Today in Astronomy 106: apes to modern humans

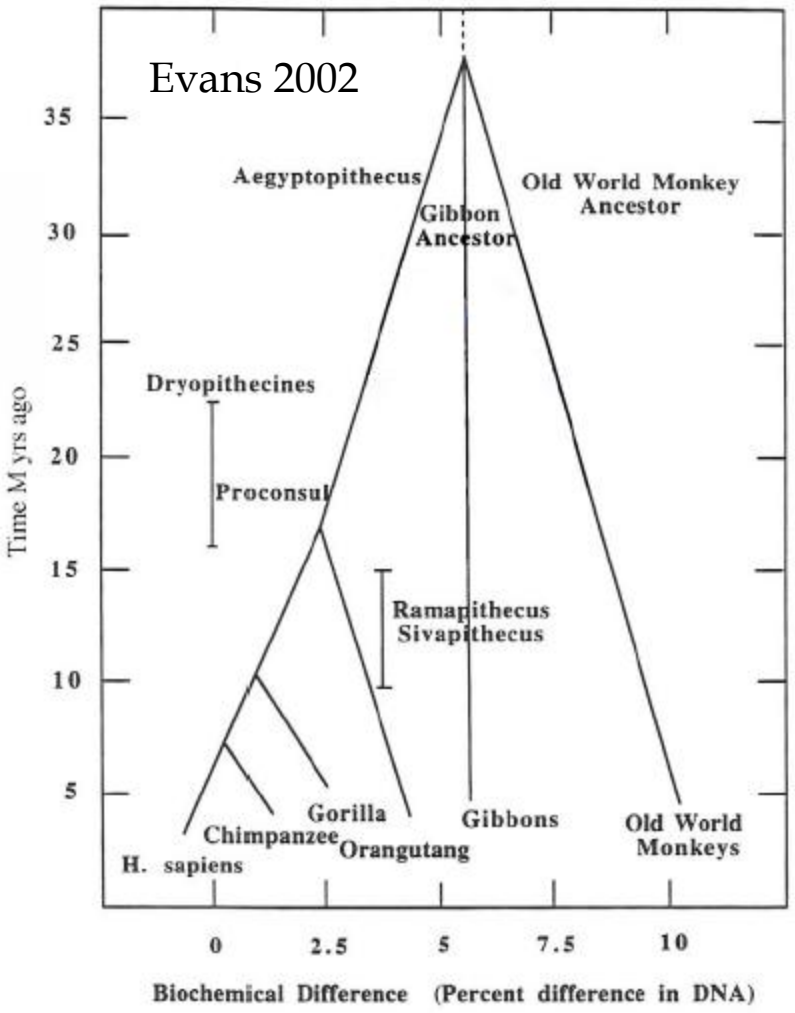
- Meet the hominids.
- Brains, diet and toolmaking: going where natural selection fears to tread.
- Genetic diversity in Africa, the Saharan bottleneck, and the spread of humanity.
- The spread of languages.

Selections from *The Dawn of Man*, in *2001: A Space Odyssey*, by Stanley Kubrick (1968).

Monkeys to hominids

Once bipedal hominids began to appear in newly-drier East Africa, many *gene* mutations were naturally selected which accelerated the differences between them and the apes.

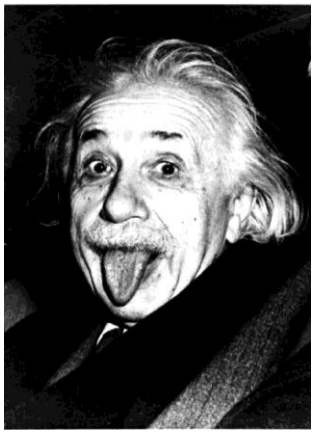
- Distinct process from steady rate of increased difference in junk DNA.
- Most evident in parts of genes called **human accelerated regions** (HARs), of which 55 have been noted.



Monkeys to hominids (continued)

- HARs were discovered in 2006 by Katie Pollard (UCSF), as one of the first huge achievements of the new science of **genomics**.
- HAR1, chromosome 20, for example:
  - Present in reptiles onward.
  - Base-pair difference between chimpanzees and chickens: 2.
  - Base-pair difference between chimpanzees and humans: **18**.

+2

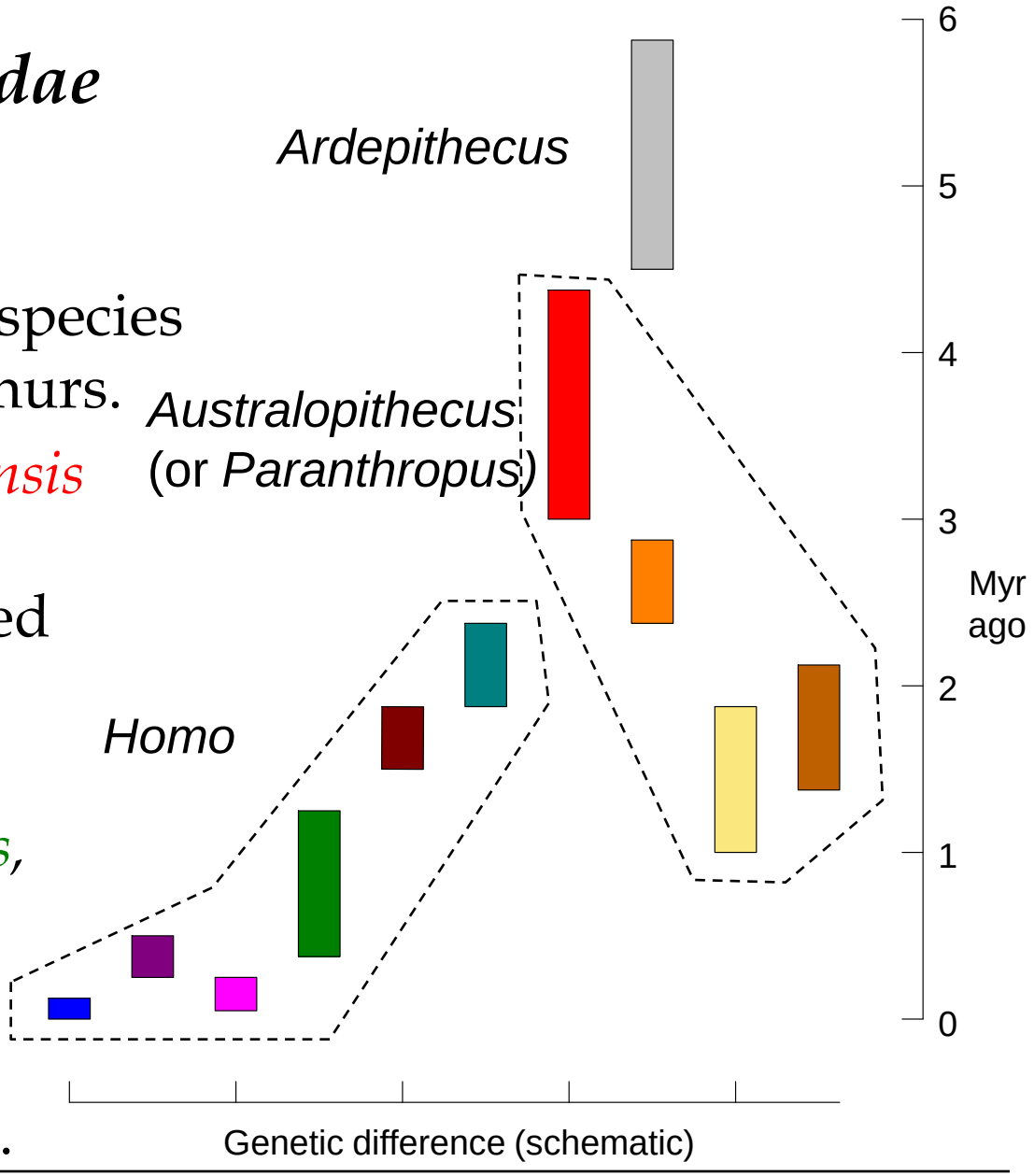


+18

Africa's *Hominidae*

All bipedal and tail-less:

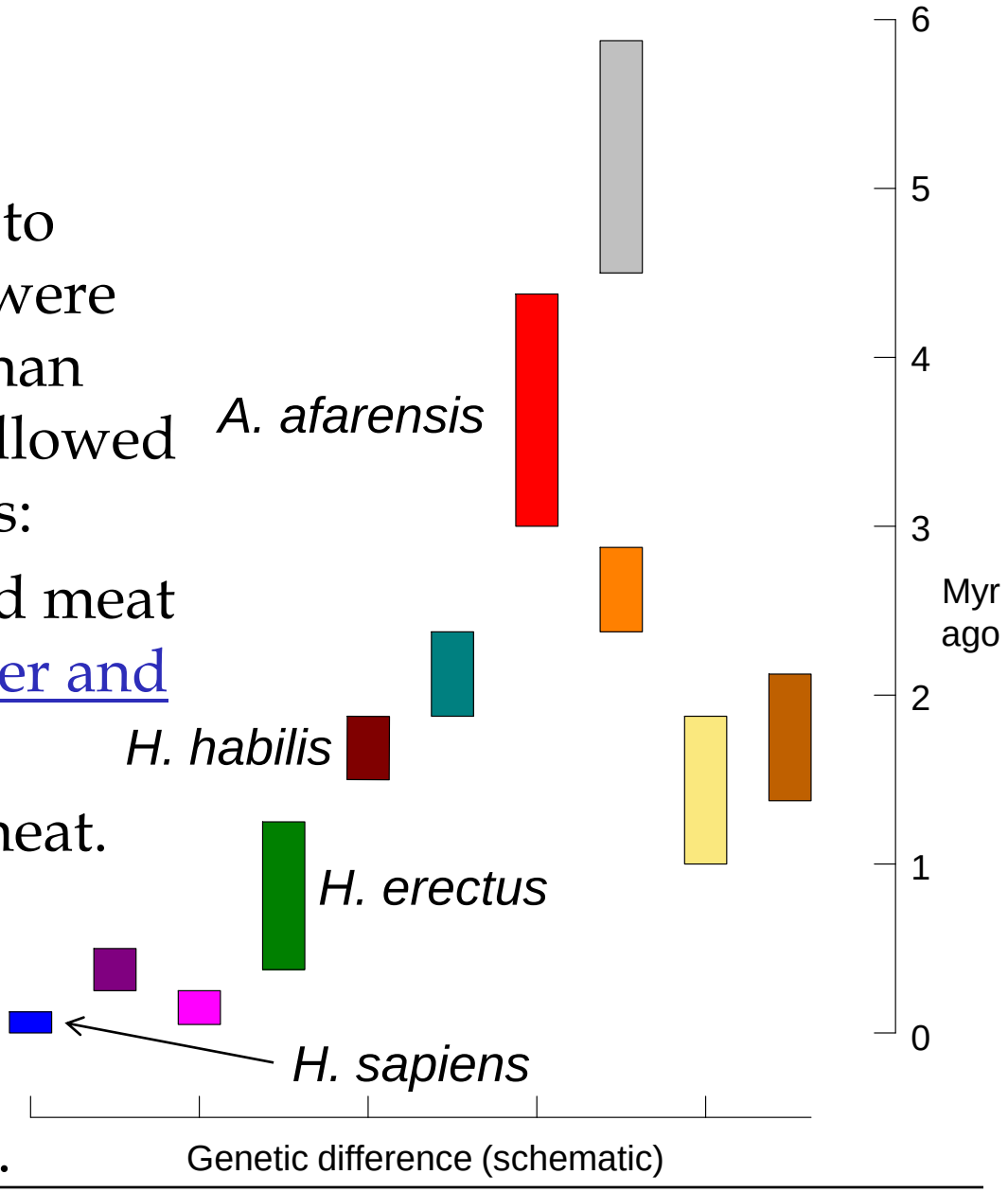
- *Ardepithecus*: several species known mostly by femurs.
- *Australopithecus afarensis* (e.g. Lucy), *africanus*, *robustus*, *bosei*. Evolved toward bigger teeth.
- *Homo rudolfensis*, *habilis/ergaster*, *erectus*, *heidelbergensis*, *neanderthalensis*, *sapiens*. Evolved toward bigger brains.



Evolution of diet

As they walked from tree to tree, hominids gradually were selected for eating more than fruit and leave, this also allowed for growth of larger brains:

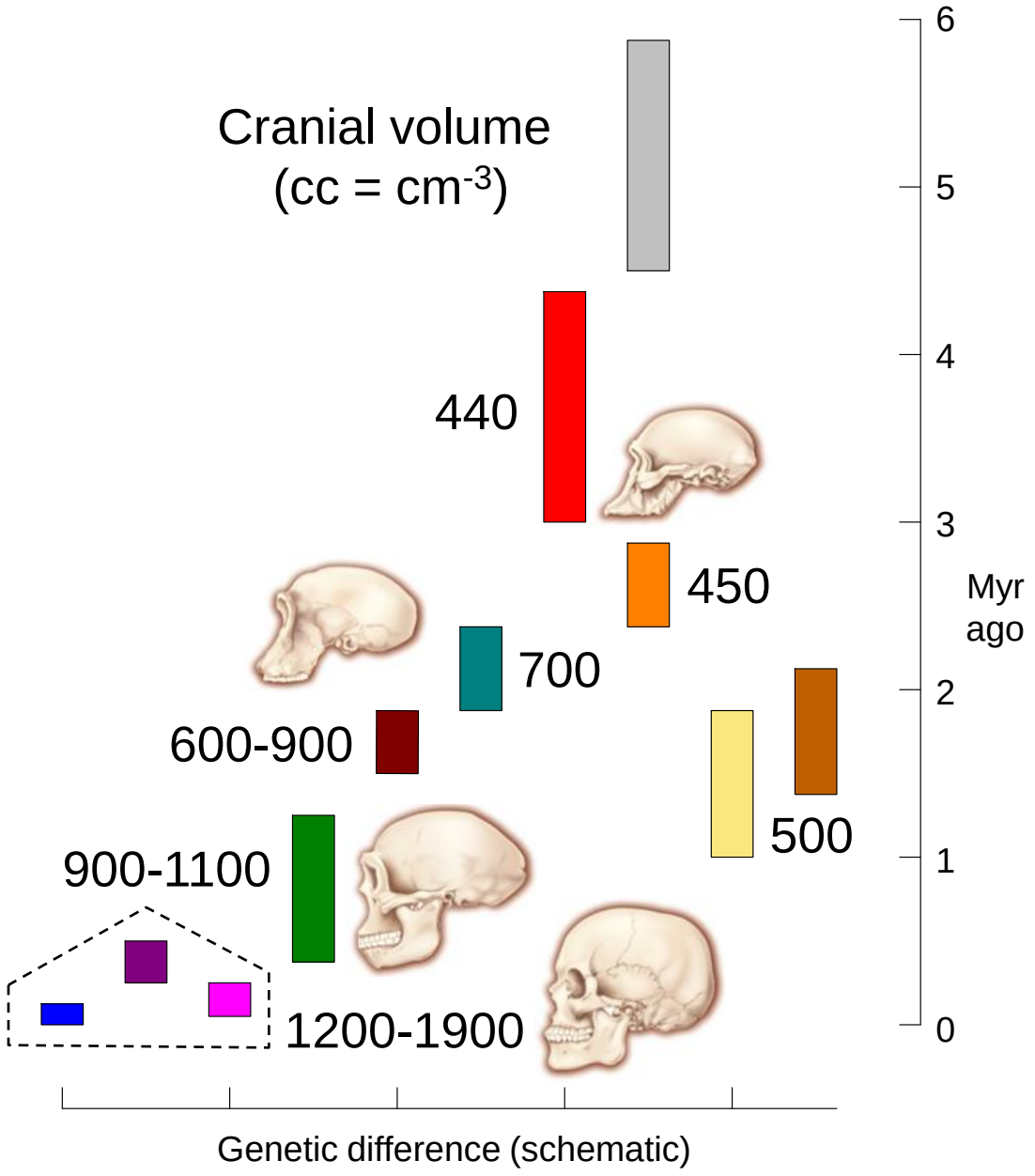
- *A. afarensis*: grasses and meat as well (e.g. Sponheimer and Lee-Thorp 1999).
- *H. habilis*: even more meat.
- *H. erectus*: wider variety of meat.
- *H. sapiens*: as much meat as they could get.



Evolution of brains

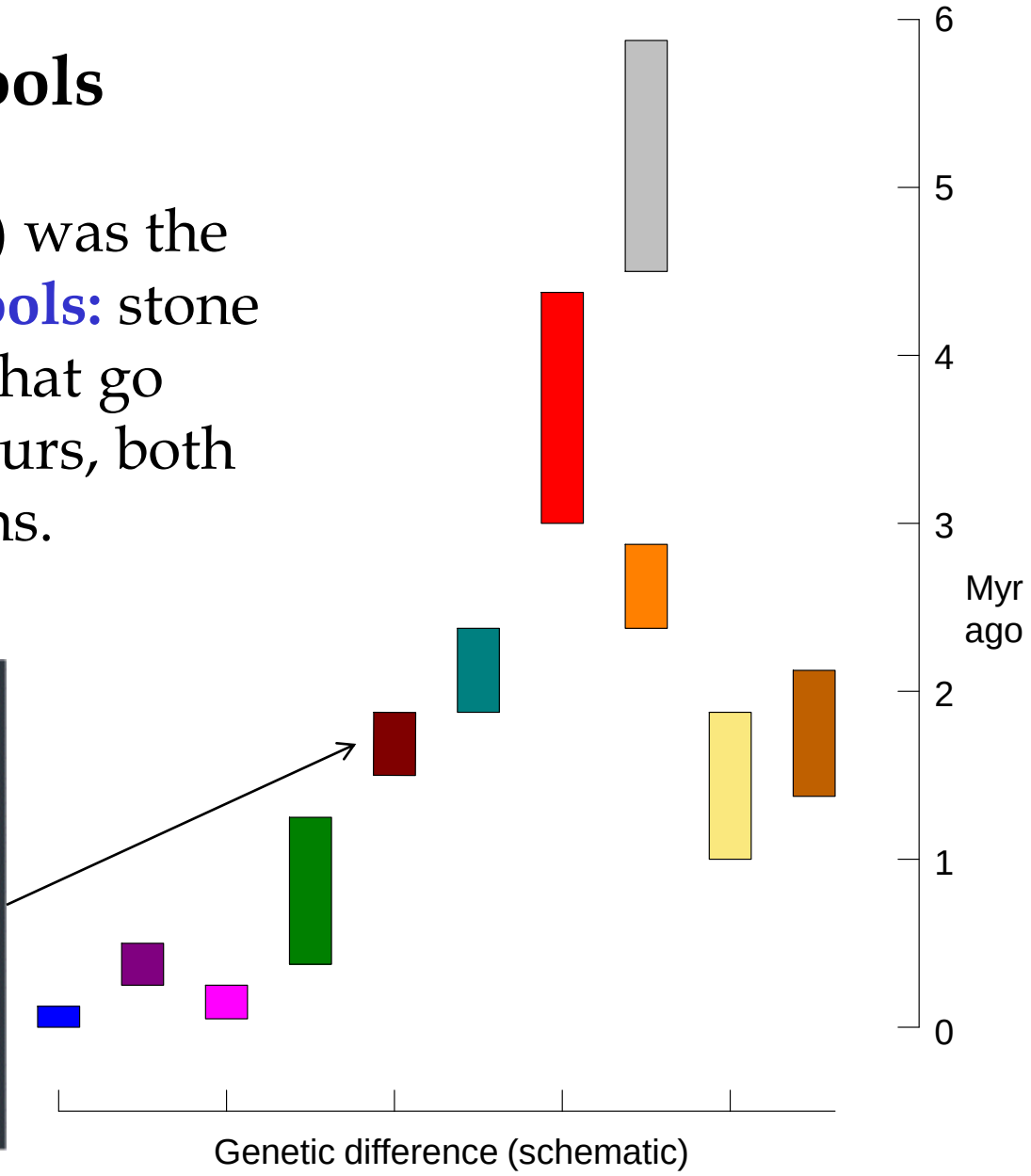
Cranial capacity increases dramatically along the *Homo* branch of the hominids.

- *A. afarensis*, at an average of 440 cc, would fit comfortably in the chimpanzee range (300-500 cc).
- Capacity about the same for all post-*erectus* species.



Evolution of tools

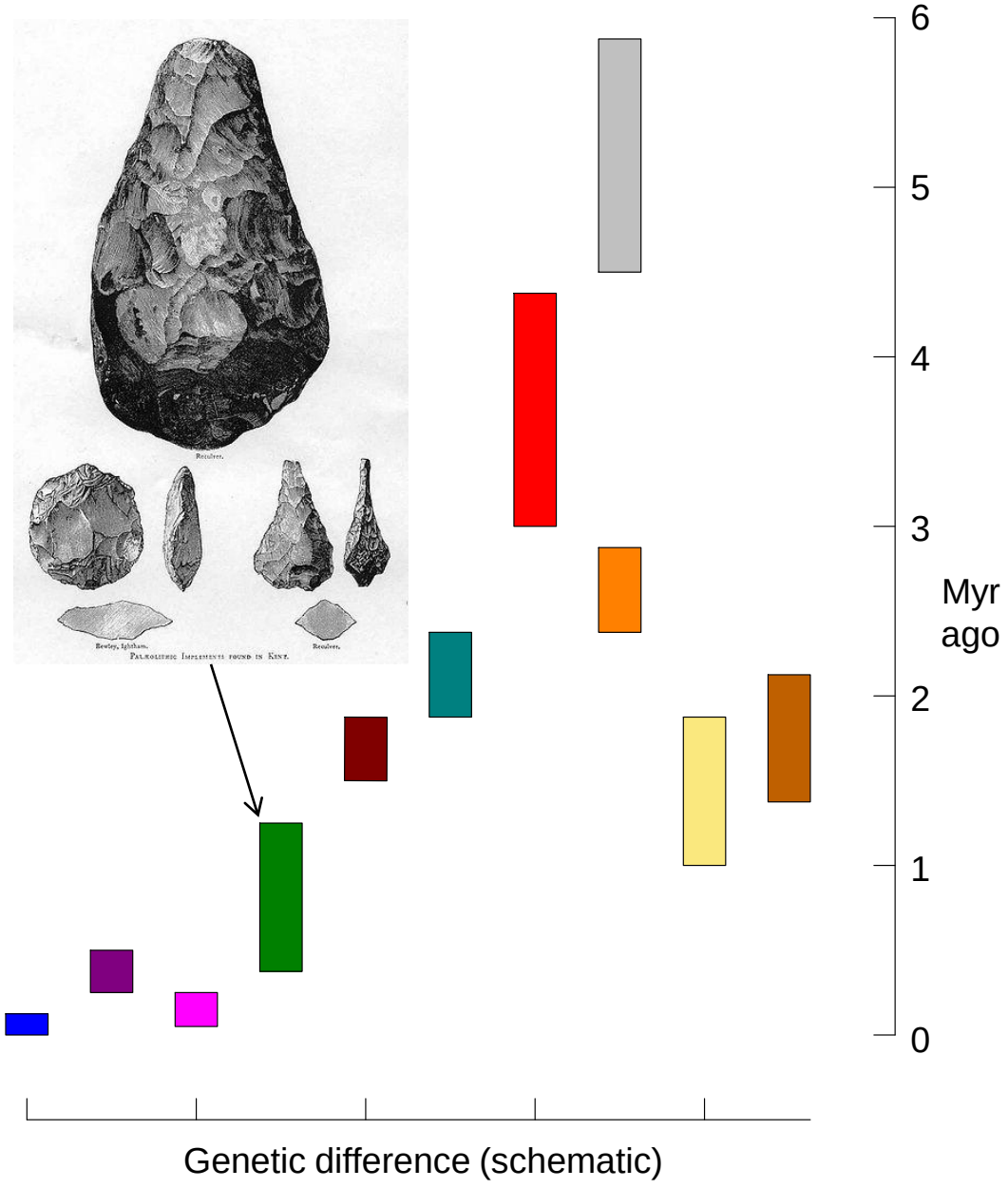
H. Habilis ("handy man") was the **first hominid to make tools:** stone hand-axes and scrapers that go with scraped animal femurs, both found with *habilis* remains.



Tools (continued)

H. erectus chipped both sides of the stone, symmetrically, to produce much better hand axes.

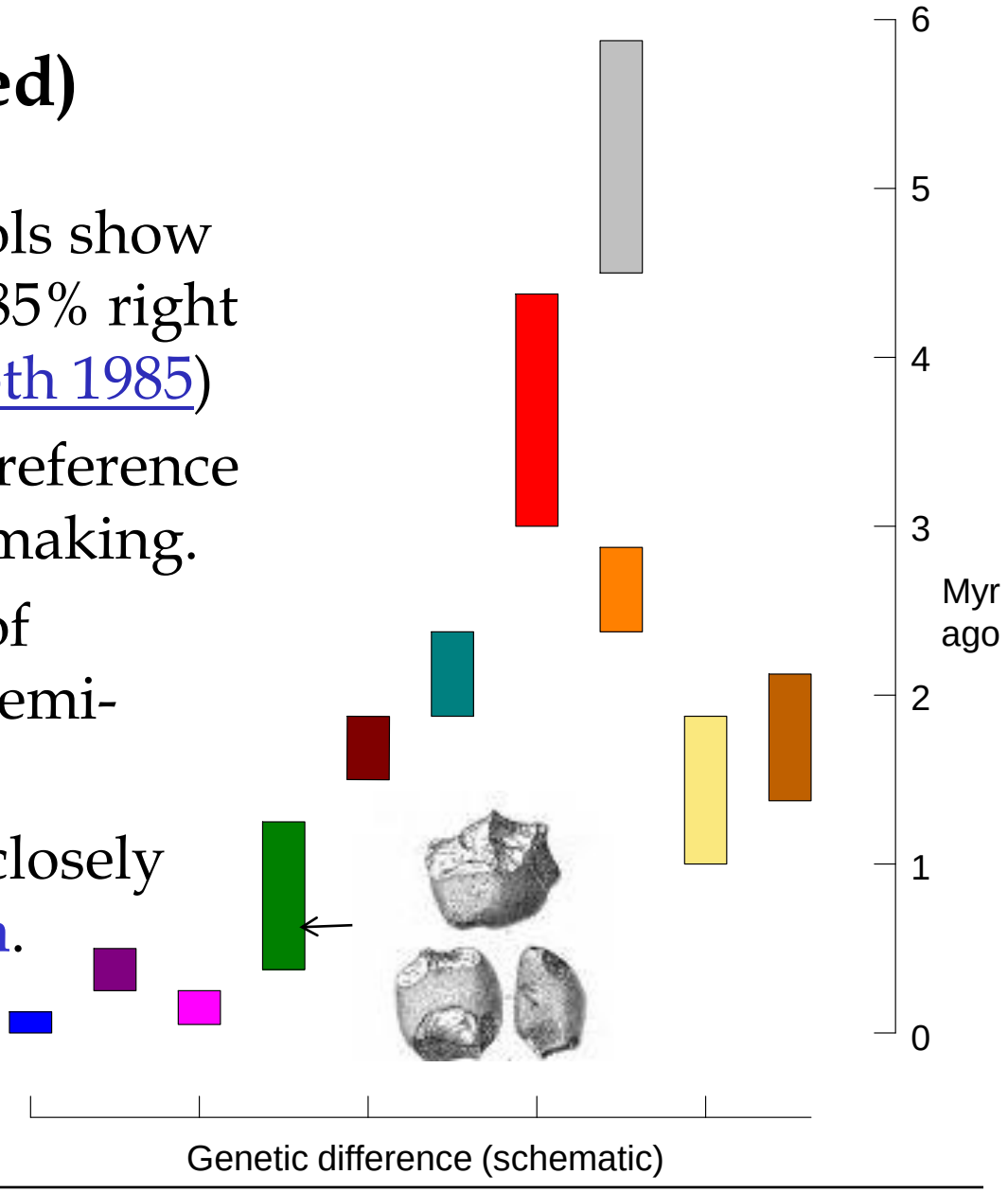
- This **biface** toolmaking tradition is called **Acheulean**, after finds in the suburb of Amiens (France) from which the tools were first characterized.



Tools (continued)

Incomplete Acheulean tools show that *H. erectus* was about 85% right handed, as we are (e.g. Toth 1985)

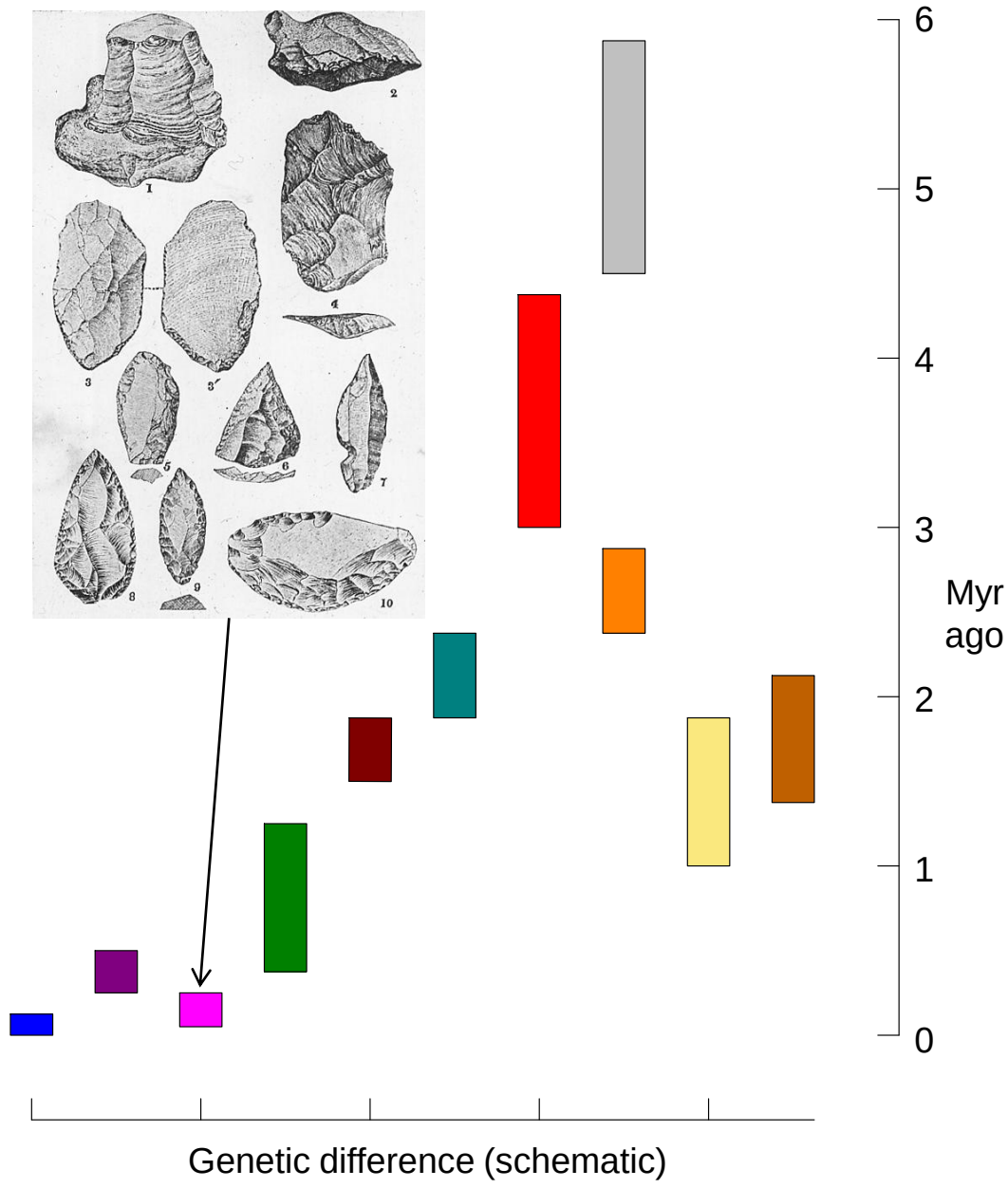
- *H. habilis* showed no preference for right or left in toolmaking.
- Handedness is a sign of **brain lateralization** (hemi-sphere specialization).
- Brain lateralization is closely connected with **speech**. *H. erectus* might, therefore, have invented **language**.



Tools (continued)

By 0.3 Myr ago, *H. heid.* and *H. neand.* had

- mastered stone tool-making by flaking, including the making of points (**Mousterian** industry.)
- learned to make fire, and probably to cook.
- could live in harsh climates (ice ages and the Arctic), and thus had invented clothing.



Early Evolution of Communication

- Raw meat is very difficult, time consuming and energetically expensive to eat and on top of that not all of it can be digested.
- *H. erectus*'s smaller teeth and gut point to the development of using fire to **cook** meat
- Gathering around a fire for protection, warmth and cooking was a natural place for the growth of **language, social skills** and **relationships**

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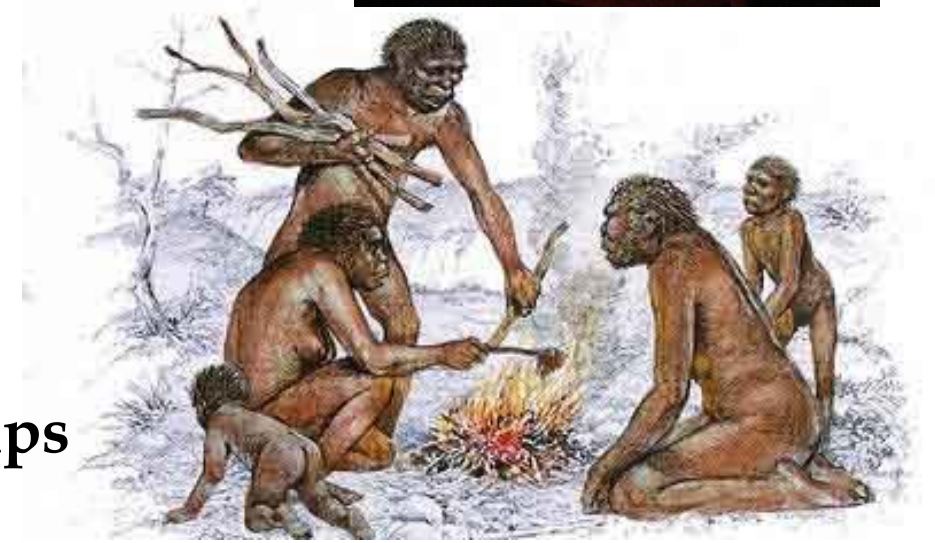
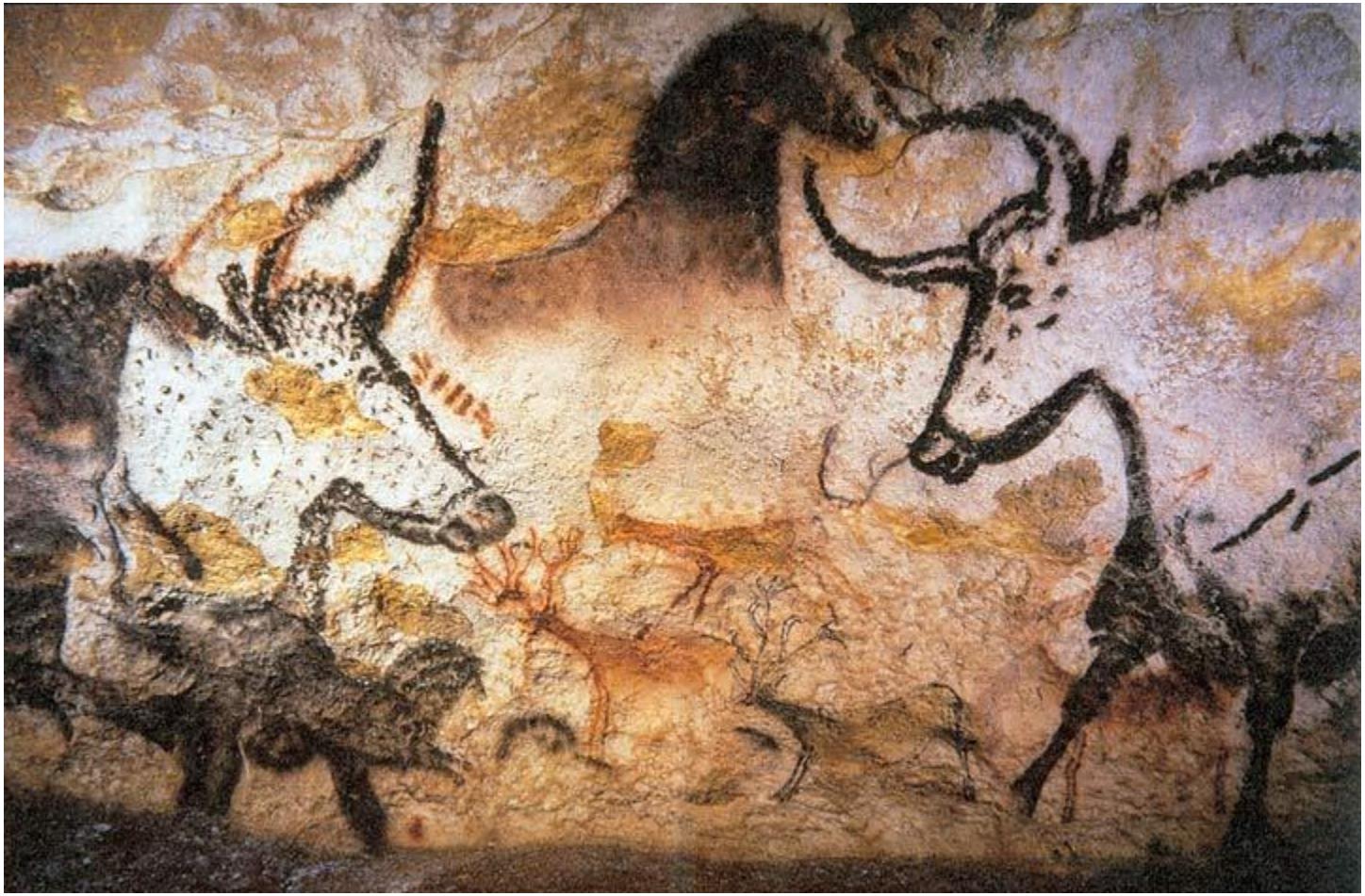


Mid-lecture Break

- Homework #4 due Thursday. Recitation tomorrow.



Genetic diversity of Africa

From *H. erectus* and onward, the adaptability and organizational skills permitted by larger brain size – especially tool- and speech-making capabilities – allowed hominids to spread past the bounds of their East African homeland.

- Indeed, they had to, for dietary reasons.
  - Grasslands spread and where prey go predators follow
  - Big herbivores like gorillas and chimps can live (in forests) at population densities of about 1 per km^2.
  - But hominids, who preferred meat, could no longer digest leaves and grasses, and weren't so efficient at hunting yet, could only live at densities no greater than about 0.1 per km^2.

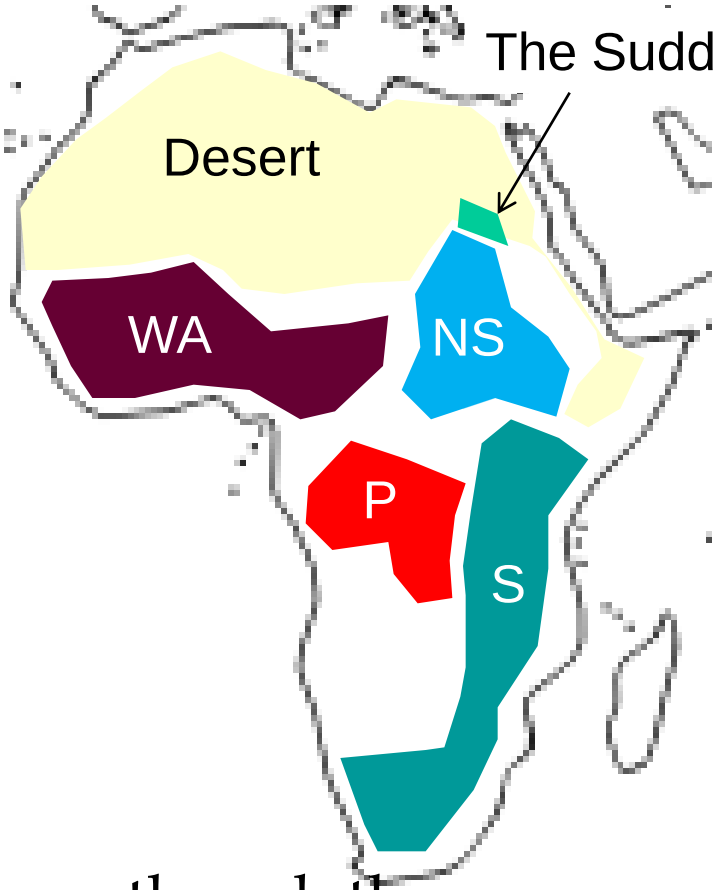
Genetic diversity of Africa (continued)

- Thus competition among the hominids …
  - more advanced ones forced less advanced ones to inhospitable places,
  - or killed them off and ate them.
- and their overspreading of temperate Africa south of the Sahara and the Sudd, a huge swamp along the Nile.
- By roughly 100,000 years ago, *H. sapiens* had occupied all of this part of Africa and eliminated its competition, leaving the apes and monkeys to their trees.
- Still dominating the hominid gene pool and having 0.1-1 Myr of differentiation, this process led to a notable diversity of **races** among *H. sapiens* that remains the greatest, even now that the species is worldwide.

Genetic diversity of Africa (continued)

The four main branches of African humanity, the differences among which are as great as the differences with the rest of the world.

- **West Africans** (Niger-Congolese language group)
- **Nilo-Saharans**
- **Pygmys**
- **San** (or Khoisan)



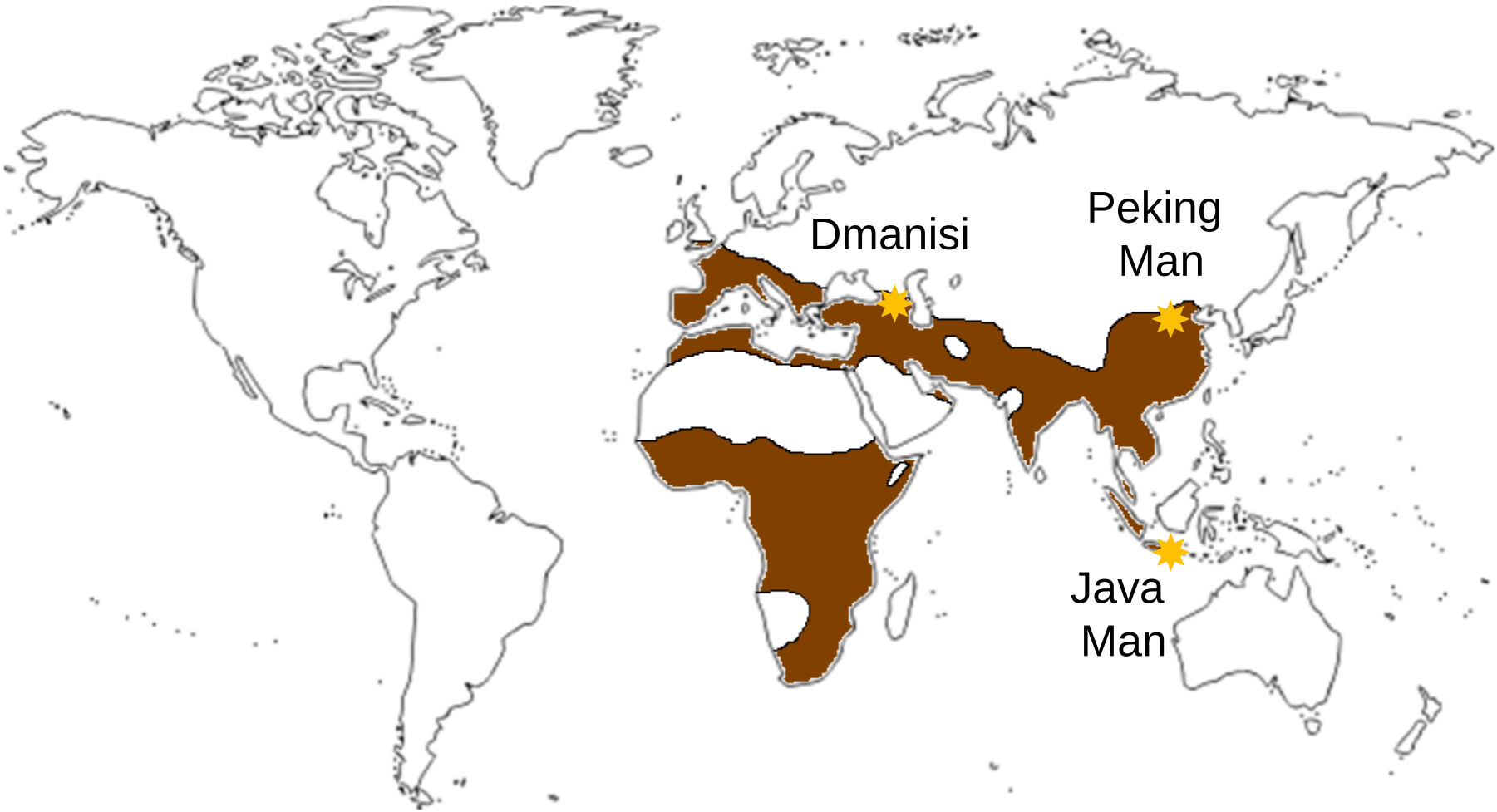
All were originally also language groups, though the Pygmys now speak West African (spec. Bantu) languages.

Out of Africa

Of course, there was some leakage from the African gene pool, as hominids explored for better food sources.

- Presumably the best exit has always been to endure the passage of the Sudd and follow the Nile; this is consistent with the ages of archaic human fossils, which tend to be older the closer they are to the isthmus of Suez.
- There have been at least three escapes: by *H. erectus.,* by *H. heidelbergensis/neanderthalensis*, and by *H sapiens*.
- A small band of *H. erectus* escaped Africa somewhere around 1 Myr ago, rather early in the life of the species. This band multiplied rapidly and spread throughout the temperate regions of Africa, Europe and Asia.
  - Thus "Java man" and "Peking man."

Range of *H. erectus*



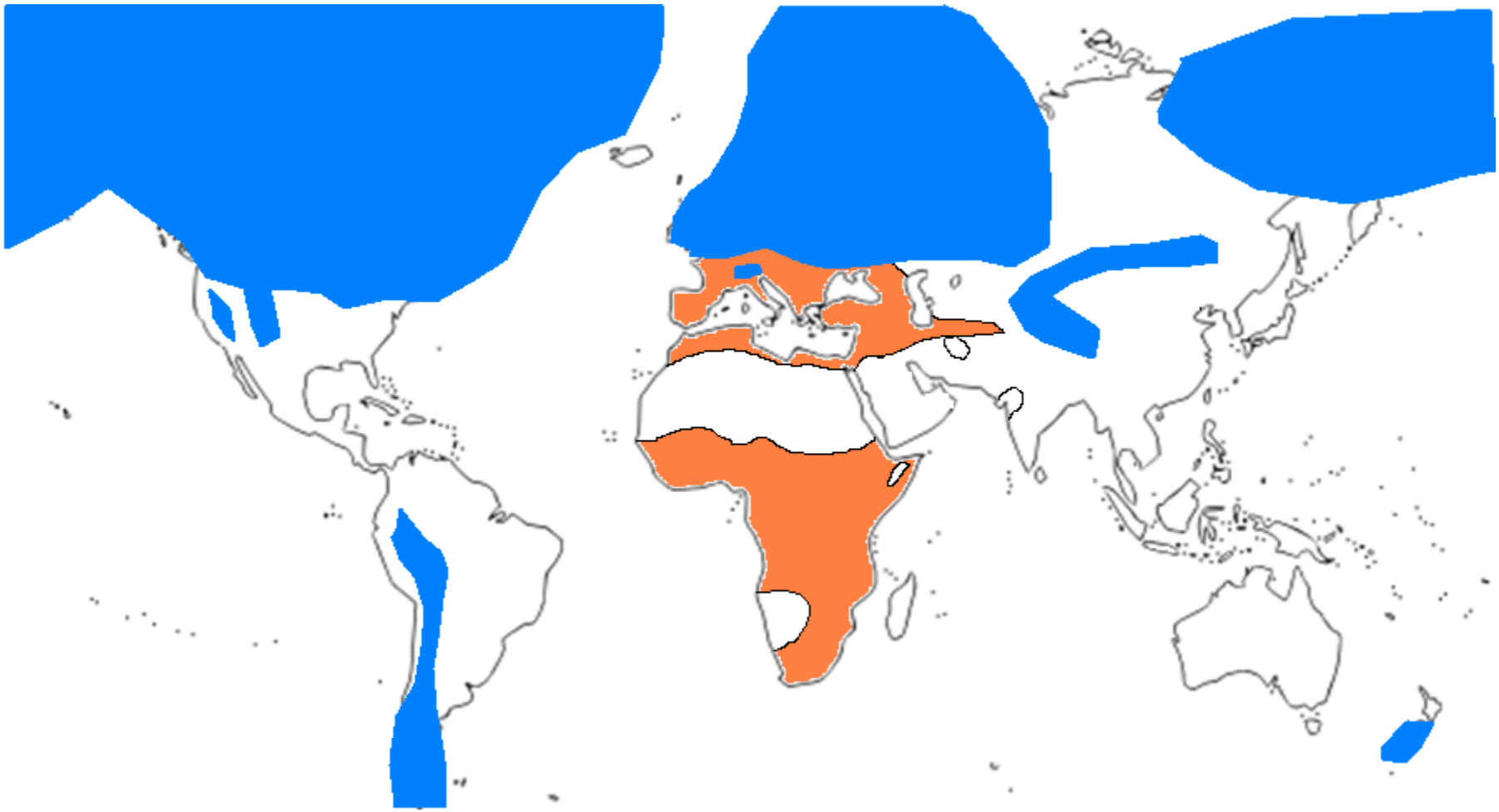
Ice-age drops in sea level enabled *H. erectus* to walk to Java and Britain.

Out of Africa (continued)

About 130,000 years ago, near the beginning of the most recent ice age (Wisconsin-Weichsel-Wurm), a small band of *H. neanderthalensis* left Africa and flourished by hunting ice-age megafauna, such as mastodons and mammoths, on the treeless tundra south of the ice sheets.

- They seem quickly to have displaced *H. erectus* in Europe and the Near East.
- Their remains, and the products of the Mousterian industry, comprise **oldest finds of the Old Stone Age**, or **lower Paleolithic Age**, in Europe.
  - This distinction means less to the rest of the world than it does to Europe, of course. Things in back home in Africa were developing more smoothly.

Ranges of *H. neanderthalensis* and (W) ice sheets



Out of Africa (continued)

Then, about 80,000 years ago, with the W ice age still in progress, a small group of *H. sapiens* left Africa *via* the Nile valley, and similarly to its predecessors began to reproduce, flourish, and expand all over the world.

- Also like its predecessors, this group represented a tiny selection of the gene pool, and reproduced very rapidly as it soon took over all the habitats.
- Since its numbers grew large so much faster than the time over which *H. sapiens* had evolved, the Out Of Africa portion of the species is genetically very homogeneous. Norwegians, Chinese and Australian Aborigines are very close genetically, and all are distinctively different from all of the remaining African races.

The Middle Paleolithic

H. sapiens brought with them many new improvements, for which the remains grace the Eurasian Middle Paleolithic:

- even better tools (the **Aurignacian** industry), including composite structures made of wood or bone and pebbles sharpened to an edge. Neanderthals tried to follow suit here (the **Chatelperronian** industry), but it was too little too late.
- new ideas, like
  - boats. With these, *H. sapiens* colonized Australia about 40,000 years ago.
  - (subprimate) animal friends. Dogs begin to appear around the campfires in the middle paleolithic.

The beginnings of the Upper Paleolithic

By about the end of the W ice age 18,000 years ago, *H. sapiens* had done away with *H. neanderthalensis* and *H. erectus*.

- Despite many claims that these species interbred, especially in East Asia, this appears to be a dubious proposition. There is essentially no genetic legacy from *H. neanderthalensis* and *H. erectus* that *H. sapiens* didn't have when they left Africa.
- *H. sapiens* began to leave the first remains of cultural development, in the form of the famous cave paintings of such locations as **Lascaux** (France, at right) and Altamira (Spain).

What was *H. sapiens* brain-size advantage over *H. erectus*?

A. No advantage: brains roughly the same size.
B. *H. sapiens* brains are 50% larger than *H. erectus*.
C. *H. sapiens* brains are about twice the size of *H. erectus*.
D. *H. sapiens* brains are five times larger than *H. erectus*.

What was *H. sapiens* brain-size advantage over *H. neanderthalensis*?

A. No advantage: brains roughly the same size.
B. *H. sapiens* brains are 50% larger than Neanderthals.
C. *H. sapiens* brains are about twice the size of Neanderthals.
D. *H. sapiens* brains are five times larger than Neanderthals.

The beginnings of the Upper Paleolithic

- Within the next few thousand years they occupied and adapted to all of the habitable land of Europe, Asia and Australia, and followed the edges of the ice sheets as they retreated north.
- The adaptation in various climes, and the lack of communication over large distances, led during this time to differentiation of habits of "culture" as well as habits of dining.
  - The most notable of these is the origin of the basic families of language, since those left the most indelible mark.

The language groups