The real reasons why we walk on two legs, and not four

There is fossil evidence that suggests our ancestors have been walking upright for at least six million years. The question is, why did they take up the iconic stance?

- By Richard Gray

12 December 2016

Scattered across a taupe-coloured slab of rock that emerges from the bed of a dried-up river in northern Tanzania are perhaps some of the most evocative relics of our evolutionary past.

Pressed into the hardened volcanic ash are three sets of footprints. The larger ones apparently lead the smaller ones along a trail that meanders for 27m (88ft) across the once-powdery surface. They were made by a species of early human that strolled confidently through the area about 3.66 million years ago, long before our own species, *Homo sapiens*, walked the Earth.

Crisscrossing around the prints are the haphazard tracks made by ancient rabbits, antelope, hyena, baboons, giraffes and rhino. The animals may have been attracted by a watering hole that once lay nearby.

We can only speculate what these human ancestors were doing when they left these normally short-lived marks on the ground during the late Pliocene. Were they chasing down prey, stalking animals at the watering hole, or merely taking an after-dinner stroll? But one thing is immediately clear to anyone who looks at the prints. Whatever those human ancestors were doing, they did it on two legs.

The Laetoli footprints in Tanzania (Credit: Images of Africa Photobank/Alamy)

The footprints were unearthed at Laetoli, close to Tanzania's Olduvai Gorge, an area rich in fossils of our prehistoric ancestors. They are the earliest indisputable evidence that our distant ancestors had shifted from four legs to two, becoming "bipeds".

> Walking upright freed the hands for carrying and manipulating tools

Exactly why and when our ancestors stood upright and started moving around on two feet is still shrouded in mystery. The scientific community disagrees over what led early humans to abandon a life on all fours – even though it is clearly one of the defining traits of our species.

However, cutting-edge research is now providing fresh clues as to what may have driven this change.

Understanding how we came to be the bipedal creatures we are today promises to answer many of the fundamental questions we have about the evolution of our species. It is widely recognised that permanently standing up opened up new opportunities for our ancestors to touch, explore, pick up, throw and learn.

"Walking upright freed the hands for carrying and manipulating tools," says Chris Stringer, a leading anthropologist at the Natural History Museum in London. "It allows longer-distance walking and, eventually, endurance running. Ultimately, it may have been a key step that led our ancestors' brains to grow."

Walking upright freed our hands to make tools (Credit: Natural History Museum/Alamy)

Our earliest "human" predecessors are thought to have diverged from the common ancestor we share with chimpanzees sometime between 13 million and six million years ago. Most scientists agree these creatures lived high in the trees that are thought to have covered much of Africa at the time.

We only need to look at newborn human babies to see some remnants of that tree-dwelling past. Place a finger under a baby's toes and they will instinctively curl their tiny digits around it to get a grip. In the trees, infant primates cling to their mothers and to branches from birth. If they do not, they will fall and perish.

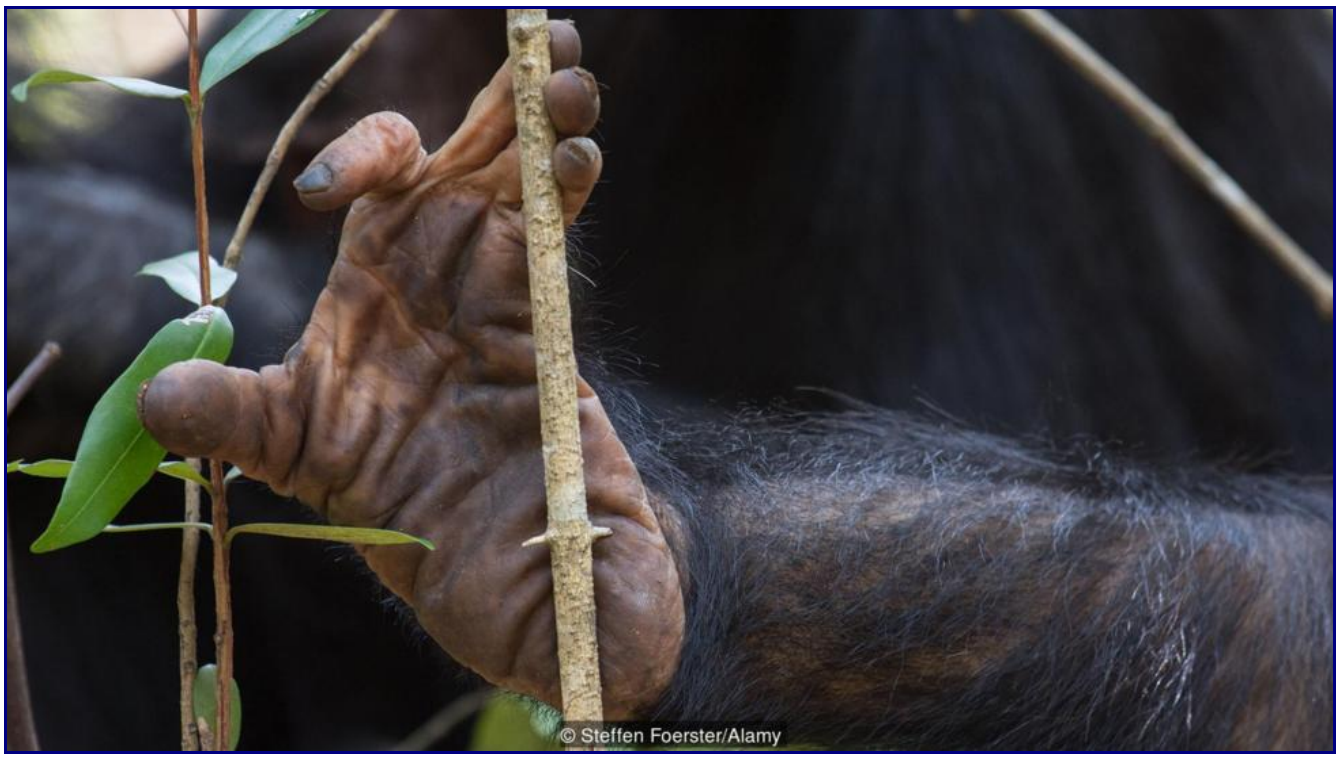
> The long-standing and dominant theory suggests climate change was a key driver of the process

Our ancestors went through several fundamental anatomical modifications to shift from four legs to two. The pelvis changed from being tall and flat from front to back to being much shorter and more bowl-shaped, giving better leverage for the muscles that move the hip in upright walking.

The angle of the thigh bone changed to point inwards, bringing our feet more directly under the centre of our bodies. Our spines also curved, forming a distinct S-shape and helping to bring our body weight over the hips and to cushion the brain while walking. Eventually our lower limbs also grew longer, allowing us to take larger, more efficient steps.

Our feet changed, too. Apes have long, opposable big toes to grab branches. Human toes are shorter and they line up with one another to create a lever to push off at the end of a step.

How and why did these changes occur?



Chimpanzees' feet are built for grasping, not walking (Credit: Steffen Foerster/Alamy)

The long-standing and dominant theory suggests climate change was a key driver of the process. Several million years ago, Africa began to lose some of its forests as vast grasslands grew, so our ancestors gradually left their ancestral forests and moved out onto the savannahs.

Bipedalism made more sense in an environment where trees were rare. Standing up allows you to see over long grass to scan for predators and prey. The ancestral humans who were best at standing would have been more likely to survive and pass on their genes, so it is easy to imagine how natural selection could have resulted in a gradual shift from simply standing up briefly to permanently moving around in an upright posture.

> The climate in Africa did not dry out enough to create savannahs until long after Sahelanthropus and Orrorin had evolved

The fossil record suggests the shift to walking on two legs might have occurred relatively early in our evolution.

For instance, fragments of a fossilised skull were discovered in Chad, west central Africa in 2001 and 2002. The ape-like creature the skull belonged to is now called *Sahelanthropus tchadensis*, and it lived between seven and six million years ago. The base of the skull shows that the neck was tucked directly below the head in a vertical position, like ours are, whereas chimpanzees tend to hold their neck horizontally. This suggests, according to its discoverers, that *Sahelanthropus* may have walked upright on two legs.

And if *Sahelanthropus* did not, another ancient ape alive six million years ago probably did. This animal, *Orrorin tugenensis*, appears to have had a thigh bone very similar in shape to a modern human one, suggesting it walked upright.

But for many, there are problems with the savannah theory. Most obviously, the climate in Africa did not dry out enough to create savannahs until long after *Sahelanthropus* and *Orrorin*

had evolved.

A skull of Sahelanthropus tchadensis (Credit: Sabena Jane Blackbird/Alamy)

In fact, the African climate has gone through many cycles through the course of human evolution, each of which altered the vegetative landscape. There was not really a clear and permanent landscape change that would have provided the impetus for such a fundamental lifestyle change as the shift from four legs to two.

> These apes move through the forest canopy by walking along branches on two legs

And then there is another niggling problem. Why do so many other creatures adapted to live on the savannah move around on all fours? There are even other primates that spend considerable time on open grasslands, like baboons, but they still move around on four legs.

Finally, there is one interesting point about the fossils of the early two-legged human ancestors. They are often found alongside the fossil bones of forest and woodland species of plants and animals.

"It sounds counter-intuitive, but perhaps the behaviour actually began in the trees," suggests Stringer. He is referring to recent research that has suggested our ancestors were already moving around on two legs long before they left the dense forests.

Observations of orangutans in Sumatra have revealed that these apes move through the forest canopy by walking along branches on two legs, using their arms to help support their weight or to hang. This helps them move over branches that are much thinner than a heavy four-legged ape would normally be able to use, allowing them to reach more fruit and also to cross from tree to tree.

Orangutans can walk on branches with their feet (Credit: dbimages/Alamy)

Human ancestors probably split from the orangutan evolutionary line about 10 million years ago, yet orangutans have knee joints strikingly similar to modern humans. According to Robin Crompton, an anthropologist at the University of Liverpool, and Susannah Thorpe, a primatologist at the University of Birmingham, this suggests the origins of bipedalism go back far further than previously believed.

"*Orrorin* shows a range of features that convince me that it is a good match for the arboreal … hand-assisted biped we envisaged," explains Crompton.

> There could be another largely overlooked intermediary step in our journey towards bipedalism

It is a theory that is gaining ground, but it is still just one of dozens of ideas that have been put forward to explain why our ancestors first stood up on two legs.

Some researchers have linked the change to a shift in hunting strategy. Two-legged apes could throw weapons and so take on bigger, faster moving prey.

Other researchers think standing upright helped our ancestors stay cool under the hot African sun. As a bonus, this idea might also help explain why our ancestors lost their hair to become naked apes. Standing up means only the top of the body needs to be protected with hair from the glare of the sun, while losing other body hair allows skin to cool more effectively in any breeze.

Arguments rage about exactly at what point in human evolution these various traits and abilities emerged, and whether they occurred early enough to push our ancestors up onto two legs.

But there is some recent research that indicates there could be another largely overlooked intermediary step in our journey towards bipedalism. And this brings us back to those footprints in Tanzania.

A reconstruction of "Lucy", an Australopithecus (Credit: Danita Delimont/Alamy)

Some researchers are now using 3D scanning technology and computer modelling to reconstruct how some species may actually have looked when they walked by studying the prehistoric footprints they left behind. Combining this with what we know about their anatomy has allowed scientists to make detailed comparisons between the gait of our early ancestors and our own way of walking today.

Two recent studies used this approach to study the Laetoli footprints. The prints are thought to belong to individuals belonging to the same species as the famous Lucy, *Australopithecus afarensis*. Living between 3.9 million and 2.9 million years ago, this species is thought to have already undergone many of the anatomical changes that allowed our ancestors to walk upright, even if there was still some way to go before walking as we would now recognise it evolved.

> She suffered multiple fractures just before her death that seem consistent with a fall from a great height

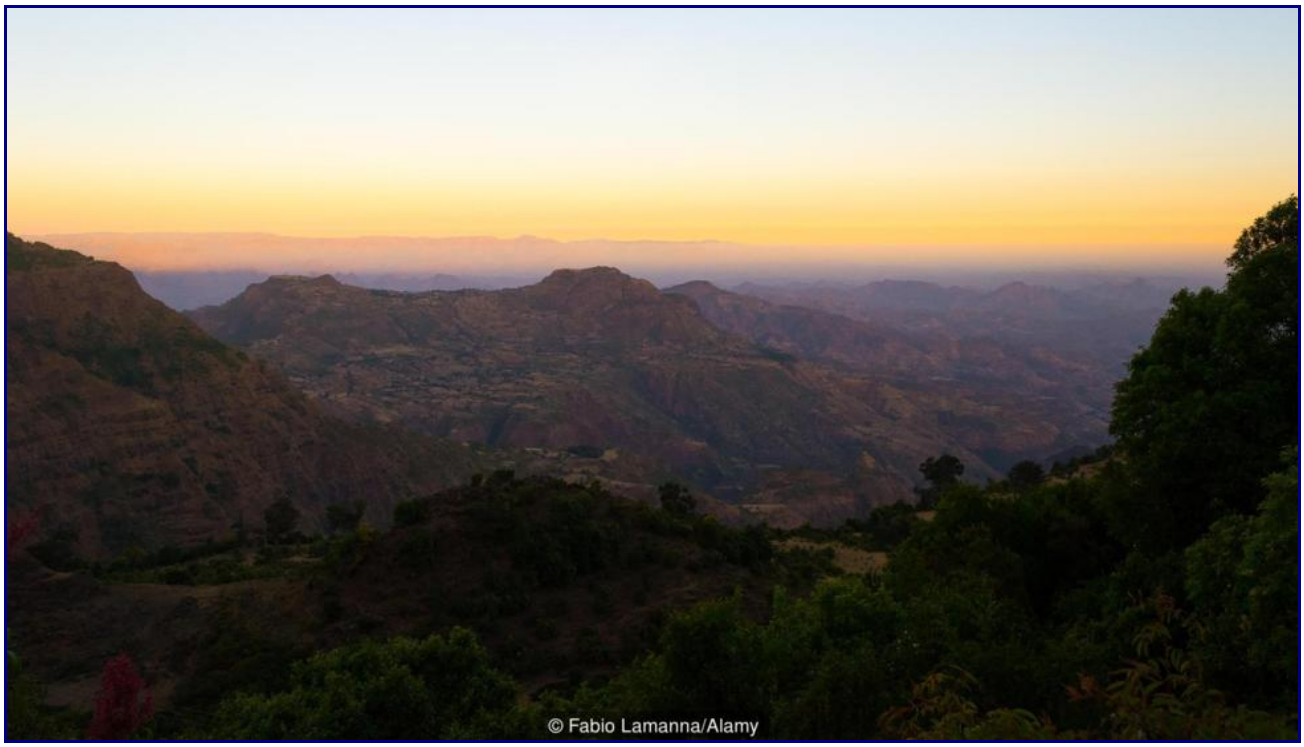
One study, by researchers at the Max Planck Institute for Evolutionary Anthropology and the American Museum of Natural History, suggested Lucy and her kin walked in a slightly unusual way. Their reconstructions from the Laetoli footprints, published in August 2016, suggest *A. afarensis* walked around on two legs with bent knees in a kind of slouched posture. This certainly would not have been terribly efficient for moving around on the open savannah at any speed.

"It does not appear that they walked in a dramatically different way from modern humans, but the Laetoli footprints still suggest some slight differences that could have made bipedal walking more energetically costly for those who made them," says Kevin Hatala of the Max Planck Institute for Evolutionary Anthropology, who led the work.

And here the story gets more perplexing. A new analysis of Lucy's skeleton, also published in

August 2016, suggests she suffered multiple fractures just before her death that seem consistent with a fall from a great height. The study – and another that the same team published in November 2016 – suggests *A. afarensis* may have spent considerable time climbing in trees.

Some new research from a surprising angle is now suggesting another possibility. Lucy might have been a rock climber.



Ethiopia's Simien Mountains, where early hominins lived (Credit: Fabio Lamanna/Alamy)

"It would be easier, evolutionarily speaking, for an ape that is already adapted to climbing to move onto rough landscapes and scramble across them, gradually spending more and more time on the ground and, eventually, more and more time out on the flat plains, than it would be for the same ape to go straight to walking on plains," says Isabelle Winder, a palaeoanthropologist at the University of York.

> Bennett believes that the human foot is actually a much more subtle and flexible tool than we give it credit for

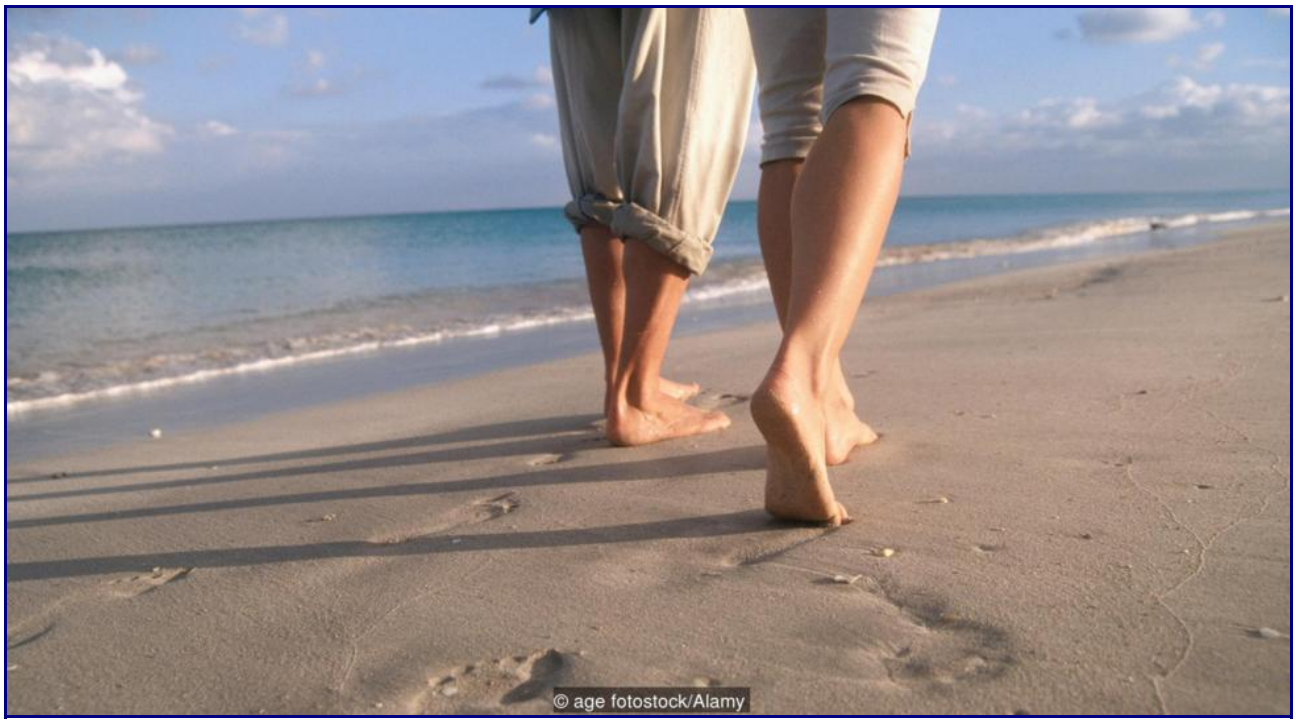
In a paper published in 2015, Winder and her colleagues suggested it may have been changes in the geological landscape that helped shape our ancestors move onto two legs.

The researchers showed that areas of east Africa where the majority of early human ancestor fossils have been found were also geologically active. Living in the tumultuous Rift Valley, these human ancestors were amidst unstable landscapes dotted with escarpments and crags.

"I think we are adapted to unstable terrain and our feet reflect that," says Matthew Bennett, an anthropologist at Bournemouth University. "East Africa has lots of fault scarps and outcrops that provide points of refuge from predators and protected places to sleep."

Bennett's own work has focused on finding new ways to study the human foot and compare

this to the feet of our ancestors. Using 3D scanning he has created models of the Laetoli footprints and others at Ileret in Kenya dating to 1.5 million years ago. These models suggest the species that made them walked around just like we do and differences to modern humans lie within the natural variability seen in the way our own species walk today.



Unlike other apes, humans mostly walk on two feet (Credit: age fotostock/Alamy)

Bennett believes that the human foot is actually a much more subtle and flexible tool than we give it credit for, perhaps because we tend to encase our own in shoes.

> Our feet are not that different from the ancient feet that made those prints more than three million years ago

"We see the foot as a simple lever that allows us to 'toe off' as we walk," he says. "That is an overly simplistic action. We have a lot of flexibility in our foot that allows us to do a range of things.

"You can scamper up a tree if you need to, you could seek refuge up a rocky slope, or you could equally make progress when moving from one water source to another on slippery ground."

So, while smudged lines of tracks in places like Laetoli provide a powerful link to our early ancestors, it seems they may also reveal that our feet are not that different from the ancient feet that made those prints more than three million years ago.