Homo erectus: A Bigger, Faster, Smarter, Longer Lasting Hominin Lineage

Charles J. Vella, PhD

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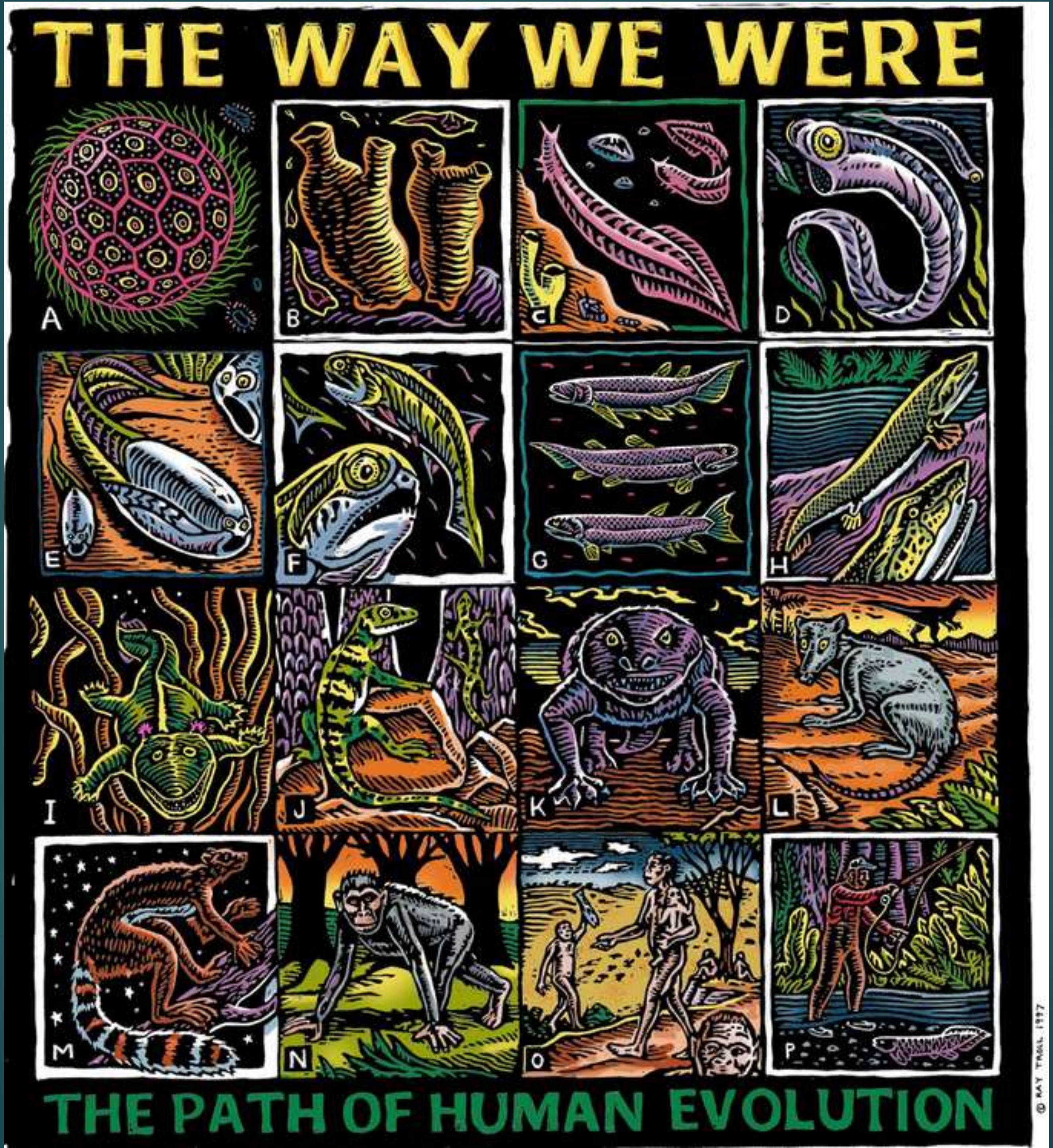
Ray Troll


THE WAY WE WERE
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THE PATH OF HUMAN EVOLUTION
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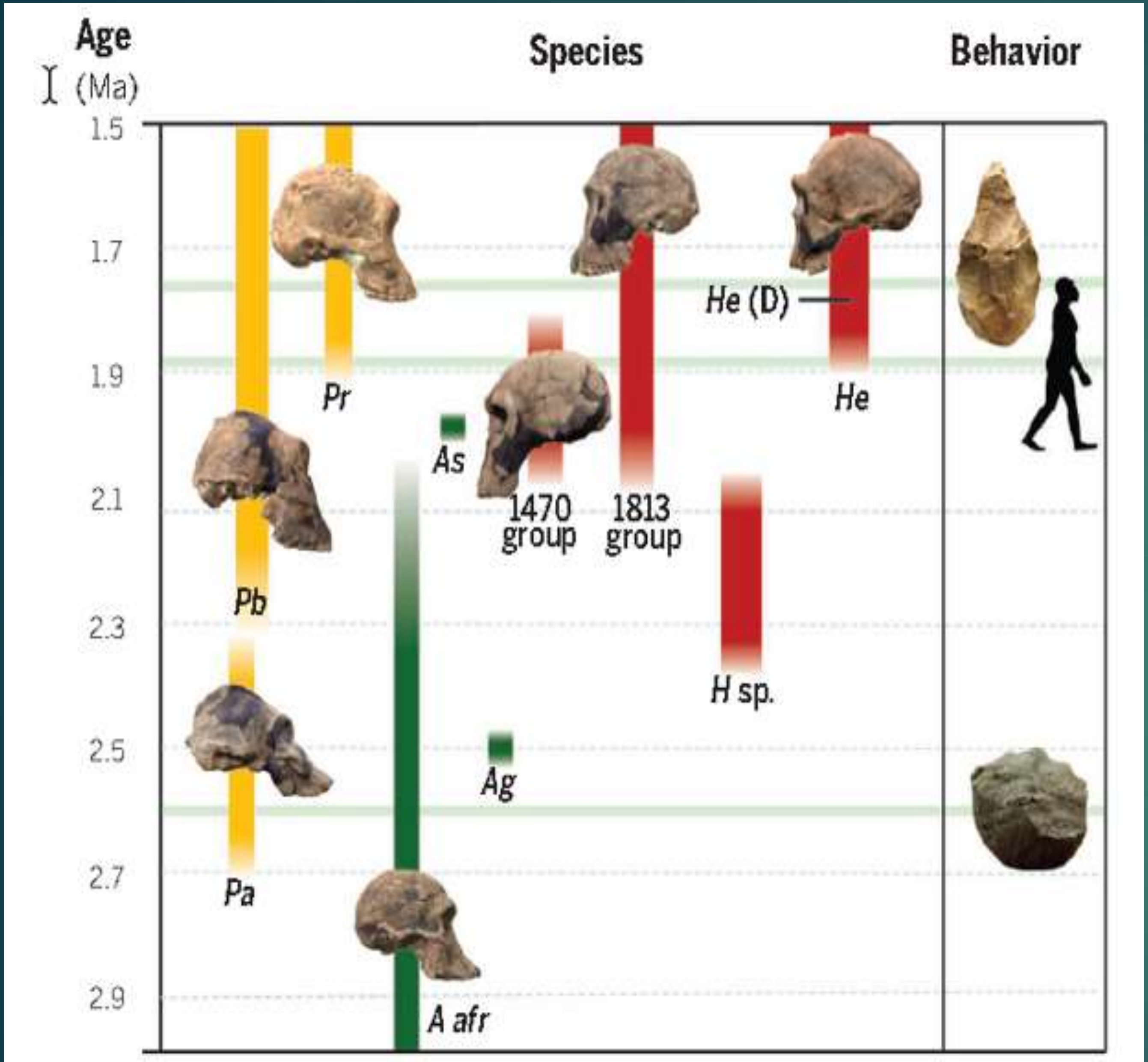
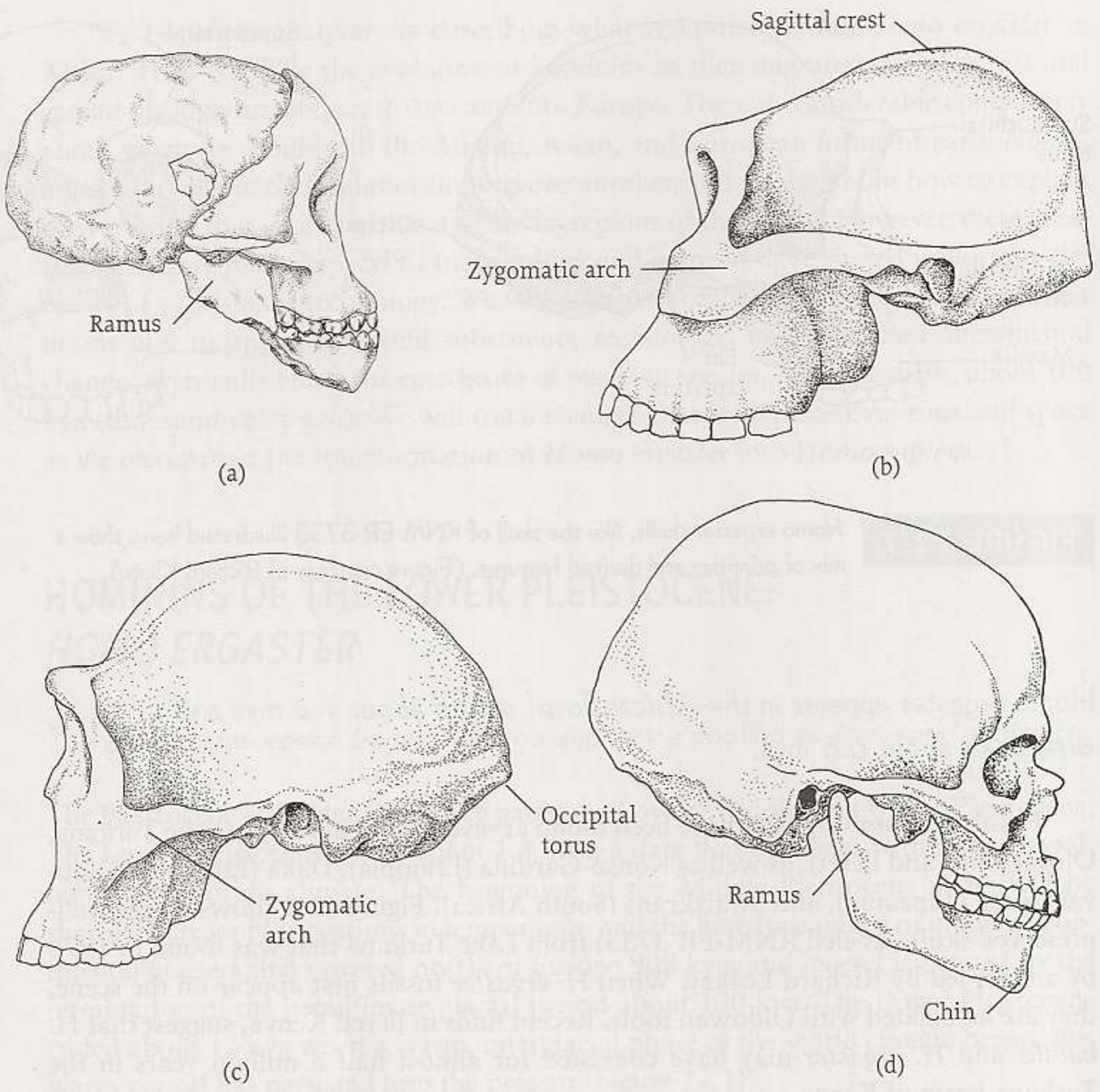
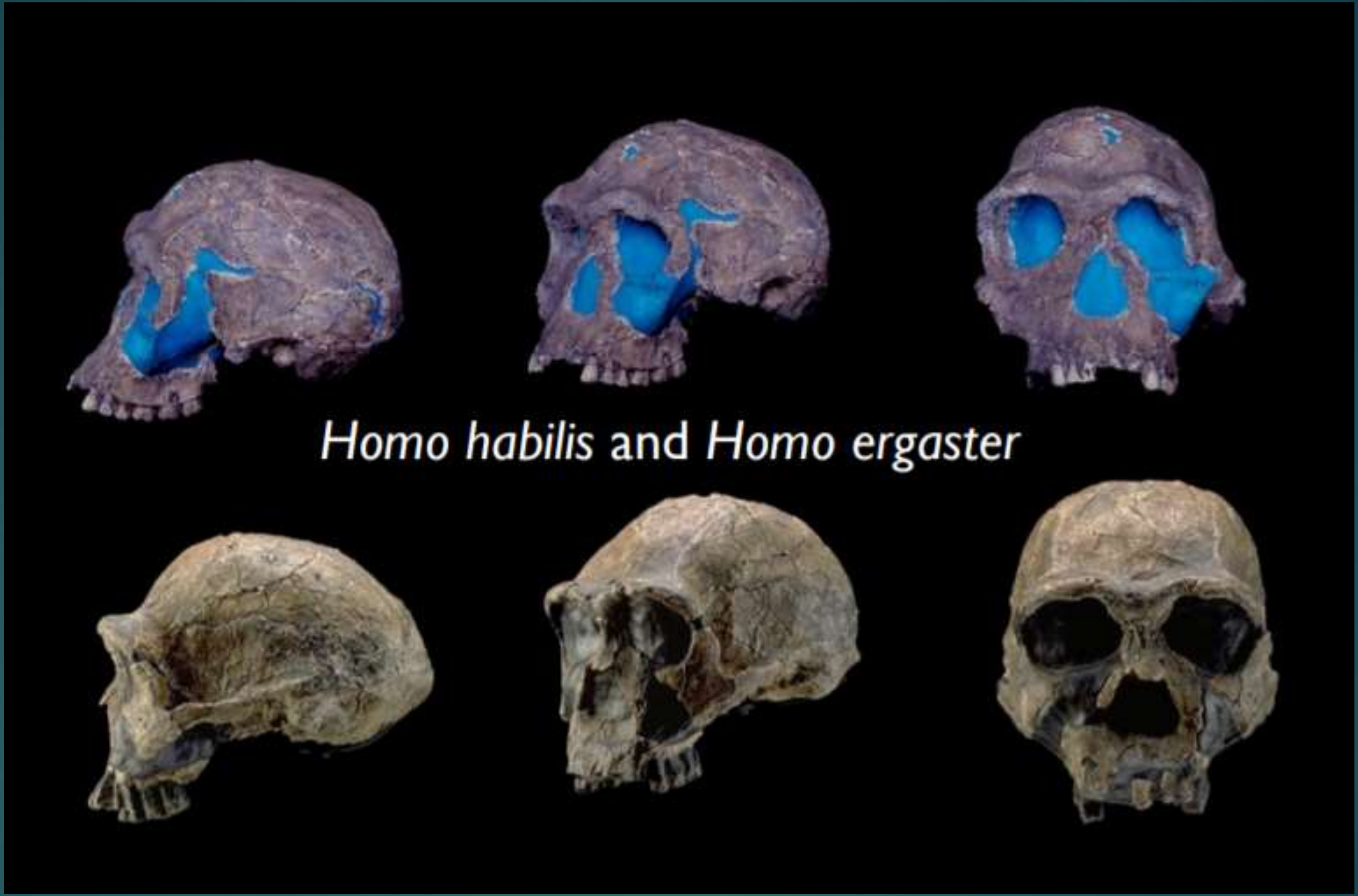


- **Hominin evolution from 3.0 to 1.5 Ma.** (Species)
- Currently known species temporal ranges for *Pa*, *Paranthropus aethiopicus*; *Pb*, *P. boisei*; *Pr*, *P. robustus*; *A afr*, *Australopithecus africanus*; *Ag*, *A. garhi*; *As*, *A. sediba*; *H* sp., early *Homo* >2.1 million years ago (Ma); 1470 group and 1813 group representing a new interpretation of the traditionally recognized *H. habilis* and *H. rudolfensis*; and *He*, *H. erectus*. *He* (D) indicates *H. erectus* from Dmanisi.

- (Behavior) Icons indicate from the bottom the
  - first appearance of stone tools (the Oldowan technology) at ~2.6 Ma,
  - the dispersal of *Homo* to Eurasia at ~1.85 Ma,
  - and the appearance of the Acheulean technology at ~1.76 Ma.
  - The number of contemporaneous hominin taxa during this period reflects different strategies of adaptation to habitat variability.

Susan C. Antón, Richard Potts, Leslie C. Aiello, 2014


Ramus
(a)
Sagittal crest
Zygomatic arch
(b)
Occipital torus
Zygomatic arch
(c)
Ramus
Chin
(d)


Homo habilis and *Homo ergaster*

Origins of *Homo:* Summary of shifts in *Homo*

- Early *Homo* appears in the record by 2.3 Ma.

- By 2.0 Ma at least two facial morphs of early *Homo* (1813 group and 1470 group) representing two different adaptations are present. And possibly 3 others as well (Ledi-Geraru, Uraha-501, KNM-ER 62000)

- The 1813 group survives until at least 1.44 Ma.

- Early *Homo erectus* represents a third more derived morph and one that is of slightly larger brain and body size but somewhat smaller tooth size.

Origins of *Homo*

- Early *Homo*: considerable variation; arguably there are several species
- Nomenclature: *Homo habilis* and *H. erectus*.
  - former group is often split into multiple taxa, usually *H. habilis* and *H. rudolfensis*,
- *H. erectus* group is also sometimes split into:
  - *Homo ergaster* for the early African and Georgian material and
  - *H. erectus* for the Asian,
  - although a consensus appears to recognize just one species, *H. erectus*.
- New early *Homo erectus* fossils in East Africa, Georgia, and Indonesia suggest large ranges of size, and perhaps shape, variation in *H. erectus*, due to local adaptation

Origins of *Homo*: Brain and body sizes

- Small cranial fossils from Georgia and Africa provide evidence of substantial individual and perhaps populational size variation within early *H. erectus* and indicate overlapping ranges of brain size with other early *Homo*.

- *H. erectus* had a larger brain size range (638– 1,067) than did other early *Homo* (510–750 cc).

- Average body and brain size increase appears to be an important shift between both early *Homo* and *Australopithecus* and again between *H. erectus* and other early *Homo* (*H. habilis*).

Origins of *Homo:* Body size

- Body size estimates for *H. erectus* from Africa and Georgia yield:
  - adult height estimates between 145 cm (4’8”) and 185 cm (6’)
  - adult body weight estimates of between 40 (88 lbs) and 65 (145 lbs) kg
- The sparser evidence for early non-*erectus Homo* overlaps the lower end of this range (118 (3’9”) –150 cm and 30–60 kg) but is about
  - 15% smaller than the combined early *H. erectus* mean (Georgia, Africa)

Holliday (2012) and Pontzer (2012)

Origins of *Homo:* Body Size implications

- Dimorphism in *Homo* seems no less than in earlier *Australopithecus*

- The overall larger size of early *H. erectus* may indicate
  - larger home range sizes and perhaps more open habitat for *H. erectus*,
  - all of which may entail greater daily energy requirements.

- Based on life history correlates in modern humans:
- Larger average body size correlates with
  - decreased extrinsic mortality rates (effects of external factors)
  - increased nutritional sufficiency
  - decreased predator and parasite load or susceptibility
  - increased diet quality.

Dating of adaptive features of early *Homo*

- What adaptive features did originate with early *Homo*?

- Facial and dental reduction defines the earliest members of the genus between 2.4 and 2.0 Ma

- Cranial capacity expanded by 2.0 Ma.

- Encephalization in *H. erectus*: Brain enlargement due to body size increase in early *H. erectus* between 1.9 and 1.5 Ma, although estimates of the degree of encephalization overlap with those of Australopithecus.

Dating of adaptive features of early *Homo*

- Brain expansion independent of body size appears to be most strongly expressed only later, between 800 to 200 Ka.

- A relatively elongated hind limb is present in *A. afarensis* (by 3.9 Ma) and in later *Australopithecus* (*A. africanus, A. garhi, and A. sediba*) but not in *Ardipithecus* (4.4 Ma).

- Longer and strongly built femora evolved between 1.9 and 1.5 Ma, coinciding with early *H. erectus*.

Adaptive features of early *Homo 2*

- Stone technology at ~3.3-2.6 Ma predates the origin of *Homo*
- *H. erectus's* Acheulean axe tradition of toolmaking lasted for 1.5 Mrs; unlike the more innovative stone technology linked to symbolic behavior typical of the latter part of the Pleistocene.
- Brain consistently over 700 cc, which occurred after ~1.8 Ma, connotes altricial (single birth) neonates and heightened cooperation among *H. erectus* adults.

Adaptive features of early *Homo 2*

- Based on first molar dental histology and eruption, the speed of life history/development was slower in *H. erectus* than in *Australopithecus* yet was similar to that of extant great apes

- Prolonged developmental growth period (childhood, adolescence), typical of *H. sapiens*, with implications for intensive social cooperation, is evident in the middle Pleistocene (781 to 126 Ka).

- This is when definitive evidence of hearths and shelters occurs in the archaeological record, implying strong centrally located social cooperation

Adaptive features of early *Homo:* Environment

- Evolution of early *Homo* was associated with recurrent periods of intensified moist-dry variability.
- Dynamic environments favored evolutionary experimentation, which governed against any simple transition from *Australopithecus* to *Homo*.

Hominins at 1.7 Ma

- *P. boisei*
- *P. robustus*
- *H* sp., early *Homo*
- *H. habilis*
- *H. rudolfensis*
- *H. ergaster*
- *H. erectus*

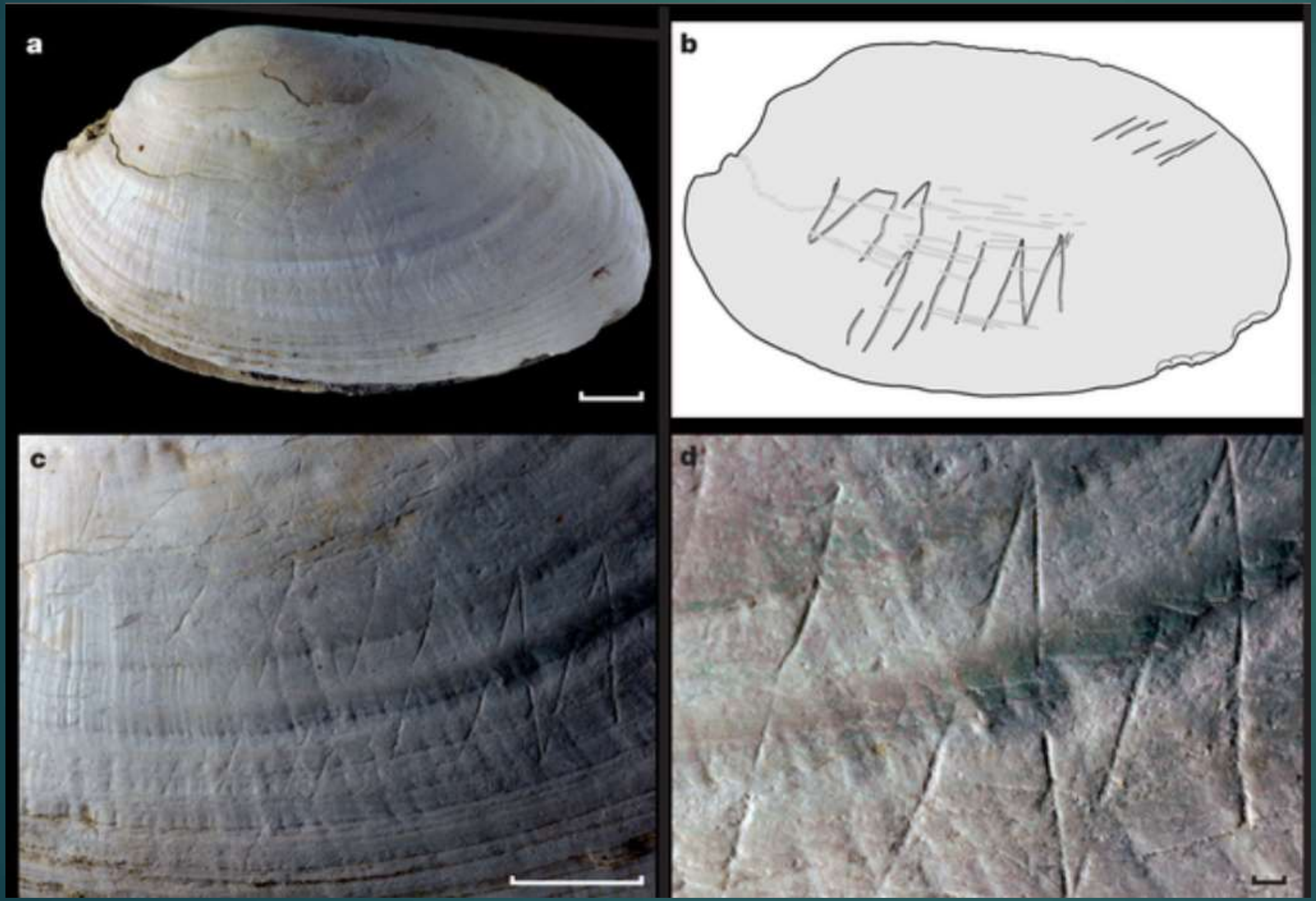
Hominins at 300 Ka

- *Homo sapiens*
- *Homo neanderthalensis*
- Denisovans
- *H. erectus*
- *H. naledi*
- *H. floresiensis*
- *H. luzonensis*
- Archaic ghost populations (2 in MHs, 1 in Denisovan, 3 in African hunter-gatherer populations)

Early *Homo*, 2.8 to 1.4 Ma: Morphologically diverse

Still unclear as to the ancestry of *Homo erectus*

540 Ka, Trinil, Java, *Homo erectus*: Oldest doodle? Geometric design carved on clam shell



The combined evidence for high-dexterity opening of shells, use of shell as a raw material to make tools, and engraving of an abstract pattern on a shell with a minimum age of 436 -540 Ma indicates that *H. erectus* was the agent responsible for the exploitation of freshwater mussels at Trinil

The inclusion of mussels in the diet of *H. erectus* is not surprising

What was *Homo erectus*

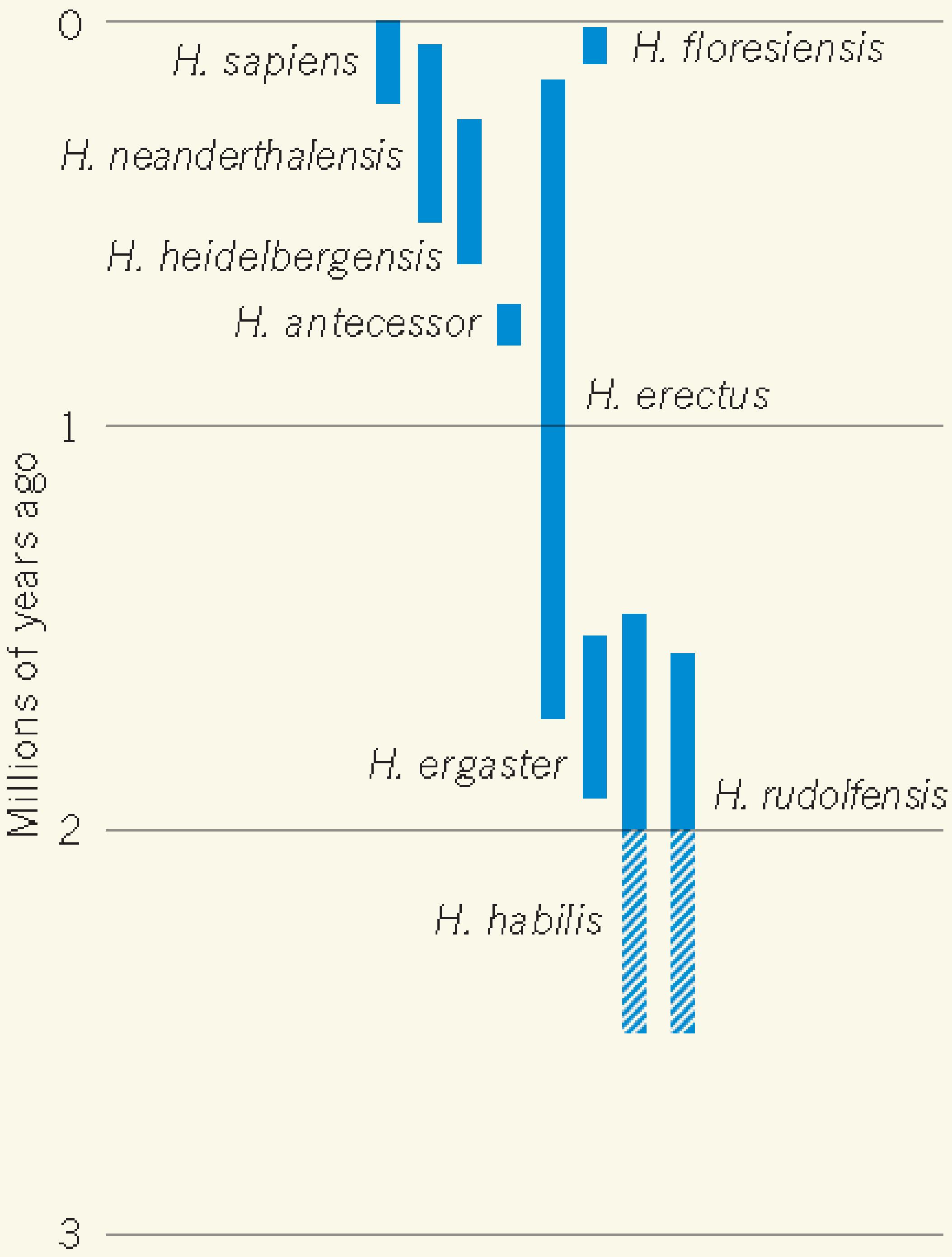
- ***Homo erectus*** (meaning "upright man," from the Latin *ērigere*, "to put up, set upright") is an extinct species of hominin that lived throughout most of the Pleistocene, with the earliest first fossil evidence dating to around 1.9 Ma and the most recent to around 143 Ka.
- It is assumed that the species originated in Africa.
- Specimens have been found in Africa (e.g., Lake Turkana and Olduvai Gorge), Georgia, Indonesia (e.g., Sangiran in Central Java and Trinil in East Java), Vietnam, China (e.g., Shaanxi) and India.
- Most assume *H. erectus* is direct ancestor of later hominins such as *Homo heidelbergensis*, *Homo neanderthalensis*, and *Homo sapiens.*

Homo erectus

- First hominin that was significantly more like modern humans than any of its predecessors
- It was not a modern human, but many traits that define modern humans first appeared in easily recognizable form in this species
- These fossils have documented a substantial increase in endocranial capacity in *H. erectus* over their Pliocene ancestors.
- Few complete fossil postcrania (except Turkana Boy; Dmanisi) have been recovered, and some basic features of *H. erectus* body shape remain poorly understood

Homo erectus basics

- Appearance of *H. erectus* circa 1.8-1.7 Ma coincides with expansion of savannah grassland & invention of Acheulean tool kits
- Cranial morphology indicates an increase in brain size, which might have increased metabolic demands
- Postcranial morphology (KNM-WT 15000) suggests increased body size and essentially modern skeletal adaptations for terrestrial walking and running in the arid savannah habitats
- Dispersal of *H. erectus* across the globe indicates that this taxon successfully occupied a broad range of habitats
- Migration may have simply followed animal herds (i.e. Dmanisi, 1.8 Ma; China & Ubeidiya, Israel, 1.5 Ma)



Millions of years ago
0
1
2
3
H. sapiens
H. neanderthalensis
H. heidelbergensis
H. antecessor
H. floresiensis
H. erectus
H. ergaster
H. rudolfensis
H. habilis

Human Evolution in last 1 M years

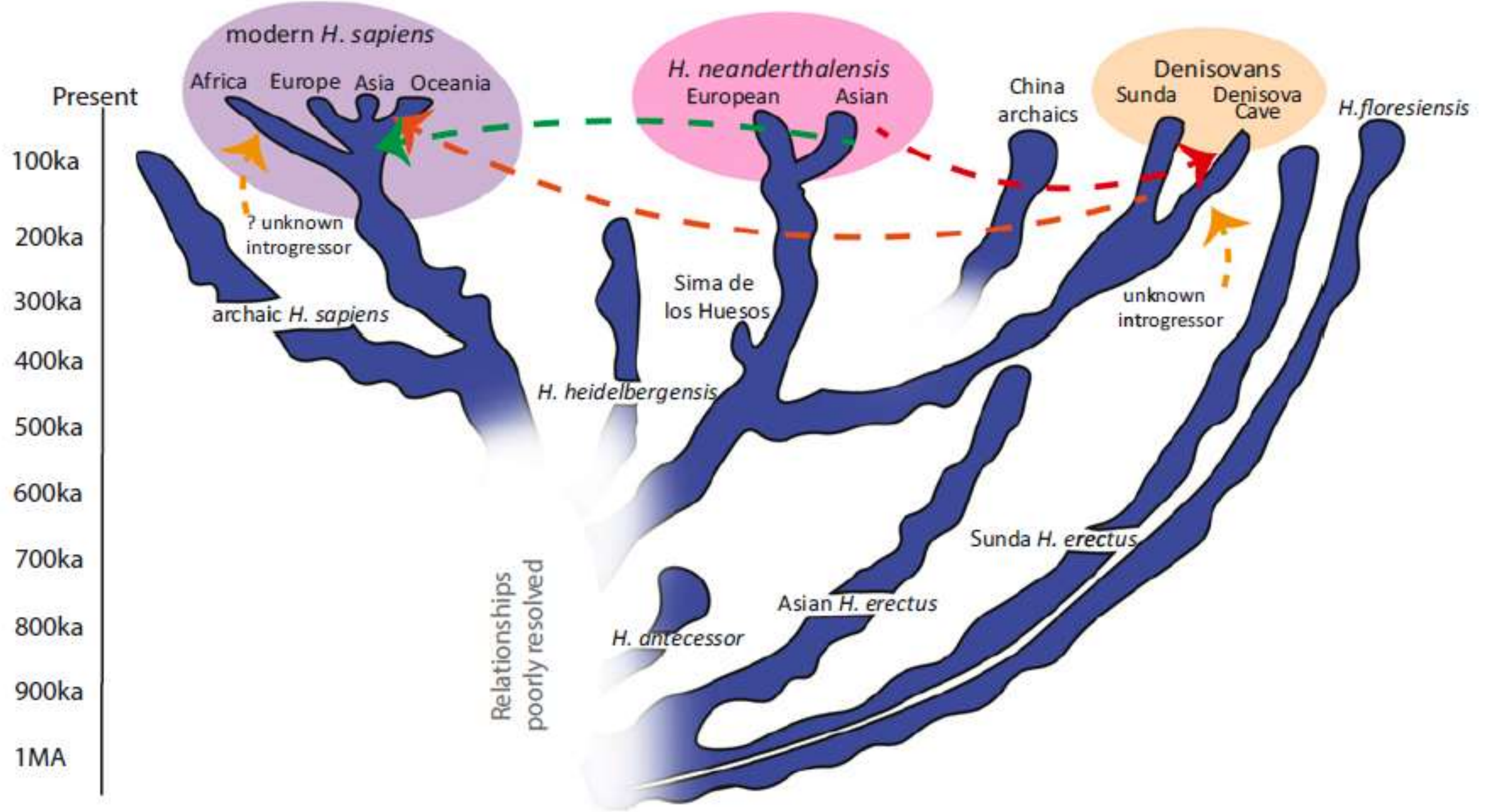


Fig. 1. Representation of human evolution during the past 1 million y. Diagnosable units from morphology or DNA are shown, but some lineages (e.g., "archaic *H. sapiens*" and China archaics) are almost certainly amalgams of fossils with differing affinities. How many of the lineages deserve specific distinction is an open question, given levels of morphological variation and the growing evidence for interlineage gene flow (indicated by dashed arrows).

Lots of firsts

- The extinct ancient human *Homo erectus* is a species of firsts.
- It was the first of our relatives to have human-like body proportions, with shorter arms and longer legs relative to its torso.
- It was also the first known hominin to migrate out of Africa
- The first human species to make handaxes (Acheulean tools)
- First appearance of systematic hunting
- First appearance of anything like “home base” (i.e. Zhoukoudian)

Lots of firsts

- Possibly the first to use fire (cook food?)
- First indication of mildly extended childhood
- The most geographically widespread species apart from *H. sapiens*. *H. erectus* appeared in Africa about two million years ago, evolving from either a late form of australopith or one of the more primitive forms of *Homo*, and went on to spread into many parts of Asia.
- In terms of species survival, fossil evidence for *H. erectus* stretches over more than 1.8 million years, making it by far the longest surviving of all our human relatives.
- *Most consider H. erectus,* ancestral to modern humans.

Homo erectus

- Although some researchers believe that *H. erectus* consists of several distinct species (including *Homo georgicus* and *Homo ergaster*), most accept a broad variety of a single species.

- The earliest fossils that are complete enough to display the anatomical pattern of *H. erectus* are from eastern Africa and western Asia, and are about <u>1.9 to 1.5 million years old</u>.

- The <u>conventional view</u> is that the species evolved in Africa about two million years ago.

The shift towards more modern *Homo* begins about 1.9 -1.7 Ma

- Hominins in Africa with:
  - Skull similar to earlier hominins
  - Taller body
  - Long legs and short arms
  - Slower growth rate, longer childhood
  - Reduced sexual dimorphism
  - Made Mode 2 tools
    - Acheulean hand axes

H. ergaster KNM ER 3733

The shift towards more modern *Homo* begins about 1.9-1.7 Ma

- Similar finds in Central Africa, South Africa, Asia
  - first hominin found in Asia
- Most call them *Homo erectus*, but
  - earlier forms in Africa sometimes called *H. ergaster*
  - later forms in Asia sometimes called *H. erectus*

H. ergaster KNM ER 3733

Historical vs present <u>models of development of *Homo*</u>

- Historical convention of sequential lineage from *H. habilis* to *H. erectus* to *H. sapiens*
- Only African “archaic” *H. sapiens (H. heidelbergensis)* evolved into MHs; *archaic H. sapiens* in Europe and Asia became extinct

- Current evidence has undermined this scenario; now more branching in evolution of *Homo*.

- R. Klein accepts *H. habilis* as ancestor of all later *Homo*; as we have seen in last lecture most others do not

Historical vs present models of development of *Homo 2*

- Now African *H. ergaster* as first human species to colonize Eurasia and by 1 Ma gave rise to *H. erectus* in Asia; most now consider them both *H. erectus*

- By 600-500 Ka, *H. erectus* becomes *H. heidelbergensis* in Africa, which then becomes *H. sapiens* in Africa and Neandertal in Europe.

- Reality is almost certainly more complex, more bushy.

- Diversification in Africa is still relatively unknown

Origins of *Homo:* What we once knew…

- A conventional wisdom: *H. erectus* as the first hominin to take important biological and behavioral steps in the direction of modern humans
- <u>*Homo erectus* was envisioned</u> as a large-brained, small-toothed, long-legged, narrow-hipped, and large-bodied hominin with relatively low sexual dimorphism. By virtue of a higher-quality, perhaps animal-based diet, *H. erectus* is said to have ranged farther, cooperated more, and quickly dispersed from Africa
- The rarity of early *Homo* fossils of *Homo habilis* sensu lato (including *Homo rudolfensis*) meant that comparisons of *Australopithecus* (*Paranthropus*) were made to *H. erectus* rather than to other early *Homo*.

Leslie C. Aiello and Susan C. Antón, 2012

Differences

- The distinctions between *Australopithecus* and *Homo* were perhaps overemphasized
  - by the diminutive size of the most complete *Australopithecus* skeleton (A.L. 288-1; Lucy), on the one hand,
  - and the surprisingly large size of the most complete *H. erectus* skeleton (KNM-WT 15000; Nariokotome boy), on the other.

- The fossil record never ceases to upset conventional wisdom, and over the past 2 decades, new discoveries from East and South Africa, Georgia, and even Indonesia, have challenged these stark distinctions between *Australopithecus* and *H. erectus*

Origins of *Homo 2*

- In particular, new small-bodied and small-brained finds from the Republic of Georgia and Kenya
  - call to question claims for universally large size in *H. erectus*
  - Indicate a larger range of size variation within that species.

- This variation in *H. erectus* has most often been referred to as
  - sexual dimorphism and/or regional/climatic adaptations,
  - But larger-sized, longer legged *Australopithecus* have also been found,

- New fossil remains of non-*erectus Homo* emphasize the diversity of the early members of the genus and the ways in which they differ from *Australopithecus*

Origins and Evolution of Genus *Homo* New Perspectives

- Three important shifts in human evolutionary history:
  - (1) the emergence of *Homo*,
  - (2) the transition between *non-erectus* early *Homo* and *Homo erectus*
  - (3) the appearance of regional variation in *H. erectus*.

Susan C. Antón and J. Josh Snodgrass, 2012

New Perspectives

- The shift from *Australopithecus* to *Homo* was marked by:
  - body and brain size increases
  - a dietary shift (meat)
  - an increase in total daily energy expenditure (hungry brain)
- These shifts became most pronounced in *H. erectus*, but the transformation was not as radical as previously envisioned.

Homo erectus: not a uniform model

- Historically, an overly simplistic view of the origin of *Homo erectus* as a punctuated event characterized by a radical shift in biology and behavior.

- Several of the key features thought to first emerge with *H. erectus*
  - narrow pelvic width,
  - relatively long legs,
  - a more “modern” pattern of growth
- seem instead to have arisen at different times and in different species.

- There was greater variation in early *H. erectus* than previously thought, including variation in form and by region.

Homo erectus

- New findings (i.e. Dmanisi) also make the differences between *H. erectus* and *Homo habilis* less stark

- There was a mosaic nature to these acquisitions and a greater range of variation, especially in *H. erectus.*

Evolution of *Homo*: Early adaptations

- Evidence over the past decade has revised understandings about the major adaptations underlying the origin and early evolution of the genus Homo.
- Many features associated with Homo sapiens, including
  - large linear bodies,
  - elongated hind limbs,
  - large energy-expensive brains,
  - reduced sexual dimorphism,
  - increased carnivory,
  - and unique life history/development traits
- were once thought to have evolved near the origin of the genus in response to heightened aridity and open habitats in Africa.

Evolution of *Homo*: Early adaptations

- However, recent analyses indicate that <u>such traits did not arise as a single package</u>.

- Instead, <u>some arose substantially earlier and some later</u> than previously thought.

- From ~2.5 to 1.5 Ma, <u>three lineages of early *Homo* evolved</u> in a <u>context of habitat instability and fragmentation</u> on seasonal, intergenerational, and evolutionary time scales.

Early adaptation: better adaptability

- These contexts gave a selective advantage to traits, such as dietary flexibility and larger body size, that facilitated survival in shifting environments.

- They favored the evolution of more adaptable species, requiring the evolution of adaptability.

How What We Now Know from the Hard Evidence Differs from What We Thought We Knew

- Over the past several decades, a consensus had emerged that the shift to humanlike patterns of body size and shape occurred with the origin of *Homo erectus*.
- This was seen by many researchers as a radical transformation reflecting:
  - a sharp and fundamental shift in niche occupation,
  - emphasized a distinct division between *H. erectus* on the one hand and non-*erectus* early *Homo* and *Australopithecus* on the other.
  - Earliest *Homo* and *Australopithecus* were reconstructed as essentially bipedal apes,
  - *H. erectus* had many of the anatomical and life history hallmarks seen in modern humans.

Changing discoveries

- New discoveries and reanalysis indicated that :
  - earliest *Homo* exhibited greater diversity
  - underappreciated differences and similarities with *H. erectus*.

- New view of *Australopithecus:*
  - *Australopithecines* share many postcranial characteristics with *Homo:*
    - including a somewhat large body and relatively long legs.
    - So now we have a larger *Australopithecus afarensis* and a smaller, more variable *H. erectus* than previously known

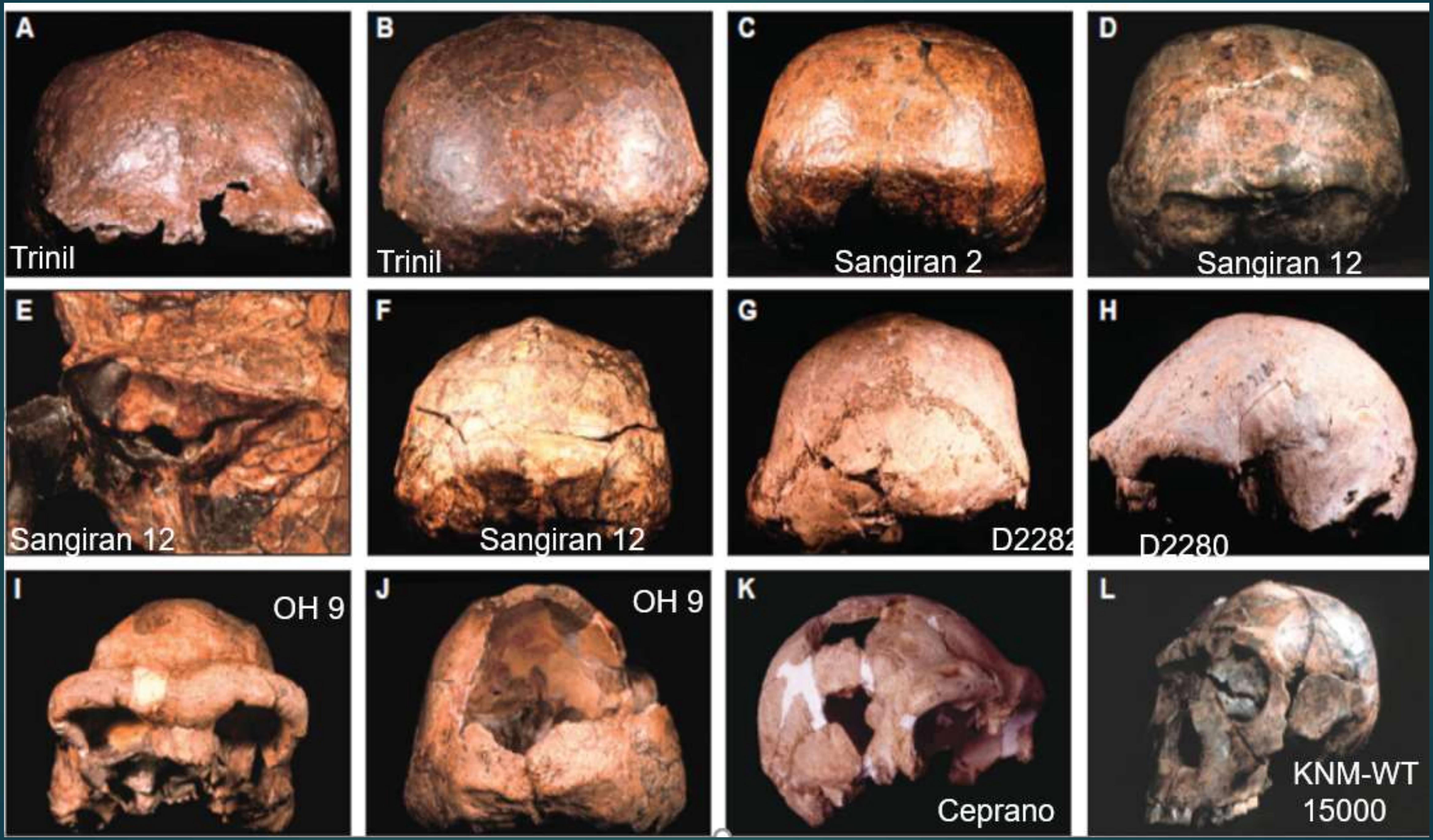
Origins: Modest Size increases

- Important size differences between these species.
- Even when including the largest of the new *Australopithecus* fossils and the smallest of the new early *Homo* fossils,
  - a body mass increase of 33% from *A. afarensis* to early *H. erectus*
  - 15% between early non-*erectus Homo* and early *H. erectus*
  - marked regional variation, with early African *H. erectus* being ~17%–24% larger on average than Georgian *H. erectus*
  - Early *H. erectus* is less “modern” and its regional variation in size more substantial than previously allowed.

	Geologic Age (Ma)	Body Weight (kg) Males	Body Weight (kg) Females	Stature (cm) Males	Stature (cm) Females	Endocranial Capacity (cc)
P. troglodytes	Extant	49	41			395
A. anamensis	4.2-3.9	51	33			n/a
A. afarensis	3.8-2.9	45	29	151	105	434
A. africanus	3.0-2.4	41	30	138	115	452
P. robustus	1.8-1.4	40	32	132	110	521
P. boisei	2.3-1.4	49	34	137	124	530
A. garhi	2.5					450
H. habilis	2.3-1.6	37	32	131	100	612
H. rudolfensis	2.4-1.8	60	51	160	150	752
H. erectus	1.8-0.2	66	56	180	160	871
H. sapiens	Extant	58	49	175	161	1350

H. erectus 145 lb/ 123 lb 71 in/ 63 in

R. Klein, 2009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Sangiran 2
D
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E
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Sangiran 12
G
D2282
H
D2280
I
OH 9
J
OH 9
K
Ceprano
L
KNM-WT
15000

Historical ideas about *Homo erectus*

- Classic lineage of australopiths to early *Homo habilis* to *Homo erectus* to archaic MHs to AMHs
- Early *Homo* gave rise to larger bodied & larger brained species, *H. erectus*, approximately 2 Ma in Africa
- About 1 Ma, *H. erectus* expanded beyond Africa, first into Asia, then Europe, with geographically variable populations
- *Homo erectus* then became ancestor of *H. sapiens*, either by speciation event in African population, which then spread outwards & replaced established populations of *H. erectus* (Out-of-Africa or single origin model) or by gradual worldwide transformation of all *H. erectus* populations (Multiregional model)
- Many of these historical hypotheses have been overturned.

Current theories of *H. erectus*

- Early *Homo* gave rise to larger-bodied & larger-brained species in Africa ca 2 Ma, now called *Homo ergaster*
- *H. ergaster* spread out of Africa and into Asia by 1.8 Ma, giving rise to *H. erectus* in China and Java.
- Possibility that *H. erectus* expanded its range throughout Asia, back into Africa & into Europe (very minor view)
- In Africa & possibly Europe, this lineage evolved into *H. heidelbergensis*
- Speciation event in Africa gave rise to *H. sapiens*

- Exactly what is meant by *Homo erectus* is controversial.

G. Philip Rightmire: Pattern of variation seen in *H. erectus*,

- No firm consensus: whether it should be defined as
  - a long lasting, polytypic (variation in 1 species) lineage or as
  - a group of relatively specialized populations geographically confined to the Far East.
- In this view, the **ecological niche** occupied by these species is more limited, leading to the isolation, and ultimately speciation, among different regional populations.
- G. Philip Rightmire: *Homo erectus* originated in Africa and then spread to Eurasia.
- Homo erectus is made up of specimens from Java, China, Northwest Africa, Olduvai Gorge, the Turkana Basin, and Swartkrans in South Africa.

G. Philip Rightmire, Evol. Anthro, , 1998

Natural History of *Homo erectus* - Susan C. Antón

- The view of Eastern *H. erectus* is vastly different today than when *Pithecanthropus erectus* was described in 1894.
- Since 1950 views of the species and its distribution have varied from a single, widely dispersed, polytypic species ultimately ancestral to all later *Homo*, to a derived, regional isolate ultimately marginal to later hominin evolution.
- *H. erectus* is a hominin, notable for its increased body size, that originates circa 1.9 Ma in Africa and quickly disperses into Western and Eastern Asia.
- with several regional morphs sustained by intermittent isolation, particularly in Southeast Asia.

History of *H. erectus* 2

- Only 2nd discovered hominin, after Neandertal, by E. Dubois (1894). Originally a debate over whether it was a hominin.

- It took the dismissal of Piltdown and the broad acceptance of *Australopithecus* as a hominin ancestor, along with the substantial Asian fossil finds of the 1930s, before the hominin nature and relatively large brain of *H. erectus* would be appreciated by most human paleontologists.

Nomenclature: Example of Significant Species Splitting

Holotype	**Species name**	**Publication**	**Place of discovery**
Homo erectus sensu lato:			
Trinil 2	***(Pithecanthropus) erectus***	Dubois 1894	Indonesia
Zhoukoudian 1	*Sinanthropus pekinensis*	Black 1927	China
Ngandong 1	*Homo soloensis*	Openoorth 1932	Indonesia
Perning 1	*Homo modjokertensis*	Von Koenigswald 1936	Indonesia
Swartkrans 15	*Telanthropus capensis*	Broom and Robinson 1949	South Africa
Ternifine 1	*Atlanthropus mauritanicus*	Arambourg 1954	Algeria
OH 9	*Homo leakeyi*	Heberer 1963	Tanzania
KNM-ER 992	***Homo ergaster***	Groves and Mazek 1975	Kenya
Dmanisi 2600	*Homo georgicus*	. Gabunia et al 2002	Georgia

Historical names

- *Homo erectus bilzingslebenensis* (Germany, 0.37 Ma)
- *Homo erectus erectus* (Java Man, 1.6–0.5 Ma)
- *Homo erectus georgicus* (Dmanisi, 1.8–1.6 Ma)
- *Homo erectus heidelbergensis* (0.7–0.3 Ma), now mostly treated as a derived species, *H. heidelbergensis*
- *Homo erectus lantianensis* (Lantian Man, 1.6 Ma)
- *Homo erectus nankinensis* (Nanjing Man, 0.6 Ma)
- *Homo erectus palaeojavanicus* (Meganthropus, Sangiran, 1.4–0.9 Ma)
- *Homo erectus pekinensis* (Peking Man, 0.7 Ma)
- *Homo erectus soloensis* (Solo Man, 0.55—0.14 Ma)
- *Homo erectus tautavelensis* (Tautavel Man, France, 0.45 Ma)
- *Homo erectus yuanmouensis* (Yuanmou Man)

History of *H. erectus* 3

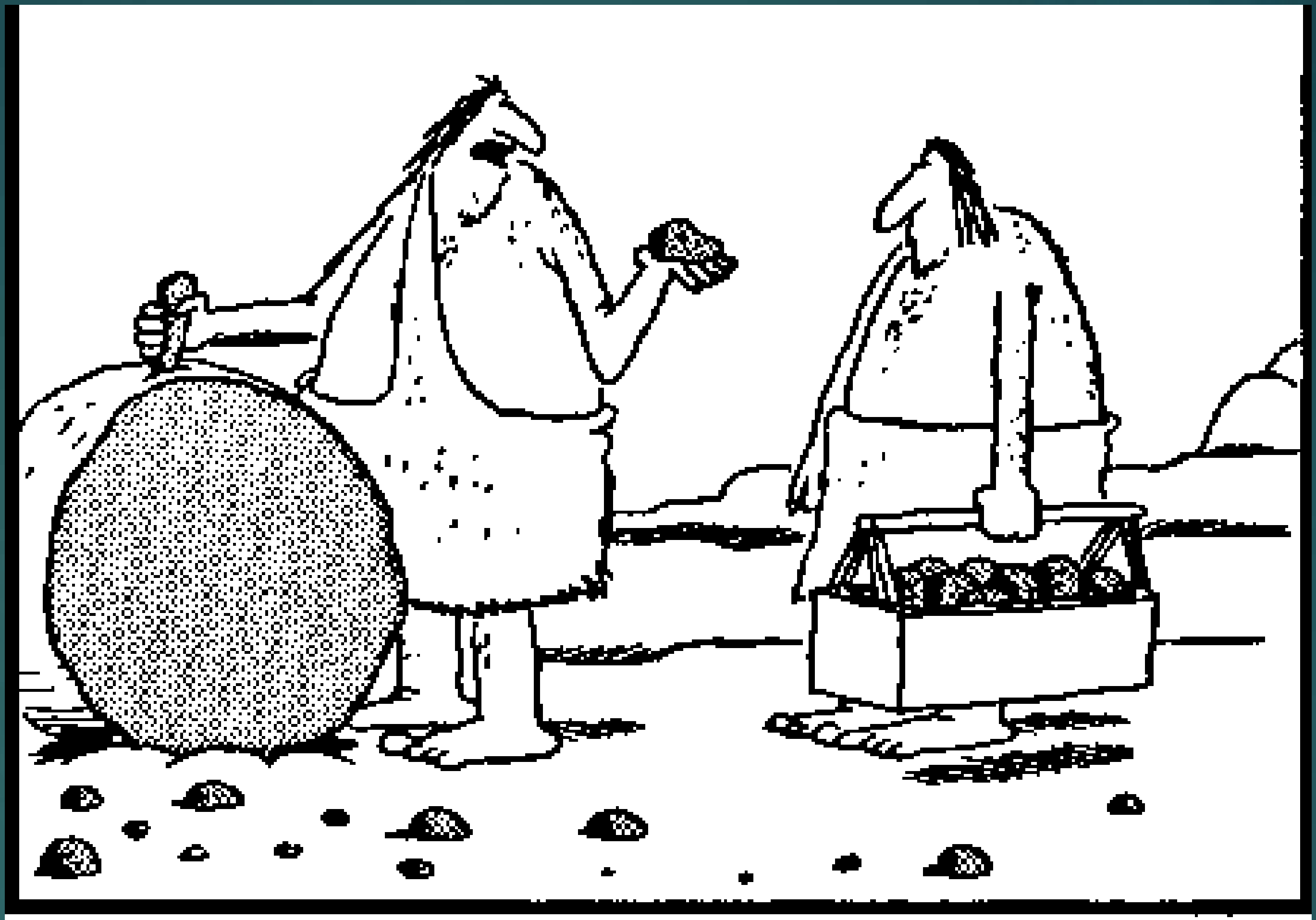
- In the context of the evolutionary synthesis of the 1940s, Mayr (1950) officially synonymized these multiple taxa under the nomen *Homo erectus*:
  - *Pithecanthropus*,
  - *Sinanthropus*,
  - *Meganthropus*,
  - *Telanthropus*
  - followed in 1964 by the inclusion of the North African remains from Ternifine
  - Cranial fossils discovered at Olduvai in the 1960s, such as Olduvai Hominid 9 (originally *Homo leakeyi*)
- Then followed a period of some 30 years during which the predominant view, particularly in the US and Western Europe, held *H. erectus* to be a single, widely dispersed, geologically long-lived, polytypic (variety of forms) species.

History of *H. erectus 4*

- *H. erectus* became the presumptive ancestor, in either a unilineal or interwoven multilineal scheme, for both Neandertals and ourselves.
- By the 1980s, the growing numbers of *H. erectus* specimens, particularly in Africa, led to the realization that Asian *H. erectus*, once thought so primitive, was in fact more derived than its African counterparts.
- Controversy over some *H. erectus* forms in Europe actually being *H. heidelbergensis*; specimens, distinct from *H. erectus,* on the basis of their double-arched brow ridge, parietal expansion, and brain size

History of *H. erectus* 5

- The taxonomic issues surrounding Asian vs. African *H. erectus* are more intractable. The *H. ergaster* question remains famously unresolved.
- Hominin dispersal from Africa now appears to commence at the same time as the origin of the species, perhaps around 1.8 Ma
- Why the dispersal from Africa?
  - result of technological advances made with the development of the Acheulean industry that likely signaled a shift in subsistence ecology,
  - changes in biological aspects of the species, including life-history patterns,
  - and responses to ecosystem change are now considered of equal importance for this hominin dispersal



So what's *this*? I asked for a *hammer*! A *hammer*!
This is a crescent wrench! Well, maybe it's a hammer,
… darn these stone tools!

Swiss army knife of the Pleistocene:
Handaxes: some 2 feet long, some inches; some in vast numbers

Bifaces
first to be
discovered:

In 1800,
at Hoxne,
Suffolk,
England

John Frere (1740 – 1807):
English Paleolithic handaxes at Hoxne

- English antiquary
- 1797: A pioneering discoverer of Old Stone Age or Palaeolithic tools in association with large extinct animals at brickyard in Hoxne, Suffolk
- First to recognize and publish on stone tools from England
- Described juxtaposition of artifacts, animal remains and stratigraphic evidence.

Jacques Boucher de Perthes (1788-1868): French prehistoric hand axes

- Described early flint tools from Abbeville, France; proved existence of flaked stone tools
- Discovered early handaxes near bones of extinct elephant bones in valley of Somme

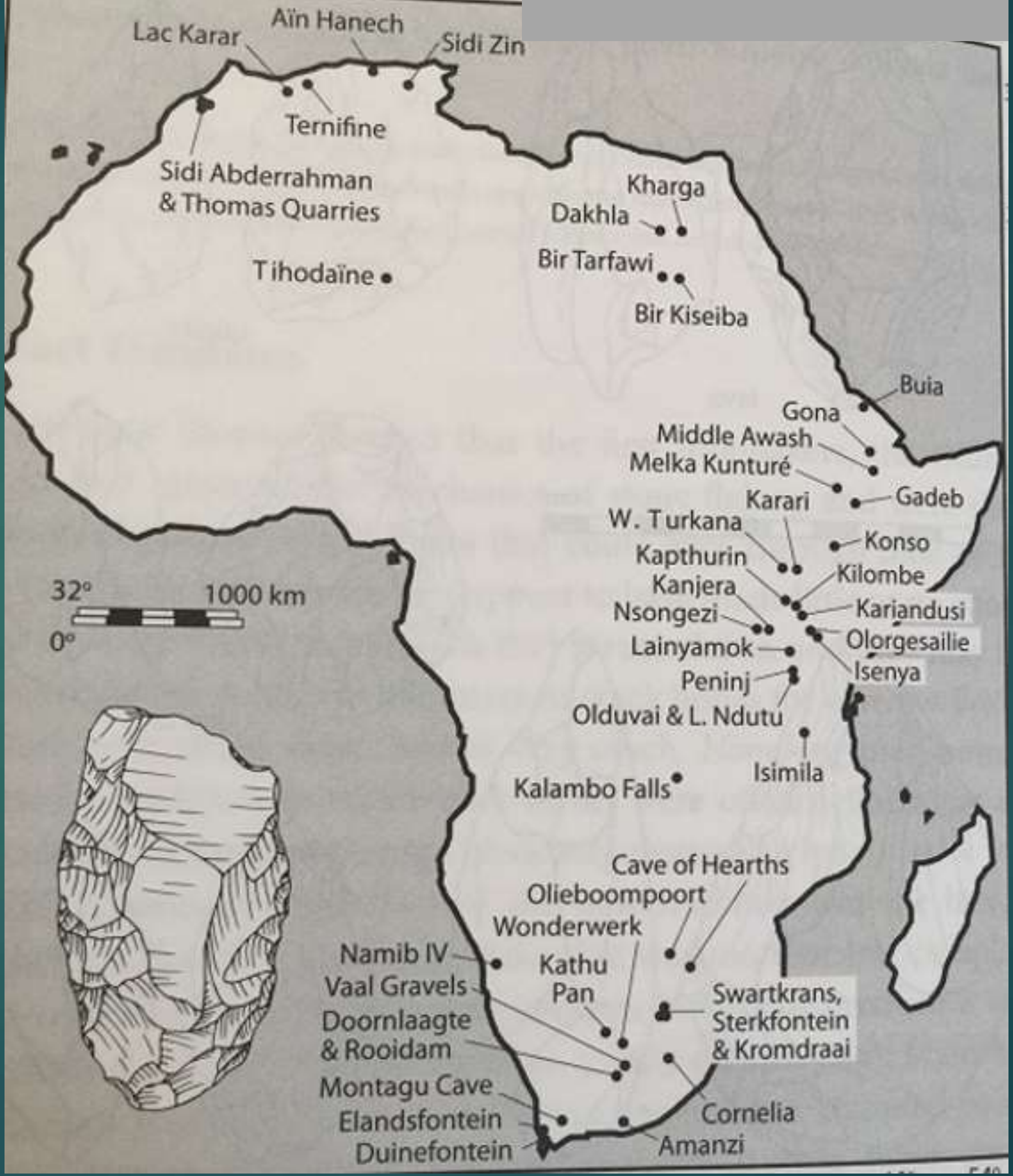
Acheulean hand axe from the collection of Jacques Boucher de Perthes and Edouard Lartet; 500-300 Ka

Paleolithic Hand Axes, Acheulean, ca. 500 K

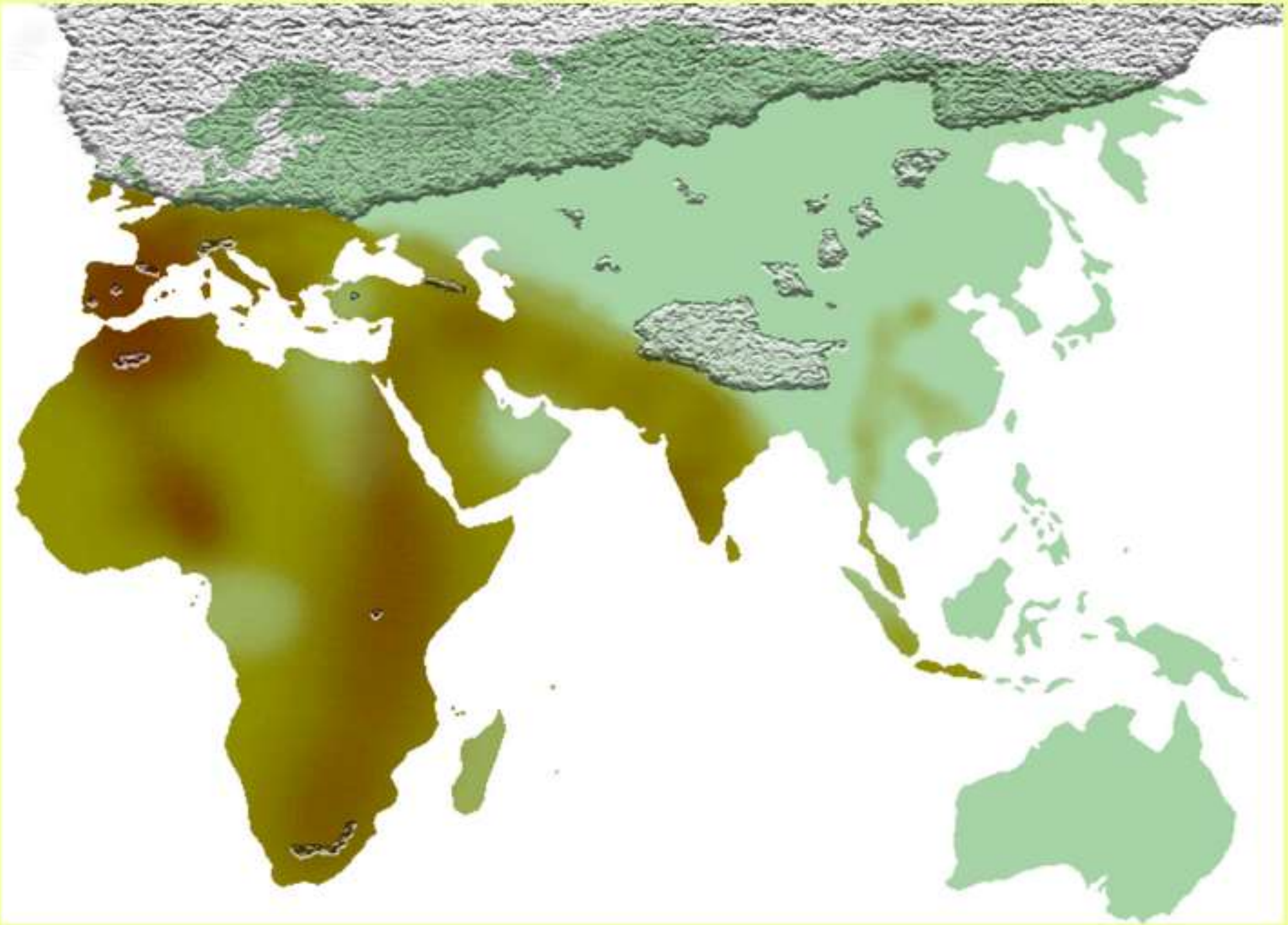
From Abbeville, Northern France. Excavated by Jacques Boucher de Perthes, 1830-40s

First site: St. Acheul, France: “Acheulean” bifaces

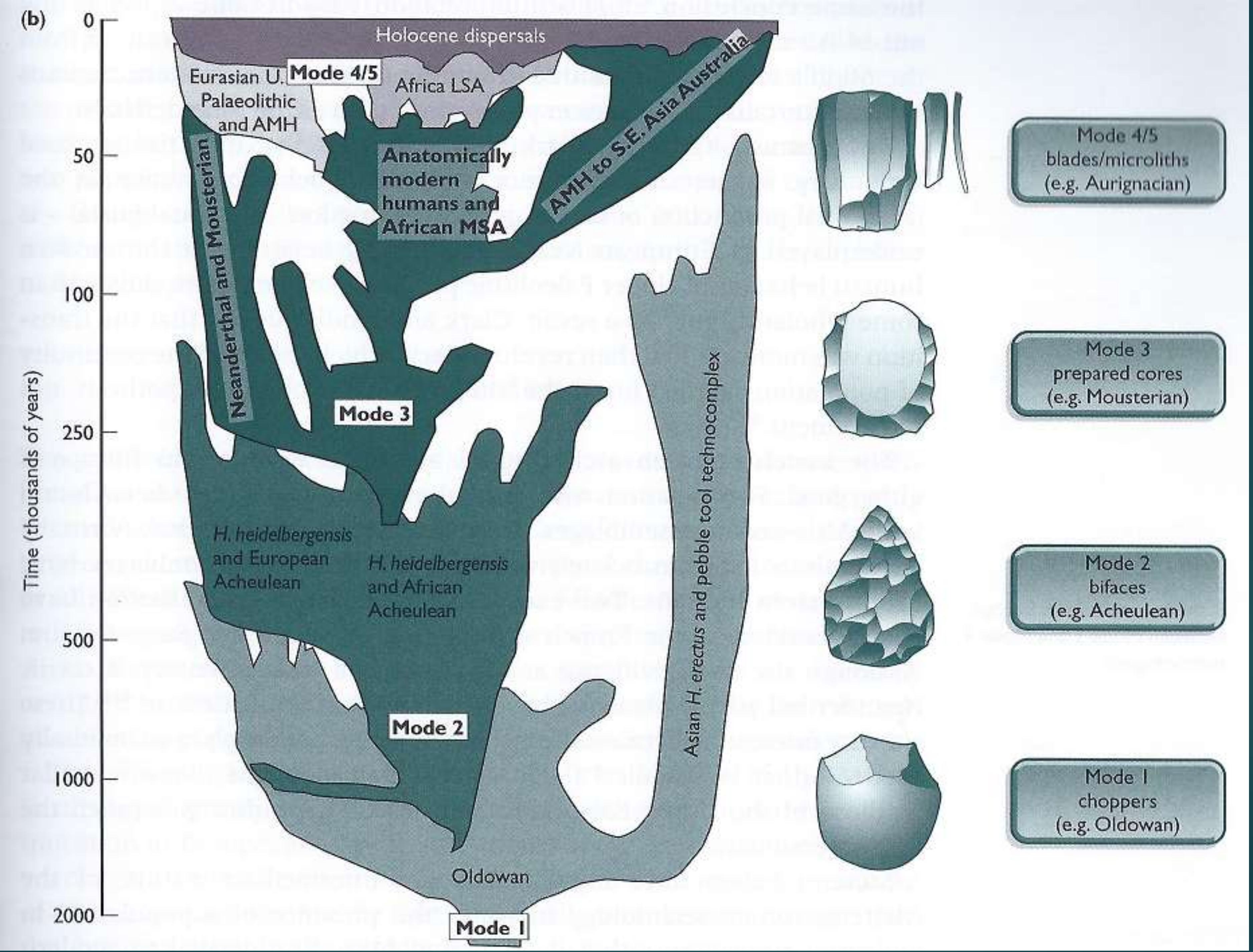
Acheulean distribution sites



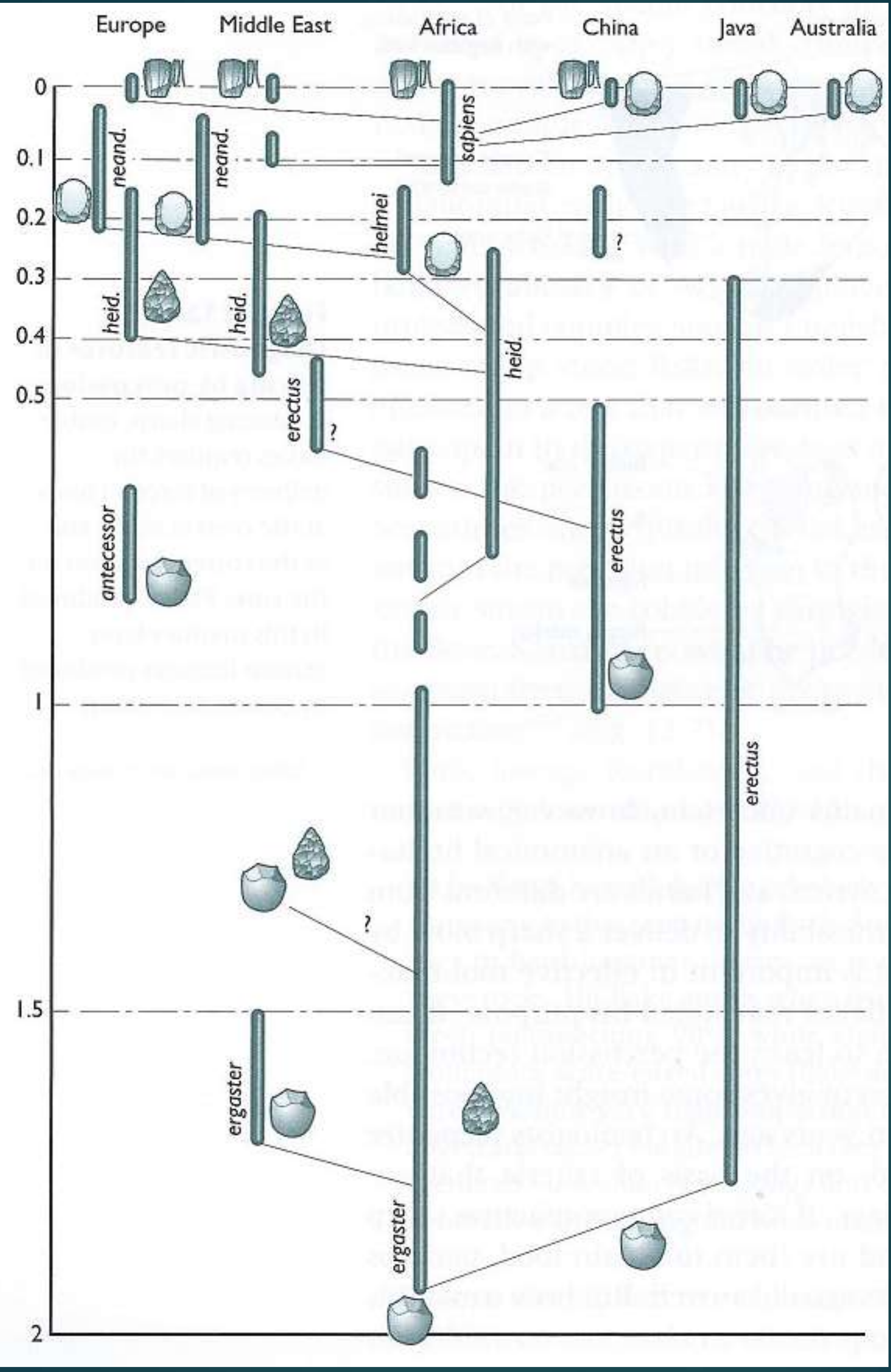
Acheulean Distribution



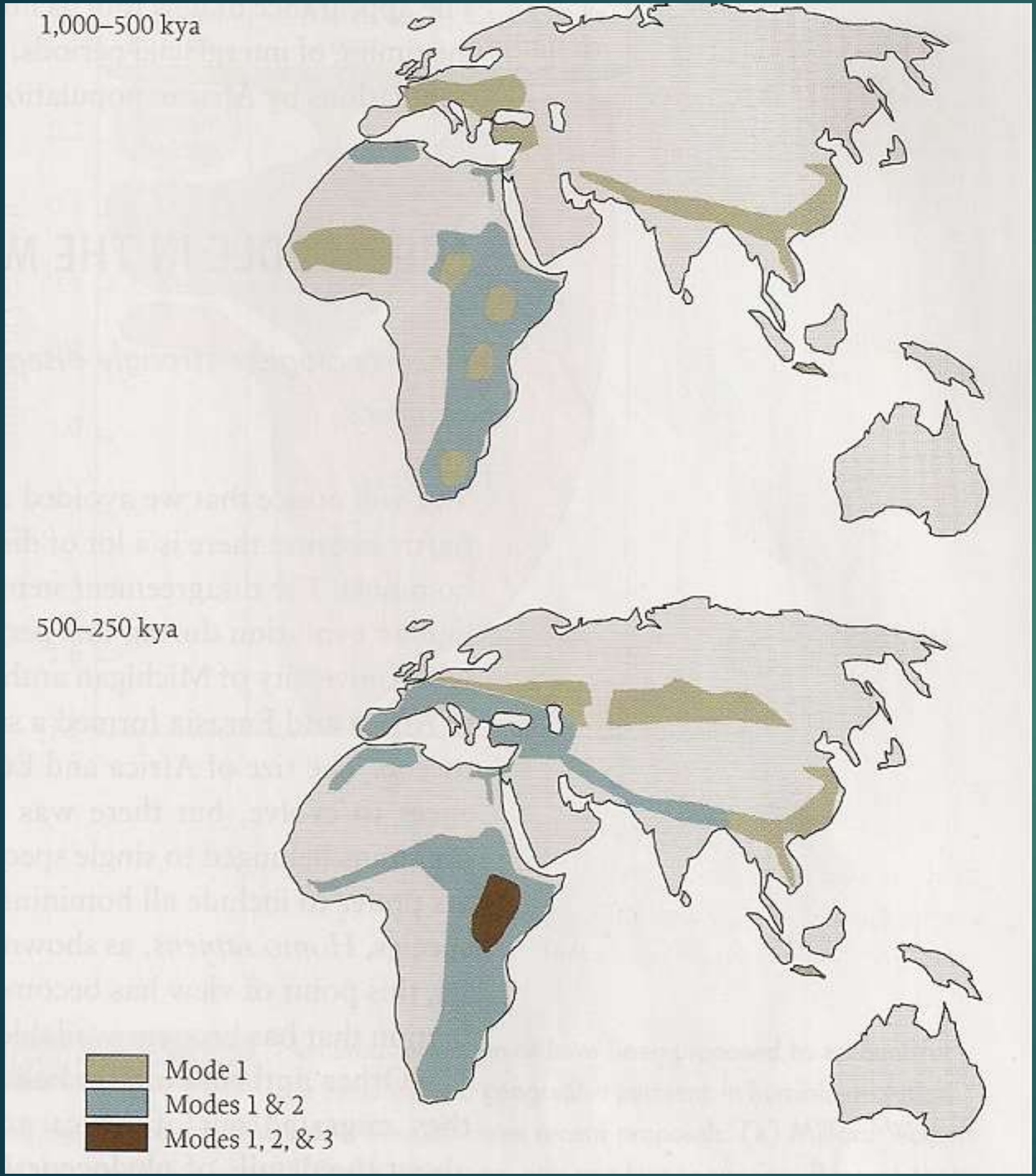
A map showing the distribution of bi-facial tools during the Acheulean

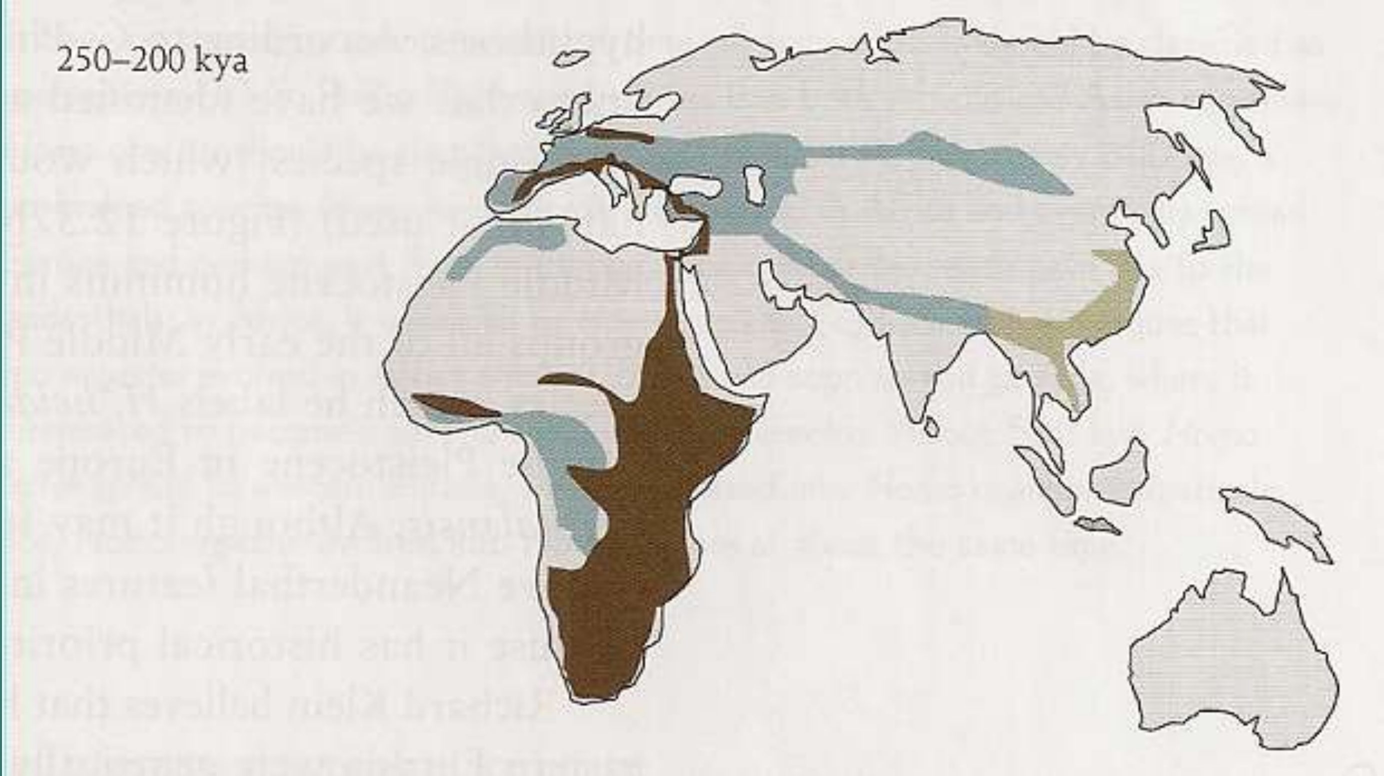


(b)
Time (thousands of years)
0
50
100
250
500
1000
2000
Holocene dispersals
Eurasian U. Palaeolithic and AMH
Mode 4/5
Africa LSA
AMH to S.E. Asia Australia
Anatomically modern humans and African MSA
Neanderthal and Mousterian
Mode 3
H. heidelbergensis and European Acheulean
H. heidelbergensis and African Acheulean
Asian H. erectus and pebble tool technocomplex
Mode 2
Oldowan
Mode 1
Mode 4/5 blades/microliths (e.g. Aurignacian)
Mode 3 prepared cores (e.g. Mousterian)
Mode 2 bifaces (e.g. Acheulean)
Mode 1 choppers (e.g. Oldowan)



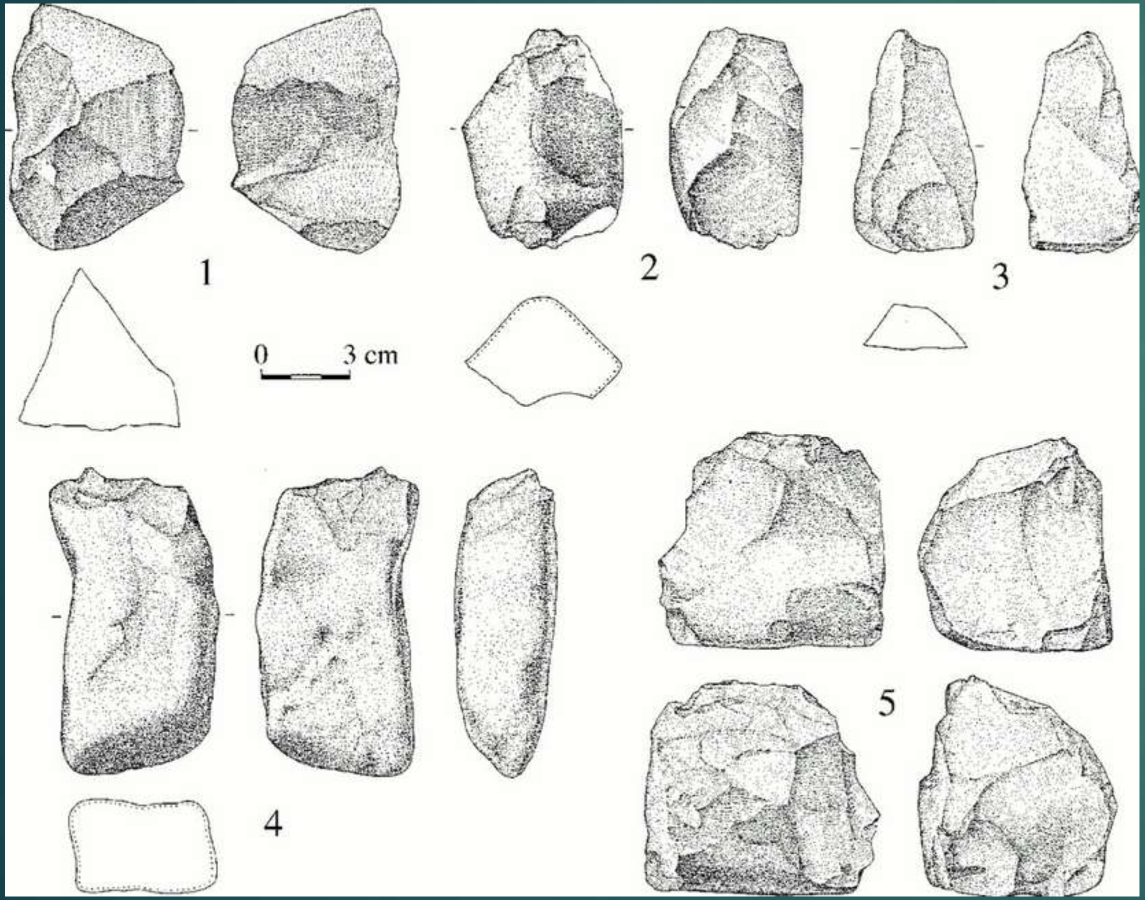
Europe
Middle East
Africa
China
Java
Australia
0
0.1
0.2
0.3
0.4
0.5
1
1.5
2
neand.
neand.
heid.
heid.
antecessor
erectus
?
sapiens
helmei
heid.
?
ergaster
ergaster
erectus
erectus
?





Mode 1 = Oldowan
Mode 2 = Acheulean
Mode 3 = Mousterian

Representative Oldowan Mode 1–type tools from Dmanisi



Lower Dmanisi vs Acheulean hand axe

Acheulean Handaxes: 750 to 90 Ka

Kalambo Falls site in Zambia, St. Acheul site near Amiens in France, Abbeville ,France, Egypt near Thebes , Romsey, England.   These handaxes were made from several different grades of chert, quartzite and basalt. They range in size from 5 to 9 1/2 inches.

Acheulean Handaxes from Konso, Ethiopia

From: "The characteristics and chronology of the earliest Acheulean at Konso, Ethiopia," by Yonas Beyene et al. *PNAS*, published online before print January 28, 2013, doi: 10.1073/pnas.1221285110

Olorgesailie, Kenya: 1000s of stone axes

Site was used from 1.2 Ma to 400 Ka; temporal compression of tools, not of same period; artificial preservation

Homo erectus: Acheulean/Mode 2 tools

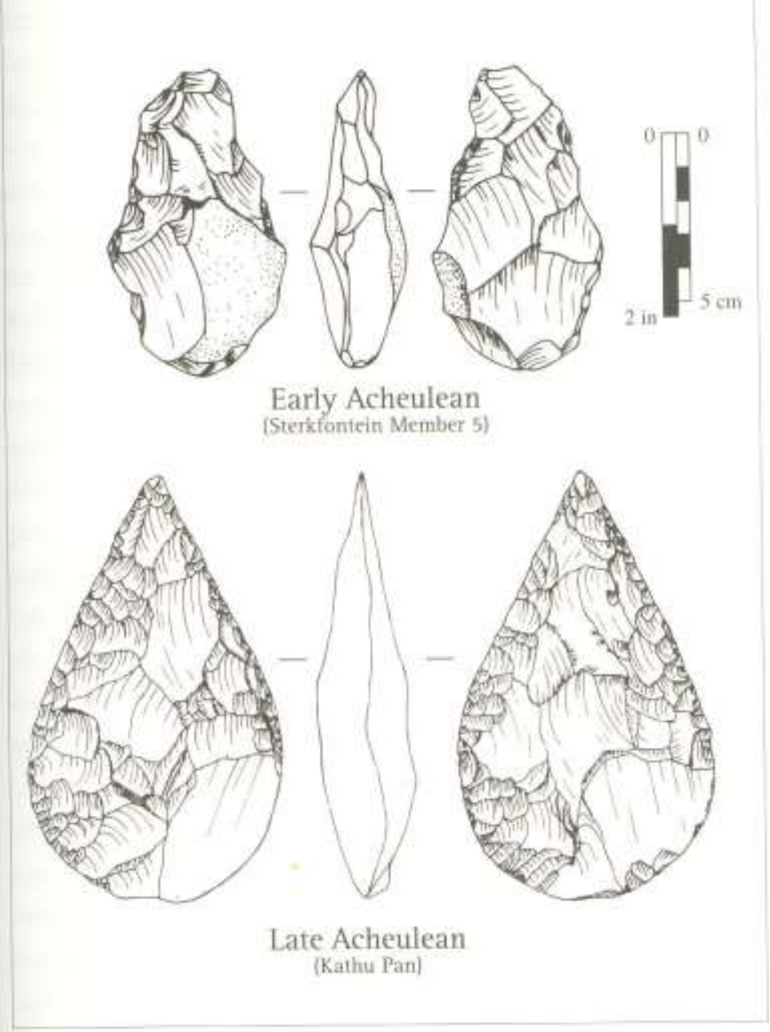


FIGURE 4.4
An early Acheulean hand axe from Sterkfontein Cave and a late Acheulean hand axe from Kathu Pan (top redrawn after K. Kuman 1994, *Journal of Human Evolution* 27, fig. 6; bottom drawn by Kathryn Cruz-Uribe from the original).

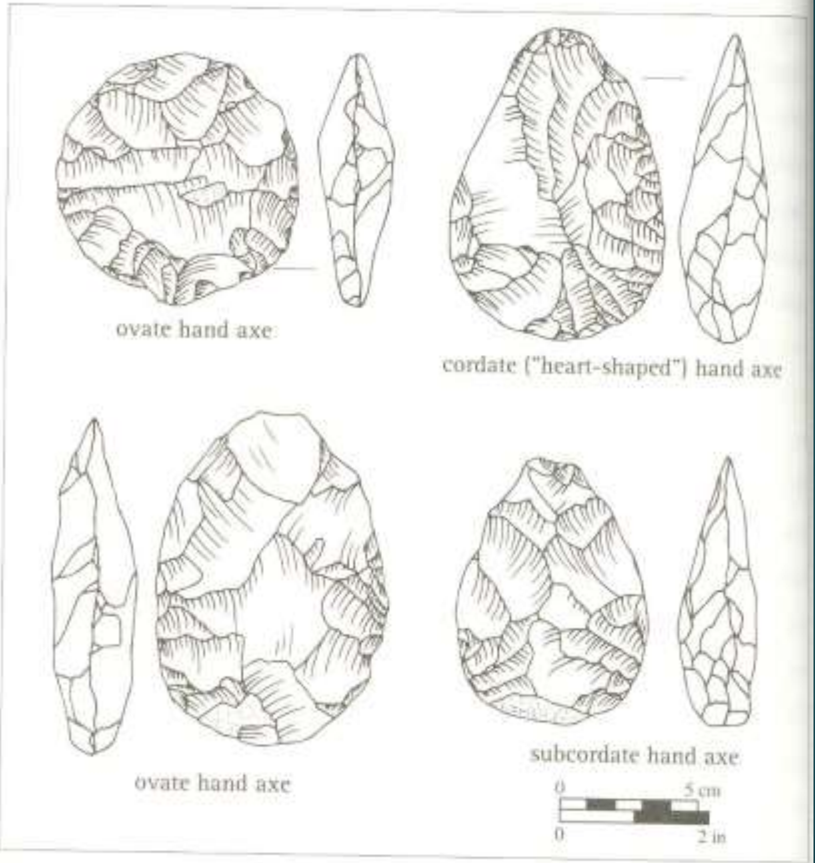


FIGURE 5.4
Late Acheulean hand axes from southern England (redrawn after J. J. Wymer 1968, *Lower Palaeolithic Archaeology in Britain*. London: John Baker, p. 147).

For Comparison: Neandertal Lavallois technique

MOUSTERIAN TOOLS (left to right): cutter or point, Levallois core and point, Aterian point with base tang, double-sided scraper (various sites in France).

Mousterian industry appeared around 200,000 years ago and persisted until about 40,000 years ago

The Enigma of the Handaxe

Africa 1.5Ma

Britain 0.4Ma

If they were talking to each other, they were saying the same thing, over and over and over...

Desmond Clark

Acheulean

Acheulean: associated with *H. erectus & H. heidelbergensis*

Geography of tool technologies

- The geography of tool technologies through time suggests that Eurasia was subjected to repeated invasions of hominins from Africa.
- Between 1.9 Ma & 500 Ka, Mode 2/Acheulean technologies were confined to Africa, and hominins in Eurasia were restricted to Mode I/Oldowan tools.
- From ~500 Ka, <u>Mode 2/Acheulean technologies appeared in Eurasia</u>, during a relatively warm, moist period.
- About 300 Ka, elements of Mode 3/Mousterian technology appeared in East Africa.
- By about 250 Ka, Mode 3 technology had spread throughout Africa and southern Europe. Once again, this spread coincided with a period of warmer climate.

Middle Stone Age: Mode 3, prepared core

- The Mousterian is … of a method of stone-knapping or reduc… technique, named after the type site in the Le… , France
- **Levallois, or pre…** the suburb in Paris where it was first recogni… paration of a rough stone core so that a num… ape could be removed.
- One of the main i… technique," was a core that was carefully … flake of predetermined size and shape c… low. This technique probably raised th… d predictability in stone technology.
- Middle Stone Age … which could be hafted on to shafts to make spears.

Implications of Acheulean tools at 1.76 Ma

- Lithic assemblage and geological context in West Turkana, Kenya
  - earliest Acheulian tools, dated to 1.76 Ma.
- Co-occurrence of Oldowan and Acheulian artefacts there indicates that
  - the two technologies were not mutually exclusive
  - Acheulian was either imported from another location yet to be identified or originated from Oldowan hominins at this vicinity.
- Acheulian did not accompany the first human dispersal from Africa despite being available at the time.
- Multiple groups of hominins distinguished by separate stone-tool-making behaviors and dispersal strategies coexisted in Africa at 1.76 Ma

Christopher J. Lepre, et al., 2011

Acheulean Lithic technology

- The Acheulean tool industry first appeared around 1.7 million years ago in East Central Africa. These tools are associated with *Homo ergaster* and western *Homo erectus.*
- The key innovations are
  - (1) chipping the stone from both sides to produce a symmetrical (bifacial) cutting edge,
  - (2) the shaping of an entire stone into a recognizable and repeated tool form,
  - (3) variation in the tool forms for different tool uses.
  - Manufacture shifted from flakes struck from a stone core to shaping a more massive tool by careful repetitive flaking.
  - The most common tool materials were quartzite, glassy lava, chert and flint.
  - <u>Lasted for 1.5 M years</u>.

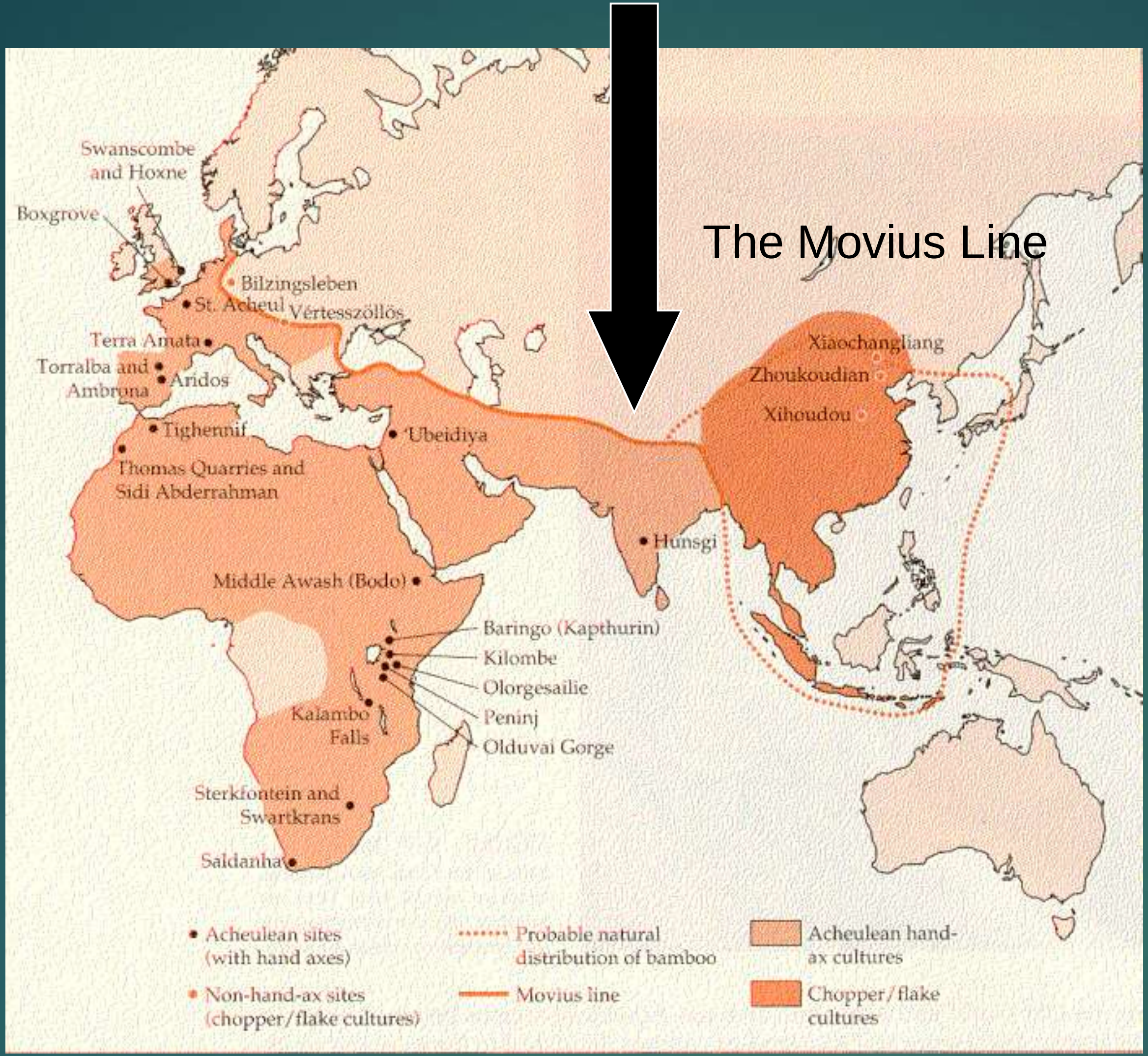
Acheulean in Asia: Movius Line

- The Acheulean extended itself more slowly eastward, arriving at Isampur, India, about 1.2 Ma.
- It does not appear in China and Korea until after 1 Ma and not at all in Indonesia.
- There is a discernible boundary marking the furthest extent of the Acheulean eastward before 1 Ma, called the Movius Line, after its proposer, Hallam L. Movius, of Harvard Univ.
- On the east side of the line the tools are additionally worked Mode 1/Oldowan, with flaking down the sides.
- The cause of the Movius Line remains speculative, whether it represents a real change in technology or a limitation of archeology
- But after 1 Ma evidence not available to Movius indicates some prevalence of Acheulean. For example, the Acheulean site at Bose, China, is dated 800 Ka. But still rare in East.

Hand axes found in the Bose Basin in southern China are the only Mode 2 tools discovered in east Asia. These tools date to about 800 Ka. Mode I tools are found in the same area both before and after this date.

Harvard's Hallam Movius, 1948: divided the world of *Homo erectus* and their immediate descendants into the Acheulean hand-ax cultures of the West and the non-handaxe "chopper-chopping" cultures to the east

Note that in the east and in southeast Asia, the absence of hand-ax cultures coincides closely with the presence of bamboo.



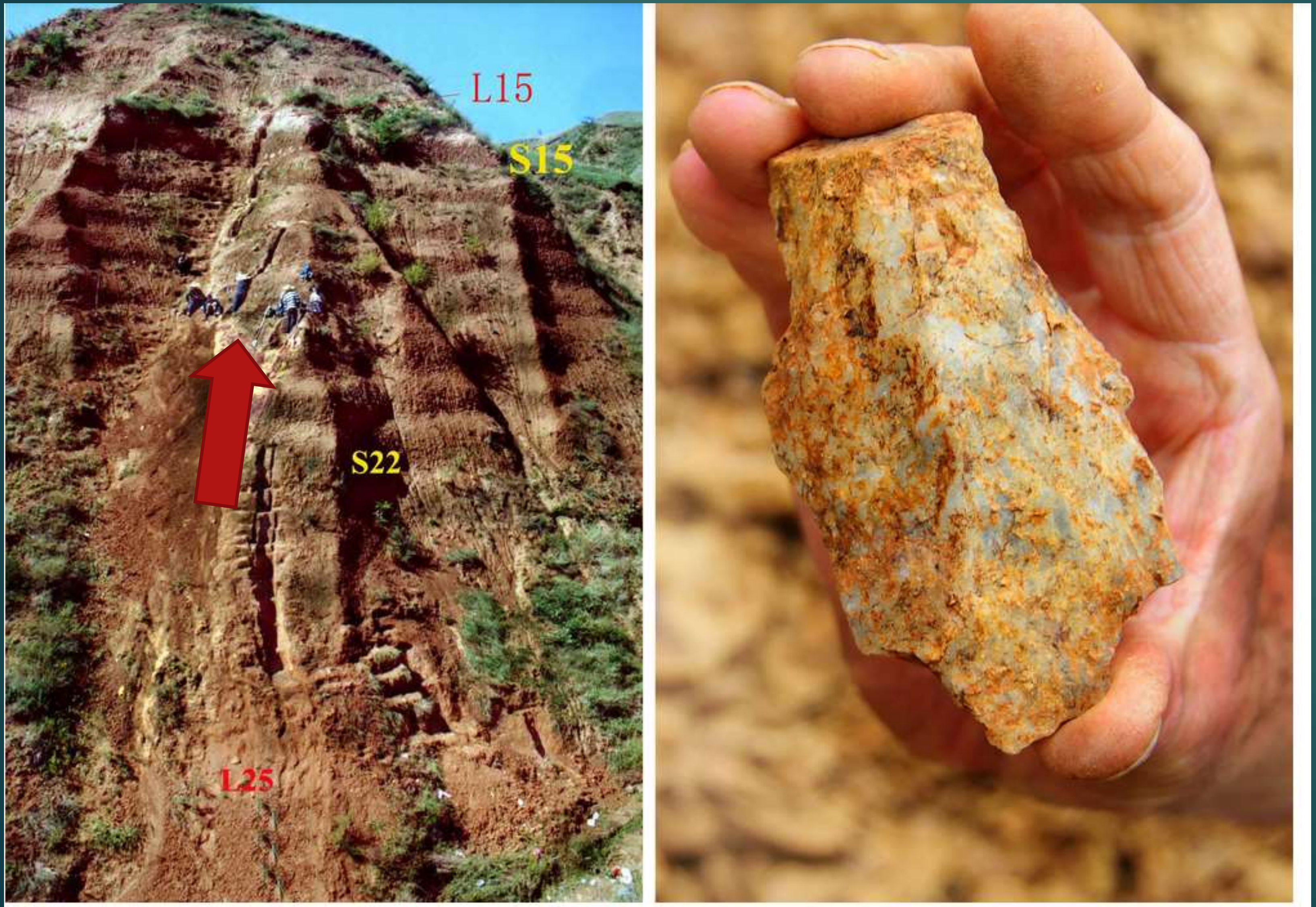
H. erectus left Africa *before* Acheulean tools were even developed in Africa (~1.7 Ma).

Lycett & Bae, 2010: After more than sixty years of further detailed research, it is evident that the Early Palaeolithic stone-tool industries of eastern Asia are dominated by core and flake tools

Demography/social transmission model (Lycett and Norton 2010) predicts that in areas with (relatively) large effective population sizes there will be higher incidences of major technological innovation, vs. those with lower demographic levels, where older technology will predominate..

St. Acheul, France, 400 Ka: perfect Acheulean

2018: Chinese 96 stone tools dated to 2.1 Ma; Shangchen, Lantian region, China



Stone tools from an archaeological site in China are as old as 2.1 million years. Credit: Zhu et al./Nature 2018

Fig. 4 | Selected artefacts found in situ in layers S27–L28 (2.09–2.12 Ma), L27 (1.95–2.09 Ma), L25 (1.73–1.80 Ma) and S23 (1.59–1.65 Ma) from the Shangchen Palaeolithic locality. a, SC 20120507-3, a flake tool from S27. **b**, SC 20120507-2, a pointed piece from S27. **c**, SC 20120516-1, a core from S27. **d**, SC 20120507-1, a core from S27. **e**, SC-B D2-2, a bipolar fragment from L27. **f**, SC 20120502-6, a flake from S23. **g**, 2010-06 SC-L25, a scraper from L25. **h**, SC-K5, a flake tool from S27–L28. **i**, SC-K4, a core from S27–L28. **j**, SC070926-1, a flake fragment from S23. Artefacts from S23 are similar in age to the the Gongwangling *H. erectus* cranium[3]. Each gradation in the scales represents 1 cm. Artefacts SC-K4 and SC-K5 are also shown in Extended Data Fig. 10. SC, abbreviation for Shangchen site.

- Excavation between 2004 and 2017
- 96 stones: 82 flaked stone tools and 14 unflaked stones.
- Were basic in their construction but diverse in terms of function, and included cores, flakes, scrapers, points, borers, picks, and hammerstones, the latter of which exhibited signs of use; also 1 deer and 1 bovine fossil; no cutmarks
- within 17 sedimentary layers, spanning 850 K years; eleven of these layers were associated with a wet and warm environment (80 stones); 6 layers in cold period
- layers ranged in age from 1.3 million to 2.1 million years ago.
- No fossil hominins

2018: Chinese stone tools dated to 2.1 Ma; doubts

- Believes it was earlier hominin.
- Dr. Potts did not think that the hominins of Lantian were short and small-brained, though. Instead, he speculated that there are *Homo erectus*-like fossils older than 2.1 million years waiting to be discovered back in Africa.
- But John J. Shea, a paleoanthropologist at Stony Brook University, is yet to be convinced that anyone crafted the stones. At the very least, he argued, Dr. Dennell and his colleagues should make a statistical comparison between these supposed tools and naturally damaged rocks. And Dr. Shea was leery of relying on tools alone for evidence that hominins were in Asia over two million years ago. “Bottom line — no hominin fossils, no hominins,” he said.
- Study: “the oldest artefact age of approximately 2.12 Ma at Shangchen implies that hominins had left Africa before the date suggested by the earliest evidence from Dmanisi (about 1.85 Ma). This makes it necessary to reconsider the timing of initial dispersal of early hominins in the Old World.”

Functional brain networks & stone technology

- FMRI study of lithic production:
- Acheulean tool production requires the integration of visual, auditory and sensorimotor information in the middle and superior temporal cortex, the guidance of visual working memory representations in the ventral precentral gyrus, and higher-order action planning via the supplementary motor area, activating a brain network that is also involved in modern piano playing.
- The right analogue to Broca's area—which has linked tool manufacture and language in prior work—was only engaged during verbal training. Acheulean toolmaking, therefore, may have more evolutionary ties to playing Mozart than quoting Shakespeare.

African *H. erectus* from 2.0 to1.5 Ma

- Early *Homo* (i.e., both 1470/*rudolfensis* and 1813/*habilis* groups):
  - 30% bigger in brain and 10% bigger in body size than Australopithecus.
- Early African and Georgian *H. erectus* together:
  - 40% bigger in brain and 25% in body size than Australopithecus.
- Early *H. erectus*:
  - 20% bigger in brain and 15% in body than the combined Early *Homo* 1470 and 1813 groups
- Importantly, ranges of variation overlap substantially

Evolution of early *Homo: Early diversification*

- The Dmanisi remains, along with small-sized remains from East Africa, have expanded the range of size variation within *H. erectus*,
  - highlighted the notion of significant variation in that species,
  - and blurred the size distinctions among morphological groups of early Homo.
- The mosaic of features in *A. sediba* (~1.98 Ma) and variation in the Dmanisi *H. erectus* sample (~1.8 Ma), both of which are contemporaneous with the three African groups, suggest that the early diversification of *Homo* was a period of morphological experimentation.
- Remember: bushy variation !!!

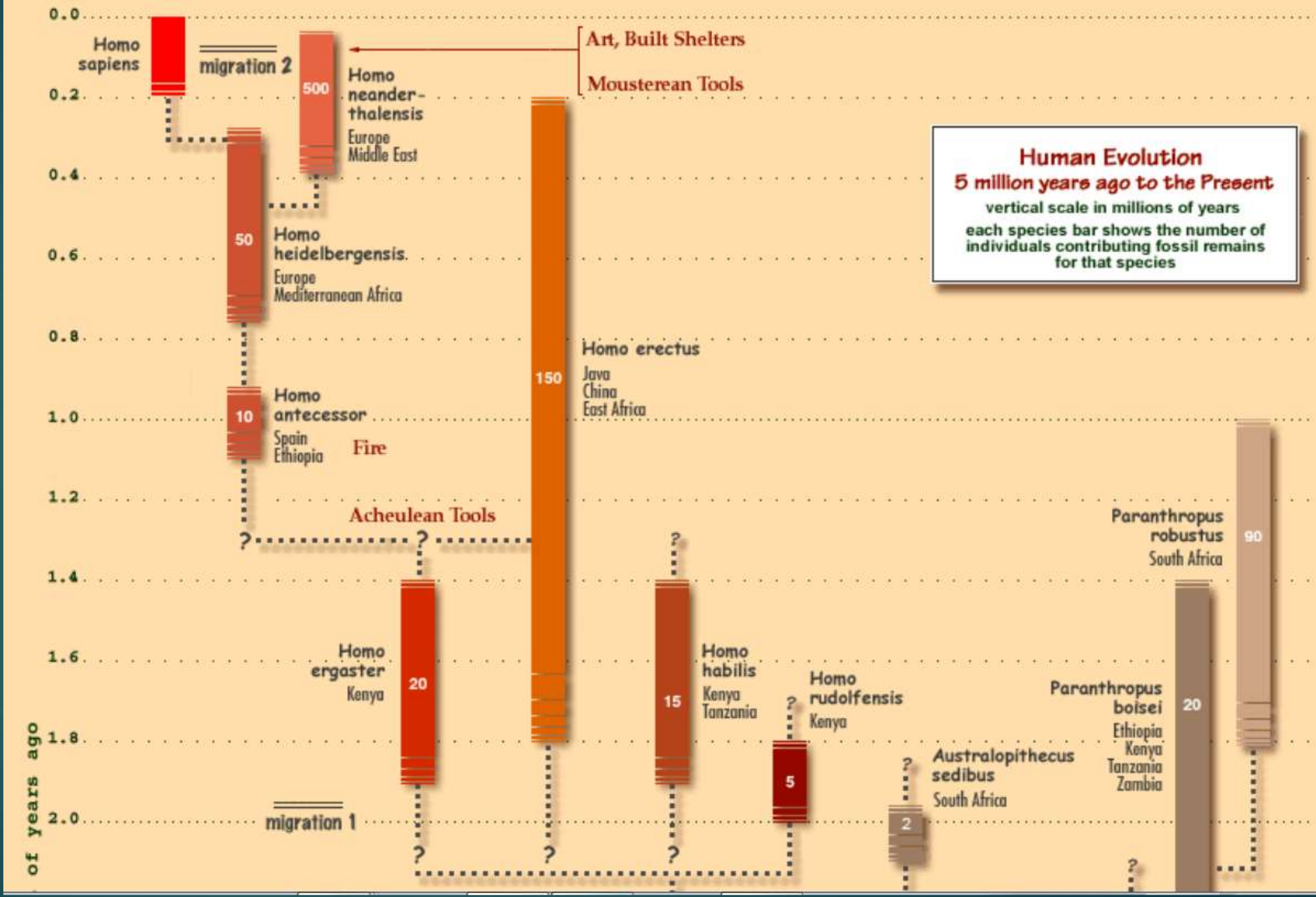
Homo erectus was the longest lasting hominin species of all time, surviving for almost 1.9 M years.

A reconstruction of a *Homo erectus* female (based on fossil ER 3733) by paleoartist John Gurche, part of the Smithsonian National Museum of Natural History's Human Origins Program.

Longevity of H. erectus:

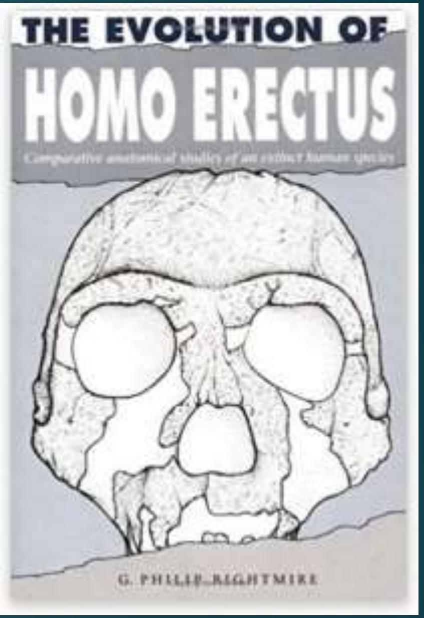
1.9 Ma to 143 Ka

Longest lasting hominin species



G. Philip Rightmire: *Homo erectus*

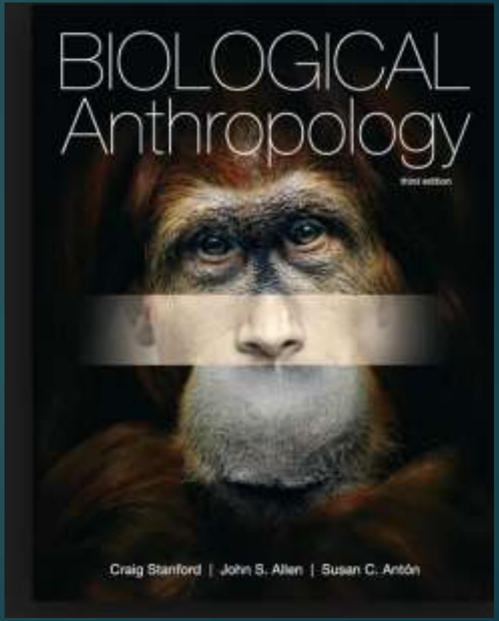
- Research Associate in the Department of Human Evolutionary Biology at Harvard University,
- Biological anthropologist
- His 1990 book, *The Evolution of Homo erectus*, is still the best systematic study of the comparative anatomy of all the major specimens of *H. erectus.*
- His current projects center on
  - Middle Pleistocene (781–126 Ka) hominins,
  - the evolutionary significance of the assemblage from Dmanisi (Georgian Caucasus),
  - the paleobiology of *Homo erectus*,
  - and the identification of likely antecedents to this species in Africa



Susan Antón: *Homo erectus*

- Paleoanthropologist, New York University, Department of Anthropology

- Several of the best reviews about *H. erectus* in the major journals*:*
  - *Natural History of Homo erectus*, Susan C. Antón, 2004
  - 2014 Antón, S.C., Aiello, L.C., Potts, R. *Evolution of Early Homo: An integrated biological perspective*. Science.



- 2012 Stanford, C.B., Allen, J.S. and Antón, S.C. *Biological Anthropology*, 3rd edition

H. ergaster

- *H. ergaster* was first hominin species whose anatomy & behavior justify the label "human" in the narrow sense

- Based on climate and plant/mammal species shifts, they emerged at a time when aridity, rainfall seasonality, or both increased sharply in Africa.

- Before 1.7 Ma, the principal grasses in E & S Africa were C^3 species, adapted to cooler conditions, but about 1.7 Ma, C^4 drought-tolerant grasses emerged, adapted to greater heat

Rightmire conclusions about *H. erectus*:

- Their fossil record is sparse, compared to other mammal species.
- Continuing problems with their chronology, particularly with Asian sites. Ngandong & Sambungmachan are undated, and there are questions about Sangiran.
- Unclear which of *habiline* species is ancestral.
- *Homo erectus* was present in both Africa and Asia and is same species
- *H. erectus* is a geographically widespread, but essentially conservative taxon, changing relatively little through most of the Pleistocene.
- Variation is significant

G. Philip Rightmire, The evolution of Homo erectus, 1993

Rightmire

- Homo erectus is a real species, not a grade or stage in a lineage

- Rightmire does not accept a 3-stage theory of human ancestry (*habiline, erectine, sapiens*) or a direct ancestry of *H. erectus* to *H. sapiens* (a la multiregionalism). Theory needs addition of post-erectus group, *H. heidelbergensis* (i.e. Petralona, Broken Hill, Arago, Ndutu, Elandsfontein, Mauer, & Bilzingsleben)

- In 1990, before the Dmanisi discovery, Rightmire believed there was not significant brain size increase over time in *H. erectus* based on his statistical analysis. Later data contradicts this.

Pre-modern *Homo*: *Homo ergaster*

- By 1.8 Ma, the remains of a new form of hominin, *Homo ergaster* (most researchers now refer to it as early African *Homo erectus*) appear in sites in the Omo region of East Africa.
- Distinguished by:
  - Cranial size: ~ 700–900 cc
  - Reduction in relative and absolute size of the face, jaws, & chewing teeth
  - A post-cranial skeleton that indicates an obligate biped.
- H. erectus has been found in East Africa; Dmanisi, Georgia; and then Far East

Homo erectus outside of Africa

- First major cosmopolitan traveler = *H. erectus:*
  - Emergence out of Africa
    - Dmanisi by 1.8 Ma (between Caspian & Black seas, in north)
    - Indonesia: by 1.6 Ma, Java (Trinil, Sangiran, Sambungmacan)
    - China: by 1.6-1.7 Ma, Lantian, Hexian, Zhoukoudian
      - China: best dated *H. erectus*

Homo ergaster

- *H. ergaster*: mainly African species; existed 1.8-1.7 Ma, perhaps to 780 Ka in Africa
- Based mainly on fossils dated 1.8 and 1.4 Ma in Lake Turkana Basin
- Core specimens are 2 skulls: KNM-ER 3733 & 3883 & partial skeleton (KNM-ER 1808) from Koobi Fora & skull & skeleton (KNM-WT 15000) from Nariokotome III, W. Turkana
- Only extra-African *H. ergaster* specimens are from Dmanisi, Georgia that closely recall Turkana skulls, dated to 1.7 Ma

Homo ergaster

- 1 Ma skulls from Buia, Eritrea & Daka, Ethiopia, document persistence of *H. ergaster* morphology for 800 K years.
- Partial cranium (KNM-OL 45500) from Olorgesailie, Kenya, indicated that some *H. ergaster* individuals retained small cranial capacities (800 cc) as recently as 900 Ka.
- *H. ergaster* was ancestral to all later species of *Homo*, incl. *H. erectus*
- Question of punctuated or gradual origin from prior species

Migration Out-of-Africa

- The earliest specimens of ***Homo ergaster*** are found in Africa, but, sometime after 2.0 Ma years ago, *Homo ergaster* migrated out of Arica.

- Acheulean tools and remains of this species have been found widely distributed in Europe and Asia.

- Stone tools and camp sites are widely distributed over Africa, including sites in what is now the Sahara desert.

Expansion out of Africa

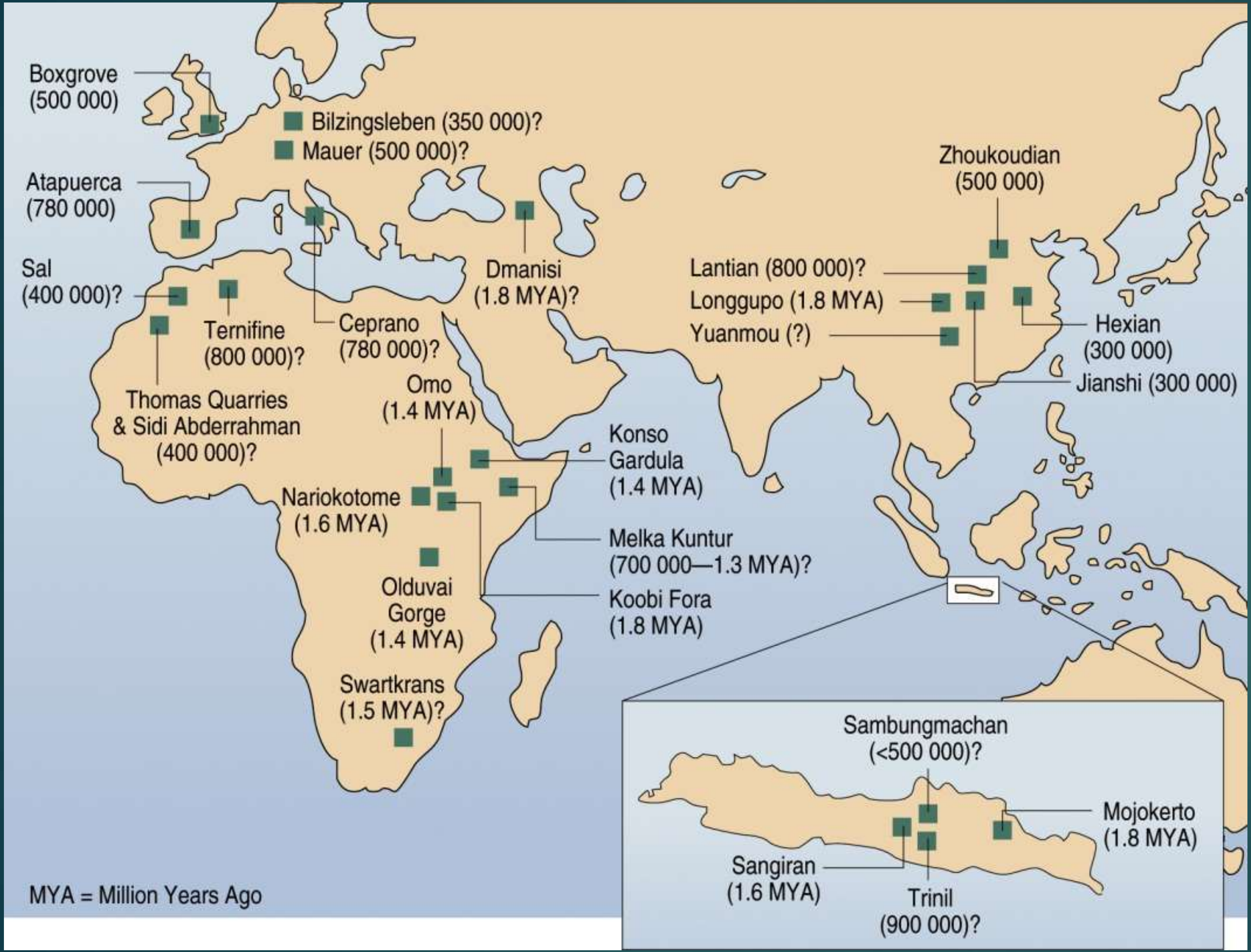
- At glacial pace of population expansion of 16 km/10 miles per generation, *Homo erectus* could move from east Africa to east Asia in 25,000 years.
- No early *Homo* (*habilis or rudolfensis*) has been discovered outside of Africa.
- Oldest African *H. erectus* ER 3733 dated to 1.8 Ma.
- Acheulean tools in Africa date to 1.7 Ma.
- 1992, Dmanisi mandible dated to 1.8 Ma
- Modjokerto & Sangiran, Indonesia fossils dated to 1.8 & 1.6 Ma.
- 2018, Shangchen, China: 2.1 Ma stone tools
- Clearly implying that a new kind of *Homo* had arrived.

Homo erectus
Out of Africa

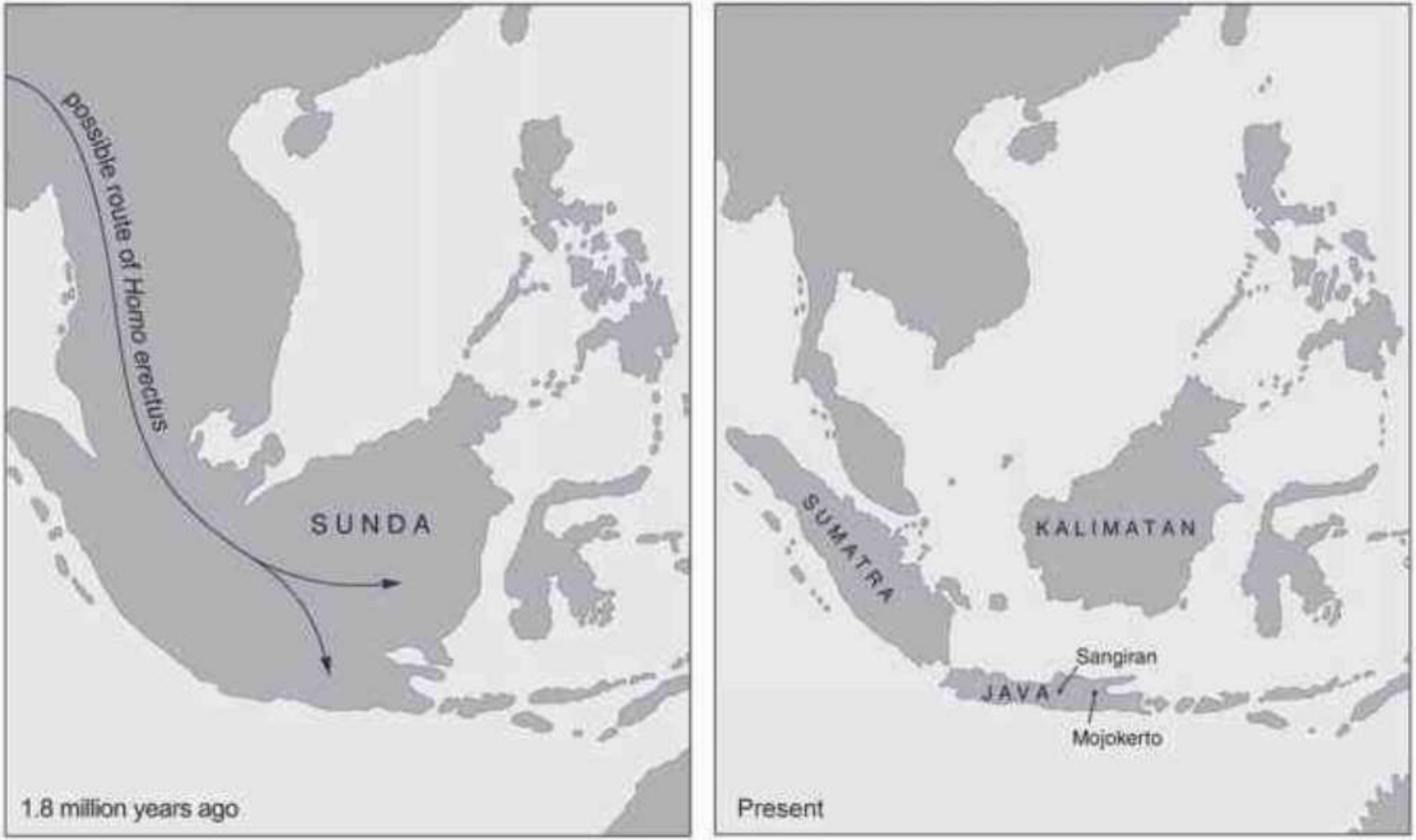
- Earliest in Africa = 1.8 Ma (*H. ergaster*)
- Dmanisi, Georgia = 1.8 Ma (*H. erectus*)
- Continental Asia = 1.4 Ma
- Island of Java, SE Asia = 1.0 Ma
- Spain = 800,000 Ka (*H. antecessor*?)
- Philippines = 700,000 Ka (*H. luzonensis*)
- Flores = 600-90 Ka (*H. floresiensis*?)

Homo erectus

- The bulk of known remains date between 1.8–1.0 Ma.
- The earliest African *H. erectus* quickly disperse into Western and Southeastern Asia, where they first appear between 1.7–1.8 Ma.
- Island Southeast Asia is the only region, at present, where *H. erectus* fossils persisted throughout the entire Pleistocene, suggesting that this region may play a unique role in the evolution of the species.
- The latest *H. erectus* on Java likely implicates the role of intermittent isolation and local adaptation in the longevity of the species.



Fossil evidence shows that by 1.8 Ma to 500 Ka, hominins of this species had spread from Africa to China, Europe, the Republic of Georgia, India, Java


possible route of Homo erectus
SUNDA
1.8 million years ago
SUMATRA
KALIMATAN
Sangiran
JAVA
Mojokerto
Present

Date (Ma)	Locality	Key Fossils
1.9 – 1.2	Koobi Fora, Kenya	WT 15000 (Nariokotome), ER-3733, ER-3883
1.9 – 0.7	Olduvai Gorge, Tanzania	OH 9, OH 12
1.8 – 1.7	Dmanisi, Georgia	D3444, D2700, D2280, D2282
1.8 – 1.6	Swartkrans, South Africa	SK 847
1.8 – 0.9	Sangiran/Trinil, Indonesia	Trinil 2, Mojokerto, Sangiran 17, Sangiran 2
0.8 – 0.4	Ceprano, Italy	Ceprano 1
0.4	Zhoukoudian, China	ZKD E1, D1, L1, L2, H3
0.2 – 0.05	Ngandong, Indonesia	Ngandong 1, 9, 10, 11

Adaptive Niche of *Homo erectus*

- What we know about *Homo erectus*:
  - Larger than earlier hominins
  - Reduced sexual dimorphism: males 20-30% larger, implying less male to male competition
  - Had a larger brain than earlier *Homo*
  - Had smaller teeth and face
  - Had a body build (tall & thin) adapted for efficient cooling in hotter area
  - Lived in a wider variety of habitats
  - Had dispersed rapidly to many tropical and subtropical regions
  - Made & used tools of much greater complexity

The *Homo erectus* Adaptive Niche

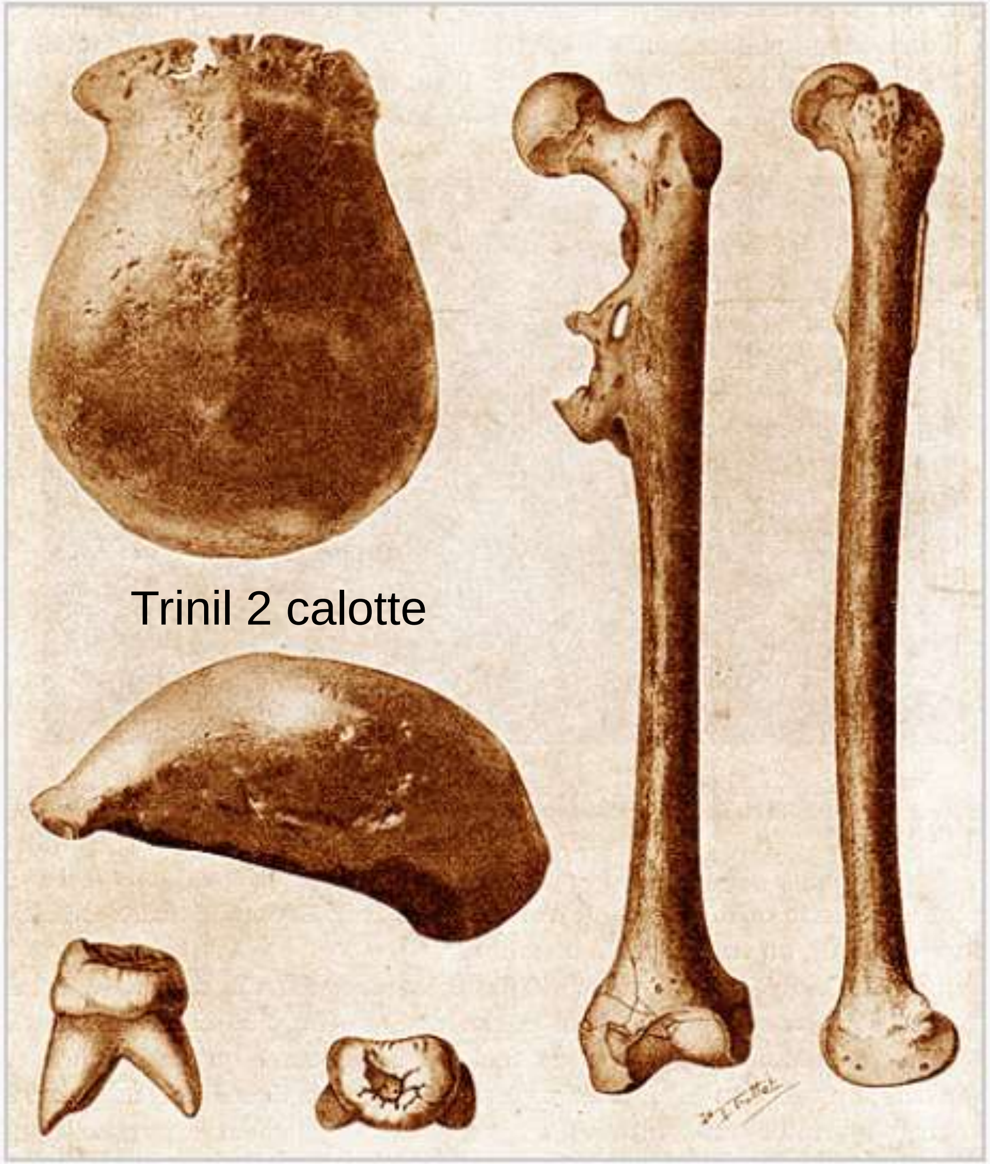
- Reasonable inferences…
  - Diets contained more high-quality foods
  - Home range of groups were up to 10x larger than those of other apes
  - The energy budgets of males & females changed
    - “grandmother hypothesis” vs. male provisioned females
  - Change in life history patterns: longer childhood than apes, but shorter than MHs
  - Encountered cognitive challenges

Homo erectus: achievements

- First hominins to make tools to a predetermined shape
- Invented new tool: Acheulean handaxe
  - Larger tools, required more prep than *H. habilis* choppers
- First hominins to hunt small to medium size game
- Probably the first hominins to use, perhaps even control, fire
  - Fire allows cooking foods (makes meat & veggie consumption easier; lengthen day into the night; keeps predators away; warmth; more social interaction)

E. Dubois, 1891: Pithecanthropus erectus

- The holotype for the name *H. erectus* is the Trinil 2 calotte.
- The original species definition by Dubois (1894) also relied heavily on the Trinil 1 femur.
- At the time, the femur was most critical for assessing the hominin (bipedal) nature of the species



Original fossils of *Pithecanthropus erectus* (now *Homo erectus*) found in Java in 1891.

Anatomy: original species description from type specimen

- Today vault characteristics are more critical to taxonomic definitions (e.g., Wood, 1991a; Rightmire, 1993).
- In this regard, Dubois (1894, 1924) noted anatomical features of the calotte critical to the current species definition, including
  - a cranial capacity (then considered 1,000 cc, but now 840 cc),
  - the lowness of the vault, particularly its frontal recession and occipital angulation,
  - and its continuous supraorbital region.

Height and Weight

- Height 4.9-6.1 ft (148-185 cm): males 1.83 m; females 1.55 m
- Weight 88-150 lb (40-68 kg): males 63 kg, females 52 kg
- Height & Weight::
  - There was a large amount of variation in the size of *Homo erectus* individuals.
  - Many fossils cannot be attributed to male or female.
  - The fossils from Africa indicate a larger body size than those from China, Indonesia, and the Republic of Georgia.
  - Larger body size indicates more wide-ranging subsistence strategy

Increased body size

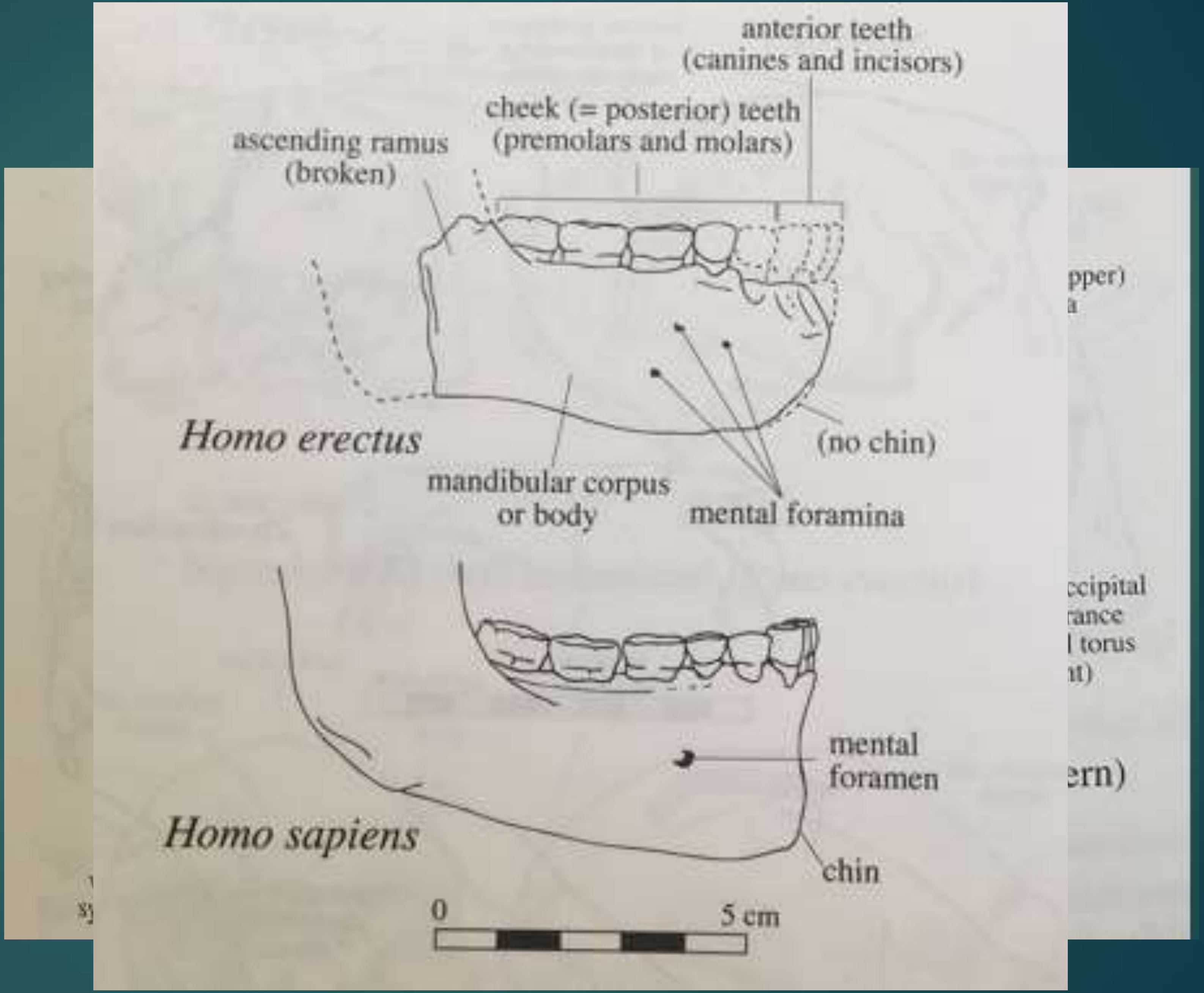
- One of the traits most commonly associated with *Homo erectus* is an increase in body size.
- The Nariokotome specimen, an adolescent male individual, was over five feet tall at the time of his death.
- It is important to note that variations in size, not just an increase in size over that of earlier hominins, is characteristic of *H. erectus*, much like living humans.
- There is clear evidence of *H. erectus* accessing medium- and large-sized animal carcasses for meat, through hunting and/or scavenging; evidence = fossil animals with cut marks left by butchery.

Homo erectus:

- Brain size — 962 cc mean; 600-1,251 cc range
- Dentition — Both anterior and posterior teeth smaller than those of early *Homo;* larger than MHs
- Limbs — Relative arm and leg lengths within modern human variation range

Classic *H. erectus* cranial features:

- Large supraorbital torus/brow ridges
- Receding frontal bone
- Long, low-vaulted (platycephalic) braincase, widest at base
- Sagittal keeling
- Thick skull bones; variable flexion of cranial base
- Sharp occipital angulation with occipital torus
- Large ramus
- Strong prognathism
- No chin



Face is wide

Large posterior teeth

Midfacial pronathism / powerfully built jaw

Receding chin

Massive browridge that is straight & barlike or arches over eye sockets

Skull narrows behind eye sockets

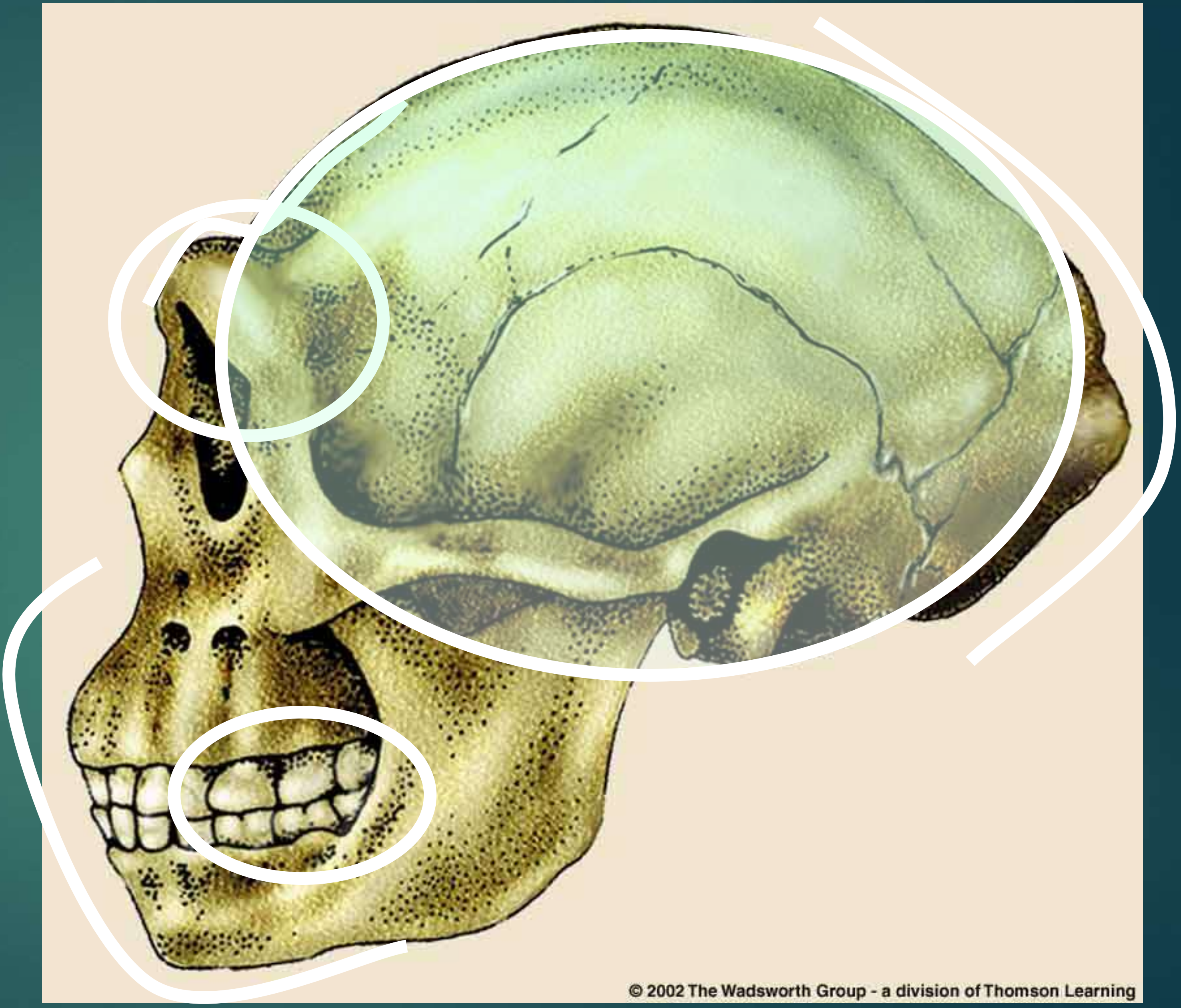
Very angulated occipital

Cranial vault long & low

Cranial capacity: ~1000 cc

Forwardly placed cheekbones

Eye sockets small & rectangular



From Franz Weidenreich, “Morphology of Solo Man” 1951

Understanding Physical Anthropology and Archaeology, 9th ed., p. 227

Pronounced Supraorbital Torus: “Shelf like”

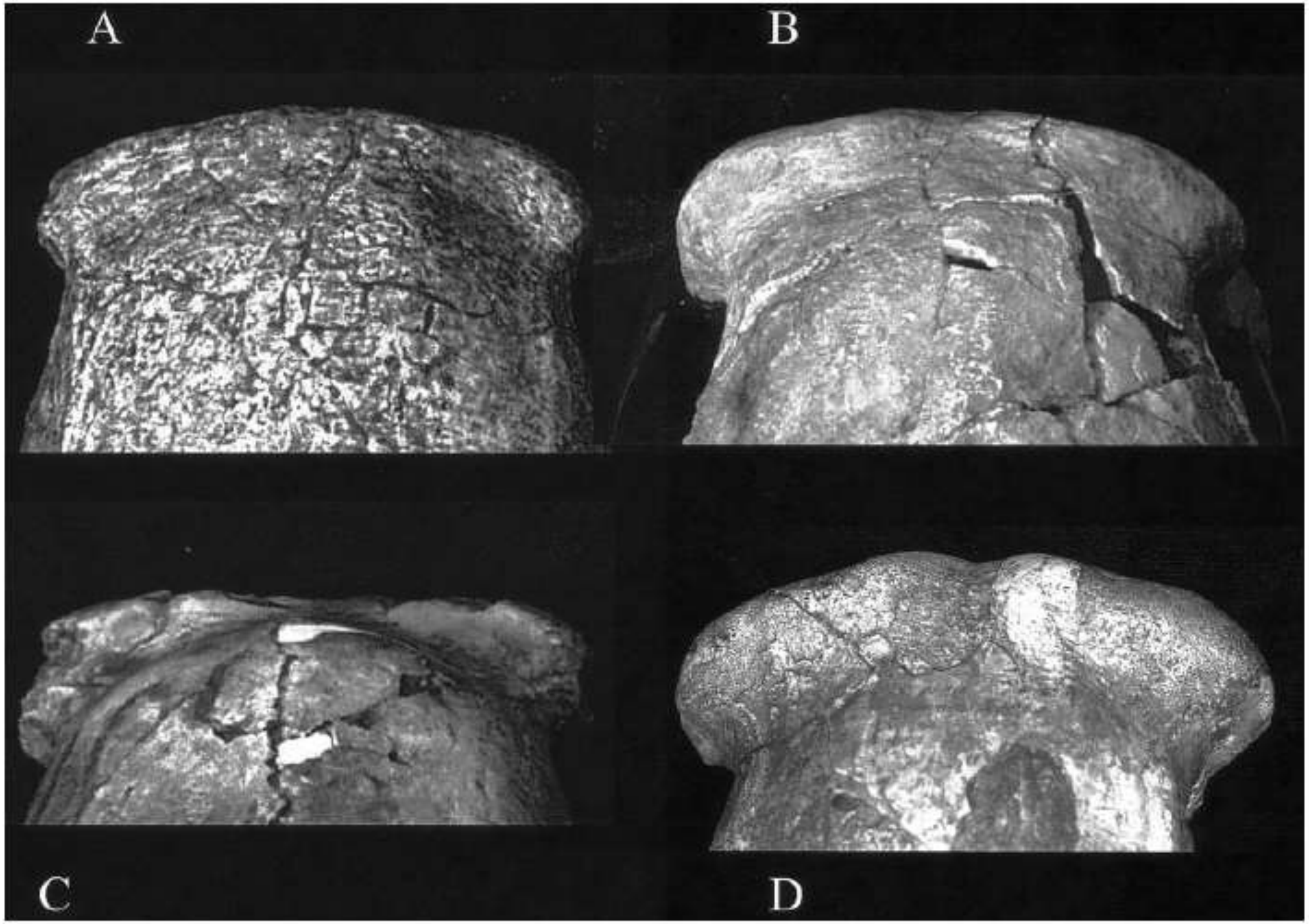
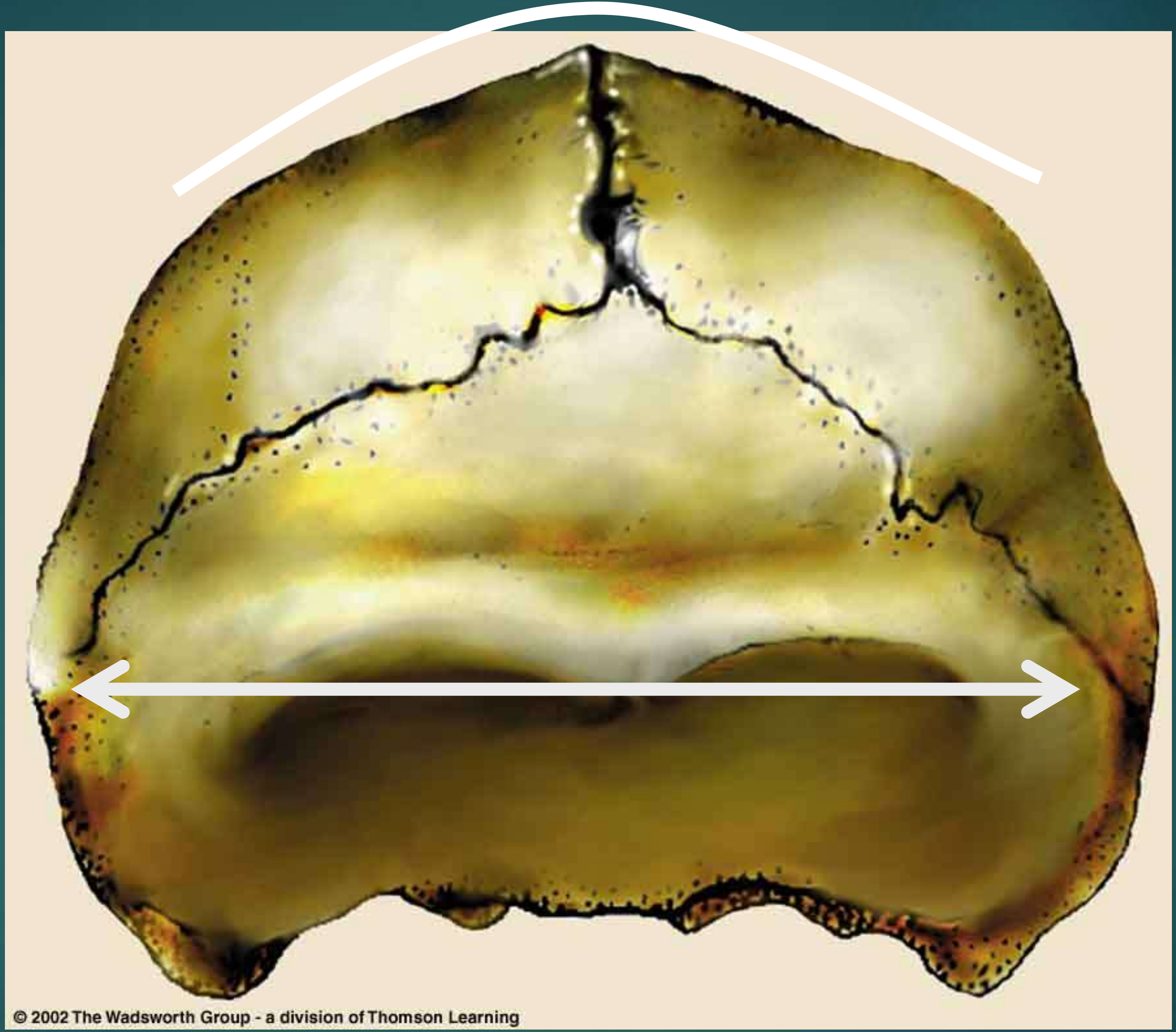


Fig. 5. Superior view of supraorbital torus in (casts) (**A**) Ngandong 6, (**B**) Sangiran 17, (**C**) Zhoukoudian XI, and (**D**) original OH 9.

Thick keel of bone runs along midline of skull

Skull widest toward the base



From Franz Weidenreich, “Morphology of Solo Man” 1951

Understanding Physical Anthropology and Archaeology, 9th ed., p. 227

From left to right: skulls of *Homo erectus*, *Homo heidelbergensis*, *Homo neanderthalensis* and *Homo sapiens*. The braincase of *H. erectus* was more elongated than that of later humans. It had a prominent brow ridge, like *H. heidelbergensis*.

Cranial vault morphology

- *H. erectus* is essentially a cranially defined species, due to the relative paucity of facial remains.
- Vault characteristics include:
  - Moderately sized cranial capacities, ranging from about 600 cc (in East Africa and Dmanisi, Georgia) to over 1,250 cc (in China and Indonesia), with gradual increase in average size through time.
  - Vault shape is relatively low and angulated, with marked frontal recession and occipital angulation and greatest breadth low down, often on the supramastoid crest.
- Postorbital constriction is marked to moderate

FIGURE 11.13

Top views of the skulls of *Homo erectus* (*left*) and modern *Homo sapiens* (*right*). Note the greater constriction behind the eyes in *Homo erectus*.

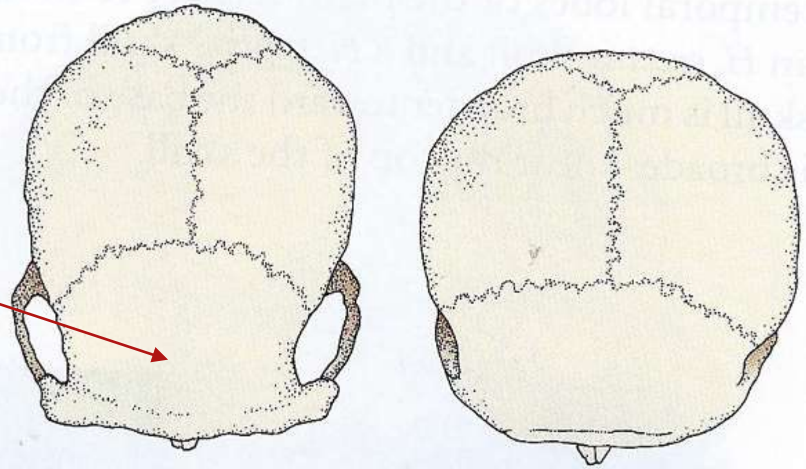
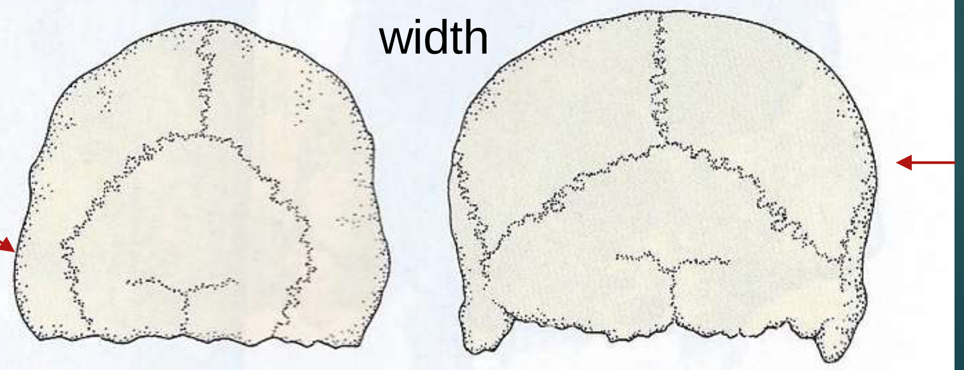


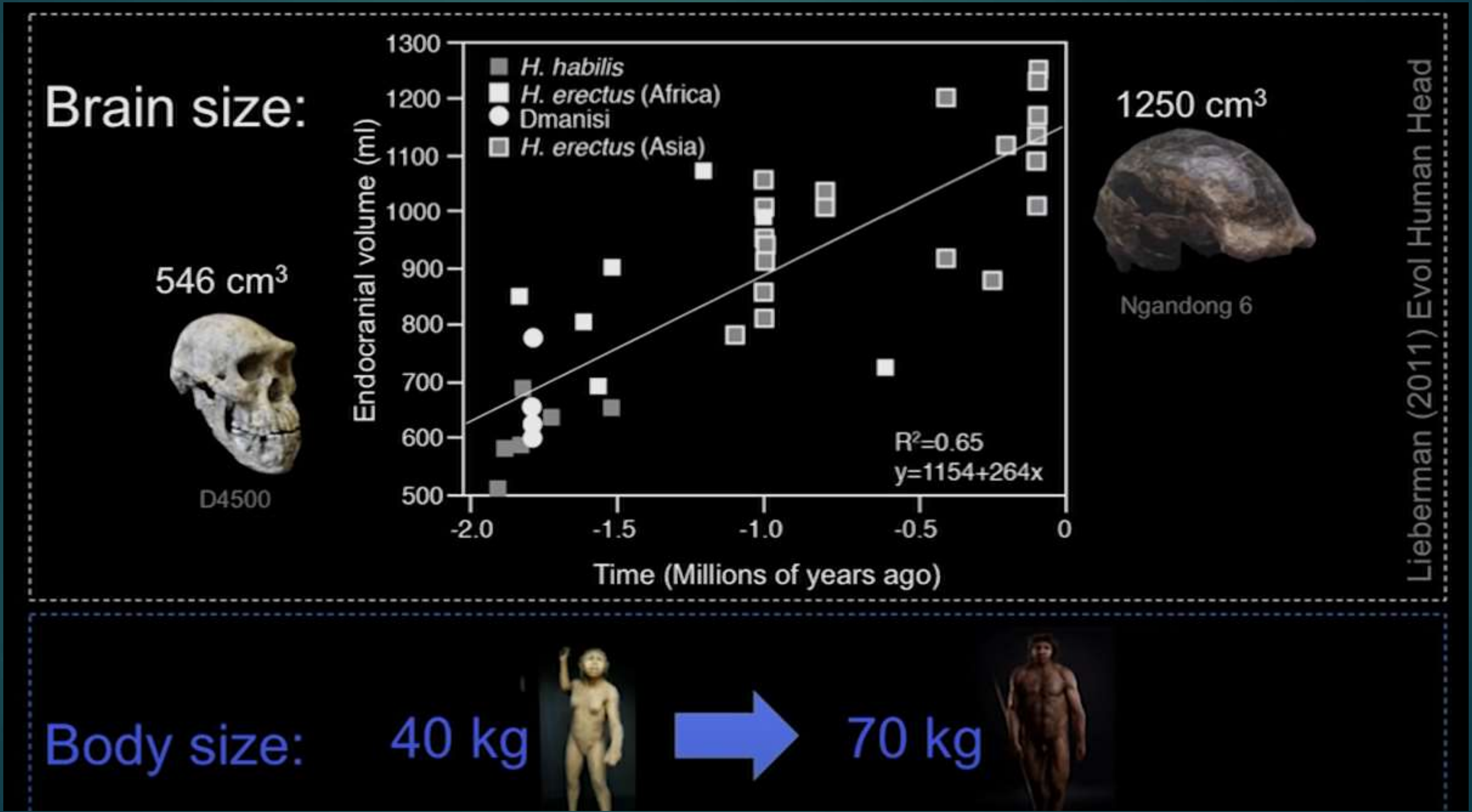
FIGURE 11.14

Rear views of the skulls of *Homo erectus* (*left*) and modern *Homo sapiens* (right). Note the broader brain case of *Homo sapiens* and how the maximum width is higher on the skull.



Parietals flat & vertical

H. erectus doubled its brain size over 2 M years



General cranial features of *H. erectus*

- As *erectus* evolved, cranial bones thicken; Cranial vault bones are nearly twice as thick as in modern humans (averaging 9-10 mm)

- Over time cranial size increases by 50%; Increased brain size correlates with body size increase.

- Adult cranial capacity: 650 to 1250 cc, with a mean value of about 883 cc;
- Brain volume varies from 650 cc in D2282 from Dmanisi (& 730 cc for OH 12) to ~1250 cc for the Ngandong 6 (Solo V) calotte

H. erectus brain size and encephalization

- In addition to the absolute increase in brain volume that accompanies an increase in body size, there is also a proportional increase. This is referred to as encephalization, and is an important characteristic of *H. erectus*.
- Throughout the evolutionary history of *H. erectus* there is substantial evidence for selection leading towards increased encephalization, so that while early members of the lineage have a cranial capacity of 600-800 cc, the cranial capacities of most later specimens are well in excess of 1000 cc, which is within the lower range of contemporary humans, without an increase in body size than early *H. erectus*.
- H. erectus EQ = 3.4 (MH = 5.1)

Cranial capacity for Genus *Homo*

Taxon	Mean Cranial Capacity
Homo habilis	675 cc
Early *H. erectus*	834 cc
Late *H. erectus*	1065 cc
All *H. erectus*	987 cc (range 650-1325 cc)
Modern *H. sapiens*	1350 cc

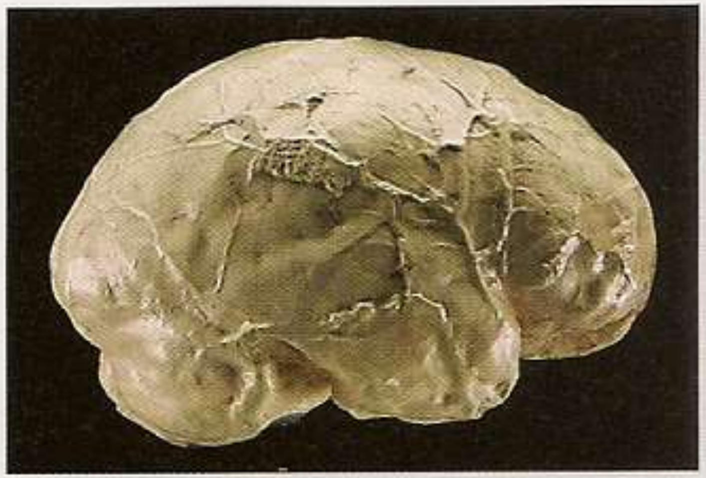
Homo erectus: Adult cranial capacity: 600-1250 cc, with mean of 883 cc (Holloway, 1981); about 65% of MH

Australopithecus afarensis
3.1 million years old; 500 cubic cm

Homo rudolfensis
1.9 million years old; 775 cubic cm

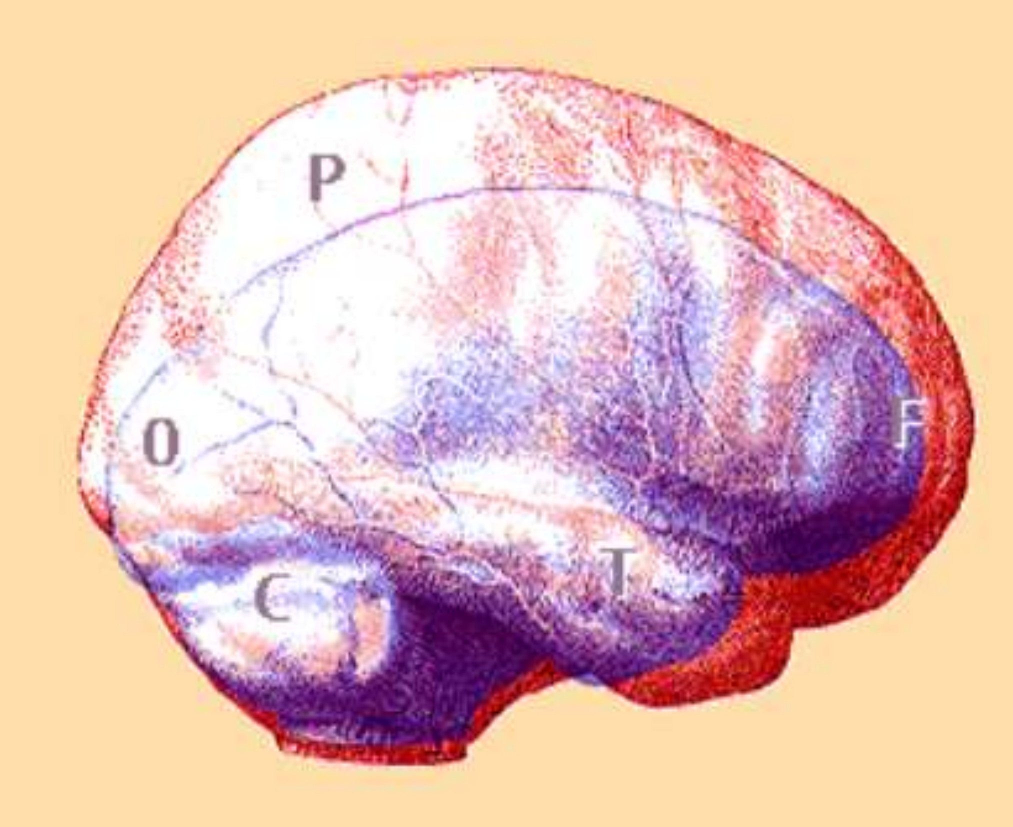
Early Homo erectus
1.8 million years old; 850 cubic cm

Homo heidelbergensis
350,000-150,000 years old; 1,200 cubic cm



Homo sapiens
26,000 years old; 1,322 cubic cm

Fossil brain endocasts provide researchers with hard evidence of how big our ancestors' brains were and some details of their surfaces.



The endocast of a *Homo erectus* brain (blue) superimposed on that of a *Homo sapiens* (red), aligned horizontally on the brain stem under the cerebellum (C), and vertically along the bottom margin of the temporal lobe (T).

H. erectus brain

- The *erectus* brain shows the characteristic "football" shape of hominin brains from *Homo ergaster* on up to Neandertal

- The modern brain shows its greatest expansion in the middle parietal lobes. This expansion accounts for the rounded (soccer ball) shape of human skulls in contrast to the flattened "football" form of skulls in earlier species

- The globularization of the brain and the enlargement of the parietal lobes are features observed uniquely in anatomically modern *H. sapiens*.

Shovel-shaped upper incisors in both *H. erectus* & neanderthalensis

Krapina Neandertal maxilla, photograph © Milford Wolpoff

Postcranial

- Postcranially, body size is human like
- Known mainly from African *H. ergaster*; Dmanisi body size is smaller (145-167 cm) than body size in E Africa
- Limbs:
  - Limbs are modern human-like in their proportions, although the bones were extraordinarily thicker, suggesting a physically demanding lifestyle
  - robust pelvis and femurs
  - pronounced muscle markings; more heavily muscled than ours
  - femoral shaft more oval, less round in circumference, are more flattened from front to back (femur) and from side to side (tibia) than in modern humans

H. erectus skeleton

- Pelvis evidences signs of a habitually upright posture and long-range bipedalism (large socket for the head of the femur (acetabulum); and the bone that connects this to the crest of the ilium is thickened)

- Dennis Bramble and Dan Lieberman: *H. erectus* was adapted to endurance running (over long distance can outpace exhausted antelope)

- No fossil evidence about dexterity of *H. erectus;* but their manufacture of hand axes would make dexterity implicit.

H. erectus: Shorter period of early development

- Modern human-like sequence of dental development is a proxy for the pace of life history in a species
- Life history traits like increased brain size, prolonged growth period (longer childhood & socialization period), age at first reproduction, & longer lifespan correlate tightly with dental development.
- The first evidence for a significant shift in enamel growth rates is with the origin of larger-brained Neanderthals (at least by 100 Ka ago) and modern humans.
- Study: Used daily incremental markings in enamel to calculate rates of enamel formation in 13 fossil hominins and identified differences in this key determinant of tooth formation time.

Dean, et al., 2001

H. erectus: change in life history variables

- Australopiths & early Homo did not share the slow trajectory of enamel growth typical of modern humans; rather, both resembled modern and fossil African apes in more rapid development.
- This study looked at tooth formation times in australopiths, in the,1.5-Ma old *Homo erectus* skeleton from Nariokotome, Kenya, and in the Homo erectus specimen, Sangiran S7-37 from Java. Their formation times were shorter than those in modern humans.
- Results do not support the notion that the sequence of tooth development in *H. erectus* indicates that the timing of slower tooth development events was like that in modern humans.

H. erectus: Shorter period of early development

- In MHs, M1 emerges at 6-7 y, M2 at 12=13, M3 at 17-21.

- M1 emergence at age 4 in KNM-WT 15000; M2 emerged at age 7.6 in Sangiran S7. Their molar emergence times was slower, in step with brain size, than those of African great apes and australopiths.

- *H. erectus* appears to have had a shorter period of dental, brain, and social development than modern humans who had longer childhoods and adolescence.

Homo erectus: about 40 skulls, but only 1 complete skeleton

Why he survived

- The reason why *H. ergaster* is assumed to have been uniquely capable of migrating out of Africa about 1.7–1.9 Myr ago into the Asian grasslands is because of:
  - its long limbs,
  - human-like body proportions,
  - probable efficient thermoregulatory mechanisms for remaining cool in hot conditions,
  - the ability to ingest more meat in an environment rich in fauna but poor in plant foods for a hungry primate,
  - and a sufficiently large brain to deal with the challenges of a more carnivorous niche

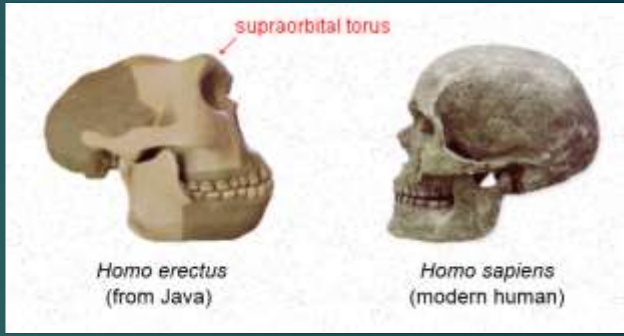
Homo erectus

- Early fossil discoveries from Java (beginning in the 1890s) and China ('Peking Man', beginning in the 1920s) comprise the classic examples of this species.
- Turkana Boy: Microscopic study of the teeth indicates that he grew up at a growth rate similar to that of a great ape.
- There is fossil evidence that this species cared for old and weak individuals.
- The appearance of *Homo erectus* in the fossil record is often associated with the earliest handaxes, the first major innovation in stone tool technology.
- The worldwide association of *H. erectus* with elephants is well documented and so is the preference of humans for fat as a source of energy

Smithsonian

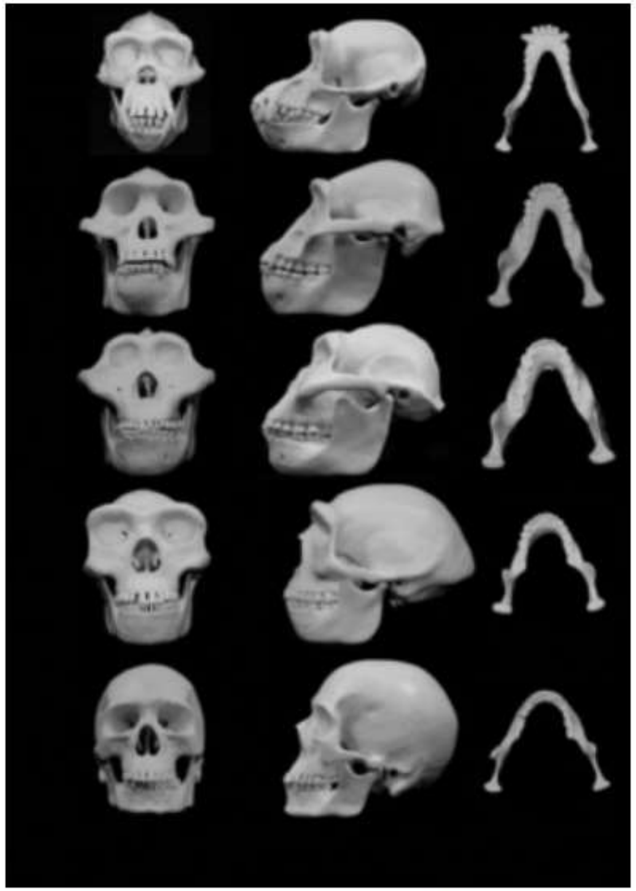
Thick browridges

- Henry Gilbert: loss of large browridges in modern humans associated with expansion of frontal lobe and expansion of frontal bone
- Cranium as helmet theory: size of browridge due to evolution to protect face in combat. N. Boaz: *Homo erectus* regularly resorted to head-bashing to settle disputes.
- Hawks thinks browridge is protective of the eyes,
- Others think it prevents stress from heavy chewing
- Major accepted theory is that there is evidence to support the hypothesis that <u>changes in diet and food processing</u> best explain the decrease in the size of the face during human evolution.



Facial development and fistfights

- Morgan, 2014: Only humans fight with fists. As this weapon got better, so did the defense: the robusticity and strength of the face. Humans developed thicker and less protruding jaws, stronger jaw muscles and teeth, and a reinforced bone under the eye socket -- all areas that take a beating in a fight. The fist evolved over that time to be a better fighting weapon.
- Most ideas concentrate on its role as a feature that strengthened the skull or helped dissipate forces passing through the skull. Researchers have recently indicated the latter was unlikely, instead speculating that it may have had a role in social signaling between archaic human individuals, enhancing friendly or aggressive facial expressions.
- Major accepted theory is that there is evidence to support the hypothesis that changes in diet and food processing best explain the decrease in the size of the face during human evolution.



University of Utah researchers contend that human faces evolved to minimize injury from punches to the face during fights between males. Top to bottom: chimpanzee, our closest primate relative; hominid ancestors Australopithecus afarensis, Paranthropus boisei, Homo erectus; and modern human. (University of Utah)

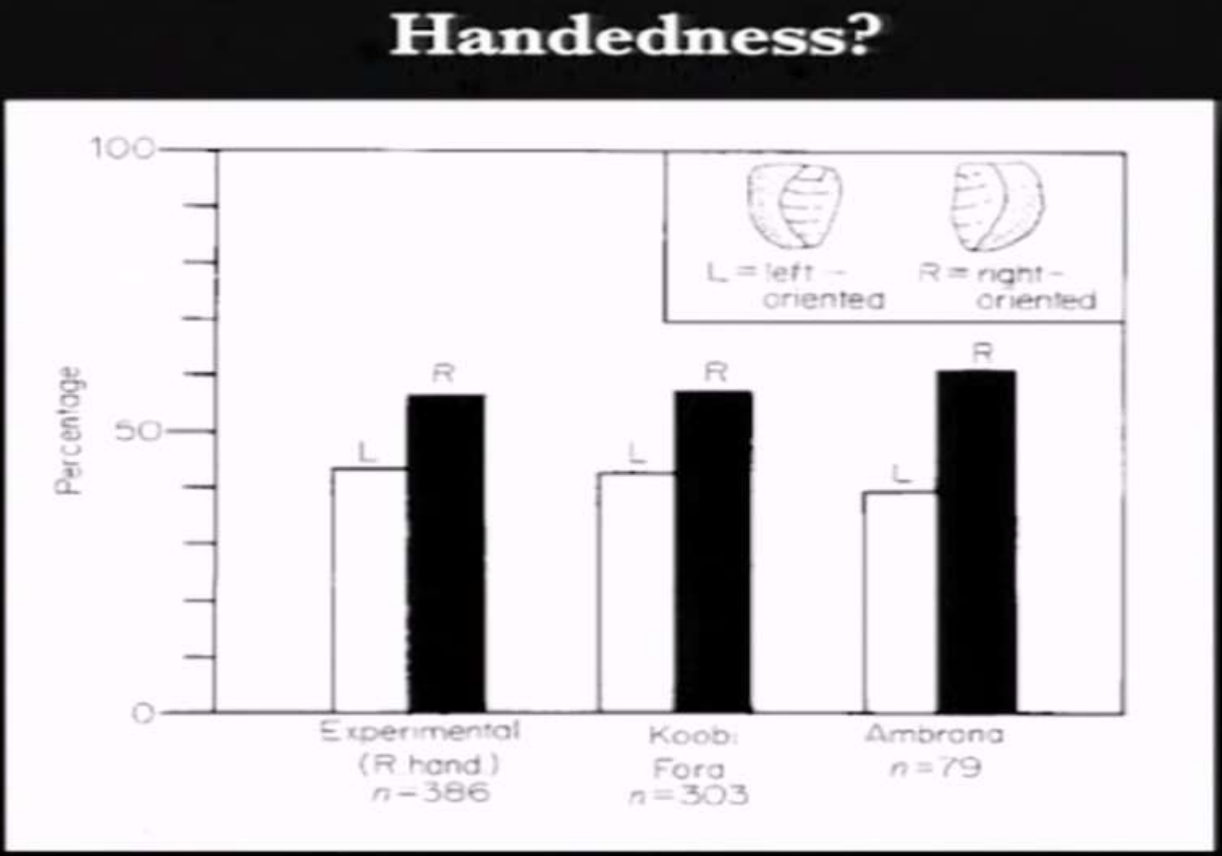
M. Morgan & D. Carrier, *Biological Reviews*, 2014

Boaz & Ciochon: Head bashing to settle disputes

- The most distinctive anatomical difference between *Homo erectus* and other hominins is the skull. The massively thick bony wall surrounding the brain - which has been likened to a tortoise carapace and a cycling helmet - has defied an adequate explanation, until now.
- Increasing brain size would have necessitated a larger skull, but not a thicker one. And the notion that a thick skull might have been required to support chewing muscles makes little sense since *Homo erectus* has smaller teeth than earlier hominins.
- Searching for a plausible evolutionary explanation, we looked to other species and were struck by a similarity between a variety of thick-skulled animals, from the Cretaceous dinosaur *Pachycephalosaurus* to bighorn sheep. All these seem to have evolved thick bone for the same purpose - protection. Could this also explain the skull of *H. erectus*? And if so, from what did these hominins need protection?
- The answer can be found on a number of skulls from Dragon Bone Hill. They show signs of trauma, and in particular the sorts of depression fractures that come from a sharp blow to the head. Our re-analysis of these fractures, originally identified by anatomist Franz Weidenreich on Zhoukoudian fossils in Beijing in the 1930s, have convinced us that, like some modern human populations, *Homo erectus* regularly resorted to head-bashing to settle disputes.

Dragon Bone Hill by Noel T. Boaz & Russell L. Ciochon, 2004

Probably Right-Handed via tool evidence



Toth, N. (1985). Archaeological evidence for preferential right-handedness in the Lower and Middle Pleistocene, and its possible implications. *Journal of Human Evolution, 14*(6), 607-614.

Have MH style petulias pattern of L & R brain organization

More right-handedness: Toth (1985): 57-43 ratio of right to left flakes at Koobi Fora; right-handed knappers produce more right handed flakes; rotates core clockwise in left hand, knapping each flake to right of previous one

1 or 2 species

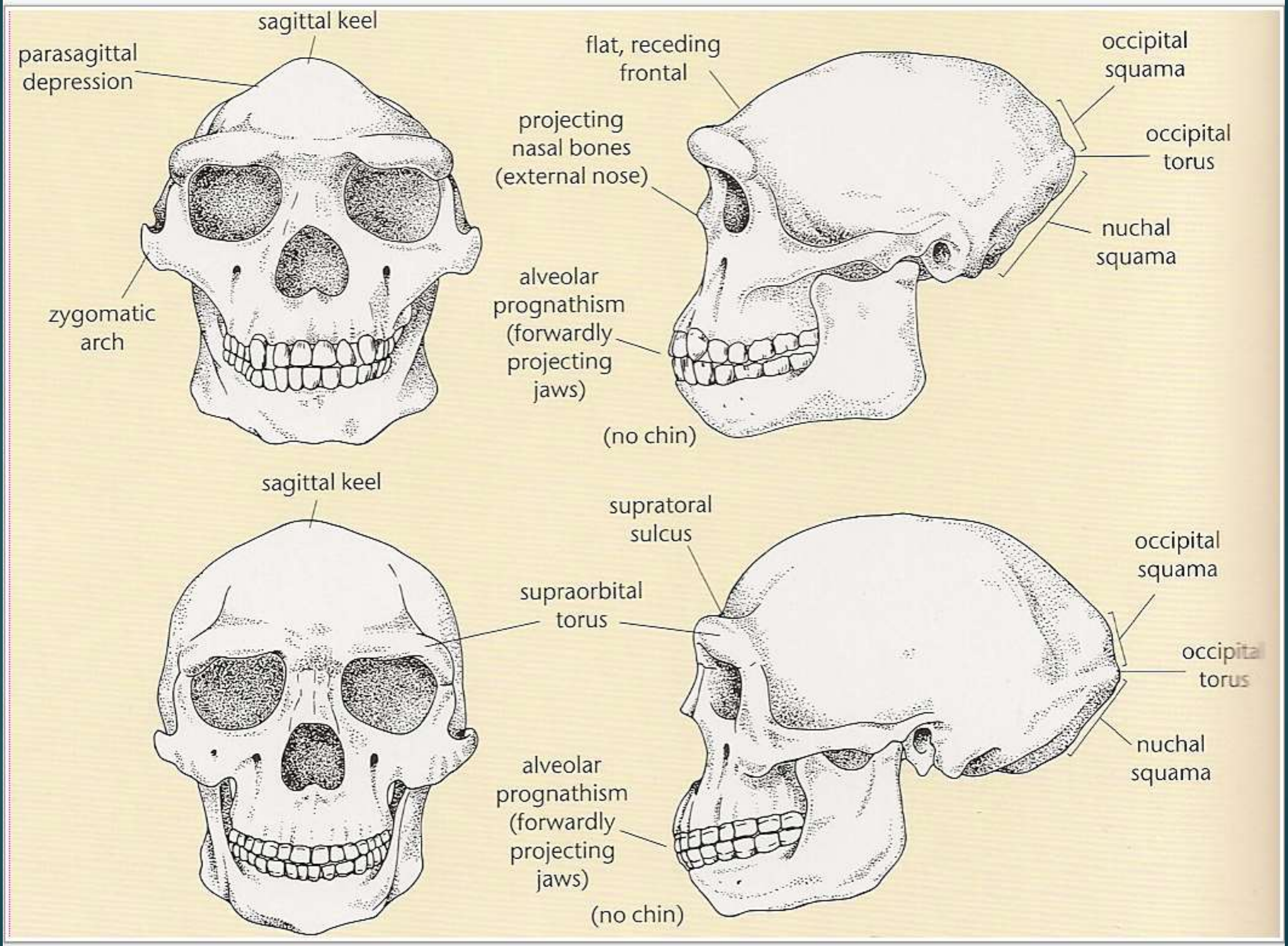
- Does anatomical variations seen in different geographical populations of *H. erectus* reflect existence of more than one species?
- Early African specimens (ER 3733) assigned to "*Homo ergaster*"
- Asian specimens remain the classic "*Homo erectus*".
- The 2 specimens are now viewed as having an ancestor/descendant relationship, with
  - *H. ergaster* originating in Africa close to 2 Ma,
  - then expanding into Asia, where it gave rise to *H. erectus*
- Most now accept *H. erectus* as a single species

Weidenreich Reconstructions:

Regional variation

Indonesian (Sangiran)

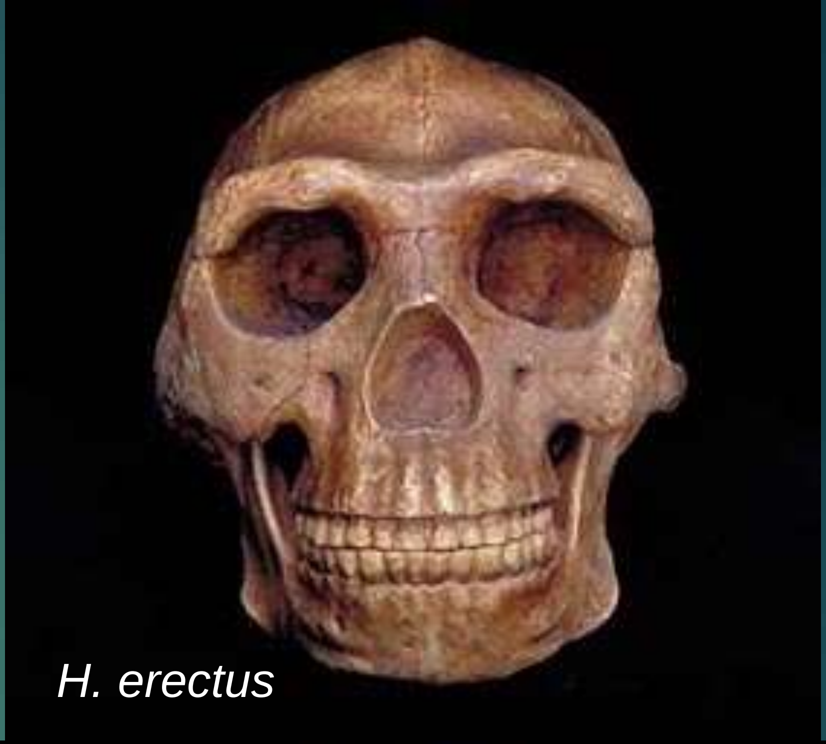
Chinese (Zhoukoudian)



Variation within Asia.

- Chinese and Indonesian *H. erectus:*
- Vault size in Asian *H. erectus* ranges from about 800 cc to 1,250 cc, with a gradual increase in mean cranial capacity with time.
- Asian *H. erectus* possess a long, low vault that, when viewed from above, is strongly pear-shaped.
- The most marked differences between Chinese and Indonesian *H. erectus* faces relate to relative prognathism. Indonesian faces (Sangiran 17 and 27), have been reconstructed to be much more prognathic than Chinese.
- The relatively narrow frontal (postorbital constriction) and occipital breadth, coupled with a relatively large brain size, separate the Chinese morph from the Indonesian samples

- Note the difference in the shape of the cranium.
- On the top, Indonesian *H. erectus*
- African *H. ergaster* has a more globe-shaped braincase



H. erectus

H. ergaster

Traits Thought to Distinguish *Homo ergaster* from *Homo erectus*

Homo ergaster traits:

- Complex multiple roots of premolars
- Longer, narrower molars
- Thinner cranial bones
- Lack of sagittal keel
- Less pronounced occipital torus
- Narrower cranial base
- Higher cranial vault

East vs. African *Homo erectus*

- In the light of discoveries at Koobi Fora, it has been suggested that the earliest African examples should be called *H. ergaster*, after the specimens found at Koobi Fora, including WT15000, Turkana Boy, that was initially published as *H. erectus*.

- Some researchers separated the two into distinct species *Homo ergaster* for early African "*Homo erectus*", and *Homo erectus* for later populations mainly in Asia.

- Consequently, it is the African *H. ergaster* that is now seen by some as the hominin that first colonized Asia and formed the founding population of what later became *H. erectus* in China and southeast Asia.

- Antón, 2003: views *H. erectus* is widely dispersed set of populations that are able to interbreed and hybridize

R. Dennell & W. Roebroeks, 2005

Asian vs African variation

- <u>Why the variation</u>?
  - Geographic distances
  - Different time: 1.8M vs 500K = 1 Ma difference
  - Different sizes (age, sex)
  - Just idiosyncratic differences

- <u>Geographical variation or different species</u>?
  - 1 species*: homo erectus*
  - 2 species: *erectus vs ergaster*

- 1980-90s: <u>more researchers go with *H. ergaster* as an ancestor to Asian *H. erectus*</u>*;* <u>Tim White</u>, of U.C. Berkeley, considers *Homo ergaster* to be a geographical variation of *Homo erectus*.

Chinese anthropologists

- In opposition to the standard Out of Africa model

- Multiregionalism: Push a mosaic of morphological similarities between *H. erectus and H. sapiens* in Far East: think it is evidence that Asian populations of *H. sapiens* evolved directly from Asian *H. erectus*

- Some claim that facial features appeared in Far East far earlier than in Europe or Africa and that *H. sapiens*-like morphology appeared first in Asia then spread secondarily to Near East and Europe.

Differences in geographic evolution of *H. erectus*

- In Africa, evidence that later *H. erectus* may have evolved into premodern *Homo* in the form of H. *heidelbergensis.*

- But in Indonesia, later *H. erectus* material seems to get more specialized. This makes it less likely that Indonesian hominins evolved into archaic *Homo* and more likely that they were a dead end.

Early
Homo erectus:

Africa

Some early *Homo erectus* were small sized

- In contrast with *1470 & 1813 Groups*, but partly overlapping them in time, is early African *H. erectus* (~1.89 Ma to 900 Ka)

- Cranial fossils KNM-ER 42700 and KNM-OG 45500 substantially extend the lower end of the size range, overlapping with early *Homo*.

- Postcranial fossils from Gona, and reevaluation of KNM–WT 15000 skeleton (Turkana Boy) suggest *H. erectus* had small sized individuals, as well as a less-linear body form than previously thought.

Evolution of early *Homo*: An integrated biological perspective
Susan C. Antón, Richard Potts, Leslie C. Aiello, 2014

KNM-ER 42700

Homo erectus skull, KNM-ER 42700; Ileret, Kenya

KNM-ER 42700
Site: Koobi Fora, Kenya
Year of Discovery: 2000
Discovered by: A team led by Meave Leakey
Age: About 1.55 Ma
Species: *Homo erectus*

KNM-ER 42700: *H. habilis* not ancestral to *H. erectus*

- 1.55 Ma
- Small brained *H. erectus*
- This cranium of a young adult has one of the smallest brain sizes known in *Homo erectus*–similar in size to *Homo habilis* fossils, but it has features more similar to other *Homo erectus* crania.
- Found in northern Kenya where younger fossils of *Homo habilis* have been found, demonstrating that these two species existed at the same time, rather than *H. habilis* being ancestral to *H. erectus.*

Olorgesailie, Kenya: 1000s of stone axes

Site was used from 1.2 Ma to 400 Ka

KNM-OG 45500: first early human fossil known from Olorgesailie, 900 Ka.

The frontal bone, including the brow ridge, of the hominin skull from Olorgesailie (KNM-OG 45500). Scale = 1 cm.

- This browridge is part of a braincase discovered by a Smithsonian team at Olorgesailie, a site known since 1942 for abundant stone tools.

KNM-OG 45500
Site: Olorgesailie, Kenya
Year of Discovery: 2003
Discovered by: A team led by Richard Potts
Age: About 900 Ka
Species: *Homo erectus*

Early *erectus*

- Between 1.9 and 1.5 Ma, substantial regional population variation in size exists;
  - brain size: 546 to 1067 cc
  - postcranial body mass estimates suggest ranges of 40 to 68 kg (88 to 149 lbs).
- Substantial size variation exists within and across regions,
- Dmanisi is the smallest population known to date.

Evolution of early *Homo*

- Possible effect of habitat variation among populations of *H. erectus*:
  - low-quality habitats would be associated with smaller body size
  - once established, larger body size provides a greater range of adaptive flexibility in response to environmental circumstances.
  - Across mammals, larger body size also equates with larger home range sizes.
  - Large home ranges imply increased total daily energy expenditure
  - Larger brain size implies efficiency in obtaining a high-quality calorie-rich diet.

Evolution of early *Homo: H. erectus* as first to disperse?

- Possibility remains, of course, that *H. erectus* was not the first or only hominin to disperse from Africa.

- *Homo floresiensis* raise the possibility of a pre-*erectus* hominin in eastern Asia

- Current fossil and archaeological evidence to date all point to *H. erectus* as the first disperser.

- Reduction of mortality risk and increased nutritional sufficiency are implied by increasing body and brain sizes, Classic (Early)

East Asia, Java

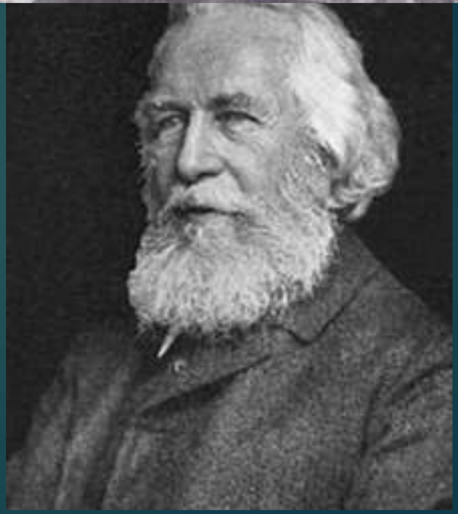
Homo erectus

First *H. erectus* to be found

Ernst Haeckel (1834-1919):

- German anatomist & zoologist
- Founded German evolutionary biology
- Coined terms ecology, ontogeny & phylogeny
- Major Darwin defender

- Darwin is right, but look to Asia



Ernest Haeckel's Tree:

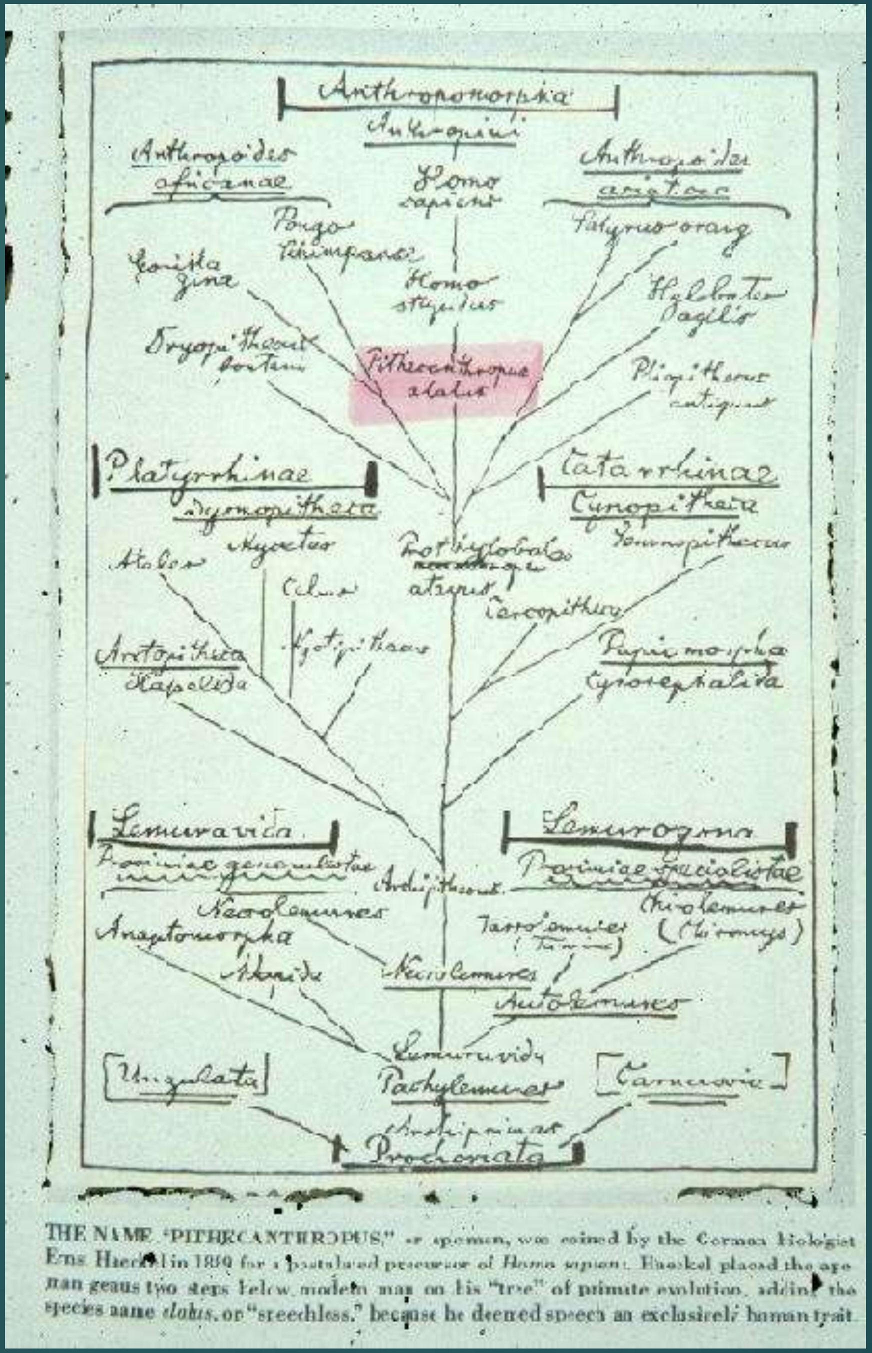
Homo sapiens

↑

Homo stupidus
(H. neanderthalensis)

↑

Pithecanthropus alalus



1866:

- published first phylogenetic tree
- predicted the discovery of a "missing" phylogenetic link between humans and apes
- Gave it name of "*Pithecanthropus*", "ape man without speech"

1891 Discovery: Java Man (*Pithecanthropus erectus*)

Skullcap: apelike, low contour, brow ridge;
brain = 800 cc; but bigger than all living apes

Eugène Dubois (1858-1940): Search for "Missing Link"
Pithecanthropus erectus in Java

- Dutch anatomist & paleontologist; (Eugène = Oy-gen)
- Joined Medical Corps of Royal Dutch East Indies Army to get to Java
- 1891: First discovery of *Pithecanthropus erectus*, or Java Man at Trinil, Java—"a species in between humans and apes;" a tooth & skull cap in 1891 & femur in 1892
- 1894: Dubois makes the Trinil calotte the type specimen of *Pithecanthropus erectus*. Eventually reclassified as *Homo erectus*.
- Returned to Netherlands in 1895, buried fossils under his floorboards and did not show for 30 years; became withdrawn;; Henry Fairfield Osborn of AMNH set up international protest. He eventually showed them, but died embittered man.

Java, during most of the Pleistocene, was continental Asia, not islands; later sea rise created archipelago

Campbell – Loy, *Humankind Emerging, 7th ed.*, p. 295

Naming: *Pithecanthropus erectus*

- The species was named by Eugène Dubois (it was originally designated as *Pithecanthropus erectus*) in 1894, after his 1891 find from Trinil, Java, in Indonesia (molar = Trinil 1, calotte = Trinil 2, femur = Trinil 3).
- Dubois was inspired by Ernest Haeckel’s conviction that the origins of modern humans might lie in Southeast Asia.
- Dubois enlisted as an army surgeon in the Royal Dutch East Indies Army, and searched for fossils in Sumatra in 1888.

Naming: *Pithecanthropus erectus*

- He had little success in Sumatra; In 1891, with the help of 50 convicts, unearthed a thick mineralized hominin skull plate (calotte) near the bank of the Solo River on the island of Java, Dutch East Indies (now Indonesia); near the village of Trinil. First a tooth, then a calotte. Then, 35 feet away and a year later, a femur.

- First thought it was an ape, named it "*Anthropopithecus*"

- Dubois made his find public a few years later; was met by derision from the dominant British paleontological hierarchy.

- Not all convinced calotte and femur are from same individual, or that femur is as old as calotte

Dubois vs British establishment anthropologists

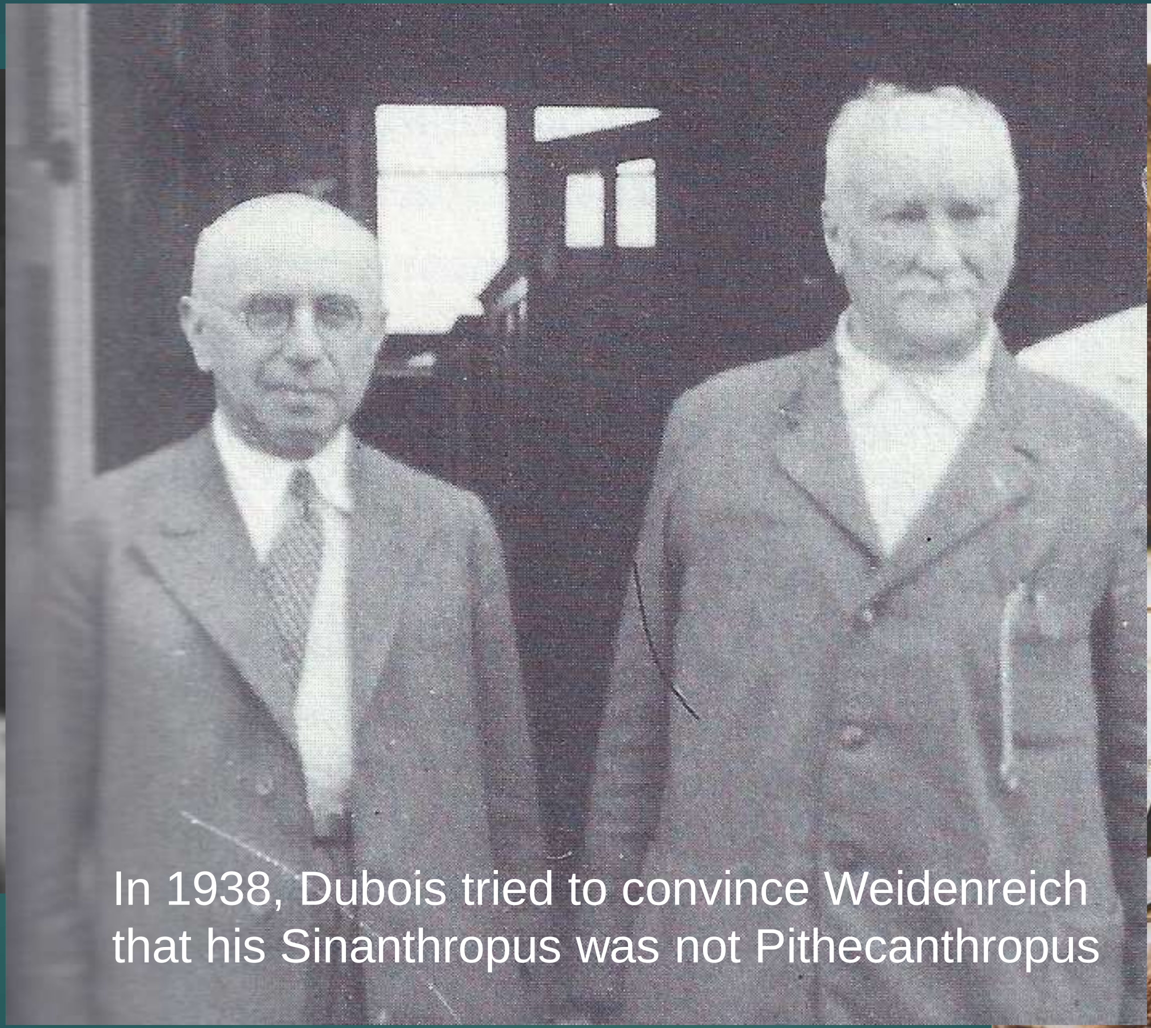
- Dubois: found specimen with human like body, but ape sized brain

- British anthropologists: expected big brain and ape body
  - Taung child (1924) did not meet this paradigm
  - Piltdown (1912) did

- Named it *Pithecanthropus erectus* (now *Homo erectus*)

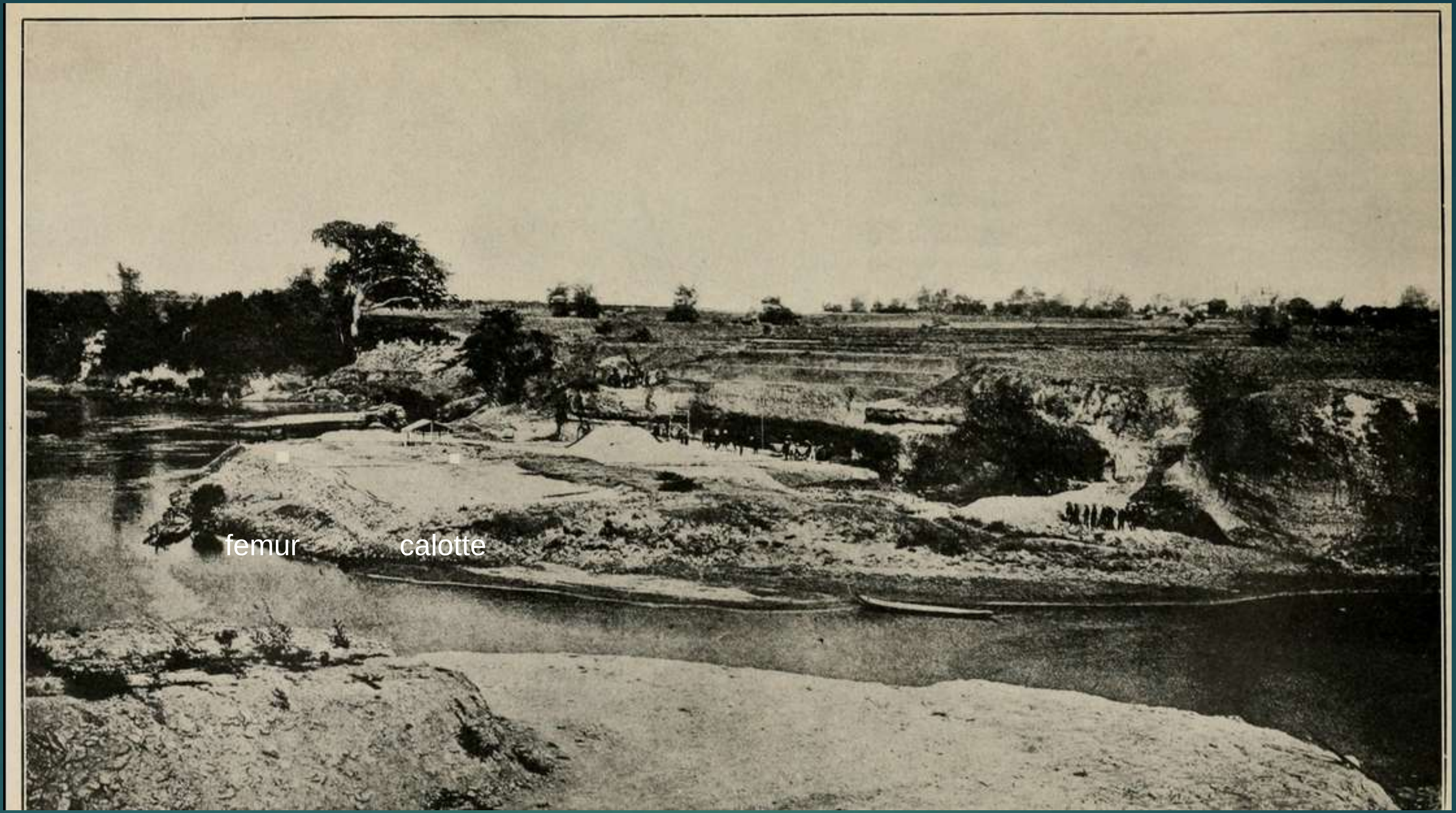
- Molar = Trinil 1, calotte = Trinil 2, femur = Trinil 3.

Eugène Dubois



In 1938, Dubois tried to convince Weidenreich that his Sinanthropus was not Pithecanthropus

1894



Two white squares show where the femur (left) and the skullcap (right) were discovered. Femur was 35 feet away & found 1 year later.

Pithecanthropus (Homo erectus), Java Man 2

- In homage to Haeckel, he described the species as
  - *Pithecanthropus erectus* (from the Greek *πίθηκος (pithec)*,"ape", and *ἄνθρωπος (anthropos)*, "man"),
  - based on a calotte (skullcap) and a femur like that of *H. sapiens* found from the bank of the Solo River at Trinil, in East Java.
  - This species is now regarded as *H. erectus*.
  - The find became known as *Java Man*
- Dubois is often considered the first paleontologist.

1891: *Pithecanthropus erectus,* Trinil 2: 1M-700K, 850-950 cc

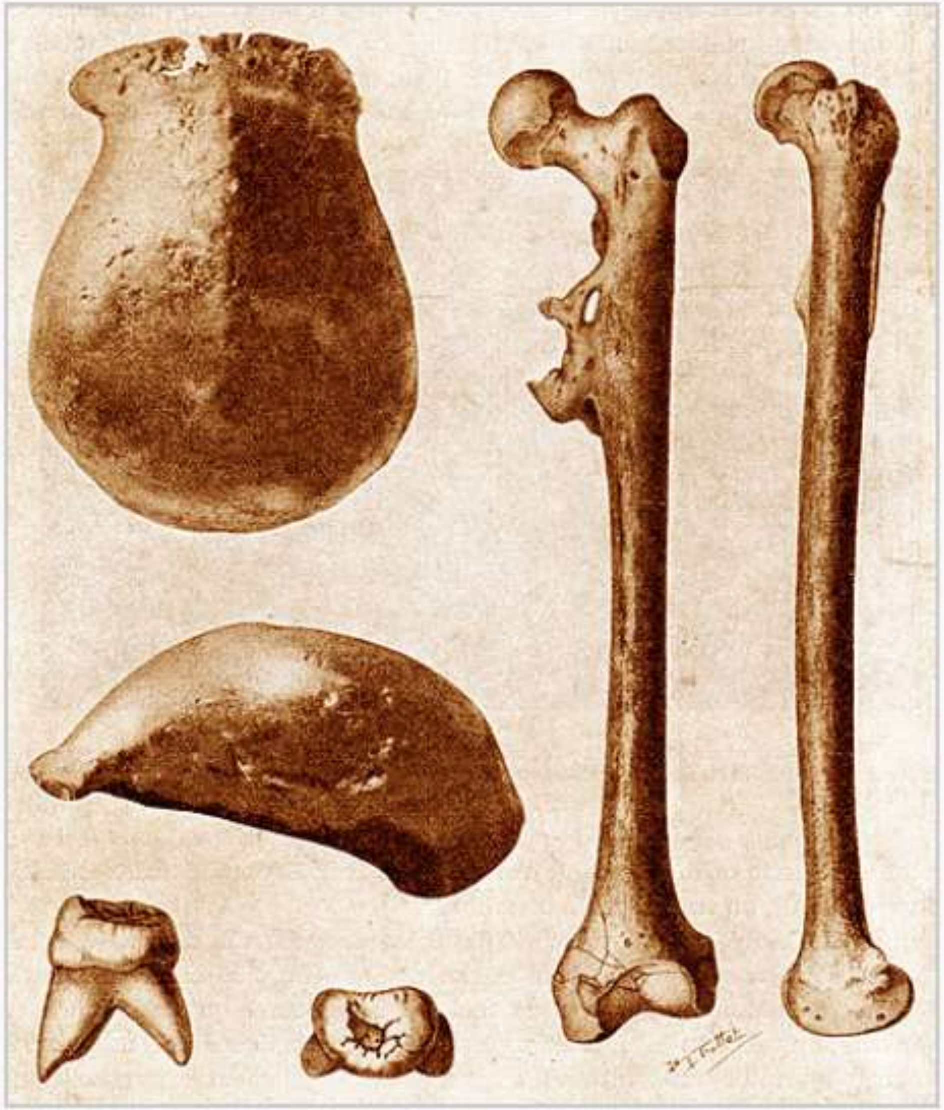
- When this skull cap was discovered in 1891, it was the first early human fossil recognized outside Europe. It is sometimes called "Java Man" because it was found on the island of Java, Indonesia.

- This calotte, Trinil 2, is long, with a flat forehead and distinct browridges and a sagittal keel, though many of its features have been worn flat with age. Dubois named a new species, *Pithecanthropus erectus* after this specimen in 1894, but Ernst Mayr reassigned Trinil 2 to *Homo erectus* in 1950.

Nickname: Java Man
Site: Trinil, Java, Indonesia
Date of discovery: 1891
Discovered by: Eugene Dubois
Age: Between 1 million and 700,000 years old

Image Credit: Matt Finarelli, Human Origins Program

Trinil 2: Calotte

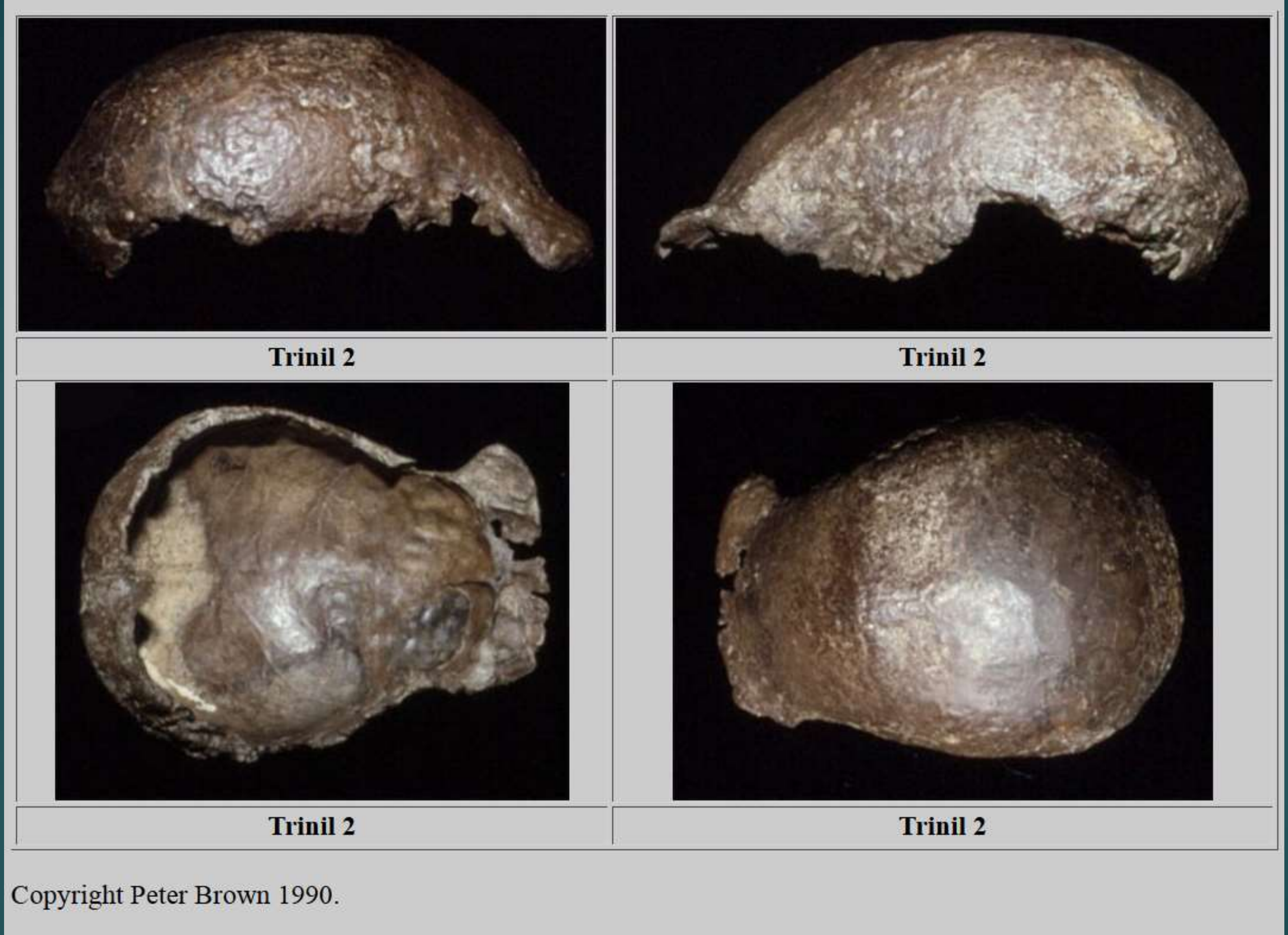


Original fossils of *Pithecanthropus erectus* (now *Homo erectus*) found in Java in 1891.

Femur has
pathological projections

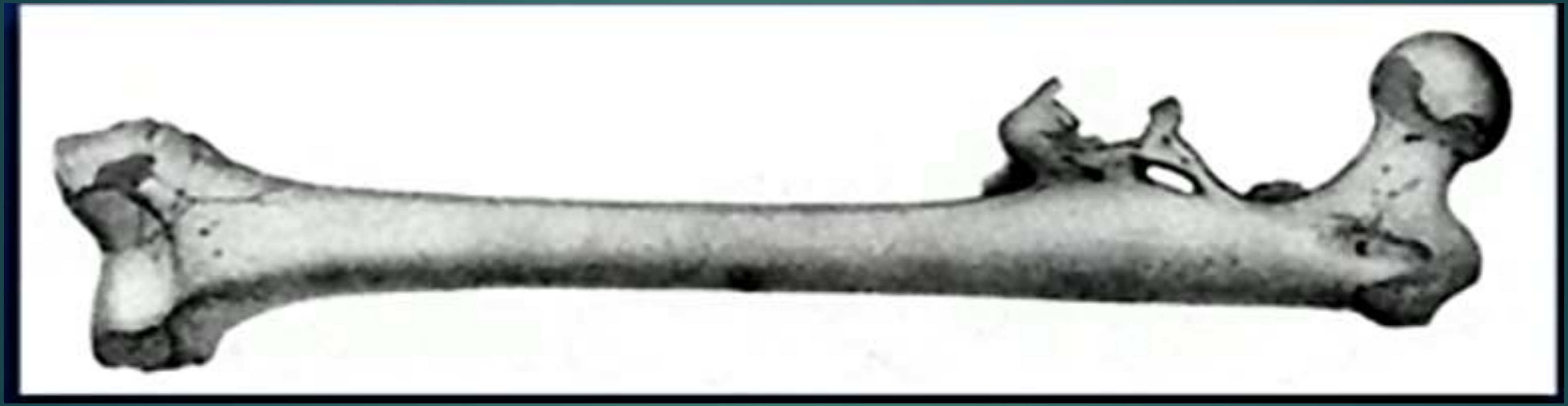
Trinil 1: Molar

Trinil 2



- Preserves much of frontal bone, small portion of left browridge, both parietals, much of upper part of occipital bone
- Cranial base is missing; Gilbert: 940 cc, 1 Ma

Trinil Femur: hominin = right length; key features of upright stance (angulation at knee; muscle markings around head and neck = bipedal)



Femur has never been confirmed to be as old as the calotte or as contemporaneous as it; most believe it is much more recent, from a MH

Dubois's 1899 reconstruction of Java Man, using son as model

Incorrect abducted/divergent toe

Ardi (4.4 Ma) had last abduction

Postcranially *H. erectus* was modern

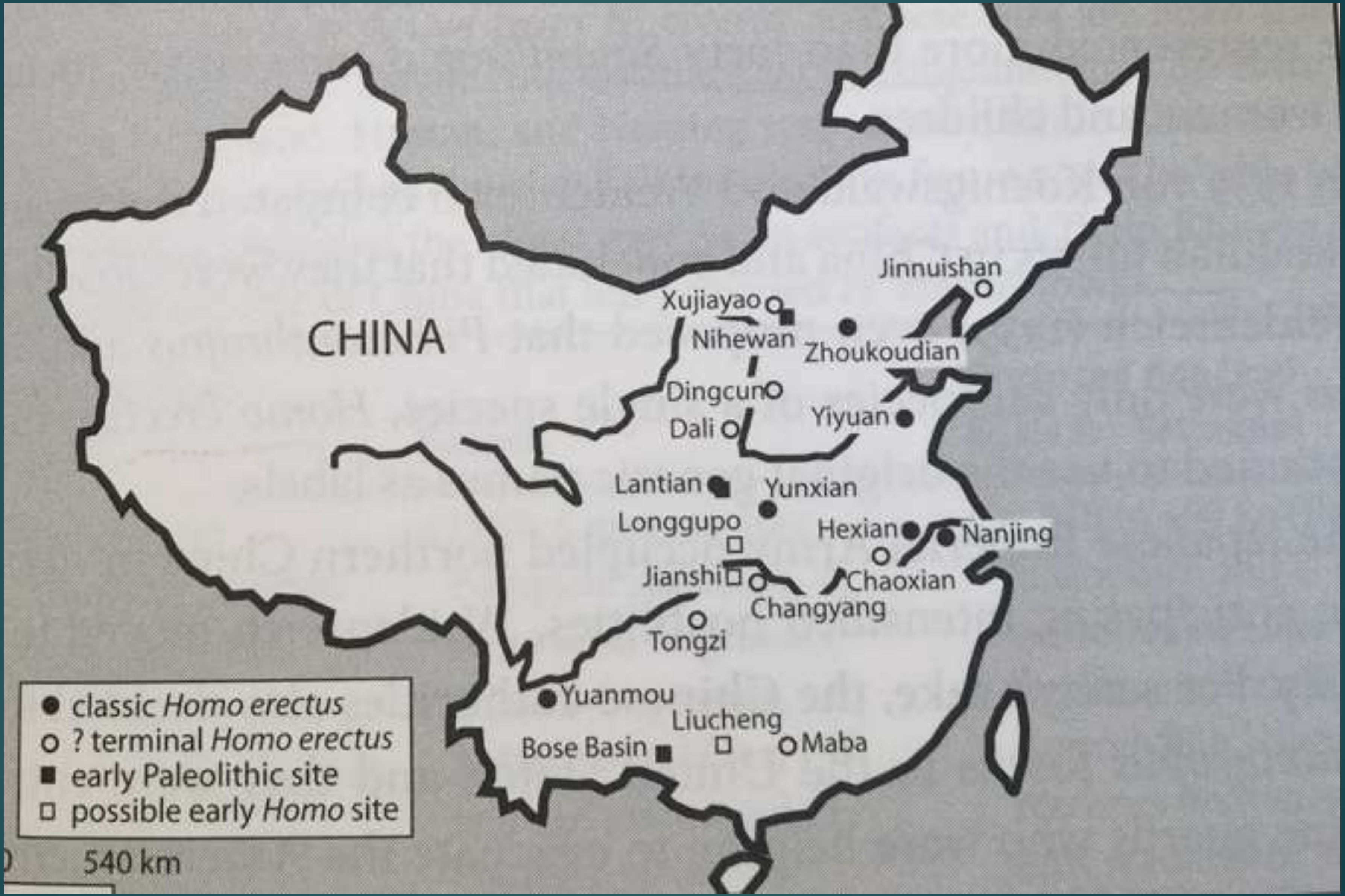
Late Classic
East Asia
Homo erectus:

Zhoukoudian, China

1929: Big Media Find, Banner Headlines

PEKING MAN RANKED AS OLDEST HUMAN

Scientists Call Fossil Nearest Approach to Missing Link Yet Discovered.


CHINA
Jinnuishan
Xujiayao
Nihewan
Zhoukoudian
Dingcun
Dali
Yiyuan
Lantian
Yunxian
Longgupo
Hexian
Nanjing
Chaoxian
Jianshi
Changyang
Tongzi
Yuanmou
Liucheng
Bose Basin
Maba
classic Homo erectus
? terminal Homo erectus
early Paleolithic site
possible early Homo site
540 km

Davidson Black (1884-1934): *Sinanthropus pekinensis*

- Canadian physician and anatomist
- 1927: described 2 fossil molars, and later a skull, and named it *Sinanthropus pekinensis* (now *Homo erectus*) or the "Peking Man" at Choukoutien (Zhoukoudian) Cave; 300K (molar found by Dr. Birger Bohlin; skull by Wenzhong Pei)
- Founder & 1st director of Cenozoic Research Laboratory (Geological Survey of China) at Peking Union Medical College
- Black's theory of an Asian origination of MHs is wrong,
- Carried a watch chain gold receptacle with 1st molar found at Zhoukoudian; died at his desk with *H. erectus* skull firmly clutched in his hand

Zhoukoudian

- In December 1929, the first of several skullcaps was found on the same site, and it appeared similar to that of Java Man, though slightly larger.

- Franz Weidenreich, who replaced Black in China after the latter's death in 1933, argued that *Sinanthropus* was also a transitional fossil between apes and humans, and was in fact so similar to Java's *Pithecanthropus* that they should both belong to the same group. In 1940, Weidenreich merged both into *Homo erectus*

- Dubois rejected these interpretations.

Franz Weidenreich (1873–1948):
Homo erectus in China

- German anatomist and anthropologist
- In 1933, Succeeded Davidson Black as head of Cenozoic Research Laboratory & collaborated with Teilhard de Chardin at Zhoukoudian.
- His monographs on *Sinanthropus* fossils at Zhoukoudian, China published between 1936 & 1943 by Geological Survey of China
- 1940: Established the name *Homo erectus* (which includes *Sinanthropus* & Javanese *Pithecanthropus*).

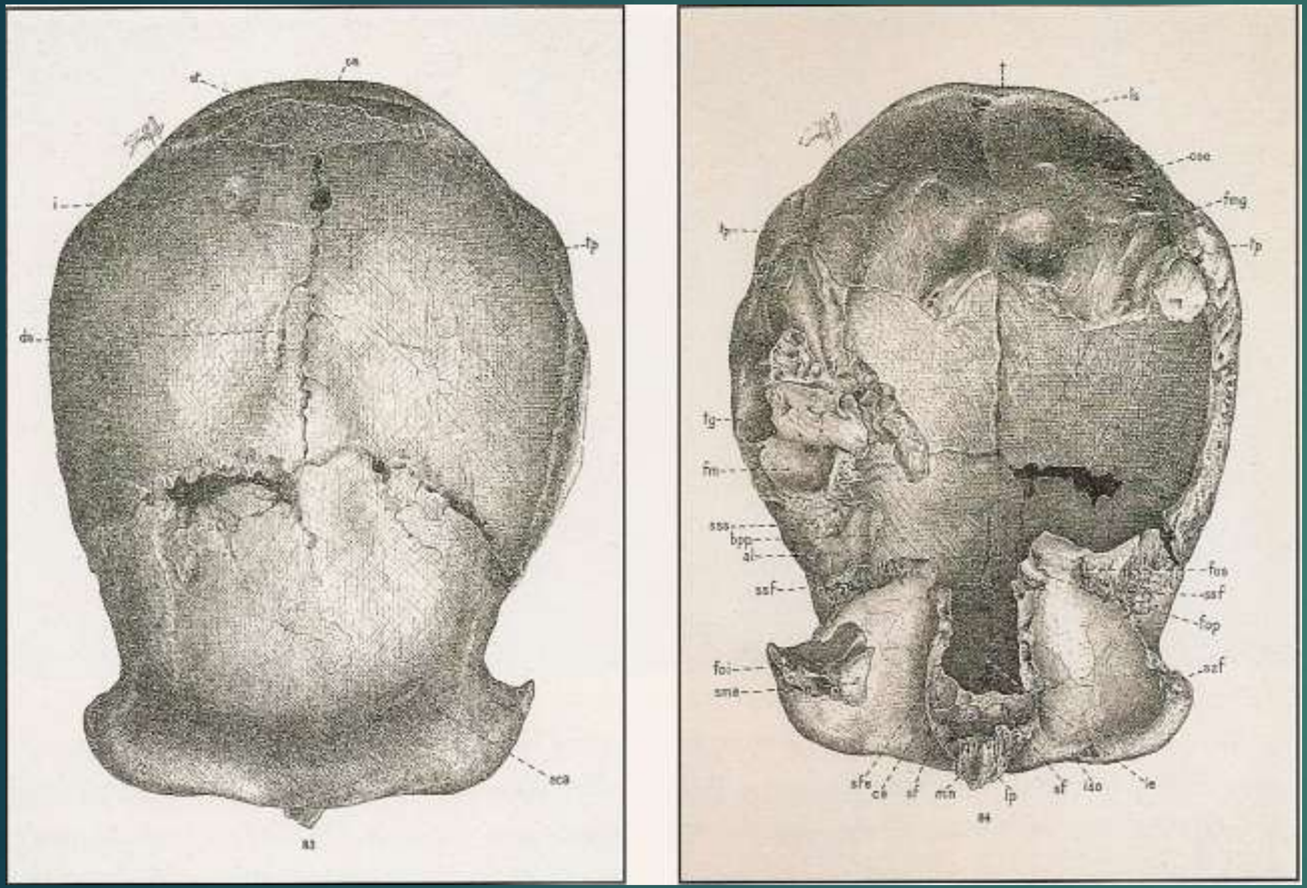
Other cranial discoveries

- Franz Weidenreich had prepared meticulous qualitative and quantitative descriptions of the material; these were sent to AMNH

- Based on Weidenreich's work and on his suggestion that *Pithecanthropus* and *Sinanthropus* interbred, German biologist Ernst Mayr reclassified them both as being part of the same species: *Homo erectus*. He proposed this conclusion in a paper he presented at the Cold Spring Harbor Symposium in 1950.

- A “revolution in taxonomy", his "single-species" approach to human evolution was quickly accepted.

1943: Franz Weidenreich's Reconstruction of *Homo erectus*



Zhoukoudian, China: Peking Man

- German anatomist Franz Weidenreich provided much of the detailed description of this material in several monographs published in the journal *Palaeontologica Sinica* (Series D).
- Nearly all of the original specimens were lost during World War II; Fossils last seen by US Marines on Dec 8, 1941; More written about their disappearance than about Piltdown Hoax
- However, authentic Weidenreichian plaster casts do exist at
  - American Museum of Natural History in New York &
  - Institute of Vertebrate Paleontology and Paleoanthropology in Beijing
  - They are considered reliable evidence.

Franz Weidenreich 2:

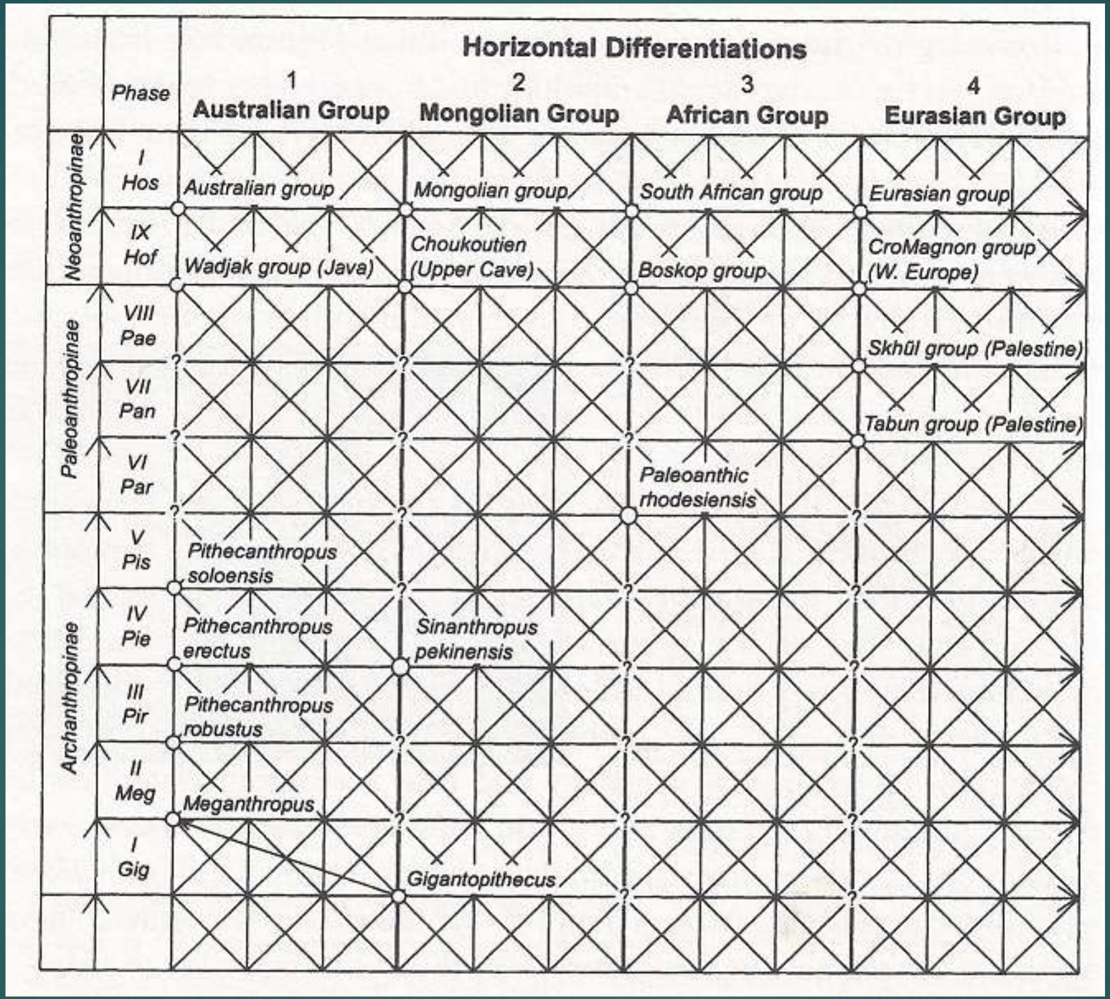
Rescue of *H. erectus* casts & Regional Continuity theory

- 1941: When he moved to AMNH, he took casts, notes & photos of all Zhoukoudian fossil discoveries.

- 1947: Created the regional continuity hypothesis (multiregionalism): Weidenreich Theory states that human races have evolved independently in the Old World from *Homo erectus* to Homo sapiens, while at the same time there was gene flow between the various populations

- Human "races" evolved from deep roots (Australian Aborigines from Java Man; Chinese from Peking man)

First Multiregional Theory: Explanation of regional morphological variation

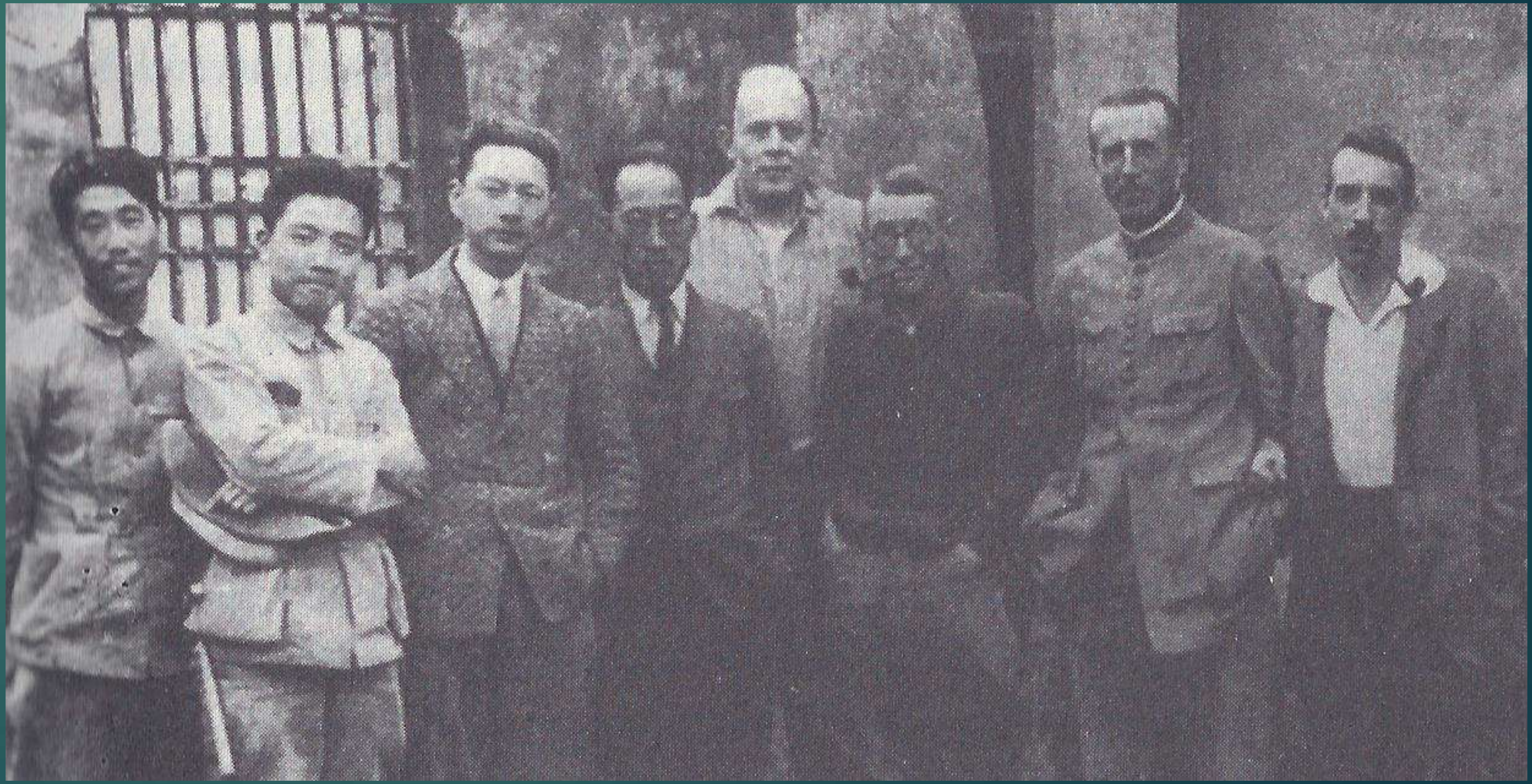


Weidenreich's 1945 theory: Population networks connected by gene exchange; early idea of population genetics in human evolution

Zhoukoudian 1929: Chinese *H. erectus* gang
(founders of Chinese paleontology)

Together with scientifics colleagues in Chou-Kou-Tien(Zhoukoudian) On the left side, Peï and Young, in center, two students, on the right side, Black and Barbour - (1929)

Wenzhong Pei, x, x, Zhongjian Yang, Birger Bohlin



Davidson Black, Teilhard de Chardin, George Barbour

Zhoukoudian: 5 skulls,
15 partial skull pieces,
14 lower jaws, 152 teeth

Peking Man skulls: Reconstructions

Continental Asia: China

- The oldest occupation of China has been proposed to occur as early as 1.8 Ma, with some contention (but note recently discovered 2.1 Ma stone tools).

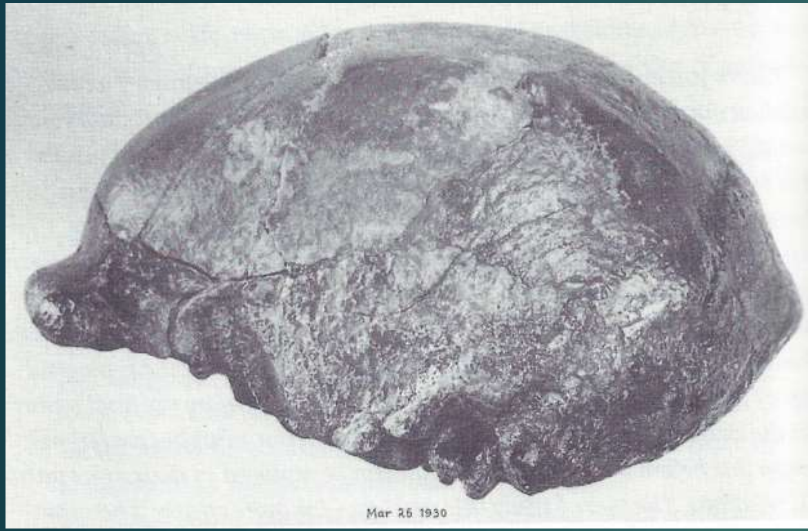
- The first certain hominins in mainland Asia appear about 1.15 Ma in Southern China at Gongwangling (Lantian), following a period of connection between mainland and Southeast Asia.

- Most Chinese *H. erectus* (those from Zhoukoudian, Nanjing, and Hexian) probably appear between 580 Ka–200 Ka

An et al., 1990; Pei, 1985; Liu et al., 1985).

1928: *Sinanthropus pekinensis:* Zhoukoudian Cave, China

Peking Man, 500-700 Ka, 850-1100 cc



Homo erectus
(Peking Man)
Discoverer: W. C. Pei
Date: 1928-1937
Locality: Zhoukoudian Cave, China
Age 300-600 K

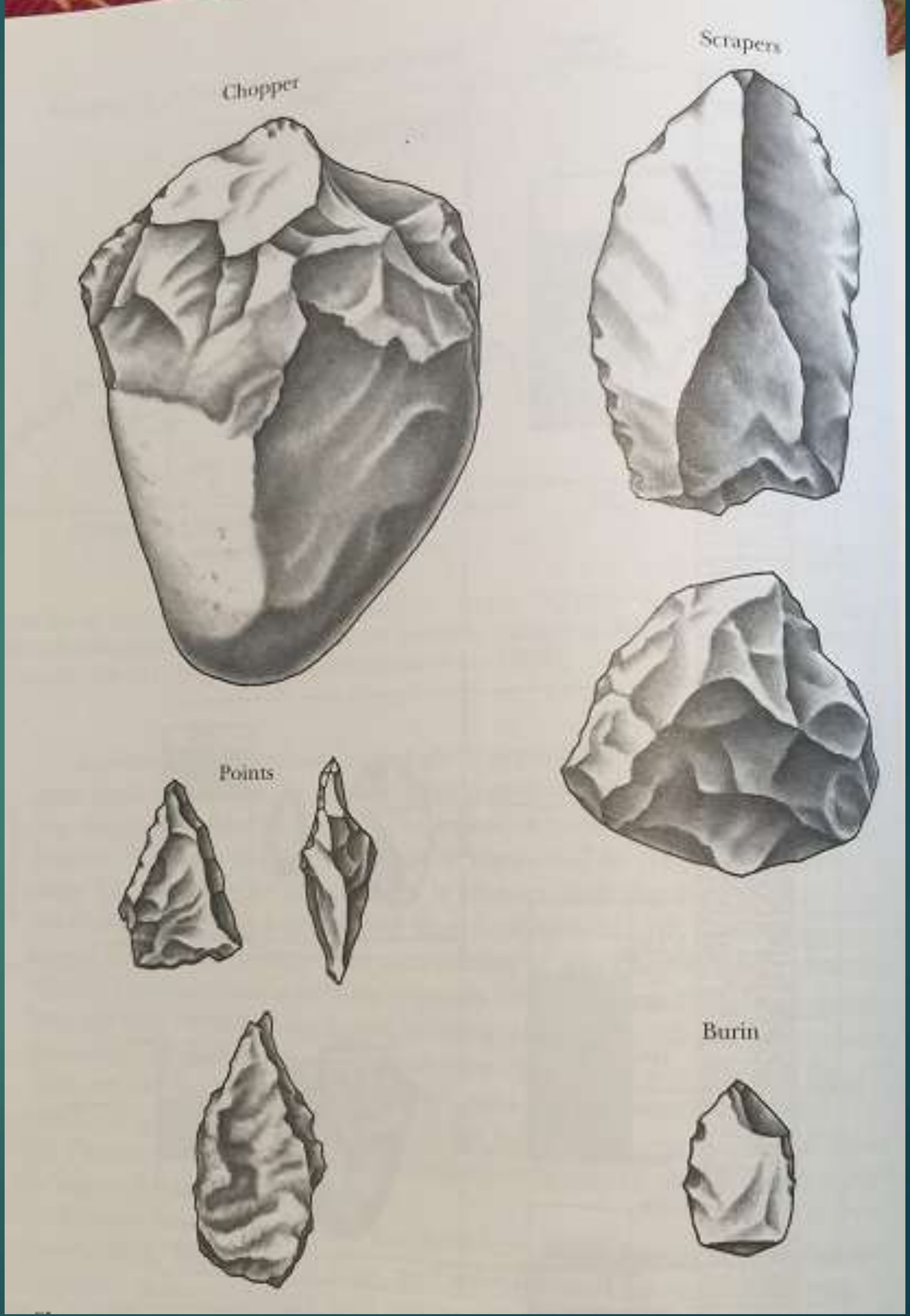
Homo erectus,
original cast of Peking Man

Homo erectus, recontruction

17,000 Oldowan stone tools at Zhoukoudian

Quartz, flint, sandstone

Choppers, scrapers, points, burins



Zhoukoudian

- The site of Zhoukoudian, 40 kilometers south of Beijing in China, has yielded the largest number of *Homo erectus* fossils from any one locality (about 50 individuals are represented by the remains, including the classic 6 skulls).

- About 17,000 stone tool artefacts were also in the cave. These were mostly quartz and sandstone chopping tools and flakes.

- It was occupied between 200,000 and 750,000 years ago, although evidence suggests that occupation was sporadic rather than permanent.

- Hyenas and other animals also used the cave site.

Dragon Bone Hill, Z

Cave now gone, as are the skulls, which vanished on train in WWII

1991 Stamp depicting the bust of Peking Man on display at Zhoukoudian #China

By 1995, remains of 40-45 individuals

Zhoukoudian

Zhoukoudian

Zhoukoudian: Dating – 600 to 250 Ka

- Deposits are more than 40 m thick; bottom not yet reached

- Age: all specimens from sediments above Maruyama/Brunhes boundary – from less than 780 Ka (Middle Pleistocene)

- 45 fossils derive from layers 3-11; 3/4s from layers 8-10

- Layer 13-17: >730 Ka; Layer 12 - >500 Ka; Layer 10 - 520-620 Ka; Layer 1-3 – 230 to 256 Ka

Zhoukoudian: 600 to 250 Ka

- Original Peking Man: 578 Ka
- Most recent dating indicates older dates: Cranium V = 400 Ka; lower strata, 600-800 Ka
- *H. erectus* occupied caves for 350 Ky, from 600 to 250 Ka

Traditional hypothesis of Zhoukoudian

The traditional interpretation of Zhoukoudian—the cave home of Peking Man. We argue that the evidence no longer supports this hypothesis.

The new interpretation—Longgushan as fossil hyena den. Peking Man (camping in the distance) was a fleeting scavenger in the cave but many times entered it unwillingly, as prey.

Benford: all animals, incl. hominins, may have been prey (more skull than limb bones)

Boaz: interpretation of Zhoukoudian cave as hyena den; Peking man as scavenger or prey (Dragon Bone Hill - Noel T. Boaz & Russell L. Ciochon)

The lion-sized *Pachycrocuta brevtrostris,* the largest hyaenid that ever lived, was a formidable predator.

This hyaenid was very likely responsible for the accumulation of the *Homo erectus* fossils at Zhoukoudian

Bite marks on hominid skulls show that hyenas crunched on face first, then the calvaria;

Zhoukoudian

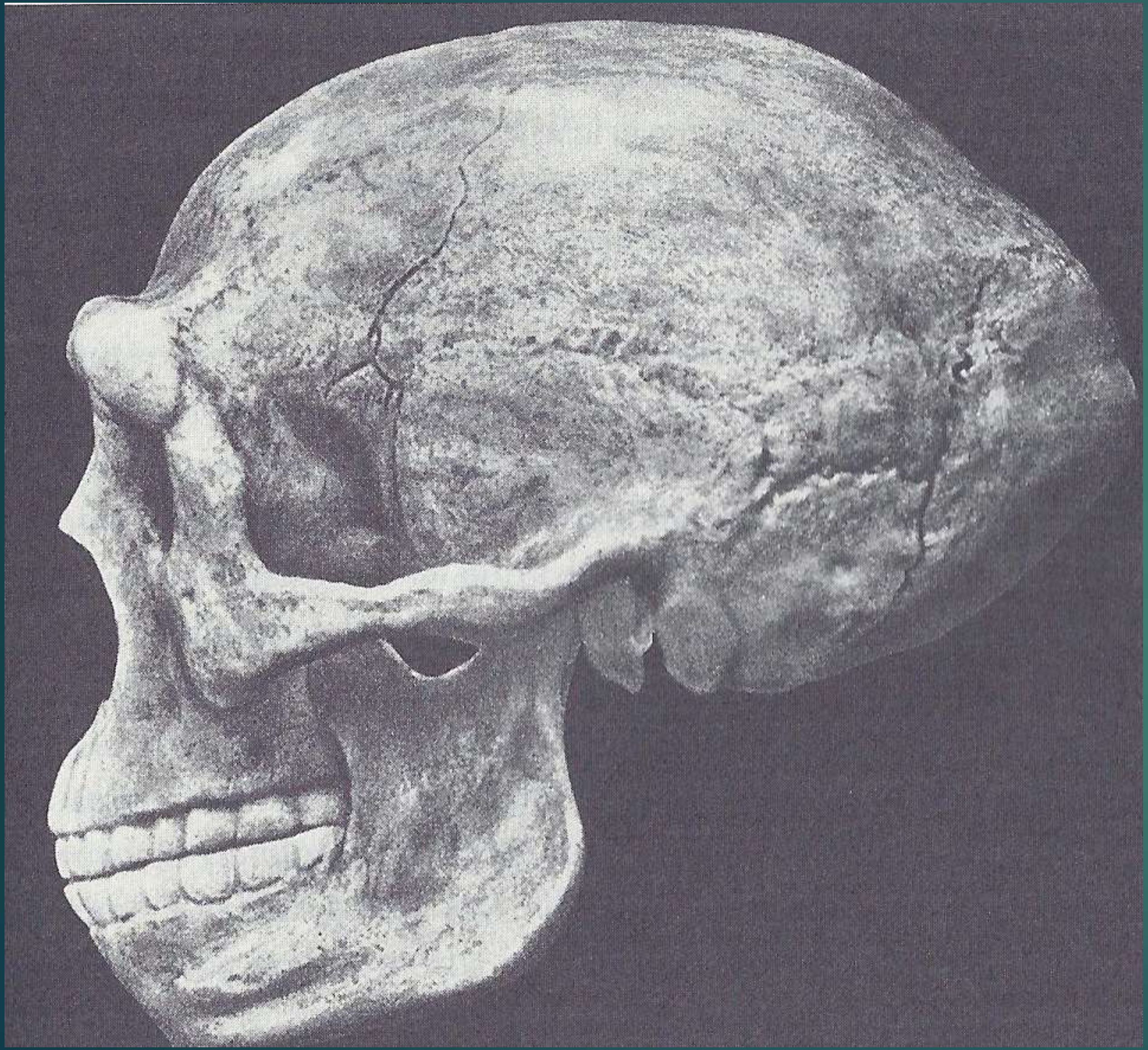
- *H. erectus* is thought to be the first to use fire, but was likely unable to control it.
- Evidence of use of fire at Zhoukoudian: 4 thick layers of ash; thickest being over 6 m deep; Benford: fire may not have been human set (too thick; guano?)
- Plant remains: seeds and pollen from hackberry, walnut, hazelnut, pine, elm, rambler rose – fruit and seed use
- Animal bones: boar, horse, buffalo, rhinos; 3000 deer (taste for venison!)
- Many archeologists think Zhoukoudian Locality 1 assemblage resulted from repeated hominin occupations

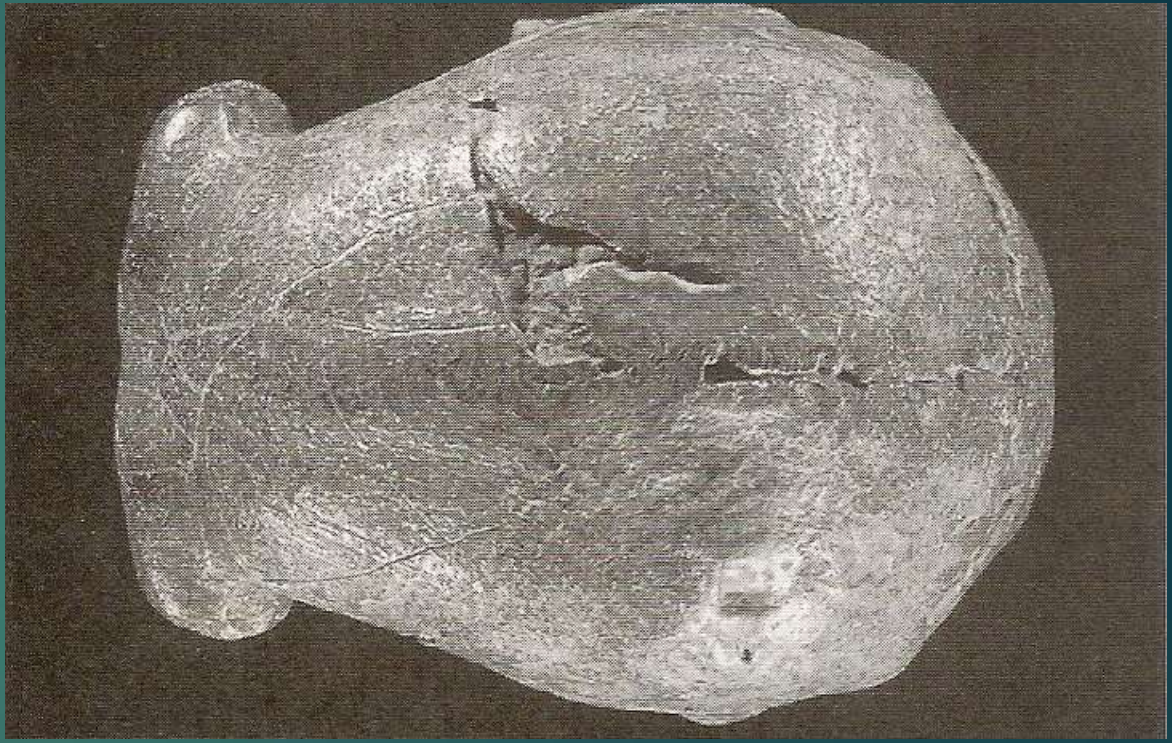
Zhoukoudian 3: Peking Man

Skull V, Peking Man: Two reconstructions

- Zhoukoudian 5 – a partial skull discovered in Zhoukoudian, China. This skull was reconstructed from several pieces found in 1934, 1936 and 1966.
- 'Peking Man' discovered in Zhoukoudian, China. The original 'Peking Man' skull was reconstructed using a mixture of male and female fossils by F. Weidenreich in 1937
- A newer reconstruction has been made by I. Tattersall and G. Sawyer in 1995 that uses fragments that are assumed to be male. The newer cranial reconstruction results in a larger cranial capacity with a more massive and projecting face, with a broader taller nasal region. This new reconstruction is more similar to *erectus* from elsewhere in the world.

Peking Man: Weidenreich original reconstruction



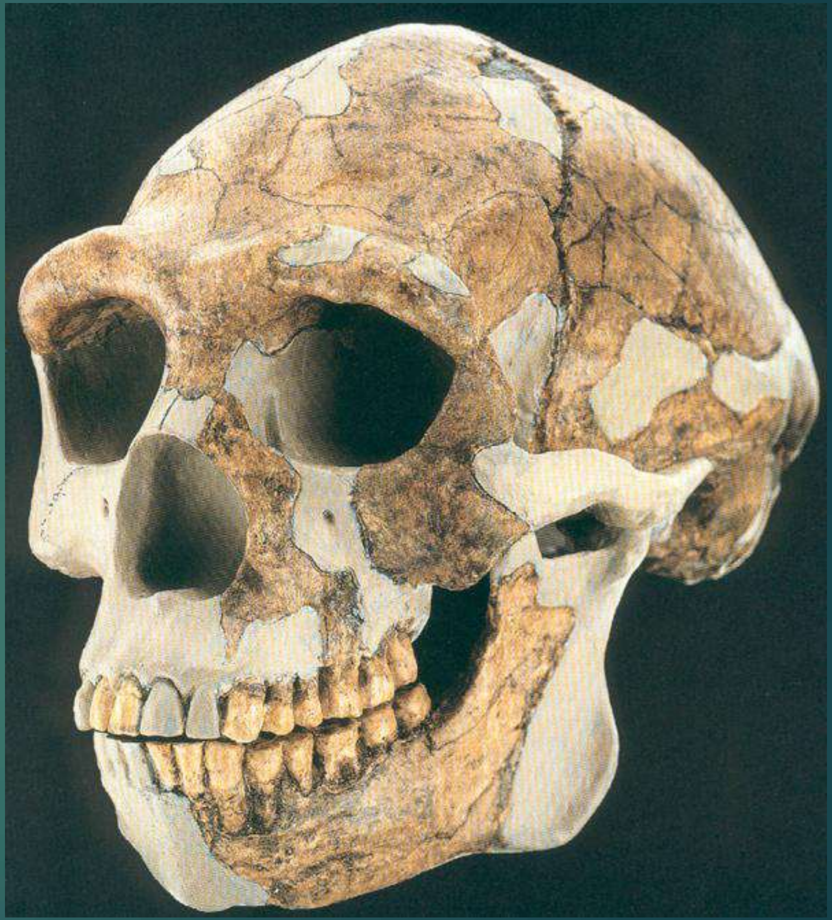


Homo erectus, 1st found, Zhoukoudian, China, 1929, Locality E

Zhoukoudian 5: 500-700 Ka, 850-1100 cc

Peking Man

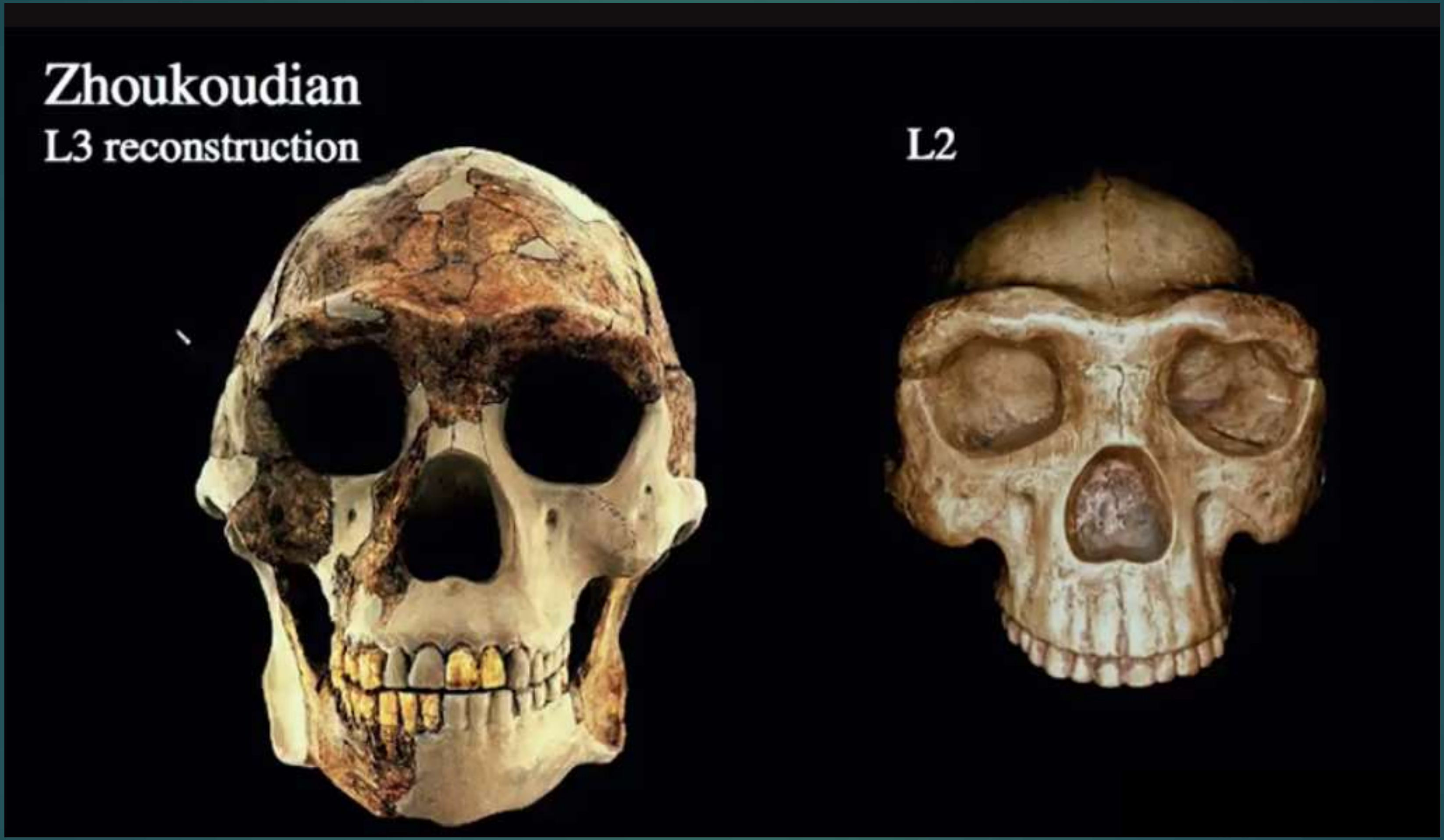
Weidenreich



Tattersall & Sawyer Reconstruction

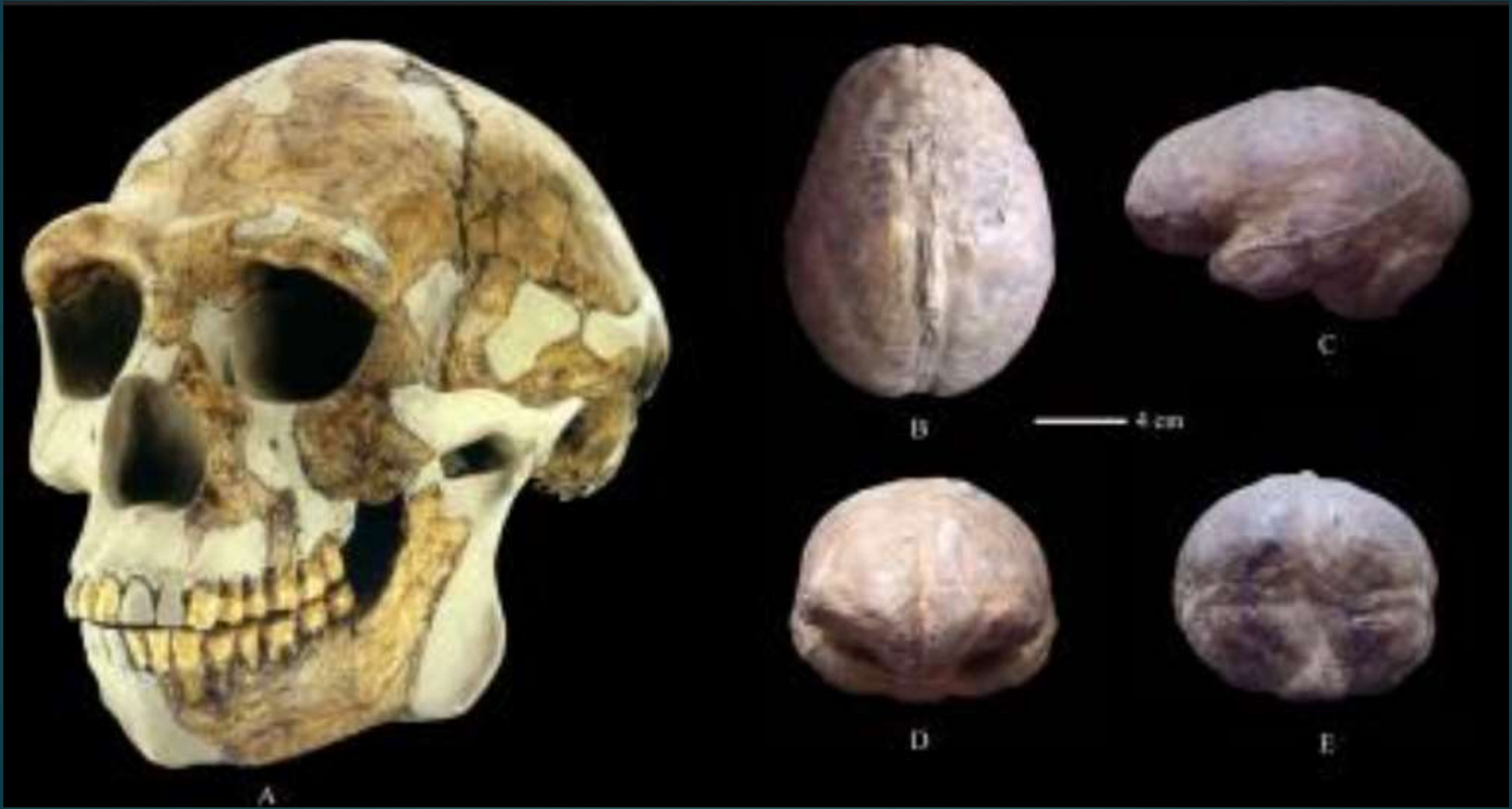
Peking Man Reconstruction by Tattersall & Sawyer

Zhoukoudian: sexual dimorphism



Weak cheeks with malar notch (starts ~600K)

Peking Man and endocast



Zhoukoudian 3: adolescent, 915 cc

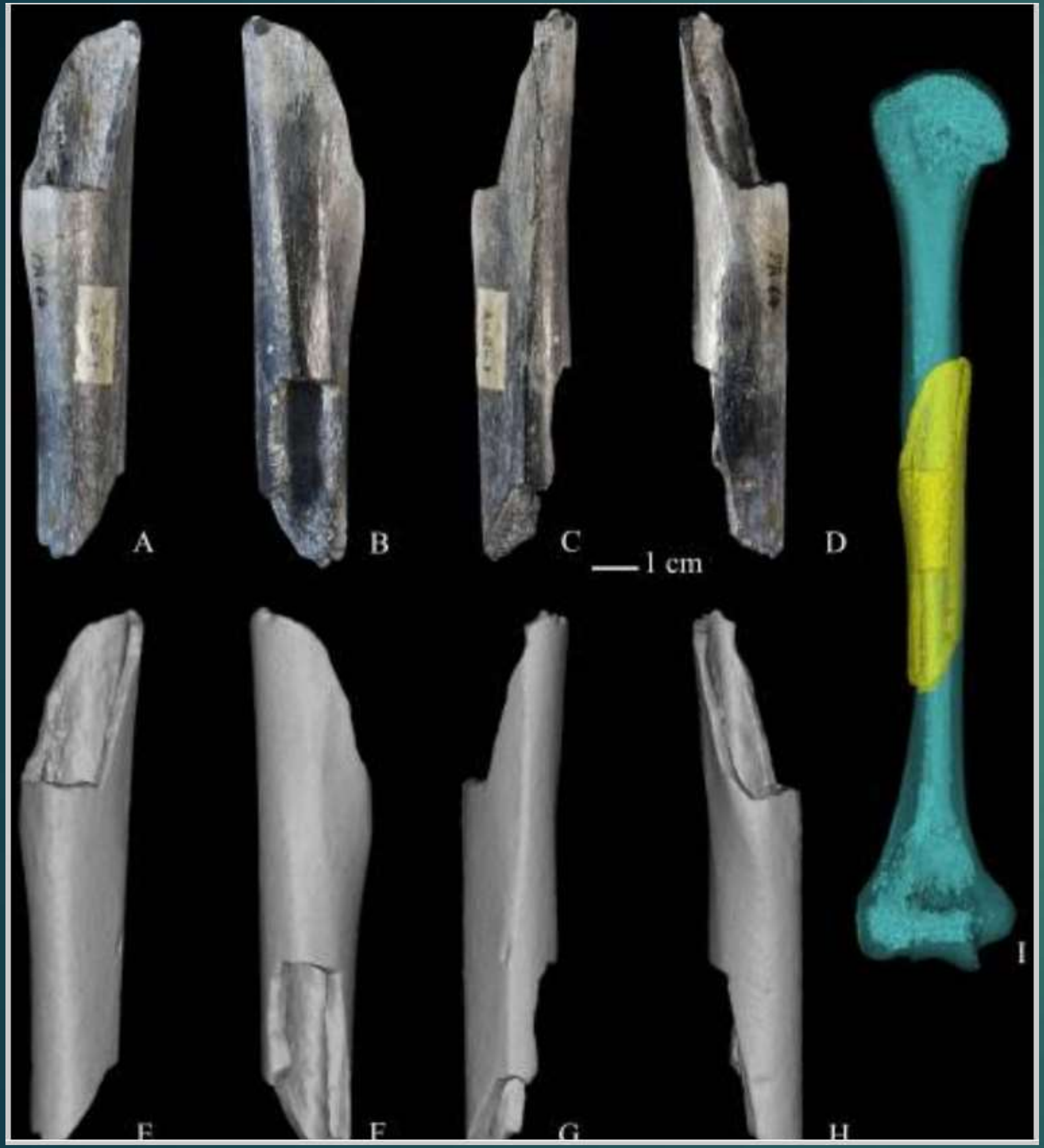
1929 in Zhoukoudian, China. This adolescent's skullcap was originally found in fragments. When the pieces were fitted together, they showed that this young individual had a brain size of 915 cc

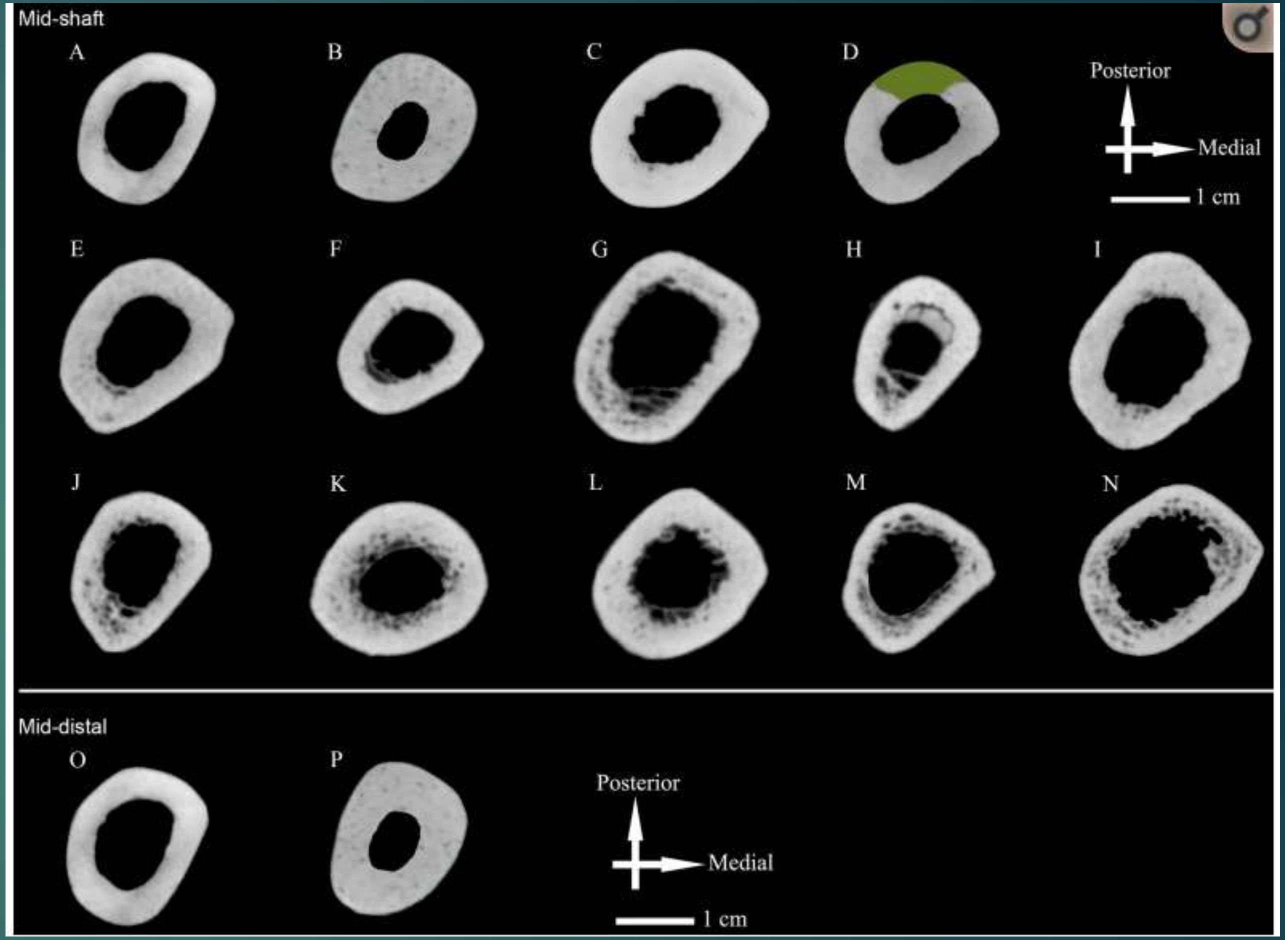
Zhoukoudian, Skull X

Skull XI

Skull XII

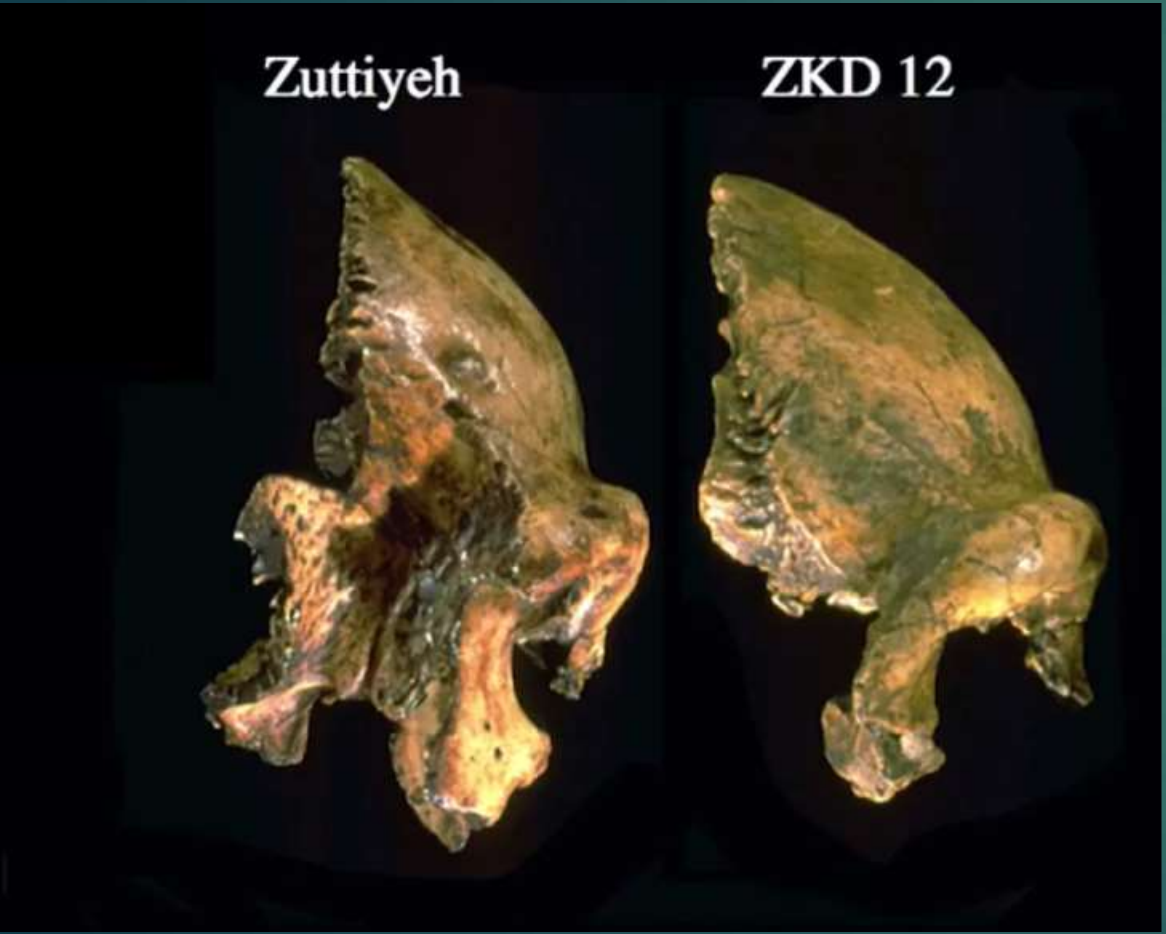
Zhoukoudian humeri (upper arm bone): Only Chinese postcranials





East Asian *H. erectus* appears to exhibit greater humeral robusticity compared to African *H. erectus*

Comparison: Israel & China – very similar browridge; variation, with regional continuity



Similarities in supraorbital torus arch, sulcal gap: Zuttiyeh, *H. heidelbergensis*; ZKD, *H. erectus*

Yuanmou: 1.7 Ma, 2 shovel shaped incisors

- *Homo erectus yuanmouensis*: two incisors, were discovered near Danawu Village in Yuanmou) in southwestern province of Yunnan, China. 1965, by the geologist Fang Qian
- Later, stone artifacts, pieces of animal bone showing signs of human work and ash from campfires
- Notable convergence of age estimates to 1.7–1.6 Ma for the earliest hominin evidence across China indicates that early humans have possibly occupied a vast area in China by 1.7–1.6 Ma (from the Nihewan Basin in North China to the Yuanmou Basin in South China).

Yuanmou

Lantian, China: 1.63 Ma, 780 cc

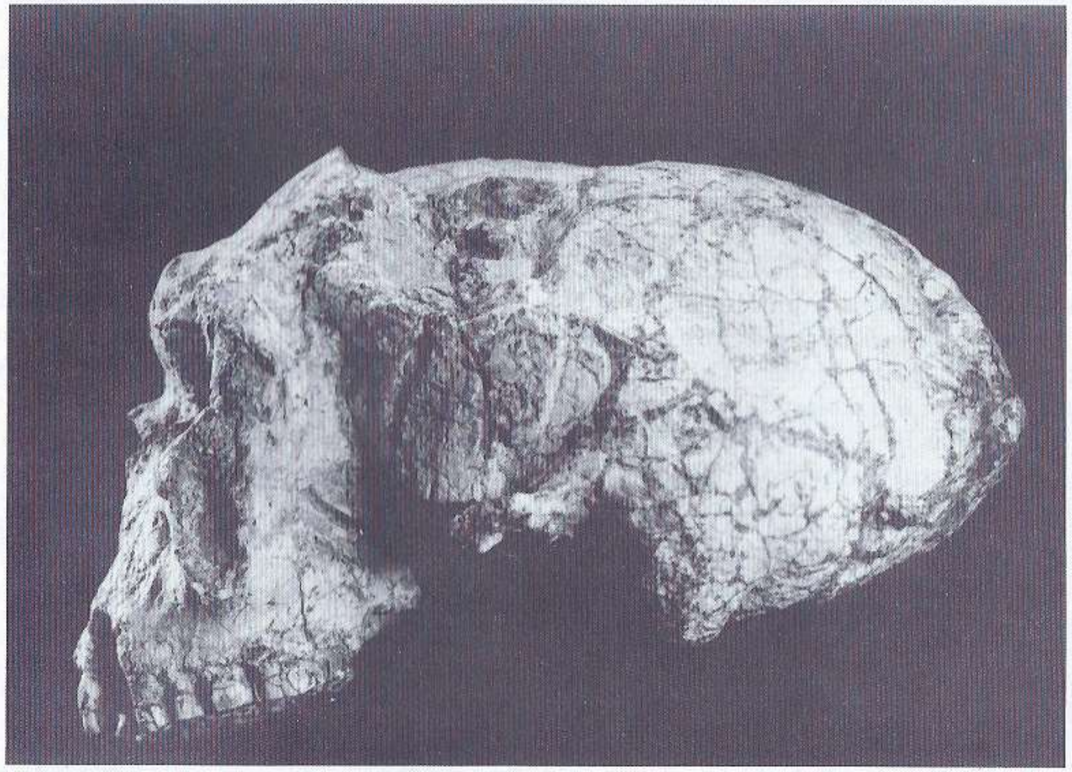
- Formerly *Sinanthropus lantianensis* (currently *Homo erectus lantianensis*); Its discovery in 1963 was first described by J. K. Woo
- Found in Lantian County (Lántián Xiàn), in China's northwestern Shaanxi province
- Age: Chenjiawo skull is 650 K & 780 cc, while Gongzhuling mandible is 800-750K
- Both female

Adult mandible with shovel-shaped incisors & absence of M3

Lantian, PA 102, 105

Yunxian, 581 Ka, ~1050 cc: largest *H. erectus* cranium ever recovered in China

FIGURE 28-5 The Yunxian 1 Cranium, Lateral View. (Courtesy Prof. Li Tianyuan)



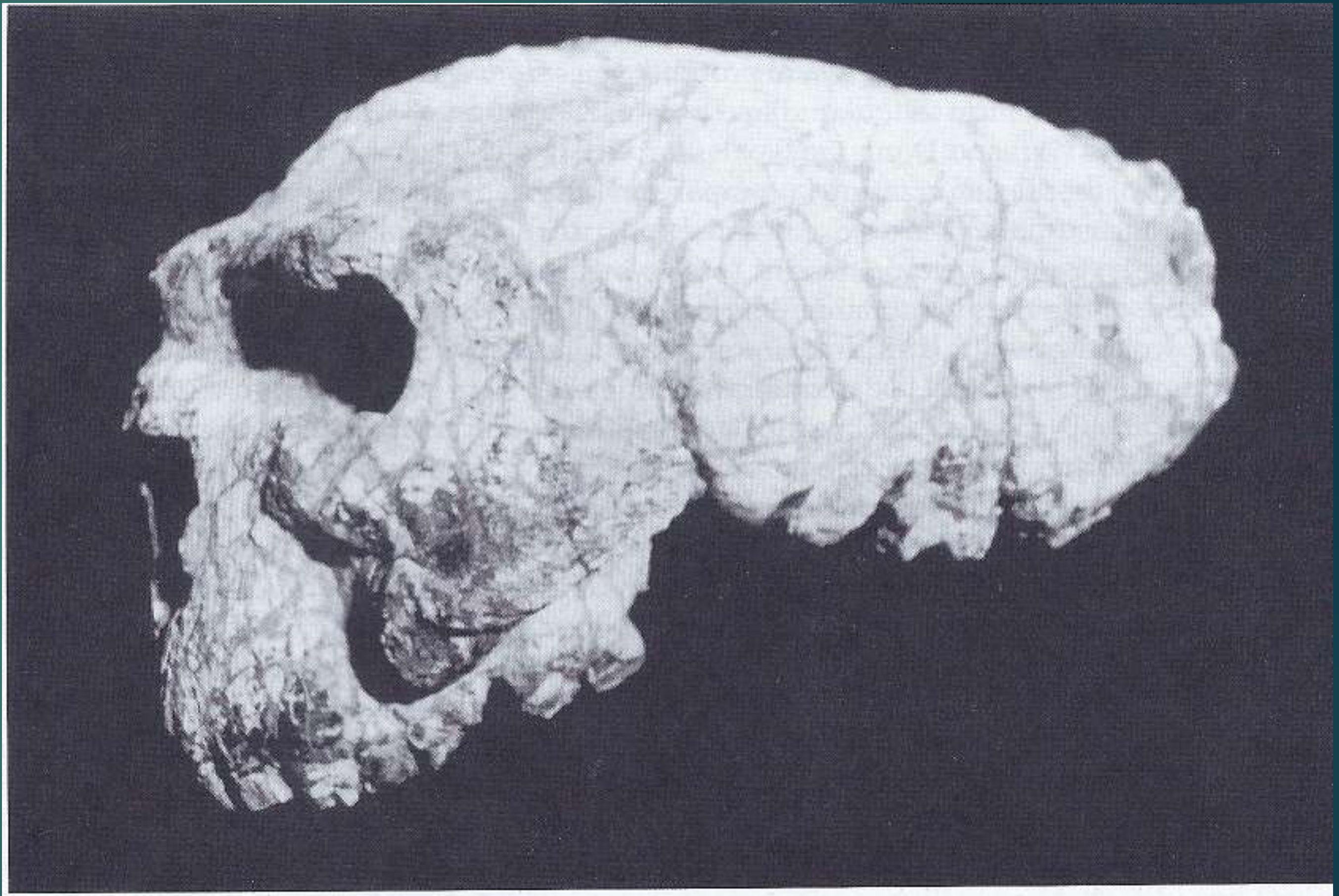
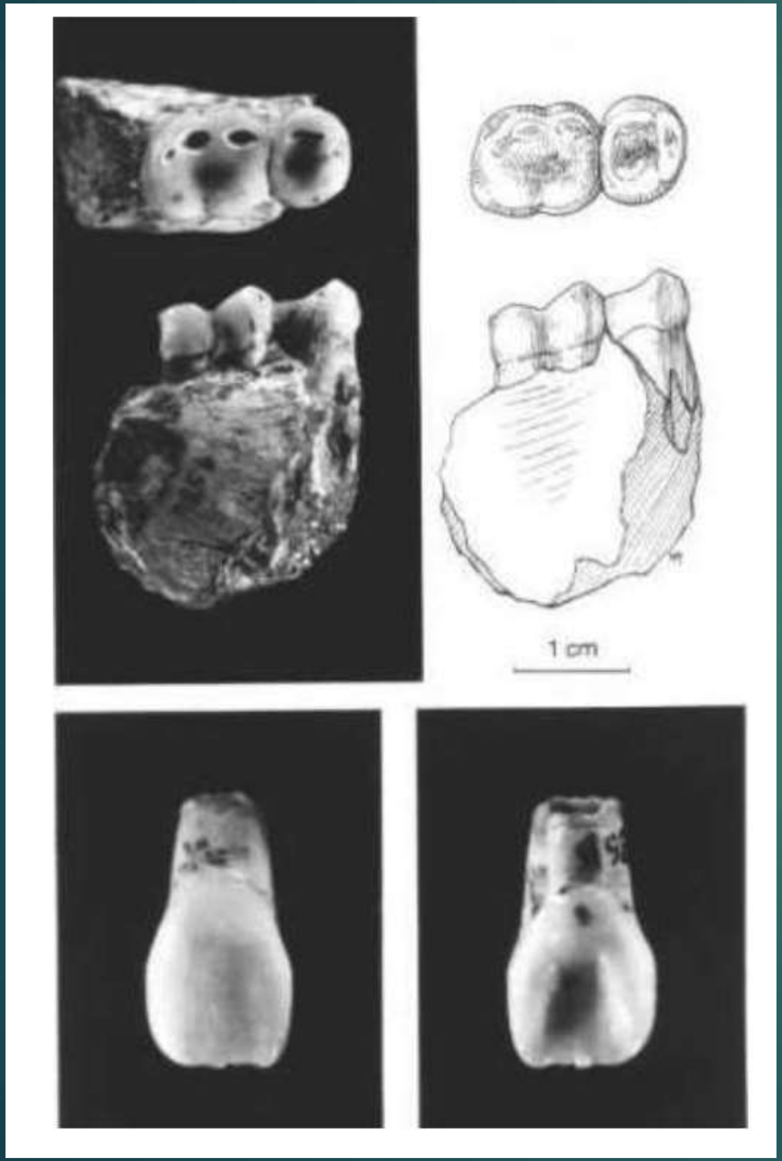


FIGURE 28-6 The Yunxian 2 Cranium, Lateral View. (Courtesy Prof. Li Tianyuan).

Lunguppo Cave, Sichuan, China, 1.4-1.8 Ma



Oldest hominin and tools from China

Age of six teeth are basically consistent, between 1.4 and 1.8 million years ago

Associated with 854 stone tools

Teeth more like African than Asian *H. erectus*

Evidence of early arrival in China

Early West Asia

Homo erectus

First out of Africa:

Dmanisi, Georgia

1991: 1st primitive *H. erectus* jaw discovered at Dmanisi, Georgia

D211 mandible

The first hominin fossil from Dmanisi was a mandible, was found on the last day of the 1991 field season, by Antje Justus.

Dmanisi, Georgia
Caused a revolution in *H. erectus* studies

Dmanisi, Georgia

- Dmanisi specimens are the earliest evidence for the emergence of early humans from Africa into Eurasia 1.75 million years ago

- First *H. erectus* to leave Africa were far more primitive than Turkana boy, African *H. ergaster*

- These fossils seem intermediate between *H. habilis* and *H. erectus* and are about 1.8 million years old.

- Dmanisi revolutionized our concept of *H. erectus*

- Dmanisi is the smallest *H. erectus* population known to date.

Dmanisi


Rostov-na-donu
Caspian Sea
(Baku) Baky
T'bilisi
Georgia
Azerbaijan
Black Sea
Armenia
Yerevan
Tabriz

The Dmanisi site overlooks the confluence of two rivers and includes a ruined medieval town and fortress.

Dmanisi, Georgia: Medieval complex, 500-1300 AD

Dmanisi castle, with Sioni Cathedral and archaeological site - where important *Homo erectus* finds have been made - in the background

Dmanisi, Georgia: Earliest known hominin site outside of Africa: small *habilis*-like skulls which have *erectus*-like features.

- Medieval church and citadel, c 1200 AD
- 1980s medieval excavations discovered bones in fill originally from deep cisterns;
- Excavations continue yearly

Dmanisi, Georgia

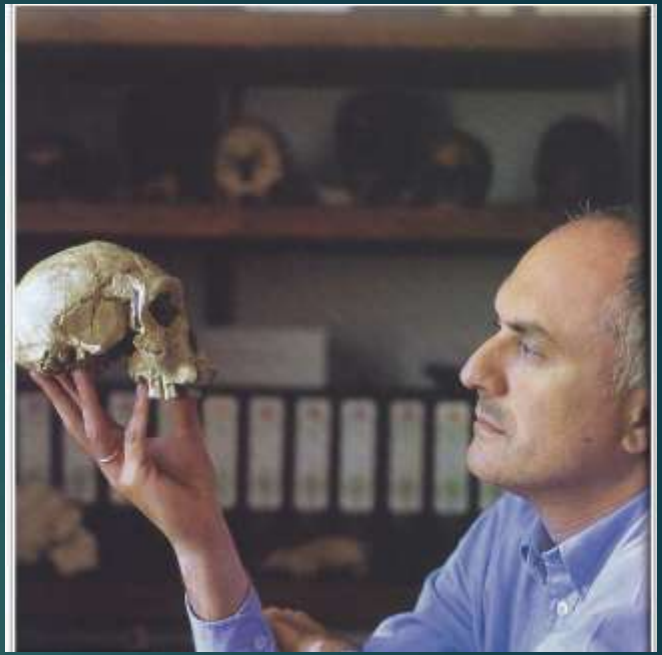
- Confluence of 2 rivers
- 1.8 Ma, active volcanos in West; produced Masavera Basalt which forms base of site, dated 1.85 Ma
- All five of the fossils had probably been attacked and killed by carnivores, their carcasses dragged into the dens
- The initial excavations of the Paleolithic sediments began in 1991; first to be discovered was Dmanisi 211 mandible

Earliest Out of Africa: Dmanisi, Georgia

- Until just less than 2 Ma, hominin fossil and archaeological record are limited to Africa. But absence of evidence is not evidence of absence
- Earliest fossil evidence outside of Africa: *H. ergaster*-like fossils at Dmanisi in Caucasus
- Radioisotope age of lava beneath the sediments & fossil animals suggest an age of 1.7-1.8 Ma.
- Stone tools are Oldowan

- Next earliest Western finds: 'Ubeidiya, Israel at 1.5 Ma; associated with Early Acheulean artefacts

David O. Lordkipanidze (1963-): *Homo erectus* at Dmanisi, Georgia

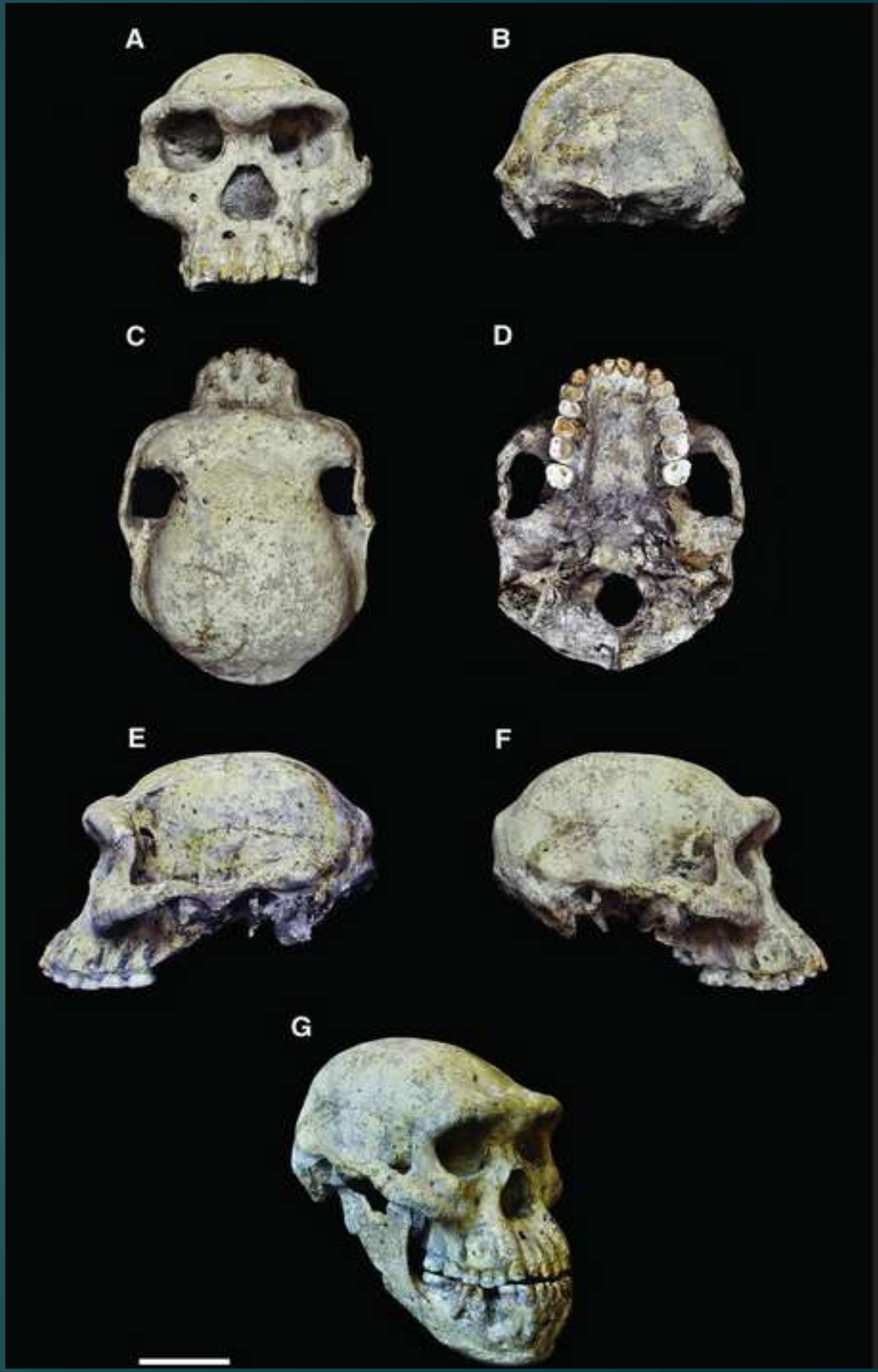


- **Georgian** anthropologist and archaeologist, Professor, Georgian National Academy of Sciences.
- 1991-2013: discovered the hominin fossil, first named *Homo georgicus*, but later reclassified as *Homo erectus*; at Dmanisi, Georgia; skull & 5 skeletons; 1.77 M
- It is the earliest known hominin site outside of Africa with hominin fossils

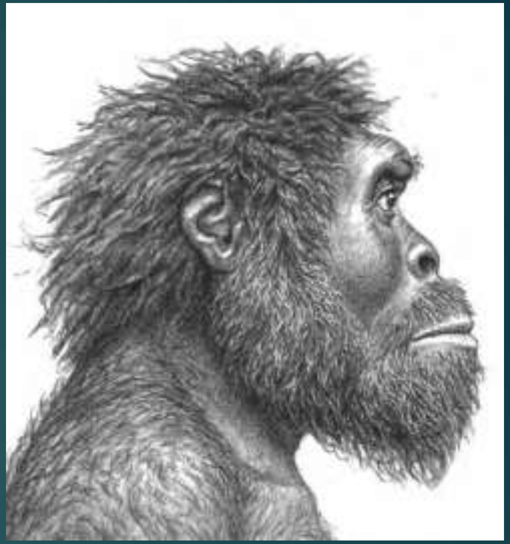
- Gabunia, Leo; Vekua, Abesalom; Lordkipanidze, David et al. "Earliest Pleistocene Hominid Cranial Remains from Dmanisi, Republic of Georgia: Taxonomy, Geological Setting, and Age". *Science* 12 May 2000: Vol. 288 no. 5468 pp. 1019-1025.

Dmanisi: Skull 5, D4500

- The most complete hominin skull ever found
- 1.77M
- Has the smallest braincase of all Dmanisi individuals (546 cc; about 1/3 of an adult modern human)



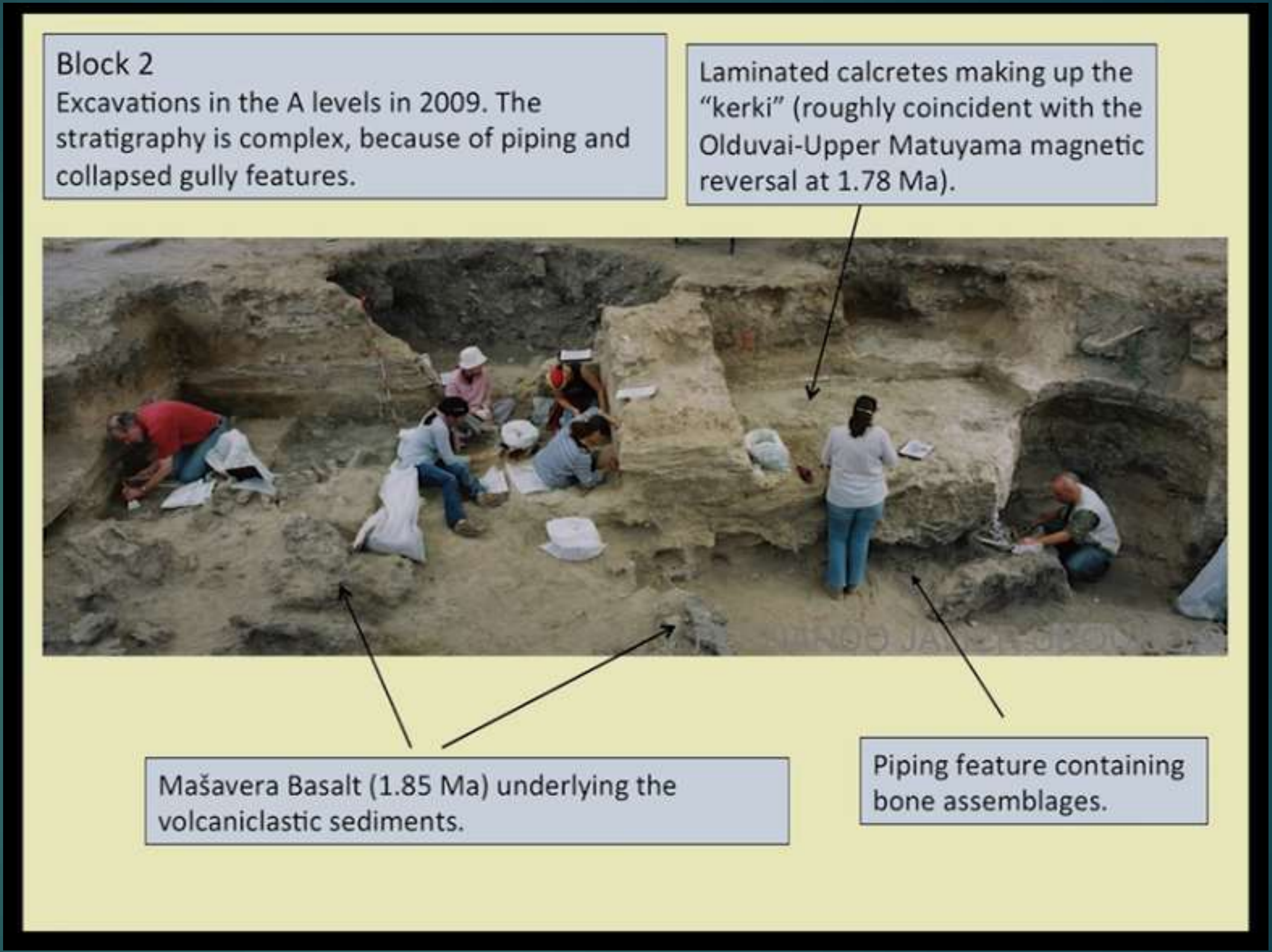
The 5 Dmanisi skulls: All now considered *Homo erectus*



Stratigraphy

Fossils found just above Masavera Basalt layer dated by argon method to 1.78-1.95 Ma; also geomagnetic polarity dating

Piping = subterranean channels (the pipes) develop as a consequence of the movement of water in currents through relatively insoluble clastic rocks



2001, *H. habilis*-like cranium, Skull 3/D2700, upside down

Dmanisi, Georgia: 1.78-1.95 Ma, small brains

- No evidence of fire
- Stratigraphic and taphonomic findings show that the hominin material was accumulated and then buried by ash falls over a relatively brief interval
- Fossils washed into site, at most over a 1000 years
- Height: ~ 4’11” (150 cm); was smallest of any adult hominin yet found outside Africa (until Flores)
- Smallest *H. erectus* brain sizes, range from 546 to 780 cc

More ape like shoulders

Oldowan Tools at Dmanisi

Simple stone flakes, like those removed from this core, enabled the Dmanisi hominins to butcher meat.

PHOTO: MALKHAZ MACHAVARIANI, ©THE GEORGIAN NATIONAL MUSEUM

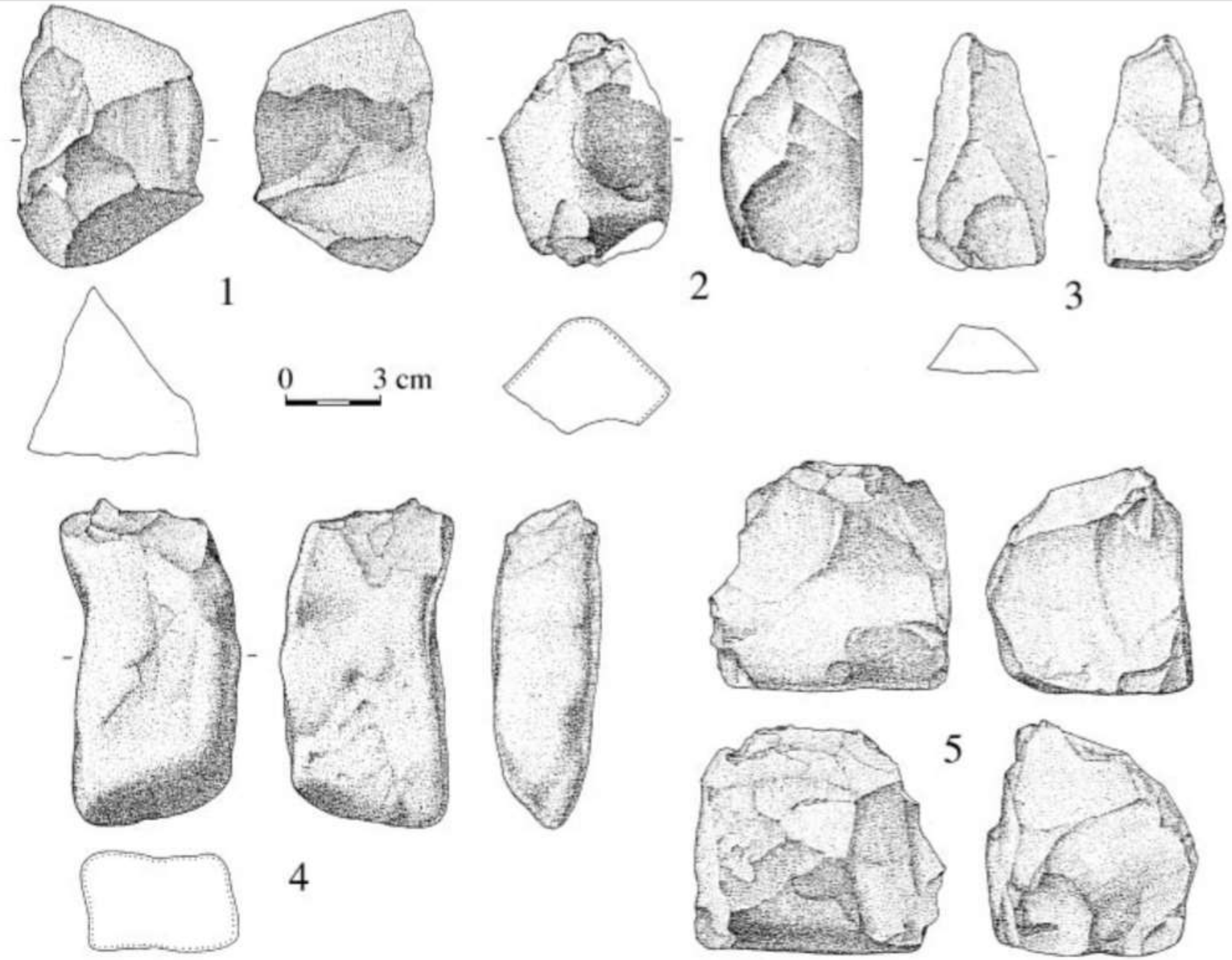


Fig. 5. Representative Oldowan Mode 1–type tools from Dmanisi.

Dmanisi, Republic of Georgia

- Thousands of Oldowan stone tools; no handaxes or cleavers; mostly local quartzite
- Abundance of carnivore fossils & evidence of carnivore chewing on herbivore fossils suggest that carnivores may have been responsible for bone accumulation
- But also stone tools, hominin fossils, and cutmarks on ungulates indicate hominins were hunting or scavenging here
- Woodland context

Dmanisi: most primitive fossils assigned to *H. erectus*

- 5 largely complete small crania
- Cranial capacity below 800 cc (Skull 3/D2700 = 546 cc)
- Share some primitive characteristics with *H. habilis* (shape of palate; relatively large canine pillar)
- But derived features <u>align them with early African *H. ergaster*</u> (presence of single-rooted upper premolars; thin supraorbital tori, angulated cranial vaults, large orbits, overall midfacial profiles)
- More like African than Eastern *erectus* (more moderate-size supraorbital tori, taller, thinner-walled cranial vaults smaller cranial capacities; long, narrow (not parabolic) dental arcade; lack of sagittal keel)

Dmanisi: most primitive fossils assigned to *H. erectus*

- Postorbital features are more like *H. habilis*
- Document first unequivocal evidence for dispersal of hominins from Africa and into Eurasia predating 1.7 Ma (but note 2.1 Ma China stone tools)
- At same time as 1st appearance of *H. ergaster* in Africa & of Acheulean tools in Africa.
- Dmanisi hominins are among most primitive fossils assigned to *H. ergaster/erectus*
- Clearly show that hominins with brain size within *H. habilis* size range were fully capable of migrating from Africa into Asia.

Original debate at Dmanisi, now resolved

- First Georgian research of the Dmanisi skulls, especially **Skull 5** with its comparatively tiny 546 cc brain, suggested that early *Homo* (1470/1813) were actually subspecies of the species *H. erectus*.
- The variation in morphology of all the Dmanisi skulls is so large that had they been discovered on different archaeological sites, they most likely would have been classified as different species. However, all Dmanisi skulls have the same age and have been found at exactly the same place.
- Georgian researchers examined normal variations in modern human skulls and chimpanzee skulls. They found that while they looked different from one another, the great variations among all Dmanisi skulls were no greater than those seen among modern people and among chimpanzees. Consequently, it was entirely possible that such a discrepancy could be found in *Homo erectus*.
- This is an ongoing debate among the scientific community. Rightmire: they are *H. erectus*.

David Lordkipanidze et al., 2013

Variation with age

- The D2700 individual is the youngest at the site.
-
- D2282 is just slightly older.

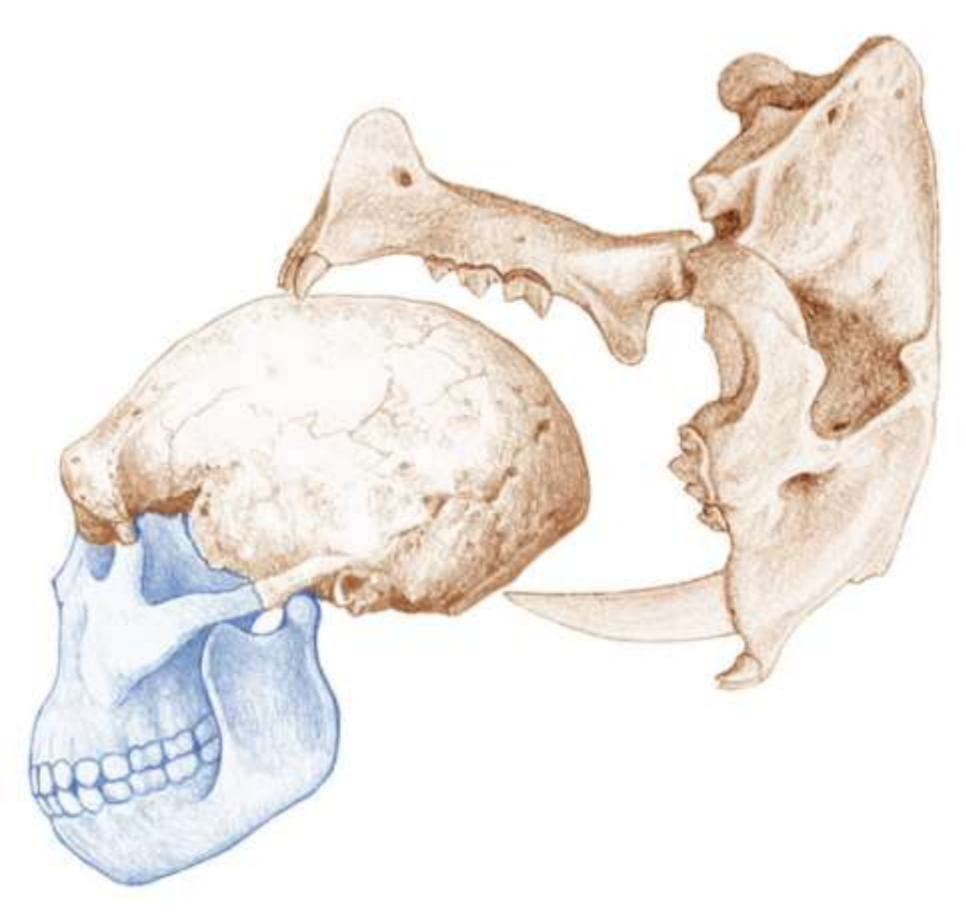
- But the two adults, D3444 and D4500, represent dramatically older individuals.
- So we have variation with age, variation with sex.

Skull 1, D2280, 1.71 Ma, 775 cc

More like African *Homo erectus* than *H. habilis*

Discovered 1999: presence of singler roots in the upper premolar teeth is a *H. erectus* trait

Skull 1: D2280 & Saber tooth tiger



Two punctures in the occipital area that correspond with amazing precision with the size and separation of the tips of Megantereon‘s upper canines.

Skull 2, D2282: 1.71 M, 650 cc, female

D211

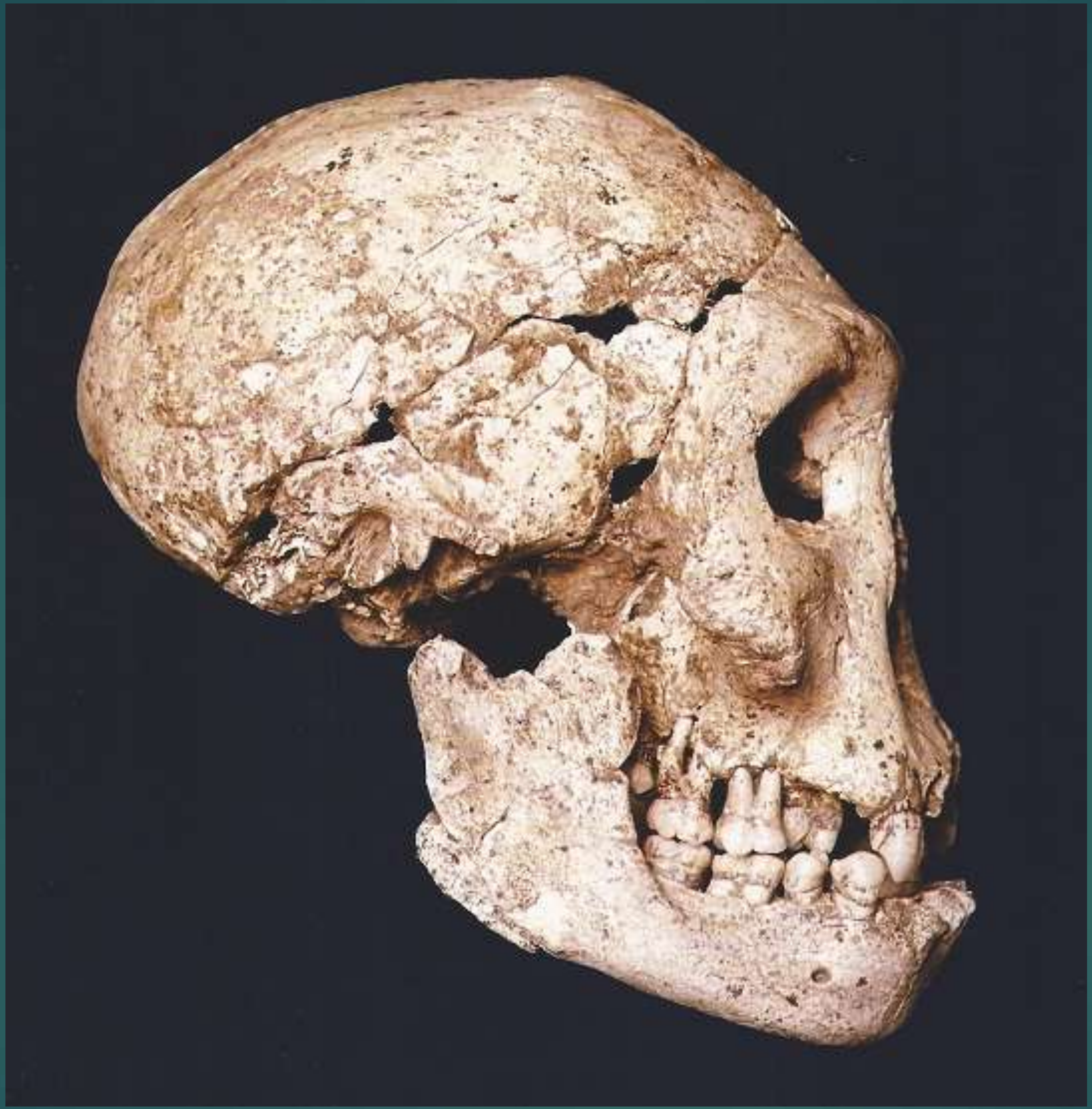
Occipital and temporal areas are crushed on the left side, as are the zygomatic bones; much of the median upper facial skeleton is missing

Skull 3, D2700

1.8 Ma

female?

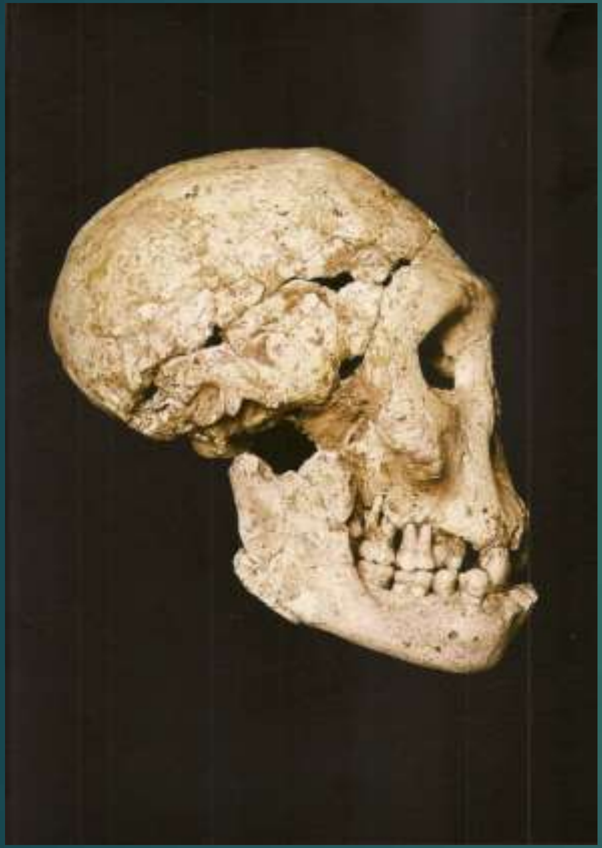
2nd Smallest cranial capacity = 655 cc

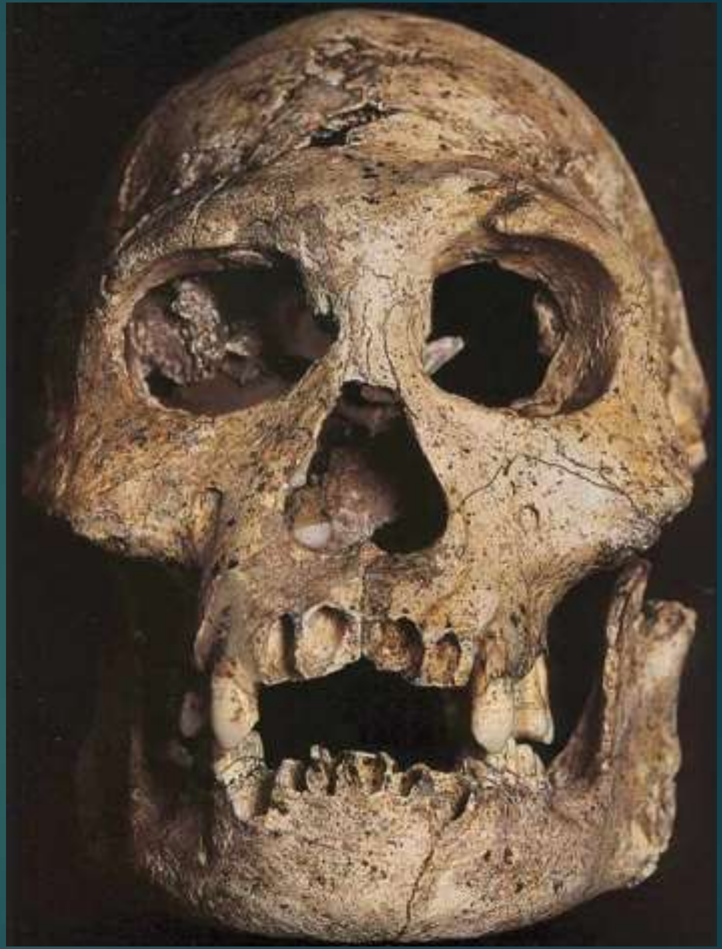


Subadult (13-15)
(M3 just erupting)

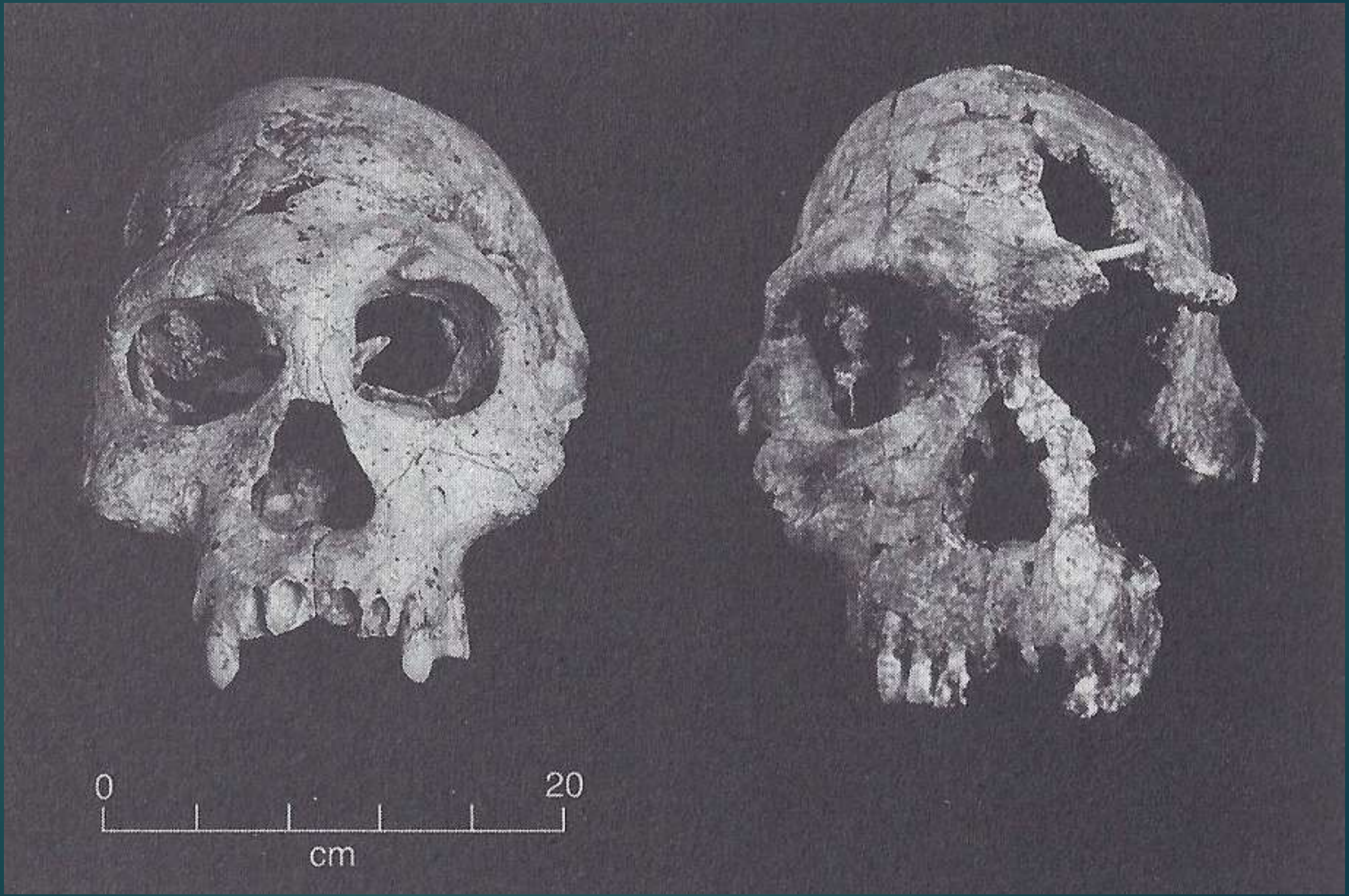
Dmanisi, Georgia:

Homo georgicus (erectus), D2700





D2700, *H. erectus* vs KNW-ER 1813, *H. habilis*



Skull 4: D3444 cranium and D3900 mandible: Empathy at 1.8 M: pathology having implications for the evidence of social behavior.

The Old Timer

Discovered: 2005

How did the toothless old man survive, unable to chew his food?: complete resorption of the tooth sockets. The implications of how he was cared for in his old age, are significant.

Skull 4: D3444

Social caregiving in *Homo erectus*

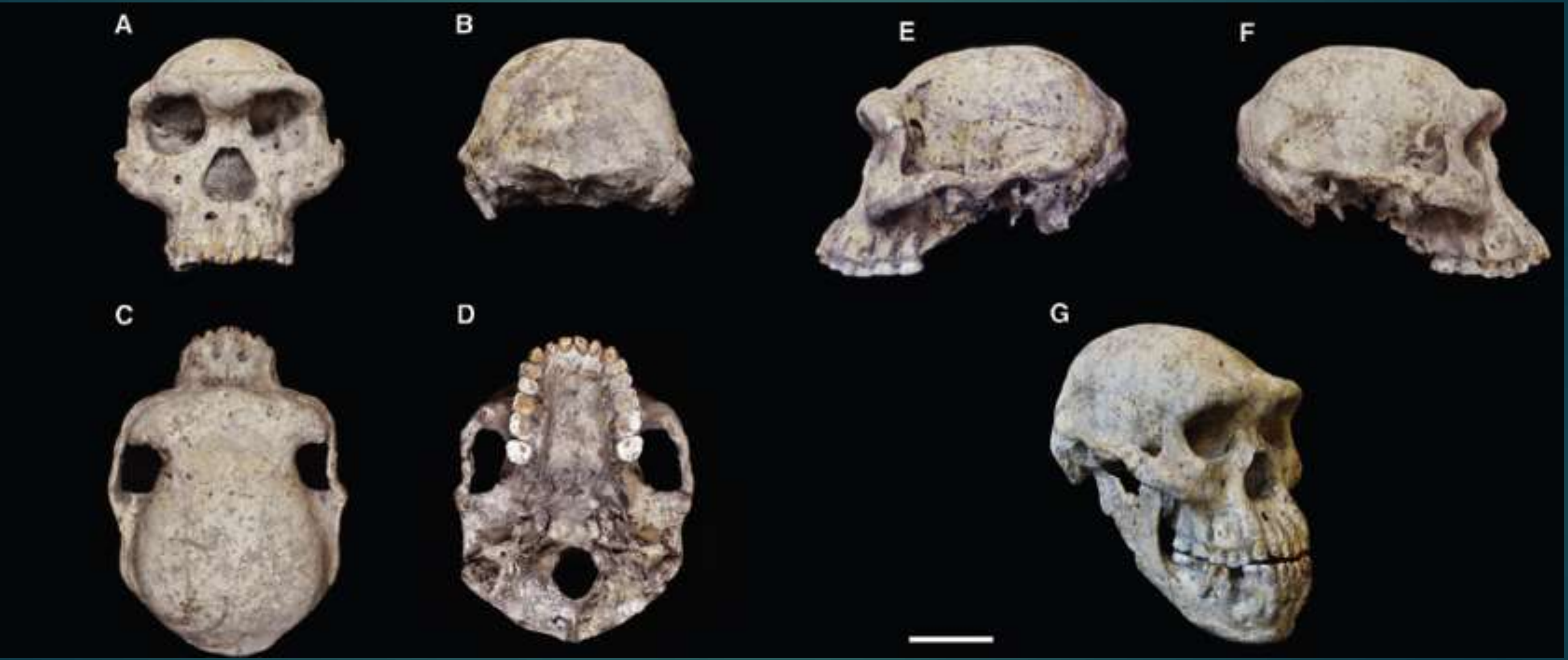
D3444 individual from Dmanisi is the earliest edentulous (lacking teeth) specimen from the hominin fossil record.

Skull 5: D4500, most recent specimen, 2005

Skull 5: D4500 & mandible D2600; 1.8 Ma, 546 cc, male

World's first completely preserved adult hominin skull from the early Pleistocene. Smallest braincase of all Dmanisi individuals

D4500 & mandible D2600

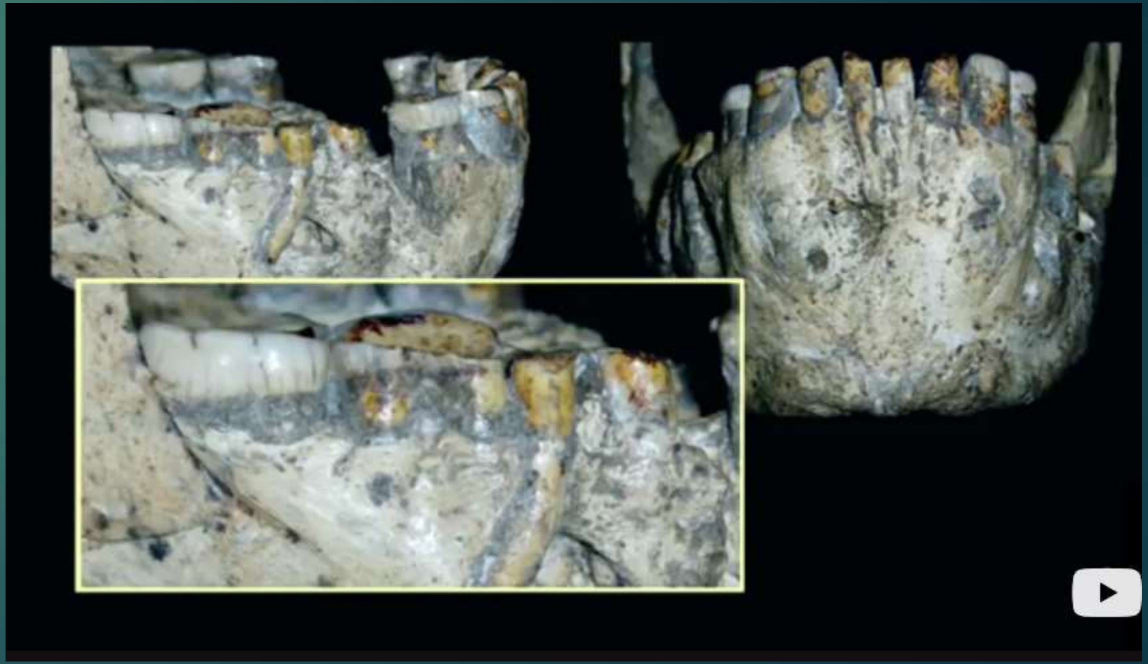


Dmanisi 2600

- Largest mandible of any fossil *Homo*
- Very tall ramus and corpus height
- Very large dentition
- Originally published as different species, *Homo georgicus*

D211 vs D2600

- D2600: Very large corpus
- Very aggressive wear of the teeth; in anterior dentition, a curvilinear pattern of wear across the roots of the incisors, suggesting doing something non-standard in terms of how it has used its teeth.
- Teeth as tool: Holding something
- Most wear of any fossil *Homo*



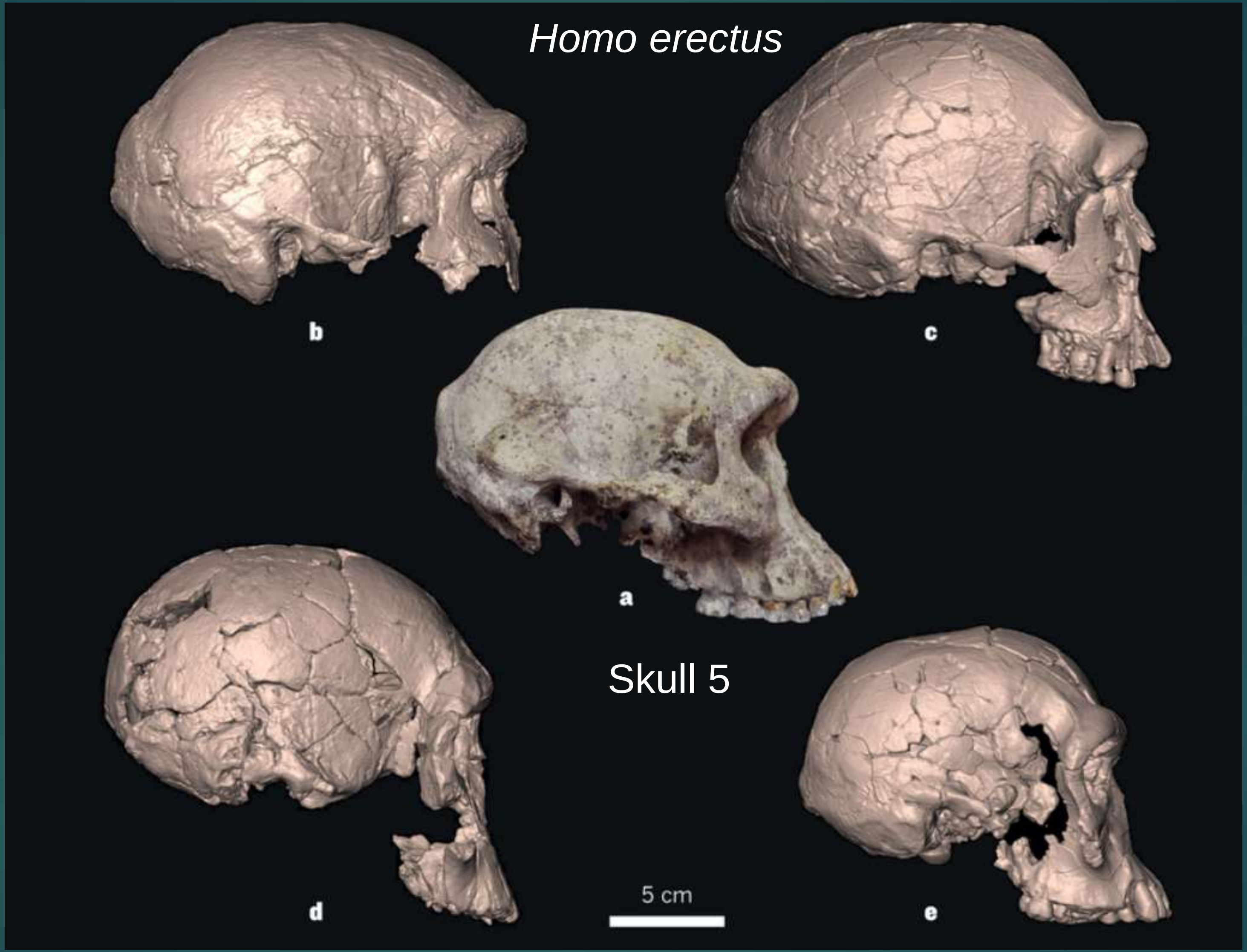
Dmanisi: lots of variation at same site & even in same sex: 2 males

largest cranial volume

smallest cranial volume

Probably a younger adult male on the left and an older adult male on the right.

Skull 5: In comparison

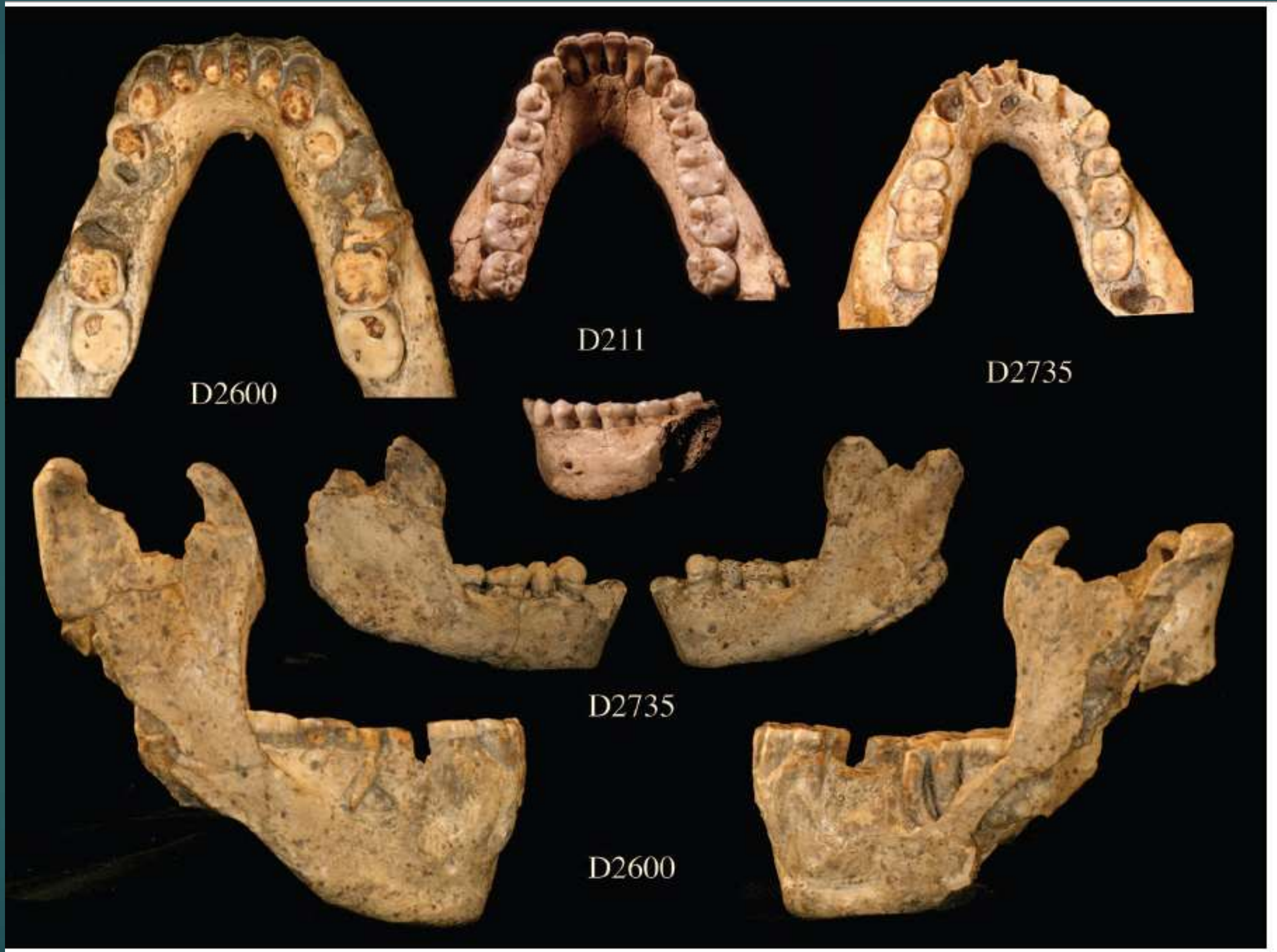


Homo rudolfensis　　　　*Homo habilis*

Abundance of specimens

- Amazingly well-preserved specimens
- There are 4 craniums with own mandibles
- Narrow time period, yet lots of variation; from 1 spot

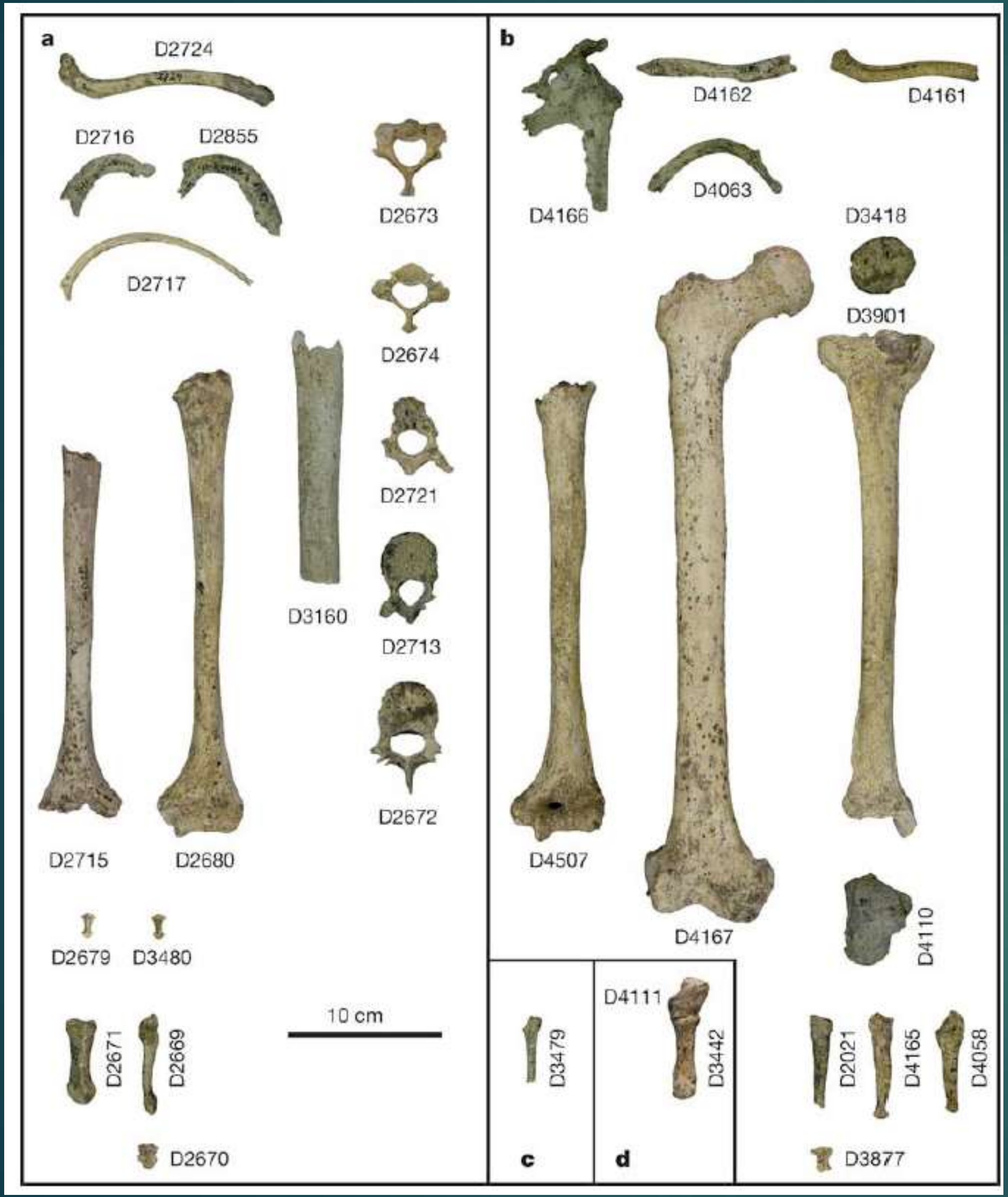
Lots of matching mandibles



ig. 1. **Comparison of Dmanisi mandibles D211, D2735, and D4500.** Note the obvious morpho-
ogical differences in bone and tooth morphology (not to scale).

Dmanisi postcranial elements: 4 individuals

- Estimates between 145–166 cm (4’8”-5”5” ft) and 40–50 kg (88-110 lbs)
- Dmanisi cranial capacity: 546 to 775 cc;
- *Habilis* average: 614 cc;
- *Erectus* average: 904 cc


a
D2724
D2716
D2855
D2673
D2717
D2674
D2721
D3160
D2713
D2672
D2715
D2680
D2679
D3480
10 cm
D2671
D2669
D2670
b
D4162
D4161
D4166
D4063
D3418
D3901
D4507
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D4110
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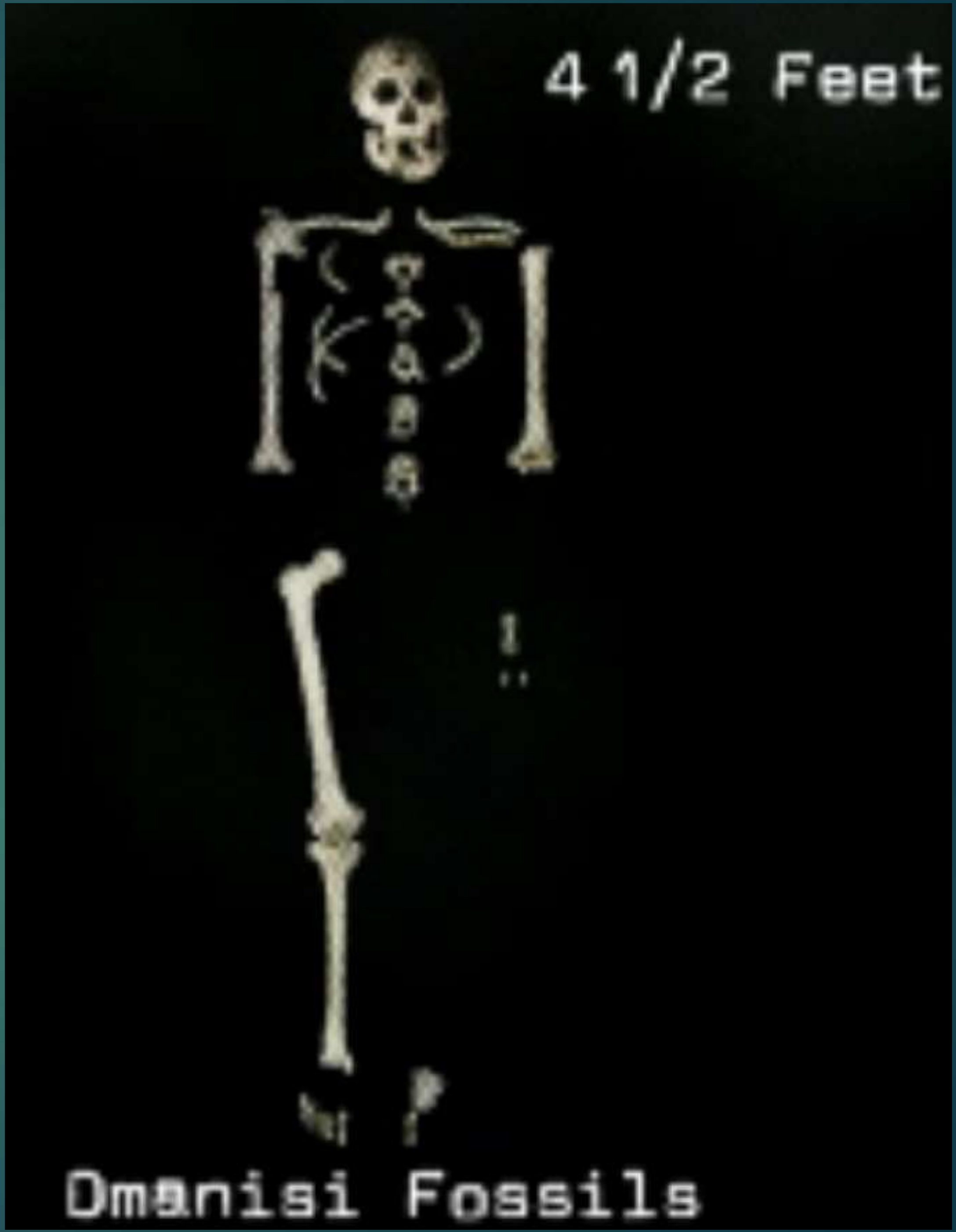
D4111
D3442
D2021
D4165
D4058
D3877


4 1/2 Feet
Dmanisi Fossils

Dmanisi: a good place to die

- The finds at Dmanisi hint that the first humans to leave Africa were not the larger-brained, hand axe-toting, potentially fire-wielding *H. erectus*. Rather, they were a much more primitive hominid population,
- All the hominin fossils found so far have been between two layers of volcanic rock from regional eruptions conclusively dated between 1.76 million and 1.85 million years ago.
- Their short stature and small braincase suggest *H. habilis.* But *H. habilis* never left Africa, according to the current fossil record.
- And other characteristics of the Dmanisi hominins, such as their more modern limb-to-body proportions, don’t match up with *H. habilis* at all but do fit with *H. erectus*, which evolved in Africa about 1.9 million years ago.

Dmanisi: a good place to die

- Access to water likely lured the animals to the area initially.
- Once they moved up the wedge-shaped bluff, however, they had nowhere to run to escape the resident megacarnivores
- About a fifth of the bones have signs of carnivore predation, and many fossils were found as segments of articulated skeletons —
- The evidence suggests that many of the bones were piled in dens of the large carnivores.

Dmanisi: a good place to die

- The beautifully preserved Skull 5, arguably the most famous Dmanisi hominid fossil, was found beside a deer bone and a baby rhinoceros femur that had been chewed.

- Evidence, however, that the hominins were predator as well as prey. The deer bone beside Skull 5, for example, had a stone flake tool embedded in it, and tool marks on some of the other animal bones suggest the hominins, at least occasionally, enjoyed the choicest cuts.

Toothpicks at Dmanisi

- Dmanisi further provides the first clear evidence for toothpick-induced local periodontitis.

- Dmanisi mandible D2735 adds to the growing evidence for habitual use of toothpicks in early Pleistocene *Homo* at 1.8 Ma.

- Although there is ample evidence for toothpicking in mid- to-late Pleistocene hominins, D2735 shows a direct link between regular dental grooming and dentognathic pathology.

Classic (Early)

African

Homo erectus

Homo ergaster: early African version of *H. erectus*

Location: Africa, Western Asia

Major sites: Nariokotome (West Lake Turkana), East Turkana (East Rudolph), Olduvai Gorge, Swartkrans, Dmanisi

Date Range: Approximately 1.9 - 1.4 Ma

Average cranial capacity: ~ 900 – 1,100 cc

Homo ergaster

- *H. ergaster* is considered by many to be the same species as *H. erectus*, with the minor difference being explained by regional variation.

- Early *H. ergaster* in Africa is associated with the Oldowan tool industry.

- *H. ergaster* is the first to move out of Africa & into more temperate regions.

Homo ergaster

- WT 15000 (the Nariokotome Boy) is the most complete skeleton we have prior to Neandertals.

- First evidence of modern limb proportions - intermembral index of approximately 75%, comparable to modern sub-Saharan African populations. Lanky torso with long, well-muscled limbs.

Early African *Homo ergaster* vs. later Asian *Homo erectus*

Homo erectus from Southeast Asia — *Homo ergaster* from East Africa

H. ergaster coexisted in East Africa with: *Homo rudolfensis, Homo habilis, Paranthropus boisei;* Sometimes at the same fossil sites.

Associated with the earliest handaxes, the first major innovation in stone tool technology.

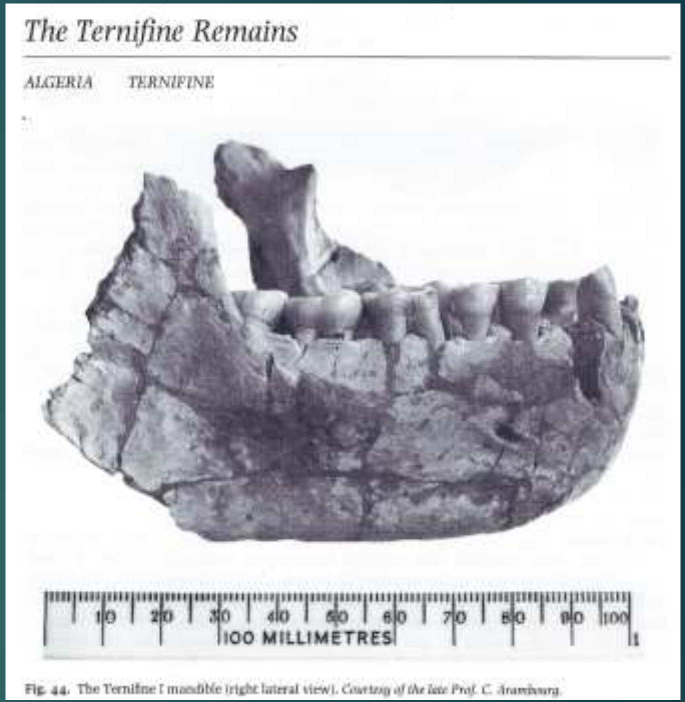
First *H. erectus* discoveries in Africa: Algeria & Morocco

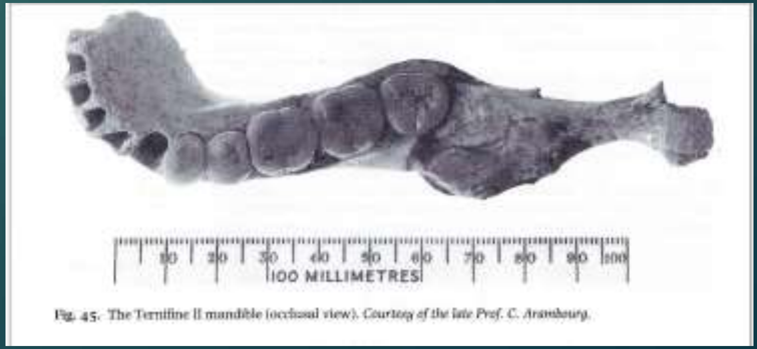
- From poorly dated sites in Ternifine, Algeria & Morocco, fragments associated with variants of Acheulean tool tradition

- 1933: Rabat, Morocco: cranial vault part, left maxilla, lower jaw with a chin, of juvenile; probably early *H. sapiens*
- 1955: Sidi Abderrahman, near Casablanca; 2 jaw fragments & teeth
- 1972: Thomas Quarries, mandible & cranial pieces
- 1971: Salé, cranial vault, endocast, part of left maxilla, lower face

Ternifine 2-3 (now Tighenif, Algeria): 700K

- C. Arambourg, Ternifine, Algeria, 1954
- Ternifine is an Acheulean site located near Palikao in the Oran region of Algeria, which contained three mandibles (jaw bone fragments) and a skull fragment probably assigned to *Homo erectus* (or possibly *H. ergaster*), dated between 730-600 Ka.
- Acheulean tools were found in association with the skeletal material, as were theropithecus faunal material.



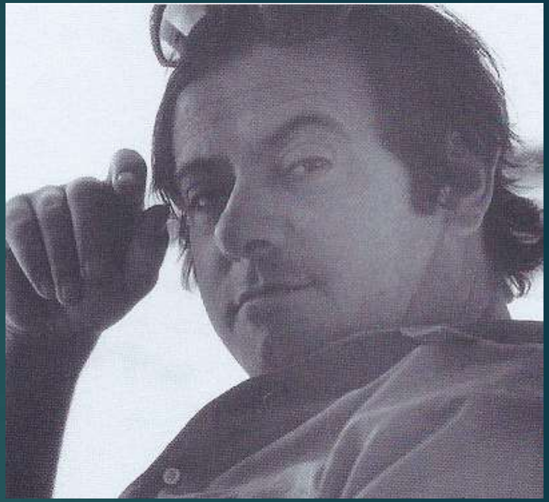


Ternifine 1 & 3

Yves Coppens (1934-):
Tchadanthropus uxoris,

- French paleontologist & paleoanthropologist

- 1965: discovered a skull of hominin in Yaho (Angamma, Chad), named *Tchadanthropus uxoris*; now *Homo erectus*, 1M.



Tchadanthropus uxoris: 1 M

- Discovered in 1961
- by Yves Coppens
- in Chad, N. Africa

African
Homo erectus sites

1971: KNM-ER 992, type specimen of *Homo ergaster*, 1.5 Ma
Koobi Fora, Lake Turkana, Kenya

Discovered by Bernard Ngeneo/Richard Leakey in 1971 at Lake Turkana, Kenya.

The mandible was considered by C. Groves and V. Mazak to be the holotype specimen for *Homo ergaster*.

Type designation based on lightly built jaw and relatively small premolar and molar teeth.

Discovered in 1971 by Bernard Ngeneo in Koobi Fora

OH 9, Olduvai Gorge, 1.47 Ma, 1060-1070 cc

- 1960: Louis Leakey, site LLK, upper Bed II
- Shelf-like & super robust supraorbital torus; no sagittal keel

Similar to Sangiran 17

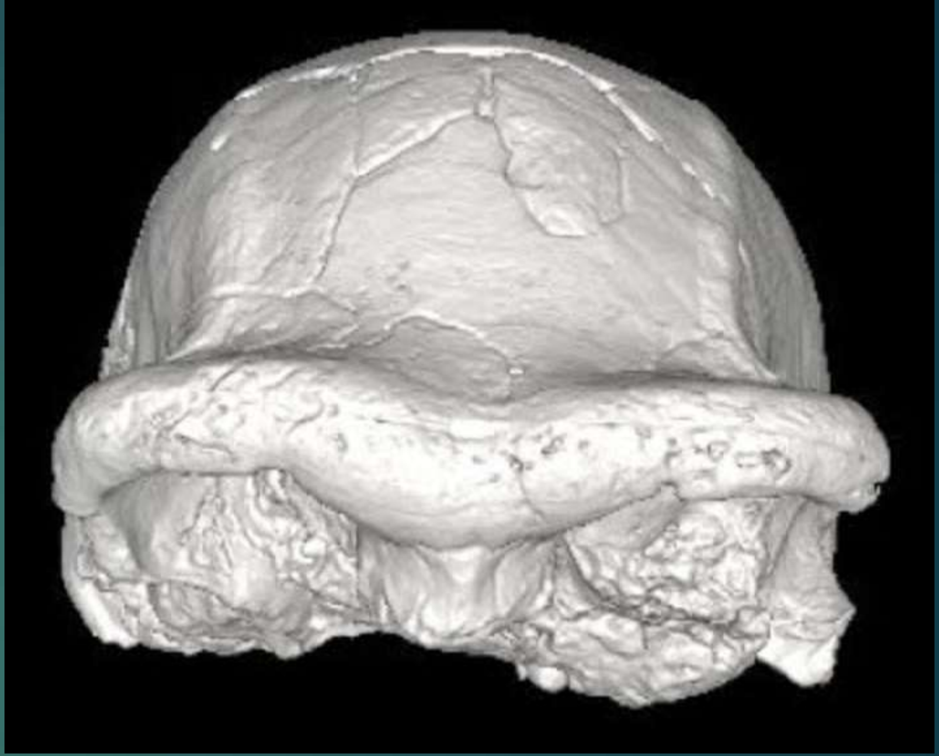
Double-arched supraorbital torus that extends fairly continuously into a fairly long sloping frontal; more of a supraorbital sulcus in OH 9

Olduvai Gorge: OH 9

- OH 9 *Chellean Man* Discovered by Louis Leakey in 1960 at Olduvai Gorge (Tanzania).
- Olduvai; not found in situ
- Oldest known early human fossil specimen with a brain size larger than 1000 cubic centimeters.

(Heberer, 1963; Rightmire, 1979)

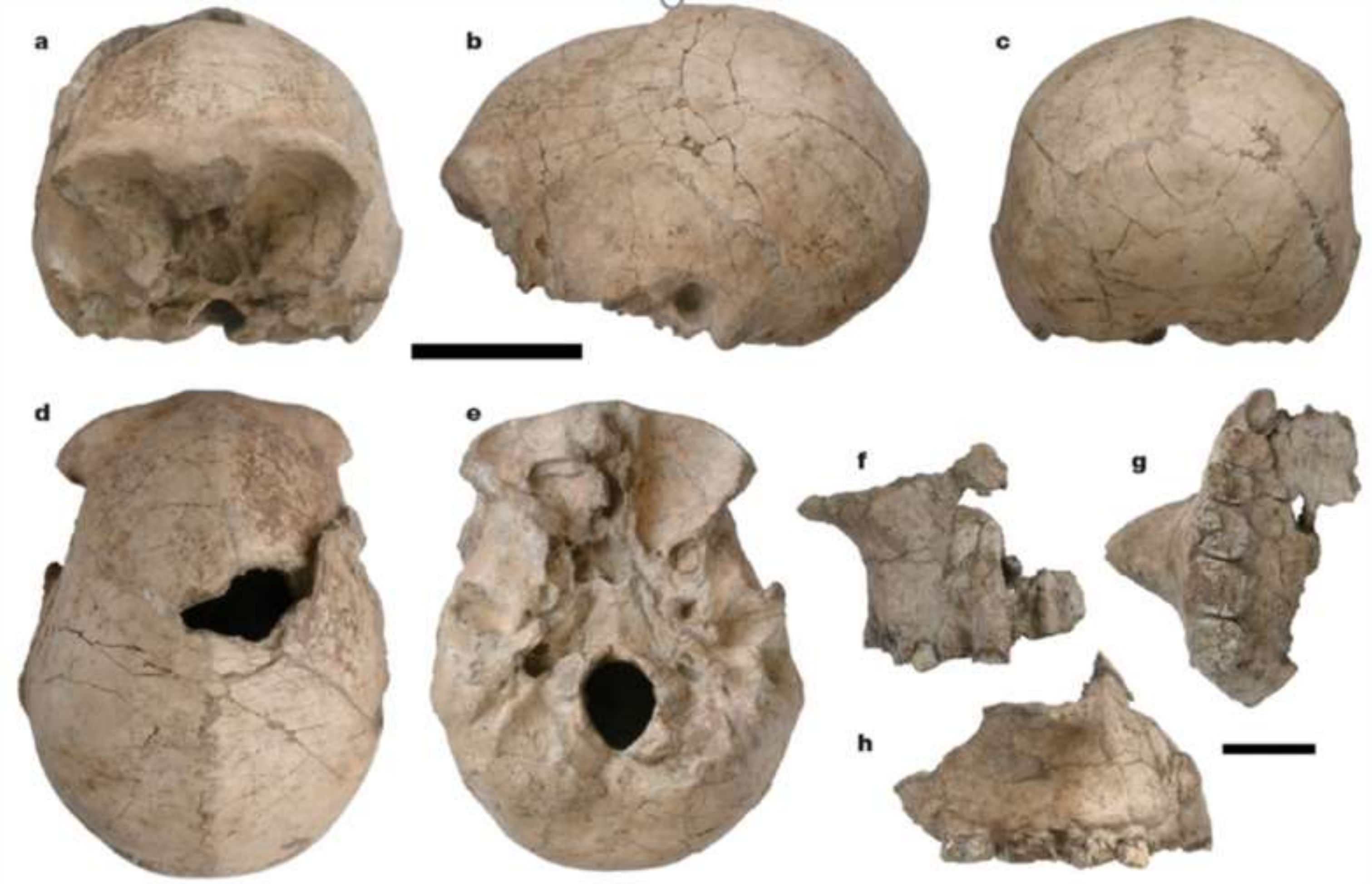
CT scans of OH 9



OH 9: largest *H. erectus* skull

High variation in the African sample: driven by the small size of KNM-ER 42700 and the large size of OH 9 (which are separated geographically by 800 kilometers, and temporally by more than 300,000 years)

KNM-ER 42700; Smallest *H. erectus* cranium



a, Anterior, **b**, left lateral, **c**, posterior, **d**, superior and **e**, inferior views of KNM-ER 42700 (scale bar, 5 cm). **f**, Anterior, **g**, occlusal and **h**, right lateral views of KNM-ER 42703 (scale bar, 2 cm).

4/fig_tab/nature05986_F1.html

H. erectus Cranial variability:

OH 9 (largest)
vs
KNM-ER 42700 (smallest)

KNM-ER 42700, Ileret, Kenya, 1.5 and 1.6 Ma, 691 cc

Homo erectus crania:
KNM-ER 42700 (small)
and OH 9 (large),

It was found in Ileret, Kenya where younger fossils of *Homo habilis* have been found, demonstrating that these two species existed at the same time, rather than *H. habilis* being ancestral to *H. erectus*.

Most recent *H. ergaster*, OH 12, 727 cc, 1.2 Ma to 780 Ka

- OH 12 is the youngest, by far, of the known African cranial *H. erectus* fossils, and is also the smallest adult with a cranial capacity estimated at 727 cc.

- Somewhat later African cranial material includes remains dated to between 780 Ka to 1.2 Ma.

- OH 12 exhibits similarities to early African *H. erectus* from Olduvai and Koobi Fora. Similar to KNM-ER 3733.

OH 28, first postcranial bones of *H. erectus*

- *Homo erectus* OH 28
- 1970, site WK, Bed IV,
- 0.8-1.2 Ma
- Pelvic and hip bones, femur
- Habitual, upright biped
- In association with Acheulean tools

Lake Turkana

Turkana Basin, Kenya: 1.4-1.8 Ma

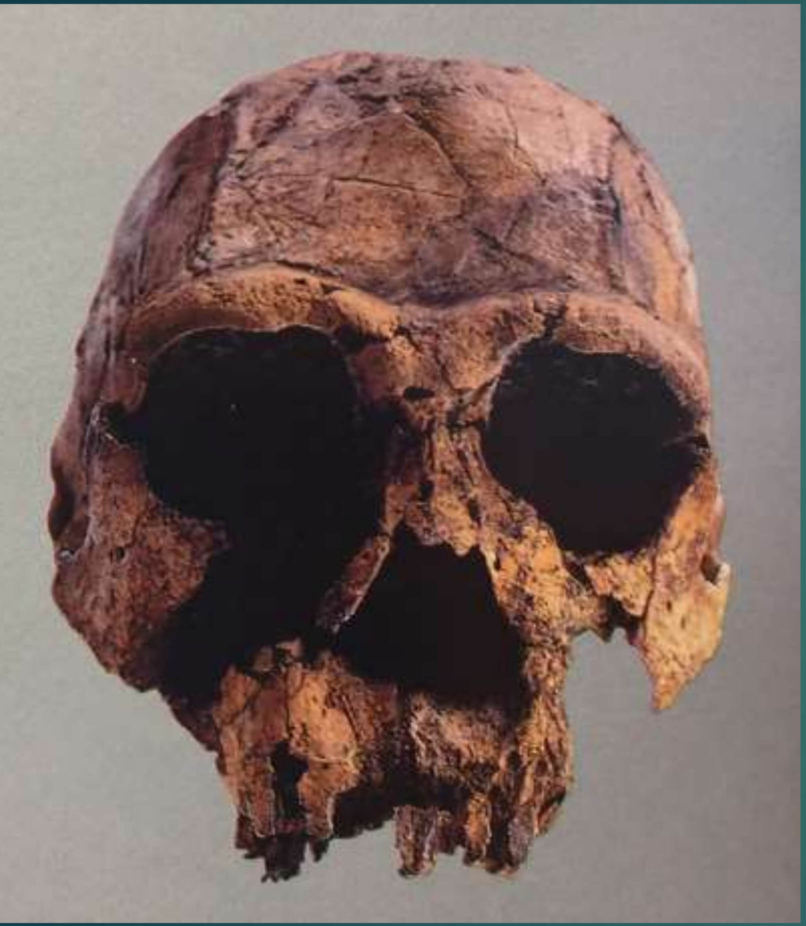
- Turkana Basin (Kenya): Since the 1970s, the has yielded more dramatic cranial and postcranial remains of early *H. erectus.*
- Age Range: 1.9 Ma to younger than 1.45 Ma.

- West Turkana: KNM-WT 15000, 1.51–1.56 Ma.
- The earliest:
  - Koobi Fora cranial remains, occipital fragment KNM-ER 2598 dated to 1.88–1.9 Ma
  - Earliest definitive *H. erectus* cranium is KNM-ER 3733 at 1.78 Ma.

Richard Leakey (1944-):
More productive than father

- Son of Louis & Mary Leakey
- Discoveries:
  - ER 1470 *(Homo habilis/rudolfensis)* type skull
  - ER 3733 (*Homo erectus/ergaster*) skull
  - ER 406 (*P. boisei*)
  - ER 3733 (*H. ergaster*): Were contemporaneous; demise of single species theory
  - KNM-WT 15000: his most important discovery—"Turkana Boy

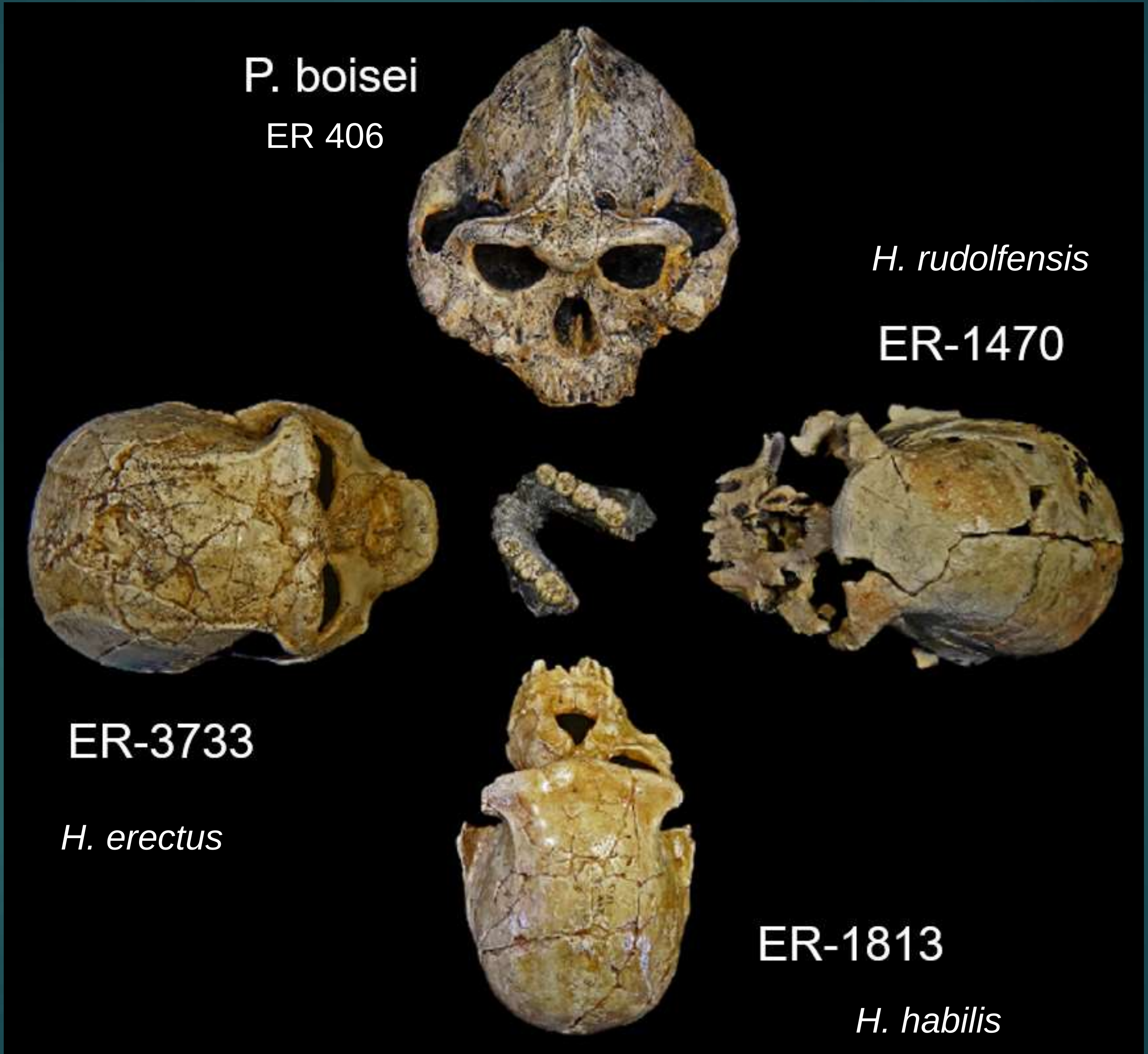
1975, Koobi Fora: *Homo ergaster,* KNM-ER 3733, female, 1.65-1.75 M, 800 cc



Homo ergaster
(KNM ER 3733)
Discoverers: Bernard Ngeneo
Locality: Koobi Fora, Kenya

This fairly complete cranium is responsible for sinking the single species concept (2 species cannot be in same ecological niche), proving evolutionary bush theory; Earliest definitive *H. erectus* cranium is KNM-ER 3733 at 1.75 Ma. The most complete East Turkana *Homo erectus* cranium

4 species in Turkana Basin, 2.05-1.85 Ma



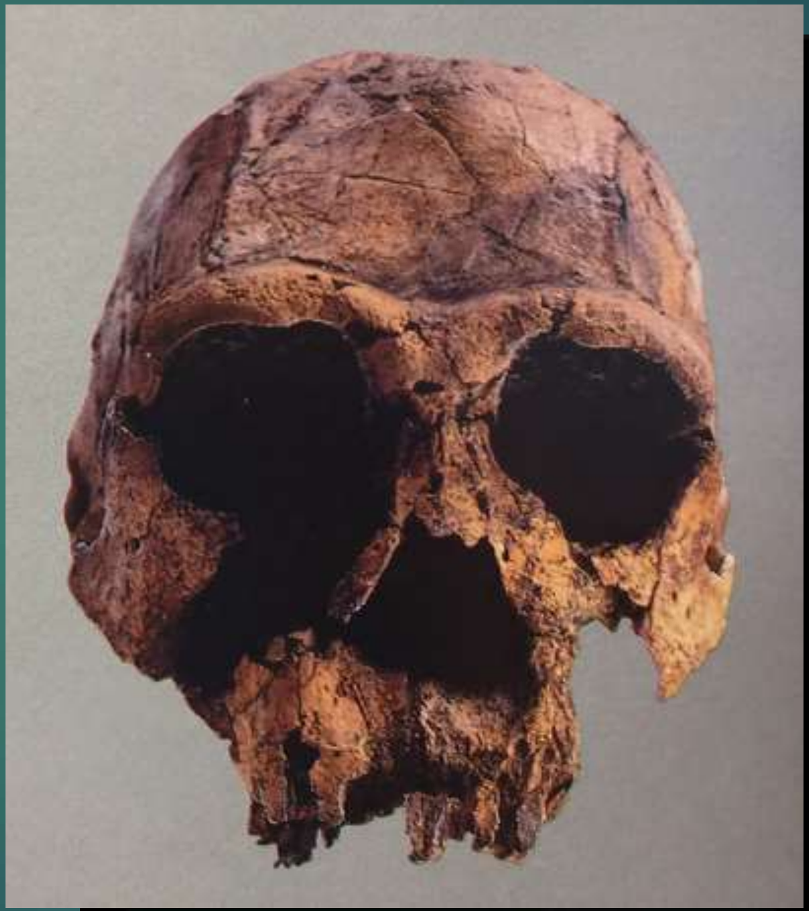
KNM-ER 3733: 1.7 Ma, 800 cc

KNM-ER 3883: Koobi Fora, 1.6-1.8 M, 775 cc, male

- Discovered by Richard Leakey in 1976 in Koobi Fora, east of Lake Turkana (formerly lake Rudolf), Kenya
- 3883 is a more robust and a little larger than KNM ER 3733
- Most likely an adult male of the species *Homo ergaster*.
- Best-preserved early male cranium

ER 3733 vs 3883: sexual dimorphism

- Female & male?
- 3883: supraorbital torus expanded (or fxs due to expansion)
- Very similar: dimorphism or variation in 1 sex
- Same species, different species, sexual dimorphism, variation in 1 sex?



KNM-ER 1808: 1.7 Ma - Vitamin overdose from raw liver

- Site: Koobi Fora, Kenya
- Date of discovery: 1974
- Discovered by: Kamoya Kimeu
- Age: About 1.7 million years old
- A female
- An outer layer of abnormal bone on this female's thigh shows evidence of bleeding just before death.
- Postcranial bones

Homo erectus; ER1808 femoral cross section

Vitamin overdose from a raw liver

- 1.7 million-year-old femur (thigh bone) of a *Homo erectus* female
- An abnormal outer layer of bone on her thigh shows evidence of bleeding just before death. Conclusion: an overdose of vitamin A—perhaps from eating a carnivore's liver, which concentrates vitamin A—caused the bleeding and her death.
- Alternative theory: causation by excess ingestion of bee brood (eggs, pupae, larvae) or other immature insects = high vitamin A content; implies alternative food strategy (like modern hunter-gatherers)

Pathology & Healthcare in 3 *H. erecti*

- KNM-ER 1808: A *Homo ergaster* , dated to 1.6 million years ago was provisioned and protected from predators for several weeks despite severe pain and loss of consciousness arising from hypervitaminosis A
- WT15000: dental abscess & limited mobility due to juvenile disc herniation
- Severe tooth loss, such as the Dmanisi hominin D3444; (but see Gilmore and Weaver 2016).

(Walker, Zimmerman, and Leakey 1982; Spikins, Rutherford, and Needham 2010; Lordkipanidze et al. 2005)

1969, SK 847, Ron Clarke: an early *Homo* in South Africa, 1.5 Ma

Homo ergaster (an early *Homo erectus* in South Africa)

Homo ergaster
partial cranium

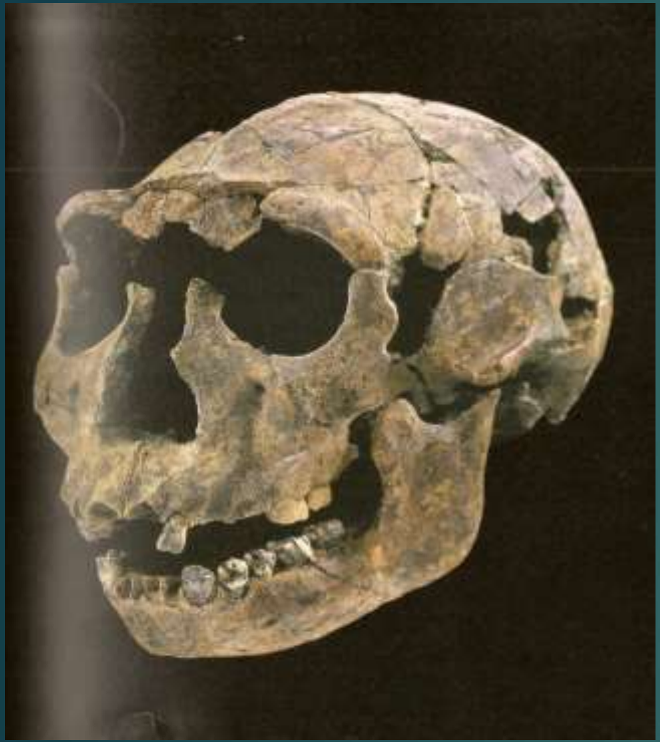
Discoverer: Ron Clarke
Locality: Swartkrans
Date 1969
Age: 1.5 M

SK 847: 2 M year old toothache

- Two-million-year-old toothache
- Teeth were worn down so much that root canals had been exposed. And above the upper incisors lay at least one dental abscess
- The earliest dental abscess in the genus *Homo* ever found.
- Shows that this individual was able to cope with several concurrent abscesses, clearly surviving for an extended period

Lake Turkana

1984: *Turkana Boy, Homo ergaster*, KNM-WT 15000, 5’3”, 9 year-old



<u>*Homo ergaster*</u>
(KNM WT 15000)
Discoverers: Kamoya Kimeu
Date: 1984
Locality: Nariokotome, Kenya
Age: 1.6 M

- 75% of skeleton of adolescent male found west of Lake Turkana in the mid 1980s
- 1.6 Ma, very modern skeleton, similar to that of fully modern human

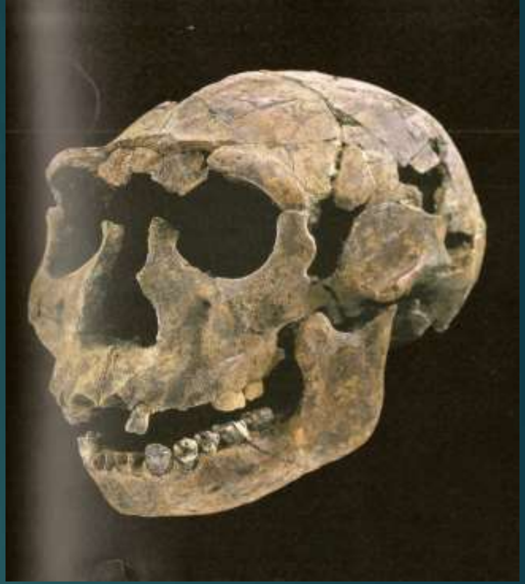
Modern Body Plan

Walker & Leakey, 1993

Modern Body Plan

1984: Turkana Boy, *Homo ergaster*,

- Boy from Nariokotome
- Very tall hominin at 1.5 Ma
- 9 years old when he died (no 3rd molar eruption); male from pelvis
- 5' 3" tall (6 feet @ maturity)
- Long legs, thick bones
- Brain size large (880 cc; adult 910 cc)
- Well adapted to staying cool in hot, dry climates
- Face, molar teeth, chewing muscles smaller than earlier hominins (softer, high-quality - perhaps cooked - foods)



Homo ergaster
(KNM WT 15000)
Discoverers: Kamoya Kimeu
Date: 1984
Locality: Nariokotome, Kenya
Age: 1.6 M

Turkana Boy

- The most complete fossil specimen in the fossil record.
- It's a skeleton that's roughly 70% to 75% complete

H. erectus Turkana boy	*A. afarensis* Lucy	*H. neanderthalensis* La Ferrassie

Importance of Turkana Boy, KNM-WT 15000

- 1.6 Ma, 880 cc, 1.53 meters tall
- First discovery of many postcranial bones of *H. erectus*
- Enables assessment of overall body proportions and relationships
- First hominin in which brain and body size could be accurately measured in same individual
- Allowed inferences about species' mode of life, including life-history factors, subsistence, language capacity
- But initially overestimated height in *H. erectus*

Post-cranial skeletons tell us a lot about *H. erectus*

- Nariokotome boy – Lake Turkana, Kenya
  - Most complete hominin fossil skeleton
- Tall adults (male 6’, female 5’)
- Long limbs
- Narrow hips?

  ==> infants born with small brains, slow development
- Tooth age indicate faster maturing than modern humans
- Narrow shoulders
- Thick bones ==> heavily muscled
- Sexual dimorphism reduced, still > MHs

KNM-WT 15000

⇒ Body proportions like modern humans in tropics

Homo ergaster: WT 15,000 Narikatome Boy

- Foramen magnum (vertebrate opening in spinal cord) was smaller than moderns
- Front tooth size increase, back tooth decrease
- Juvenile disc herniation
- His spinal vertebrae were diseased, causing a subtle curvature (scoliosis) and probably slow movement.
- This may have contributed to his death, although his cause of death at such a young age is unknown.

Turkana Boy

- Pelvis shows he was male.

- Second molars had erupted, but not his third (the wisdom teeth), indicating he was not an adult.

- Microscopic structure of his teeth tells us how quickly his teeth grew – and thus his age: eight or nine years old.

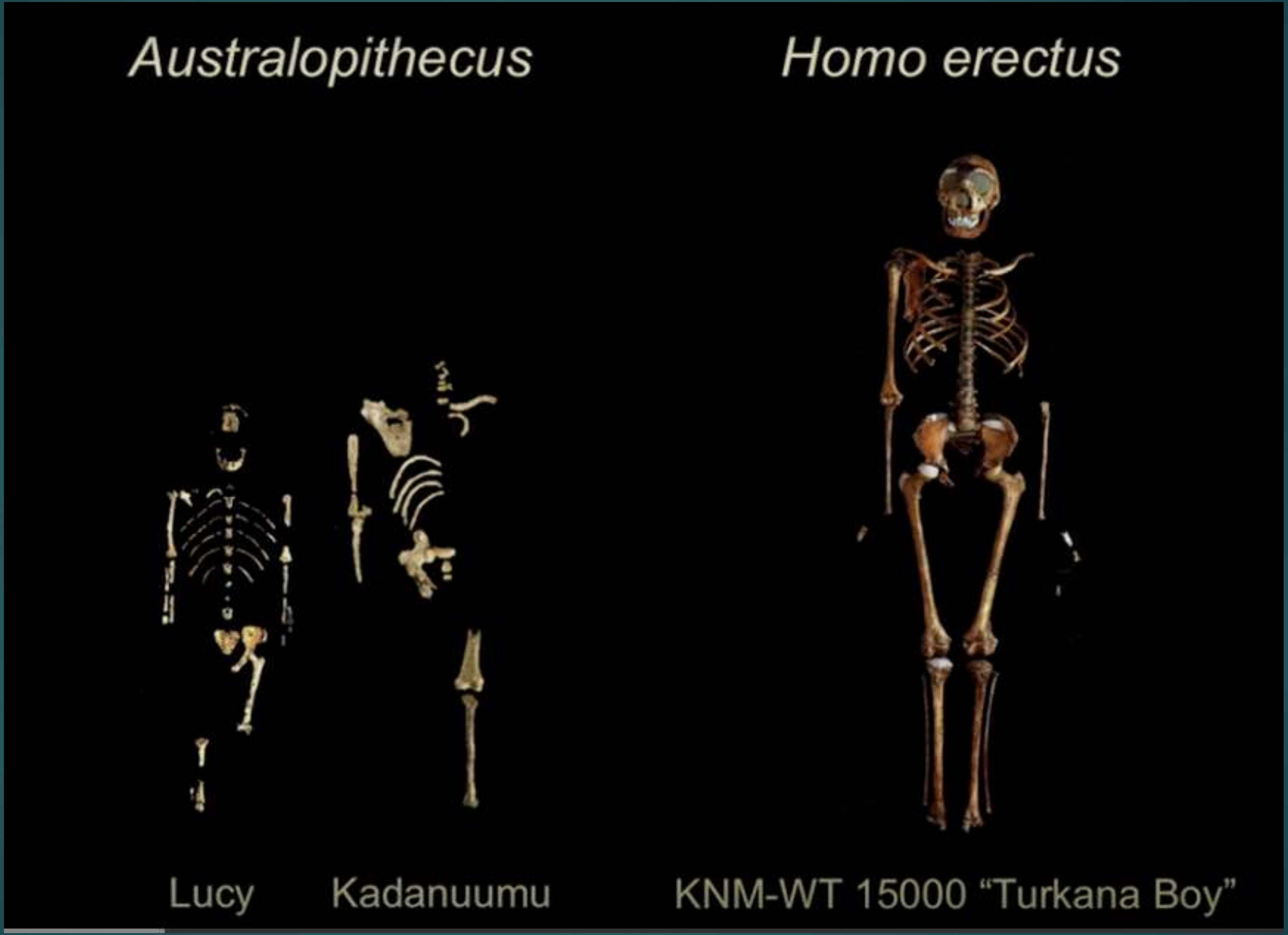
- 1.6 m (5 ft 3 in) tall and weighed 48 kg (106 lb) when he died

- Cranial capacity at death = 880 ccs; would have reached 909 cc if full adulthood.

- Body shows long legs and narrow shoulders typical of humans who live in hot, dry climate today.

Body forms

Australopiths: smaller bodies, significant sexual dimorphism, shorter lower limbs, longer upper limbs, more curved fingers and toes

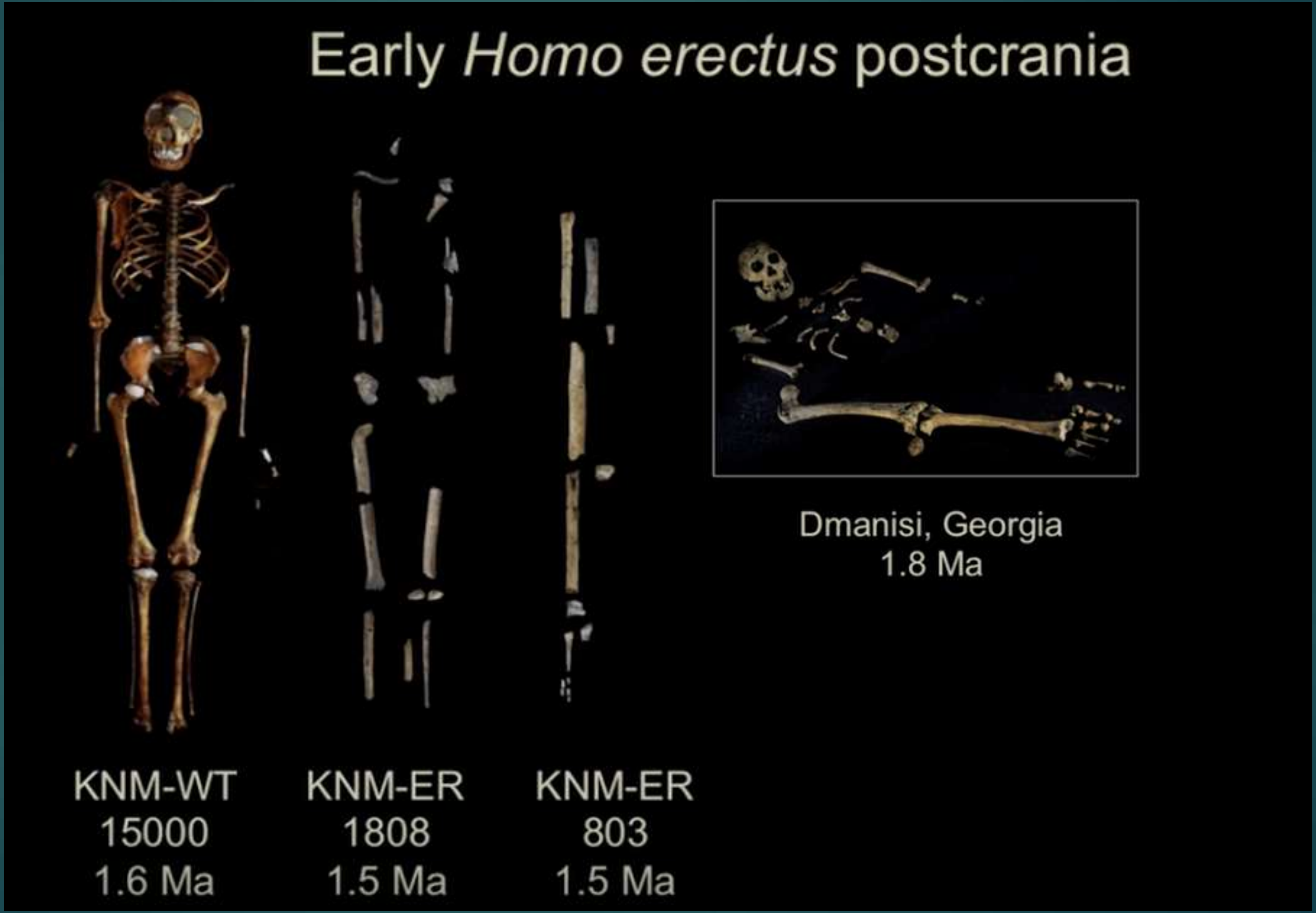


5’1”

5’3”

Turkana boy (more like MH): longer, stronger legs, larger lower limb joints, smaller upper limbs, thinner body form

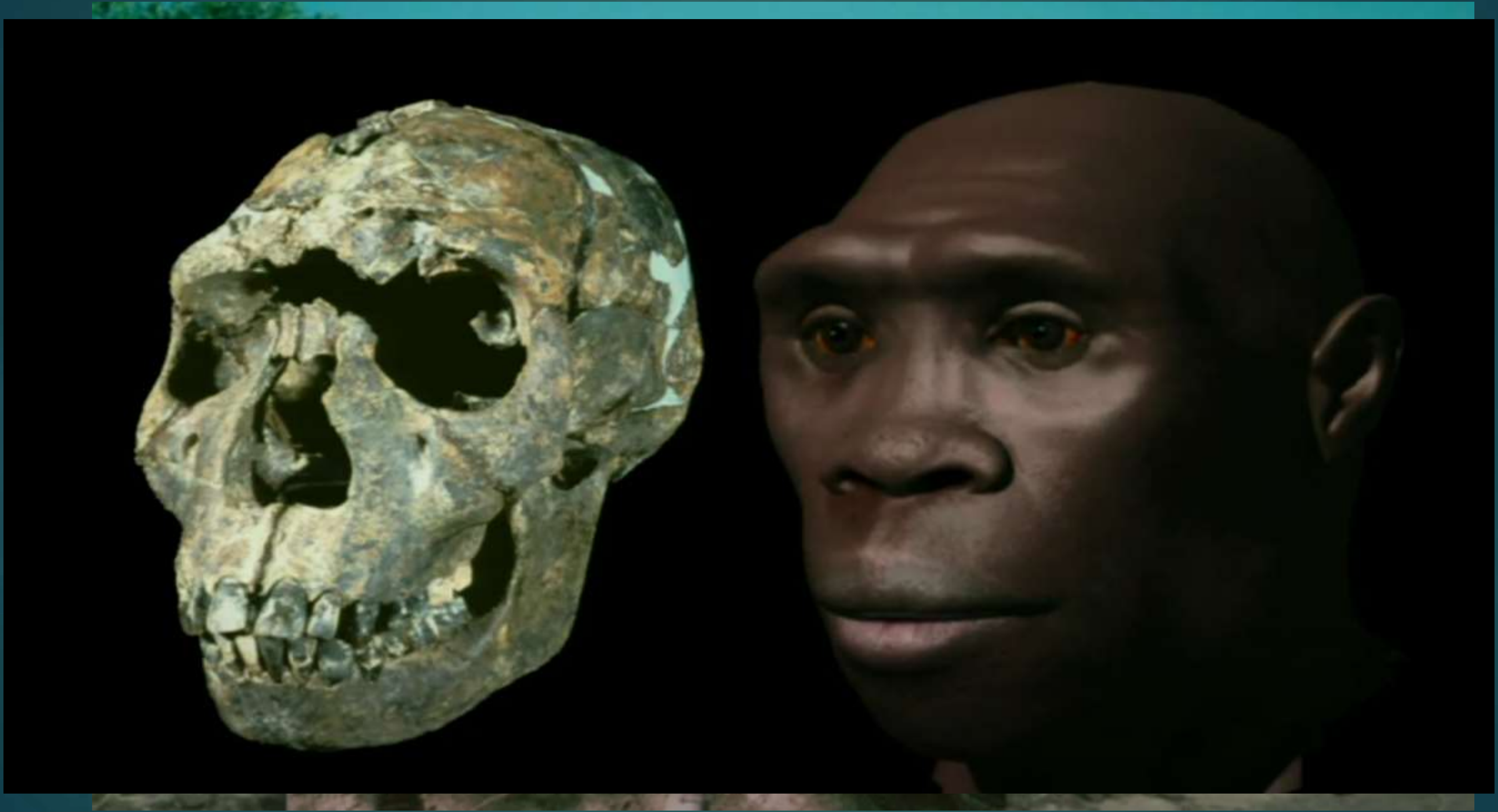
Early *Homo* postcrania: 1.5-1.8 Ma



Was this how Turkana Boy met his end?

Maeve Leakey: Washed into a swamp; Carnivores never got to it.
Footprints of hippos had walked over bones; some of the ribs were vertical

Kamoya Kimeu finds first fossil of skull of Turkana boy



Alan Walker finds rest of skull: tree seed grew from middle of skull, which held water; roots kept skull together


Most early hominids
is immature male.
surpassed a height
of National

Runner

Source and text: Facsimile, Neanderthal Museum, Mettmann, near Düsseldorf, Germany

Victor Deak

Turkana Boy & Peking Man

H. erectus characteristics

- Read *Wisdom of Bones* by A. Walker & P. Shipman
- Tall: Turkana boy = 5'3" (but Dmanisi & Olduvai were short)
- Brain size increase = greater than 800 cc; with increased body size; but greater encephalization (later >1000 cc); needed more energy
- New technology = Acheulean
- Alternative food ecology: clear evidence of *H. erectus* accessing <u>medium- and large-sized animal carcasses for meat</u>, through hunting and/or scavenging, in the form of fossil <u>remains of animals with cut marks left by butchery</u>. This behavior, regularly accessing animal carcasses, is an ecological change from earlier hominins

"*Homo erectus* - A Bigger, Smarter, Faster Hominin Lineage" (2013); Van Arsdale

H. erectus characteristics 2

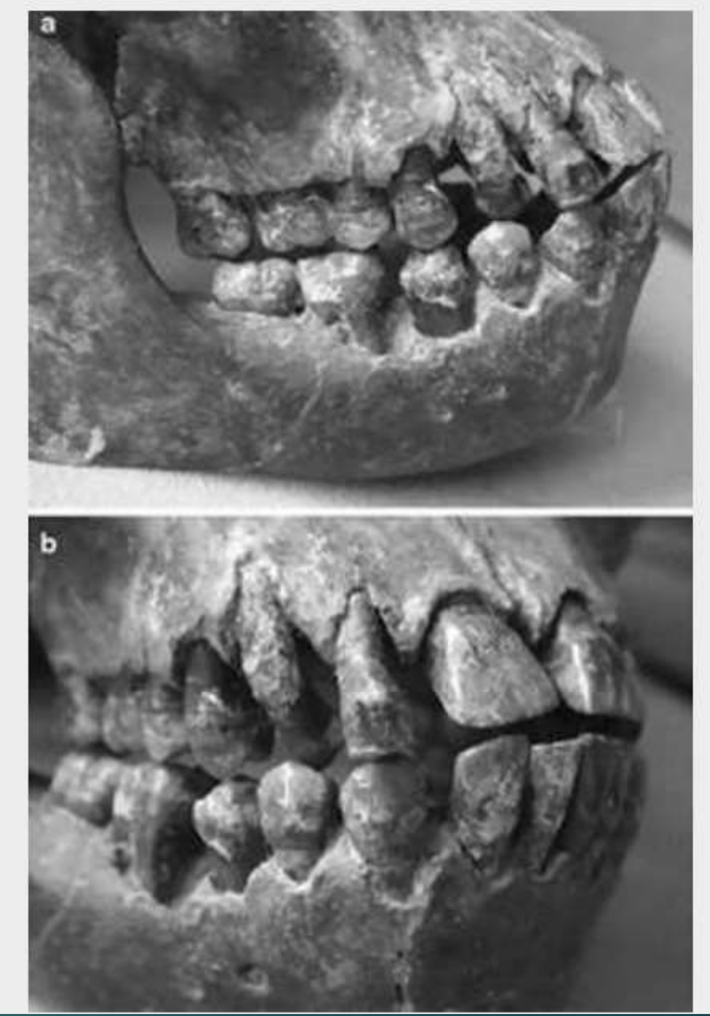
- Social
- Sweat; 85-87 degree temperature
- Long legs
- Less hair
- Larger ranges
- Projecting nose
- Right-handed (petulias same as MH)

Homo erectus Skin

- No evidence about skin hair in *H. erectus*
- **Nina Jablonski:** loss of hair well over 1 million years ago for thermal regulation; ability to sweat crucial
- Hairless skin is an adaptation to becoming very active bipeds in open environments in equatorial Africa.
- Dark pigmentation to protect against sun damage would have almost certainly evolved at the same time as body hair was lost

Large front teeth

The teeth are unworn. Shovel-shaped incisors.


a
b

Turkana Boy: Speech & Foramen Magnum

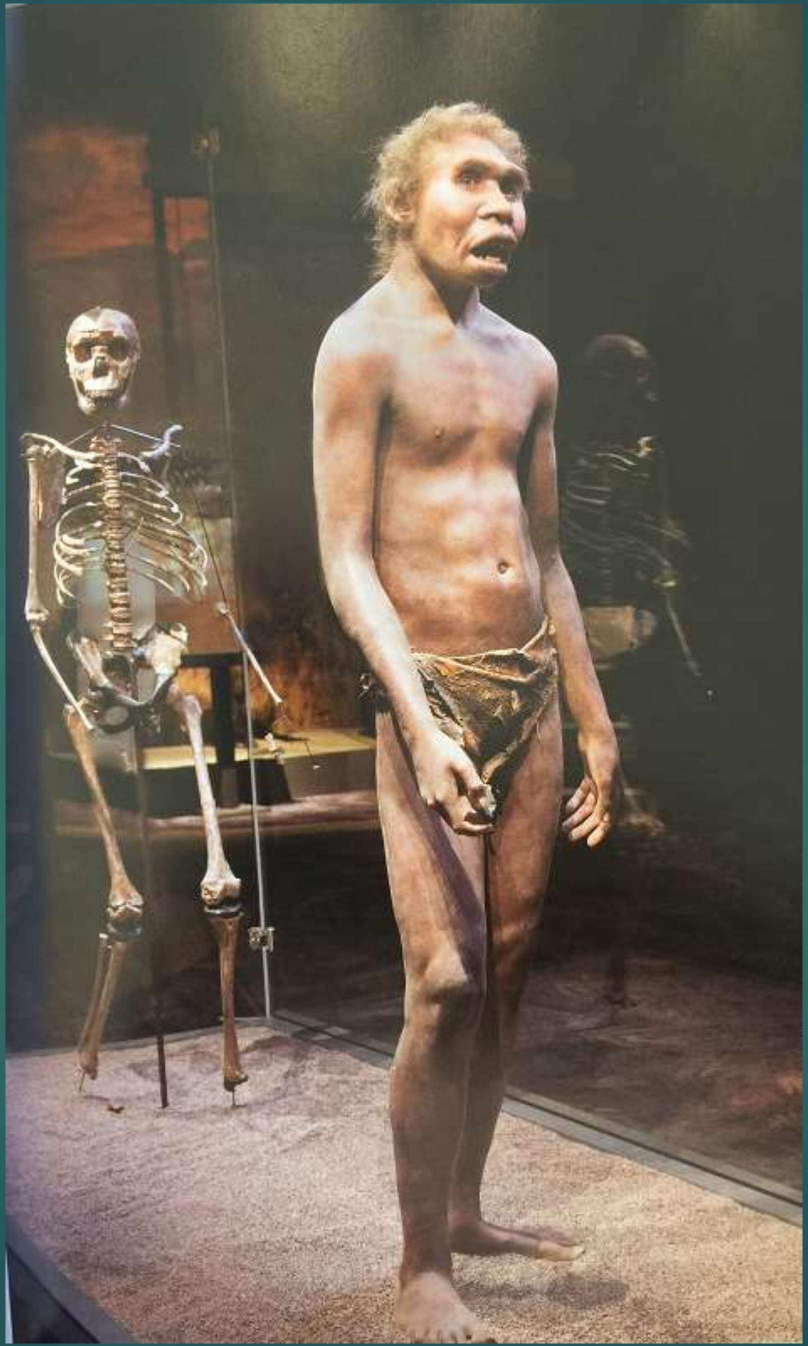
- The narrow spinal canal (foramen magnum) has been an issue of much speculation.
- Some contend that this means that KNM-WT 15000 had small intercostal muscles (used for fine air control during speech in modern humans).
- However, this was a juvenile and the neurocanal size may have increased by 30% by maturity.
- Also, even though it has a small canal size relative to its body size, it is still within the modern human range (albeit, at the bottom.)
- This is a very tenuous piece of evidence that has been used to make very specific statements about early human capacity for speech.
- Considering it is within the human range at all, it makes it unlikely that this would have prevented the capacity for speech, and since it is a juvenile specimen, sweeping statements about the species capacity for language based on this trait is very weak.

Language in *H. erectus*

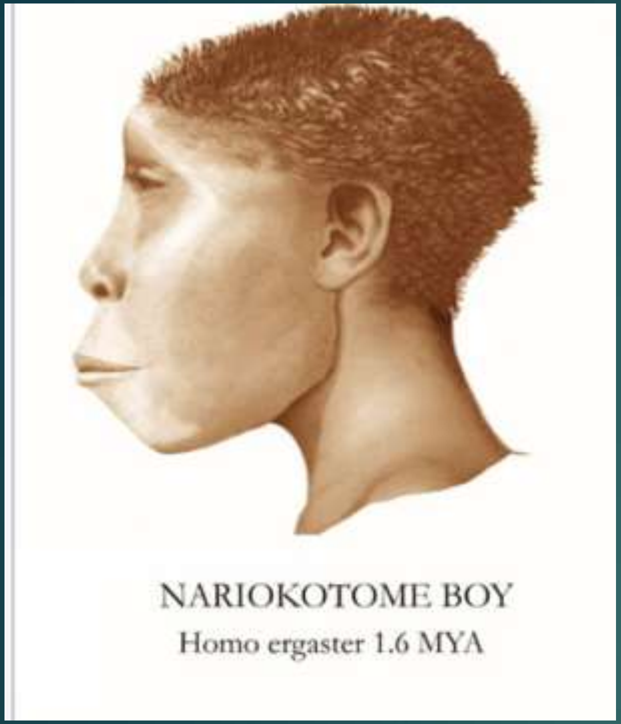
- According to Dan Everett, *Homo erectus* was probably the first of the primates that used language. Language is the tool that was invented to solve how to communicate in a social group. Disagrees with innate universal grammar concept.
- The capacity for language:
  - the size of the vertebral canal (a proxy for the size of the spinal cord), and
  - external features of endocasts (Both brain-size and the presence of the Broca's area also support the use of articulate language);
  - no evidence vs. language; was *H. erectus* the source of *FOXP2* found in Ns and Ds?
- If it is true, then language might have started as early as 1.9 million years ago. He bases his hypothesis on the sophisticated social organizations and technology, which might have required a complex system of communication. Sign languages, for instance, all rely on symbolic gestures. They are considered languages due to their complex grammar.
- Runnels: “I do not believe that any hominin lacked language ability. Hell, the birds and the elephants and the dolphins talk to each other and so do we.”

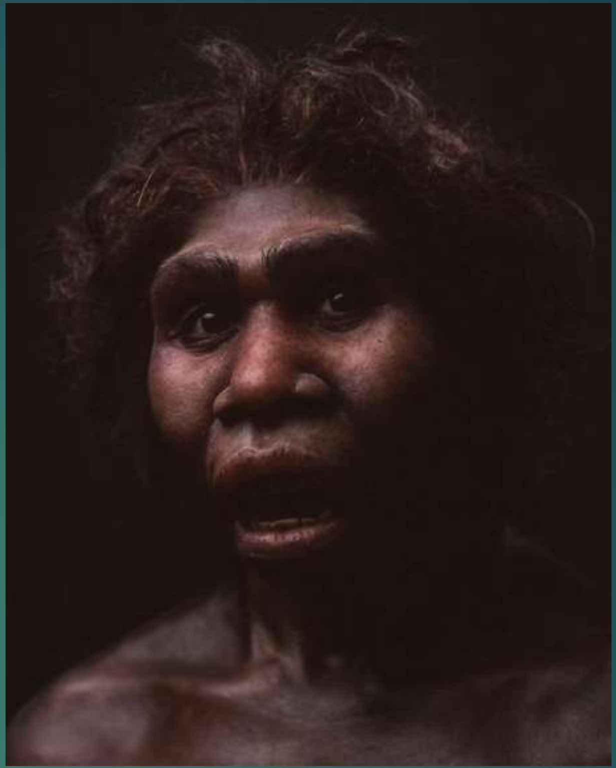
Reconstruction

Elizabeth Daynès.



Reconstruction of *Homo ergaster* by Élisabeth Daynès

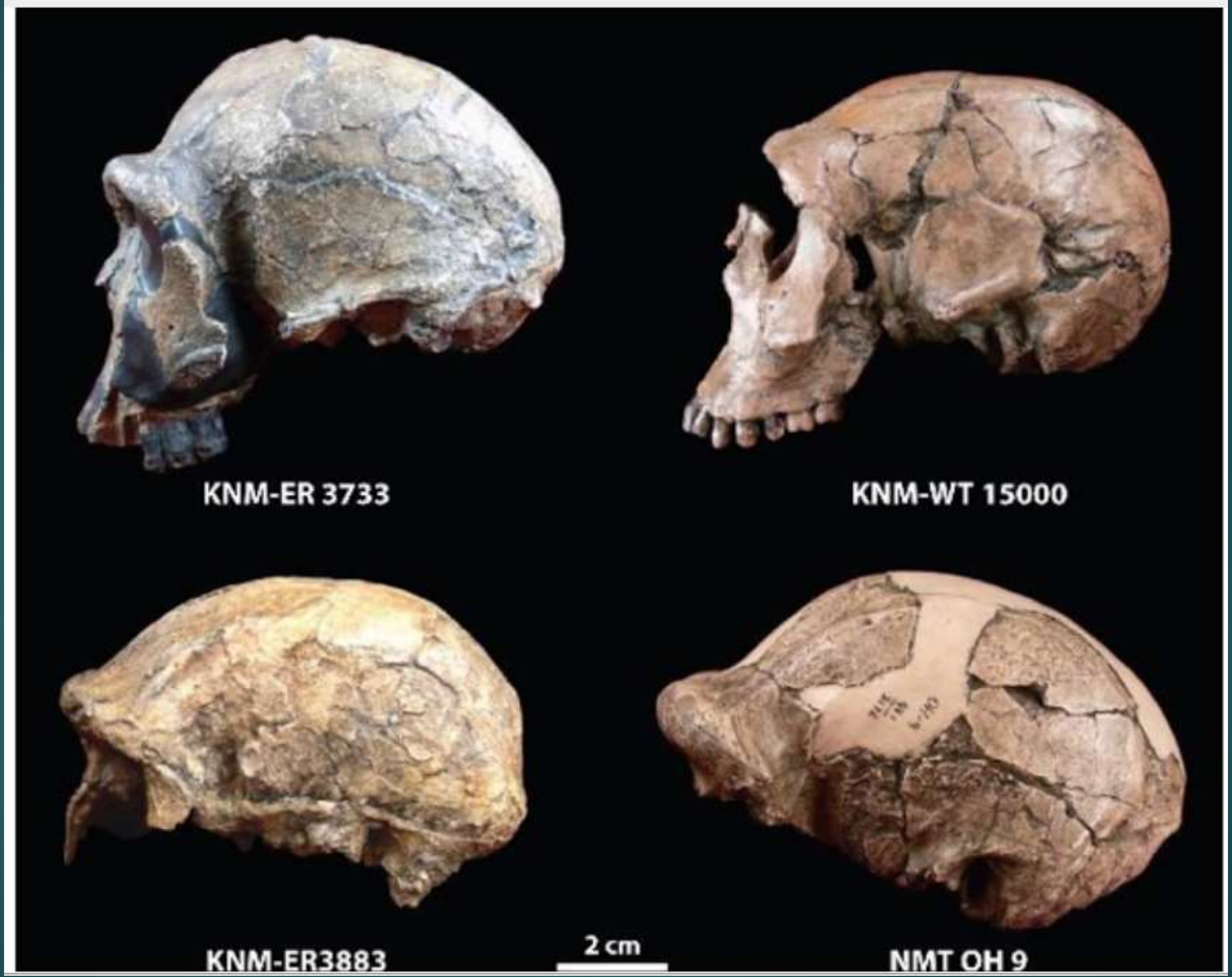

NARIOKOTOME BOY
Homo ergaster 1.6 MYA



Skull Variability in *Homo erectus*

Koobi Fora

Turkana
Boy



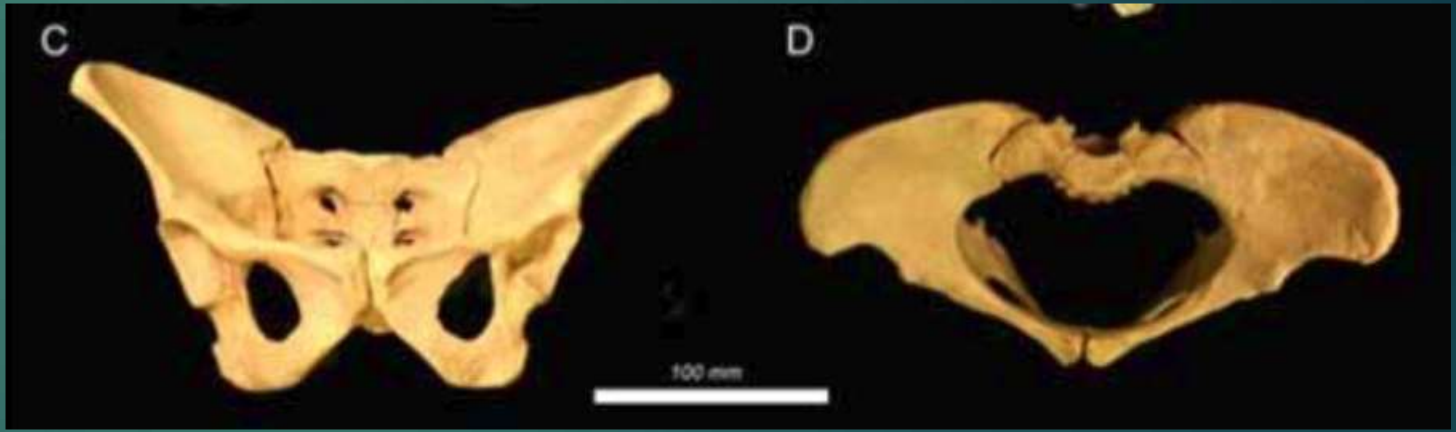
Koobi Fora

Olduvai
Gorge
OH 9

Only 3 female pelves prior to 1 Ma

Homo erectus, Gona

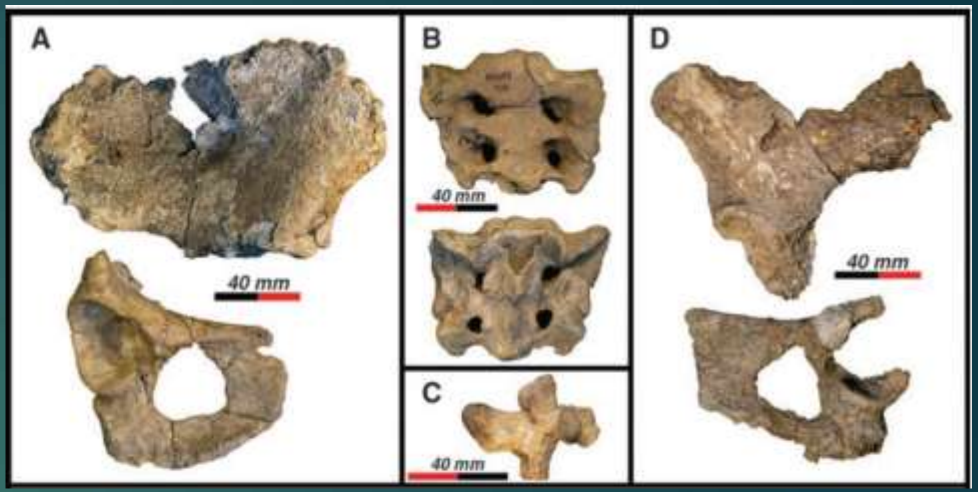
A. afarensis, Lucy

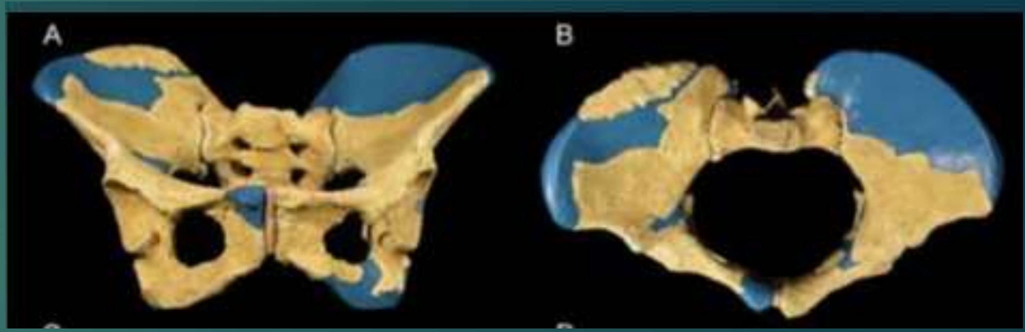


The discovery of a nearly complete adult female *H. erectus* pelvis from Gona, Ethiopia, which is transversely broad and has a relatively large birth canal, raises questions about the narrow-hipped, Nariokotome-based pelvic reconstruction and whether *H. erectus* infants were secondarily altricial (single birth, but helpless).

Gona pelvis, BSN49/P27: 1.8 Ma

- Female pelvis from Gona, Afar in Ethiopia by Scott Simpson
- The size of this pelvis suggest the female was quite short at only about 130 cm (4'3') in height
- The size and shape of the pelvis indicates the female could have given birth to an infant with a brain 30-50% the size of an adult's (more mature than MH's 25%).
- H. erectus neonates may have been larger brained at birth & had faster development.

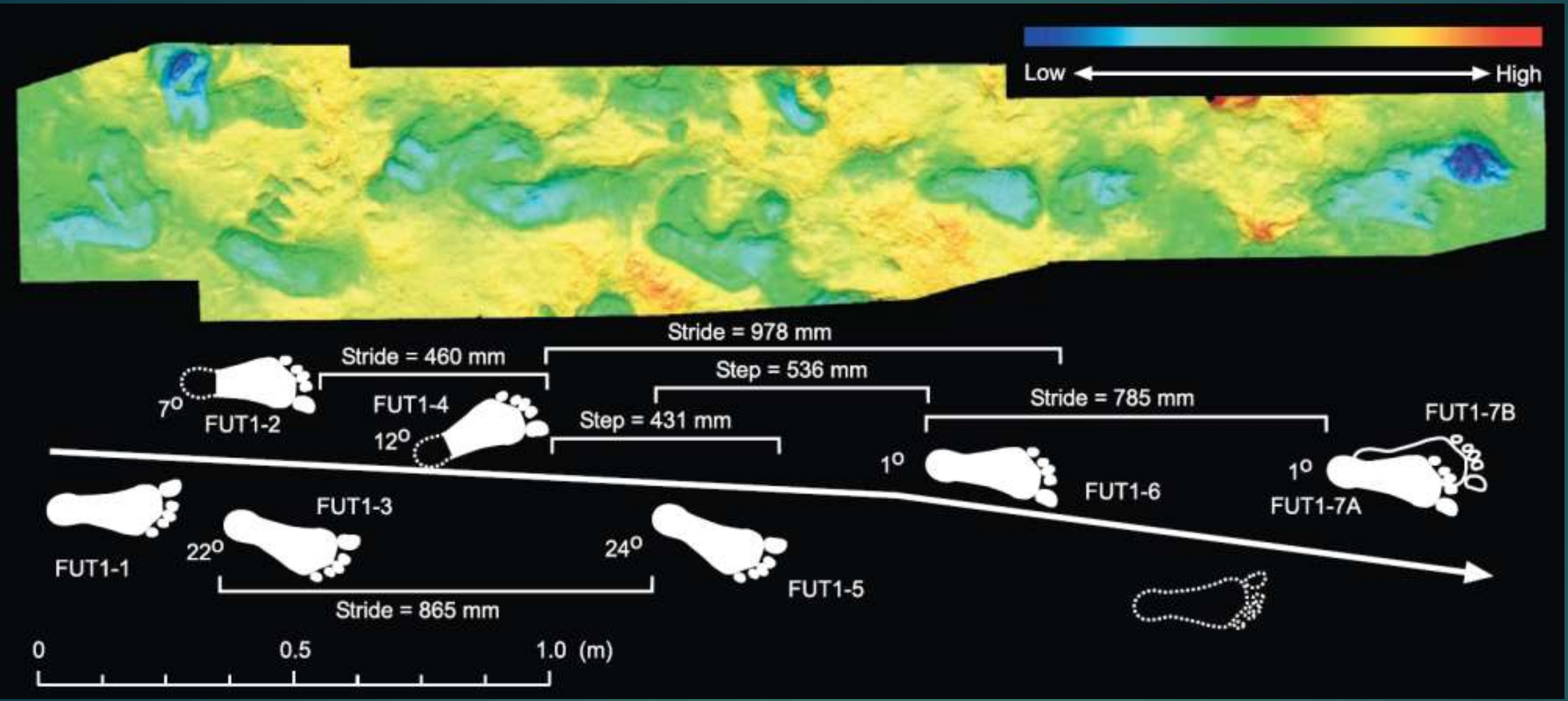




Gona pelvis

- Early *Homo erectus* simply *didn't* look uniformly like KNM-WT 15000. There are many body sizes represented in early *Homo*, even within Africa, considering the *other* new small-bodied African *Homo erectus* specimens, like KNM-ER 42700.
- It is now clear that the *H. erectus* pelvis retained many elements of its australopithecine heritage, although substantially modified by the demands of birthing large-brained offspring.
- H. erectus neonates may have been larger brained at birth & had faster development.

Ileret, Kenya, Footprints: 1.5 M



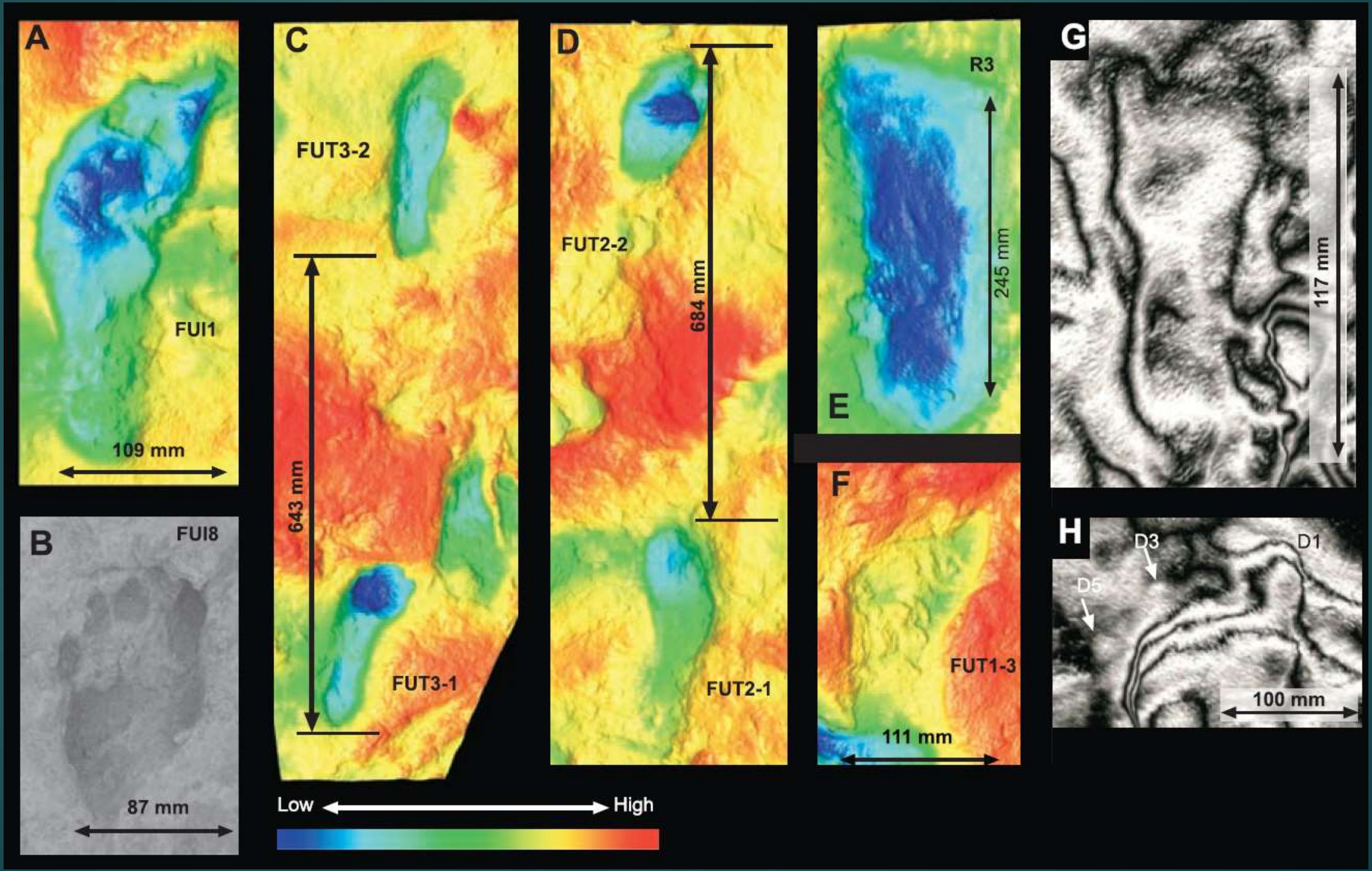
- These are the oldest known evidence of an essentially modern human-like foot anatomy and differ from the Laetoli footprints left by australopithecines 3.6 million years ago.
- The size and shape suggest that they were made by *Homo ergaster*, which also makes them the oldest surviving footprints made by a human species.

1.5 M Ileret, Kenya Footprints, 20 individuals: social behavior

Figure 1. 1.5 Ma hominin tracks from Ileret, Kenya. Representative images of hominin tracks uncovered in the Ileret area between 2007 and 2014. These tracks come from five different sites within about 1.5 km of each other. Some tracks show deterioration and overprinting, while many preserve fine detail, indicating that they were rapidly hardened and covered with sediment. No two sites represent the same continuous surface, as all come from different stratigraphic levels within the Ileret tuff complex. The total sample includes 97 hominin tracks produced by at least 20 different individuals.

Kevin G. Hatala, et al., 2016

Ileret, Kenya, Footprints: 1.5 M



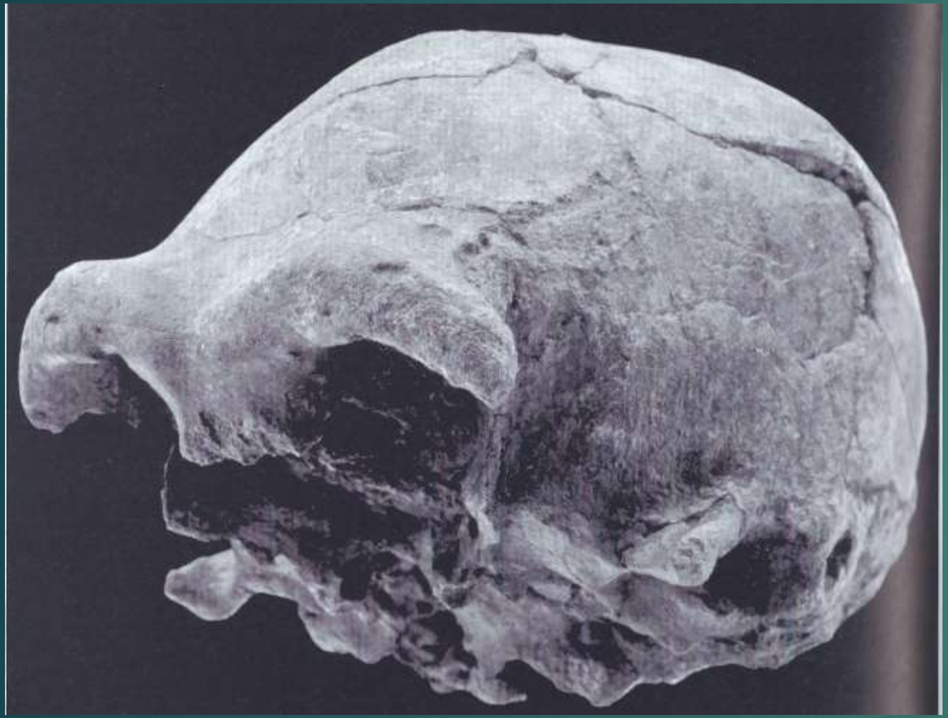
97 Footsteps of 20 *H. erecti*

- Ninety-seven, 1.5-million-year-old footprints made by at least 20 (23 to 15) different *Homo erectus* individuals at multiple sites near Ileret, Kenya

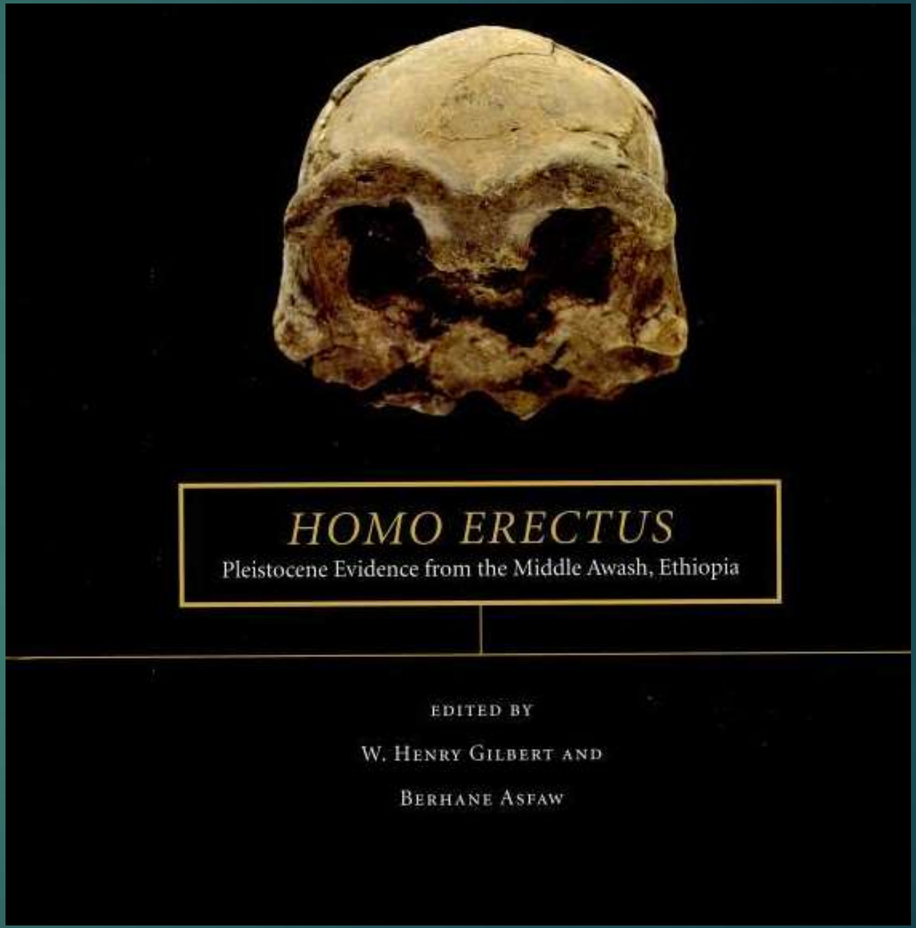
- Oldest direct evidence for modern human-like weight transfer; The mean mass from these 20 Ileret hominin trackways was 48.9 kg(108 lbs)
- Confirm the presence of an energy-saving longitudinally arched foot in *H. erectus*.
- These *H. erectus* individuals lived and moved in cooperative multi-male groups, offering direct evidence consistent with human-like social behaviors in *H. erectus*. Could be evidence of sexually divided foraging behavior in *H. erectus.*
- Implied that *H. erectus* regularly used lake margin habitats perhaps to access aquatic foods or water.

Kevin G. Hatala, et al., *Scientific Reports*, 2016

William Henry Gilbert: African *H. erectus* at Daka



Homo erectus calvaria BOU-VP-2/66.



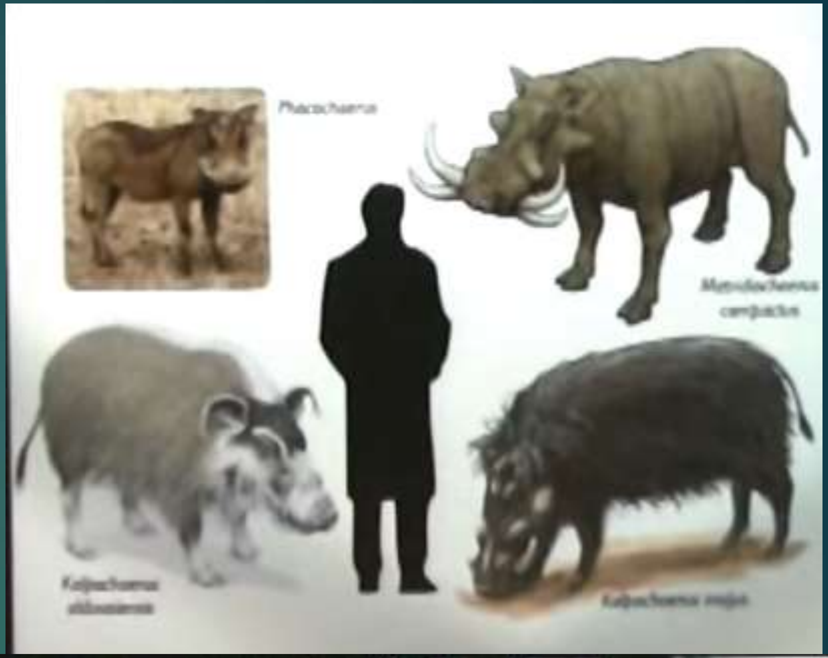
BOU-VP-2/66: Daka: 1 Ma, 995 cc

- From the Daka Member of the Bouri Formation in the Middle Awash Study Area of the Awash valley of the Ethiopia Rift.
- Date of discovery: 1997
- Discovered by:

  W. Henry Gilbert
- Clear link between Asian *Homo erectus* and African *H. erectus*

Photo from cover of Nature. Photo © David L. Brill \ Brill Atlanta

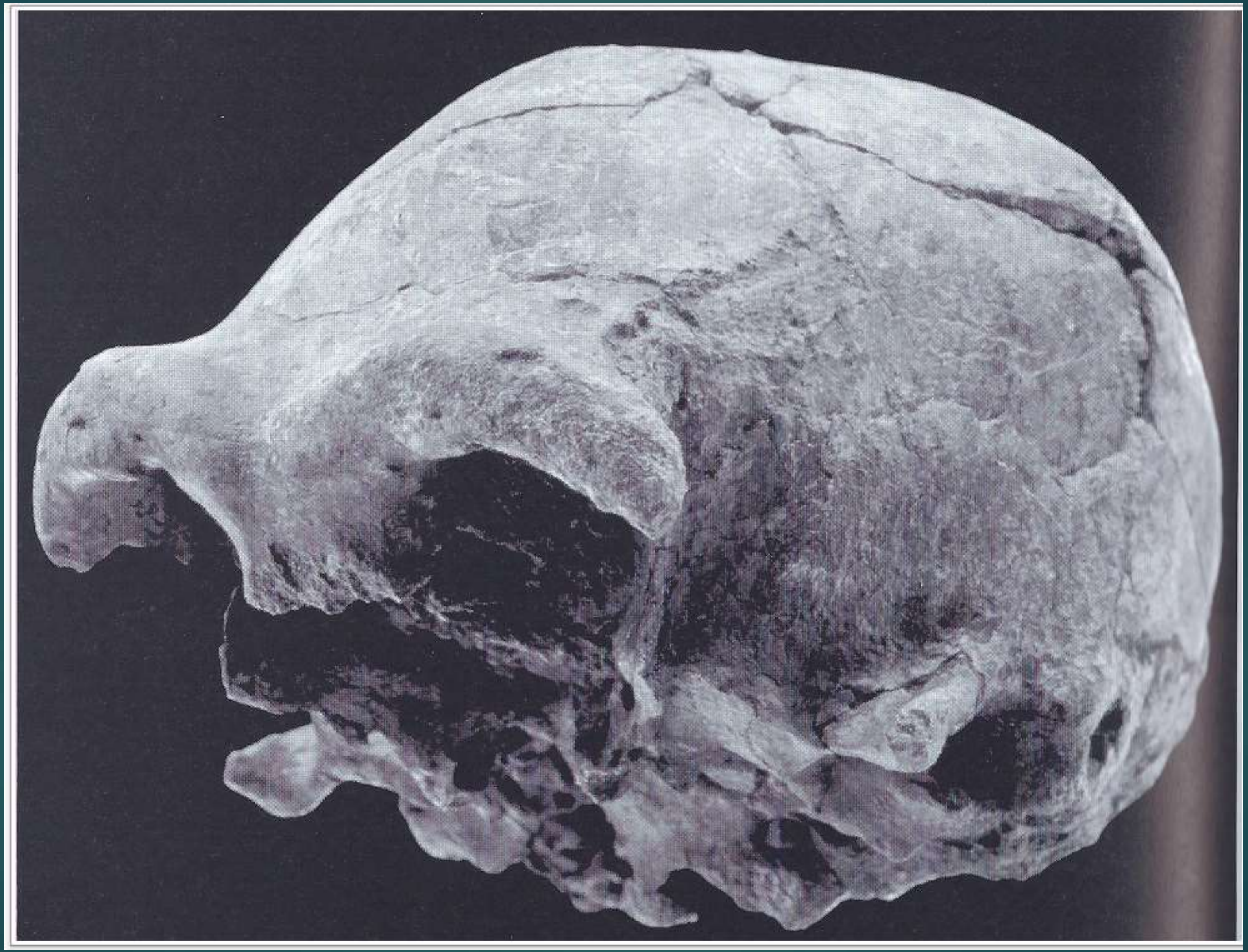
Daka



Looks like Asian
H. erectus

Lots of stone tools
And animal fossils,
Incl. 4 pig craniums,
hippos, hyenas, lions,
leopards, elephants,
horses, giraffes,
monkeys, 1 rodent,
bovids (dry open
environments),
buffalos,

Daka

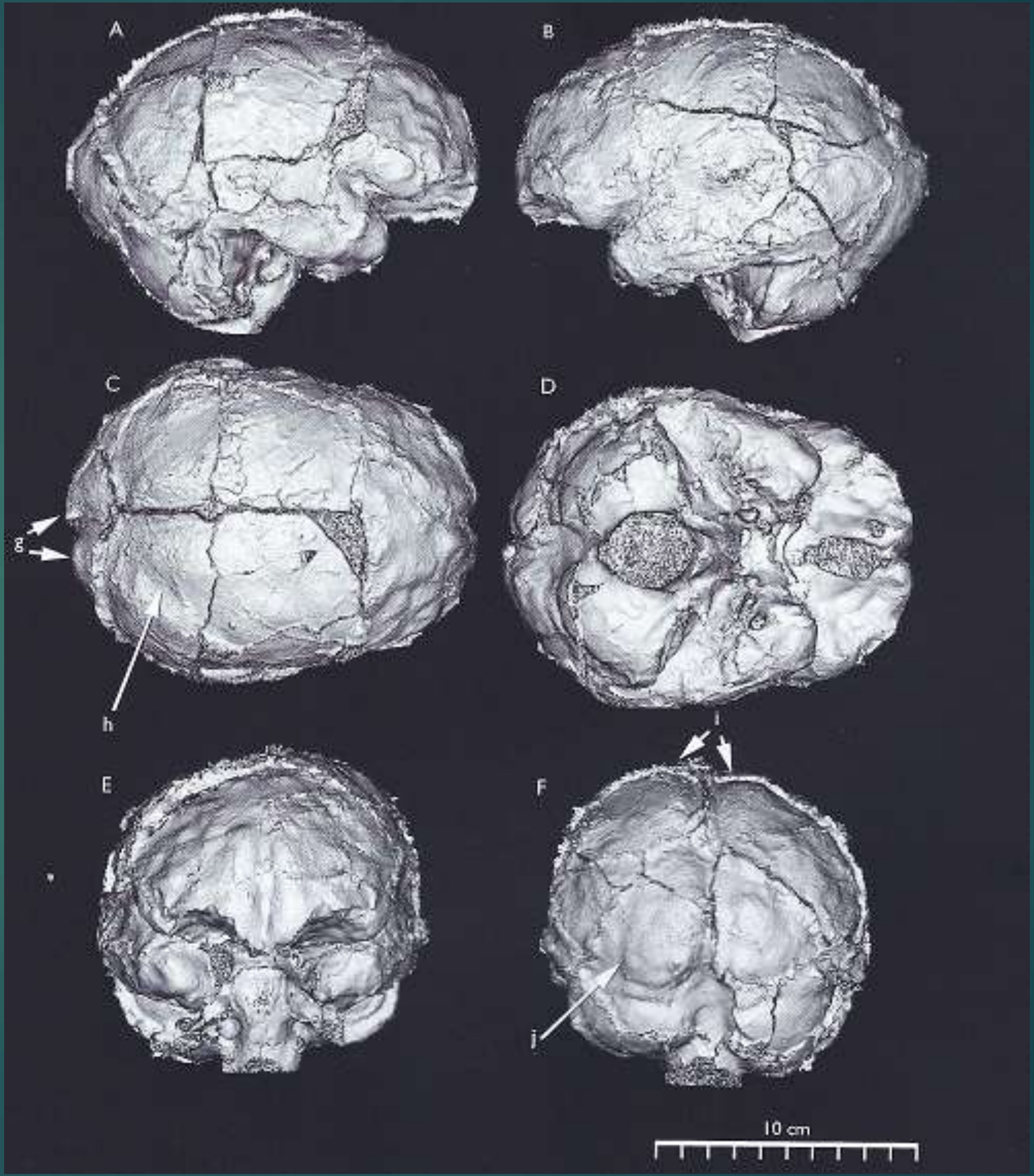


Possible
Bite
marks

Browridge variation in *H. ergaster*

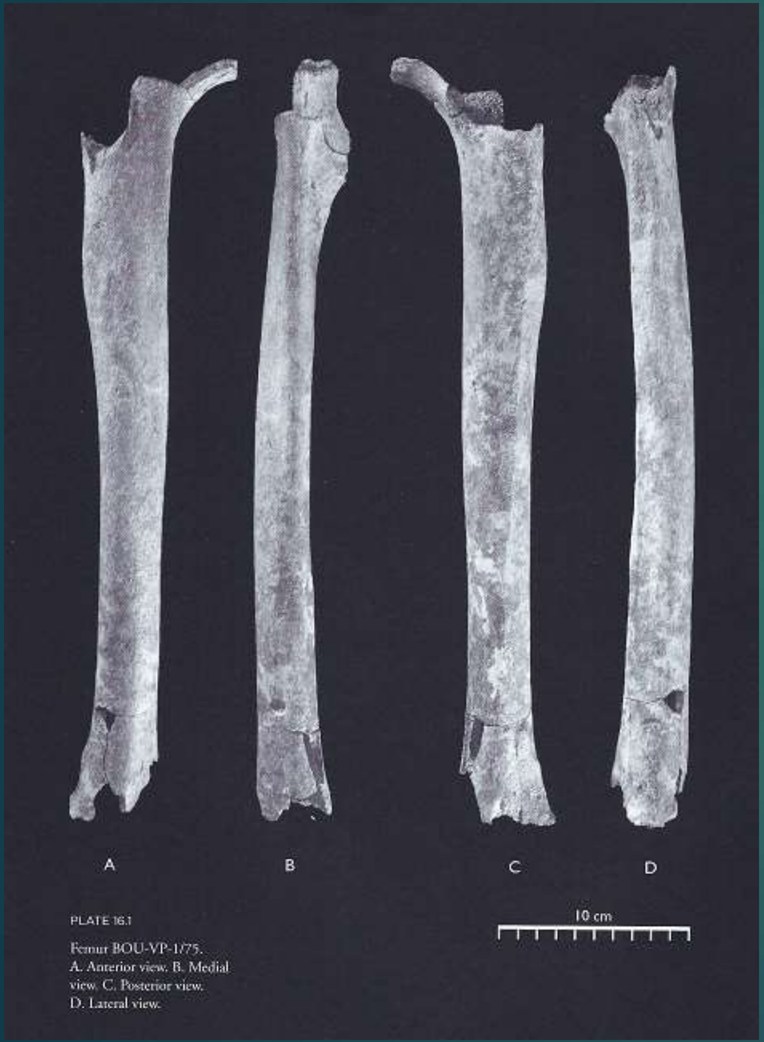
Daka ER-3733 OH 9

Daka Endocast

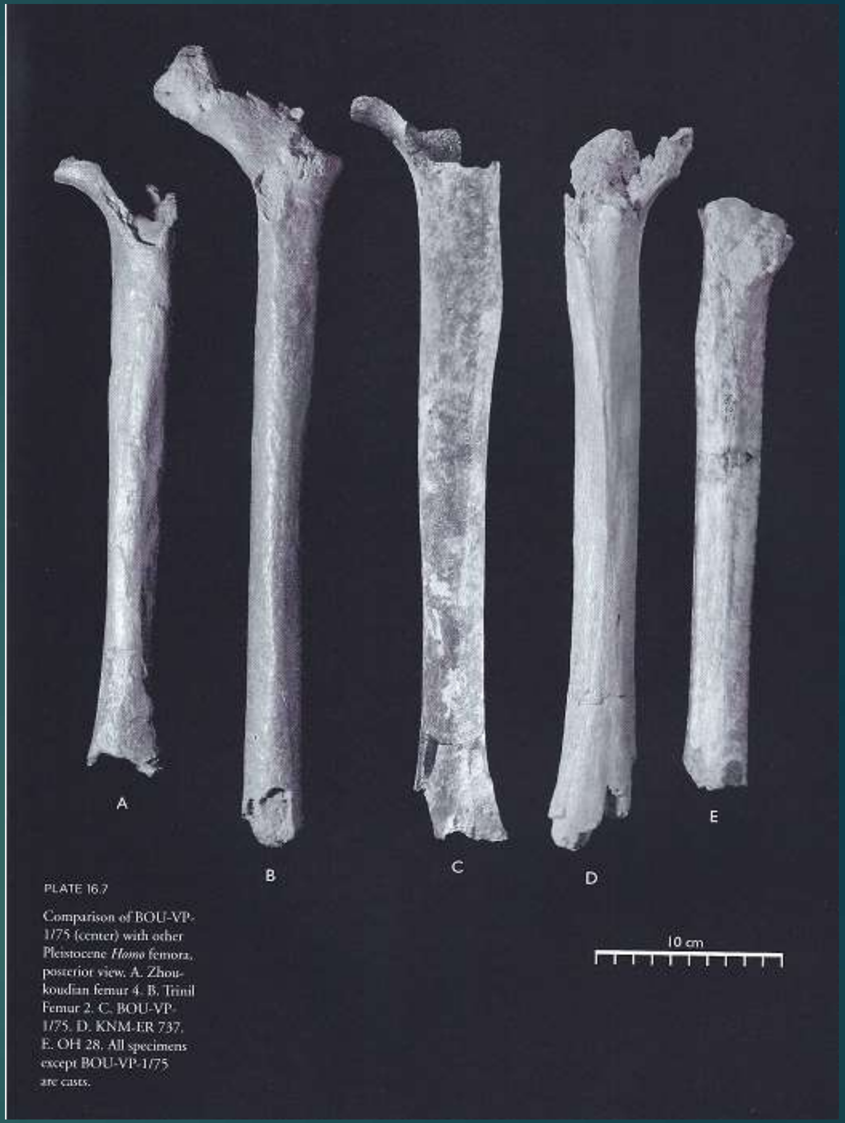


Femurs:

BOU-VP-1-75



BOU-VP-19-63



A. Zhoukoudian femur 4. B. Trinil Femur 2. C. BOU-VP- 1/75. D. KNM-ER 737, E. OH 28.

Konso-Gardula (KGA), Ethiopia, 1.4 Ma

- Numerous handaxes, trihedral points, rare cleavers, basalt cores and flakes on quartz, quartzite and other volcanic rocks.

- It is associated with fauna, notably elephant, rhinoceros, hippopotamus, as well as several species of Equids, Suidae, and Bovids.

- Many paleontological remains of great mammals show clear signs of human cutmarks.

1993:
KGA 10-525: P. boisei

Yonas Beyene, et al., 2013

Konso-Gardula (KGA):

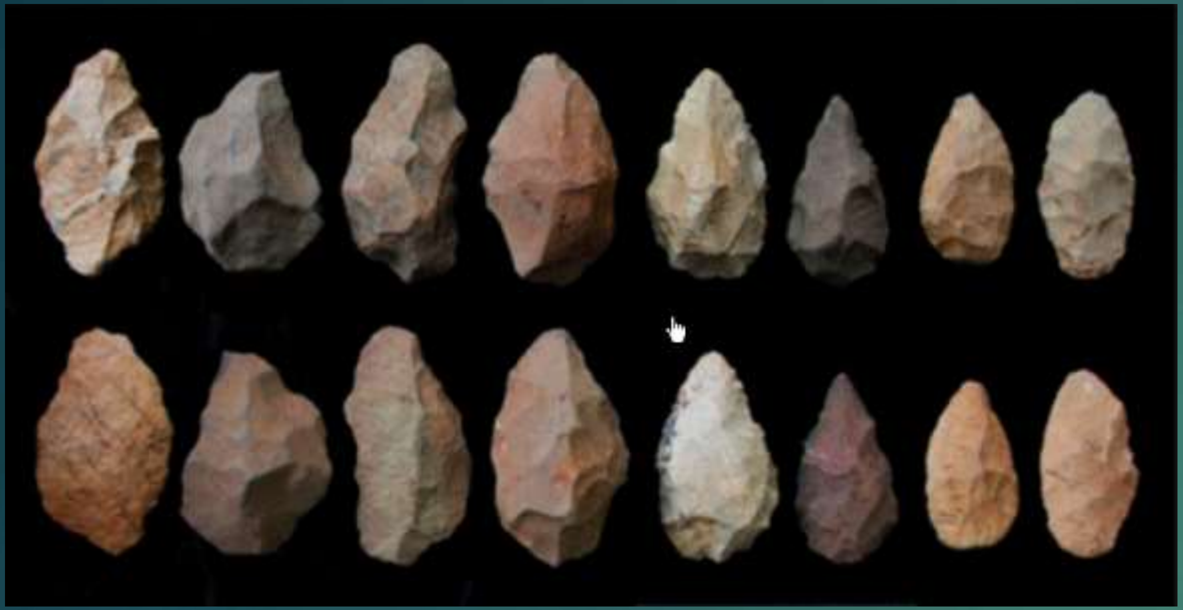
H. erectus remains recovered at Konso.

- Top right and left, KGA10-1 mandible (with enlarged lateral view radiograph of M1);
- middle left, KGA10-656 parietal and frontal fragment;
- bottom left, KGA7-395 occipital fragment;
- bottom middle, KGA10-620 parietal fragment; all to same scale.
- Middle right, occlusal view close up of dentition: top, KGA10-1 P4 to M3; bottom from left to right, KGA4-14 right upper M3, KGA11-350 left upper M1, KGA12-970 right upper dm2, KGA8-150 left lower P4 fragment;
- all to the same scale, buccal towards the top.

2 hominin species at Konso-Gardula & lithics:

- The remains of twelve hominins, attributed to *Homo erectus* (8) and *P. boisei*, have been found at Konso-Gardula so far, in levels K/Ar dated to 1.44 Ma.
- Coexistence of these two species in this time period.
- A variety of functions for Acheulean bifaces, including woodworking and carcass processing, usually interpreted as a part of an advanced subsistence strategy with the emergence of *Homo erectus/ergaster*.
- Grooves between mandibular teeth indicate use of toothpicks

Earliest Acheulean Lithics at Konso-Gardula (KGA), Ethiopia: ~1.75 Ma

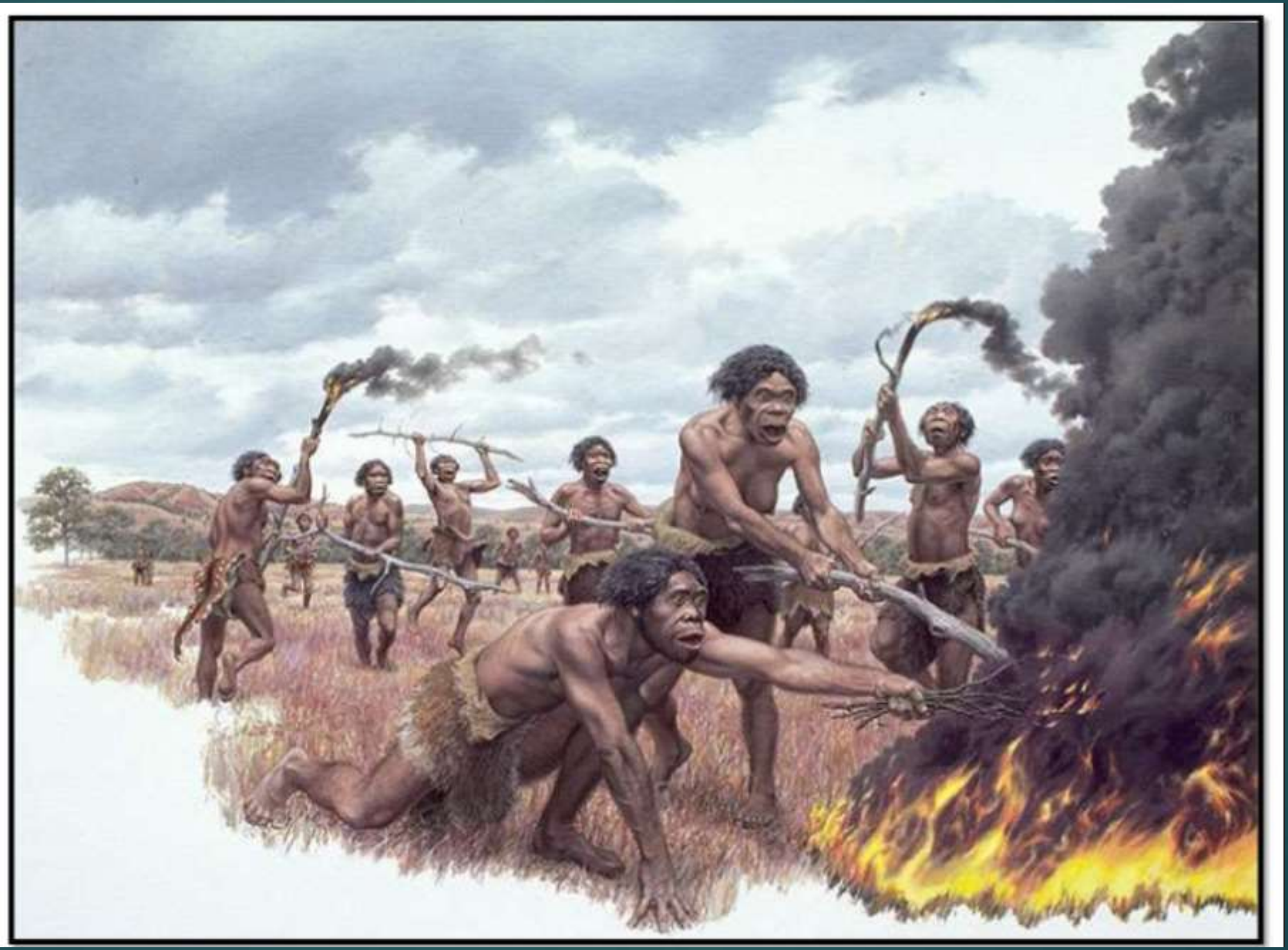


Scientists have unearthed more than 350 ancient tools in Konso, Ethiopia that were used by humans' ancient ancestors. The tools, which span roughly 1 million years of evolution, show a gradual progression to more refined shaping.

Konso lithics prove that Acheulean was firmly established by 1.4 Ma, following a million years of Oldowan technology.

- First African appearance of *H. erectus* and Acheulean date to about 1.75 Ma,
- Both those appearances substantially postdate the marked period of global cooling dated to about 2.8-2.4 Ma.
- This challenges the view that changes to open and arid conditions may have triggered the origin of *H. erectus* and of the Acheulean toolkit

Homo erectus Learning to Utilize Natural Fire - Jay Matternes



Famous theory: Torralba & Ambrona, Spain: F. Clark Howell

At **Ambrona** and **Torralba** in central Spain, bands of hunters drove elephants into swamps, killed the mired animals, and butchered them where they lay.

Torralba & Ambrona, Spain

- 1961: model of site excavation at Torralba & Ambrona, Spain (theory that *H. erectus used* grass fires to hunt elephants, 400K)
- Proposed as evidence of coordinated hunting behavior by Acheulean people around 400 Ka.

F. Clark Howell

Torralba & Ambrona, Spain: How new science changes old interpretations

- Reanalysis (Klein & Shipman 1980's) –
  - hominins *(H. erectus/ heidelbergensis)* definitely used some of the carcasses (have cut marks), but no conclusive evidence of actual hunting:
  - either scavenging the remains of animals that had died or that had been killed previously by carnivores
- Taphonomic re-exam: Elephant deaths due to natural causes and not due to selective hunting; The accumulation of fossil remains fits well with the non- anthropic patterns of elephant graveyards in present day African elephant cemeteries.
- 1st confirmed driving/ambush -> La Cotte de St. Brelade (Jersey): mammoth and rhino drives (240Ka-125 Ka) by *H. heidelbergensis or Ns*

Ecology: Type of Hunting

- R. Klein: In Africa, probably more tortoises than big game

- Proficient big game hunting only after 250 Ka; bones covered with cutmarks

- Klein: Hadza people of Tanzania with iron tipped arrows do not bring down big game; rely mostly on plant food, tubers, small game, tortoises; implication that it was same 500 Ka ago
- Hadza study: foraging societies do indeed participate in more physical activity, but that their total energy output is almost identical to that of today's pudgy Westerners. Foragers have lower basal metabolic rate: they expend less energy while at rest. It's genetic.

Classic

East Asia

Homo erectus:

Java: Sangiran, Ngandong, Sambungmacan

Asia

- *Homo erectus* inhabited a wide geographic area of Asia, ranging from 40° north latitude in China to 8° south latitude in island Southeast Asia.

- Asian *H. erectus* sites span from about 1.8 Ma to possibly 143 Ka on Java

- All recent chronologies suggest that the oldest Indonesian fossils (e.g., Sangiran, Mojokerto) are relatively older than the Chinese fossils, which are in turn relatively older than the youngest Indonesian fossils (from Ngandong and Sambungmacan).

Swisher et al., 1994, 1996; Larick et al., 2001

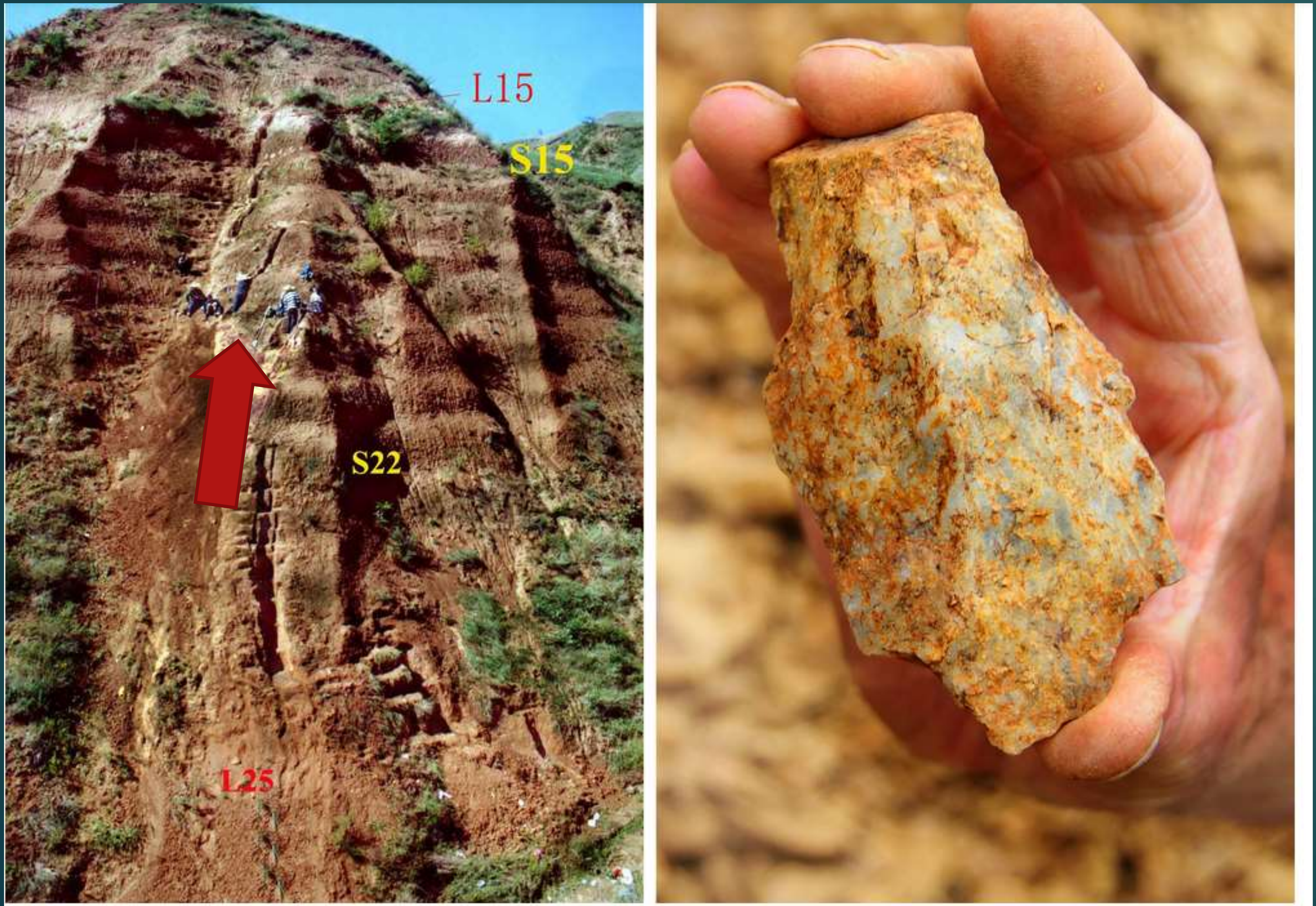
Asia

- The Asian sample represents the bulk of the *H. erectus* cranial record, and by and large represents the larger end of the range of variation.
- Even the smallest-brained of the adult Asian fossils are around 800 cc; and are larger than the Dmanisi group.
- The extent and kind of variation of certain traits appear consistent across all Asian *H. erectus* fossils.
- There is significant regional variation in Asia

Indonesia: Last refugia of *H. erectus*

- The latest surviving Javan *H. erectus* (Ngandong/ Sambungmacan) lived at least to 100 Ka and possibly 50 Ka), based on U-series/ESR analyses.
- Recent additional gamma spectrometric U-series analyses of the Ngandong 1 hominin calvaria also yielded dates close to 80 Ka.
- However, at present the majority of data suggest that both the hominins and fauna from Ngandong are from the very latest Pleistocene.
- The latest *H. erectus* in Indonesia may prove a hominin example of relative biogeographic isolation and survival, and would provide a parallel case to the last Neandertals in Western Europe.

2018: Chinese 96 stone tools dated to 2.1 Ma; Shangchen, Lantian region, China



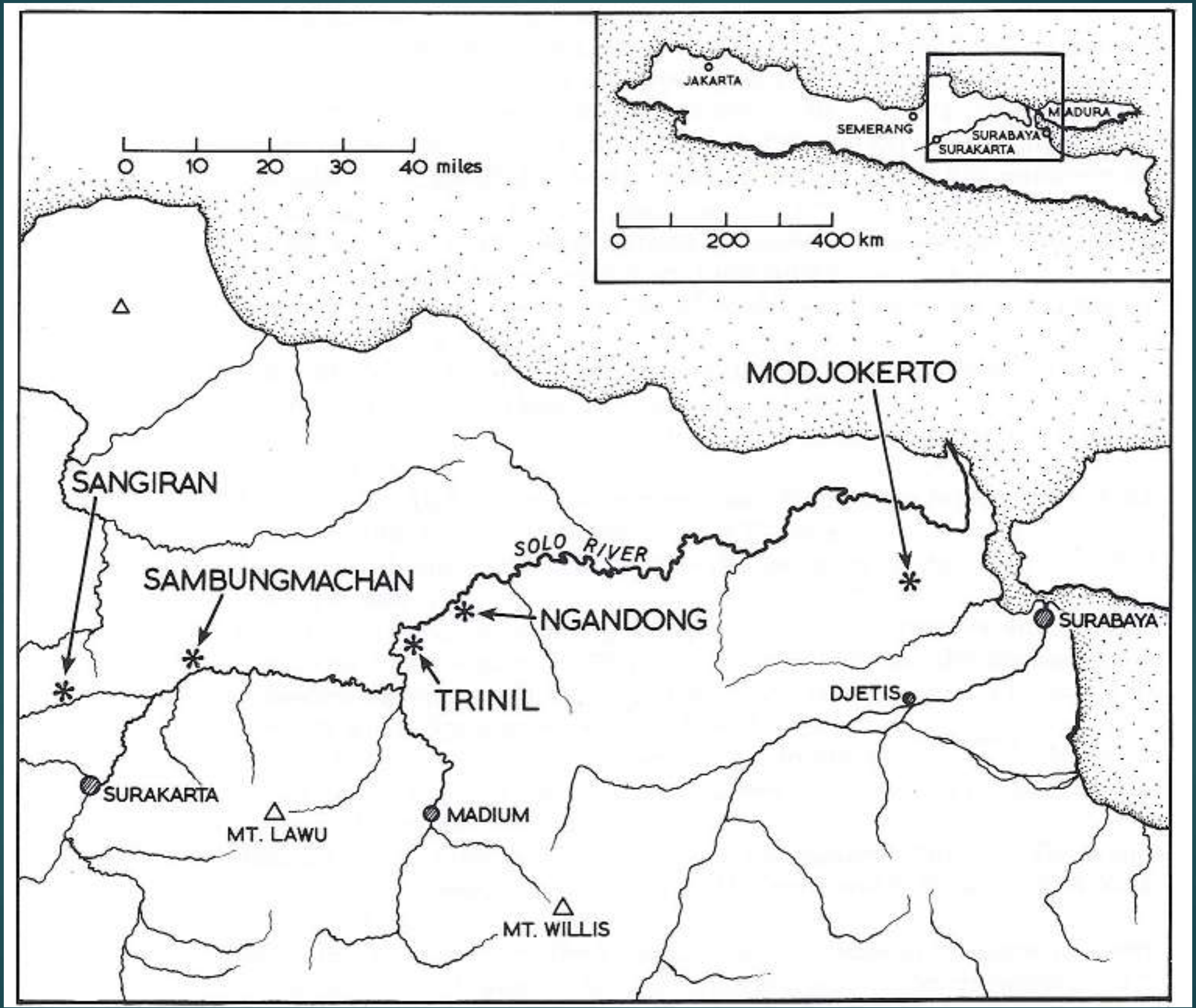
Stone tools from an archaeological site in China are as old as 2.1 million years. Credit: Zhu et al./Nature 2018

Earliest Asian dates

- 1.26- 2.12 Ma: Shangchen, of the southern Chinese Loess Plateau, near Gongwangling in Lantian county. 17 artefact layers
- 1.9 Ma: Longgupo Cave
- 1.77-1.85 Ma: Dmanisi, Georgia - earliest skeletal and artefactual evidence for the genus *Homo* in Asia
- 1.7 Ma: Yuanmou, S. China - Two incisors that may belong to *Homo erectus*
- 1.63 Ma: Lantian (Gongwangling) -The next-oldest evidence is an *H. erectus* cranium
- 1.5-1.6 Ma: Sangiran dome, Java - hominin fossils
- 1.6-1.7 Ma: Majuangou III and Shangshazui in the Nihewan basin, north China - artefacts

Java:

Solo River



W.F.F. Oppenoorth: *Homo (Javanthropus) soloensis* in Ngandong, Java

- Dutch paleontologist
- 1931-1933: Geological Survey of the Netherlands Indies unearthed 14 *Homo erectus* fossils from a single excavation site on Java (Excavation I Ngandong).
- 1931: Solo River terrace, Ngandong, Java: discovers several skulls interpreted as "tropical Neanderthals", naming them *Homo (Javanthropus) soloensis*; now assigned to *H. erectus*

- GHR von Koenigswald worked under him.

Gustav Heinrich Ralph von Koenigswald (1902–1982): *Homo erectus* at Ngandong & Sangiran, Java

- German paleontologist
- Systematic search for fossils in Java: *Homo (Javanthropus) soloensis* & research on *Pithecanthropus/H. erectus* at Ngandong & Sangiran in 1930s
- Sangiran: first find in one site of successive deposits with several evolutionary phases of *Homo erectus*

- Unfortunately paid for each specimen; farmers broke them up; exact locations questionable
- Weidenreich and von Koenigswald in 1939 agreed that Javanese *Pithecanthropus* and *Sinanthropus* in Zhoukoudian were identical, but represented geographical variants;

Javanese Dating: Controversies

- The Javanese specimens are a source of great controversy. No specimen from Indonesia has been found in a well-dated locale.
- Often, they have been found by locals and paid for by researchers or interested laypersons. The older dates (ranging near 1.7 Ma) are very controversial, and very tenuous.
- For example, the Modjokerto child was discovered by a hired workman in 1936, and the specimen was "dated" decades later by looking at the material that adhered to the cranium, and matching that matrix to a strata based on the information of where the specimen was found, finding a strata that matched the material taken from the specimen, then dating the samples of stratum that were assumed to be where the specimen originally came from.
- Specimens like Sangiran 17 and Trinil 2 have been dated to approximately 800 Ka and 400 Ka, respectively.

Mojokerto child (Perning I): 1.49 Ma

Site: Mojokerto, Java, Indonesia
Date of discovery: 1936
Discovered by: a workman on von Koenigswald team
Age: original 1.81; revision 1.49 M

Only *H. erectus* **non-adult** with good estimate of brain size probably 630 to 660 cc
6 m to 6 y old

High, human-like infant brain growth rates in *Homo erectus* by around 1 million years ago

Sangiran: 1.6 Ma

- Sangiran on the island of Java, is the most important *Homo erectus* site in Indonesia. The remains of over 80 individuals have been found here at a number of localities. The region was first occupied about 1.6 Ma.

- Sangiran 1 – a 1.5 Ma partial lower jaw discovered in 1936 in Sangiran, Indonesia. This is the first human fossil discovered at Sangiran.

- Sangiran 4 – a 1.5 Ma upper jaw discovered in 1939 in Sangiran, Indonesia. The canine teeth were larger than those found in modern humans. This is one of the oldest specimens from Sangiran.

Newer dating of Sangiran: 1.8 to 1.0 Ma

- Sangiran on the island of Java, is the most important *Homo erectus* site in Indonesia. The remains of over 80 individuals have been found here at a number of localities. The region was first occupied about 1.6 Ma.

- Newer Argon 40 dating of volcanic horizons at Sangiran indicate dates may range from 1.7 to 1.0 Ma

- All of the hominins from Sangiran are older than 1.0 Ma; Some as old as 1.6 to 1.8 Ma

- Java hominins are older than Trinil; and older than Olduvai Gorge (OH 9, 1.5 Ma); comparable to Lake Turkana erecti and Dmanisi

Later Indonesia (<100 ka)

- Later Indonesian fossils from Ngandong and Sambungmacan lack upper facial, mandibular, or dental remains

- Cranial size ranges from 900 to 1,250 cc, and averages over 1,000 cc

- The main differences between earlier and later Indonesian *H. erectus* seem to relate to brain size increase, including increases in average capacity, increases in vault height, and decreases in postorbital constriction.

Sangiran 2, Java, 1 Ma, 800 cc

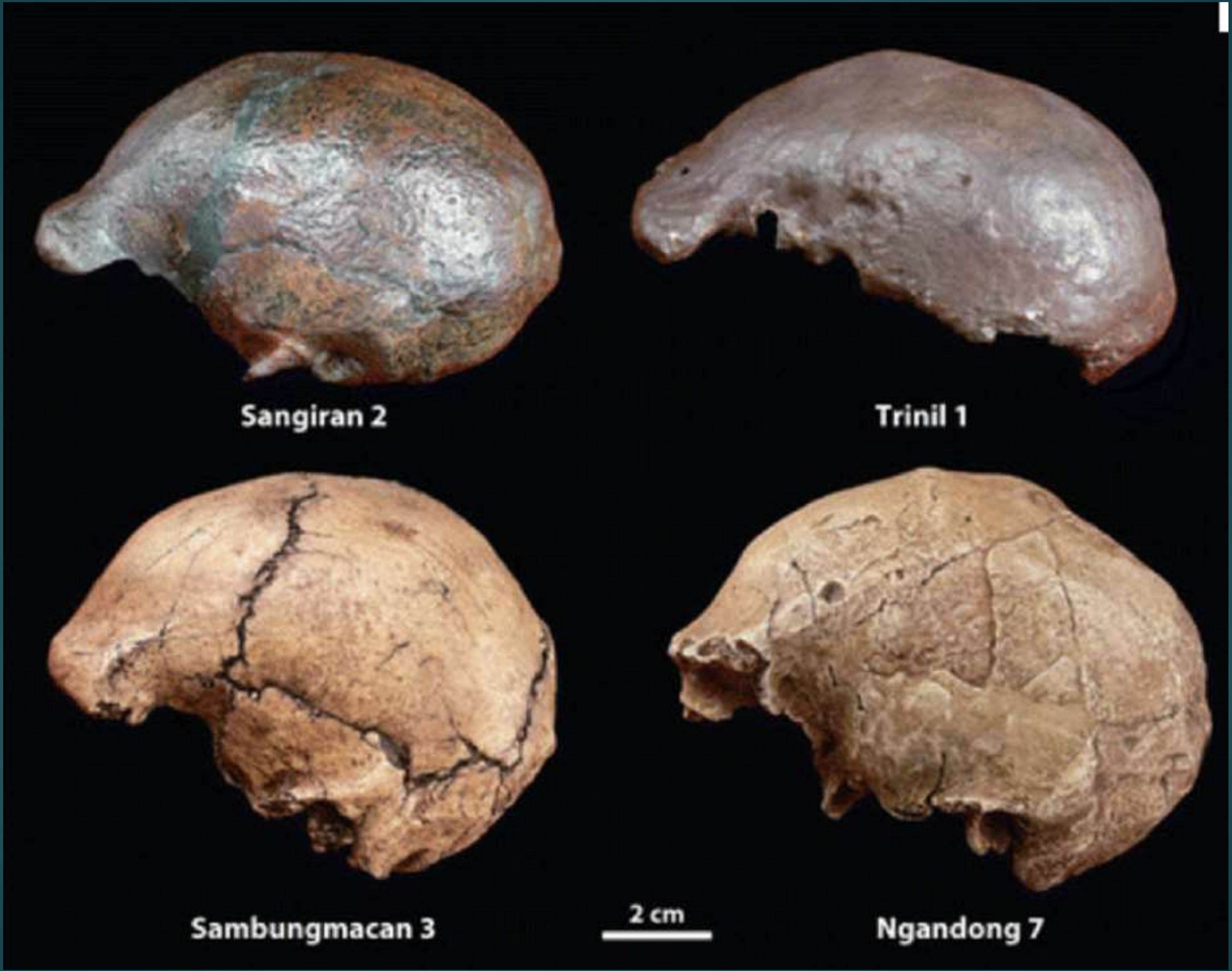


Skullcap discovered in 1937 in Sangiran, Indonesia, by Ralph von Koenigswald

- Found in 40 pieces
- Very similar to Dubois's *Pithecanthropus*: low cranium, sagittal keeling, strongly angled occipital bone. Dubois thought it was a fake.
- Many Javanese erecti found without cranial base: cannibalism?
- Like Gibraltar 1 & Shanidar 5, evidence of endocranial hyperostosis (expansion of endocranial surface)

OH 9 vs. Sangiran 2

OH 9 Sangiran 2


Sangiran 2
Trinil 1
Sambungmacan 3
2 cm
Ngandong 7

1937: *Homo erectus*, Sangiran 17, Java, 800 Ka, 1000 cc

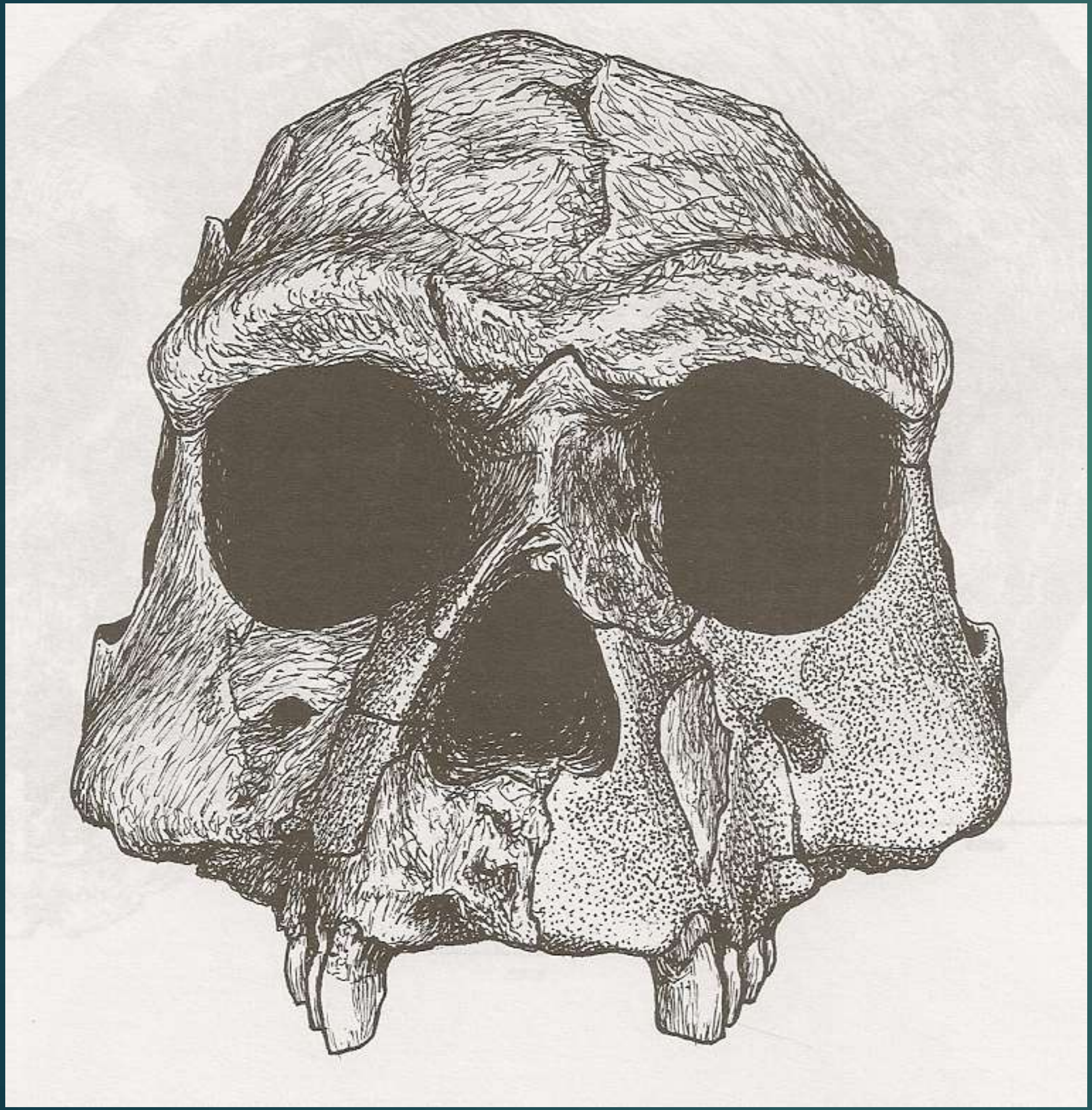
Indonesian characteristics of flat forehead & cheeks; projecting face, & flat braincase on sides and broad at base: Male; 1 of only Sangiran specimens that preserves a face

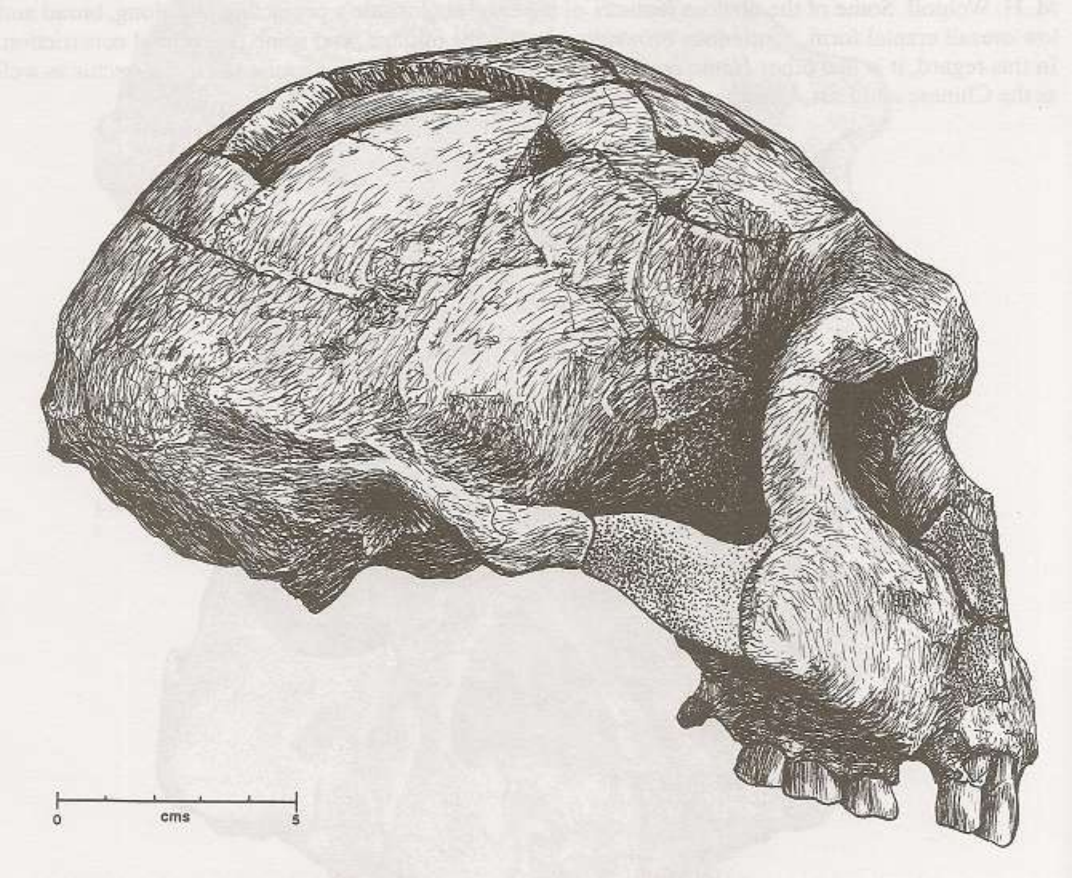
Homo erectus
(Sangiran 17)
Discoverer: Mr. Towikromo (under Sastrohamidjojo Sartono)
Date: 1969
Locality: Sangiran, Java, Indonesia

Sangiran 17

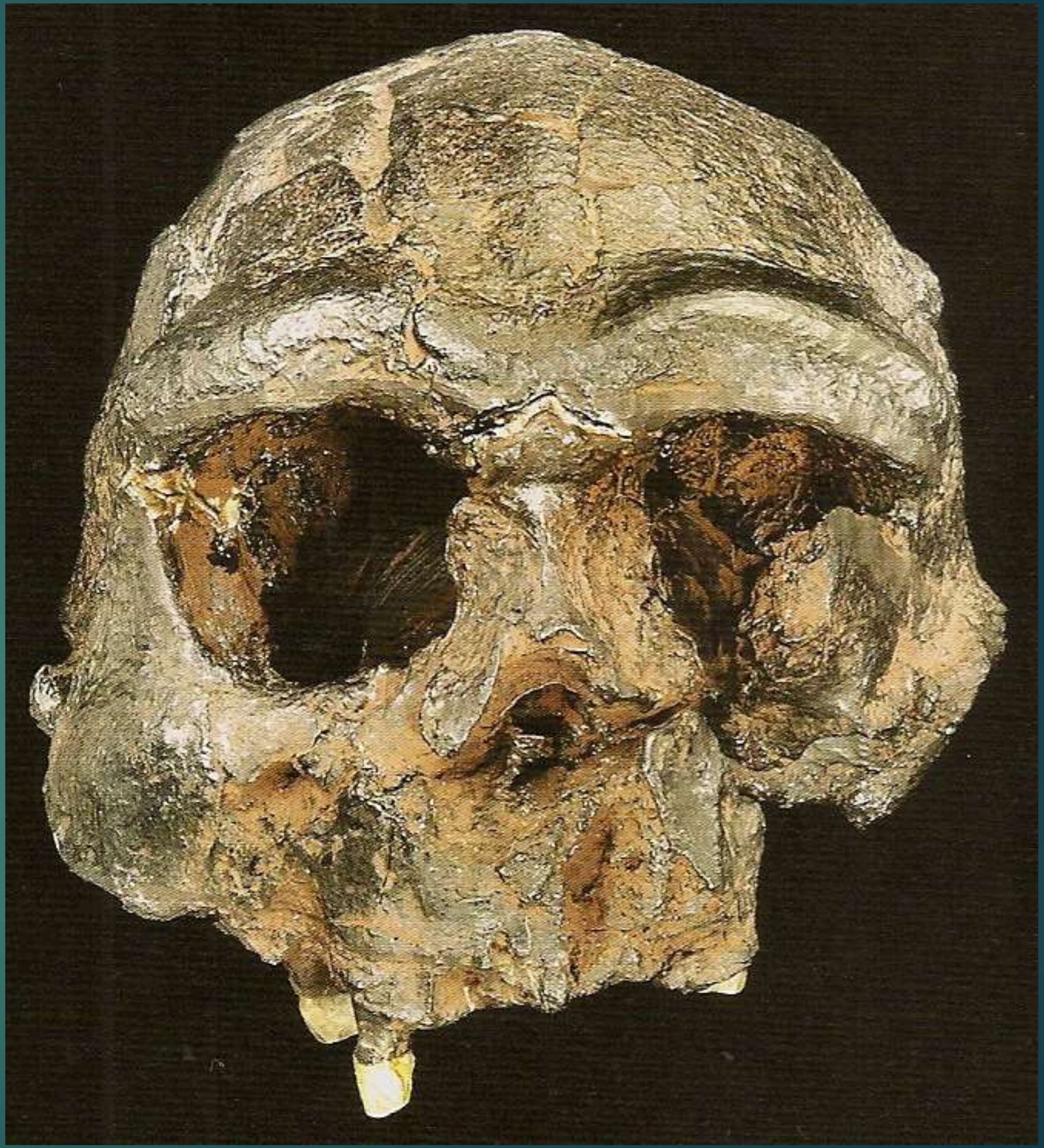
- The best-preserved hominin cranium from Java is Sangiran 17. This specimen was discovered by a farmer at Sangiran, Java, Indonesia, in 1969.
- Sangiran 17 has been an important specimen for those who accept the multiregional hypothesis that has *erectus* moving into Asia early, and evolving into *Homo sapiens* with gene flow being maintained between various African, Asian, and European populations. In Indonesia, this hypothesized lineage begins with Modjokerto, moves on through Sangiran 17, the material from Sambungmachan, Ngandong, all the way through present day Javanese. Some of the traits that are cited to link this lineage together includes:
- A long relatively flat frontal bone.
- A projecting face with massive, flat zygomatics.
- A zygomaxillary tuberosity at the base of the zygomatics.
- A rounded edge to the bottom at the eye sockets.
- The lack of a clear demarcation between the nasal region and the lower face.

Sangiran 17 (*Pithecanthropus* VIII)

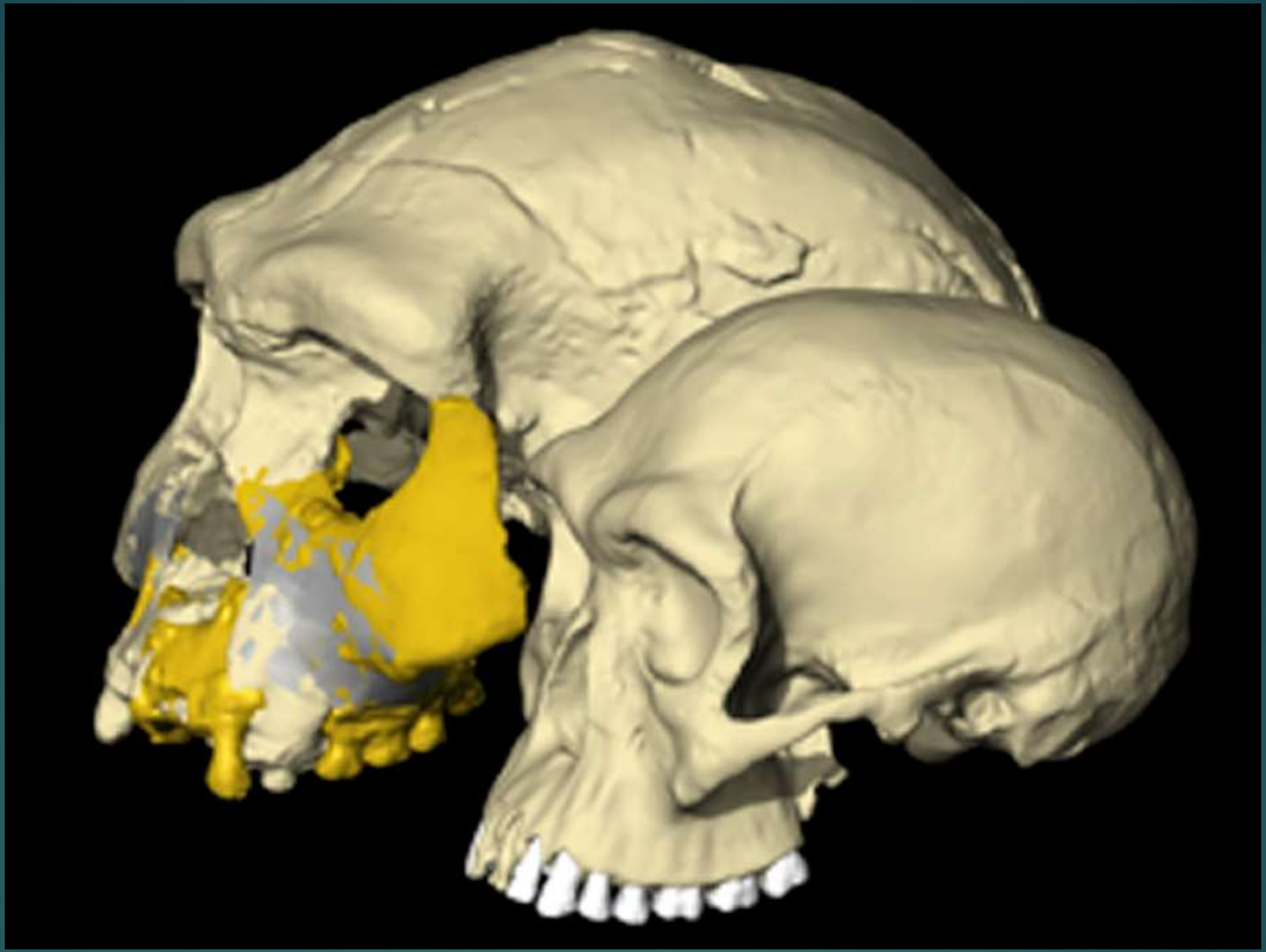




Sangiran 17



H. erectus
Sangiran
17

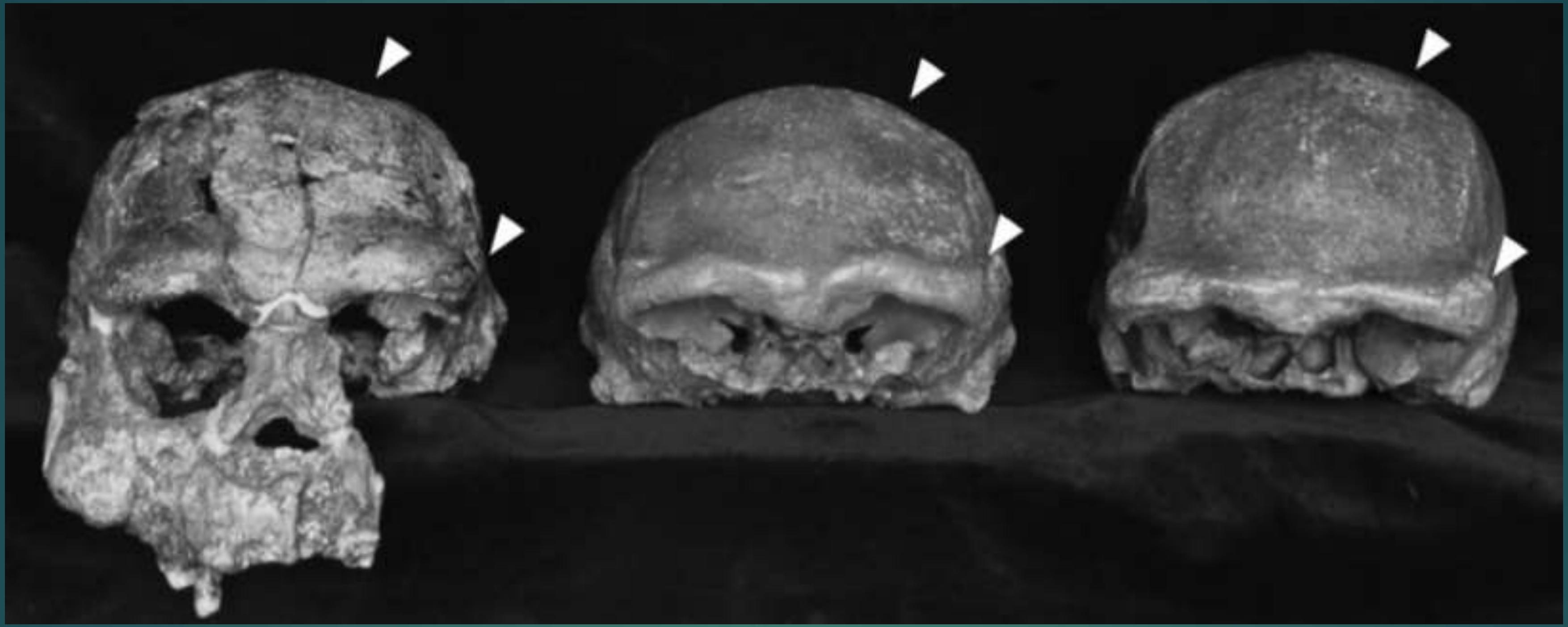


H. habilis
KNM-ER
1813

Early Homo head to head: Reconstructions of the best preserved skulls of Javan *Homo erectus* (Sangiran 17) ca. 1–1.3 Ma and East African *Homo habilis* from Koobi Fora, Kenya (KNM-ER 1813) ca. 1.9 million years old. Besides size, the two specimens display differences in the face and braincase shapes, notably the presence of bone buttresses over the orbits or on the occipital.

Unique cranial features:

Thickened supraorbital torus & rounded parietals



Left, Sangiran 17 (0.8 Ma); *center,* Sambungmacan 4 (270 Ma); *right,* Ngandong 12 (100 Ma).

Examples of the development of peculiar cranial features in the chronological series of Javanese *Homo erectus.*

Sambungmacan 4 exhibits a laterally thickened supraorbital torus and rounded parietals (indicated by the arrowheads), two of many characteristic features of Ngandong *H. erectus,* while it retains a primitive low cranial vault morphology similar to that of Sangiran/Trinil *H. erectus..*

Ngandong (Solo River), Java, 11 skulls

1931-1933: Dutch Geological Survey, 11 hominin crania & 2 tibiae (collectively named, "Solo Man" from upper Terrace of Solo River near Ngandong

Ngandong ("Nan-dong"): 500-143K?; 1025-1250 cc

- Between 1931 and 1933 the Dutch Geological Survey conducted excavations in the upper terrace of the Solo River near Ngandong, Java.

- These excavations uncovered a large faunal sample, including the cranial vaults of 11 hominins. The precise stratigraphic position of these skulls remains unknown.

- Initially assigned to a new species, *Homo soloensis*, by Oppenoorth (1932), the Ngandong crania are now widely accepted as belonging to *H. erectus.*

- Entrusted to von Koenigswald & moved with him to AMNH after WWII, & eventually back to Indonesia in 1976

(Santa Luca 1980).

Dating Ngandong *Homo erectus:* probably ~143 Ka

- Indriati et al. (2011) have reported new 40Ar/39Ar, ESR and U-series dates for Ngandong, Sambungmacan.

- They argue that the different dating methods indicate an age in the range of 546-612 Ka, significantly older than Swisher et al. (1996) previous estimate of 27-53 ka, However, they caution that the ESR/U-series date that complies with all modeling criteria is ~143 ka.

- It is not certain that any of these dates provide an accurate age, or range of ages, for either Sambungmacan or Ngandong.

- The age of the sites and hominins is at least bracketed between these estimates and is older than currently accepted.

Which Species?

- Controversy over taxonomy of the Ngandong crania
- Von Koenigswald, Loring Brace: “tropical” Neandertals
- Weidenreich: *H. erectus*
- Most thorough review by Sant Luca (1980): Ngandong hominins share basic shape with Peking & Sangiran; they are Far Eastern *H. erectus* specimen
- Now contain parts of 40 individuals; but no further postcranials,
- Very few stone tools: mostly chalcedony cores and flakes; No association of Solo hominins with them; No handaxes

“Solo Man”, generic name for Ngandong skulls

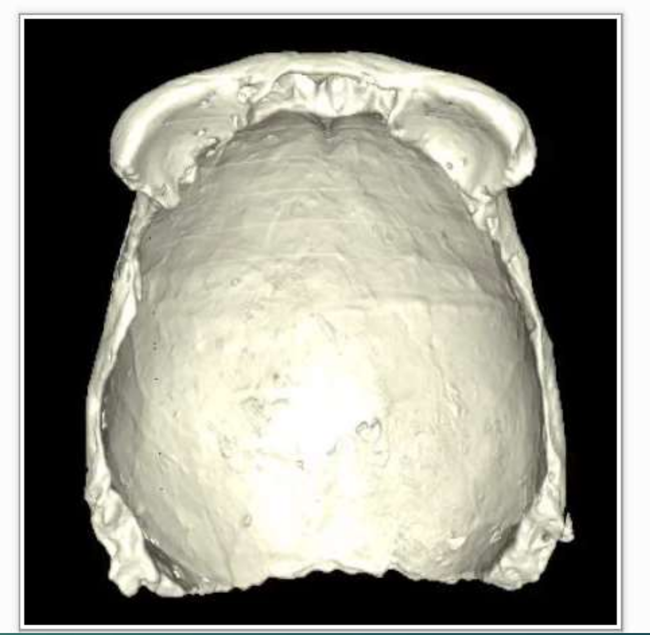
‘Solo Man’ or Ngandong: ‘Solo Man’ or Ngandong – a skull cap discovered in 1932 in Ngandong, Indonesia. Because its exact original location is unknown, published dates have ranged from 500 to 35 K old.

‘Solo Man’ shares similarities with earlier *Homo erectus* specimens from Sangiran and is considered a late *Homo erectus*.

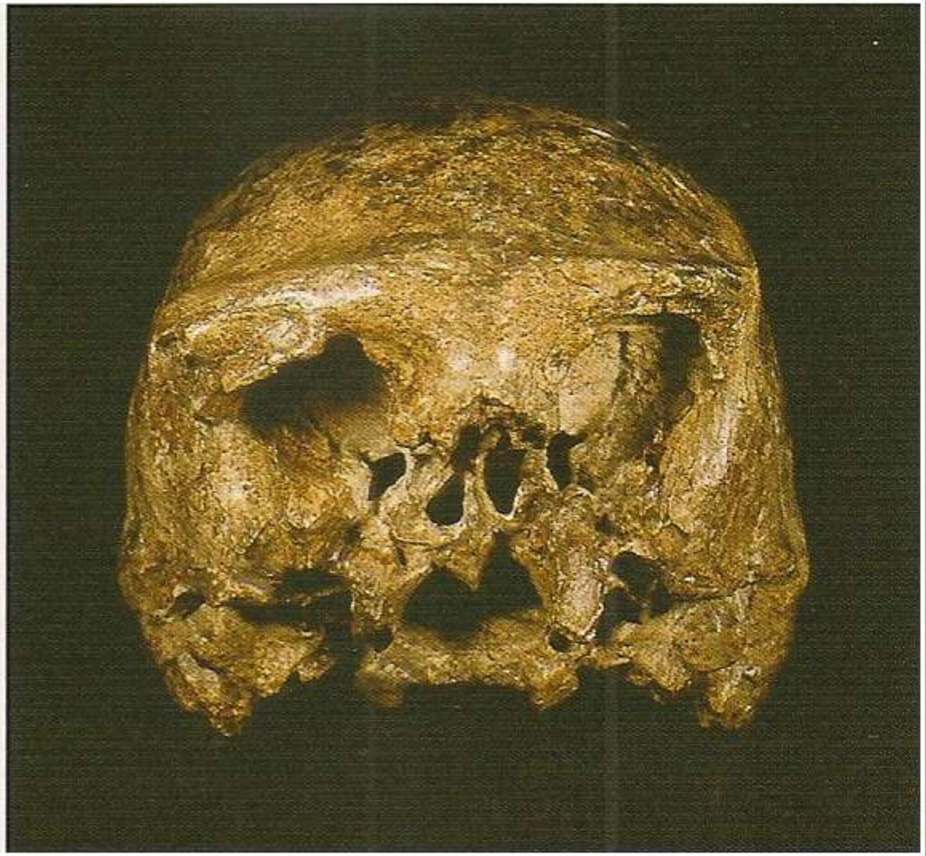
Ngandong 1: 1172 cc

C. Ter Haar & R. von Koenigswald, 1931–1932

CT of Ngandong 3



Ngandong 6 & 4



Ngandong 6 (Solo V): 1250 cc

C. Ter Haar & R. von Koenigswald, 1931-1932

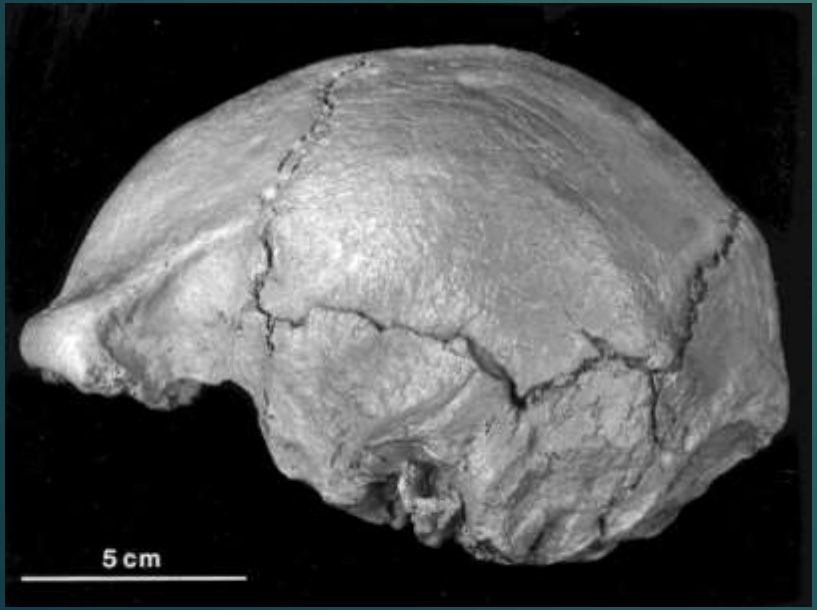
Sambungmacan: 1Ma to ~143 Ka

- Sambungmacan is an open site on the south bank of the Solo River in central Java.
- An adult *Homo erectus* calotte, Sambungmacan 1, was discovered in 1973 by T. Jacob.

Sambungmacan 1

Eric Delson, et al., 2001

Sambungmacan 3, a female (a New York fossil)



Sambungmacan 3: In 2000, was discovered in a NYC specialty shop. A calvaria, discovered on Java in 1977, was illegally removed from Indonesia in 1998 and appeared in New York City early 1999 at the Maxilla & Mandible, Ltd. Natural history shop. It was returned.

709 Ka Stone Tools: Luzon, Philippines

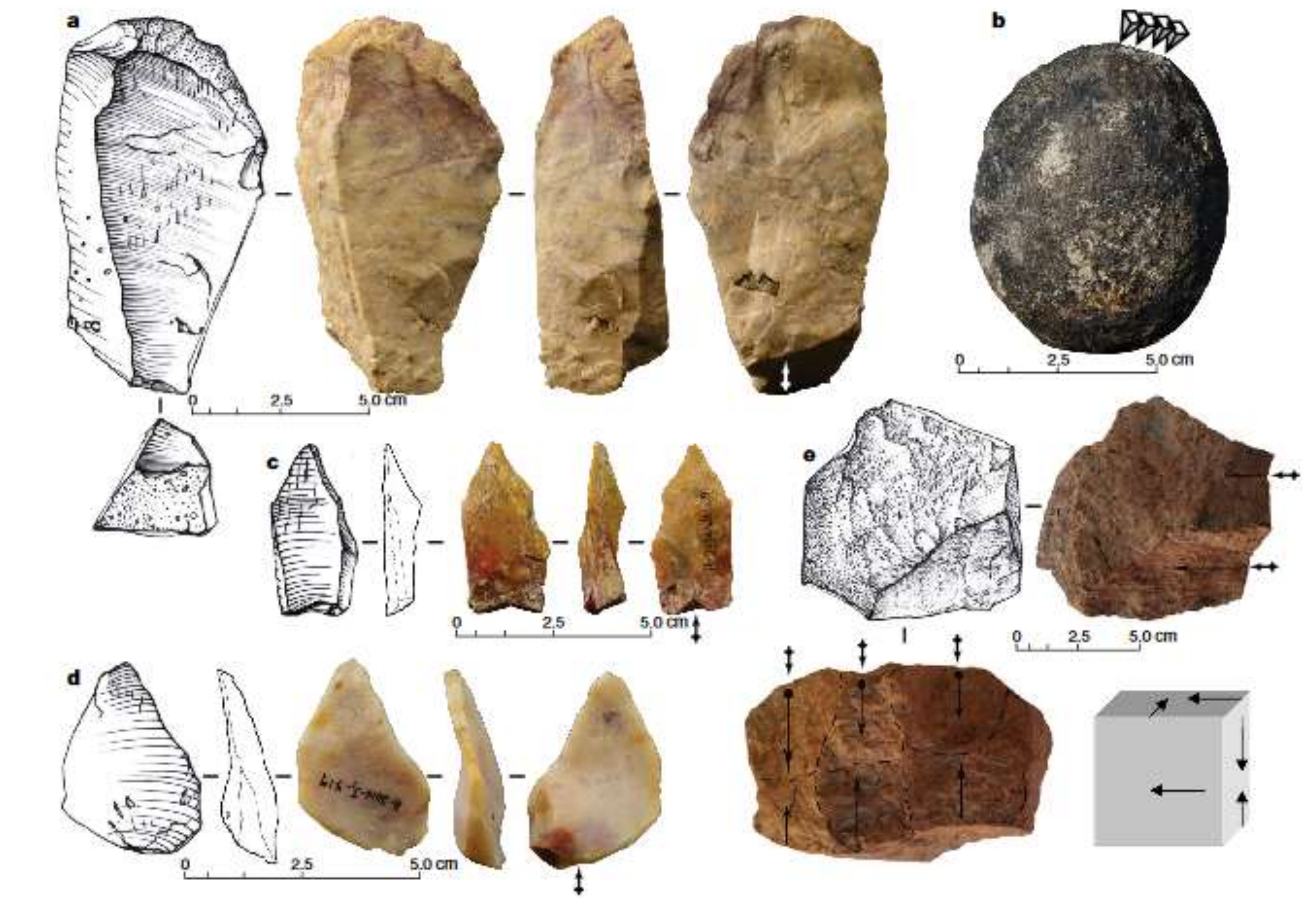


Fig. 2 | Lithic artefacts from Kalinga. a, Cortical flake on chert (II-2014-J1-362; length (L) = 100 mm, breadth (B) = 55 mm, thickness (T) = 33 mm). **b**, Possible hammerstone on dacite (II-2014-J1-371), although its highly eroded aspect precludes any definitive conclusion. Arrows indicate crushed areas interpreted as the result of precussions. **c**, Siret kombewa flake on jasper (II-2014-J1-391; L = 40 mm, B = 18 mm, T = 8 mm) that has a longitudinal and oblique fracture on the inferior two-thirds of the left side resulting from a knapping accident while flaking. **d**, Double-backed flake on flint (II-2014-J1-519). **e**, Core on quartz (II-2014-J1-396), with clear marks of knapping on an anvil, and its diachritic diagram. Arrows indicate the percusion axes.

H. erectus in Philippines at 709 Ka?

- Discovery of 57 stone tools associated with an almost-complete disarticulated skeleton of Rhinoceros philippinensis, which shows clear signs of butchery, together with other fossil fauna remains on the Philippines's largest island, Luzon at Kalinga in the Cagayan Valley.

- 75% of a fossilized rhino skeleton—ribs and leg bones still scarred from the tools that removed their meat and marrow

- Using electron spin resonance (ESR) applied to tooth enamel and fluvial quartz. Dated to 709 Ka. Bottom sediment layer to about 727,000 years old, the rhino tooth to about 709,000 years old, and the top sediment layer to about 701,000 years old.

T. Ingicco, et al., Science, 2018.

H. erectus in Philippines?

- Who exactly these ancient humans were (most likely bet is *H. erectus*)—and how they crossed the deep seas that surrounded that island and others in Southeast Asia (probably carried to distant islands by tsunami waves, or arrived there via floating islands of land and debris detached during typhoons)

- It's now becoming increasingly clear that ancient forms of hominins were able to make significant deep-sea crossings.

Late Classic
East Asia
Homo erectus:

Rest of China

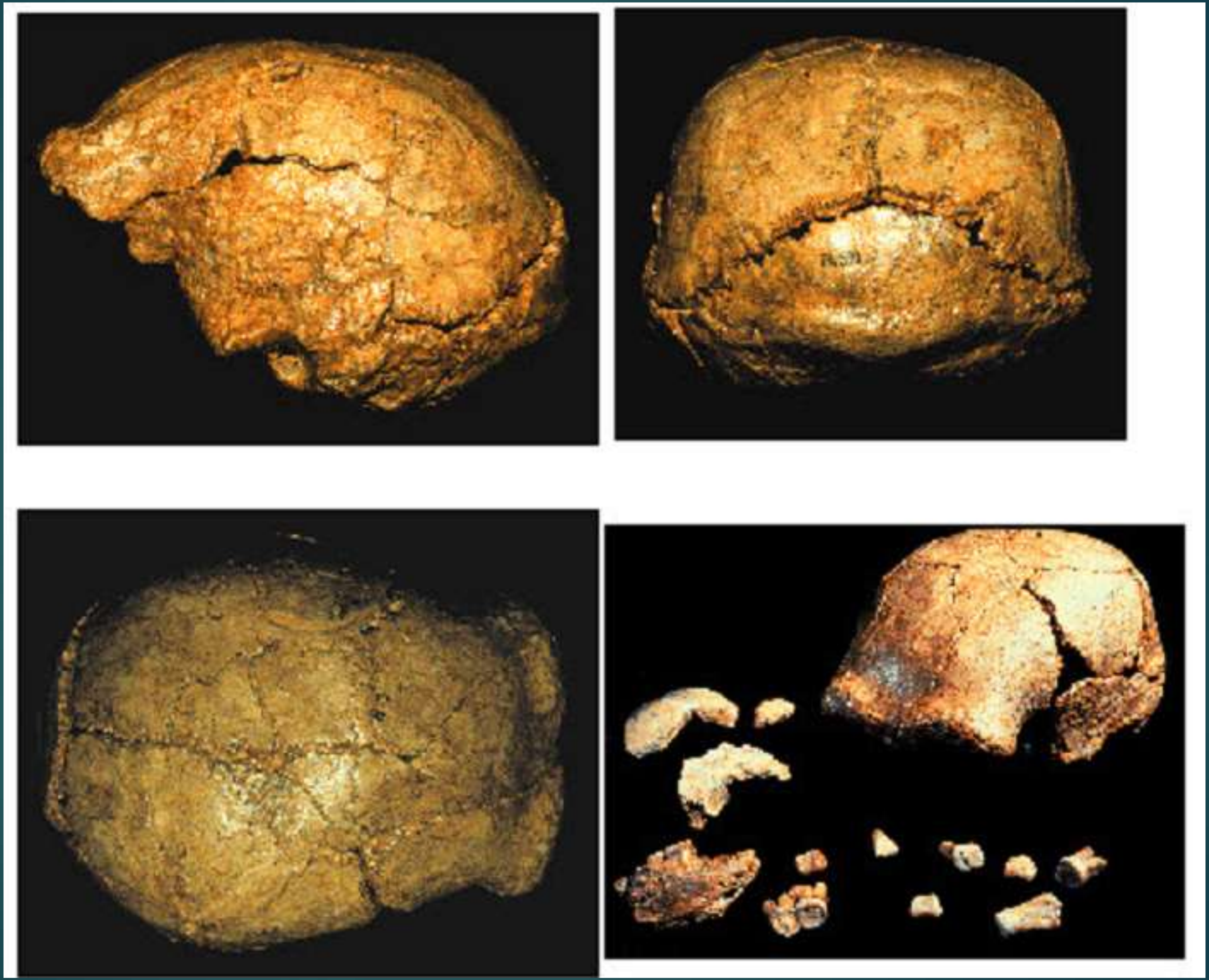
<u>Hexian ("Hoo-san")</u>: 412K, 1000 cc

- Longtandau Cave, Anhui Province, China
- Date of discovery: 1980
- Age: originally younger than 700 Ka, and may be as young as 250-280 Ka; but now dated to 412 Ka
- First discovered outside northern temperate zone of China
- Cranial capacity = ~1000 cc (compared to 1050 cc for Zhoukoudian & 1100 cc for Ngandong)

Comparison of Hexian and Zhoukoudian Homo erectus and Dali archaic Homo sapiens.

Hexian is most similar to Zhoukoudian

No simple continuous decrease in cranial robusticity through time in Chinese *H. erectus* sample



Continental Asia:
Early H. erectus from China (1.2 Ma).

- Early *H. erectus* from Gongwangling (Lantian) is badly deformed postmortem.
- Brain size is reconstructed to be small (780 cc), but due to deformation this may be an unreliable estimate
- The supraorbital torus is massive and probably barlike, with a dip inferiorly at midline.

Middle *H. erectus from China (200–600 Ka).*

- This sample is comprised principally of the Zhoukoudian and Nanjing crania.
- The vault size of continental Asian fossils from this middle period ranges from 855 to over 1,200 cc, with a mean of over 1,000 cc.
- Viewed superiorly, the vault is pear-shaped, with strongly diverging temporal lines posteriorly. However, the posterior vault is extremely narrow at the asterion, but remains wide at the auriculare.
- In sagittal view, the vault is long, low, and angular, although the frontal squama rises sharply from the posttoral sulcus.

European

Homo erectus

Migration: Eurasia and the Near East

- *Homo erectus* arrived in Eurasia at about 1.75 Ma in the Republic of Dmanisi, Georgia.

- Archaeological sites in the Near East suggest a hominin presence, probably attributable to *H. erectus?*,
  - 1.3 Ma at ’Ubeidiya, and
  - 780 Ka if the Gesher Benot Ya’aqov lithics and femur from Israel can be attributed to *H. erectus*; Acheulean lithics

- In continental Europe, however, even the earliest hominins display characters of more advanced *Homo*, *H. heidelbergensis*, and not *H. erectus*.

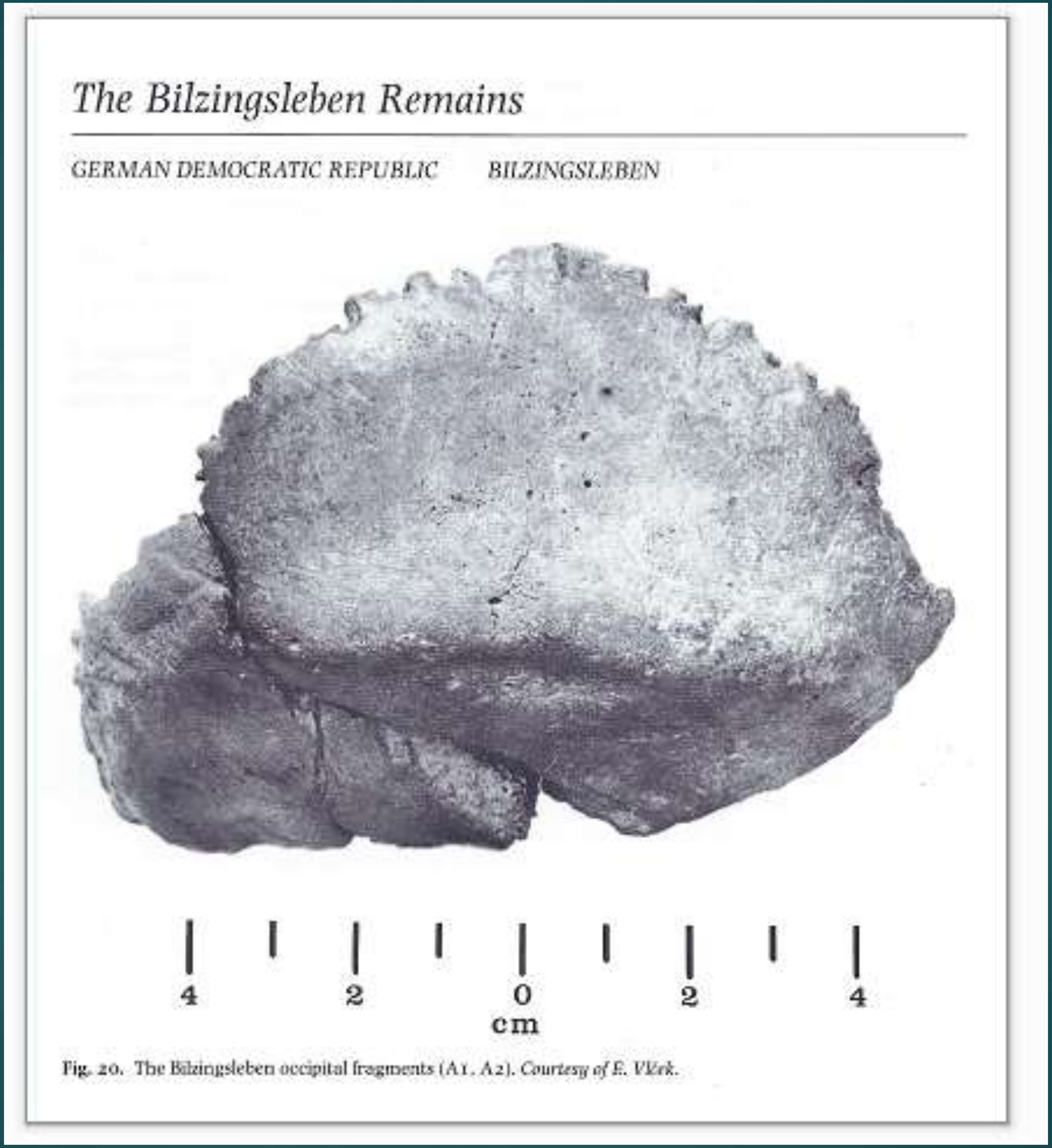
Republic of Georgia & Europe

- The age of the Dmanisi hominins and fauna is constrained to about 1.7 Ma, based on the geomagnetic polarity of the sediments, radiometric age of the underlying Masavera Basalt (1.78–1.95 Ma), (Gabunia et al, 2000a, b).
- The earliest uncontested hominin occupation of Europe is at the Gran Dolina locality (Sierra de Atapuerca, Spain) at about 800 Ka (Carbonell et al., 1999).
- The subadult cranial remains from Gran Dolina exhibit none of the derived features of *H. erectus;* but were suggested to be ancestral to both modern humans and Neandertals (Arsuaga et al., 1999).

Bilzingsleben, Germany

skull fragments (frontal and occipital bone)

Emanuel Vlček, 1978



The Bilzingsleben Remains

GERMAN DEMOCRATIC REPUBLIC *BILZINGSLEBEN*

Fig. 20. The Bilzingsleben occipital fragments (A1, A2). *Courtesy of E. Vlček.*

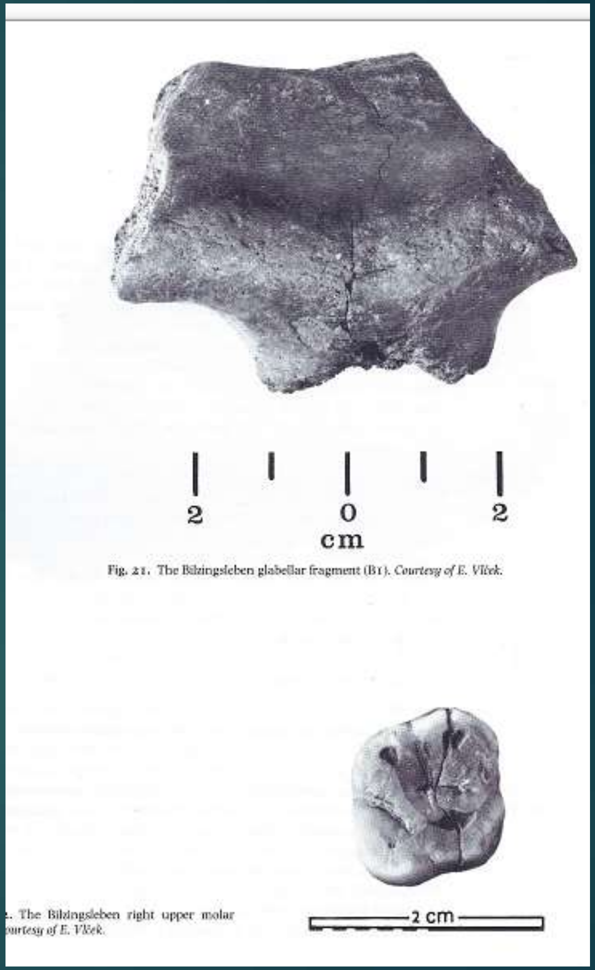
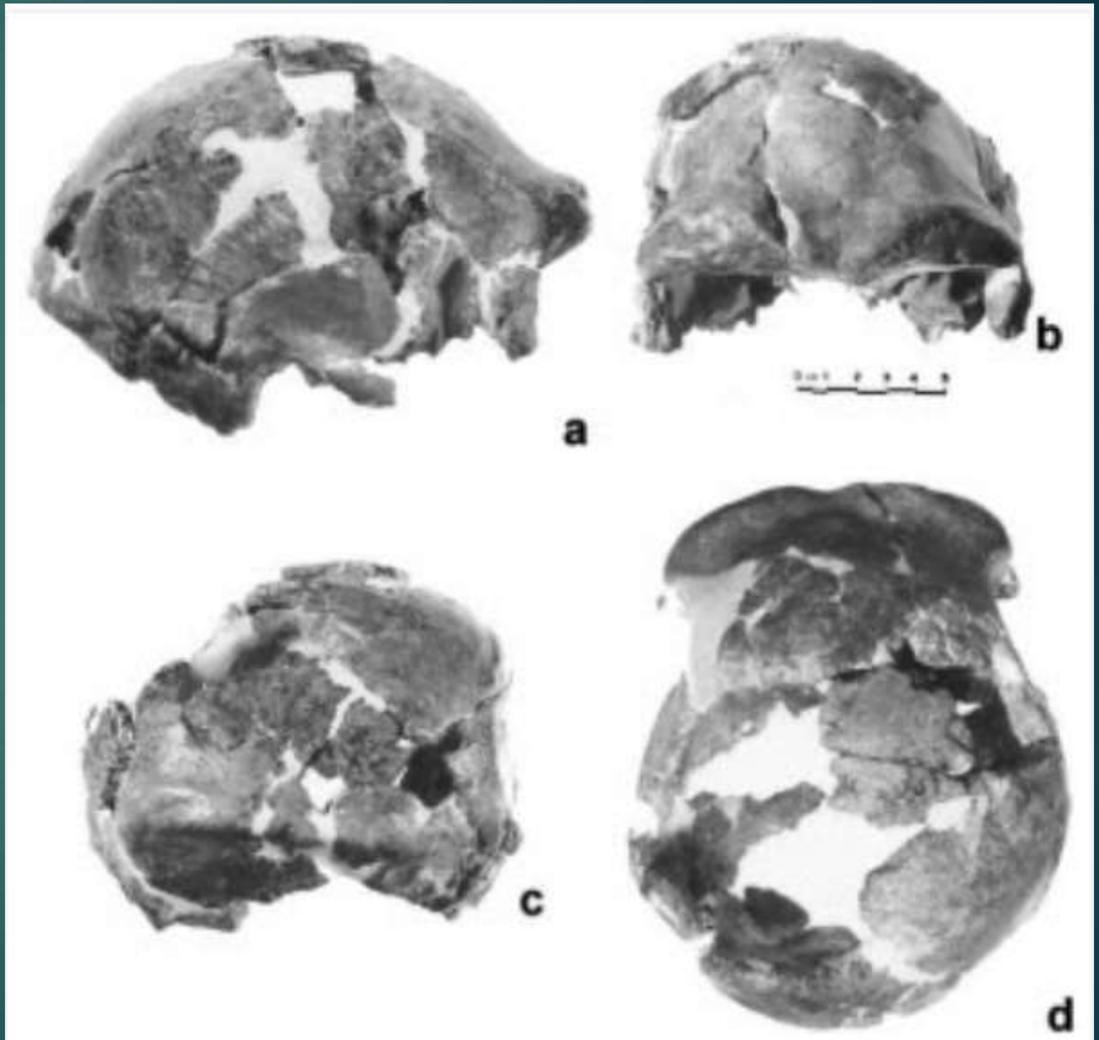


Fig. 21. The Bilzingsleben glabellar fragment (B1). *Courtesy of E. Vlček.*

. The Bilzingsleben right upper molar *ourtesy of E. Vlček.*

Ceprano: 350-400 Ka, 1057 cc, *H. cepranensis/erectus*

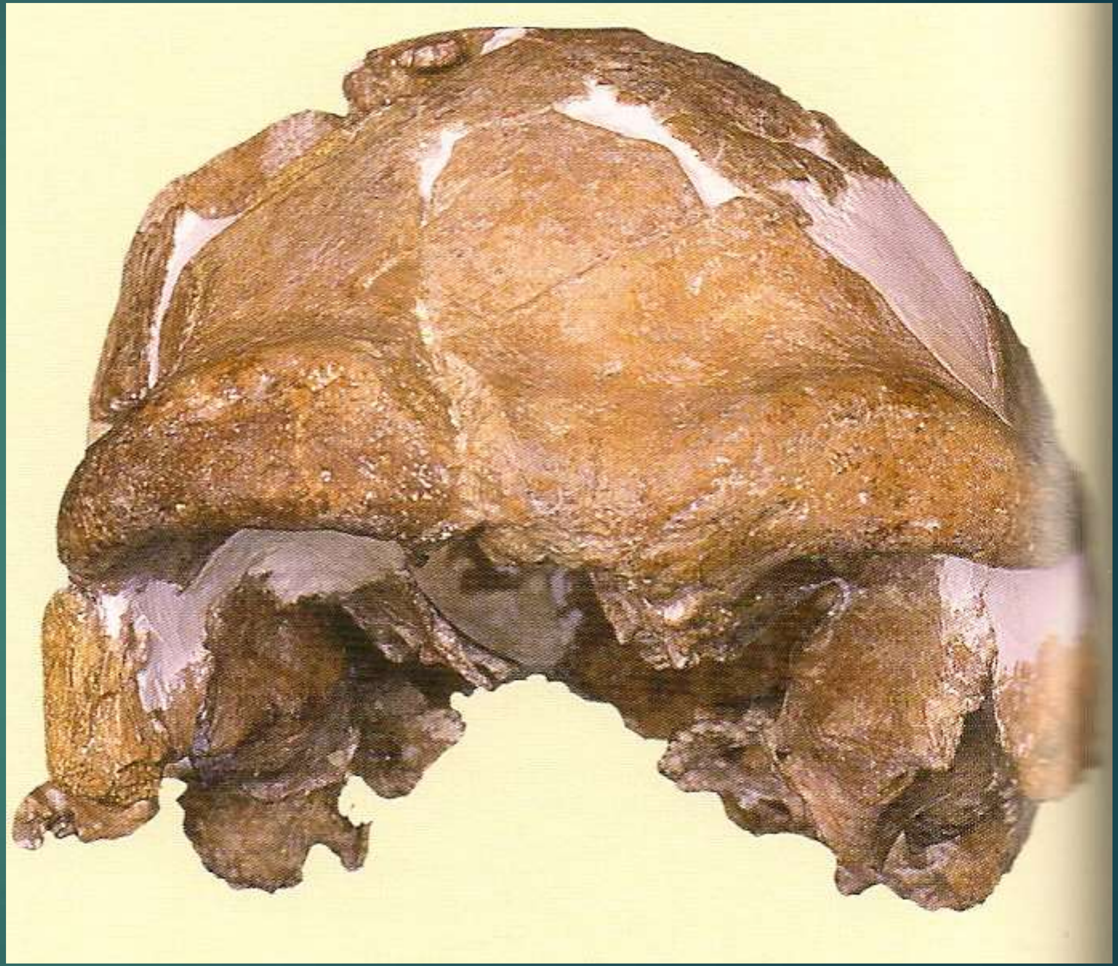
Archaeologist Italo Biddittu discovered a nearly complete hominin calvaria in 1994 near town of Ceprano, about 10 km south of Rome



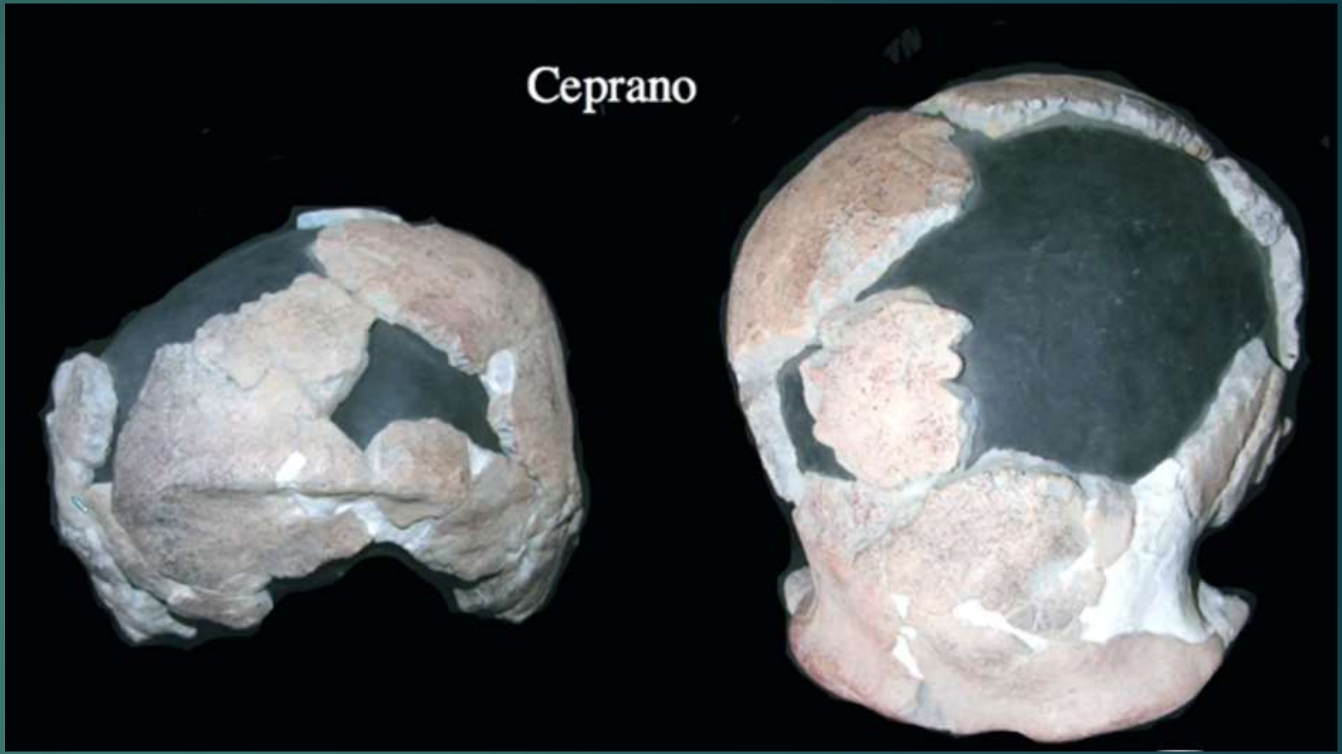
Homo erectus or Homo heidelbergensis?

Found in a roadcut; dating issues

Ceprano, Italy



Ceprano, 400 Ka



Massive skull - tall, long vault; thicker bone; wide cranium; Through out hx of *H. erectus*: skull gets thicker and more robust; as brain size increases, as do supraorbital torus and skull thickness

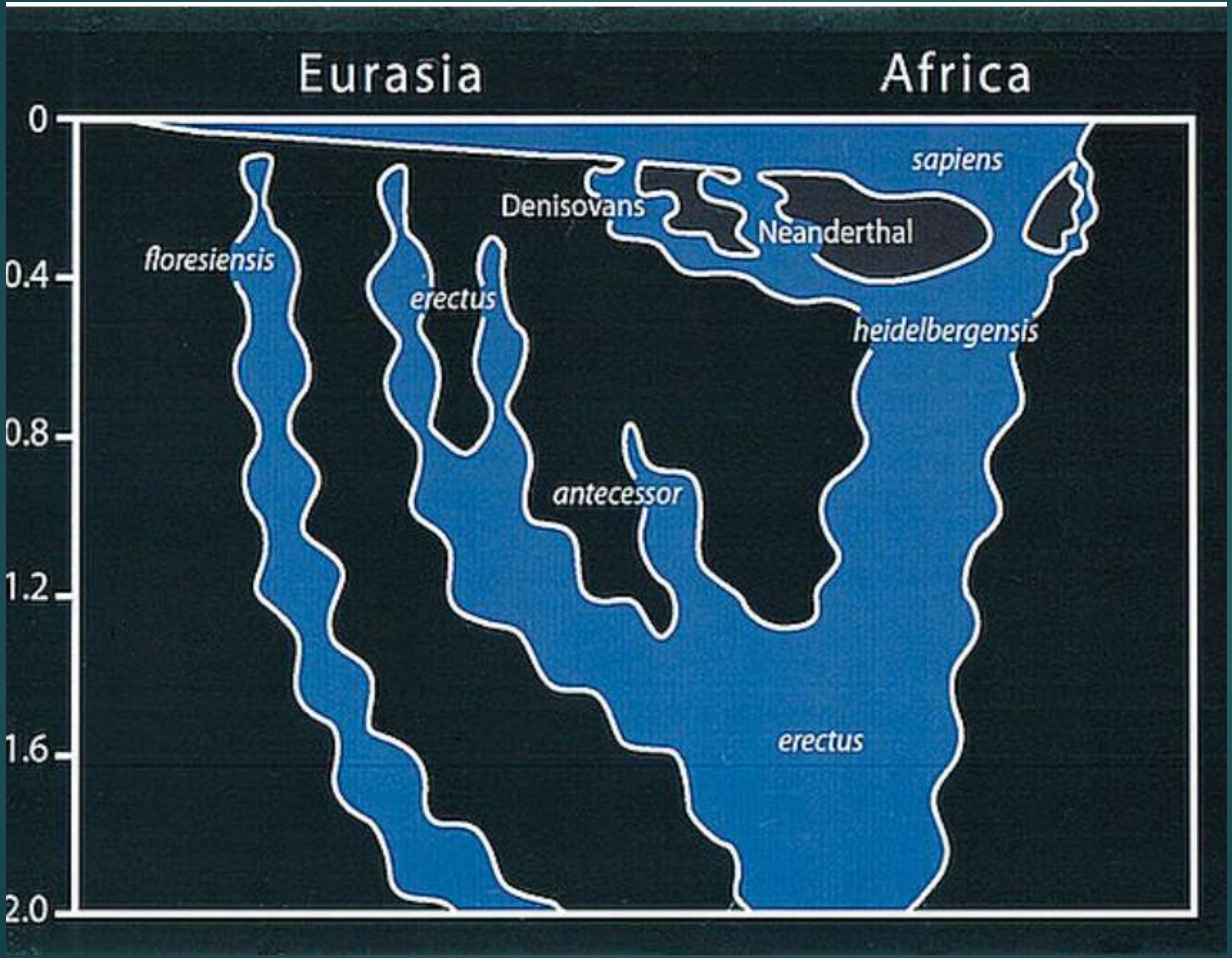
What ultimately happened to *H. erectus*?

- We have approximately 40 *H. erectus* skulls
- Size: range = 4’3 to 6’;Turkana boy, 800 cc, 5’3”; Dmanisi specimens who are shorter
- Ancestral to *H. heidelbergensis/sapiens* in Africa: no extinction date there
- Isolated pockets of non-surviving dead ends, esp. in Asia
- In East Asia: increased cranial capacity:
  - is this in situ evolution or gene flow;
  - disappear with appearance of *H. sapiens*
  - Not in Western Eurasia; more a tropical group in East

So What Became of *Homo erectus*?

- While *Homo erectus* became extinct in Asia, in Africa, they became us.
- *Homo erectus* is the grandfather species of *Homo sapiens* (by way of a *H. heidelbergensis*)
- Alan Walker: "If you looked into the eyes of Turkana Boy, would you feel it was a human you were looking at or an animal?"
- What kind of intelligence? Think of your dog or a 5-year-old – both can do amazing things, but can be amazingly stupid too.
- But whatever *H. erectus* was, it was highly successful - they lasted for almost 2 M years (10x longer than current *H. sapiens*).

Henry Gilbert: *Homo erectus* did not go extinct



Stringer, Nature

H. erectus?: Archaic Human Contribution To Denisova Genome

- Denisova genome harbors a component that derives from a population that lived before the separation of Neanderthals, Denisovans and modern humans.
- 2.7–5.8% of the Denisova genome comes from putative archaic hominin which diverged from the other hominins 0.9–1.4 million years ago
- Second method estimates that 0.5–8% of the Denisovan genome comes from an unknown hominin which split from other hominins between 1.1 and 4 million years ago.
- The estimated population split time is also compatible with the possibility that this unknown hominin was *Homo erectus*.

Beware of our prejudices

- Michelangelo once said that he “saw the angel in the marble and carved until I set him free.”

- A *Homo erectus* flintknapper once saw a tool in a flint and chipped until *she* set it free

- We have no evidence of gender differentiation in hominin behavior and work: who did hunting, the gathering, the tool making, etc.

Still unanswered questions about *Homo*

1. Was *Homo erectus* the direct ancestor of *Homo sapiens*, our own species?

2. Data suggest that increasing body size, greater reliance on animal food resources, and increased range size were part of a web of factors that facilitated the initial early dispersal of *H. erectus* from Africa. Was one of these factors more important than the others?

3. Are the fossils from earlier time periods in East Africa, and from Georgia, all part of a single species (*Homo erectus*), regionally variable in size and shape? Or are there actually several species of early human represented by what we are now calling *Homo erectus*?

Still unanswered questions about *Homo*

4. How well did *Homo erectus* master the control of fire and how widespread was fire used? What does this say about possible dietary shifts in this species?

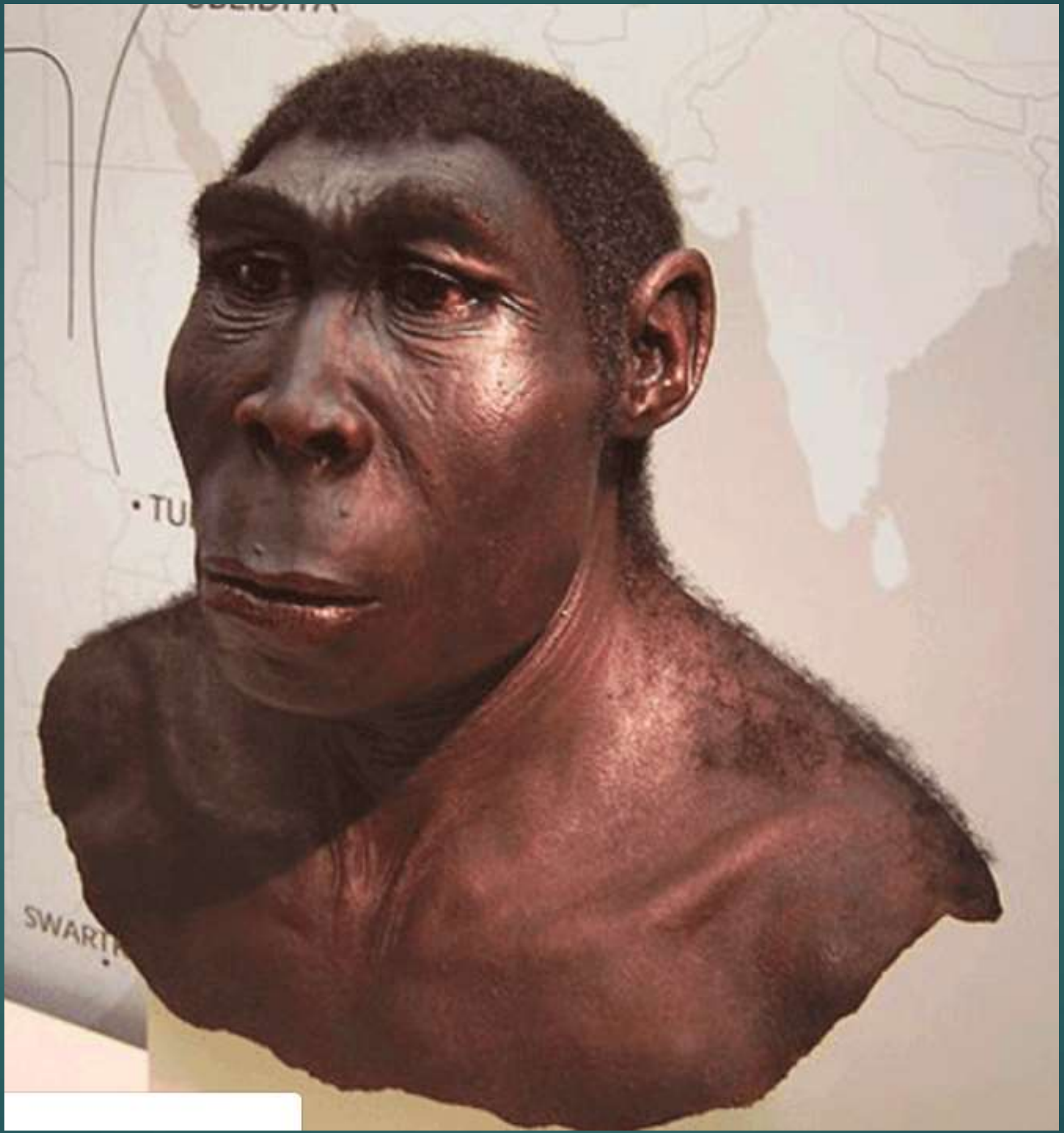
5. Did *Homo erectus* grow up in a more human-like pattern and rate, or a more ape-like one? Was *Homo erectus* the first early human species to experience an adolescent growth spurt?

Reconstructions

Homo Erectus, the paleo-arctic explorer. A reconstruction by paleoartist John Gurche

AMNH: *Homo erectus*

An early hominid, *Homo ergaster*, depicted in this diorama from the American Museum of Natural History's Hall of Human Biology and Evolution, lived nearly 2 million years ago in the eastern Rift Valley of Africa.



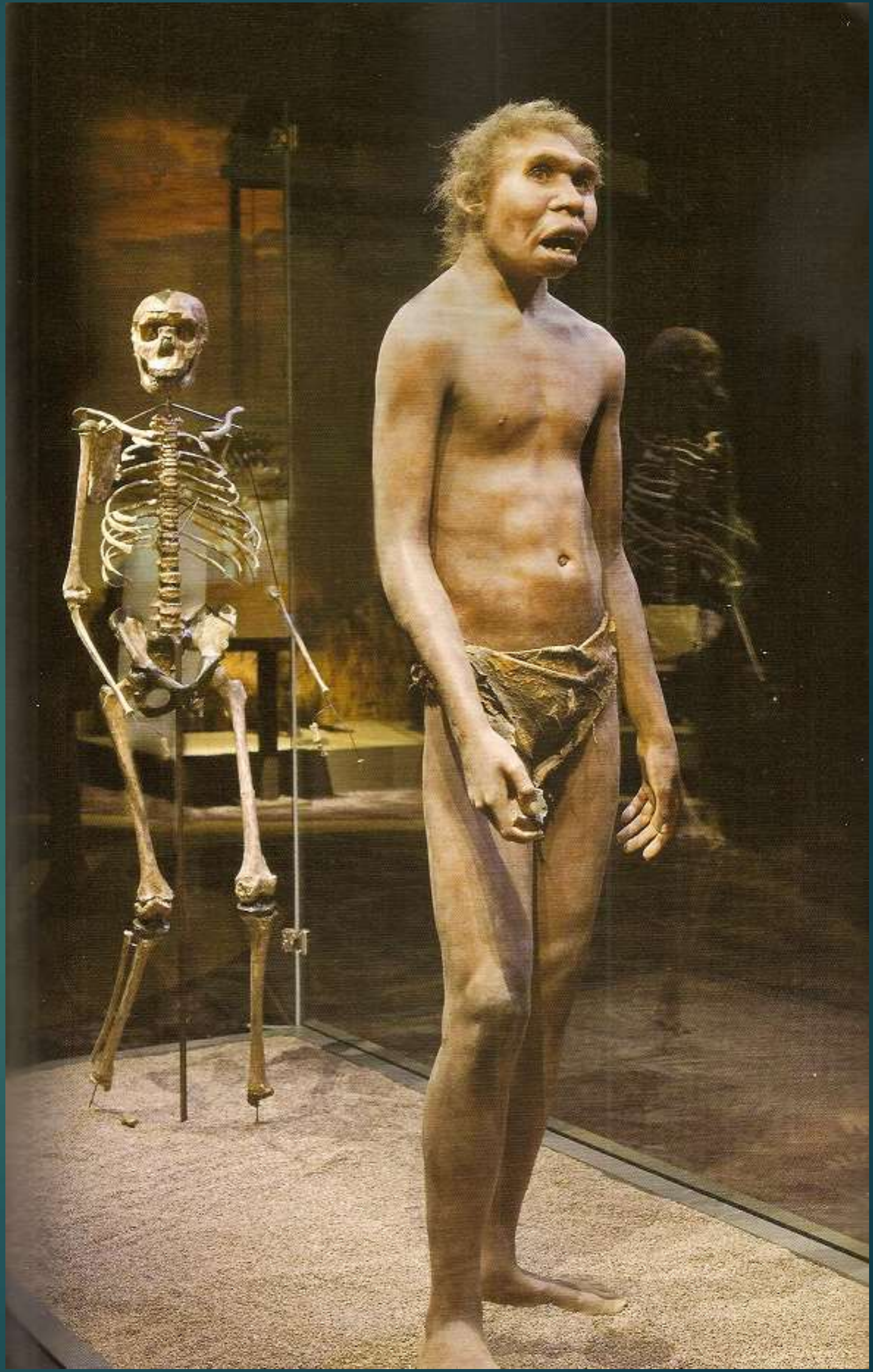
Homo rudolfensis and *Homo erectus*

Reconstructions

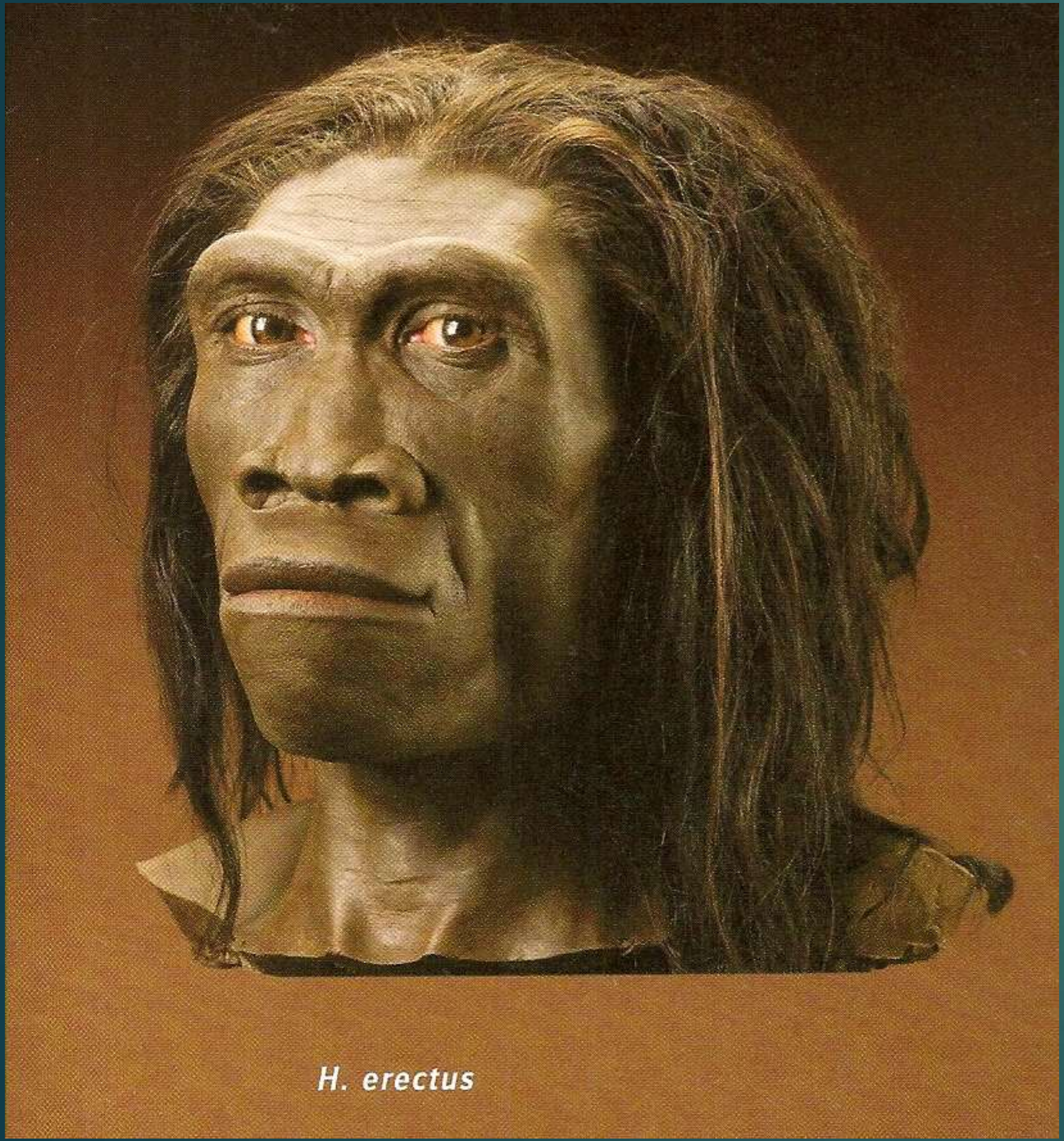
Reconstructions of *Homo erectus* based on fossils from different locations. There is a lot of variety between individuals, which may be accounted for by the species having existed for so long and over such a wide area.

Turkana Boy

Reconstruction of Turkana Boy, the approximately 1.5-million-year-old, nearly complete skeleton discovered in Kenya. He was only about nine years old and already 1.6m tall. This reconstruction by Élisabeth Daynès is on display at the Musée National de Préhistoire in France. © Wolfgang Sauber, licensed under CC BY-SA 4.0, via Wikimedia Commons.

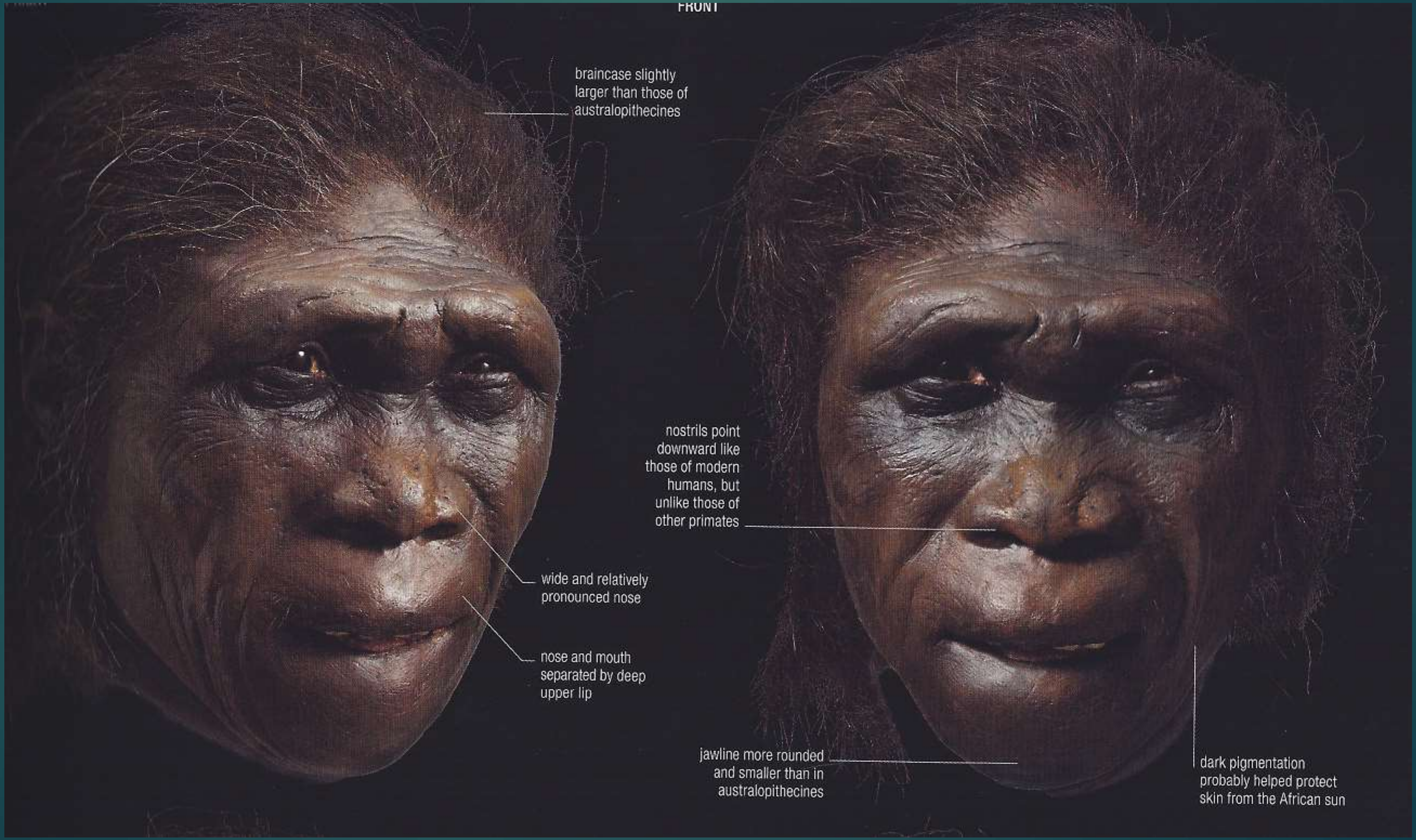


ER 3733

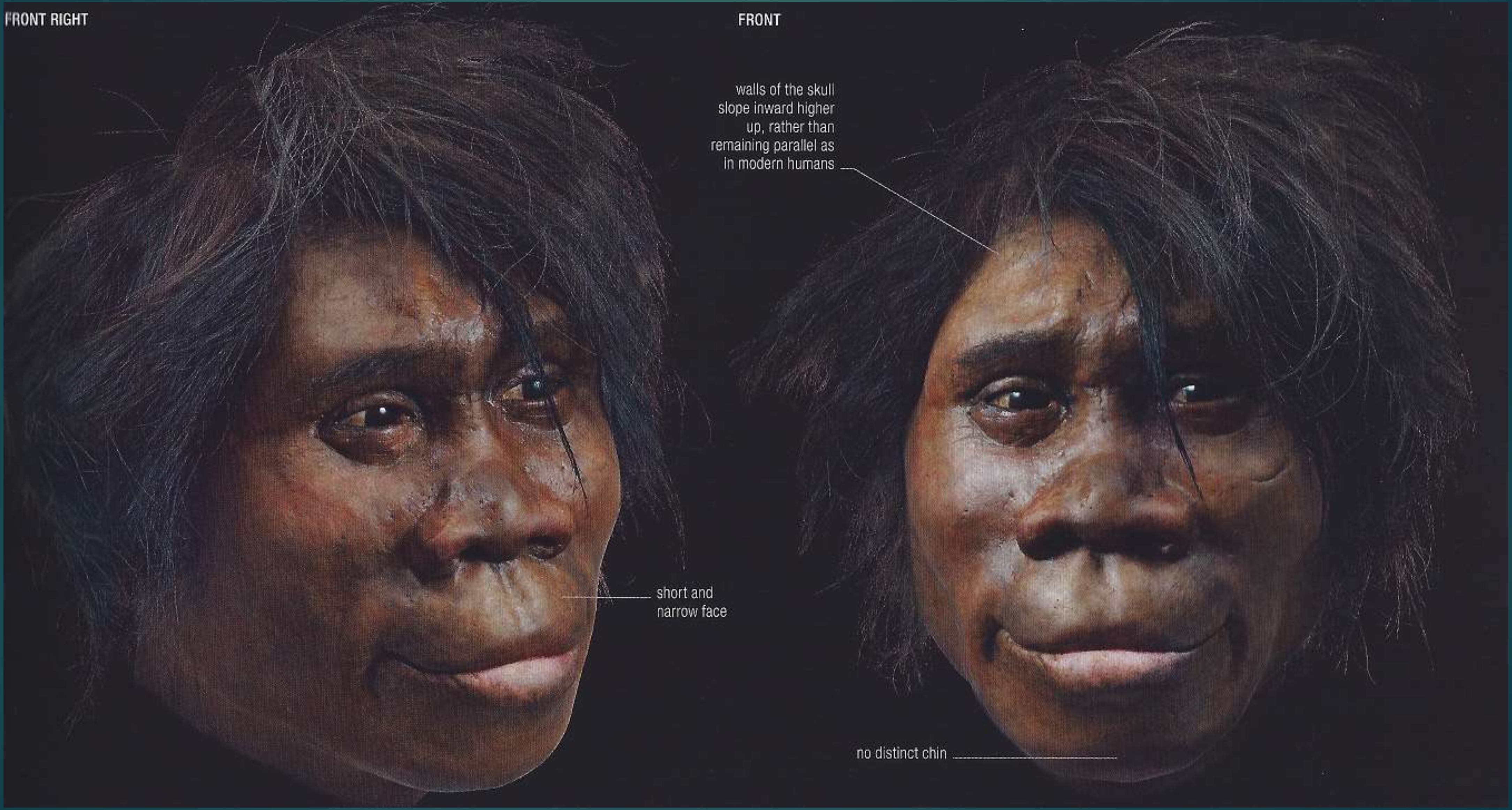


John Gurche

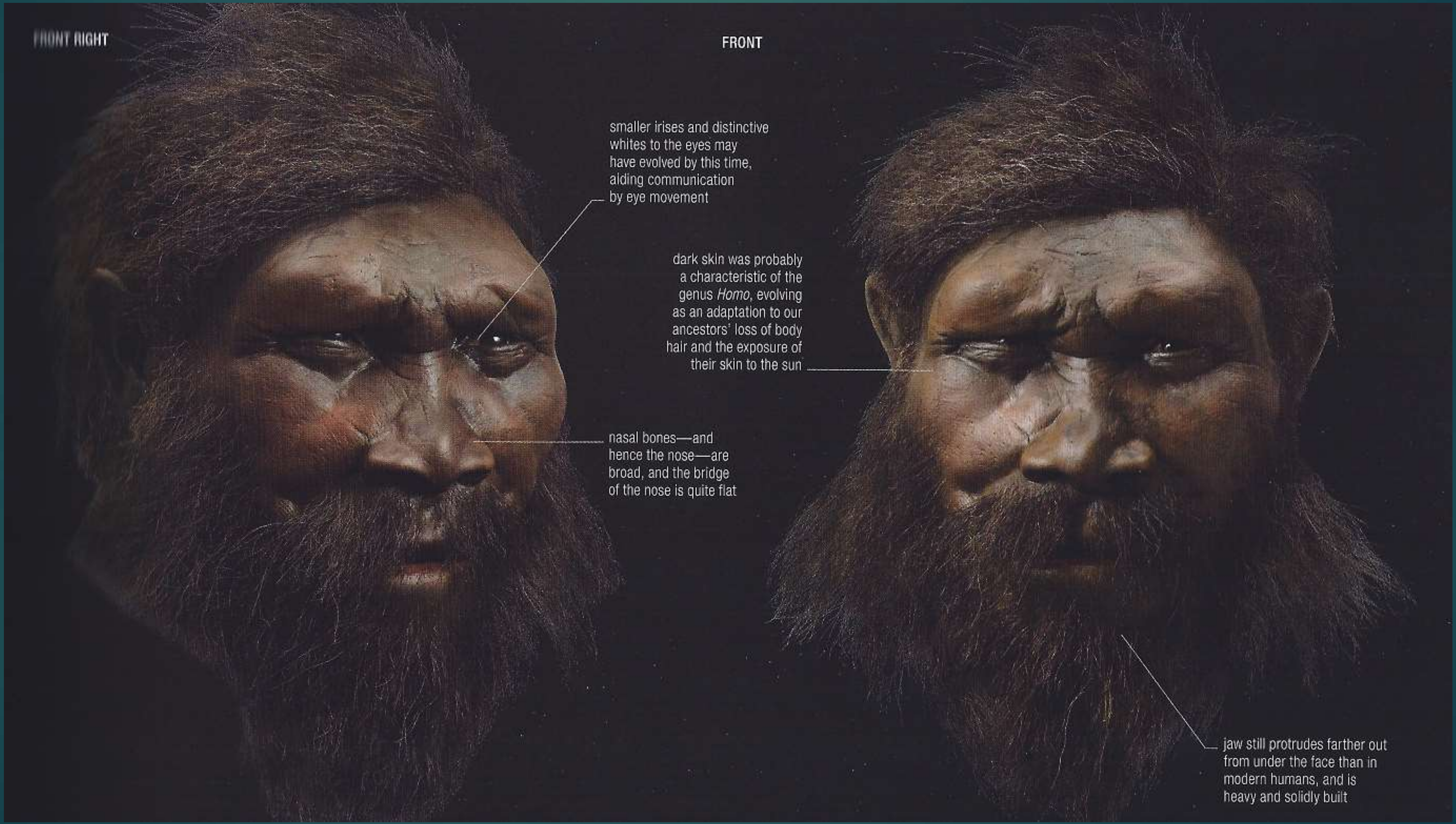
ER 3733 (Kennis brothers)



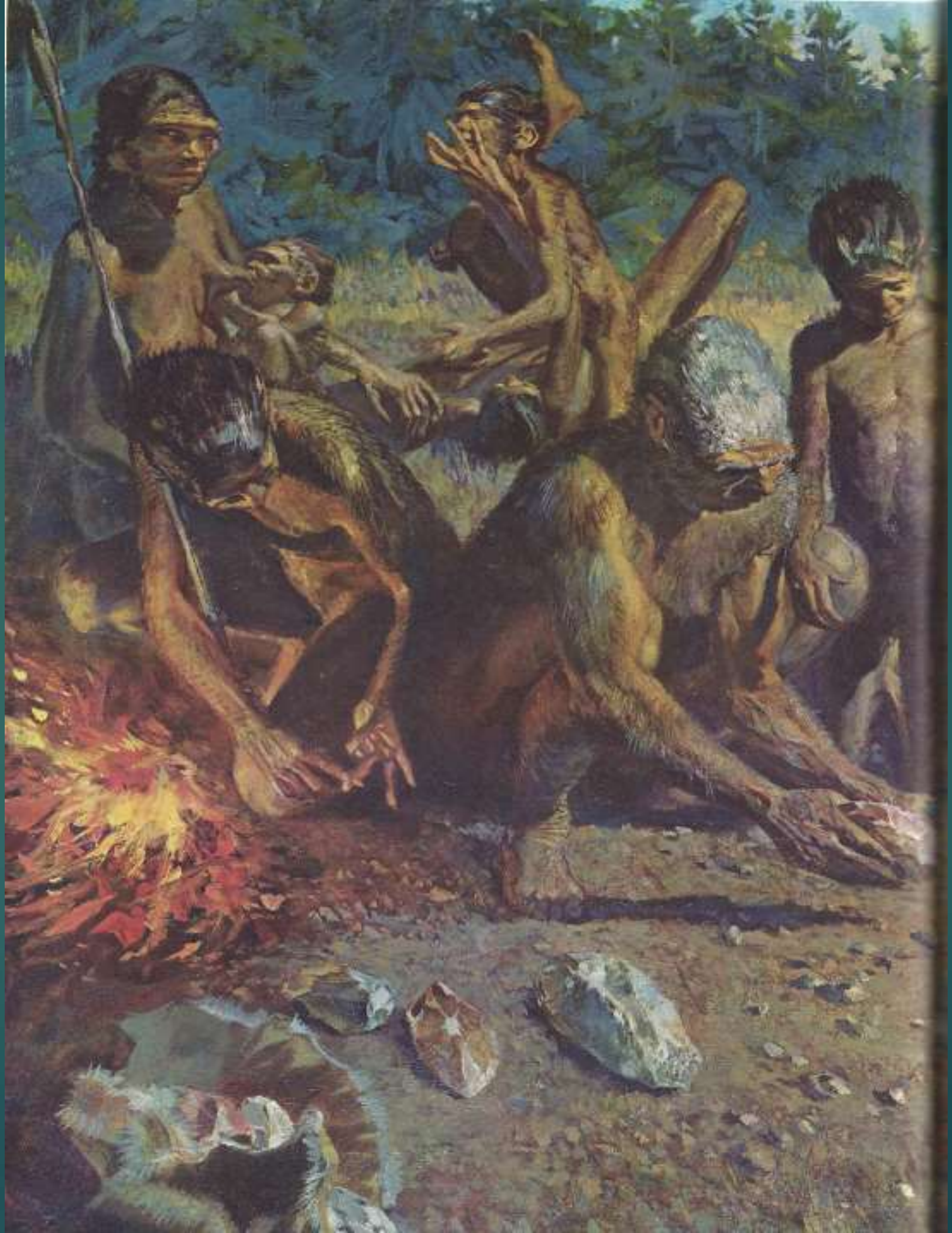
Dmanisi, D 2700, Kennis Brothers

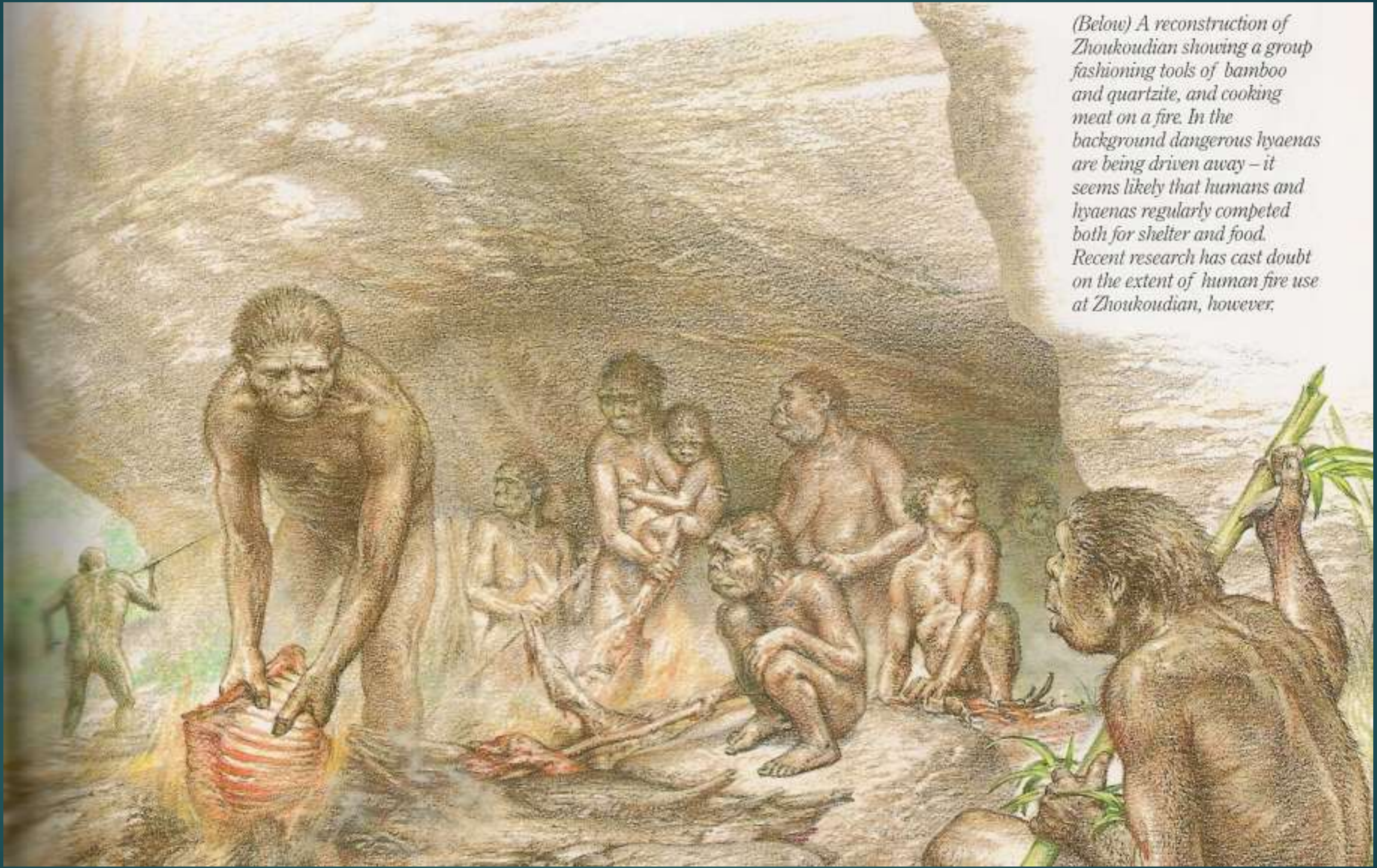


Sangiran 17, Kennis Brothers

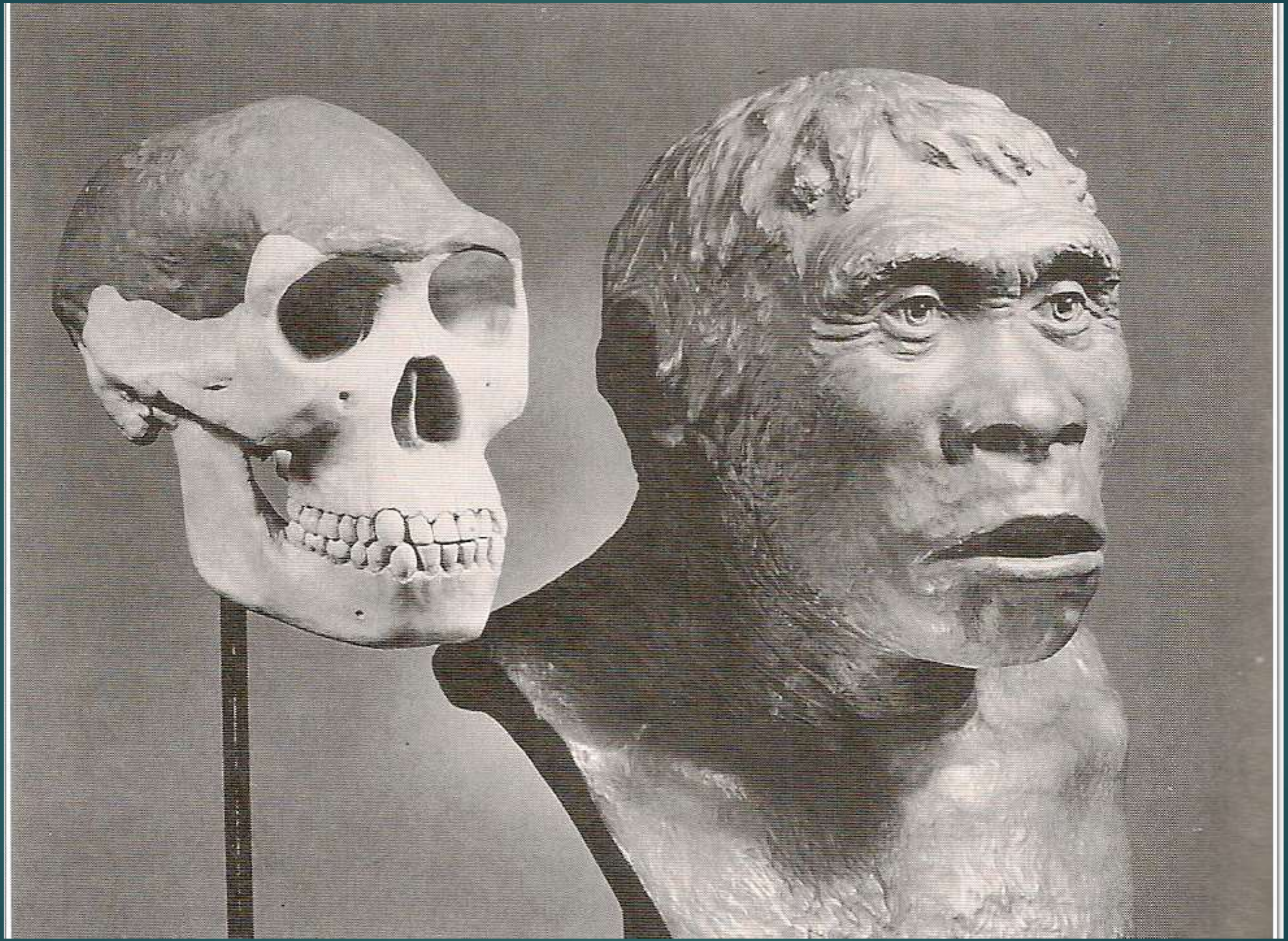


Early Man –
F. Clark Howell

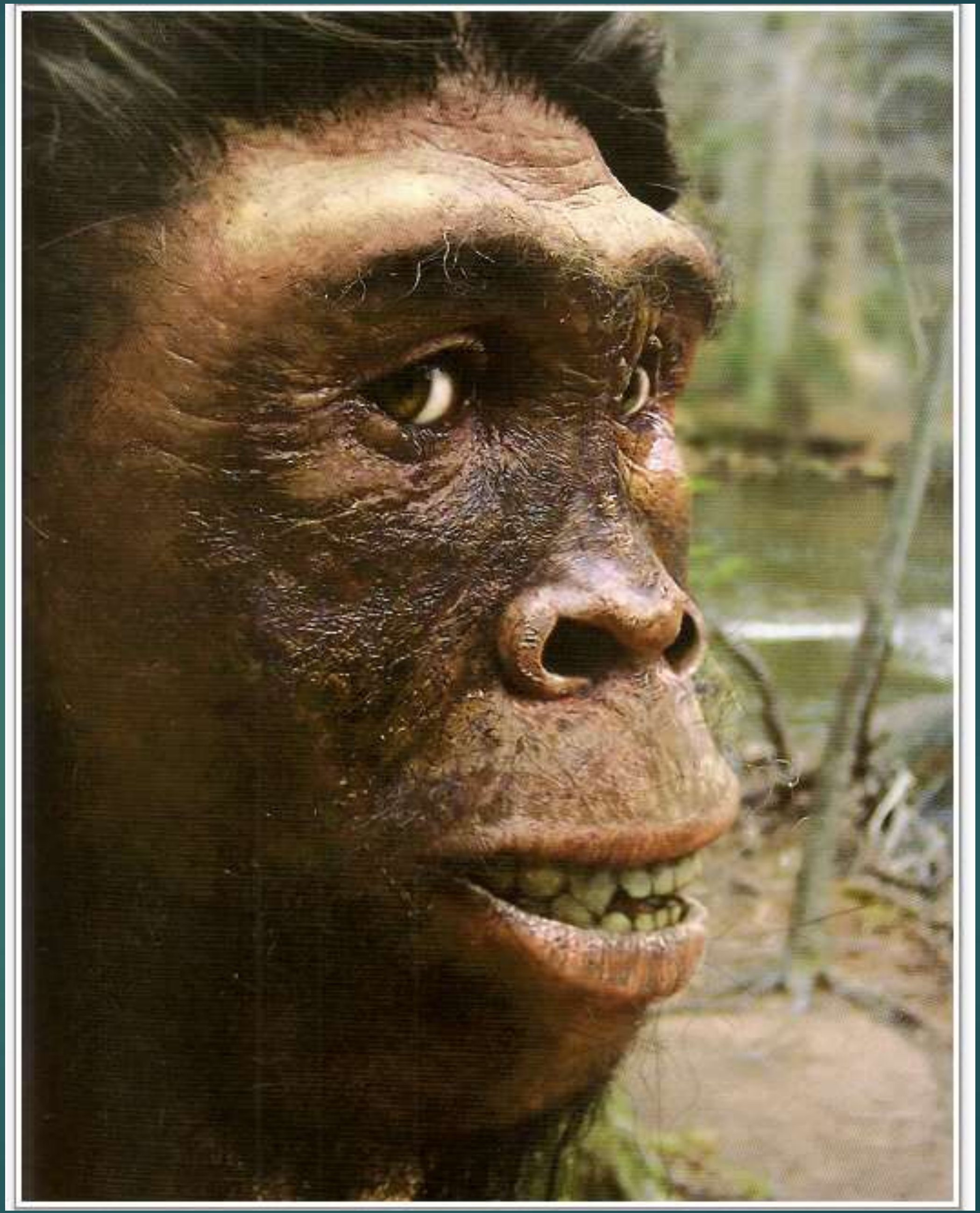




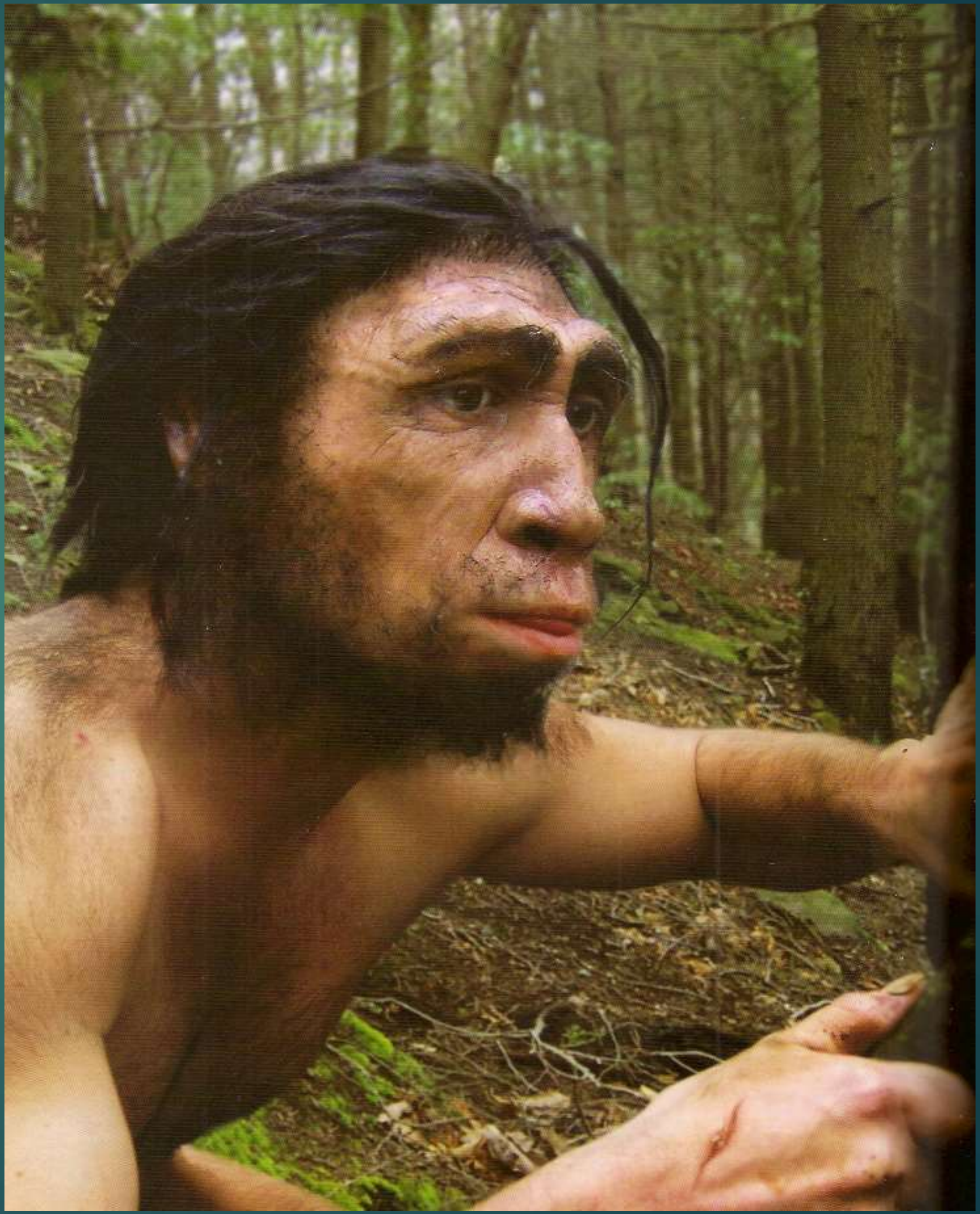
(Below) A reconstruction of Zhoukoudian showing a group fashioning tools of bamboo and quartzite, and cooking meat on a fire. In the background dangerous hyaenas are being driven away – it seems likely that humans and hyaenas regularly competed both for shelter and food. Recent research has cast doubt on the extent of human fire use at Zhoukoudian, however.

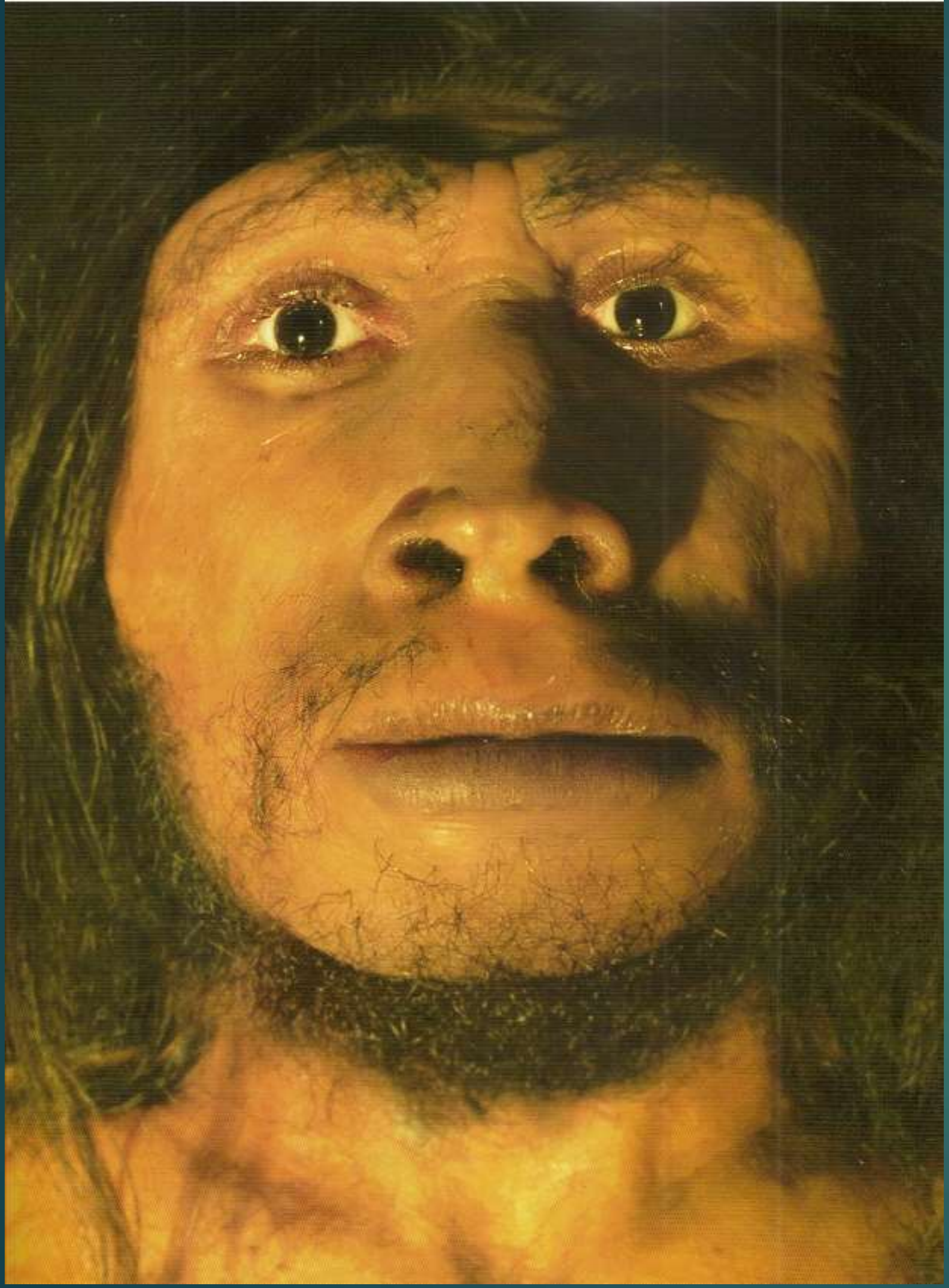
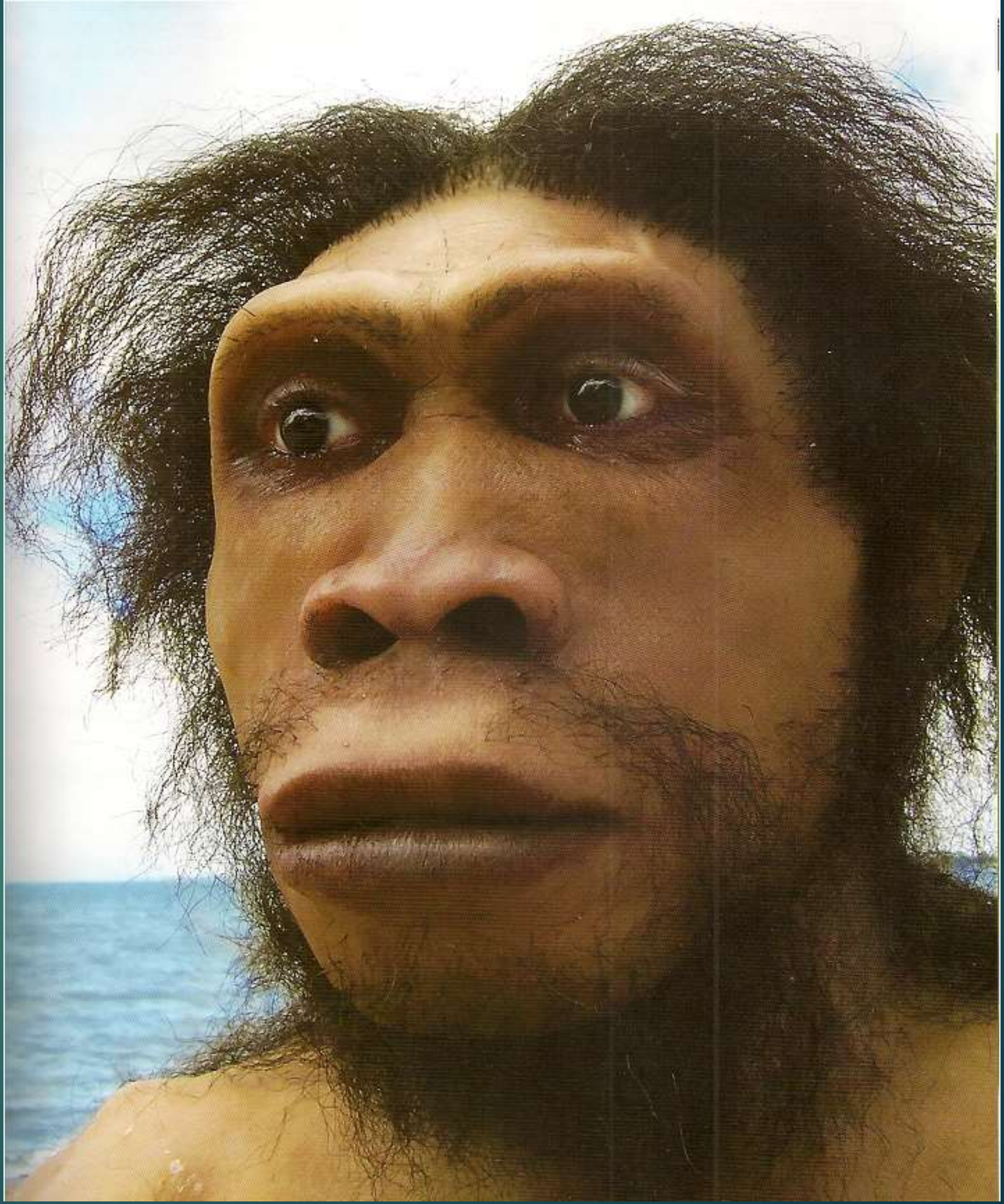


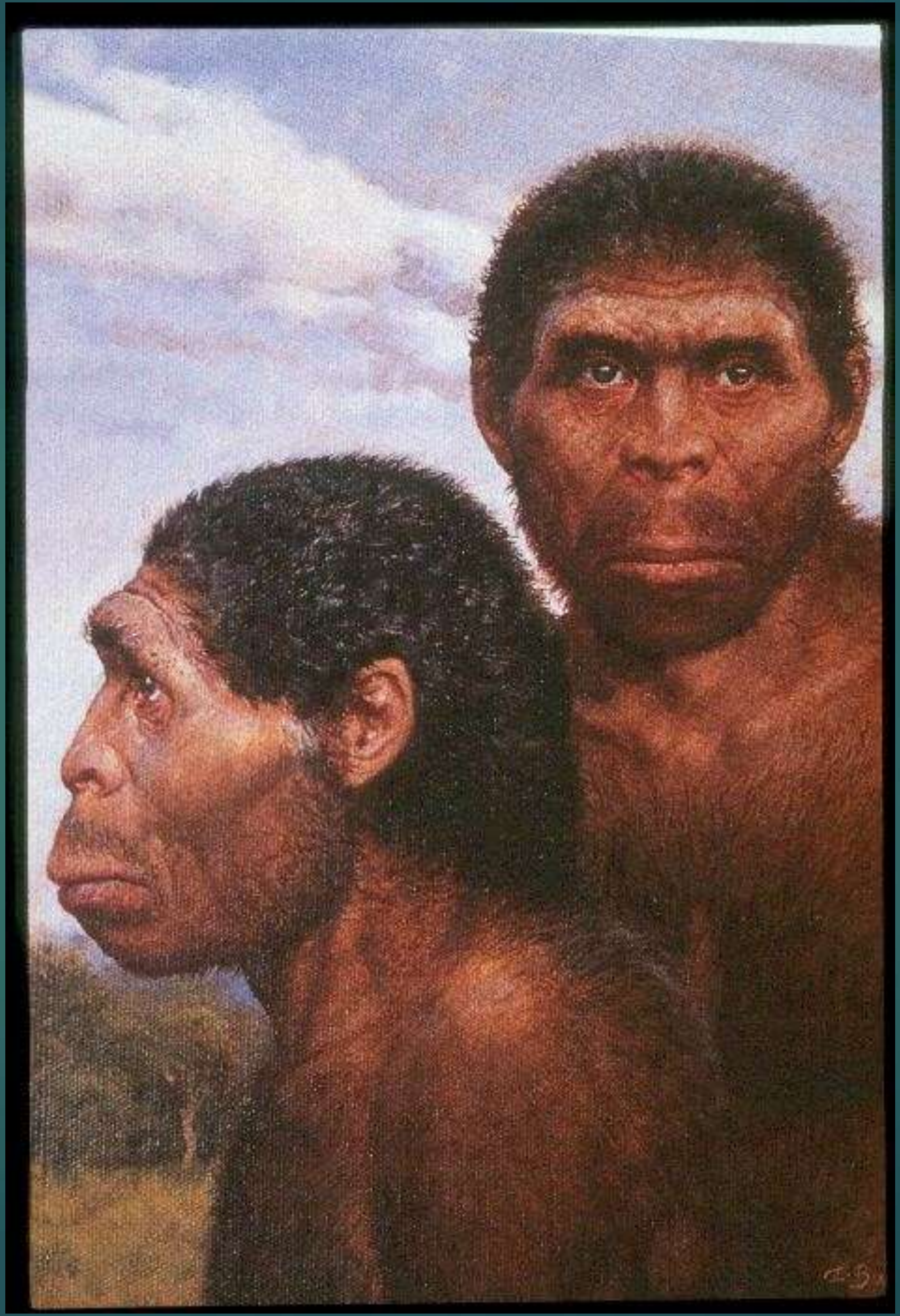
Dmanisi, by V. Deak

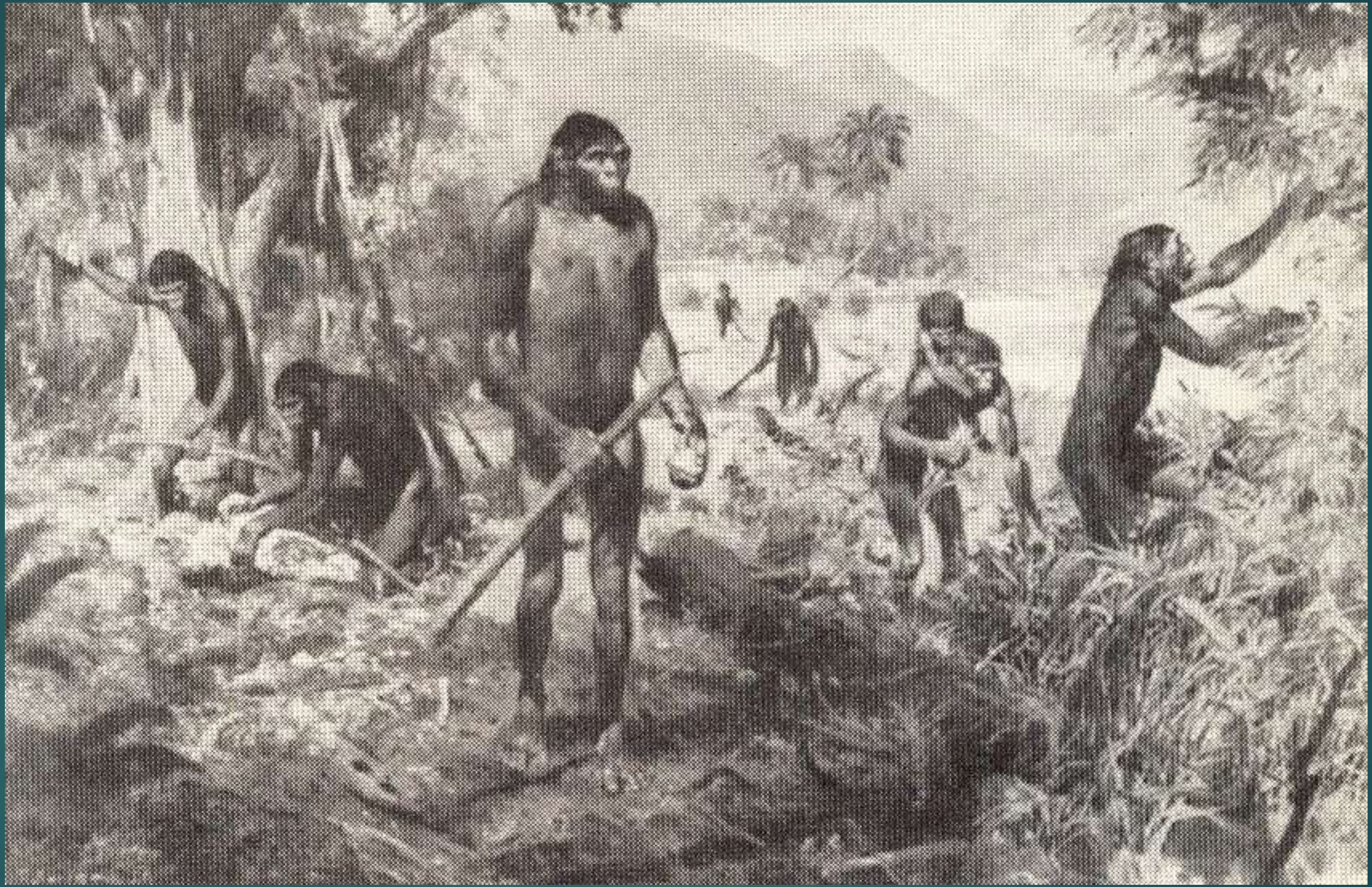


H. pekingensis, V. Deak







The Emergence of Humankind 4th Ed., p. 105

H. erectus the hunted, AMNH

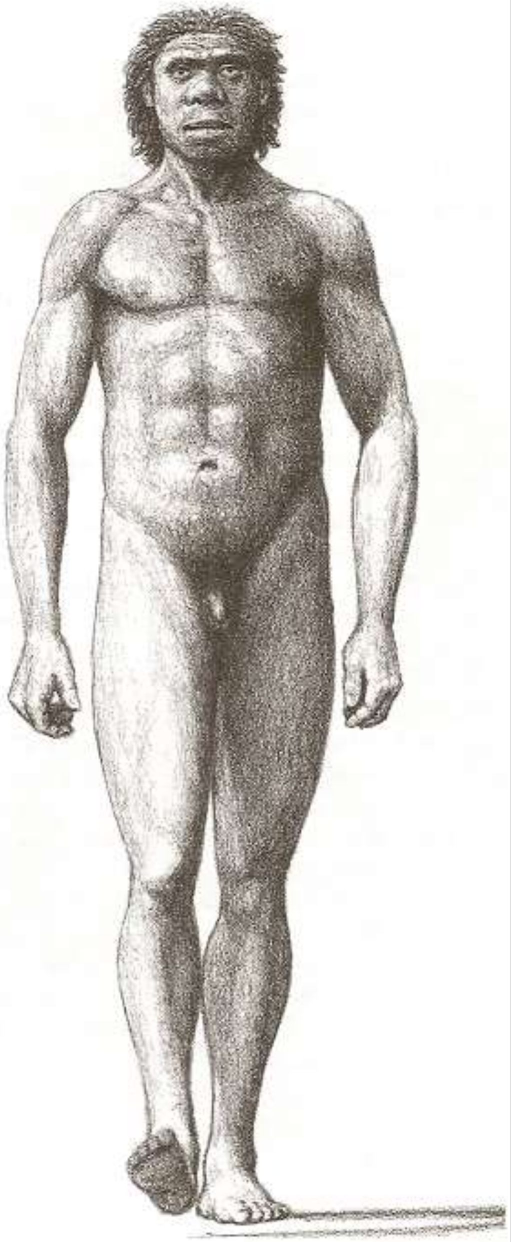


Figure 7.5 *Homo ergaster*

Bibliography

- Antón, S. C. (2003). "Natural history of *Homo erectus*". *Am. J. Phys. Anth.* 122: 126–170.
- Aiello LC, Wheeler P. *1995.* "The expensive tissue hypothesis: the brain and digestive system in human and primate evolution"*. Curr Anthropol 36: 199–221.*
- Arambourg C. 1954*.* "L'hominien fossile de Ternifine (Algérie)"*. C R Hebdom Seances Acad Sci 239: 893–895.*
- Noel T. Boaz and Russell L. Ciochon, 2004: *Dragon Bone Hill: An Ice-Age Saga of Homo erectus,*
- Dubois E. 1894. "Pithecanthropus erectus: eine menschenaehnlich Uebergangsform aus Java"*. Batavia: Landsdrukerei.*
- Gilbert, W. Henry and Berhane Asfaw, Homo erectus: Pleistocene Evidence from the Middle Awash, Ethiopia

Bibliography 2

- Groves CP, Mazek V. 1975*.* “An approach to the taxonomy of the hominidae: gracile Villafranchian hominids of Africa”*. Caspos Miner Geol 20: 225–247.*
- Howells, W. W. *1980. “Homo erectus-Who,* When and Where: A Survey”, Yearbook of Physical Anthropology, 23:1-23
- Klein RG. 1989*. The human career: human biological and cultural origins. Chicago: University of Chicago Press.*
- Le Gros Clark W.E., 1964. The fossil evidence for human evolution, 2nd ed. Chicago: University of Chicago Press.
- Leonard, W.R., Robertson, M.L., 1997. “Comparative primate energetics and hominin evolution”. Amer Jour of Phys Anthropology 102, 265–281.
- Mayr, E., 1950. Taxonomic categories of fossil hominins. Cold Spring Harbor Symposium, Quant Biol 25, 109–118.

Bibliography 3

- Potts R. 1996. *Humanity's descent: the consequences of ecological instability. New York: William Morrow.*
- Rightmire GP. 1993. *The evolution of Homo erectus, comparative anatomical studies of an extinct human species.* New York: Cambridge University Press.
- Tattersall I. 2000. "Paleoanthropology: the last half-century". *Evol Anthropol 9: 2–16.*
- Wood B, Collard M. *1999.* "The human genus". *Science 284: 65–71.*
- Wrangham RW, Jones JH, Laden G, Pilbeam D, Conklin-Brittain N. *1999.* "The raw and the stolen: cooking and the ecology of human origins". *Curr Anthropol 5: 567–594.*

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The End

Grandmother hypothesis

- Man the hunter: happens to coincide with Western ideas about the division of labor and the nuclear family that were prevalent in the 1960s when this so-called "Man the Hunter" theory first emerged.
- Hadza hunters who hunt everyday and bag an animal 3.4% of time. Their women, both young and old, were providing the majority of calories to their families and group-mates.
- Mostly, they were digging tubers, which are deeply buried and hard to extract. The success of a mother at gathering these tubers correlated with the growth of her child.
- New variable was the amount of food children's grandmother was gathering.

Grandmother hypothesis

- Grandmothers were probably more important to child survival than fathers. Mom and grandma were keeping the kids fed. Not Man the Hunter.
- Maybe it wasn't an accident that humans are the only great ape species in which women live so long past reproductive age. If having a helpful grandmother increased a kid's chances of survival, natural selection may well have started selecting for older and older women
- While the men were out hunting, grandmothers and babies were building the foundation of our species' success – sharing food, cooperating on more and more complex levels and developing new social relationships. In a nutshell, humanity's success may all be dependent on the unique way our ancestors raised their kids. Thanks to Grandma.

Tapeworms

- Tapeworm phylogeny offers additional evidence that *H. erectus* consumed other animals.
- The molecular phylogenies of the two most closely related human-specific tapeworms (*Taenia saginata* and *T. asiatica*) suggest the species diverged sometime between 0.78 ka and 1.7 Ma (Hoberg et al., 2001).
- Since the species are host specific, such a divergence date is consistent with a human host (*H. erectus*) being infected, presumably by consuming the flesh of an infected animal, during this time period. Since the third human-specific tapeworm (*T. solium*) is closely related to those that are specific to other African carnivores, early humans are inferred to have sampled similar animals (and parasites) as these carnivores.

Lice and date of loss of body hair

Lice on hair predates pubic lice

Pubic lice from gorillas

Mark Stoneking: When we lost our hair, pubic lice migrated to our heads; with later contact with gorillas, we gained gorilla pubic lice; Estimate of when we lost our body hair related to divergence of these 2 lice; using molecular clock data, Stoneking estimated divergence of gorilla and human lice at 3 Ma (around Lucy's time); Turkana boy was probably hairless