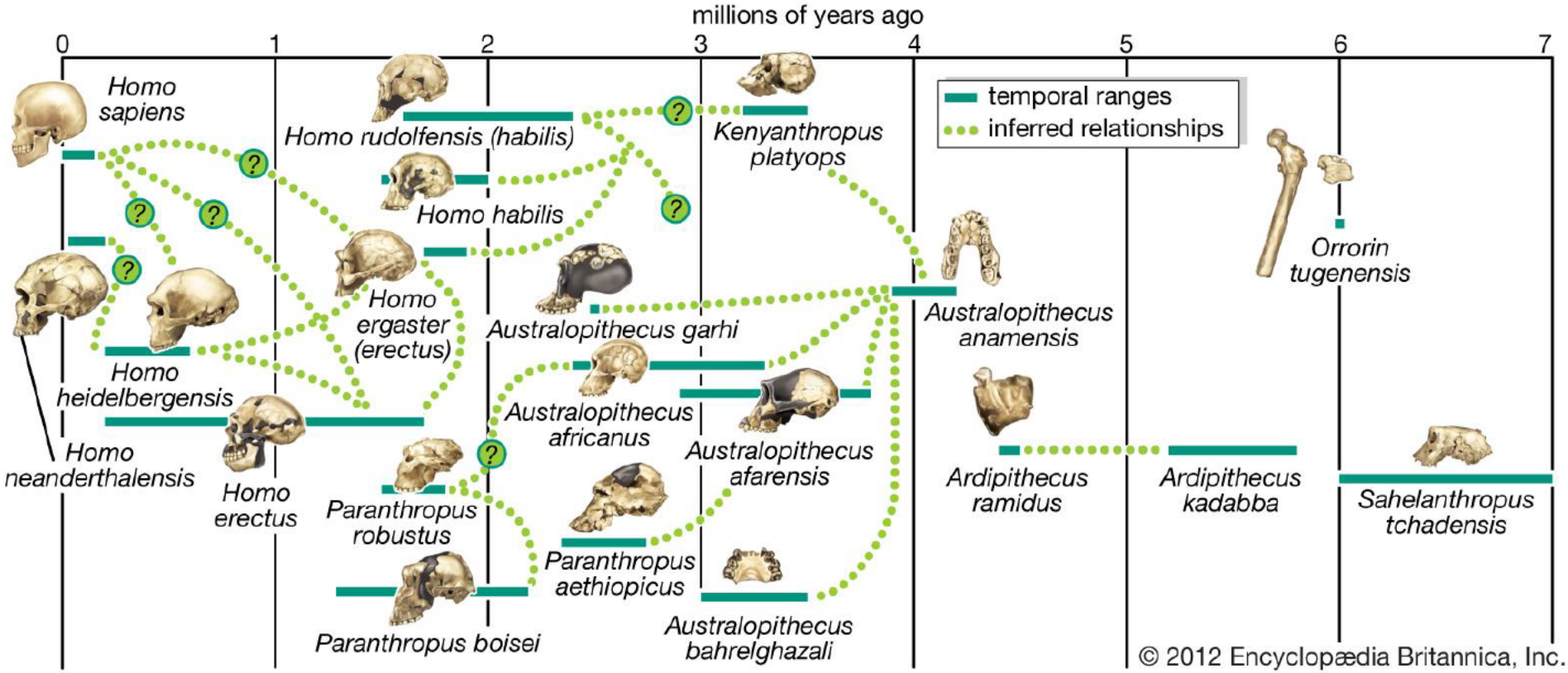
Fossil hominins

Then God said, “Let us make man in our image, in our likeness”

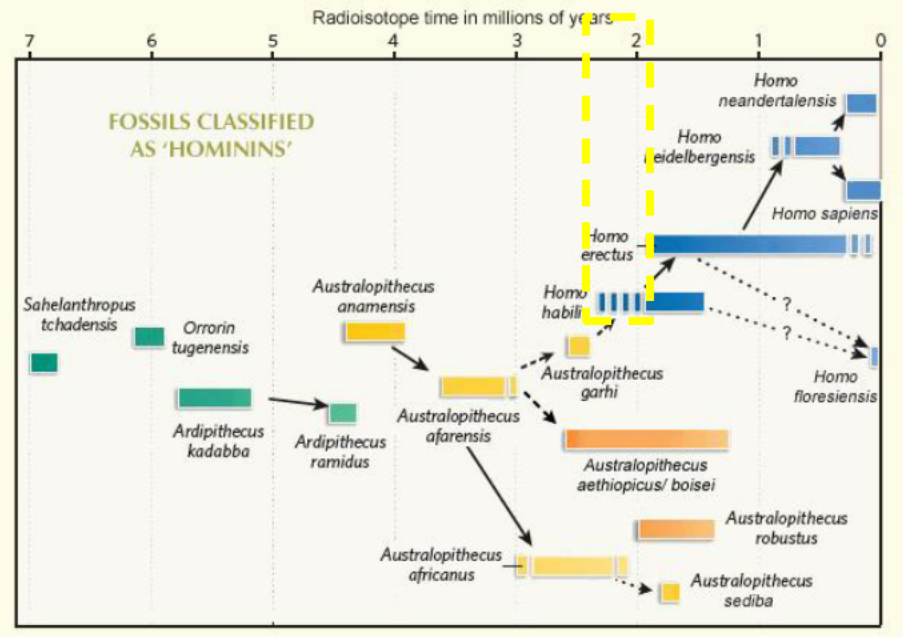
Genesis 1:26

Why are we talking about this topic: The evolutionary scenario



Dashed lines and question marks: uncertainty and gaps, but overall narrative has become major tenet of mainstream academia

How good is the record: the good, the bad, the ugly



From http://www.earthhistory.org.uk/wp-content/Hominidphylogeny.jpg

- The good:
Homo neanderthalensis: 500
Homo erectus: 150
Australopithecus africanus: 130
Australopithecus afarensis: 120
Paranthropus robusts: 90

Note that these numbers rarely represent relatively complete individuals, more often just fragments

- The bad:
Ardipithecus ramidus: 35
Homo floresiensis: 9
Australopithecus sediba: 6
Australopithecus garhi: 1

- The ugly:
Lower Pleistocene fossil gap, only a few fragments of putative ancestral *Homo* species

From Villmoare et al., 2015, Science 347/6228, 1352-1355

What is the research question?

From http://www.jasondejong.ca/Muses/Hominid_Fossils.html; http://dmanisi.ge/page?id=12&lang=en; https://3.bp.blogspot.com/_7ZYqYi4xigk/S73kcrBV2nI/AAAAAAAAF0U/a973pLg8QEk/s1600/hominid2.jpg

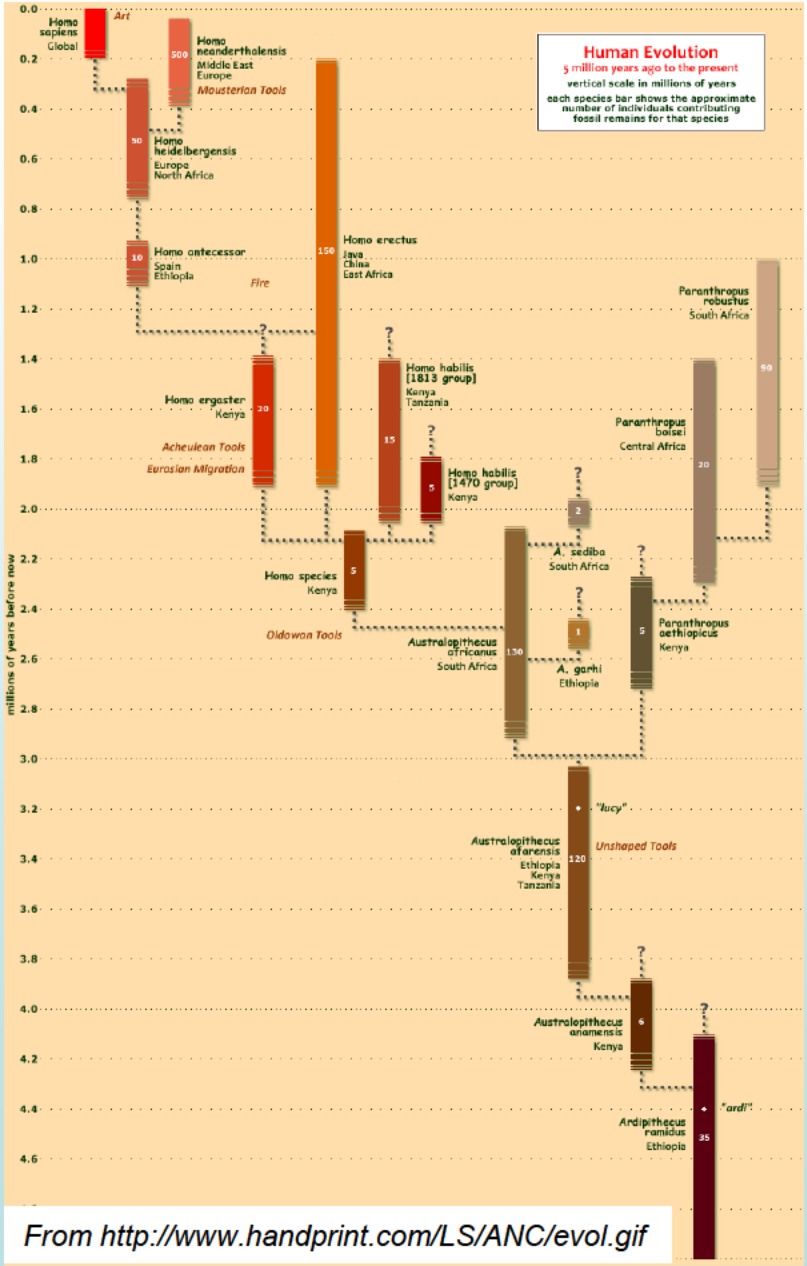
Systematics:
What are they?
Are they related?
If yes, how?

Both for creationist and evolutionist models

How is the question addressed?

Stratigraphy
+
Morphometry/ Cladistics

Stratigraphy: what's younger, what's older



From http://www.handprint.com/LS/ANC/evol.gif

1) Basic principle of superposition:
   what's below is older than what's above

- Superposition works only if physical correlation can be established between different sites

- Does not provide absolute age

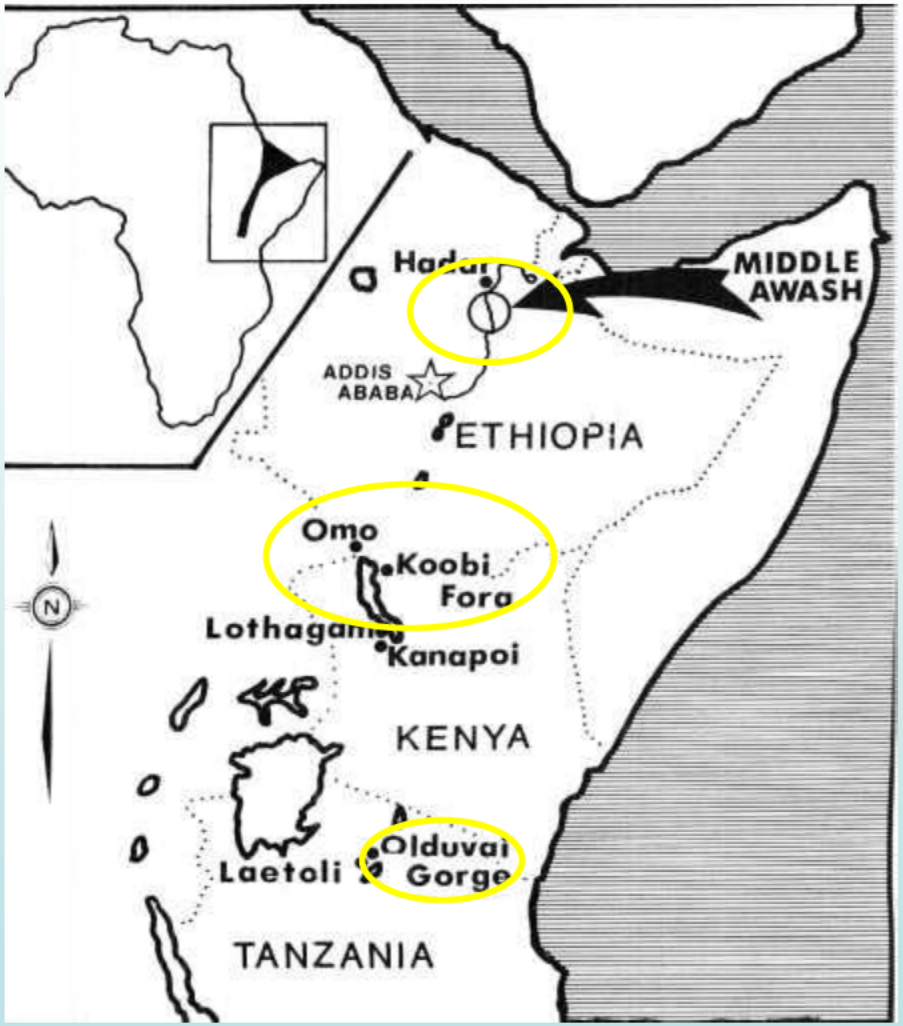
Stratigraphy: what's younger, what's older

Basic principle of superposition: Notable locations

Olduvai Gorge (Tanzania)

Lake Turkana and surrounding region (Koobi Fora, Kenya; Lower Omo Valley, Ethiopia)

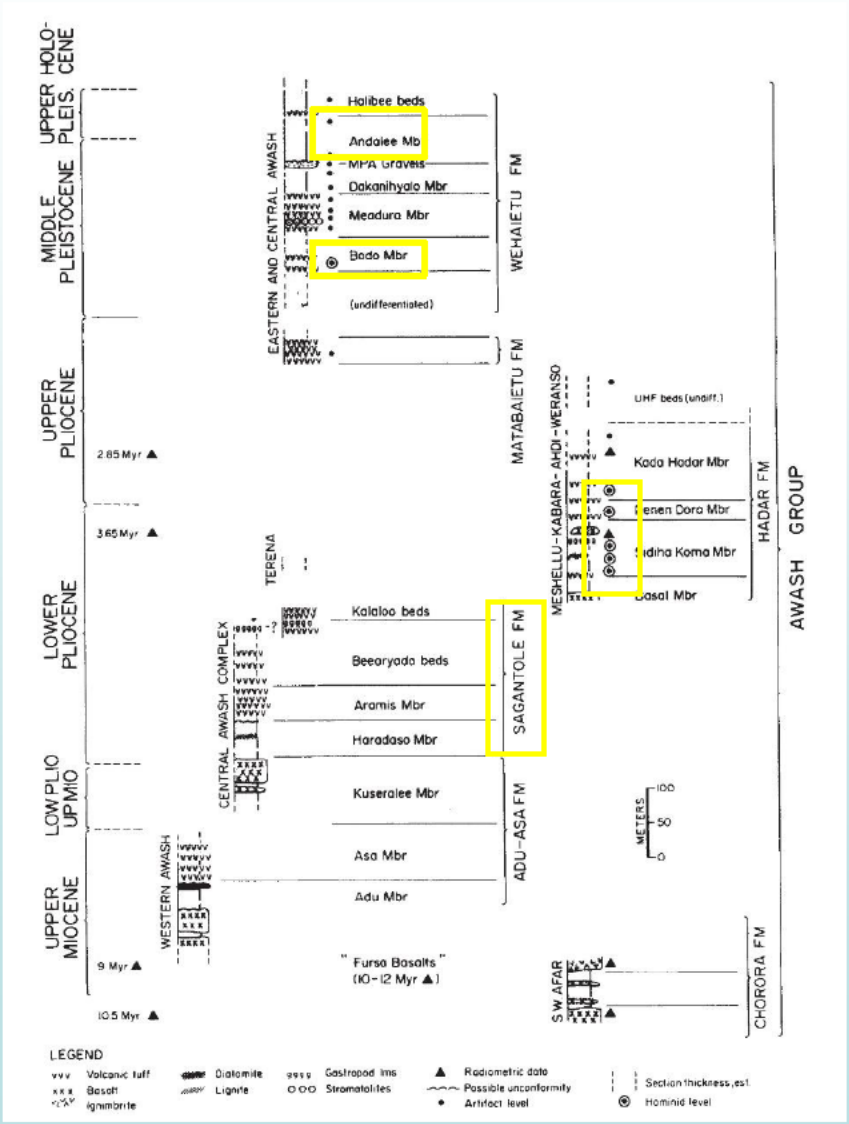
Awash Valley, Afar region, Ethiopia



From http://users.hol.gr/~dilos/prehis/Mpafrica.jpg

Stratigraphy: what's younger, what's older

Awash Valley, Afar region, Ethiopia



From Kalb et al. (1982) Nature 289/1, 17-25

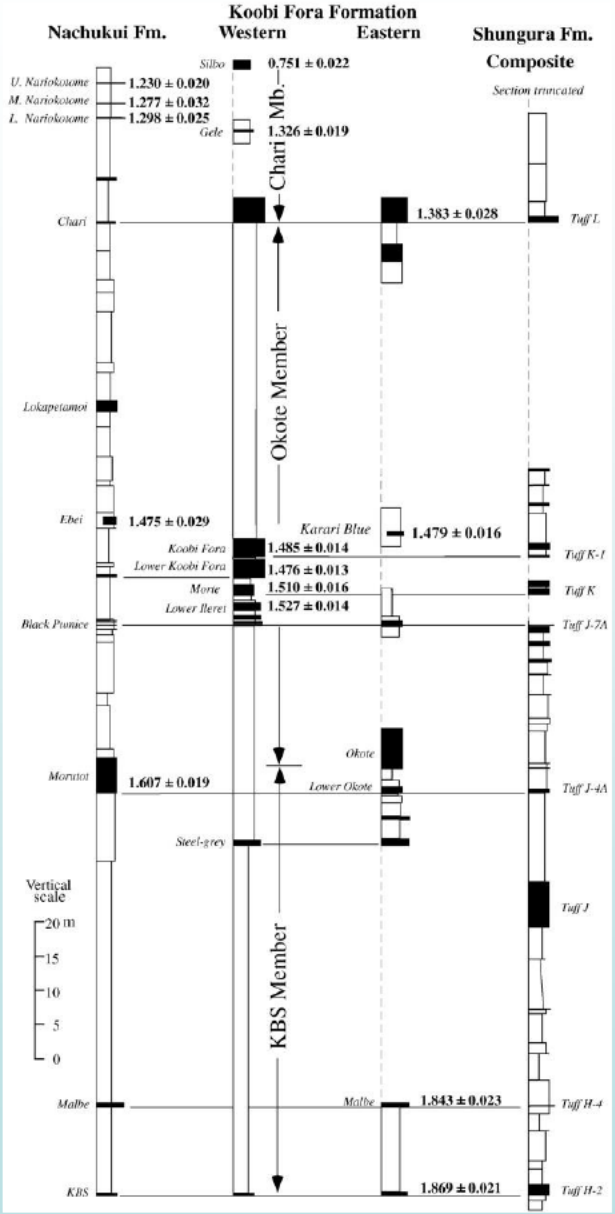
Findings include: *Ardipithecus ramidus* (Ardi), *Australopithecus anamensis, A. afarensis* (Lucy), *A. garhi, Homo habilis, H. erectus, H. heidelbergensis, H. sapiens*

From White et al., 2003. Nature 423, 743

From http://en.wikipedia.org/wiki/File:Lucy_blackbg.jpg

From White et al., 2009. Science 326, 64

Stratigraphy: what's younger, what's older



From McDougall & Brown (2006), J. Geol. Soc. 163, 205-220

Absolute dating: How is a numerical age obtained?

- Carbon dating (only up to 40k)
- Luminescence and ESR dating (up to 300k)
- Radiometring dating (tuffs, volcanics, flowstones)

What is the research question?

From http://www.jasondejong.ca/Muses/Hominid_Fossils.html; http://dmanisi.ge/page?id=12&lang=en; https://3.bp.blogspot.com/_7ZYqYi4xigk/S73kcrBV2nI/AAAAAAAAF0U/a973pLg8QEk/s1600/hominid2.jpg

Systematics:
What are they?
Are they related?
If yes, how?

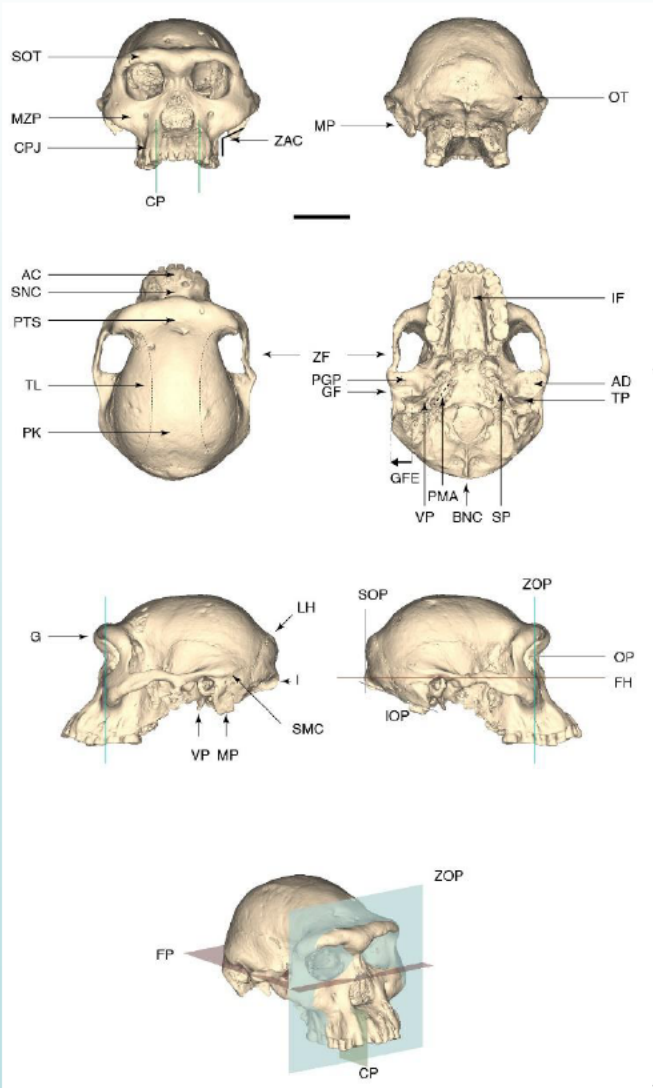
Both for creationist and evolutionist models

How is the question addressed?

Stratigraphy
+
Morphometry/ Cladistics

Morphometry/Cladistics: what's most similar to what

Way of quantifying similarity in morphology between different specimens



Build character matrixes and apply statistical methods to cluster

Table S4A. Non-metric characters of the cranium: definitions.

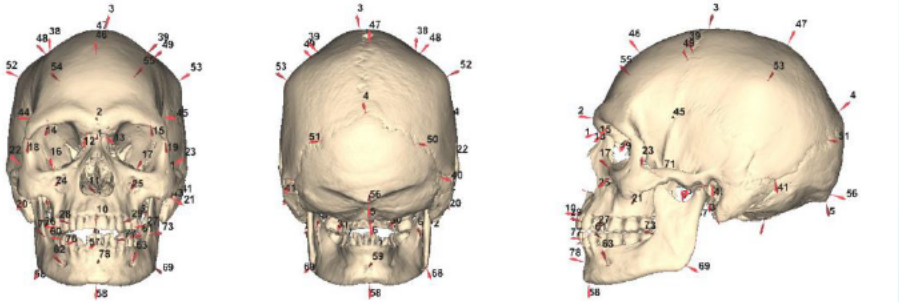
nr.	character	description	character states 0	1	2
	braincase				
1	Vault thickness	at parietal eminence	thin (≤6mm)	intermediate	thick (>12mm)
2	Cranial vault keeling	frontal and/or parietal	no	weak	marked
3	Postorbital constriction	bi-pterionic to bi-frontomalare-temporale width	weak	moderate	marked
4	Posttoral sulcus	concavity of the region between supraorbital torus and frontal squama	absent to weak	moderate	marked
5	Occipital torus morphology	robusticity	absent-weak	moderate	marked
6	Supramastoid crest	morphology	moderate	marked	
7	Mastoid size	relative to temporal size	small	moderate	large
	base				
8	Glenoid fossa shape	depth of TMJ	shallow	deep	
9	Glenoid fossa overhang	proportion of the fossa that overhangs the external cranial vault	<50%	≥50%	
10	Tympanic shape	shape of anteroinferior surface	rounded	flat	
11	Petromedian angle	angle between pyramid axis (basal aspect) and midsagittal plane; (*73*)	<30°	30°-40°	>40°
12	Basicranial flexion	flexion between the pre-sellar sphenoid and the spheno-occipital clivus [CBA4; (*58*)]	weak	moderate	strong
	face				
13	Supraorbital torus morphology	supercoinferior size	small	moderate	large
14	Glabellar morphology	glabellar size and shape	small	marked	prominent
15	Facial proportion	mid/upper facial width (bi-maxillary tubercle width versus bi-frontomalare-temporale width	~1	>1	
16	Malar orientation	orientation of the anterior malar surface relative to Frankfurt Horizontal	posteriorly inclined	vertical	anteriorly inclined
17	Zygomatico-alveolar crest shape	angulation of the crest between its	~straight	curved	angled
18	Alveolar prognathism	Position of anterior surface of zygomatic root	M1 to M2	P4 to M1	P3 to P4
19	Naso-alveolar clivus angle	angle formed with alveolar plane	low (<35°)	moderate (~45°)	high (>55°)
20	Subnasal clivus shape	overall curvature in sagittal and transverse directions	convex	flat	concave
21	Alveolar clivus shape	overall curvature in sagittal and transverse directions	convex	flat	concave
22	Projection of naso-alveolar region	anterior project of prosthion relative to canine alveoli	absent	moderate	strong
23	Canine root orientation	inclination relative to parasagittal plane	inclined	parallel	
24	Canine/P3 juga	prominence of juga	weak	moderate	marked
25	P3 position	position of P3 relative to C	posterior	posterolateral	
26	Palate depth	palate depth/half-width at M2	shallow (≤.9)	deep (>.9)	
27	Position of incisive foramen	at or posterior to premolar	P4	P3	
28	M1/M2 size	ratio of crown areas (MDxBL)	≥1	<1	
29	M1/M3 size	ratio of crown areas (MDxBL)	≥1	<1	
30	M2/M3 size	ratio of crown areas (MDxBL)	≥1	<1	

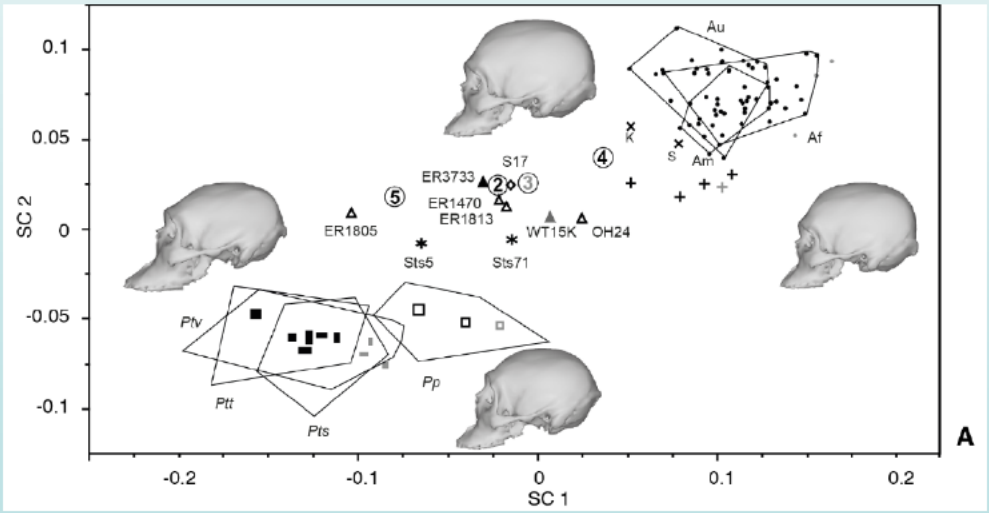
Dmanisi	char #	1	2	3	4	5	6	7	8	9	10	11	12
	D4500	2	0	2	1	2	1	2	0	1	1	1	1
	D2280	1	0	1	0	1	1	1	1	0	1	1	-
	D2282	0	0	1	1	0	0	0	0	0	1	1	-
	D2700	2	1	2	0	1	0	1	0	0	1	1	2
	D3444	1	1	2	1	1	1	0	0	1	1	1	2
	Sts 71	1	0	1	0	0	0	0	0	0	0	-	-
	Sts 5	0	0	1	0	0	0	0	0	1	0	1	1
	A.L. 666-1	-	-	-	-	-	-	-	-	-	-	-	-
	KNM-BC 1	-	-	-	-	-	-	-	0	0	0	-	-
	Stw 53	0	-	1	-	-	1	0	0	1	0	-	-
	SK 847	-	-	-	1	-	-	1	0	0	0	-	-
	OH 65	-	-	-	-	-	-	-	-	-	-	-	-
	KNM-ER 1470	1	0	1	0	0	1	?	0 ?	0	?	-	-
	KNM-ER 62000	-	-	-	-	-	-	-	-	-	-	-	-
	KNM-ER 1805	2	2	?	-	2	0	2	0	?	1	?	?
	KNM-ER 1813	0	0	1	1	0	0	0	0	0	1	?	?
	OH 24	0	0	1	1	0	-	?	1	0	0	?	-
	KNM-WT 15000	1	1	1	1	0	0	0	1	0	0	1	1?
	KNM-ER 3733	1	0	0	2	0	0	0	1	0	0	1	1
	KNM-ER 3883	1	0	0	0	0	0	1	0	0	1	1	1
	KNM-ER 42700	0	1	0	0	0	0	0	1	0	0	1	1
	KNM-ER 42703	-	-	-	-	-	-	-	-	-	-	-	-
	OH 9	2	-	2	2	1	0	?	1	0	1	1?	?
	BOU-VP-2/66	2	1	1	2	0	0	1 ?	1	0	1	1	2
	Sangiran 2	2	1	1	1	2	1	0	0	0	0	-	-
	Sangiran 4	2	2	2	-	-	2	1	1	0	1	1	-
	Sangiran 17	2	2	1	0	2	2	1	0	0	1	?	?
	Sambungmacan 3	2	1	1	2	1	1	1	1	0	1	-	-
	Sambungmacan 4	1	2	0	1	2	0	1	1	0	1	1	1
	Ngawi 1	2	1	0	1	1	1	0	0	0	1	-	1
	Ngandong 5 (Solo IV)	0	1	0	0	-	-	-	-	-	-	-	-
	Ngandong 7 (Solo VI)	0	1	0	2	2	0	1	1	0	1	1	-
	Ngandong 12 (Solo IX)	1	1	0	1	2	0	2	1	0	0	-	-
	Ngandong 14 (Solo XI)	2	1	0	1	2	0	1	1	0	0	1	-
	ZKD III	2	2	1	1	2	2	2	1	0	1	1	-
	ZKD X	1	2	1	2	1	1	1 ?	-	-	-	-	-
	ZKD XI	1	2		1	1	2	1	1	0	1	-	-
	ZKD XII	2	2		2	2	0	1	1	0	1	1	-

From Lordkipanidze et al. (2013), Science 342, 326

Morphometry/Cladistics: what's most similar to what

Way of quantifying similarity in morphology between different specimens





Metric and non-metric characters

	supraorbital torus thickness	fmt-fmt	min. frontal breadth	biorbital width	bizygomatic width	na-pr	ba-pr	na-ba	clivus angle	palate length
Martin #			M9.1	M44	M45	M48		M5		
Wood #	W62			W50	W52	W43		W5		W89
specimen										
D4500/2600	12	112	75	99	149	73	127	99	42	75
D2280	11	105	74.5	(103)						
D2282/211	10.5	87?	65	(93)	(131)	(76)	113	(95)	45	54
D2700/2735	8	85?	66	90	(127)	69?	(100)	92	43	55
D3444/3900	10	91?	67.5	98	132					
Sts 71			66	81	(126)	71			35	
Sts 5			65	83	124	77			36	69
A.L. 666-1									47	63
Stw 53	4		(68)						45	
SK 847	7	101	(64)		(118)	84			46	
OH 65									41	64
KNM-ER 1470	8	114	81	107		90			(55)	
KNM-ER 62000				(74)					56	43
KNM-ER 1805			88			71				
KNM-ER 1813	9	100	70	88	(117)	66	94?	82?	42	60
OH 7										
OH 16			66							
OH 24	6	100	(75)	92		(67)		71	35	(55)
KNM-WT 15000	13	112	77	103		77			42	61
KNM-ER 3733	9	119	91	(104)	(138)	83	118	107	44	50
KNM-ER 3883	13	120	88	108	(150)			102		
KNM-ER 42700	7	96	77	(88)						
KNM-ER 42703									?	(57)
OH 9	18		(100)	(119)				(115)		
BOU-VP-2/66	19	124	89	111.2				95.5		
KNM-OL 45500	7	(88)	66							
Sangiran 2	12	102	(79)							
Sangiran 4										70
Sangiran 17	18	125	99	(115)	(150)	(82)	129?	115	72	(55)
Sangiran 27	18									
Sambungmacan 3	14	115	101							
Sambungmacan 4	15		110							
Ngawi 1		113	97							
Ngandong 1 (Solo I)	13	120?	106?							
Ngandong 7 (Solo VI)	14	116	103					111		
Ngandong 12 (Solo IX)	12		103							
Ngandong 13 (Solo X)	13	122?	112							
Ngandong 14 (Solo XI)	10	114?	103	113?				113		
ZKD II	20		84							
ZKD III	12		82							
ZKD X	12	110?	89							
ZKD XI	14	106	84							
ZKD XII	14	108	91							

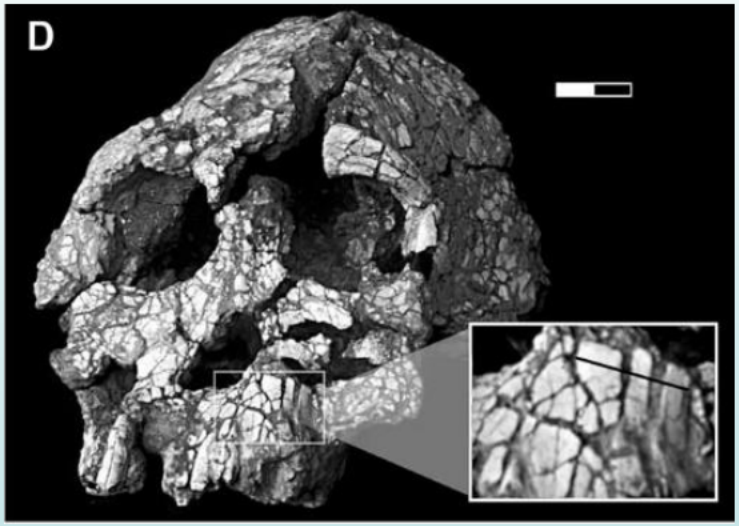
all linear measurements in mm;
(): reconstructed; ?: approximate

From Lordkipanidze et al. (2013), Science 342, 326

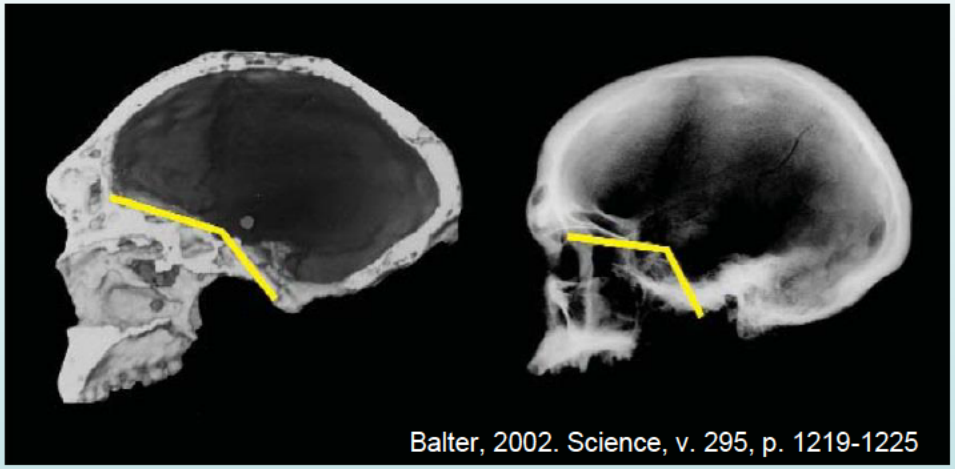
Morphometry/Cladistics: some limitations of the approach

Methodological

- Fragmentary record (cannot always compare)
- Distortion (post-mortem)



From White (2003), Science 299, 1994-1996



- Choice of characters: could be correlated instead of independent (e.g., globosity and prognathism controlled by size and inclination of cranial base)

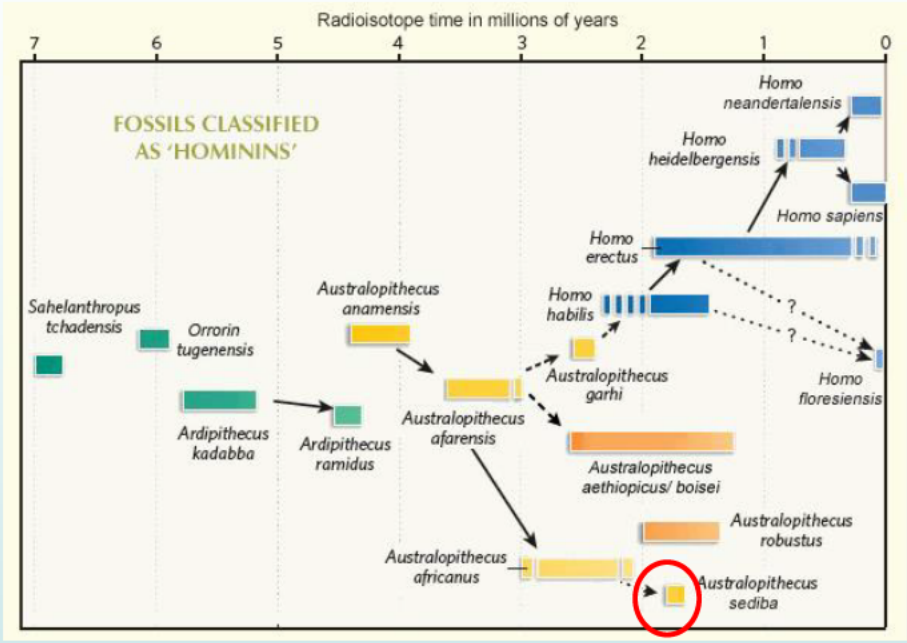
Morphometry/Cladistics: some limitations of the approach

Intraspecific Variability

- Dimorphism
- Adult/Juvenile

Australopithecus sediba

http://www.bradshawfoundation.com/origins/australopithecus_sediba.php



From http://www.earthhistory.org.uk/wp-content/Hominidphylogeny.jpg

"we found that key aspects of MH 1's resemblance to *Homo* are accounted for by its immaturity." *Kimbel & Rak, 2017*

"A famous 'ancestor' may be ousted from the human family" *Gibbons (2017), Science*

Morphometry/Cladistics: some limitations of the approach

Intraspecific Variability

- Dimorphism
- Adult/Juvenile
- Range of variability in population

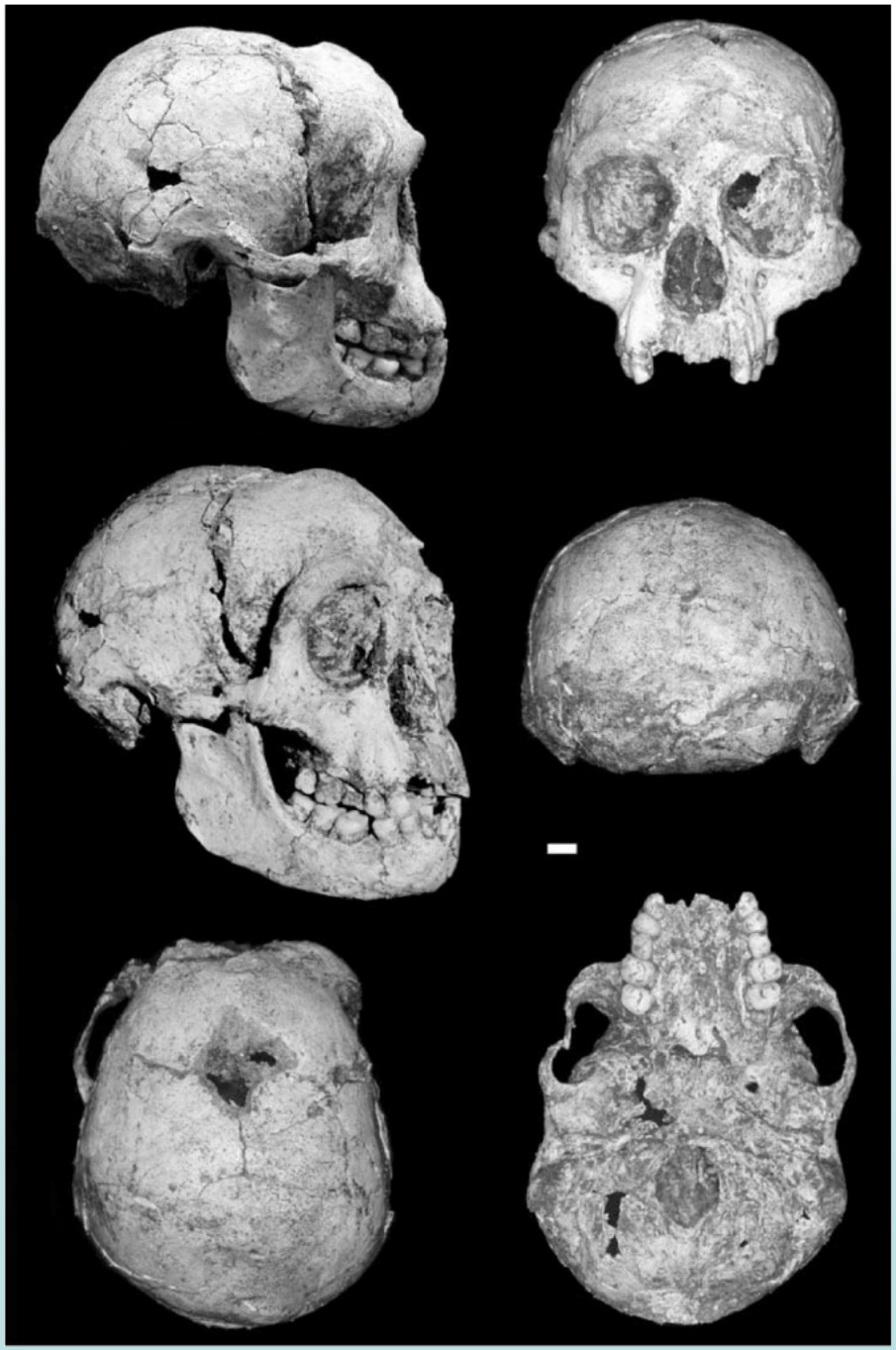
From White (2003), Science 299, 1994-1996

Craniofacial variability in female bonobos

Morphometry/Cladistics: some limitations of the approach

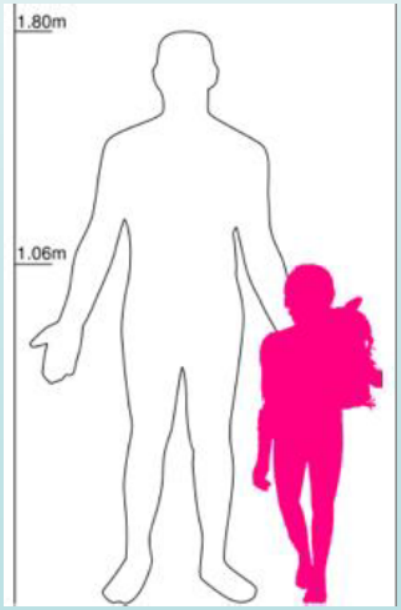
Intraspecific Variability

- Dimorphism
- Adult/Juvenile
- Range of variability in population
- Disease



From Brown et al. 2004, Nature 431, 1055-1061

Homo floresiensis (from the island of Flores, Indonesia)



http://www.incitoprima.com/details.php?catid=6&aid=48

Morphometry/Cladistics: some limitations of the approach

Intraspecific Variability

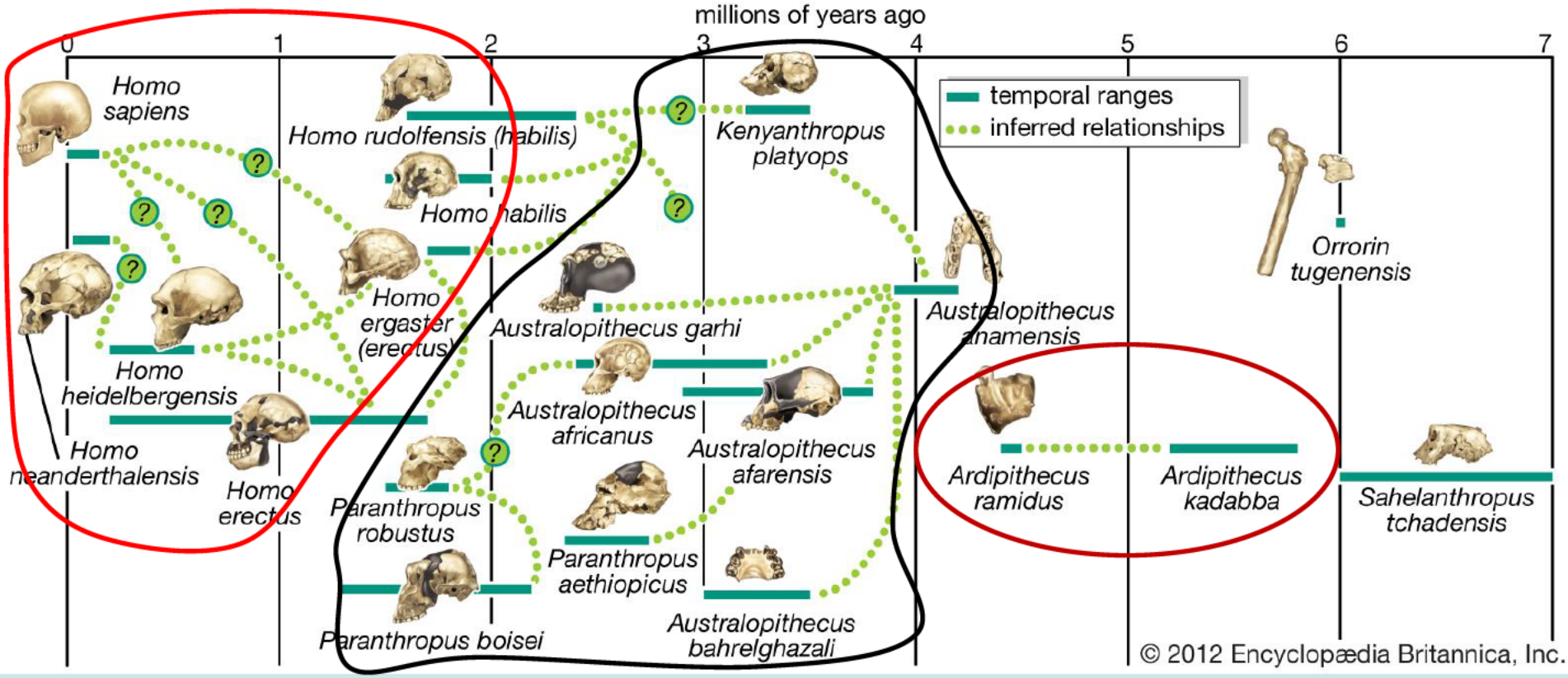
- Dimorphism
- Adult/Juvenile
- Range of variability in population
- Disease
- Environmental "*in vivo*" effects

Robusticity related to function;
Diet;
Stress factors influencing age of maturation

Can morphological difference be a reliable indicator of distinct biological species?

From http://1.bp.blogspot.com/-o7Lf08Nuz_E/TiVyEB4D4XI/AAAAAAAAHPY/RLpR9BAkBkk/s1600/Mapping_The_Neandertal_Genome_Image_1.jpg

Trying to organize the data…



3 groups: *Ardipithecus*

Australopithecines

Homo

Ardipithecus ramidus

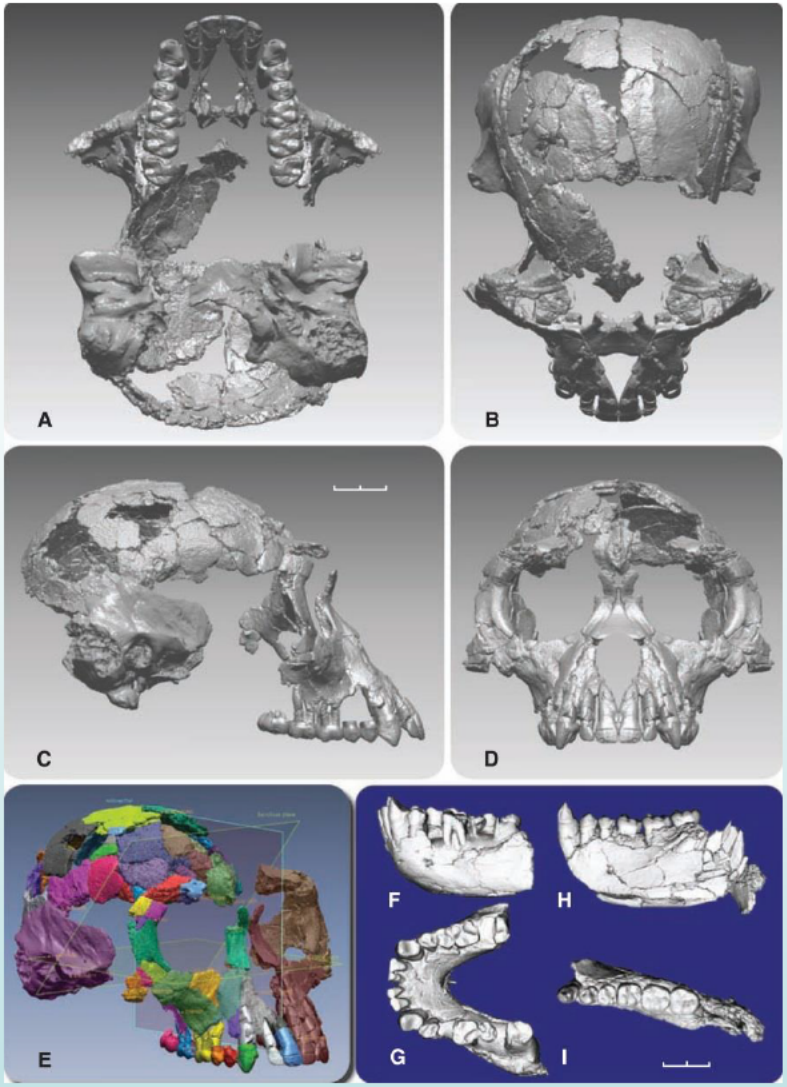
Locality: Ethiopia, Afar region

Specimens: fragments from an adult female and several other individuals

Size: ~120 cm

Brain size: 300-350 cc

Results: woodland not grassland, bipedal + arboreal (opposing big toe, but modified pelvis), small teeth and incisors



From Suwa et al., 2009. Science 326, 68

From White et al., 2009. Science 326, 64

"enormous taxonomic jump to *Australopithecus*"
(Kimbel in Gibbons, 2009. Science 326, p.39)

Australopithecines and humans: general remarks

From Lovejoy, 1993; in Rasmussen: the Origin and Evolution of Humans and Humanness

Overall: clearly distinct from humans, in many aspects more similar to chimp (size, brainsize, skull morphology).

Comparison modern human, *Australopithecus afarensis*, modern chimp

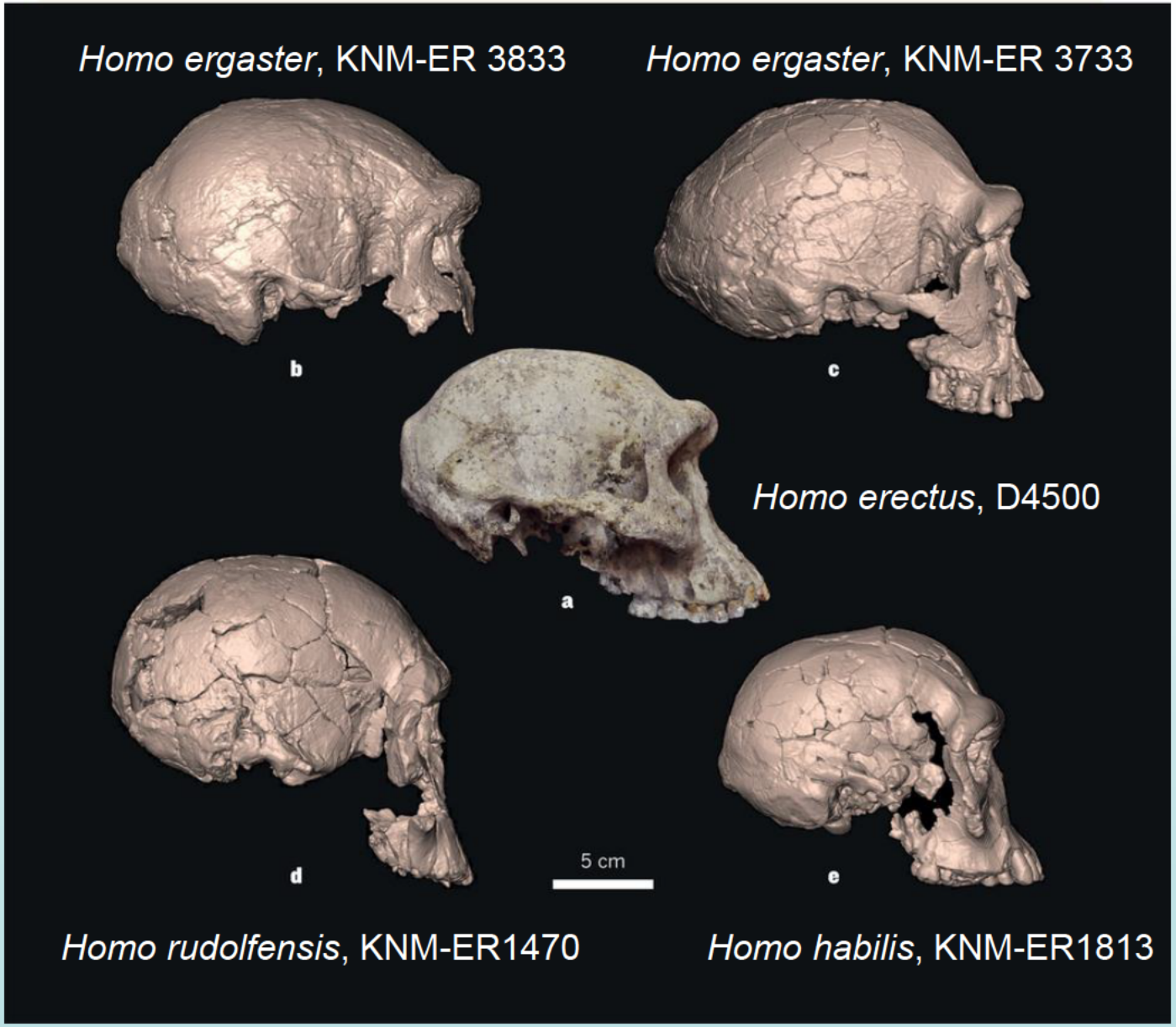
Skull very similar to chimp (morphology, brain volume, teeth size)

Some differences in dental features (larger molars, reduced canines)

From Lovejoy, 1993; in Rasmussen: the Origin and Evolution of Humans and Humanness

More similar to humans in other aspects (e.g., pelvis: possible bipedal locomotion; reduced canine size)

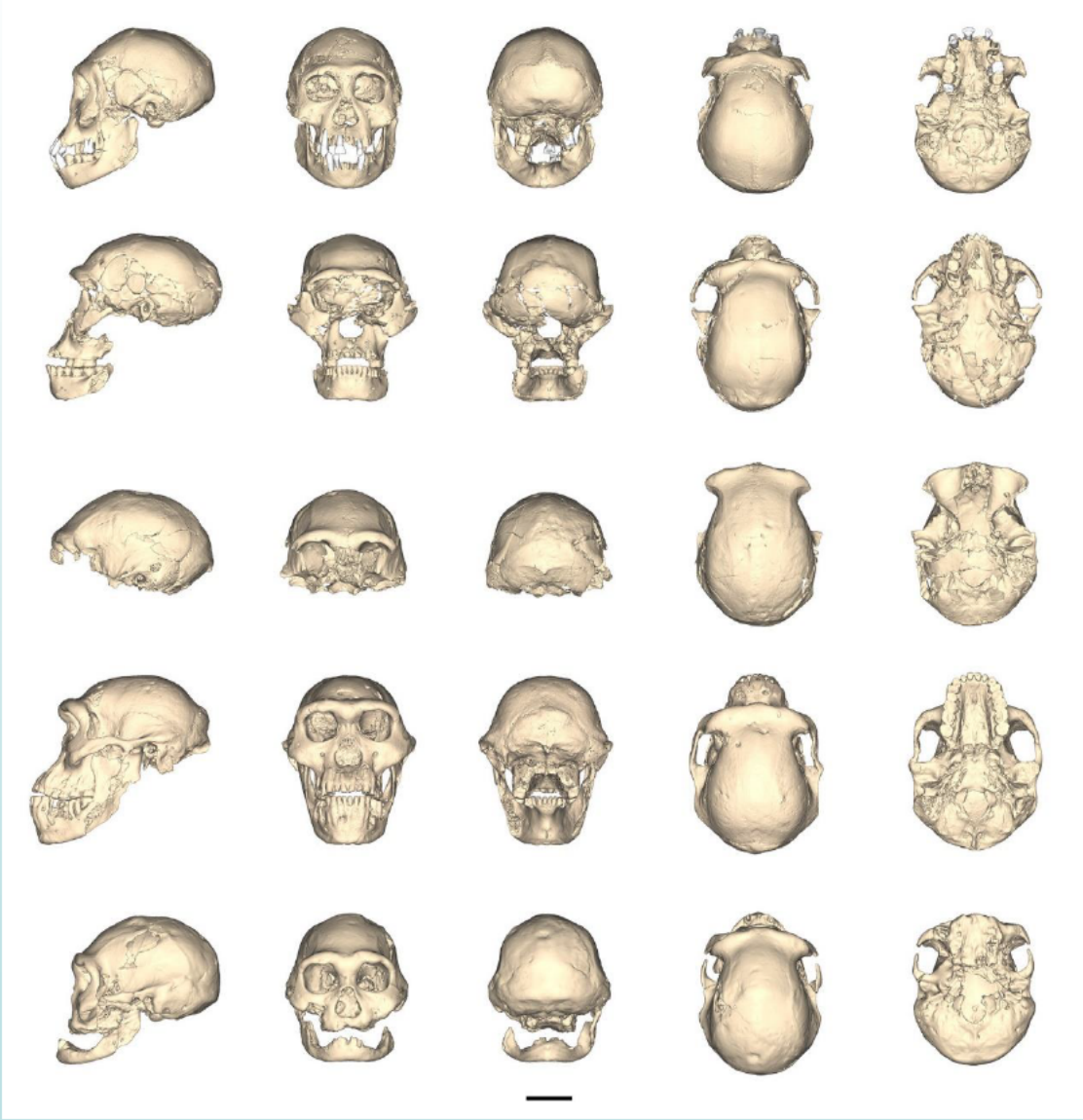
“Early” *Homo* fossils and variability: splitters and lumpers



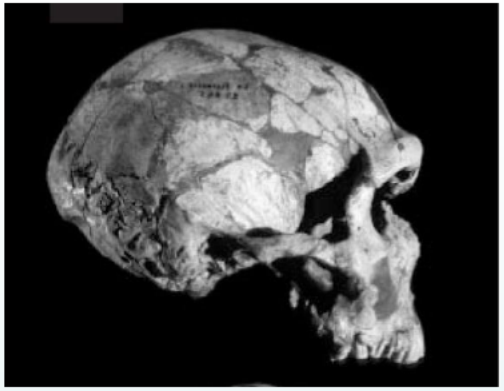
From http://www.nature.com/nature/journal/v502/n7472/fig_tab/502452a_F1.html

One high-variability type or multiple low-variability types?

The Dmanisi insight



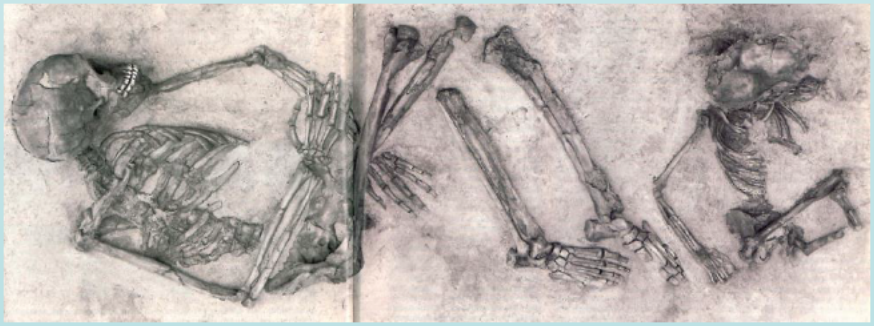
Homo neanderthalensis, La Ferrassie



From White et al., 2003. Nature 423, 746

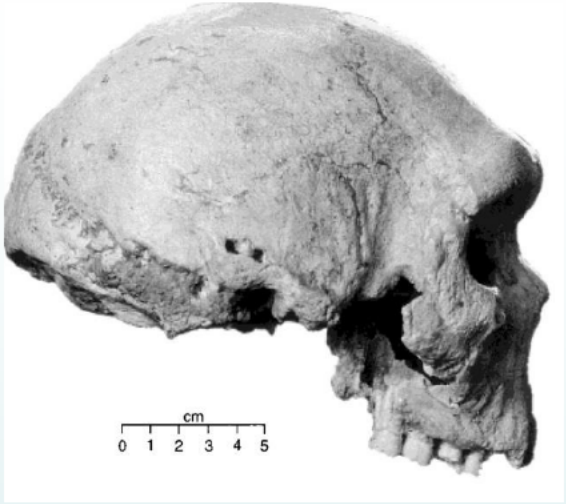
Homo sapiens, Herto, Ethiopia

Homo sapiens, Qafzeh, Israel



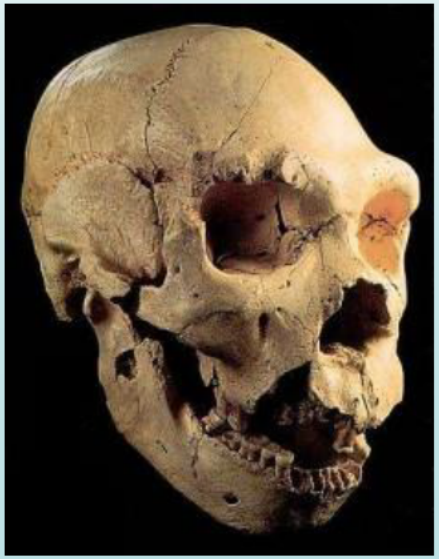
From Bar-Yosef and Vandermeersch, April 1993. Scient. Am., 94-95

Homo heidelbergensis, Petralona, Greece, Middle Pleistocene



From Rightmire, 1998. Evol. Anthropol. 6, 222

Homo heidelbergensis, Atapuerca, Spain, Middle Pleistocene

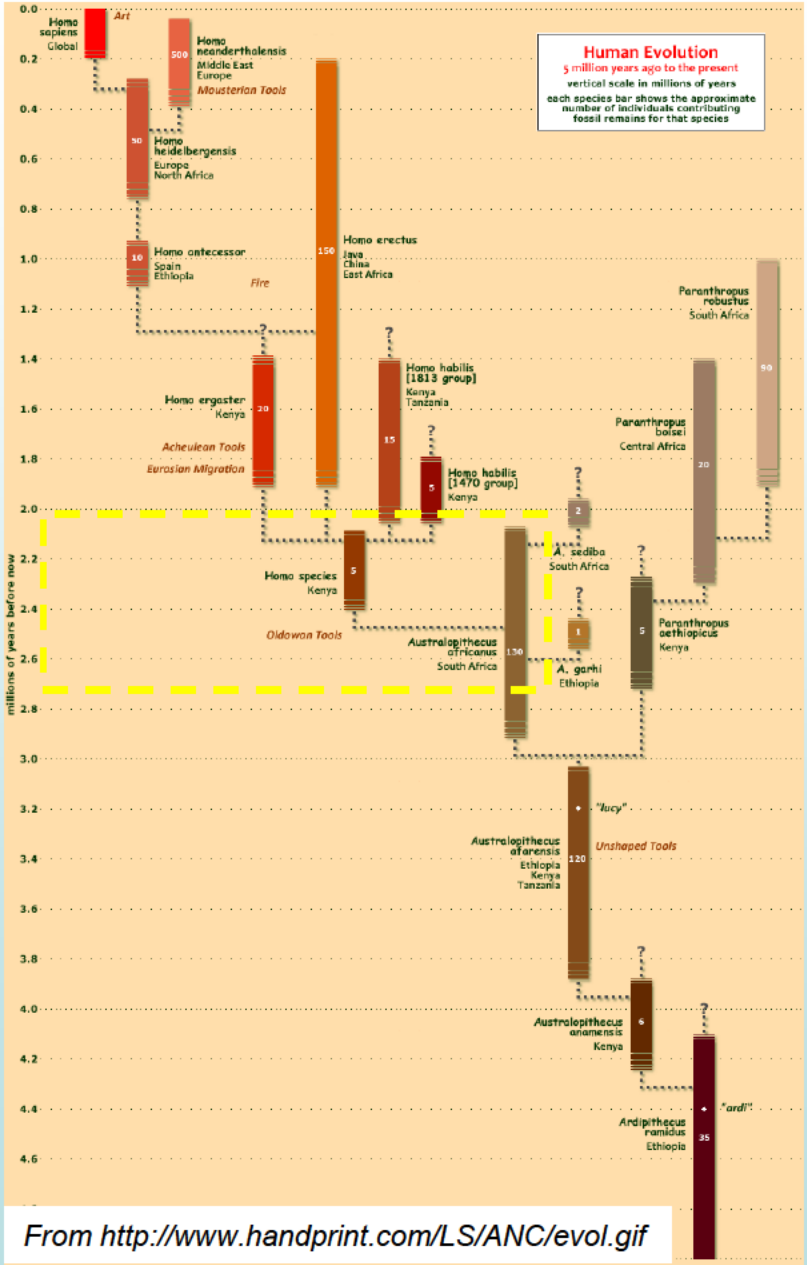


From http://www.paleontologiaumana.it/heidelbergensis.htm

Homo erectus, Nariokotome (or Turkana) boy, KNM-WT 1500, Kenya

From http://upload.wikimedia.org/wikipedia/commons/2/2d/Turkana_Boy.jpg

Australopithecus to *Homo*: the stratigraphic gap

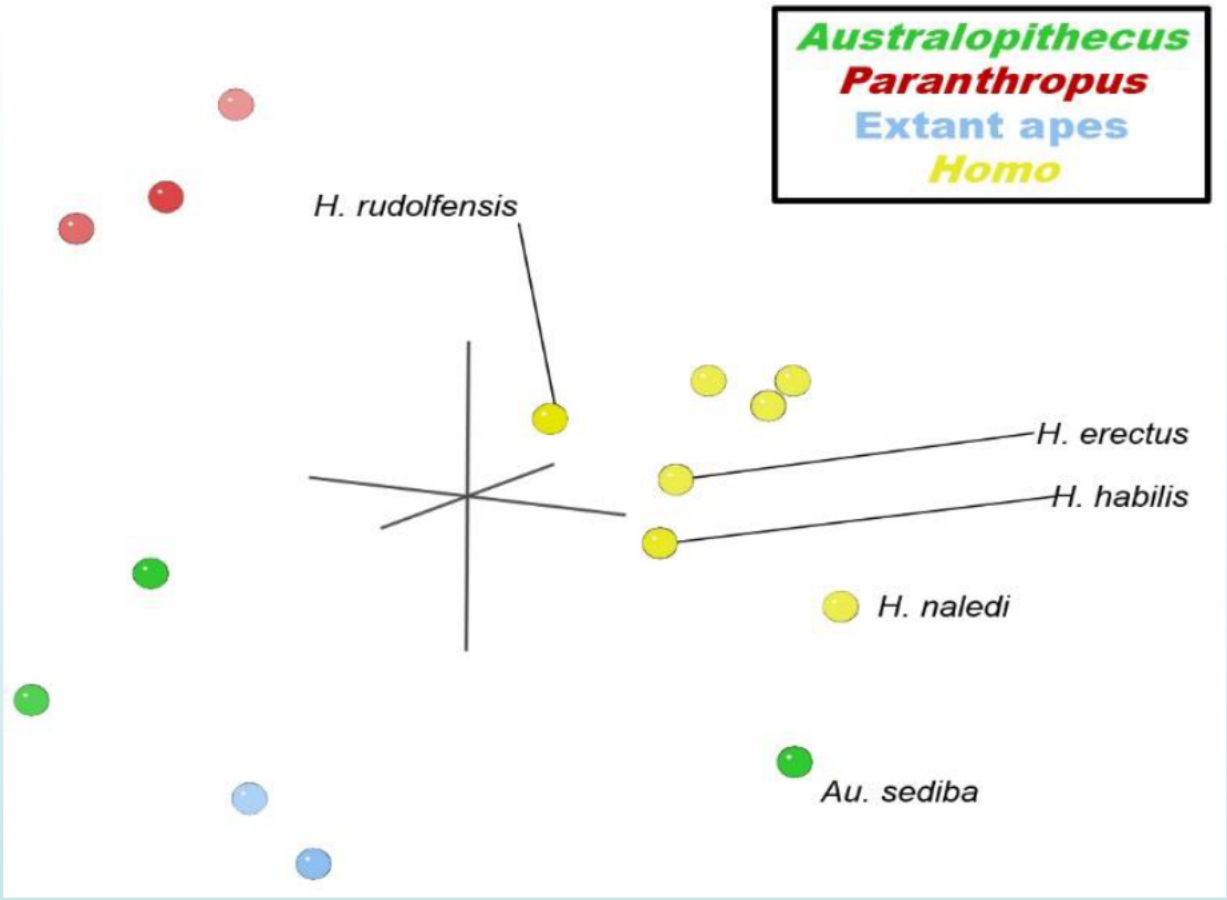


From http://www.handprint.com/LS/ANC/evol.gif

William H. Kimbel, a paleoanthropologist at the Institute of Human Origins at Arizona State University, said that the million-year period "has long been the source of frustrating gaps" in the hominid fossil record. "It's not that sites containing rocks this age are particularly rare, or that the time period in eastern Africa has not been searched by several groups," Dr. Kimbel said. "The problem is that the fossil yield has thus far been low or poorly preserved, compared to the time periods on either side of this interval."

From NYT, Lost in a Million-Year Gap, Solid Clues to Human Origins, Wilford, Sept. 18, 2007

Australopithecus to *Homo*: the morphologic gap



From Wood, 2016

Statistical analysis groups Homo *and clear separation with* Australopithecus *(but* A. sediba *clusters closer to* Homo)

The issue of **mosaic** distribution of characters

Australopithecus sediba

Size: ~130-150 cm

Brain size: 420-450 cc

Results: bipedal and arboreal (curved fingers, modified pelvis, brachial index); close to *A. africanus* but smaller teeth, more expanded cranial vault

Mosaic distribution of characters: some human-like (e.g., pelvis, foot-arch, ankle) but some clearly ape-like (e.g., brachial index, cranial capacity, curved finger bones).

http://www.sciencemag.org/content/340/6129/163.full

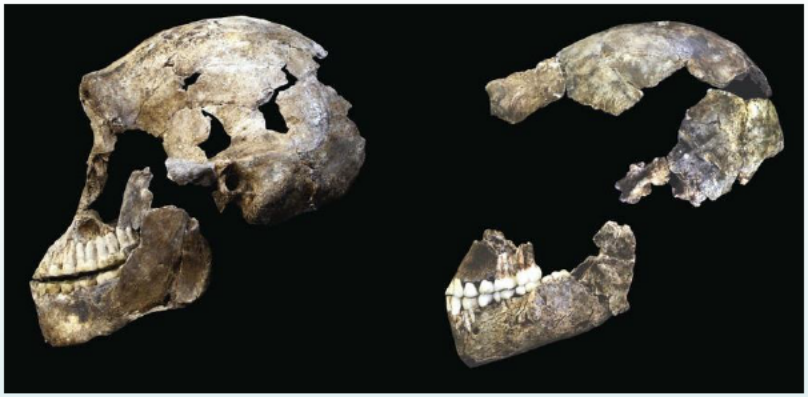
The issue of **mosaic** distribution of characters

Homo naledi

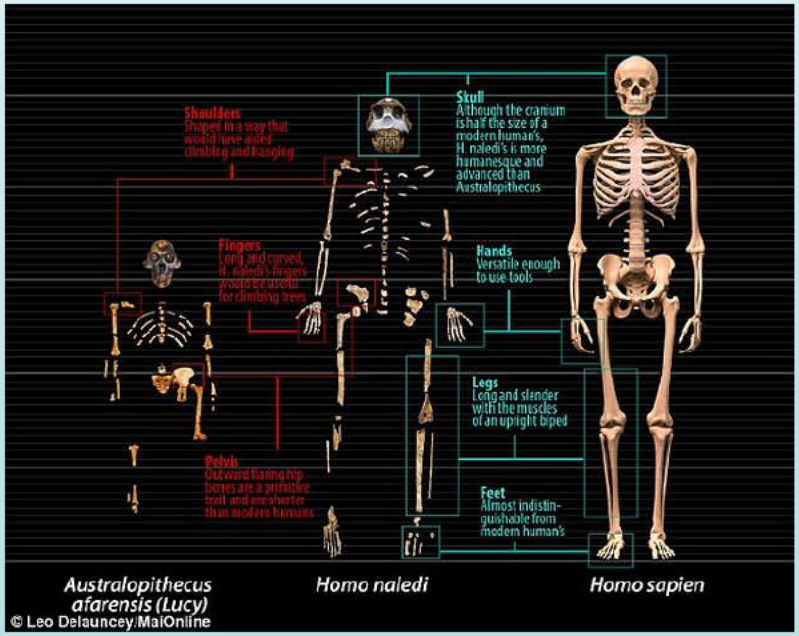
Brain size: ~460-610 cc

Mosaic distribution of characters: some human-like (lower limb, hand, teeth, general shape of the cranium) some ape-like (pelvic area, shoulder region, ribcage)

"Overall, *H. naledi* resembles more primitive species of *Homo* such as *H. erectus, H. habilis, or H. rudolfensis* much more than it resembles archaic or modern humans. *H. naledi* does, however, possess a number of derived features that are otherwise known only from modern humans and Neandertals" *Hawks et al., 2017*



From http://img-3.newatlas.com/homo-naledi-dating-discovery-3.jpg?auto=format%2Ccompress&fit=max&h=670&q=60&w=1000&s=b2fefbb2969bd9c2d16324b508a24814



From https://s-media-cache-ak0.pinimg.com/originals/cb/e3/c5/cbe3c5a0482f331309ee9431dfe4a91c.jpg

Mosaic forms: how did they form?

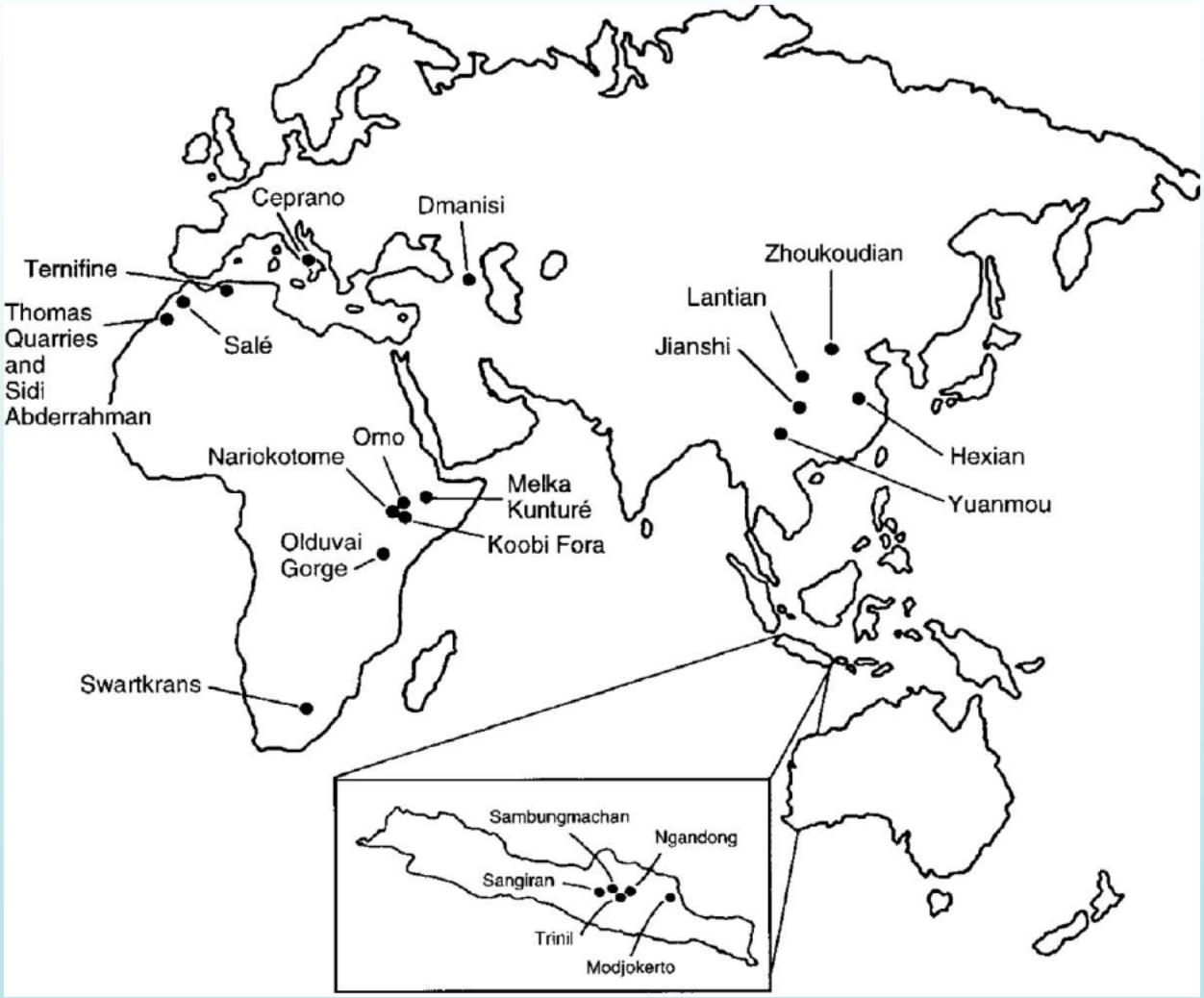
3 hypotheses (Antón et al., 2014)

1) morphological and developmental ***plasticity*** related to environmental conditions. (availability of food + low risk of mortality = extend growth + delayed puberty = larger body size + slower maturation)
2) vicariance (isolation -migration or geographical barriers- leads to diversification)
3) hybridization between different groups

"It is also conceivable that, rather than indicating a recent branching of *H. naledi* from an archaic human lineage, such derived similarities may have resulted from introgressive hybridization between *H. naledi* and other hominin lineages."

Hawks et al., 2017

A tale of migrations



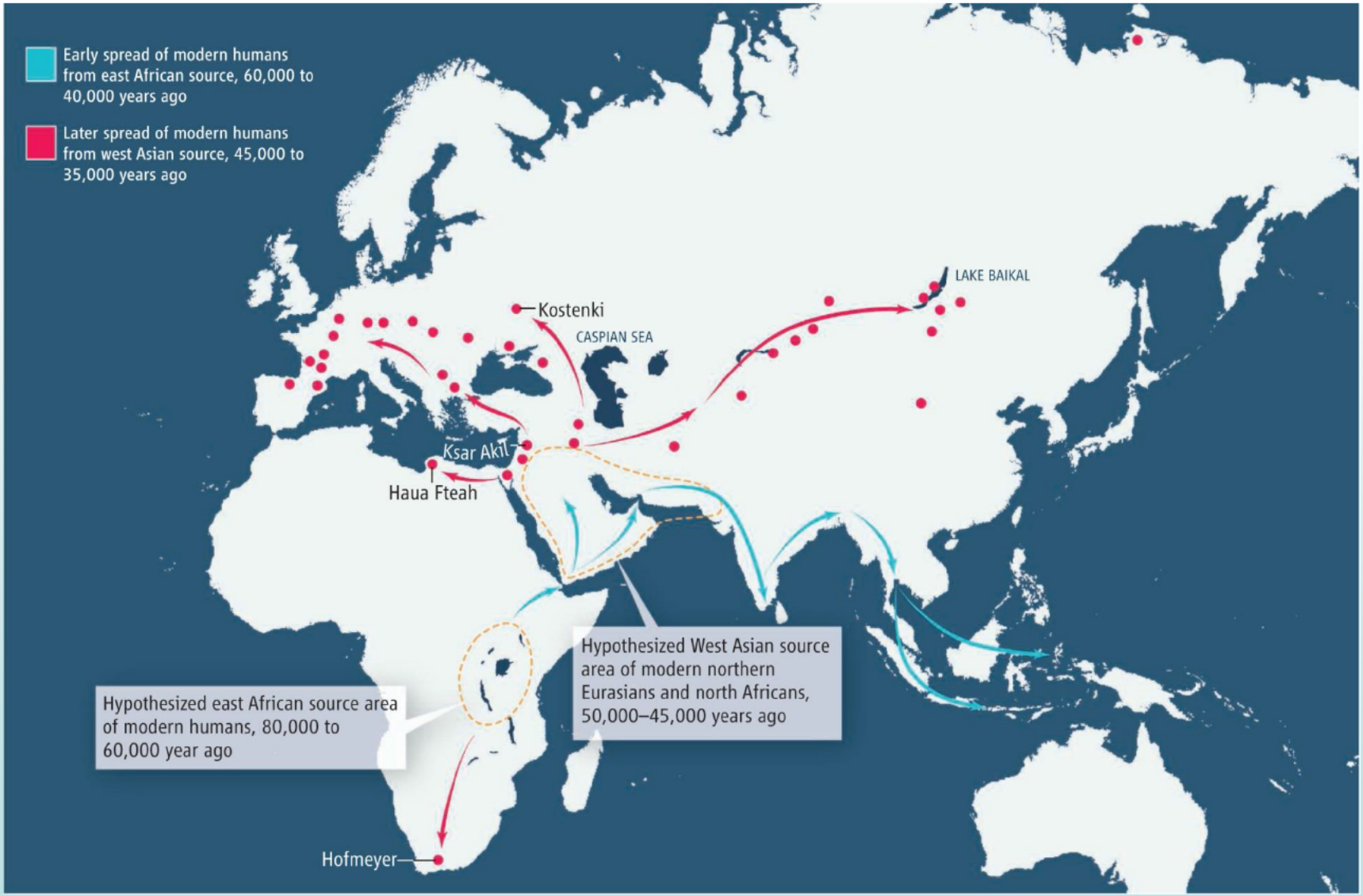
From Rightmire, 1998. Evol. Anthropol. 6, 219

Homo erectus, a sudden radiation?

Geographical distribution:

Africa, Caucasus, China, Java

A tale of migrations



From Goebel, 2007. Science 315, 195

Spread of anatomically modern humans

Discussion

-*Problematic aspects of evolutionary model:*

a) Transition from australopithecines to *Homo*

b) Mosaic distribution of characters

-*Problematic aspects for creationist model:*

a) Stratigraphic order (modern combination only at top)

b) Mosaic distribution of characters

Suggestions of a creationist model

- Australopithecines were not humans but a distinct group of apes

- After the flood, there existed humans with morphological characteristics different than ours (e.g., Neanderthals, *Homo erectus*).
Morphological variability was higher in the past and diminished with time

- Anatomically modern humans seem to disperse from the Middle East and rapidly colonize the rest of the world, replacing (or assimilating) other local types (Noah's ark - tower of Babel dispersals?)

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