Footprints to Fill: Flat feet and doubts about makers of the Laetoli tracks
By Kate Wong
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*Australopithecus afarensis*

[1] It is one of the most evocative traces of humanity's ancestors ever found, a trail of footprints pressed into new fallen volcanic ash some 3.6 million years ago in what is now Laetoli, Tanzania. Discovered in 1978 by a team headed by Mary Leakey, the Laetoli footprints led to the stunning revelation that humans walked upright well before they made stone tools or evolved large brains. They also engendered controversy: scientists have debated everything from how many individuals made the prints to how best to protect them for posterity. Experts have generally come to agree, however, that the tracks probably belong to members of the species *Australopithecus afarensis*, the hominid most famously represented by the Lucy fossil. Now new research is calling even that conclusion into question.

[2] The case for *A. afarensis* as the Laetoli trailblazer hinges on the fact that fossils of the species are known from the site and that the only available reconstruction of what this hominid's foot looked like is compatible with the morphology evident in the footprints. But in a presentation given at the American Association of Physical Anthropologists meeting in April, William E. H. Harcourt-Smith of the American Museum of Natural History and Charles E. Hilton of Western Michigan University took issue with the latter assertion.

[3] The prints show that whoever made them had a humanlike foot arch, and the reconstructed *A. afarensis* foot exhibits just such an arch. So far, so good. The problem, Harcourt-Smith and Hilton say, is that the reconstruction is actually based on a patchwork of bones from 3.2-million-year-old afarensis and 1.8-million-year-old Homo habilis. And one of the bones used to determine whether the foot was in fact arched— the so-called navicular— is from *H. habilis*, not *A. afarensis*.

[4] To get a toehold on the Laetoli problem, the researchers first compared the gaits of modern humans walking on sand with two sets of the fossil tracks. This analysis confirmed that the ancient footprints were left by individuals who had a striding bipedal gait very much like that of people today. The team then scrutinized naviculars of *A. afarensis, H. habilis*, chimpanzees and gorillas. The dimensions of the *H. habilis* navicular fell within the modern human range. In contrast, the *A. afarensis* bone resembled that of the flat-footed apes, making it improbable that its foot had an arch like our own. As such, the researchers report, *A. afarensis* almost certainly did not walk like us or, by extension, like the hominids at Laetoli.

[5] But according to bipedalism expert C. Owen Lovejoy of Kent State University, other features of the australopithecine foot, such as a big toe that lines up with, rather than opposes, the other toes, indicate that it did have an arch. Even if it did not, Lovejoy contends, that would not mean *A. afarensis* was incapable of humanlike walking. "Lots of modern humans are flat-footed,” he observes. "They are more prone to injury, because they lack the energy-absorptive capacities of the arch, but they walk in a perfectly normal way."

Becoming Human
http://www.becominghuman.org/node/australopithecus-africanus-essay
**Australopithecus africanus**

[1] The first member of its genus to be discovered, *Australopithecus africanus* is the oldest species of hominin to be found in southern Africa. Cave sites where it is found have been dated approximately to 3-2.0 ma based mostly on biochronological methods (dating methods utilizing the relative chronologies of non-hominin animal fossils). Its morphology is similar to *Australopithecus afarensis*, but it has important differences in the skull and teeth. The fact that *Au. africanus* shares some morphological features with *Au. afarensis*, and others with early *Homo* species makes it a difficult species to place in the hominin lineage. Thus, understanding *Au. africanus* is central to understanding early hominin phylogeny.

[2] The first specimen of *Au. africanus* to be found, in 1924, was a juvenile skull from the site of Taung in South Africa. The biologist Raymond Dart believed that this specimen was a member of the hominin clade based on the forward positioning of the foramen magnum (the hole in the base of the skull where the spinal cord connects with the brain), which is seen in humans and other bipedal hominins. Many scientists at the time did not believe Dart’s assertion and thought the skull was of a non-hominin ape, particularly because they thought that hominins would have larger brains than that possessed by *Au. Africanus* . . .

[3] It was not until the 1950s that *Au. africanus* was recognized by the scientific community as such, a true hominin. By this time, a number of cranial and other postcranial (skeletal material not from the skull) specimens attributed to *Au. africanus* had been found in limestone caves at Sterkfontein, Taung, and Makapansgat, all in South Africa. These sites are limestone caves that were eaten away by rainwater and filled with animal remains and sediments from the surface.

[4] Because of this context, the sites at which *Au. africanus* has been found do not have easily defined layers and dating of the sites is difficult, especially since South Africa lacks volcanic layers that would allow for radioactive isotopic dating (dating of the volcanic material using the timing of decaying isotopes within the material). Thus, these sites are primarily dated using biochronological methods. The fauna that are used to date these sites have also led scientists to reconstruct the habitats at which *Au. africanus* lived as woodland and open woodland savanna.

[5] The morphology of *Au. africanus* is similar to *A. afarensis* in many ways. For instance, it is small-bodied compared to later hominins and possesses the pelvic structures and adaptations to the legs and feet that characterize habitual bipeds, such as a broad, short pelvis and a valgus knee (a knee that is angled underneath the body). It also has curved phalanges (finger bones) like *Au. afarensis*; this fact, coupled with finding remains in areas reconstructed as wooded environments, has led to the possibility that *Au. africanus* spent at least some time in trees. *Au. africanus* also lacks many features associated with consumption of hard foods; for example, *Au. africanus* lacks sagittal crests (crests along the midline of the skull where chewing muscles attach) and flared zygomatics (cheek bones), which are found in most specimens assigned to more primitive hominins.

[6] However, *Au. africanus* has a slightly larger estimated brain size than *Au. afarensis*, and has larger post-canine teeth (molars and premolars) and smaller anterior teeth (incisors and canines) than does *Au. Afarensis*. These traits are derived relative to *A. afarensis*; that is, they are different than the condition found in *A. afarensis* and have evolved in the lineage leading to *Au. africanus*. *Au. Africanus* also has a slightly less prognathic (projecting) face, although this trait is variable in the species.

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**The Rise of the Human Predator**

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*By Kate Wong*

[1] Some 279,000 years ago, on a ridge overlooking a vast lake in central Ethiopia’s Rift Valley, hunters painstakingly shaped chunks of greenish black volcanic glass into small, sharp points. After chipping the brittle material to create cutting edges, they attached each point to a shaft of wood, producing a sort of javelin. It might sound like a modest feat of engineering by today’s standards. But the technology was nothing less than revolutionary. With it, members of the human lineage had at their disposal a weapon that would allow them to kill much more effectively from afar than a simple wooden spear could. Not only would that development enable our predecessors to hunt a broader range of animals, but it also upped their odds of emerging from the hunt unscathed by putting a safe distance between them and large, dangerous prey, perhaps including the hippos that would have lurked in and around the nearby lake.

[2] As far as technological inventions go, this stone-tipped throwing spear was arguably humanity’s crowning achievement at the time. But perhaps more remarkable than the hunting gains it afforded is the fact that the conceptualization, manufacture and use of this
seemingly simple device were made possible only through the piecemeal acquisition, over tens of thousands of generations, of traits that helped our forebears acquire meat.

[3] In our era of supermarkets and fast food, it is easy to forget that we humans are natural-born hunters. We certainly don’t look the part. We are slow, we are weak, and we lack the killer teeth and claws that other carnivores wield against their quarry. Indeed, compared with other carnivores—from crocodiles to cheetahs—humans appear decidedly ill suited to procuring prey. Yet we are the most lethal predators on earth—a distinction earned long before the advent of vehicles to carry us to our targets and guns to dispatch them.

[4] Over the course of millions of years evolution transformed our mostly vegetarian ancestors (creatures like the famous Australopithecus afarensis individual known as Lucy) into a singularly deadly primate. In fact, many of the characteristics that set us apart from our closest living relatives, the great apes—from our ability to run long distances to our oversize brains—may have arisen at least in part as adaptations to hunting. Recent discoveries have illuminated some previously murky phases of this metamorphosis, documenting among other things the debut of our throwing arm and the earliest known evidence of big game hunting. With these new insights, researchers now have the most detailed picture yet of the emergence of the traits that honed our hunting prowess—and in so doing made us human.

BRAVE NEW WORLD

[5] To understand how important a role hunting played in our evolution, we must page back some three million years to a time when early hominins (creatures more closely related to us than to our closest living relatives, the chimpanzees and bonobos) were headed toward a cross roads. The climate was changing, and across Africa the forests and wood lands where our forebears had long foraged for fruit and leaves were giving way to more open grasslands, where such foods were harder to come by. The hominins would have to adapt or die. Some, namely the so-called robust australopithecines, seem to have coped with this environmental change by evolving massive jaws and teeth that could grind up grasses and other tough plant foods. The lineage that includes our genus, Homo, took a radically different tack, expanding its diet to include increasing amounts of animal protein and fat. Both approaches stood our predecessors in good stead for a long time. But eventually, around a million years ago, the robust australopithecines went extinct.

[6] Scientists may never learn exactly why the robusts died out. Perhaps they had become so specialized that when environmental conditions changed again, they could not shift gears and effectively exploit other menu options. Or maybe Homo out-competed them. What is abundantly clear, however, is that in turning to animals for sustenance, the Homo lineage hit on a winning strategy, one that would help fuel its rise to world domination.

[7] Numerous changes to the anatomy of our hominin ancestors conspired to make them formidable competitors on the savanna, where sabertooth cats and other large-bodied carnivores had long reigned unchallenged. One important suite of characteristics compensated for our lack of speed. Although, to this day, we humans, with our bipedal form of locomotion, are lousy sprinters compared with quadrupeds, we excel at long-distance running. No other living primate even comes close to this level of running ability. Daniel Lieberman of Harvard University and Dennis Bramble of the University of Utah have proposed that this capability evolved to help hominins hunt, allowing them to pursue their prey until it slowed or collapsed from exhaustion. Judging from the relevant traits that are preserved in the fossil record—such as enlarged hind-limb joints and short toes, among many other characteristics that improved running performance—endurance running originated in Homo by around two million years ago . . .

[8] Catching up to fleet-footed prey was only half the battle, however. To close the deal, the hunters needed to be able to deliver the deathblow, preferably with a heavy or sharp object lobbed from a safe distance. Could early Homo manage this feat? Modern humans shine at throwing with speed and accuracy. Chimpanzees, in contrast, perform this task dismally. Recently Neil T. Roach of George Washington University and his colleagues set out to determine why we humans are so much better at throwing than chimps are and when this ability evolved. The key to our throwing skills, it turns out, lies in the elastic energy in our shoulder muscles. Studying college baseball players, Roach and his coworkers identified three features present in modern humans but not in chimps that greatly enhance our upper body’s range of motion and thus its ability to store and release this energy: a flexible waist, a less twisted upper arm bone and a shoulder socket that faces out to the side rather than upward as it does in apes.

[9] Turning to the fossil record, Roach’s team was able to identify when these traits that permitted high-speed throwing evolved. They did not emerge in lockstep but rather in mosaic fashion. The longer waist and straighter upper arm bone appeared early on, in the australopithecines; the shift in shoulder-socket orientation, for its part, debuted some two million years ago in Homo erectus. It is
admittedly difficult to establish with certainty that natural selection favored any given trait for a particular purpose, such as endurance running or throwing as a means to hunt. In some cases, selection might have initially promoted the trait for a different reason altogether—only to subsequently see it co-opted for another activity. Our tall waist, for example, seems to have originated as part of a package of traits that facilitated upright walking. But later, with the addition of other, complementary features, it took on a new role, helping our ancestors increase their torque production so as to hurl an object at a target with greater force.

[10] Nevertheless, Roach suspects that selection for throwing was driving the shoulder changes that emerged around two million years ago. He thinks so in part because those changes were making our ancestors worse at another important activity: climbing trees, which had long furnished hominins with food and safe haven from ground-dwelling predators. “When you give up going up into trees easily, you need to be getting something else,” Roach remarks. A better throwing arm would have afforded *Homo* improved access to animal foods rich in calories while allowing hominins to drive off predators that tried to attack them or steal their kills.

**BUTCHERED BONES**

[11] Although the fossil record indicates that hominins had evolved a suite of anatomical features well suited to hunting by two million years ago, it does not establish that they were in fact systematically killing animals for food at that time. To do that, scientists must find telltale traces of hunting in the archaeological record—no easy task. Stone tools and cut-marked bones show that early humans started butchering animals by 2.6 million years ago. But did our ancestors kill the prey themselves, or did they let big cats and other carnivores do the heavy lifting?

[12] For decades experts have debated whether early *Homo* hunted or scavenged. The earliest unequivocal evidence of hunting—wooden spears and animal remains from the German site of Schöningen—was just 400,000 years old. But over the past few years compelling evidence of much earlier hunting has emerged from studies of large assemblages of butchered animal remains from sites in East Africa that date to the time of early *Homo*.

[13] One of these assemblages comes from a site in Tanzania’s famed Olduvai Gorge known as FLK Zinj. Some 1.8 million years ago hominins transported carcass after carcass of wildebeest and other large mammals there to carve up and eat. British paleoanthropologist Mary Leakey excavated most of the bones in the 1960s, and scholars have been arguing ever since about whether the animals there were hunted or scavenged. Henry T. Bunn of the University of Wisconsin–Madison was thinking about the problem of distinguishing hunted animals from scavenged ones when it dawned on him that the tactics should leave different signatures in what is called the mortality profile of the bones. For instance, when it comes to hunting large game, such as waterbuck, lions tend to pick off a disproportionately high number of old individuals relative to their frequency in a typical living herd. Thus, if early humans were scavenging kills by lions or other large carnivores at FLK Zinj, the assemblage should show a similar overrepresentation of old individuals. Instead Bunn and his colleagues found, the butchered large mammal remains at the site skew much more heavily to individuals in their prime than to old or juvenile animals, exhibiting the pattern one would expect to see if humans were selecting the animals they wanted and killing them themselves.

[14] In fact, the FLK Zinj pattern closely resembles that of prey hunted nowadays by the Hadza hunter-gatherers in Tanzania and the San in Botswana using bows and arrows. So far as is known, *Homo* had yet to invent long-range projectile weapons such as the bow and arrow at this point. But Bunn thinks that the hominins may have engaged in ambush hunting by parking themselves in trees near water sources and launching sharpened wooden spears at unsuspecting animals at close range as they passed below en route to drink.

[15] Even older traces of hunting have come from western Kenya, at a site called Kanjera South on the shores of Lake Victoria, where Joseph Ferraro of Baylor University, Thomas W. Plummer of Queens College, C.U.N.Y., and their collaborators have unearthed thousands of stone tools and animal bones that were stripped of their flesh and marrow. Most of the bones, which date to about two million years ago, come from small, young antelopes and show little carnivore damage, which supports the idea that hominins hunted the prey rather than acquiring carnivore leavings. Moreover, Plummer says, the antelopes were small enough that if large carnivores had killed them, they would have completely consumed the carcasses rather than leaving any tissue behind.

[16] The Kanjera remains are “the oldest solid evidence for hunting so far,” Plummer asserts. Most important, the hominins at this site clearly did not merely prepare an experimental steak dinner only to return to a vegan lifestyle. The bones hail from sediment layers representing hundreds or perhaps thousands of years of what the team calls “persistent hominin carnivory.” These individuals had committed to routine consumption of substantial amounts of animal tissue. It is not the only thing they ate—analyses of the tools from the site show that they were also processing plants, including tubers—but it formed a mainstay of their diet.
DEEP IMPACT
[17] It is hard to overstate the impact of Homo’s shift to a meaty diet. Trends evident in the fossil and archaeological records indicate that it established a feedback loop in which access to calorie-packed food fueled brain growth, which led to the invention of technologies that permitted our ancestors to obtain even more meat (as well as high-quality plant foods), which in turn powered further expansion of gray matter. As a result, between two million and 200,000 years ago brain size swelled from roughly 600 cubic centimeters on average in the earliest representatives of Homo to around 1,300 cubic centimeters in Homo sapiens.

[18] Carnivory also would have radically changed the social dynamics among our ancestors, particularly once they began hunting larger prey that could be shared with other members of the group. Travis Pickering of the University of Wisconsin–Madison explains that this development ultimately led to greater social organization in early Homo, including a division of labor whereby men hunted large game and women gathered plant foods and both groups returned to a central meeting place at the end of the day to eat. By the time our ancestors were hunting large game such as the wildebeest at FLK Zinj, he thinks, they were organizing themselves in this way. And although today it might sound like an antiquated arrangement, that divvying up of responsibilities between the sexes proved to be a remarkably successful hominin adaptation.

[19] Pickering furthermore suspects that the shift toward meat eating fostered self-control in our forebears. Although conventional wisdom holds that hunting promoted aggression in humans—a view based on observations of chimps hunting aggressively—he believes it cultivated level-headedness. Unlike chimps, which have brute strength and lethal teeth, early humans could not merely overpower their quarry with an aggressive attack. Instead, Pickering argues, “they gained emotional control” and acquired prey using brains not brawn. In his view, the advent of tools that enabled hominins to kill from a distance helped them decouple aggressive emotions from hunting.

[20] Support for this hypothesis comes from Iowa State University primatologist Jill Pruetz’s studies of an unusual population of grassland-dwelling chimpanzees in Senegal. Unlike their forest-dwelling counterparts, which hunt large, dangerous monkeys with their bare hands, the Senegalese chimps mostly target tiny nocturnal primates known as bush babies using sharpened sticks that they jab into tree hollows where the tiny primates sleep during the day. Pickering notes that the Senegalese chimps go about their hunting in a far more subdued manner than the forest chimps, which subject their prey to frenzied beatings. Perhaps the “spears” used by these chimps help them keep their cool.

[21] Hunting also made us human in another respect. H. sapiens is unique among primates in having colonized every corner of the globe. For the first five million years of hominin evolution, our predecessors remained within the bounds of Africa. But sometime after two million years ago, Homo began to expand its reach into other parts of the Old World. Why the sudden wanderlust? Theories abound, but it may well be that hunting led hominins out of the motherland. Back then, much of Eurasia was covered by savanna grasslands similar to those in which Homo was accustomed to foraging in Africa. Thus, hominins might have been pursuing game when they took those first fateful steps out of Africa.

[22] Many more hominin migrations ensued in the millennia that followed, each driven by its own unique circumstances. And although our predecessors may not have always been tracking game on these trailblazing journeys, their ability to colonize far-flung places and thrive under wholly new ecological conditions hinged on the physical and behavioral traits that helped Homo become the least likely, most successful predator the world has ever known.

THE PREDATORY TRANSITION FROM APE TO MAN [excerpt]
by Raymond A. Dart
International Anthropological and Linguistic Review, v. 1, no.4, 1953

The carnivorous habit in mankind
[1] The loathsome cruelty of mankind to man forms one of his inescapable characteristics and differentiative features; and it is explicable only in terms of his carnivorous, and cannibalistic origin. The blood-bespattered, slaughter-gutted archives of human history from the earliest Egyptian and Sumerian records to the most recent atrocities of the Second World War accord with early universal cannibalism, with animal and human sacrificial practices of their substitutes in formalized religions and with the world-wide scalping, head-hunting, body-mutilating and necrophilic practices of mankind in proclaiming this common bloodlust differentiator, this predaceous habit, this mark of Cain that separates man dietetically from his anthropoid relatives and allies him rather with the deadliest of Carnivora.
Yet, although he cited Roman gladiator shows, scalping, head-hunting, infanticide, slavery, love of inflicting torture and indifference to suffering, as indications of a low-state of moral sense amongst civilized and primitive peoples, Darwin did not deduce from those observations, that man had arisen from a predaceous anthropoid stock. Still, whether cognizant of the wider implications of his comments or not, he made this statement: "If it be an advantage to man to stand firmly on his feet and to have his head and arms free, of which, from his pre-eminent success in the battle of life, there can be no doubt, then I can see no reason why it should not have been advantageous to the progenitors of man to have become more and more erect or bipedal. They would thus have been better able to defend themselves with stones and clubs, to attack their prey, or otherwise obtain food".

Thus Darwin dared to picture not merely early men but also their progenitors as hunters.' What is 'prey'? According to the Concise Oxford Dictionary (3d ed., 1934) it is "animal hunted or killed by carnivorous animal for food". The predaceous habit is therefore 'living by preying', i.e. hunting down and killing animals for food. On this thesis man's predecessors differed from living apes in being confirmed killers: carnivorous creatures, that seized living quarries by violence, battered them to death, tore apart their broken bodies, dismembered them limb from limb, slaking their ravenous thirst with the hot blood of victims and greedily devouring livid writhing flesh. Further, if Darwin's reasoning was correct, man's erect posture is the concrete expression of signal success in this type of life. It emerged through and was consolidated by the defensive and offensive stone-throwing and club-swinging technique necessitated by attacking and killing prey from the standing position.

This purposive industrial specialization of the hands in accurate hitting & throwing, as I pointed out (1949b), was the only persistent stimulus capable of transferring the body weight from the clambering knuckles . . . Man makes such persistent use of his hands and his whole torsional bodily strength in the erect posture that he can use his fists deftly and accurately as weapons, either open as in slapping and cuffing, or closed as in boxing and pounding. He is the only fisted creature on earth.