Hobbits and Komodo Dragons

2015 Expedition to Flores Island
of Eastern Indonesia

Synopsis—XMAS visit December 2015

- Investigate two controversial issues:
  a) Identity of LB1, aka the “Hobbit”, a new potential archaic member of genus Homo.
  b) Validity of contention that Komodo dragons kill prey via induction of sepsis via oral bacteria.

- Photo-documentation of local people
- Visit hospitals, clinics and pharmacies
- Investigate potential humanitarian project(s)

Indonesian Collaborator

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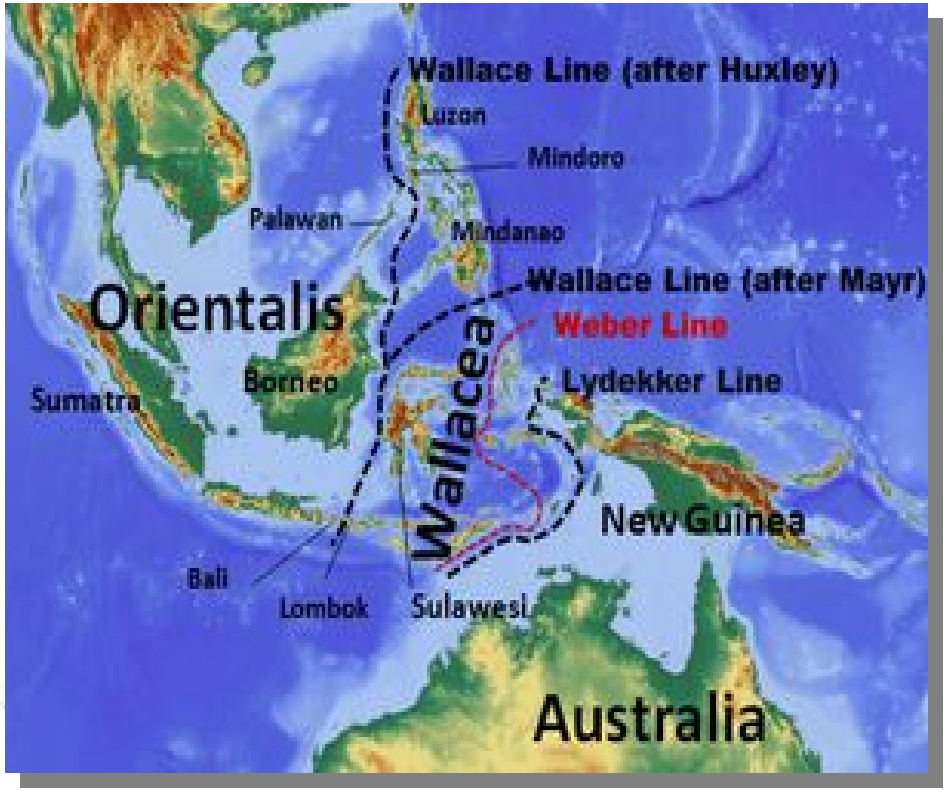
Flores island, Indonesia

Republic of Indonesia – largest Islamic nation

Population:	255,461,700 (4th)
Size:	735,358 sq mi. (15th); >14000 islands!
Capital:	Jakarta
GDP (per capita):	$3,511 (117th)
Government:	Unitary presidential constitutional republic

Indonesia: >14,000 islands



Wallace's Line

Biogeograpical faunal boundary line drawn in 1859 by the British naturalist Alfred Russel Wallace (Darwin's co-discover of *Natural Selection*).

Separates ecozones of Asia and Wallacea, transitional zone between Asia and Australia.

West of line: organisms related to Asiatic species; **East:** mixture of species of Asian and Australian origin.

Labuan Bajo, Flores

Port city for eastern Flores, fishing fleet
Gateway to Komodo National Park via boat (west)
Four hr. overland to Liang Bua cave (east)

Orientation

Komodo National Park

Sights on Flores Island

1.8M inhabitants
13.5 km^2

Fishing, seaweed production, rice, maize, sweet potato and cassava.

Cash crops -- coffee, coconut, candle nut and cashew.

District hospital in Labuan

No X-ray, limited surgery: refer to Ruteng, 3+ hr by jeep

Priority given to basic perinatal care

Primitive lab and pharmacy: major needs

Regional Hospital in Ruteng

Referrals from western Flores
Modest surgery, ICU
X-ray facility
50 beds
Predominantly Roman Catholic

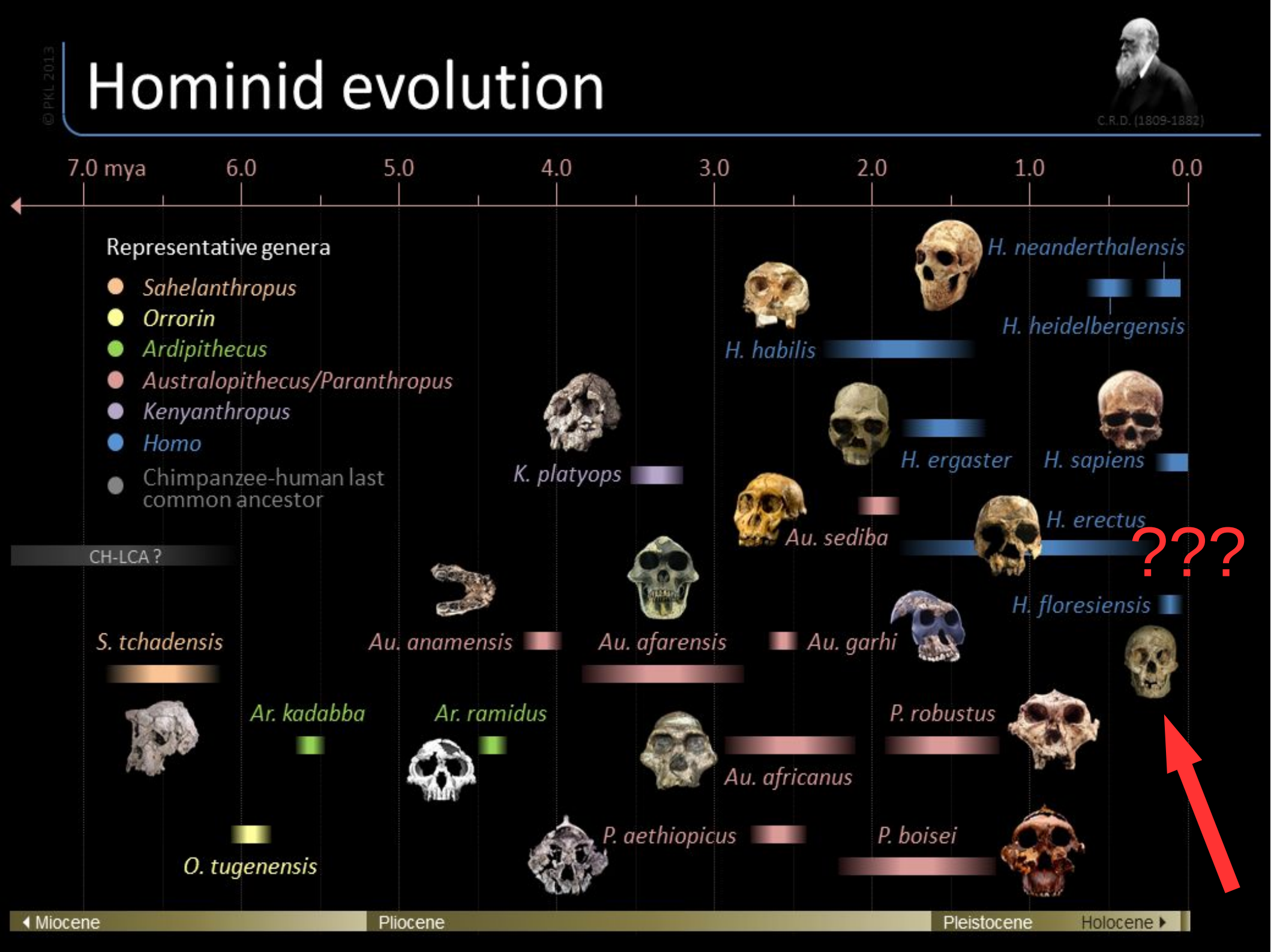
Man bitten by green tree snake: hemorrhagic diathesis

Green tree snake: ***aka*** **White-lipped pit viper** (***Trimeresurus albolabris***) venomous pit viper species endemic to Southeast Asia.

Narrative Fallacy #1:

Where does the “Hobbit” of Liang Bua Cave, Flores, Indonesia”, aka LB1 belong on the family tree of genus Homo?

Hominid evolution



Putative classification

Kingdom:	**Animalia**
Phylum:	**Chordata**
Class:	**Mammalia**
Order:	**Primates**
Family:	**Hominidae**
Tribe:	**Hominini**
Genus:	***Homo***
Species:	***H. floresiensis***


WELCOME TO LIANG BUA
SELAMAT DATANG DI LIANG BUA


Liang Bua cave
Flores
P. Sangeang
G. Api
P. Seraya Besar
P. Komodo
Komodo Nat. P.
P. Rinca
Ruteng
Reo
Bajawa
P. Loren
Sel. Sumba


SITUS LIANG BUA

Homo floresiensis ("Flores Man"; nicknamed "hobbit" and "Flo")

Discovered in 2003.

Extinct species widely believed to be in the genus *Homo*.

Partial skeletons of 9 individuals recovered, including one complete skull, referred to as "LB1".

This hominin is remarkable for its **small body** and **brain** and for its **survival until relatively recent times (~12,000 y ago).**

Is *H. floresiensis* a species distinct from modern humans!

Hobbit vs. Modern Human Skull

Liang bua cave hominoids

Limestone cave

Skeletons, date from 38,000 to 13,000 years ago.

An arm bone provisionally assigned to *H. floresiensis* is about 74,000 years old.

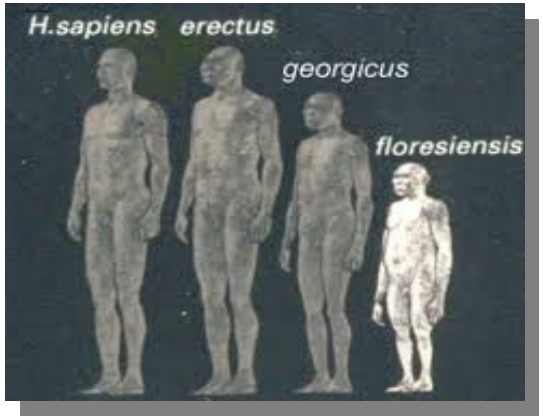
Specimens are not fossilized and have been described as having "the consistency of wet blotting paper"; once exposed, the bones must be left to dry before they could be dug up.

Issues:

- Small body size, causes?
- Small brain size, relationship to genus Homo?
- Recent occupation of site, modern human neighbors?

LB1 near-complete skeleton

Small body size



LB1's height is ~1.06 m (3 ft 6 in).
LB8, height is ~1.09 m (3 ft 7 in) based tibia.

BOTH – Outside range of nl. modern human height:

Smallest modern humans, Mbenga and Mbuti (< 1.5 m (4 ft 11 in)),Twa, Semang (1.37 m (4 ft 6 in) for adult women) of the Malay Peninsula,or the Andamanese (1.37 m (4 ft 6 in) for adult women.

By body mass, differences between modern pygmies and *Homo floresiensis* are even greater.

LB1's body mass has been estimated at 25 kg (55 lb): **smaller than** that of not only modern *H. sapiens*, but also *H. erectus*

LB1 and LB8 are also somewhat smaller than the ***australopithecines*** from three million years ago, not previously thought to have expanded beyond Africa.

Thus, LB1 and LB8 may be the shortest and smallest members of the extended human family discovered thus far.

Perhaps LB1 is related to the "pygmy people" of nearby Flores village, Rampasasa?

Nearby “Pygmy” village of Rampasasa*

1929 Biljmer study – >50% residents of region had body height of about 155 to 163 cm.

Today: 77 families

80% of Rampasasa inhabitants classified as “pygmy”.

10 people ~155 cm; 2 of ~160 cm, married residents outside of the village.

Victor Jehabut
80-year-old, 4' height

***Waemulu region, Waeriri subdistrict, Manggarai regency, south Flores**

Modern populations of small size

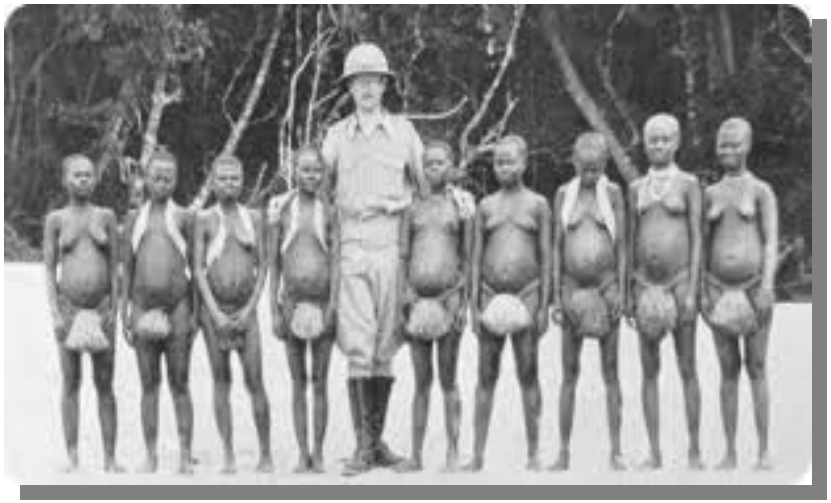
Definition: Adult men on average <150 cm (4 feet 11 inches) tall.

AFRICA – "Pygmies", ~500,000

Mbenga (Aka and Baka) of the western Congo basin, speak Bantu and Ubangian languages.
Mbuti (Efe etc.) of the Ituri Rainforest, speak Bantu and Central Sudanic languages.
Twa of the African Great Lakes, speak Bantu Rundi and Kiga.

SOUTHEAST ASIA – "Negritos"

Batak and **Aeta** of Philippines.
Andamanese of Andaman Islands.
Semang of Malay peninsula.



Insular dwarfism?

Aside from smaller body size, the specimens seem otherwise to resemble *H. erectus*, a species known to have been living in Southeast Asia at times coincident with earlier finds purported to be of *H. floresiensis*.

Observed similarities form basis for suggested phylogenetic relationship. Controversially, the same team has reported finding material evidence (stone tools) on Flores of a *H. erectus* occupation dating back 840,000 years ago, but not remains of *H. erectus* itself or transitional forms.

To explain the small stature of *H. floresiensis*, Brown *et al.* have suggested that in the limited food environment on Flores, *H. erectus* evolved a smaller body size via insular dwarfism,

This form of speciation observed in other species on Flores – including several species of the proboscidean genus *Stegodon*, an elephant-like creature. (A dwarf stegodont species of Flores, *Stegodon sondaari*, went extinct by about 850,000 years ago and was replaced by another species of normal size, *Stegodon florensis*, which then also evolved into a dwarf form, *Stegodon florensis insularis*, which disappeared about 12,000 years ago.)

Insular dwarfism (II)

- Brain-to-body mass ratio of LB1 lies between that of *H. erectus* and the great apes.
- **Insular dwarfism** posited to explain LB1 brain size reduction.
- **EXAMPLE:** Scientists at Natural History Museum (London) documented that eduction in brain size of extinct pygmy hippopotamuses in Madagascar compared with living relatives is <u>greater than</u> the reduction in body size, and similar to the reduction in brain size of *H. floresiensis* compared with *H. erectus*.

Recent survival

- Survival on Flores at least until ~12,000 y ago – longest lasting non-*H. sapiens* human, surviving long past the Neanderthals (*H. neanderthalensis*), which became extinct between 39,000 and 41,000 years ago.

- Because of a deep neighbouring Lombok strait, Flores remained isolated during the Wisconsin glaciation (the most recent glacial period), despite the low sea levels that united Sundaland.

- Species, or its ancestors, could only have reached the isolated island by water transport, perhaps arriving in bamboo rafts around 100,000 years ago (or, if they are *H. erectus*, then about 1 million years ago).

- At this time the islands of Komodo and Flores were joined, leaving a 12-mile-wide (19 km) strait to be crossed with Komodo visible from the mainland.

- Idea of *H. floresiensis* using advanced technology and cooperation on a modern human level has prompted the discoverers to hypothesize that *H. floresiensis* almost certainly had language.

- Volcanic eruption on Flores ~12,000 years ago responsible for demise of *H. floresiensis*, along with other local fauna, including the elephant *Stegodon*.

Small brain, different wiring?

- LB1 brain volume of 380 cm^3 (23 cu in), in the range of chimpanzees or the extinct australopithecines.

- *H. erectus* is 980 cm^3 -- (60 cu in).

- Anatomically modern humans – 1,310–1,475 cm^3 (79.9–90.0 cu in).

- Size of Brodmann's area 10, the dorsomedial prefrontal cortex, an area of the brain associated with higher cognition.

  HOWEVER, LB1's region 10 is about the same size as that of modern humans, despite the much smaller overall size of the brain!

- Discoverers claim associated it exhibited “advanced behaviors”:

- Cave shows evidence of the use of fire for cooking, and *Stegodon* bones associated with the hominins have cut marks.

- Some of these tools were apparently used in the necessarily cooperative hunting of *Stegodon* by these hominins.

Alternative skeptical hypotheses!

Numerous authors have disputed archaic origin of *H. floresiensis* – *suggesting instead LB1 is a modern human suffering from one malady or another!*

Microcephaly hypothesis (2006)

Laron syndrome hypothesis (2006)

Endemic cretinism hypothesis (2008)

Insular dwarfism hypothesis (2006)

Down syndrome hypothesis (2014)

Still hotly debated and unresolved!

Most recent "counter-hypothesis" in PNAS!

Evolved developmental homeostasis disturbed in LB1 from Flores, Indonesia, denotes Down syndrome and not diagnostic traits of the invalid species *Homo floresiensis*

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Contributed by Kenneth J. Hsü, May 14, 2014 (sent for review November 21, 2013; reviewed by Alan G. Fix, Robert G. Bednarik, and Judith Hall)

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

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Other unusual finds from Liang Bua: Giant storks and dwarf elephants

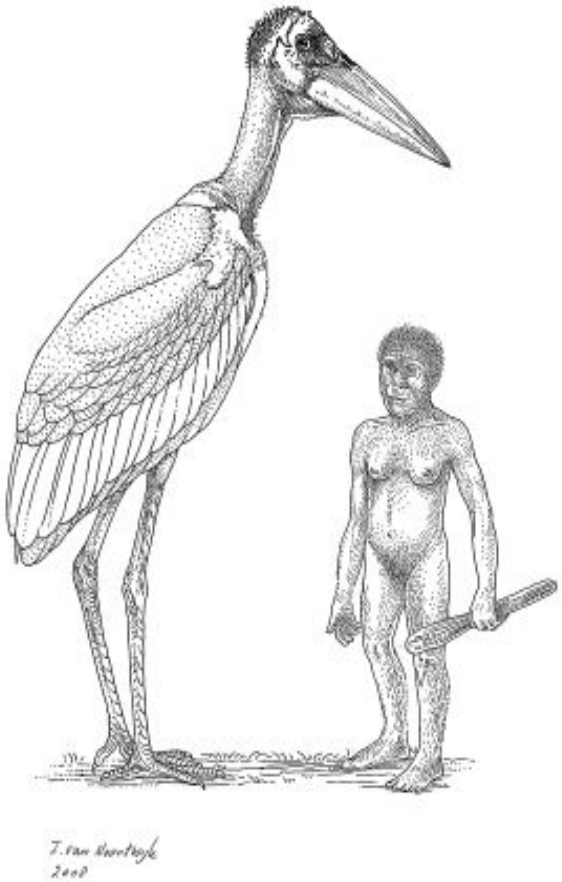


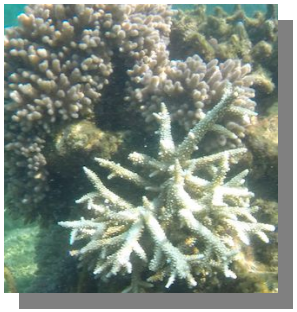
Figure 12. Artist's impression of the size of ***Leptoptilos robustus* sp. nov.** (estimated at 1.8 m) compared to *Homo floresiensis* (estimated at 1.0 m). Drawing by I. van Noortwijk.

Stegodon florensis insularis is an extinct subspecies of *Stegodon* endemic to the island of Flores, Indonesia: an example of insular dwarfism.


Largest living lizard
>2200 Komodo dragons
on Komodo island

Travel to Komodo National Park: Rinca and Komodo islands

10x marine diversity of Caribbean!



Komodo Island

Komodo Dragon
Varanus komodoensis

Range: Indonesian islands: Komodo, Rinca, Flores, Gili Motang, Padar.

Monitor lizard family Varanidae

Largest living lizard, max. length ~ 3 m (10 ft), weight of 70 kg (150 lb).

Dominate the ecosystems in which they live: hunt and ambush prey including invertebrates, birds, and mammals.

Group behavior in hunting is exceptional in the reptile world.

Occasionally attack humans.

Komodo dragons were first recorded by Western scientists in 1910.

Range has contracted due to human activities, listed as vulnerable by the IUCN: protected under Indonesian law.

Komodo National Park, founded to aid protection efforts.

Large size?

Hypothesis #1: "Island gigantism"

- No other carnivorous animals fill the niche on the islands where they live.

Hypothesis #2: "Relic population of lizard magafauna"

- Populations of very large varanid lizards once lived across Indonesia and Australia, most of which, along with other megafauna, died out after the Pleistocene.
- Fossils very similar to *V. komodoensis* found in Australia dating to >3.8M yr. ago
- Body size remained stable on Flores over the last 900,000 years
- Last million years marked by major faunal turnovers, extinction of the island's megafauna, and the arrival of early hominids by 880 ka.

Mating

- Mating occurs between May and August, with eggs laid in September. During this period, males fight over females and territory by grappling with one another upon their hind legs, with the loser eventually being pinned to the ground.
- Males may vomit or defecate when preparing for the fight.
- Winner of fight will then flick his long tongue at the female to gain information about her receptivity.
- Females are antagonistic and resist with their claws and teeth during the early phases of courtship.
- Therefore, male must fully restrain the female during coitus to avoid being hurt. Other courtship displays include males rubbing their chins on the female, hard scratches to the back, and licking.
- Copulation occurs when the male inserts one of his hemipenes into the female's cloaca.
- Komodo dragons may be monogamous and form "pair bonds", a rare behavior for lizards.

Lifecycle--reproduction

- Female Komodos lay eggs from August to September using several types of locality.

- in one study, 60% eggs laid in nests of orange-footed scrubfowl (a moundbuilder or megapode), 20% on ground level and 20% in hilly areas.

- Females make many camouflage nests/holes to prevent other dragons from eating the eggs.

- Clutches contain an average of 20 eggs, which have an incubation period of 7–8 months.

Young dragons

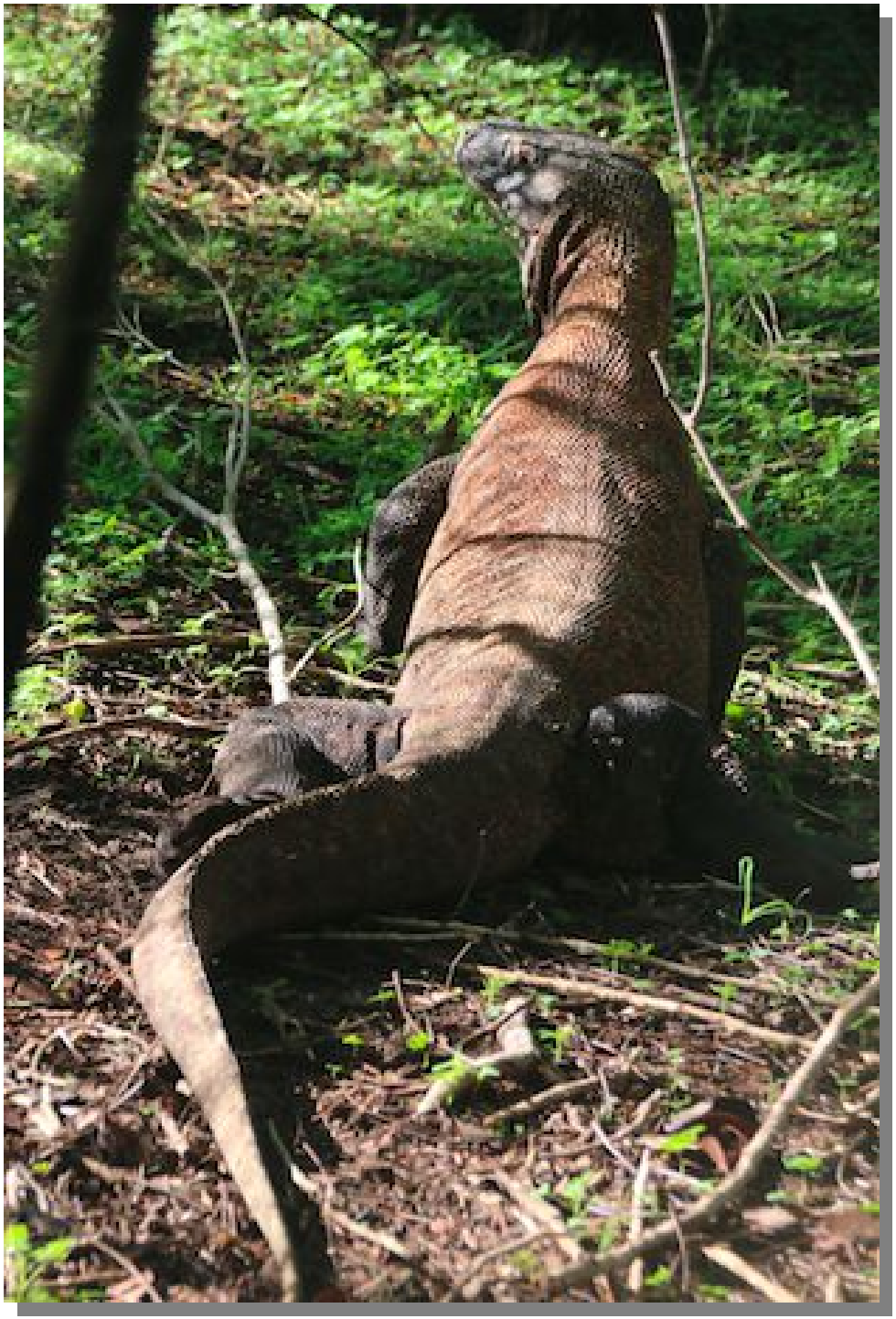
Hatching is an exhausting effort for the neonates, which break out of their eggshells with an egg tooth that falls off soon after. After cutting themselves out, the hatchlings may lie in their eggshells for hours before starting to dig out of the nest. Born quite defenseless and are vulnerable to predation . Sixteen youngsters from a single nest were on average 46.5 cm long and weighed 105.1 gm.

Young Komodo dragons spend much of first few years in trees, where they are safer from predators, including cannibalistic adults, as juvenile dragons make up 10% of their diets.

Habit of cannibalism may be advantageous in sustaining the large size of adults, as medium-sized prey on the islands is rare.

When the young approach a kill, they roll around in faecal matter and rest in the intestines of eviscerated animals to deter hungry adults.

Komodo dragons take approximately three to five years to mature, and may live for up to 50 years.



Dragons molt in patches

Parthenogenesis!

- ZW chromosomal sex-determination system, vs. mammalian XY system.

- Female Komodo dragon (with ZW sex chromosomes) provides progeny with only one chromosome from each of her pairs of chromosomes, including only one of her two sex chromosomes. **This single set of chromosomes is duplicated in the egg, which develops parthenogenetically.**

- Eggs receiving a Z chromosome become ZZ (male); those receiving a W chromosome become WW and **fail to develop**, thus only males are produced.

- Allows **single female** to enter an isolated ecological niche (such as an island) and by parthenogenesis produce male offspring, thereby establishing a sexually reproducing population (via reproduction with her offspring that can result in both male and female young).

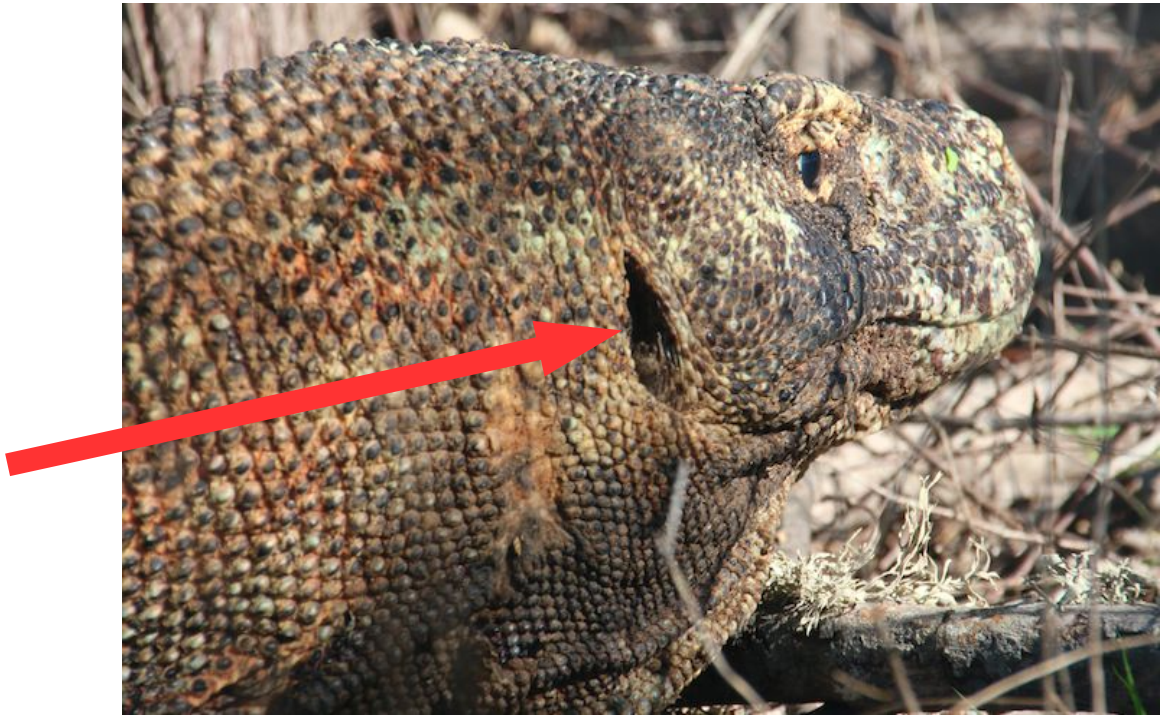
Dragon Senses (I)

Hearing (arrow) --only a single ear bone, the stapes, for transferring vibrations from the tympanic membrane to the cochlea.

Restricted to sounds in the 400 to 2,000 hertz range,

Thought to have poor night vision: retina only contains cones,

Probably sees in color, but poor visual discrimination of stationary objects.



Senses (II)

Tongue used detect, taste, and smell stimuli, like other reptiles, with the vomeronasal sense using the Jacobson's organ, rather than using the nostrils.

With the help of a favorable wind and its habit of swinging its head from side to side as it walks, a Komodo dragon may be able to detect carrion from 4–9.5 km (2.5–5.9 mi) away.

Has a few taste buds in the back of its throat.

Scales, some of which are reinforced with bone, have sensory plaques connected to nerves to facilitate sense of touch.

Scales around the ears, lips, chin, and soles of the feet may have three or more sensory plaques.

Dragon hunting

- Ambush live prey: suddenly charge at the animal and go for the underside or the throat.
- Locate prey using keen sense of smell, purportedly can locate dead or dying animal up to 9.5 km (5.9 mi).
- Have been observed knocking down large pigs and deer with their strong tails.
- Eat by tearing large chunks of flesh and swallowing them whole while holding the carcass down with their forelegs.
- Smaller prey up to the size of a goat: loosely articulated jaws, flexible skulls, and expandable stomachs allow them to swallow prey whole.
- Vegetable contents of stomach and intestines are avoided.
- Copious red saliva helps to lubricate the food, but swallowing is still a long process (15–20 minutes to swallow a goat).
- May attempt to speed up the process by ramming the carcass against a tree to force it down its throat, sometimes ramming so forcefully, the tree is knocked down.

Dragon chow

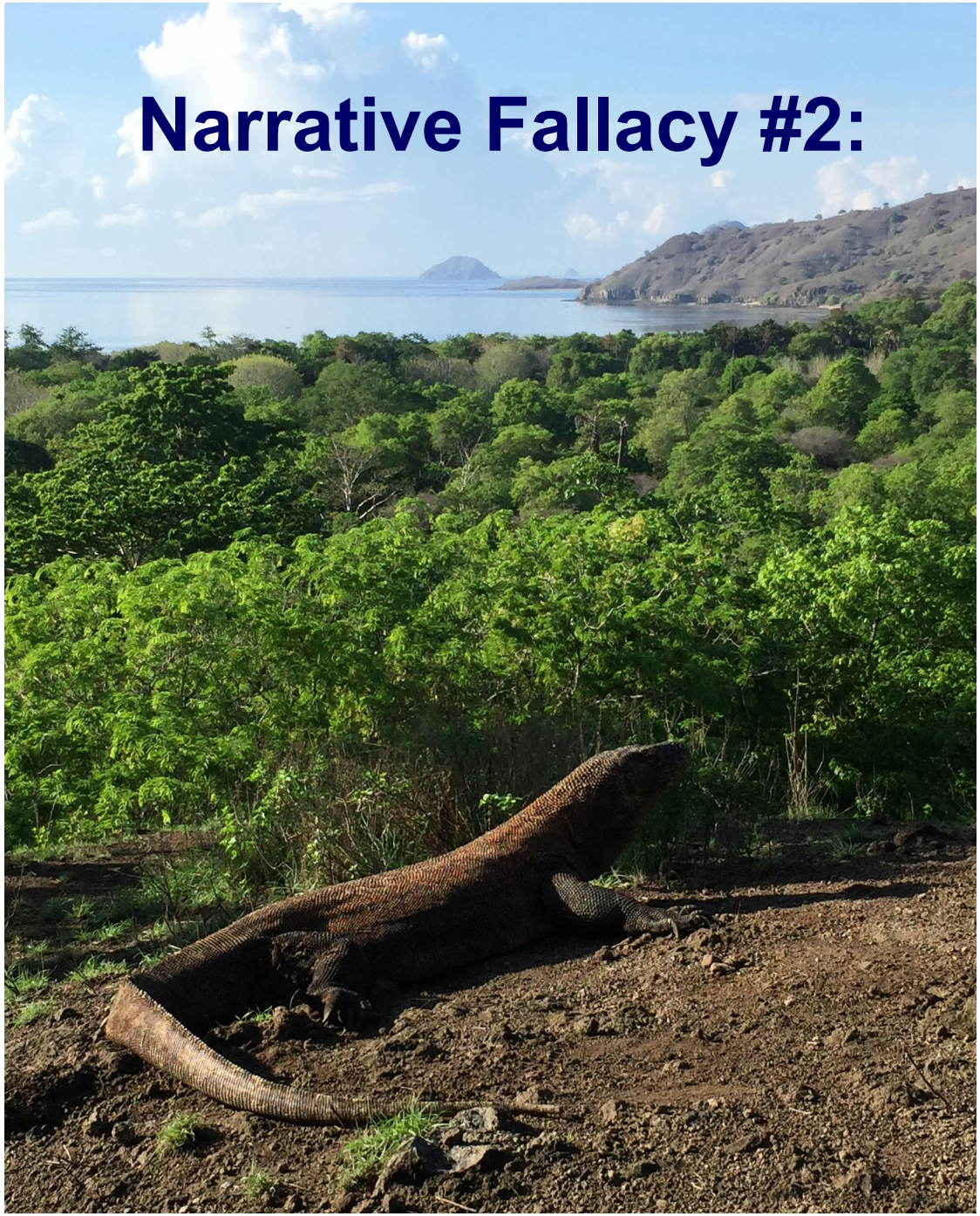
Wild water buffalo

Dragon hunting (II)

- To prevent itself from suffocating while swallowing, it breathes using a small tube under the tongue that connects to the lungs.
- After eating up to 80% of its body weight in one meal, it drags itself to a sunny location to speed digestion, as the food could rot and poison the dragon if left undigested for too long.
- Because of their slow metabolism, large dragons can survive on as little as 12 meals a year.
- After digestion, the Komodo dragon regurgitates a mass of horns, hair, and teeth known as the gastric pellet, which is covered in malodorous mucus. After regurgitating the gastric pellet, it rubs its face in the dirt or on bushes to get rid of the mucus, suggesting it does not relish the scent of its own excretions!
- No evidence that prey by induction of “sepsis”

Diet

- Largest male asserts his dominance and the smaller males show their submission by use of body language and rumbling hisses; eats first.
- Dragons of equal size may resort to "wrestling".
- Losers usually retreat, though known to be killed and eaten by victors.
- Komodo excrement: dark portion, is stool, with whitish portion which is urate, the nitrogenous end-product of digestion process.
- Diet is wide-ranging, and includes invertebrates, other reptiles (including smaller Komodo dragons), birds, bird eggs, small mammals, monkeys, wild boar, goats, deer, horses, and water buffalo.
- Young Komodos will eat insects, eggs, geckos, and small mammals. Sometimes consume human corpses, digging up bodies from shallow graves.
- Habit of raiding graves caused villagers of Komodo to move their graves from sandy to clay ground and pile rocks on top of them to deter the lizards.
- Drinks by sucking water into its mouth via buccal pumping (a process also used for respiration), lifting its head, and letting the water run down its throat.



Komodo Dragons kill prey via oral transfer of pathogenic “sepsis-inducing” bacteria?

A central role for venom in predation by *Varanus komodoensis* (Komodo Dragon) and the extinct giant *Varanus* (*Megalania*) *priscus*

Bryan G. Fry[a,b,1], Stephen Wroe[c], Wouter Teeuwisse[d], Matthias J. P. van Osch[d], Karen Moreno[c,e], Janette Ingle[f], Colin McHenry[f], Toni Ferrara[c], Phillip Clausen[f], Holger Scheib[g], Kelly L. Winter[h], Laura Greisman[a,b,h], Kim Roelants[i], Louise van der Weerd[d,j], Christofer J. Clemente[k], Eleni Giannakis[l], Wayne C. Hodgson[h], Sonja Luz[m], Paolo Martelli[n], Karthiyani Krishnasamy[o], Elazar Kochva[p], Hang Fai Kwok[q,2], Denis Scanlon[b], John Karas[b], Diane M. Citron[r], Ellie J. C. Goldstein[r], Judith E. Mcnaughtan[s], and Janette A. Norman[a,b,t]

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The predatory ecology of *Varanus komodoensis* (Komodo Dragon) has been a subject of long-standing interest and considerable conjecture. Here, we investigate the roles and potential interplay between cranial mechanics, toxic bacteria, and venom. Our analyses point to the presence of a sophisticated combined-arsenal killing apparatus. We find that the lightweight skull is relatively poorly adapted to generate high bite forces but better adapted to resist high pulling loads. We reject the popular notion regarding toxic bacteria utilization. Instead, we demonstrate that the effects of deep wounds inflicted are potentiated through venom with toxic activities including anticoagulation and shock induction. Anatomical comparisons of *V. komodoensis* with *V. (Megalania) priscus* fossils suggest that the closely related extinct giant was the largest venomous animal to have ever lived.

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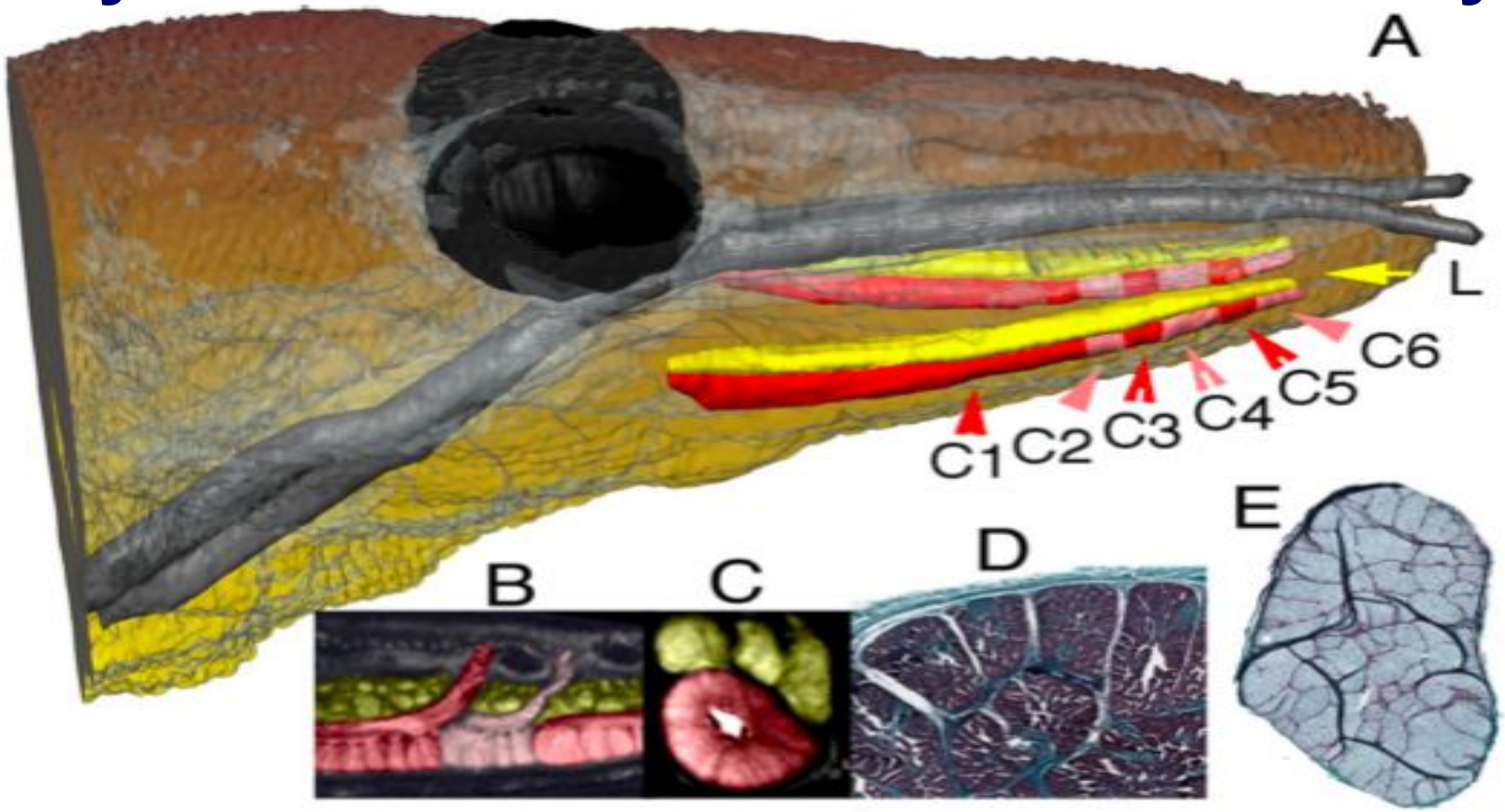
Anatomy of *Varanus komodoensis* venom system



(A) MRI of *V. komodoensis* head showing the protein-secreting mandibular venom gland, with the 6 compartments colored in alternating red and pink (C1–C6), and the mucus-secreting infralabial gland in yellow (L).
(B) Longitudinal MRI showing large ducts emerging separately from each compartment of mandibular venom gland and threading between the mucus lobes of infralabial gland to terminate between successive teeth (black oval areas).
(C) Transverse MRI showing the large central lumen of the mandibular venom gland and individual lobes of the labial gland.
(D) Transverse histology of Masson's Trichrome-stained section showing intratubular lumina of mandibular venom gland that feed into the large central lumen.
(E) Transverse histology of Masson's Trichrome-stained section of a mucus infralabial gland showing numerous tightly packed internal lobules.

Table 1. Molecular biodiversity of toxin types detected in *V. komodoensis* venom

Toxin type	Previously characterized bioactivities (refs. 6, 9, and 13)
AVIT	Potent constriction of intestinal smooth muscle, resulting in painful cramping, and induction of hyperalgesia.
CRISP	Basal toxic activity of paralysis of peripheral smooth muscle and induction of hypothermia via blockage of L-type Ca^{2+}- and BK_{Ca} K^{+}-channels. Derived activities include blockage of cyclic nucleotide gated calcium channels.
Kallikrein	Basal toxic activity of increasing vascular permeability and production of hypotension in addition to stimulation of inflammation. Derivations affect the blood through the cleavage of fibrinogen.
Natriuretic	Basal activity potent induction of hypotension leading to loss of consciousness. Derived activities include cardiovascular effects independent of the GC-A receptor and antiplatelet activities evolved for emergent domains upstream of the natriuretic peptide domain.
PLA_2 (T-III)	Anticoagulation via platelet inhibition.

Conclusion: Doubtful if dragons kill prey by "inducing sepsis"!

Komodo Village

~1500 people

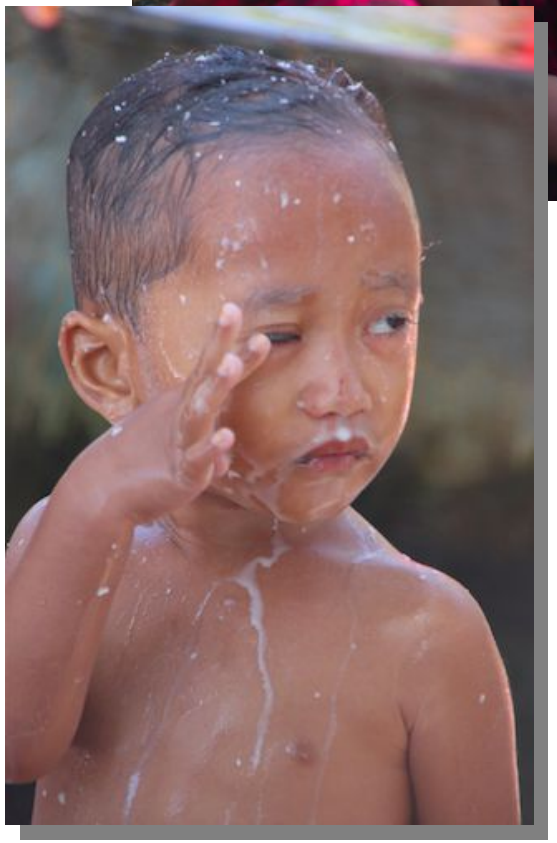
Muslim village

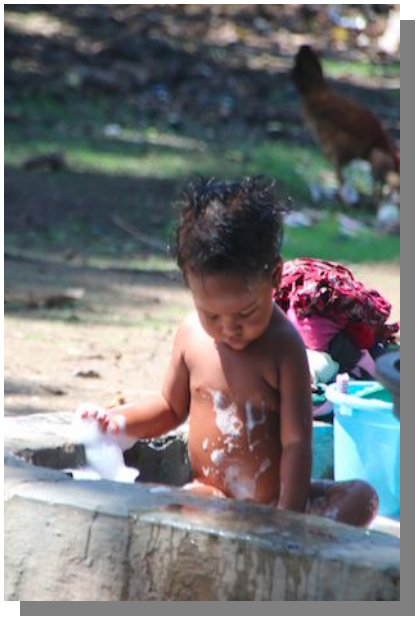
Formerly fishing

Presently National Park employer

Komodo village mausoleums protect buried bodies, i.e. “human carrion” from dragons!

Tuesday is wash day!





Bathtub warm water!

Komodo Village Healthpost

Komodo island clinic contact

Ms. Fifi Sumanti, nurse practitioner

Pustu Komodo

Flores, Indonesia

Facebook: Fifi Ilham

Email: “Unreliable internet connection”

Most basic primary care

Perinatal care

Vaccinations (no HBV, HPV)

Any serious illness sent to Labuan Bajo

Komodo Island Clinic Needs

- Diabetes care equipment and supplies, e.g. glucometers, urine dipstix, etc.
- Decent BP cuff
- BP meds/DM meds?
- Hematology lab equipment
- Simple ECG machine
- Basic clinic and laboratory guides
- Improved internet access
- Computer for records, etc.

Tanah lot Hindu Temple, Bali, Indonesia