Human evolution writ small

Marta Mirazón Lahr and Robert Foley

We are the only living species of the genus *Homo*. Given the startling results of a cave excavation in Southeast Asia, it seems that we coexisted with another species until much more recently than had been thought.

The fossils described elsewhere in this issue probably left no descendants, are not very old, and were found on a remote island. Despite this, they are among the most outstanding discoveries in palaeoanthropology for half a century. The two papers concerned — by Brown *et al.*[1] and Morwood *et al.*[2] — appear on pages 1055 and 1087 of this issue, and respectively describe the fossils and their archaeological context. The find is startling. It is of a pygmy-sized, small-brained hominin, which lived as recently as 18,000 years ago, and which was found on the island of Flores together with stone tools, dwarf elephants and Komodo dragons. Discoveries don't get better than that.

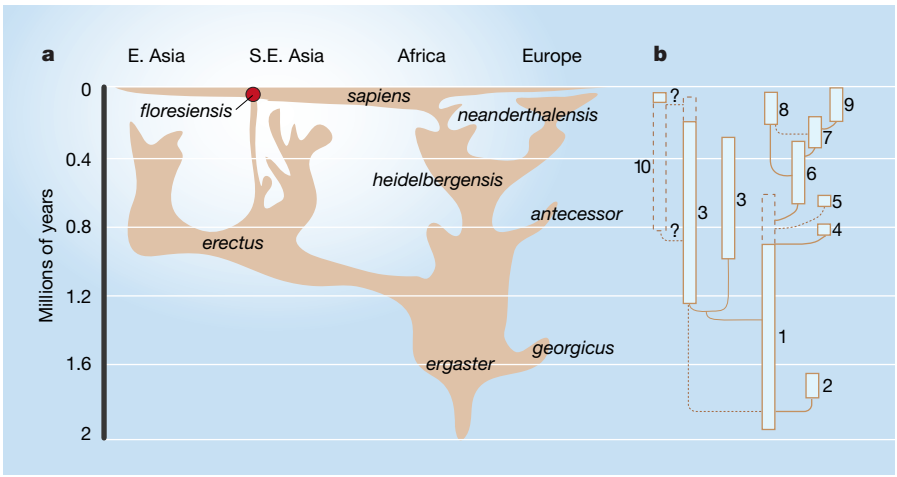
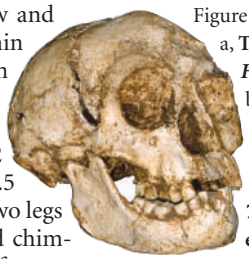


Figure 1 ***Homo floresiensis* in the context of the evolution and dispersal of the genus *Homo*.** a, **The new species as part of the Asian dispersals of the descendants of *H. ergaster* and *H. erectus*, with an outline of the descent of other *Homo* species provided for context.** b, **The evolutionary history of *Homo* is becoming increasingly complex as new species are discovered. *Homo floresiensis* (left) is believed[1] to be a long-term, isolated descendant of Javanese *H. erectus*, but it could be a recent divergence. 1, *H. ergaster*/African *erectus*; 2, *georgicus*; 3, Javanese and Chinese *erectus*; 4, *antecessor*; 5, *cepranensis*; 6, *heidelbergensis*; 7, *helmei*; 8, *neanderthalensis*; 9, *sapiens*; 10, *floresiensis*. Solid lines show probable evolutionary relationships; dashed lines, possible alternatives.**



The Flores fossils add a new and surprising twig to the hominin family tree, which diverged from the chimpanzee lineage about 7 million years ago. The first African hominins existed 7–1.2 million years ago, were 1–1.5 metres tall, walked upright on two legs (that is, were bipedal), and had chimpanzee-size brains. These early forms comprised as many as six genera and fourteen species, of which the australopithecines are the best known. By 2.5 million years ago, our own genus, *Homo*, had emerged, with its different body shape, slower growth, greater reliance on meat in the diet, and 'encephalization' — larger brains than expected for body size. These were the first hominins to make stone tools systematically and to colonize Eurasia. They include the familiar names of *H. habilis*, *H. erectus*, *H. neanderthalensis* and, finally, *H. sapiens*, which put in an appearance about 160,000 years ago. The new fossil is part of this *Homo* group (Fig. 1).

Flores lies to the east of Java, and was probably never connected to the mainland. The presence of 800,000-year-old simple stone tools first attracted attention in 1998 (ref. 3), raising the controversial possibility that *H. erectus* had produced them and had crossed major sea barriers to reach Flores. Now we have the announcement of the discovery of an 18,000-year-old hominin skeleton from a cave, Liang Bua, on Flores. Although this date is more than 140,000 years after modern humans evolved in Africa, more than 25,000 years after *H. sapiens* reached Australia, and about 10,000 years after the last known Neanderthal, the skeleton is that of a new species — *Homo floresiensis*. Its most remarkable features are its diminutive body (about a metre in height) and brain size (at 380 cm^3, the smallest of any known hominin).

Homo floresiensis is a challenge — it is the most extreme hominin ever discovered. An archaic hominin at that date changes our understanding of late human evolutionary geography, biology and culture. Likewise, a pygmy and small-brained member of the genus *Homo* questions our understanding of morphological variability and allometry — the relation between the size of an organism and the size of any of its parts. Brown *et al.*[1] claim that the skeleton, designated LB1, represents a new species within the genus *Homo*. They believe that it may have been a female. They also conclude that it was a dwarfed descendant of Javanese *H. erectus*, and part of an endemic island fauna. But what other taxonomic assignments are possible?

Convergence — a process through which two species become more similar to each other than their ancestors were — is a strong evolutionary force[4], and LB1, with its minute brain, could be a convergent Southeast Asian ape. But it evidently was an obligatory biped and had small canine teeth, key hominin traits that, with the rest of its morphology, firmly place it within the hominin group[5]. Given its body and brain size, as well as some other features, could the remains be those of an australopithecine? Those features include bony reinforcements along the sides of the nose, thigh bones that were less obliquely aligned than ours (a trait essential for the way we walk and deal with gravity), and pelvic bones that were very wide, giving it a different overall body shape from ours. But the answer is again no. Most of LB1's other characteristics, such as the thickness and proportions of the skull, the flexion evident at the skull base, and the shape of the teeth, are derived traits of the genus *Homo*.

Could LB1 be a pygmy *H. sapiens*? Again, no. Compared with a human skull scaled to less than a third of full size, the LB1 skull differs in shape, robusticity and key features of the base. Furthermore, although human pygmies are short (1.4–1.5 m), they show very little reduction in brain size, probably because their small size is attained through mechanisms that curtail growth during puberty, when brains are already fully grown[6].

In general terms, LB1's morphology groups it with *H. erectus*[7]. The name includes African and non-African hominins with

brains smaller than 1,250 cm^3, which may be one species (*H. erectus*), or several (*antecessor, cepranensis, erectus, ergaster, georgicus, mauritanicus* and *soloensis*). Height among these 'erectines' is considered[8] to range between 1.55 m and 1.78 m, and brain size between 650 cm^3 and 1,260 cm^3. The body and brain size of LB1 (about 1 m and 380 cm^3) clearly indicate a major departure from the erectine extremes, while its peculiar combination of primitive and derived traits points towards the complex effects of dwarfism and its allometric consequences.

Island dwarfism is well known among mammals[9]. Released from predation pressure or constrained by restricted resources, and limited by population size, the phenomenon can be dramatic. Some examples can be truly extreme — for example, the one-metre-high fossil elephants, found on Sicily and Malta, which may have become dwarfed from a 4-metre ancestor in less than 5,000 years[10]. Indeed, remains of now-extinct primitive elephants (*Stegodon*), which had become dwarfed in relation to their mainland relatives, were found in the same deposits as LB1.

The dwarfism of *H. floresiensis* is also dramatic, resulting in the shortest adult *Homo*, and possibly hominin, known. Most significantly, the relative proportions of LB1's brain and body size (Fig. 2) indicate that the size reduction was more pronounced in the brain than the body, so a non-encephalized descendant evidently arose from an encephalized ancestor. This raises many questions about encephalization and hominin behaviour. Such questions aside, *H. floresiensis* is clear evidence that, in spite of their 'cultural niche', hominins were subject to the same evolutionary rules as other widespread mammals, with local isolation and small population sizes producing differentiation in size and form. This find strengthens the view that the genus *Homo* was probably much subdivided, resulting in a bushy human evolutionary tree. That view is itself consistent with the idea that the extreme climatic shifts of the past million years promoted population dispersal and isolation, and potentially resulted in instances of local evolution[11].

Necessarily, the discovery of *H. floresiensis* bears on the debate over the origins of modern humans — whether *H. sapiens* evolved in various regions throughout the world from *H. erectus* populations, or as a distinct and recent African species. Multiregional evolution requires the existence of large populations for long periods, with isolation being rare or absent so that the global species could evolve in a single direction. Palaeoanthropological and genetic studies have already done much to discredit this model, and *H. floresiensis* puts yet another (the last?) nail in the multiregional coffin. Not only did *H. floresiensis* evolve in the absence of gene exchange with other hominins, but

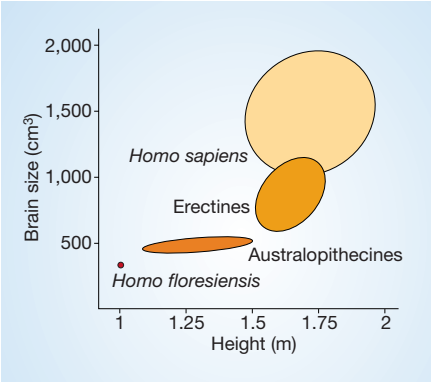


Figure 2 **The relative brain and body size of *H. floresiensis*. The dimensions of the skull and skeleton (LB1) described by Brown *et al.*[1] fall well outside the extremes seen in *H. sapiens* and the 'erectines' (a range of hominin species, of which *H. erectus* is the most familiar). LB1 is closer 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*.**

no one can argue that LB1 contributed to our own species' genetic make-up.

Finally, accomplishing the sea-crossing that must have been necessary for the founding population to reach Flores adds to the baffling evidence for complex, supposedly 'sapient', behaviours among archaic hominins[12]. And the behaviour of *H. floresiensis* itself, of course, remains elusive. Are the 800,000-year-old stones really artefacts? If so, does their date indicate when the taller ancestors of the dwarfed form arrived?

The archaeological evidence is controversial. The 800,000-year-old artefacts are simple, crudely flaked pebbles, similar to those found with Javanese *H. erectus*, as are some found at Liang Bua dating to more than 100,000 years ago. Only a few tools are associated with LB1. But thousands were found with the *Stegodon* skeleton in another sector of the cave: some are small flakes struck from radial cores; others consist of points, perforators, blades and possibly hafted microblades. Although Morwood *et al.*[2] attribute the production of all of these tools to *H. floresiensis*, elsewhere such implements are associated with *H. sapiens*, and their contrast with tools found anywhere with *H. erectus* is very striking. One could speculate that modern humans, who were dispersing across southern Asia between 100,000 and 50,000 years ago, may have made the tools, and come across these creatures. They may also have had a part in their ultimate extinction.

It is breathtaking to think that such a different species of hominin existed so recently. Brown *et al.*[1] point to the probability of similarly unexpected fossils being found in other isolated areas. For most of its 160,000-year history, *H. sapiens* seems to have shared the planet with other bipedal and cultural beings — our global dominance may be far more recent than we thought. ■

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Astronomy

Tycho's mystery companion

David Branch

A famous sixteenth-century supernova, seen by Tycho Brahe, is still a hot topic. The stellar explosion might have been initiated by a companion star — and modern astronomers have at last identified it.

On 11 November 1572, Danish astronomer Tycho Brahe looked up at the constellation of Cassiopeia and saw a bright new star. In fact, what he saw was the death of a star — a supernova. The appearance of this 'star', now known as Tycho's supernova, refuted the Aristotelian immutability of the heavens, and might have been the inspiration[1] for the celestial portent in the opening scene of Shakespeare's *Hamlet*. The remnant of the supernova, 10,000 light years from Earth, now glows at radio and X-ray wavelengths, owing to the strong interaction between the high-velocity matter ejected from it and the interstellar gas that was swept up in the cataclysm. The event is thought to have been a type Ia supernova — the complete disruption of a white-dwarf star provoked by the transfer of mass from a close binary companion. More than four centuries later, Ruiz-Lapuente *et al.*[2] (page 1069) claim to have identified the