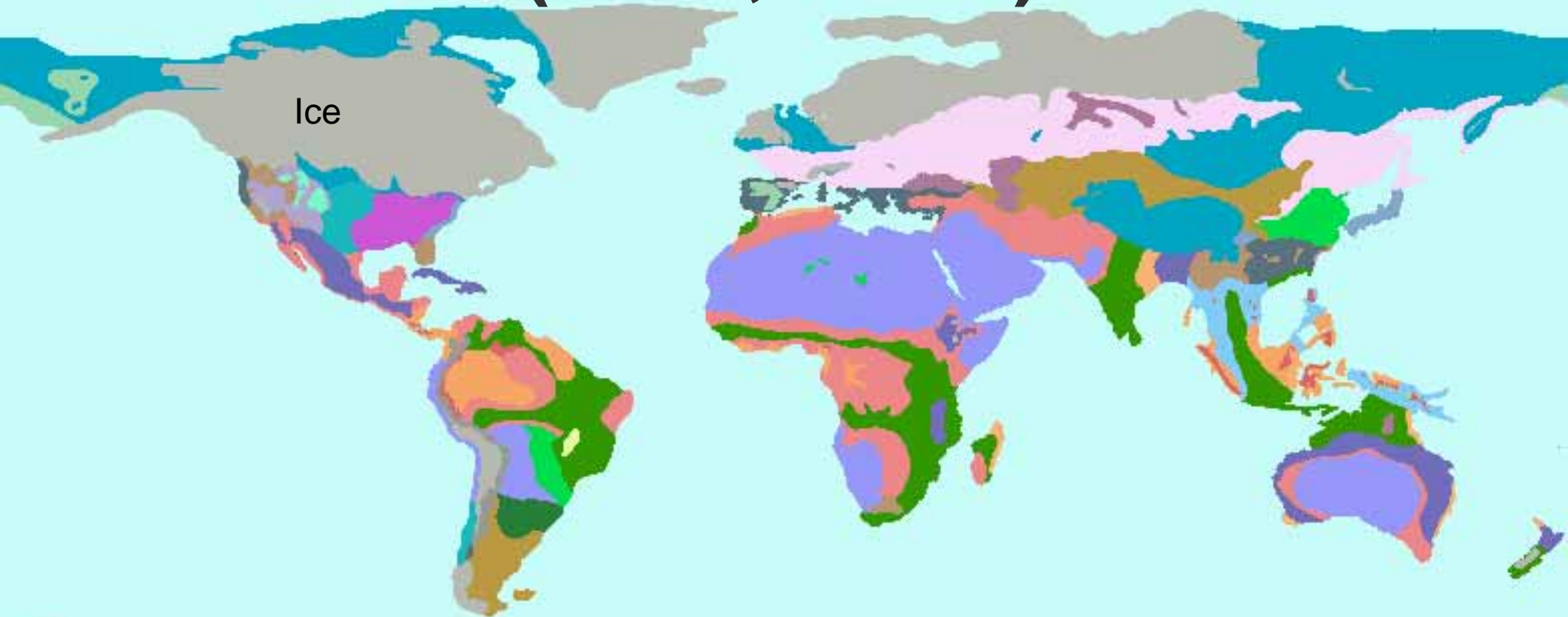
## Stephan Matthiesen

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](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

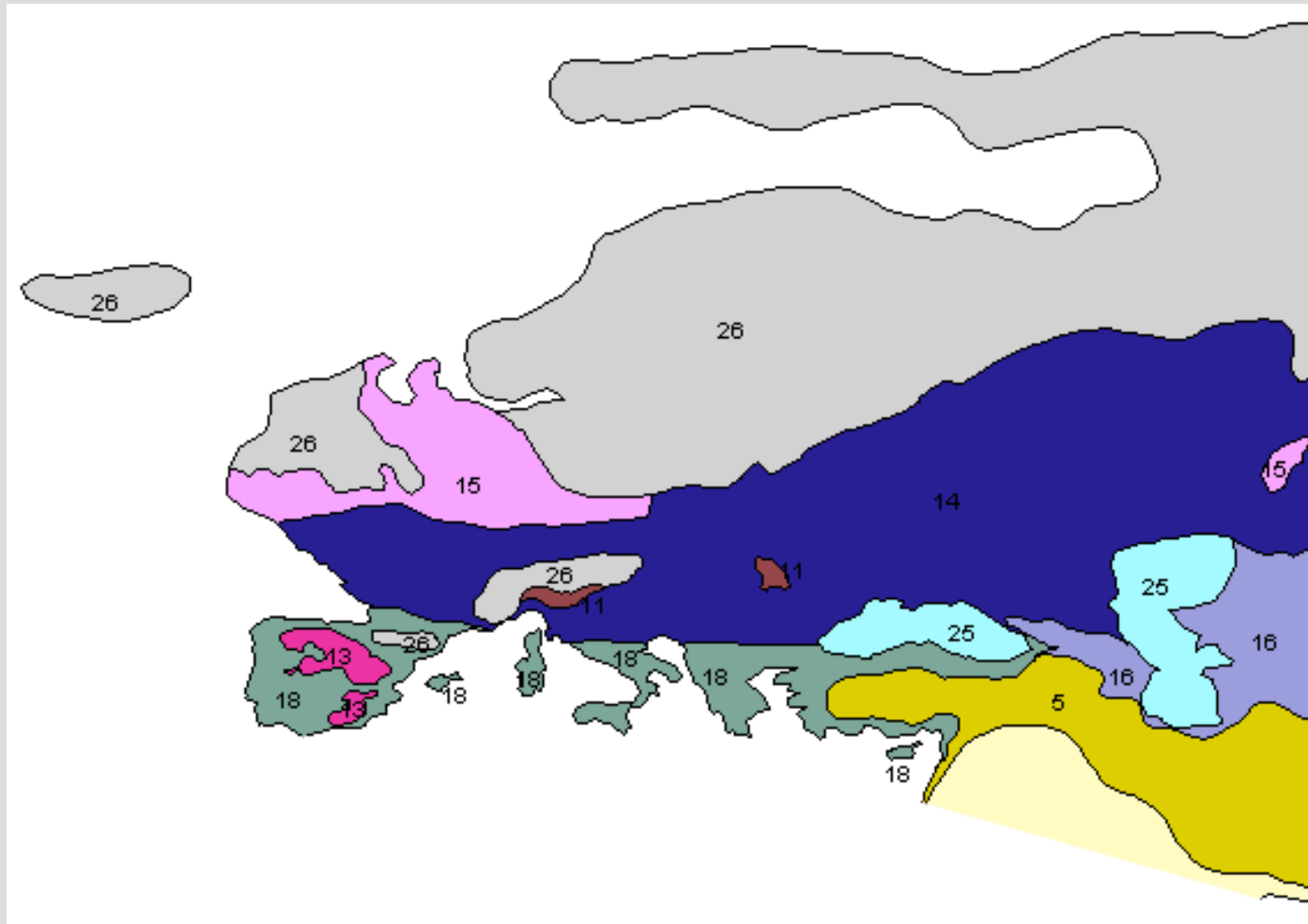
# Europe in the LGM

26: Permanent ice

15: Polar and alpine desert  
(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 faunas in Central Europe

Forest elephant fauna

Mammoth fauna

## Waldelefanten - Fauna



*Dama dama*



*Bubalus murrensis*



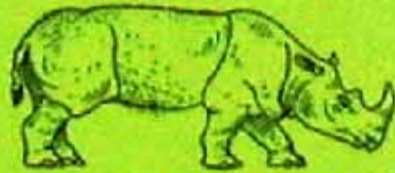
*Capreolus capreolus*



*Bos primigenius*



*Hippopotamus amphibius*



*Stephanorhinus kirchbergensis*



*Sus scrofa*



*Elephas antiquus*



*Crocuta c. spelaea*



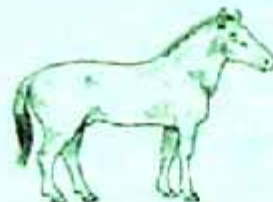
*Panthera leo spelaea*



*Ursus spelaeus*



*Cervus elaphus*



*Equus ferus*

## Mammut - Fauna



*Ovibos moschatus*



*Rangifer tarandus*



*Coelodonta antiquitatis*



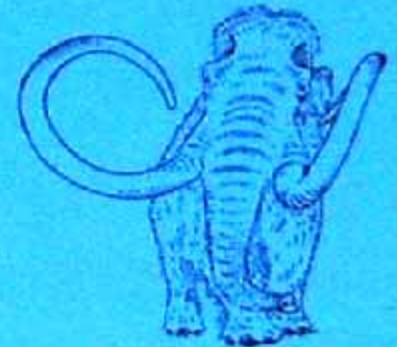
*Bison priscus*



*Saiga tatarica*

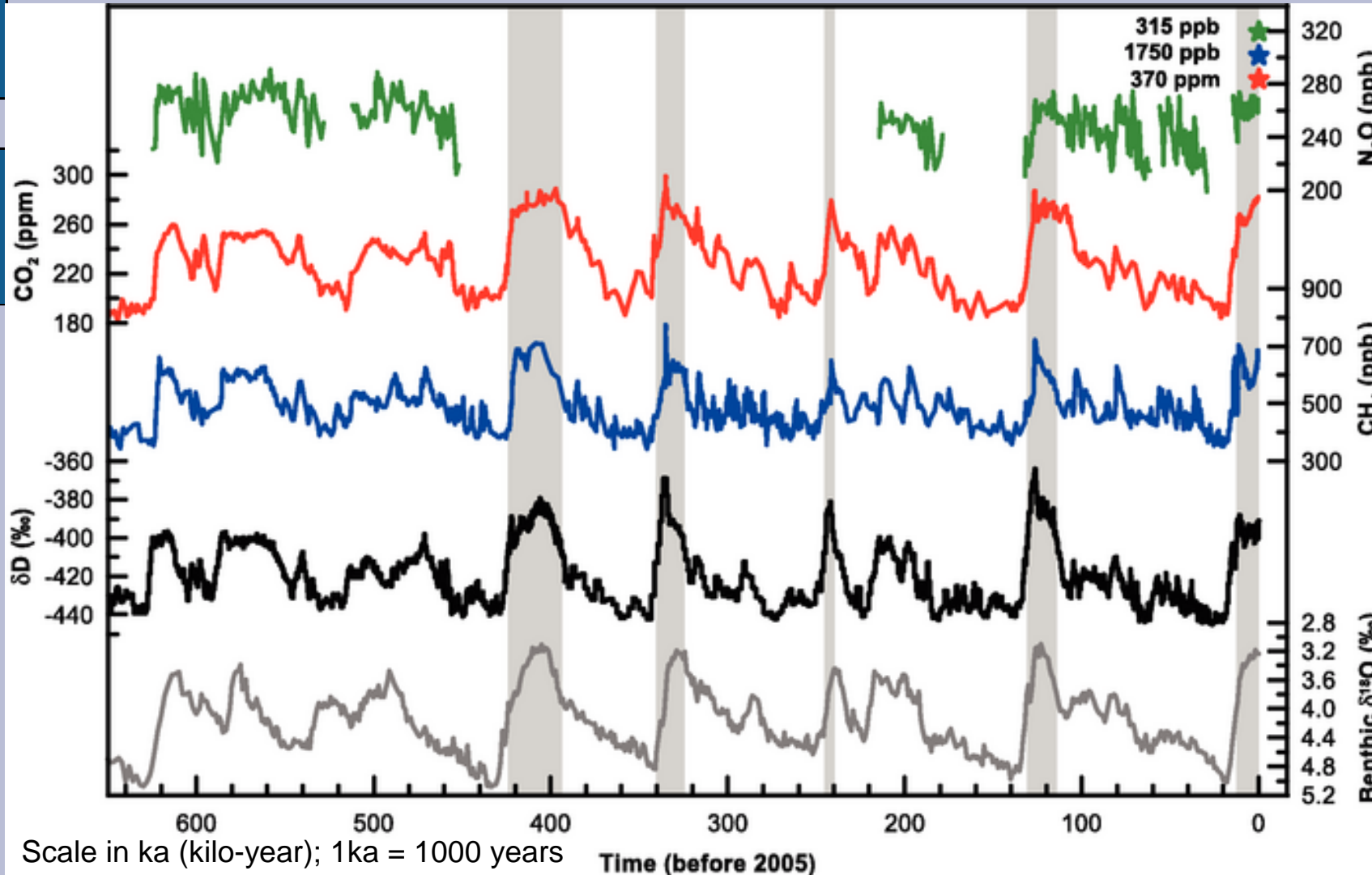


*Megaloceros giganteus*



*Mammuthus primigenius*

# Ice Cores



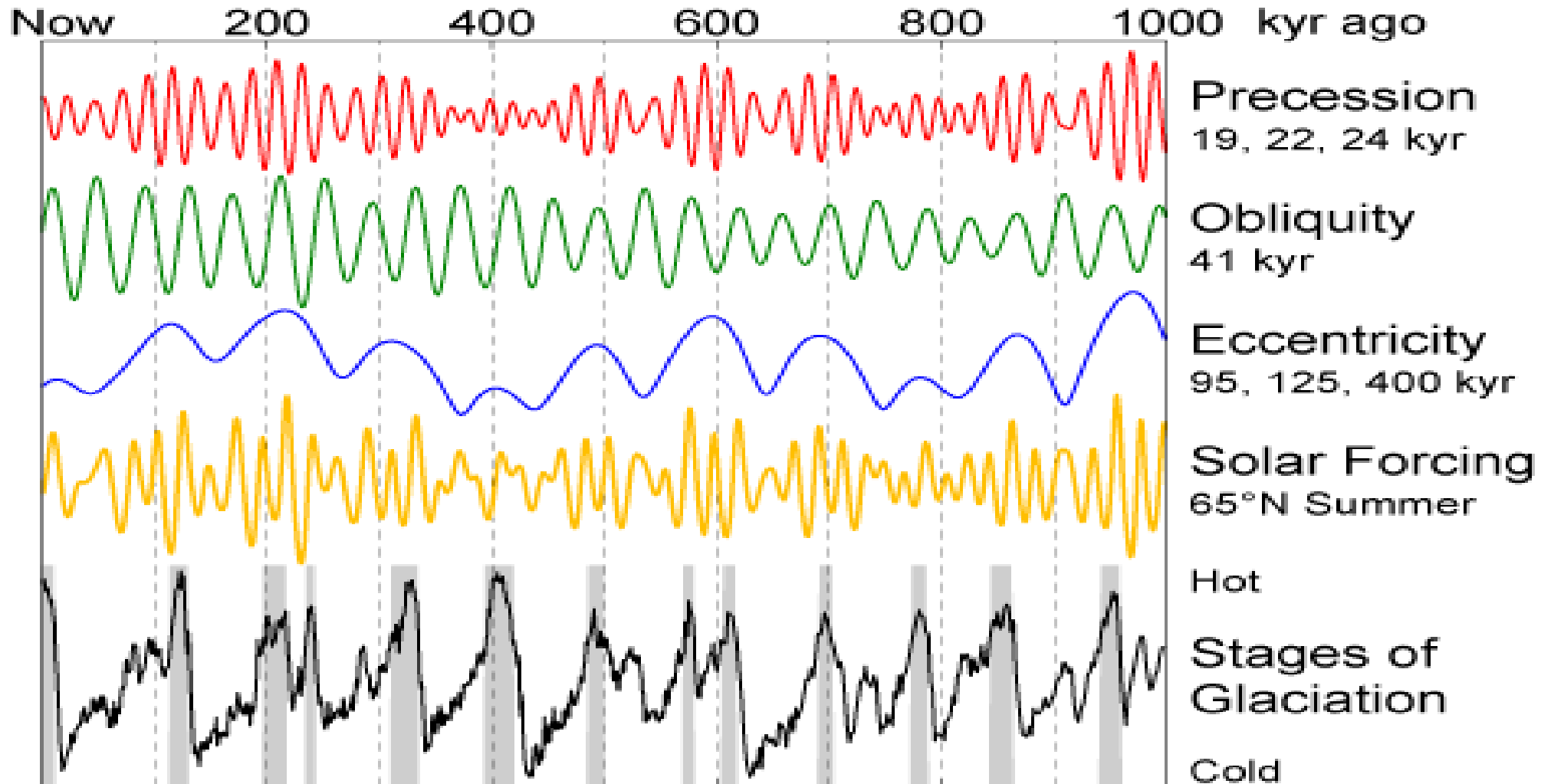
Greenhouse  
gases

proxy for  
**temperature**

from sediment  
cores: Proxy for  
**ice volume**

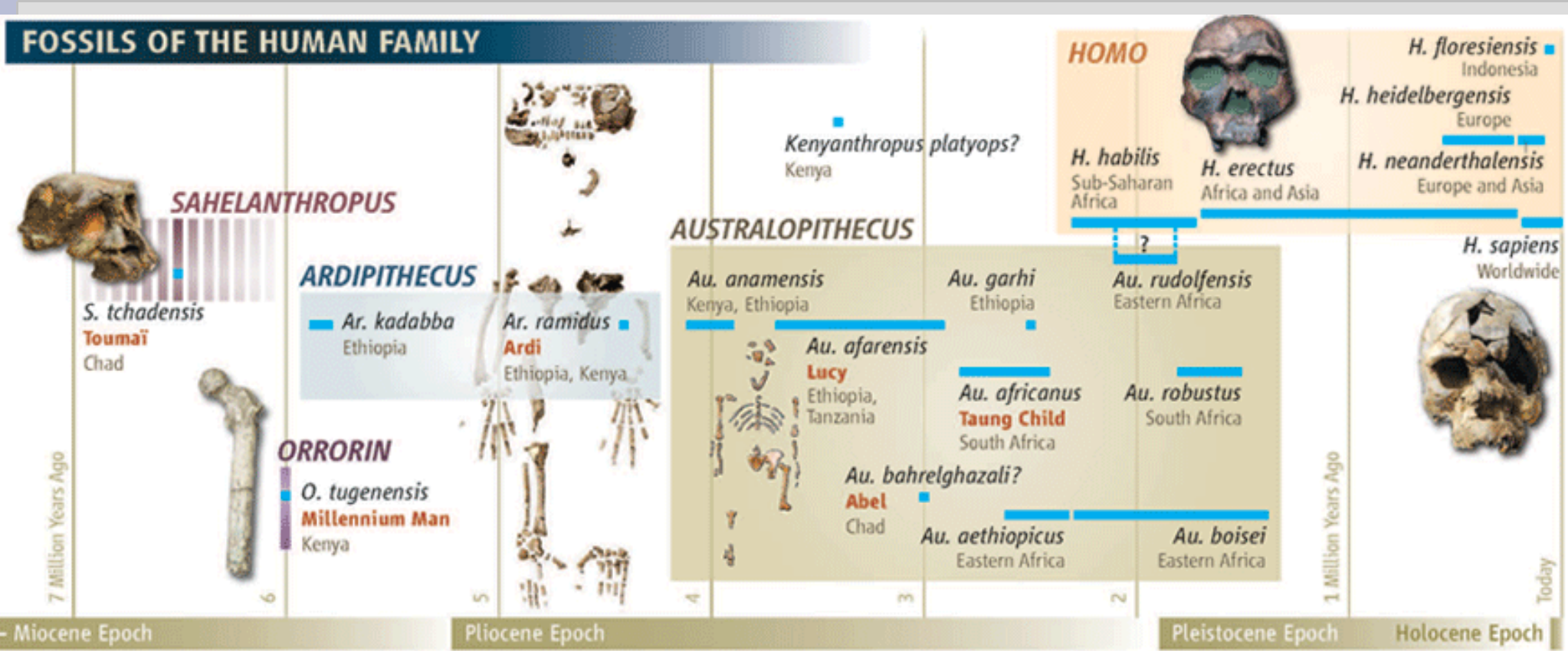
Note: „High-resolution ice core records of temperature proxies and CO<sub>2</sub> during deglaciation indicates that antarctic temperature starts to rise several hundred years before CO<sub>2</sub>.“ (IPCC)

# 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

# Human evolution and climate



Search Alert: 1 New article Available on ScienceDirect

Name of Alert: Arctic ecosystem

1. **Cenozoic vegetation, climate changes and hominid evolution in tropical Africa**  
*Global and Planetary Change, In Press, Accepted Manuscript, Available online 18 January 2010*  
Raymonde Bonnefille

Access the new result in ScienceDirect for: TITLE-ABSTR-KEY(arctic) and ecosystem

yesterday!

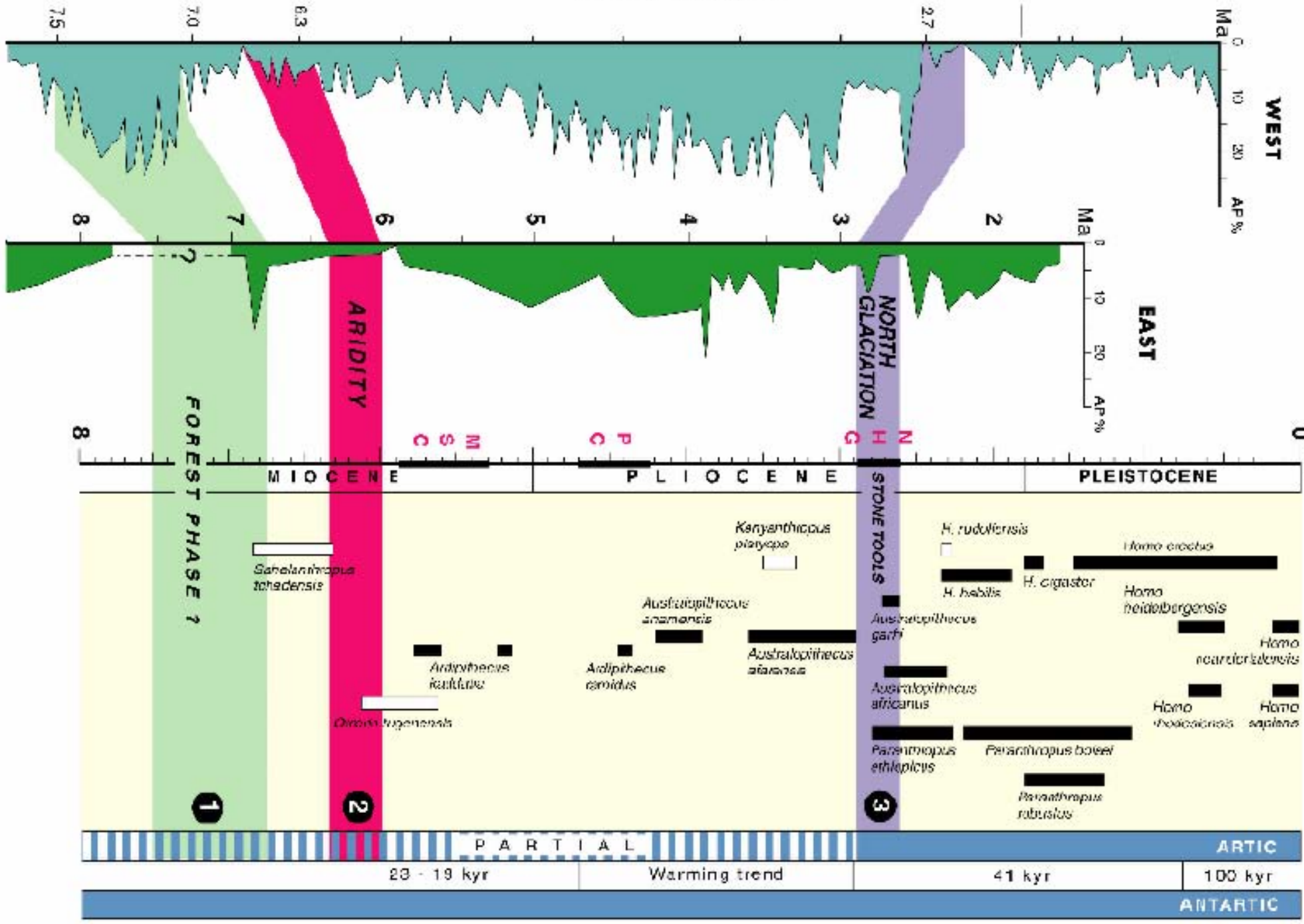
A thin black arrow points from the word "yesterday!" up and to the left towards the article title "Cenozoic vegetation, climate changes and hominid evolution in tropical Africa".

# TROPICAL AFRICA TREE COVER DENSITY

# HOMINID RECORD

# POLAR ICE

TIME SCALE



WEST

EAST

Ma

Ma AP%

MIOCENE

PLIOCENE

PLEISTOCENE

FOREST PHASE 1

ARIDITY

NORTH GLACIATION

STONE TOOLS

*Sahelanthropus tchadensis*

*Kenyanthropus platyops*

*H. rudolfensis*

*Homo erectus*

*Ardipithecus kadabba*

*Australopithecus anamensis*

*Ardipithecus ramidus*

*Australopithecus afarensis*

*H. habilis*

*H. ergaster*

*Homo heidelbergensis*

*Orrorin tugenensis*

*Australopithecus garhi*

*Homo neanderthalensis*

*Australopithecus africanus*

*Homo thobacensis*

*Homo sapiens*

*Paranthropus aethiopicus*

*Paranthropus boisei*

*Paranthropus robustus*

PARTIAL

ARTIC

23 - 19 kyr

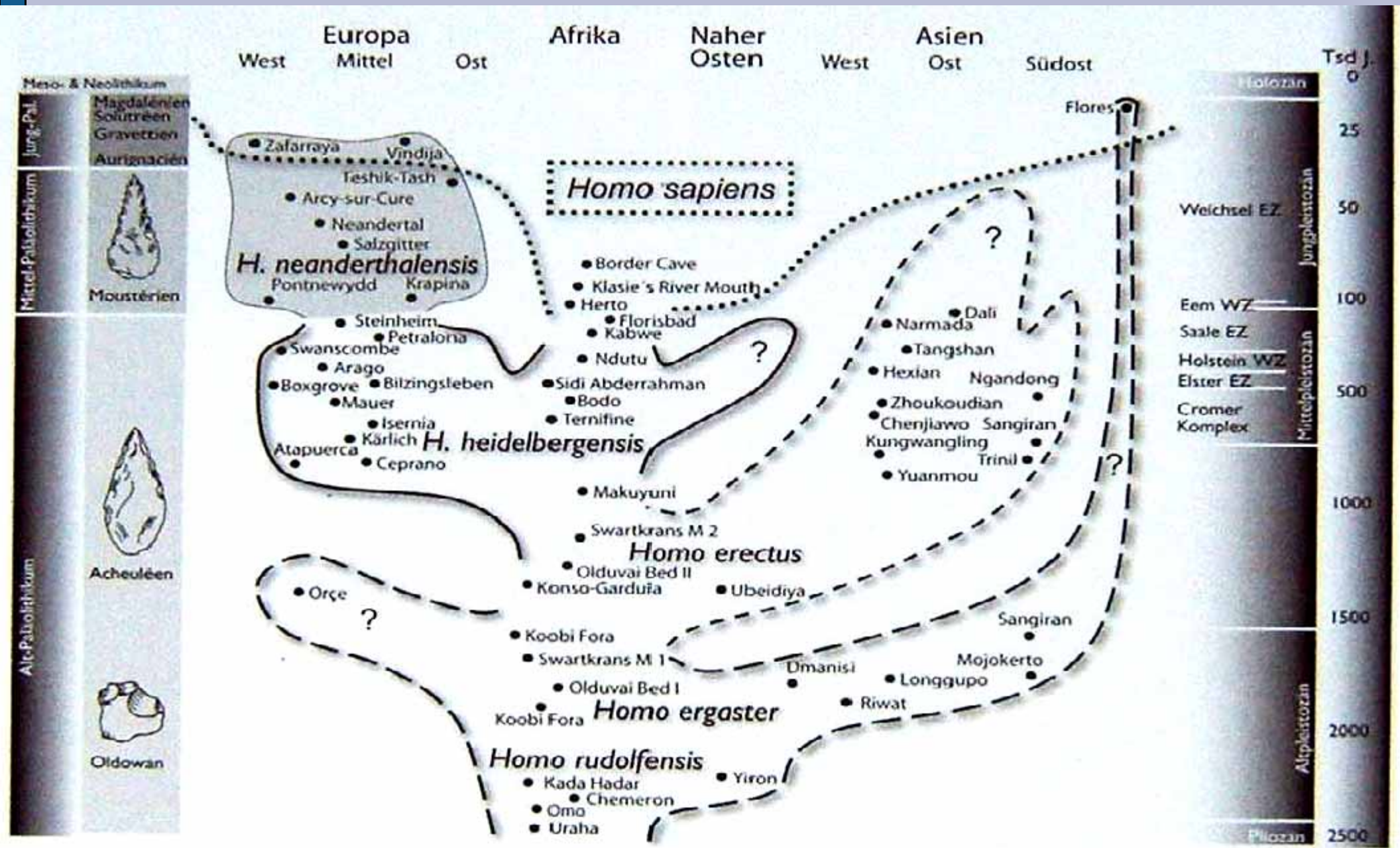
Warming trend

41 kyr

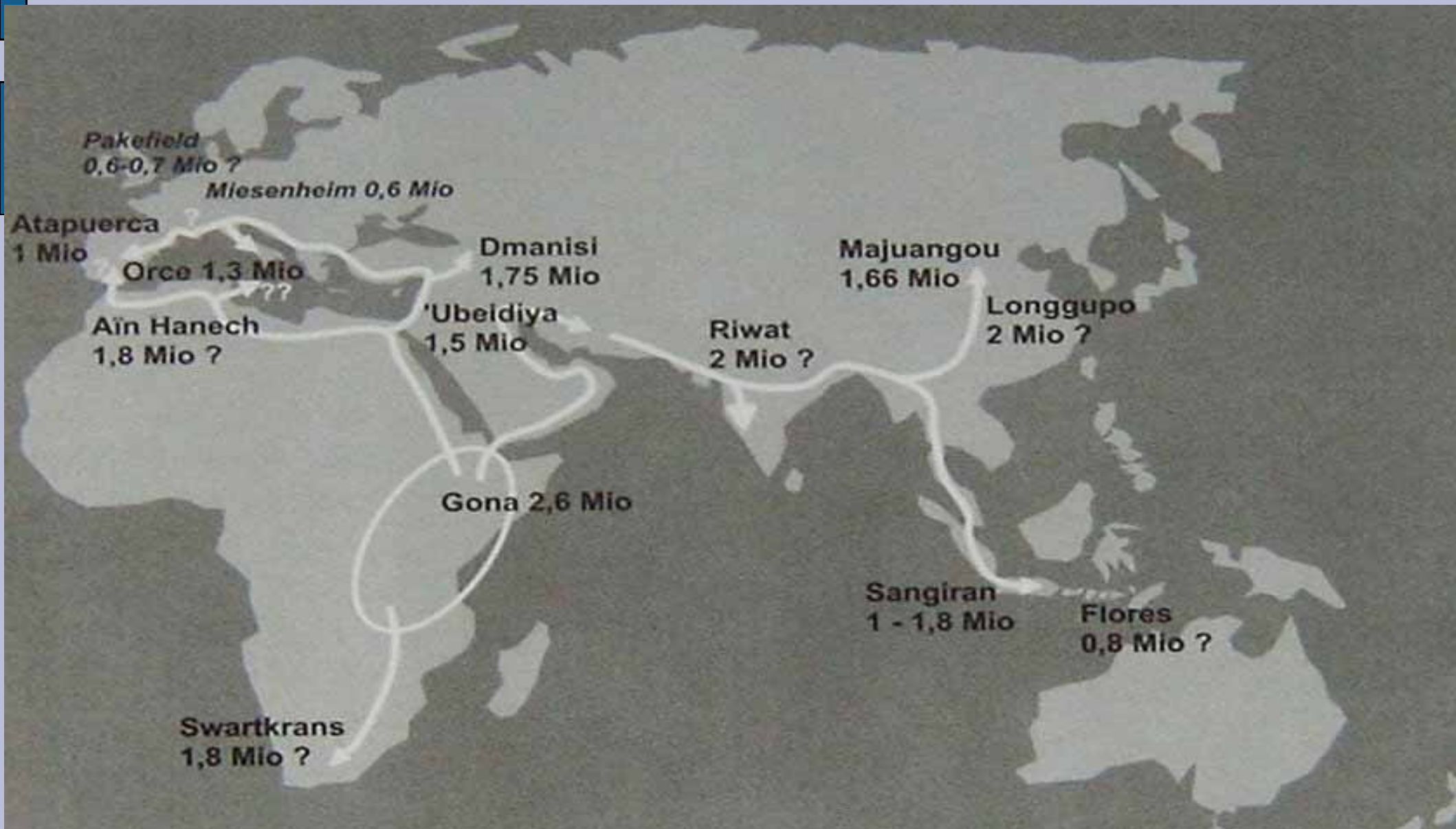
100 kyr

ANTARTIC

# Human evolution



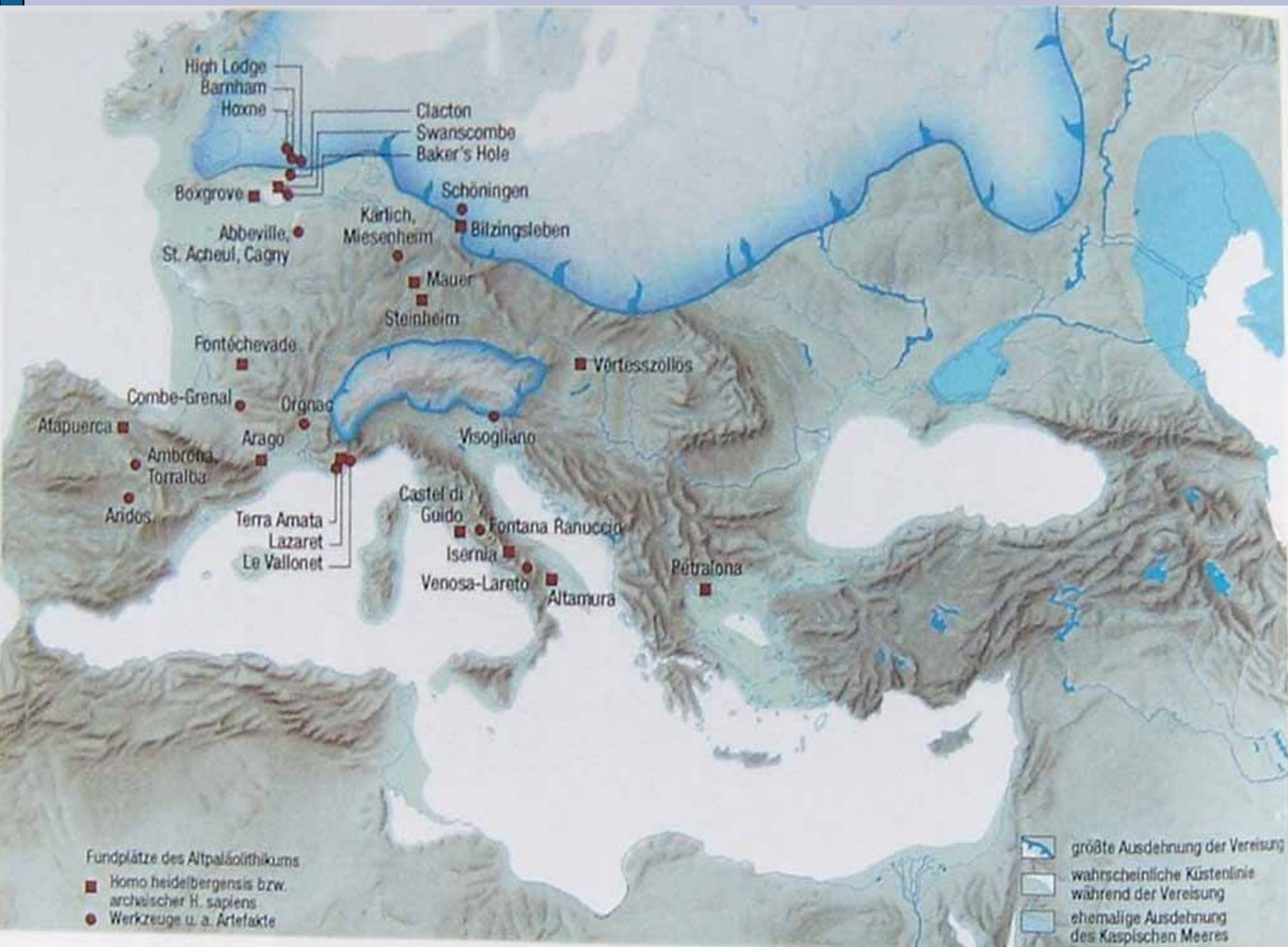
# First Human Migration



# The first Europeans

Bilzingsleben excavation site



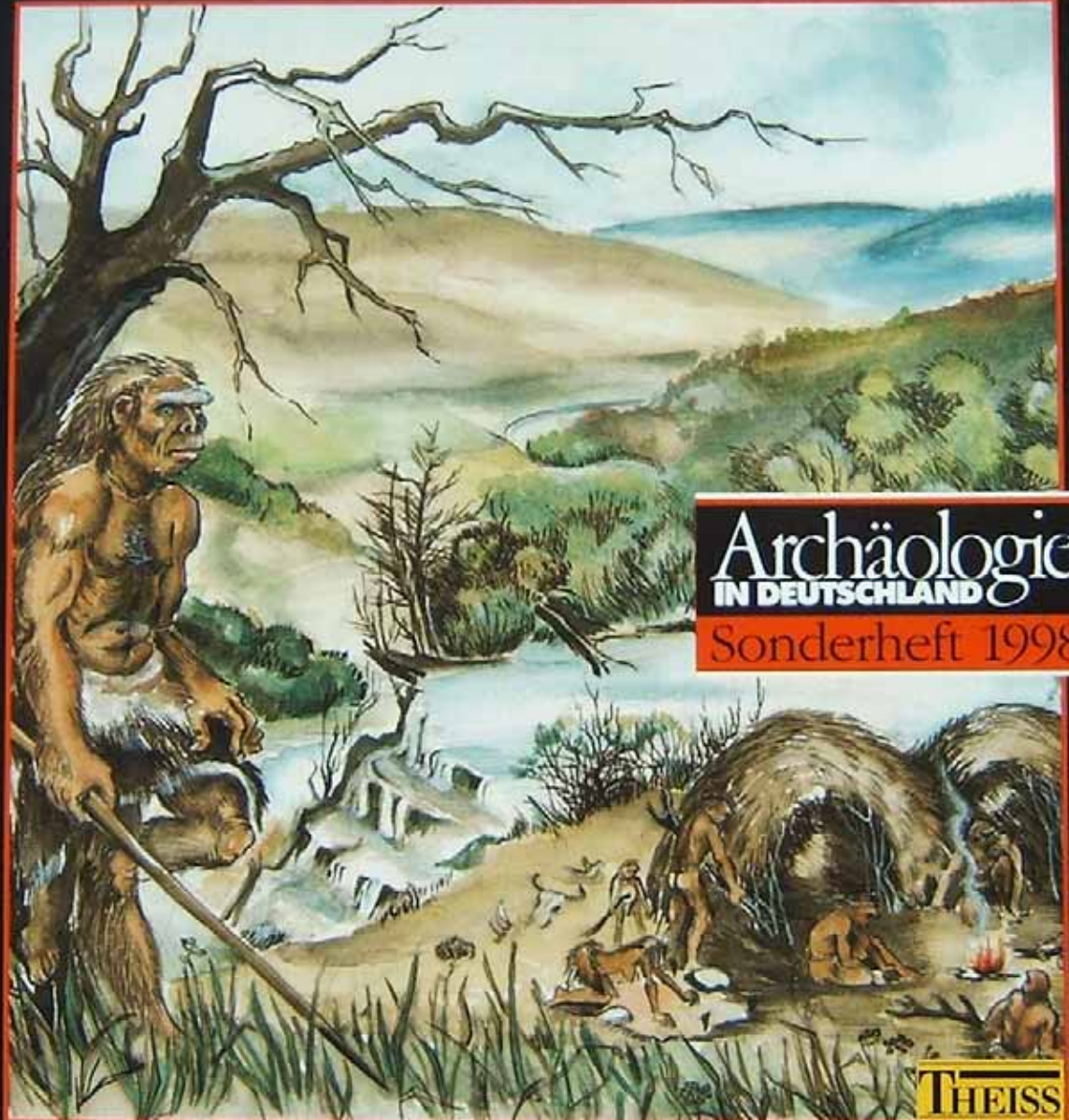


# Bilzingsleben 400,000 years ago



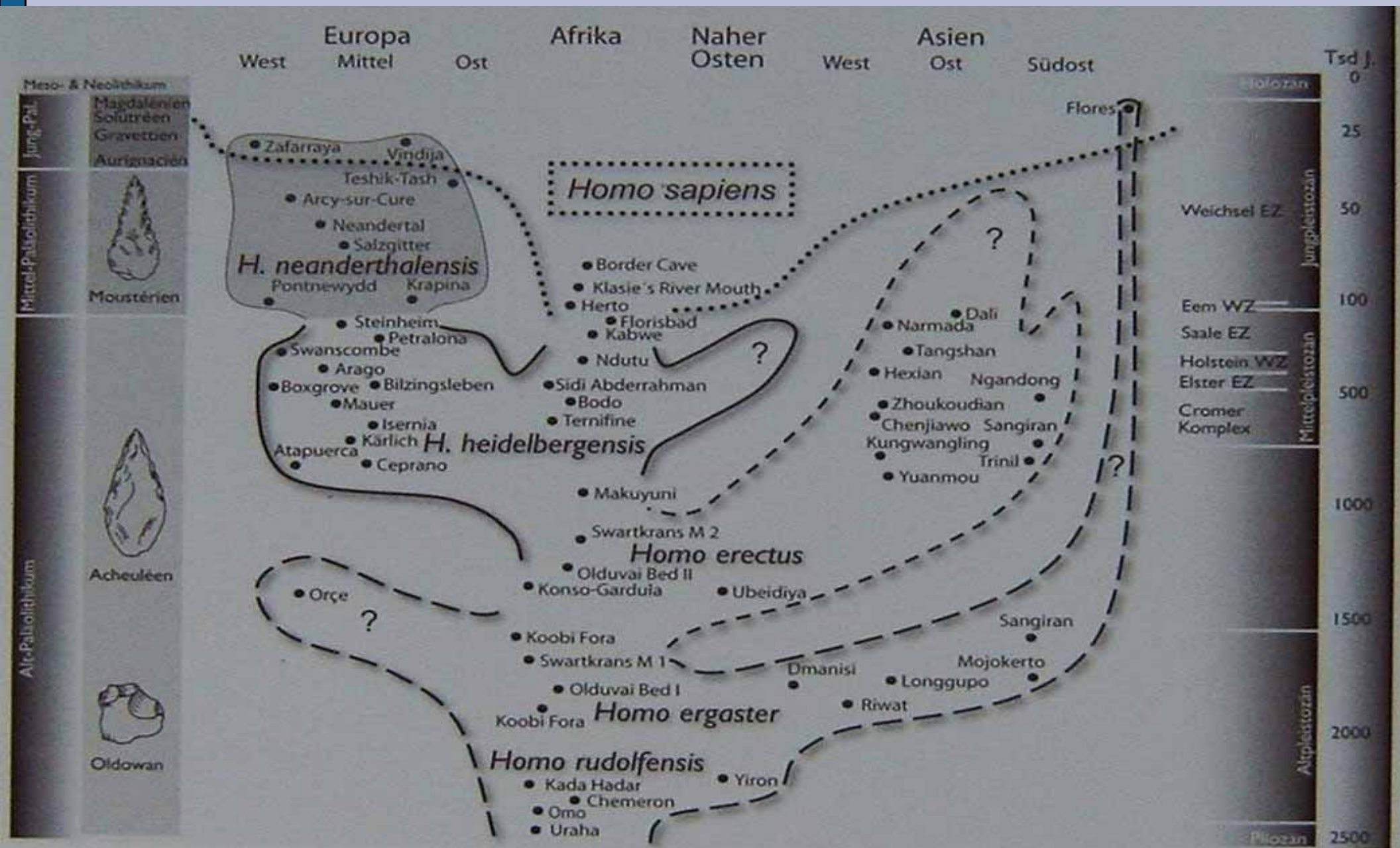
Antler tools from Bilzingsleben

# DIE ERSTEN MENSCHEN IN EUROPA

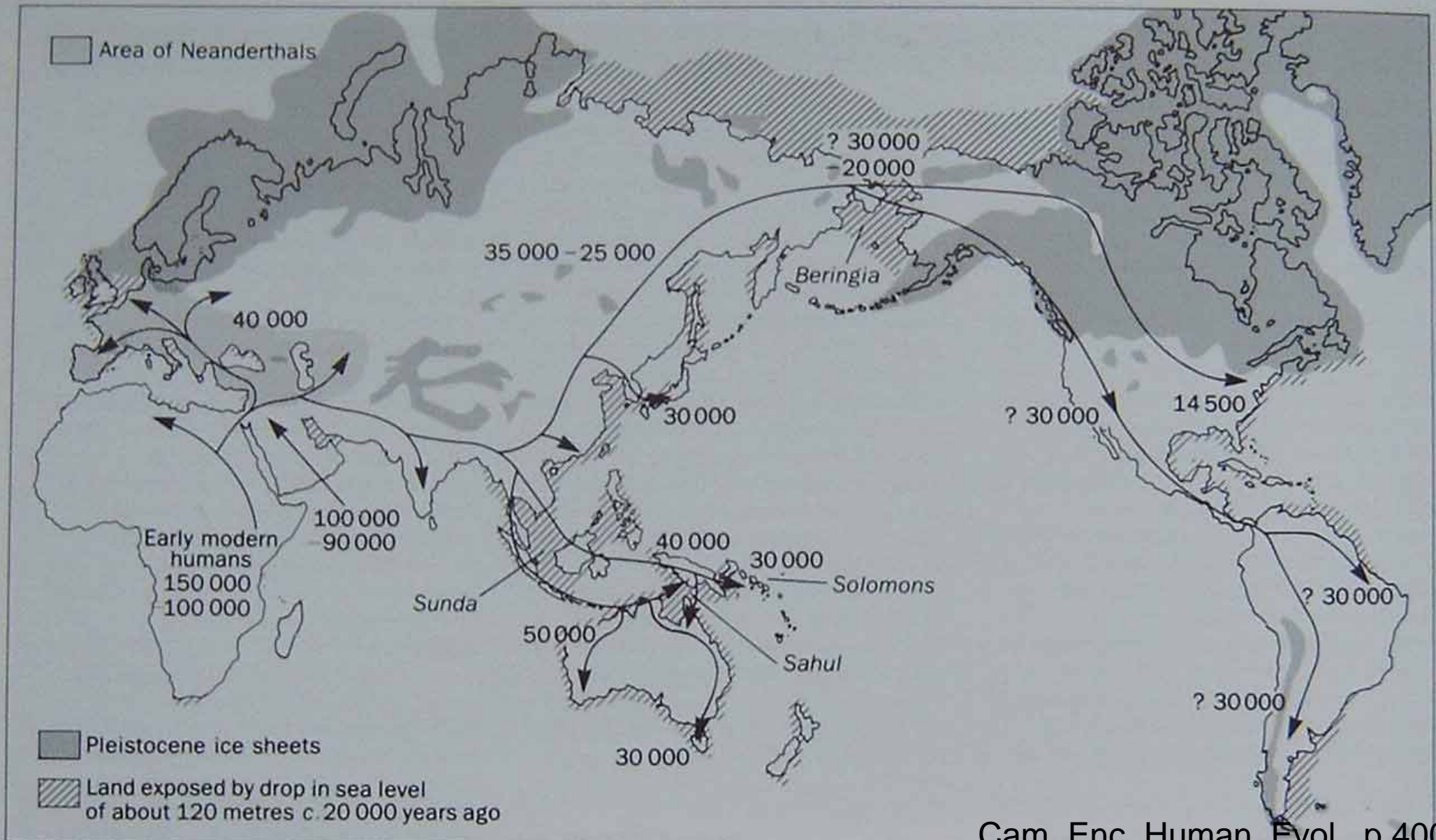




# Human evolution



# “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

Christopher A. Scholz<sup>a,b</sup>, Thomas C. Johnson<sup>c</sup>, Andrew S. Cohen<sup>d</sup>, John W. King<sup>e</sup>, John A. Peck<sup>f</sup>, Jonathan T. Overpeck<sup>d</sup>, Michael R. Talbot<sup>g</sup>, Erik T. Brown<sup>c</sup>, Leonard Kalindegakhe<sup>h</sup>, Philip Y. O. Amoako<sup>i</sup>, Robert P. Lyons<sup>a</sup>, Timothy M. Shanahan<sup>d</sup>, Isla S. Castañeda<sup>c</sup>, Clifford W. Heil<sup>e</sup>, Steven L. Forman<sup>j</sup>, Lanny R. McHargue<sup>k</sup>, Kristina R. Beuning<sup>l</sup>, Jeanette Gomez<sup>j</sup>, and James Pierson<sup>l</sup>

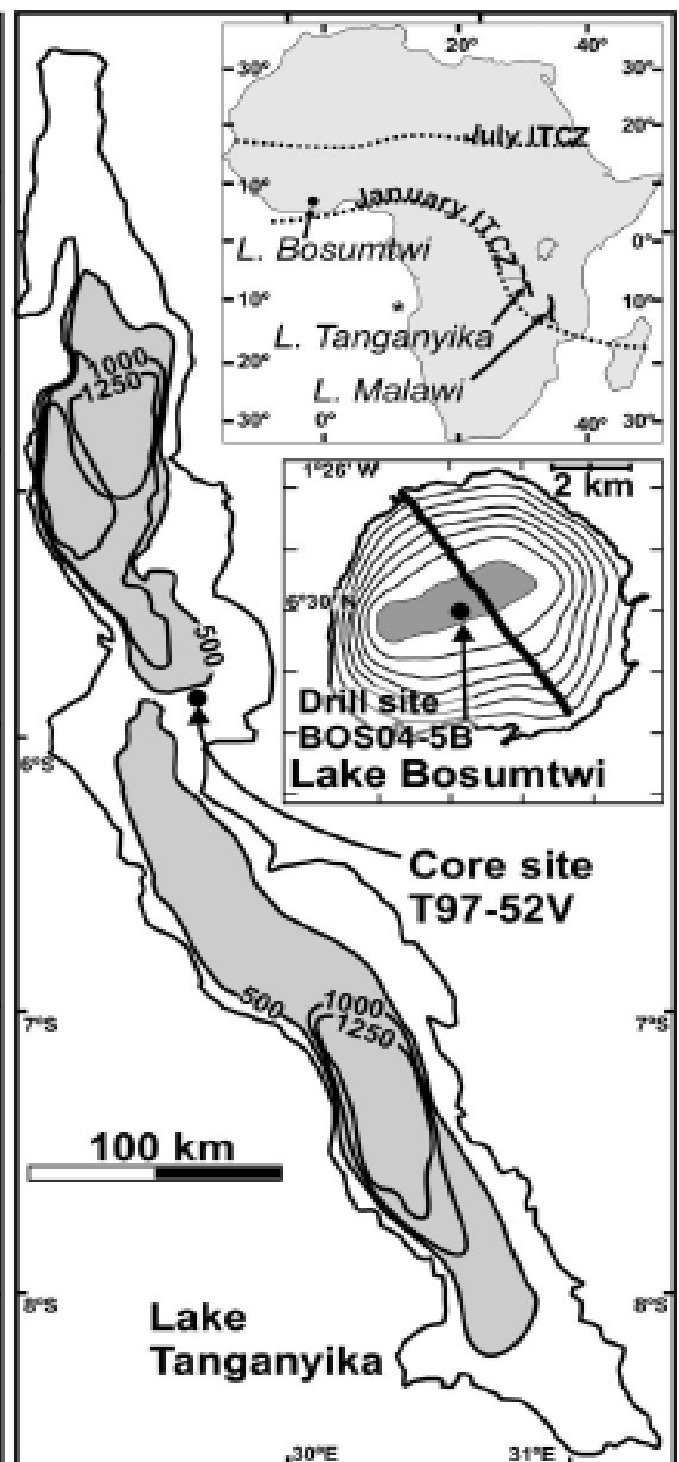
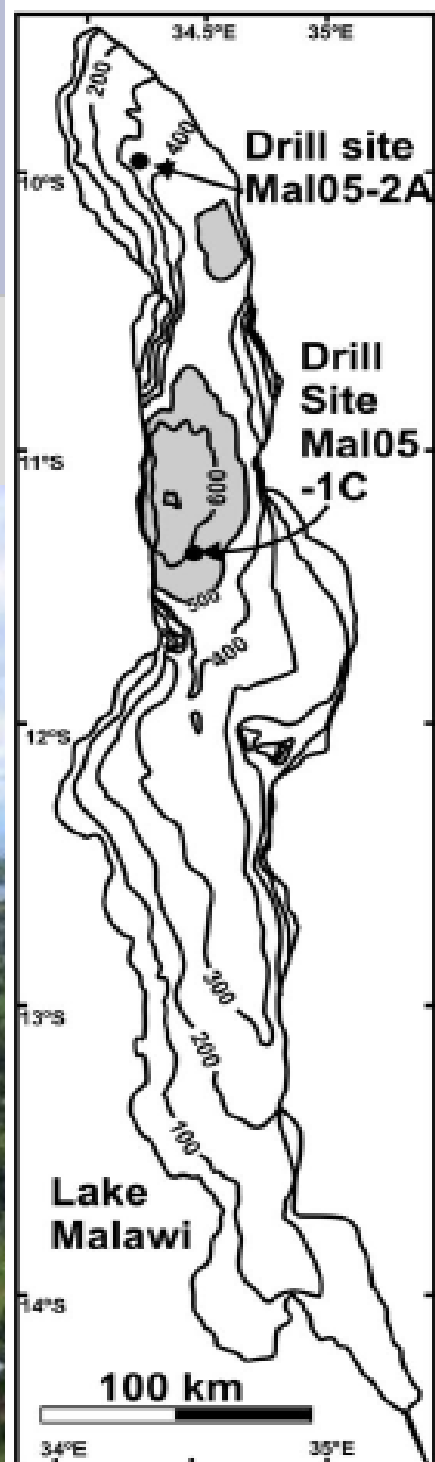
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Edited by William F. Ruddiman, University of Virginia, Charlottesville, VA, and accepted by the Editorial Board July 27, 2007 (received for review April 30, 2007)

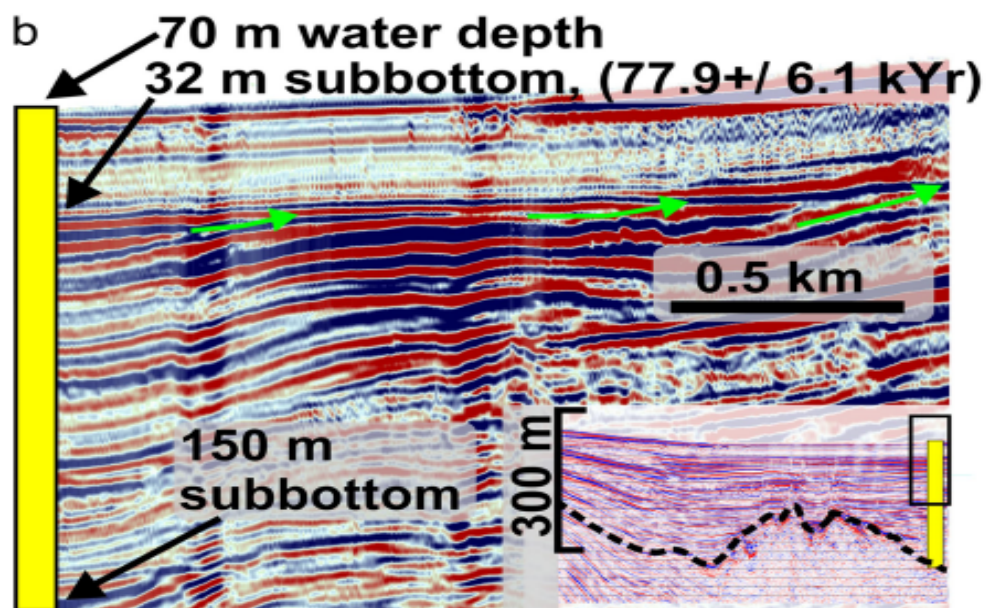
The environmental backdrop to the evolution and spread of early *Homo sapiens* in East Africa is known mainly from isolated outcrops and distant marine sediment cores. Here we present results from new scientific drill cores from Lake Malawi, the first long and continuous, high-fidelity records of tropical 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  $\approx 70$  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

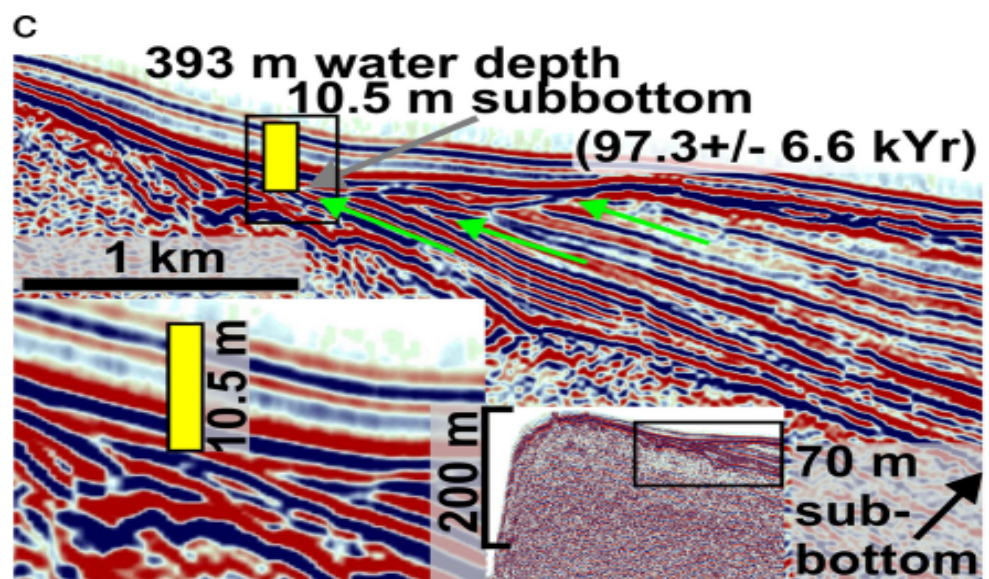
# Lake Malawi



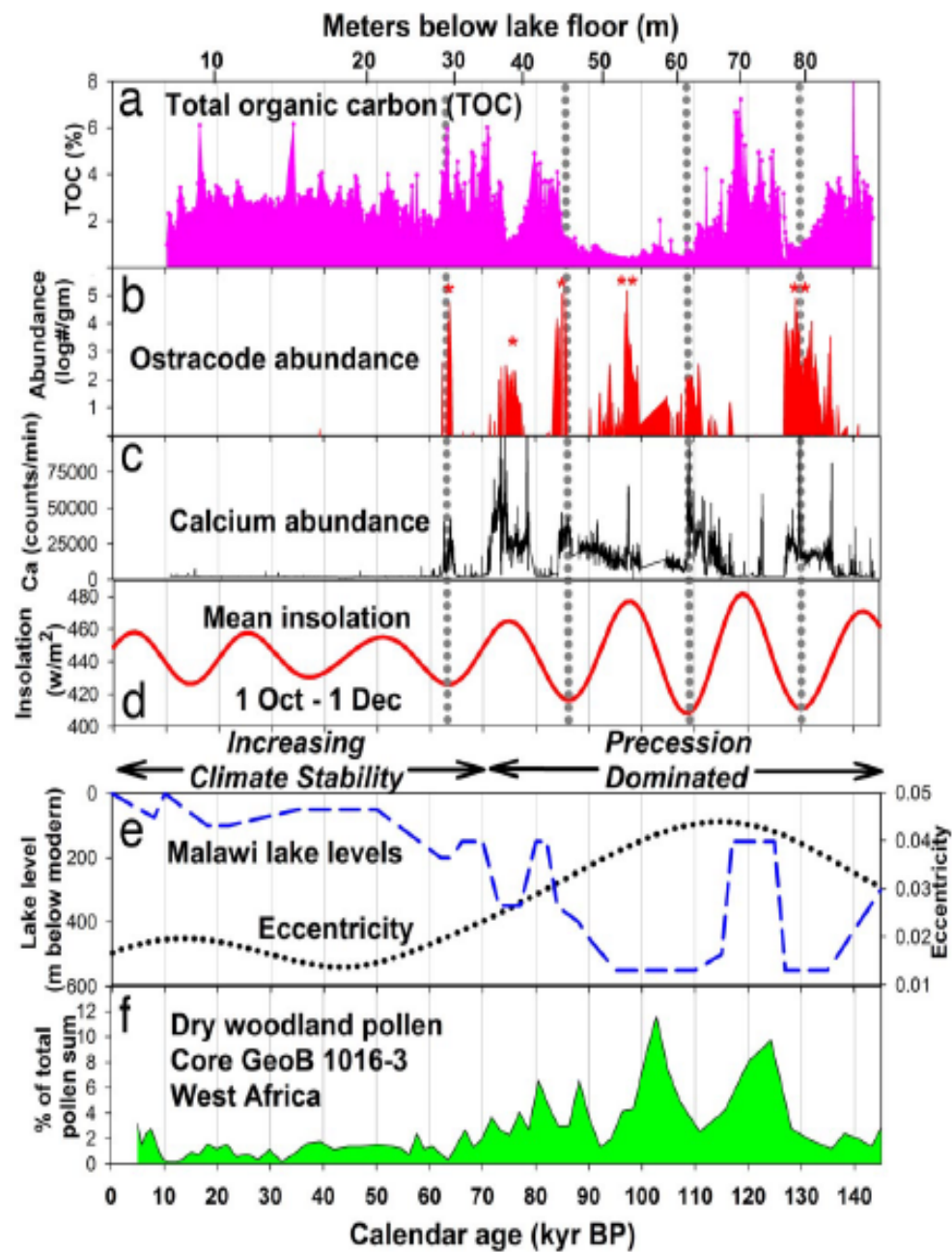
# Lake level indicators



Lake Bosumtwi Drill Site BOS04-5B



Lake Tanganyika Core Site T97-52V



# And humans?

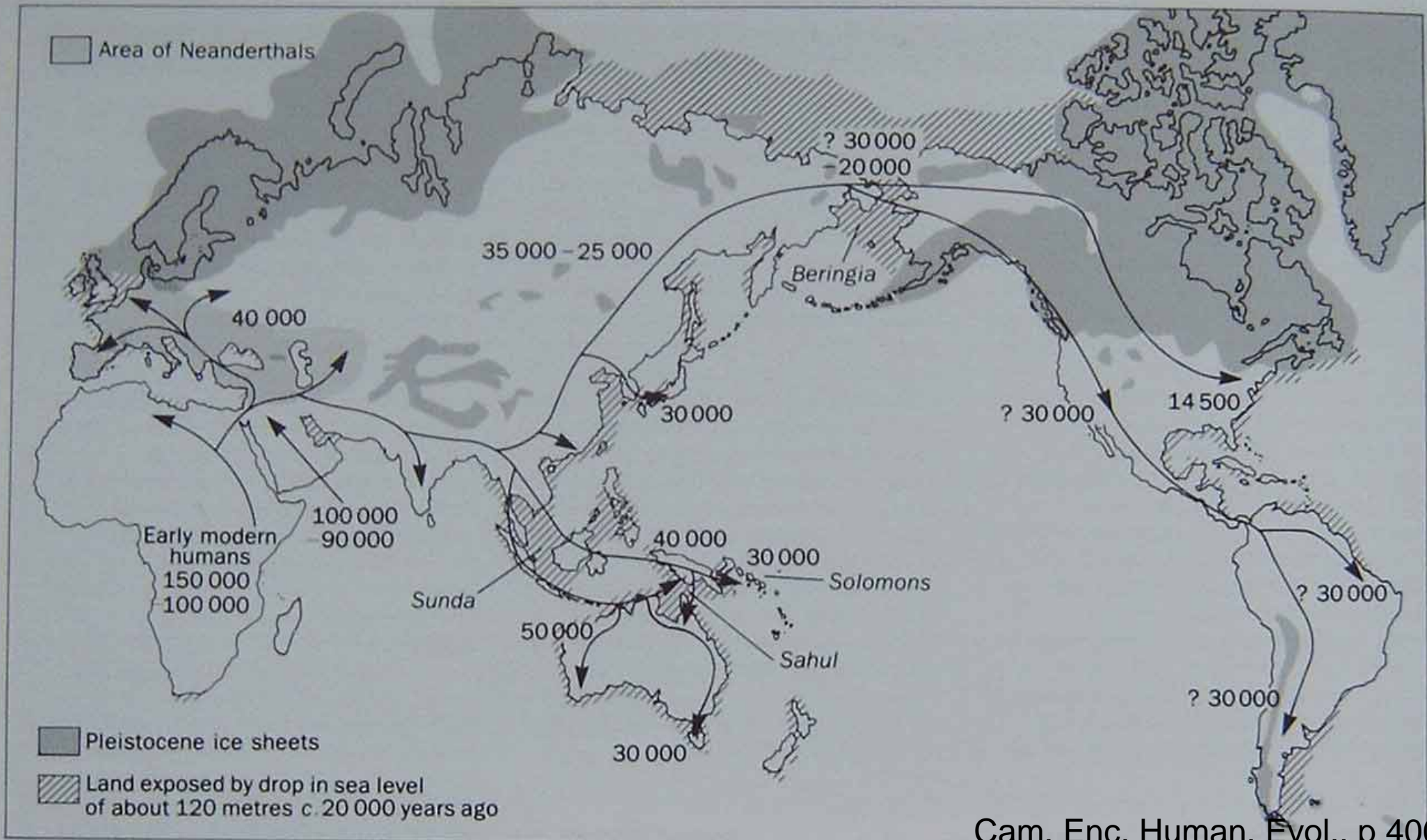
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coincides with the marked expansion of early modern human populations, suggested from studies of modern mtDNA inherent in maternal lineages (12) and Y-chromosome analyses (13). Although still controversial, several early studies of mtDNA deduced that 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  $\approx 50$  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, *Viphya*,

# Possible dispersal routes



# A question to think about

Humans spread from Africa several times.  
Apparently only the last wave survived.  
Why?



# Summary

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

# Literature

- Prehistory. The definite visual history of life on Earth. Dorling Kindersley, 2009
- IPCC (2007) WG1, Chapter 6
- Jones et al. (1992): The Cambridge Encyclopedia of Human Evolution
- Bradley (1999): Paleoclimatology. Academic Press.
- Scholz et al. (2007); and Cohen et al. (2007): PNAS 104, 42, 16416 and 16422
- Bonneville (2010): Global and Planetary Change, 10.1016/j.gloplacha.2010.01.015

# Climate and Human History

Next session (26 January):

3. Farming and City States