

Rethinking the Hobbits of Indonesia

New analyses reveal the mini human species to be even stranger than previously thought and hint that major tenets of human evolution need revision

BY KATE WONG

PHOTOGRAPHS BY DJUNA IVEREIGH



KEY CONCEPTS

- In 2004 researchers working on the island of Flores in Indonesia found bones of a miniature human species—formally named *Homo floresiensis* and nicknamed the hobbit—that lived as recently as 17,000 years ago.
- Scientists initially postulated that *H. floresiensis* descended from *H. erectus*, a human ancestor with body proportions similar to our own.
- New investigations show that the hobbits were more primitive than researchers thought, however—a finding that could overturn key assumptions about human evolution.

—The Editors

In 2004 a team of Australian and Indonesian scientists who had been excavating a cave called Liang Bua on the Indonesian island of Flores announced that they had unearthed something extraordinary: a partial skeleton of an adult human female who would have stood just over a meter tall and who had a brain a third as large as our own. The specimen, known to scientists as LB1, quickly received a fanciful nickname—the hobbit, after writer J.R.R. Tolkien’s fictional creatures. The team proposed that LB1 and the other fragmentary remains they recovered represent a previously unknown human species, *Homo floresiensis*. Their best guess was that *H. floresiensis* was a descendant of *H. erectus*—the first species known to have colonized outside of Africa. The creature evolved its small size, they surmised, as a response to the limited resources available on its island home—a phenomenon that had previously been docu-

mented in other mammals, but never humans.

The finding jolted the paleoanthropological community. Not only was *H. floresiensis* being held up as the first example of a human following the so-called island rule, but it also seemed to reverse a trend toward ever larger brain size over the course of human evolution. Furthermore, the same deposits in which the small-bodied, small-brained individuals were found also yielded stone tools for hunting and butchering animals, as well as remainders of fires for cooking them—rather advanced behaviors for a creature with a brain the size of a chimpanzee’s. And astonishingly, LB1 lived just 18,000 years ago—thousands of years after our other late-surviving relatives, the Neandertals and *H. erectus*, disappeared [see “The Littlest Human,” by Kate Wong; *SCIENTIFIC AMERICAN*, February 2005].

Skeptics were quick to dismiss LB1 as nothing more than a modern human with a disease that



stunted her growth. And since the announcement of the discovery, they have proposed a number of possible conditions to explain the specimen's peculiar features, from cretinism to Laron syndrome, a genetic disease that causes insensitivity to growth hormone. Their arguments have failed to convince the hobbit proponents, however, who have countered each diagnosis with evidence to the contrary.

A Perplexing Pastiche

Nevertheless, new analyses are causing even the proponents to rethink important aspects of the original interpretation of the discovery. The recent findings are also forcing paleoanthropologists to reconsider established views of such watershed moments in human evolution as the initial migration out of Africa by hominins (the group that includes all the creatures in the human line since it branched away from chimps).

Perhaps the most startling realization to emerge from the latest studies is how very primitive LB1's body is in many respects. (To date, excavators have recovered the bones of an estimated 14 individuals from the site, but LB1 remains the most complete specimen by far.) From the outset, the specimen has invited comparisons to the 3.2-million-year-old Lucy—the best-known representative of a human ancestor called *Australopithecus afarensis*—because they were about the same height and had similarly small brains. But it turns out LB1 has much more than size in common with Lucy and other pre-*erectus* hominins. And a number of her features are downright apelike.

A particularly striking example of the bizarre morphology of the hobbits surfaced this past May, when researchers led by William L. Jungers of Stony Brook University published their analysis of LB1's foot. The foot has a few modern fea-

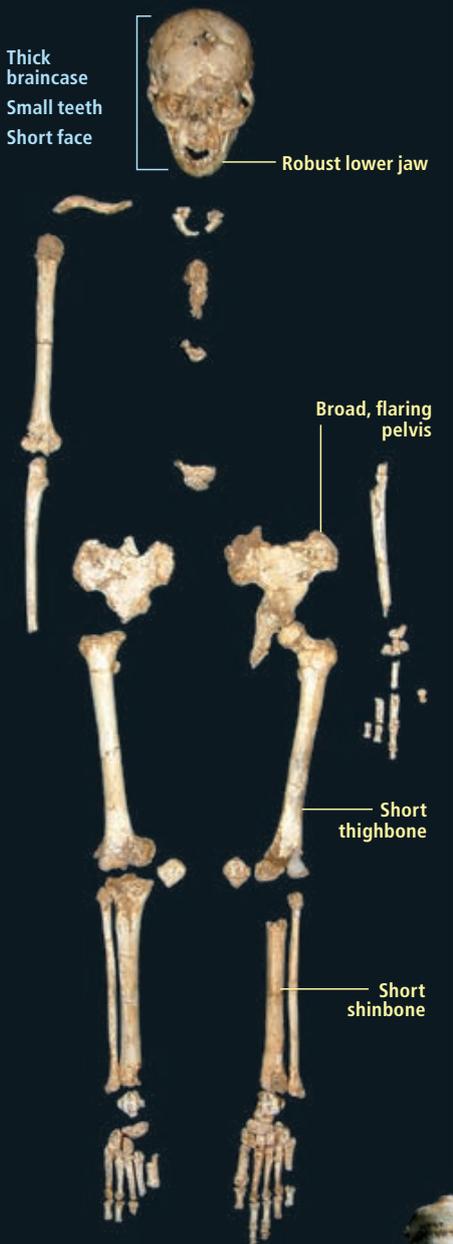
STRANGE SKELETON from Flores, Indonesia, calls into question which human ancestor was the first to leave Africa—and when. Archaeologist Thomas Sutikna (left) is one of the leaders of the excavation of the cave that yielded the skeleton.

[THE EVIDENCE]

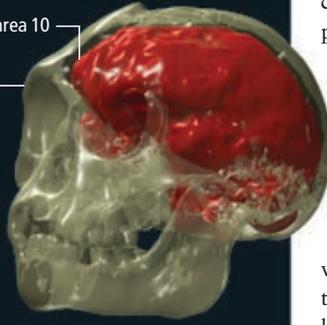
A Mysterious Mosaic

To date, excavators have recovered the remains of about 14 individuals from Liang Bua, a cave site on Flores. The most complete specimen is a nearly complete skeleton called LB1 that dates to 18,000 years ago. Some of its characteristics call to mind those of apes and of australopithecines such as the 3.2-million-year-old Lucy. Other traits, however, are in keeping with those of our own genus, *Homo*. This mélange of primitive features (yellow) and modern ones (blue) has made it difficult to figure out where on the human family tree the hobbits belong.

Homo traits	Ape and australopithecine traits
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Brodman area 10



BRAIN is the size of a chimpanzee's. But a virtual reconstruction—generated from CT scans of the interior of the braincase—indicates that despite its small size, the organ had a number of advanced features, including an enlarged Brodmann area 10, a part of the brain that has been theorized to play a role in complex cognitive activities. Such features may help explain how a creature with a brain the size of a chimp's was able to make stone tools.

WRIST resembles that of an African ape. Of particular interest is a bone called the trapezoid (shown), which has a pyramidal form. Modern humans, in contrast, have a trapezoid shaped like a boot, which facilitates tool manufacture and use by better distributing forces across the hand.



FOOT is exceptionally long compared with the short leg. This relative foot length is comparable to that seen in bonobos, and it suggests the hobbits were inefficient runners. Other apelike traits include long, curved toes and the absence of an arch. Yet the big toe aligns with the rest of the toes, among other modern characteristics.



tures—for instance, the big toe is aligned with the other toes, as opposed to splaying out to the side as it does in apes and australopithecines. But by and large, it is old-fashioned. Measuring around 20 centimeters in length, LB1's foot is 70 percent as long as her short thighbone, a ratio unheard of for a member of the human family. The foot of a modern human, in contrast, is on average 55 percent as long as the femur. The closest match to LB1 in this regard, aside from, perhaps, the large-footed hobbits of Tolkien's imagination, is a bonobo. Furthermore, LB1's big toe is short, her other toes are long and slightly curved, and her foot lacks a proper arch—all primitive traits.

"A foot like this one has never been seen before in the human fossil record," Jungers declared in a statement released to the press. It would not have made running easy. Characteristics of the pelvis, leg and foot make clear that the hobbits walked upright. 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 distances—say, to avoid becoming dinner for one of the Komodo dragons that patrolled Flores—they would not have won any marathons.

If the foot were the only part of the hobbit to exhibit such primitive traits, scientists might have an easier time upholding the idea that *H. floresiensis* is a dwarfed descendant of *H. erectus* and just chalking the foot morphology up to an evolutionary reversal that occurred as a consequence of dwarfing. But the fact is that archaic features are found throughout the entire skeleton of LB1. A bone in the wrist called the trapezoid, which in our own species is shaped like a boot, is instead shaped like a pyramid, as it is in apes; the clavicle is short and quite curved, in contrast to the longer, straighter clavicle that occurs in hominins of modern body form; the pelvis is basin-shaped, as in australopithecines, rather than funnel-shaped, as in *H. erectus* and other later *Homo* species. The list goes on.

Indeed, from the neck down LB1 looks more like Lucy and the other australopithecines than *Homo*. But then there is the complicated matter of her skull. Although it encased a grapefruit-size brain measuring just 417 cubic centimeters—a volume within the range of chimpanzees and australopithecines—other cranial features, such as the narrow nose and prominent brow arches over each eye socket, mark LB1 as a member of our genus, *Homo*.

WILLIAM L. JUNGERS (skull); SMITH/Mal/Inckrodt (Institute of Radiology, Washington University School of Medicine (skull)); COURTESY OF KIRK E. SMITH (wrist); SONY BROOK UNIVERSITY (skeleton); COURTESY OF KIRK E. SMITH/Mal/Inckrodt (Institute of Radiology, Washington University School of Medicine (skull))

Primitive Roots

Fossils that combine *Homo*-like skull characteristics with primitive traits in the trunk and limbs are not unprecedented. The earliest members of our genus, such as *H. habilis*, also exhibit a hodgepodge of old and new. Thus, as details of the hobbits' postcranial skeletons have emerged, researchers have increasingly wondered whether the little Floresians might belong to a primitive *Homo* species, rather than having descended from *H. erectus*, which scientists believe had modern body proportions.

A new analysis conducted by doctoral candidate Debbie Argue of the Australian National University in Canberra and her colleagues bolsters this view. To tackle the problem of how the hobbits are related to other members of the human family, the team employed cladistics—a method that looks at shared, novel traits to work out relationships among organisms—comparing anatomical characteristics of LB1 to those of other members of the human family, as well as apes.

In a paper in press at the *Journal of Human Evolution*, Argue and her collaborators report that their results suggest two possible positions for the *H. floresiensis* branch of the hominin family tree. The first is that *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. The second is that it emerged after *H. habilis* but still well before *H. erectus*, which arose around 1.8 million years ago. More important, 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.)

If the hobbits are a very early species of *Homo* that predates *H. erectus*, that positioning on the family tree would go a long way toward accounting for LB1's tiny brain, because the earliest members of our genus had significantly less gray matter than the average *H. erectus* possessed. But Argue's findings do not solve the brain problem entirely. LB1 aside, the smallest known noggin in the genus *Homo* is a *H. habilis* specimen with an estimated cranial capacity of 509 cubic centimeters. LB1's brain was some 20 percent smaller than that.

Could island dwarfing still have played a role in determining the size of the hobbit's brain?

Did *Homo sapiens* Copy Hobbits?

Analysis of hobbit implements spanning the time from 95,000 to 17,000 years ago indicates that the tiny toolmakers used the same so-called Oldowan techniques that human ancestors in Africa employed nearly two million years ago. The hobbits combined these techniques in distinctive ways, however—a tradition that the modern humans who inhabited Liang Bua starting 11,000 years ago followed, too. This finding raises the intriguing possibility that the two species made contact and that *H. sapiens* copied the hobbits' style of tool manufacture, rather than the other way around.



HOBBIT KNIFE

SICK HUMAN HYPOTHESES

Scientists who doubt that LB1 belongs to a new human species argue that she is simply a modern human with a disease resulting in a small body and small brain. Those who think LB1 does represent a new species, however, have presented anatomical evidence against each of the proposed diagnoses, several of which are listed below.

Laron syndrome, a genetic disease that causes insensitivity to growth hormone.

Myxoedematous endemic cretinism, a condition that arises from prenatal nutritional deficiencies that hinder the thyroid.

Microcephalic osteodysplastic primordial dwarfism type II, a genetic disorder whose victims have small bodies and small brains but nearly normal intelligence.

When the discovery team first attributed LB1's wee brain to this phenomenon, critics complained that her brain was far smaller than it should be for a hominin of her body size, based on known scaling relationships. Mammals that undergo dwarfing typically exhibit only moderate reduction in brain size. But study results released this past May suggest that dwarfing of mammals on islands may present a special case. Eleanor Weston and Adrian Lister of the Natural History Museum in London found that in several species of fossil hippopotamus that became dwarfed on the African island nation of Madagascar, brain size shrank significantly more than predicted by standard scaling models. 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.

The work on hippos has impressed researchers such as Harvard University's Daniel Lieberman. In a commentary accompanying Weston and Lister's report in *Nature*, Lieberman wrote that their findings "come to the rescue" in terms of explaining how *H. floresiensis* got such a small brain.

Although some specialists favor the original interpretation of the hobbits, Mike Morwood of the University of Wollongong in Australia, who helps to coordinate the Liang Bua project, now thinks the ancestors of LB1 and the gang were early members of *Homo* who were already small—much smaller than even the tiniest known *H. erectus* individuals—when they arrived on Flores and then "maybe underwent a little insular dwarfing" once they got there.

[FIELD NOTES]

Digging for Hobbits

Liang Bua (*right*) is a large limestone cave located in the lush highlands of western Flores. Beyond the remains of some 14 hobbits, excavations there have yielded thousands of stone tools, as well as the bones of Komodo dragons, elephantlike stegodonts, giant rats and a carnivorous bird that stood some three meters high. The hobbits seem to have occupied the cave from around 100,000 to 17,000 years ago. They may have been drawn to Liang Bua because of its proximity to the Wae Racang River, which would have attracted thirsty prey animals. Researchers are now looking for clues to why, after persisting for so long, the hobbits eventually vanished. They are also eager to recover a second small skull. Such a find would establish that LB1 and the other specimens do indeed represent a new species and are not just the remains of diseased modern humans. Bones and teeth containing DNA suitable for analysis would be likewise informative. —K.W.



▲ The hobbit occupation levels at Liang Bua extend deep into the moist ground. To keep the walls of the trenches from collapsing, which could kill workers, the team employs a sophisticated shoring system.

► Inside the pit team members carefully scrape away dirt layer by layer, exposing bones and artifacts as they go. They record the position of each item of interest before placing it into a plastic bag. Meanwhile the dirt itself is loaded into buckets that are sent up to the surface for closer inspection.



▼ An excavator examines a *Stegodon* rib. The concentration of stone tools in this spot indicates that the hobbits butchered the creature here.



▲ The sediment removed from the excavation pit is thoroughly examined for bone and artifact fragments that might have gone unnoticed in the pit. The local Manggarai villagers who work at the site sort through the sediment in three stages: first with their hands (shown), then by sieving the dry sediment through screens, and last by taking the sediment bucket by bucket out to a station set up in the rice paddy outside the cave and wetting the contents before sieving them again, in hopes of recovering even the tiniest teeth and shards of bone.

Artifacts left behind by the hobbits support the claim that *H. floresiensis* is a very primitive hominin. Early reports on the initial discovery focused on the few stone tools found in the hobbit levels at Liang Bua that were surprisingly sophisticated for a such a small-brained creature—an observation that skeptics highlighted to support their contention that the hobbits were modern humans, not a new species. But subsequent analyses led by Mark W. Moore of the University of New England in Australia and Adam R. Brumm of the University of Cambridge have revealed the hobbit toolkit to be overall quite basic and in line with the implements produced by other small-brained hominins. The advanced appearance of a handful of the hobbit tools at Liang Bua, Moore and Brumm concluded, was produced by chance, which is not unexpected considering that the hobbits manufactured thousands of implements.

To make their tools, the hobbits removed large flakes from rocks outside the cave and then struck smaller flakes off the large flakes inside the cave, employing the same simple stone-working techniques favored by humans at another site on Flores 50 kilometers east of Liang Bua called Mata Menge 880,000 years ago—long before modern humans showed up on the island. (The identity of the Mata Menge toolmakers is unknown, because no human remains have turned up there yet, but they conceivably could be the ancestors of the diminutive residents of Liang Bua.) Furthermore, 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*.

Tiny Trailblazer

In some ways, the latest theory about the enigmatic Flores bones is even more revolutionary than the original claim. “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,” reflects David S. Strait of the University at Albany. Scientists have long believed that *H. erectus* was the first member of the human family to march out of the natal continent and colonize new lands, because that is the hominin whose remains appear outside of Africa earliest in the fossil record. In explanation, it was pro-

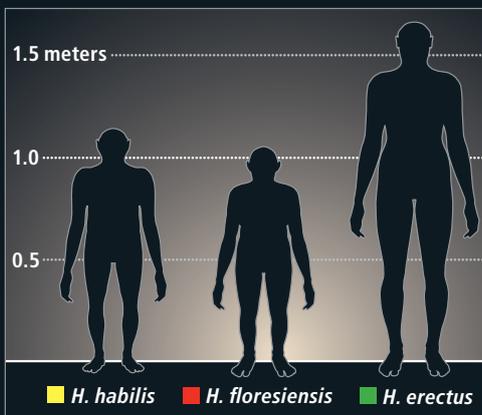
[FINDINGS]



LB1

The Hobbits' Roots

Researchers originally believed that LB1 (left) and the other hobbits, formally known as *Homo floresiensis*, were descendants of a human ancestor with essentially modern body proportions known as *H. erectus* that shrank dramatically in response to the limited resources available on their island home. But a new analysis suggests *H. floresiensis* is significantly more primitive than *H. erectus* and evolved either right after one of the earliest known members of our genus, *H. habilis* (right tree) or right before it (far right tree). Either way, the study implies that *H. floresiensis* evolved in Africa, along with the other early *Homo* species, and was already fairly small when the species reached Flores, although it may have undergone some dwarfing when it got there.



posed that humans needed to evolve large brains and long striding limbs and to invent sophisticated technology before they could finally leave their homeland.

Today the oldest unequivocal evidence of humans outside of Africa comes from the Republic of Georgia, where researchers have recovered *H. erectus* remains dating to 1.78 million years ago [see “Stranger in a New Land,” by Kate Wong; SCIENTIFIC AMERICAN, November 2003]. The discovery of the Georgian remains dispelled that notion of a brawny trailblazer with a tricked-out toolkit, because they were on the small side for *H. erectus*, and they made Oldowan tools, rather than the advanced, so-called Acheulean implements experts expected the first pioneers to make. Nevertheless, they were *H. erectus*.

But if proponents of the new view of hobbits are right, the first intercontinental migrations were undertaken hundreds of thousands of years earlier than that—and by a fundamentally different kind of human, one that arguably had more in common with primitive little Lucy than the colonizer paleoanthropologists had envisioned. This scenario implies that scientists could conceivably locate a long-lost chapter of human prehistory in the form of a two-million-year record of this primitive pioneer stretching between Africa and Southeast Asia if they look in the right places.

This suggestion does not sit well with some researchers. “The further back we try to push the divergence of the Flores [hominin], the more difficult it becomes to explain why a [hominin]

lineage that must have originated in Africa has left only one trace on the tiny island of Flores,” comments primate evolution expert Robert Martin of the Field Museum in Chicago. Martin remains unconvinced that *H. floresiensis* is a legitimate new species. In his view, the possibility that LB1—the only hobbit whose brain size is known—was a modern human with an as yet unidentified disorder that gave rise to a small brain has not been ruled out. The question, he

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MORE TO EXPLORE

The Primitive Wrist of *Homo floresiensis* and Its Implications for Hominin Evolution. Matthew W. Tocheri et al. in *Science*, Vol. 317, pages 1743–1745; September 21, 2007.

A New Human: The Startling Discovery and Strange Story of the “Hobbits” of Flores, Indonesia. Mike Morwood and Penny van Oosterzee. *Smithsonian*, 2007.

The Foot of *Homo floresiensis*. W. L. Jungers et al. in *Nature*, Vol. 459, pages 81–84; May 7, 2009.

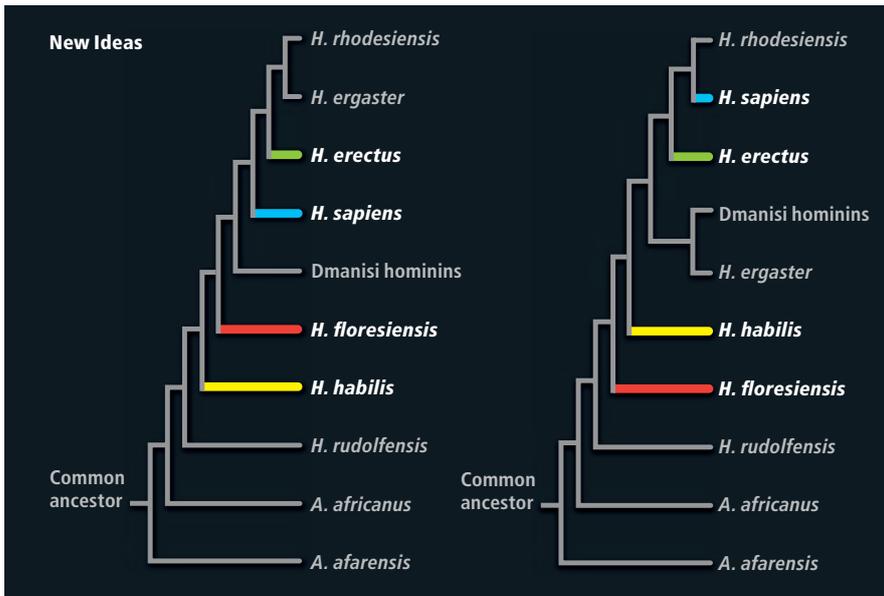
***Homo floresiensis* and the African Oldowan.** Mark W. Moore and Adam R. Brumm in *Interdisciplinary Approaches to the Oldowan*. Edited by Erella Hovers and David R. Braun. Springer, 2009.

***Homo floresiensis*: A Cladistic Analysis.** Debbie Argue et al. in *Journal of Human Evolution* (in press).

LB1’s Virtual Endocast, Microcephaly and Hominin Brain Evolution. Dean Falk et al. in *Journal of Human Evolution* (in press).

[IMPLICATIONS]





BASED ON "HOMO FLORENSIENS: A CLADISTIC ANALYSIS," DEBBIE ARGHETT ET AL. IN *JOURNAL OF HUMAN EVOLUTION* (IN PRESS) (trees)

says, is whether such a condition can also explain the australopithecinelike body of LB1.

In the meantime, many scientists are welcoming the shake-up. LB1 is “a hominin that no one would be saying anything about if we found it in Africa two million years ago,” asserts Matthew W. Tocheri of the Smithsonian Institution, who has analyzed the wrist bones of the hobbits. “The problem is that we’re finding it in Indonesia in essentially modern times.” The good news,

he adds, is that it suggests more such finds remain to be recovered.

“Given how little we know about the Asian hominin record, there is plenty of room for surprises,” observes Robin W. Dennell of the University of Sheffield in England. Dennell has postulated that even the australopithecines might have left Africa, because the grasslands they had colonized in Africa by three million years ago extended into Asia. “What we need, of course, are more discoveries—from Flores, neighboring islands such as Sulawesi, mainland Southeast Asia or anywhere else in Asia,” he says.

Morwood, for his part, is attempting to do just that. In addition to the work at Liang Bua and Mata Menge, he is helping to coordinate two projects on Sulawesi. And he is eyeing Borneo, too. Searching the mainland for the ancestors of the Liang Bua hobbits will be difficult, however, because rocks of the right age are rarely exposed in this part of the world. But with stakes this high, such challenges are unlikely to prevent intrepid fossil hunters from trying. “If we don’t find something in the next 15 years or so in that part of the world, I might start wondering whether we got this wrong,” Tocheri reflects. “The predictions are that we should find a whole bunch more.”

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Blazing a Trail

The textbook account of human origins holds that *H. erectus* was the first human ancestor to wander out of Africa and colonize distant lands around 1.8 million years ago. But the evidence from Flores suggests that an older, more primitive forebear was the original pioneer, one who ventured away from the natal continent perhaps around two million years ago. If so, then paleoanthropologists may have missed a significant chunk of the human fossil record spanning nearly two million years and stretching from Africa to Southeast Asia.

Already hobbit hunter Mike Morwood (right) is looking for more remains of *H. floresiensis* and its ancestors at two sites on Sulawesi. And he thinks further excavation at Niah cave in north Borneo could produce evidence of hominins much older than the ones at Liang Bua. The mainland will be harder to comb, because rocks of the right age are rarely exposed there.

