The following articles address the growth and spread of humanity across the continent.

The Greatest Journey

The genes of people today tell of our ancestors' trek out of Africa to the far corners of the globe.
By James Shreeve, National Geographic March 2006

Everybody loves a good story, and when it's finished, this will be the greatest one ever told. It begins in Africa with a group of hunter-gatherers, perhaps just a few hundred strong. It ends some 200,000 years later with their six and a half billion descendants spread across the Earth, living in peace or at war, believing in a thousand different deities or none at all, their faces aglow in the light of campfires and computer screens.

In between is a sprawling saga of survival, movement, isolation, and conquest, most of it unfolding in the silence of prehistory. Who were those first modern people in Africa? What compelled a band of their descendants to leave their home continent as little as 50,000 years ago and expand into Eurasia? What routes did they take? Did they interbreed with earlier members of the human family along the way? When and how did humans first reach the Americas?

In sum: Where do we all come from? How did we get to where we are today? For decades the only clues were the sparsely scattered bones and artifacts our ancestors left behind on their journeys. In the past 20 years, however, scientists have found a record of ancient human migrations in the DNA of living people. "Every drop of human blood contains a history book written in the language of our genes," says population geneticist Spencer Wells, a National Geographic explorer-in-residence.

The human genetic code, or genome, is 99.9 percent identical throughout the world. What's left is the DNA responsible for our individual differences – in eye color or disease risk, for example – as well as some that serves no apparent function at all. Once in an evolutionary blue moon, a random, harmless mutation can occur in one of these functionless stretches, which is then passed down to all of that person's descendants. Generations later, finding that same mutation, or marker, in two people's DNA indicates that they share the same ancestor. By comparing markers in many different populations, scientists can trace their ancestral connections.

In most of the genome, these minute changes are obscured by the genetic reshuffling that takes place each time a mother and father's DNA combine to make a child. Luckily a couple of regions preserve the telltale variations. One, called mitochondrial DNA (mtDNA), is passed down intact from mother to child. Similarly, most of the Y chromosome, which determines maleness, travels intact from father to son.

The accumulated mutations in your mtDNA and (for males) your Y chromosome are only two threads in a vast tapestry of people who have contributed to your genome. But by comparing the mtDNA and Y chromosomes of people from various populations, geneticists can get a rough idea of where and when those groups parted ways in the great migrations around the planet.

In the mid-1980s the late Allan Wilson and colleagues at the University of California, Berkeley, used mtDNA to pinpoint humanity's ancestral home. They compared mtDNA from women around the world and found that women of African descent showed twice as much diversity as their sisters. Since the telltale mutations seem to occur at a steady rate, modern humans must have lived in Africa twice as long as anywhere else. Scientists now calculate that all living humans are related to a single woman who lived roughly 150,000 years ago in Africa, a "mitochondrial Eve." She was not the only woman alive at the time, but if geneticists are right, all of humanity is linked to Eve through an unbroken chain of mothers.

Mitochondrial Eve was soon joined by "Y chromosome Adam," an analogous father of us all, also from Africa. Increasingly refined DNA studies have confirmed this opening chapter of our story over and over: All the variously shaped and shaded people of Earth trace their ancestry to African hunter-gatherers.

Looking more closely at DNA markers in Africa, scientists may have found traces of those founders. Ancestral DNA markers turn up most often among the San people of southern Africa and the Biaka Pygmies of central Africa, as well as in some East African tribes. The San and two of the East African tribes also speak languages that feature a repertoire of unique sounds, including clicks. Perhaps these far-flung people pay witness to an expansion of our earliest ancestors within Africa, like the fading ripples from a pebble dropped in a pond.

What seems virtually certain now is that at a remarkably recent date – probably between 50,000 and 70,000 years ago – one small wavelet from Africa lapped up onto the shores of western Asia. All non-Africans share markers carried by those first emigrants, who may have numbered just a thousand people.

Some archaeologists think the migration out of Africa marked a revolution in behavior that also included more sophisticated tools, wider social networks, and the first art and body ornaments. Perhaps some kind of neurological mutation had led to spoken language and made our ancestors fully modern, setting a small band of them on course to colonize the world. But other scientists see finely wrought tools and other traces of modern behavior scattered around Africa long before those first steps outside the continent. "It's not a 'revolution' if it took 200,000 years," says Alison Brooks of George Washington University.

Whatever tools and cognitive skills the emigrants packed with them, two paths lay open into Asia. One led up the Nile Valley, across the Sinai Peninsula, and north into the Levant. But another also beckoned. Seventy thousand years ago the Earth was entering the last ice age, and sea levels were sinking as water was locked up in glaciers. At its narrowest, the mouth of the Red Sea between the Horn of Africa and Arabia would have been only a few miles wide. Using primitive watercraft, modern humans could have crossed over while barely getting their feet wet.

Once in Asia, genetic evidence suggests, the population split. One group stalled temporarily in the Middle East, while the other followed the coast around the Arabian Peninsula, India, and beyond. Each generation may have pushed just a couple of miles farther.

"The movement was probably imperceptible," says Spencer Wells, who heads the National Geographic Society's Genographic Project, a global effort to refine the picture of early migrations. "It was less of a journey and probably more like walking a little farther down the beach to get away from the crowd."

Over the millennia, a few steps a year and a few hops by boat added up. The wanderers had reached southeastern Australia by 45,000 years ago, when a man was buried at a site called Lake Mungo. Artifact-bearing soil layers beneath the burial could be as old as 50,000 years – the earliest evidence of modern humans far from Africa.

No physical trace of these people has been found along the 8,000 miles from Africa to Australia – all may have vanished as the sea rose after the Ice Age. But a genetic trace endures. A few indigenous groups on the Andaman Islands near Myanmar, in Malaysia, and in Papua New Guinea – as well as almost all Australian Aborigines – carry signs of an ancient mitochondrial lineage, a trail of genetic bread crumbs dropped by the early migrants.

People in the rest of Asia and Europe share different but equally ancient mtDNA and Y-chromosome lineages, marking them as descendants of the other, stalled branch of the African exodus. At first, rough terrain and the Ice Age climate blocked further progress. Europe, moreover, was a stronghold of the Neandertals, descendants of a much earlier migration of pre-modern humans out of Africa.

Finally, perhaps 40,000 years ago, modern humans advanced into the Neandertals' territory. Overlapping layers of Neandertal and early modern human artifacts at a cave in France suggest that the two kinds of humans could have met.

How these two peoples – the destined parvenu and the doomed caretaker of a continent – would have interacted is a potent mystery. Did they eye each other with wonder or in fear? Did they fight, socialize, or dismiss each other as alien beings?

All we know is that as modern humans and distinctly more sophisticated toolmaking spread into Europe, the once ubiquitous Neandertals were squeezed into ever shrinking pockets of habitation that eventually petered out completely. ~~On current evidence, the two groups interbred rarely, if at all. Neither mtDNA from Neandertal fossils nor modern human DNA bears any trace of an ancient mingling of the bloodlines.~~

About the same time as modern humans pushed into Europe, some of the same group that had paused in the Middle East spread east into Central Asia. Following herds of game, skirting mountain ranges and deserts, they reached southern Siberia as early as 40,000 years ago. As populations diverged and became isolated, their genetic lineages likewise branched and rebranched. But the isolation was rarely if ever complete. "People have always met other people, found them attractive, and had children," says molecular anthropologist Theodore Schurr of the University of Pennsylvania.

Schurr's specialty is the peopling of the Americas – one of the last and most contentious chapters in the human story. The subject seems to attract fantastic theories (Native Americans are the descendants of the ancient Israelites or the lost civilization of Atlantis) as well as ones tinged with a political agenda. The "Caucasoid" features of a 9,500-year-old skull from Washington State called Kennewick Man, for instance, have been hailed as proof that the first Americans came from northern Europe.

In fact most scientists agree that today's Native Americans descend from ancient Asians who crossed from Siberia to Alaska in the last ice age, when low sea level would have exposed a land bridge between the continents. But there's plenty of debate about when they came and where they originated in Asia.

For decades the first Americans were thought to have arrived around 13,000 years ago as the Ice Age eased, opening a path through the ice covering Canada. But a few archaeologists claimed to have evidence for an earlier arrival, and two early sites withstood repeated criticism: the Meadow-croft Shelter in Pennsylvania, now believed to be about 16,000 years old, and Monte Verde in southern Chile, more than 14,000 years old.

The DNA of living Native Americans can help settle some of the disputes. Most carry markers that link them unequivocally to Asia. The same markers cluster in people who today inhabit the Altay region of southern Siberia, suggesting it was the starting point for a journey across the land bridge. So far, the genetic evidence doesn't show whether North and South America were populated in a single, early migration or two or three distinct waves, and it suggests only a rough range of dates, between 20,000 and 15,000 years ago. Even the youngest of those dates is older than the opening of an inland route through the Canadian ice. So how did the first Americans get here? They probably traveled along the coast: perhaps a few hundred people hopping from one pocket of land and sustenance to the next, between a frigid ocean and a looming wall of ice. "A coastal route would have been the easiest way in," says Wells. "But it still would have been a hell of a trip." Beyond the glaciers lay immense herds of bison, mammoths, and other animals on a continent innocent of other intelligent predators. Pushed by population growth or pulled by the lure of game, people spread to the tip of South America in as little as a thousand years.

The genes of today's Native Americans are helping to bring their ancestors' saga to life. But much of the story can only be imagined, says Jody Hey, a population geneticist at Rutgers University. "You can't tell it with the richness of what must have happened." With the settling of the Americas, modern humans had conquered most of the planet. When European explorers set sail 700 years ago, the lands they "discovered" were already full of people. The encounters were often wary or violent, but they were the reunions of a close-knit family.

Perhaps the most wonderful of the stories hidden in our genes is that, when unraveled, the tangled knot of our global genetic diversity today leads us all back to a recent yesterday, together in Africa.

After Near Extinction, Human Split Into Isolated Bands

By Amitabh Avasthi, National Geographic, 24 April 2008

After nearly going extinct 150,000 years ago, humankind split into small groups – living in isolation for nearly a hundred thousand years before "reuniting" and migrating out of Africa, a new gene study says.

At one point our species may have been down to as few as 2,000 individuals, probably due to climate change – a longstanding theory bolstered by the new findings.

The research fills a gap in our understanding of what was happening in Africa before humans first left the continent.

"The assumption has always been that the original population [in sub-Saharan Africa] was very small but probably a single population," said Spencer Wells, head of the Genographic Project, which oversaw the study.

"Turns out, that is not the case." The study appears in the current issue of the American Journal of Human Genetics.

Around 200,000 years ago, modern humans emerged as a distinct species. All people alive today can trace their ancestry back to these humans, according to previous genetic studies. By the time the first great migrations out of Africa began, around 60,000 years ago, humanity had split into distinct populations with unique genetic lineages.

So what happened between 200,000 years ago and 60,000 years ago? To find out, Wells and his colleagues analyzed 624 complete genomes of mitochondrial DNA – which is passed down from mothers – from various indigenous populations across sub-Saharan Africa. A genome is a person's complete set of DNA. The researchers tracked mutations in genetic samples. Samples from Khoisan hunter-gatherers in South Africa were particularly revealing – perhaps not surprising, as the Khoisan have some of the oldest paternal and maternal lineages among modern humans.

The team found that a population that had probably originated in eastern Africa split about 150,000 years ago. One group went south, the other northeast. Humankind "remained apart for nearly a hundred thousand years and then about 40,000 years ago, [then] reunited to become part of a single pan-African population," said Doron Behar, a Genographic associate researcher based at Rambam Medical Center in Haifa, Israel.

While it is not fully clear why the populations split in the first place, climate change may have played a role, the researchers say. (Related: "Did Climate Change Trigger Human Evolution?" [February 2, 2006].) "There seems to have been some major climatic events that probably contributed to the separation," said Wells, pointing to evidence that Lake Malawi, in what is now Mozambique, went through a series of severe droughts during that time.

"The population size was driven down to probably as low as 2,000 individuals, perhaps – just a few hundred individuals in each population," Wells added. "We were on the brink of extinction."

Once the rough climatic conditions let up, the populations apparently expanded and ultimately moved out of Africa – perhaps helped by the new tools and technologies of the late Stone Age.

Colin Groves is an anthropologist at the Australian National University in Canberra. He says the findings "remind us that, before the spread of Homo sapiens out of Africa, things were nonetheless going on within Africa, involving population splits. "Human diversity within Africa is fascinating, and with the previous focus on non-African peoples, it has tended to be overlooked or forgotten," he added. But archaeologist Peter Forster says, "The conclusions do not strike me as being particularly new. "We published along these lines since 1997. But it's good to know that independent analyses come to similar conclusions."

Shortly after Homo sapiens arose, harsh climate conditions nearly extinguished our species. Recent finds suggest that the small population that gave rise to all humans alive today survived by exploiting a unique combination of resources along the southern coast of Africa

With the global population of humans currently approaching seven billion, it is difficult to imagine that Homo sapiens was once an endangered species. Yet studies of the DNA of modern-day people indicate that, once upon a time, our ancestors did in fact undergo a dramatic population decline. Although scientists lack a precise timeline for the origin and near extinction of our species, we can surmise from the fossil record that our forebears arose throughout Africa shortly before 195,000 years ago. Back then the climate was mild and food was plentiful; life was good. But around 195,000 years ago, conditions began to deteriorate. The planet entered a long glacial stage known as Marine Isotope Stage 6 (MIS6) that lasted until roughly 123,000 years ago.

A detailed record of Africa's environmental conditions during glacial stage 6 does not exist, but based on more recent, better-known glacial stages, climatologists surmise that it was almost certainly cool and arid and that its deserts were probably significantly expanded relative to their modern extents. Much of the landmass would have been uninhabitable. While the planet was in the grip of this icy regime, the number of people plummeted perilously – from more than 10,000 breeding individuals to just hundreds. Estimates of exactly when this bottleneck occurred and how small the population became van among generic studies, but all of them indicate that everyone alive today is descended from a small population that lived in one region of Africa sometime during this global cooling phase.

I began my career as an archaeologist working in East Africa and studying the origin of modern humans. But my interests began to shift when I learned of the population bottleneck that geneticists had started talking about in the early 1990s. Humans today exhibit very low genetic diversity relative to many other species with much smaller population sizes and geographic ranges – a phenomenon best explained by the occurrence of a population crash in early H. sapiens. Where, I wondered, did our ancestors manage to survive during the climate catastrophe? Only a handful of regions could have had the natural resources to support hunter-gatherers.

Paleoanthropologists argue vociferously over which of these areas was the ideal spot. The southern coast of Africa, rich in shellfish and edible plants year-round, seemed to me as if it would have been a particularly good refuge in tough times. So, in 1991, I decided I would go there and look for sites with remains dating to glacial stage 6. My search within that coastal area was not random. I had to find a shelter close enough to the ancient coastline to provide easy access to shellfish and elevated enough that its archaeological deposits would not have been washed away 123,000 years ago when the climate warmed and sea levels surged. In 1999 my South African colleague Peter Nilssen and I decided to investigate some caves he had spotted at a place called Pinnacle Point, a promontory near the town of Mossel Bay that juts into the Indian Ocean. Scrambling down the sheer cliff face, we came across a cave that looked particularly promising – one known simply as PP13B. Erosion of the sedimentary deposits located near the mouth of the cave had exposed clear layers of archaeological remains, including hearths and stone tools. Even better, a sand dune and a layer of stalagmite capped these remnants of human activity, suggesting that they were quite old. By all appearances, we had hit the jackpot. The following year, after a local ostrich farmer built us a 180-step wooden staircase to allow safer access to the site, we began to dig.

Since then, my team's excavations at PP13B and other nearby sites have recovered a remarkable record of the activities undertaken by the people who inhabited this area between approximately 164,000 and 35,000 years ago, hence during the bottleneck and after the population began to recover. The deposits in these caves, combined with analyses of the ancient environment there, have enabled us to piece together a plausible account of how the prehistoric residents of Pinnacle Point eked out a living during a grim climate crisis.

The remains also debunk the abiding notion that cognitive modernity evolved long after anatomical modernity: evidence of behavioral sophistication abounds in even the oldest archaeological levels at PP13B. This advanced intellect no doubt contributed significantly to the survival of the species, enabling our forebears to take advantage of the resources available on the coast.

While elsewhere on the continent populations of H. sapiens died out as cold and drought claimed the animals and plants they hunted and gathered, the lucky denizens of Pinnacle Point were feasting on the seafood and carbohydrate-rich plants that proliferated there despite the hostile climate. As glacial stage 6 cycled through its relatively warmer and colder phases, the seas rose and fell, and the ancient coastline advanced and retreated. But so long as people tracked the shore, they bad access to an enviable bounty.

From a survival standpoint, what makes the southern edge of Africa attractive is its unique combination of plants and animals. There a thin strip of land containing the highest diversity of flora for its size in the world hugs the shoreline. Known as the Cape Floral Region, this 90,000-square-kilometer strip contains an astonishing 9,000 plant species, some 64 percent of which live only there.

Indeed, the famous Table Mountain that rises above Cape Town in the heart of the Cape Floral Region has more species of plants than does the entire U.K. Of the vegetation groups that occur in this realm, the two most extensive are the fynbos and the renosterveld, which consist largely of shrubs. To a human forager equipped with a digging stick, they otter a valuable commodity: the plants in these groups produce the world's greatest diversity of geophytes – underground energy-storage organs Such as tubers, bulbs and corms.

Geophytes are an important food source for modern-day hunter-gatherers for several reasons. They contain high amounts of carbohydrate; they attain their peak carbohydrate content reliably at certain times of year; and, unlike aboveground fruits, nuts and seeds, they have few predators. The bulbs and corms that dominate the Cape Floral Region are additionally appealing because in contrast to the many geophytes that are highly fibrous, they are low in fiber relative to the amount of energy-rich carbohydrate the) contain, making them more easily digested by children. (Cooking further enhances their digestibility.) And because geophytes are adaptations to dry conditions, they would have been readily available during arid glacial phases.

The southern coast also has an excellent source of protein to offer, despite not being a prime hunting ground for large mammals. Just offshore, the collision of nutrient-rich cold waters from the Benguela upwelling and the warm Agulhas current creates a mix of cold and warm eddies along the southern coast. This varied ocean environment nurtures diverse and dense beds of shellfish in the rocky intertidal zones and Sandy beaches. Shellfish are a very high quality source of protein and omega-3 fatty acids. And as with geophytes, glacial cooling does not depress their numbers. Rather, lower ocean temperatures result in a greater abundance of shellfish.

With its combination of calorically dense, nutrient-rich protein from the shellfish and low-fiber, energy-laden carbs from the geophytes, the southern coast would have provided an ideal diet for early modern humans during glacial stage 6. Furthermore, women could obtain both these resources on their own, freeing them from relying on men to provision them and their children with high-quality food. We have yet to unearth proof that the occupants of PP13B were eating geophytes – sites this old rarely preserve organic remains--although younger sites in the area contain extensive evidence of geophyte consumption. But we have found clear evidence that they were dining on shellfish. Studies of the shells found at the site conducted by Antonieta Jerardino of the University of Barcelona show that people were gathering brown mussels and local sea snails called alikreukel from the seashore. They also ate marine mammals such as seals and whales on occasion.

Previously the oldest known examples of humans systematically using marine resources dated to less than 120,000 years ago. But dating analyses performed by Miryam Bar-Matthews of the Geological Survey of Israel and Zenobia Jacobs of University of Wollongong in Australia have revealed that the PP13B people lived oft the sea far earlier than that: as we reported in 2007 in the journal Nature, marine foraging there dates back to a stunning 164,000 years ago. By 110,000 years ago the menu had expanded to include species such as limpets and sand mussels.

This kind of foraging is harder than it might seem. The mussels, limpets and sea snails live on the rocks in the treacherous intertidal zone, where an incoming swell could easily knock over a hapless collector. Along the southern coast, safe harvesting with sufficiently high returns is only possible during low spring tides, when the sun and moon align, exerting their maximum gravitational force on the ebb and flow of the water. Because the tides are linked to the phases of the moon, advancing by 50 minutes a day, I surmise that the people who lived at PP13B – which 164,000 years ago was located much farther inland, two to five kilometers from the water, be cause of lower sea levels – scheduled their trips to the shore using a lunar calendar of sorts, just as modern coastal people have done for ages.

Harvesting shellfish is not the only advanced behavior in evidence at Pinnacle Point as early as 164,000 years ago. Among the stone tools are significant numbers of "bladelets" – tiny flakes twice as long as they are wide – that are too small to wield by hand. Instead they must have been attached to shafts of wood and used as projectile weapons. Composite toolmaking is indicative of considerable technological know-how, and the bladelets at PP13B are among the oldest examples of it. But we soon learned that these tiny implements were even more complex than we thought.

Most of the stone tools found at coastal South African archaeological sites are made from a type of stone called quartzite. This coarse-grained rock is great for making large flakes, but it is difficult to shape into small, refined tools. To manufacture the bladelets, people used fine-grained rock called silcrete. There was something odd about the archaeological silcrete, though, as observed by Kyle S. Brown of the Institute of Human Origins at Arizona State University, an expert stone tool flaker on my team. After years of collecting silcrete from all over the coast, Brown determined that in its raw form the rock never has the lustrous red and gray coloring seen in the silcrete implements at Pinnacle Point and elsewhere. Furthermore, the raw silcrete is virtually impossible to shape into blade-lets. Where, we wondered, did the toolmakers find their superior silcrete?

A possible answer to this question came from Pinnacle Point Cave 5-6, where one day in 2008 we found a large piece of silcrete embedded in ash. It had the same color and luster seen in the silcrete found at other archaeological deposits in the region. Given the association of the stone with the ash, we asked ourselves whether the ancient toolmakers ought have exposed the silcrete to fire to make it easier to work with – a strategy that has been documented methnographic accounts of native North Americans and Australians.

To find out, Brown carefully "cooked" some raw silcrete and then attempted to knap it. It flaked wonderfully, and the flaked surfaces shone with the same luster seen in the artifacts from our sites. We thus concluded that the Stone Age silcrete was also heat treated. We faced an uphill battle to convince our colleagues of this remarkable claim, however. It was archaeology gospel that the Solutrean people in France invented heat treatment about 20,000 years ago, using it to make their beautiful tools. To bolster our case, we used three independent techniques. Chantal Tribolo of the University of Bordeaux performed what is called thermoluminescence analysis to determine whether the silcrete tools from Pinnacle Point were intentionally heated. Then Andy Merries of the University of New South Wales in Australia employed magnetic susceptibility, which looks for changes in the ability of rock to be magnetized – another indicator of heat exposure among iron-rich rocks. Finally, Brown used a gloss meter to measure the luster that develops after hearing and flaking and compare it with the luster on the tools he made. Our results, detailed last year in the journal Science, showed that intentional heat treatment was a dominant technology at Pinnacle Point by 72,000 years ago and that people there employed it intermittently as far back as 164,000 years ago.

The process of treating by heat testifies to two uniquely modern human cognitive abilities. First, people recognized that they could substantially alter a raw material to make it useful – in this case, engineering the properties of stone by heating it, thereby turning a poor-quality rock into high-quality raw material. Second, they could invent and execute a long chain of processes. The making of silcrete blades requires a complex series of carefully designed steps: building a sand pit to insulate the silcrete, bringing the heat slowly up to 350 degrees Celsius, holding the temperature steady and then dropping it down slowly. Creating and carrying out the sequence and passing technologies down from generation to generation probably required language. Once established, these abilities no doubt helped our ancestors outcompete the archaic human species they encountered once they dispersed from Africa. In particular, the complex pyrotechnology detected at Pinnacle Point would have given early modern humans a distinct advantage as they entered the cold lands of the Neandertals, who seem to have lacked this technique.

In addition to being technologically savvy, the prehistoric denizens of Pinnacle Point had an artistic side. In the oldest layers of the PP13B sequence, my team has unearthed dozens of pieces of red ochre (iron oxide) that were variously carved and ground to create a fine powder that was probably mixed with a binder such as animal far to make paint that could be applied to the body or other surfaces.

Such decorations typically encode information about social identity or other important aspects of culture – that is, they are symbolic. Many of my colleagues and I think that this ochre constitutes the earliest unequivocal example of symbolic behavior on record and pushes the origin of such practices back by tens of thousands of years. Evidence of symbolic-activities also appears later in the sequence. Deposits dating to around 110,00 years ago include both red ochre and seashells that were clearly collected for their aesthetic appeal, because by the time they washed ashore from their deepwater home, any flesh would have been long gone. I think these decorative seashells, along with the evidence for marine foraging, signal that people had, for the first time, begun to embed in their worldview and rituals a clear commitment to the sea.

The precocious expressions of both symbolism and sophisticated technology at Pinnacle Point have major implications for understanding the origin of our species. Fossils from Ethiopia show that anatomically modern humans had evolved by at least 195,000 years ago. The emergence of the modern mind, however, is more difficult to establish. Paleoanthropologists use various proxies in the archaeological record to try to identify the presence and scope of cognitive modernity. Artifacts made using technologies that require out-side-the-box connections of seemingly unrelated phenomena and long chains of production--like heat treatment of rock for tool manufacture are one proxy. Evidence of art or other symbolic activities is another, as is the tracking of time through proxies such as lunar phases. For years the earliest examples of these behaviors were all found in Europe and dated to after 40,000 years ago. Based on that record, researchers concluded that there was a long lag between the origin of our species and the emergence of our peerless creativity.

But over the past 10 years archaeologists working at a number of sites in South Africa have found examples of sophisticated behaviors that predate by a long shot their counterparts in Europe. For instance, archaeologist Ian Watts, who works in South Africa, has described hundreds to thousands of pieces of worked and unworked ochre at sites dating as far back as 120,000 years ago. Interestingly, this ochre, as well as the pieces at Pinnacle Point, tends to be red despite the fact that local sources of the mineral exhibit a range of hues, suggesting that humans were preferentially curating the red pieces – perhaps associating the color with menstruation and fertility. Jocelyn A. Bernatchez, a Ph.D. student at Arizona State, thinks that many of these ochre pieces may have been yellow originally and then heat-treated to turn them red. And at Blombos Cave, located about 100 kilometers west of Pinnacle Point, Christopher S. Henshilwood of the University of Bergen in Norway has discovered pieces of ochre with systematic engravings, beads made of snail shells and refined bone tools, all of which date to around 71,000 years ago [see "The Morning of the Modern Mind," by Kate Wong; *SCIENTIFIC AMERICAN*, June 2005]. These sites, along with those at Pinnacle Point, belie the claim that modern cognition evolved late in our lineage and suggest instead that our species had this faculty at its inception.

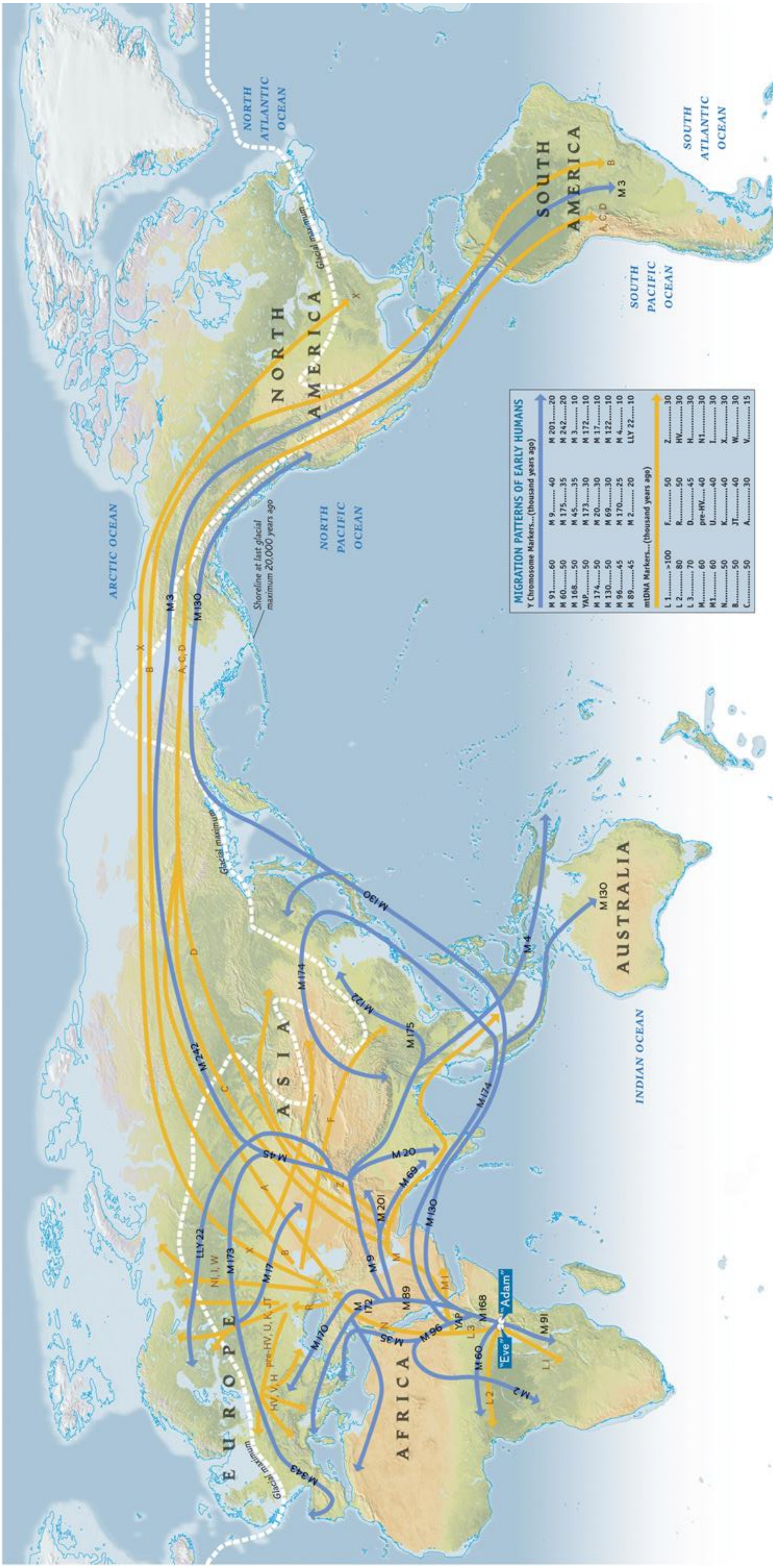
I suspect that a driving force in the evolution of this complex cognition was strong long-term selection acting to enhance our ancestors' ability to mentally map the location and seasonal variation of many species of plants in arid environments and to convey this accumulated knowledge to offspring and other group members. This capacity laid the foundation for many other advances, such as the ability to grasp the link between the phases of the moon and the tides and to learn to schedule their shellfish-hunting trips to the shore accordingly. Together the readily available shellfish and geophytes provided a high-quality diet that allowed people to become less nomadic, increased their birth rates and reduced their child mortality. The larger group sizes that resulted from these changes would have promoted symbolic behavior and technological complexity as people endeavored to express their social identity and build on one another's technologies, explaining why we see such sophisticated practices at PP13B.

PP13B preserves a long record of changing occupations that, in combination with the detailed records of local climate and environmental change my team has obtained, is revealing how our ancestors used the cave and the coast over millennia. Modeling the paleocoastline over time, Erich C. Fisher of the University of Florida has shown that the conditions changed quickly and dramatically, thanks to a long, wide, gently sloping continental shelf off the coast of South Africa called the Agulhas bank. During glacial periods, when sea levels fell, significant amounts of this shelf would have been exposed, putting considerable distance – up to 95 kilometers between Pinnacle Point and the ocean. When the climate warmed and sea levels rose, the water advanced over the Agulhas bank again, and the caves were seaside once more.

Judging from rainfall and vegetation patterns evident in records from stalagmites spanning the time between 350,000 and 50,000 years ago, we see that the fynbos probably followed the retreating coast out onto the now submerged continental shelf and back again, keeping the geophytes and shellfish in close proximity. As for the people, during these periods of low population density they were tree to target the best part of the landscape, and that was the intersection of the geophytes and shellfish – so I suspect they followed the sea.

The tracking of resources would explain why PP13B appears to have been occupied intermittently. Our excavations at PP13B have intercepted the people who may very well be the ancestors of everyone on the planet as they shadowed the shifting shoreline. Yet if I am correct about these people and their connection to the coast, the richest record of the progenitor population lies underwater on the Agulhas bank. There it will remain for the near future, guarded by great white sharks and dangerous currents. We can still test the hypothesis that humans followed the sea by examining sites on the current coast such as PP13B and another site we are excavating called PP5-6. But we can also study locations where the continental shelf drops steeply and the coast was always near – investigations that my colleagues and 1 are currently initiating.

The genetic, fossil and archaeological records are reasonably concordant in suggesting that the first substantial and prolonged wave of modern human migration out of Africa occurred around 50,000 years ago. But questions about the events leading up to that exodus remain. We still do not know, for example, whether at the end of glacial stage 6 there was just one population of H. sapiens left in Africa or whether there were several, with just one ultimately giving rise to everyone alive today. Such unknowns are providing my team and others with a very clear and exciting research direction for the foreseeable future: our fieldwork needs to target the other potential progenitor zones in Africa during that glacial period and expand our knowledge of the climate conditions just before that stage. We need to flesh out the story of these people who eventually pushed out of their refuge, filled up the African continent and went on to conquer the world.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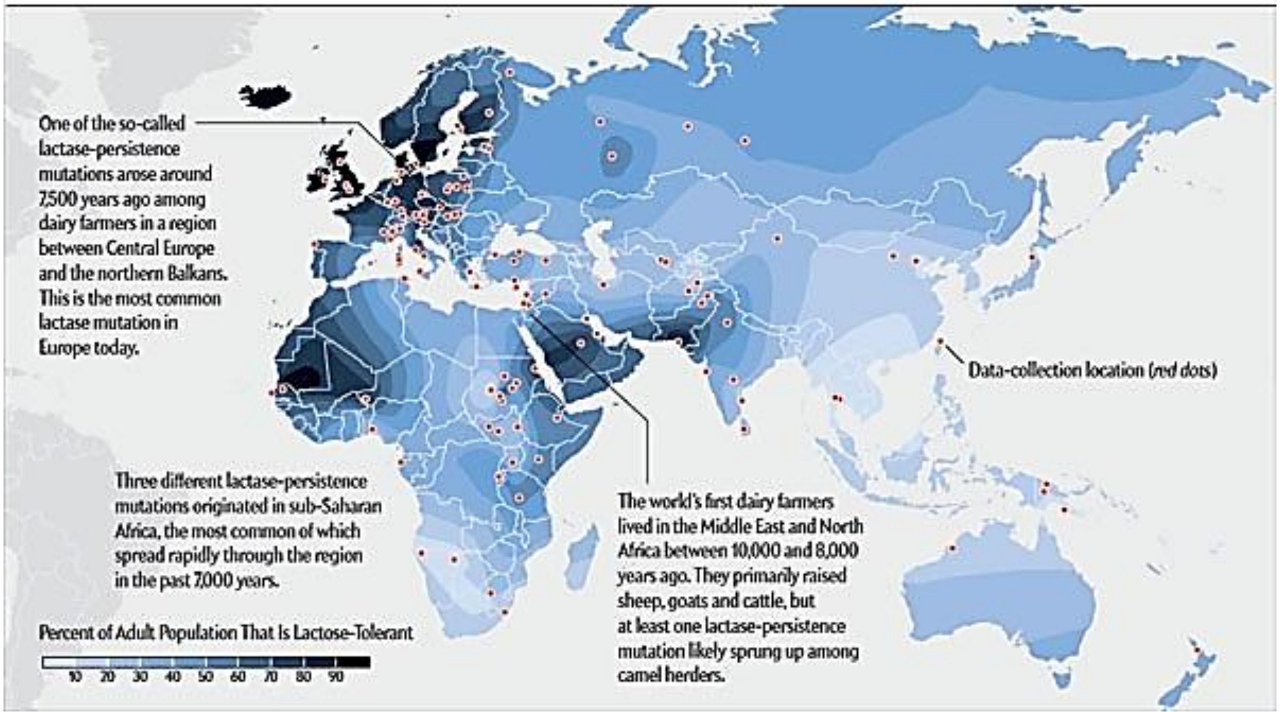
M 60........50 M 175......35 M 242......20
M 168......50 M 45........35 M 3......... 10
YAP..........50 M 173......30 M 172......10
M 174......50 M 20........30 M 17........10
M 130......50 M 69........30 M 122......10
M 96........45 M 170......25 M 4......... 10
M 89........45 M 2......... 20 LLY 22..... 10
mtDNA Markers...(thousand years ago)
L 1.......... >100 F............ 50 Z............ 30
L 2.......... 80 R............ 50 HV.......... 30
L 3.......... 70 D............45 H............30
M............ 60 pre-HV..... 40 N1...........30
M1.......... 60 U............40 I............ 30
N............50 K............40 X............30
B............50 JT...........40 W.......... 30
C............50 A............30 V............ 15
EUROPE
ASIA
AFRICA
AUSTRALIA
NORTH AMERICA
SOUTH AMERICA
ARCTIC OCEAN
NORTH PACIFIC OCEAN
NORTH ATLANTIC OCEAN
SOUTH PACIFIC OCEAN
SOUTH ATLANTIC OCEAN
INDIAN OCEAN
Shoreline at last glacial maximum 20,000 years ago
Glacial maximum
"Eve"
"Adam"

FINDINGS

The Milk Mutation

Enjoying dairy in adulthood is a privilege that emerged relatively recently in our evolutionary history. We depend on the enzyme lactase to break down lactose, the sugar found in milk, but the human body usually stops producing lactase after adolescence. In fact, most of the world's adults are lactose-intolerant. Within the past 10,000 years, however, different populations of dairy farmers independently evolved genetic mutations that kept lactase active throughout life (lactase persistence). Scientists have identified several such mutations, but there are likely more. Collectively, all these adaptations explain the prevalence of lactose tolerance seen around the world today.



More information online at:
https://www.scientificamerican.com/article/why-we-got-milk/

Other interesting links

Acquiring the Ability to Digest Milk
https://www.scientificamerican.com/article/why-we-got-milk/

Ancient Girls Parents Were Two Different Human Species
https://www.nationalgeographic.com/science/2018/08/news-denisovan-neanderthal-hominin-hybrid-ancient-human/

How Running Made Us Human
https://www.sciencedaily.com/releases/2004/11/041123163757.htm

Mystery Human
(This can be made available be request as a pdf)

The Downside of Sex with Neanderthals
https://www.theguardian.com/science/blog/2011/aug/25/neanderthal-denisovan-genes-human-immunity

Skull Fossils in Cave Show Mix of Human Relatives Roamed South Africa
https://www.nytimes.com/2020/04/02/science/skulls-africa-caves.html

Blue Eyed Humans Have a Single, Common Ancestor
https://www.sciencedaily.com/releases/2008/01/080130170343.htm

Neanderthal Genes Hint at Much Earlier Human Migration From Africa
https://www.nytimes.com/2020/01/31/science/neanderthal-dna-africa.html?action=click&auth=login-email&login=email&module=RelatedLinks&pgtype=Article