Week 5 May 2018

The First Geniuses by Billy Collins Poet Laureate United States, University of Pittsburgh Press, Page 31

It is so early almost nothing has happened. Agriculture is an unplanted seed. Music and the felt hat are thousands of years away. The sail and the astrolabe, not even specks on the horizon. The window and scissors; inconceivable.

But even now, before the orchestra of history has had time to warm up, the first geniuses have found one another and gathered into a thoughtful group. Gaunt, tall and bearded, as you might expect, they stand outlined against a landscape of smoking volcanoes or move along the shores of lakes, still leaden and unnamed, or sit on high bare cliffs looking like early arrivals at a party the earth is about to throw now that the dinosaurs have finally cleared the room.

They have yet to discover fire, much less invent the wheel so they wander a world mostly dark and motionless wondering what to do with their wisdom like young girls wonder what to do with their hair.

Once in a while someone will make a pronouncement about the movement of the stars, the density of silence, or the strange behavior of water in winter, but there is no alphabet, not a drop on ink on earth, so the words disappear into the deep green forests like flocks of small, startled birds.

Eventually one of them will come up with the compass or draw the first number in sand with a stick, and he will let out a shout like Archimedes in his tub and curious animals will look up from their grazing.

Later the water screw and the catapult will appear; the nail, the speedometer and the bow tie will follow. But until then they can only pace the world gravely, knowing nothing but the thrumming of their minds, not the whereabouts of north or the notion of zero, not even how to sharpen a stone to deadly point.

Billy Collins poem captures in comic fashion the frustration of what it must have been (and still is for many) to imagine ideas without the-where-with-all to make those ideas happen or if in some way they happen, pass them on to later generations; and so the great silence between ideas in the brain of one and the realization of those ideas within the minds of others in the present and future**.** Thus many potentially great ideas have been extinguished before they take hold to be forgotten or to be reimagined in the future, perhaps many times.

From Robin Dunbar. ***Human Evolution***. Pelican an imprint of Penguin Books 2014, Page 97

Robin Dunbar is an evolutionary psychologist and fellow of Magdalen College, Oxford University, UK

"By far the most iconic moment in the study of human evolution is represented by a 35 m trackway of fossilized footprints that were discovered by at Laetoli in northern Tanzania by the fossil hunter Mary Leakey in 1978. Dated to around 3.6 million years ago, they show the tracts of two adults and a juvenile preserved in light volcanic ash that was falling from nearby Mount Sadiman during one of its periodic eruptions. A light rain hardened the ash shortly afterwards and preserved the footprints under further layers of volcanic ash. The two adults were walking more or less in each other's footsteps, while the juvenile's prints cross in and out of their tracks. The footprints are all but identical to those made by modern living humans, and quite different to those made by an ape. The stride is relatively short and the prints full-footed, indicating that the individuals were walking at a leisurely, unhurried pace… It is impossible not to see this as a vignette of everyday life frozen in time, and many have been tempted to do so."

Robin Dunbar's view that the trail of footprints in ash left behind by our ancestors 3.6 million years ago might just be one of the most iconic images in the story of human origins is surely close to the mark. For nothing sparks our human imaginations more than speculation about these three hominins leisurely walking along, the juvenile's footprints weaving back and forth

through the adults. Who were they, what were they thinking about, where were they going and why? All questions. Those handprints in European and Indonesian caves, millions of years later provoke their own questions but together our response, whether to the footprints or the handprints, remind us that we are a highly imaginative, and yes, spiritual species.

Jacob Bronowski from his *Book* ***The Ascent of Man*** (1973) Little, Brown and Company, Boston, Pages 19-20

"Man is a singular creature. He has a set of gifts, which make him unique among the animals: so that unlike them, he is not a figure in the landscape – he is a shaper of the landscape. In body and in mind he is the explorer of nature, the ubiquitous animal, who did not find but has made his home in every continent … Among the multitude of animals that scamper, fly, burrow an swim around us, man is the only one who is not locked into his environment. His imagination, his reason, his emotional subtlety and toughness, make it possible for him not to accept the environment but to change it… Man is distinguished from other animals by his imaginative gifts. He makes plans, inventions, new discoveries, by putting different talents together; and his discoveries become more subtle and penetrating, as he learns to combine his talents in more complex and intimate ways. So the great discoveries of different ages and different cultures, in technique, in science, in the arts, express in their progression a richer and more intricate conjunction of human faculties, an ascending trellis of his gifts."

Human Origins: Two odd balls and the future

The story of human origins began roughly five-six million years ago with the common ancestor for what would evolve through chance and natural selection on the one hand, into modern apes such as chimpanzees, bonobos and gorillas and on the other hand, through a mish-mash of transitional species, to one species, itself probably transitional, *Homo sapiens*.

The earliest members of what would eventually become sapiens were fitted out for life in the trees, what with strong long arms, coupled with curled fingers and short hind limbs, and opposable great toes, the better to grip branches and tree trunks. They may have walked on their hind limbs, but if so occasionally and awkwardly at best – the beginnings perhaps of bipedalism; all this with chimpanzee-sized brains.

Over the next two to three million years several variant species appeared, the best known of which is *Australopithecus afarensis*. Three members (two adults and one adolescent) of that species left a trail of human-like footprints in rain-wetted ash from a nearby volcano, leaving to us 3.3 million years later, what the Oxford University evolutionary psychologist *Robin Dunbar* claims is one of the most iconic markers in human history. *Mary Leakey*, the matriarch of the famous Leaky family of paleoanthropologists, found the prints. One of that species, discovered several years earlier by *Donald Johanson*, was given the name '*Lucy*', after the Beatle's song, '*Lucy in the Sky*'. When the remains of her fossilized skeleton were recently reexamined, the findings suggested that she might have fallen from a tree and died from her injuries.

Lucy and other related species – the *Australopiths* – still had small brains (~400 cc) but the skeleton, especially the feet, ankles, knees, hips, pelvis, and spine were better suited to the easy transfer of weight to one leg, typical of fluid well balanced bipedalism. Even so, Lucy probably spent much of her time in trees, possibly to rest; hide scavenged or hunted food from roving animals and others of their kind and escape less agile predators. Certainly Lucy's relatively long arms and the thick arm bones suggest that she was strong, well-muscled and regularly climbed trees.

Later a series of transitional species, more adept at walking and possibly running, and possessing larger brains (~600cc), were discovered, the first one of which was found by Richard Leakey, the patriarch of Leakey dynasty, and famously his own best publicist. He named him, *Homo habilis* – 'the tool maker'. However more recent evidence strongly suggests that later members of the genus *Australopithecines* made stone tools too and even chimpanzees have been observed to chip stones – although not necessarily use them as tools.

Then roughly two million years ago, the first of what most archeologists would agree belonged to the genus Homo appeared in Africa – *Homo erectus*. He was also the first of our ancestors to migrate out of Africa, as early as one million years ago, and disperse widely throughout Eurasia, including reaching what is now China. Overall, *erectus* was taller than his predecessors, his arms were relatively shorter and the thumbs, now fully opposable, were larger and stronger, the legs longer and the skeletal changes were now fully in place in the spine, pelvis, hip, knee, ankle and foot bones to support running and a life spent entirely on the ground. *Erectus* was the first of our ancestral species to make hafted tools such as hand axes and later employ fire for warmth and probably cook. Mary Leakey claimed erectus was dim-witted based on the observation that hafted axes made by erectus are so similar over hundreds of thousands of years. Maybe so, but *erectus's* brain increased in size from ~ 700 cc in early versions of the species, to nearly double that size for later versions of the same species within Africa, and probably China as well. Of course this all begs the question; does it make sense to subsume under one species name, what became widely dispersed later editions spanning almost two million years and fifty thousand or so generations of evolutionary history and, eventually span three continents? Throughout which time and space, widely and repeatedly separated groups would have been subjected to differing selective pressures, depending on local environmental differences; it makes no sense to me.

Within Africa, later versions of *erectus* transitioned into the yet larger brained, brawnier, thicker-boned *Heidelbergs*, which in turn, roughly six hundred thousand years ago branched into what would later become fully

evolved *Neanderthals* three hundred thousand years ago in Eurasia and later, the *Denisovans* in Asia, while some would evolve into *anatomically modern humans (AMH)* within Africa. Some modern humans, would in turn, disperse into the Middle East a little over one hundred thousand years ago, and again seventy thousand years ago or possibly earlier, to reach Europe and the British islands forty thousand years ago, Australia sixty five thousand years ago and later New Zealand and eventually the Americas, twenty to thirty thousand years ago.

The foregoing picture is a tidy familiar tale of human origins. There was progressive accretion of skeletal, behavioral and neural traits, the last inferred from the size and shape of the cranium and the artifacts left behind, beginning five-six million years ago and ending with us. The story is upheld by studies of ancient DNA, which support the general outlines of human migrations, including a migration out of Africa roughly seventy thousand years ago, and a common origin for all modern humans in Africa approximately one hundred and fifty thousand years ago based on studies of mitochondrial, and nuclear DNA. Those same studies also make clear that separate species bred with one another, which of course explains why humans living outside Africa contain a small percentage of *Neanderthal* DNA and Australian aboriginals contain some *Denisovan* DNA.

The story is actually a lot messier. First there is the fact that much of Eurasia has yet to be studied, and what has been discovered is sometimes based on a few fragments such as a jawbone. What is clear is that sometimes several identifiably distinct species lived at the same time and sometimes the same region. Of course we know that *Neanderthals*, *Denisovans* and modern humans sometime had sex with one another. Such cross-species sex was probably common for differing species living in the same neighborhoods in the past, the whole making for a lot of mixing and matching of DNA.

In my opinion the best way to look at the story of human origins is to consider every named species as a transitional species, whose anatomical, behavioral, neural and other specific traits were dictated by natural selection acting on variants within the species in response to environmental pressures, including the variety and supply of food, competition with other

species and animals and perhaps pathogens. Naming specific species may be a useful tool for highlighting differences and tracing changes in traits but misses the fact that the changes sometimes took thousands and thousands of generations or sometimes much more nimbly, if the climate and environment changed abruptly and threatened the species 'as is'.

Then there are the odd balls in the story; species who simply don't fit the mold, a combination of the old with the new, of which there are two examples, *Homo floresiensis* and *H naledi*. Both species are odd because they combine ancient and more modern skeletal features. First lets deal with *Homo naledi*.

Lee Berger, an American anthropologist, and his team, working in South Africa, discovered this odd species. The fossils were found in a cave barely accessible except for those of slight stature able to wiggle their way through the tight passageway. Once through the narrow passage however, the cave opened into a large deep chamber containing no less than the nearly complete remains of fifteen skeletons, each one an odd mix of the 'old' and 'new'. The 'old' traits included small crania, not much larger than a chimpanzee, curled fingers so typical of those fitted out to climb trees and much of the rest of the skeleton all of which were common in *Australopiths*. However these truly ancient features were mixed with modern hands (except for those curling fingers), relatively long legs, ankles and feet, and a small face and teeth, all traits, which were surprisingly modern.

They named the species *H. naledi* and provisionally they were given a provisional date range of 2.5-2.8 million years ago, largely because of the small brain and australopithic features. Later dating suggested a much more recent time – 236,00 to 336,000 years. The latter period overlaps with several much bigger-brained *hominins* such as the *Heidelbergs* and their descendants within Africa, derivatives from the latter such as the Neanderthals and *Denisovans* and skulls discovered in China with cranial cavities the equal of modern humans and the recently re-dated early sapiens skulls from Morocco (~300,000 years ago). So at the very least then, as many as six distinct species existed about the same time frame in Africa, Europe and Asia, and counting. All but *H. naledi* left tools behind and other

artifacts consistent with cognitive powers consistent with the sizes of their brains – no tools have been found so far for *naledi*. And of the six species, naledi, on balance is the most primitive.

Then there's the story of the similarly short species found on the island of Flores off the coast of Indonesia called *Homo floresiensis* (or the hobbits named after the hobbits in the Lord of The Rings series, because of their relatively large feet). The human remains, mostly unfossilized, date back at least to 190,000 years ago and the traces of the species are traceable to 60,000 years ago, about when modern humans were pushing their way through South Asia into Sumatra and later Australia. Whether those modern humans were responsible for the demise of the *Homo floresiensis* isn't known but corresponds with the demise of other fauna on the island.

They were short (about 3 feet tall) and their brains were small (~400cc). The, as yet unsettled question, is where they came from? Are they descendants of erectus or much less likely *Australopithecines*? And whatever their ancestral origins, were they an example of insular dwarfing – the dwarfing of species isolated on small islands and akin to small-bodied humans who lived on the island of Palau in Micronesia? No one knows. Stone tools were found they were not particularly sophisticated and in any case might have been left by other species, such as Homo erectus, much earlier. Like *H. naledi*, they were small-brained and left no evidence in artifacts or tools to suggest that they were anything but primitive compared to similarly aged modern humans.

What about the future?

That's the big question mark. Will sapiens survive another few millennia, or perhaps a few hundred thousand years or will we be wiped out by war, natural disasters – possibly of our own making – or continue to evolve into yet other species. There is the matter that the human birth canal is already a tight fit for the human skull and brain, making every full term birth a preemie relative developmentally, to other primates and possibly most of our ancestors before the Neanderthals. But then again, intelligence doesn't depend so much on the size of the brain as the way the brain is organized and wired. The size of the human brain may have shrunk a little as did

height (the later only increasing in recent decades), in the last several thousand years, possibly related in some fashion to the transition from hunter-gatherer societies to small towns and eventually cities.

Despite evidence that the pace of human evolution has increased in the last few thousand years, that pace may well change dramatically if complex traits such as intelligence prove modifiable using gene editing technology. We're a long way from changing much more than editing single gene disorders, but then again the pace in gene editing and the will to develop the technology is frenetic these days, especially in China.

Moroccan Skull ~ 300,000 years old

This mysterious human species lived alongside our ancestors, newly dated fossils suggest (H.Naledi)

By Ann Gibbons May. 9, 2017

Just as a high-profile expedition to retrieve fossils of human ancestors from deep within a cave system in South Africa was getting underway in 2013, two spelunkers pulled aside paleoanthropologist Lee Berger. They had found what looked like an ancient thigh-bone in a completely different cave. “Can we go get it?” they asked.

Berger was overseeing a team of 60 people, some of whom were 18 meters below ground gathering fossils. “This was day two. Lives were in danger. This was the beginning of my hair turning really white,” says Berger, of the University of the Witwatersrand in Johannesburg, South Africa. “I said ‘No, and don’t tell anyone. I don’t want anyone distracted.’”

But on the last day of the expedition, which retrieved 1500 fossils of a mysterious new species of hominin named *Homo naledi*, Berger gave the spelunkers the go-ahead. They came back with the thigh bone plus photos of a skull poking out of the dirt in a second chamber of the cave system. “I couldn’t believe it,” Berger says.

He and his team present the nearly complete new cranium plus 131 *H. naledi* fossils from the second cave in a series of papers in *eLife* this week. The new fossils reinforce a picture of a small-brained, small-bodied creature, **which makes the dates reported in one paper all the more startling: 236,000 to 335,000 years ago**. That means a creature reminiscent of much earlier human ancestors such as *H. habilis* lived at the same time as modern humans were emerging in Africa and Neandertals were evolving in Europe. “This is astonishingly young for a species that still displays primitive characteristics found in fossils about 2 million years old,” says paleoanthropologist Chris Stringer of the Natural History Museum in London.

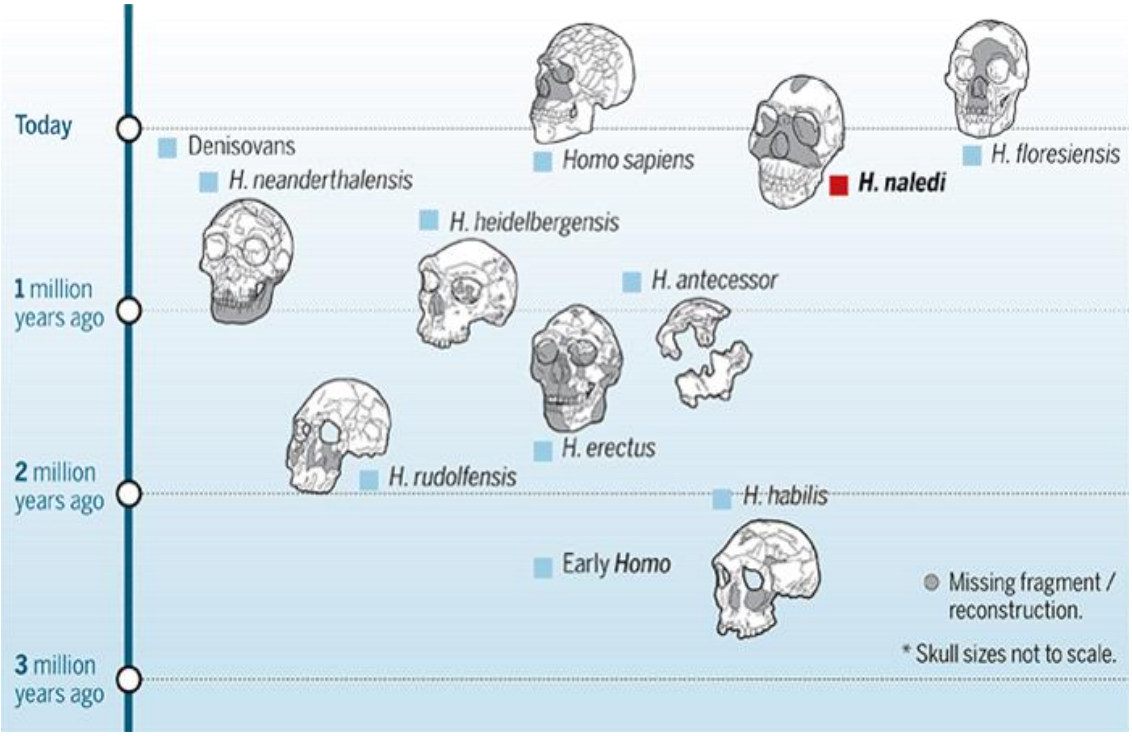
First announced in 2015, *H. naledi* was a puzzle from the start. **Fossils from 15 individuals, including fragile parts of the face that are preserved in the new skull**, show that the species combines primitive traits such as a small brain, flat midface, and curving fingers with more modern-looking features in its teeth, jaw, thumb, wrist, and foot. Berger’s team put it in our genus, *Homo*.

But where it really fit in our family tree “hinged on the date,” says paleoanthropologist William Kimbel of Arizona State University in Tempe. Dating cave specimens is notoriously difficult because debris falling from cave walls or ceilings can mix with sediments around a fossil and skew the dates. And these fossils likely were moved over time by rising and falling groundwater, so identifying the sediments where they were originally buried is a challenge, says geologist Paul Dirks of James Cook University in Townsville, Australia. He enlisted 19 other scientists and several labs to independently test samples using several methods. They dated cave formations deposited atop the fossils using a technique called optically stimulated luminescence, which provided a minimum age of 236,000 years for the fossils. The radioactive decay of uranium in three teeth of *H.*

naledi provided a maximum age of 335,000 years.

A timeline of the human family

Homo naledi, now dated to 236,000 to 335,000 years ago, joins a half-dozen members of our genus that lived during the past half-million years or so, as seen in a timeline of their first appearances. Yet *H. naledi* has some primitive features that hark back to early *Homo*, which lived about 2 million years ago.



Graphic: A. Cuadra/*Science*

Geochronologist Warren Sharp of the Berkeley Geochronology Center in California cautions that the maximum age may be off if the team didn't accurately estimate how much uranium the teeth absorbed from groundwater over time. But Dirks points out that the results from several methods all point to fairly recent dates. "There is a little play in the upper limit, but it certainly isn't going to shift to 1 million years," he says.

National Geographic leaked the dates in a brief Q&A with Berger in April, but without presenting the evidence. Now that he has seen the paper,

geochemist Henry Schwarcz of McMaster University in Hamilton, Canada, calls the dating effort “an impressive tour de force.”

The recent dates suggest that like the 60,000- to 100,000-year-old fossils of tiny *H. floresiensis* (the “Hobbit”) in Indonesia, *H. naledi* was a “twig off the mainstream of *Homo*—some little relic of a relatively archaic population,” Kimbel says. It was “a lineage that existed for 1 million years or more and we missed it,” says co-author John Hawks, a paleoanthropologist at the University of Wisconsin in Madison.

Researchers remain skeptical, however, of some of **Berger’s other claims**, such as that *H. naledi* might have made Middle Stone Age tools found in the region. That would imply surprising sophistication in a small-brained hominin. “Yes, that hand could make and use tools,” says paleoanthropologist Bill Jungers of State University of New York in Stony Brook. But he agrees with paleoanthropologist Rick Potts of the National Museum of Natural History in Washington, D.C., who says the idea is a nonstarter because no tools, fire, or other signs of culture have been linked to the fossils.

Ditto for the claim that *H. naledi* purposefully buried the bodies of its fellows in both caves, or that it might have acquired some of its modern traits by mating with other early members of *Homo*. “It’s just sheer speculation,” Kimbel says.

Berger says the search for stone tools and other evidence to test whether *H. naledi* was capable of modern symbolic behavior is his top priority. “We’re going after all these critical questions—is there fire in there, is there DNA?” he says. His team began new forays into the caves last week.Posted in: **ArchaeologyPaleontology**
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Ann Gibbons

Brain Size

Species		CC
Chimpanzee		275-500
Gorilla		340-750
Orangutan		275-500
Afarensis		440
Africanis		450
Neanderthal		1500-1800
H. Sapiens	M	1050-1500
	F	950-1400

The Human Species: Fait Accompli or Work in Progress?
Version 1

Have we reached the end of the line as Homo sapiens or is change in the wind? If the past is prologue for our future we're fated to evolve into other species or quite possibly, become extinct. That's our past – a story recounted by Chris Stringer in his 2014 book, '*Lone Survivors: How we came to be the only humans on earth*'. Standing still just isn't in the cards. Ever since the lines leading to the great apes and humans split five to six million years ago, the evolutionary record to what would become modern humans was strewn with ancestors whose body shapes and brains morphed repeatedly in response to environmental changes affecting various regions in Africa.

Our oldest ancestor's bodies were well adapted to getting about and living in trees foraging for food, with occasional forays to the ground where, like the great apes, they knuckle-walked their way about or sometimes stood and awkwardly walked on their hind limbs. Over the next several million years much was to change for their descendants. The climate in Africa changed in response to cycles of spreading glaciation, dropping sea levels and cooling, alternating with periods of global warming, receding glaciers and rising sea levels. The result was to profoundly change the forest cover and types of food available for our ancestors. Sometimes, for example, heavily forested areas became open savannas. This and a shift in diet to more underground foodstuffs such as tubers, put a premium on large robust teeth with jaw muscles and jaws to match, the better chew and grind up those rough foods. Lives spent increasingly on the ground began to favor musculoskeletal traits better adapted to walking, running and getting about on two feet, with less emphasis on scampering up trees.

These became the australopiths many of which overlapped with one another in time and occasionally place, if not habitat. Taken as a group their brains were ape-sized affairs similar in size to those of modern day chimpanzees. However unlike their predecessors, they became increasingly adept at getting about on two feet, while retaining the agility to scamper up trees when necessary to escape predators (think of the iconic Lucy here). Despite their small brains, recent studies suggest that some later

variants among the australopiths may have acquired a talent for not only using but creating edged stone tools; a skill which previously was thought to be reserved for transitional species such as the 'handyman' and later Homo species.

The last of the australopiths exited the evolutionary stage a little less than two million years ago. Overlapping with the last of them and the earliest defined Homo species beginning roughly two million years ago were several transitional species with modestly larger brains compared to the australopiths and skeletal features now well suited to running on two feet and forelimbs now better adapted for grasping and manipulating tools.

Then roughly two million years ago, emerged the first of what paleoanthropologists consider the first truly Homo species – Homo erectus. Erectus was taller and the first to look human-like, although like most if not all species, there was considerable variation in the size and shape of their skulls from specimen to specimen found at the same site and dating to the same time. On the whole however, the size of erectus's brain was clearly larger than any australopith or transitional species, and at the top end the their range, overlapped with the lower range for modern humans. There were other changes too, such as a shift toward the shape and relative scales of their forelimbs and hands and hind limbs and feet, to those more in line with modern humans.

With these skeletal and brain changes came a shift to meat as an important source of enriched food compared to plants. And it wasn't long before erectus began to use fire to cook their food. With the shift to meat and cooking, the large incisors, molars and large jaw muscles so characteristic of their australopith ancestors, were no longer necessary and teeth, jaw bones and jaw muscles became smaller - much as they are in modern humans. Erectus may have been dim-witted as the great paleoanthropologist Mary Leaky jested, but erectus was also the first of our ancestors to migrate out of Africa, and through thousands of successive generations, eventually reach much of Eurasia and perhaps parts of modern day Indonesia. For which travels erectus was aptly named 'The Traveler'. There may be more to erectus than we thought. Recent genomic studies of modern humans from around the world suggest that unlike the present day

widely accepted model, which holds the view that all modern humans were seeded from Africa, Chinese scientists suggest that modern day East Asians may have evolved from erectus in for example China, and not from migrants of modern humans leaving Africa one hundred thousand years ago or less.

The next one - two million years was characterized by further increases in the size of the brain, increasingly robust skeletons and musculature and what we might recognize as culture by increasingly masterful hunters such as the heidelbergs and neandertals. Finally modern humans appeared well over one hundred thousand years ago.

Throughout the last two million years especially, the brain increasingly matured, not only to become larger but the two hemispheres began to take on differing but complementary functions. These differences are most obvious in the well-developed localization of symbolic speech and right-handedness within the left hemisphere seen in most modern humans while other related functions such as spatial sense became localized in the right hemisphere. And to keep the two now distinctive hemispheres humming together in harmony, connections between the two hemispheres such as the corpus callosum became increasingly robust. These changes, and the increased size of association cortices and the frontal lobes were all features, which evolved over the last two million years to become what they've probably been in the last one hundred to one hundred and fifty thousand years since modern humans evolved.

The whole story of human origins beginning with the split to lines leading to the great apes on the one hand and modern humans on the other hand is one of constant tweaking of what was in the beginning a thoroughly ape-like ancestor five to six million years ago into what Chris Stringer so aptly called "The Sole Survivor". The changes in various traits such as the form and function of various parts of the skeleton to transform what was a four-legged tree dwelling ancestral ape into a skeletal platform adapted for standing and running upright, rejigged forelimbs arms and hands capable of fabricating and employing a wide variety of tools and a brain capable of unparalleled imagination, social intelligence, symbolic language, music, mathematics and story telling, were each acquired in bits and pieces, often

thousands of years apart from one another, in response to differing environmental pressures and natural selection. The story of human origins is not one of simple linear progression, but fits and starts and competing evolutionary solutions to environment changes. The discovery of an entirely new species in South Africa in 2015 reminds us that the story is anything but complete. There are probably other species yet to be discovered and others that may never be found.

This brings us to what's ahead for our species. It's all too easy to look at the human family with which we're familiar in our families, communities and recorded history and conclude that other members of our species are much the same, even if their culture, beliefs and languages differ. That's only superficially true. What's become obvious is the human species continues to evolve, quite possibly at an ever-faster rate in response to various environmental changes. Examples include the acquisition of the ability to break down lactose and acquired immunity to various pathogens. These and other examples of evolution in the last several thousand years remind us that humans continue to evolve.

The big game changer in evolution has been the recent development of precise gene editing techniques such as *CRISPR-Cas9*. This and more robust similar technologies to come will make it possible to edit the human genome in ways unimagined ten years ago. For now, the technology is being applied to fix single gene errors in diseases such as *Huntington's chorea* and *Duchenne muscular dystrophy*. But it won't be long before someone or country will try to use gene editing to modify complex human traits such as height, certain favorable athletic skills or highly desired cognitive powers in perhaps mathematics, or the arts. The last will be the most challenging but the challenge is not insurmountable given the resources and commitment. Does anyone doubt that someone will try sometime in this century? For the first time since life began three-point eight billion years ago, natural selection is set to be upended by technology, employed by humans too impatient to wait for the relatively slow pace, chance and uncertainty of evolution and natural selection. Of course we've been breeding animals for millennia and inserting genes in everything from fruit flies to mice for decades but not on this scale and not with this precision.

Even without gene editing, it's well to remember that none of our archaic ancestors lasted much more than a million years or so and some for less. This suggests that modern humans will follow a similar path, morphing enough in the coming hundred thousand or more years to become a new species. Looking to the past again, that new species or perhaps several species, is likely to be smarter and more capable than we. And if so, anything we've striven for in the arts and sciences may look like child's play. I fanciful notion I admit – but possible. What's your response?

William F. Brown October 24, 2016

PS:
I used to be intimidated by those Latin names paleoanthropologists use to name the various species in the human origins story. Those names helped to identify unique species based on their skeletal features and so provide handy markers along the path to modern humans. However handy as those names might be, they're often misleading. How so? For starters as Richard Dawkins playfully pointed out, the names and their associated skeletal traits suggest a much sharper transition between species that was ever plausibly the case. Transitions from one species to another probably took many hundreds, if not thousands of generations, before the full panoply of skeletal traits scientists assign to a specific species, evolved. During that long period, unless physically separated by some natural barrier, closely related descendants of the original common ancestors would have continued to mate with one another, mixing their gene pools along the way.

Then there's the matter of when those traits appeared. There's no reason to suppose that the skeletal traits we associate with a specific species such as the *neanderthals*, for example, appeared at the same time. Indeed there's every good reason to think that different traits and their related genes probably emerged at different times in response to differing selective pressures favoring those traits. Thus changes in diet, the result of changes in the food supply, might favor distinctive musculoskeletal and dental traits affecting the teeth, jaw and related muscles, while other selective pressures related to long distance running might be expected to affect the

structure of the spine, pelvis, hips, knees, ankles and feet and their related muscles. And those differing selective pressures and associated traits might well have emerged at different times. What we see when we examine skeletal remains from different periods in human history is the effect of changing constellations of traits, which emerged at differing times in response to differing selective pressures. In short, natural selection acts on different traits at different times in response to differing environmental and other pressures. Highlighting specific constellations of functionally unrelated traits as specific to this or that species is misleading and misses the important point that the story of human origins was a far messier and complex affair than a few highlighted species would suggest.

Homo erectus is a case in point. Homo erectus is presumed to have been around for almost two million years. For much of *erectus's* history, erectus was on the move throughout Eurasia reaching places as far distant as modern day China and Indonesia, while yet others remained in Africa. The scattering of *erectus's* thousands of generations of descendants over such a wide area strongly suggests that countless small groups would have lost contact with one another and some might have died out. As a consequence surviving small groups would have been free to evolve and differentiate themselves from one another in response to whatever distinctive environmental challenges and opportunities each group and their descendants faced. This suggests that the history of *erectus* is far more complex than assumed by paleoanthropologists more focused on migration patterns, especially as they affected modern humans into the Middle East, Europe and to a lesser extent South and East Asia. Maybe the Chinese have a point. Perhaps late generations of *erectus* did evolve into modern day Chinese although if that were the case it would be hard to account for the similarity overall in the genomes of modern humans around the world, including the Chinese.

Scientists have made great strides in filling in the gaps in the human origins story but we have a long way to go, a trail perhaps paved in the future by the discovery of many more fossils scattered throughout the world and dating from a wide spectrum of times, and perhaps the good luck to be able to sequence much older mitochondrial and especially somatic DNA. It's all very exciting – at least to me. If I have any regrets at leaving this world it's

that I won't be around to hear later chapters in the story. That's a bummer wouldn't you agree?

The Human Species: Fait Accompli or Work in Progress?

Version 2 Aug 10, 2017

Are humans a fait accompli or a work in progress? And if, as a species we are evolving – in what direction (s)? The evidence from the past strongly suggests, that like our ancestral species, our species, Homo sapiens is fated to evolve or perhaps become extinct. Evolutionary stasis just isn't in the cards.

Over the several million years between the split leading to the great apes on one hand and modern humans on the other hand, there were many changes in body size, shape and function. What initially were small ape-like tree-climbing primates with skeletons, muscles and brains to match, evolved over the next several million years into a wide variety of species, differing somewhat from one another in specific traits, but overall, increasingly better adapted by virtue of tweaks to their spines, pelvises, hips, knees, legs and feet for spending most of their time on the ground, walking and running on two feet. These evolutionary changes were accompanied by selective changes to the shoulders, forearms and hands – the better for creating and manipulating tools. And along the way size of the brain increased by two to three fold.

Changes in diet had much to do with changes in the appearance of the face, jaw and head musculature. Diets based largely on underground tubers and other rough hard-to-digest food required large molars and incisors and matching large jaws and powerful jaw muscles to chew and grind the food as well as a large gut to breakdown all that roughage. But with the increasing reliance on meat and bone marrow – rich sources of protein, fat and vitamins, and cooking – the latter of which greatly aided the breakdown of animal or marine flesh, smaller guts were possible. And with all those changes in diet and cooking, the need for those powerful large incisors and molars and the associated large powerful jaw muscles, receded to be replaced by an evolutionary shift toward smaller teeth and jaws, and looking increasingly like us.

Throughout this long period of several million years, the brain matured, not only to become larger but along the evolutionary path the two hemispheres began to take on differing but complementary functions. These differences became most obvious in the localization of symbolic speech and right-handedness within the left hemisphere as found in most modern humans while spatial sense became localized in the right hemisphere. And to keep the two now distinctive hemispheres humming, connections between the two hemispheres such as the corpus callosum became increasingly robust. Most of these changes, and the increased size of association cortices and the frontal lobes were all features, which probably evolved over the last two million years toward what would become the modern human brain.

But whether anatomically modern skulls harbored physiologically modern brains, with cognitive powers matching our own is unknown. There's more than the size and shape of the brain to consider. Without any surviving brains to analyze, it's impossible to trace the development of the neocortex and its connections for any of our archaic ancestors or for that matter, anatomically modern humans. The only surrogate measures suggestive of enhanced cognitive and imaginative powers in our ancestors living hundreds of thousands of years ago up to the appearance of the rich trove of cave art in Europe beginning roughly forty thousand years ago, are the tools and art work they left behind. And here records fails us, for except for some decorative artifacts and skillfully rendered tools and weapons in South Africa antedating the cave art and tools of Europe, there's little hint of enhanced cognitive powers for the first hundred thousand years of the existence of anatomically modern humans in Africa, perhaps because most artifacts were perishable or simply lost.

At least that was the story until recently when skulls with faces very similar to our own except for heavier brows, were found in Morocco together with finely crafted and heat-treated flint tools, which could be dated to three hundred thousand years ago. Despite the human-like flattened faces and brain sizes similar to our own, the lower and longer profiles of the skulls suggest that the underlying brains had some way to go before becoming fully modern human brains. Their heavier brows suggest that they might

have been later editions of the Heidelbergs, but it's probably better to think of them as yet other transitional pre-modern humans.

Whatever the controversies surrounding the emergence of minds like our own, there's plentiful evidence of continued evolution at work in modern humans and every reason to think the pace of evolution will continue into the distant future. If so, our physical and cognitive traits are likely to continue to evolve. The latter might include larger, more complex brains with cognitive powers exceeding our own combined perhaps with some downsizing of our skeletal and muscle development in favor of lighter frames consistent with less need for robust musculature. And perhaps with evolution of the human diet toward foods requiring less processing by the gastrointestinal tract and containing less waste, might lead to further downsizing of our gastrointestinal tracts.

Should our species or successor species migrate to live in colonies in outer space in space arks of some sort or find homes on other habitable planets, our evolution as a species will surely continue. So we can look forward to change – probably slow if natural selection is in charge or possibly much faster if gene editing is employed to modify human traits in future generations. Given the fact that many traits such as height and behavior, never mind cognition, depend on families of hundreds, if not thousands of related genes acting together, and the fact that current gene editing techniques are limited to fixing at the most a few genes, changing complex behavioral and cognitive traits will probably take a few more decades and greatly enhanced gene editing technologies, to achieve. Even so, imagine what the impact might be for our future gene edited species should we successfully master enhancing desirable cognitive powers in our descendants. What will they think of our achievements in what we call the arts and sciences? Will they look on our artifacts as child-like by comparison with their own? And if so, what will become of any of our current belief systems? Will any endure? Probably not - or if religious belief system somehow survives - the underlying narratives will likely differ widely from those of today's religions.

No one can predict the future with any certainty much beyond a few years, never mind a century or two and certainly not a million years from now.

And so your guess is as good as mine. The only thing that's for certain is change itself and if the past is prologue to the future, profound change is in store for our species and species to come. Any thoughts?

References

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From Seventy Thousand Generations Ago to Seventy Thousand Generations into the Future: Shaping Humanity: How Science, Art, And Imagination Help Us Understand Our Origins

By John Gurche (2013) Yale University Press
And Post Script by W.F. Brown

Forward by John Gurche

He had not been sick, and was not injured in any way. So the sight of him face-down in the marsh was a shock to his family. Surely this could not be so. Surely the stillness and seeming lifelessness of his body could not mean the end of his story. In truth it did not, although the future of his story was far beyond his family's power to imagine.

They call to him. The gentle rocking of his body is his only response. They wade out to him. In the quiet, the buzzing of flies is obscenely loud. They roll him over onto his back and see his face and then they know. Moments later they are startled by a wailing sound that they find to be their own. They carry his body ashore.

Some time later, they become aware that the shadows have lengthened into long stripes. The people do not know how long they have been here, but it is time to go. The lions will be waking now. Although the stone axe the man carried will remain in the marsh, his body will be gone tomorrow. It does not occur to them to move it.

The man persisted as a memory for a short time among his people, day by day, year following year, until there was no one left alive who remembered him. Long before this time his body had been dragged off and partially consumed by hyenas, and much of it had been decomposed by organisms, which could use its nutrients for purposes of their own.

His bones were buried by over-washing sediment and lay undisturbed for generation upon generation, encased in earth under the hurrying clouds. Bone that had once been alive was, little by little, replaced with groundwater minerals. Thousands of generations passed: birth cries, and

love, struggle and bright flashes of pain, until there was no member of his species still alive.

His bones remained still, in their bed of silt, as the surface of the land shifted above them. Rains swept away sediment, floods scoured the surface, cutting into the earth until, one and a half million years after his death, the water opened a window and the sun once more warmed the bone of his cheek.

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Something is moving in the distance: back and forth, back and forth, scanning the surface, a figure coming closer, silhouetted against the brilliant blue sky. Closer. An unintelligible shout, and a hand reaches down to touch the bone of the cheek. A stream of sounds – like a complicated birdsong but in a lower register, and then a second figure appears, bending low over the bones.

These are the man's descendants of thirty thousand generations. They look different, with their domed heads and delicate flat faces. They are quick and curious, prying into everything, turning every stone. They chatter incessantly in rapid-fire streams of tongue-bending, tube-modified sound, punctuated by a series of pops, clicks and hisses.

These inheritors have swarmed the globe and colonized virtually every environment on earth. They change everything they put their hands to. Too restless and curious to stop at their own world, they set foot upon the earth's moon, and have sent fantastic descendants of the dead man's hand axe on journeys deep into space to look in upon other worlds. While the bodily shape of the man's descendants has changed only subtly from his, the hand axe's descendants bear no visible resemblance to their ancestors. They are composed of geometric shapes of light and ore and structural petrochemical. With them, the earth's inheritors extend their eyes, ears and consciousness far beyond the home planet's living envelope.

Those inquisitive descendants have also devised lenses that allow them to peer through immense distances backward in time, and strange lanterns

with which to illuminate the shapes of their ancestors, We are those descendants and, at a distance of one and a half million years, we are straining to see you.

Who are you? We beings from your future are using every method we can devise to bring you into focus and answer this question. We want to know you, to see your face, even to experience the world through your senses. We measure you: we generate long chains of words and numbers in our effort to understand you. Past events leave residues you have not dreamed of. Past moments can be partially accessed, and, in a limited way, we can unfold them and study them.

We sift through the debris you cast off, trying to understand the way you lived. We hold the tools that you made and feel a connection to you. Did you give a thought to the distant future of the artifacts you were making? Could you have imagined that it would last for uncountable years, outlasting even your lakeside homeland?

We would so like to know about your life, what you think about when you gaze into a starry night sky. Do you wonder about your people's future, about whether there will be heirs to inherit your world and your ways? We can answer: Yes, for we are they.

Our eyes are different now. If you could meet us, how unimaginably strange we would seem to you. We and our technology are more closely connected than in your time. And we as individuals are linked in ways you cannot dream of. If you could see us, without fear, you might grasp in some way the geometries of our lives.

We look into your empty eye sockets and wonder what you saw. We probe inside the space within your skull in our attempts to learn about your thoughts. We can see that in some ways you are like us. In other ways, you are still very much like the animals that came before you, and you conduct the affairs of your lives and your world as an animal would. If we could experience your thoughts, would they be those of an uncomprehending animal? We have found signs of your consciousness, and in this mirror of awareness we think we see a bit of ourselves. We view ourselves as part of

a larger evolutionary stream of ancestors and descendants, of which you are also a part (and we are a part). We cannot help feeling a powerful kinship with you. You are, after all, our physical and symbolic link to the rest of creation.

Post-script (W.F. Brown)

Gurche wrote this imagined story about an archaic human ancestor – probably *H. erectus* - whose variants spanned nearly two million years and from which stock sprang a physically robust big-brained species living in South-West Africa several hundred thousand years ago – and from which our species, H. sapiens evolved as recently as 150 thousand years ago.

But what if we looked into the future and equivalent period of time (~70,000 generations or 1.5 million years), to a time when our descendants will almost certainly have evolved into entirely different species, possibly with larger, more complex and cleverer brains – and cognitively as far ahead of us as we are from that ancient human who dropped dead in the marsh 1.5 million years ago? What will our descendants ~70,000 generations into the future think of us when they peer into our empty eye sockets or poke into our skulls? What questions would they ask? Would they look on us, much as we look on that skull, as primitive beings holding primitive beliefs?

If the past is any indication about what we might expect to happen to our species in the future, then based on the trajectory of the human origins story over the last five-six million years, our species, like so many of our ancestors, will become extinct or continue to evolve. There's plenty of evidence that chance and natural selection continued to tweak our genes throughout our hundred and fifty thousand year history to date and every reason to expect that trend to continue well into the future - perhaps with a boost from gene editing.

There's no getting around the fact that most humans don't relish the idea that, like so many species before us, we too will likely become extinct or morph into other evolutionary way-stations, possibly much more intelligent and cognitively capable than we can imagine. If we're prepared to listen,

that's the lesson of the last several million-years of our history speaking to our future.

Religion was a relative new comer in evolutionary history. There is no evidence that other animals, however intelligent, possess a sense of the spiritual and life beyond death. The first inklings of a sense of the spiritual appeared in the cave art of South Africa beginning one hundred thousand years ago and later in Europe forty thousand years ago. Temples and other evidence of ritualized religion were latecomers – only twelve thousand years ago in what is now Turkey. But it was only within the last few thousand years, beginning with Judaism, later Christianity and still later Islam, that the big three of the monotheistic religions appeared and incidentally share the same root in Abraham.

How might such a perspective shape your beliefs?

Historical Event	Years Ago	Generations Ago
Homo erectus (Gurche prologue)	~1.8 mya	~50,000
Mitochondrial Eve (modern humans)	~15 tya	~7500
Cave art in Europe and Indonesia	~40 tya	~2000
Destruction of Temple in Israel	2 tya	~100
Norman Conquest	1 tya	~50
Publication of Darwin's "On the Origin of Species'	150 ya	~10

mya = million years ago
tya = thousand years ago
ya = years ago

The Evolution of Modern Humans August 28, 2017

Last common ancestors (LCAs)

Monkeys, Apes and Humans	20 million-years-ago
Apes (Gorillas, Bonobos and Chimpanzees	5-6 million-years-ago

Definition of species

The term species has been operationally defined by anthropologists studying the story of human as a particular constellation of musculoskeletal traits considered sufficient to separate the putative species from other related species. Given that transitions between species often took hundreds of thousands of years and thousands of generations, evidence that different traits were acquired at different times, in response to differing evolutionary pressures, that variations between members of a given species were sometimes substantial, and that species often bred with one another, its clear that the term 'species' as applied to the human origins story, though a useful tool for tracking the evolution of humans, is non-the-less, arbitrary and over simplifies a far more complex story. The definition of species is wholly based on musculoskeletal and dental traits.

Hurdles facing those who try to construct the evolutionary tree of humans include:

1. Reaching agreement on which musculoskeletal traits merit naming them as belonging to a separate and distinct species

When early hominins such as the famous *Lucy*, later early humans such as *Homo habilis* or *erectus* and still later the *Neanderthals* and modern humans died, what was left usually were a few fossilized bones and teeth. Sometimes these were found in a cave or pit where they were relatively well preserved and protected from the elements. However, when the sedimentary layer in which the body was buried ancient river, later heaved up as happened in the Great Rife Valley of Africa, skeletal elements such as a jaw bone or other parts of the skull and skeleton were often found lying in the open, or close to the surface. Occasionally several more or less

complete fossilized skeletons were found, and sometimes fragments of DNA dating back thousands, if not a few hundred thousand years, could be found within the sediment in the floor of caves.

But except for the few examples where several well-preserved skeletons were found dating back ~400,000 years in the case of the pit in northern Spain, the recent finding of fifteen or so, more or less complete skeletons found in caves in Southern Africa, dating back over ~300,000 years, or the several skulls found in a Georgian cave whose cranial volumes differed considerably from one another, but which were linked, to Homo erectus, there aren't many examples of well preserved complete or nearly complete skeletons much past a few hundred thousand years ago. This means that characterizing the skeletal traits and behavior of the species they belonged to was often dictated by a few bits and pieces, cross-referencing with other dated specimens and a lot of inference and even guess work.

2. Finding sufficient pieces of the skeleton or fossils to decide on what species they're dealing with. Sometimes there's little more to go on than a jaw, or part of the skull. That's not much given the likely considerable variation within a species – never mind between species.

3. Dating specimens accurately

Errors in dating can make a big difference. This was recently illustrated by a follow up study of modern human skulls previously found in Morocco and erroneously dated to roughly 100,000 years ago and hence well within the commonly accepted bounds for anatomically *modern humans (AMHs*) of 150,000 to 200,000 years ago, which dates, with better dating techniques were recently revised to ~300,000 years ago. This finding set the clock back for *anatomically modern humans (AMH),* although some features of the skulls were Neanderthal-like such as heavier brows, and a lower and longer skull compared to the more globular shape of the modern human skull.

Then there's the updated revision for the arrival of modern humans in Australia to contend with. Until this year the earliest date for the arrival of modern humans in Australia was estimated to be 45,000 years ago. However recent dating techniques, including *photoluminescence*, have

forced a revision to 65,000 years ago, 20,000 years earlier than the earlier estimate. The difference is significant. Why, because while the more recent of the two estimates was consistent with the commonly held view that the modern humans, which over thousands of generations, eventually populated much of Eurasia and beyond, left Africa roughly 70,000 years ago, the earlier estimates for the arrival of *AMH* in Australia and Sumatra, strongly suggests that those founding modern humans left Africa much earlier.

The remains of what may be *AMH* in the Middle East 110,000 years ago would be consistent with the latter hypothesis that *AMH* humans left Africa, perhaps in successive small bands beginning over 100,000 years ago, to eventually reach Sumatra and Australia 65,000 years ago, or earlier.

Making sense of this story is complicated further by the recent claim that modern humans or if not modern, relatives of Neanderthal, Denisovans or late erectus, may have reached South America as early as 125,000 years ago, an estimate, which if true, really would throw a monkey wrench into the whole out of Africa story, but not the old and recently resurgent idea, resurrected primarily by Chinese anthropologists, that modern humans emerged, not simply in Africa but elsewhere as well and that *AMHs* in China dating back ~300,000 years are descendants of much earlier *Homo erectus* migrants to Asia. Maybe, but such a multicentric view of human evolution is hard to reconcile with the fact that DNA from modern humans from around the world shows very little variation, relative to that of modern Africans. This genomic view suggests that most of human evolution took place in Africa and only a small founding group left Africa to populate the world. It's a big mystery and might take decades to resolve.

4. Absence of DNA data for all but the last several hundred thousand years of human and prehumen history

DNA much older than several hundred thousand years ago has not been recovered so far, or is likely to be recovered, given the challenges posed by finding and reconstructing ancient DNA. This places genomic comparisons between early homo species such as *habilis* and *erectus* and every transitional species before them, back to the *last common ancestor*, out of

reach – at least for now. Thanks largely to the pioneering efforts of the *Max Planck Institute* in Germany, we do have comprehensive genomic data spanning the last four hundred thousand years for the Neanderthals, living and ancient modern humans and a mysterious group in Siberia named the *Denisovans* from which mitochondrial and nuclear DNA have been successfully sequenced from a tooth and a bit of a digit, but for which species we have no clues about what they actually looked like.

Skeletal Traits

Body size and height – Experience has shown that height is dictated by hundreds, if not thousands of genes but can change significantly within a generation – possibly related to nutrition. Below are some traits commonly used to differentiate between species

Shape and size of the cranial cavity and therefore the underlying brain
Thickness of the skull and bones
Orbital ridges
Shape of the face
Size of the jawbones and chin
Shape and size of the teeth including the shape of the dental arcade
The relative lengths of the arms and legs
The hand – the size of the thumb relative to the fingers and whether the thumb is opposable
Shape of the pelvis
Hip, knee and ankle joints
The foot

Time required to raise young

Points

1. Every species is transitional – in transition from earlier species variants and transitioning into future species

2. The traits – skeletal, neural and behavioral – associated with any given species are often acquired at different times, possibly in response to differing environmental pressures.
3. There is substantial variation within a species

4. Many more species remain to be found and hence the story of human origins is sure to change dramatically in the future

5. Use of the word 'species' is misleading when it comes to human evolution because different species, provided they overlapped in time and place and weren't too different in their habits, probably bred with one another – indeed this may have been a way of acquiring or modifying traits. The term may be useful for highlighting certain constellations of traits but it most be understood, that each named species was and is in transition from its ancestors and toward as yet unknown descendants.

6. Many species inbred with other species

7. Migration patterns can be studied using DNA

8. Genomes from ancient species including archaic humans such as the Neanderthals and Denisovans may be going back several hundred thousand years for both mitochondrial DNA (simpler and simpler to do) and nuclear DNA

Human Evolution – More references and notes

Ancient Ape

Brenda B. Benefit (2017) ***Skull features of an ancient ape: Fossil evidence is scarce for early stages on evolution in the ape family tree at a time before apes and the ancestors of humans diverged. A 13-million-year-old skull now offers insights into ape development at that time***, Nature, 548, 19 August, Pages 160-161

Isaiah Nengo et al. (2017) ***New infant cranium from the African Miocene sheds light on ape development***, Nature, 548, 19 August, Pages 169-174

Early Homo - Homo habilis

Susan C. Anton, Richard Potts, Leslie Aiello (2014) ***Evolution of early homo: An integrated biological perspective***, Science, 345, 4 July, Page 45

Earlier studies quibbled about the status Homo rudolfensis and habilis; did they belong with the genus Homo or not.
"New environmental data sets suggest that homo evolved against a background of long periods of habitat unpredictability that were superimposed on the underlying aridity trend. New fossils support the presence of multiple groups of early Homo that overlap in body, brain, and tooth size and challenge the traditional interpretation of H. habilis and H. rudolfensis as representing small and large morphs respectively. … traits once thought to define early Homo, particularly H. erectus, did not arise as a single package. Some features once considered characteristic of Homo are found in Australopithecus (e.g., long hind limbs), whereas others do not occur until much later in time (i.e., narrow pelves and extended ontogeny). When integrated with our understanding of the biology of living humans and other mammals, the fossil and archeological record of early Homo suggests the key factors in the success and expansion of the genus rested on dietary flexibility in unpredictable environments, which along with cooperative breeding and flexibility in development, allowed range expansion and reduced mortality risks. "

*Fred Spoor et al. (2015) ***Reconstructed Homo habilis type OH7 suggests deep-rooted species diversity in early Homo***, Nature, 519, 5 March, Pages 83-86

Handy Man reborn: *A digital makeover for iconic Homo habilis* type specimen (cover of Nature, 5 March, 2015)

"*Here we present a 'virtual' reconstruction of the OH7 mandible, and compare it to other early Homo fossils. The reconstructed mandible was remarkably primitive, with a long and narrow dental arcade more similar to Australopithecus afarensis compared to the similarly derived arades of Homo sapiens, or H. erectus. We find that this shape variability was not consistent with a single species of early Homo. Moreover, this shape variability is incompatible with fossils assigned to Homo rudolfensis and with the A.I., 666-1 Homo maxilla. The latter is morphologically more derived than OH7 but 500,000 years older, suggesting that the H. habilis lineage originated before 2.3 million years ago, thus marking deep-rooted species diversity in the genus Homo. We also reconstructed the parietal bones of OH7 and estimated its endocranial volume. At between 729 and 82f4 ml it is larger than any previously published value, and emphasizes the near-complete overlap in brain size among species of early Homo. Our results clarify the H. habilis hypdiagm, but raise questions about its phylogenetic relationships. Differences between species of early Homo appear to be characterized more by gnathic diversity than differences in brain size, which was highly variable within all taxa*."

John Noble Wilford (2012) ***New Fossils Indicate Early Branching of Human Family Tree***, The New York Times, August 8

The discovery of three new fossil specimens, announced Wednesday (August, 2012), is the most compelling evidence yet for multiple lines of evolution of our own genus, Homo, scientists said. The fossils showed that there were least two other contemporary Homo species, in addition to Homo erectus, living in East Africa as early as two million years ago."

Homo erectus

Ann Gibbons (2016) ***The wanderers: Fossils of the first human ancestors to trek out of Africa reveal primitive features and a brutal way of life***, Science, 354, 6 December, Pages 958-961

This article highlights fossils found in Georgia who were among the first early humans to migrate out of Africa. But unlike the taller, larger brained fossils more typical of H. erectus, which appeared roughly 1.9 million years ago and which soon developed the hand ax, the fossils highlighted in this paper were found Georgia, dated back 1.77 million years, were much shorter in stature (1.5 metres tall), and their brains were significantly smaller – one third to half the size –compared to modern humans ranged, and smaller than more typical erectus skulls. Their tools were also relatively simple. They apparently suffered from early dental disease, possibly related to malnutrition. Five skulls were found at the same site and differed significantly from one another, differences, which highlight variations within a species. These early humans might represent yet another transitional form, not yet what is normally associated with H. erectus.

Neanderthals

Lizzie Wade (2016) ***Neanderthal baby brains may have grown like ours*** Posted in: Brain & Behavior Evolution DOI: 10.1126/science.aag0688

Marie Soressi (2014) ***Neanderthals built underground: The finding of 175,000-year-old structures deep inside a cave in France suggest that Neanderthals ventured underground and were responsible for some of the earliest constructions made by hominins***, Nature, 354, 2 June, Pages 43-44

Ann Gibbons (2017) ***Close relative of Neanderthals unearthed in China: Partial Skulls may belong to elusive Denisovans, who are known almost exclusively by their DNA***, Science, 355, 3 March, Page 899

105,000 – 125,000 years old
Skulls have large cranial volumes (upper end of Neanderthals)
Prominent brow ridges
Neanderthal-hollow at back of the skull
Inner ears similar to Neanderthals

Differ from Western Neanderthals in that the eyebrows were thinner and the skulls lighter

China and human evolution

Jane Qiu (2016) ***The forgotten continent: Fossil finds in China are challenging ideas about the evolution of modern humans and our closest relatives*, Nature, 535, 14 July, Pages 218-220

Describes alternative routes for out of Africa migrations for prehumans and modern humans

Standard model for migration patterns out of Africa

Homo erectus 1.8 million years ago to Middle East, Asia including China by 1.7 million years ago and Indonesia by 1.5-0.9 million years ago

Homo heidelbergensis within Africa to out of Africa and Neanderthals in Europe by 430,000 years ago (Spain) and East Asia to become Denisovans and possibly a variety of transitional forms

Alternative model

Source population in Middle East, populates most of Africa 600,000 years ago, Europe (Neanderthals) by 430,000 years ago, and East Asia (Denisovans and transitional forms)

Modern humans evolve in Africa from H. heidelbergensis or another hominin derived from the Middle East and later migrate to Middle East 120,000-60,000 years ago, Europe by 40,000 years ago, Asia by 60,000 and 120,000-80,000 years ago and Indonesia by 80,000 years ago

Zhan-Yang li et al. (2017) ***Late Pleistocene archaic human crania from Xuchang, China*, Science, 355, 3 March, Pages 969-972
Amir D. Aczel (2007) ***The Jesuit & the Skull: Tehhard De Chardin, Evolution, and the Search for Peking Man*, Riverhead Books

Peking man's brain was small relative to modern humans - ~900 cc and the skull thick and the brows well developed – consistent with the hypothesis that these specimens were later versions of H. erectus and estimated to be over 500,000 years old

Zhan-Yang Li et al. (2017) ***Late Plesistocene archaic human crania from Xuchang, China***, Science, 355, 3 March, Pages 969-972

"*Two early Late Pleistocene (~105,000- to 125,000-year-old) crania from Lingjing, Xuchang, China, exhibit a morphological mosaic with differences to their western contemporaries. They share pan-Old World trends in encephalization and in supraorbital ridge, neurcranial vault, and nuchal gracilization. They reflect eastern Eurasian ancestry in having low, sagitally flat and inferiorly broad neurocrania. They share occipital (supraainiac and nuchal torus) and temporal labyrinthine (semicircular canal) morphology with the Neanderthals. This morphological combination reflects Pleistocene evolutionary patterns in general biology, as well as both regional continuity and interregional population dynamics*. "

Wu suggests these skulls represent a coming together of Neanderthals and descendants of earlier archaic people

Homo Naledi

Lee Berger, an American anthropologist, and his team, working in South Africa, discovered this odd species. The fossils were found in a cave barely accessible except for those of slight stature able to wiggle their way through the tight passageway. Once through the narrow passage however, the cave opened into a large deep chamber containing no less than the nearly complete remains of fifteen skeletons, each one an odd mix of the 'old' and 'new'. The 'old' traits included small crania, not much larger than a chimpanzee, curled fingers so typical of those fitted out to climb trees and much of the rest of the skeleton all of which were common in Australopiths. However these truly ancient features were mixed with modern hands (except for those curling fingers), relatively long legs, ankles and feet, and a small face and teeth, all traits, which were surprisingly modern. They named the species H. naledi and provisionally they were given a provisional date range of 2.5-2.8 million years ago, largely because of the small brain and australopithic features. Later dating suggested a much more recent time –

236,00 to 336,000 years. The latter period overlaps with several much bigger-brained hominins such as the Heidelbergs and their descendants within Africa, derivatives from the latter such as the Neanderthals and Denisovans and skulls discovered in China with cranial cavities the equal of modern humans and the recently re-dated early sapiens skulls from Morocco (~300,000 years ago). So at the very least then, as many as six distinct species existed about the same time frame in Africa, Europe and Asia, and counting. All but H. naledi left tools behind and other artifacts consistent with cognitive powers consistent with the sizes of their brains – no tools have been found so far for naledi.

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*Ann Gibbons (2015) ***New human species discovered***, 349,11 September, Pages 1149-1150
*Ann Gibbons (2017) ***This mysterious human species lived alongside our ancestors, newly dated fossils suggest***, Posted in: Archaeology Paleontology, DOL: 10.1126/science.aal1154
230,000 to 335,000 years ago Figure illustrates species timelines last 3 million years
Ann Gibbons (2017) ***Newest member of human family is surprisingly young***, Science, 356, 12 May, Page 571
*Chris Stringer and Julia Galway-Witman (2017) ***On the origin of our species***, Nature, 546, 8 June, Pages 212-213

Early Modern Humans – Morocco

*Jean-Jacques Huhlin et al. (2017) ***New fossils from Jebel Irhoud, Morocco and the pan-African origin of Homo sapiens***, Nature, 546, 8 June, Pages 285-292

*Daniel Richter et al. (2017) ***The age of the hominin fossils from Jebel Irhoud, Morocco, and the origins of the Middle Stone Age***, Nature, 546, 8 June, Pages 293-296
*Ann Gibbons (2017) ***Oldest members of our species discovered in Morocco: New fossils and dates put a face on early Homo sapiens***, Science, 356, 9 June, Pages 993-993
*Ann Gibbons (2017) ***World's oldest Homo sapiens fossils found in Morocco***, Posted in: ArchaeologyHuman Evolution, DOI: 10.1126/science.aan6934
Illustrates 3D CT of head and species time-line last 400,000 years
Carl Zimmer (2017) ***Oldest Fossils of Homo Sapiens Found in Morocco, Altering History of Our Species***, The New York Times, June 7

In 2017, anthropologists and others reexamined a mixed bag of modern looking crania, other fossils and some finely worked tools. These were originally dated to ~40,000 years ago. However recent dating using thermo-luminescence revealed that they were much older (315 +/- 34 thousand years). This finding taken together with the retention of some archaic features such as the long, relatively low cranium and modestly thickened brow ridges, a modern face and teeth, suggested these crania represented transitions to anatomically modern humans. Such transitions from older Heidelberg transitions and possibly Neanderthal-like features are not unlike the crania discovered in China and consistent with continuing transitions to modern humans and interbreeding between extent species within Africa and later beyond.

The case in China is similar in that similarly sized skulls and skilled tools have been found in which the crania bear some Neanderthal features, and theoretically at least, features drawn from the mysterious Denisovans, and even derivative features from late editions of H. erectus akin in time perhaps to the Heidelbergs in Africa. Who knows? The Chinese skulls have their own distinctive features.

Tool making, art, cognition and social organization

Lizzie Wade (2017) ***Unearthing Democracy's Roots: In some ancient Mesoamerican societies, rulers shared power and ordinary people had a voice***, Science, 355, 17 March, Pages 1114-1118
Sarah Wild (2017) ***Dreams of the Stone Age dated in southern Africa breakthrough***, Nature, 545, 4 May, Pages 14-15

Migration Patterns

Carl Zimmer (2016) ***A Single Migration From Africa Populated the World, Studies Find***, The New York Times, September 23
Carl Zimmer (2017) ***In Neanderthal DNA, Signs of a Mysterious Human Migration***, The New York Times, July 4
Carl Zimmer (2016) ***How We Got Here: DNA Points to a Single Migration From Africa***, The New York Times, September 21
Michael Balter (2015) ***New mystery for Native American origins***, Science, 349, 24 July, Pages 354-356
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Nicholas Wade (2016) ***Otzi the Iceman's Stomach Bacteria Offers Clues on Human Migration***, International New York Times, January 7
Rasmus Nielsen et al. (2017) ***Tracing the peopling of the world through genomics,* Nature, 541, 19 January, Pages 302-309
Excellent review and accompanying graphics
*Martin Kuhlwilm et al. (2016) ***Ancient gene flow from early modern humans into Eastern Neanderthals***, Nature, 530, 25 February, Pages 429-440
*Josif Lazaridis et al (2016) ***Genomic insights into the origin of farming in the ancient Near East***, Nature, 536, 25 August, Pages 419-424

*Monkol Lek (2016) ***Analysis of protein-coding genetic variation in 60,706 humans,*** Nature, 536, 18 August, Pages 285-291
*(2016) ***The Simons Genome Diversity Project: 300 genomes from 142 diverse populations***, Nature, 538, 13 October, Pages 201-214
Ewan Callaway (2017) ***Plaque DNA hints at Neanderthal lifestyle***, Nature, 543, 9 March, Page 144
Justine Kupferman & Franck Polleux (2016) ***Genomic remodeling in the primate brain,*** 539, 10 November, Pages 171-172
Ewen Callaway (2017) ***Ancient genomes expose Africa's past***, Nature, 547, Page 149
(2016) ***Genomic analyses inform on migration events during the peopling of Eurasia,*** Nature, 538, 13 October, Pages 238-247
Carl Zimmer (2017) ***In Neanderthal DNA, Signs of a Mysterious Human Migration***, The New York Times, July 4

Migrations out of Africa

Neanderthals ~400,000 ya
Modern humans
~ 270,000 ya
~100,000 ya
~70,000 ya

*Gina Kolata (2017) ***No Bones About It: Scientists Recover Ancient DNA From Cave Dirt***, The New York Times, April 27
*Lizzie Wade (2017) ***DNA from cave soil reveals ancient human occupant***s, Science, 358, 29 April, Page 363
Nicholas St. Fleur (2017) ***Humans First Arrived in Australia 65,000 Years Ago***, Study Suggests, The New York Times, July 19
*Curtis W. Marean (2017) ***Early Signs of human presence in Australia***, Nature, 547, 20 July, Pages 285-287
*Chris Clarkson et al. (2017) ***Human occupation of northern Australia by 65,000 years ago***, Nature, 547, 20 July, Pages 306-309
Ann Gibbons (2017) ***The first Australians arrived early: 65,000-year-old tools suggest very ancient migration out of Africa***, Science, 357, 21 July, Pages 238-239
K.E. Westaway et al. (2017) ***An early modern human presence in Sumatra 73,000-63,000 years ago***, Nature, 548, 17 August, Pages 322-325

Based on dating teeth using uranium-series and electron spin resonance techniques and the morphology of the enamel-dentine junction to establish that the teeth belong to modern humans - This finding together with the finding of the arrival of modern humans in Australia ~65,000 years ago strongly suggests that modern humans must have left Africa long before the ~70,000 years ago date suggested by fossil studies but is in line with genetic studies suggesting migration of modern humans before 75,000 years ago.

Serena Tucci & Joshua M. Akey (2016) ***A map of human wanderlust***, Nature, 538, 13 October, Pages 179-180

Ancient DNA

*Elizabeth Culotta (2015) ***New Life for Old Bones: After a stormy adolescence, the field of ancient DNA enters it golden era***, Science, 346, 24 July, Pages 358-361

*Ann Gibbons (2015) ***Revolution in human evolution***, Science,346, 24 July, Pages 362-366

Lizzie Wade (2015) ***Breaking a tropical taboo***, Science, 346, 24 July, Pages 370-371

Oldest hominin DNA sequenced (2013) ***Max Planck researchers sequence the mitochondrial genome of a 400,000-year-old hominin from Spain***, Evolutionary Biology, December 14

Gina Kolata (2017) ***No Bones About It: Scientists Recover Ancient DNA From Cave Dirt,*** The New York Times, April 27

Viviane Slon et al (2017) ***Neanderthal and Denisovan DNA form Pleistocene sediments***, Science, 356, 12 May, Pages 605-608

This study highlights the fact that DNA can be salvaged from sediments, even in sites and layers where there's no other trace of hominin remains and thus offers a means of tracking hominin DNA where no skeletal remains are present.