Homo floresiensis

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THANKS: L. AIELLO, D. FALK, G. HURLEY

Every once in a while, there comes to light a fossil that shakes the foundation of paleoanthropology to its very core and forces us to reconsider what we thought we knew about human evolution.

—Donald C. Johanson, Lucy's Legacy

This applies to *Homo floresiensis*

Flores legend of Ebu Gogo

- There were legends about the existence of little people on the island of Flores, Indonesia.
- They were called the Ebu Gogo.
- The islanders describe Ebu Gogo as being about one meter tall, hairy and prone to "murmuring" to each other in some form of language.

Discovery

- 2003 *Homo floresiensis*, ("the hobbit,") found in a late Pleistocene context at the cave of Liang Bua by Michael Morwood's group

- 2003: Associated with a core and flake assemblage that extended back to ca 95 ka LB1 originally dated to 38 to 13 ka; Lived there from 74 to 17 **ka** according to original conclusions.

- An arm bone provisionally assigned to *H. floresiensis* is about 74,000 years old
- 2016: new geological assessment places H. floresiensis between 100,000 and 60,000 years old. Measurements of the decay of radioactive elements in an arm bone from the partial skeleton indicate that the find dates to between 86,900 and 71,500 years ago. Until now, researchers suspected these bones were only about 18,000 years old. Later excavations that have dated more rock and sediment around the remains now suggest that hobbits were gone from the cave by 50,000 years ago, according to a study published in *Nature* on 30 March 2016. The older dates resolve the mystery of how hobbits co-existed with humans for tens of thousands of years: they didn't

(Brown et al., 2004; Morwood et al., 2004), (Moore et al.,2009; Roberts et al., 2009); (Brown *et al.*, 2004); T. Sutikna, et al. 2016

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Terrible Unscientific brawls

- Current debate is over the taxonomic status and evolutionary position of the hominin material known as *Homo floresiensis*
- Study of *H. floresiensis* has been marked by unprofessional jealousy, rancor, name-calling, side-taking, and wagon-circling and *ad hominem* attacks.
- Morwood has likened detractors to flat-earthers, for example, while Robert Eckhard, a distinguished member of Teuku Jacob's team in 2006, has averred a "racist" effect to the naming it new species.
- Individuals on each side have accused their counterparts of not being "real scientists."

A Challenge to Standard Model

- Standard model of human origins: *H. erectus* was the first human ancestor to wander out of Africa and colonize distant lands around 1.8 million years ago.

- Prior first Out of Africa: Dmanisi *H. erectus* at 1.78 million years ago, also found with Oldowan tools

- But the evidence from Flores suggests the possibility of an older, more primitive forebear was the original pioneer.

- *H. floresiensis* is latest-surviving human apart from our species *H. sapiens.*

David S. Strait
University at Albany

- "The possibility that a very primitive member of the genus Homo left Africa, perhaps roughly two million years ago, and that a descendant population persisted until only several thousand years ago, is one of the more provocative hypotheses to have emerged in paleoanthropology during the past few years."

Historical Bomb Shells

- Fossil discoveries that were fundamentally inconsistent with prevailing notions about the course of human evolution:

- 1856: Neandertal (H. neandertalensis): a Mongolian Cassock with rickets

- 1891: Java man (*H. erectus*): an ape

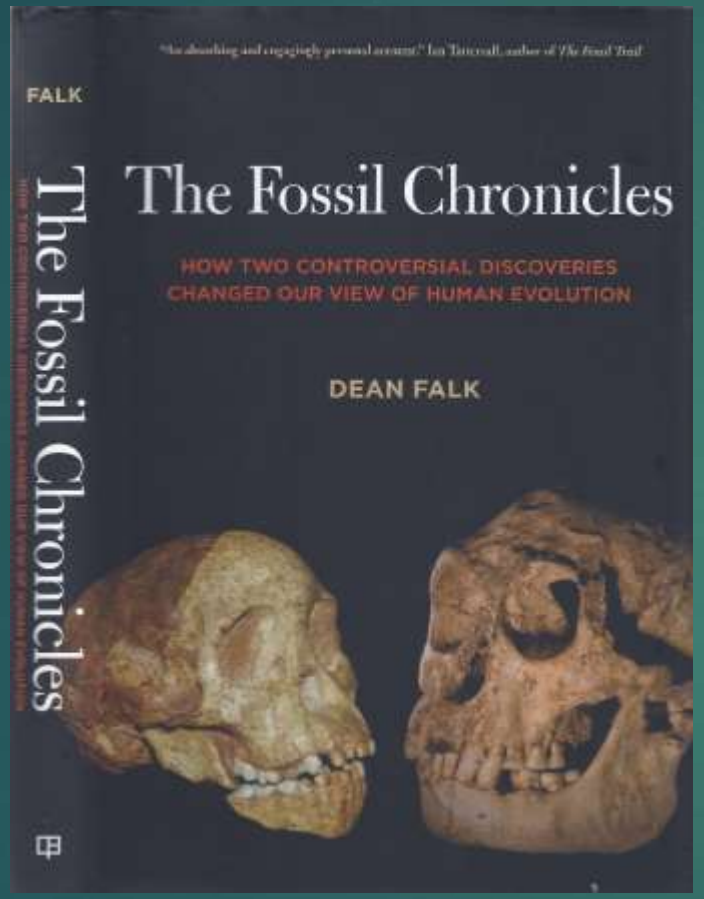
- 1924: Taung child (*A. africanus*): small brain, therefore an ape

- 1974: *Lucy (A. afarensis)*

- *1991-2005: Dmanisi (H. erectus):* brain too small

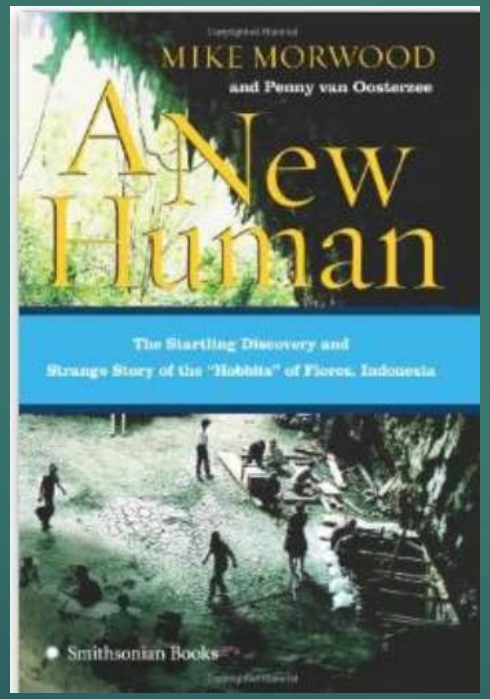
Nature, 2004 & 2009

The Fossil Chronicles – Dean Falk



The Taung fossil and LB1 faced similar opposition from the scientific establishment and "you will burn in hell" from religious fanatics. Taung waited 40 years for final acceptance.

Mike Morwood's Account



Naming

- *Homo floresiensis* was unveiled on 28 October 2004, and was swiftly nicknamed the "Hobbit", after the fictional race popularized in J. R. R. Tolkien's book *The Hobbit*, and a proposed scientific name for the species was *Homo hobbitus*.

- It was initially placed in its own genus, *Sundanthropus floresianus* ("Sunda human from Flores"), but reviewers of the article felt that the cranium, despite its size, belonged in the genus *Homo*.

- The species name, floresianus, also became floresiensis because of the fear that generations of students would refer to it as ‘‘floweryanus’’ (Gee, 2007; Morwood and van Oosterzee, 2007).

- LB1 has been nicknamed the *Little Lady of Flores* or "Flo"

Not fossilized

- The specimens were not fossilized, but were described as originally having "the consistency of wet blotting paper" .
- Once exposed, the bones had to be left to dry before they could be dug up.

Some of the Flores discovery team

Mike Morwood

Wahyu Saptomo

Peter Brown
for analysis

Thomas Sutikna, Rokus Due Awe

The Discovery Team

The Liang Bua Excavation Team Leaders in 2009, from left to right, Dr. Kira Westaway, Jatmiko, Dr. Mike Morwood, Dr. Matt Tocheri, Thomas Sutikna, Wahyu Saptomo, Kompyang, Rokus Due Awe, and Sri Wasisto.

LB-1

- Type specimen
- Nickname: Hobbit
- Site: Liang Bua, Flores, Indonesia
- Date of discovery: 2003
- Discovered by: Wahyu Saptomo, Benjamin Tarus, Thomas Sutikna, Rokus Due Awe, Michael Morwood, and Raden Soejono
- Age: 18,000 years old
- Originally thought to be juvenile *Homo erectus*
- Current species: *Homo floresiensis*

LB1: *Homo floresiensis*

- The type specimen, LB1:
  - 30 yo female
  - 1 m in height
  - cranial capacity of 426 cc
- To date, excavators have recovered the bones of an estimated 9 to 14 individuals from the site (Morwood et al., 2005 & 2009)
- LB1 remains the most complete specimen.

(Brown et al., 2004; Falk et al., 2005, D. Kubo, et al, 2013)

Findings

- Majority of the H. floresiensis remains are found in the levels of the cave dating between 18 and 16 ka
- It was rapidly covered in a standing pool of water.
- There is no evidence of intentional burial.
- Other H. floresiensis material was found in the center of the cave in association with charred bone and clusters of reddened fire-cracked rocks suggesting the use of fire.
- Parts of 47 neonatal and juvenile Stegodons (cooperative hunting?) and komodo dragons
- Stegodon remains show cut marks

(Morwood et al., 2005).

First Views

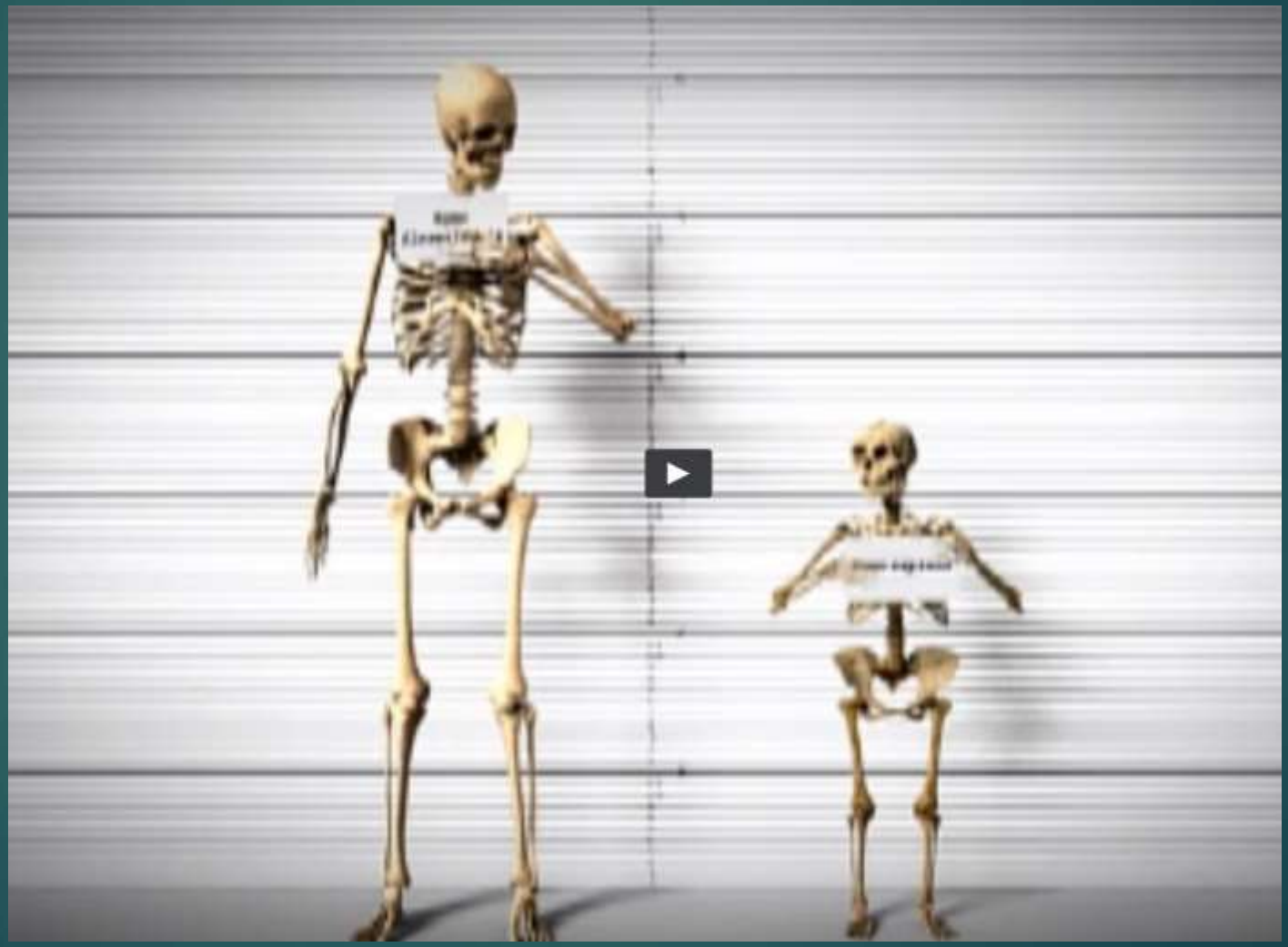
Thomas Sutikna (blue hat) and Benyamin Tarus (white hat) at Liang Bua work to uncover the partial skeleton of Homo floresiensis in 2003.

First look

Local worker Benyamin Taurus unearthed first skull part; Rhokus Due Awe identified LB1 as hominin

Original layout

Short stature



Damaged goods

CREDIT: ANNAMARIA TALAS/REAL PICTURES

- Teuku Jacob was considered "grandfather of Indonesian paleontology"
- Teuku Jacob took possession over the bones for 3 months in late 2004, and returned the remains with portions severely damaged and missing two leg bones to the worldwide consternation of his peers. The pelvis, cheekbone and mandible were broken.

- In the LA Times piece, one of the co-authors of the original *Homo floresiensis* report accused Jacob of trying to make the skull look more like a member of our own species (the other hominid species that lived in Indonesia, *Homo erectus*, had a weaker jaw). Morwood was enraged.
- In 2005 Indonesian officials forbade access to the cave, reopening it only after Jacob died in 2007.

Morwood and Oosterzee (2007), Henneberg & Schofield (2008), & in Nature (Dalton, 2005), Science (Balter, 2004a,b; Culotta, 2005a) & (Powledge, 2005).

Dating

- First found an arm and then a premolar tooth at a depth of 20 feet
- Stratigraphic context and associations have been described only briefly
- Radiocarbon, U-series, ESR, luminescence dates suggest duration from before 38 Ka to 12 Ka.
- LB1 dates from ~71 Ka.
- Overlying deposits contain *H. sapiens* deposits

Human Career by Richard Klein

Small brain, but stone tools, fire use

- Findings reverse a trend toward ever larger brain size over the course of human evolution.
- Evidence of stone tools for hunting and butchering animals
- There were remainders of fires for cooking
- Rather advanced behaviors for a creature with a brain the size of an australopithecine's.

Not an anomaly

- Originally LB1 was thought to be an solitary anomaly.
- But seven more inhabitants (LB3–LB9) that were recovered from sediments dating between 95,000 or 74,000 to around 12,000 years ago
- All were diminutive. LB6 was also estimated to be about 3,000 years younger than LB1.
- Currently: parts of 14 individuals
- This was a population of small-bodied individuals
- LB1 is not an anomaly.

(Morwood 2005).

Findings

- Section 7: LB1, 32 artifacts
- Section 4 (same level): 5500 artifacts per cubic meter; radial cores & biface volcanic tools, bone tools of pygmy elephants, points, perforators, blades, microblades (for hafting?)

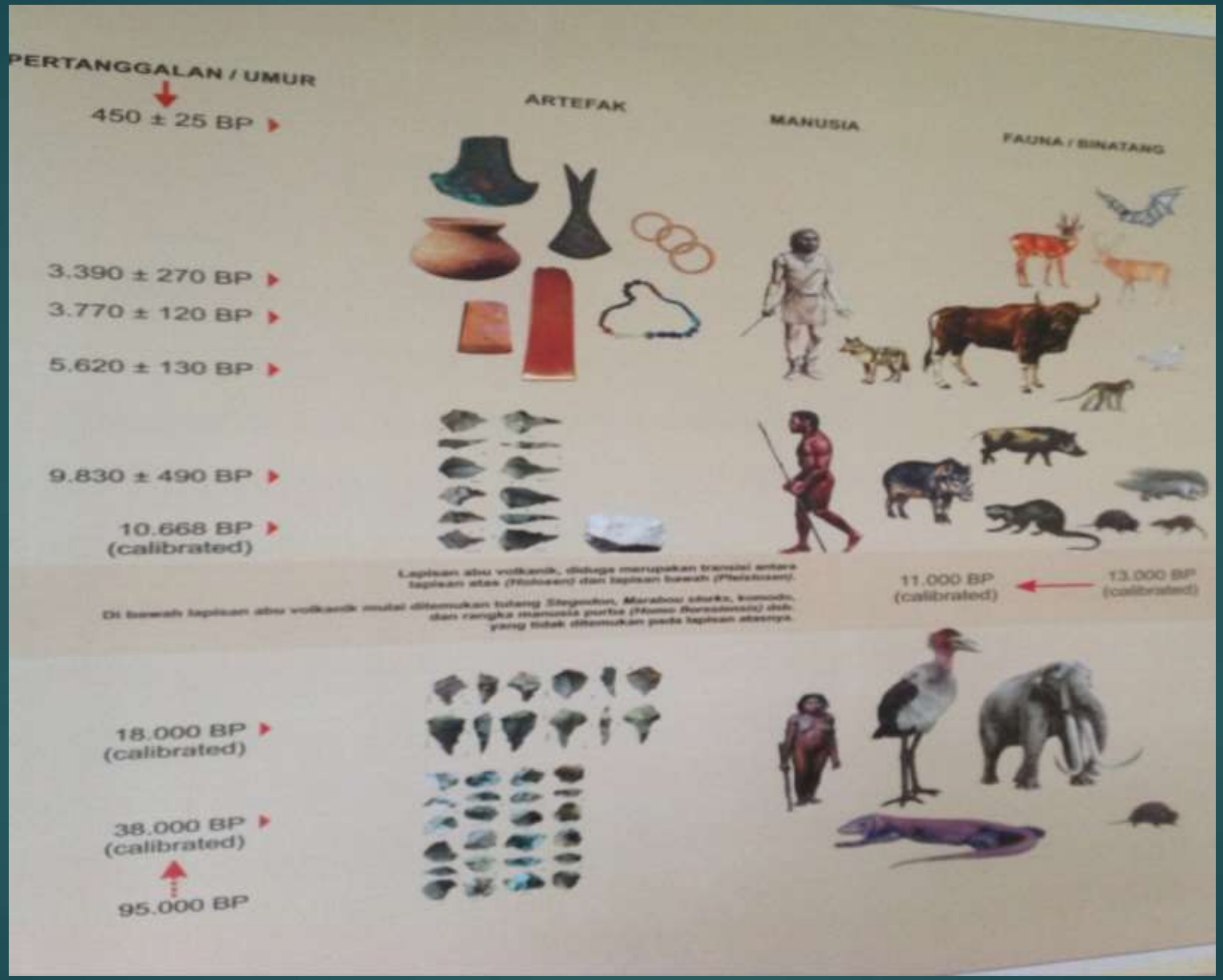
Dating of surface levels

- The *H. floresiensis* was found in a layer with *Stegodon* remains
- This layer is below a layer of thick deposits of volcanic tuff.
- All traces of Flo & elephants disappear above the 12,000 year level of white tuffaceous silts derived from volcanic eruptions that coincide with the probable extinction of *Homo floresiensis*.

(van den Bergh 2008).

Homo Sapiens in Flores

- *Homo erectus* was in Trinil, Java between 700 Ka to 1 Ma
- *Homo sapiens* reached the Indonesian region by around 45,000 years ago
- Evidence for *H. sapiens* on Flores: 12,000 Ka
- *H. sapiens* evidence of: tools made from chert, stone rectangular adzes, greater fire use, body ornamentation and pigments, deliberate burials, new animals


PERTANGGALAN / UMUR
450 ± 25 BP
3.390 ± 270 BP
3.770 ± 120 BP
5.620 ± 130 BP
9.830 ± 490 BP
10.668 BP (calibrated)
18.000 BP (calibrated)
38.000 BP (calibrated)
95.000 BP
ARTEFAK
MANUSIA
FAUNA / BINATANG
11.000 BP (calibrated)
13.000 BP (calibrated)

12 Ka level

Comparison of size:
Pygmy,
European,
& *H. floresiensis*

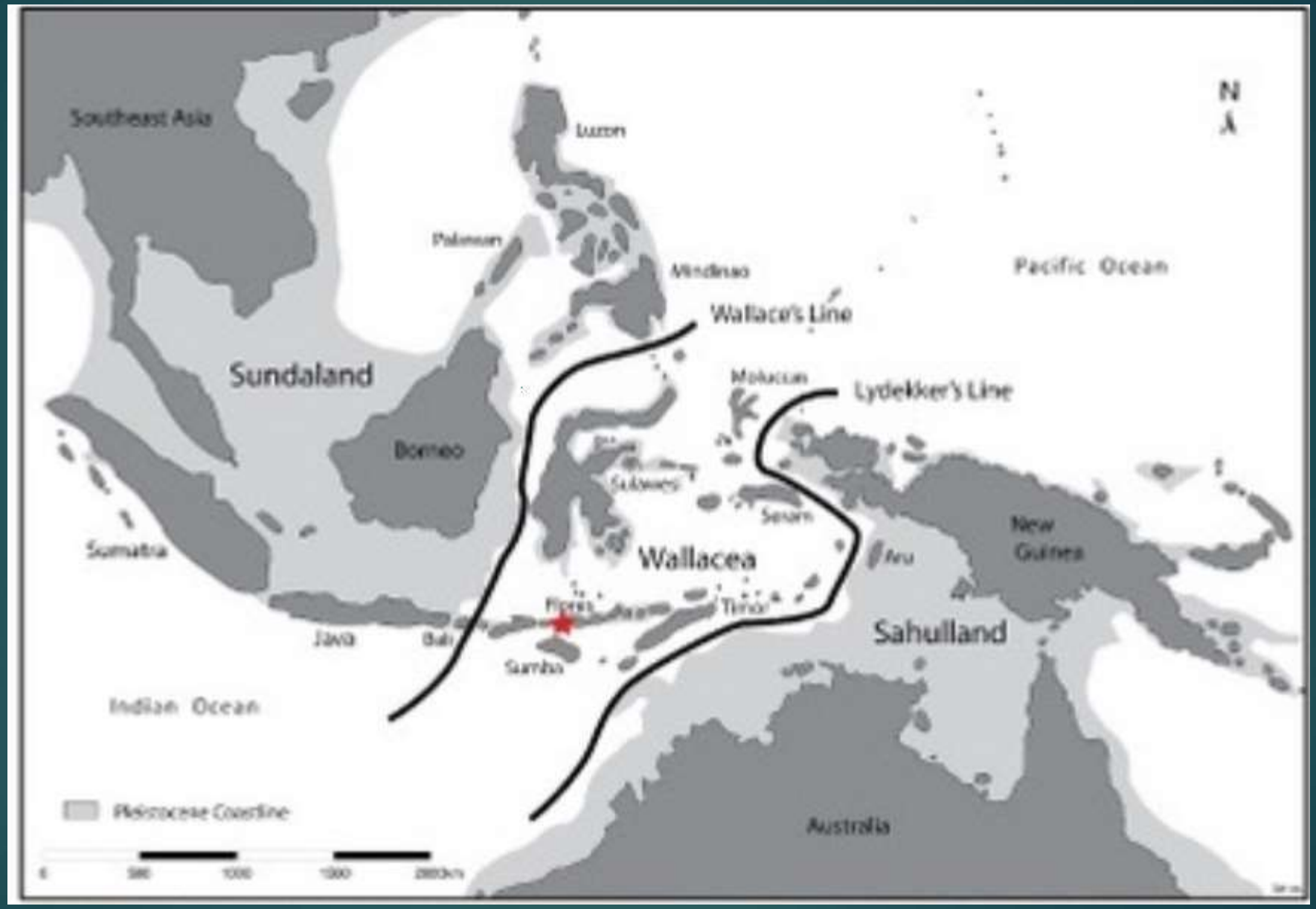
LB1: Height and Weight

- Height:
- 1.06 m (3 ft. 6 in) - estimate from a female skeleton;
  - A. afarensis: average 3 ft. 5 in (1.05 m)
  - roughly the size of a 3–4 year old modern human child.

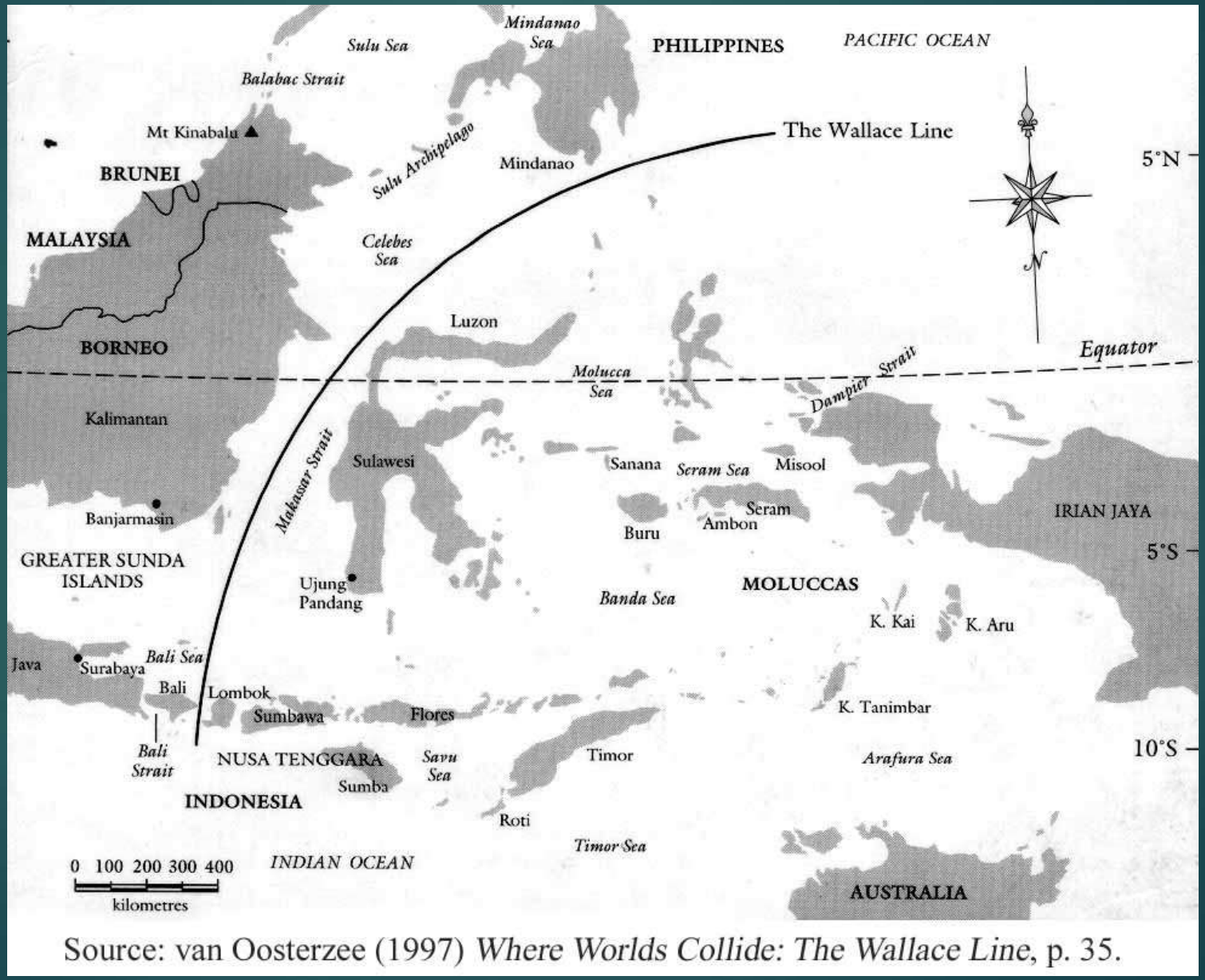
- Weight:
- 30-32.5 kg (66-72 lbs.) - estimate from a female skeleton;
  - A. afarensis: 29 kg (64 lb.

- Cranial capacity: 385–417 cc; most recent: 426 cc (Kubo, et al., 2013)

(Brown et al., 2004; Falk et al., 2005a; Holloway et al., 2006)


Southeast Asia
Luzon
Palawan
Mindanao
Pacific Ocean
Wallace's Line
Sundaland
Molucan
Lydekker's Line
Borneo
Sulawesi
Sumatra
Wallacea
Aru
New Guinea
Flores
Timor
Java
Bali
Sahulland
Sumba
Indian Ocean
Pleistocene Coastline
Australia

Flores is East of Wallace Line



Source: van Oosterzee (1997) *Where Worlds Collide: The Wallace Line*, p. 35.

Island of Flores, Indonesia

Flores belongs to a highly tectonically active region where three major plates meet and collide.

Flores was always isolated, even during glacial periods

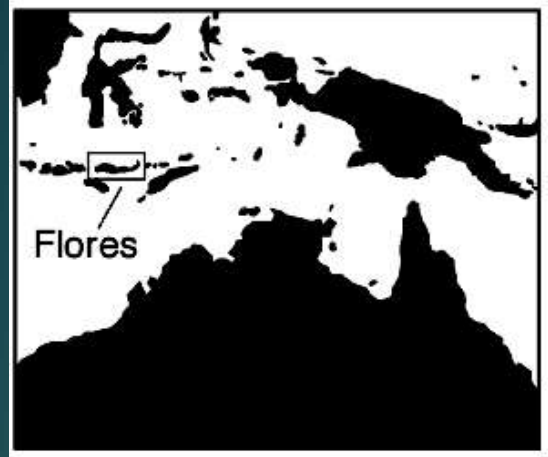
FIGURE 12.22 Fossils of *Homo floresiensis* were discovered on the island of Flores in eastern Indonesia. The shaded areas give the approximate coastlines during glacial periods, showing that Flores was isolated from both Asia and Australia even when sea levels were at their lowest levels. As a result, Flores was home to an odd mix of creatures, including a dwarf elephant, huge monitor lizards, and one-meter-tall hominins.

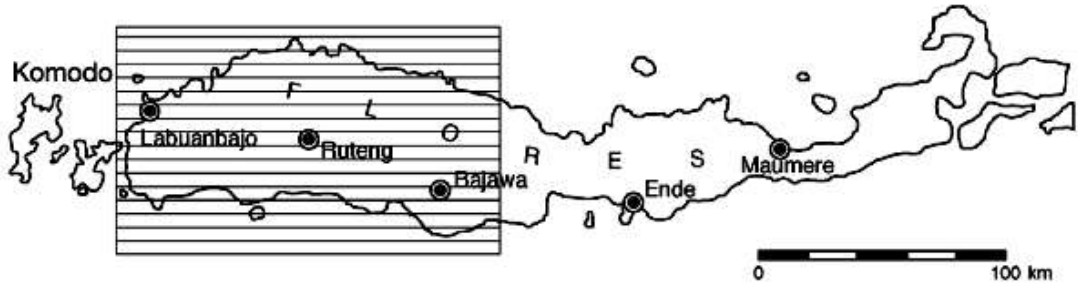
Because of a deep neighboring strait, Flores remained isolated during the Wisconsin glaciation (the most recent glacial period), despite the low sea levels that united Sundaland; leaving a 12 mile (19 km) wide strait to be crossed with Komodo visible from the mainland.

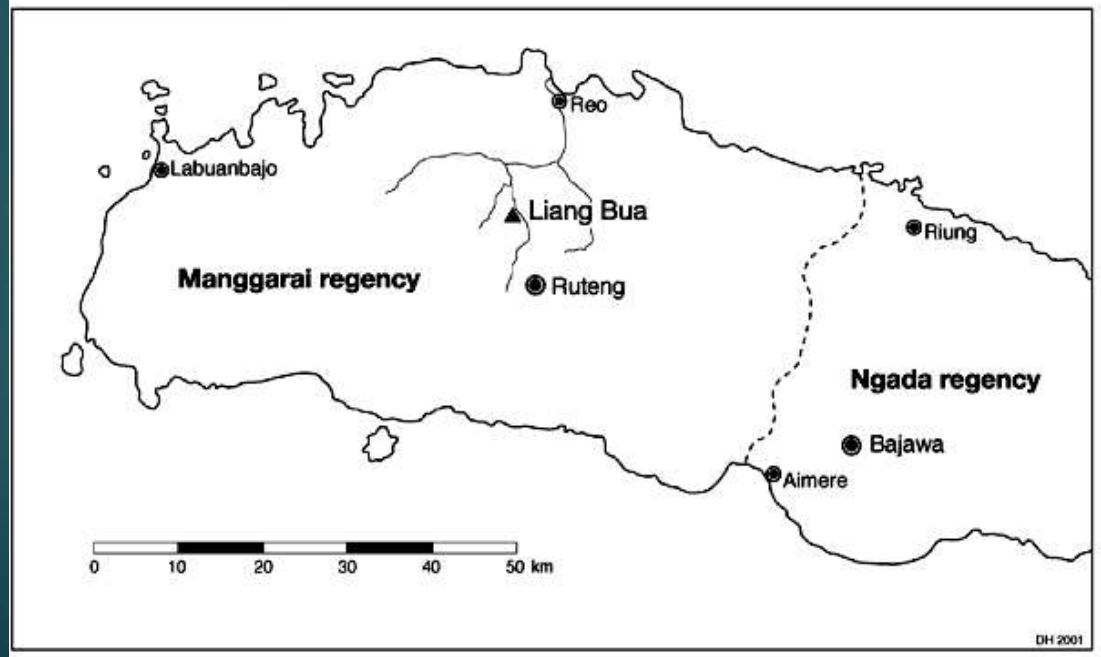
Location of Ling Bua

Home to 15 volcanoes: Ilikedeka | Leroboleng | Ilimuda | **Lewotobi** | Ranakah | Egon | Poco Leok | Wai Sano | Ndete Napu | Inielika | Kelimutu | Sukaria | **Ebulobo** | Inierie | Iya

Indonesian Island of Flores







Liang Bua

LB1 found here

Liang Bua excavation Lower Right shaft where LB1 found

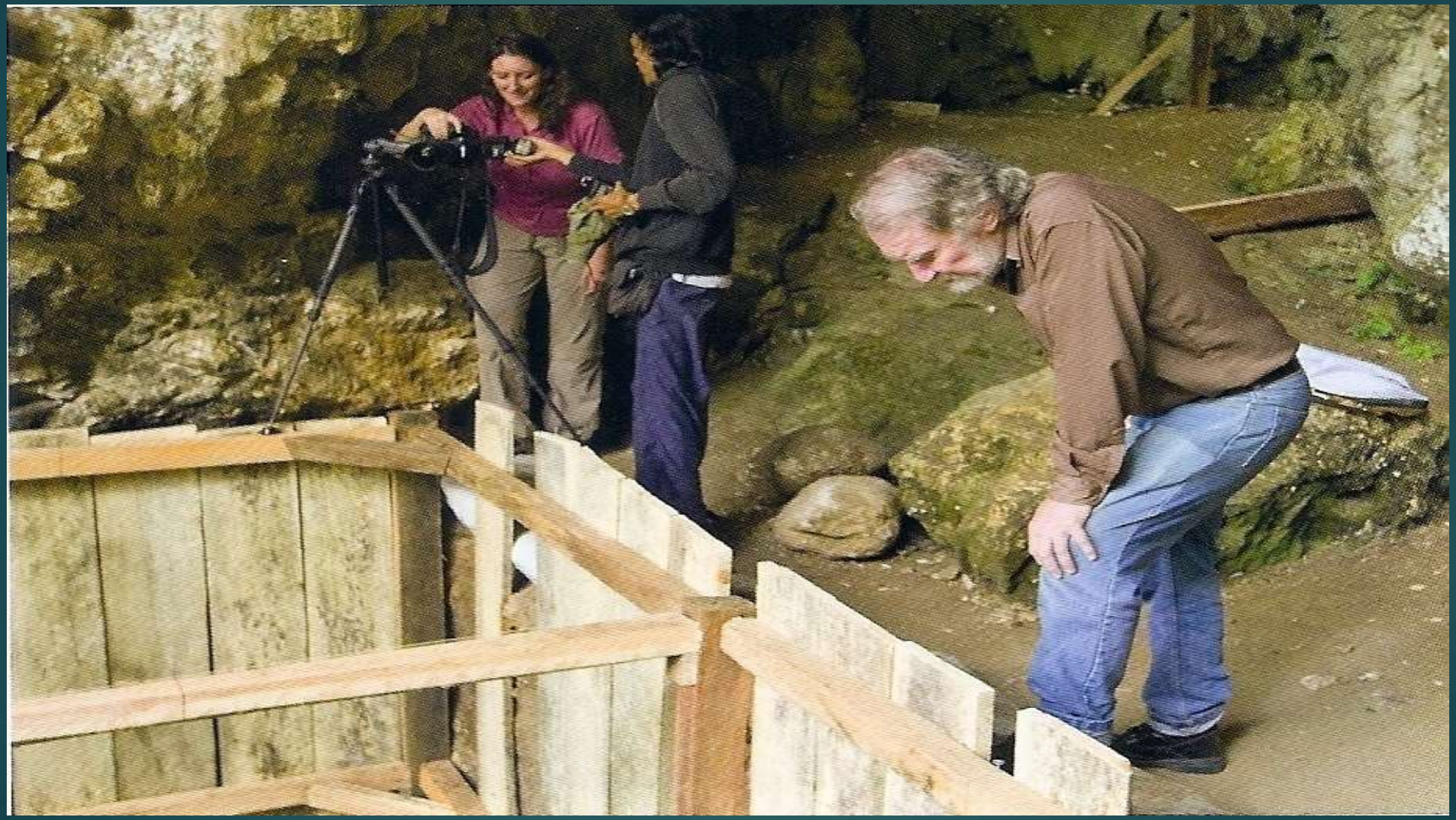
Mike Morwood, 2003 Liang Bua- Australian-Indonesian team

- First layers - Immense layers of silt- torrential rains flood the cave leaving wet silt
- Excavations with wood scaffolding

- Next layers - extinct animals-stone tools like Mata Menge
- Next layer -A tiny hominin radius
- Next layer -Fired charred stones

- Bottom layer -Remains of hominin female skeleton, who had fallen into a deep pool in the cave; preserved from decay in the oxygen- free waters at the pool's bottom. She was a mature adult –her wisdom teeth had all erupted.

M. Morwood looks into shaft - LBI under 20 ft. of silt. Lip along cave entrance allowed silt to build up, water flowed into the cave- sealing remains of humans & animals.



Dig -2nd shaft at Liang Bua

-search for more bones, artifacts

Aerial View of Liang Bua: Find the Cave entrance!

How did they get to Flores?

- Robin Dennell (2013) :
- Mammalian, avian, and reptilian fauna on Flores arrived from a number of sources including Java, Sulawesi and Sahul.
- Able to float or swim (e.g. stegodons, giant tortoises and the Komodo dragon),
- Rodents and hominins probably accidentally rafted from Sulawesi, following the prevailing currents.
- Precise route by which hominins arrived on Flores cannot at present be determined, although a route from South Asia through Indochina, Sulawesi and hence Flores is tentatively supported on the basis of zoogeography.

The origins and persistence of *Homo floresiensis* on Flores: biogeographical and ecological perspectives, Robin W. Dennell, et al., 2013

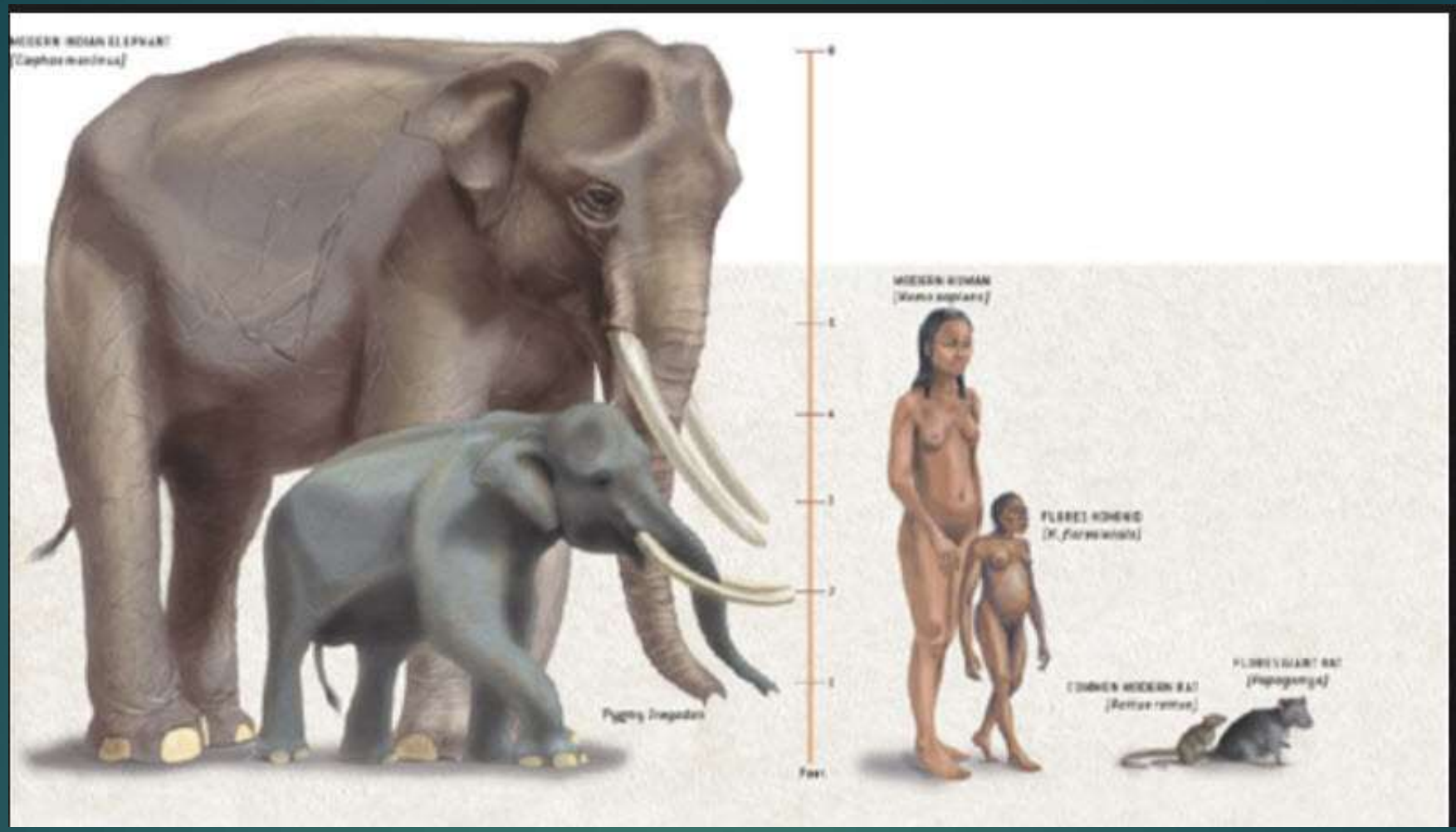
Fauna of Flores

Island Animals in the time of *Homo Floresiensis*

- Insular environment + abundant prey + lack of mammalian carnivores.
- Top carnivore: 70 kg (154 lb.) *Varanus komodoensis* (komodo dragon).
- Top herbivore: 300 kg (661 lb.) *Stegodon*, a dwarf elephant.
- A giant marabou stork, ***Leptoptilos robustus* sp. nov.** This giant bird, estimated at 1.80 m in length, 16 kg (35 lb.) in weight; with reduced flight capability.
- Also Flores giant rat, *Papagomys armandvillei*, 45 cm (17 in.)

An alien island

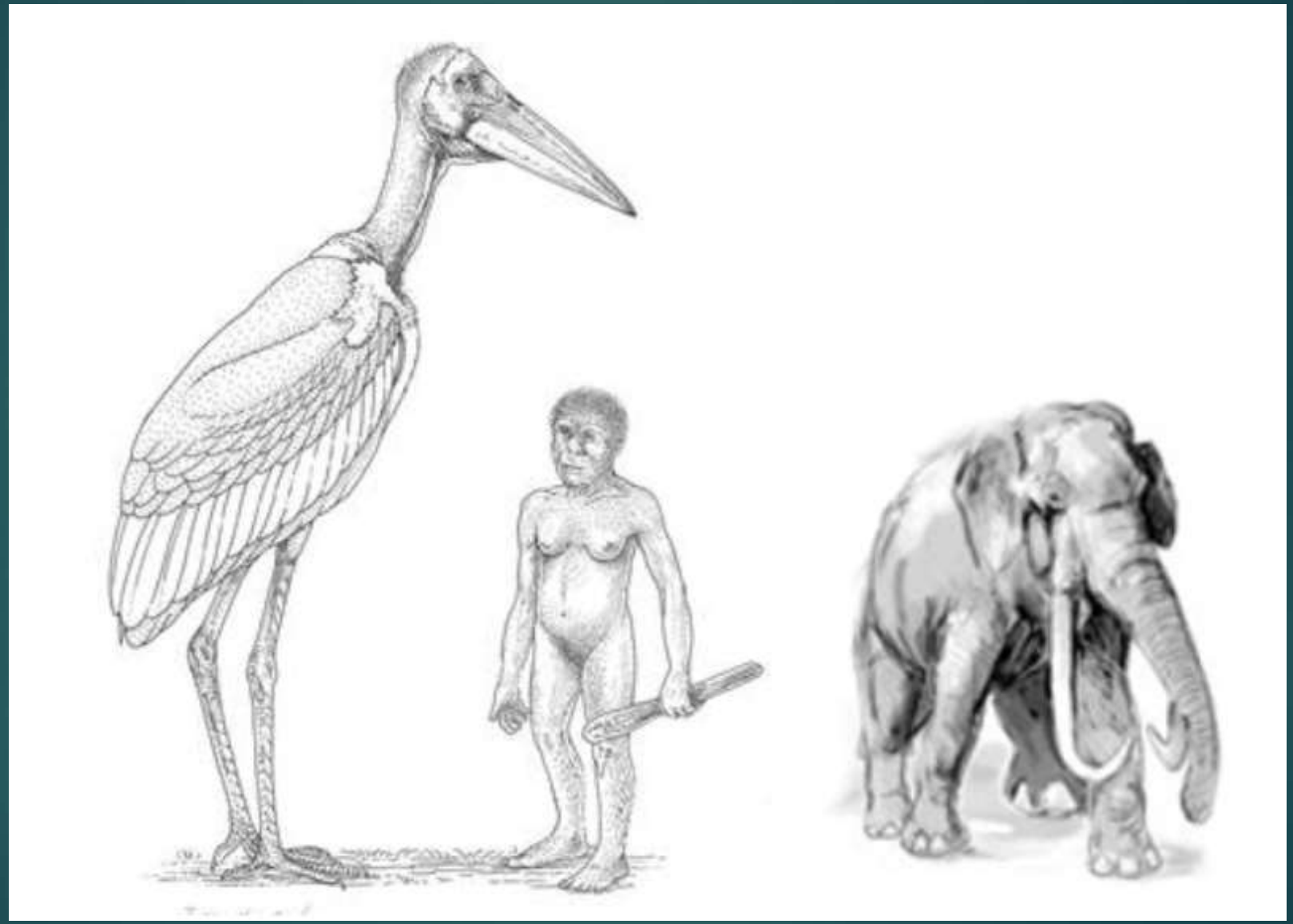
Homo floresiensis & a large rat



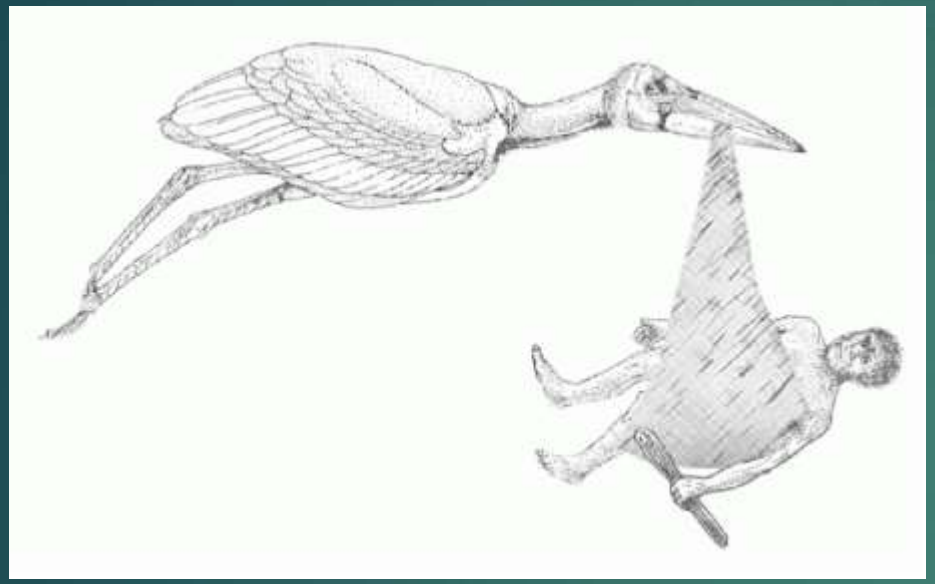
Island dwarfism on Flores, Indonesia

Stegodon, a dwarf elephant

H. floresiensis & giant 2 meter stork



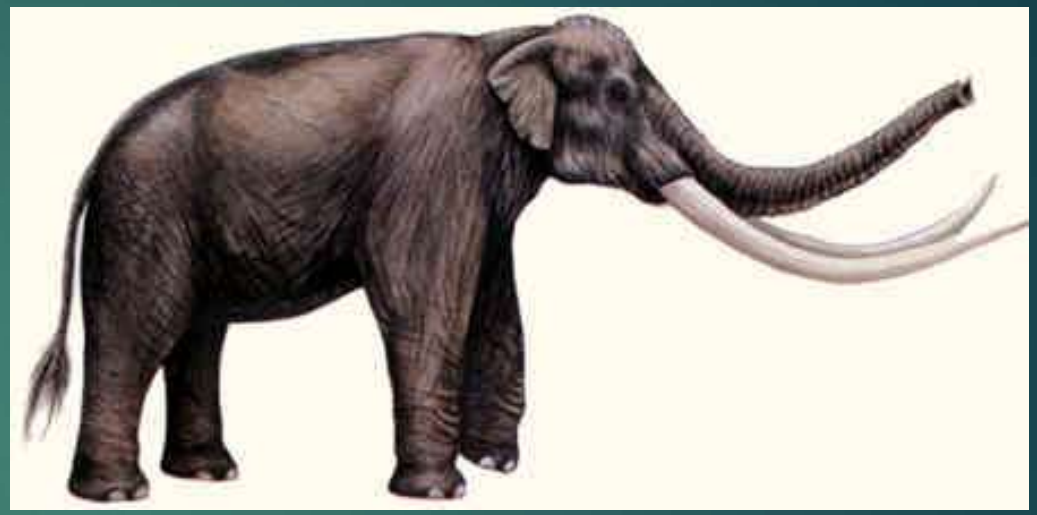
2 other versions



Komodo Dragon bones found at site

Komodo dragons
(10 feet, 150 lbs.) on Flores

Diet



- Fish
- Frogs
- Snakes
- Tortoises
- Birds
- Rodents
- Stegadon-a dwarfed elephant
- Komodo dragons

- H. floresiensis was a successful forager, scavenger and hunter

LB1: She lead a tough live

- Robust limb bones, phalanges with osteophytes (bone spurs) and signs of healed trauma on the cranial vault and tibia point to an active life rather than a disabled condition in this individual

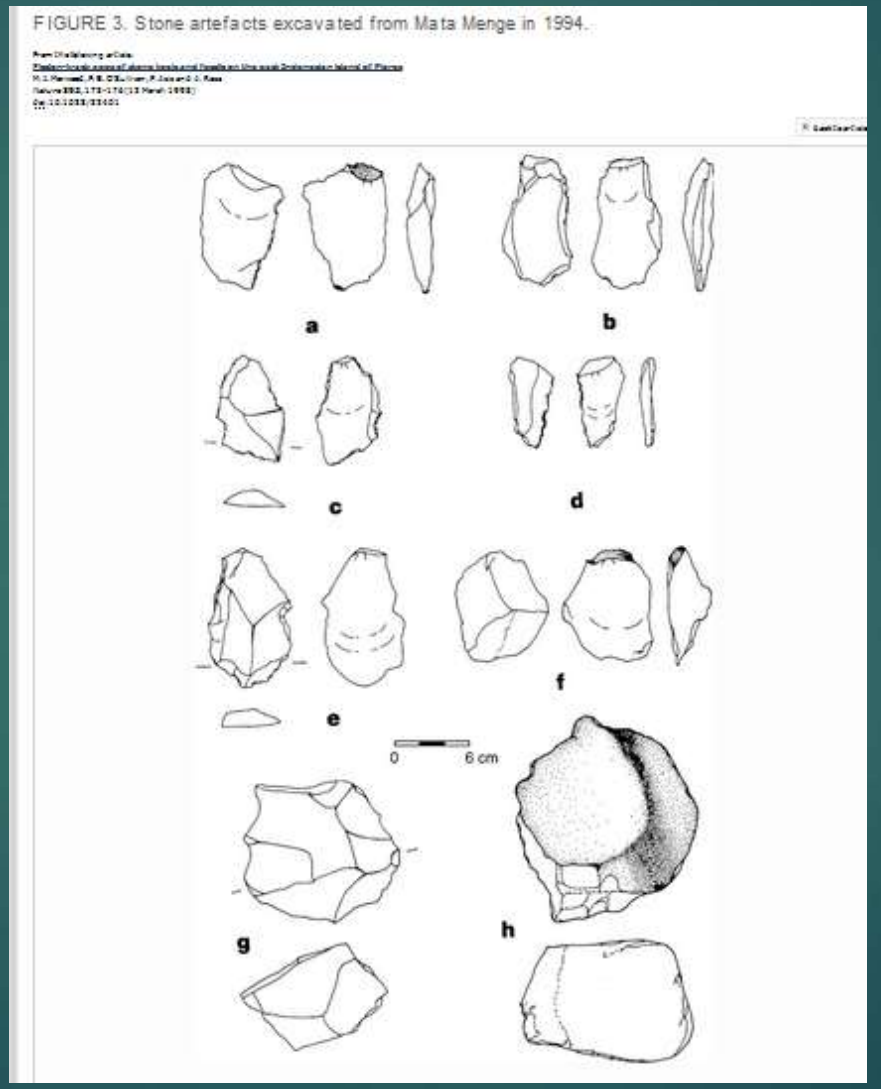
Volcanic eruptions, stone tools & stegodons

- Around 900 Ka, massive volcanic eruption eliminated much of animal life on Flores, including original *Stegodon*.
- There are stone tools at Liang Bua dating to 190 Ka that were washed into the cave
- By 95,000Ka, dwarf *Stegodons* had become 30% smaller than 700 Ka ancestors.
- Another volcanic eruption occurred circa 17,000 Ka

1965 Fr. Verhoeven Dig at top level of Liang Bua

In 1957, Father Theodor Verhoeven was the first to report and publish that stone tools were found in association with Stegodon remains in central Flores at several sites within the Soa Basin. He even argued that *Homo erectus* from Java was likely behind making the stone tools found on Flores and may have reached the island around 750,000 years ago. At the time, paleoanthropologists took little notice of Verhoeven's claims or if they did, they discounted them outright. Professor Raden Soejono, the leading archeologist in Indonesia, heard about Liang Bua from Verhoeven and conducted six different excavations there from the late 1970s until 1989, but only dug 1st 3 meters. Not deep enough!

Stone tools from Mata Menge, 1994



Current Excavation at Mata Menge, Flores, 2010-2015: 840K

Archaeological excavations at the 880,000-year-old site of Mata Menge, Flores, Indonesia

The trenches uncovered a surface area of 380m^2 and yielded an extraordinary collection of 3,000 fossils and 1,500 stone artefacts, three times the amount of finds than the previous six field seasons at Mata Menge combined. Among this rich haul were a 2.5m long Stegodon tusk, the largest known from Flores, rare skull pieces from Komodo dragons, even rarer bird and amphibian remains, and abundant evidence for crocodiles and giant rats.

Stone Tool evidence that Hominins on Flores by 840 Ka

- Excavations at Mata Menge and Boa Lesa in the Soa Basin of Flores, Indonesia, recovered stone artefacts in association with fossilized remains of the large-bodied *Stegodon florensis florensis*

- Hominins had colonized the island by 0.88 ± 0.07 million years (Myr) ago·

- Wolo Sege, an archaeological site in the Soa Basin that has *in situ* stone artefacts and that lies stratigraphically below Mata Menge and immediately above the basement breccias of the basin.

Adam Brumm, et al., Nature, 2010

First mass animal extinction by hominid? No.

- An ignimbrite overlying the artefact layers at Wolo Sege was erupted 1.02 ± 0.02 Myr ago, providing a new minimum age for earliest hominins on Flores.
- This predates the disappearance from the Soa Basin of 'pygmy' *Stegodon sondaari* and *Geochelone* spp. (giant tortoise), as evident at the nearby site of Tangi Talo, which has been dated to 0.90 ± 0.07 Myr ago.
- It now seems that this possible extinction event and the associated animal turnover were the result of natural processes rather than the arrival of hominins·

Arrival of hominids on Flores

- Evidence of volcanic eruption and a major faunal turnover around 900 Ka
- Associated with the first evidence for stone artifacts and the first appearance of Stegodon florensis, which is closely associated with another stegodon species known from Sulawesi.
- Suggest that first hominins may have arrived on Flores as the result of a tsunami-like occurrence with Sulawesi as the probable source.
- H. floresiensis might be a direct descendent of the much earlier Soa Basin hominins.

van den Bergh et al. (2009):

Cranium

LB1 skull is *Homo*

- The skull resembles those belonging to extinct species of our own genus ***Homo*** (Brown *et al.*, 2004; Baab and McNulty, 2009).

Cranium

- Thicker superior cranial vault than Australopithecus (but similar to *H. erectus* and *H. sapiens*)
- Endocranial volume smaller than or equal to *A. afarensis*
- Smaller facial height, facial prognathism , and canine teeth than in either *Australopithicus or Paranthropus*
- Flexed cranial base
- Large canine juga form maxillary pillars
- Moderate supraorbital torus (not continuous: with supraorbital sulcus)

Brown et al., 2004; Morwood, et al., 2004

Cranium

- No evidence of parietal keeling, but some sagittal keeling on frontal bone
- Cornoid process of mandible higher than condyle
- Mandibular symphysis lacks a chin
- Skull long
- Low vaulted
- Widest near the base

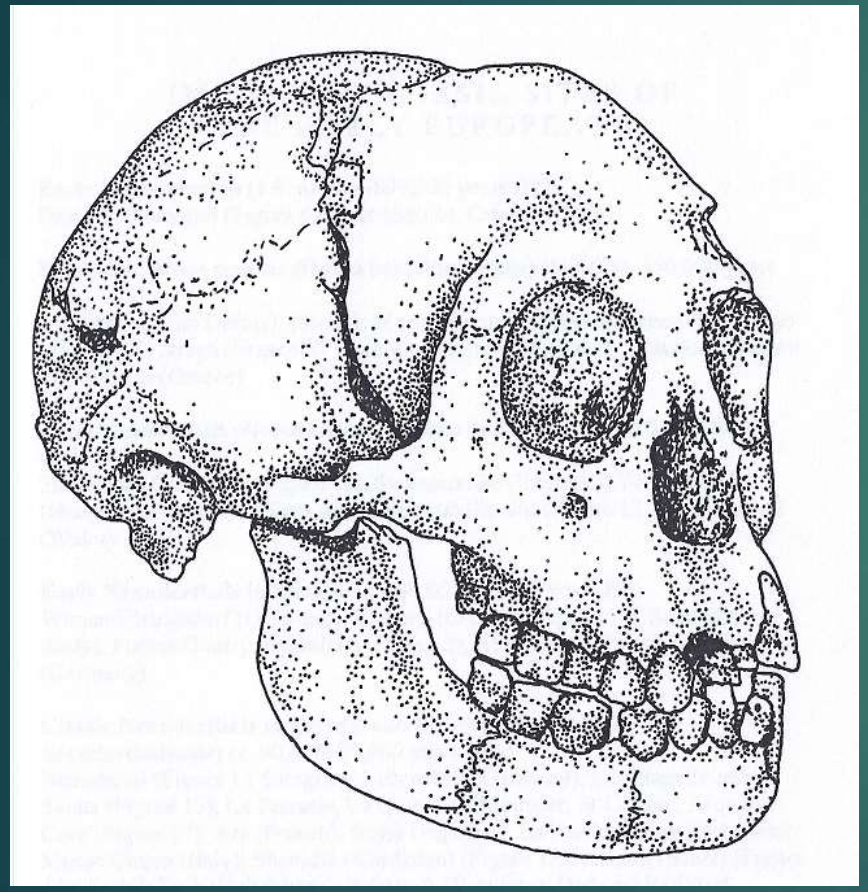
Dentition

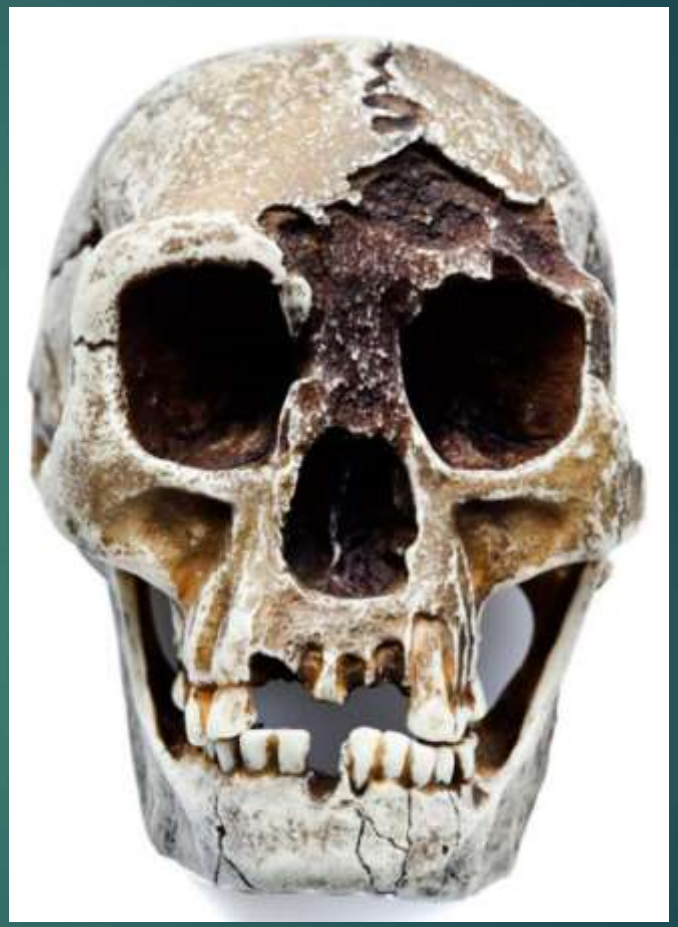
- Parabolic tooth row
- Short canines
- I2 smaller than I1; maxillary diastema possible
- P3 with relatively large occlusal surface
- Grinding teeth in LB1 are large in relation to both *H. sapiens* and *H. erectus* and is equivalent to *H. habilis;*
- The size and morphology of the teeth and mandible share more resemblances to Australopithecus and the earliest Homo species than to *Homo erectus* (Brown and Maeda, 2009).

Brown et al., 2004; Morwood, et al., 2004

The only complete skull, LB1

Skull

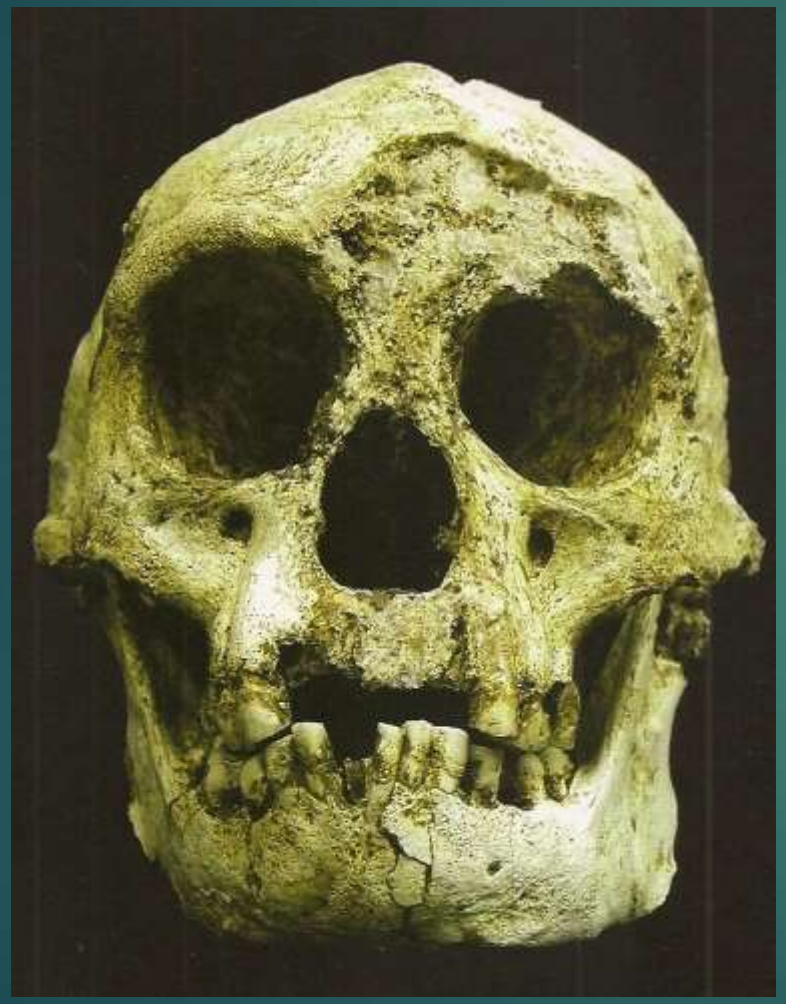




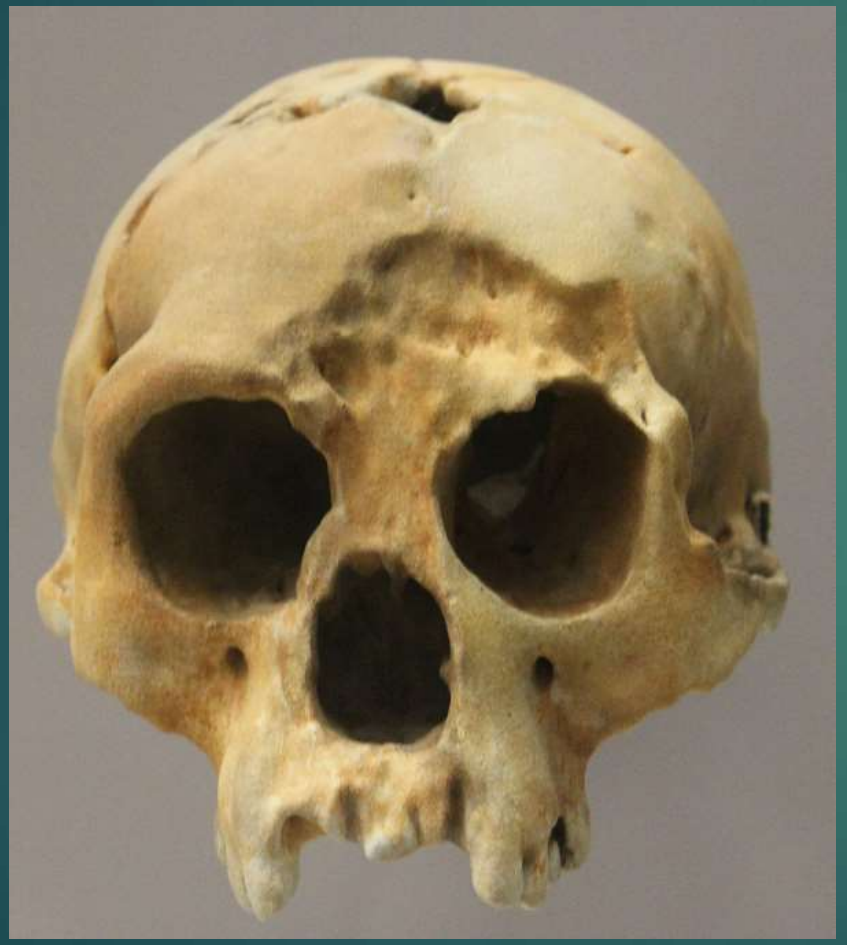
Homo floresiensis vs. *sapiens* skulls:
426 cc vs. 1350 cc

Lateral views

Frontal



Views



Frontal Lateral

Resin Cast

Resin cast of the skull and lower jaw of the "Hobbit", donated to the UNE library by Professor Peter Brown.

Photo: Don Hitchcock 2009

Source: Facsimile, display at University of New England Library

Lateral

The LB1 cranium and mandible (Brown et al., 2004)

Homo floresiensis

(LB1)

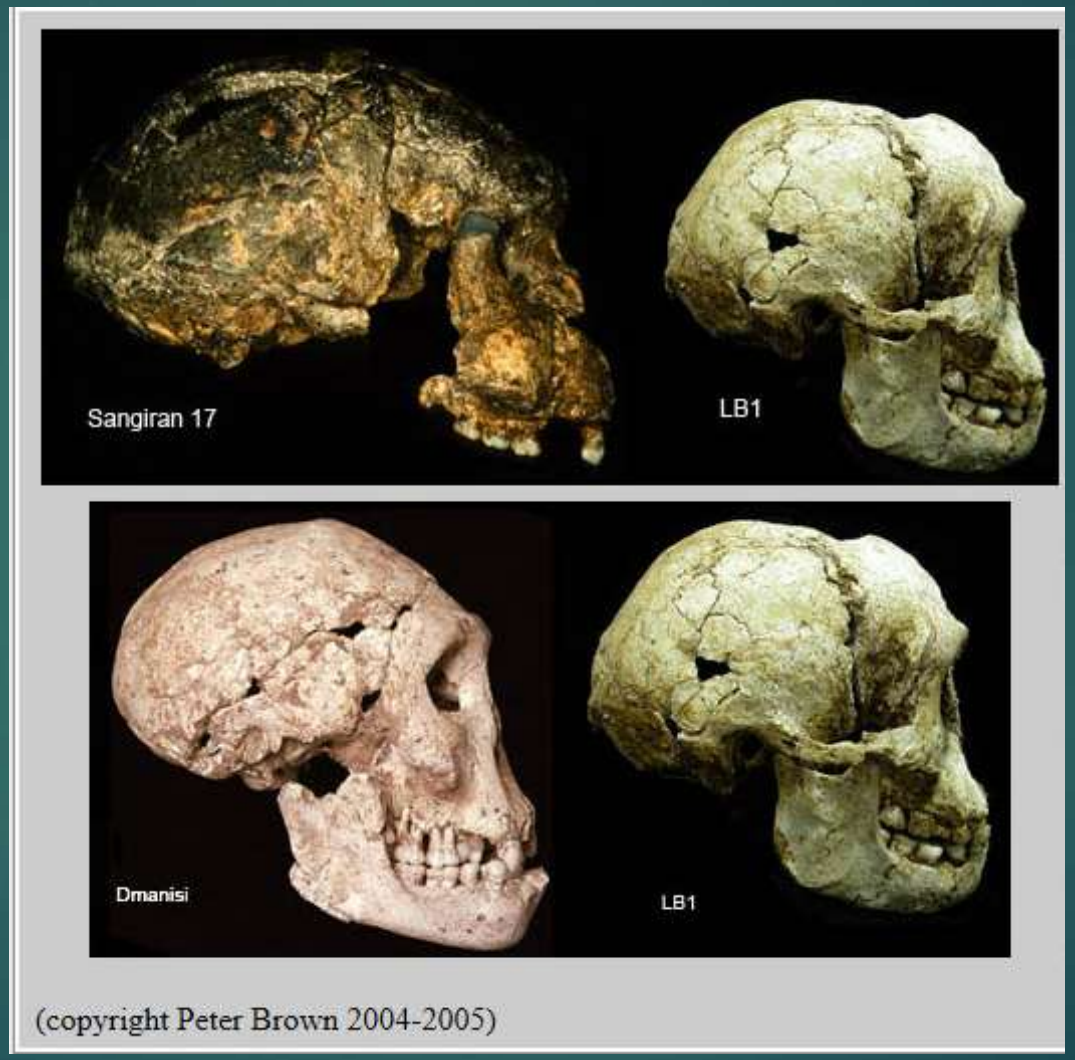
"The Hobbit"

http://news.bbc.co.uk/2/hi/science/nature/3948165.stm

H. Erectus compared to LB1

H. erectus: Sangiran

H. erectus: Dmanisi



LB1

H. Floresiensis mandibles

Dentition

LB2 LB1

Several thousand years difference; but same premolars;
Shara Baily: all teeth are systematically smaller

LB1 and LB6/1
H. floresiensis mandibles

Figure 4 Right lateral and occlusal views of the LB1 mandible, sagittal profile of the symphysis, occlusal view of the mandibular dentition and occlusal views of the mandibular premolars. Scale bars, 1 cm.

Brown et al., 2004; Morwood et al. 2005

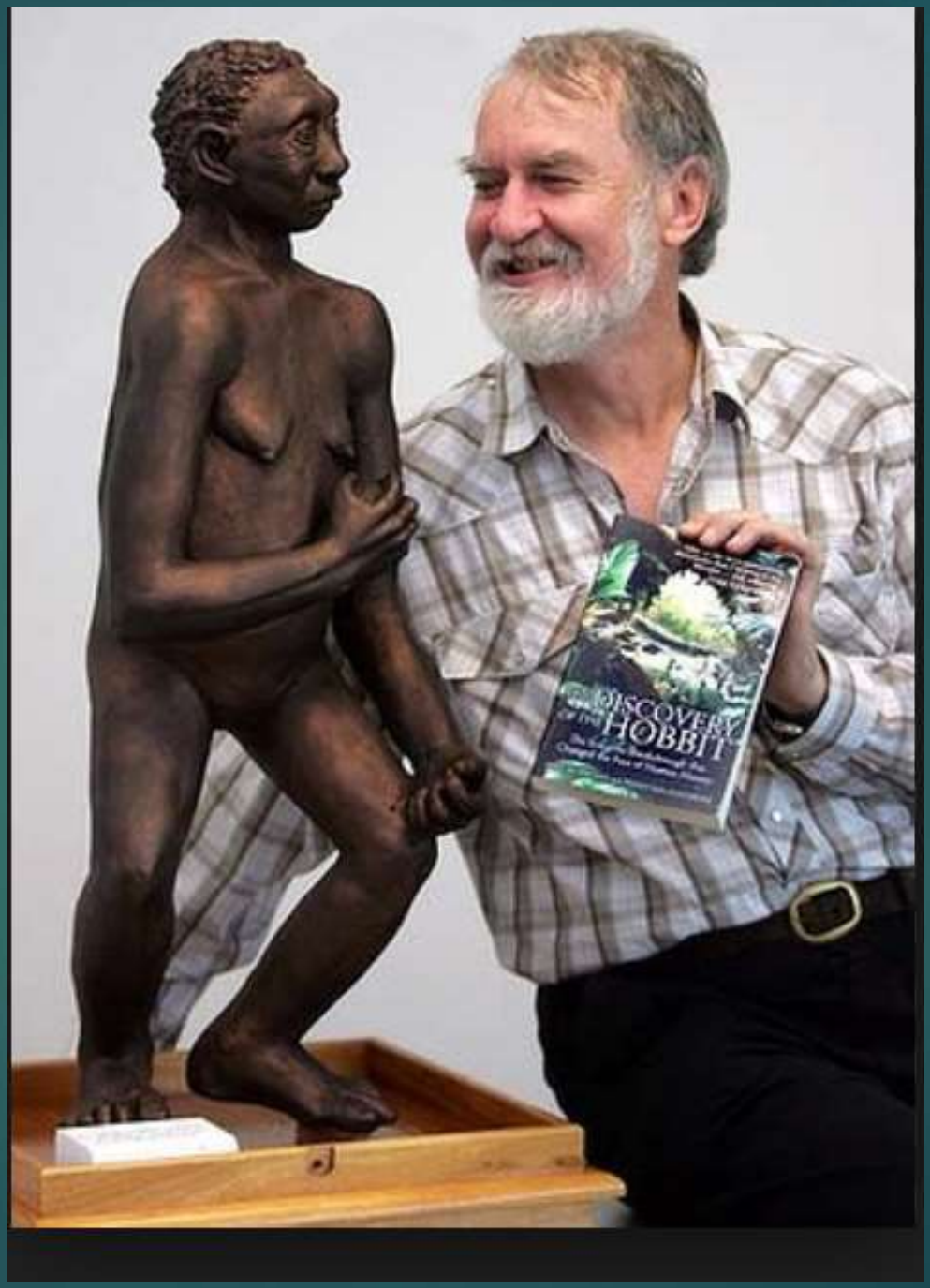
Cranium: Conclusion

- There does not appear to be direct evidence from the cranium that LB1 is pathological or (except for dental size) has a particularly close relationship to any modern humans.

- The closest phylogenetic similarities lie with earlier hominins and particularly with early Homo.

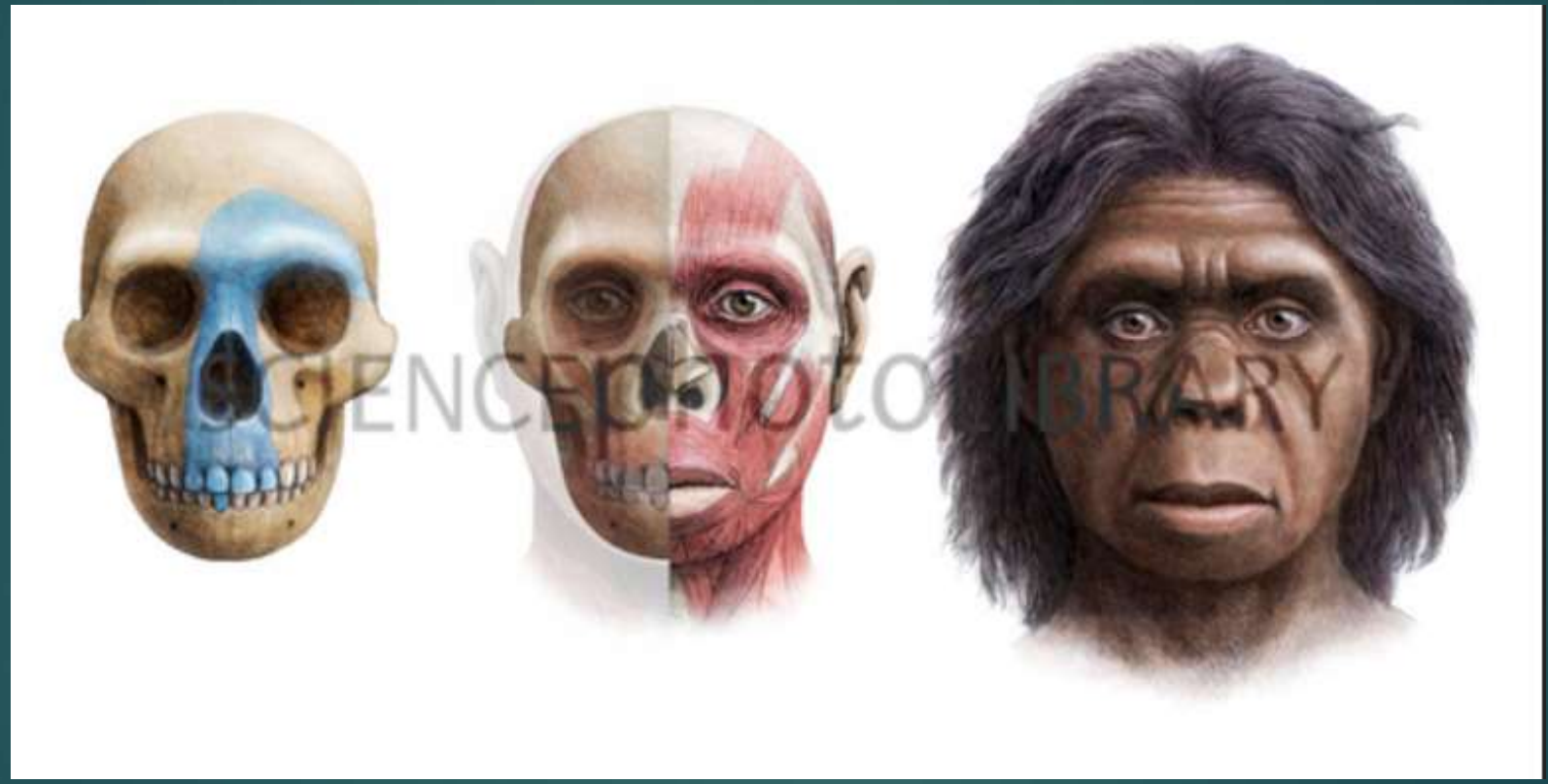
Aiello, 2010

Reconstructions/Approximations


DISCOVERY
HOBBIT

Alfons and Adrie Kennis.

Anton

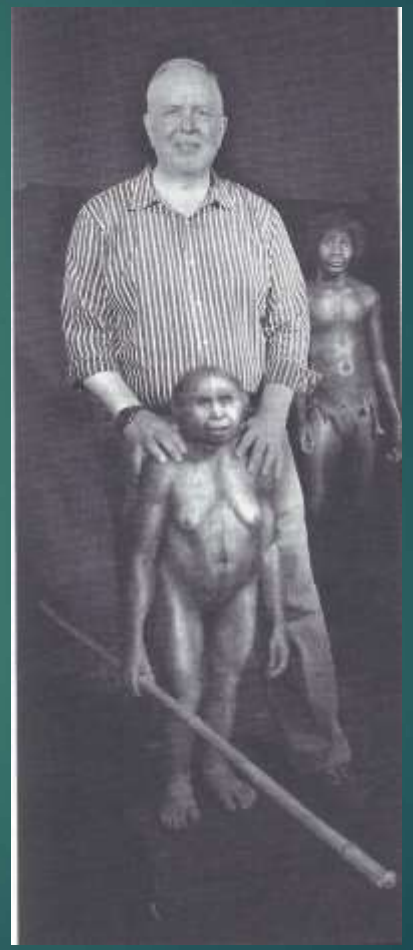


Sawyer & Deak

Elisabeth Daynes

A recent full-body reconstruction of LB1, the 'little lady of Flores', by the Parisian paleoartist Elisabeth Daynès. (©2009, S. Plailly/E. Daynès—Reconstruction Atelier Daynès Paris). Photo from The geometry of hobbits: *Homo floresiensis* and human evolution.

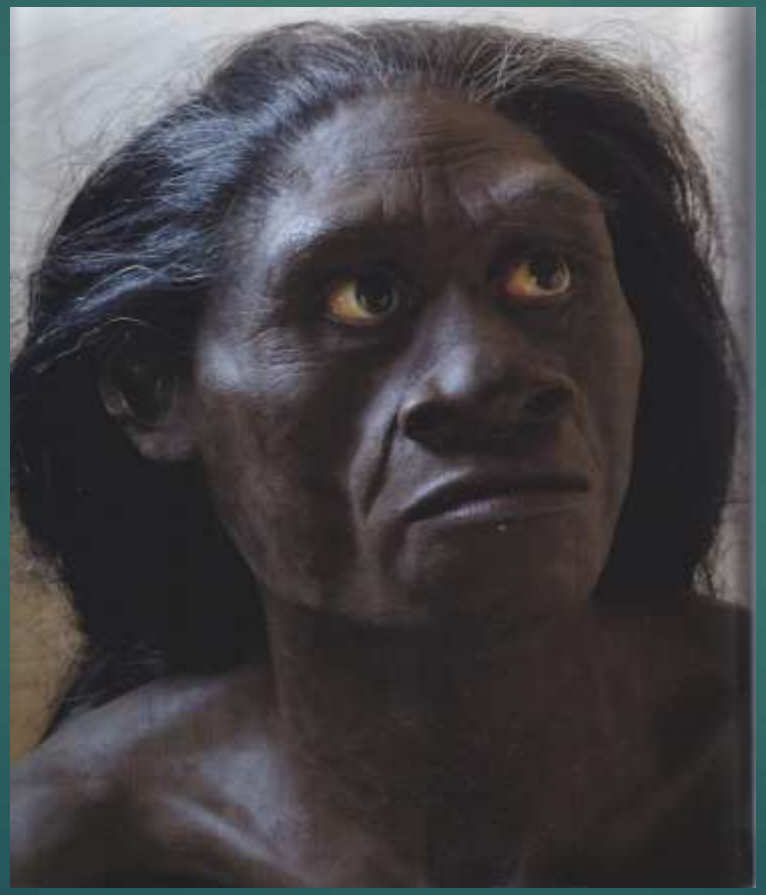
Elizabeth Daynes



W. Jungers & hobbit

Karen Carr

Shaping Humanity - John Gurche

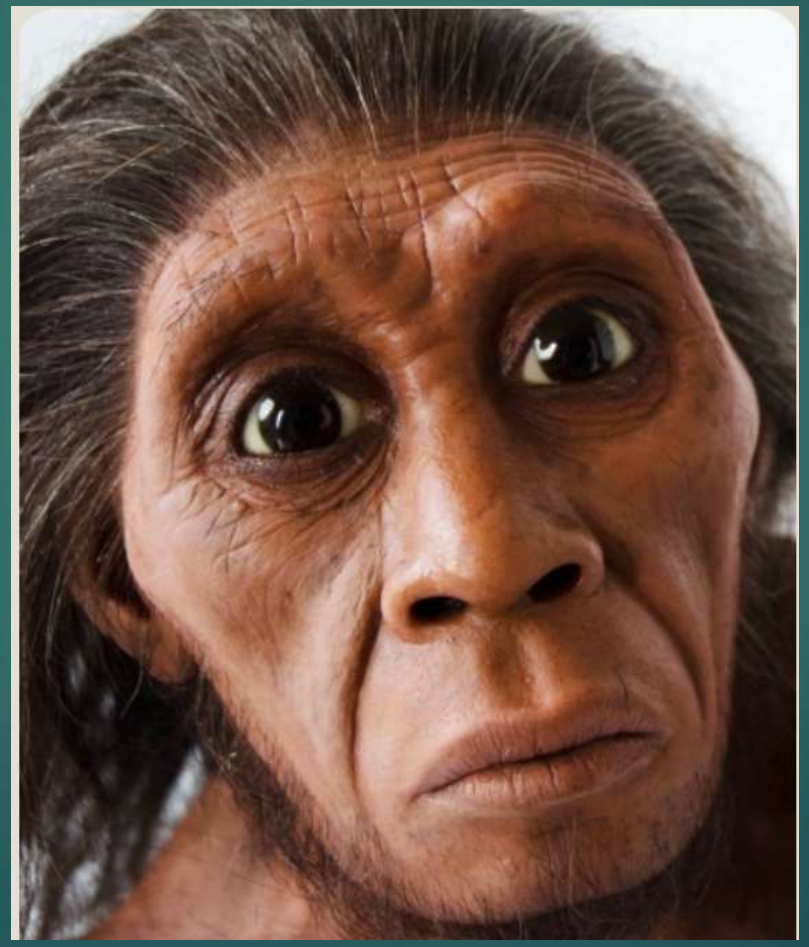


National Geographic

Peter Schouten

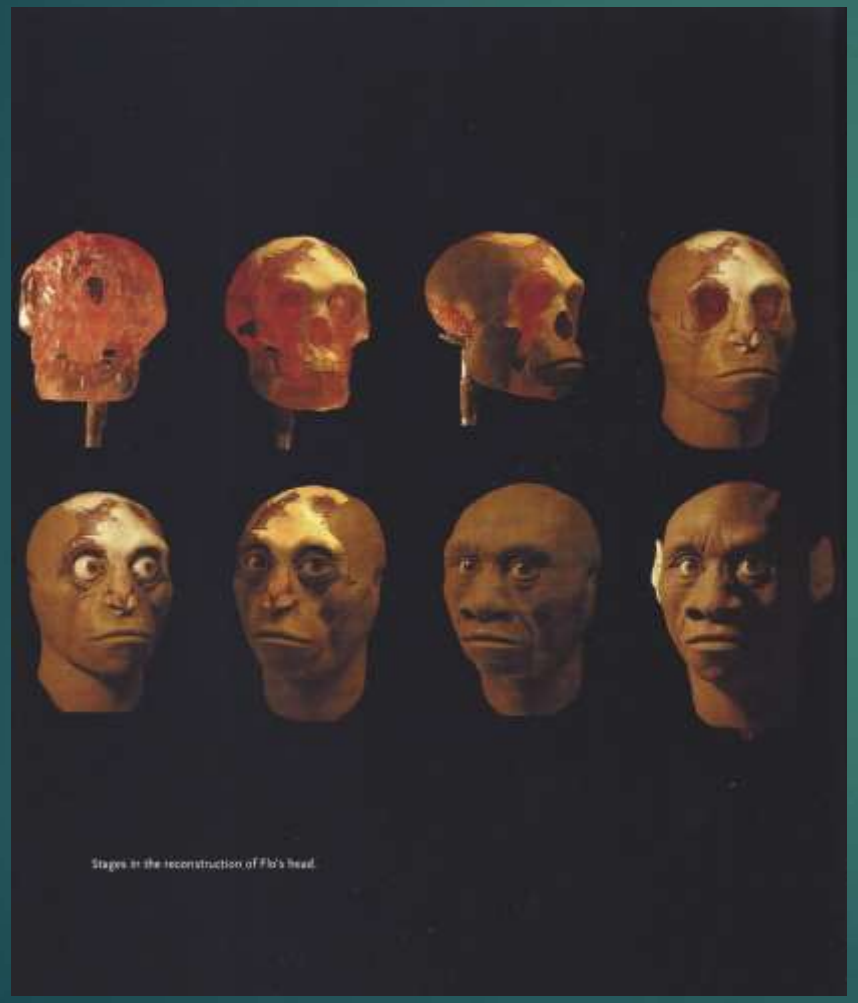
Homo floresiensis painting by Peter Schouten supplied by the University of Wollongong

Lisa Büscher

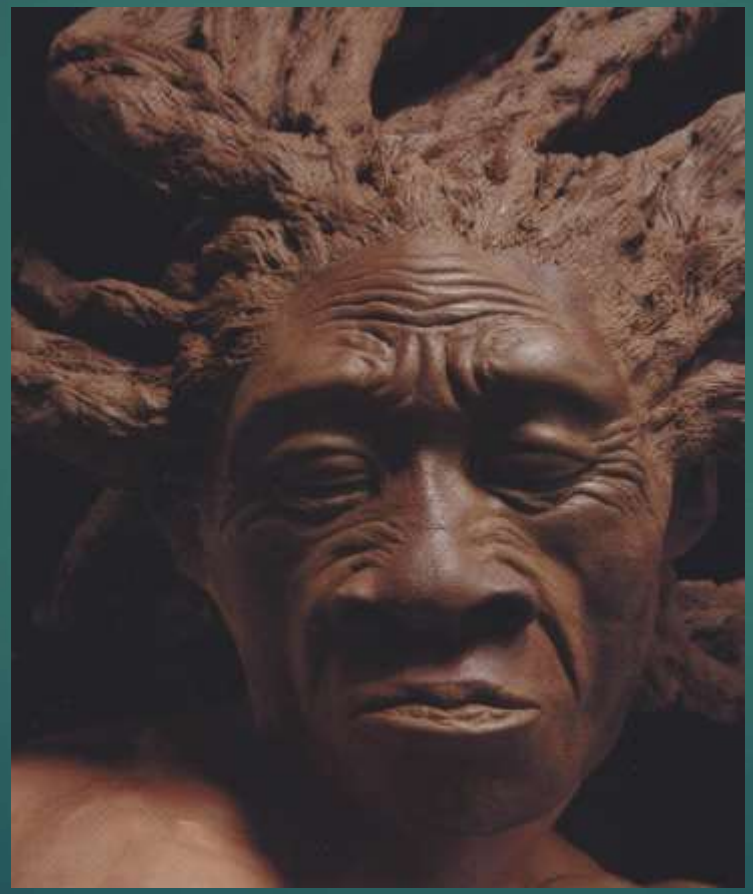


Martin Freeman
as the Hobbit Bilbo Baggins

Gurche: development process



John Gurche



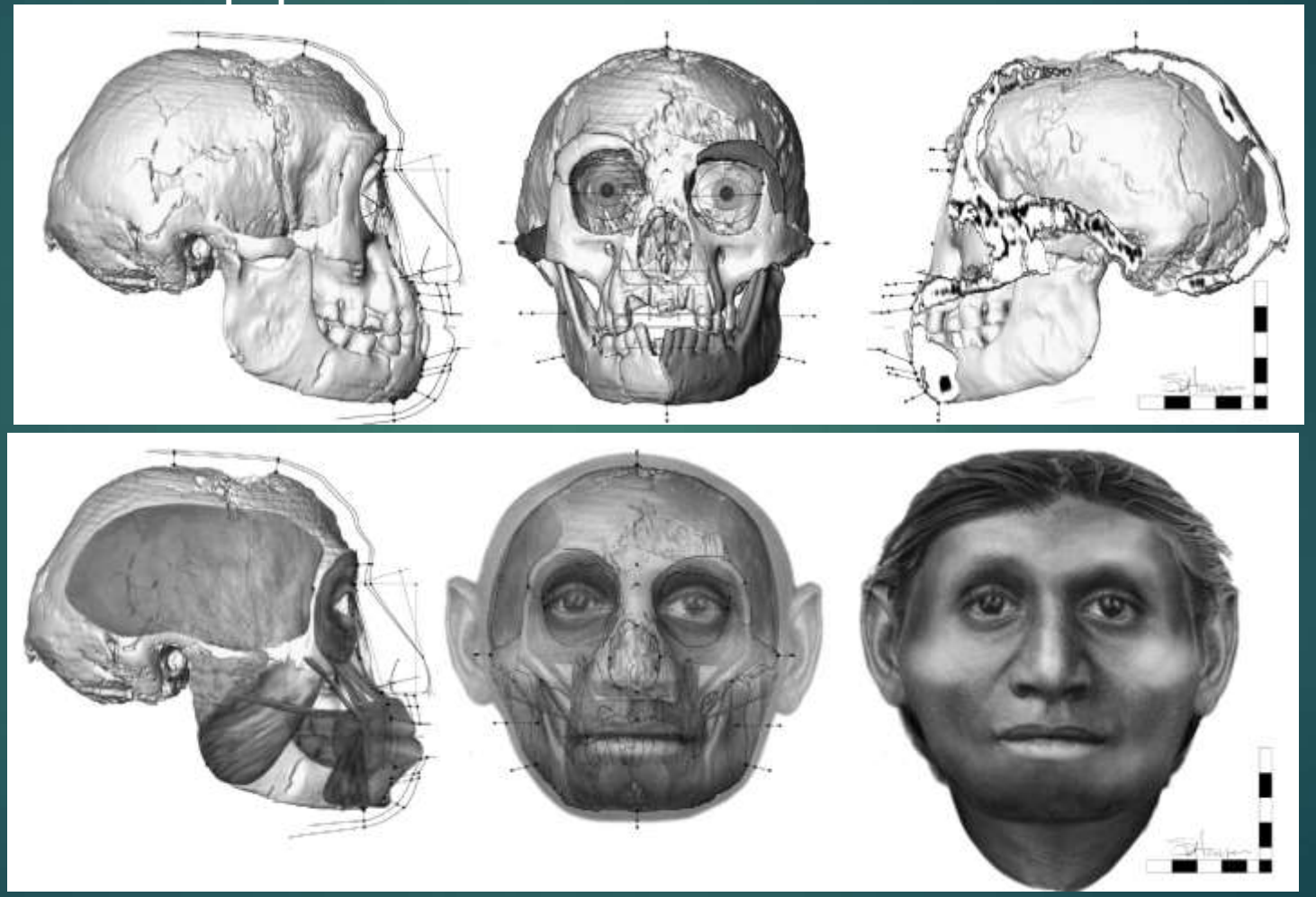
Dramatic Pose: Smithsonian

Gurche

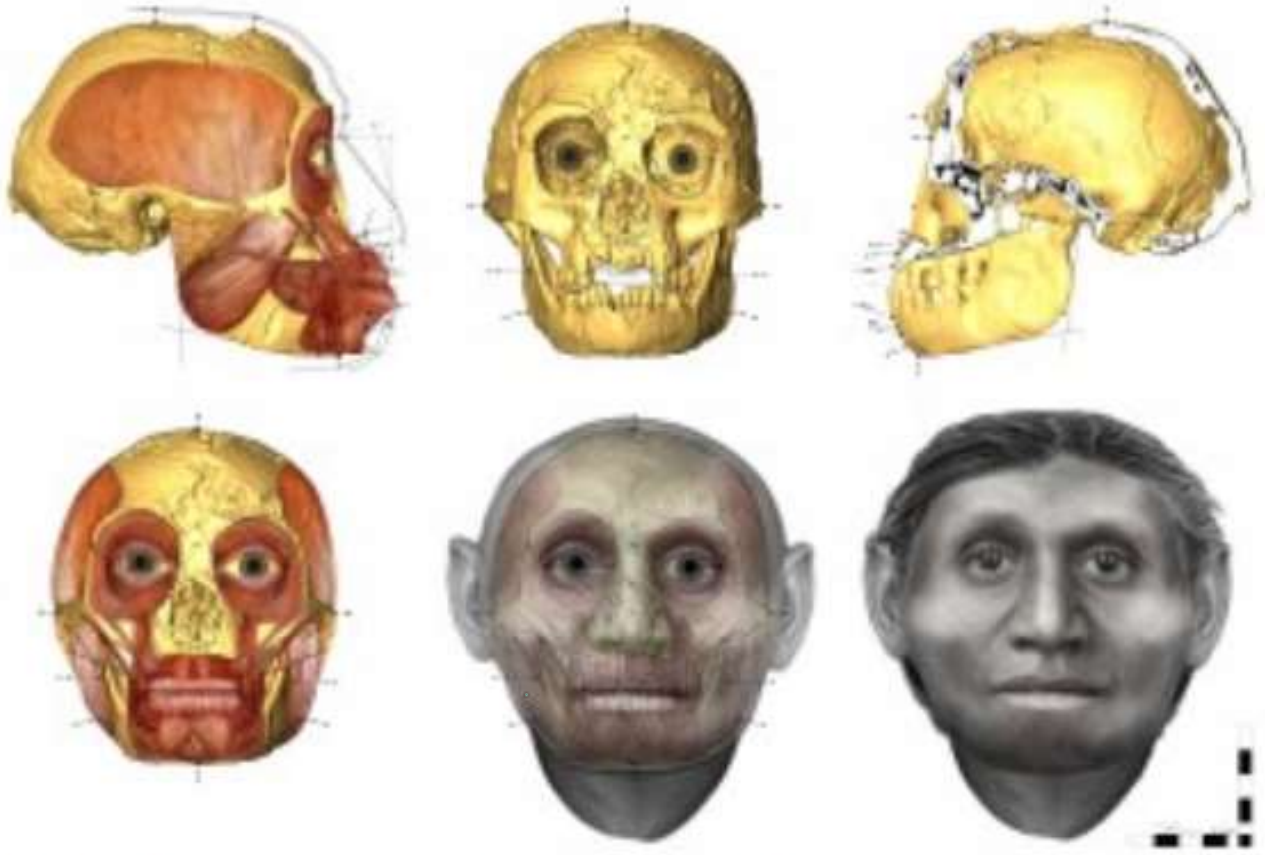
Tsunami?

H. floresiensis reconstruction
Smithsonian
(John Gurche, artist & Chip Clark, photo)

Hayes & Morwood:
best scientific approximation

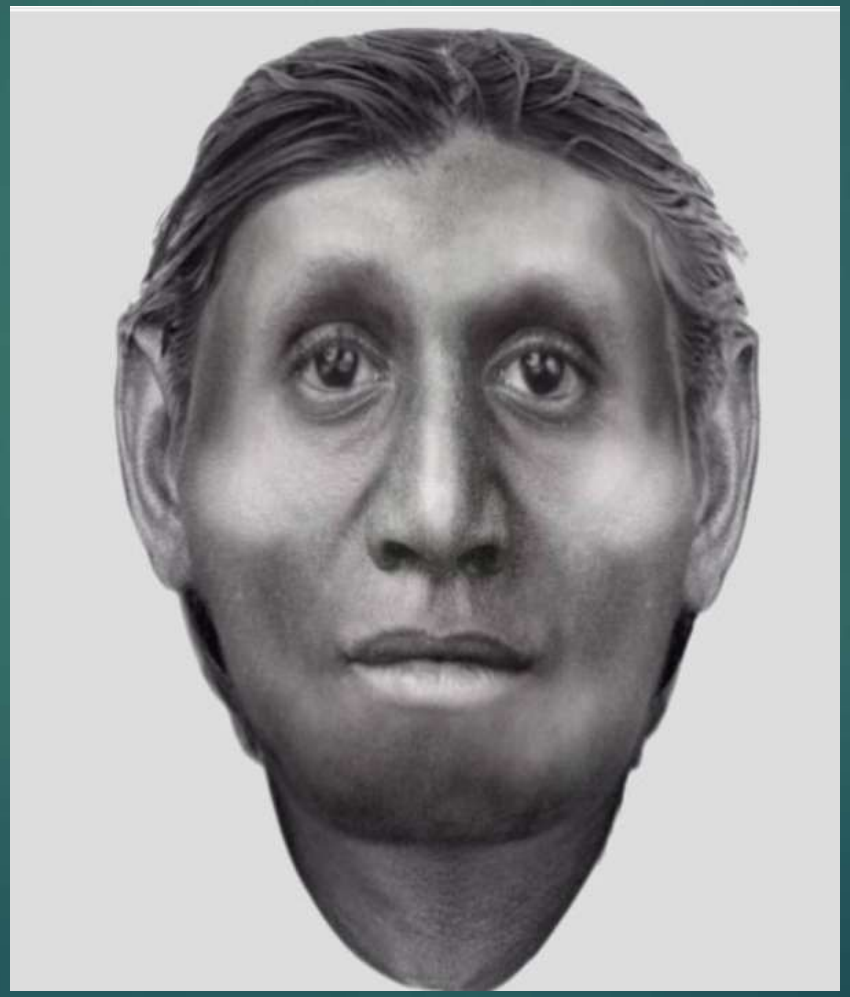


Susan Hayes, Thomas Sutikna, Mike Morwood, 2013



Anthropologist Susan Hayes used forensic techniques to recreate the face of the Homo floresiensis individual known as LB1 from her 18,000-year-old skull. Image: Susan Hayes

Susan Hayes



The endocranial cast

Brain size

- The brain of the holotype LB1 was originally estimated to have had a volume of 380 cc, placing it at the range of chimpanzees or the extinct australopithecines.

- LB1's brain size is half that of its presumed immediate ancestor, *H. erectus* (980 cc)

LB1 Brain: 426 cc

- Kubo et al. 2013: The extremely small endocranial volume (ECV) of LB1, the type specimen of *Homo floresiensis*, poses a challenge in our understanding of human brain evolution.
- Inconsistency in the published endocast cranial volumes for LB1: 380–430 cc)
- Accurately determined the ECV of LB1 using high-resolution micro-CT scan.
- The ECV of LB1 thus measured, 426 cc, is larger than the commonly cited figure in previous studies (400 cc).

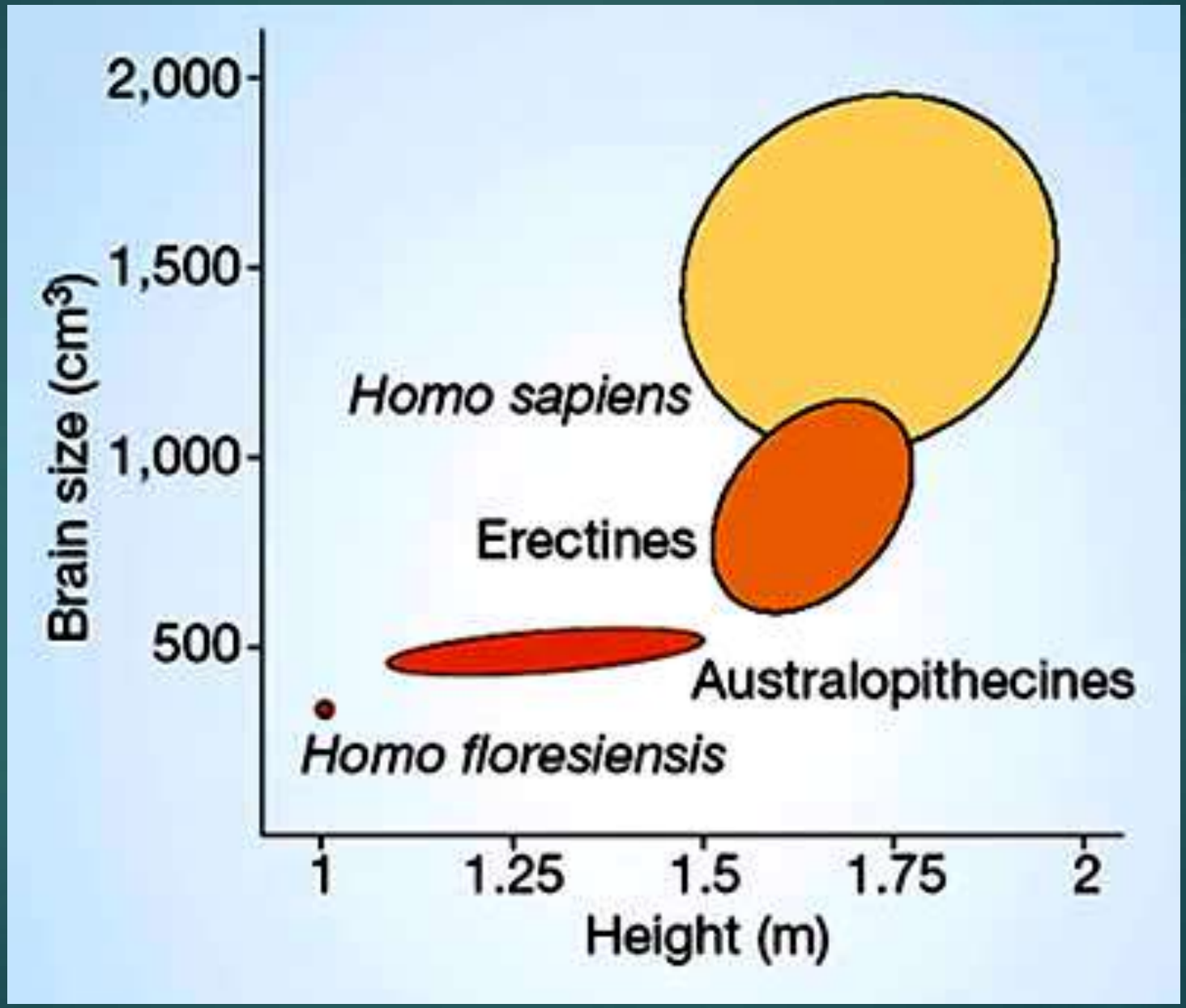
Daisuke Kubo, et al., 2013

Hominid cranial capacity

	CC	EQ	MYA	
Chimpanzee	390			
Gorilla	440/540			
Sahelanthropus tchadensis:		400		
[H. floresiensis		426]		
A. afarensis		446	4.9	3.5
A. garhi		450		
A. africanus		461	5.2	
A. robustus & boisei		503	5.3	
H. habilis		610	7.1	1.8
H. rudolfensis		789	7.4	
H. ergaster		801	6.3	1.5
H. erectus		951 (727-1200)		7.3
H. heidelbergensis		1263	8.6	600kya
H. neanderthalensis		1427	10.6	
H. sapiens sapiens		1496/1350	9.6	200 kya

(Allen, based on Martin 1983)

Relative brain to body size



H. Sapiens (1350 cc) vs. *H. floresiensis (426 cc)* brain

H. Floresiensis (426 cc), Dmanisi *H. erectus* skull 5 (546 cc), *H. habilis* (614 cc), earliest Indonesian *H. erectus* (860 cc), *H. sapiens* (1350cc)

Not island dwarfism

- An argument against island dwarfing as an explanation for *Homo floresiensis* stems from the relationship between brain size and body size.
- LB1's endocranial volume is only 426 cc.
- This is because brain size typically "dwarfs" less than overall body size.
- For example, despite having bodies that are much smaller than their neighbors, modern human pygmies have brains which are only slightly smaller.

Brain size

- Martin: degree of brain size reduction is simply too much to be explained by insular dwarfism (Martin et al., 2006a,b; Martin, 2007).
- The great majority of dwarfed mammals, including humans have relatively large brain sizes because the brain does not reduce in a one-to-one relationship with body size reduction

(Schoenemann and Allen, 2006)

2009:
Island Hippo brains shrink significantly

- Eleanor Weston and Adrian Lister of the Natural History Museum in London found that in several species of fossil hippopotamus that became dwarfed on Madagascar, brain size shrank significantly more than predicted by standard scaling models.
- Brains of certain extinct island hippos had shrunk to a size 30 percent smaller than would otherwise be predicted under the traditional dwarfing model
- Based on their hippo model, the study authors contend, even an ancestor the size of H. erectus could conceivably attain the brain and body proportions of LB1 through island dwarfing.

(Weston and Lister 2009).

Insular mammal brain underestimates

- Montgomery 2013: Analysis of brain and body size evolution in seven extant insular primates reveals that although insular primates follow the 'island rule', having consistently reduced body masses compared with their mainland relatives, neither brain mass nor relative brain size follow similar patterns, contrary to expectations that energetic constraints will favor decreased relative brain size.
- Brain: body scaling relationships previously used to assess the plausibility of dwarfism in *H. floresiensis* tend to underestimate body masses of insular primates.
- In contrast, under a number of phylogenetic scenarios, the evolution of brain and body mass in *H. floresiensis* is consistent with patterns observed in other insular primates.

Primate brains, the 'island rule' and the evolution of *Homo floresiensis*
Stephen H. Montgomery, 2013

Falk: Frontal Lobes & Brodmann's area 10

- Large temporal lobes (speech and hearing in H. sapiens)
- Highly folded and convoluted frontal lobes: "There are two huge convolutions," Falk says. "I haven't seen swellings like this before in any [extinct] hominid endocasts," including those of *Homo erectus*.
- Brodmann's area 10: The most convoluted region is in the most forward-projecting part of the frontal lobe, called the frontal pole. Falk identifies this region as Brodmann's area 10, which is expanded in modern humans and is involved in undertaking initiatives and planning future
- Normally area 10 can only be observed histologically.

Falk

- Only thing that LB1's endocast has in common with microcephalic endocasts is its small size.
- The shape of LB1's endocast is the opposite of that which typifies microcephalic endocasts.
- Unlike microencephalics, LB1's brain had:
  - Occipital lobe projecting farther back than cerebellum
  - Very wide temporal lobes with pointed rather than blunted tips
  - Frontal lobe that was wide and had expanded areas at and underneath its anterior part

3 D Prints of LB1 cranium

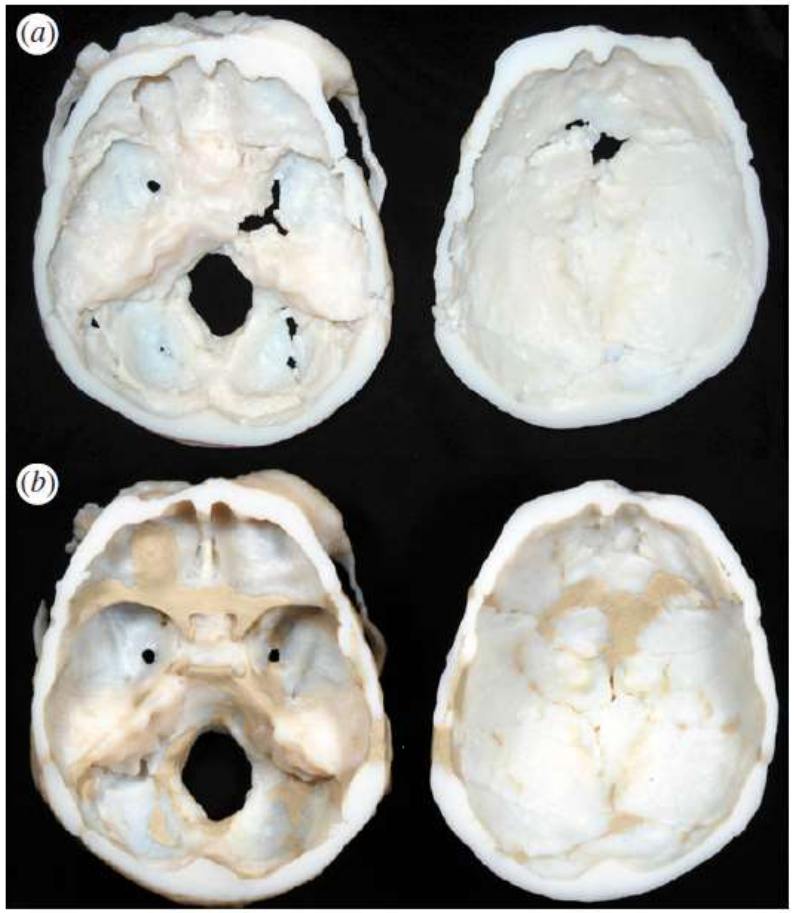


Figure 1. Physical replicas (three-dimensional prints) of horizontally sectioned cranium of LB1 (*a*) before and (*b*) after cleaning and clay-based reconstruction. (Online version in colour.)

Daisuke Kubo, et al., 2013

3D-CT endocast of LB1

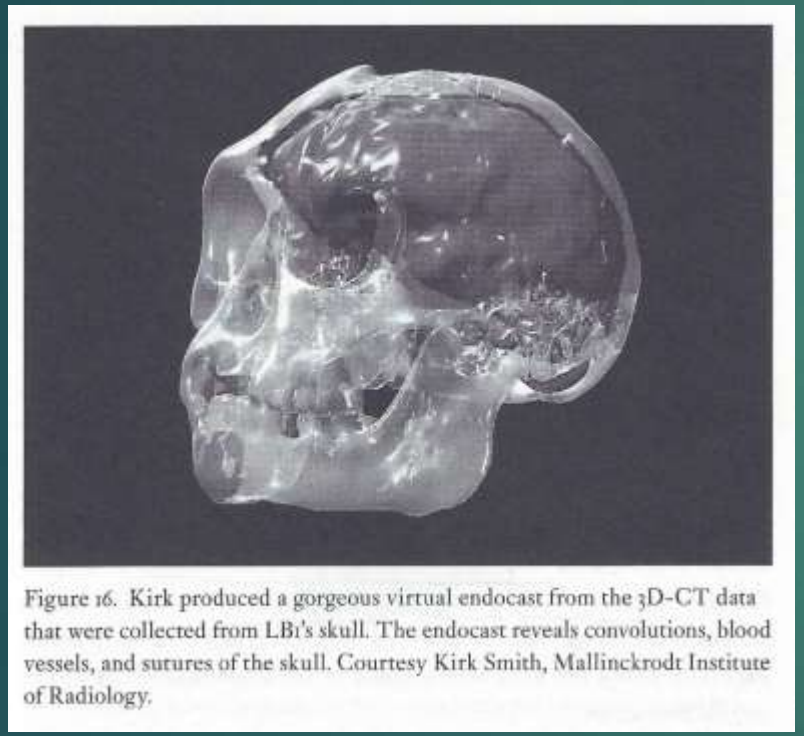
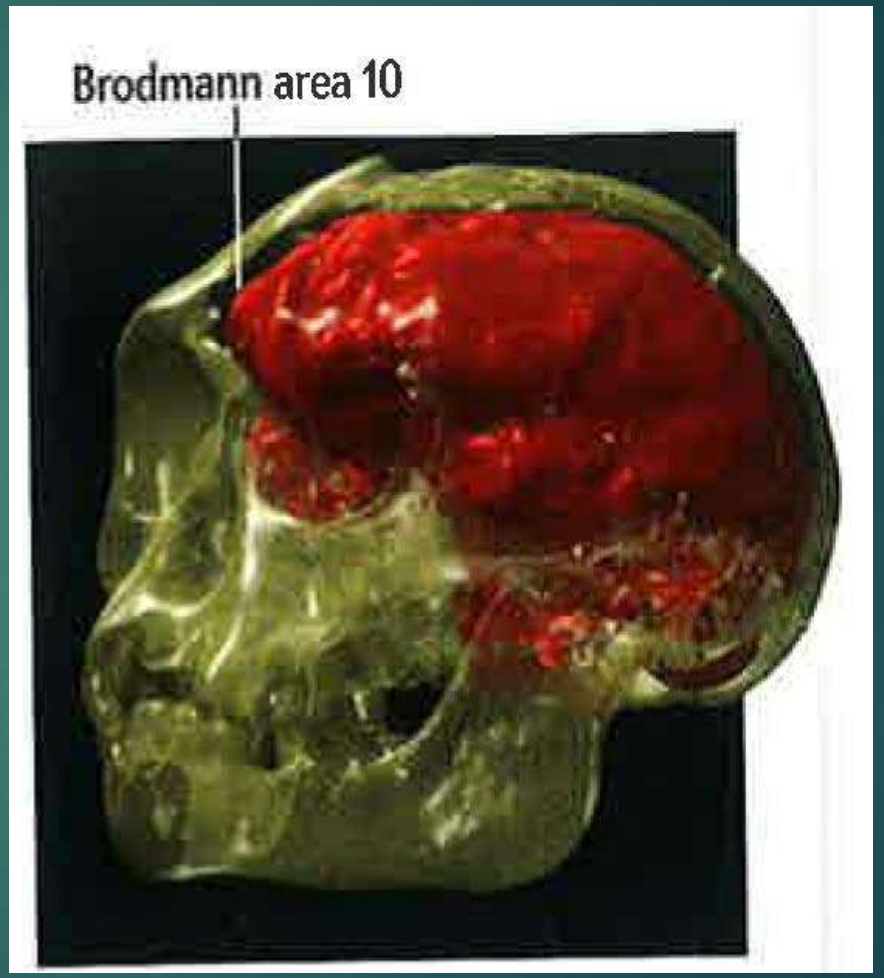
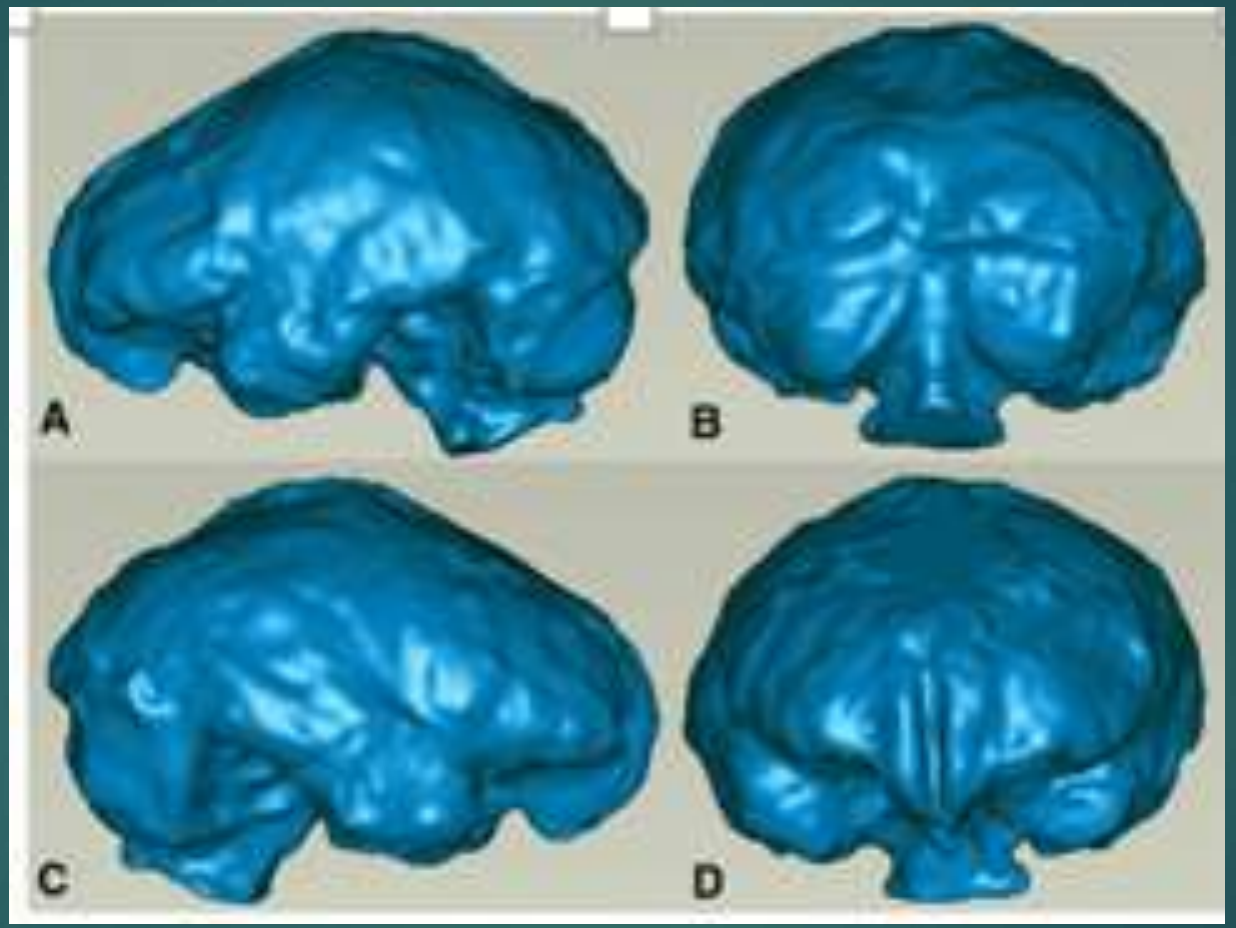


Figure 16. Kirk produced a gorgeous virtual endocast from the 3D-CT data that were collected from LB1's skull. The endocast reveals convolutions, blood vessels, and sutures of the skull. Courtesy Kirk Smith, Mallinckrodt Institute of Radiology.



Virtual endocast of LB1



D Falk et al. Science 2005;308:242-245

Published by AAAS

2013 virtual endocasts of LB1

rspb.royalsocietypublishing.org Proc R Soc B 280: 20130338

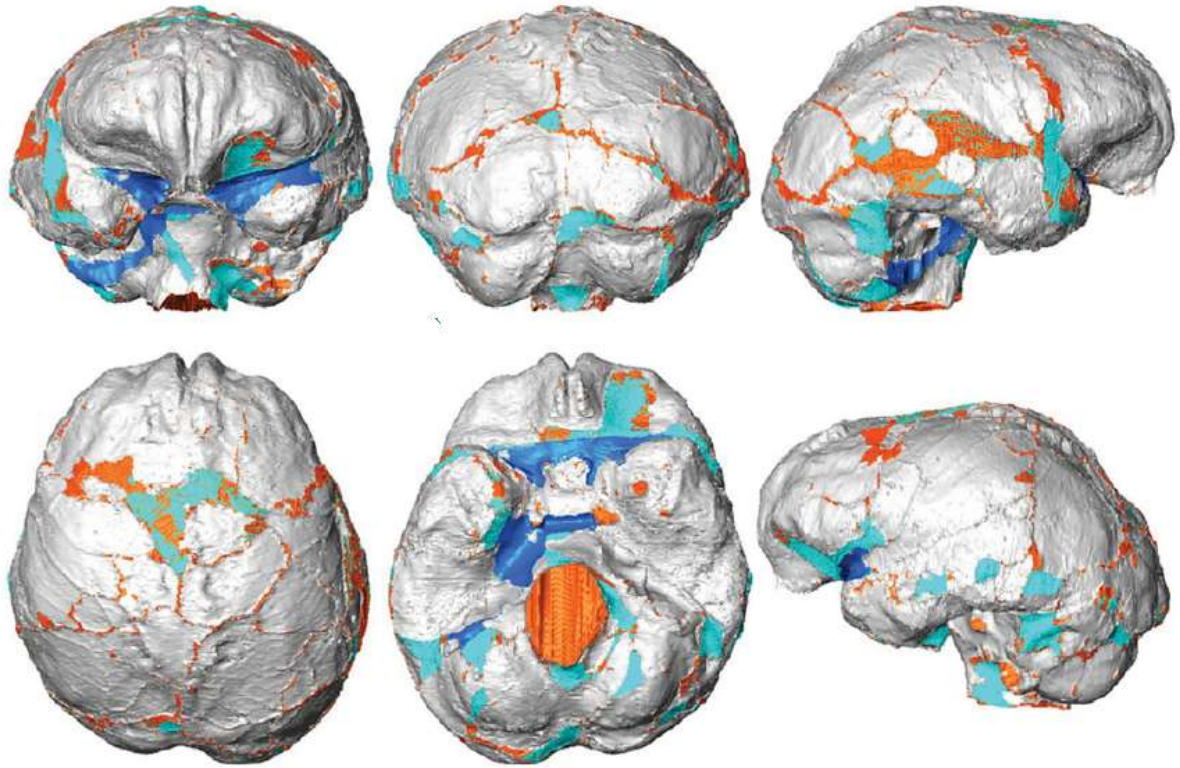


Figure 2. Virtual endocast of LB1 showing reconstructed areas. Anterior, posterior, right lateral, left lateral, basal and superior views (clockwise). Grey, intact original bone surface (untreated); light blue, clay reconstruction of relatively simple surfaces; blue, clay reconstruction of relatively complex structures (with minute digital correction when necessary); orange, anatomical foramina, and cracks and other damages treated digitally. See text for methodological details.

Daisuke Kubo, et al., 2013

Postcranial Anatomy

Similarity to earlier hominins

- Postcranial features found in H. floresiensis are similar to the morphology of earlier hominins

(Tocheri et al., 2007, 2008; Larson, 2007; Larson et al., 2007a,b, 2009; Jungers et al., 2008, 2009a,c)

Mosaic skeleton

- The LB1 skeleton has limb proportions that resemble A. afarensis with short legs relative to arms,
- Other postcranial features that individually are most similar either to apes, or to australopithecines, or to Homo erectus or are totally unique such as its unusually large feet
- The skeleton is considerably more primitive than skull and in some respects aligns the LB1 specimen and the other Flores fossils with older and even more primitive species like those belonging to *Australopithecus afarensis*

(Jungers et al., 2008, 2009a); (Tocheri *et al.*, 2007; Jungers *et al.*, 2009).

Skeleton vs. skull

- Archaic features are found throughout the entire skeleton of LB1. From the neck down LB1 looks more like the australopithecines than *Homo* .
- Trapezoid bone of wrist, which in our own species is shaped like a boot, is instead shaped like a pyramid, as it is in apes
- Clavicle is short and quite curved, in contrast to the longer, straighter clavicle that occurs in hominins of modern body form;
- Pelvis is basin-shaped, as in australopithecines, rather than funnel-shaped, as in *H. erectus* and other later *Homo* species.
- But still *Homo*: skull, narrow nose, prominent brow arches over each eye socket

Chris Stringer

- Archaic (like Australopithecus):
  - Lack of chin,
  - thick body,
  - divergent tooth rows
  - body proportions,
  - wrist bones (shaped before birth),
  - hip bones,
  - shape and robustness of arms and legs
  - unusual shoulder joint

Skeleton

- Bipedal
- Body height smaller than or equal to *A. afarensis*
- Lesser angle in the head of the humerus (upper arm bone)
- Short legs
- Femur broadly similar to *H. sapiens*, although much smaller
- Femur with long neck relative to head diameter
- Long arms
- Flared pelvis: Iliac blade is short and wide; greater lateral flare of the iliac blades than in *H. sapiens*
- Ischial spine not particularly pronounced

Brown et al., 2004; Morwood, et al., 2004

Shoulder joint & Clavicle

- The morphology of the LB1 shoulder also appears to predate the appearance Homo antecessor (Larson, 2007; Larson et al., 2007a).

- The two key features are the short clavicle and a humerus with a low torsion angle. Both features are shared with early Homo erectus (Nariokotome and H. georgicus from Dmanisi).

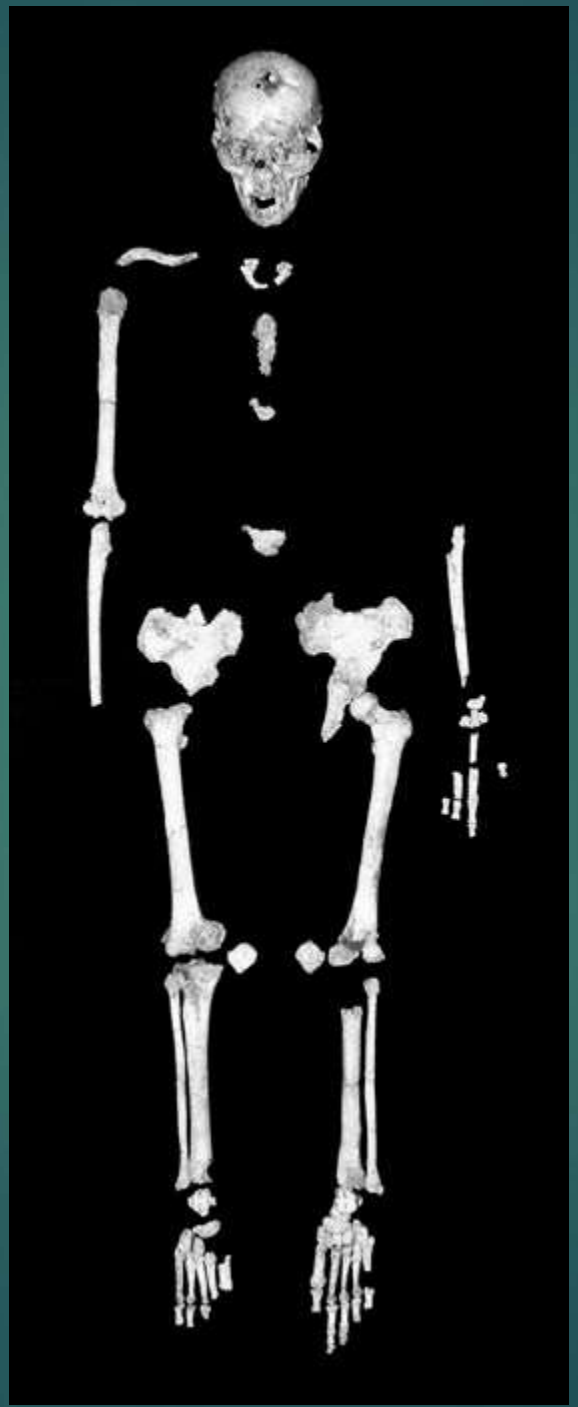
- Susan Larson, 2007: LB1 vs. *H. erectus* (Turkana boy) - In both LB1 and *H. erectus*, Larson discovered an primitive low humeral torsion, a relatively short clavicle, and a more modern scapula.

Unlike *H. sapiens*: Low humeral torsion

- But it was the feature of low humeral torsion (technically, "the orientation of the humeral head relative to the mediolateral axis of the distal humerus"; head facing less medially) that Larson found most remarkable.
- By contrast, high torsion characterizes modern humans.

Homo floresiensis and modern human
© AMNH Exhibitions

2003: *Homo floresiensis*, Island of Flores, Indonesia: 1 meter tall
About 100,000- 60,000 years ago

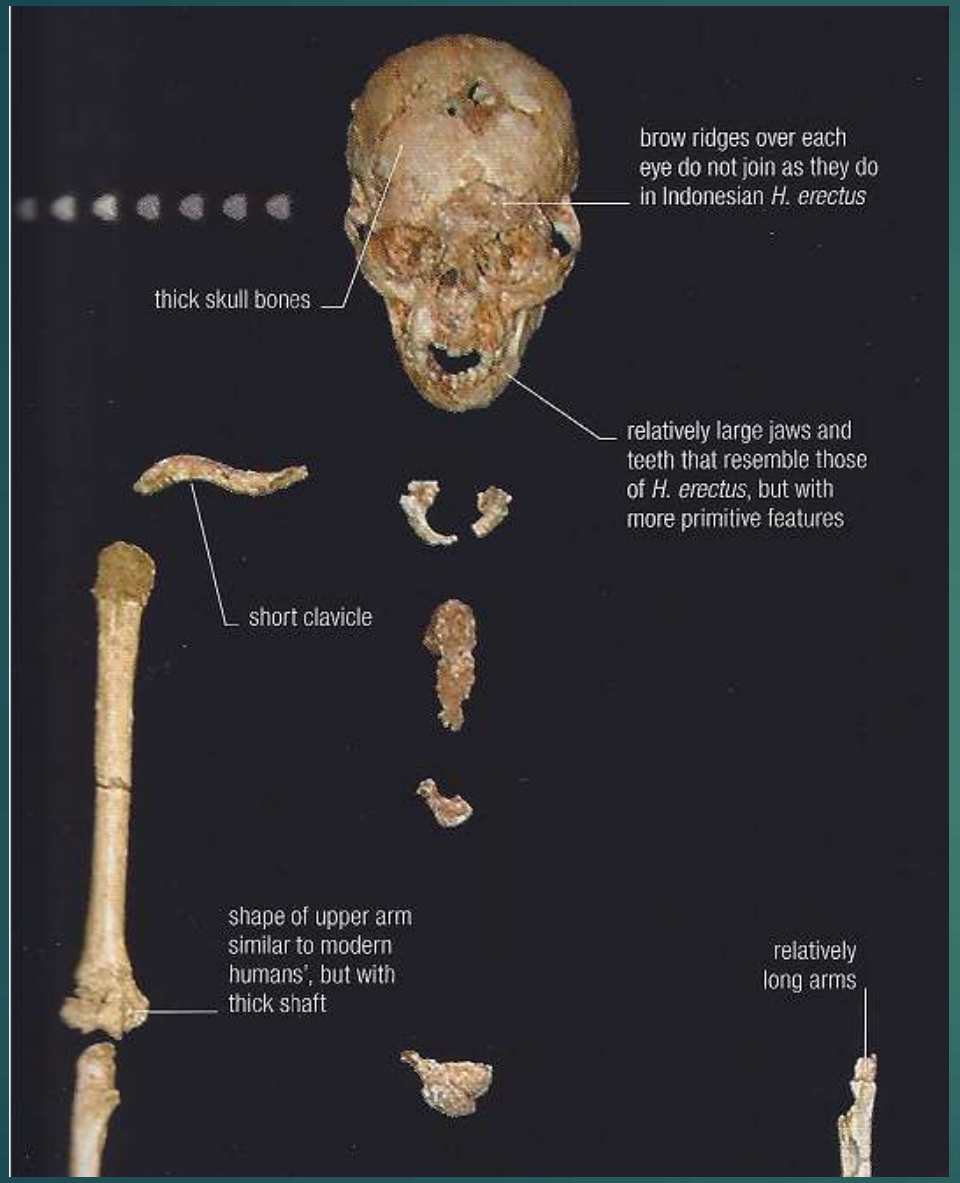


Homo floresiensis

A 3D cast of a skeleton of the controversial meter-tall adult hominin named Homo floresiensis by its discoverers and popularly called the Hobbit.

Photo: Tim Wiencis/ Splash News

LB1


brow ridges over each eye do not join as they do in Indonesian *H. erectus*
thick skull bones
relatively large jaws and teeth that resemble those of *H. erectus*, but with more primitive features
short clavicle
shape of upper arm similar to modern humans', but with thick shaft
relatively long arms


wider pelvis than in *H. sapiens*
fairly short legs
shafts of leg bones thick relative to their length
big toe aligned with other toes
very long foot relatively to leg length

Right Tibia and Humerus: LB vs Pygmy

Figure 3 | LB8 right tibia morphology. Posterior and anterior views of the LB8 right tibia, from Spit 58A, and anterior view of an African female Pygmy tibia scaled to the same length. Scale bar, 1 cm.

LB8 vs. Pygmy

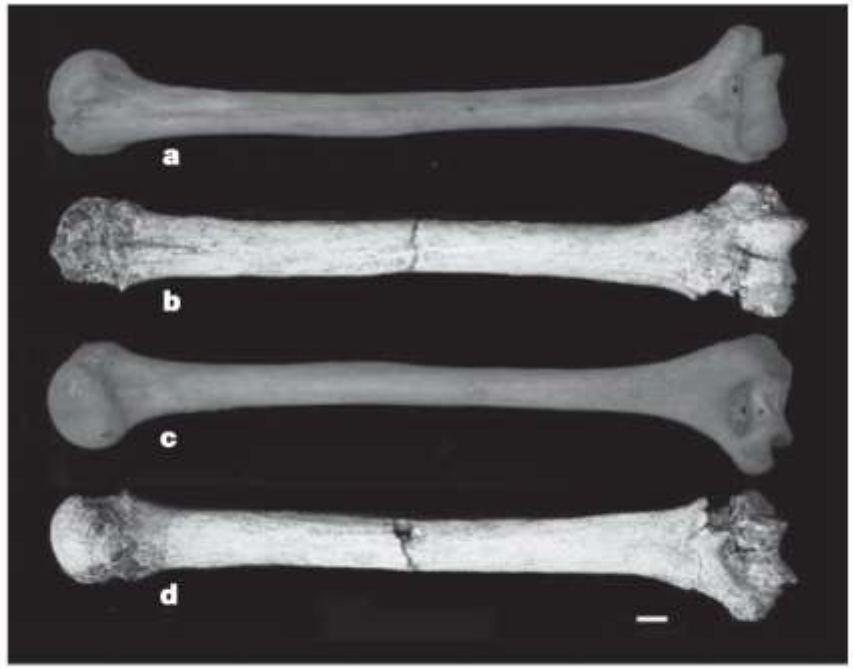


Figure 4 | LB1 right humerus morphology. Posterior (**b**) and anterior (**d**) views of the right humerus of LB1 *H. floresiensis*, with a small-bodied modern human (African Pygmy) humerus scaled to the same length (**a**, **c**). Scale bar, 1 cm.

LB1 (b, d) vs. Pygmy (a, c)

Morwood et al., 2005

Tocheri, 2007: Primitive wrist

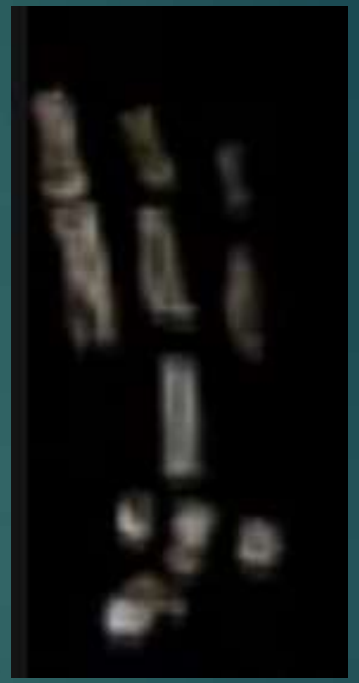
- Analyses of the trapezoid, scaphoid, and capitate show that these H. floresiensis wrist bones have a primitive morphology; predates the wrist morphology found in Neanderthals and modern humans and also Homo antecessor (evidence from the capitate).
- Unlike the human's boot-shaped trapezoid, LB1's trapezoid is more wedge-shaped, like those of other primates.
- The morphology therefore predates 800 ka.
- Wrist morphology emerges early in embryonic growth while developmental pathologies tend to appear later. This significantly reduces the probability that developmental pathologies could result in the primitive condition of the LB1 carpals.

(Tocheri et al., 2007, 2008).

Wrists: Ape, Human, Flores

Ape trapezoid:
Triangular Pyramid shape

Trapezoid bone
Below Index finger
Boot shaped



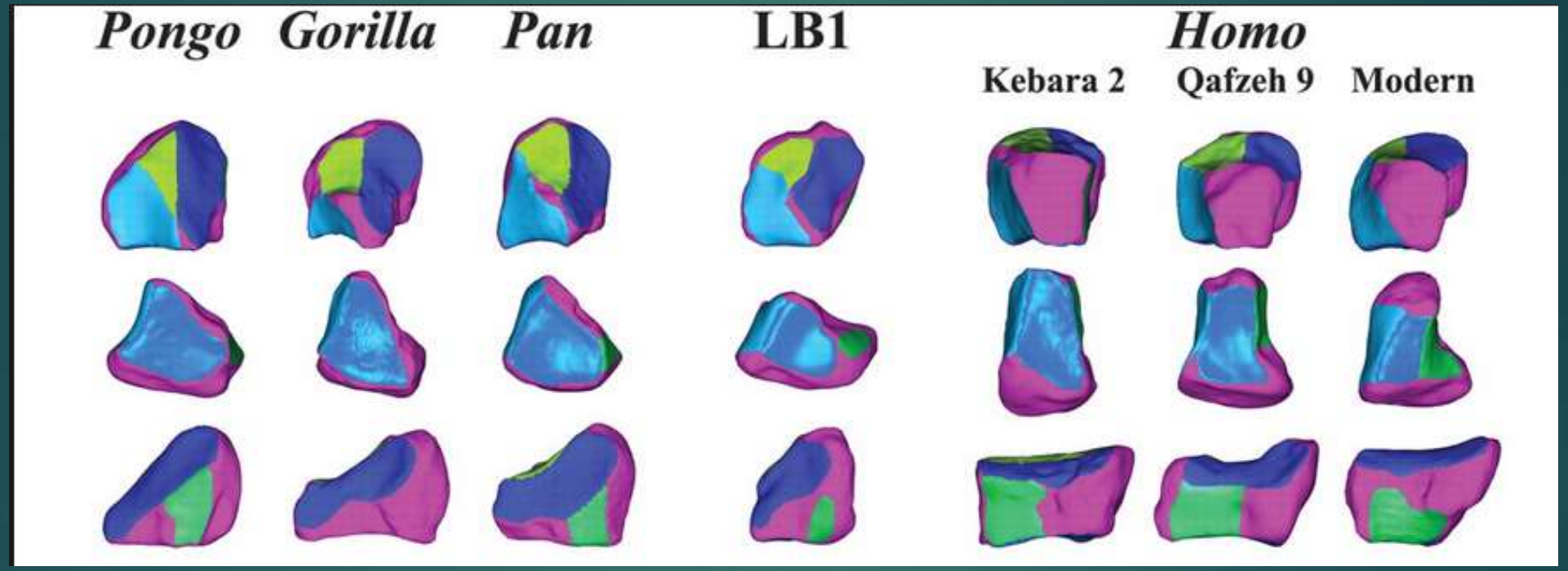
By 10 weeks in embryo

Better grasping

Matthew Tocheri

Trapezoid

Palmar (top row), proximal (middle row), and ulnar views (bottom row) of trapezoid morphology



Triangular Triangular Boot

Orr, 2013:
Homo floresiensis wrist is primitive

- The carpals from two *Homo floresiensis* specimens lack features (incl. palmarly blocky trapezoid) show an overall primitive articular geometry.
- Refutes claims that the wrist of the type specimen represents a modern human with pathology.
- In total, the carpal anatomy of *H. floresiensis* supports the hypothesis that the lineage leading to the evolution of this species originated prior to the cladogenetic event that gave rise to modern humans and Neandertals.

Caley M. Orr, et al., 2013

Relation of LB1 Foot to Femur

The reconstructed left foot of the hobbit, *Homo floresiensis,* is 70% as long as its leg bones. Here, the foot length is contrasted with the length of its right tibia. Photo by William Jungers.

No foot like this in fossil record

- William Jungers (2009): unusually large feet, measuring 196 mm/20cm in length (7.7 inches).
- LB1's foot-to-femur ratio was about 0.7, in fact, which "far exceeds the upper limits for modern humans (70% vs. 55% in moderns)
- CJV: my ratio is 30% shorter than LB1
- Jungers believes this supports LB1 as primitive hominin.

Totally Unique LB1 Foot

- 1 - Foot exceptionally long compared to its short leg; almost 70% of the femur (thigh bone) length
- 2 - Long slightly curved toes
- 3 - No arch
- 4 - Big toe aligns with rest of toes (MH)
- 5 - Toe is considerably shorter than the lateral toes
- 6 - Lateral toes (the forefoot) are proportionally long compared with the ankle bones.

Homo floresiensis foot compared to that of a modern human

There are no known diseases that cause alterations in limb proportions as seen in the hobbit.

Not a runner

- William L. Jungers: analysis of LB1's foot.
- But with their short legs and relatively long feet, they would have had to use a high-stepping gait to avoid dragging their toes on the ground. Thus, although they could probably sprint short distance, but not run
- When walking, it would have had to bend its knees further back than modern people do. This would force the gait to be high stepped and walking speed to be low.

Femur & Foot: Lateral view

Not a Homo erectus foot

Both left feet: *Homo erectus* *Homo floresiensis*

Bennett, Matthew R., et al. 2009 Early Hominin Foot Morphology Based on 1.5-Million-Year-Old Footprints from Ileret, Kenya. *Science* 323:1197-1201.

Femur and tibia

Figure 7 Anterior and posterior views of the LB1 right femur and tibia, with cross-sections of the femur neck and midshaft, and tibia midshaft. The anterior surfaces of the medial and lateral condyles of the femur are not preserved. With the exception of the medial malleolus, the tibia is complete and undistorted. Scale bar, 1 cm.

2015:

These individuals belonged to a primitive population distinct from modern humans

Pelvis

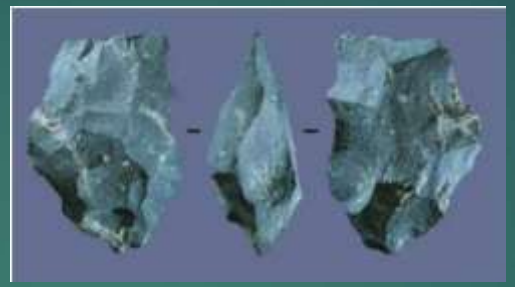
- Pelvis shows a mix of features (Jungers et al., 2009c).
- Pelvis is basin-shaped, as in australopithecines, rather than funnel-shaped, as in *H. erectus* and other later *Homo* species.
- Flared pelvis: Iliac blade is short and wide; greater lateral flare of the iliac blades than in *H. sapiens*

Pelvis: LB1 vs. H. sapiens

Figure 6 Comparison of the left innominate from LB1 with a modern adult female *H. sapiens*. Lateral (external), and medial and lateral views of maximum iliac breadth. The pubic region of LB1 is not preserved and the iliac crest is incomplete. Scale bar, 1 cm.

Tools

Mata Menge and Liang Bua Tools



Liang Bua tools

- 1994: Mata Menge - 507 tools date back at least 840,000 years ago.
- 2004: 3626 younger tools found with the *H. floresiensis* bones.
- Made from volcanic rocks found along rivers.
- Brown: The simplest explanation for these similarities is that stone artefacts from Mata Menge and Liang Bua represent a continuous technology made by the same hominin lineage.
- The Liang Bua and Mata Menge tools bear a striking resemblance to artifacts from Olduvai Gorge in Tanzania that date to between 1.2 million and 1.9 million years ago and were probably manufactured by *H. habilis*.

Olduvai, Mate Minge, Liang Bua Tools

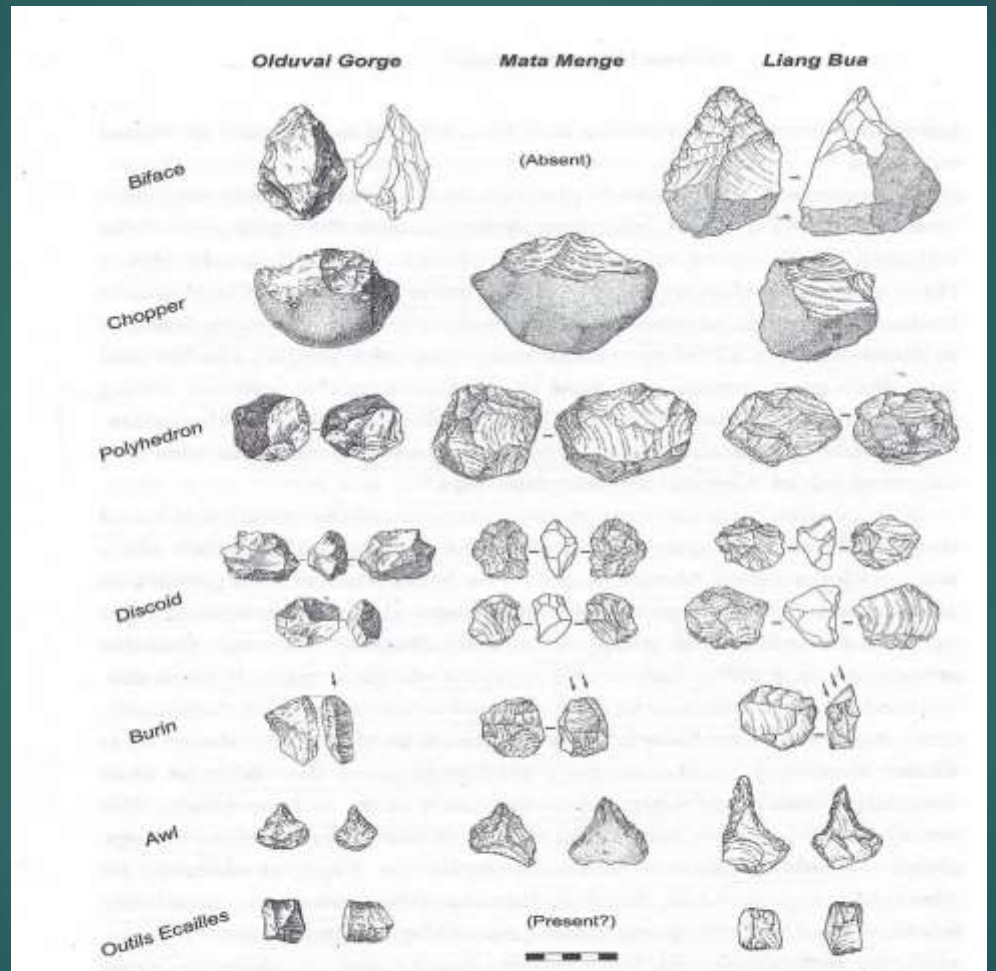


Figure 30. Comparison of artifacts from Olduvai Gorge, Mata Menge, and Liang Bua Pleistocene deposits. Images connected by short lines are different views of the same artifact. Arrows indicate scars resulting from the production of the burins. The scale is 50 mm. From Moore and Brumm 2008, courtesy of Mark Moore.

Mata Menge and Liang Bua Tools

- On the basis of the recovery and analysis of artifacts from the site of Mata Menge (800–880 ka) in the Soa Basin of Flores, Moore, Morwood et al. argue for technological continuity with the archaeological material

- Liang Bua stone tools resemble those found elsewhere on the island at sites that are closer to a million years in age (Brumm *et al.*, 2006; 2010).

- Similarities include the use of volcanic/metavolcanic fluvial cobbles as raw materials, core reduction strategies, and the maximum dimensions of flake scars

Bua (Brumm et al., 2006; Moore and Brumm, 2007; Moore et al., 2009).

Tools and Fire

- The Liang Bua implements are at levels from 95,000 to 13,000 years ago and were found in the same stratigraphic layer as the extinct genus *Stegodon*
- In addition to tools, there is also evidence in the form of cut marks on some *Stegodon* bones indicating that the hominins were butchering these animals
- Charcoal, charred bones, fire-cracked rocks, including circular arrangement of burned pebbles (hearth?); whether this was the result of intentional or accidental fire is still unknown

(Morwood *et al.*, 2005, (Westaway *et al.*, 2009).

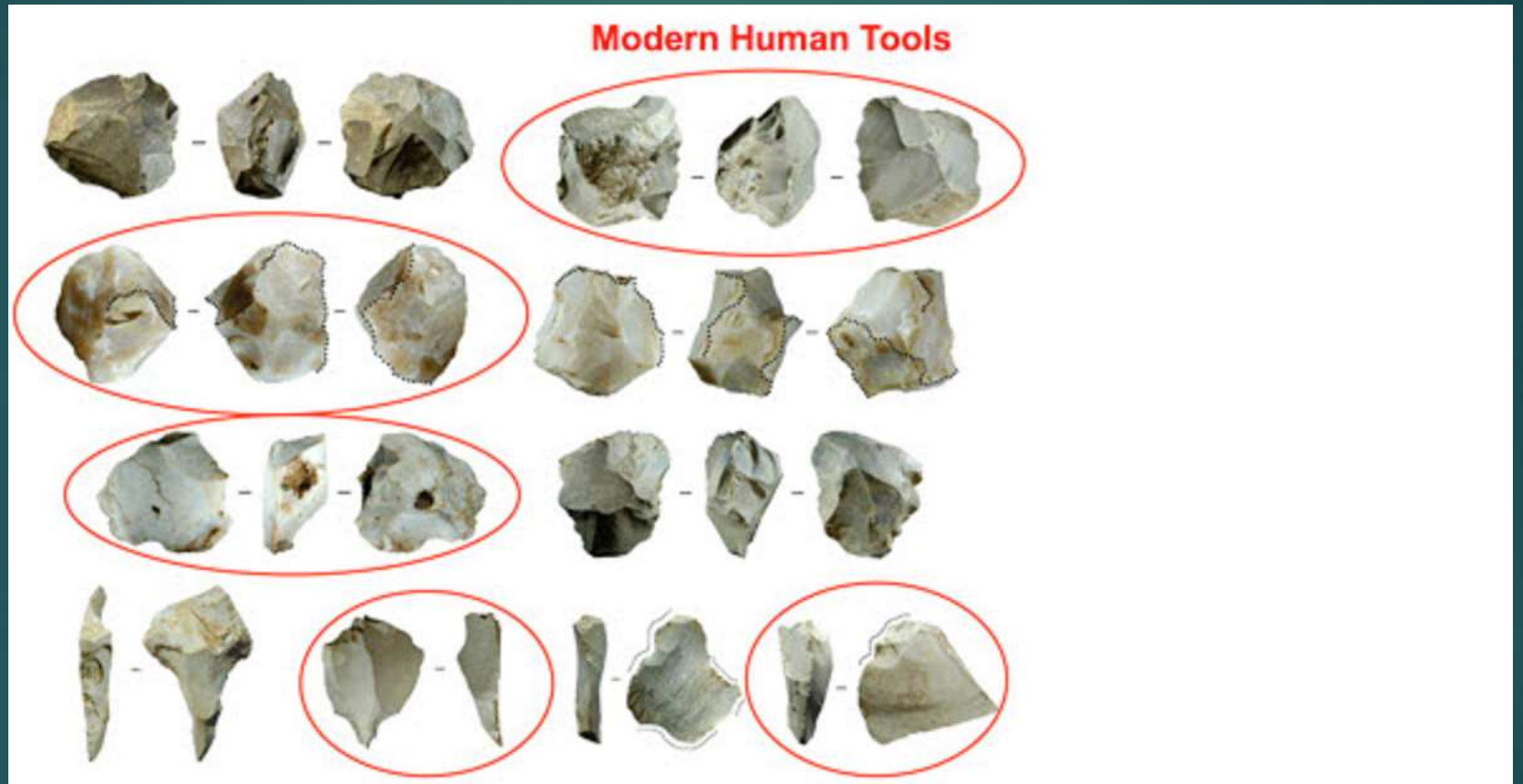
Tools

- There are a large number of bifacial (struck on both sides) and radial (struck from the outer edge towards the center) cores (rocks from which pieces [flakes] are chipped to produce tools).
- More complex tools—e.g., points (sharpened, pointed tools), perforators (tools designed to make holes or incisions), blades (flake that is at least twice as long as it is wide) and microblades (blades less than 10 mm, often components of composite tool technology)— have also been recovered (Adam R. Brumm: produced by chance)

Flores Stone Tools

Examples of stone tools from Liang Bua Cave, Flores. Scale bars10 mm.
(copyright Mark Moore 2009)

Flores Stone Tools

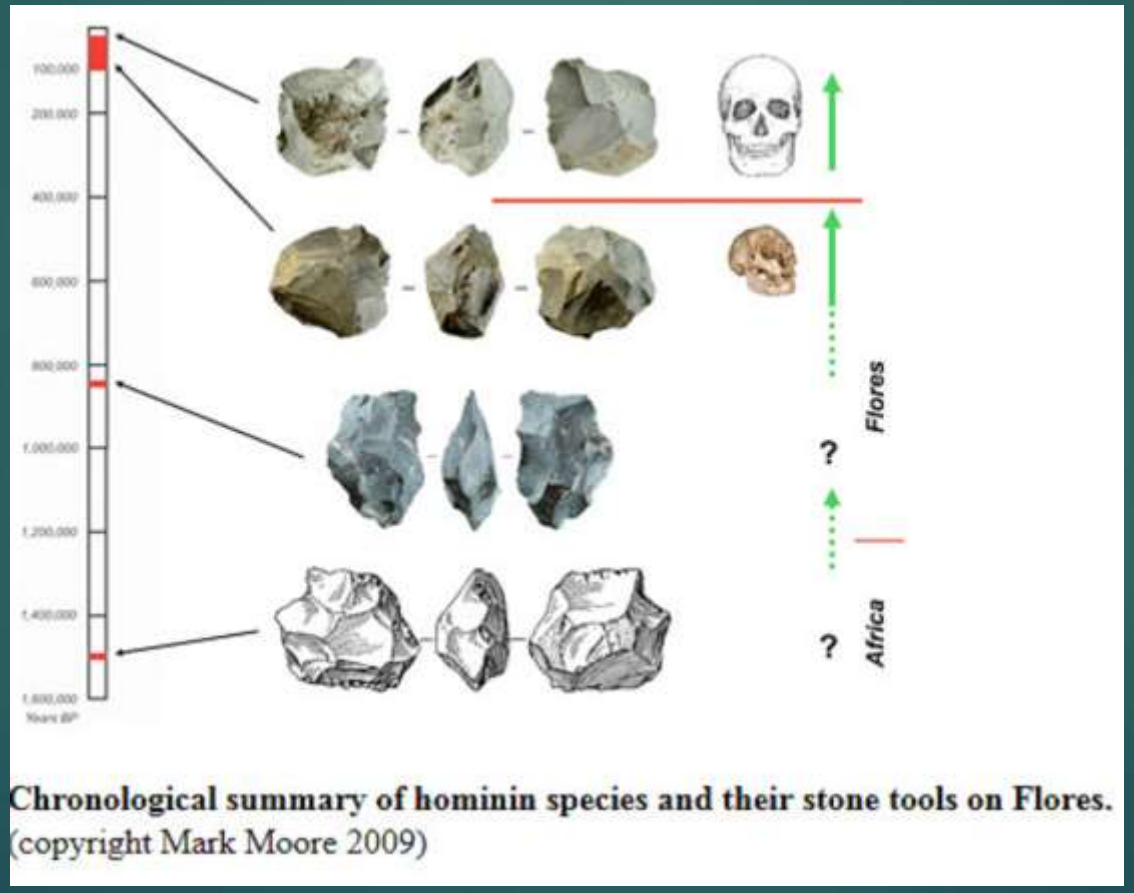


Comparison of stone tools made by *H. floresiensis* and modern *H. sapiens* at Liang Bua. (copyright Mark Moore 2009).

Tools

Stone tools excavated from the Hobbit home in Flores *(Image: Mike Morwood)*

Flores Stone Tools



Chronological summary of hominin species and their stone tools on Flores.
(copyright Mark Moore 2009)

Modern

Flores

840Ka

1.4Ma

Mata Menge & Liang Bua: Same tool lineage

- Australian archaeologist Adam Brumm compared the LB tools to some 500 stone artifacts excavated from the Mata Menge site in the Soa Basin of central Flores (just fifty kilometers west of the LB cave) dated from 840,000 years ago—at least 500,000 years prior to *H. sapiens*

- Both assemblages evidenced the same use of raw materials and a very similar freehand reduction technique. Both sites, in fact, produced the same types of tools of similar maximum dimensions.

- According to Brumm, "the stone artifacts from Mata Menge and Liang Bua represent a technology made by the same hominin lineage. Pronouncements that *H. floresiensis* lacked the brain size necessary to make stone artifacts," he concluded, "are therefore based on preconceptions rather than actual evidence."

(Brumm 2006).

Hypotheses of the origination of *H. floresiensis*

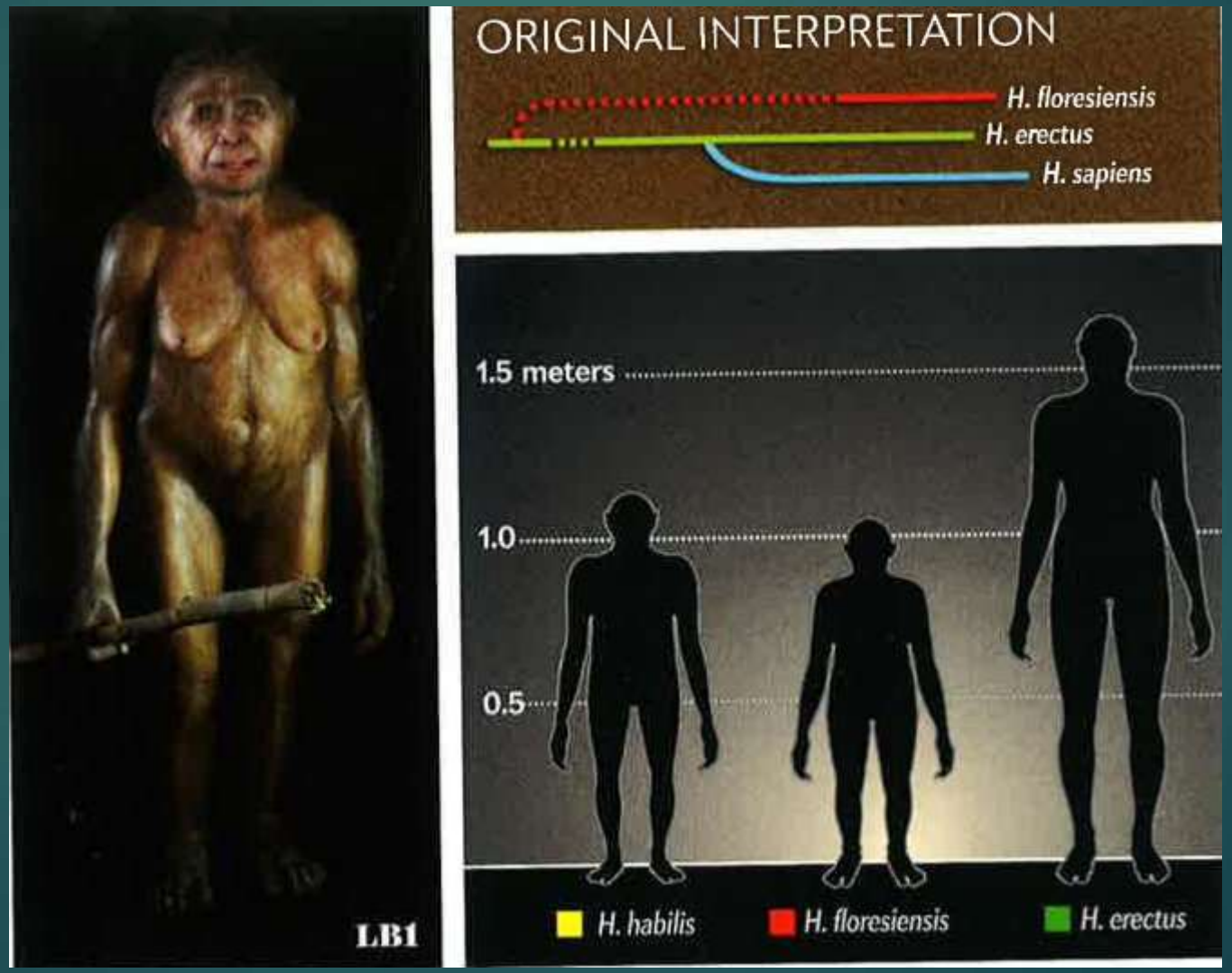
Conflicting Hypotheses

- There are major conflicting hypotheses on the cause of the small stature and small cranial capacity of LB1

- Three major camps quickly emerged over its possible ancestry:
  - 1 - dwarfed population descended from the type of *Homo erectus* populations seen on neighboring Java (Brown et al., 2004, Kaifu and Fujita, 2012);
  - 2 - pathological or pygmy population of *H. sapiens* (Jacob et al., 2006; Richards, 2006; Hershkovitz et al.,2007; Perry and Domini, 2009);
  - 3 - most contentious of all is the suggestion that it belonged to a primitive lineage that extended back to early forms of *Homo* or even Australopithecus that dispersed from Africa in the earliest part of the Pleistocene (Argue et al., 2006; Tocheri et al., 2007; Brown and Maeda, 2009; Falk et al., 2009; Jungers et al., 2009; Larsson et al.,2009; Morwood and Jungers, 2009; Aiello, 2010).

H. floresiensis
is a dwarfed *H. erectus*

Original Interpretation: *Homo floresiensis* is a dwarfed descendant of *Homo erectus*



First Theory:
Homo erectus descendant

- Original hypothesis by Brown & Morwood: Endemic island dwarfing of *Homo erectus* (Brown et al., 2004; Morwood et al., 2005).
- One time unique by-sea colonization; since recurrent ones would have interrupted dwarfing process (Meijer *et al.*, 2010).
- *Homo erectus* was the only hominid in Indonesia in the time period just preceding the Flores time period (95Ka); *Homo sapiens* arrives ~50Ka.

Homo erectus and LB1

Fig. 2. Sangiran 17 (left) and LB1 (right). (Photo: Peter Brown).

Brown's original assessment: stature due to "island rule"

- "Island rule,": the selective advantage of insular dwarfing in the context of isolated, predator-free environments marked by reduced competition and resources.
- Smaller species would be favored in such situations due simply to their reduced energy requirements.
- Would make *H. floresiensis* the first example of a human following the so-called island rule.
- Brown concluded that H. floresiensis resulted from dwarfing of *Homo erectus*

Morphology related to *H. erectus*

- *Homo* floresiensis has morphology similar to that of a *Homo erectus* juvenile, since it has a high orbital, dental and brachial index, low humeral torsion, low tibial torsion and a high jaw angle. (Brown *et al.*, 2004; Falk *et al.*, 2005; Baab and McNulty, 2009).

- The low neurocranium (the part surrounding the brain) with a flat and sloping forehead, thick cranial bones, short and flat face, and other details of LB1's skull anatomy (e.g., an occipital torus and a mastoid fissure), as well as the shape of the brain provide a link to *Homo erectus*.

- But the small body size and brain size are outside of the expected range for that species (Brown *et al.*, 2004; Falk *et al.*, 2005; Baab and McNulty, 2009).
- Therefore, based primarily on the cranial evidence, the original description proposed that these fossils represented a new species, *Homo floresiensis*, that was a dwarfed descendent of *Homo erectus.*

Baab, 2012

Sick Hobbit Hypothesis:
H. floresiensis
is a pathological *H. sapiens*

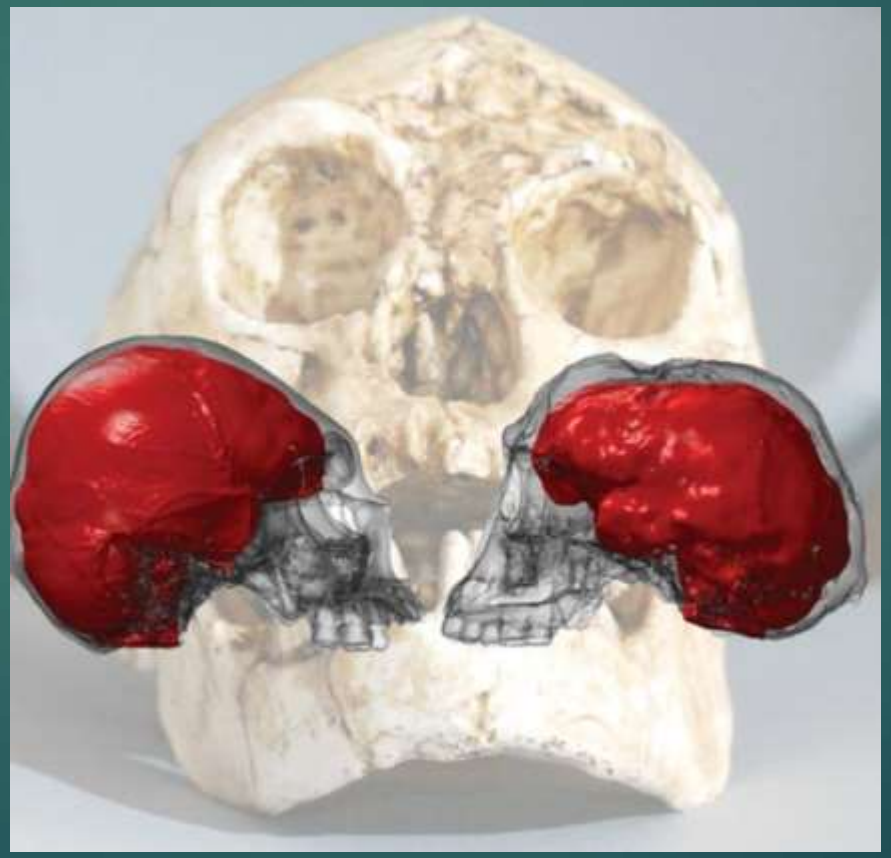
LB1 is a Modern Human but has a pathological condition

- Some researchers suggest that some or all of the specimens recovered from Liang Bua are pathological members of a small-bodied modern human population.

- Two major theories:
  - Microencephaly
  - Hormone problem

Microencephaly: abnormally small heads and brains

Microencephalic



LB1

Freaks, 1932

Figure 20. Madame Tetrallini (Rose Dione) with her arms around (left to right) the famous microcephalics Simon Metz (Schlitzie) and Zip and Pip (Jenny Lee and Elvira Snow). Another microcephalic called Bird Girl (Elizabeth Green) peeks from behind Dione's right arm, while Angeleno (Angelo Rossitto, who is not a microcephalic) clings to Schlitzie. Image from Tod Browning's 1932 film *Freaks*. Obtained from Photofest Photo Archives, New York City.

2006: LB1 is microcephalic

- LB1 is a modern human that suffered from microcephaly, a condition in which the neurocranium is considerably smaller than that of normal, healthy people (Henneberg and Thorne, 2004; Martin *et al.*, 2006; Jacob *et al.*, 2006).

- LB1 is drawn from an earlier pygmy *Homo sapiens* population but individually shows signs of a developmental abnormality, including microcephaly
  - Teuku Jacob et al., 2006

- LB1 could well be a microcephalic *Homo sapiens*
  - Robert D. Martin et al, 2006

- Others believe that *Homo floresiensis* is a population of microcephales, or that LB1 is a microcephale from a population of pygmies (Richards, 2006; Jacob et al., 2006).

- Lee Berger: Using a Palauan comparison sample, a pygmy with small brain due to congenital abnormalities (L. Berger, 2008)

Multiregionalists Henneberg &Thorne

- Marciej Henneberg and Alan Thorne published their criticisms of Brown and Morwood's conclusions in a non-peer-reviewed journal *Before Farming* (Henneberg and Thorne 2004).

- Secondary microcephaly (secondary, meaning occurring later in development), explains LB1's paradoxically small braincase (five to six standard deviations below the modern average) relative to her "normal" face, nose, and jaw (three standard deviations below average).

- Comparing two microcephalic skulls described in the archaeological records to the skull of LB1, the authors found that not one of the fifteen dimensions evaluated differed by more than 2.5 standard deviations.

- Henneberg and Thorne also described LB1's orthodontic crowding and rotation problems and her receding chin as consistent with the suggested growth disorder.

Jacob: LB1 is asymmetrical

- Jacob et al. (2006), the most important opponents, have tried to make a case for the possible pathology of LB1. One of their arguments is that LB1 is very asymmetrical, which would interfere with mastication and represent a developmental abnormality.

- Apart from the fact that most crania, which have been buried, are asymmetrical due to taphonomy, it is actually quite normal for crania to be asymmetrical

- But Kaifu et al. (2009): posterior deformational (positional) plagiocephaly (PDP): asymmetries
- do not lie outside of the normal range of variation

Three Faces of LB1: The image on the left shows LB1's actual skull. The other two photos are composites made by dividing right and left sides at the midline and mirroring each side to yield two photos displaying obvious differences in right and left side facial architecture.

LB1 2 Rights 2 Lefts

Powledge TM (2006) What Is the Hobbit?. PLoS Biol 4(12): e440. doi:10.1371/journal.pbio.0040440
http://www.plosbiology.org/article/info:doi/10.1371/journal.pbio.0040440

Teuku Jacob: Microcephaly

- Teuku Jacob offered and tested an alternative hypothesis: the "LB1 was an Australomelanesian *H. sapiens* who manifested microcephaly, which is commonly accompanied by other developmental abnormalities" (Jacob 2006).
- Jacob contended that none of the ninety-four previously described cranial features of LB1 or the forty-six features of the two mandibles were outside the range for regional modern humans.
- Explanation for absence of a chin—Jacob referred to the Rampassa pygmies currently living near the Hobbits' cave, 93 percent of whom display flat or even negative chins.
- Jacob found LB1's face to be highly asymmetrical: six of seven measured areas of its right side were as much as 40 percent larger than those on the left.

The fight begins

- Doubts that the remains constitute a new species were soon voiced by the Indonesian anthropologist Teuku Jacob, who suggested that the skull of LB1 was a microcephalic modern human.

- Two studies by paleoneurologist Dean Falk and her colleagues (2005, 2007) rejected this possibility.

- Falk *et al.* (2005) has been rejected by Martin *et al.* (2006) and Jacob *et al.* (2006), but defended by Morwood (2005) and Argue, Donlon *et al.* (2006).

- Many studies: Weber et al., 2005; Falk et al., 2005a,b, 2006, 2007a,b,c, 2009b; Holloway et al., 2006; Martin et al., 2006a,b; Martin, 2007

Many studies

- Pathological explanation: Weber, 2005; Martin et al., 2006a,b; Martin, 2007; Richards, 2006; Henneberg, 2007; Hershkovitz et al., 2007; Tuttle and Mirsky, 2007; Rauch et al., 2008; Obendorfet al., 2008).
- Others equally strongly support the ‘‘new species hypothesis’’: Argue et al., 2006, 2007; Brumm et al., 2006; Falk et al., 2005a,b, 2006, 2007a,b,c; Larson 2007; Larson et al., 2007a,b; Tocheri et al., 2007; Zeitoun et al., 2007; Van Heteren and de Vos, 2007; Gordon et al., 2008; Jungers et al., 2008, 2009a; Lyras et al., 2009; Jungers and Morwood, 2009

Robert Martin: Brain too small

- Robert Martin, an allometry (relative growth) specialist at the Field Museum of Natural History in Chicago, refuted Morwood's initial claim that the Hobbits had descended from *H. erectus* (Martin 2006a).
- LB1's braincase was smaller than any other known hominin less than 3.5 million years old, he observed, and much too small to derive from *H. erectus* by normal dwarfing.
- Martin et al. (2006) compare the skull and endocast of *Homo floresiensis* with two microcephales. They conclude that the size and shape of the cranium of *Homo floresiensis* is very similar to one of these individuals. Therefore they think it is likely that LB1 also suffered from this disease.

Martin leaves open an alternative

- Martin conceded an important point, however. LB1's forelimb/hindlimb ratio did resemble that of something more primitive than *H. erectus*.
- It was "marginally possible," therefore, that LB1's remains provided "evidence of a new species from a lineage that diverged at a very early australopithecine stage, about 3 mya, when cranial capacity was still very small."

Falk

- Morphometric, allometric, and shape data indicate that LB1 is not a microcephalic or pygmy.
- There are fundamental differences between normal human endocranial casts and all known microcephalic endocranial casts
- H. floresiensis falls clearly with modern humans
- LB1 has derived frontal and temporal lobes and a lunate sulcus in a derived position, which are consistent with capabilities for higher cognitive processing.

D. Falk, et al., 2005

Falk: Brain size vs. reorganization

- Compared LB1's virtual endocast to those of nine "heterogeneous" microcephalics and ten normal humans (Falk 2007): unique = "the frontal breadth relative to cerebellar width and lack of cerebellar protrusion" classified LB1 at "100% probability with normal *H. sapiens* rather than microcephalics"
- In the second paper, Falk identified seven distinct features of LB1's brain that were derived and not pathological (Falk 2009a).
- Not just product of brain size alone, but of cortical reorganization as well.

Falk: Advanced brain features: reorganization independent of brain size

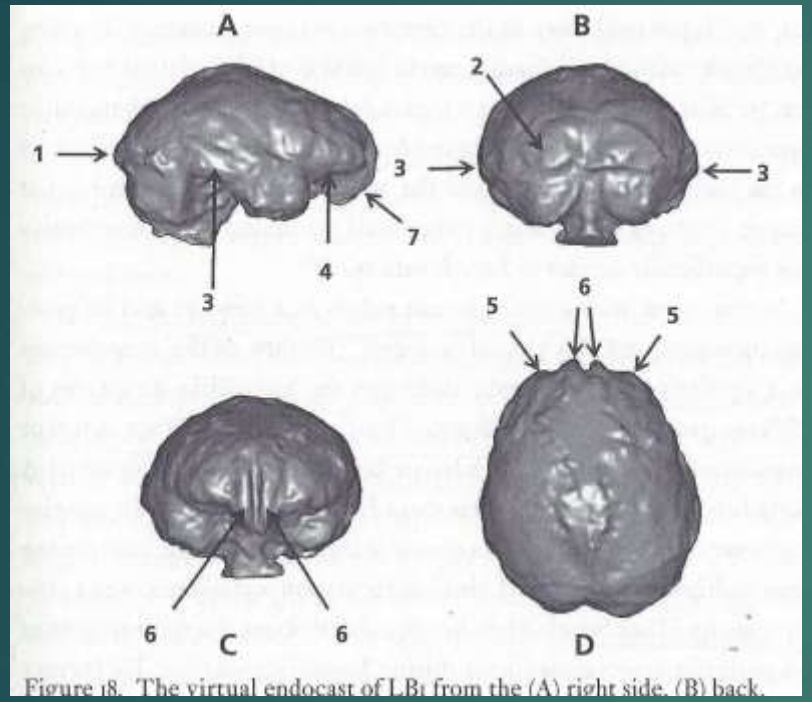


Figure 18. The virtual endocast of LB1 from the (A) right side, (B) back,

- 1 Protruding occipital lobe
- 2 Posterior lunate sulcus
- 3 Temporal lobe expanded at back
- 4 Lateral prefrontal lacks apelike sulcus
- 5 Anterior prefrontal
- 6 Expanded Area 10
- 7 Expanded bottom of prefrontals

Falk recognizes seven derived features of the LB1 endocranial cast, suggesting that that neurological reorganization occurred independently of an
increase in brain size (Falk et al., 2009b)

Dean Falk: Brodmann's area 10

- Comparison of LB1's virtual endocasts with brain molds of great apes, an australopithecine, an H. erectus, an average-sized H. sapiens, a pygmy, and a microcephalic H. sapiens (Falk 2005b).
- SLB1 closely resembled A. africanus in terms of relative brain-to-body size, its brain's general shape was most similar to that of H. erectus. Importantly,
- Flores hominin's endocast bore little likeness to that of the pygmy and least of all to the microcephalic.
- LB1's extremely wide temporal lobes and expanded frontal polar region (Brodmann's area 10—probably involved in planning and initiative taking—in humans).
- In the end, Falk's team (including Brown and Morwood) settled on two potential evolutionary scenarios: *H. floresiensis* either dwarfed under the island's unusual allometric constraints or shared with *H. erectus* an unknown, small-bodied, and tiny-brained ancestor.

Virtual endocasts: LB1 most like *H. erectus*

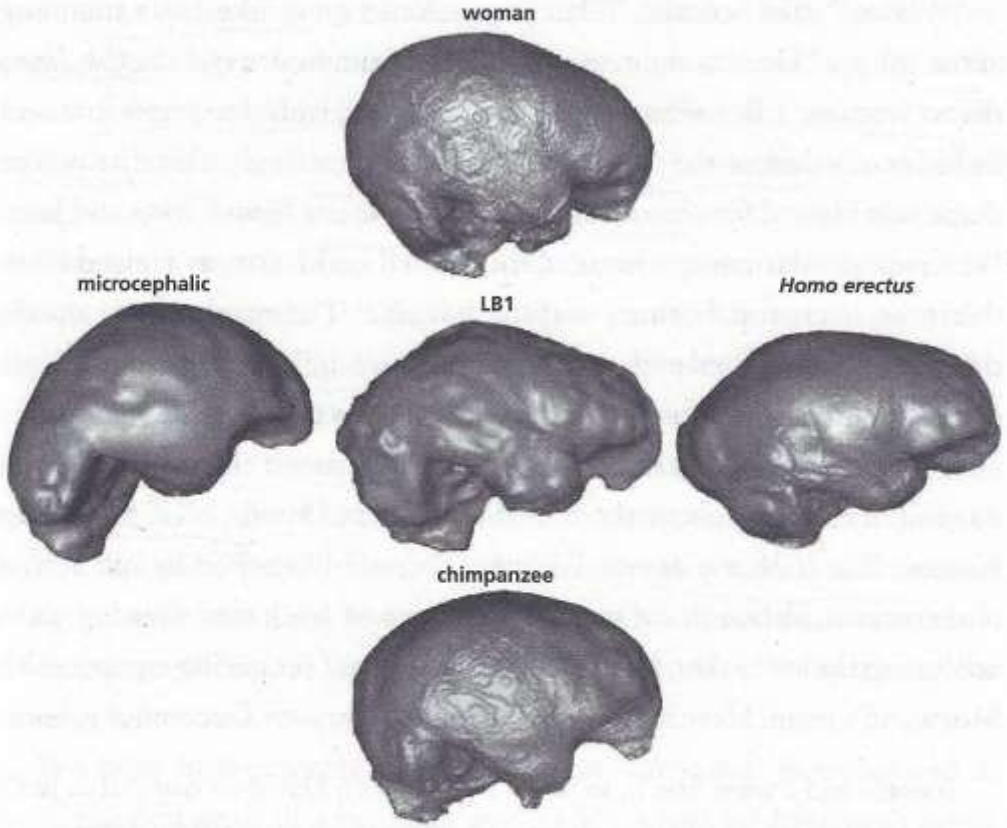


Figure 17. Virtual endocasts viewed from their right sides. The frontal lobes face to the right; the back end of the brains (occipital lobes) are to the left. The endocasts have all been made the same volume electronically so that the shapes are easier to compare visually. LB1's endocast looks most similar to that from *H. erectus* and differs most from the endocast of the microcephalic. Courtesy Kirk Smith, Mallinckrodt Institute of Radiology.

Falk

- Falk's claims did not go unchallenged.
- German neuroscientist Jochen Weber, for example, analyzed nineteen different microcephalics (with a mean brain capacity of 404 cc) and found that seven, like LB1, presented an enlarged Brodmann's area 10 (Weber 2006).
- Falk discovered many errors in Weber's data.

2008: 3D-morphometrics – not microencephaly

- Falk's argument was supported by Lyras et al. (2008) in that 3D-morphometric features of the skulls of microcephalic *H. sapiens* indeed fall within the range of normal *H. sapiens* and that the LB1 skull falls well outside this range.
- This was interpreted as proving that LB1 cannot, on the basis of either brain or skull morphology, be classified as a microcephalic *H. sapiens*.
- Dean Falk has very recently referred to the pathology hypotheses—as unscientific "cognitive dissonance" (Falk 2009b).

A. *H. floresiensis*, B. Microcephalic *H. sapiens*; C. *H. erectus*; D. *H. sapiens*

LB1

H. erectus

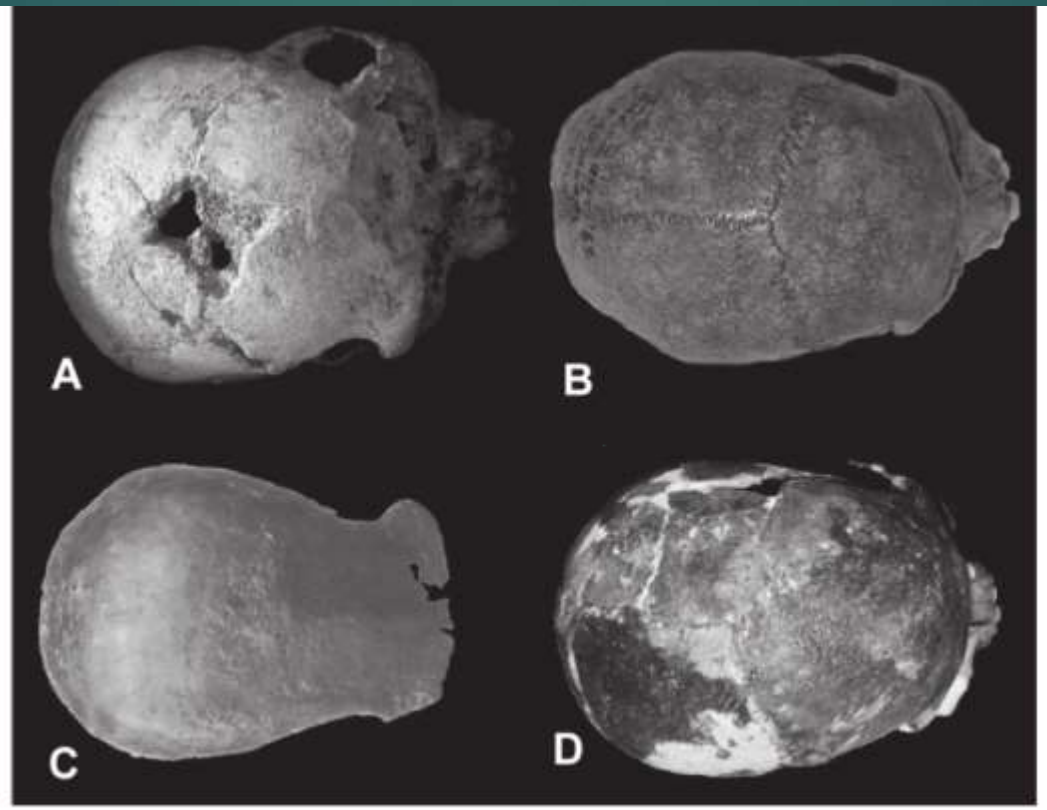


Figure 2. Dorsal view of (A) *H. floresiensis* (LB1), (B) Microcephalic *H. sapiens* from Crete (NAMA–Malakari–1962), (C) *H. erectus* (NNML–Trinil–2), and (D) *H. sapiens* from Liang Momer (NNML–Momer skull E). All specimens are scaled to the same anteroposterior length.

Microcephalic *H. sapiens*

H. sapiens

Pathological H. sapiens vs. LB1

hypothyroidism **LB1** **microcephaly**

Despite similarities due to a small cranium, the profile and facial skeleton differ

2 Microencephalics on the left

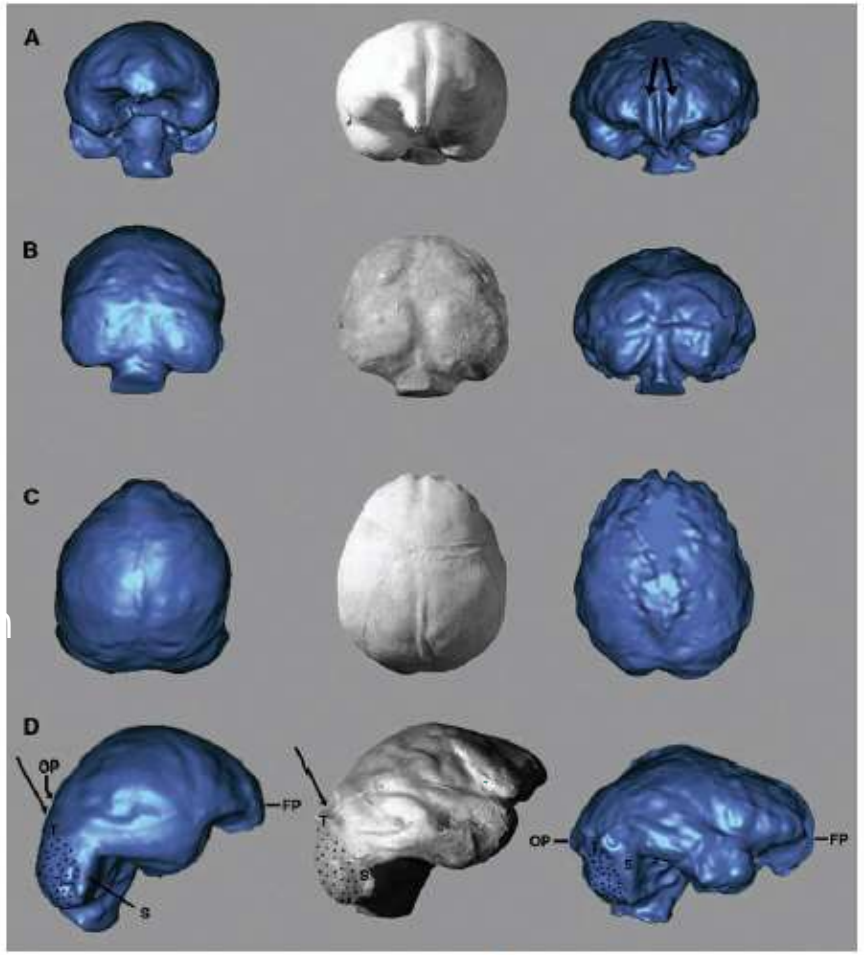


Fig. 1. Endocasts, from left to right, of a microcephalic we described (*2*), microcephalic(s) described by Weber *et al.* (*1*), and LB1 (*2*). Views: (**A**) frontal; (**B**) posterior; (**C**) dorsal; (**D**) right lateral. Blue images are virtual endocasts (*2*); images are scaled to approximately the same size to facilitate shape comparison. The brainstem was used to align the lateral views. FP, frontal pole; OP, occipital pole; S, sigmoid sinus; T, transverse sinus. Stippled areas represent the cerebellum. Arrows in top row point to two distinct convolutions on the frontal lobe of LB1 that are not seen on the two microcephalics. The lateral view provided by Weber *et al.* (D, middle) appears truncated on the inferior surface of its frontal lobe, contrary to the frontal view (A, middle), which points down in the region of the olfactory bulbs. The outlines in the frontal and posterior views of our microcephalic's endocast are similar, which is also true for LB1 but not for the Weber *et al.* specimen. We therefore question whether the images in the middle column are from one individual as stated by Weber *et al.* (see their caption for Figure 2). Arrows in the bottom row identify the superior margin of the transverse sinus. The occipital pole of the cerebrum of Weber *et al.*'s microcephalic must be rostral to the arrow (i.e., to its right), as is the case for our microcephalic on the left (*2*). Contrary to these microcephalics, OP in nonpathologic *Homo* (including LB1 on the right) protrudes farther back than the caudal pole of the cerebellum.

LB1

Falk: Completely different shapes

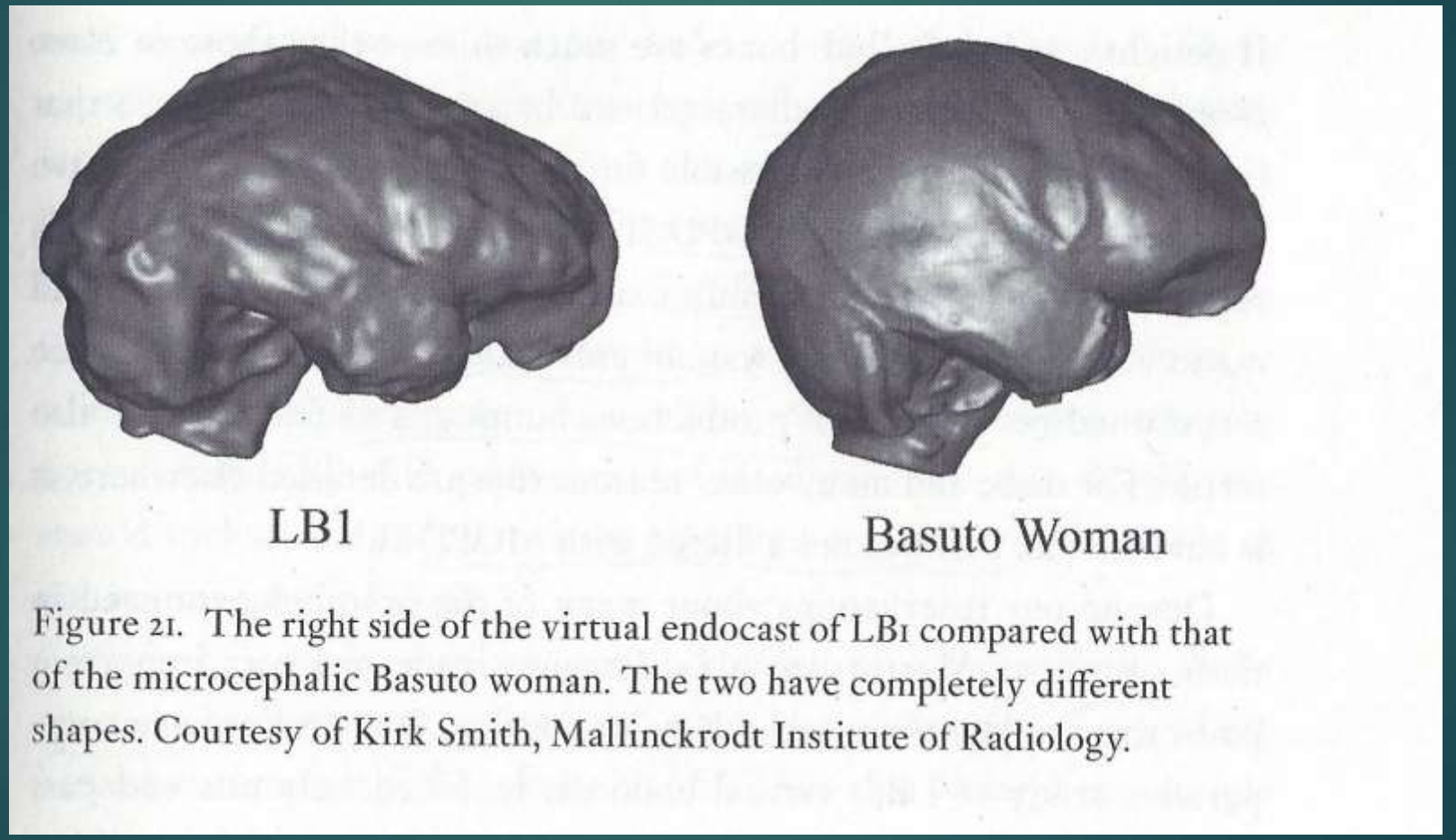
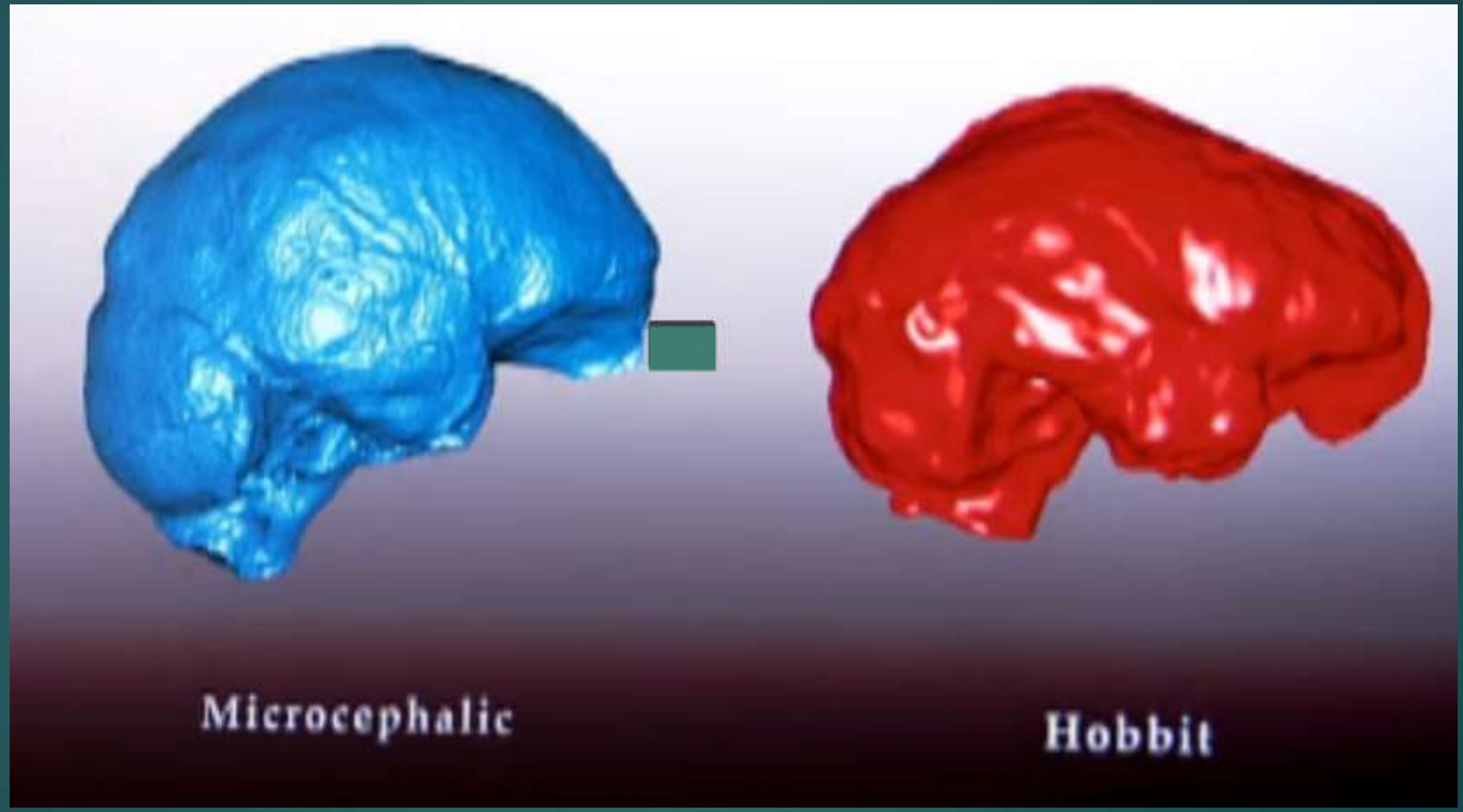
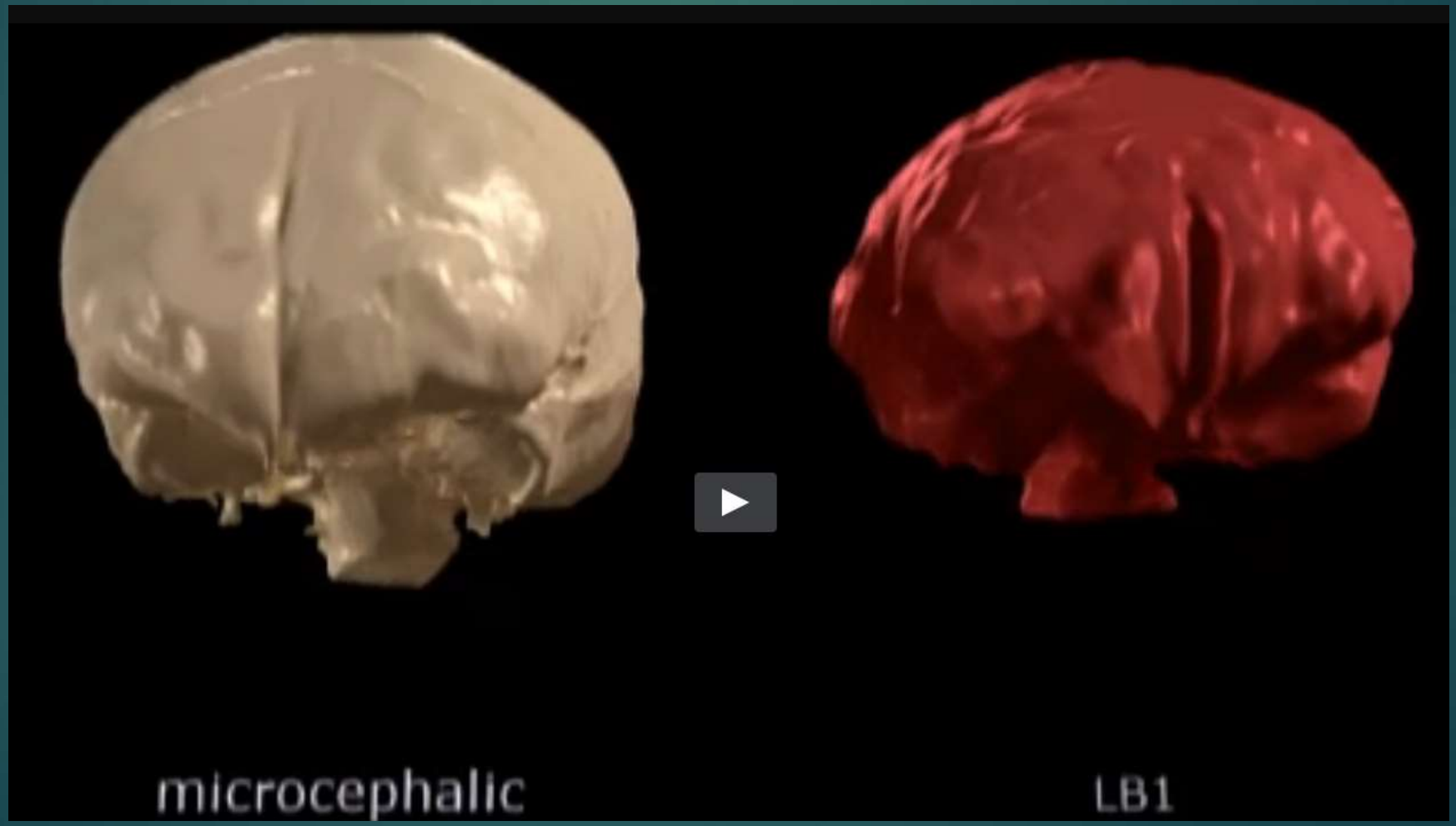


Figure 21. The right side of the virtual endocast of LB1 compared with that of the microcephalic Basuto woman. The two have completely different shapes. Courtesy of Kirk Smith, Mallinckrodt Institute of Radiology.

Falk



Falk



2013: Microencephalic

- Vannucci & Holloway: Compared to 79 modern human adult endocasts and 12 modern microcephalic endocasts, LB1 (*Homo floresiensis*) clustered more consistently with the microcephalic sample than with the normocephalic sample.
- Specifically, LB1 clusters to a greater extent with microcephalics than with normocephalics, supporting—but not proving—the contention that LB1 represents a modern pathological microcephalic individual.

Robert C. Vannucci, et al., Anat Rec, 2013

Critique of this hypothesis

- There is a clear similarity in the shape of the skull between archaic species of *Homo* and humans with microcephaly — primarily in the high ratio of facial to neurocranial size.
- Similarity in in shape for two very different reasons:
  - microcephalic humans have pathologically underdeveloped brains
  - early hominins belonged to species normally characterized by smaller brains
  - These similarities are only superficial and more detailed examination of the cranial vault shape, as well as the shape of the underlying brain, shows that LB1 shares important characteristics with fossil *Homo* species (Falk *et al.*, 2005, 2007; Baab, 2010).

Critique 2:
not same postcranial morphology

- The proponents of the pathology hypothesis have thus far failed to identify exactly what disorder can account for the large number of apparently primitive traits in the LB1 skeleton.

- Abnormal growth seems an unlikely explanation as growth-hormone-related dwarfism and microcephaly in modern humans result in normal limb and pelvic proportions.

Hormone Problem

2006: Growth Hormone Deficiency

- University of California at Berkeley biologist Gary Richards
- Richards first proposed a genetic rather than a pathological cause of the Hobbits' morphology
  - a mutation in the MCPH gene family combined with a modification of the growth hormone/insulin-like growth factor I axis).
- The remains represent a variant of *H. sapiens* possessing a combined growth hormone – insulin-like growth factor I axis modification and mutation of the MCPH gene family

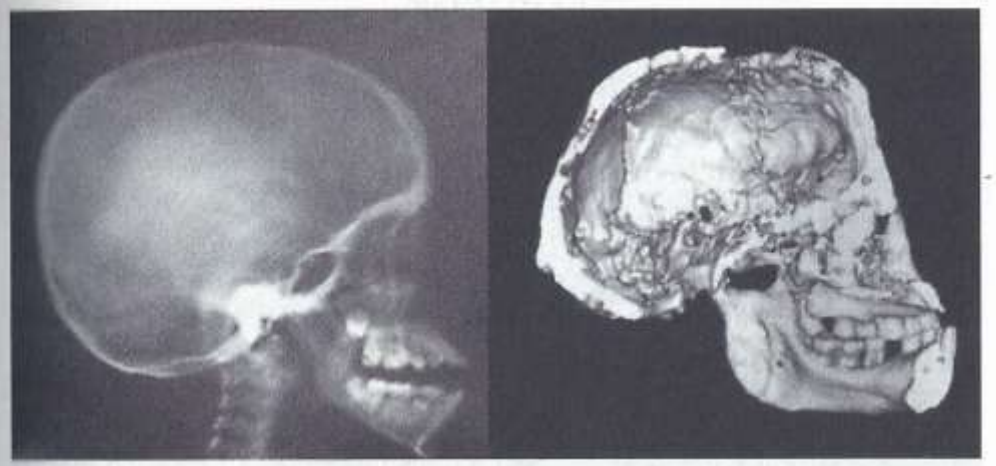
(Gary D. Richards, 2006)

2007: Laron Syndrome

- Hershkovitz: Laron syndrome (primary growth hormone insensitivity (Hershkovitz *et al.*, 2007): Laron patients have normal levels of growth hormones, but a genetic mutation causes their bodies to fail to respond to the hormones.

- LS, or primary growth hormone insensitivity, is a recessively inherited malady resulting from deletions or mutations within the growth hormone receptor (GH-R) gene
- The resulting phenotype, is extremely low stature and small head, but normally shaped bones.
- Falk: it is now clear that the case was overstated (Falk *et al.*, 2009), and that the evidence for this particular syndrome in LB1 is nonexistent. Patients with Laron Syndrome typically have a protruding forehead, underdeveloped facial bones (face looks small), and a skull that is disproportionately wide across the **parietal bones**. The LB1 skull shows the opposite pattern: the forehead slants backwards rather than protruding, the face is large relative to the rest of the skull, and it is wide at the base rather than the parietals (Falk *et al.*, 2009; Baab, 2010).
- Falk: many of Hershkovitz's criteria were completely alien to the LS diagnostic standards.

LS vs. LB1



A B

Figure 25. X-ray of the skull of an LS patient (A) compared with a CT image of LB1's skull (B). The image for the LS patient has been enhanced with image adjustments for shadow and highlights, which reveal that the chin is not underdeveloped as claimed (Hershkovitz, Kornreich, and Laron 2008). Notice that the shapes and thicknesses of the two braincases differ dramatically, as do the sizes and configurations of the jaws and teeth. Created by Kirk Smith, Mallinckrodt Institute of Radiology; reproduced from Falk, Hildebolt, et al., "Nonpathological asymmetry," 2009.

Note thickness of braincases: differ dramatically

2008: Thyroid Problem – Iodine deficiency

- Thyroid hypothesis: myxoedematous endemic (ME) cretins, (Peter Obendorf et al., 2008)
- An environmental rather than a strictly genetic explanation: myxoedematous endemic (ME) cretinism.
- Suffering from a lack of iodine, ME cretins are born without a functioning thyroid. The congenital hypothyroidism that results leads to severe dwarfism and reduced brain size but less severe mental retardation and motor disability than in neurological endemic cretinism.
- Jungers (along with Falk, Tocheri, Larson, and Morwood, among others) contended that Obendorf's cretinism hypothesis "can be rejected due to numerous errors of fact and unsubstantiated speculations" (Jungers 2009).

Modern – hypothyroidism LB! Modern Microcephaly

Figure 4: The LB1 cranium (center) compared to skulls of a modern human with endemic hypothyroidism (left) and a modern human showing microcephaly (right).

All photographs were scaled to the same maximum cranial length to emphasize shape differences among them. For example, the skull of the "cretin" (on the left) is much taller but shorter front-to-back than LB1. Despite the superficial similarities due to a small neurocranium relative to face in both LB1 and the microcephalic modern human, the midline profile of the neurocranium and the facial skeleton differ among them. The photograph of the human with endemic hypothyroidism was mirrored for easier comparison with the other photographs.

Hypothesis: born without a functioning thyroid resulting in a type of endemic cretinism (myxoedematous, ME); myxoedematous endemic hypothyroidism ("cretinism"; Obendorf *et al.*, 2007; Oxnard *et al.*, 2010)

LB1 vs. Swiss Cretin

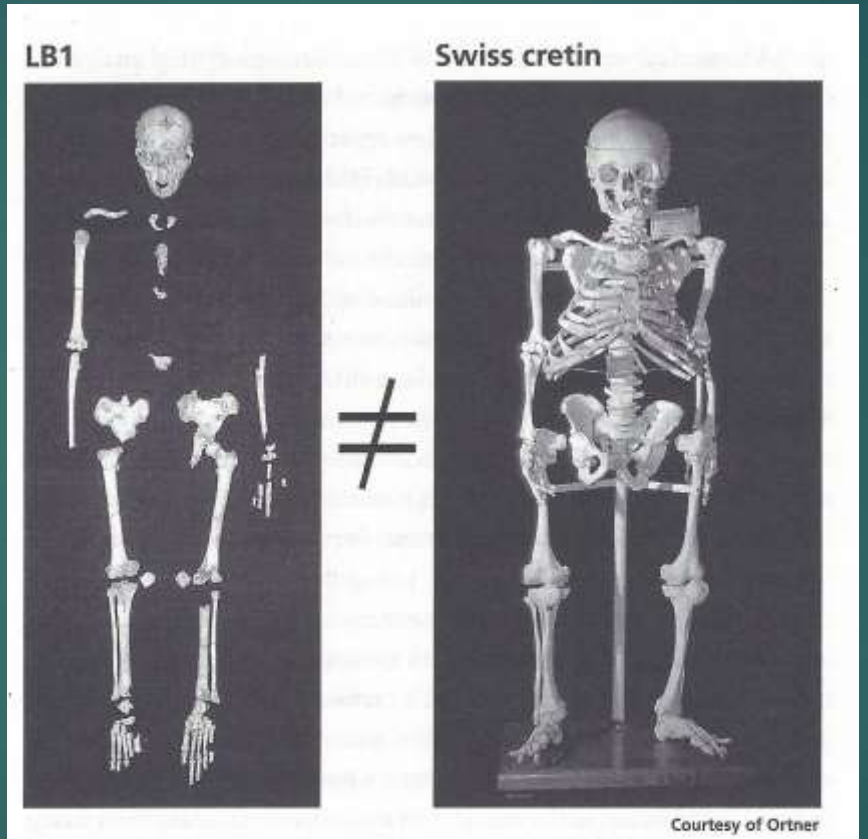


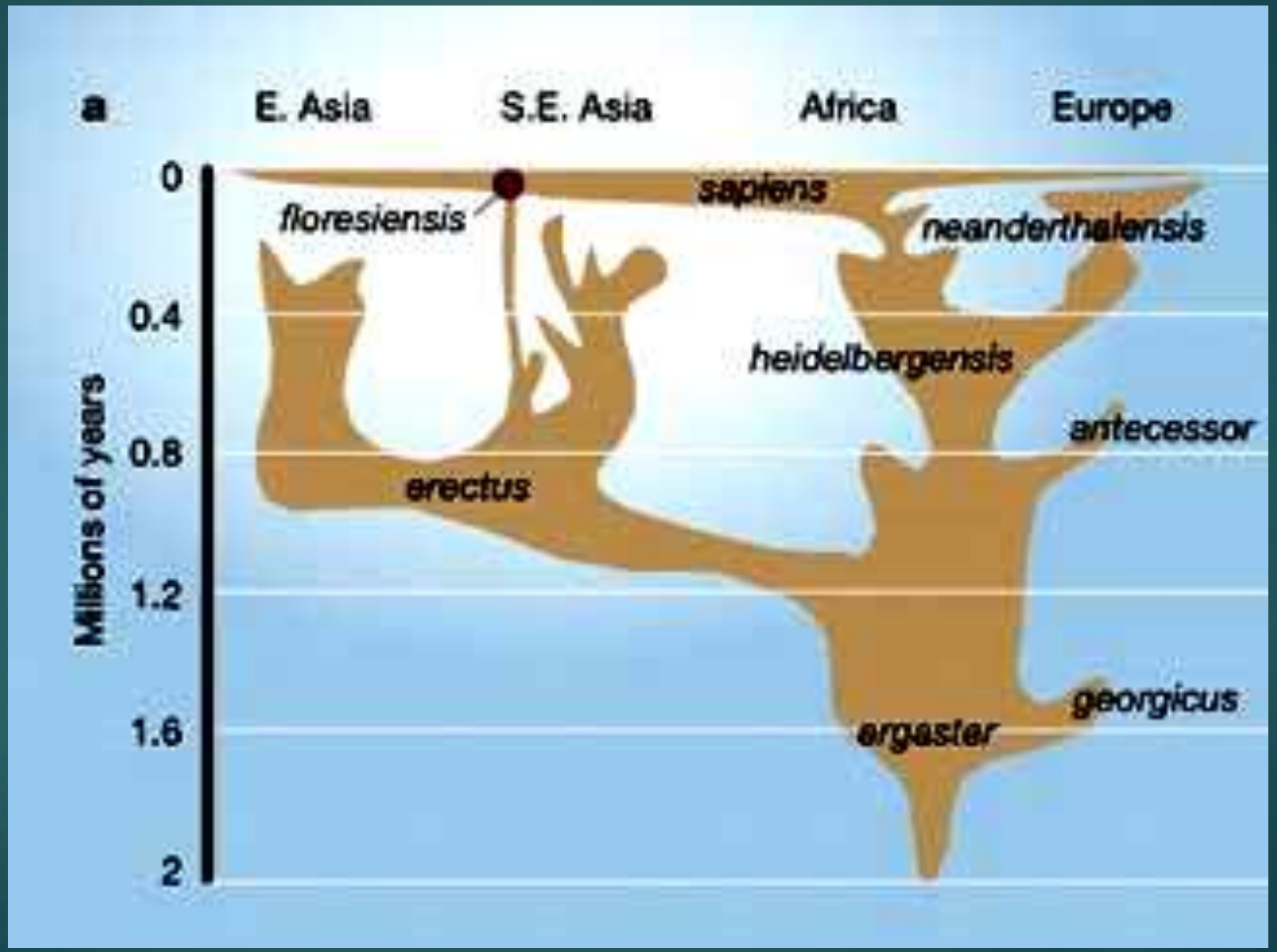
Figure 26. Skeleton of LB1 compared with the skeleton of a Swiss cretin. The skeletons differ dramatically in the shape, thickness, and relative size and proportion of their bones. The cretin's skull is absolutely and relatively larger than LB1's. Photograph of LB1 provided by William Jungers, the State University of New York at Stony Brook; that of the Swiss cretin courtesy of Donald Ortner, Smithsonian National Museum of Natural History.

Conclusion about Pathology

- No pathological syndrome seems to adequately explain the suite of features exhibited by *H. floresiensis*.
- The fact that all of the individuals found at the cave site exhibit similar cranial and postcranial morphology, it is unlikely multiple individuals would all show signs of relatively rare diseases.
- Taken together, the weight of evidence does not support a pathological explanation for the particular characteristics found in LB1 and her kin in Liang Bua cave.
- Pathological explanations for H. floresiensis that have been suggested to date do not account for the complete morphology recognized in H. floresiensis.

A New Hominin Species

H. floresiensis: A new species?



A more primitive ancestry

- *H. floresiensis* is significantly more primitive than *H. erectus* and might have evolved either right before or right after *H. habilis*.
- *H. floresiensis* may have evolved in Africa along with other early *Homo* species, was fairly small when the species reached Flores, and could have undergone some additional dwarfing while on the island.

Do you need long legs to leave Africa?: A challenge to the Out of Africa hypothesis

- The last hypothesis: *Homo floresiensis* was derived directly from a more primitive and smaller-brained form such as Homo habilis (approx. 600 cc) or even Australopithecus (approx. 400 cc).
- This idea demands a revision of the current Out of Africa 1 hypothesis, which supposes first colonization of Eurasia by Homo ergaster (early African Homo erectus) and that no other hominid from pre 2 Ma (Australopithecus or Homo) made it out of Africa.
- Hypothesis that earlier and more primitive hominids (than H. ergaster/erectus) were the first to leave Africa.

Mike Morwood Last Theory

- Mike Morwood of the University of Wollongong in Australia, who helped to coordinate the Liang Bua project before his death, thought the ancestors of LB1 and the gang were early members of *Homo* who were already small—much smaller than even the tiniest known *H. erectus* individuals—when they arrived on Flores and then "maybe underwent a little insular dwarfing" once they got there.

He was already small when he arrived on Flores

- A pre-erectus hominin that arrived on Flores with both a small body and a small brain, as is currently favored by Brown (Brown and Maeda, 2009) and is the consensus opinion of the discovery team (Morwood and Jungers, 2009; and Sankhyan and Rao, 2007; Van Heteren and Sankhyan, 2009).
- *H. floresiensis* is in many ways more similar to early *Homo* species (e.g., *Homo habilis*) than to later *Homo* species.
- This observation supports the idea that the ancestors of *H. floresiensis* left the African continent before the evolution of *H. erectus*, but the precise origins of this species remain unknown.

More primitive postcranially

- Two orthopedic researches published in 2007 reported evidence to support species status for *H. floresiensis*.
- A study of carpal (wrist) bones concluded there were similarities to the carpal bones of a chimpanzee or an early hominin such as *Australopithecus* and also differences from the bones of modern humans.
- A study of the bones and joints of the arm, shoulder, and lower limbs also concluded that *H. floresiensis* was more similar to early humans and apes than modern humans.

Postcranial evidence

- Offshoot of a more primitive, pre-*erectus* hominin species with a small body size and small brain. Evidence from the mandible and the rest of the skeleton supports this hypothesis (Argue *et al.*, 2009).
- The very short legs (relative both to the arms and to the feet) are a pattern seen in apes and australopiths rather than *Homo erectus* (a good *Homo habilis* skeletal comparison has not yet been discovered).
- LB1 was also disproportionately heavy for her height — a pattern closely approximated by the famous 3.2 million year old *Australopithecus afarensis* skeleton of "Lucy" (Jungers and Baab, 2009).

Cranial morphology: not *H. sapiens*

- Three teams have published general studies of LB1's cranial morphology in recent years, and each of the three arrived at a similar conclusion.
- Debbie Argue (2006): LB1's cranium does not resemble those of pygmies and is unlikely to belong to a microcephalic H. sapiens (Argue 2006). Instead, she proposed that LB1's skull is most similar to that of H. ergaster, and that its limb proportions most resembles those of A. garhi.
- Adam Gordon: first scaling analysis of LB1's cranium; found that in the absence of scaling, LB1's skull was most similar to that of non-Asian H. erectus and H. ergaster and that when modern human skulls were scaled to LB1's size, the Flores hominin's cranium proved "even more distinct" from H. sapiens (Gordon 2008).
- Karen Baab: agreed generally that the shape of LB1's skull did not resemble that of small modern humans (Baab and McNulty 2008). They also addressed Jacob's concern regarding LB1's facial asymmetry, finding LB1's features to be "consistent with the degree of asymmetry found in extant apes and humans," and, in fact, "less asymmetrical than some other fossil Homo crania."

Archaic features

- The cranium of LB1 displayed many archaic features:
  - a sloping forehead,
  - browrigdes,
  - absence of a bony chin
  - skull is widest at the level of the mastoids.
  - face is slightly prognathic
  - carpals are very similar in overall morphology to those of *H. habilis* and *Australopithecus*
  - a shoulder morphology comparable to that of Nariokotome boy (Larson et al., 2007).

A. Gordon, et. al., 2008; A.H. van Heteren, 2008

No DNA

- In 2006, two teams, one from ACAD and one from the Max Planck Institute of Evolutionary Anthropology in Leipzig, Germany, attempted to recover DNA from another H. floresiensis tooth excavated in 2003. Both attempts failed.
- In 2011 another team led by Christina Adler also failed.

Cheryl Jones, 2011

Multiregionalists

- Supporters of *H. floresiensis* such as Chris Stringer and Dean Falk attribute opposition partly to the fact that the existence of the species challenges the theories of multiregionalists, who believe that *Homo sapiens* was the only living species of hominin, evolving simultaneously in different regions, at the time when the Flores individuals were alive. Early multiregionalist critics included Alan Thorne and Maciej Henneberg.

2014: Down's Syndrome

- Specimen LB1 from Liang Bua Cave is unusual, but craniofacial and postcranial characteristics originally said to be diagnostic of the new species are not evident in the other more fragmentary skeletons in the sample that resemble other recent small-bodied human populations in the region (including the Andaman Islands, Palau, and Flores itself). Here we demonstrate that the facial asymmetry, small endocranial volume, brachycephaly, disproportionately short femora, flat feet, and numerous other characteristics of LB1 are highly diagnostic of Down syndrome, one of the most commonly occurring developmental disorders in humans and also documented in related hominoids such as chimpanzees and orangutans.

Maciej Henneberg, et al., 2014

2014: Not a species

- The original centrally defining features of "*Homo floresiensis*" are based on bones represented only in the single specimen LB1. Initial published values of 380-mL endocranial volume and 1.06-m stature are markedly lower than later attempts to confirm them, and facial asymmetry originally unreported, then denied, has been established by our group and later confirmed independently. Of nearly 200 syndromes in which microcephaly is one sign, more than half include asymmetry as another sign and more than one-fourth also explicitly include short stature. The original diagnosis of the putative new species noted and dismissed just three developmental abnormalities. Subsequent independent attempts at diagnosis (Laron Syndrome, Majewski osteodysplastic primordial dwarfism type II, cretinism) have been hampered a priori by selectively restricted access to specimens, and disparaged a posteriori using data previously unpublished, without acknowledging that all of the independent diagnoses corroborate the patent abnormal singularity of LB1. In this report we establish in detail that even in the absence of a particular syndromic diagnosis, the originally defining features of LB1 do not establish either the uniqueness or normality necessary to meet the formal criteria for a type specimen of a new species. In a companion paper we present a new syndromic diagnosis for LB1.

Eckhardt, Henneberg al., 2014

Challenges to Older ancestry

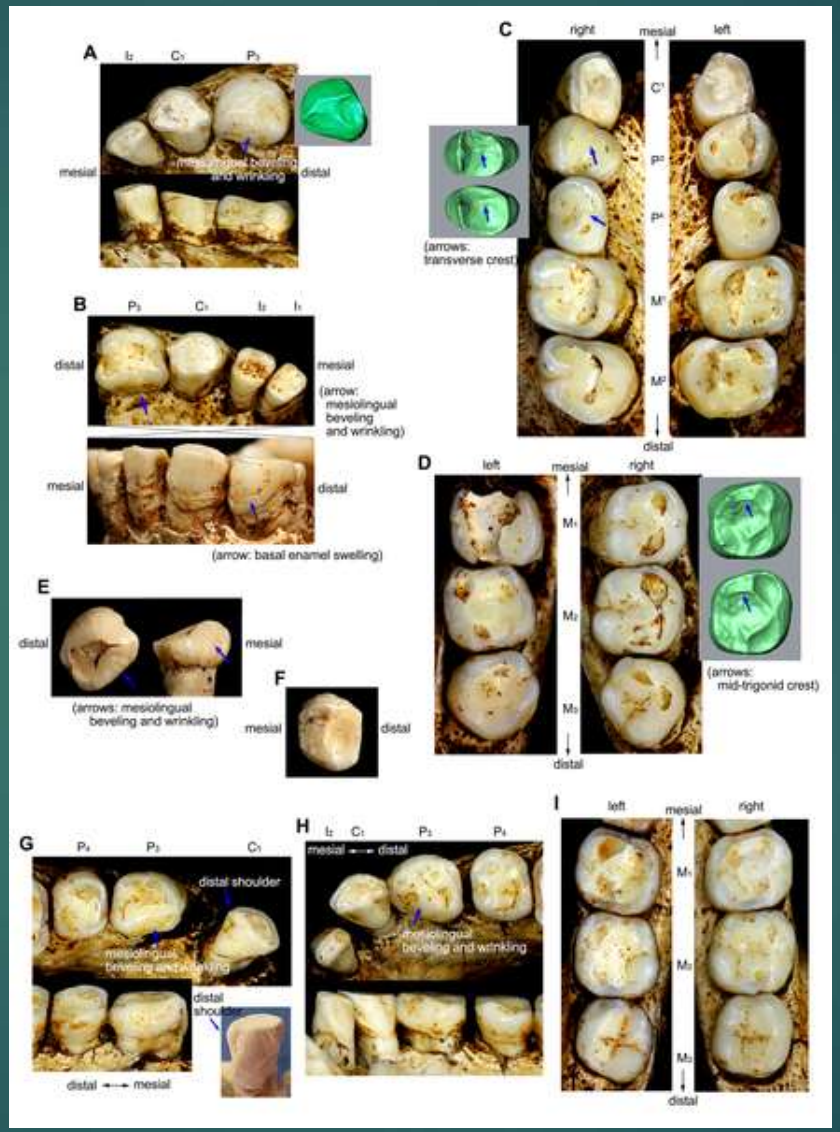
- Least accepted because unlikely that such a lineage could have reached Flores while remaining undetected elsewhere

- One major challenge to the idea that *Homo floresiensis* has an ancestry deeper than *Homo erectus* is the absence of fossils of any such species in either island or mainland Southeast Asia.
- The hominin fossil record prior to *Homo erectus* is found only in Africa.
- A second complication is that the fossil record of postcranial anatomy for pre-*erectus* species of *Homo* is poor and their morphology is not as well documented as other species, so comparison with *Homo floresiensis* is limited.

Leslie Aiello's conclusion

- Leslie Aiello: *Homo floresiensis* is a late-surviving species of early *Homo* with its closest morphological affinities to early African pre-*erectus/ergaster* hominins.
- Evidence supports the hypothesis that *Homo floresiensis* is a late-surviving species of early *Homo* with shared morphological similarities of the early African pre-*erectus/ergaster* hominins.
- This hypothesis provides a more reasonable explanation for *H. floresiensis* than previously established hypotheses about genetic mutations, diseases, and disordered growth.
- None of the current explanations account for the range of features observed in H. floresiensis, nor do they provide explanations for why a pathological condition in modern humans would mimic so closely the morphology observed in earlier hominins.

Teeth of Homo floresiensis.



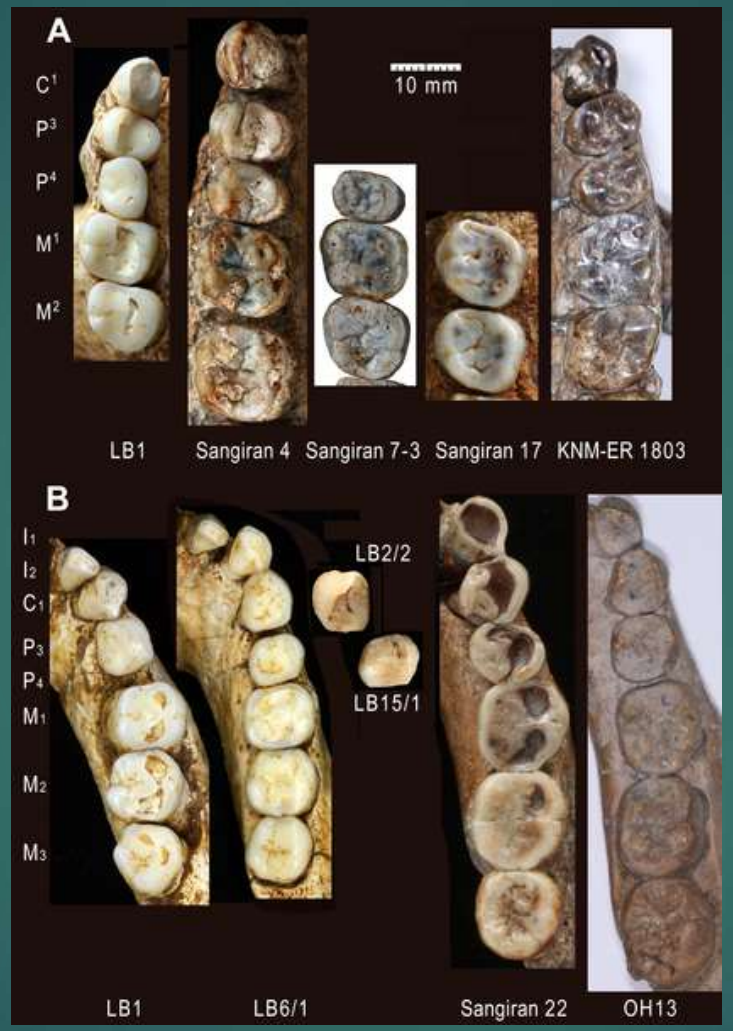
Kaifu Y, Kono RT, Sutikna T, Saptomo EW, Jatmiko ., et al. (2015) Unique Dental Morphology of Homo floresiensis and Its Evolutionary Implications. PLoS ONE 10(11): e0141614. doi:10.1371/journal.pone.0141614
http://journals.plos.org/plosone/article?id=info:doi/10.1371/journal.pone.0141614

2015: Dental analysis

- Dental remains from multiple individuals indicate that *H. floresiensis* had primitive canine-premolar and advanced molar morphologies, a combination of dental traits unknown in any other hominin species.
- The primitive aspects are comparable to *H. erectus* from the Early Pleistocene, whereas some of the molar morphologies are more progressive even compared to those of modern humans.
- This evidence contradicts the earlier claim of an entirely modern human-like dental morphology of *H. floresiensis*, while at the same time does not support the hypothesis that *H. floresiensis* originated from a much older *H. habilis* or *Australopithecus*-like small-brained hominin species currently unknown in the Asian fossil record.
- These results are however consistent with the alternative hypothesis that *H. floresiensis* derived from an earlier Asian *Homo erectus* population and experienced substantial body and brain size dwarfism in an isolated insular setting. The dentition of *H. floresiensis* is not a simple, scaled-down version of earlier hominins.

Yousuke Kaifu, et al., PLOS 1, 2015

Fig 9. Dentitions of H. floresiensis and selected Early Pleistocene Homo specimens.



Kaifu Y, Kono RT, Sutikna T, Saptomo EW, Jatmiko ., et al. (2015) Unique Dental Morphology of Homo floresiensis and Its Evolutionary Implications. PLoS ONE 10(11): e0141614. doi:10.1371/journal.pone.0141614
http://journals.plos.org/plosone/article?id=info:doi/10.1371/journal.pone.0141614

Conclusions

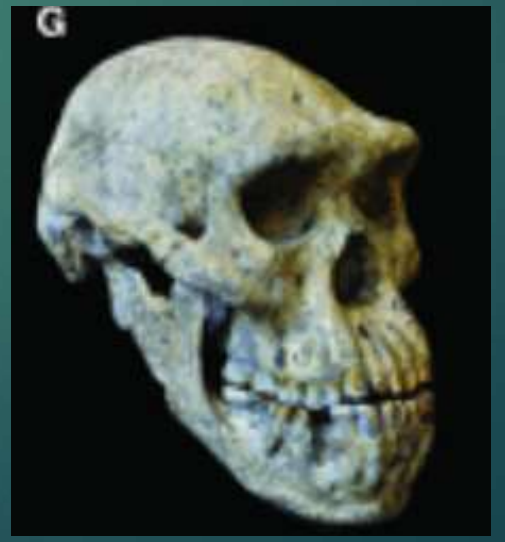
- The Flores species has been retained in the genus *Homo*.
- The genealogy of *H. floresiensis* remains uncertain.
- While some claim that it does not appear to be just "an allometrically scaled-down version of *H. erectus*." , the new dental analysis supports this theory
- These competing hypotheses of origination — insular dwarf of *H. erectus* versus small-bodied, pre- erectus hominin — remain the most viable scientific alternatives currently under active debate.

- R. Roberts: All skeletal remains assigned to *H. floresiensis* are from the pedestal deposits dated to approximately 100–60 kyr ago, while stone artefacts reasonably attributable to this species range from about 190 kyr to 50 kyr in age. Parts of southeast Asia may have been inhabited by Denisovans or other hominins during this period, and modern humans had reached Australia by 50 kyr ago. But whether *H. floresiensis* survived after this time, or encountered modern humans, Denisovans or other hominin species on Flores or elsewhere, remain open questions that future discoveries may help to answer.

Where on hominid tree?

Dmanisi

Dmanisi Skull = Skull 5 = 546 cc



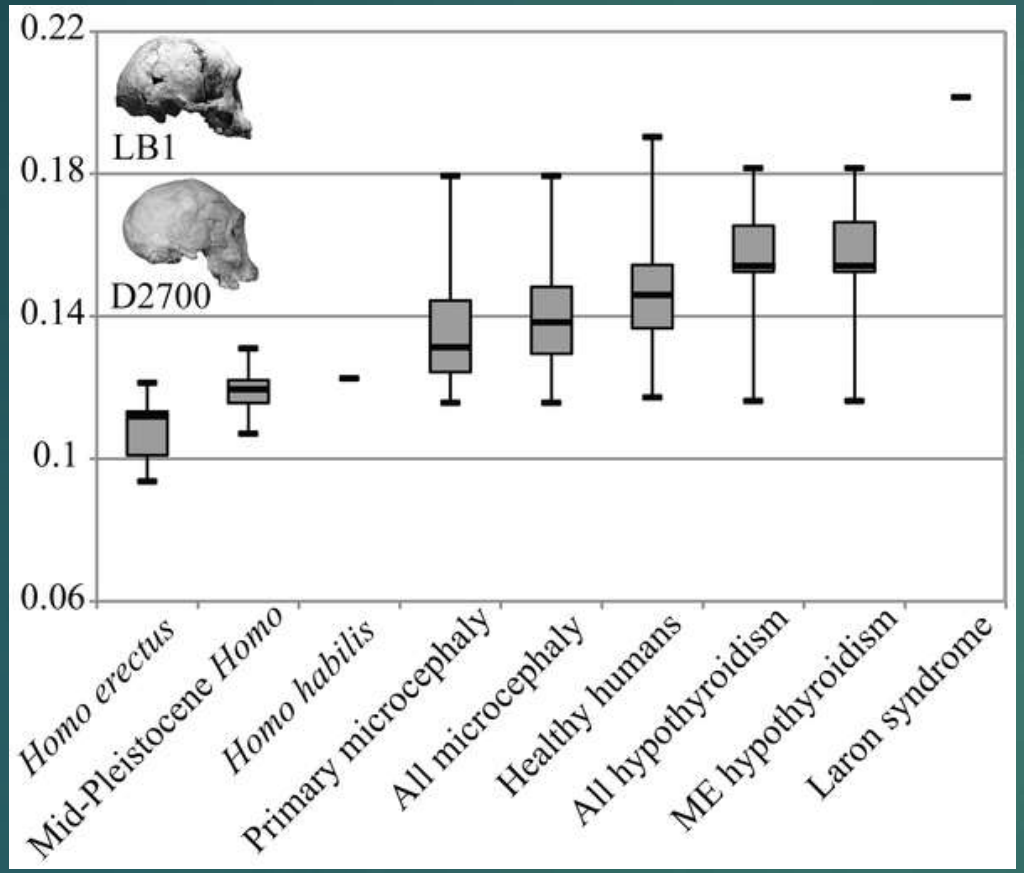
(D4500)

H. habilis, LB1 and *H. erectus*

***Homo habilis*, Kenya (1.9)** **LB1** ***Homo erectus*, Dmanisi (1.8)**

Figure 5: The LB1 cranium (center) compared to Homo habilis from Kenya (1.9 Ma) (left) and the slightly younger Homo erectus cranium from the Republic of Georgia (1.8 Ma) (right).

Baab, 2013: A Geometric Morphometric Comparative Analysis
Box-and-whisker plot of Procrustes distances between LB1 and each of the other specimens.



LB1 is most similar to the *H. erectus* sample and most dissimilar to the Laron syndrome individual. LB1 has the shortest distance to the D2700 *H. erectus* fossil from Dmanisi, Georgia.

Shape of the LB1 neurocranium is outside the ranges of variation documented here for the ME hypothyroidism specimens and distinct from the specimen with Laron syndrome
Supports LB1 as a distinct taxon, *H. floresiensis*.

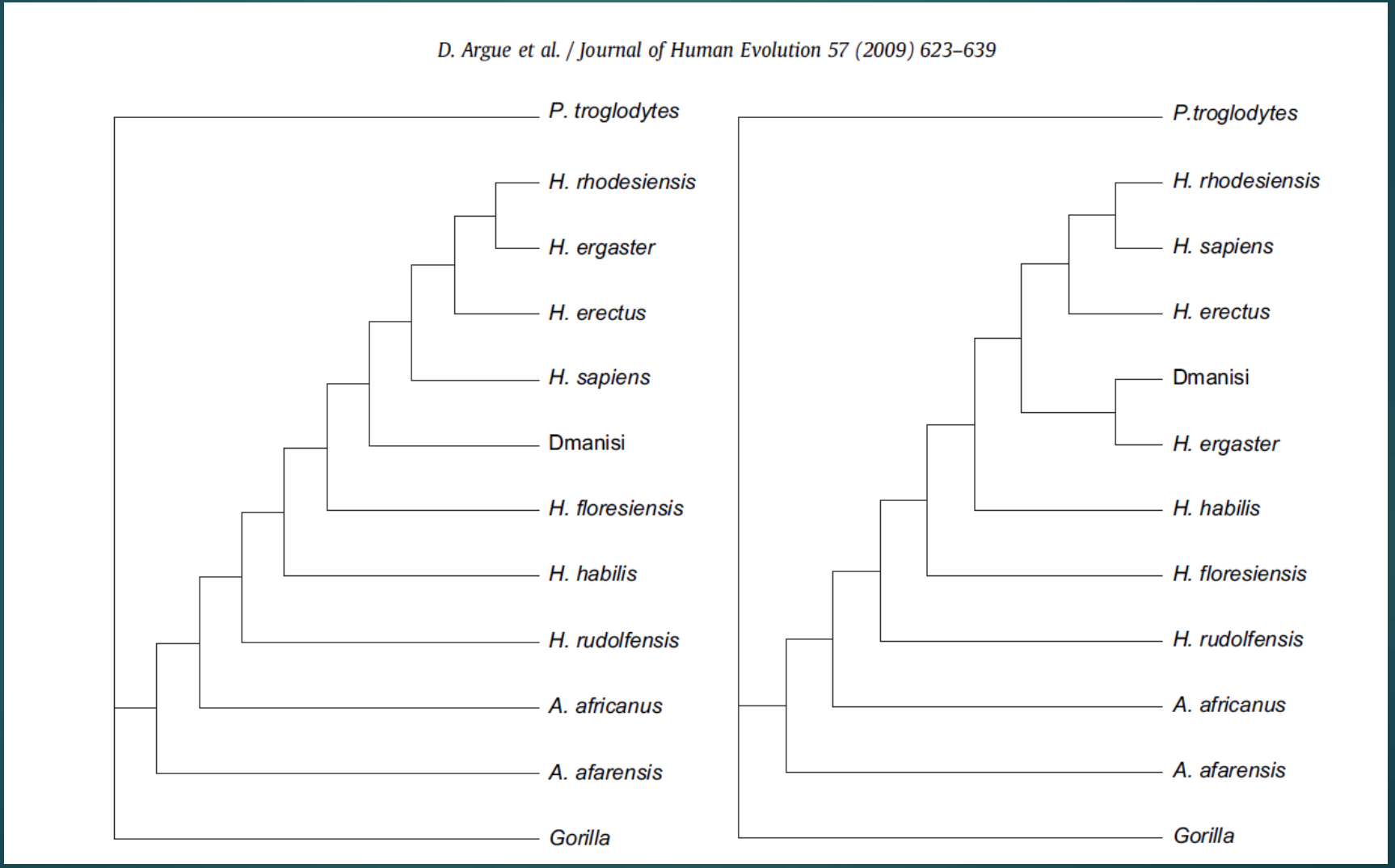
Baab KL, McNulty KP, Harvati K (2013) Homo floresiensis Contextualized: A Geometric Morphometric Comparative Analysis of Fossil and Pathological Human Samples. PLoS ONE 8(7): e69119. doi:10.1371/journal.pone.0069119
http://www.plosone.org/article/info:doi/10.1371/journal.pone.0069119

Cladistics: use of shared, novel traits to work out relationships

- Debbie Argue et. al. 2012: results suggest two possible positions for the *H. floresiensis* branch of the hominin family tree. With divergence nearly 2 million years ago, meaning that Homo floresiensis did not share an immediate ancestor with modern humans.
- 1 - *H. floresiensis* evolved after a hominin called *H.* rudolfensis , which arose some 2.3 million years ago but before *H.* habilis, which appeared roughly two million years ago.
- 2 - emerged after *H.* habilis but still well before *H. erectus* , which arose around 1.8 million years ago.
- Argue's team found no support for a close relationship between *H. floresiensis* and *H. erectus*, thereby dealing a blow to the theory that the hobbits were the product of island dwarfing of *H. erectus* .
- The study also rejected the hypothesis that hobbits belong to our own species, *H. sapiens*.

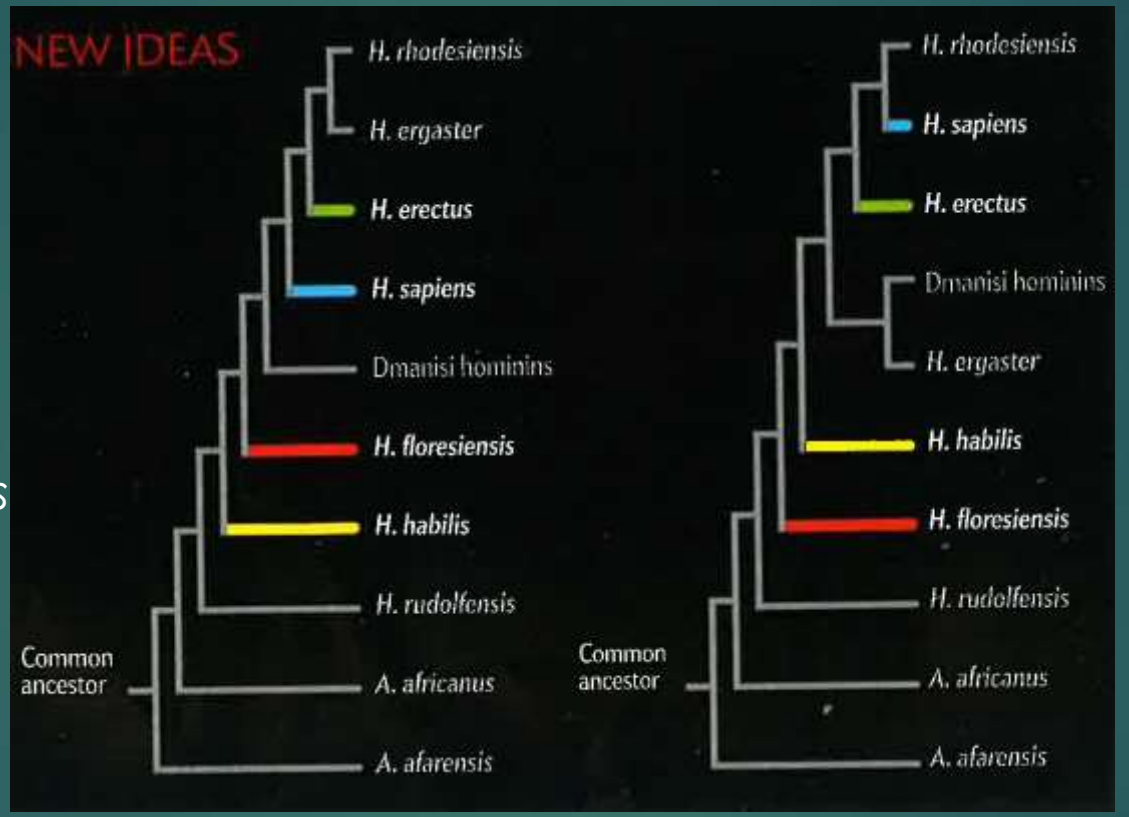
Debbie Argue et. al., Journal of Human Evolution , 2012

Argu2009: Cladistics



Argue, 2009: ***Homo floresiensis*** **evolved right before or after Homo habilis in Africa**

Scenario 2:
After *H. habilis*



Scenario 1:
before *H. habilis*
1.66 to
1.86 Ma

1 - H. floresiensis is an early hominin that emerged after *Homo rudolfensis* (1.86 Ma) but before *H. habilis* (1.66 Ma, or after 1.9 Ma if the earlier chronology for *H. habilis* is retained). 2- second tree indicates *H. floresiensis* branched after *Homo habilis*.

D. Argue, et al., 2012

Phylogenetic tree with possible evolutionary relationships among *Homo* taxa; with possible ancestors of *Homo floresiensis*: Asian *Homo erectus* or earlier *Homo* populations from Africa.

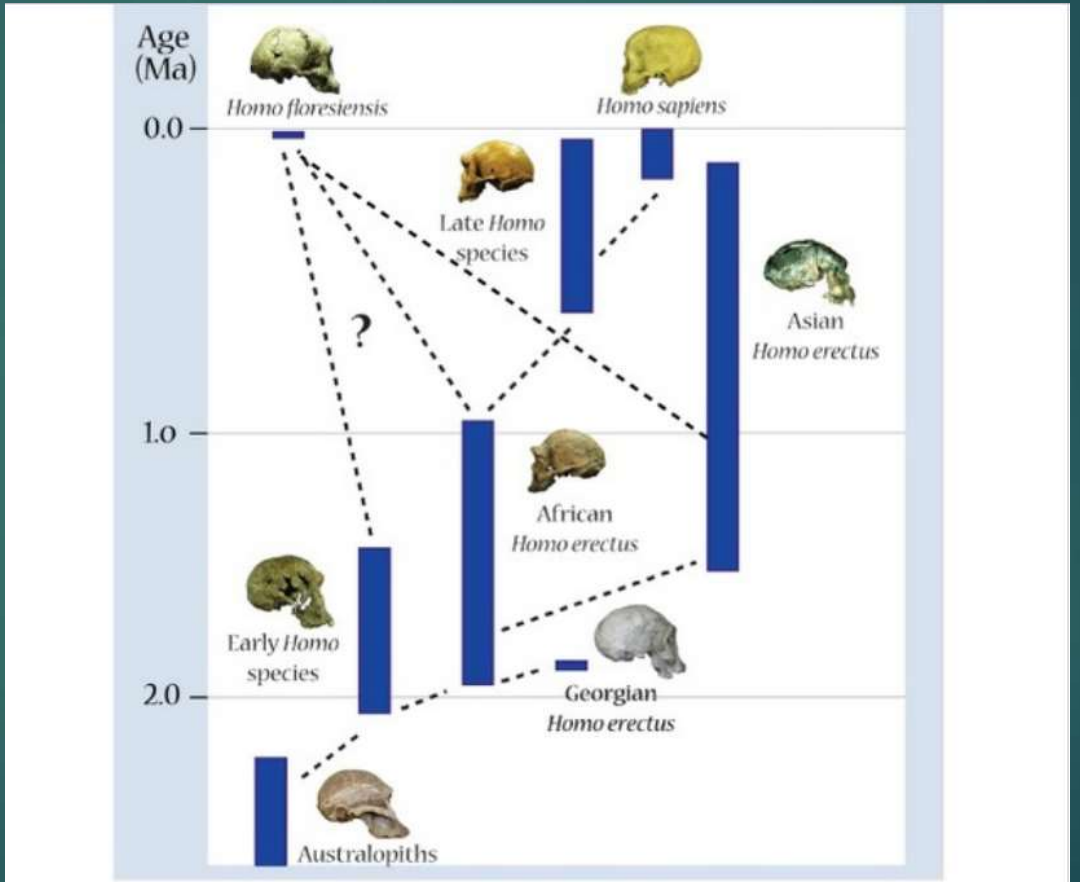


Figure 3: Phylogenetic tree demonstrating possible evolutionary relationships among *Homo* taxa, illustrating some of the possible ancestors of *Homo floresiensis*: Asian *Homo erectus* or earlier *Homo* populations from Africa.

Two theories

The two most popular evolutionary hypotheses position Homo floresiensis as the following:

1)The dwarf descendant of Homo erectus (if true then Homo floresiensis certain skeletal traits reappeared in this lineage that were seen in earlier australopith species but lost prior to the origin of Homo erectus

2) Descendant of an even more primitive species (if true then Homo floresiensis was descended from a species such as Homo habilis for which there is not evidence elsewhere in Asia .

Only additional fossils or analyses will determine the evolutionary history of the "Hobbits "of Flores Island .

What is the Significance of the Finding

- The *H. floresiensis* discovery is widely considered the most important of its kind in recent history.
- The new species challenges many of the ideas of the discipline.
- It is so different from other members of genus *Homo* that it forces the recognition of a new, undreamt-of variability in the genus.

What Next?

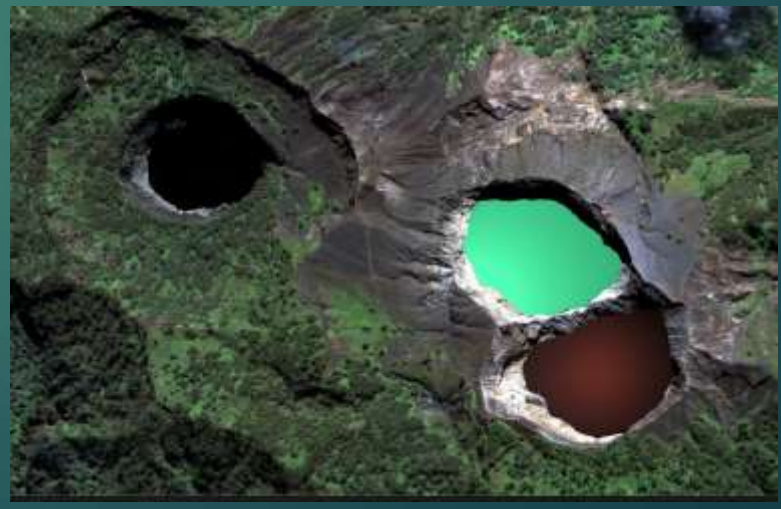
- The discoverers of *H. floresiensis* fully expect to find the remains of other, equally divergent *Homo* species on other isolated islands of Southeast Asia.
- Mike Morwood, before his recent death, was looking for more remains of H. floresiensis and its ancestors at two sites on Sulawesi. And he planned further excavation at Niah cave in north Borneo which could produce evidence of hominins much older than the ones at Liang Bua.
- What we need, of course, are more discoveries—from Flores, neighboring islands such as Sulawesi, mainland Southeast Asia or anywhere else in Asia.

Leslie C. Aiello

- …conclude that the evidence supports the hypothesis that *Homo floresiensis* is a late-surviving species of early *Homo* with its closest morphological affinities to early African pre-*erectus/ergaster* hominins. Although this hypothesis requires fundamental paradigm changes in our understanding of human evolution, it provides a more economical explanation for *H. floresiensis* than do the alternatives. None of the current explanations for microcephaly and disordered growth account for the range of features observed in *H. floresiensis*. Neither do they provide explanations for why a pathological condition in modern humans would mimic so closely the morphology observed in earlier hominins. This conclusion is based on the current evidence for *H. floresiensis* and on the particular pathological explanations that have appeared in the literature. There is no doubt that controversy over *H. floresiensis* will continue until new and conclusive evidence is available to settle the debate one way or another.

Five years of *Homo floresiensis* by Leslie C. Aiello, 2010

Volcanic Demise?



Lakes of Mount Kelimutu

Debated Extinction

- The last surviving non-human member of the Homo genus: Homo floresiensis, disappeared from the stratigraphic record in nearby Liang Bua cave between 17 and 10kyr BP in original dating (Roberts et al. 2009).
- The cause of the disappearance, (e.g. climate change, volcanic catastrophe or human competition), has not been established.
- In contrast to the environmental upheaval around 68kyr BP, the period between 17 and 10kyr BP is remarkably stable. With little change in vegetation at this time, we can rule out volcanism or climate change as a likely cause of the extinction if circa 17K.
- Later excavations that have dated more rock and sediment around the remains now suggest that hobbits were gone from the cave by 50,000 years ago, according to a study published in *Nature* on 30 March 2016
- We are left with an intriguing puzzle as to what caused the recent extinction of Homo floresiensis.

Scroxton, N., et al., 2013

Continuing questions

- Why, for instance, has only one skull been found if the species lived on Flores for 70,000 years?
- Should the textbooks be rewritten based on that single cranium?
- Is it not peculiar that we have discovered only one tiny-brained species capable of using tools and that it was located only on the remote island of Flores?

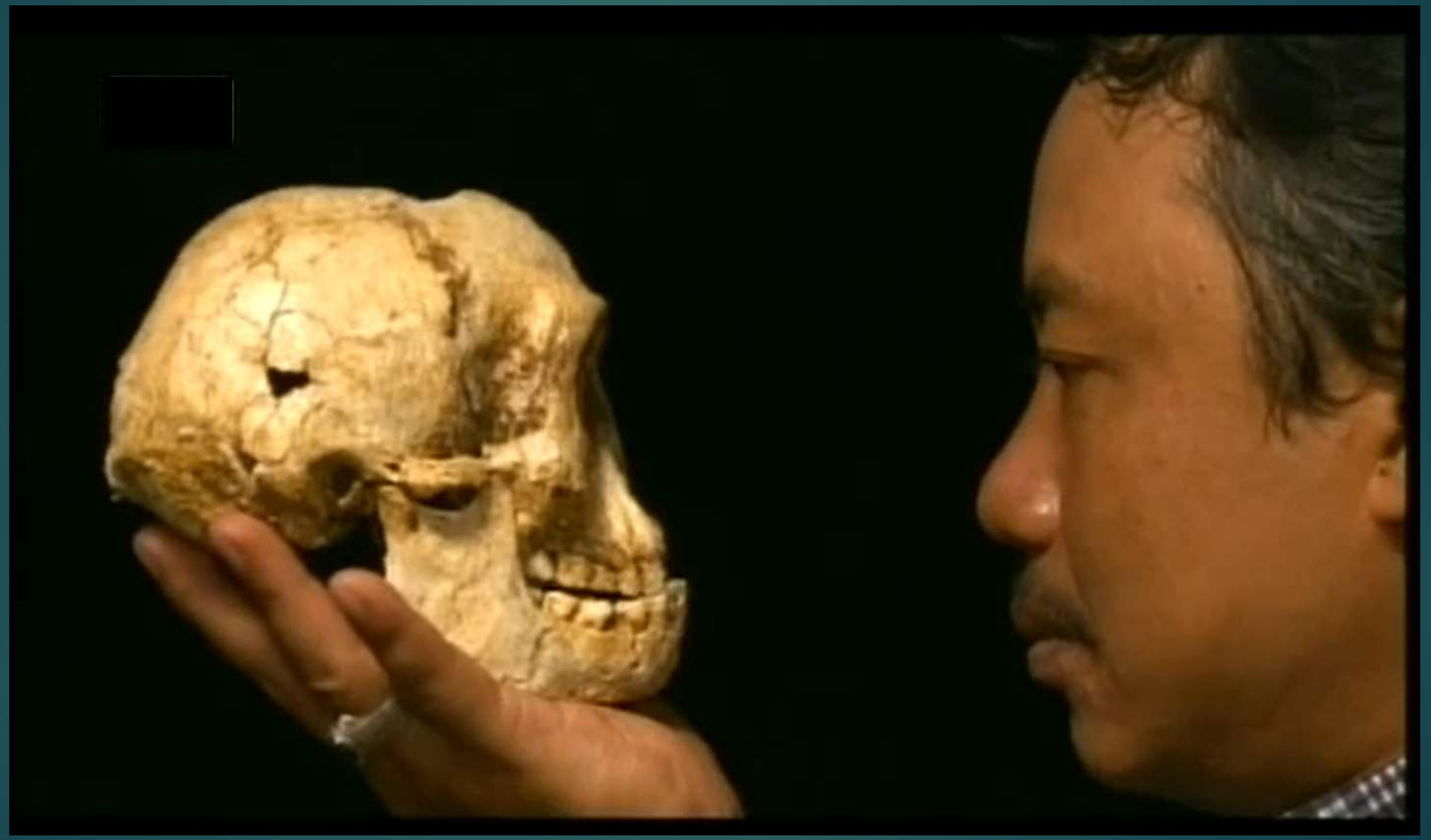
Smithsonian ?s

- Evolutionary lineage, geographic distribution, period of existence still unanswered
- Which hominin species made the 800,000 year old stone tools found on Flores?
- How did these early humans manage to get to the island of Flores?
- Did *H. floresiensis* have language, make art, and have other forms of cultural expression?
- Did *H. floresiensis* and our species, *H. sapiens,* ever come into contact with one another?
- Was a volcanic eruption on Flores the reason *H. floresiensis* went extinct?
- How similar is the DNA of *H. floresiensis* to the DNA of other human species?

Evidence that Evolution is not linear

- For the first time, many believe that a more primitive but nonetheless highly intelligent species of human recently coexisted on earth with *H. sapiens* for tens of thousands of years.
- Homo floresiensis reminds us that evolution is not linear. And even though we've seen a linear pattern in previous hominid brain size growth patterns and associated archaeological complexity, it is possible a smaller brained hominid also evolved simultaneously.

Where do you fit in?



Jatmiko; member of discovery team

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