Homo Floresiensis & Homo Luzonensis

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2020

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

Historical Bomb Shells in Paleontology

- 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*): bipedal at 4 Ma?
- 1991-2005*: Dmanisi (H. erectus):* brain too small
- 2004: *Homo floresiensis*: microcephalic *H. sapiens?*

“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 clearly applies to the discovery of *Homo floresiensis*

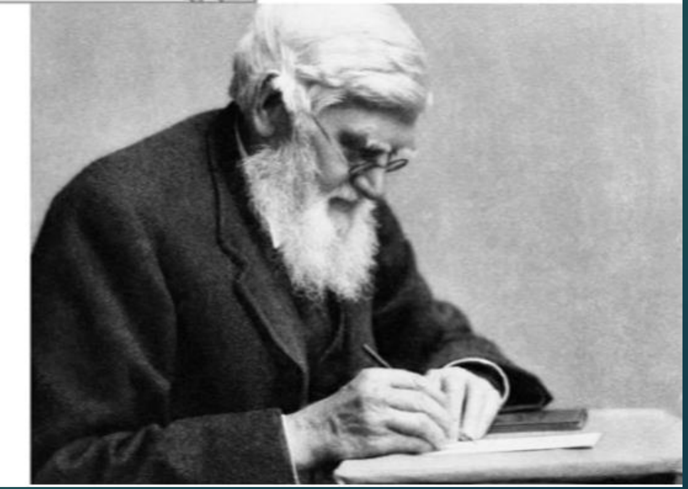
What is the Significance of the Finding

- The *H. floresiensis* discovery is widely considered one of the most important of its kind in recent history.

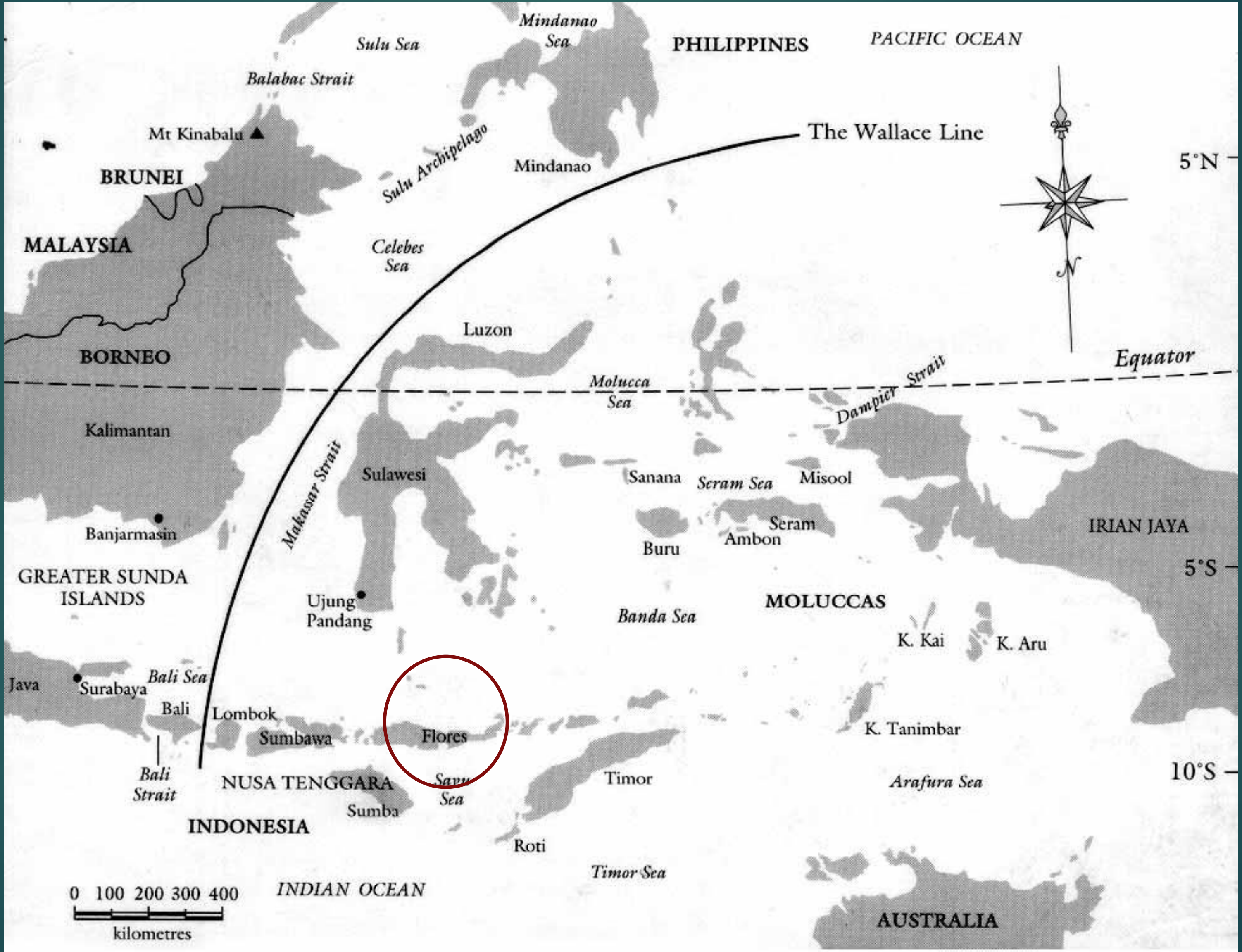
- The new species challenges many of the ideas of the discipline.

- It is so different from other members of genus *Homo* that it forces the recognition of a new, undreamt-of variability in the genus.

Wallace Line



Island of Flores is East of Wallace Line



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

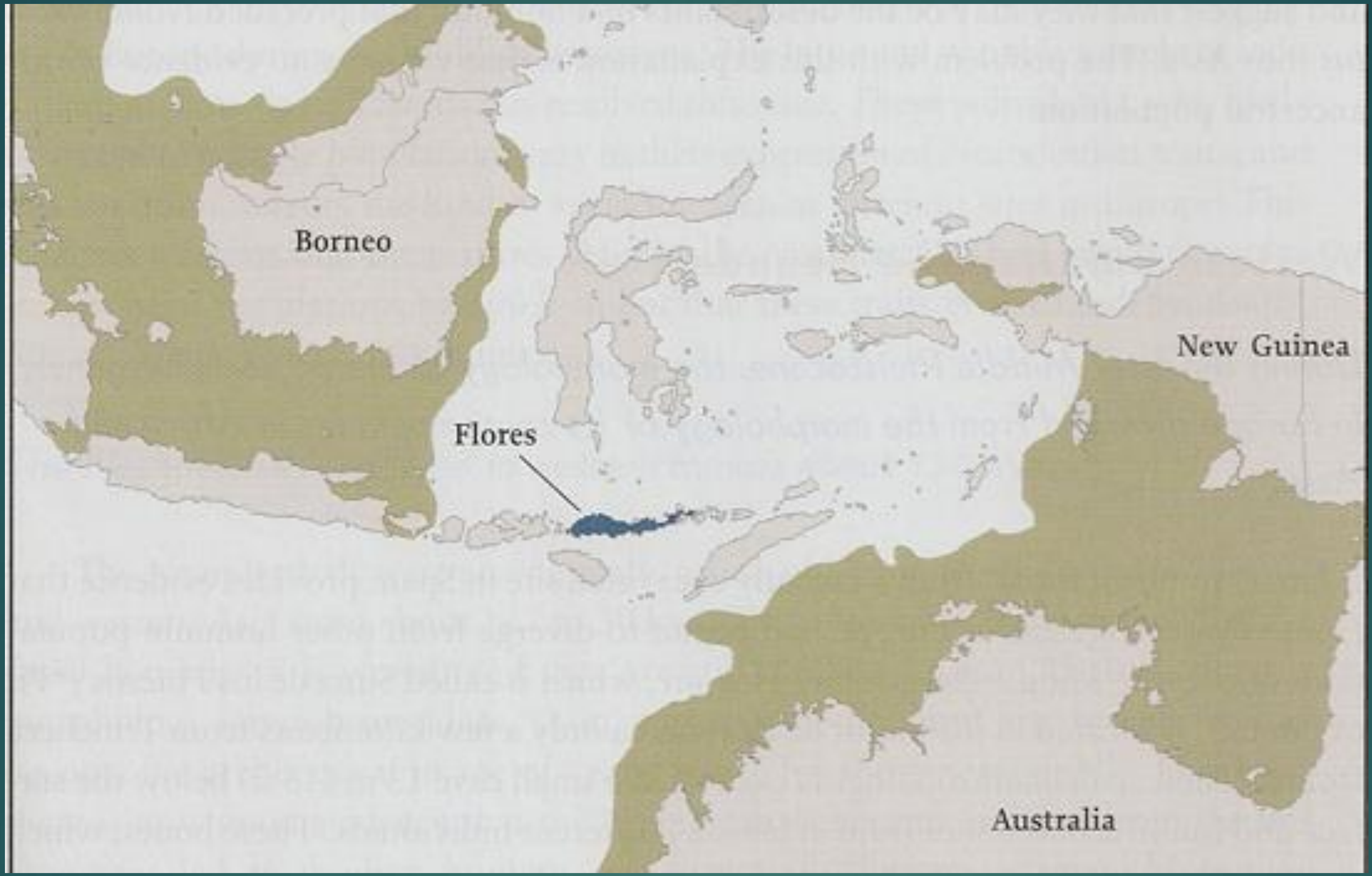
Island in Indonesian Archipelago
Flores was always based on a sea trip. Someone who wanted to get to Flores had to cross open ocean.


MALAYSIA
Borneo
Sumatra
INDONESIA
Java
Indian Ocean
Flores
Bali
Lombok


Komodo
Flores


Komodo
Flores

Flores was always isolated, even during glacial periods



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.

History of Hominins in SE Asia

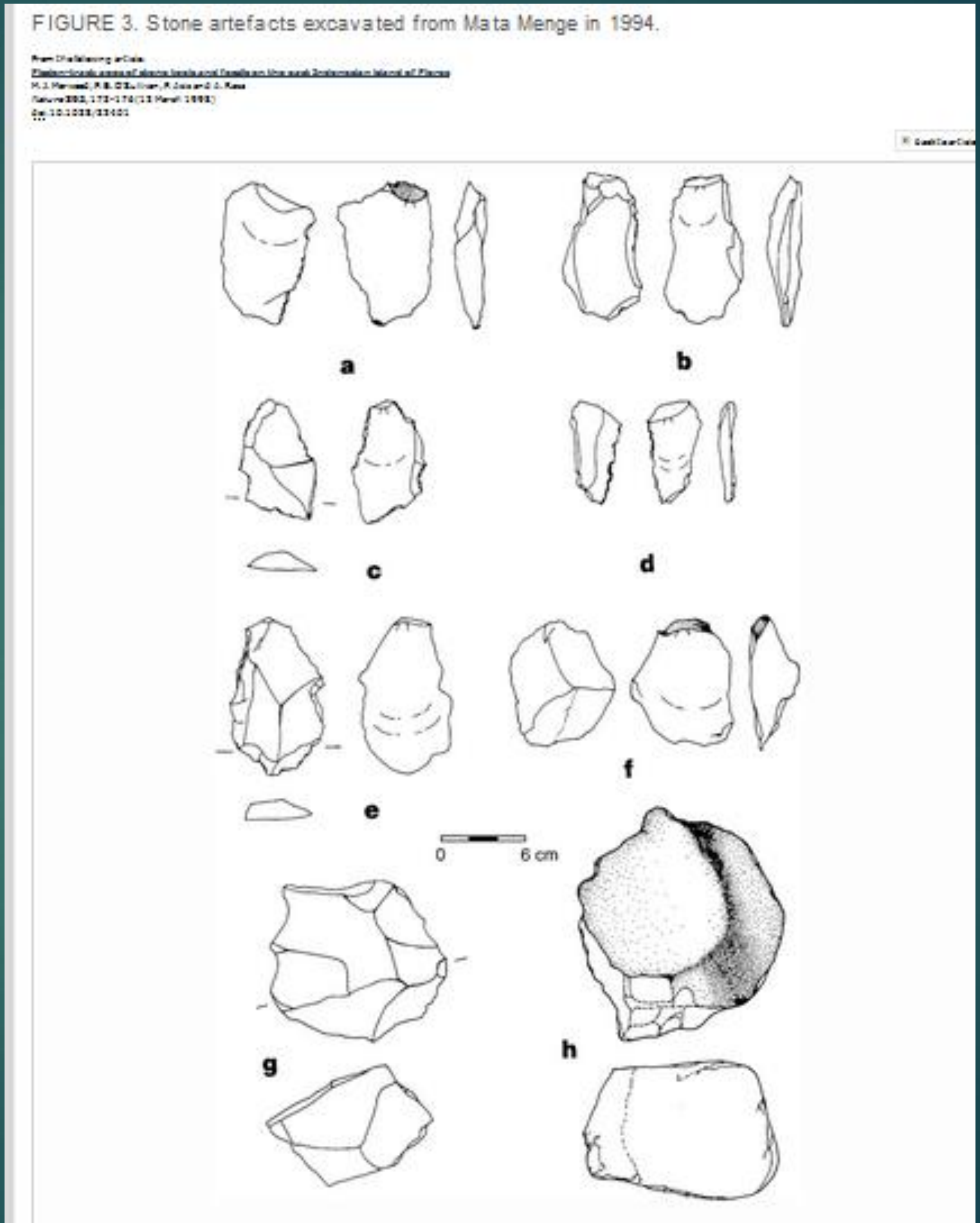
- Fossils on Java at 1.5 Ma (*Homo erectus*)
- Fossils on Flores at 880 Ka and 100 Ka
- Stone tools on Luzon, Philippines
- Archaeological sites on Sulawesi at 118,000
- Modem humans in Australia 65,000
- Borneo at 30-40,000
- East Timor at 42,000
- New Guinea at 40,000 (perhaps 60,000)

- Mike Moorwood was hoping to find evidence on Flores of the earliest modern humans to colonize Wallacea, Australia and New Guinea

1965 Fr. Verhoeven Dig at top level of Liang Bua (“Cold Cave”)

- In 1957, Dutch priest Fr. Theodor Verhoeven was the first to report and publish that stone tools were found in association with Stegodon remains at Mata Menge 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 Ka.
- 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 380 m^2 and yielded an extraordinary collection of 3,000 animal 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, rare skull pieces from Komodo dragons, even rarer bird and amphibian remains, and abundant evidence for crocodiles and giant rats.

Mata Menge: Stone Tool evidence that Hominins on Flores by 880 Ka

- 2010: 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 880 Ka

- 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

Arrival of hominins 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*

- 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):

Hominins on Flores after volcanic extinction at 1 Ma

- $^{40}Ar/^{39}Ar$ dating of volcanic ignimbrite layer overlying the artefact layers at Wolo Sege was erupted 1 Ma, providing a new minimum age for hominins on Flores.

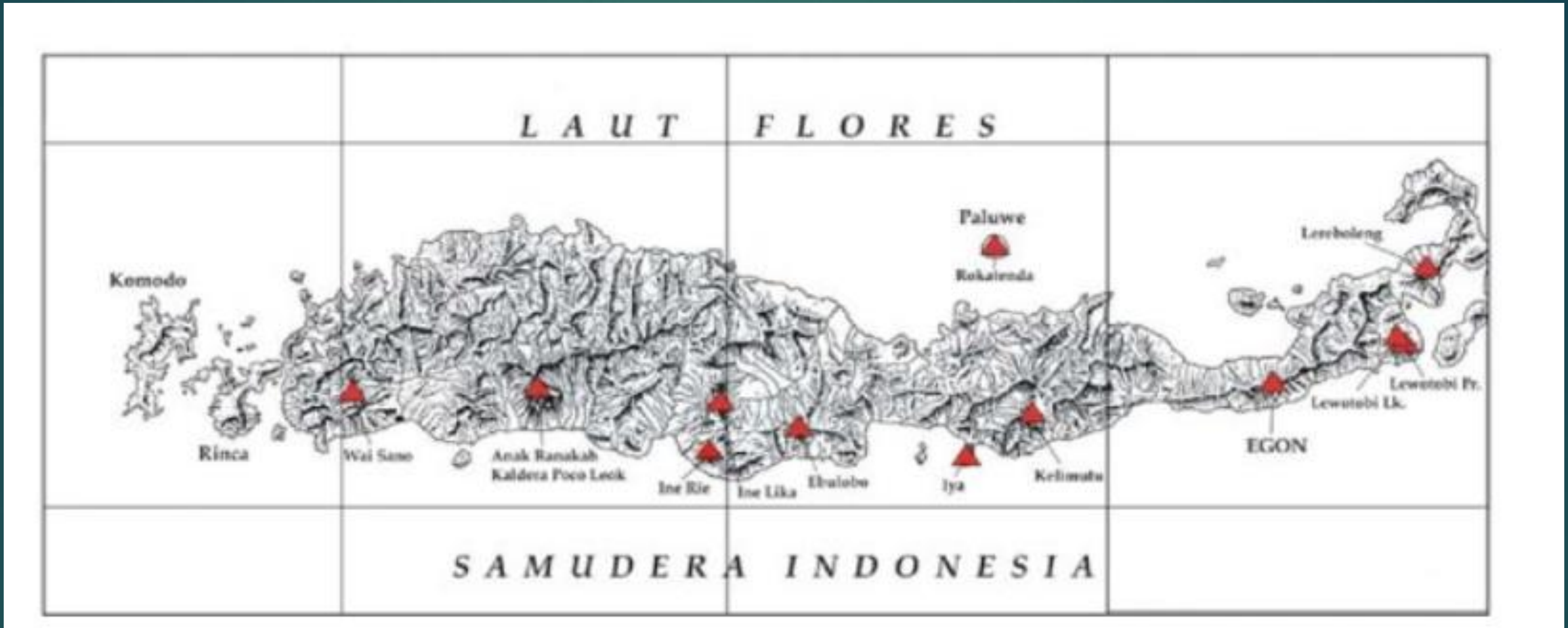
- This predates the disappearance from the Soa Basin of ‘pygmy’ *Stegodon sondaari* and *Geochelone* spp. (giant tortoise), as evident at the nearby site of Tangi Talo, which has been dated to 900 Ka.

- Zircon fission-track ages: hominins had colonized the island by 880 Ka.

- Contents, context and age of Wolo Sege, *in situ* stone artefacts and that lies stratigraphically below Mata Menge and immediately above the basement breccias of the basin.

Adam Brumm, et al., 2010

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



<u>Flores has 15 volcanoes</u>: Ilikedeka | Leroboleng | Ilimuda | Lewotobi | Ranakah | Egon | Poco Leok | Wai Sano| Ndete Napu | Inielika | Kelimutu | Sukaria | Ebulobo| Inierie | Iya

Location of Ling Bua cave

220 by 41 miles = 5320 sq mi

Aerial View of Liang Bua:
Find the Cave entrance!

Swipe of a spade

- In 2003, a single swipe of a spade by Benyamin Tarus rocked the field of paleoanthropology.
- During a routine excavation, digging through damp clay of a cave floor, that single swipe revealed an entirely unexpected creature.
- It was the small skull of a primitive-looking hominin, hypothesized to be a new species of human, *Homo floresiensis*.
- This incident occurred six meters below ground, in a pit dug deep into the cave floor at Liang Bua, a large limestone cave on the oceanic island of Flores.

Liang Bua, a limestone cave on the Indonesian island of Flores

LB1 found here?

2017 Excavation leaders, Dr. Matt Tocheri and Dr. Richard Roberts

Over 80% of the bones found at Liang Bua are rats

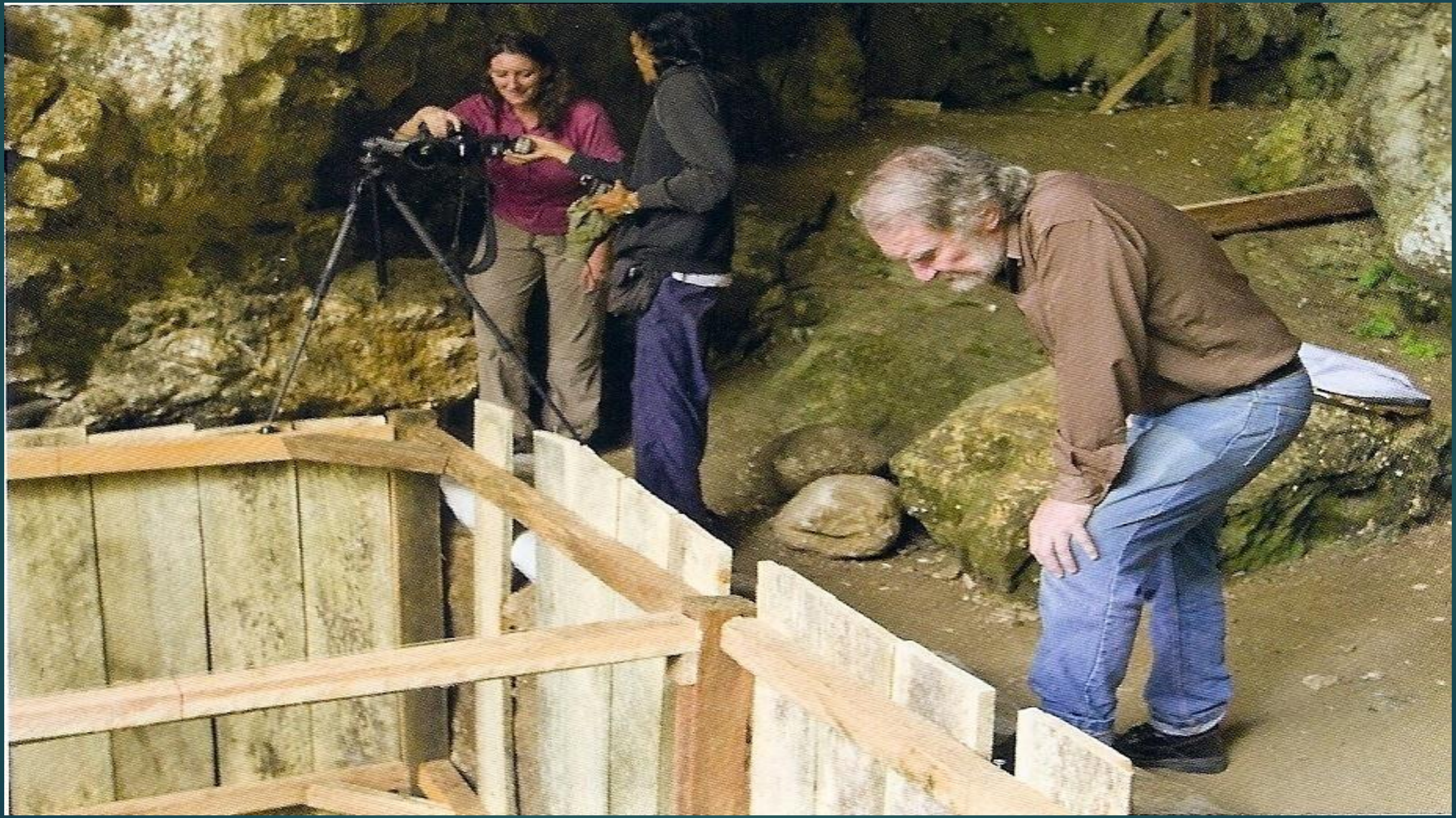
Mike Morwood, 2003, Liang Bua-Australian-Indonesian team

- 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 LB1 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.



Site is difficult to excavate

Dig -2nd shaft at Liang Bua - search for more bones, artifacts

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 (“Grandmother who eats everything”).

- The islanders describe Ebu Gogo as being about one meter tall, hairy and prone to "murmuring" to each other in some form of language.

Is it a coincidence that Hobbits were filmed on nearby New Zealand?

Lord of the Rings films in 2001, 2002, 2003

Naming LB1

- *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;* Morwood half jokingly proposed the 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"

Discovered
In 2003

Published
In 2004

LB 1:

Only skull that has been found

Nature, 2004

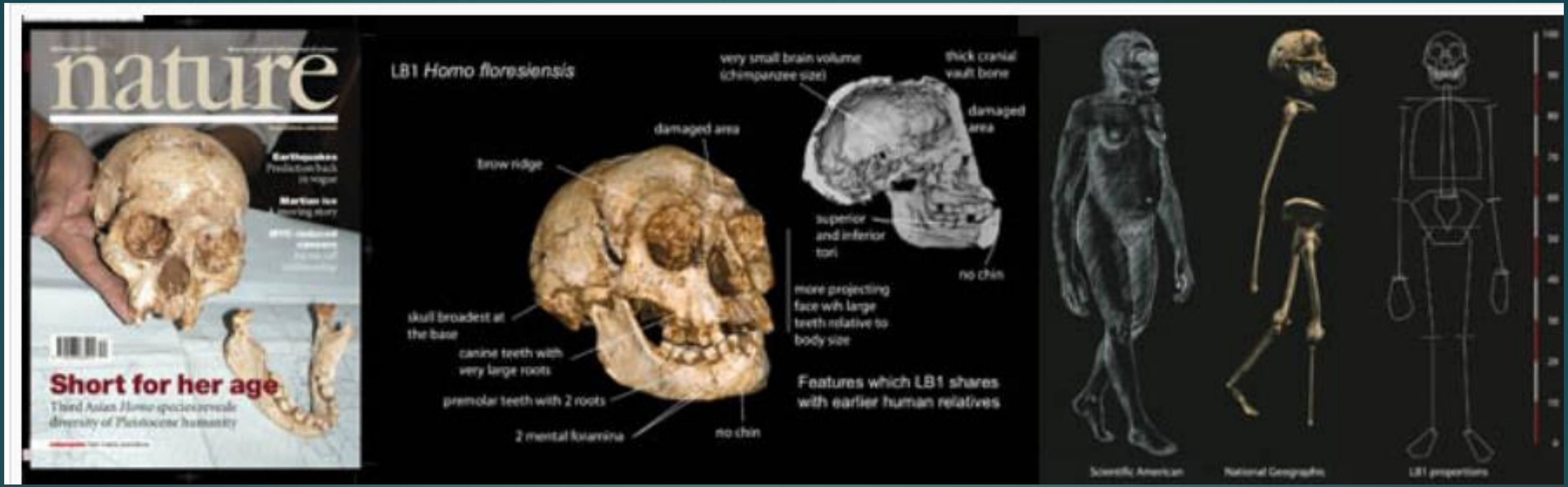
A new small-bodied hominin from the Late Pleistocene of Flores, Indonesia

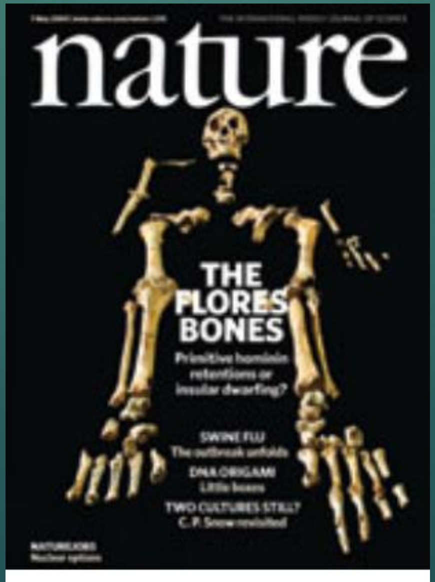
P. Brown[1], T. Sutikna[2], M. J. Morwood[1], R. P. Soejono[2], Jatmiko[2], E. Wayhu Saptomo[2] & Rokus Awe Due[2]

[1]*Archaeology & Palaeoanthropology, School of Human & Environmental Studies, University of New England, Armidale, New South Wales 2351, Australia*
[2]*Indonesian Centre for Archaeology, Jl. Raya Condet Pejaten No. 4, Jakarta 12001, Indonesia*

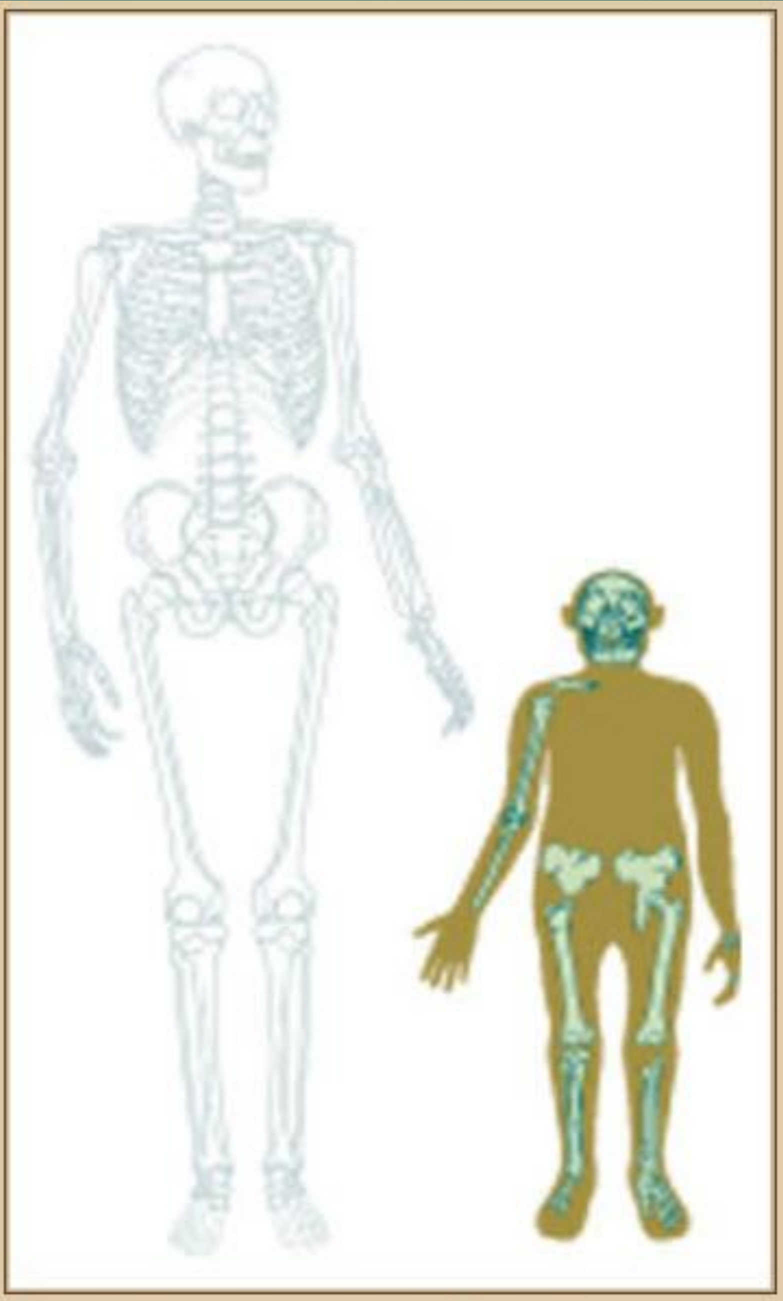
Currently, it is widely accepted that only one hominin genus, *Homo*, was present in Pleistocene Asia, represented by two species, *Homo erectus* and *Homo sapiens*. Both species are characterized by greater brain size, increased body height and smaller teeth relative to Pliocene *Australopithecus* in Africa. Here we report the discovery, from the Late Pleistocene of Flores, Indonesia, of an adult hominin with stature and endocranial volume approximating 1 m and 380 cm^3, respectively—equal to the smallest-known australopithecines. The combination of primitive and derived features assigns this hominin to a new species, *Homo floresiensis*. The most likely explanation for its existence on Flores is long-term isolation, with subsequent endemic dwarfing, of an ancestral *H. erectus* population. Importantly, *H. floresiensis* shows that the genus *Homo* is morphologically more varied and flexible in its adaptive responses than previously thought.

Homo floresiensis, Nature, 2004 & 2009





2003:
Homo floresiensis,
Island of Flores, Indonesia:
1 meter tall
17 Ka

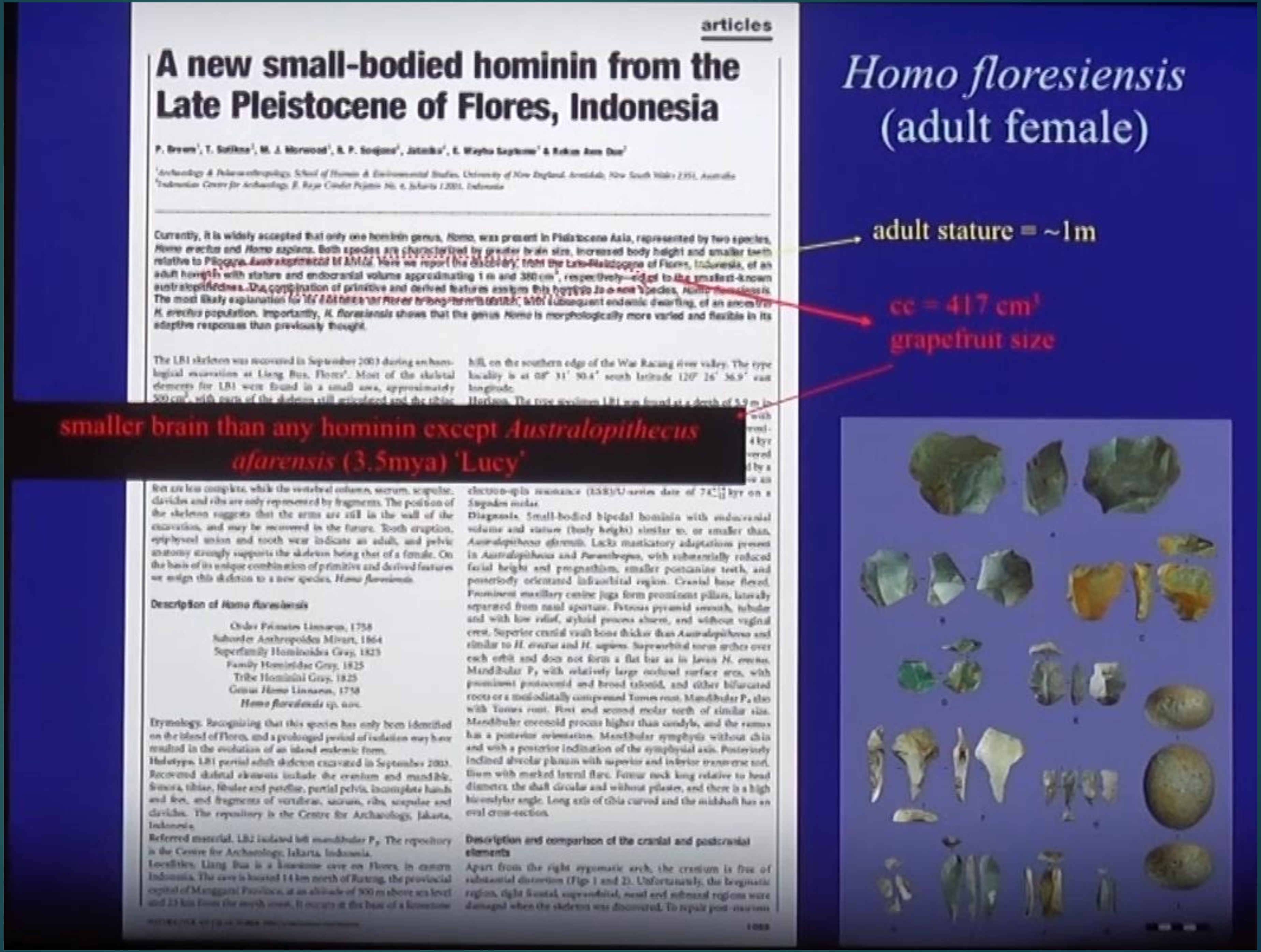


Homo floresiensis and modern human

2004 Publication

Cc = 380

Can a small brained creature produce these tools

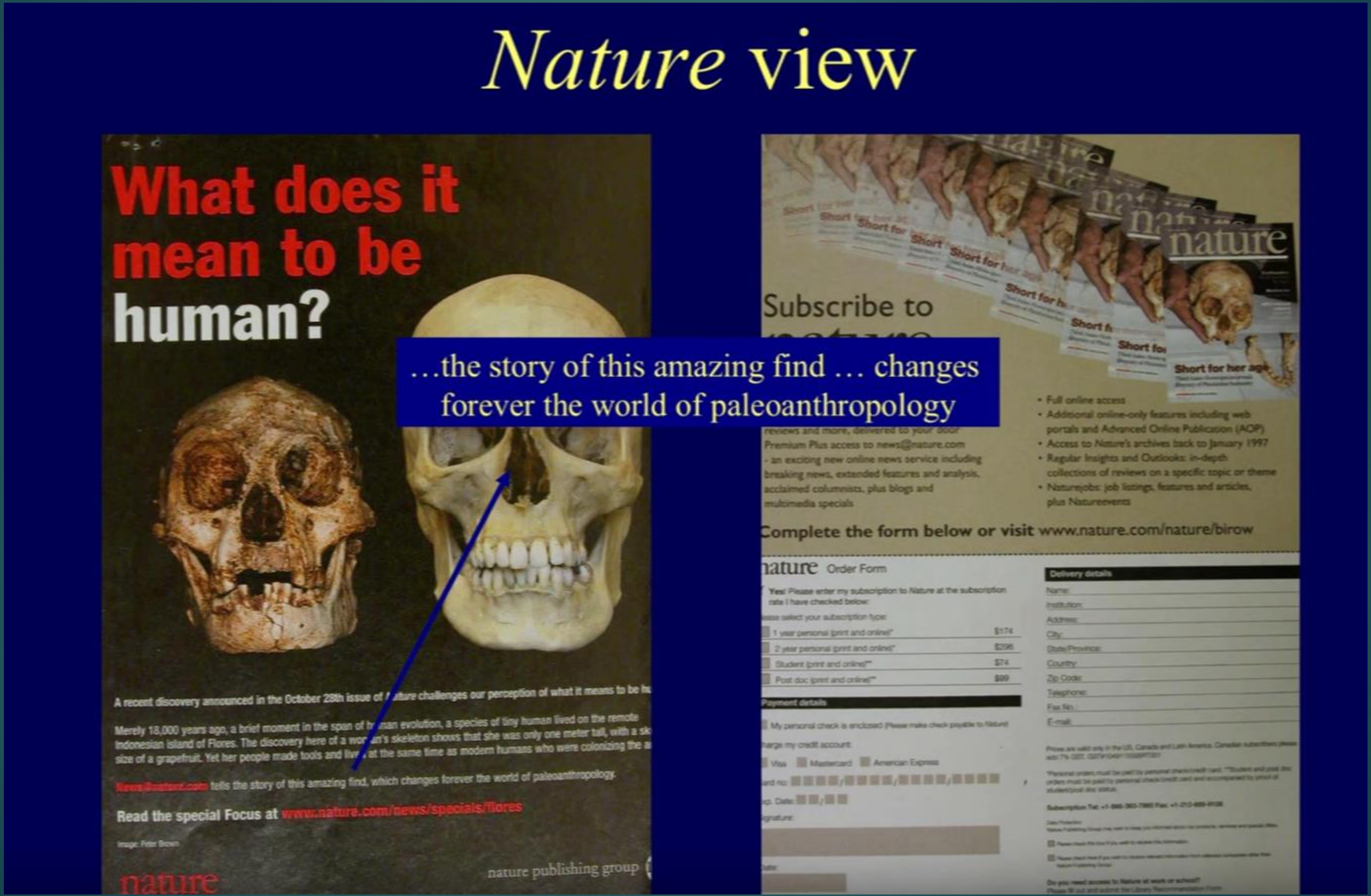


A new small-bodied hominin from the Late Pleistocene of Flores, Indonesia -- P. Brown, et al., 2004

- Currently, it is widely accepted that only one hominin genus, *Homo,* was present in Pleistocene Asia, represented by two species, *Homo erectus* and *Homo sapiens.* Both species are characterized by greater brain size, increased body height and smaller teeth relative to Pliocene *Australopithecus* in Africa.
- Here we report the discovery, from the Late Pleistocene of Flores, Indonesia, of an adult hominin with stature and endocranial volume approximating 1 m and 380 cm^3, respectively—equal to the smallest-known australopithecines.
- The combination of primitive and derived features assigns this hominin to a new species, *Homo floresiensis.*
- The most likely explanation for its existence on Flores is long-term isolation, with subsequent endemic dwarfing, of an ancestral *H. erectus* population.
- Importantly, *H. floresiensis* shows that the genus *Homo* is morphologically more varied and flexible in its adaptive responses than previously thought.

LB1 =
Flo

Claim in Nature: most amazing fossil find in history



Press had field day

Professional Journal articles

Fossils have not been made widely available for review

Journal of Human Evolution xxx (2008) 1–16

Contents lists available at ScienceDirect

ELSEVIER

Journal of Human Evolution

journal homepage: www.elsevier.com/locate/jhevol

Descriptions of the upper limb skeleton of *Homo floresiensis*

Susan G. Larson[a,*], William L. Jungers[a], Matthew W. Tocheri[b], Caley M. Orr[c], Michael J. Morwood[d], Thomas Sutikna[e], Rokhus Due Awe[e], Tony Djubiantono[e]

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LB1's virtual endocast, microcephaly, and hominin brain evolution

Dean Falk[a,*], Charles Hildebolt[b], Kirk Smith[b], M.J. Morwood[c], Thomas Sutikna[d], Jatmiko[d], E. Wayhu Saptomo[d], Fred Prior[b]

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Journal of Human Evolution xxx (2008) 1–15

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Size, shape, and asymmetry in fossil hominins: The status of the LB1 cranium based on 3D morphometric analyses

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Journal of Human Evolution xxx (2008) 1–17

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Journal of Human Evolution

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Descriptions of the lower limb skeleton of Homo floresiensis

William L. Jungers[a,*], Susan G. Larson[a], W. Harcourt-Smith[b], Michael J. Morwood[c], Thomas Sutikna[d], Rokhus Awe Due[d], Tony Djubiantono[d]

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Journal of Human Evolution xxx (2008) 1–11

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The Liang Bua faunal remains: a 95 k.yr. sequence from Flores, East Indonesia

G.D. van den Bergh[a,d,*], H.J.M. Meijer[a], Rokus Awe Due[b], M.J. Morwood[d,e], K. Szabó[c], L.W. van den Hoek Ostende[a], T. Sutikna[b], E.W. Saptomo[b], P.J. Piper[e], K.M. Dobney[f]

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CORRESPONDENCE

Everyone listed on Dolly paper met established criteria for authorship

It's incredible how often we're surprised by findings

Funding should recognize outcome, not income

In 2006 Michal Jasienski surveyed 30+million Natural Science and 8+million Social Science & Humanities abstracts

"surprising" occurs 12 times more common in Natural Science than everyday English; 1.3 times more than Social Science & Humanities

Not fossilized

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

Some of the Flores discovery team

Leader Mike Morwood

Wahyu Saptomo

Thomas Sutikna, Rokus Due Awe

Peter Brown
for analysis

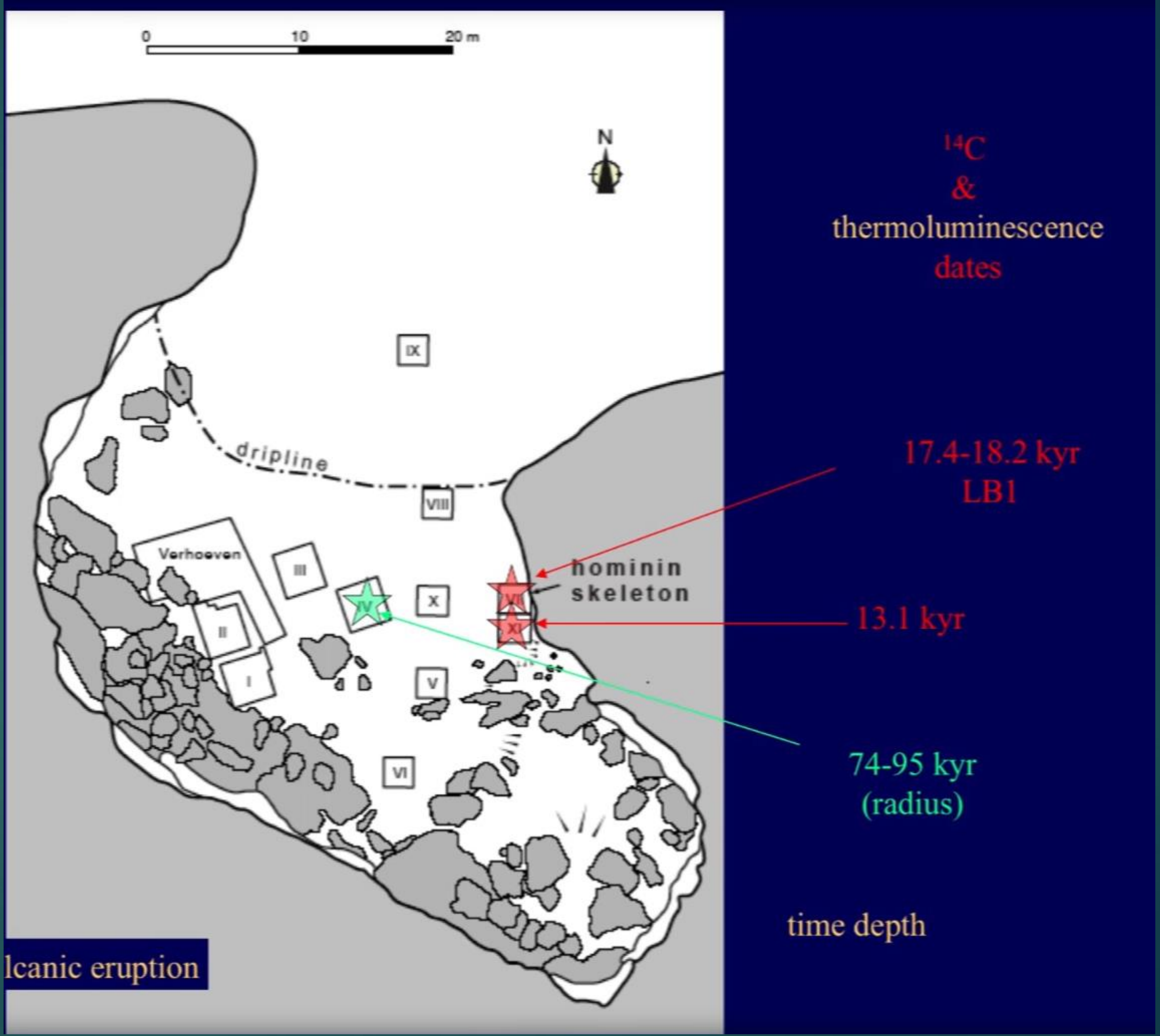
The Team

Liang Bua team, 2003 (photo courtesy of Thomas Sutikna)

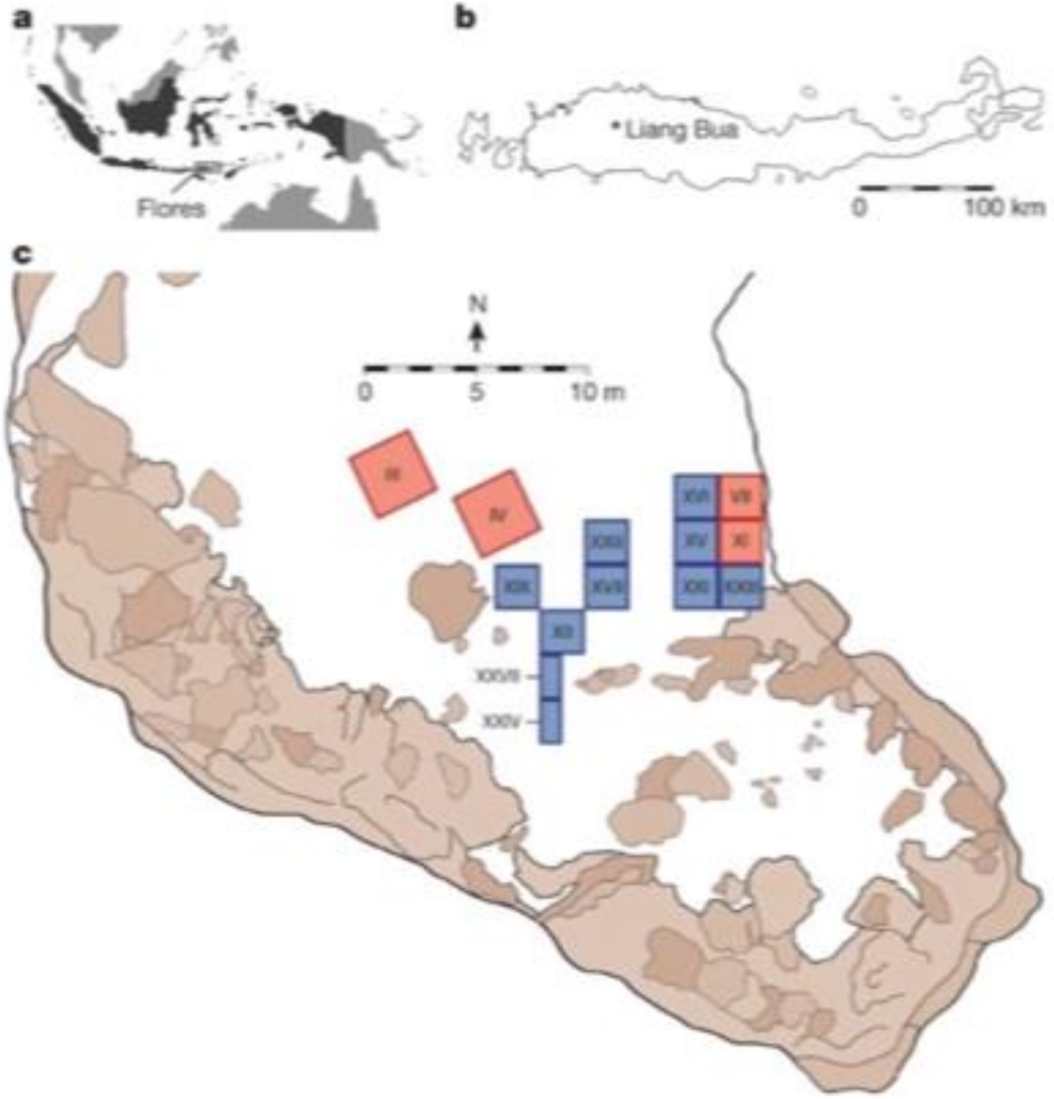
Original rendition of locations

Only Indonesians workers were present at the actual moment of discovery — the Australian contingent had departed back to Oz,

Things changed



More changes



T Sutikna *et al.* *Nature* 1–4 (2016) doi:10.1038/nature17179

LB-1

- Type specimen = LB-1
- 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: Originally dated to 18 Ka, now 100-60 Ka
- Originally thought to be juvenile *Homo erectus*
- Current species: *Homo floresiensis*

LB1: Height and Weight

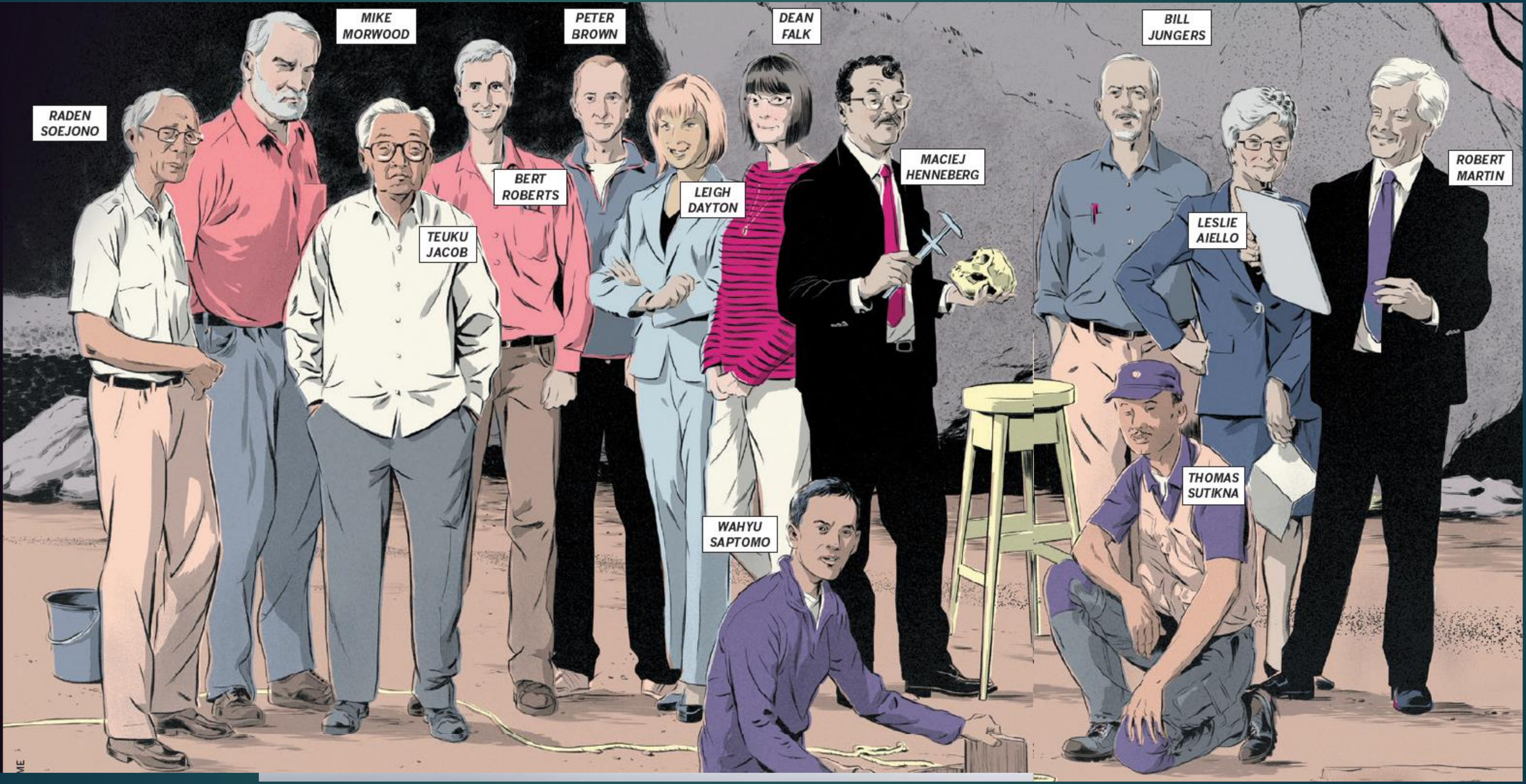
- Height: 1.06 m (3 ft. 6 in) - estimate from a female skeleton
  - *A. afarensis*: average 3 ft. 5 in (1.05 m)
  - roughly the size of a 3–4 year old modern human child.

- Weight: 30-32.5 kg (66-72 lbs.) - estimate from a female skeleton
  - *A. afarensis*: 29 kg (64 lb.
- Cranial capacity: 417 cc; most recent: 426 cc (Kubo, et al., 2013)

- LB1 and LB8 may be the shortest and smallest members of the extended human family discovered thus far.
- To date, estimated 9 to 14 individuals from the site (Morwood et al., 2005 & 2009)

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

Original crew: Tales of the Hobbit. Ewen Callaway, 2014



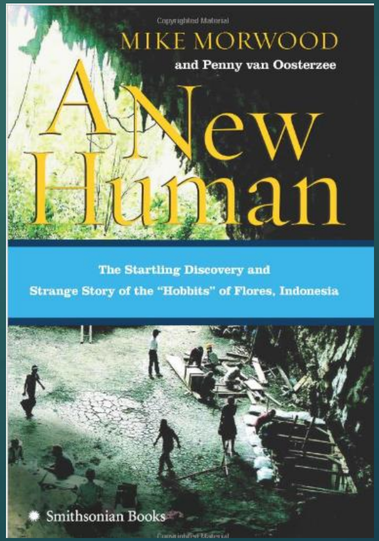
Nature: great history of discovery article

- http://www.nature.com/news/the-discovery-of-homo-floresiensis-tales-of-the-hobbit-1.16197
- Ewen Callaway, 2014: **The discovery of *Homo floresiensis*: Tales of the hobbit**

Michael Morwood (27 October 1950 – 23 July 2013): *Homo floresiensis*

- Australian archeologist; rock art specialist
- Professor in Archeology, School of Earth and Environmental Sciences, University of Wollongong, Australia

- 2003: Liang Bua Cave, Flores, Indonesia, *Homo floresiensis;* research team leader



Peter Brown:
Homo floresiensis

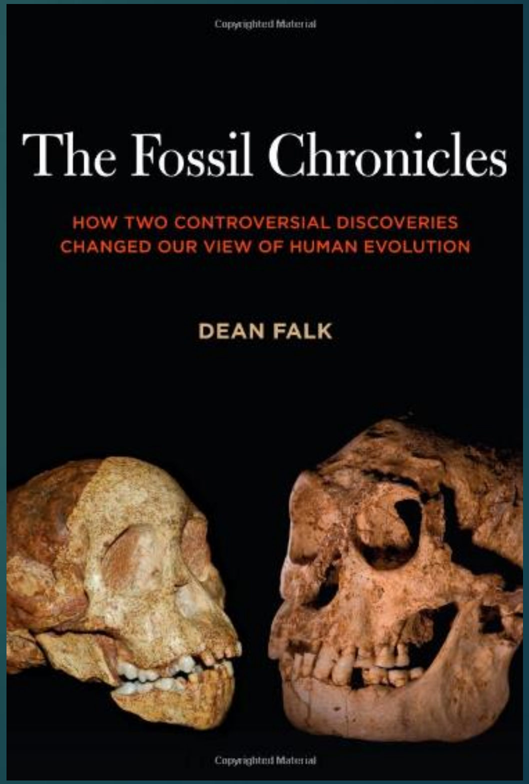
- Australian paleontologist
- University of New England, Armidale, Australia
- Expert on Australian and Asian fossils
- 2003: on the island of Flores, Indonesia, discovered *Homo floresiensis*

- 2004: A new small-bodied hominin from the Late Pleistocene of Flores, Indonesia, P. Brown, et al., *Nature*

- 2005: made LB 1 the type specimen

Dean Falk (1944-):
hominin brain evolution & MRI use

- American anthropologist
- Professor and chair of the Department of Anthropology, Florida State University
- Specializes in the evolution of the brain and cognition in higher primates.
- Among a group of anthropologists who pioneered the use of magnetic resonance imaging to study the skulls of ancient humans.
- Long academic feud with Holloway over lunate sulcus
- 2005: supports the claim that the *Homo floresiensis* represented a new species, closely related to *Homo erectus*. Not pathological microcephalic.
- Author of The Fossil Chronicles – LB1 and Taung



Teuku Jacob (1929-2007): Indonesian paleoanthropology

- Indonesia's "king of paleoanthropology"
- Studied fossil hominins under famed paleontologist G. H. R. von Koenigswald, then found and was curator of many important specimens, particularly of *Homo erectus*
- Skeptic of the 1-meter-tall "hobbit" remains from the Indonesian island of Flores
- In 2004, Jacob removed most of the remains from Soejono's institution, Jakarta's National Research Centre of Archaeology, for his own research without the permission of the Centre's directors.

CREDIT: ANNAMARIA TALAS/REAL PICTURES

Damaged goods

- Teuku Jacob took possession over the bones for 3 months, 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.
- Made casts; sent part to Leipzig
- Morwood was enraged. 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 hominin species that lived in Indonesia, *Homo erectus*, had a weaker jaw).
- 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,

Date(s) of interest:

- Originally dated from 70 to 18-16 Ka (for LB1).
- Updated sedimentary chronology of the cave in 2016, places the fossils at approximately 100-60 Ka
- Stone tools made by this species date to between about 190-50 Ka.
- Earliest modern humans on the island, 11 Ka.
- Earliest archaeological materials on the island (site of Mata Menge) at 800-880 Ka
- Earliest hominin remains at 700,000.

Fossil evidence

- A partial adult skeleton (LB1) with some components still articulated,
  - Full skull
  - an isolated left Premolar 3 (LB2)
  - left radius
  - right pelvic bone,
  - femur and tibia.
- *Characteristics and inferred behavior*:
  - combination of *H. erectus*-like cranial and dental morphology,
  - a hitherto unknown suite of pelvic and femoral features,
  - archaic hominin-like carpal bones,
  - a small brain (426 cc),
  - small body mass (25–30 kg)
  - small stature (1 m).

Homo floresiensis

- *H. floresiensis:*
  - 3 feet 6 inches tall (hgt of ave. 6 yo),
  - tiny brains (426 cc)
  - large teeth for their small size,
  - shrugged-forward shoulders,
  - no chins,
  - receding foreheads,
  - relatively large feet due to their short legs.

- *H. floresiensis*
  - made and used stone tools,
  - hunted small elephants and large rodents,
  - coped with predators such as giant Komodo dragons and giant storks
  - may have used fire.

Smithsonian

Homo floresiensis: Island dwarfism

- The diminutive stature and small brain of *H. floresiensis* may have resulted from island dwarfism—an evolutionary process that results from long-term isolation on a small island with limited food resources and a lack of predators.

- The "island rule" stipulates that body size of mammals alters when a founder population reaches an island, becomes reproductively separated from its mainland origin group and faces an environment different from that of its mainland cousins. For example, a smaller body size could be expected as an evolutionary response to a limited food supply, or conversely a larger body size may occur in the absence of predation.

- *H. erectus* is the only known early hominin species from Indonesia. It is much larger than *H. floresiensis* and lived on Java 1.5 million years ago. There is no evidence for *H. erectus* on Flores, but then, Flores is relatively unknown archaeologically.

- Pygmy elephants on Flores, now extinct, showed the same adaptation.

- The smallest known species of *Homo* and *Stegodon* elephant are both found on the island of Flores, Indonesia.

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. But remember stone tools at 3.3 Ma at Lomekwi 3, Kenya

LB1 is not an anomaly in size

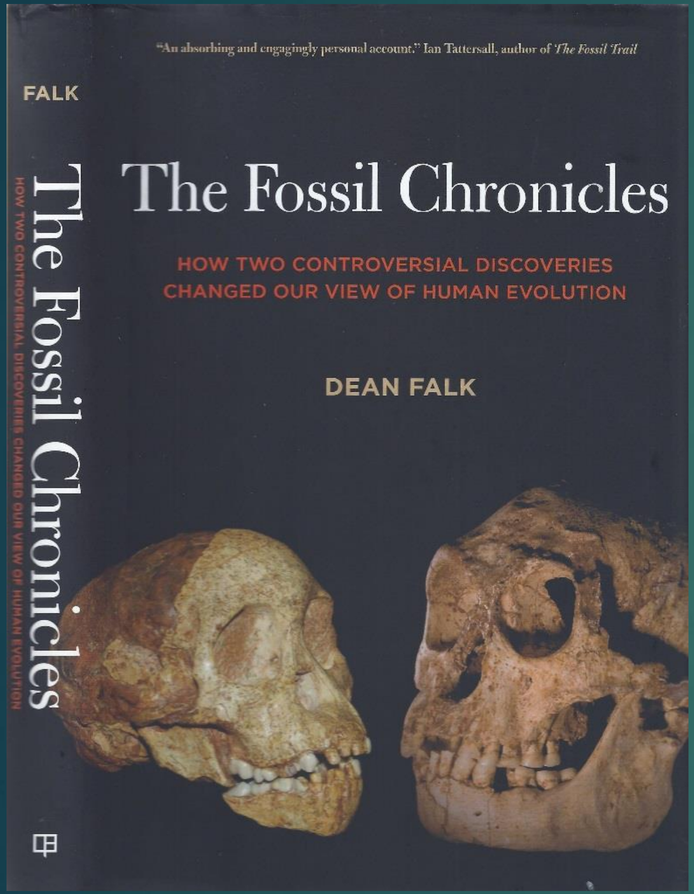
- Originally LB1 was thought to be an solitary size anomaly.
- But seven more inhabitants (LB3–LB9) were later recovered
- All were diminutive. LB6 was also estimated to be about 3,000 years younger than LB1.
- Currently: parts of 14 individuals
- This was a population of small-bodied individuals
- LB1 is not an anomaly.

(Morwood 2005).

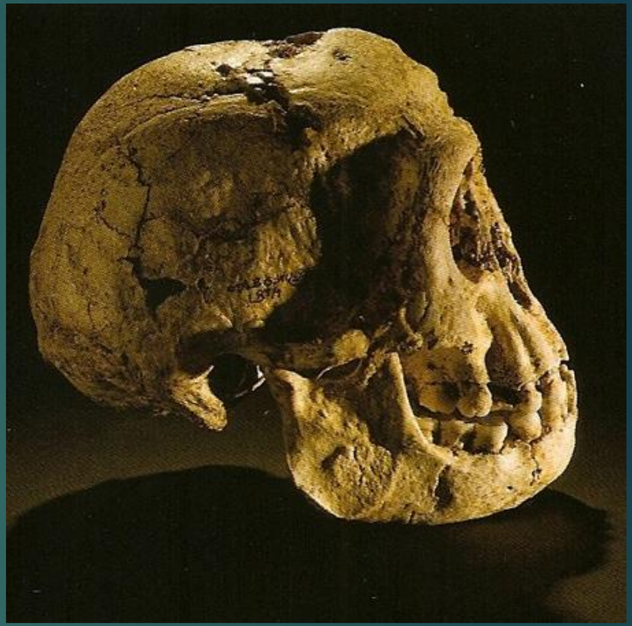
LB1 is not unique; Multiple samples of same type of hominin

- Analysis of skeletal material from another eight individuals tends to confirm the discovery team’s interpretation of a new, non-*sapiens* member of the genus Homo (Morwood et al. 2005), but disagreement over the nature of the hominin is likely to continue for some while yet.

The Fossil Chronicles – Dean Falk



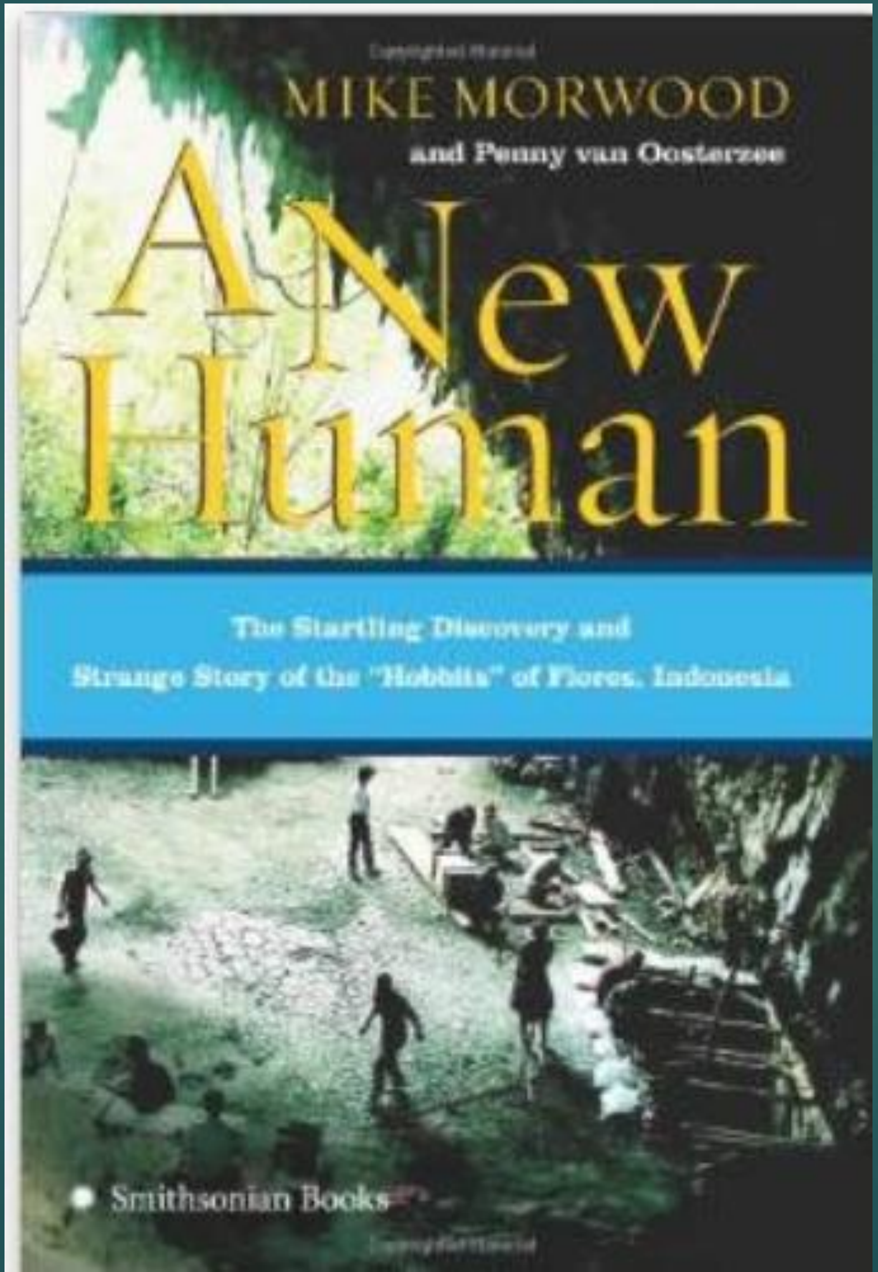
Taung



LB1

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



Fossil Findings

- Majority of the H. floresiensis remains are found in the levels of the cave dating between 100-60 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 bones 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 view

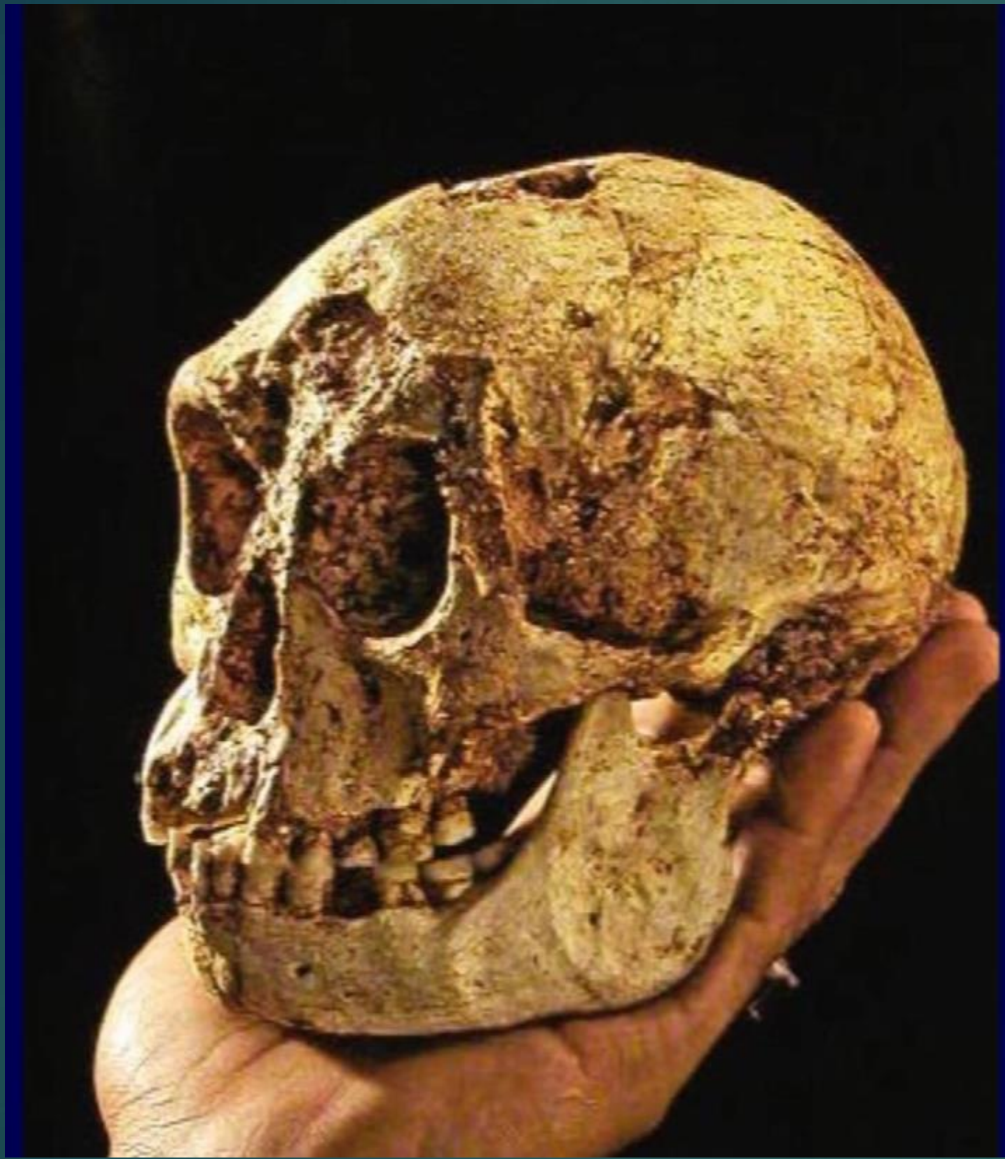
LB1 in situ, photo Thomas Sutikna

Inventory (as of Oct. 2005)

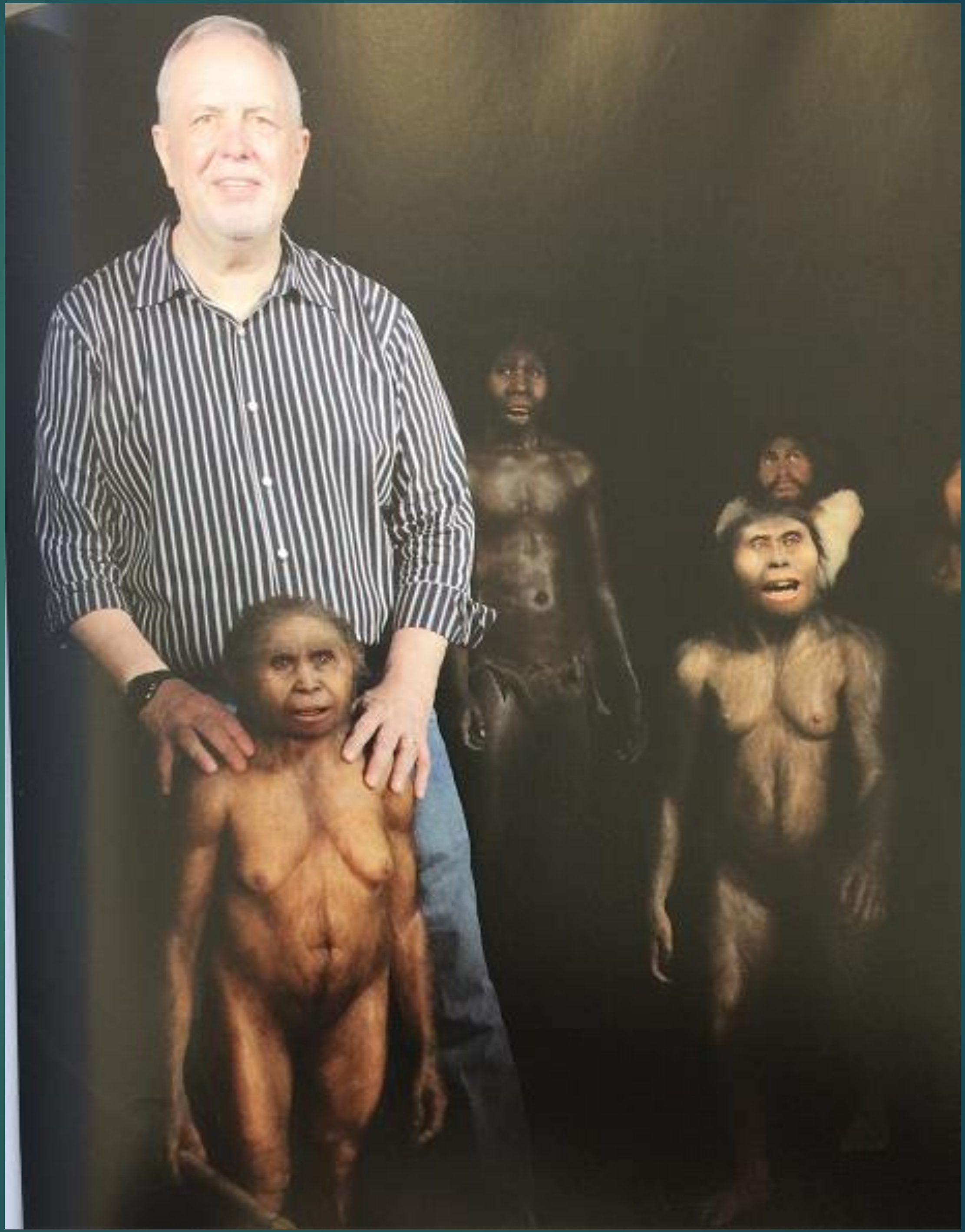
- 100 bones so far, including:
- LB1 skull & partial skeleton
- LB2 isolated left P_3
- LB3 proximal ulna (arm)
- LB4 radius, tibia (child)
- LB5 first cervical vertebra, metacarpal
- LB6 mandible, radius, ulna, scapula, metatarsals, phalanges
- LB7 hand phalanx
- LB 8 tibia
- LB9 femur shaft

MH

LB1
=
3.5 ft




Bill Jungers & model



MH, N, Hobbit women

2014: Mata Menge site

Mata Menge site in the Soa Basin

2014: Mata Menge: 700 Ka mandible and teeth, smaller than LB1

Mata Menge hominin finds dated to 700,000
(found in 2014 and published in 2016)

Mandible
6 teeth

from 3 individuals

Volcanic eruptions, stone tools & Stegodons

- There are stone tools at Liang Bua dating to 190 Ka that were washed into the cave

- By 95 Ka, dwarf *Stegodons* had become 30% smaller than 700 Ka ancestors.

- Another major volcanic eruption occurred circa 17 Ka

Initial micromorphological results from Liang Bua, Flores (Indonesia): Site formation processes and hominin activities at the type locality of *Homo floresiensis* -- Mike W. Morley, et al., 2016

First stratigraphic analyses applied to the site of Liang Bua.

- Sediments analyzed cover a previously identified ‘missing’ chronological period ~46–20 ka.
- Marked changes in site environment recorded in the cave sediment record.
- Combustion features indicate fire-use at the site over a period ~41–24 ka.
- Evidence suggests *Homo sapiens* are most likely candidates for using fire at the site.

Flores Pygmies

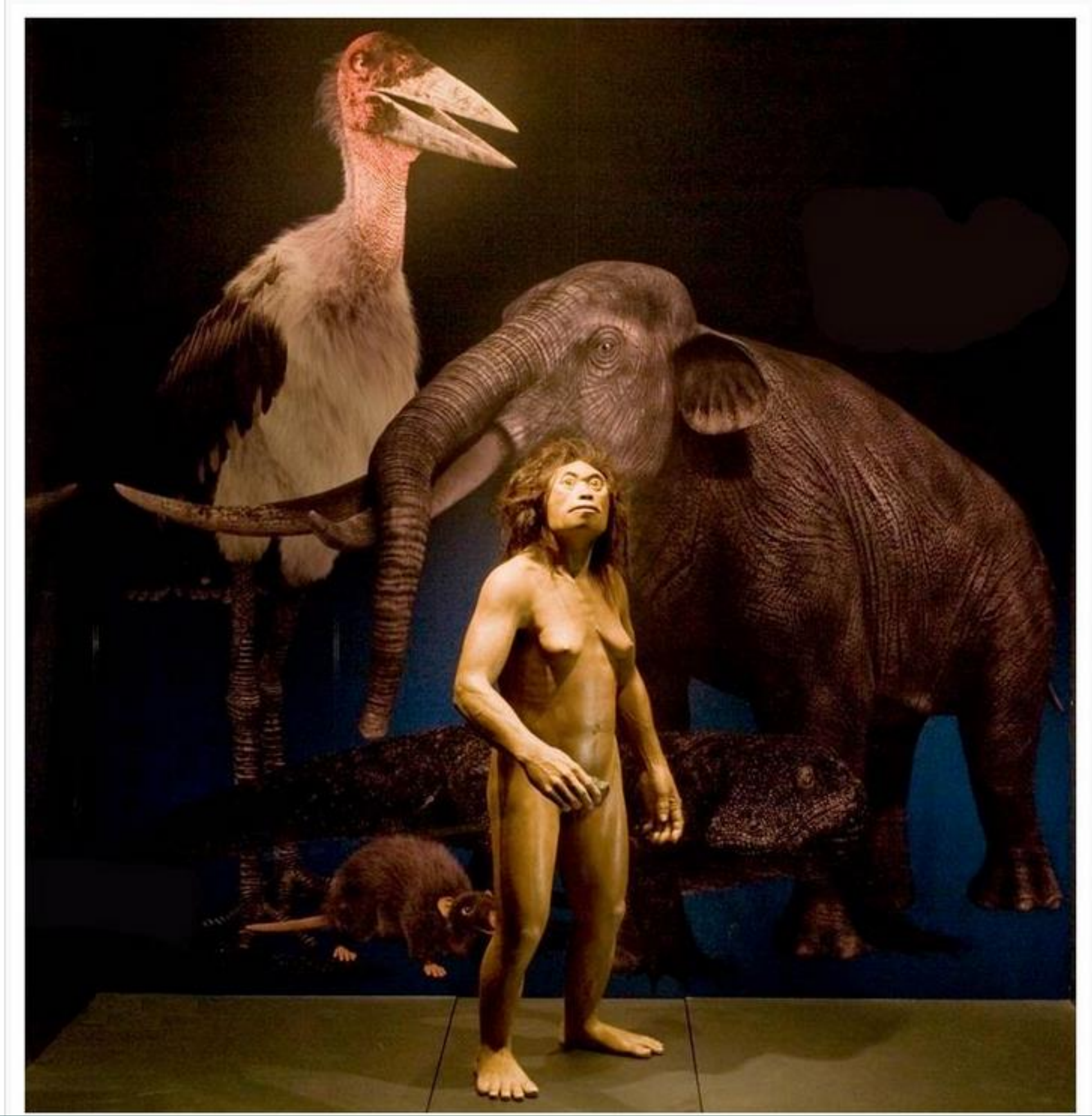
- Current pygmy population living in the village of Rampasasa, near the Liang Bua cave
- Flores pygmies likely trace their ancestry back to the ancestors of Near Oceanic populations and experienced a recent admixture event with populations of East Asian ancestry.
- Flores pygmies harbor, on average, 0.8% Denisovan ancestry
- Collectively, these data provide evidence that polygenic selection acting on standing genetic variation was an important determinant of short stature in this Flores pygmy population.

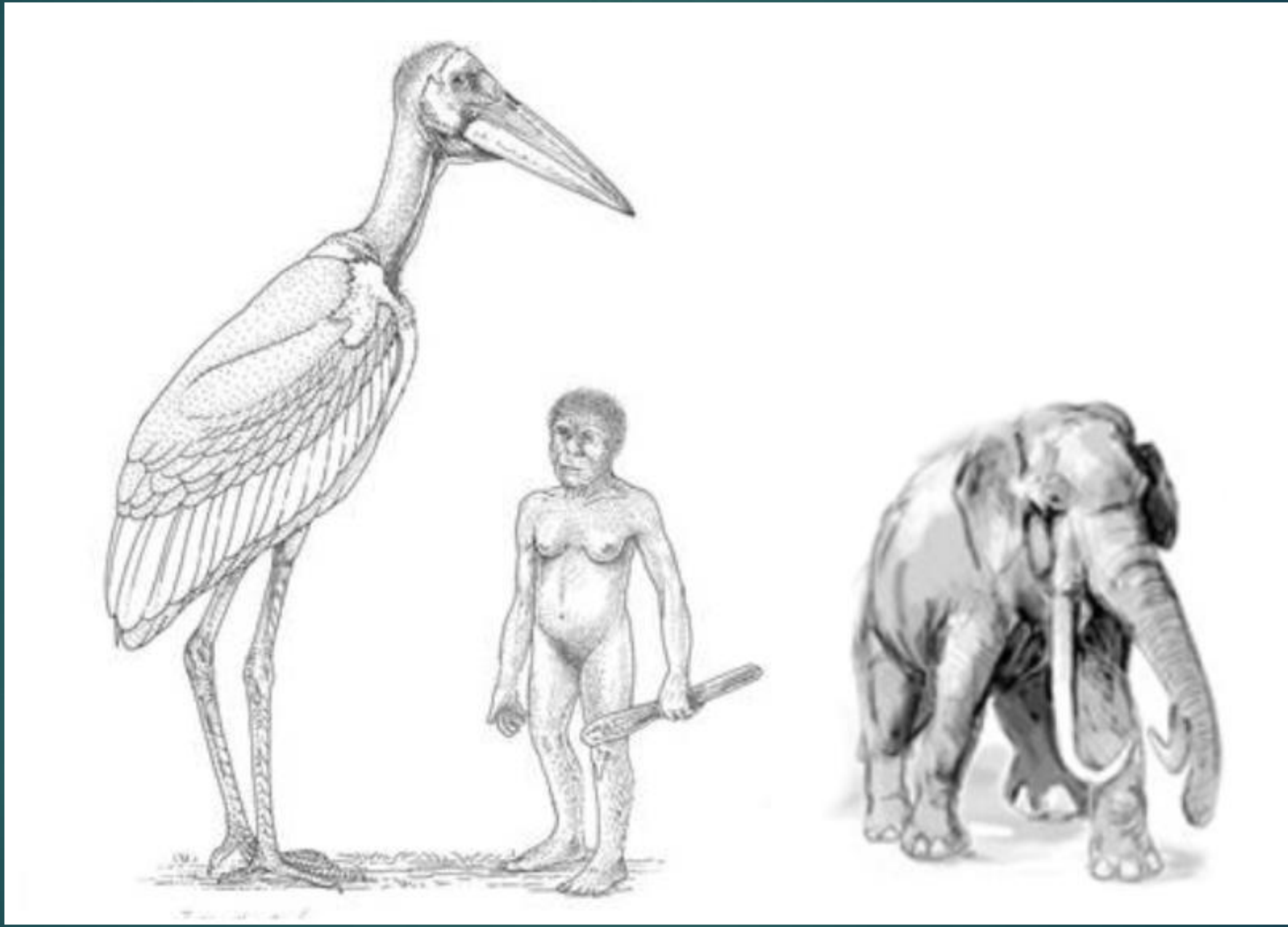
Pygmy genome: Island dwarfism caused small stature

- 2018: Genome study of 32 modern pygmies of Flores. Flores pygmies differ from their closest relatives on New Guinea and in East Asia in carrying more gene variants that promote short stature. The genetic differences testify to recent evolution
- Joshua Akey: Flores produces short people. This is the only example in the world where insular dwarfism has arisen twice in hominins.
- Ancestors of pygmies came to Flores in several waves: in the past 50,000 years or so, when MHs first reached Melanesia; and in the past 5000 years, when settlers came from both East Asia and New Guinea.
- No trace of archaic DNA that could be from the hobbit DNA. researchers couldn't find any additional hominin mixing ancient enough to have come from a species like the hobbit.

Fauna of Flores

An alien island: Flo and Fauna





Island Animals in the time of *Homo Floresiensis*

- Island Dwarfism: Insular environment + abundant prey + lack of mammalian carnivores. Island effect = holds that when food and predators are scarce, big animals shrink and little ones grow.

- 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.)

Island elephants: elephants are excellent swimmers and have ended up on many islands; all dwarfed

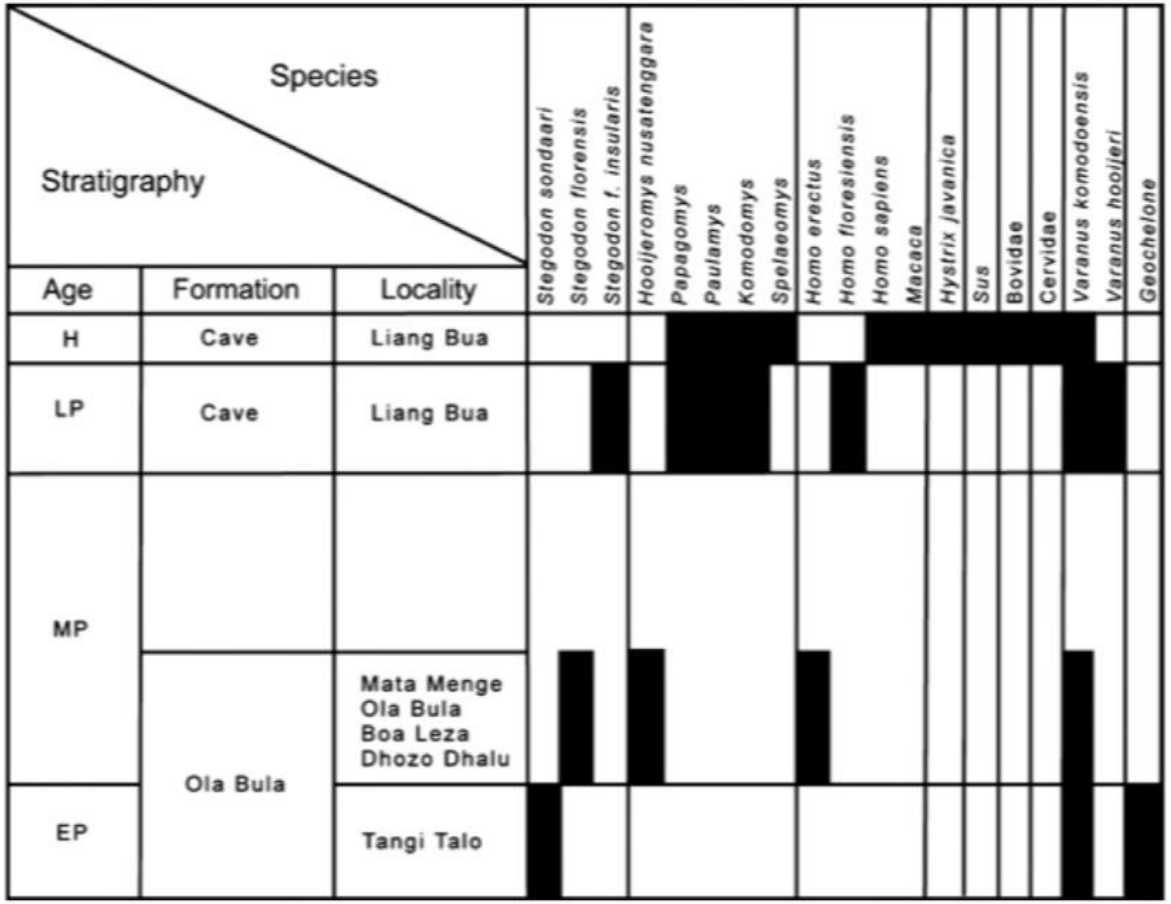
When elephants reach islands:
Lesser resources
No carnivores
They shrink: island dwarfism
i.e. Malta, Cyprus, Crete

Fauna on Flores

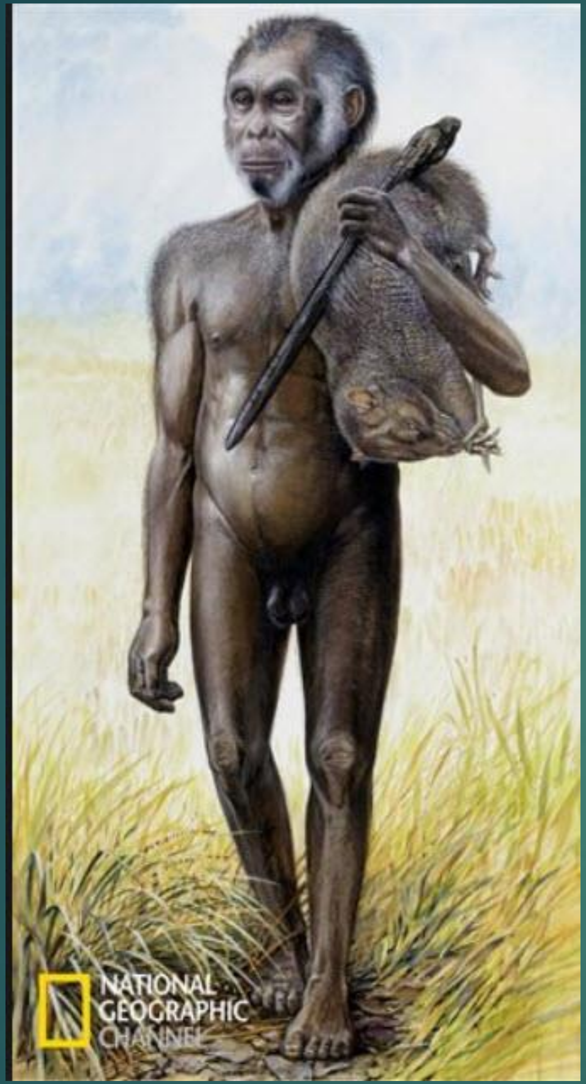
Elephants
Rats
Macaques
Porcupines
Deer
Pigs
Bovids
Komodo Dragons
Tortoises

All smaller size

The fellowship of the hobbit: the fauna surrounding *Homo floresiensis*

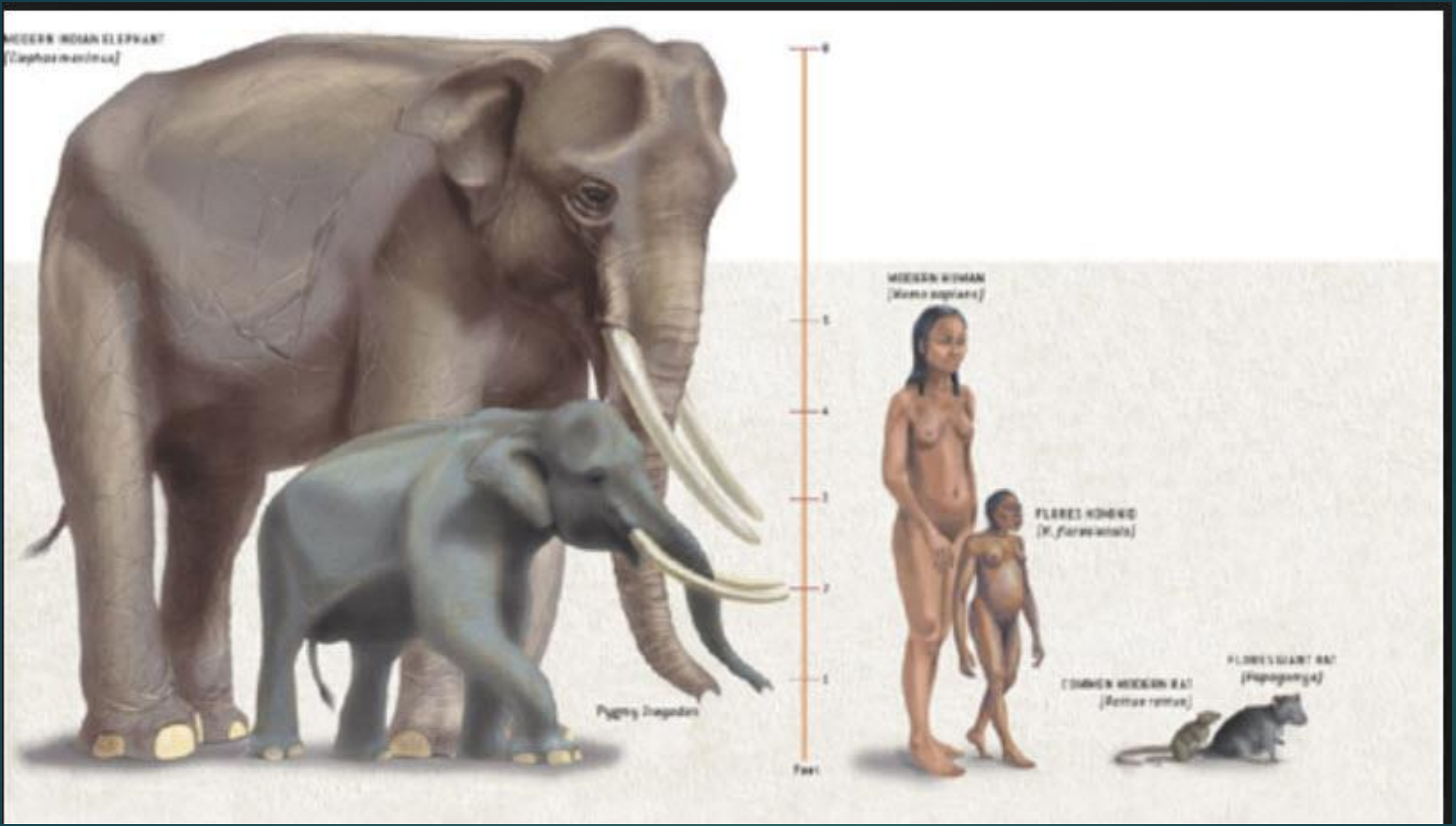


Journal of Biogeography
Volume 37, Issue 6, pages 995-1006, 23 APR 2010 DOI: 10.1111/j.1365-2699.2010.02308.x
http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2699.2010.02308.x/full#f3



Homo floresiensis & a large rat

Modern variant



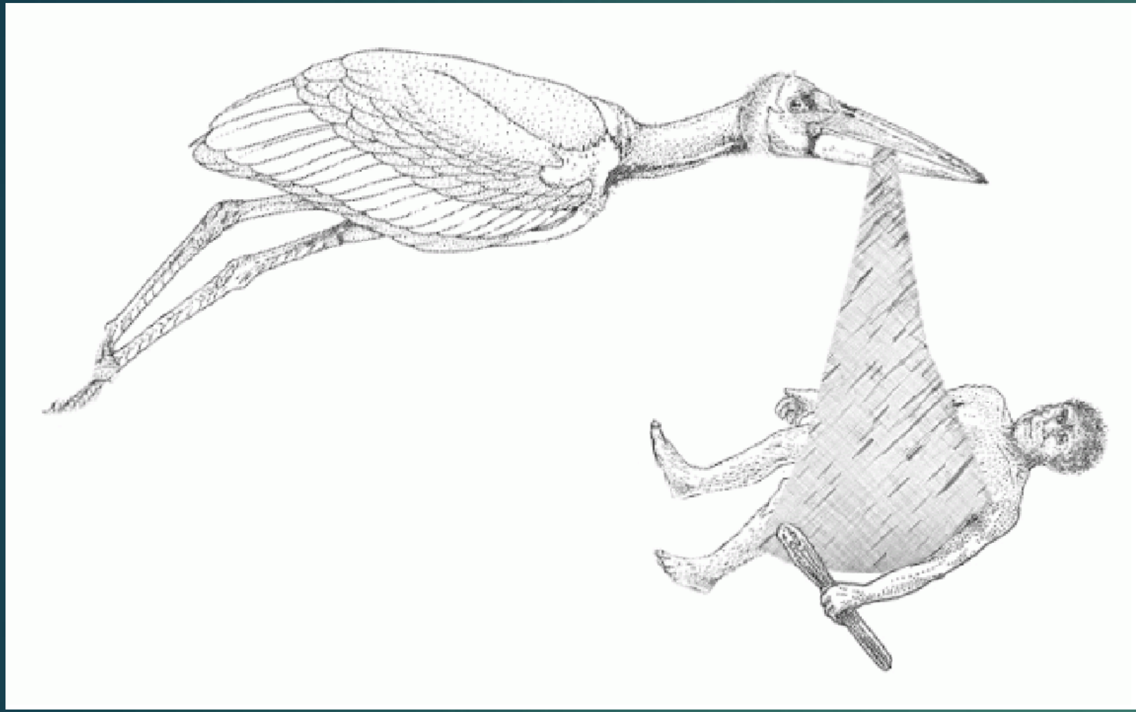
Island dwarfism on Flores, Indonesia

H. floresiensis & giant 2-meter stork

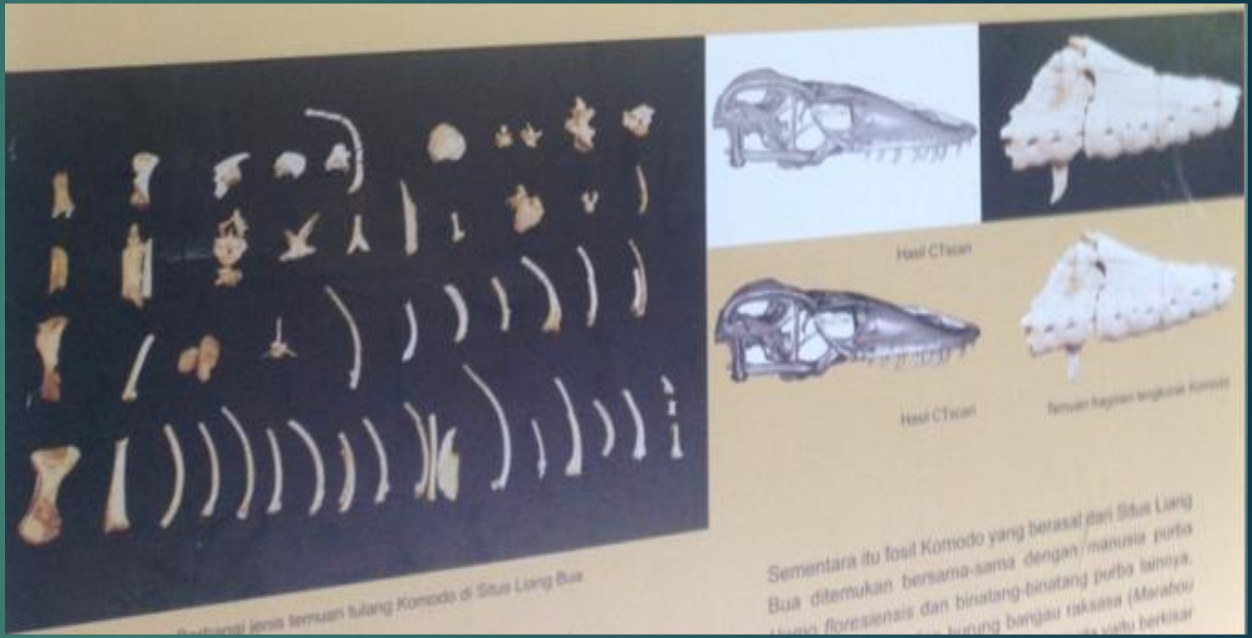
Modern: marabou stork (*Leptoptilos crumenifer*):

60 inches, 20 lbs, largest bird wingspan

2 other versions

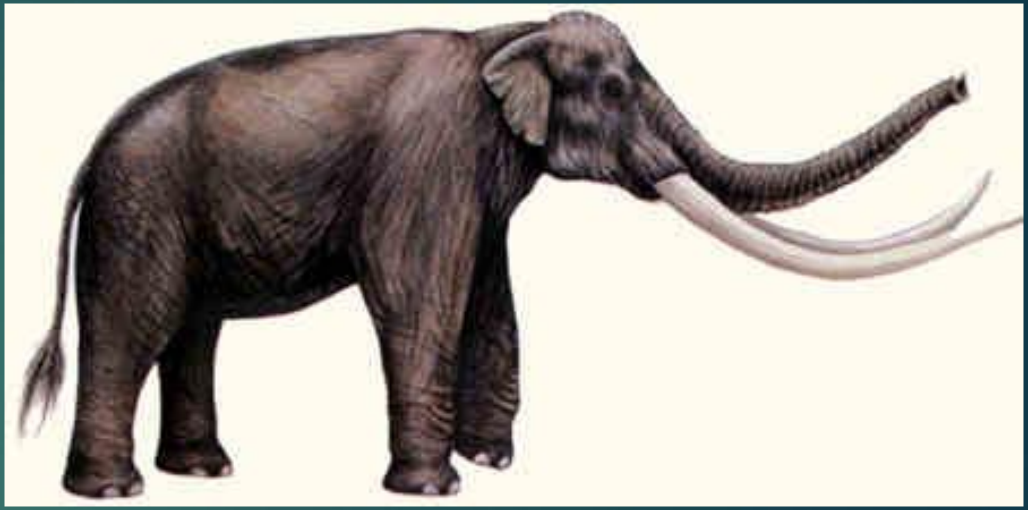


Komodo Dragon bones found at site



Komodo dragons: 10 feet, 150 lbs. on Flores

Diet ?



- Fish
- Frogs
- Snakes
- Tortoises
- Birds
- Rodents (80 % of fossil bones)
- Stegodon - dwarfed elephant
- Komodo dragons

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

- Whether they ate any of these creatures is unknown; their stone tools would have enabled butchery, but the researchers found only a few cut marks on any of the animal bones.

Ecological shift on Flores: Rat bones used for fossil dating

- Liang Bua cave is known as the rat cave
- Evidence for major shifts in past rat populations—including one around 60 Ka, when hobbit remains started vanishing from the cave
- Rats make up 80 percent of the identifiable bones at the site; rats persisted for the 190 Ka stretch preserved under the cave floor.
- Study of 12,000 rat bones: Medium-size rats that prefer more open habitats dominated the site until 60 Ka, when the bones give way to smaller, more forest-adapted rats.
- This shift reflects a change in the environment surrounding the cave with more open habitats giving way to more forested ones,

Rat thigh bones

Excavations at Liang Bua turned up this assortment of thigh bones from small and medium-size rats.

Bones from the Liang Bua cave revealed that hobbits shared the cave with rats from five body-size categories, shown here matched with partial jawbones holding molar teeth.

Rats 2: Hobbit migration before 50 Ka?

- By 50 Ka ago, all traces of hobbit, stegodon, vulture, stork, and komodo dragon were gone from the cave

- Scientists had hypothesized that the large fauna on Flores went extinct. The signal from the rats, however, suggests *H. floresiensis*' departure from Liang Bua may simply be because they—and the rats—left in search of more forested environments.

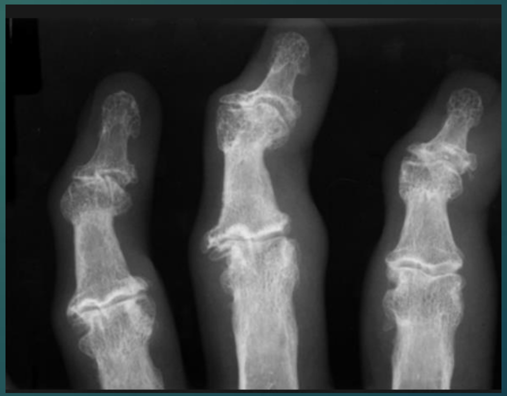
- Hobbit migration at 60 Ka: In essence, the hobbits and their giant animal neighbors didn't necessarily die out at that time, but may have moved on to more hospitable parts of the island.

Rats 2: Hobbit migration?

- There is the possibility that some of them still survived after that time somewhere on Flores
- The results could mean that the hobbit species lingered into the more recent past—and may have even come into contact with MHs (remember the Ebu Gogo).
- Modern humans (*Homo sapiens*) appear to have arrived on the island by about 46 Ka ago

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



Cranium

Cranium is small!

Cranium and Dentition:

- Cranial shape: argued it is closest to *Homo erectus.* (but similarities are also noted to *Homo habilis* and *Homo georgicus)*
- The <u>skull resembles those belonging to extinct earlier species of our own genus ***Homo***</u> (Brown *et al.*, 2004; Baab and McNulty, 2009).
- The modern appearance of the face is associated with small overall cranial size and NOT to similarities to modern humans
- Features of the mandible are more closely aligned to early *Homo* or even *Australopithecus*
- Absolute tooth size is in the range of modern humans but when scaled to body size, the teeth are relatively large
- Tooth wear shows a pattern of powerful chewing, and strange uneven wear pattern

- Summary: <u>closest relationship is to early members of the genus Homo but with a unique combination of features that denotes a new species in human evolution.</u>

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

- Moderate supraorbital torus (not continuous)

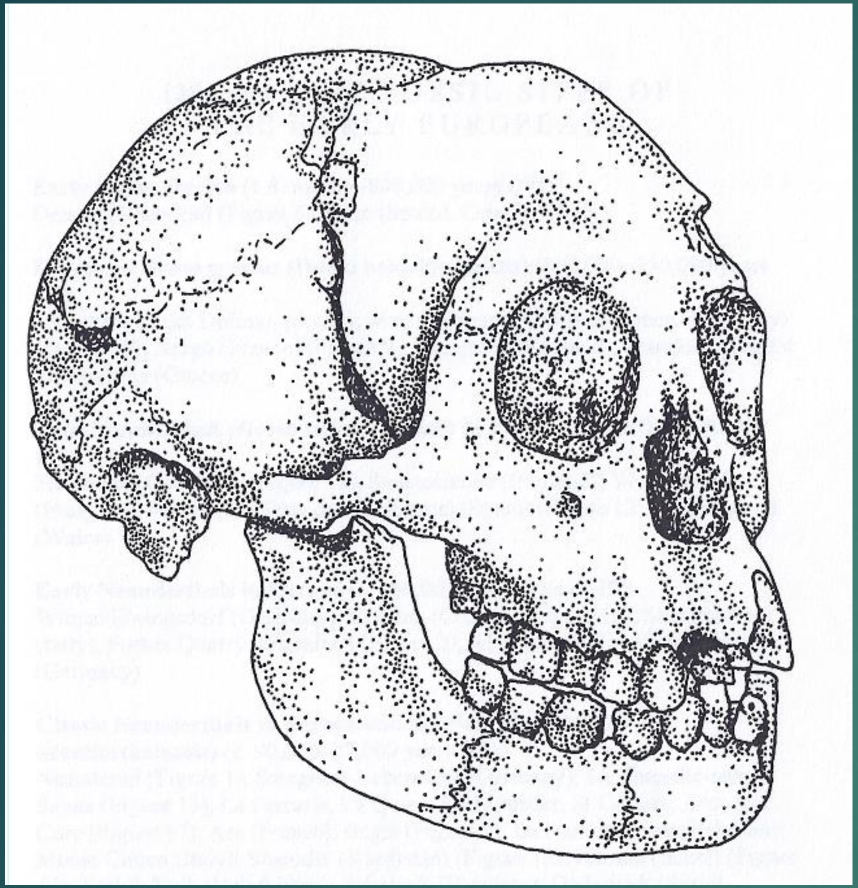
Brown et al., 2004; Morwood, et al., 2004

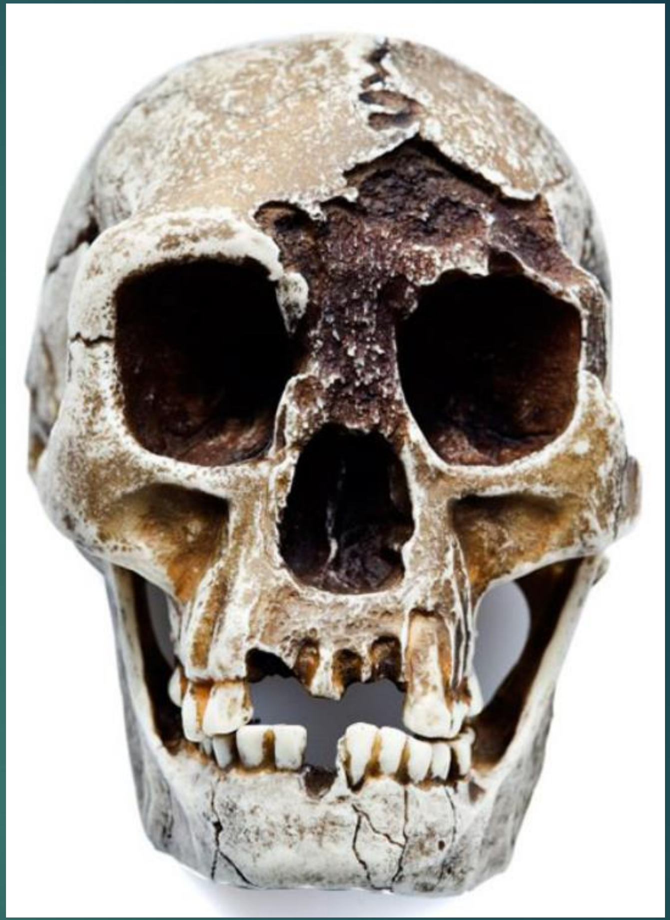
Cranium

- Mandibular symphysis <u>lacks a chin</u>
- Skull long
- Low vaulted
- <u>Widest near the base</u>

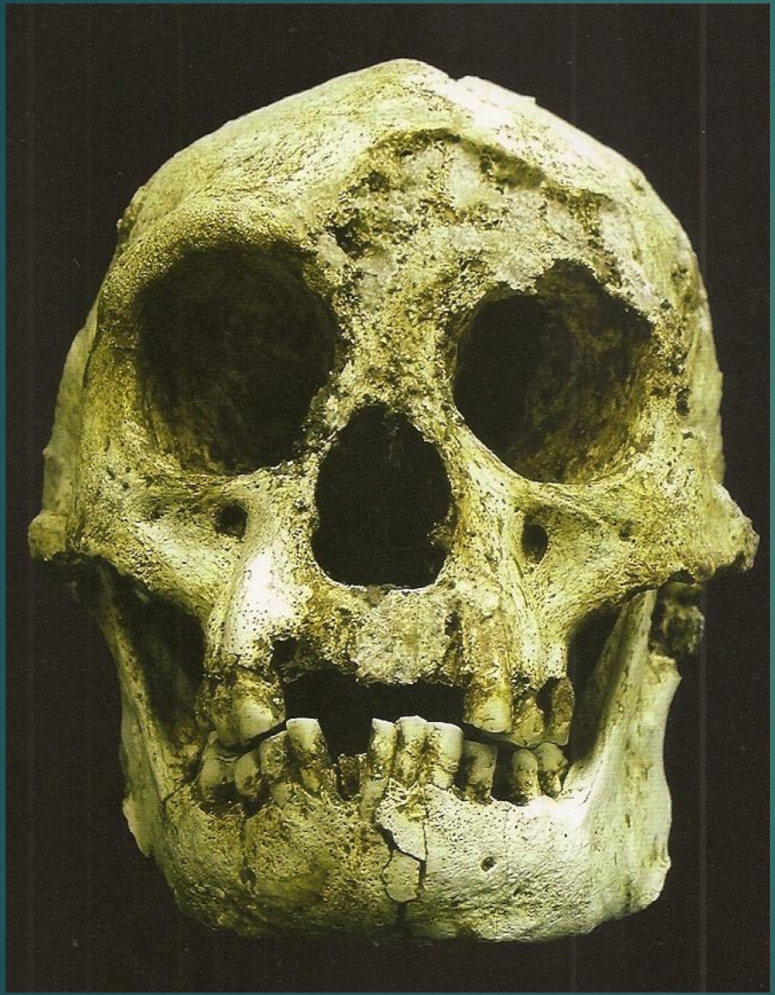
Homo floresiensis vs. *sapiens* skulls: 426 cc vs. 1350 cc

Skull

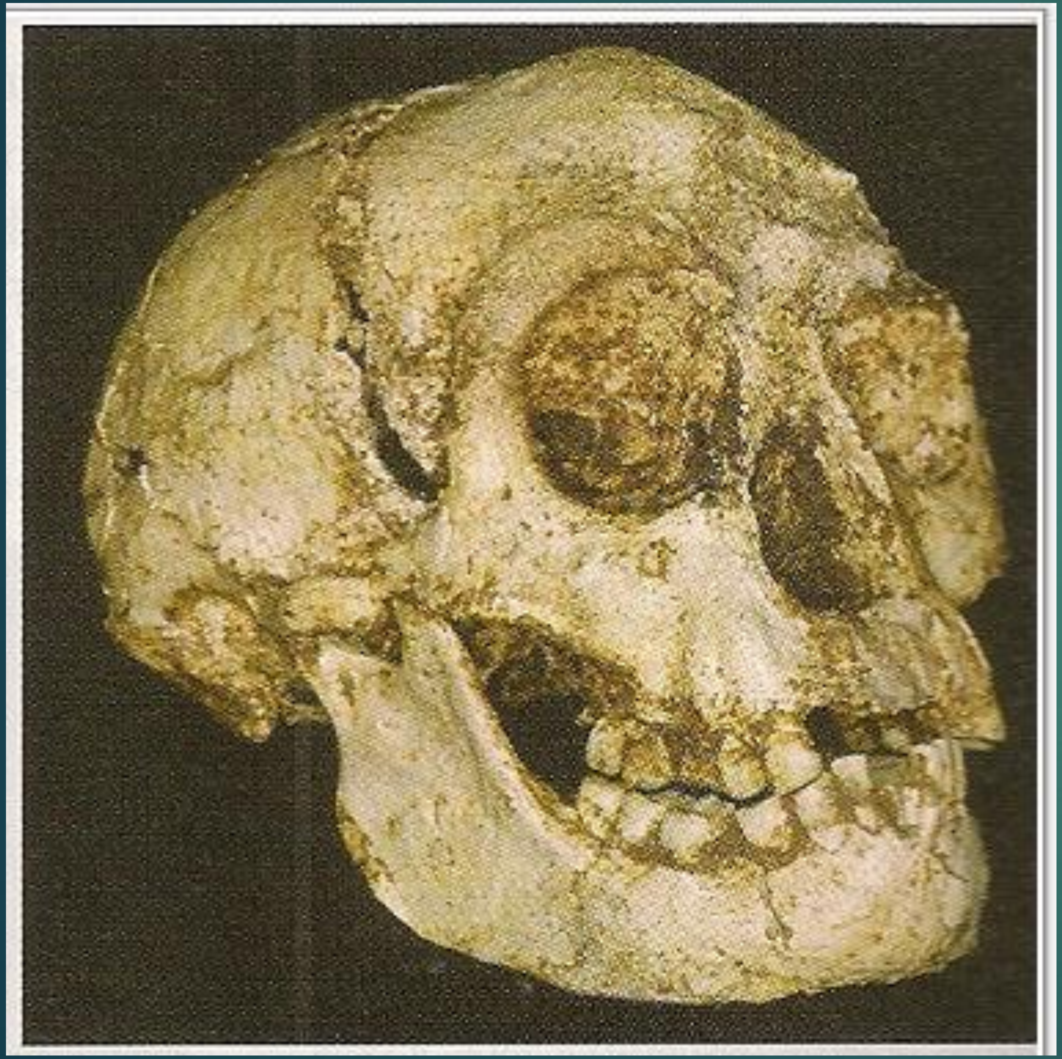




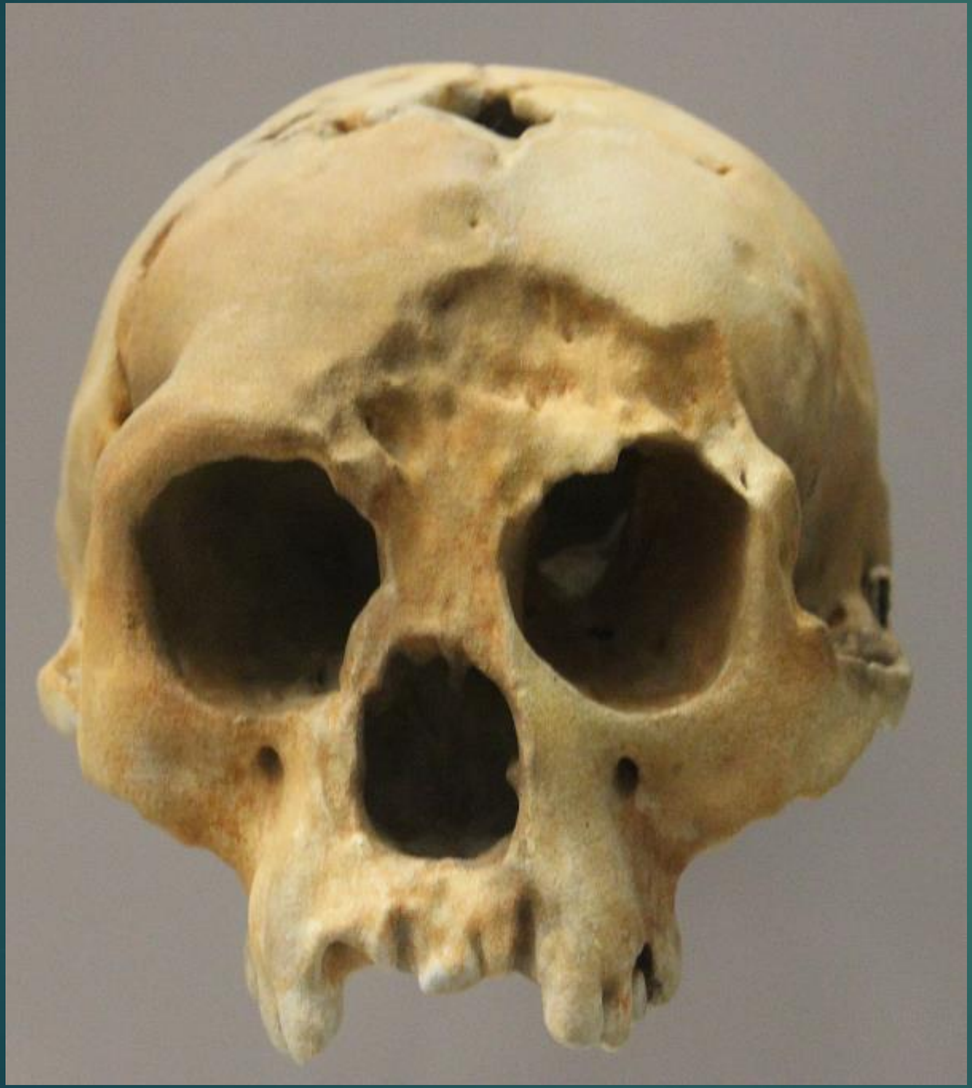
Frontal



Lateral views



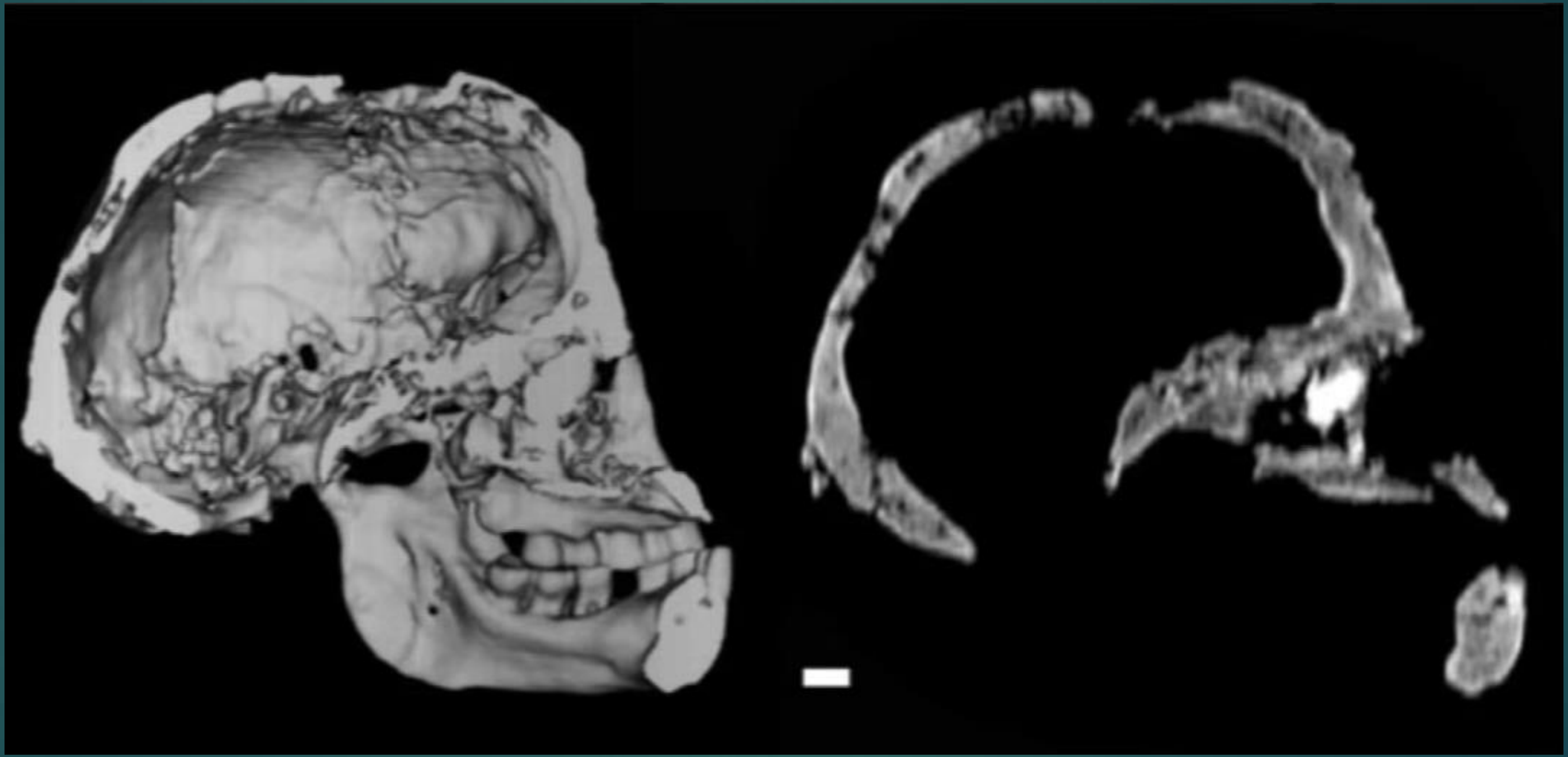
Views



Lateral

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

Skull bone abnormally thick on CT; no sutures



Homo floresiensis

(LB1)

"The Hobbit"

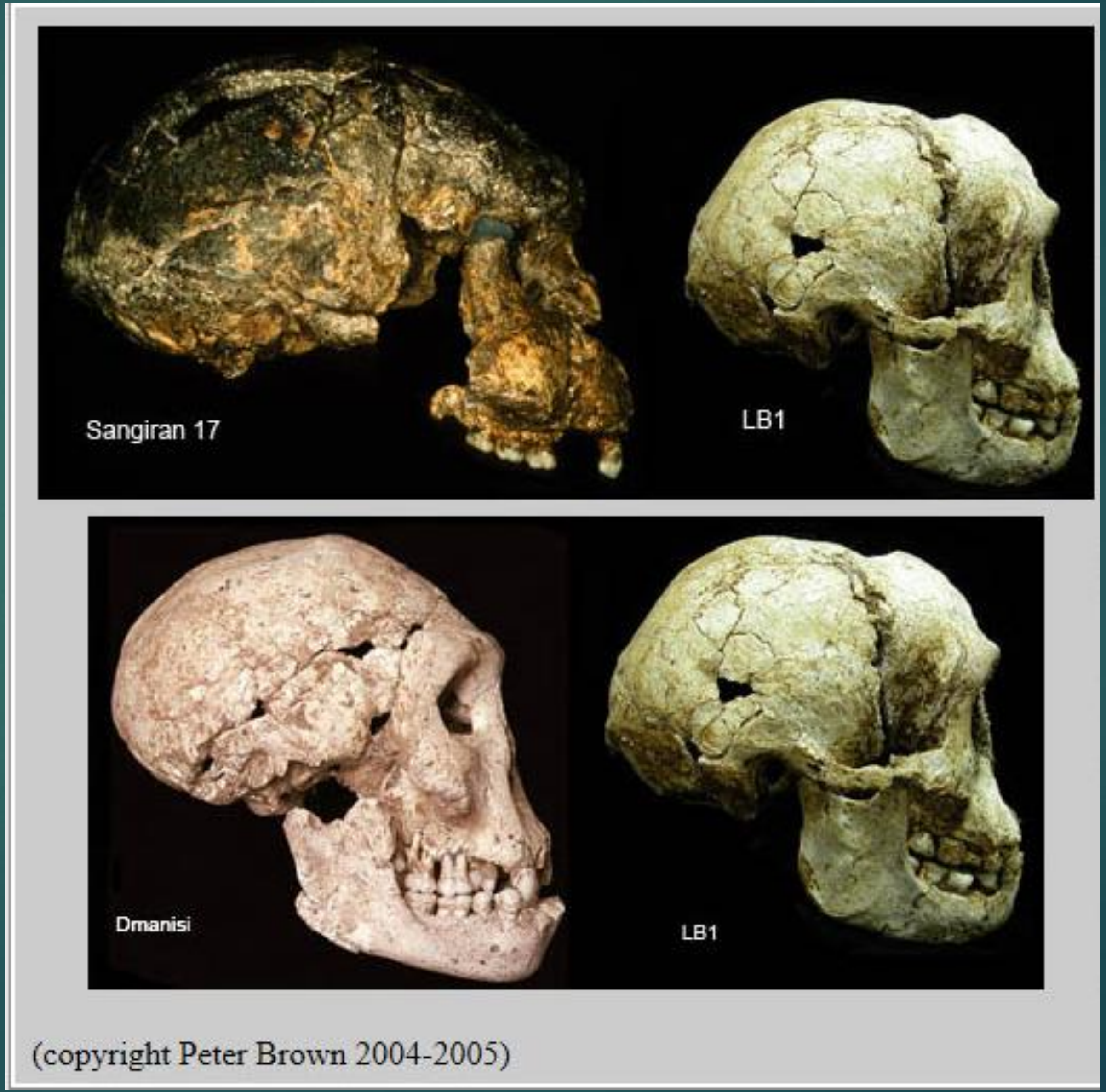
Flore, LB 1
~ 0.02 MA

Dmnisi 2700
~ 1.76 MA

H. Erectus compared to LB1

H. erectus:
Sangiran

H. erectus:
Dmanisi



LB1

Cranium: Conclusion

- Aiello, 2010: 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

Dentition

- Parabolic tooth row
- Short canines
- Incisor 2 smaller than Incisor 1; 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).
- Hawkes: 1st molar large, 3rd smaller = like MHs

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

H. floresiensis mandibles

Dentition

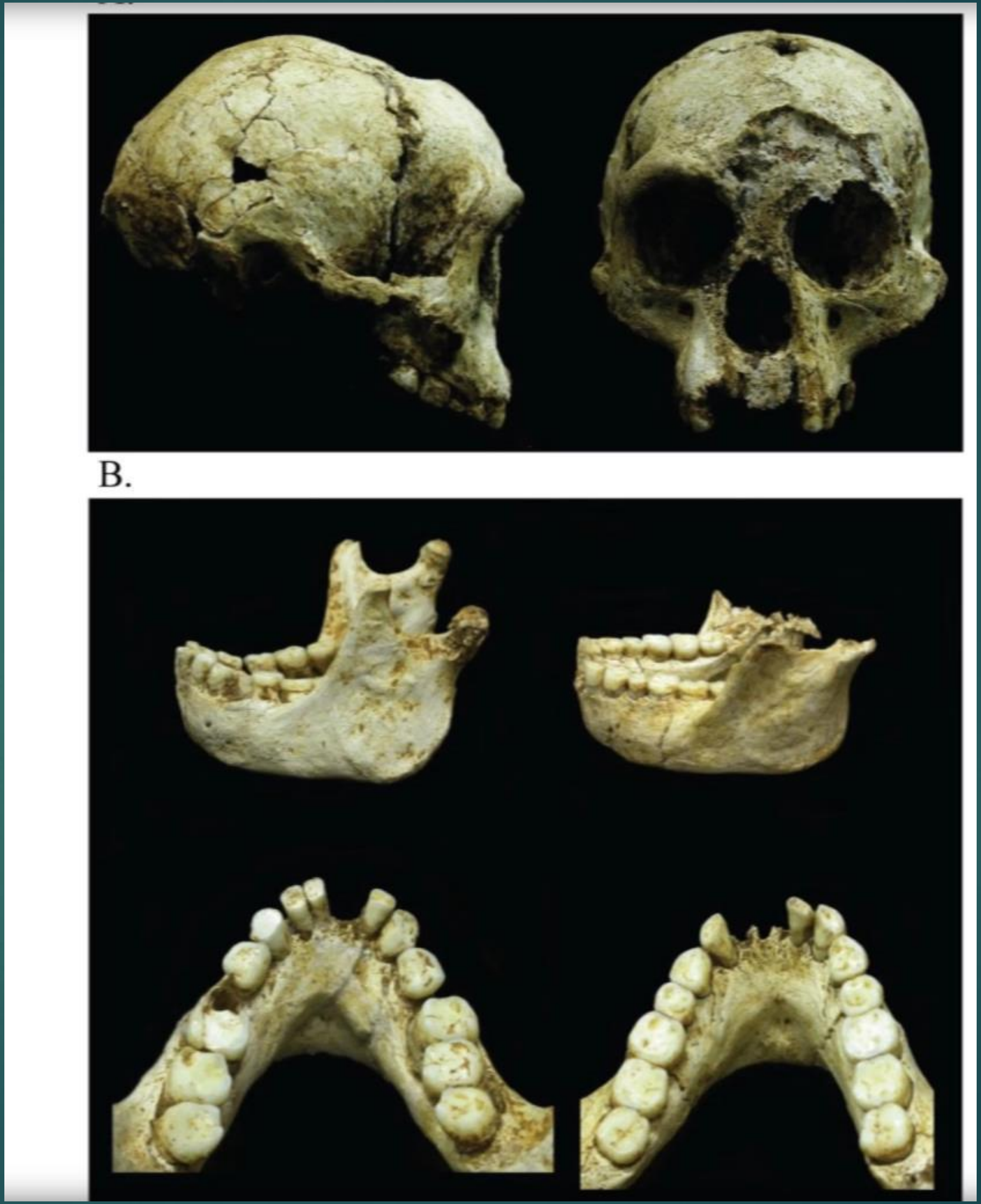
LB2 LB1

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

Teeth

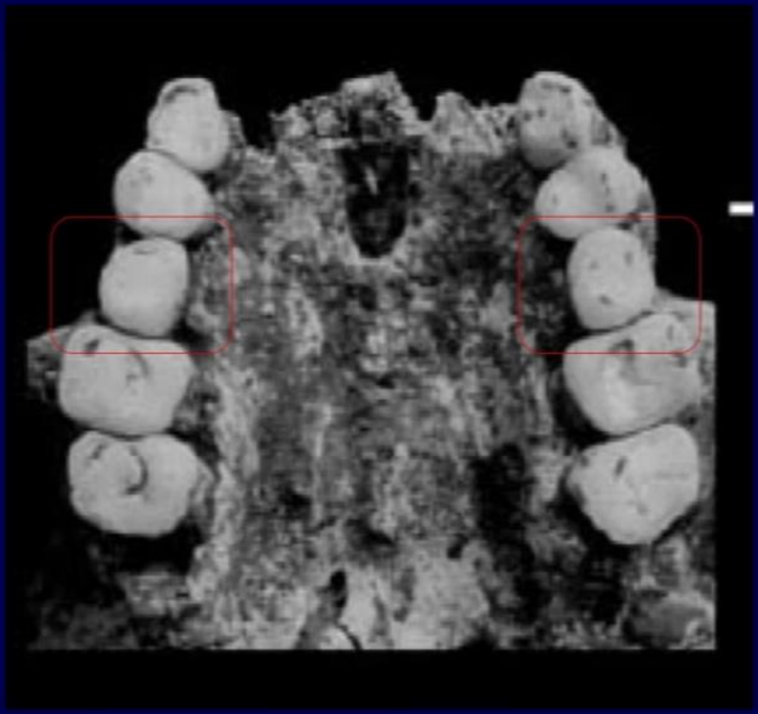
Modern teeth

Chin region matches australopithecines



Premolar rotation has never been seen before

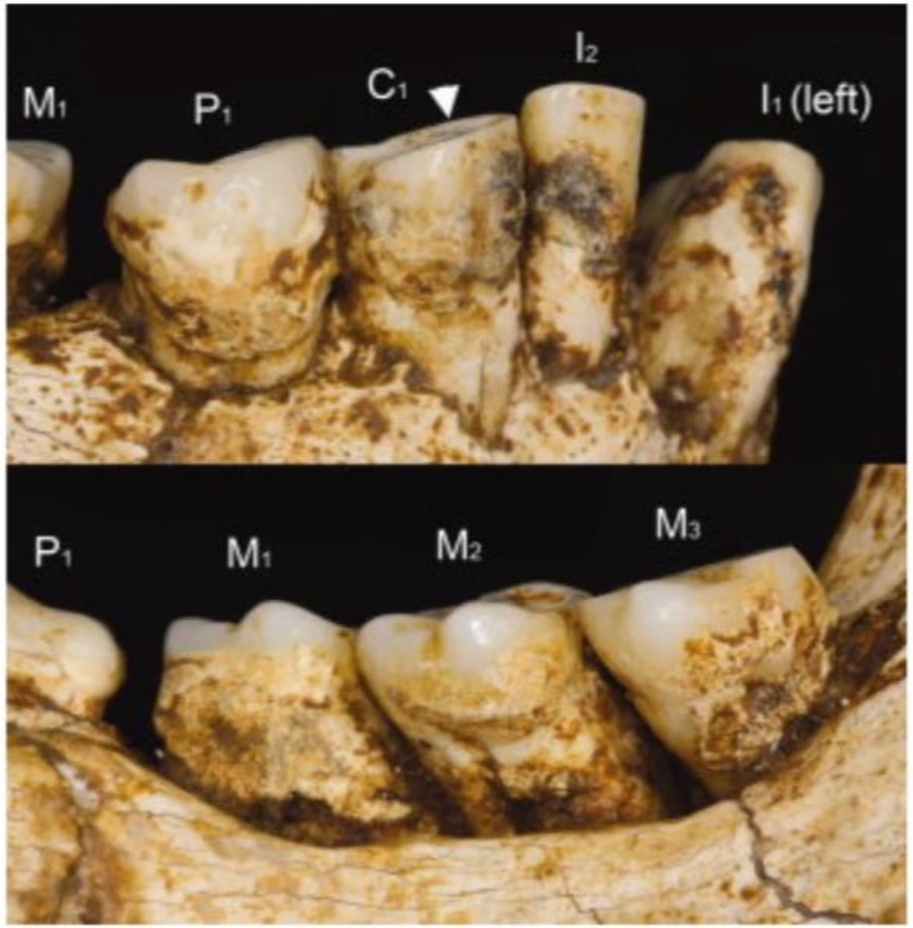
Unusually, both maxillary P4s are rotated parallel to the tooth row, a trait that seems to be unrecorded in any other hominin. (2004: 1058)



16% of Rampasasa exhibit tooth rotation (no bilateral)

Teeth do not wear on same plain

On dental wear, dental work, and oral health in the type specimen (LB1) of *Homo floresiensis*



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olume 145, Issue 2, pages 282-289, 16 MAR 2011 DOI: 10.1002/ajpa.21492
ttp://onlinelibrary.wiley.com/doi/10.1002/ajpa.21492/full#fig5

The endocranial cast

Brain size

- No endocasts found; brain size measured by filling endocranial area or CT imaging.
- 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.
- Later estimated volume: *426 cc*
- LB1's brain size is half that of its presumed immediate ancestor, *H. erectus* (980 cc)

H. sapiens (1350cc)

H. Floresiensis (426 cc),

Dmanisi *H. erectus* skull 5 (546 cc),

H. habilis (614 cc),

Earliest Indonesian *H. erectus* (860 cc),

LB1 Brain: 426 cc

- Kubo et al. 2013: Inconsistency in the published endocast cranial volumes for LB1: 380–430 cc)

- Accurately determined the ECV of LB1 using high-resolution micro-CT scan.

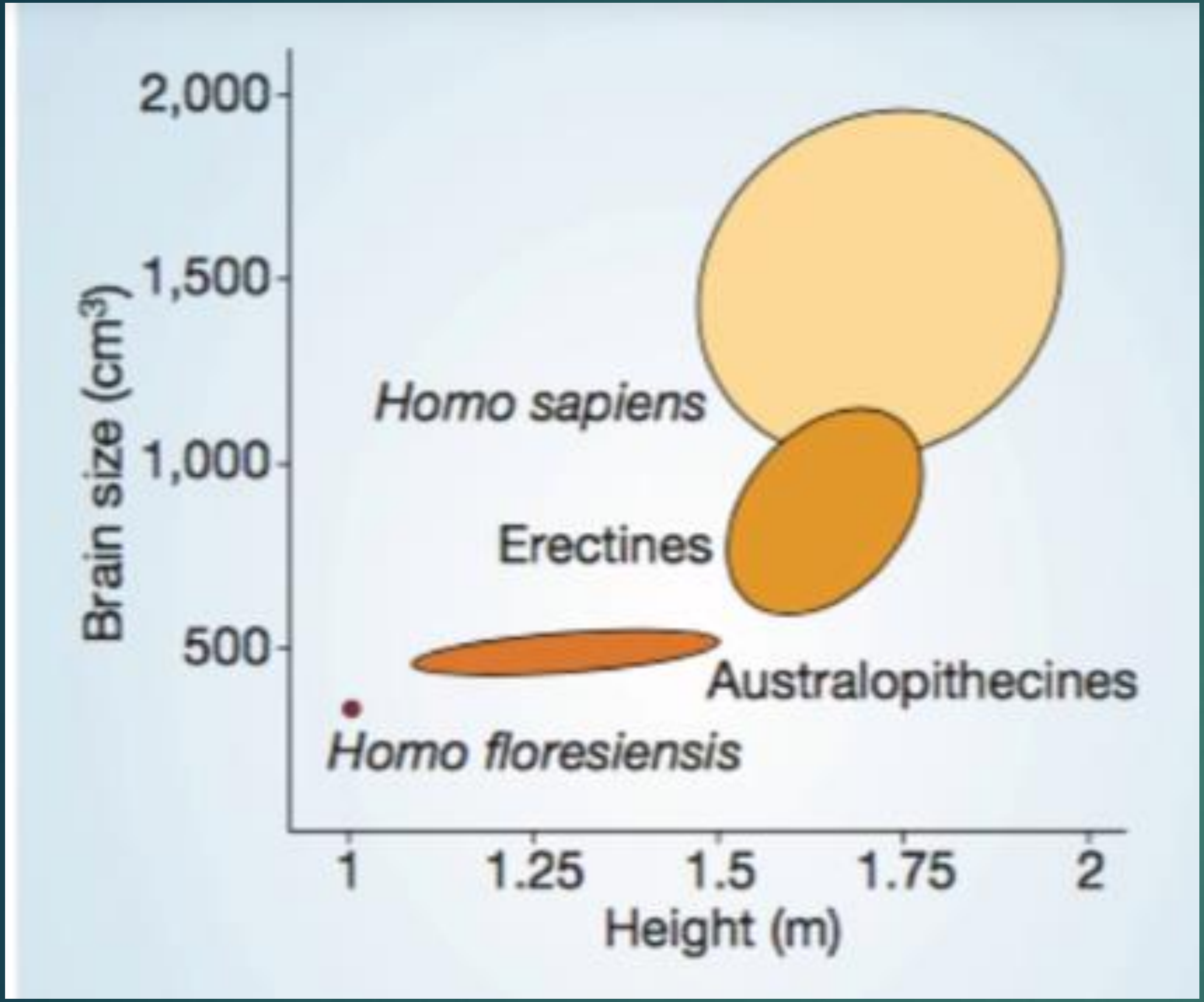
- The ECV of LB1 thus measured, 426 cc, is larger than the commonly cited figure in previous studies (400 cc).

Daisuke Kubo, et al., 2013

Hominin cranial capacity

	CC	EQ	MYA
Chimpanzee	390		
Sahelanthropus tchadensis:	400		
H. floresiensis	426		100 Ka
A. afarensis	*446*	*4.9*	*3.5* Ma
A. garhi	*450*		
A. africanus	*461*	*5.2*	
A. robustus & boisei	*503*	*5.3*	
H. habilis	*610*	*7.1*	*1.8* Ma
H. rudolfensis	*789*	*7.4*	
H. ergaster	*801*	*6.3*	*1.5* Ma
H. erectus	*951*	*7.3*	
H. heidelbergensis	*1263*	*8.6*	*600 Ka*
H. neanderthalensis	*1427*	*10.6*	
H. sapiens sapiens	*1350*	*9.6*	*200 Ka*

(Allen, based on Martin 1983)



- The relative brain and body size of *H. floresiensis.*
- The dimensions of the skull and skeleton (LB1) described by Brown *et al.* fall well outside the extremes seen in *H. sapiens* and the 'erectines'.
- LB1 is closer in size to, but even smaller than, the australopithecines, of which the best known example is Lucy.
- On various anatomical grounds, however, Brown *et al.* believe that LB1 represents a dwarfed *H. erectus.*

Brain to body scaling

- The first and most serious criticism has been that LB1's brain is too small to be explained by known scaling relationships between brain and body size.

- Across species, brain mass typically scales to body mass to the power of 0.75

- If LB1 were a dwarfed human of 30 kg, then its predicted brain volume would be about 1,100 cm^3
- If it were a dwarfed *H. erectus* then its brain volume would be expected to be about 500–650 cm^3.

Island dwarfism cannot explain LB1

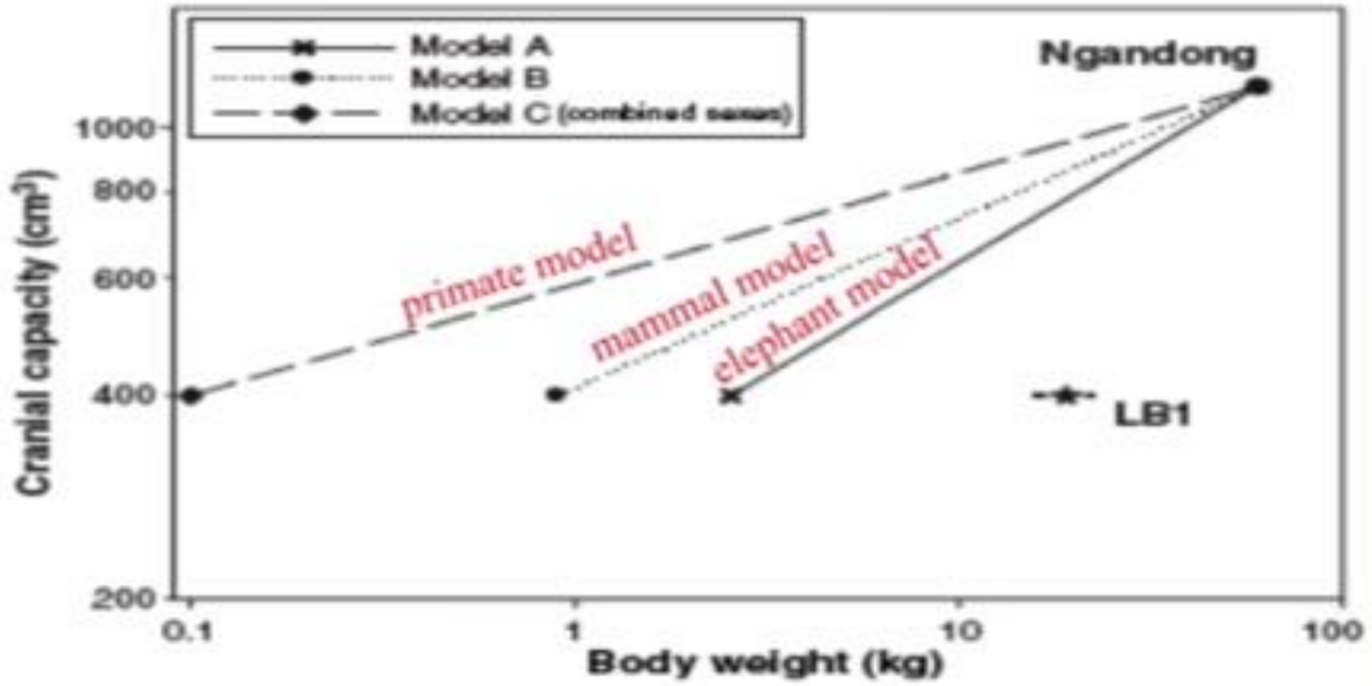


Fig. 1. Example of the dwarfing models presented in Table 1 showing the derivation of dwarf forms with the cranial capacity of LB1 from Ngandong *H. erectus* following the dwarfing models A to C. Body weight predictions for LB1 from all three models are substantially lower than the estimated values from the skeleton itself.

LB1 scales from 100g -11kg

Martin et al. 2006:
Dwarfing of body size in mammals is usually associated with only moderate brain size reduction.
The tiny cranial capacity of LB1 cannot be attributed to intraspecific dwarfism in *H. erectus.*

Science 206: 99

Relative Brain size

- Martin: degree of brain size reduction is simply too great 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
- For example, despite having bodies that are much smaller than their neighbors, modern human pygmies have brains which are only slightly smaller.

(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: 3D-CT endocast of LB1

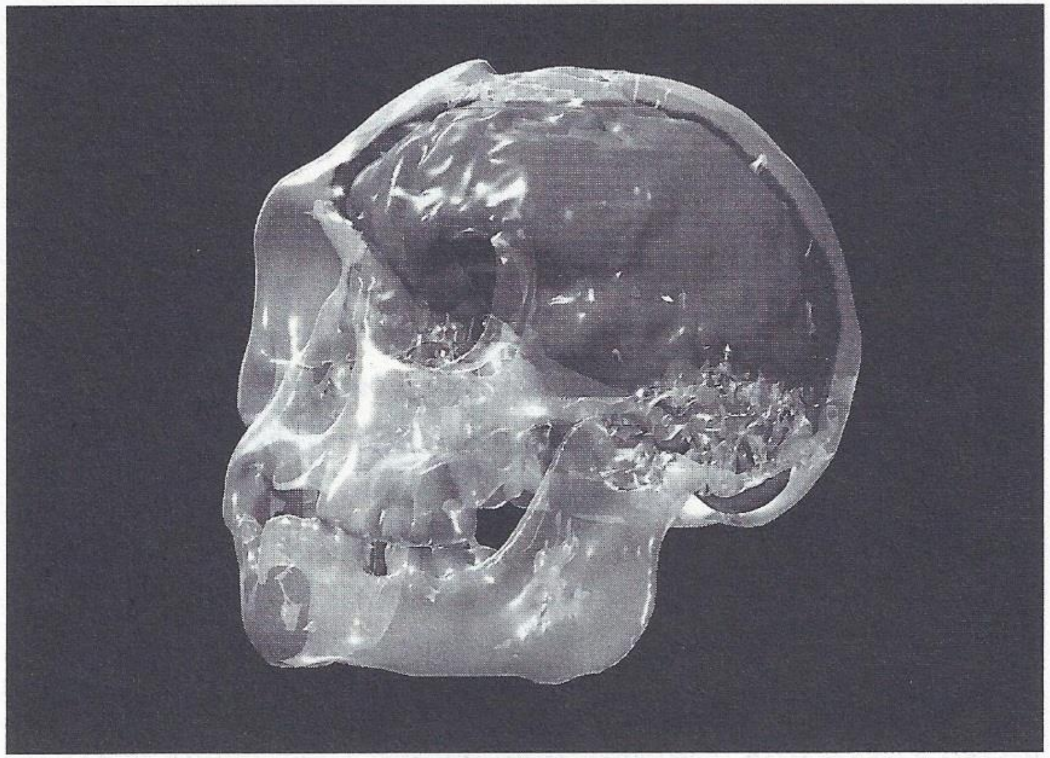


Figure 16. Kirk produced a gorgeous virtual endocast from the 3D-CT data that were collected from LB1's skull. The endocast reveals convolutions, blood vessels, and sutures of the skull. Courtesy Kirk Smith, Mallinckrodt Institute of Radiology.

Virtual endocast of LB1

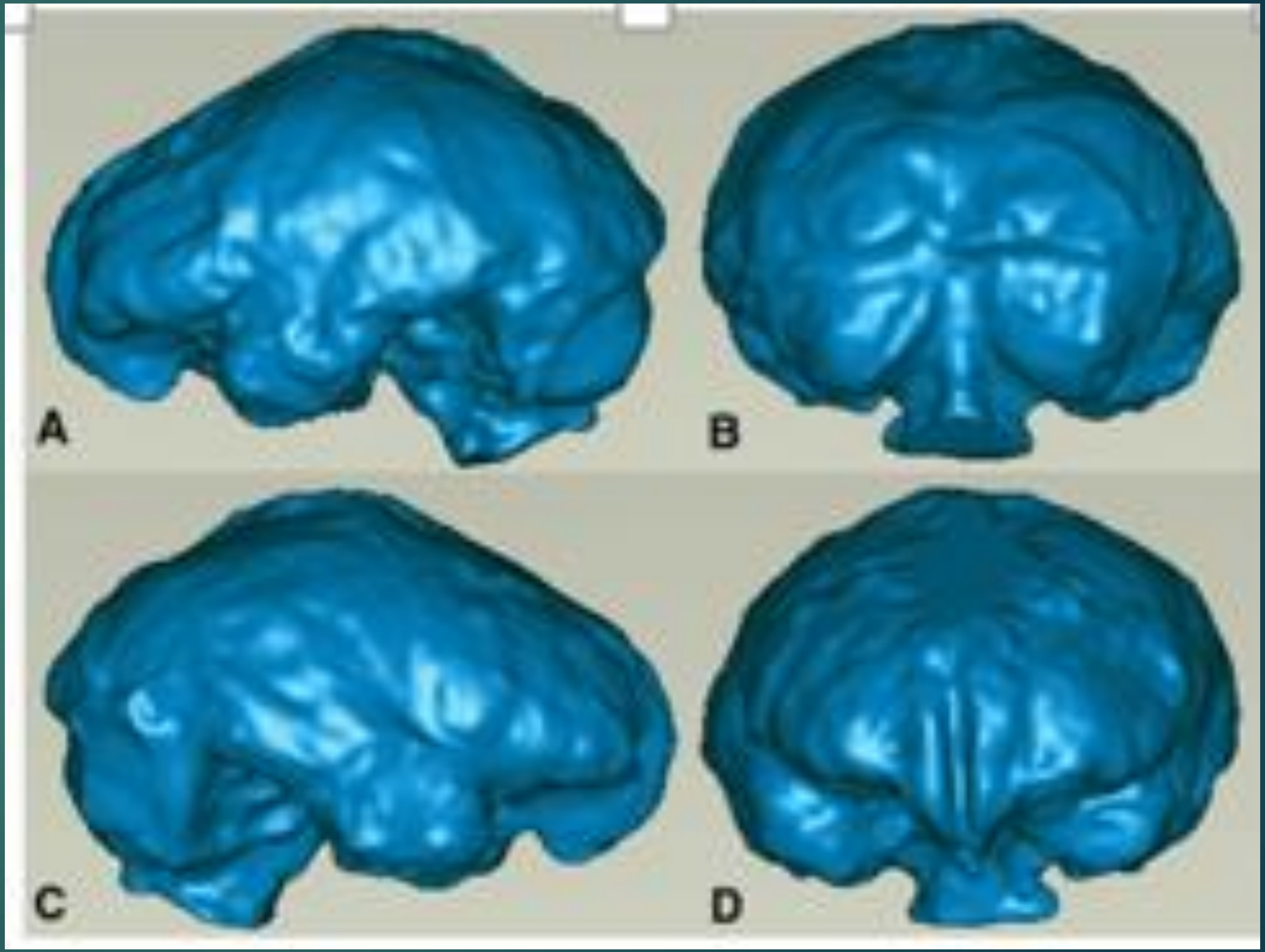
3 advanced, derived features:

1 – Caudal Lunate sulcus – toward back, like in MHs

2 – Temporal lobe: large & wide

3 – Frontal area 10 enlarged

Implies brain reorganization



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

Postcranial Anatomy

Thomas Sutikna has been at Liang Bua since the early 2000s (photo courtesy of Sutikna)

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

Descriptions of the lower limb skeleton of *Homo floresiensis* -- W. L. Jungers, et al., 2008

- 2008: Bones of the lower extremity have been recovered for up to nine different individuals of *Homo floresiensis* – LB1, LB4, LB6, LB8, LB9, LB10, LB11, LB13, and LB14.
- LB1 is represented by a bony pelvis (damaged but now repaired), femora, tibiae, fibulae, patellae, and numerous foot bones.
- LB4/2 is an immature right tibia lacking epiphyses.
- LB6 includes a fragmentary metatarsal and two pedal phalanges.
- LB8 is a nearly complete right tibia (shorter than that of LB1).
- LB9 is a fragment of a hominin femoral diaphysis.
- LB10 is a proximal hallucal (toe) phalanx (bone).
- LB11 includes pelvic fragments and a fragmentary metatarsal.
- LB13 is a patellar (knee) fragment,
- LB14 is a fragment of an acetabulum (femur socket).

Postcranial Anatomy: Mosaic pattern

- Foot:
  - Similar to *australopithecines* with the navicular as weight-bearing and with no transverse arch.
  - Feet as long in relationship to the lower limb bones. Phalanges are curved.
- Relatively long arms
- Wrist bones more similar to African apes than any other hominin species
- Shoulder blades moved forward as if in a hunched position

Postcranial Anatomy:

- Unusual low twist of the humerus
- Short and curved clavicle
- Wide femora in comparison to the length
- These features seem to suggest a very primitive group of features more similar to australopithecines than any later in time hominins.
- Based on foot and shoulder morphology:
  - inconsistent with endurance running like in modern humans
  - forelimb morphology would make tool making and other manipulative behaviors more difficult

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 the 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).

Archaic features

- The tiny brain of LB1, its body shape, and its foot, hand and wrist bones look more primitive than those of any human dating to within the past million years.
- Primitive traits of the wrist bones and jaw are replicated in at least one more individual from the site.
- Like LB1, the LB6 lower jaw is small, lacks a chin, and shows internal bony reinforcements most like those in pre-human fossils more than 2 million years old.

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 monkeys

- Clavicle is short and quite curved, in contrast to the longer, straighter clavicle that occurs in hominins of modern body form

- But still *Homo*: skull, narrow nose, prominent brow arches over each eye socket

Chris Stringer's list of LB1 archaic features

- 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

Shoulder joint & Clavicle

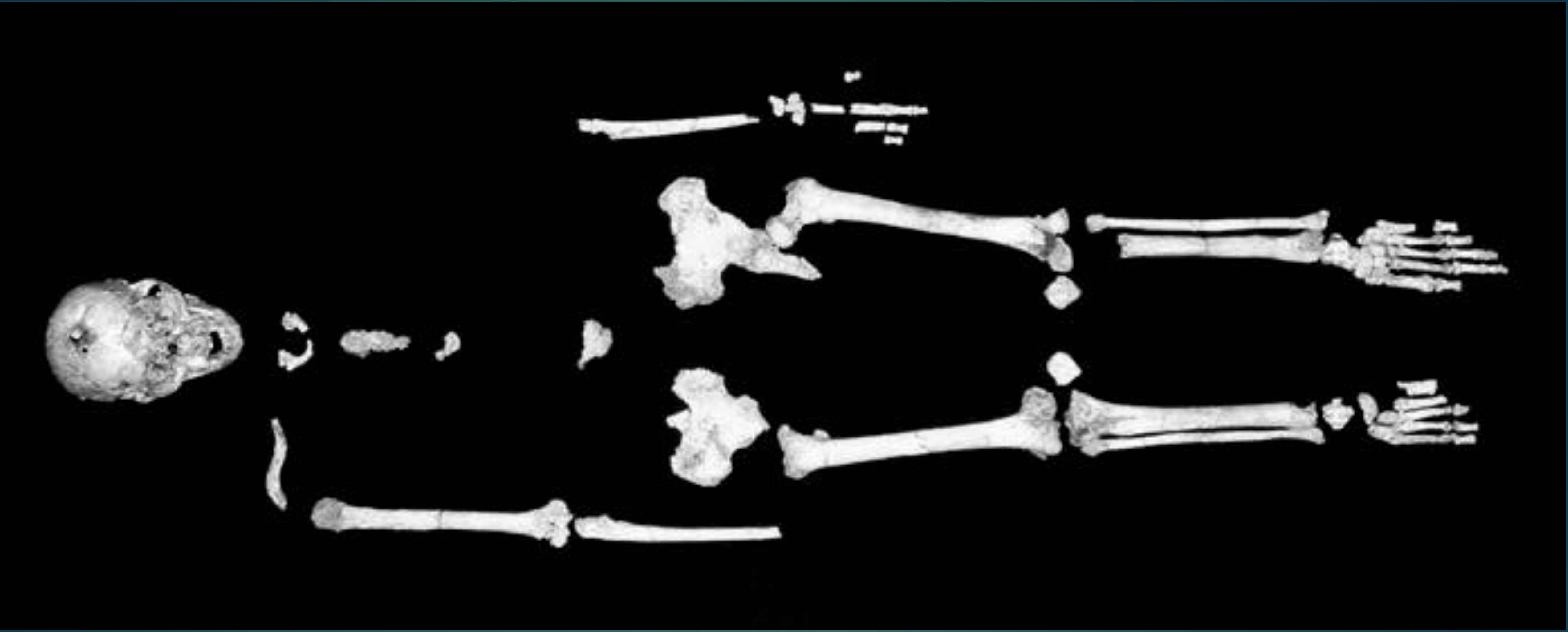
- LB1 shoulder: The two key features are the short clavicle and a humerus with a low torsion angle. Both features are shared with early *Homo erectus* (Turkana boy and *H. georgicus* from Dmanisi).

- 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.

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

Humerus

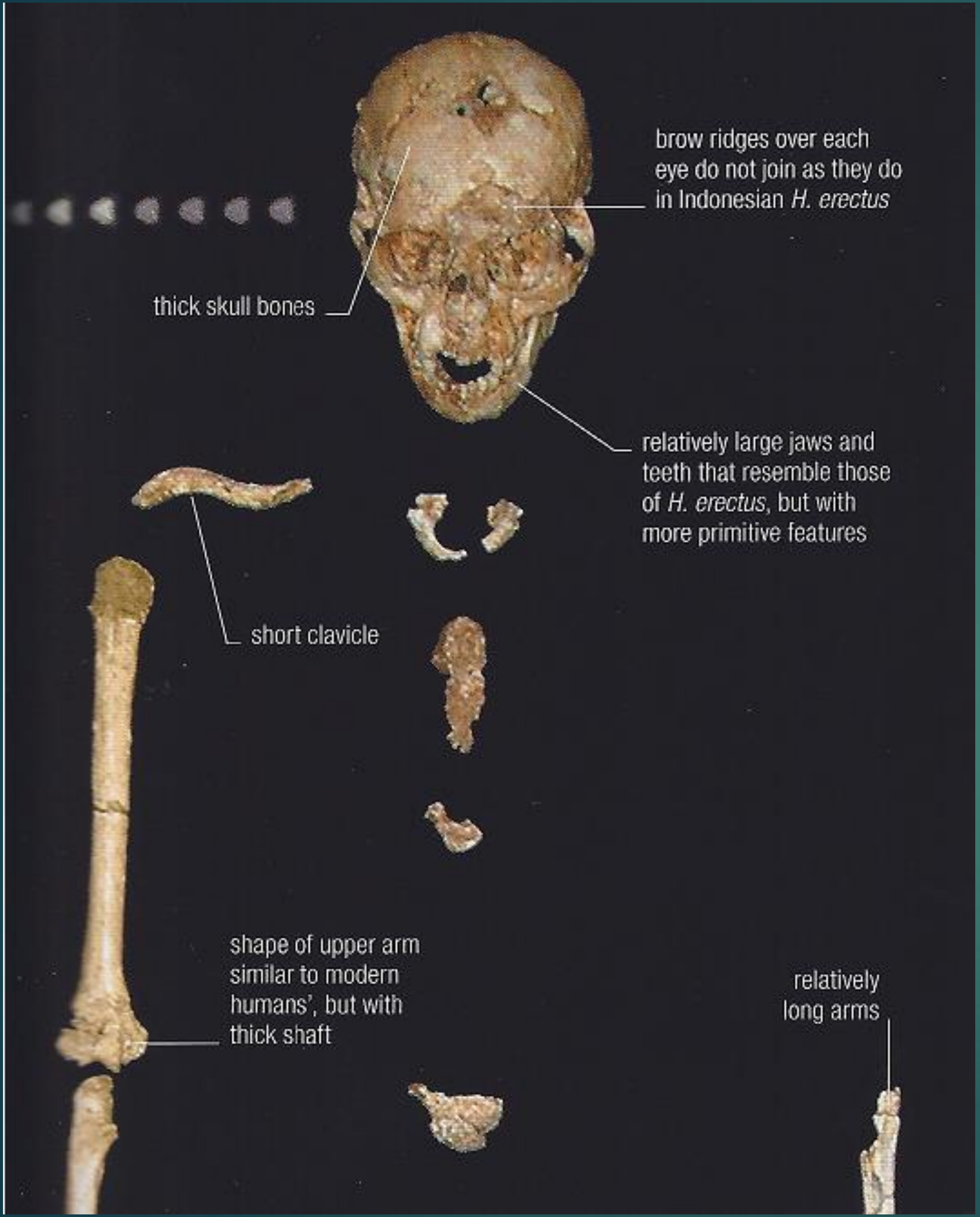
Humerus is normally rotated 90 degrees from shaft; LBI is not rotated as much; has humeral tension, just like Turkana boy

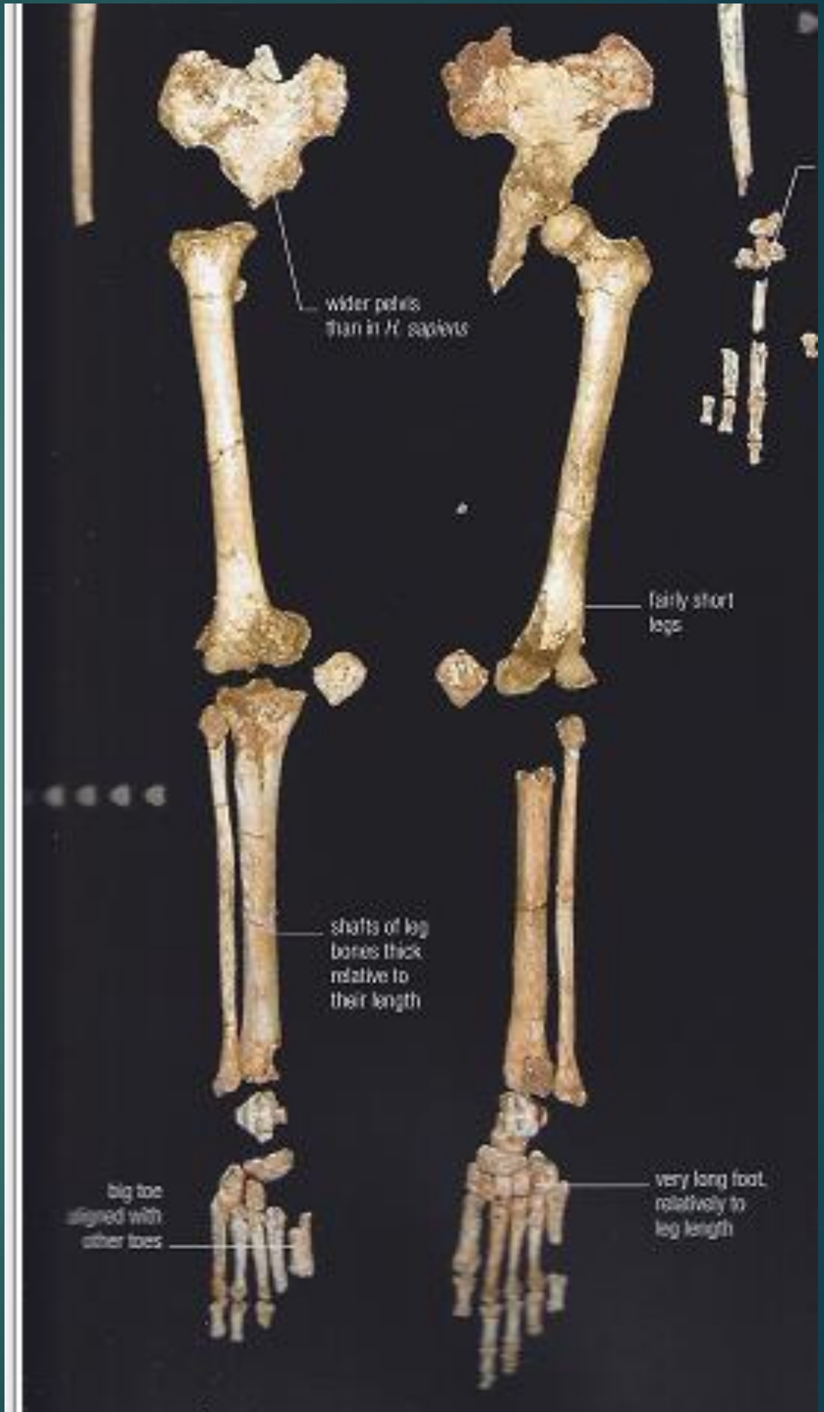


Homo floresiensis

LB1

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


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

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.

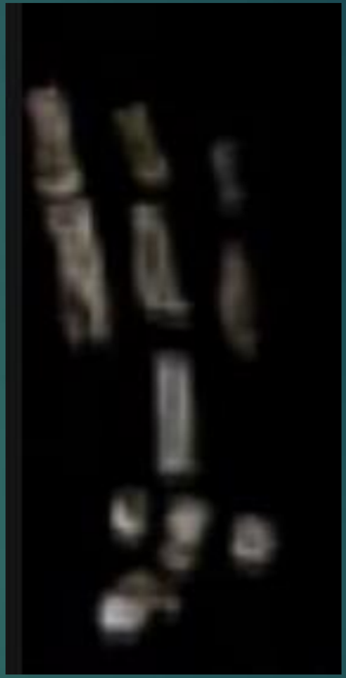
(Tocheri et al., 2007, 2008).

Wrists: Ape, Human, Flores

Ape trapezoid:
Triangular Pyramid shape

Trapezoid bone
Below Index finger
Boot shaped

Better grasping



By 10 weeks in embryo

Matthew Tocheri

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 being a 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 (like 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.

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.

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.

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.

Did the assumed partial skeleton LB1 (aka *Homo floresiensis*) really have long feet? S. Flohr, 2018

Of 100 hominin bones found, more than 60 of them were assigned to the partial skeleton LB1 which was designated as the holotype of a new species, Homo floresiensis.

Analyses of skeletal proportions of LB1 led to the conclusion that its foot was exceptionally long relative to femur and tibia, respectively. This ratio was considered a unique feature that contributes to the definition of the new species.
The published illustrations of the in situ-situation and the published inventory of the bones suggest a <u>high degree of commingling rather than the presence of larger anatomically joining units that was asserted</u> in the publications on the findings.
The available information further suggests that <u>hand and foot bones of several individuals were found commingled</u> as well.
Here <u>I argue, based on the published data,</u> that <u>certain problems exist regarding the correct anatomical identification of some of the phalangeal bones that contributed to the results on which the conclusions about skeletal proportions in LB1 were based</u>. It is further suggested that the assignment of bones to specific individuals is debatable.
Conclusions on the taxonomic status of the Liang Bua hominins and their pattern of bipedalism based on these data therefore need to be substantiated by further studies. Specifically, on the basis of the available information, a large relative foot length should no longer be claimed as a unique feature of the presumed new species H. floresiensis.

Pelvis

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

Pelvis: LB1 vs. H. sapiens

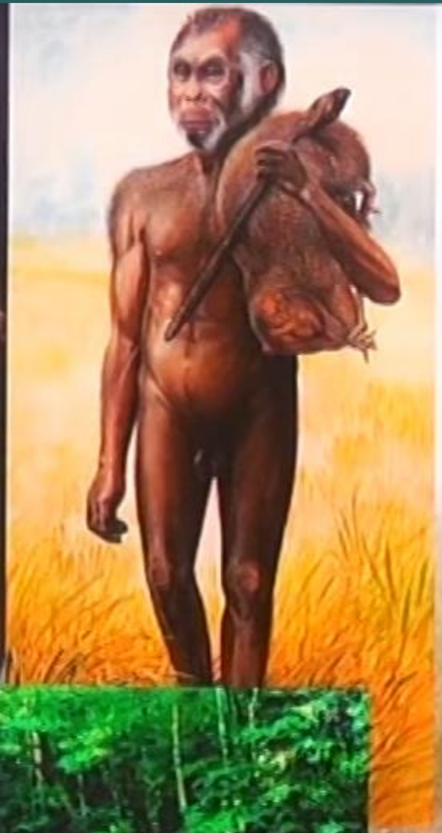
Figure 6 Comparison of the left innominate from LB1 with a modern adult female *H. sapiens*. Lateral (external), and medial and lateral views of maximum iliac breadth. The pubic region of LB1 is not preserved and the iliac crest is incomplete. Scale bar, 1 cm.

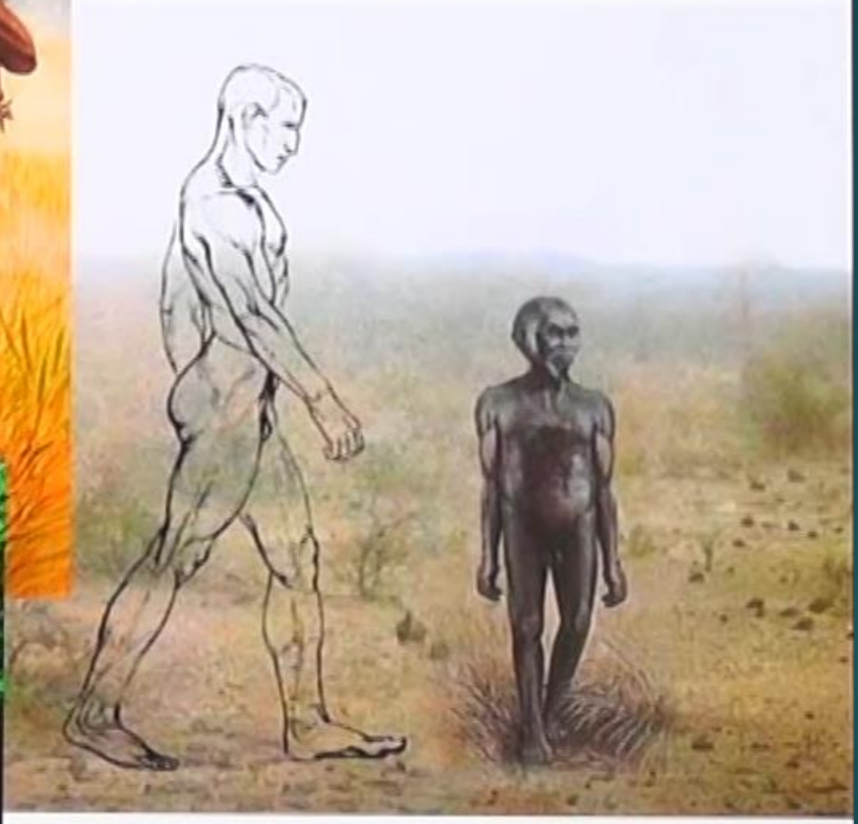
Reconstructions/Approximations

National Geographic Peter Schouten

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

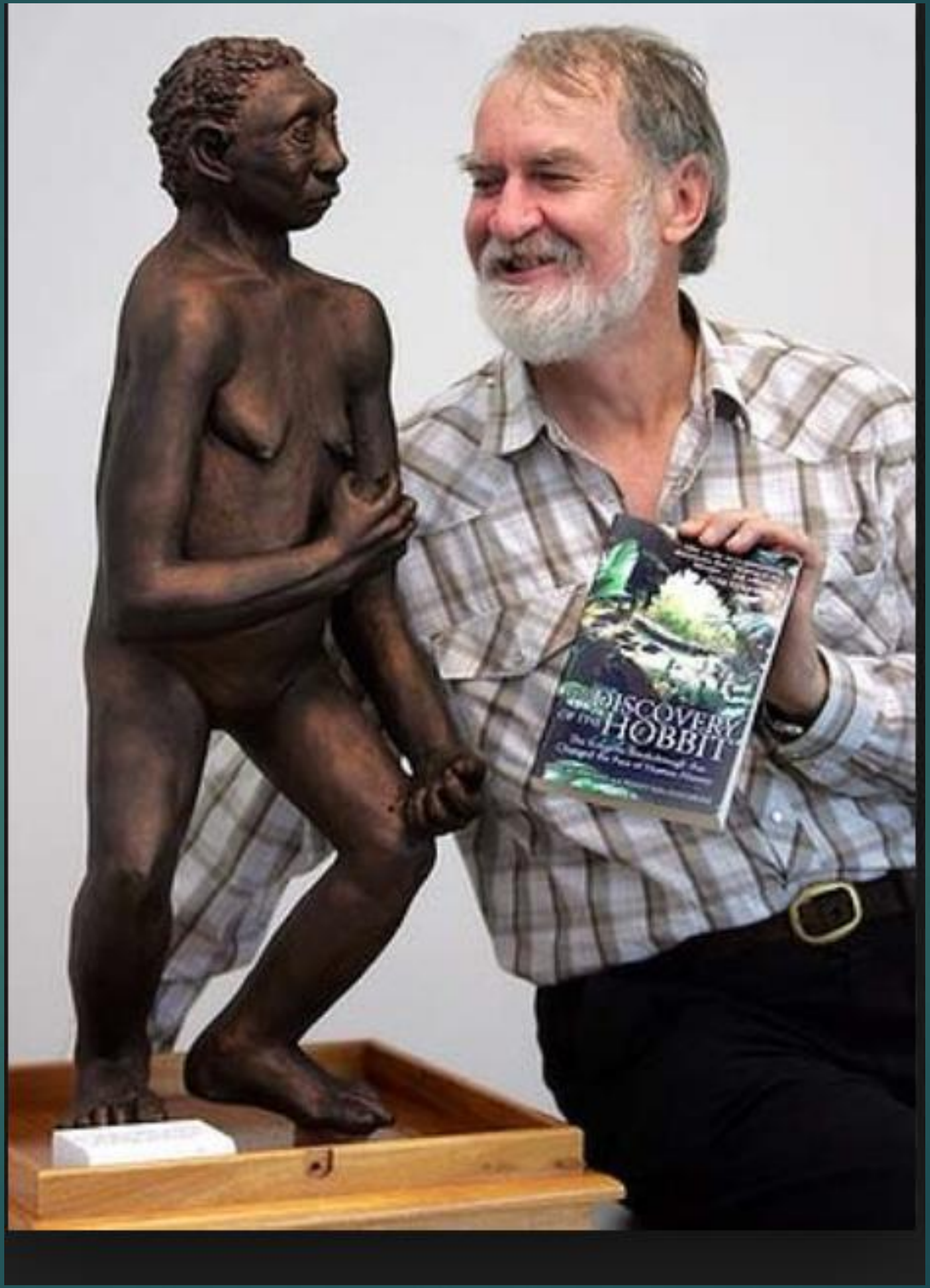
Reconstructions





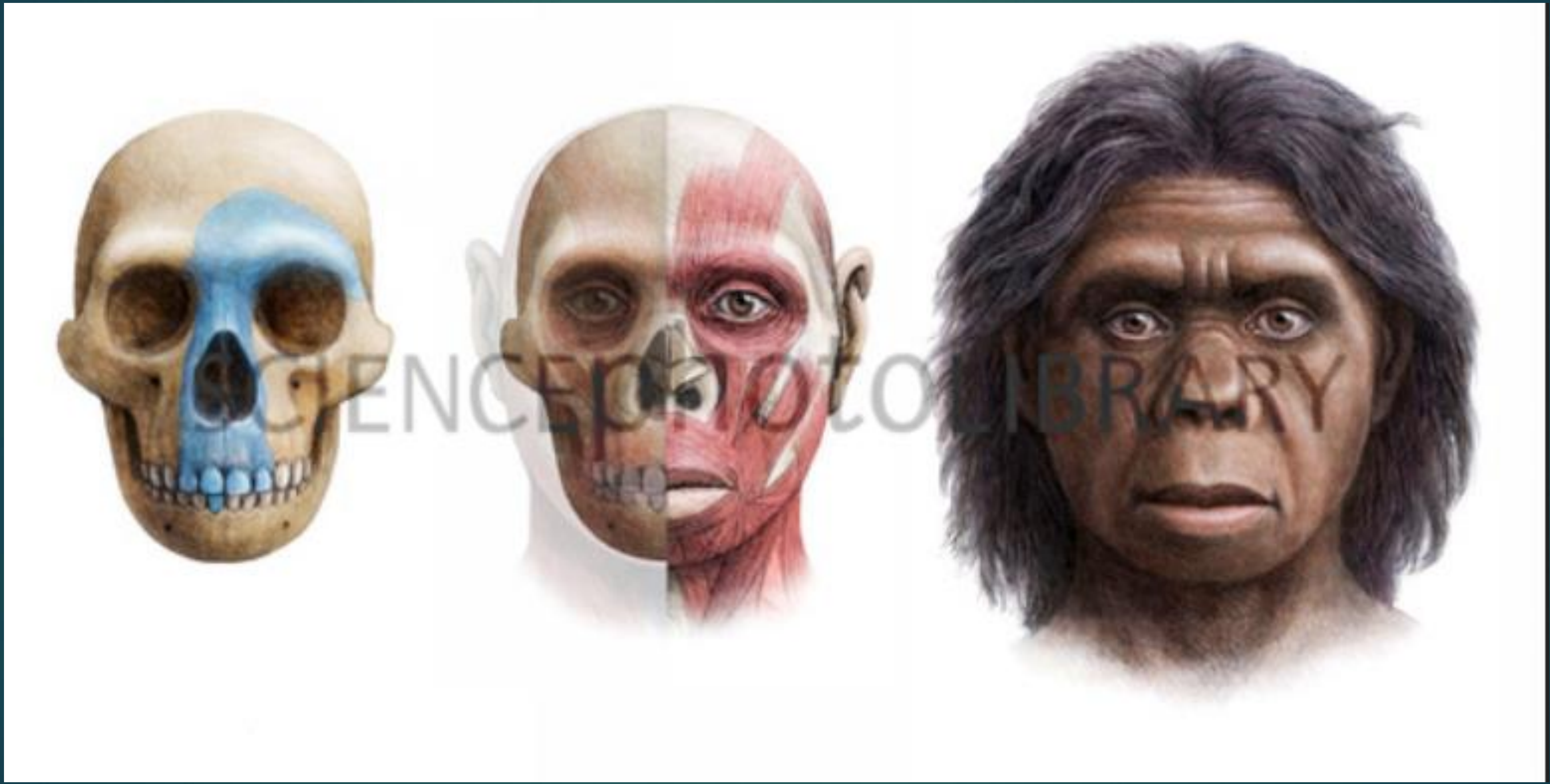
Most remarkable features:

1. small body size (3.2 feet, 75 lbs)
2. small brain size (417 ml)


DISCOVERY
OF THE
HOBBIT

Alfons and Adrie Kennis.

Anton

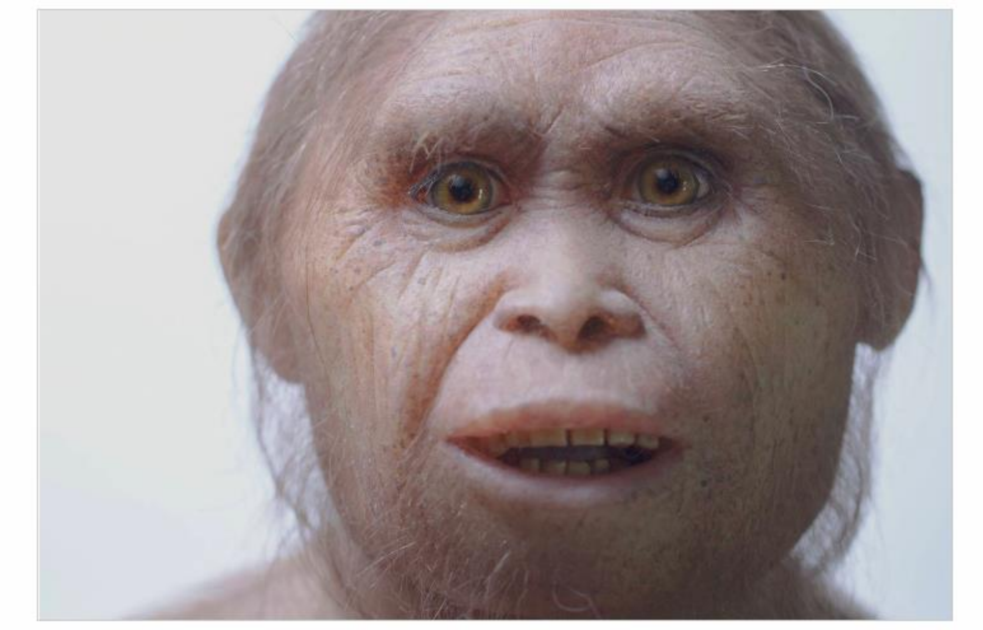


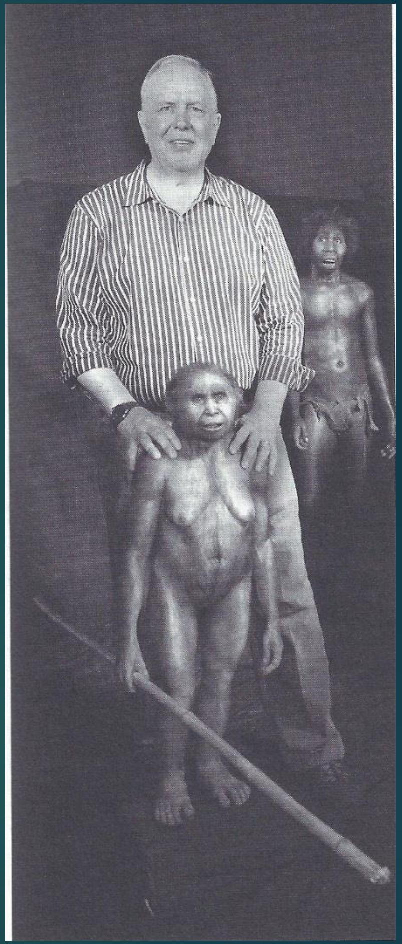
Sawyer & Deak

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

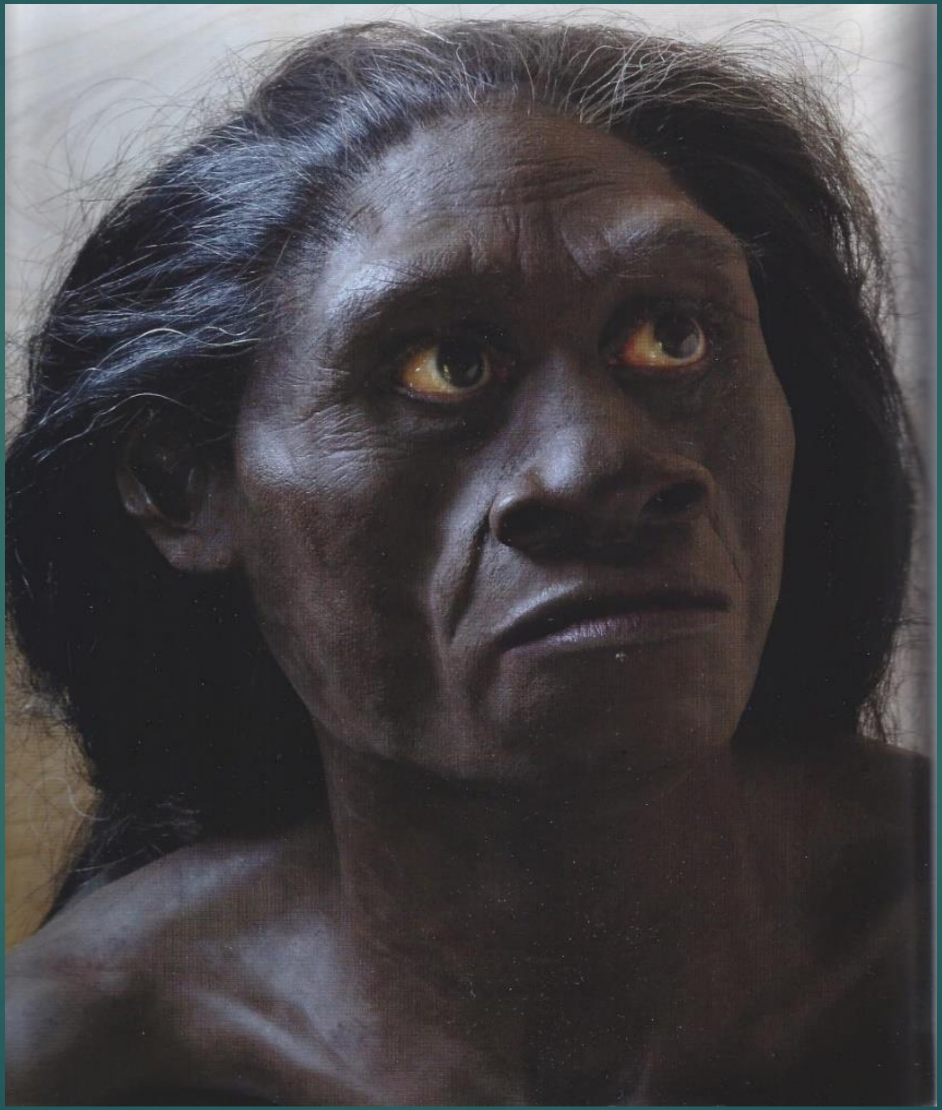




W. Jungers & hobbit

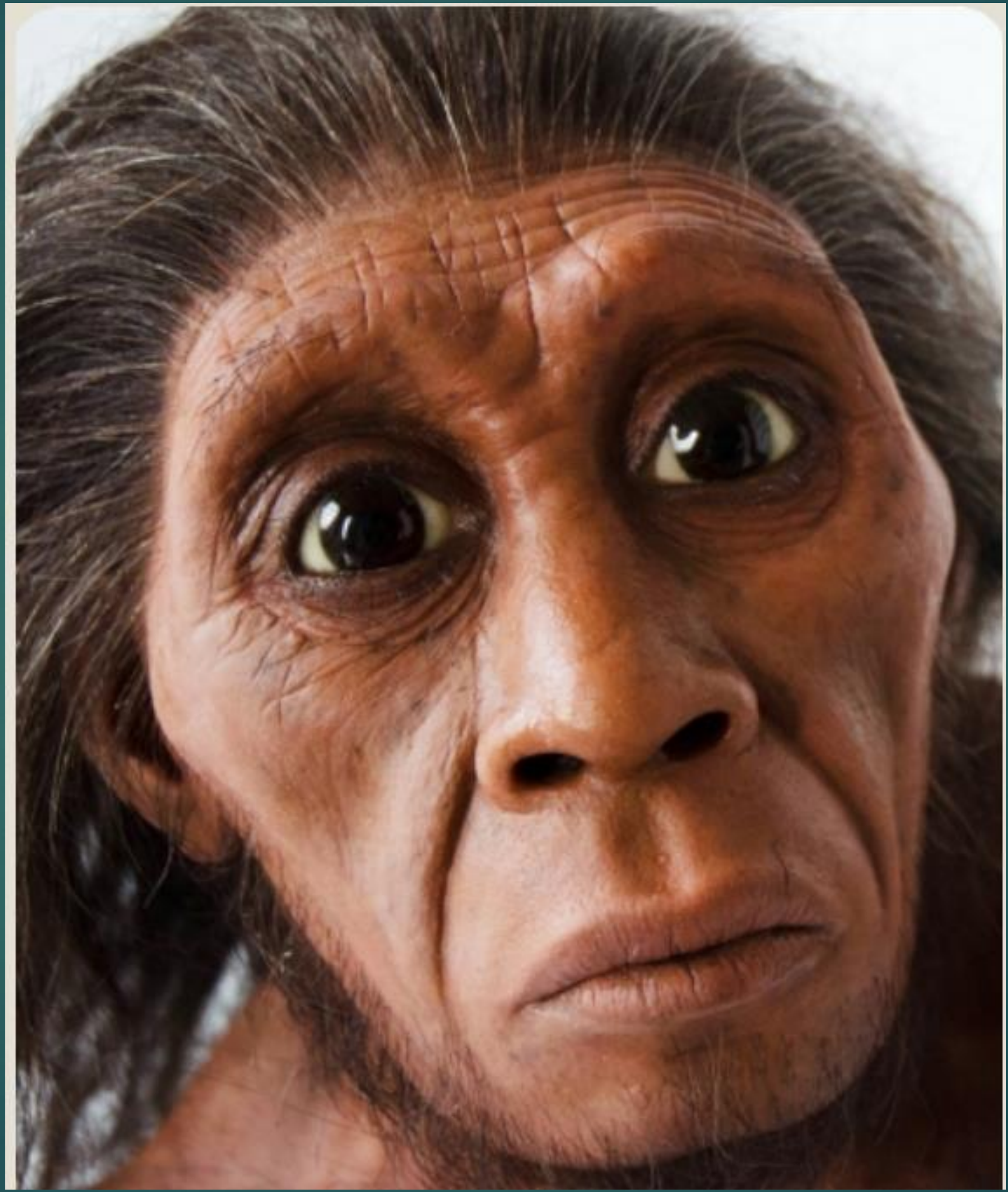
Karen Carr

Shaping Humanity - John Gurche



National Geographic

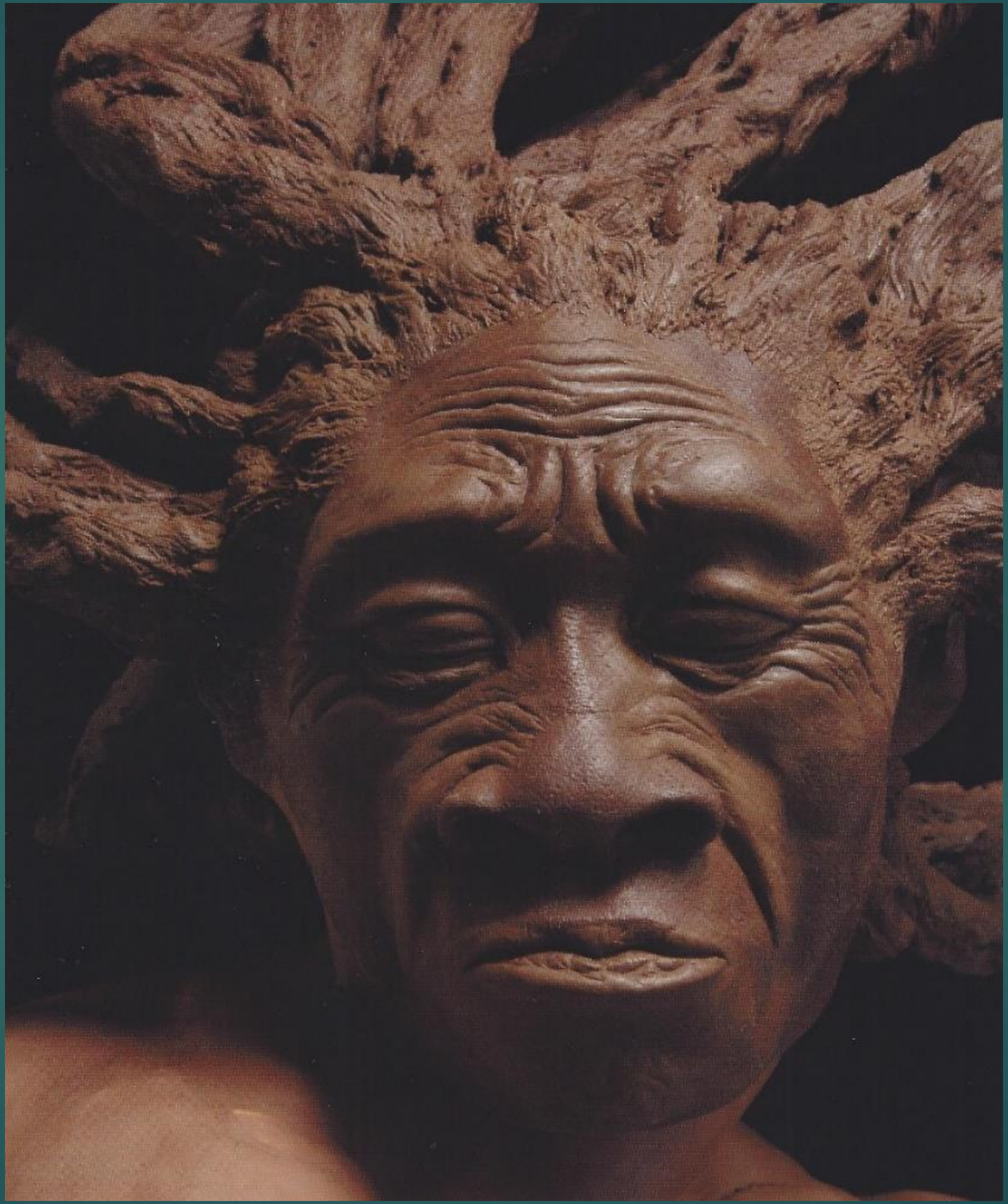
Lisa Büscher



Martin Freeman
as the Hobbit
Bilbo Baggins

Gurche: development process

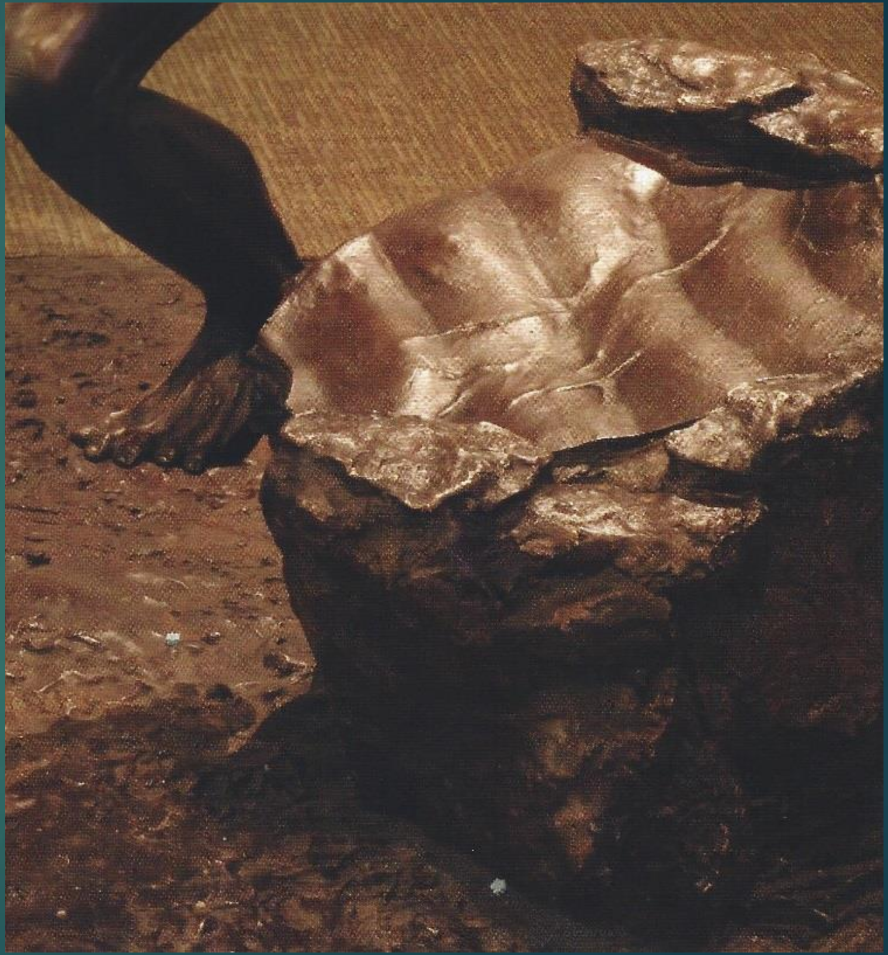
John Gurche

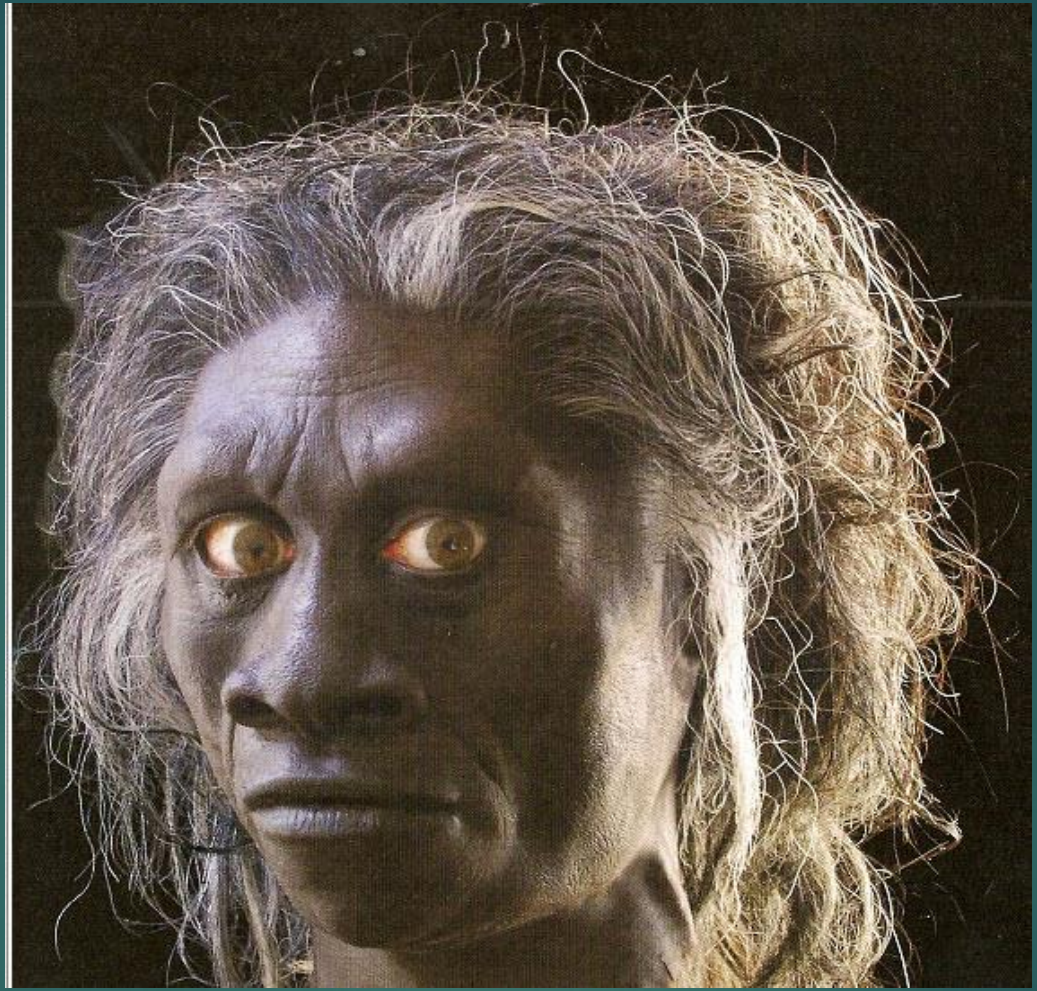


Dramatic Pose: Smithsonian

Flo in bronze.

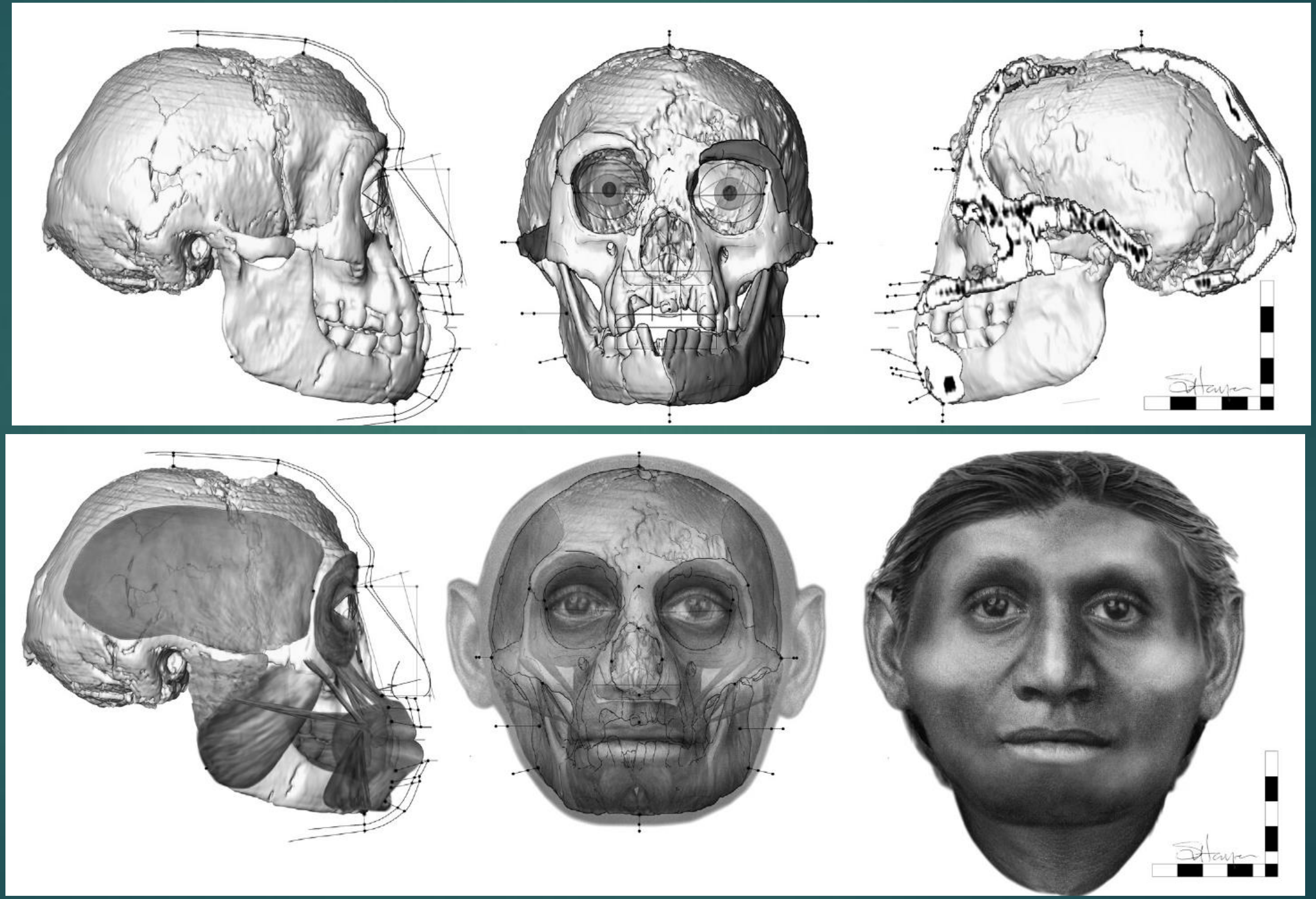
Tsunami?



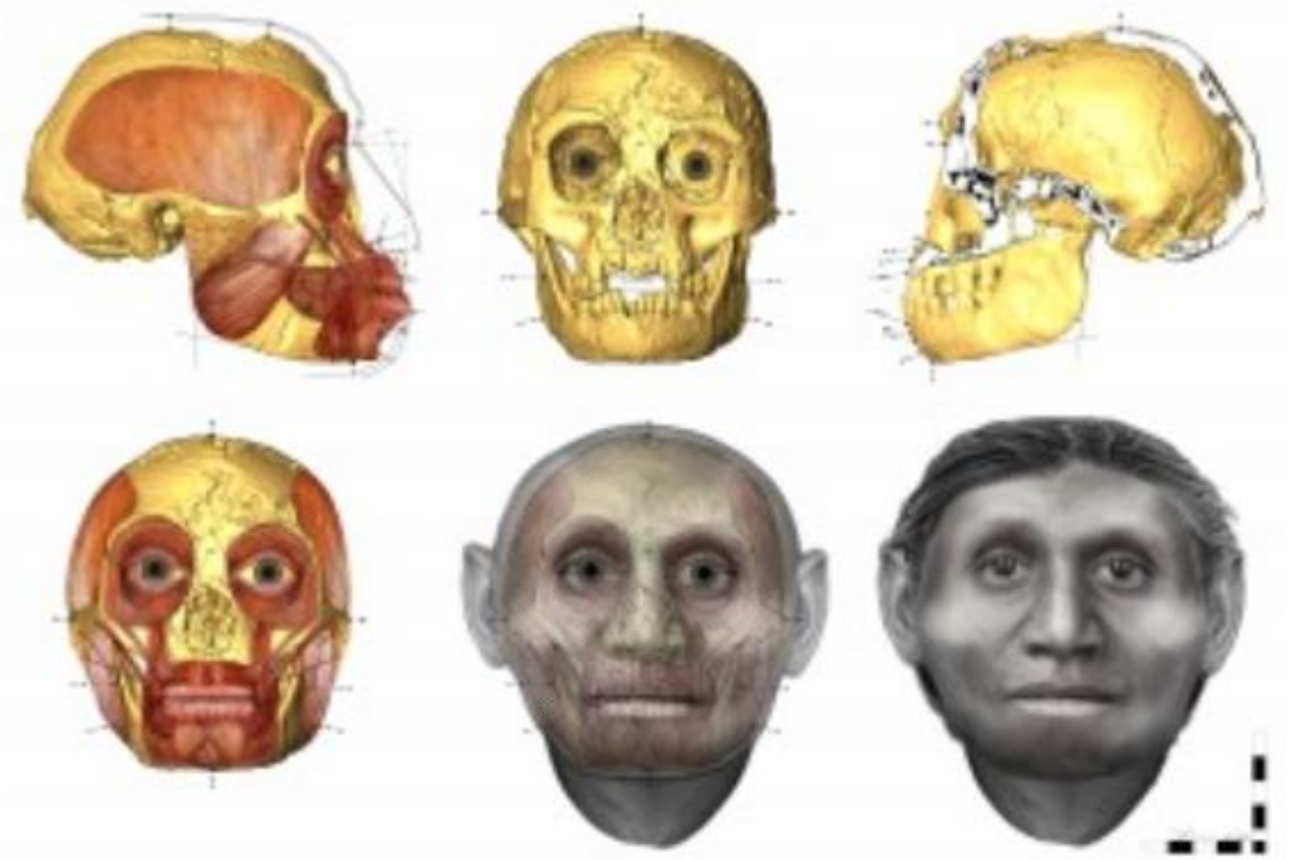


H. floresiensis reconstruction
Smithsonian
(John Gurche, artist & Chip Clark, photo)

Hayes & Morwood:
best scientific approximation



Susan Hayes, Thomas Sutikna, Mike Morwood, 2013

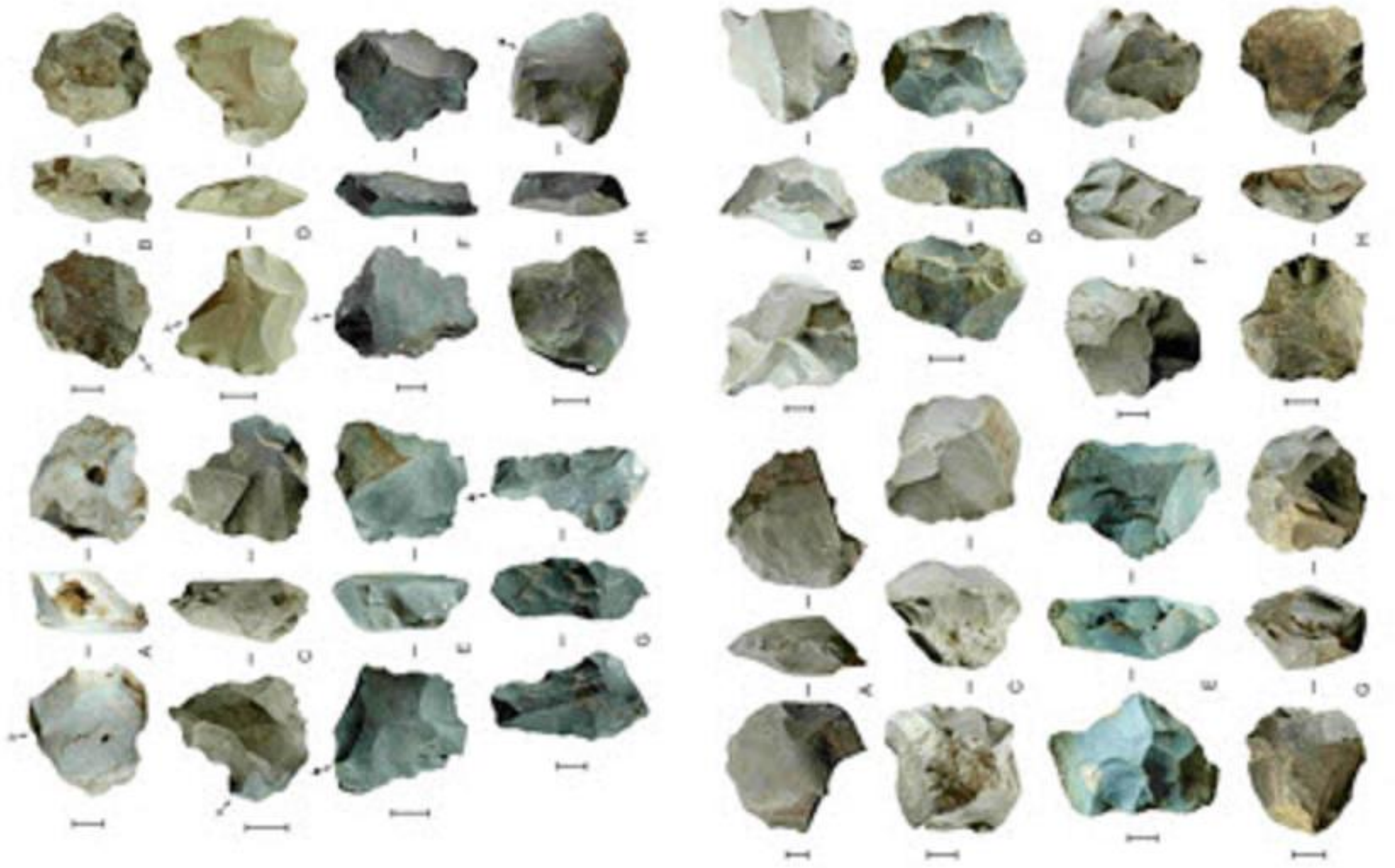


Anthropologist Susan Hayes used forensic techniques to recreate the face of the Homo floresiensis individual known as LB1 from her 18,000-year-old skull. Image: Susan Hayes

Susan Hayes

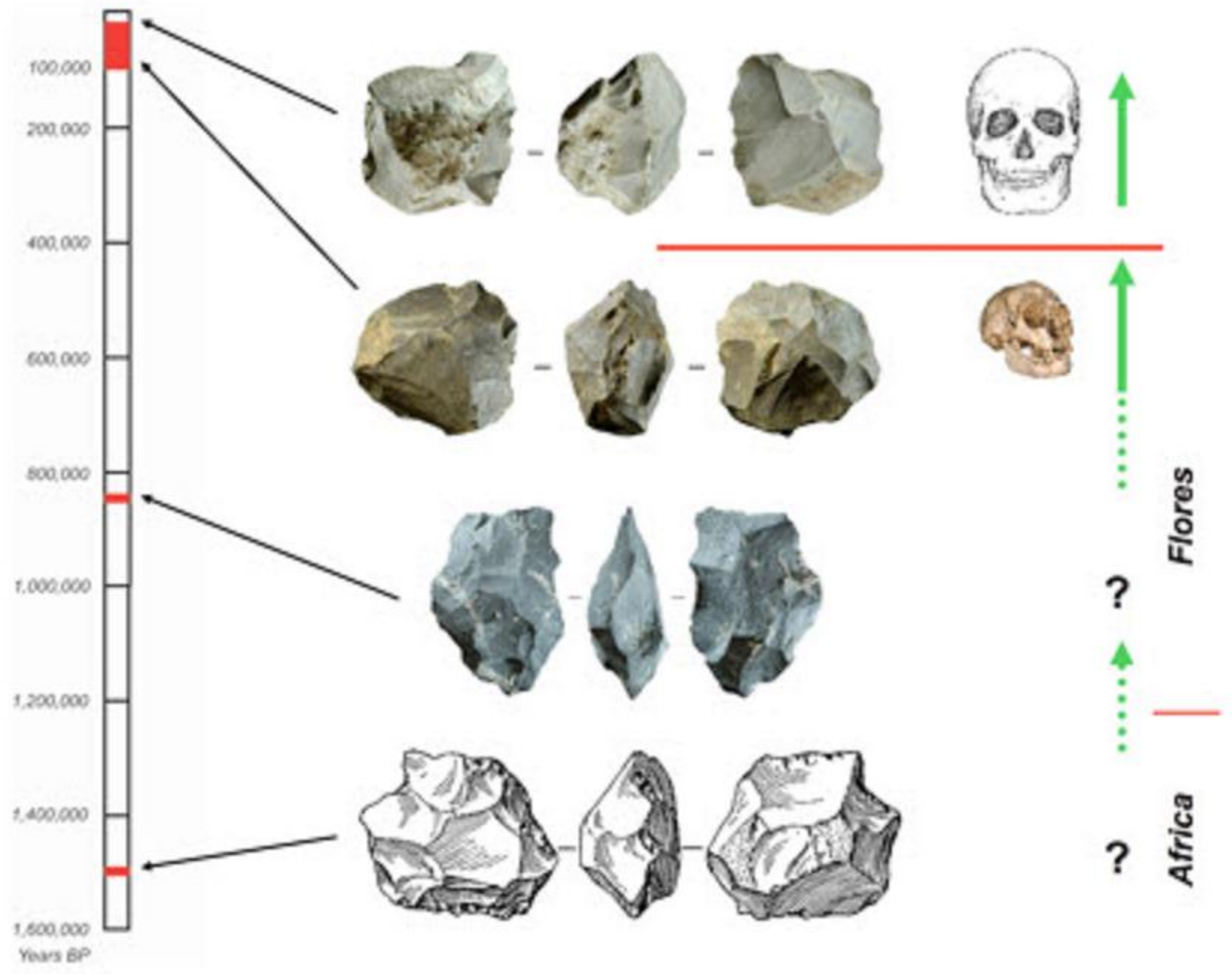
Tools

Flores Stone Tools



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

Flores Stone Tools



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

Modern

Flores

840 Ka

1.4 Ma

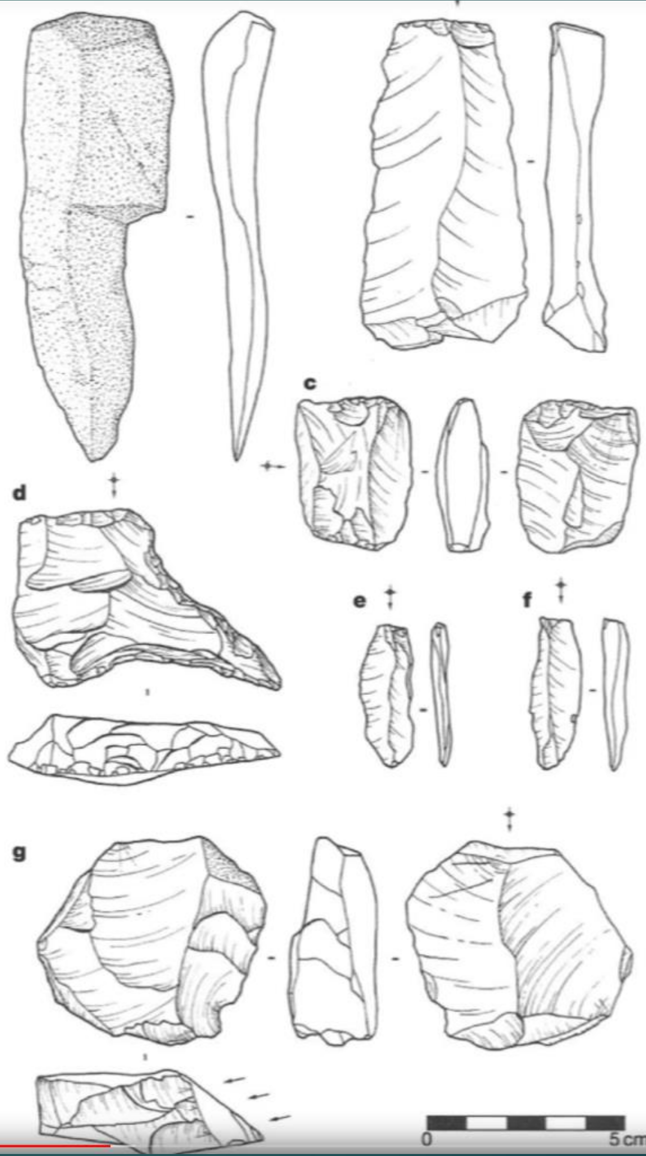
Stone tools similar to African Oldowan

Stone tool technology:

Appears to be consistent from the first evidence of stone tools at 800,000 through the disappearance of *H.floresiensis*. The tools of SE Asia appear very African "Oldowan" like from *H.erectus* to *H.sapiens*.

Change occurs only with the appearance of modern humans at 11,000 years ago (along with evidence of burial of the dead, pigments and objects of personal ornaments).

Could just a small brained form such as *H.floresiensis* make these kinds of tools?



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 of Liang Bua

- 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

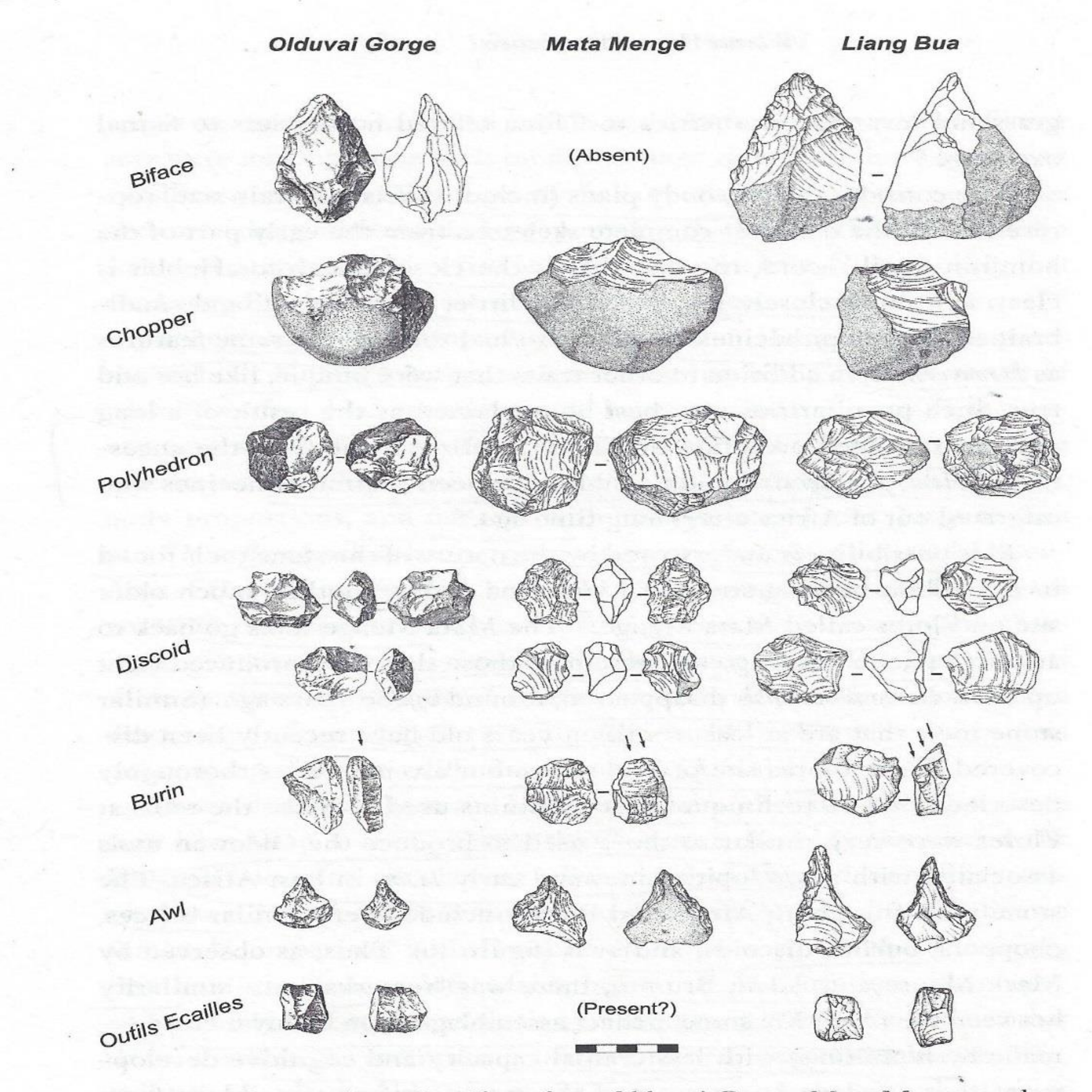
Brumm et al., 2006; Moore and Brumm, 2007; Moore et al., 2009).

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



Tools and Fire

- The Liang Bua implements are at levels from 95,000 to 60,000 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).

Hypotheses of the origination of *H. floresiensis:* The Great Debate

Some skeletal oddities

- Skull is asymmetrical
- A premolar is rotated
- Tibias are curved
- Muscle attachments on bones are strange
- Strangest: brain size of 426 cc

Leslie Aiello, 2010: Pathology and Preconceived ideas

- "There is no doubt that a pathological explanation for H. floresiensis is, at face value, a simpler and more comfortable solution to the many questions raised by the discoveries at Liang Bua. The argument has been used many time in the past to account for unexpected fossil discoveries that do not fit with preconceived notions for human evolution.
- However, when pathological explanations are not supported by the available evidence it is time to examine the preconceived notions that we hold."

L. Aiello, 2010: AAPA 142:176

Terrible scientific 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, while Robert Eckhard, a distinguished member of Teuku Jacob's team in 2006, has averred a "racist" effect to the naming it a new species.

- Individuals on each side have accused their counterparts of not being "real scientists."

Explaining *H. floresiensis*

- Hypothesis 1: Pathology
- Hypothesis 2: Early arrival of primitive hominin (2-3 Ma)
- Hypothesis 3: Later arrival, subsequent island dwarfing

Conflicting Hypotheses

- There are 3 major conflicting hypotheses on the cause of the small stature and small cranial capacity of LB1

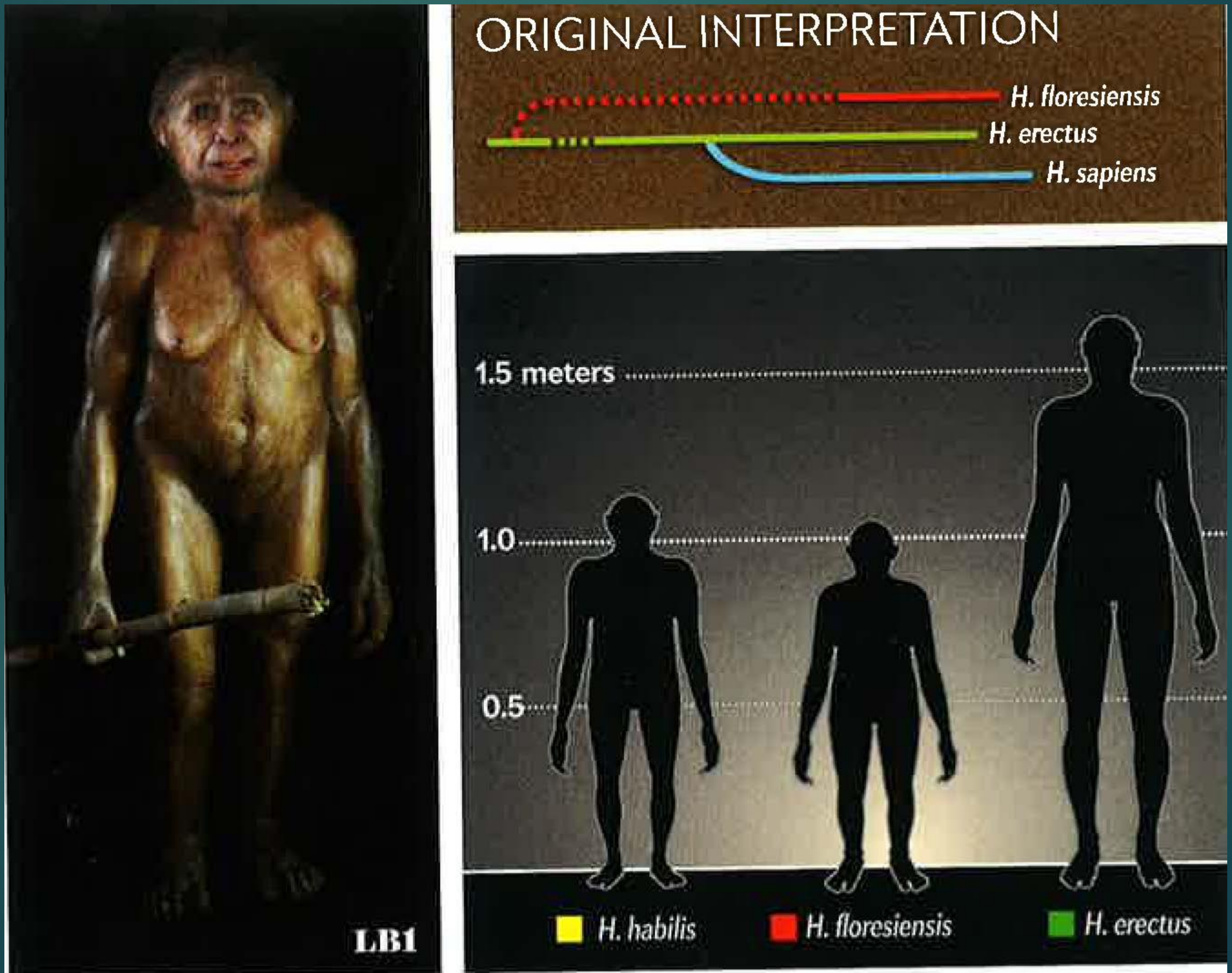
- Three major camps quickly emerged over its possible ancestry:
  - 1- Pathological or pygmy population of *H. sapiens* (Jacob et al., 2006; Richards, 2006; Hershkovitz et al.,2007; Perry and Domini, 2009);
  - 2 - Dwarfed population descended from *Homo erectus* populations seen on neighboring Java (Brown et al., 2004, Kaifu and Fujita, 2012); this was original hypothesis of type specimen paper

Conflicting Hypotheses

- 3 – *Homo habilis* left Africa: 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 hominin in Indonesia in the time period just preceding the Flores time period (700-95 Ka); *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*
- They later changed their mind.

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 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 size 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

The place of Homo floresiensis in human evolution - K. Baab, 2016

- Two main evolutionary scenarios:
  - 1 - H. floresiensis was a dwarfed descendent of H. erectus or
  - 2- late-surviving remnant of a older lineage, perhaps descended from *H. habilis.*
  - only a small number of characters support each of these scenarios uniquely.
- H. floresiensis exhibits
  - a cranial shape and many cranial characters that appear to be shared derived traits with *H. erectus*,
  - but postcranial traits are more primitive and resemble those of early *Homo* or even australopiths.
  - Mandibular and dental traits show a mix of derived and primitive features.

Baab, 2016

- 1 - *H. erectus* ancestry implies evolutionary convergence on a
  - postcranial configuration similar to australopiths and early *Homo*, which could be explained by a return to more climbing behaviors.
- 2 - *H. habilis* ancestry implies parallel evolution of numerous cranial characters, as well as a few dentognathic traits.
- A pre-H. erectus ancestry also implies an early migration to Southeast Asia that is as yet undocumented in mainland Asia

Sick Hobbit Hypothesis:

H. floresiensis is a pathological *H. sapiens*

LB1 is Pathological: Many studies pro and con

- 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 reject pathology idea and 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
- Initially it was suggested that *H. floresiensis* was a dwarfed *H. erectus,* but the burden of subsequent analyses suggests that it may be more closely related to a more primitive hominin such as *H. habilis sensu stricto* (Tocheri et al.. 2007; Argue et al.. 2009; Brown and Maeda. 2009. Morwood and Jüngers. 2009).

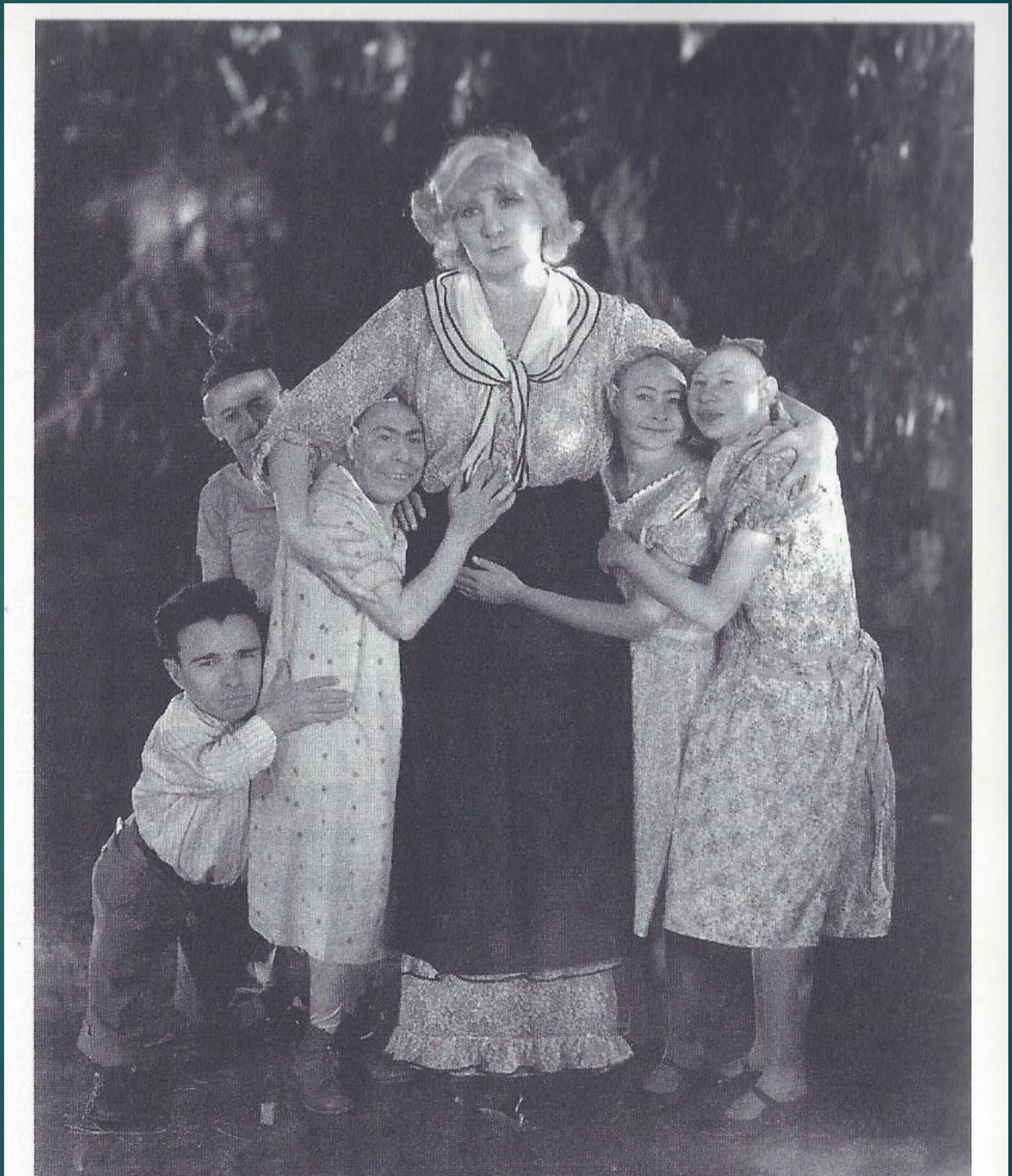
When arguing pathology, it gets mean

"We suspect that there may be a simple explanation ..

Microcephaly, a growth disorder of multiple aetiology, producing short individuals with normal faces and very small brain cases."

- Maciej Henneberg & Alan Thome, *2004*

Freaks, 1932: Microcephaly



Dwarfed H. erectus or sick H. sapiens

- Other researchers have suggested that no new taxon needs to be erected because they claim the "*Homo floresiensis* hypodigm" has been sampled from a population of *Homo sapiens*
  - most likely related to the small-statured Rampasasa people who live on Flores today
  - afflicted by either a range of syndromes that include microcephaly, or an endocrine disorder

The fight begins: “This is hobbit politics as usual.”

- 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

Teuku Jacob: Microcephaly

- Teuku Jacob: 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 cranial features of LB1 or 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.

Flores Pygmies have no chin & twisted premolars

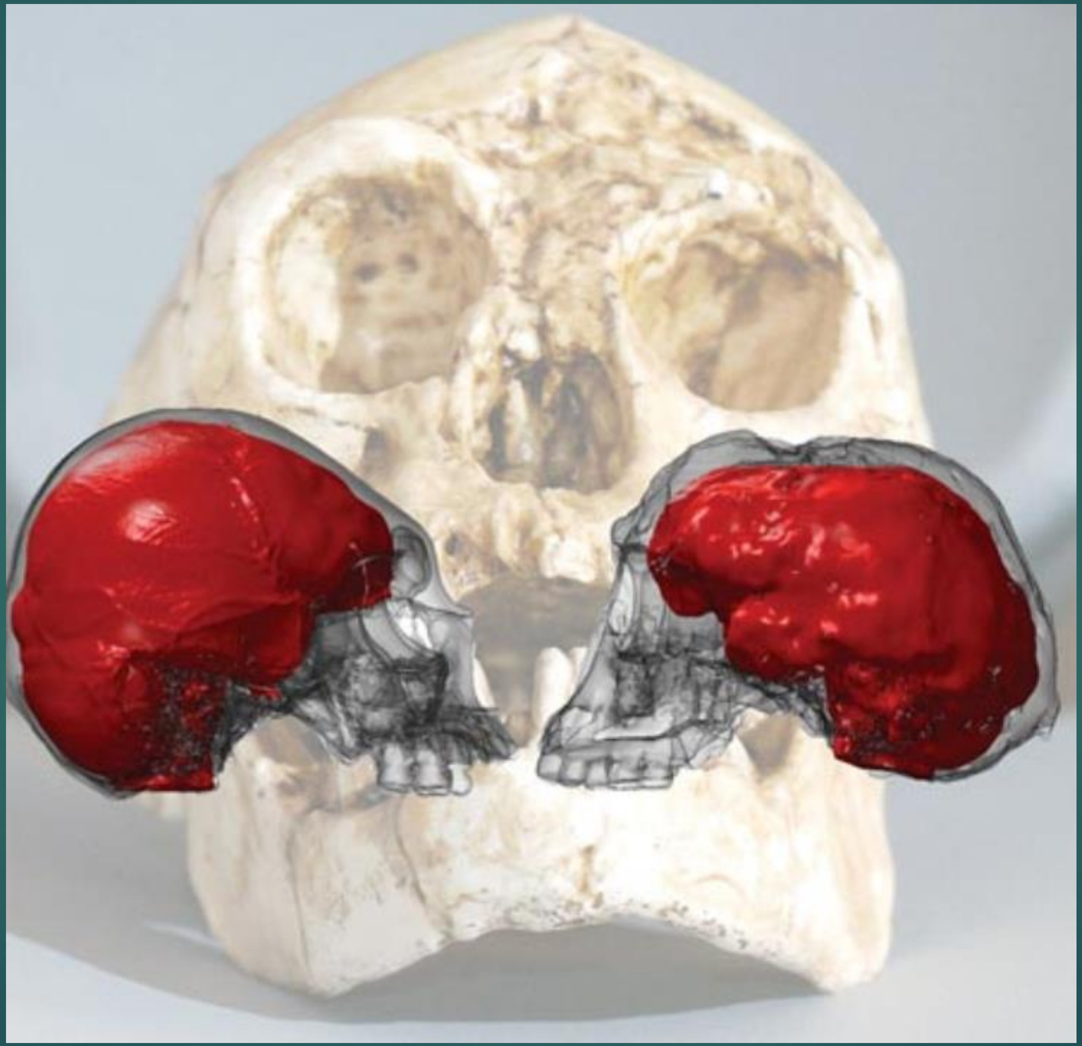
Hypotheses of pathological *H. sapiens*

- Pathological conditions proposed to explain their documented anatomical features include:
  - Microcephaly
  - Identification of *Homo floresiensis* as a malformed human pygmy (T. Jacob, 2006)
  - Laron Syndrome: primary growth hormone insensitivity
  - Microcephalic Majewski osteodysplastic primordial dwarfism type II
  - Myxoedematous endemic hypothyroidism ("cretinism"): deficient thyroid due to abnormal pituitary gland

- Conclusion: LB1 is not a new species; sick *H. sapiens*

Microencephaly:
abnormally small heads and brains

microcephalic



LB1

Multiregionalists: could only be *H. sapiens*

- Supporters of *H. floresiensis* as a new species, such as Chris Stringer and Dean Falk, attribute opposition partly to the fact that the existence of the species challenges the theories of multiregionalists,

- This group 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 multiregionalists: Alan Thorne and Maciej Henneberg.

Multiregionalists Henneberg & Thorne = microcephaly

- 2004: 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).

- LB1 did not differ from two microcephalic skulls; not one of the fifteen dimensions evaluated differed by more than 2.5 standard deviations.

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

LB1 is microcephalic *H. sapiens*

- Jacob: 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). The average brain size for a human microcephalic brain is 400 cm^3, the same as LB1.

- LB1 is from an earlier pygmy *Homo sapiens* population but individually shows signs of a developmental abnormality, including microcephaly

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

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

D. Falk: Not microcephalic

- Only thing that LB1’s endocast has in common with microcephalic endocasts is its small size.

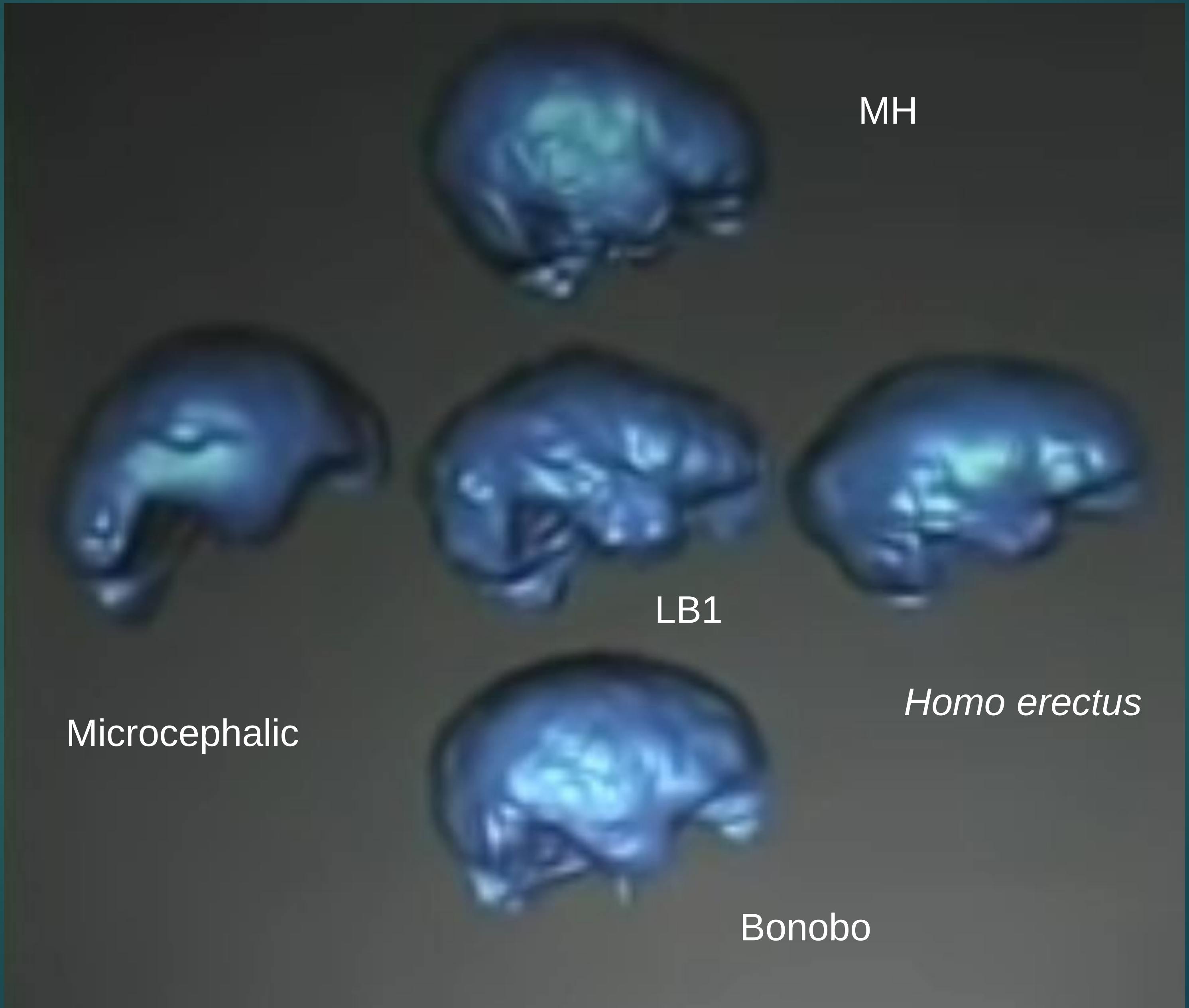
- The shape of LB1’s endocast is the opposite of that which typifies microcephalic endocasts.

- Unlike microcephalics, 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

Falk: computerized endocast of LB1: 417 cc

All scaled to 417 cc;

LB1 most
like *H. erectus*



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: LB1's 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] hominin 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: Advanced brain features: neocortical reorganization independent of brain size

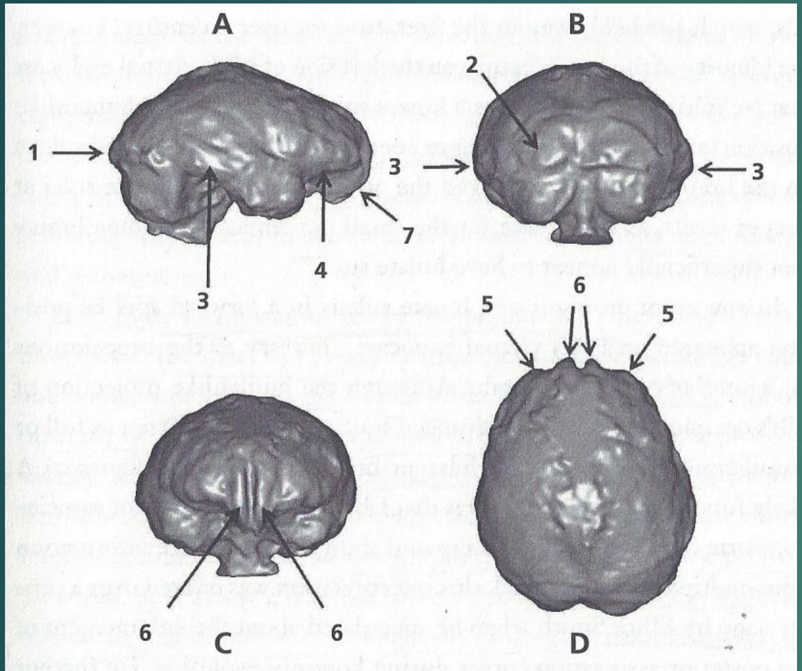


Figure 18. The virtual endocast of LB1 from the (A) right side, (B) back.

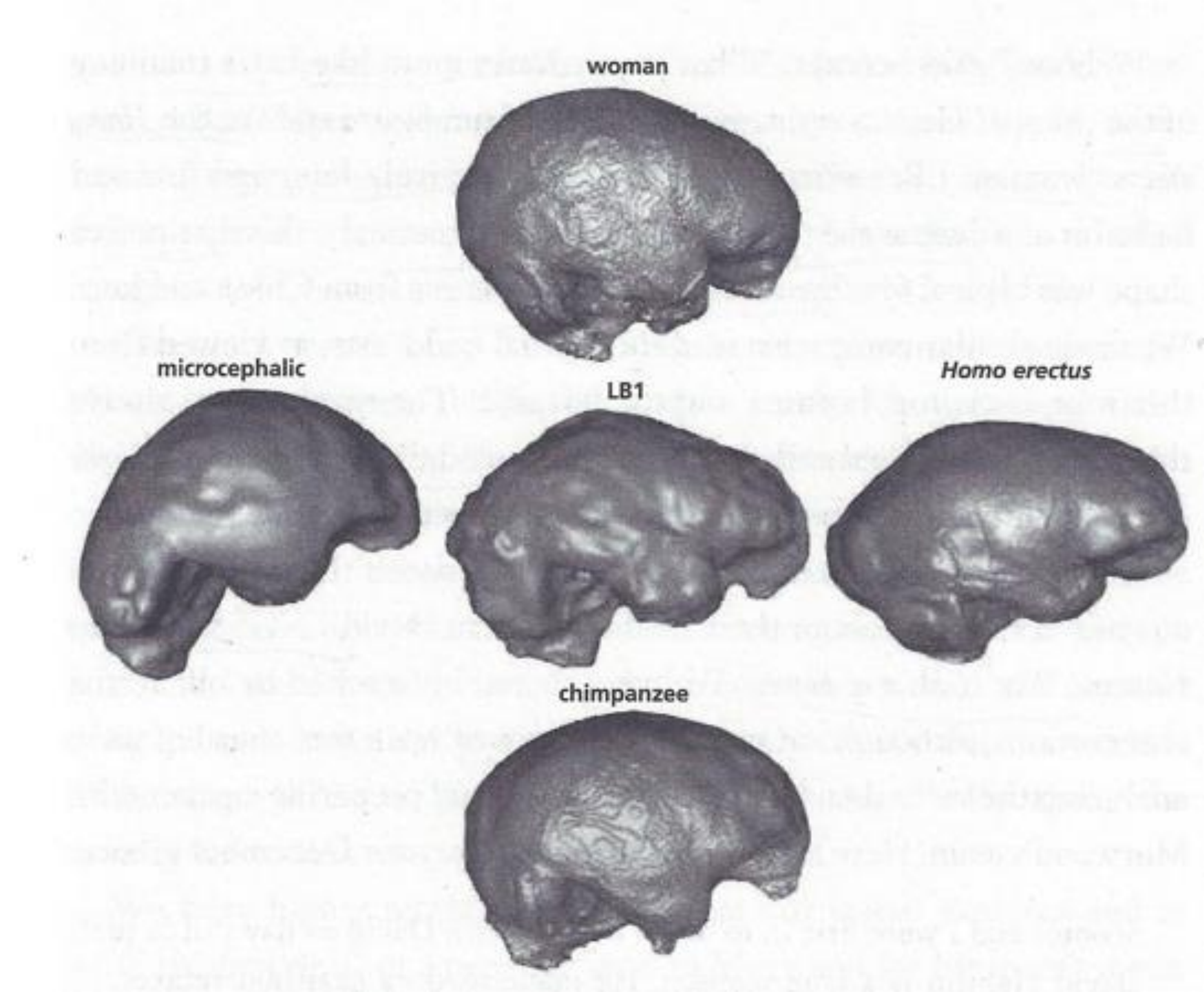
Falk recognizes seven derived features of the LB1 endocranial cast, suggesting that that neurological reorganization occurred independently of an increase in brain size (Falk et al., 2009b).

- 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

Dean Falk: Derived features, incl. Brodmann’s area 10

- Comparison of LB1’s 7 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).
- LB1 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*.
- Flores 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)—involved in planning and initiative taking—in MHs).
- 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*



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.

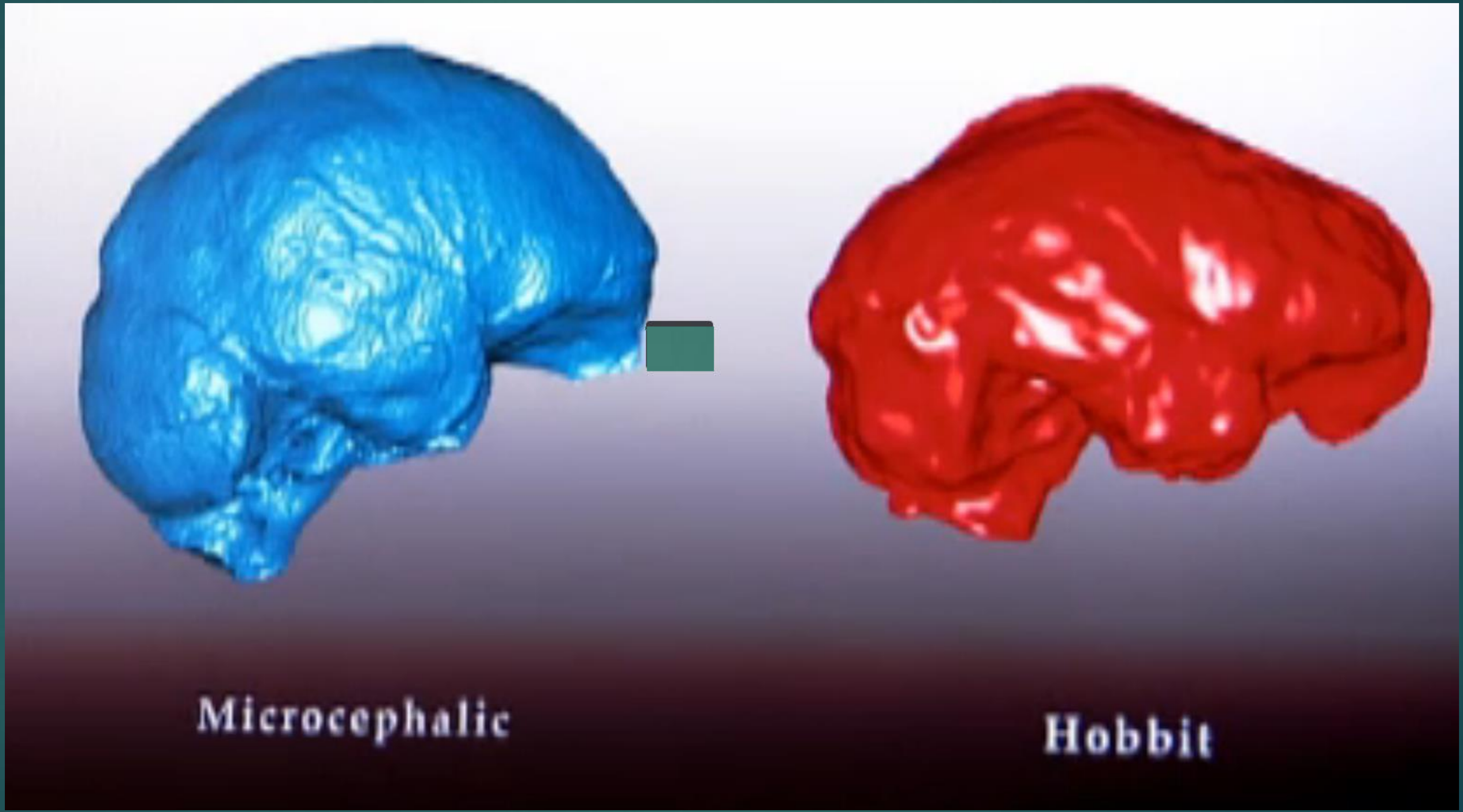
2008: 3D-morphometrics – not microencephaly

- 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).

Falk



Critique: 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 postcranial skeleton.

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

LB1 had a 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 Hobbit's' 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: Autosomal recessive primary microcephaly

(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.

2007: Falk = Not Laron Syndrome

- 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.

2008: Thyroid Problem – Iodine deficiency

- Thyroid hypothesis: myxoedematous endemic (ME) cretins (Peter Obendorf et al., 2008)

- An environmental rather than a strictly genetic explanation

- 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.

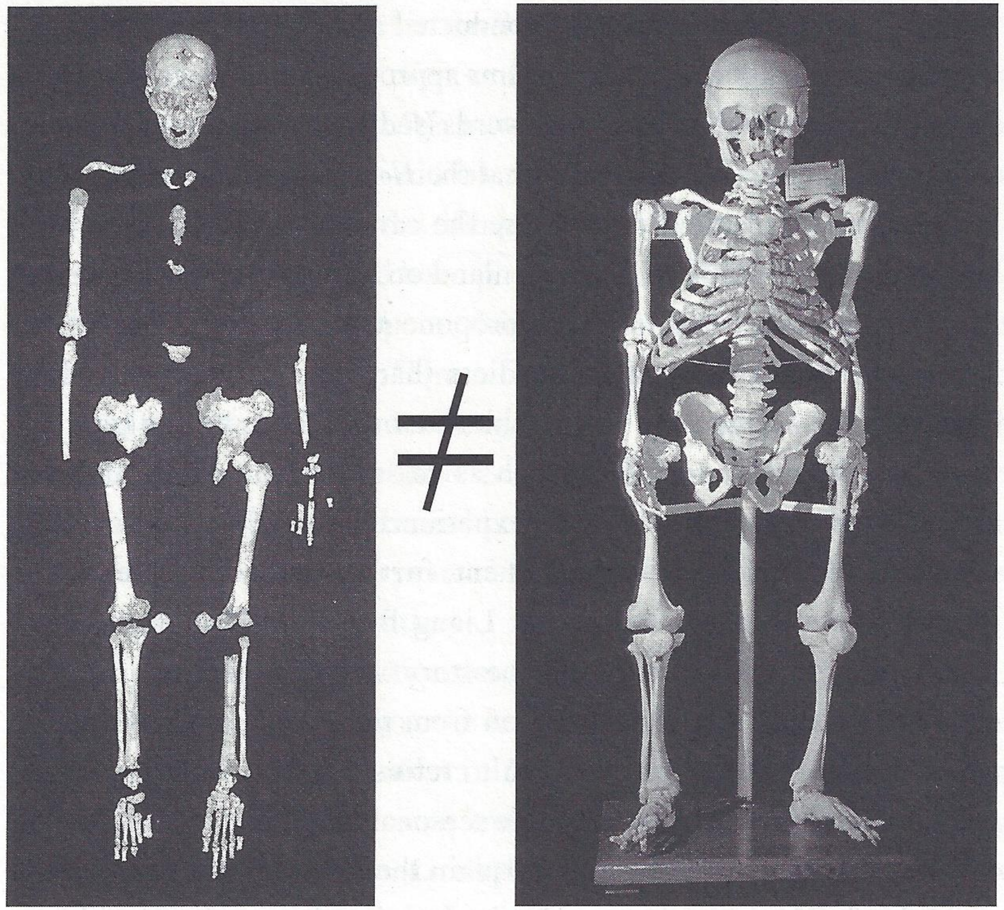
- Jungers (along with Falk, Tocheri, Larson, and Morwood, among others) contended that Obendorf's cretinism hypothesis "can be rejected due to numerous errors of fact and unsubstantiated speculations" (Jungers 2009).

Cretin: MH with Hypothyroidism LB1 MH with microcephaly

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 LB 1 and the microcéphalie 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.

LB1 vs. Swiss Cretin

LB1 Swiss cretin



Courtesy of Ortner

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.

2014: Down's Syndrome

- Maciej Henneberg, et al., 2014:
- 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.

Maciej Henneberg, et al., 2014

Conclusion about Pathology

- No pathological syndrome seems to adequately explain the full suite of features exhibited by *H. floresiensis*.
- 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

Archaic features

- The cranium of LB1 displayed many archaic features:
  - a sloping forehead,
  - browrigdes,
  - absence of a bony chin
  - skull is widest at the low 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

Mike Morwood’s Last Theory: small ancestry

- 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 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.

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 from Africa
    - such as *Homo habilis* (approx. 600 cc)
    - or even *Australopithecus* (approx. 400 cc).

- Challenging hypothesis that earlier and more primitive hominins (than *H. ergaster/erectus*) were the first to leave Africa.

- 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 hominin from pre-2 Ma (Australopithecus or Homo) made it out of Africa.

Postcranial evidence

- D. Argue: 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 Ma old *Australopithecus afarensis* skeleton of "Lucy" (Jungers and Baab, 2009).

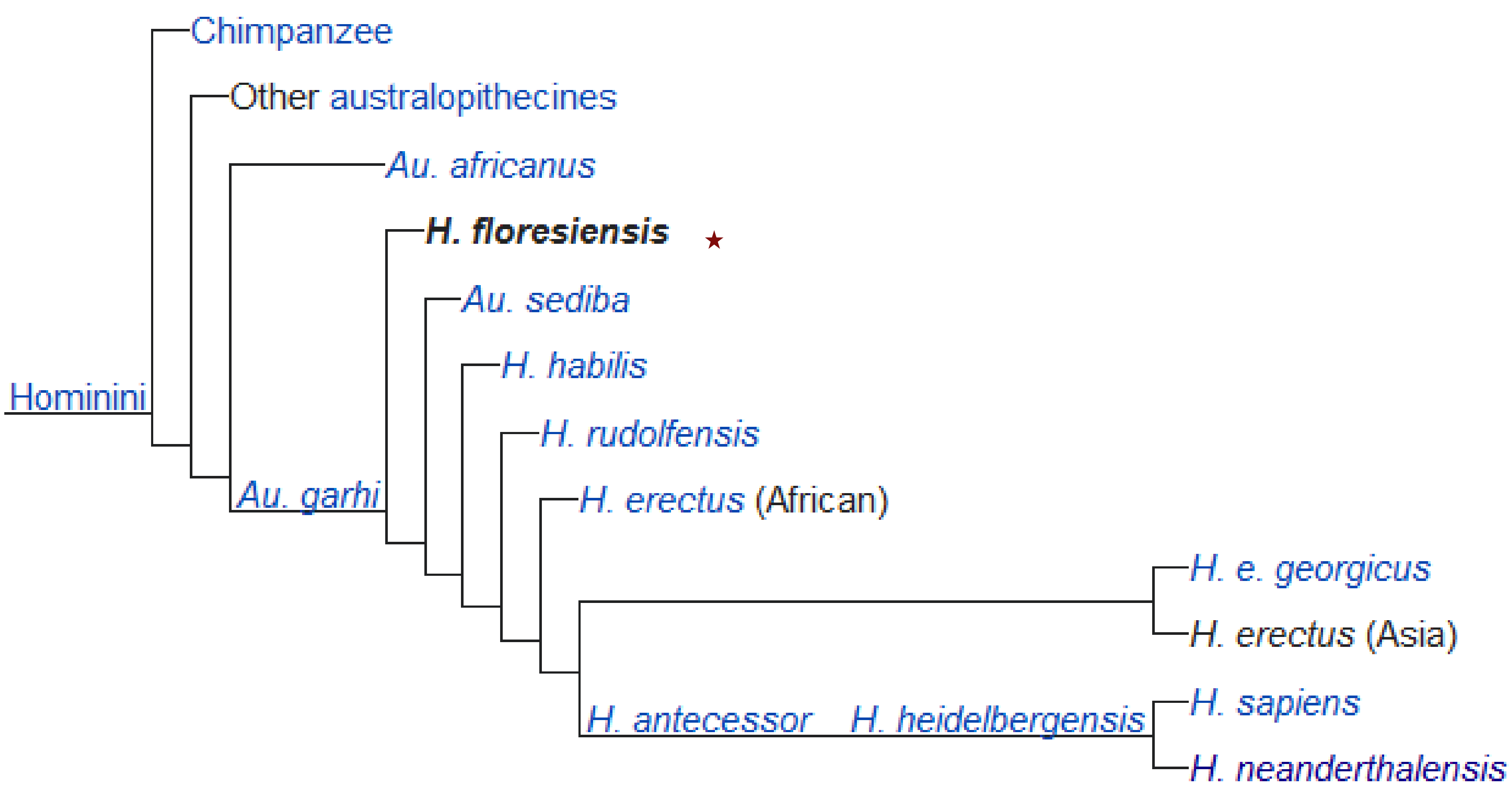
Cranial morphology: not *H. sapiens*

- 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*.

-

Evolutionary tree according to a 2019 study:



No ancient DNA despite 3 attempts

- 3 attempts to extract DNA: all failed

- 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.

- In 2011 another team led by Christina Adler also failed.

Cheryl Jones, 2011

Homo floresiensis Contextualized: A Geometric Morphometric Comparative Analysis of Fossil and Pathological Human Samples - Karen L. Baab , et al., 2013

- Comparative analysis of cranial morphology.
- Geometric morphometric analyses of landmark data show that the sole Flores cranium (LB1) is clearly distinct from healthy modern humans and from those exhibiting hypothyroidism and Laron syndrome. Modern human microcephalic specimens converge, to some extent, on crania of extinct species of *Homo*.
- However in the features that distinguish these two groups, LB1 consistently groups with fossil hominins and is most similar to *H. erectus*. Our study provides further support for recognizing the Flores hominins as a distinct species, *H. floresiensis*, whose affinities lie with archaic *Homo*.

Leslie Aiello's conclusion: pre-*erectus* hominin

- Leslie Aiello: *Homo floresiensis* is a late-surviving species of early *Homo* with its closest morphological affinities to early African pre-*erectus/ergaster* hominins.

- Postcranial 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.

- 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.

Challenges to Older ancestry

- Early African ancestry is least accepted theory because it is unlikely that such a lineage could have reached Flores while remaining undetected elsewhere
  - 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.

Conclusions

- The Flores species has been retained in the genus *Homo*.

- 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.

These stone tools were found scattered on the gravelly shore of the Walanae river near Talepu, Sulawesi

(Image: Erick Setiabudi)

Tools on Sulawesi

- The infamous hobbit may not have been the only ancient human species to travel deep into Indonesia. A collection of stone tools found on the island of Sulawesi hints that other early humans might have lived there too

- In 2016, a collection of some 300 stone tools have been found at a site called Talepu on the island of Sulawesi, also in Wallacea. They date from 118 to 194 Ka – and include an array of choppers and sharp flakes.

- The tools could also indicate that other species made the crossing, perhaps *Homo erectus*: who lived on Java, just a few hundred kilometers west of the line until some 500 Ka.

Where does *H. floresiensis* belong on hominin tree?

Summary

- 2020: Know a lot about *H. floresiensis*.
  - Individuals were short - ~1 meter tall.
  - They had a small brain - only 426 cc
  - had backward sloping foreheads, yet they possessed an expanded frontal cortex. This implies they could do some smart things such as plan, learn from mistakes, and hand down information from generation to generation.
  - They lacked a chin, and instead had some ape-like structures inside the jaw.
  - Wrist bones were also ape-like.
  - The arms were relatively long and its shoulders were shrugged and hunched forward.
  - This species walked upright. Its walk, however, would have been somewhat odd because its feet were quite long compared to its legs. It had to lift those feet up higher than we do, just to get ground clearance.

David S. Strait
University at Albany

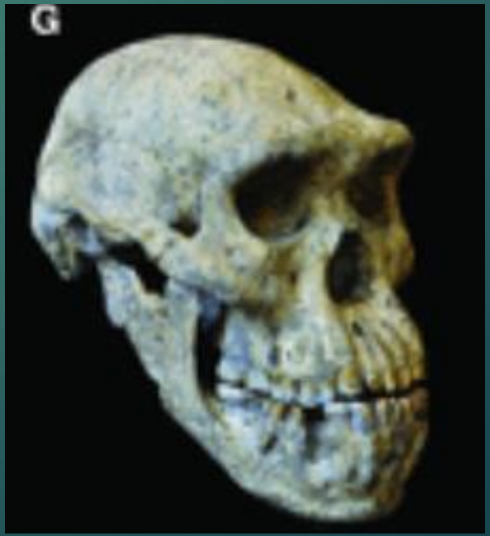
- “The possibility that a very primitive member of the genus Homo left Africa, perhaps roughly two million years ago, and that a descendant population persisted until only several thousand years ago, is one of the more provocative hypotheses to have emerged in paleoanthropology during the past few years.”

A Challenge to Standard Model of Human Evolution

- Standard model of human origins: *H. erectus* was the first human ancestor to wander out of Africa and colonize distant lands around 1.8 Ma ago.
- Prior first Out of Africa: Dmanisi *H. erectus* at 1.78 million years ago, also found with Oldowan tools
- But the postcranial evidence from Flores suggests the possibility of an older, more primitive forebear was the original pioneer.

Dmanisi

Dmanisi *H. erectus* skull = Skull 5 = 546 cc



(D4500)

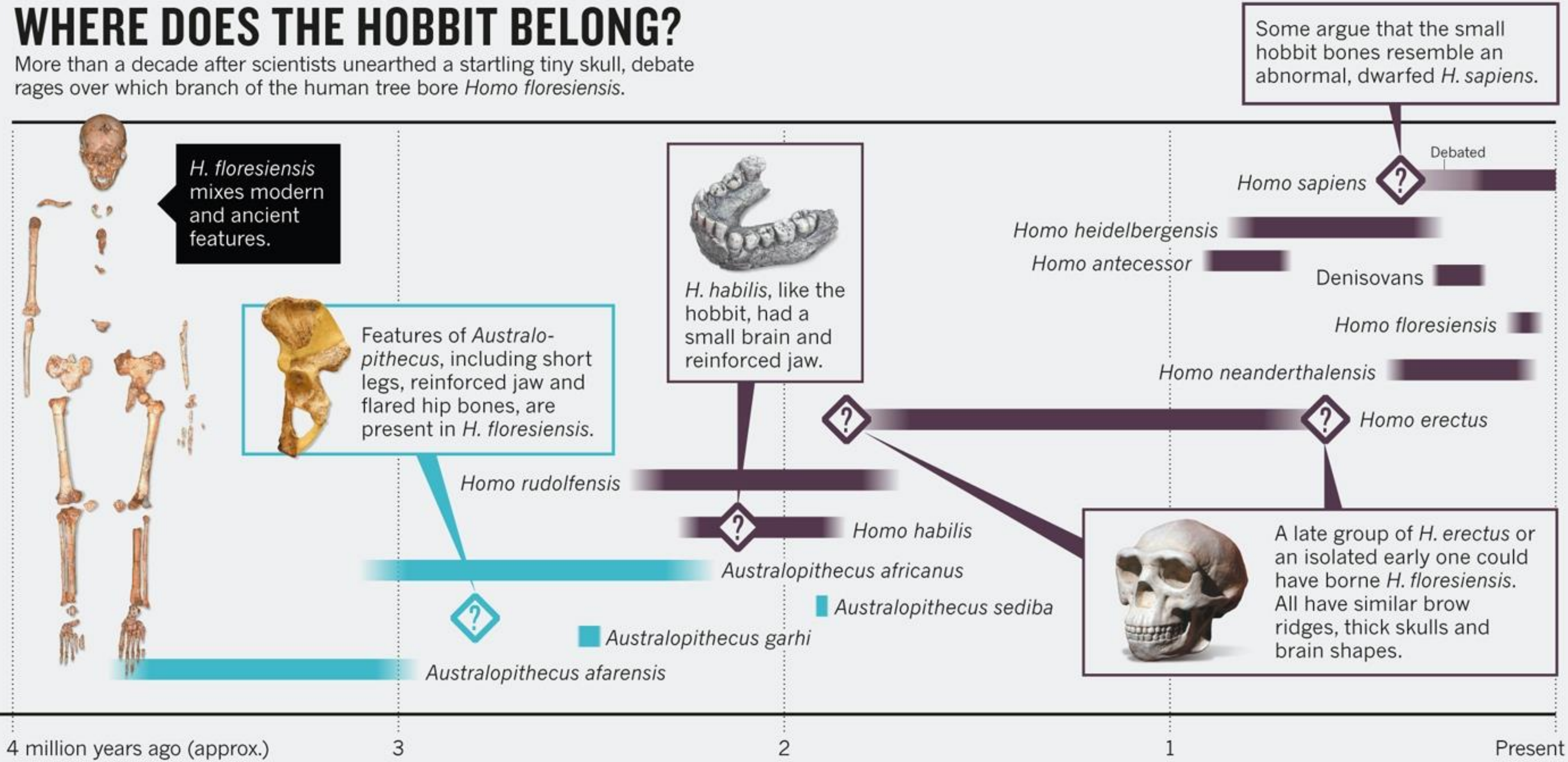
H. habilis, LB1 and *H. erectus*

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).

WHERE DOES THE HOBBIT BELONG?

More than a decade after scientists unearthed a startling tiny skull, debate rages over which branch of the human tree bore *Homo floresiensis*.



Two theories

The <u>two most popular current evolutionary hypotheses</u> position *Homo floresiensis* as the following:

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

2) <u>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 .</u>

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

Phylogeny

- Despite considerable early scientific debate over whether
  - Most scientists now recognize *H. floresiensis* as a valid taxon and a human species distinct from *Homo sapiens*.

- Debate: how *H. floresiensis* is phylogenetically related to other species in the genus *Homo*.

- For example, did *H. floresiensis* evolve from
  - an earlier population of *H. erectus*, or
  - did it evolve from a smaller species, such as the early humans found in Dmanisi (Republic of Georgia), or
  - perhaps another earlier species of the genus *Homo*?

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 Ma 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.

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

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

- 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.*

The affinities of Homo floresiensis based on phylogenetic analyses of cranial, dental, and postcranial characters – Debbie Argue, et al., 2017

- The phylogenetic status of *H. floresiensis* remains highly contentious.

- 1 - *H. floresiensis* is derived from Asian *Homo erectus* that arrived on Flores and subsequently evolved a smaller body size, perhaps to survive the constrained resources they faced in a new island environment. Fossil remains of *H. erectus*, well known from Java, have not yet been discovered on Flores.

- 2 - *H. floresiensis* is directly descended from an early *Homo* lineage with roots in Africa, such as *Homo habilis*;

- 3 – it is *Homo sapiens* with pathology.

- We use parsimony and Bayesian phylogenetic methods to test these hypotheses. Our phylogenetic data build upon those characters previously presented in support of these hypotheses by broadening the range of traits to include the crania, mandibles, dentition, and postcrania of *Homo* and *Australopithecus*.

The affinities of Homo floresiensis based on phylogenetic analyses of cranial, dental, and postcranial characters – Debbie Argue, et al., 2017

- The new data and analyses support the hypothesis that *H. floresiensis* is an early *Homo* lineage:
- *H. floresiensis* is sister either to *H. habilis* alone or to a clade consisting of at least *H. habilis, H. erectus, Homo ergaster,* and *H. sapiens.*
- A close phylogenetic relationship between *H. floresiensis* and *H. erectus* or *H. sapiens* can be rejected
- Most of the traits separating *H. floresiensis* from *H. sapiens* are not readily attributable to pathology (e.g., Down syndrome).

- The results suggest *H. floresiensis* is a long-surviving relict of an early (>1.75 Ma) hominin lineage and a hitherto unknown migration out of Africa, and not a recent derivative of either *H. erectus* or *H. sapiens.*

D. Argue

- That study, led by Debbie Argue of the Australian National University (ANU), used 133 data points ranging across the skull, jaws, teeth, arms, legs and shoulders of the *H. floresiensis* fossil to conclude that many features were more primitive than *H. erectus*, and that therefore the hobbits were most likely a sister species of *Homo habilis*, (Africa,1.75 Ma).
- It was possible that *H. floresiensis* evolved in Africa and migrated, or that a common ancestor moved from Africa then evolved into *H. floresiensis*.
- Another 2017 study found the opposite.

What Next?

- The discovererers 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, 2010

- 2010: …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.

- None of the current explanations for microcephaly and disordered growth account for the range of features observed in *H. floresiensis*.

- 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

Homo floresiensis **-** Leslie C. Aiello, 2014

There has been considerable controversy over the evolutionary position of H. floresiensis.

1 - H. floresiensis is a small-bodied and small-brained hominin that has a unique mosaic morphology which, taken at face value, suggests that its closest evolutionary affinity is with early *Homo*. Various analyses have suggested either *H. habilis*, *H. georgicus*, or *H. erectus* from Africa or Asia as the most probable ancestor.

2 - The alternative to this "new species" hypothesis is that *H. floresiensis*, and particularly the LB1-type skeleton, represents a pathological modern human suffering from one or a combination of syndromes, which produce disordered growth (dwarfism) and microcephaly.

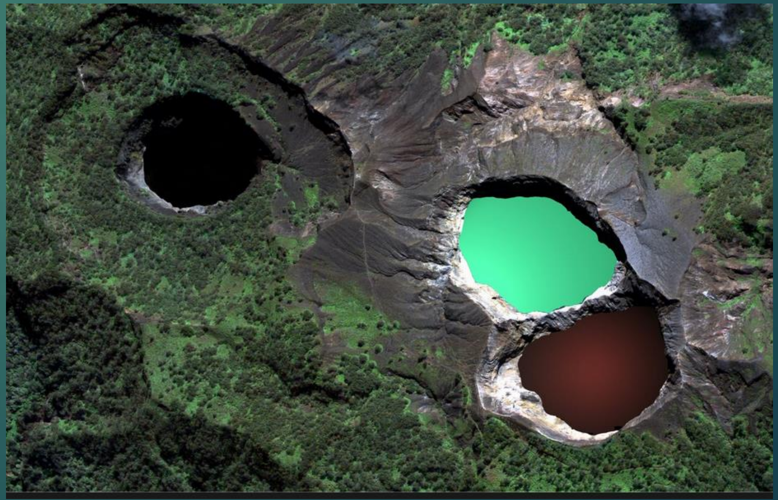
L. Aiello, 2014

Both hypotheses have compelling aspects, but the "pathological modern human" hypothesis has yet to account for the total morphological pattern observed in *H. floresiensis*. At present this is a less convincing hypothesis than the "new species" hypothesis.

Recent research is pointing to a *H. erectus* as the most plausible *H. floresiensis* ancestor.

H. erectus is known from Island Southeast Asia in the proper time frame and would avoid the paradigm changing necessity of postulating an unknown Asian pre-*erectus* ancestor

Volcanic Demise?



Lakes of Mount Kelimutu

Continuing questions

- Why, for instance, has only one skull been found if the species lived on Flores for 700 K 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?

2016: Back to Mata Menge

- ‘Hobbit’ relatives found after ten-year hunt
- New Mata Menge mandible and teeth are similar to those of *H. floresiensis* from Liang Bua. The exception is the mandibular first molar, which retains a more primitive condition.
- Notably, the Mata Menge mandible and molar are even smaller in size than those of the two existing *H. floresiensis* individuals from Liang Bua.
- The Mata Menge fossils are derived compared with Australopithecus and *H. habilis*, and so tend to support the view that *H. floresiensis* is a dwarfed descendent of early Asian *H. erectus*.
- Unusually petite jaw and teeth are from at least one adult and two children — the first possible ancestors of *Homo floresiensis* ever to be discovered

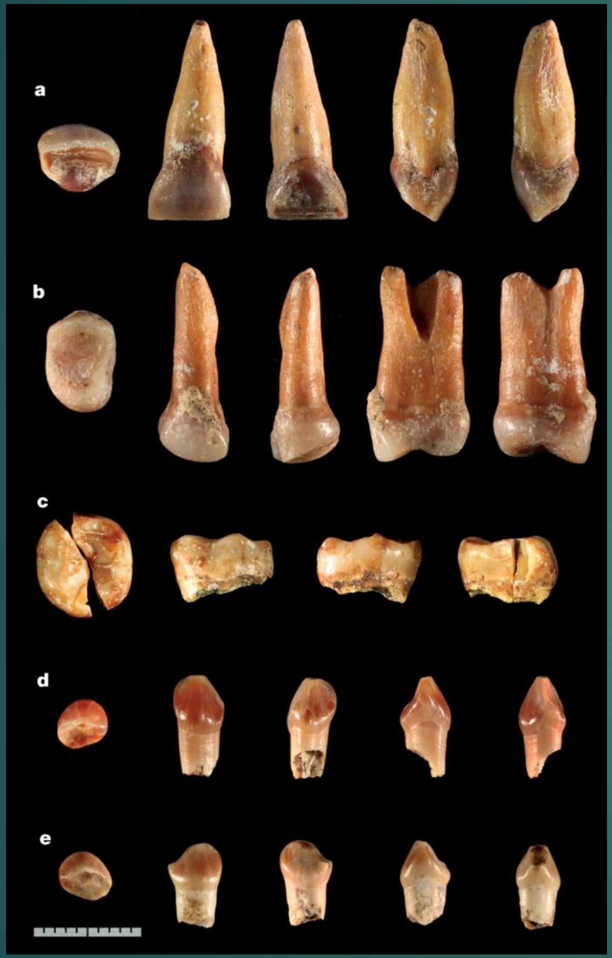
Mata Menge mandible (700K) compared with a Liang Bua *H. floresiensis* specimen (100-60K)

Mata Menge jaw

Liang Bua jaw

G D van den Bergh *et al.* *Nature* **534,** 245–248 (2016) doi:10.1038/nature17999

Isolated teeth from Mata Menge



G D van den Bergh *et al. Nature* **534,** 245–248 (2016)

2016 Mata Menge mandible

- Jaw from an adult (its wisdom tooth had erupted) who was even smaller than the hobbit, and that two canines are the milk teeth of two different children.
- The thin jaw looks more like that of *H. erectus* and *H. floresiensis* than the beefier jaws of more primitive hominins such as *H. habilis.*
- One tooth and the rock around it led the team to estimate that the remains are some 700 Ka old.
- The oldest artefacts in the region, meanwhile, suggest that a group of *Homo erectus* arrived on Flores about one million years ago, says van den Bergh.
- Remains point to large-bodied *H. erectus* as the likeliest ancestor of the hobbit, and propose that it became dwarfed in just a few hundred thousand years to cope with the meagre resources on Flores.

2016

- Spoor and Stringer agree that *H. erectus* is now the best fit for the hobbit's ancestor, although Stringer isn't so sure that the shrinkage happened on Flores.

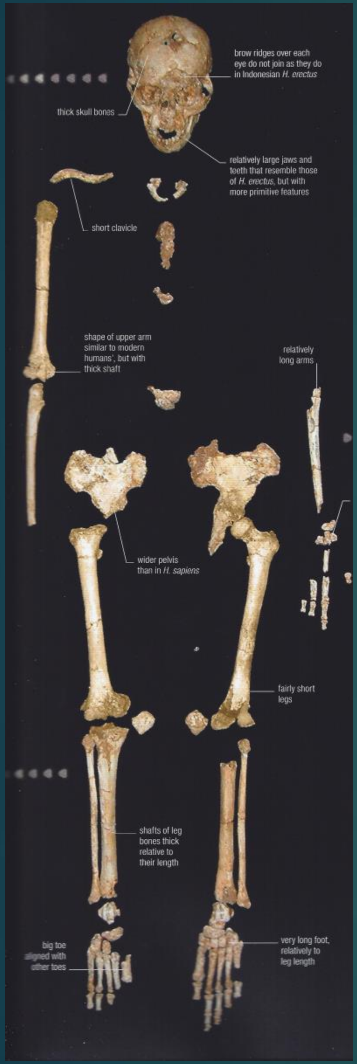
- William Jungers says that the fossils are not complete enough to favor the *H. erectus* origin

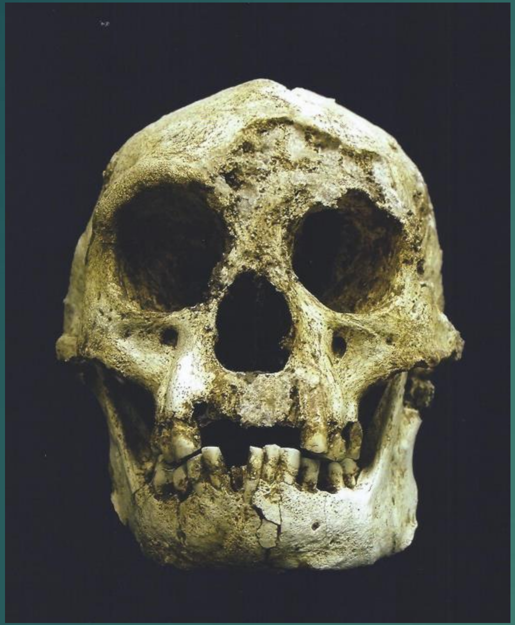
- Too few fossils have been found to exclude the possibility that, even if Mata Menge and Liang Bua hominins were related, they belonged to different populations that arrived on Flores at different times

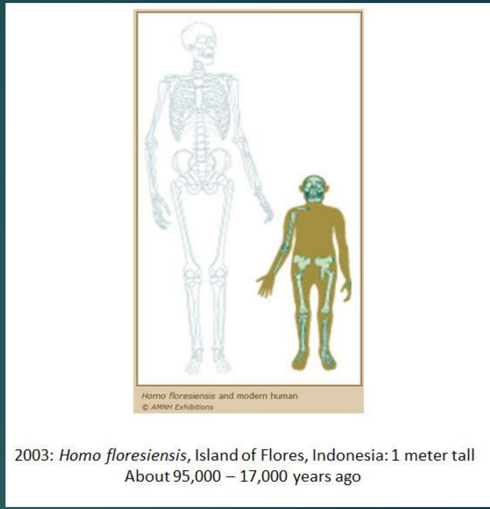
Where do you fit in?

Jatmiko; member of discovery team

2003: *Homo floresiensis*, 426 cc, 700 to 100-60K



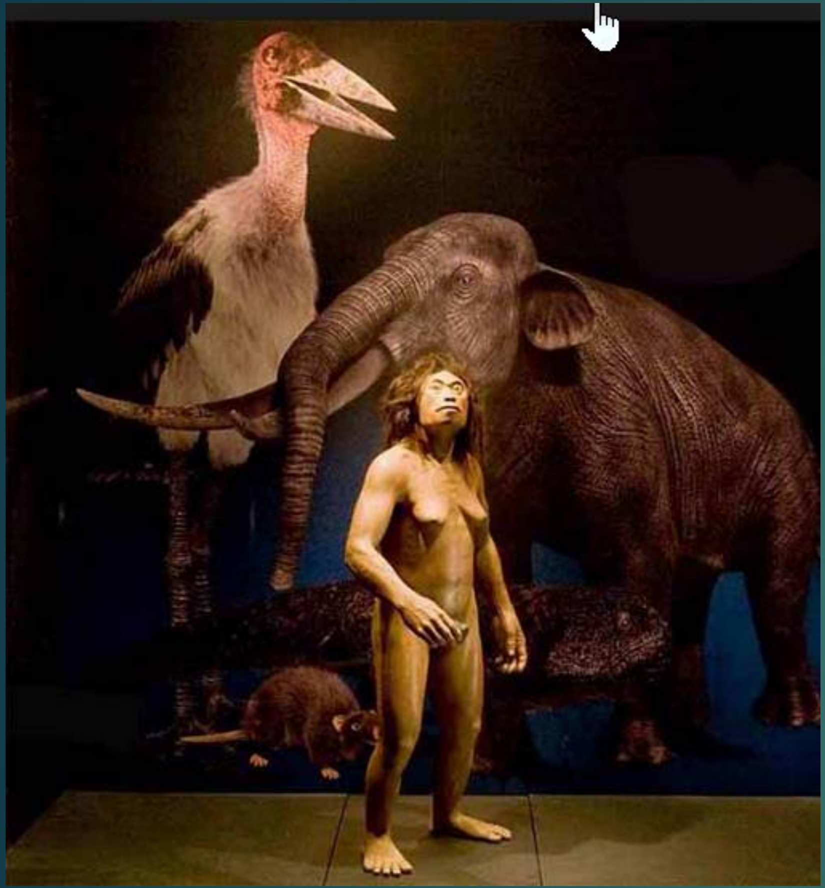




3 feet tall

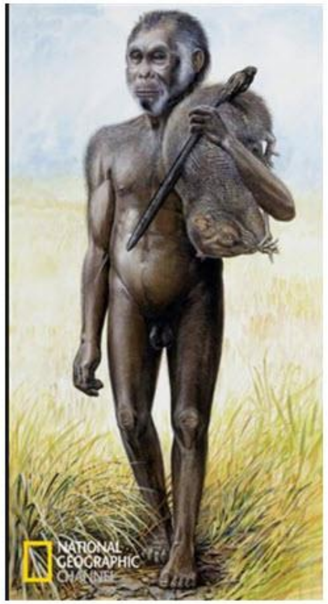
Homo floresiensis
(LB1, type, partial skeleton)
Discoverer: Thomas Sutikna
Locality: Liang Bua, Flores, Indonesia
Date: 2003
Age: 100-60K

Flores, Indonesia: 100-60 Ka



Stegodon dwarf elephant

H. Floresiensis & giant storks

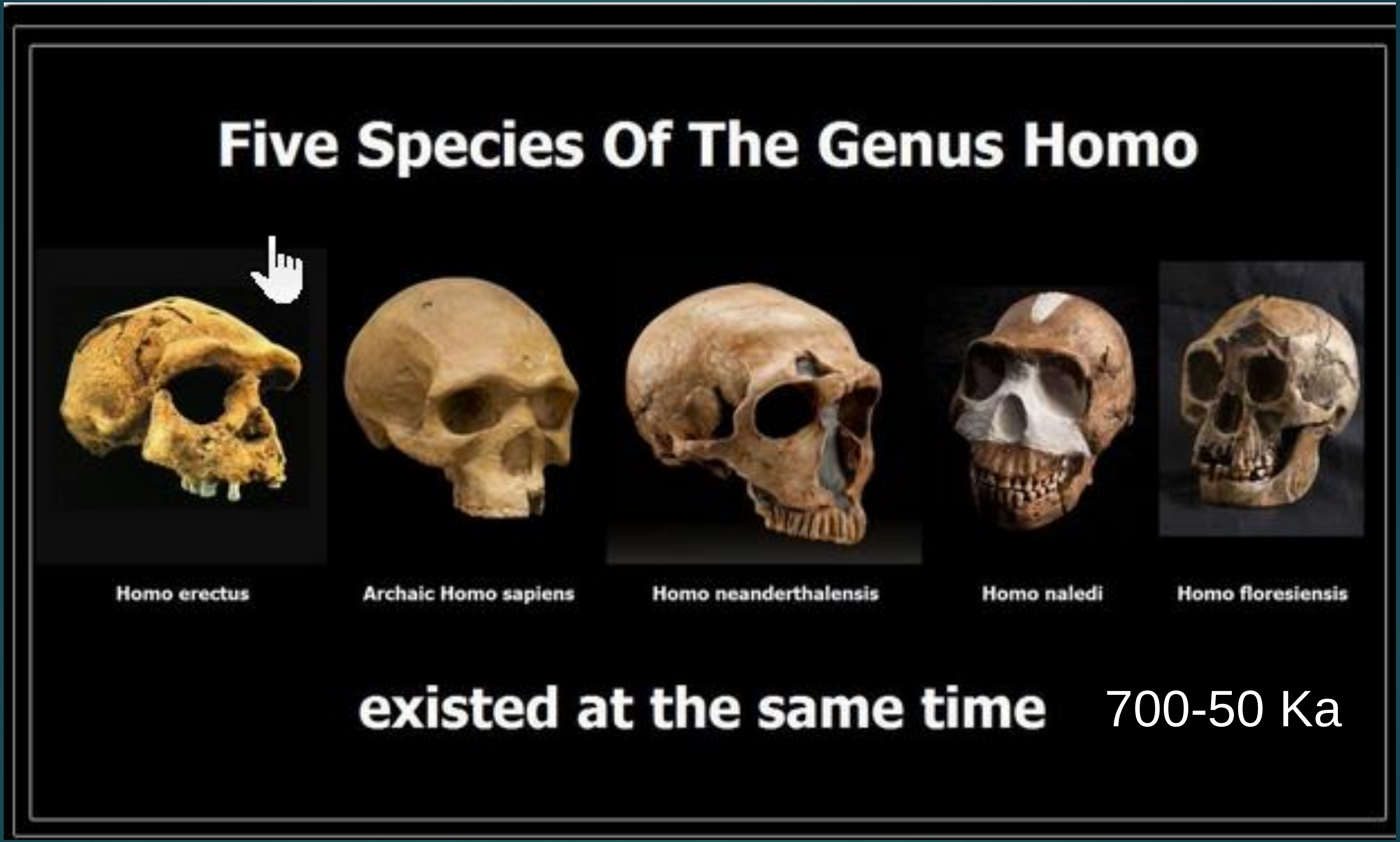


Homo floresiensis & Large rats

Giant Komodo dragons on Flores

Homo floresiensis: 426cc, now 700 to 100-60 kya

- Originally considered to have survived until 12,000 years ago,
- More extensive stratigraphic and chronological work: 100 to 60 Ka; Stone tools dated = 190 to 50 Ka
- 2014 new smaller ancestors: Fossil teeth and a partial jaw: date to 700 Ka and are even smaller than the later fossils; site on Flores called Mata Menge, about 74 km from Liang Bua. Stone tools from 840 Ka.
- Theories:
  - Derived from a population of *H. erectus* circa a million years ago and rapidly became dwarfed
  - a sister clade to *Homo habilis* based on a phylogenetic analyses, implying a >1.8 My migration from Africa (Debbie Argue, et al., 2017)



Six with the Denisovans

Smithsonian: Unanswered questions

Below are some of the that may be answered with future still unanswered questions about *Homo floresiensis* discoveries*:*

1. Which hominin species made the 1 MA old stone tools found on Flores?

2. How did these early humans manage to get to the island of Flores?

3. Did *H. floresiensis* have language, make art, and have other forms of cultural expression?

4. Did *H. floresiensis* and our species, *H. sapiens,* ever come into contact with one another?

Unanswered questions

5. Was a volcanic eruption on Flores the reason *H. floresiensis* went extinct?

6. How similar is the DNA of *H. floresiensis* to the DNA of other human species? So far, no DNA has been retrieved from the bones of a *H. floresiensis* individual.

7. At present we do not even know the extent of sexual dimorphism in the species — would a male skeleton be much larger and more *H. erectus*-like?

8. H. floresiensis is now generally accepted as a valid species, but its evolutionary lineage, geographical distribution and period of existence remain open questions

Bibliography

- *A New Human by Morwood*, Mike; van Oosterzee, Penny (2009)
- *The Fossil Chronicles* by Dean Falk
- ***** Five Years of Homo floresiensis by Leslie C. Aiello, *AJPA*, 2010 (best hx of research)**
- Rethinking "Hobbits": What They Mean for Human Evolution, *SciAm*, Oct 22, 2009, by Kate Wong
- *Homo floresiensis*: Making Sense of the Small-Bodied Hominin Fossils from Flores *Nature Education*; by Karen L. Baab
- Pathology or Paradigm Shift? Human Evolution, Ad Hominem Science and the Anomolous Hobbits of Flores, *Skeptical Inquirer*, by Kenneth W. Krause, Volume 33.4, July / August 2009
- The Hobbit of Flores Island: Body and Soul; Dean Falk, Santa Fe Institute, 2012, YouTube

Bibliography

- Tales of the Hobbit. Ewen Callaway, 2014
- Estimating humeral torsion on incomplete fossil anthropoid humerus by S.G. Larson, 2014
- *Tiny Humans: The Hobbits of Flores* video
- Great Beasts of Legend: The Hobbits of Flores Island: Myth, Magic, Majesty of Homo floresiensis, YouTube, Dr. Monge lecture, Penn Museum, 2017
- *Alien from Earth*, Nova episode
- *Shaping Humanity,* by John Gurche, 2013
- *The Last Human* by G. J. Sawyer and V. Deak

Journal Articles

- Aiello, L.C. Five years of *Homo floresiensis*. *American Journal of Physical Anthropology* **142,** 167-179 (2010).
- Argue, D. *et al*. *Homo floresiensis*: a cladistics analysis. *Journal of Human Evolution* **57**, 623-639 (2009).
- Baab, K. L. Comparison of the LB1 neurocranium to extinct hominins, normal and pathological modern humans. *American Journal of Physical Anthropology* **141**, 59 (2010).
- Baab, K. L. & McNulty, K. P. Size, shape, and asymmetry in fossil hominins: the status of the LB1 cranium based on 3D morphometric analyses. *Journal of Human Evolution* **57**, 608-622 (2009).
- Brumm, A. *et al.* Hominins on Flores, Indonesia, by one million years ago. *Nature* **464,** 748-752 (2010).
- Boyages, S. C. *et al.* A comparative study of neurological and myxedematous endemic cretinism in western China. *Journal of Clinical Endocrinology and Metabolism* **67**, 1262-1271 (1988).
- Brown, P. *et al.* A new small-bodied hominin from the Late Pleistocene of Flores, Indonesia. *Nature* **431**, 1055-1061 (2004).
- Brumm, A. *et al.* Early stone technology on Flores and its implications for *Homo floresiensis*. *Nature* **441,** 624-628 (2006).
- Falk, D. *et al.* The brain of LB1, *Homo floresiensis*. *Science* **308**, 242 - 245 (2005).
- Falk, D. *et al.* Brain shape in human microcephalics and *Homo floresiensis*. *Proceedings of the National Academy of Sciences USA* **7**, 2513-2518 (2007).

Journal Articles

- Falk, D. *et al.* The type specimen (LB1) of *Homo floresiensis* did not have Laron Syndrome. *American Journal of Physical Anthropology* **140**, 52-63 (2009).
- Groves, C. & Fitzgerald, C. Healthy hobbits or victims of Sauron. *HOMO - Journal of Comparative Biology* **61,** 211 (2010).
- Halpern, J.-P. *et al.* The neurology of endemic cretinism. *Brain* **114**, 825-841 (1991).
- Henneberg, M. & Thorne, A. Flores may be pathological *Homo sapiens*. *Before Farming* **1**, 2-4 (2004).
- Hershkovitz, I. *et al.* Comparative skeletal features between *Homo floresiensis* and patients with primary growth hormone insensitivity (Laron syndrome). *American Journal of Physical Anthropology* **134**, 198-208 (2007).
- Huffman, O.F. *et al.* Provenience reassessment of the 1931-1933 Ngandong *Homo erectus* (Java), confirmation of the bone-bed origin reported by the discoverers. *PaleoAnthropology*, 1-60 (2010).
- Indriati, E. *et al.* The age of the 20 meter Solo River terrace, Java, Indonesia and the survival of *Homo erectus* in Asia. *PLoS ONE* **6,** e21562.
- Jacob, T. *et al.* Pygmoid Australomelanesian *Homo sapiens* skeletal remains from Liang Bua, Flores: population affinities and pathological abnormalities. *Proceedings of the National Academy of Sciences USA* **103**, 13421-13426 (2006).
- Jungers. W. L. *et al.* The hobbits (*Homo floresiensis*) were not cretins. *American Journal of Physical Anthropology* **S48,** 161 (2009).

Journal Articles

- Jungers, W. L. *et al.* The foot of *Homo floresiensis*. *Nature* **459**, 81-84 (2009).
- Jungers, W. & Baab, K. The geometry of hobbits: *Homo floresiensis* and human evolution. *Significance* **6,** 159-164 (2009).
- Köhler, M. & Moyà-Solà, S. Reduction of brain size and sense organs in the fossil insular bovid *Myotragus*. *Brain Behavior and Evolution* **63,** 125-140 (2004).
- Koplik, H. *The Diseases of Infancy and Childhood.* New York, NY: Lea & Febiger, (1 918).
- Larick, R. *et al.* Early Pleistocene $^{40}Ar/^{39}Ar$ ages for Bapang Formation hominins, Central Jawa, Indonesia. *Proceedings of the National Academy of Sciences USA* **98,** 4866-4871 (2001).
- Larson, S. G. *et al.* Descriptions of the upper limb skeleton of *Homo floresiensis*. *Journal of Human Evolution* **57**, 555-570 (2009).
- Martin, R. D. *et al.* Comment on "The Brain of LB1, *Homo floresiensis*." *Science* **312,** 999 (2006).
- Meijer, H. J. M. *et al.* The fellowship of the hobbit: the fauna surrounding *Homo floresiensis*. *Journal of Biogeography* **37,** 995-1006 (2010).

Journal Articles

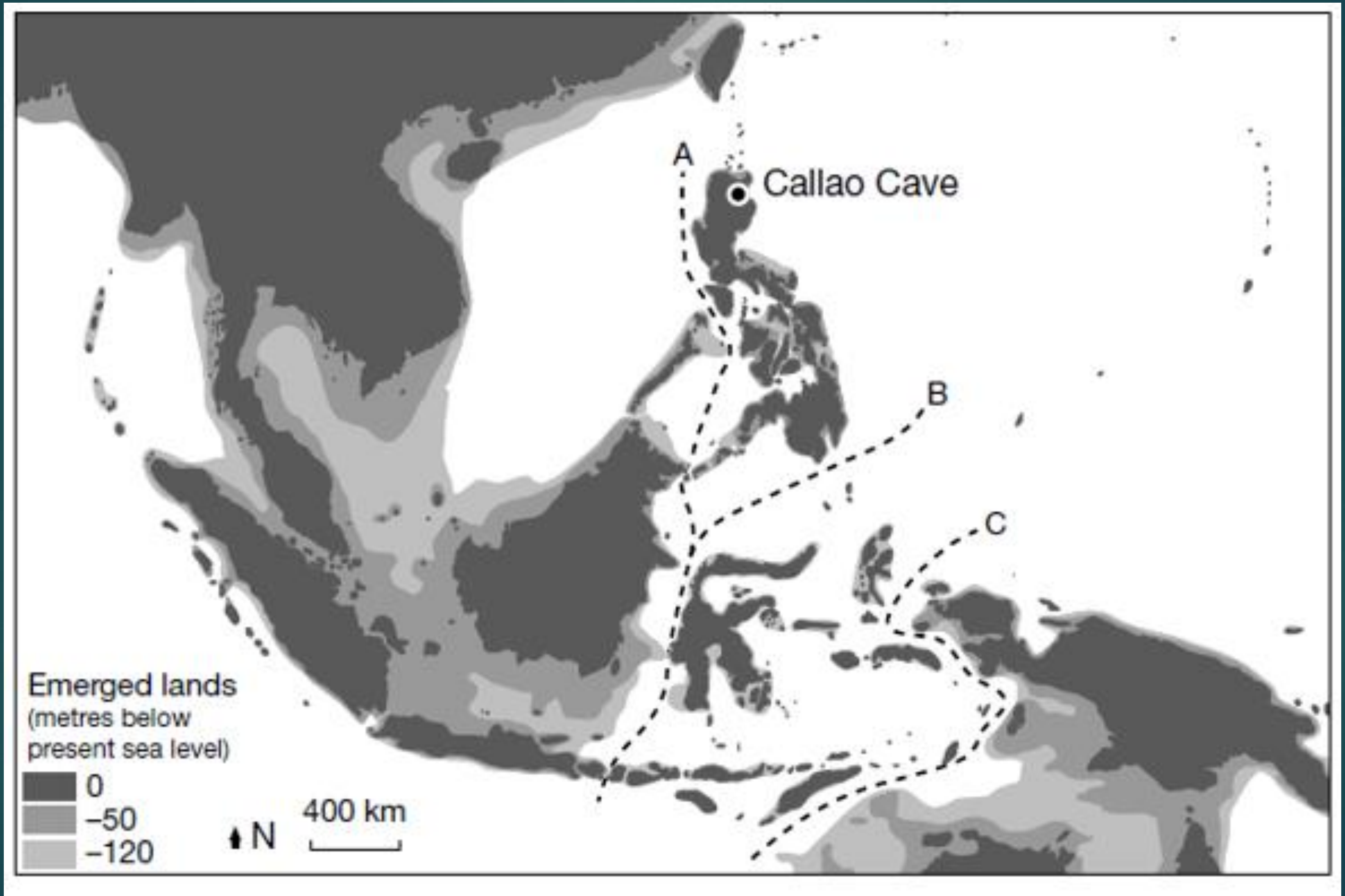
- Moore, M. W. & Brumm, A. *Homo floresiensis* and the African Oldowan. In Hovers, E. & Braun, D.R. (Eds.) *Interdisciplinary Approaches to the Oldowan*. Springer: New York, 61-69 (2009).
- Obendorf, P. J. *et al.* Are the small human-like fossils found on Flores human endemic cretins? *Proceedings of the Royal Society B: Biological Sciences* **275**, 1287-1296 (2008).
- Oxnard, C. *et al.* Post-cranial skeletons of hypothyroid cretins show a similar anatomical mosaic as *Homo floresiensis*. *PLoS ONE* **5**, e13018 (2010).
- Tocheri, M. W. Derived wrist anatomy in the genus *Homo* as evidenced by 3D quantitative analyses: the implications for understanding the evolution of stone tool behaviors in hominins. *American Journal of Physical Anthropology* **132**, 232-322 (2007).
- Van den Bergh, G.D. *et al.* The youngest *Stegodon* remains in Southeast Asia from the Late Pleistocene archaeological site Liang Bua, Flores, Indonesia. *Quaternary International* **182,** 16-48 (2008).
- Weston, E. M. & Lister, A. M. Insular dwarfism in hippos and a model for brain size reduction in *Homo floresiensis*. *Nature* **459,** 85-88 (2009).
- Westway, K. E. *et al.* Reconstructing the geomorphic history of Liang Bua, Flores, Indonesia: a stratigraphic interpretation of the occupational environment. *Journal of Human Evolution* **57,** 465-483 (2009).

Homo luzonensis

Homo floresiensis may have been far from alone

2019

Callao Cave, Luzon, Philippines



Kalinga & Callao Cave, Luzon, Philippines

Callao Cave, Luzon, Philippines

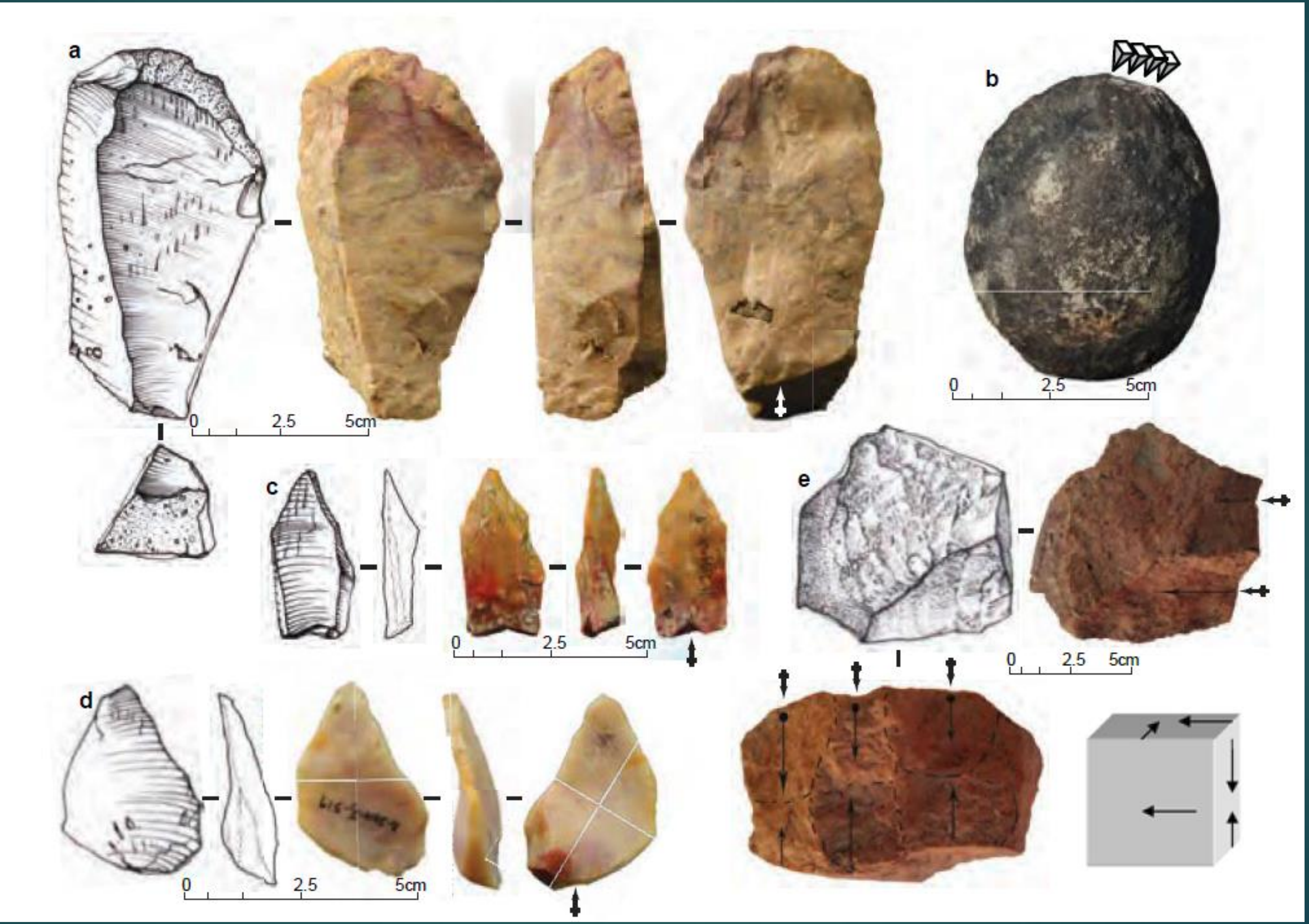
Kalinga, Luzon, Philippines

- Luzon was never connected to the Asian mainland, even when sea level was at its lowest during the Ice Ages. To get there, ancient hominins had to float. Who were they, and how did they get there?
- We don't know yet if the Luzon toolmakers could have been the same population as the Flores hobbits. The tiny foot bone from Callao Cave hints that there might have been a hobbit-like population on Luzon as well.
- History of SE Asian Archipelago was complicated:
  - *Homo erectus* inhabited Java by 1.4 Ma
  - Flores hominin by 1 Ma
  - On Luzon, somebody made stone tools and butchered a rhinoceros before 700 Ka.

Earliest known hominin activity in the Philippines by 709 thousand years ago –T. Ingicco, et al., 2019

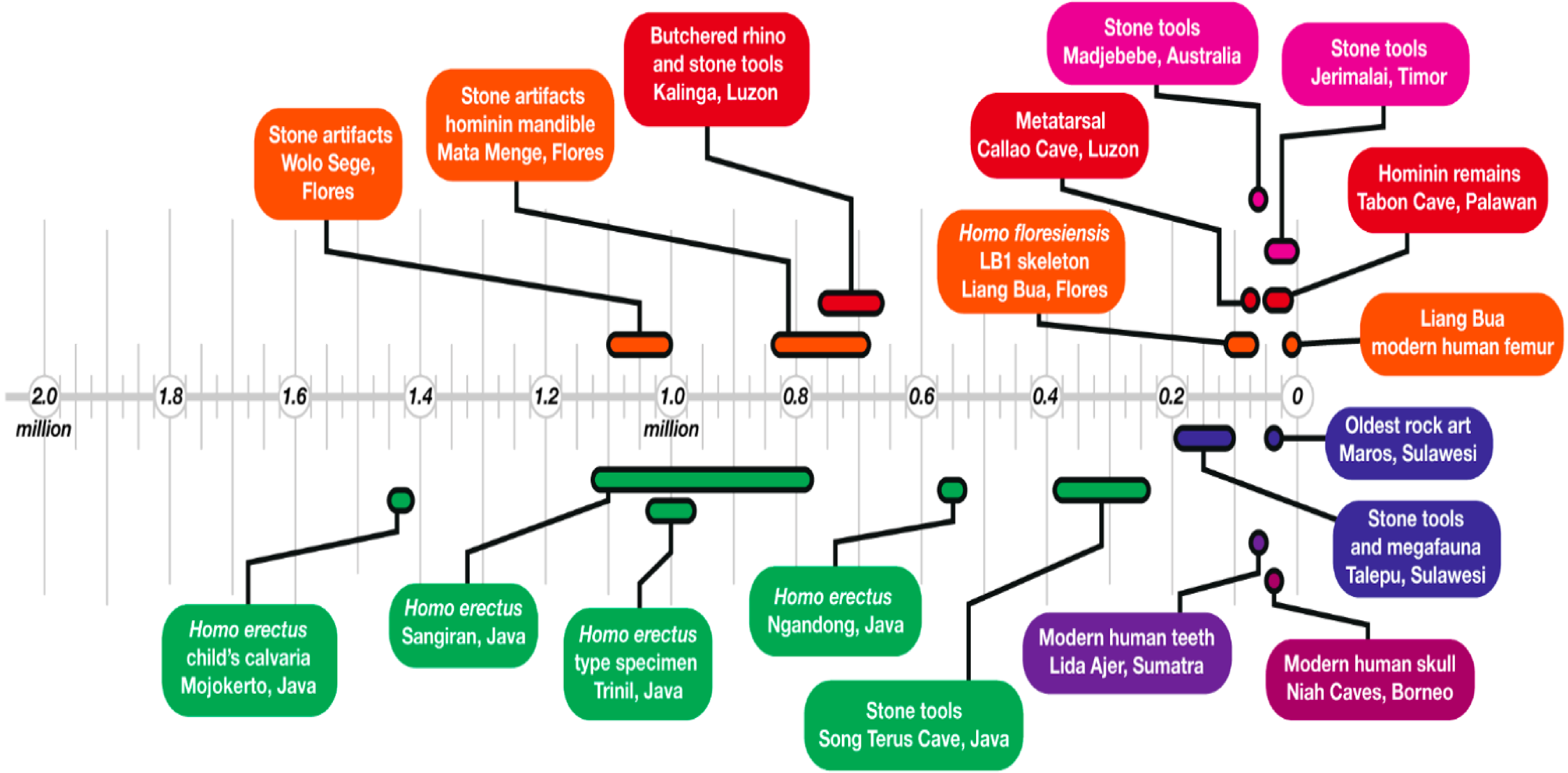
- Excavations at Kalinga Cave in the Cagayan Valley of northern Luzon in the Philippines that have yielded 57 stone tools associated with an almost-complete disarticulated skeleton of *Rhinoceros philippinensis*, which shows clear signs of butchery, together with other fossil fauna remains attributed to stegodon, Philippine brown deer, freshwater turtle and monitor lizard.
- Dated to between 777-631 Ka using electron-spin resonance methods that were applied to tooth enamel and fluvial quartz.
- The Philippines therefore may have had a central role in southward movements into Wallacea, not only of Pleistocene megafauna, but also of archaic hominins.
- They didn’t find any hominin fossil skeletons, but the stone tools and the butchered remains of a rhinoceros show that somebody lived on this island long before modern people evolved in Africa.

Kalinga, Luzon, Philippines: stone tools



Sulawesi

- In 2016, Gerrit van den Bergh and archaeologist coworkers found stone tools at Telepu, Sulawesi, that are older than 118 Ka. That date may not seem as impressive as the much older artifacts on Luzon and Flores, but it’s still far earlier than modern humans are thought to have arrived in this region.
- Who were these ancient islanders, and how did they manage these deepwater crossings so long ago?



Timeline of hominin occupation of island Southeast Asia

Location

100 miles
100 km
CALLAO CAVE
Philippine Sea
South China Sea
Manila
PHILIPPINES
Sulu Sea
MALAYSIA
Celebes Sea
INDONESIA

Callao Cave, Luzon, Philippines

The first chamber of Callao Cave on Luzon Island, in the Philippines, where the fossils of Homo luzonensis were discovered. (Callao Cave Archaeology Project)

Callao Cave lies on the northern end of Luzon, an island that has not been connected to mainland Asia anytime in the last 2.5 million years.

Callao Cave

Right: Researchers carefully dig through several feet of thick clay in this picture from the 2011

April 2019

A new species of *Homo* from the Late Pleistocene of the Philippines

Florent Détroit, Armand Salvador Mijares, Julien Corny, Guillaume Daver, Clément Zanolli, Eusebio Dizon, Emil Robles, Rainer Grün & Philip J. Piper

History of the discoveries, 2007-2019

- The best known MHs are from
  - Niah Cave in Borneo (40-42 Ka), and from
  - Tabon Cave on the island of Palawan, southwest Philippines (47+/-11 Ka), and
  - *Homo floresiensis* on the island of Flores.

- In 2003 team at Callao Cave excavated down to 6 feet looking for traces of the first farmers on the Philippines; no fossils found.

- During a second dig season at Callao in 2007, Armand Mijares, an archaeologist at the University of Philippines, asked Philip Piper to examine some animal bones. They found a single hominin foot.

- In 2010, Piper, Mijares and their team published a description of the foot bone (CCH1), the oldest human remain in the Philippines, dated to 66 Ka.

Professor Philip Piper from the ANU School of Archaeology and Anthropology inspects the cast of a hominin third metatarsal discovered in 2007. The bone

CCH1, a 67,000 year old third metatarsal bone

A Homo luzonensis toe bone, showing the longitudinal curve. (Callao Cave Archaeology Project)

Curving in the toe bone of *H. luzonensis* may have been adaptations for climbing.

2010 footbone

- Its morphological features, as well as size and shape characteristics, indicate that the Callao metatarsal definitely belongs to the genus *Homo.*

- It has a gracile structure, close to other small-bodied Homo sapiens. Interestingly, the Callao metatarsal also falls within the morphological and size ranges of a small *H. sapiens*, *Homo habilis and H. floresiensis*

- Also a deer bone found in the same sediments bears what look like stone-tool cut marks

History of the discoveries

- In 2011, on another dig, he and his colleagues found more humanlike fossils, including teeth, part of a femur and hand bones.
- In 2015, they found two more molars, dated to 50 Ka.
- In 2019, after the discovery of 12 new specimens and based on the apparent presence of both modern-humanlike and primitive *Australopithecus*-like features, they reassigned the remains to a new species, *Homo luzonensis*, the species name deriving from the name of the island.
- Attempts to extract DNA from the remains were unsuccessful.

Kalinga stone tools at 709 Ka: same or different hominin

- 2018: evidence that *H. luzonensis,* or another ancient hominin, lived on Luzon even further back in time.

- Mijares and his colleagues announced the discovery of stone tools and a butchered rhinoceros skeleton that are more than 709,000 years old, found 20 miles from Callao Cave.

- Because of the time gap between the remains and the tool site, however, it’s unclear whether the stone tool users were predecessors of *H. luzonensis* or an unrelated hominin.

New finds: 12 specimens at Callao Cave

- Continued excavations in Callao Cave that originally yielded the hominin third metatarsal (the holotype, CCH1 for 'Callao Cave Hominin 1') have produced another twelve hominin elements from the same stratigraphic layer (layer 14) representing 3 individuals:
- 7 postcanine maxillary teeth (CCH6-a to CCH6-e, CCH8, CCH9), two or three roots, a primitive feature
- 2 manual phalanges (CCH2 and CCH5),
- 2 pedal phalanges (CCH3 and CCH4)
- 1 femoral shaft (CCH7.
- CCH1 and CCH6-a are directly dated by U-series analysis to minimum ages of 67 Ka and 50 Ka, respectively.
- The specimens are kept at the National Museum of the Philippines, Manila

Deer and tools

- About 90% of the bone fragments from Callao Cave belong to the Philippine deer, which suggests that deer carcasses were periodically brought into the cave..

- There are cut marks on a deer tibia, and a lack of tools in the cave could either have resulted from the use of organic material for tools rather than stone, or the processing of meat away from the cave.

Homo luzonensis

- Dating: one foot bone found in 2007 dated to 67 Ka, the other fossils found between 2011-2015 dated to 50 Ka.
- Teeth: 2 premolars and 3 molars, are very small, reminiscent of *Homo floresiensis* or modern humans in their size and simple structure, but reminiscent of australopithecines teeth in the enamel and roots.
- Phalanges of the hands and feet and a metatarsal bone: of primitive appearance, similar to those of the australopithecines, curved phalanges and that of the foot shows signs of strong muscular insertions for flexion. They suggest an <u>adaptation to the arboreal life</u>
- Although it is speculated that they could be of small stature, it <u>can not be inferred from these remains.</u>

New species

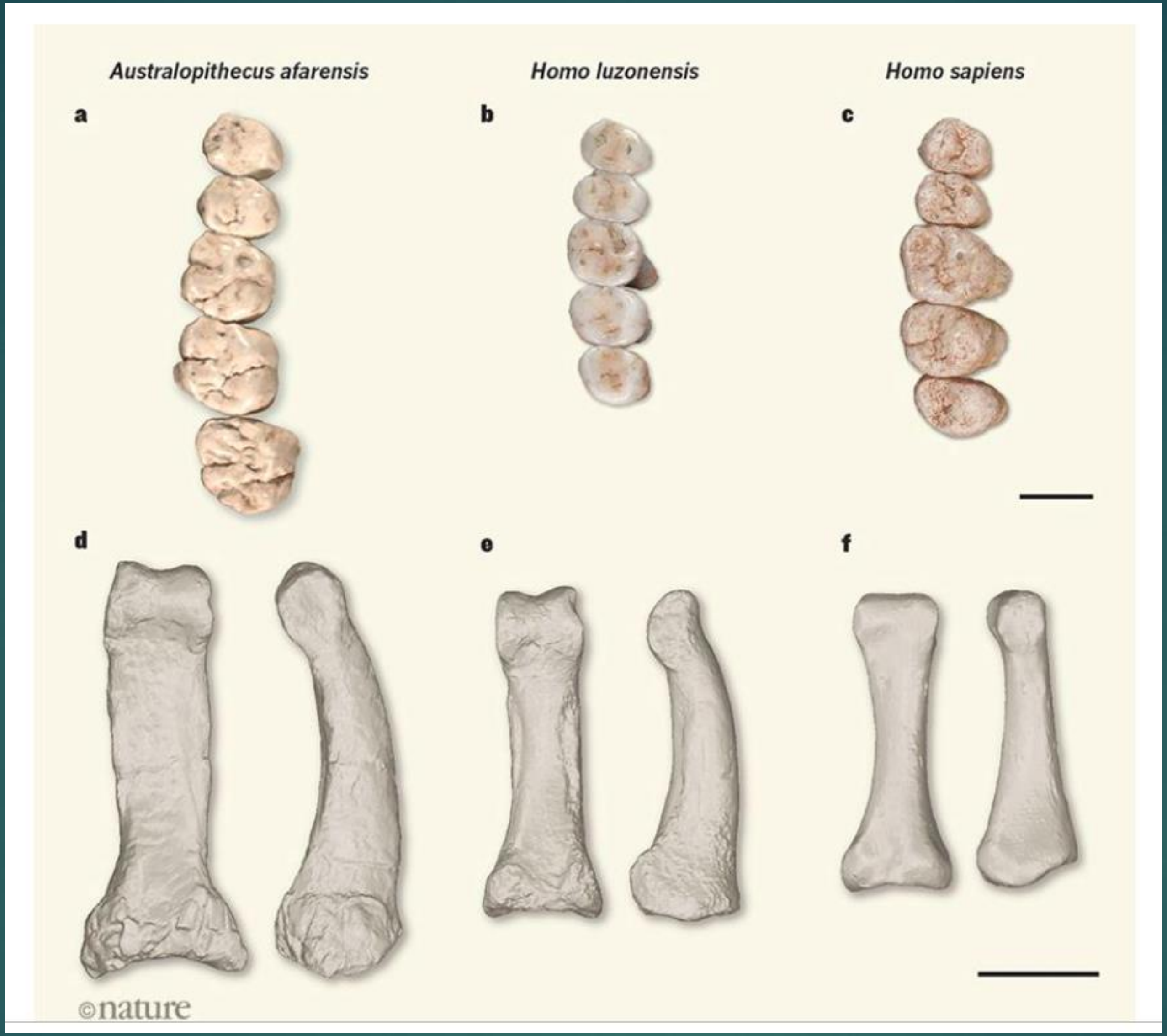
- Recovered in 2007, 2011 and 2015 from the same excavation area and layer as the holotype: CCH1; then 3 years of field work for rest
- Small-jawed with very small teeth, able to walk upright but with feet still shaped to climb, these island creatures were a mix-and-match patchwork of primitive and advanced features in a unique variation of the human form
- Five of the upper right teeth belonged to a single male individual
- The presence of two right upper third adult molars (M3; CCH6-a and CCH9) and a juvenile femoral shaft (CCH7) indicates that at least three individuals are represented.
- On the basis of the unique mosaic of primitive fingers and toes (*Australopithecus*-like) and derived (*H. sapiens*-like) morphological features (molars) observed on these specimens, they assigned them to a new species, *H. luzonensis*.

These adult teeth are smaller than any hominin known. Could it be that these teeth belonged to adults that were even smaller than Homo floresiensis?

Photo credit: Callao Cave Archaeology Project.

- The teeth are very small.

- The size of teeth generally reflect the overall body-size, so we think *Homo luzonensis* was probably relatively small. Probably taller than hobbits of Flores.

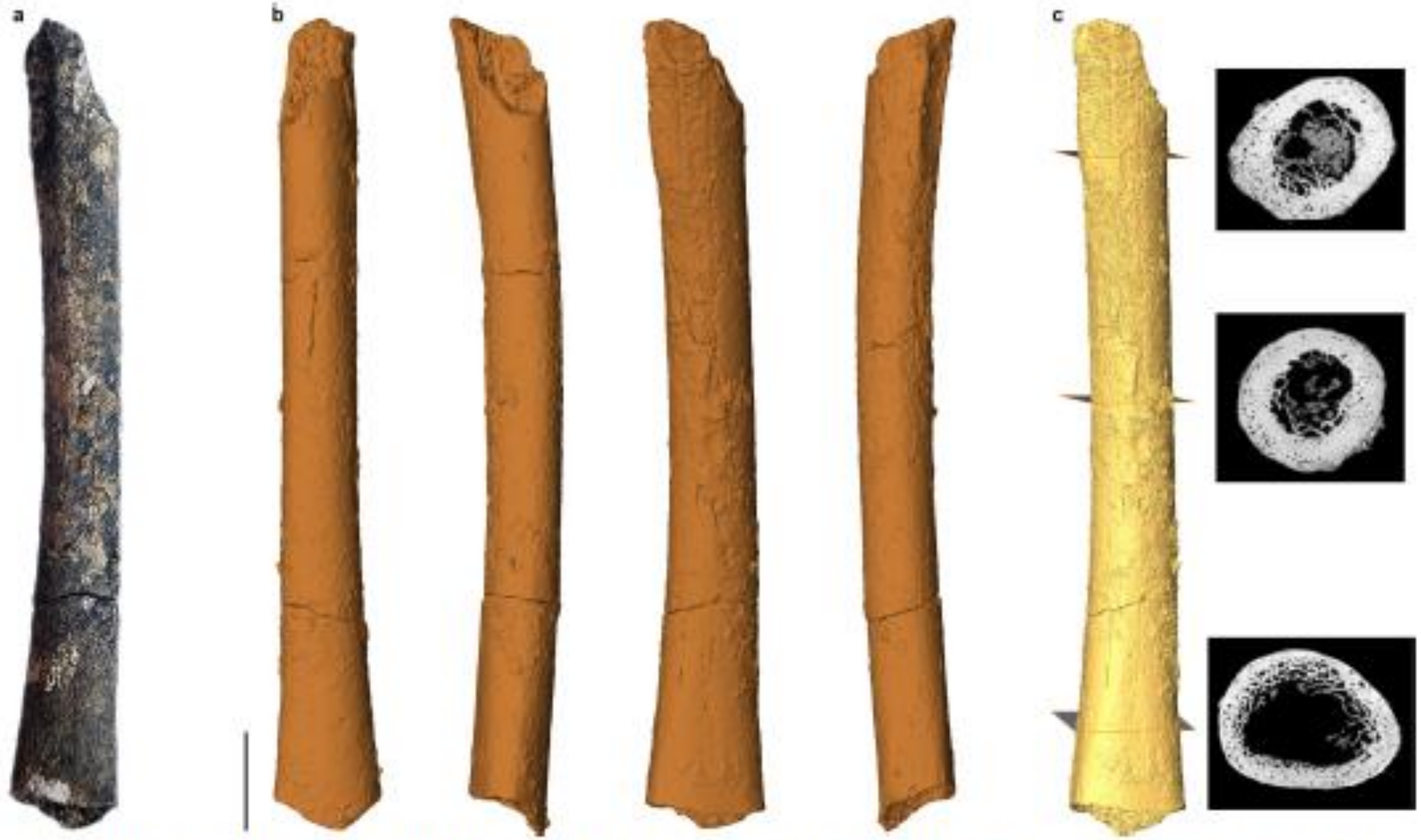


Shape of the toe bone is essentially indistinguishable from the toe bones of *Australopithecus afarensis* and *Australopithecus africanus*


use (k)

2019: *Homo Luzonensis*, *50*-67 Ka, Callao Cave, Luzon, Philippines: Modern molars & ancient curved toes

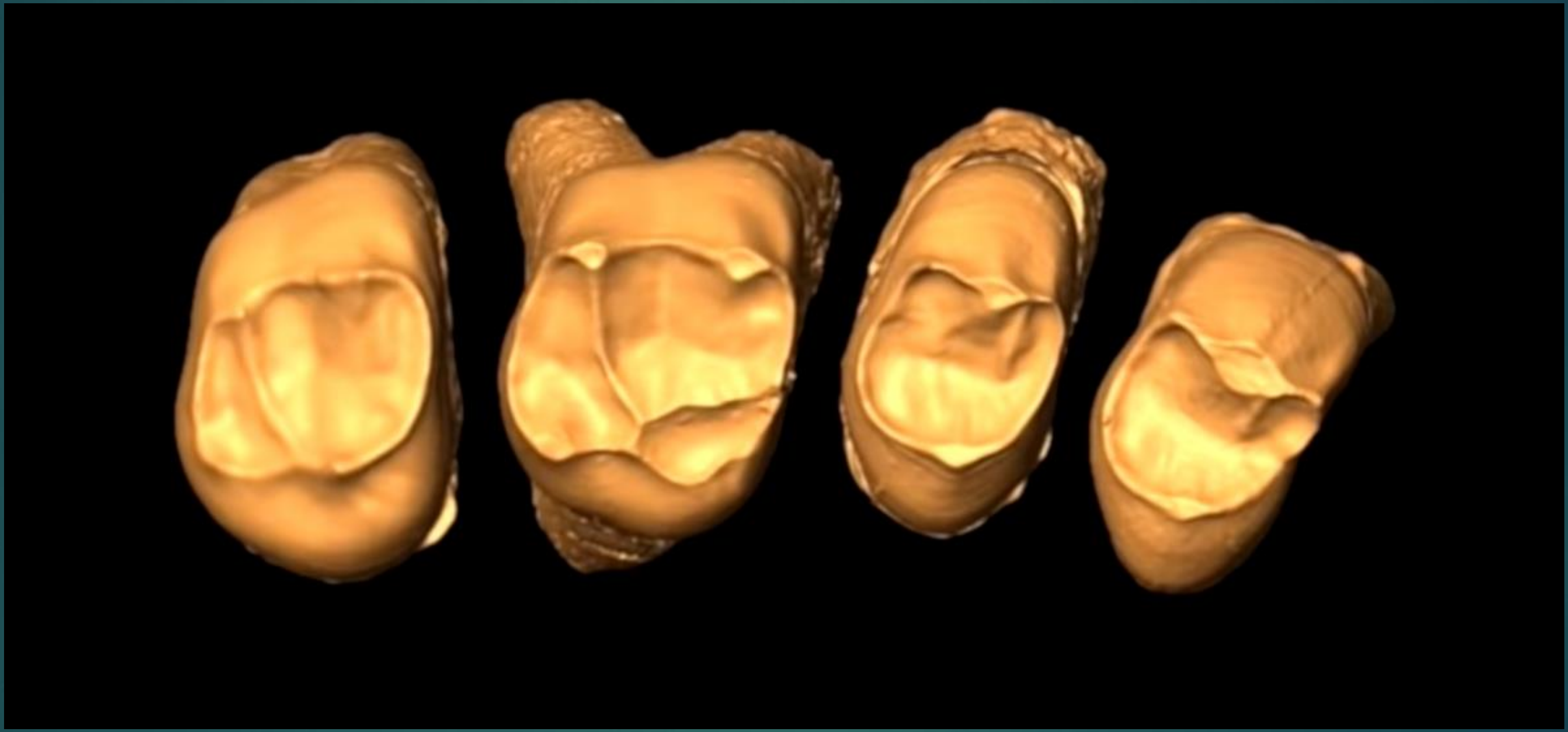
- 3 individuals/13 specimens
- a: Type specimen: CCH6, maxillary right postcanine dentition of a single individual discovered in 2011
- Modern molars & ancient curved finger & feet bones
- 1 juvenile femur bone
- 4 feet tall?



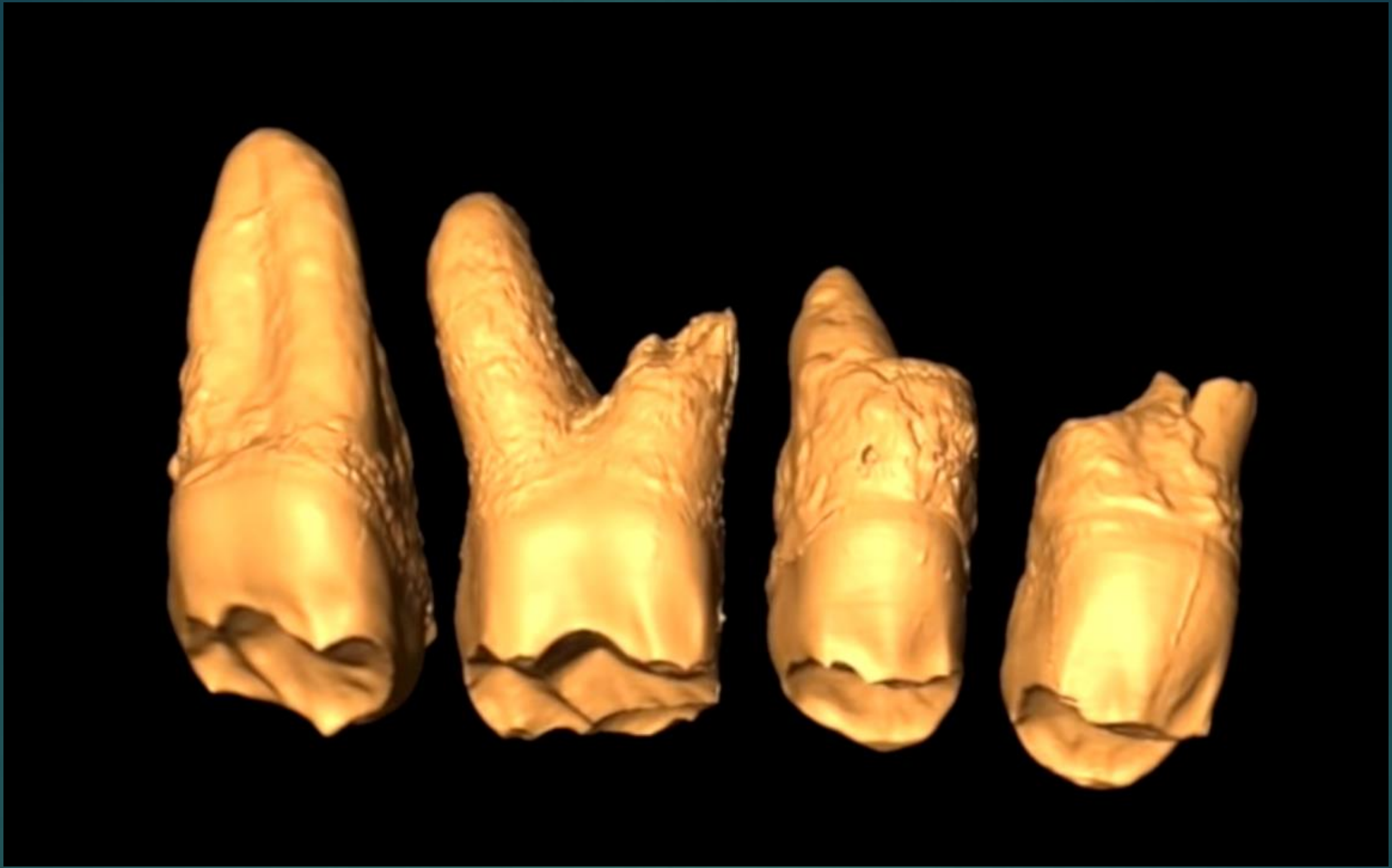
Extended Data Fig. 10 | CCH7, femoral shaft of a juvenile individual of *H. luzonensis*. **a**, Photograph of the original specimen CCH7 (posterior aspect). **b**, Three-dimensional rendering of CCH7. From left to right: anterior, medial, posterior and lateral aspects. Scale bar, 20 mm. **c**, Transverse micro-CT slices of CCH7 at proximal diaphysis (top), midshaft (middle) and distal diaphysis (bottom), and posterior aspect of the three-dimensional rendering of the femoral shaft, during the segmentation process (orientation of slices: anterior is up, posterior is down, lateral is left, medial is right).

Juvenile femur

Teeth



Teeth



The teeth have a peculiar shape. Some of the front teeth had three roots, whereas those of our species usually only have just one. And the teeth were tiny. D. Argue: These adult teeth are smaller than any hominin known,

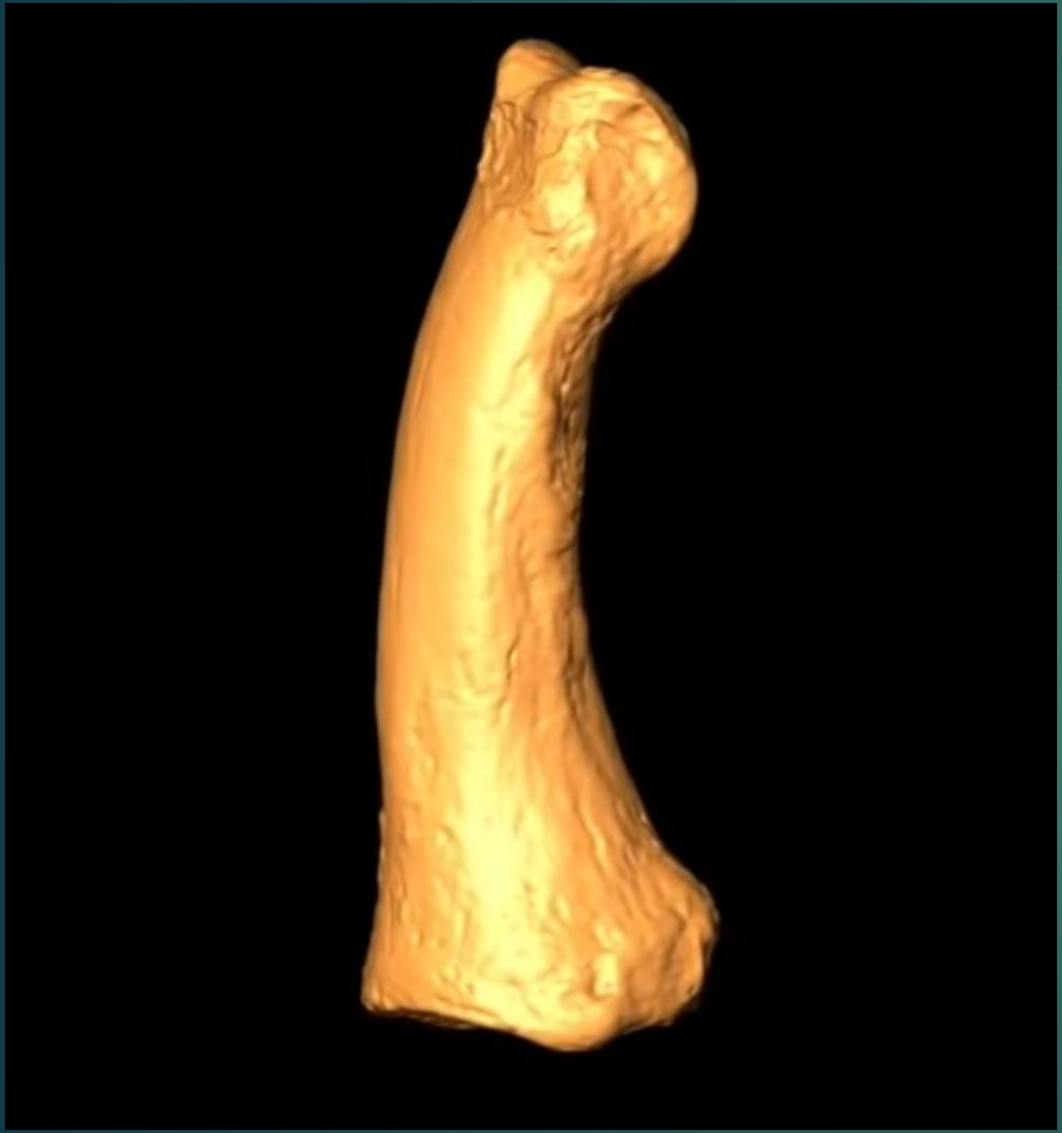
Finger bone

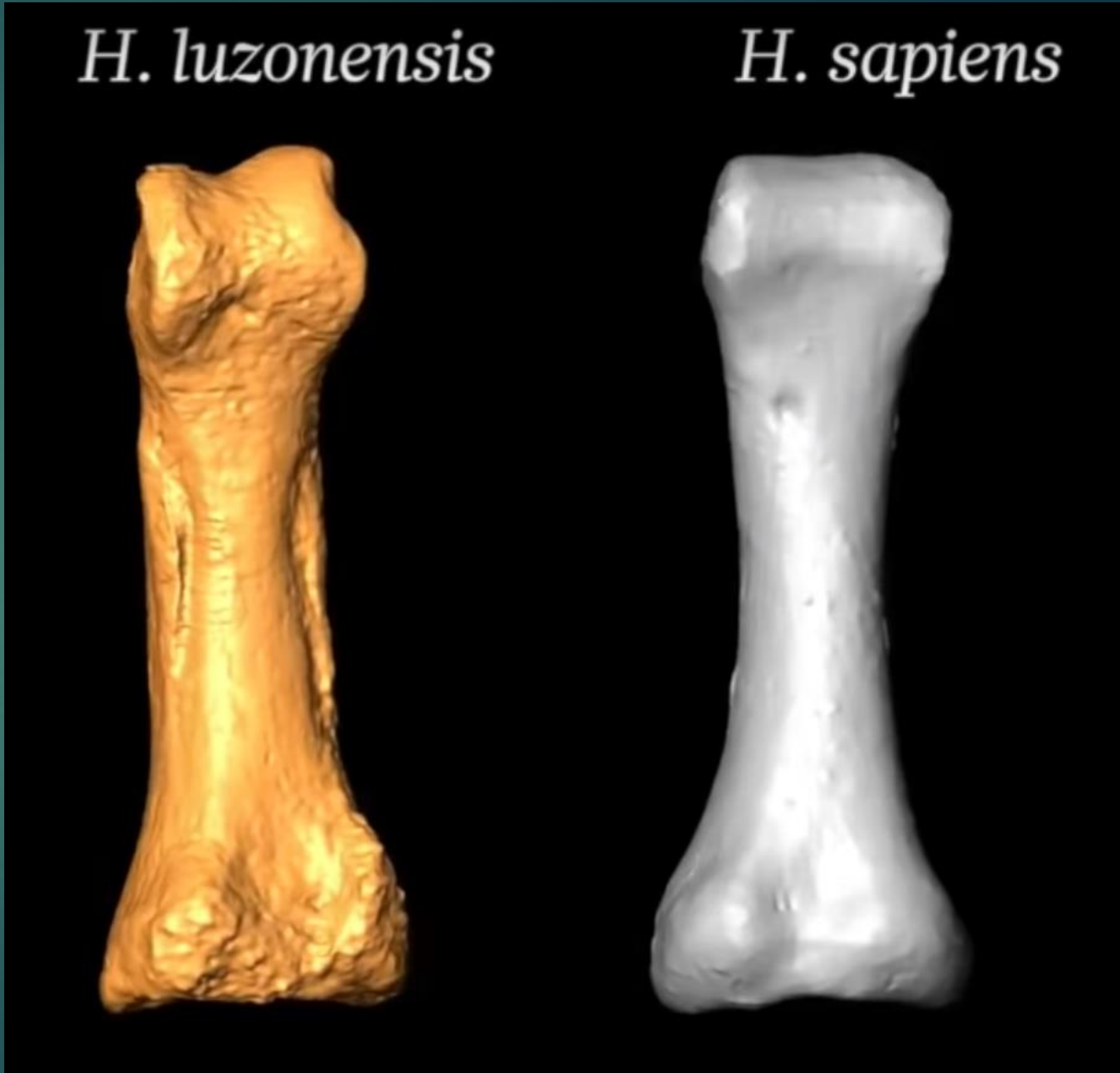
- *H. luzonensis* finger bone most resembles the finger bones of australopiths and species of early *Homo*.
- *H. luzonensis* finger and toe bones are curved, an adaptation to climbing

- We have yet another hominin species that, like *H. floresiensis*, was around 66 Ka, had *Homo*-like teeth but australopith-like hands and feet, and that lived on an island only reachable after a major sea crossing.

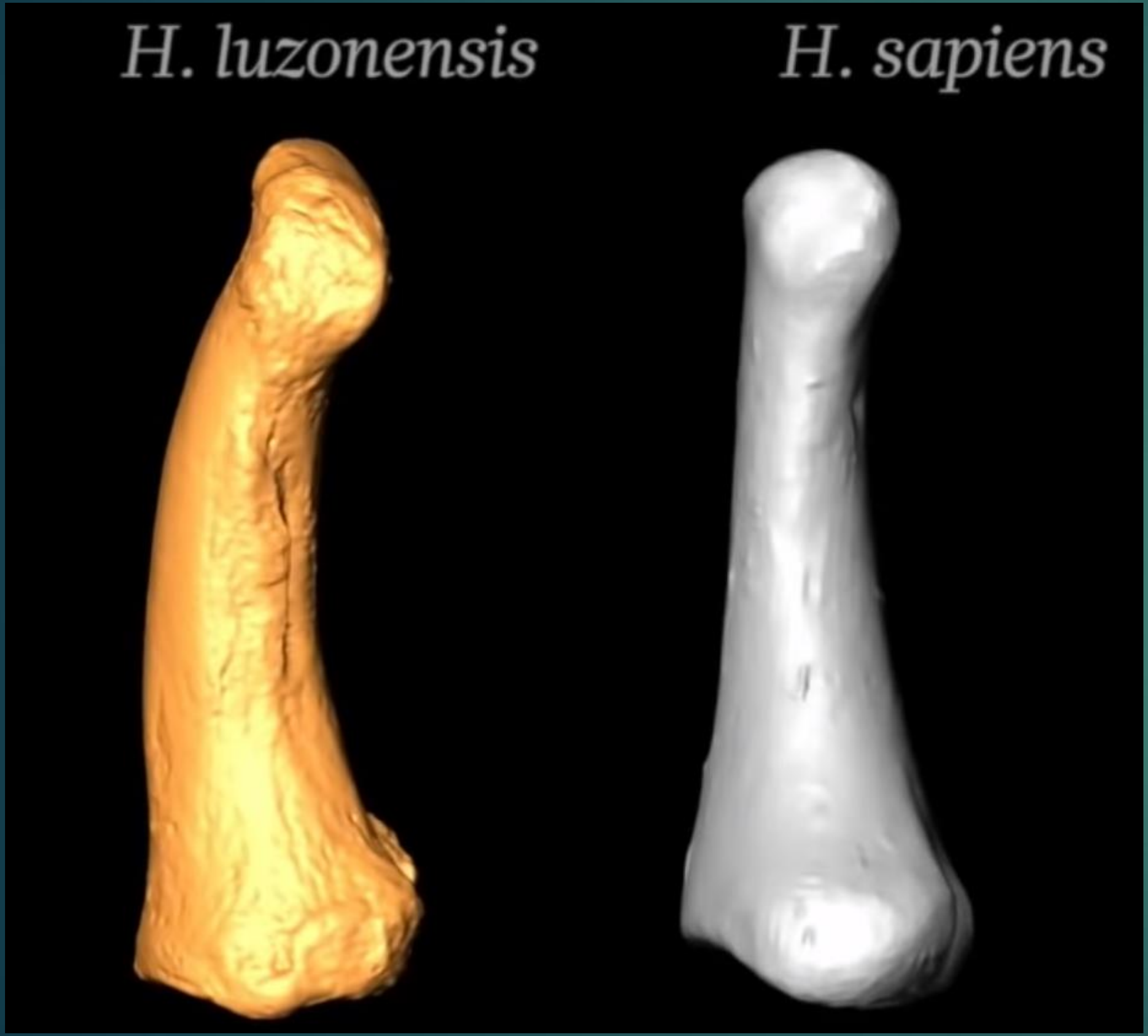
- Perhaps *H. floresiensis* and *H. luzonensis* are both descendants of *H. erectus* populations that evolved separately on their respective islands for hundreds of thousands of years.

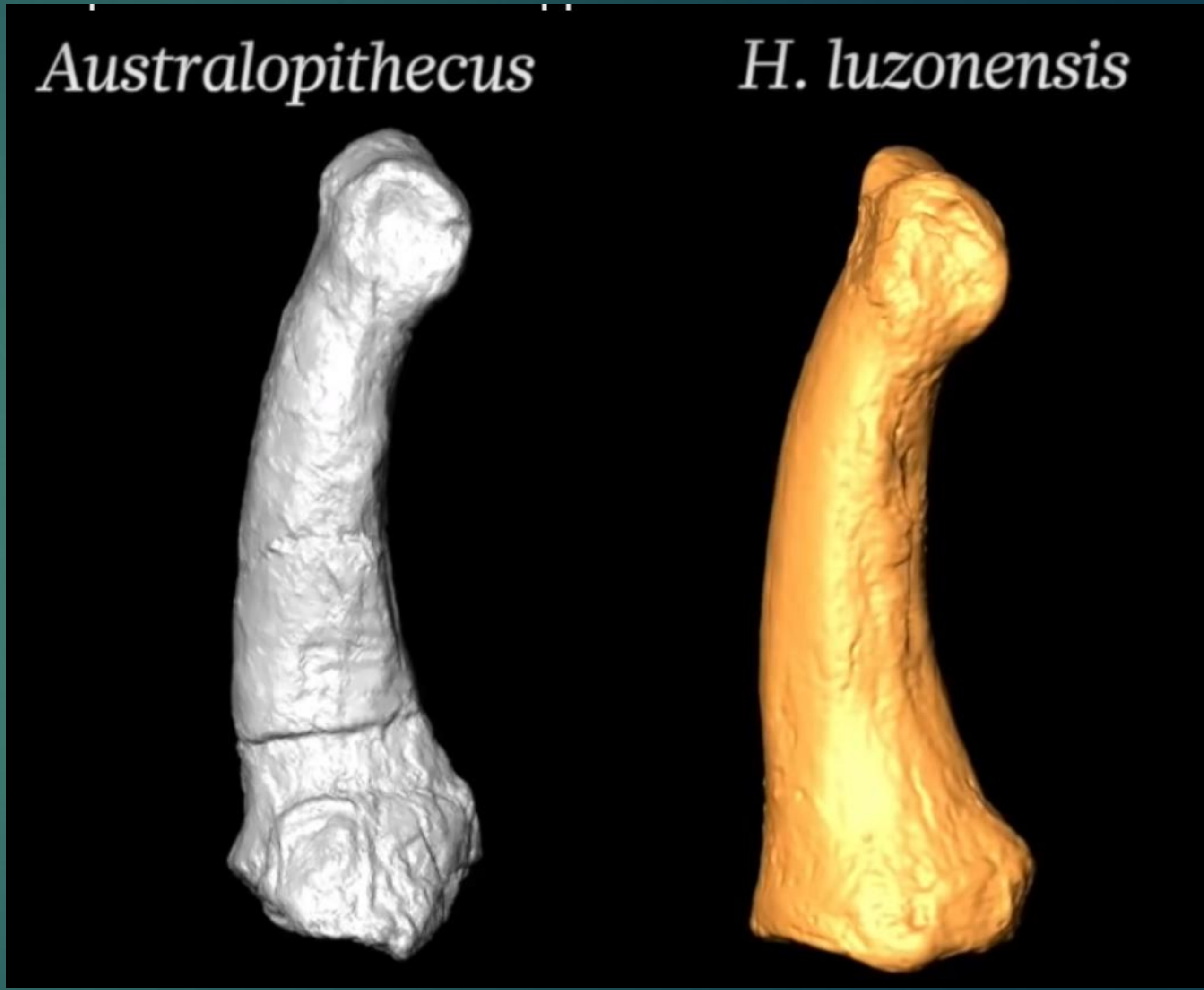
Curved Finger



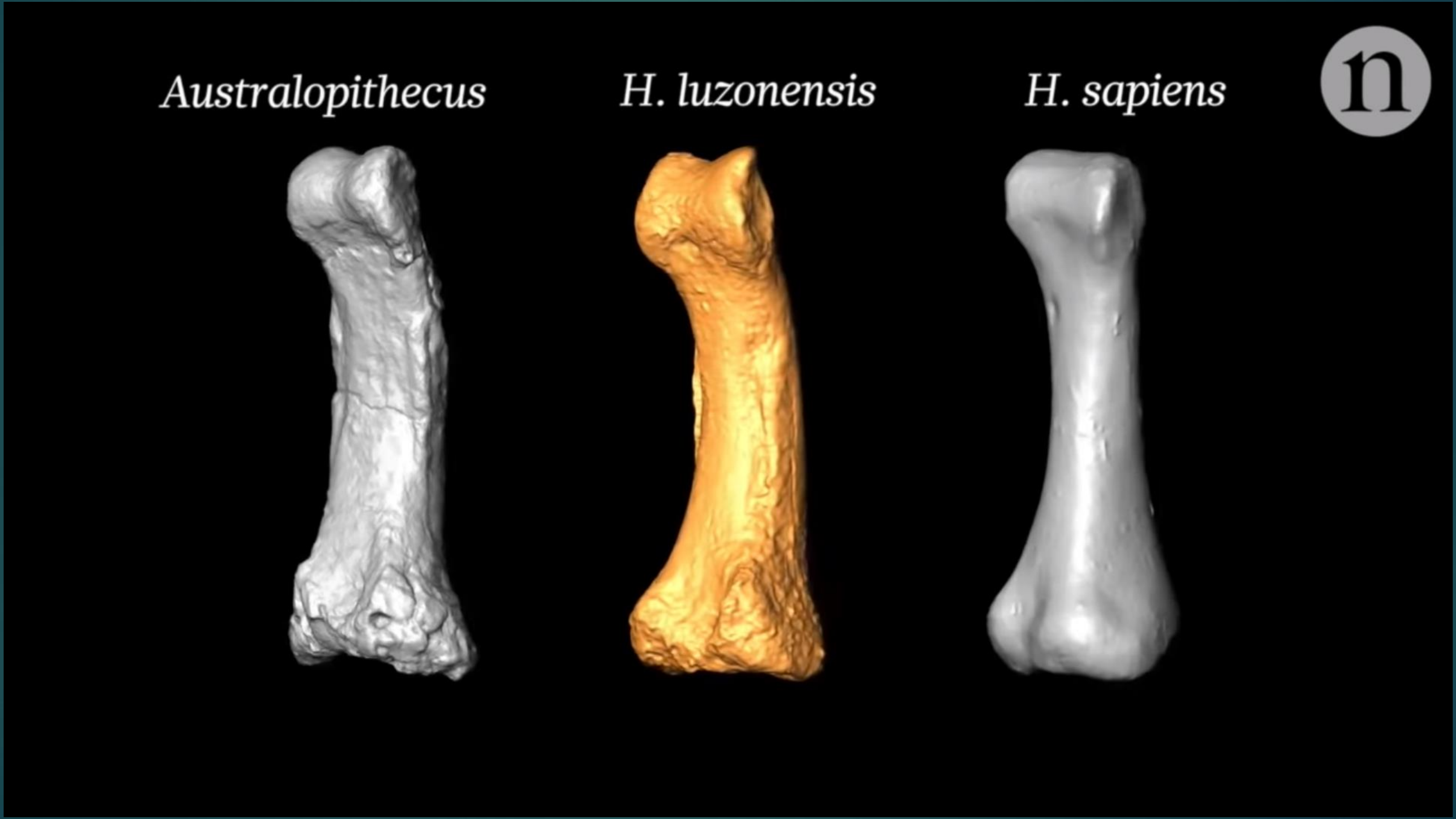


Curved Finger





Fingers



What if….

- Given the rich history of the Out of Africa I paradigm, *H. erectus* has been the center of attention in ideas about early hominin evolution and dispersals in Asia.
- Nevertheless, it is worth considering how different these ideas might be if, in the 1890s, *H. floresiensis* or *H. luzonensis* had been discovered rather than *H. erectus*.

Height

- The researchers are cautious about estimating *H. luzonensis*' height, because there are only a few remains to go on.

- But given its small teeth, and the foot bone reported in 2010, Détroit thinks that its body size was within the range of a small *H. sapiens*, such as members of some Indigenous ethnic groups living on Luzon and elsewhere in the Philippines today, sometimes known collectively as the Philippine Negritos.

- Men from these groups living in Luzon have a recorded mean height of around 151 centimeters (4' 9") and the women about 142 centimeters.

Origins: still controversy

- Détroit favors the view that the new species descends from a *H. erectus* group

- *Homo erectus* may have been the ancestor of the tiny hominins on both Flores and Luzon — perhaps swept to the islands by storms, clinging to trees. But others disagree with this interpretation.

- You get different evolutionary pathways on islands," says paleontologist Gerrit van den Bergh at the University of Wollongong in Australia. "We can imagine *H. erectus* arrives on islands like Luzon or Flores, and no longer needs to engage in endurance running but needs to adapt to spend the night in trees."

- Given the species' similarities to *Australopithecus*, Tocheri wonders whether the Callao Cave dwellers descended from a line that migrated out of Africa before *H. erectus*.

Southeast Asia

- Taken alongside the remains from Flores and Luzon, the sites suggest that ancient hominin dispersal throughout the region wasn't necessarily so rare—or as accidental—as researchers once thought.
- “If rhinos can swim and get to places, certainly we can think of *erectus*, *floresiensis*, and *luzonensis* not necessarily just swimming but at least rafting, if not boating,” Petraglia says. “It's just pure speculation, but you could posit that and make some convincing arguments.”
- One thing remains clear: Southeast Asia probably was home to more hominin species than current fossils let on.
- For his part, Mijares is continuing to look for other signs of *H. luzonensis,* including a current search at Luzon's Biak na Bato National Park

The exciting Southeast Asia

- In **Kalinga, north of Luzon** , evidence of human presence was recovered with a formidable dating of 631-777 Ka *:* 400 rhinoceros bones (13 with cutting marks) and 57 lithic tools.

- On the island of **Sulawesi, Indonesia** , lithic tools have been found in Talepu, southwest, at 85-120 Ka (some to levels of more than 200 Ka),

- In Leang Burung 2 tools at 50 Ka

- Cave paintings in Leang Timpuseng south of antiquity corresponding to *Homo sapiens:* between 35 and 39 Ka (contemporary to the oldest cave El Castillo, Spain).

Critiques: Anton and Wood

- New York University anthropologist Susan Anton, an expert on *Homo erectus*, was skeptical the remains came from a new species. The study authors “don’t have any heads,” said Anton, who described herself as “somewhat conservative and somewhat of a lumper.”
- The small stature of *H. luzonensis* could also cause some traits of the bones to appear more primitive than they truly are, says John Hawks. he thinks the case for a new species is reasonable, his overall take is: “I really wish there were more bones.”
- Bernard Wood: There could be other explanations for the unique combination of tooth features, he says. The group of individuals that reached Luzon was likely a random assortment of genotypes. With inbreeding over time, genetic drift could have pushed them to develop the unique characteristics that Détroit and his colleagues observed. So there’s a possibility that the remains represent merely an unusual island population of individuals, rather than a new species. “it’s hard to tell whether this is a primitive-looking, relatively modern hominin, or an older hominin whose molars happen to have become like the molars that you would see" in modern humans.”

Evidence that Evolution is not linear

- *Homo floresiensis* and *H. luzonensis* reminds us that evolution is not linear.

- And even though we've seen a linear pattern in previous hominin brain size growth patterns and associated archaeological complexity, it is possible a smaller brained hominin also evolved simultaneously.

- It continues to challenge the outdated idea that the human line neatly progressed from less advanced to more advanced species.

The Philippines

- The Philippines is made up of a group of large islands that have been separated long enough to have potentially facilitated archipelago speciation.
- There is no reason why archaeological research in the Philippines couldn't discover several more species of hominin.
- It's probably just a matter of time.

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