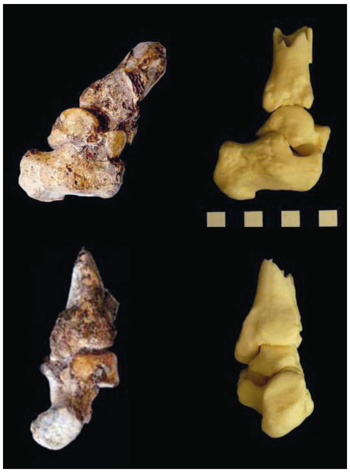
For Early Hominins in Africa, Many Ways To Take a Walk

If the bureaucrats of Monty Python's Ministry of Silly Walks were to establish a hall of fame, they might consider inducting *Australopithecus sediba*, who walked with its weight balanced oddly on the inside edge of its soles about 2 million years ago in South Africa. Or they might ponder the contrasting way two types of australopithecines strolled across the same region of Ethiopia's Rift Valley about 3.4 million years ago. While one strode much like humans do today, the other tucked in its opposable big toe and swayed from side to side. "The take-home message here this morning is … there were different ways of being a good biped throughout early human evolution," paleoanthropologist Jeremy DeSilva of Boston University reported.

Of course, the walks weren't silly to these early hominins, the group that includes humans and our ancestors but not other apes. At the time, these gaits were adaptive, and so they shed light on how upright walking evolved in different habitats. Several new studies of incredibly rare fossils of feet and partial skeletons reported at the meeting reveal the complexity of early bipedalism. "By seeing subtle differences in different species, we're moving beyond the (simple) debate of whether a hominin had a humanlike bipedalism or not," says paleoanthropologist Brian Richmond of George Washington University in Washington, D.C.

Until recently, many thought that upright walking—a defining trait of being a hominin—evolved step by step in one lineage relatively quickly, perhaps just before the emergence of *Au. afarensis*—the species of the famous fossil Lucy—about 3.6 million years ago. But the discovery of older upright walkers, including the 4.4-million-year-old *Ardipithecus ramidus* and the 6-million-year-old *Orrorin tugenensis*, have pushed back the origins of bipedalism to 6 million years ago (*Science*, 2 October 2009, p. 36).

This spring, researchers unveiled the more primitive foot of a still-unnamed species of *Australopithecus* from Burtele, near Hadar, Lucy's home in Ethiopia. That showed that at least two kinds of hominins walked upright in different ways at the same time 4 million to 3 million years ago (see http://scim.ag/EarlyAncestor).



Different steps. The Burtele foot from Ethiopia (*left*) and the *Au. sediba* foot from South Africa show different ways of walking upright.

In a talk, paleoanthropologist Yohannes Haile-Selassie of the Cleveland Museum of Natural History in Ohio showed how the new foot shared features such as an opposable big toe with older *Ar. ramidus*, which suggests that both hominins still spent considerable time in trees. The foot also shared a key trait (the shape of a toe bone) with *Au. africanus*, which lived about 2 million years ago in South Africa. Neither of those features is found in *Au. afarensis*, suggesting that Lucy's species cannot be the direct ancestor of *Au. africanus*. That means that a second hominin lineage, with a different way of walking, must have led to *Au. africanus*, Haile-Selassie notes. (Lucy's species is still the leading candidate for ancestor to early *Homo*.)

Meanwhile, DeSilva reported at the meeting that his analysis of the feet of two newly discovered partial skeletons of *Au. sediba*, considered a relative of *Au. africanus*, shows that this species walked with "excessive" pronation. It landed on its primitive, narrow heel and shifted its weight to the inside of its sole. "The big question now is why did it walk this way?" DeSilva says. All this variation in bipedalism shows that "through much of human evolution, there were several experiments in bipedalism going on," he adds.

One long-standing hypothesis holds that bipedalism arose because it's energetically more efficient to walk upright on two legs rather than on four. But paleoanthropologist Herman Pontzer of Hunter College in New York City and David Raichlen of the University of Arizona in Tucson reported in a poster that that idea doesn't hold up. They modeled the energy cost of walking and found that long-legged hominins are energetically efficient because they walk with straight legs, with their knees directly over their lower legs. In contrast, the crouched, bent-knee posture of the earliest hominins, such as *Ardipithecus,* required more muscle activation and energy. Simply walking on two legs instead of four doesn't save energy, so the earliest hominins must have begun walking upright for other reasons. Taken together, the flurry of new reports suggest to Pontzer that "our models of the origins of bipedalism are overly simple."

How the Modern Body Shaped Up

Modern humans have gone through a lot of changes in the past 30,000 years. We switched from hunting and gathering to farming and herding; from life as nomads to settling in urban centers; from eating meat, nuts, and tubers to consuming grains, sugars, and dairy products. Now, a remarkably comprehensive analysis of more than 2000 European skeletons presented at the meeting reveals how these cultural changes have altered our physiques. "When you become a modern human, what happens to your body?" asked paleoanthropologist Christopher Ruff of Johns Hopkins University in Baltimore, Maryland, co-chair of the session on skeletal adaptation in recent Europeans.

While other studies have documented a decrease in height after the transition to agriculture, this is the first systematic study

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Older Dads Have Healthier Kids Than You Think

Older fathers often get blamed for passing on genetic mutations to their children, causing some types of autism, schizophrenia, and other disorders. But new data presented at the meeting suggest that children of older fathers and grandfathers may inherit at least one advantage from aging patriarchs: longer telomeres, structures at the tips of chromosomes that may protect against aging and disease. And the effect is amplified over the generations: "We've shown that the paternal grandfather's age is associated with longer telomeres in his grandchildren," graduate student Dan Eisenberg of Northwestern University in Evanston, Illinois, reported in a talk.

Telomeres are repetitive sequences of DNA that prevent the ends of chromosomes from unraveling, much like the plastic tips on the ends of shoelaces. As cells divide and replicate, telomeres get shorter and eventually can no longer prevent the fraying of DNA and the decay of aging. Recent studies have found a link between living to 100 and having a hyperactive version of telomerase, an enzyme that keeps telomeres long.

Telomeres in sperm cells, however, are exceptional: Several studies have shown that they grow longer, not shorter, over the years, probably because telomerase activity is high in testes. As a result, sperm cells from older men have longer telomeres than those of younger men. That would suggest that the older a father is at conception, the longer the telomeres his sons and daughters inherit.

Working with Northwestern biological anthropologist Christopher Kuzawa and anthropological geneticist Geoff Hayes, Eisenberg examined data from a long-term study of 3327 women who were pregnant in 1983 in the Cebu Longitudinal Health and Nutrition Survey in the Philippines. They had gathered the ages of fathers and in 2005 measured telomere length in the blood of 1845 moms and 1681 children.

Children of older fathers did indeed have longer telomeres than those of younger dads: For each additional decade of age in fathers at conception, sons and daughters had 4% longer telomeres, a finding that corroborates earlier work. The Northwestern group also found that for every additional decade of age in grandfathers, the grandchildren's telomeres added another 4%. But grandfathers did not pass on their longer telomeres to their daughters' children, only their sons', suggesting that this is a paternal effect.

Grandfather effect. Older fathers in the Philippines passed on long telomeres to their sons and grandsons.

The increase in telomere length per year of fathers' age is just about the same amount as telomere length lost per year in normal aging, Eisenberg says. So the longer telomeres in sperm roughly offset normal aging, giving children of older dads an advantage. "It's as if you delay reproduction, you earn this kind of higher fitness for your offspring," says biological anthropologist Koji Lum of Binghamton University in New York.

Any benefit in telomere length may still be swamped out by the risk of passing on more mutations, Eisenberg warns: "We don't know yet the net health effect." So at the moment, he's not advising anyone to delay fatherhood. **–A.G.**

of how the skeleton changed from the time modern humans spread through Europe 30,000 years ago until they were circling the globe in jets by the 1960s. In 10 posters, Ruff and his colleagues focused on how each part of the body, from the spine to leg and arm bones, evolved over time through both genetic and cultural change.

One of the most significant findings is a dramatic drop in strength in leg bones. Leg bending strength, or resistance to fracture, declined by 25% to 33% from 27,000 years ago to 1900 C.E., as shown by the cross-sectional dimensions of the upper and lower leg bones of 1834 men and 786 women, according to a poster by Brigitte Holt of the University of Massachusetts, Amherst, and her colleagues. This is "huge," Ruff says. "We interpret this to reflect the move from a hunting-gathering lifestyle to a more sedentary agricultural lifestyle across Europe." Our ancestors needed stronger legs to walk farther, especially if carrying goods.

Over the same 30,000-year period, upper body strength declined after the introduction of agriculture. In males, it then increased in the Medieval period, possibly due to intensive upper-body labor such as blacksmithing. One trend through time is that the right arm lost much of its asymmetric larger size compared to the left arm, perhaps due to fewer strongly lateralized activities such as spear throwing. Women show particularly symmetrical arms from the beginning of agriculture 7000 years ago to Europe's Bronze Age, 3000 years ago. The researchers suspect that this stems from using both arms to make flour with grinding stones.

Strong-arm tactics. Men had stronger right arms, perhaps from throwing spears and other activities, before the invention of agriculture.

As for overall height, about 30,000 years ago, European men stood 1.72 meters tall, almost as tall as Europeans today. Their height and weight dropped steadily until 4000 years ago, probably because of poorer nutrition and health, particularly with the advent of agriculture 10,000 years ago. With a few exceptions—for example, milk-drinking Scandinavians—Europeans got even shorter during the Medieval period and stayed short until 1900.

The study has produced "an awesomely comprehensive picture of skeletal adaptation," says bioarchaeologist Clark Spencer Larsen of Ohio State University in Columbus, who was not part of the team. Jay Stock of the University of Cambridge in the United Kingdom agrees that the study is a "major milestone. … It is a major achievement to quantify human variation through time and space with this resolution." **–ANN GIBBONS**

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