Earthly Remains: *Homo Erectus* and the Lure of Volcanism

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The end might have been quick - a great grey wave thick with mud and trees and rock, roaring downhill, faster than a deer can run. Or it might have come slowly, months of ash and smoke billowing from the mountain, smothering the land, starving the animals.

One of the most significant discoveries of fossilized human remains was made in the early 1930s at a site near the village of Ngandong in east-central Java, in what was known to some as the Dutch East Indies. A team led by Dutch and German geologists first spotted – or were more likely told about – protruding animal bones in a layer of gravelly alluvium beside the Solo River. Extensive excavations between 1931 and 1934 unearthed some 25,000 bones from numerous mammals including, most notably, 14 skullcaps, two lower legbones and a pelvis section identified as human. The human bones have subsequently been classified as *Homo erectus.*[1]

It looks as though the humans and the mostly herbivorous animals had been swept into the river and transported some distance before their remains came to rest in a logjam. Researchers who recently revisited the Ngandong bone bed found a high-energy-fluvial blend of sand and gravel – the tell-tale trace of a lahar.[2] Adopted from Javanese, lahar is the geological term for a fastmoving slurry of water, volcanic debris and organic matter

[1] Huffman, O. F., de Vos, J., Berkhout, A. W. & Aziz, F. (2010) Provenience reassessment of the 1931–1933 Ngandong *Homo erectus* (Java), confirmation of the bonebed origin reported by the discoverers. *Paleoanthropology* 2010: 1–60.

[2] Rizal, Yan et al (2020) Last appearance of *Homo erectus* at Ngandong, Java, 117,000–108,000 years ago. *Nature* 577: 381-385.

that results from the collapse of a crater lake or from heavy rainfall running down the slopes of volcano. Descending from volcanic uplands at speeds that can exceed 200 kilometres an hour, then fanning out into stream channels and valleys, lahars tend to be far more hazardous to humans than lava flows.

There is a belt of stratovolcanoes to the south of Ngandong, and three active volcanoes Lawu, Merapi and Merbabu are upstream of the Solo River. Volcaniclastic rock surrounding the sand and gravel in the fossil bed is also suggestive of an eruption, leaving researchers speculating as to whether the humans and grazing animals – crowded together – may have succumbed to ash-poisoning of their food sources, their jumbled remains later washed into the river when monsoonal rains triggered a lahar. 'Volcanism', concludes a major study, 'deeply affected life, death, and fossilization of *Homo erectus* in eastern Java'.[3]

The timing is important. In the last few years, analyses of uranium traces in human and wild cattle bones have dated the event to between 108,000 and 117,000 years ago.[4] This makes it by far the most recent evidence of *Homo erectus* in the archealogical record, substantiating earlier claims that the Java sub-species long outlived its relatives elsewhere.

The emergence of *Homo erectus* in East Africa is currently calibrated at around 2 million years ago, the species subsequently migrating over most of the African continent and vast areas of Eurasia. The African branch is believed to have gone extinct around 500,000 years ago, and an offshoot that settled in China looks to have lasted until 400,000 years ago. But on the island of Java, the furthest point of their migration, *H. erectus* endured, having inhabited the island continuously for perhaps a million and a half years.

While the lineage of the multiple species who make up the genus *Homo* now looks to be much more overlapping and entangled than was once imagined, there is no evidence of

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[3] Huffman, O. Frank et al. (2010a) Mass death and lahars in the taphonomy of the Ngandong Homo erectus bonebed, and volcanism in the hominin record of eastern Java. *Abstracts of the PaleoAnthropology Society 2010 Meetings.*

[4] Rizal, Last appearance of *Homo erectus*

Homo erectus evolving into *Homo sapiens* or intermixing with our species. But whether we are dealing with 'our' beginnings or those of distant relatives, human originary tales tend to be partial, troublesome and contested. Stories woven around scant remains often seem to say more about the storytellers – their politics, culture and notions of identity – than they do about the ancient lives in question.

Much of what is problematic about locating, exhuming and storying fossilized human remains applies to the Ngandong operations. It is vital to critically unpack this history, as commentators have begun to do, not least because it is inextricable from the European colonization of the islands that became Indonesia. But western and globalizing science, I want to suggest, also has a habit of exceeding and unsettling its own assumptions, and evolutionary thinking is no exception.

So I am also interested in the other tales that might be spun around a small band of ancient hominins tangling with a chain of active stratovolcanoes on the island of Java: who they were, how they came to be there, and what else we might make of their still unfolding story.

Distant human ancestors and their relatives were literally few and far between. What gets preserved in the fossil record is deeply selective, as is its discovery and unearthing. Chance plays a huge part. But so too does intent, ambition and resourcing, especially in colonial contexts.

The Ngandong discovery was one outcome of an early 1930s geological survey: the Java Mapping Program (*Javakaarteering*), undertaken by the Netherlands Indies Bureau of Mining (*Mijnwezen*).[5] Like other colonial powers, the Dutch were interested in potentially lucrative mineral ores and energy – especially oil, and this was one of the most extensive surveys of its kind. But 'universal' insights into the human family were a useful supplement to the all-too-particular interests of resource prospecting, so it is unsurprising that the program included a specialist paleontologist – G.H.R. von Koenigswald – in its leadership team.

[5] Huffman et al. Provenience reassessment of the 1931–1933 Ngandong *Homo erectus*

Critics of colonialism draw attention to an extractive logic common to the quest for mineral resources and human remains, and the *Javakaarteering* program was no exception. Credit for discoveries went to the Europeans geologists – Oppenoorth, ter Haar, and von Koenigswald, who between them notched up just 24 days at Ngandong over the 828-day dig. Other than their first names – Samsi and Panudju, nothing is recorded of the Indonesian excavation supervisors who made the vital initial identification of the human bones, though it is likely they were trained in surveying, geology and paleontology.[6] Still less is known of the scores of local labourers who did the digging.

Publication from the richly productive Ngandong operations was hindered by redeployment, dismissal, retirement, illness and a death amongst the European geologists, loss of onsite records, the Great Depression, and by Japanese wartime occupation of Indonesia. After a circuitous journey, most of the recovered human remains ended up at Utrecht University in the Netherlands, before being repatriated to Indonesia in 1978.

If it can be said that the protocols of colonial paleontology were adopted in central Java, a case could also that they were at invented here, a few miles downriver of Ngandong. For it was at Trinil, also on the Solo River, that Dutch anatomist Eugène Dubois – on an 1891 expedition – famously uncovered a tooth, skullcap and thighbone from an archaic human species.

Dubois is credited with being the first researcher to both look for and find fossilized human remains. Although Darwin had speculated that humans first evolved in Africa, other early evolutionary thinkers preferred South East Asia, ostensibly on account of this region being home to two great apes – gibbons and orangutans. Following this logic, Dubois set out to the then Dutch East Indies in search of the transitional form or 'missing link' between apes and humans. The fossilized remains he discovered – which he later named *Pithecanthropus erectus* and others referred to as Java Man – generated huge international interest.

Subsequent debate was strident – and revealing. Some early critics, sceptical of the very idea of evolutionary transitions, relegated Java Man to an extinct side branch of the

[6] Huffman et al. Provenience reassessment of the 1931–1933 Ngandong *Homo erectus*

human family (a reading we might now see as more-or-less valid but for the wrong reasons). Many other EuroAmerican scientists preferred the idea of a central Asian human origin over an African one. Expressing deeply engrained notions of racial hierarchy, this view tended towards a climatic determinism that associated (northern) temperate climates with vigour and evolutionary advancement and tropical latitudes with lethargy and stagnation. Consequently, a prevalent reading of Java Man, reinforced by the Peking Man finds in North China in the 1920s, was that it was an offshoot of an archaic Asian ancestor which had degenerated by drifting south to the tropics.[7]

It wasn't until the 1950s that German biologist Earnest Mayr redefined Peking Man and Java Man – including the Ngandong fossils – as a single species which he termed *Homo erectus*. While his classification of *H. erectus* has largely held, Mayr's belief that the genus *Homo* formed a single, unbranching line, subsequently lost support. The current consensus is that for the vast majority of its more than two-million-year tenure, the genus *Homo* has consisted of multiple, and sometimes interbreeding species. This view, clarified by evidence from Java, has 'anatomically modern' *Homo sapiens* and *Homo erectus* overlapping temporally but not geographically.

Contemporary researchers are inclined to celebrate *Homo erectus* for their behavioural diversity and flexibility, their exceptional longevity – which includes enduring the climatic see-sawing of the Pleistocene – and their adaptation to a range of geographical conditions. Alongside the consensus that they are not our direct ancestors, it is an aptitude for migration that renders *Homo erectus* an increasingly unsuitable candidate for nationalist or ethnocentric secondment. As paleoanthropologist Susan Antón observes '*H. erectus* was a group of wanderers', the latest archeological evidence suggesting 'an almost immediate habit of long-range dispersal'.[8]

Homo erectus are thought to be the first humans to leave Africa. A recent approach to hominin evolution, still controversial, puts an interesting twist on the human dispersal story. With now widespread acceptance that the genus *Homo* emerged in and around the

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[7] Yen, Hsiao-Pei (2014) Evolutionary Asiacentrism, Peking Man, and the Origins of Sinocentric Ethno-Nationalism*, Journal of the History of Biology:* 47:585–625.

[8] Antón, Susan (2020) All who wander are not lost*, Science 368* (6486) 34-35.

East African Rift Valley, the specific physical features of that region have come in for increased attention. Theorists associated with the 'complex topography hypothesis' argue that active plate tectonics in East Africa, and the rugged, variegated landscape it produced, played a vital role in early human evolution. They also propose that when human migrants first dispersed across Africa and moved into Eurasia, wherever possible they followed similarly complex, rifted and uneven terrain.[9]

The East African Rift as currently the largest and most enduring example of the continental fracturing that occurs when rising, extra-hot magma pushes the Earth's crust upwards. As cracks open, land also subsides, creating steep-sided walls and a deep valley floor that collects water and accumulates sediment. The result, complex topography theorists note, is a biologically diverse mosaic landscape, subject to frequent revitalising disturbance by volcanoes and earthquakes.

The African Rift Valley, they suggest, offered plentiful nutrient-rich resources for foraging and hunting, while escarpments and outcrops provided platforms from which early hunters could observe prey. More than this, rocky canyons and hardened lava flows functioned as natural stockades – safe nesting spaces – for a ground-dwelling and relatively defenceless primate. Clambering over steep, uneven ground may have been a crucial transitional phase in learning to walk upright: a more feasible route to bipedalism, as the complex topography approach would have it, than going straight from tree-climbing to striding across savannah.

As well as helping shape a distinctive human niche, active volcanism provided stone amenable to flaking and shaping into tools, a long-term speciality of *Homo erectus*. Volcanoes also provided pulses of fire that helped jolt and regenerate ecosystems. Complex topography theorists and others have speculated whether lava flows may have provided *H. erectus* – thought to be the first fire-handing human – with a formative experience of the power of heat and fire, perhaps serving as a more approachable source of flame than fast-moving wildfire.

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[9] King, Geoffrey, and Bailey Geoff (2006) Tectonics and Human Evolution. *Antiquity,* 80: 265–86.

Geological evidence indicates that a chain of volcanoes along the African Rift was highly active over the first few million years of human and prehuman evolution. 'Our' original home, and that of our extended family, was a fractured and volatile one, a place forged by the intermeshing of dynamic inner and outer Earth processes. But origins and endings both tend to be complicated, and they have an uncanny habit of tangling with each other.

For *Homo erectus*, then, there is a seismically active land and a belt of eruptive volcanoes at either end of its epic migration. From East Africa to the Indonesia archipelago is an overland journey of some 18,000 kilometres, with a final crossing to an island that may have been made temporally accessible by regional tectonic events. Java is the furthest point from Africa that *H. erectus* reached. Once there, they settled into an unequalled million and half years of dwelling – in another landscape that was rocked and pulsed, fired and fertilized by volcanic activity.

There is speculation that what finally spelled the end of *Homo erectus* in Java was climate change, an episode of inter-glacial warmth and humidity during which dense rainforest replaced the savannah upon which the species had supposedly grown over-dependent. But the question of an ending is perhaps less important than the matter of the remarkable longevity that preceded it, just as the focus on grassland seems to miss what is most interesting in the story – the jolting and generative experience of living with active volcanism.

This circles back on another point made by complex topography theorists. During bouts of climate change, they argue, the tectonically active African Rift seems to have served as a refugium for early humans and the ecosystems they relied upon.[10] The key to enduring the variability of the Earth system, perhaps, is to embrace volatile Earth processes.

In 2014 an archaeologist visiting the collection of Eugène Dubois in the Netherlands snapped a series of photos of fossilized mussel shells recovered from Trinil – the site that yielded the first *Homo erectus* remains in the 1890s. Examining the photos back home, he noticed that one shell was marked with what looked like engravings. Many of the freshwater mussels had holes bored – perhaps with a shark tooth – at the exactly spot

[10] King and Bailey, Tectonics and Human Evolution

where a muscle clamps the shells shut, suggesting ancient foragers had a working knowledge of mollusc anatomy. One or two other shells had been crafted into tools. But most surprising was the shell whose surface was etched with zigzag or triangular strokes.[11]

Traces of volcanic ash have enabled the shells to be dated to between 430,000 and 540,000 years old. Experiments suggest that the engraver had scratched through a dark outer layer of the bivalve, and that the grooves were made in one sitting by a right-handed individual, most likely using a shark tooth – which were also present in the fossil bed. No comparable graphic gesture appears in the human archeological record for at least another 300,000 years.

Knowing nothing of the engraver's intentions, researchers are reluctant to describe the inscriptions as art, and even more loathe to attribute any representational function to the marks. But they readily admit that the designs on the shell are skilfully wrought, the lines deep and straight, the sides of the triangles meeting cleanly at their apex with no crossover. A series of sharp peaks, we might say, gesturing to us across an interval of half a million years: a gift from a wandering species that has itself yet to return home

[11] Joordans, Josephine et al. (2015) Homo erectus at Trinil on Java used shells for tool production and engraving, *Nature* 518: 228-231.

Fig 1:

Inscriptions on Trinil mussel shell. Photo Stephen Munro (Courtesy Naturalis Biodiversity Center)