Global Future Research

Insight summaries

Insight #8: Human Origins - Where did we come from and how did we become who we are?

Our human origins have always been a hugely fascinating question. We know Homo sapiens has only been around a relatively short time—our oldest fossil is 315,000 years old, which is equivalent to 1 minute on the Earth's 24-hour clock. We are a newcomer, and today we are the only remaining human species of up to 25 hominin species that are part of our family tree. We are also the only known advanced technological civilisation in the Universe.

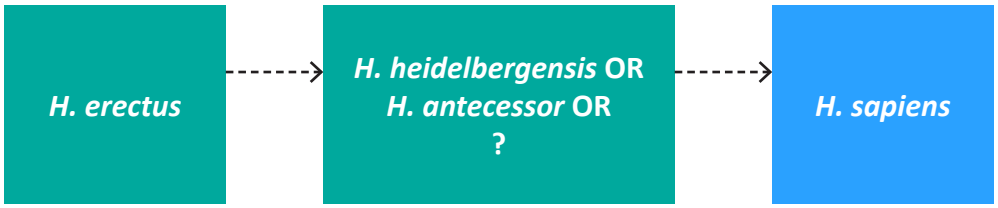
To explore our past evolution requires painstaking palaeontological work, greatly aided these days by improved dating techniques and genomics. As we learn more, by finding new fossils, re-analysing past fossil finds, or expanding and interpreting our DNA datasets, knowledge of our history is continuously changing – occasionally quite radically. Unravelling our past is an exciting journey, but it's more than simple description – because our 'human design' today has evolved over millions of years.Who we are today is very much a result of retained past designs and evolutionary modifications. Our make-up, our instincts and our behaviours hark back to our origins and evolution. Insight 8 uses the latest science and discoveries to describe our human story and answer some key questions.

What are our human origins?

As confronting as it may seem, we are simply one of the great apes. We separated from our closest 'great ape' cousins, the chimpanzees and bonobos, around 8 My ago, and then over time, and through contributions from various hominin species, developed increasingly human-like traits that we possess today.

Can we trace our evolutionary family tree from our origins to now?

While the concept of a simple linear human family tree is long gone, our best guess for our direct lineage is that Homo sapiens (*H. sapiens*) speciated from either Homo heidelbergensis, or Homo antecessor, or an unknown species. Prior to this, we most likely evolved from Homo erectus (*H. erectus*). There are insufficient fossils to clearly identify earlier ancestors, but Australopithecus and Ardipithecus are candidates, preceded with isolated examples of early hominins showing human traits of bipedalism and smaller teeth.

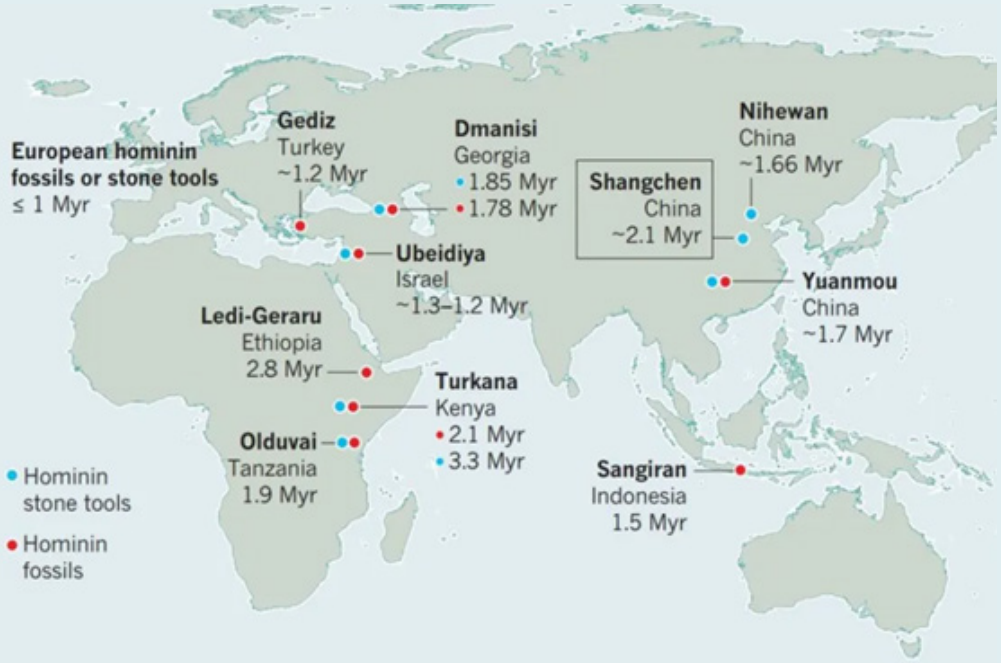


Can we identify at what point the first truly human-like species emerged?

Our earliest ancestors only showed limited human traits and were much more like their ape cousins. Homo erectus appeared about 2 My ago, showing for the first time a modern, tall, lean, human-like form with shorter arms and longer legs, less hair and sweat glands, and adapted for long distance walking and running in the savannas. Their advanced stone tools enabled the hunting of animals, in turn extracting more energy for a diet that included meat, which supported the development of a larger and rapidly growing brain. H. erectus was the first hominin to migrate out of Africa, travelling extensively across the globe. It is also the longest living hominin species to date, surviving almost 2 My, up to 100,000 years ago in Indonesia.

Where did we originate?

All our very early ancestors emerged in Africa. In fact, DNA analyses show that all humans living today can be traced back to Homo sapiens living in Africa at least 315,000 years ago and spreading across the globe in the 'Recent Out of Africa' migration between 70,000-50,000 years ago.. The earliest known evidence of human ancestors outside of Africa is tools dating back 2.12 My in China, prior to the emergence of *H. erectus*, and the oldest human fossils found so far are from the Eurasian Homo erectus site at Dmansi in Georgia, securely dated to 1.8 My ago



Sites of early human fossils and tools. Source: An early hominin arrival in Asia (nature.com)

Can we understand our step-by-step evolution of human traits towards modern humans?

Evolutionary changes towards modern human traits included: (i) changing anatomy and diet as we moved out of trees and an arboreal lifestyle, to a bipedal upright stature suitable for long distance walking and running on the ground; (ii) gradual growth in brain size, eventually by some 400 per cent; (iii) use of hands and arms for making and deploying increasingly sophisticated tools; (iv) development of animal hunting skills to become the world's greatest predator; (v) development and expansion of social groups who could trade and share knowledge over considerable distances; (vi) hunter-gatherer cultures defined by skilled animal hunting and plant gathering, supporting global migrations; (vii) emergence of a single human species (*H. sapiens*) from nine co-existing hominin species; (viii) agricultural revolution and the commencement of civilisations; (ix) industrial revolution supporting rapid population growth into the technology-dominated Anthropocene. Distinctive human traits and behaviours such as the use of language, art, sophisticated tools, control of fire, cooking, big game hunting and sailing, thought to originate with H. sapiens, are increasingly being pushed back in time to earlier human species.

How did we evolve socially?

Not a lot is known of the social lives of our most distant ancestors, but it can be inferred that social bonds were crucial for survival--helping early humans source and share food, care for infants and defend themselves against predators. By around 2.6 My ago, some groups were collecting tools and food from various places and bringing them to favoured spots. *H. erectus* launched hunter-gatherer societies; small bands of a few families who were mostly nomadic, combing large expanses of land for resources. Over time, they began to gather at fire hearths and shelters to eat and socialise. The largely nomadic hunter-gatherer lifestyle persisted until around 12,000 years ago when the agricultural revolution, starting with domestication of plants and animals, allowed humans to urbanise, building villages and then cities. The concentrated agricultural food production system gradually replaced hunter-gatherer societies, and at the same time allowed human populations to expand and civilisations to develop.

How did we impact non-hominin species?

H. erectus and its descendants developed intimate knowledge of its prey. By using increasingly sophisticated hunting weapons, trapping techniques and butchering tools, it became the world's most effective predator. Their migrations across parts of the globe often coincided with the depletion and loss of megafauna—which were easy prey for the new, intelligent hunters. Loss of biodiversity accelerated with the development of the agricultural and industrial revolutions, accompanied by rapid expansion of human population.

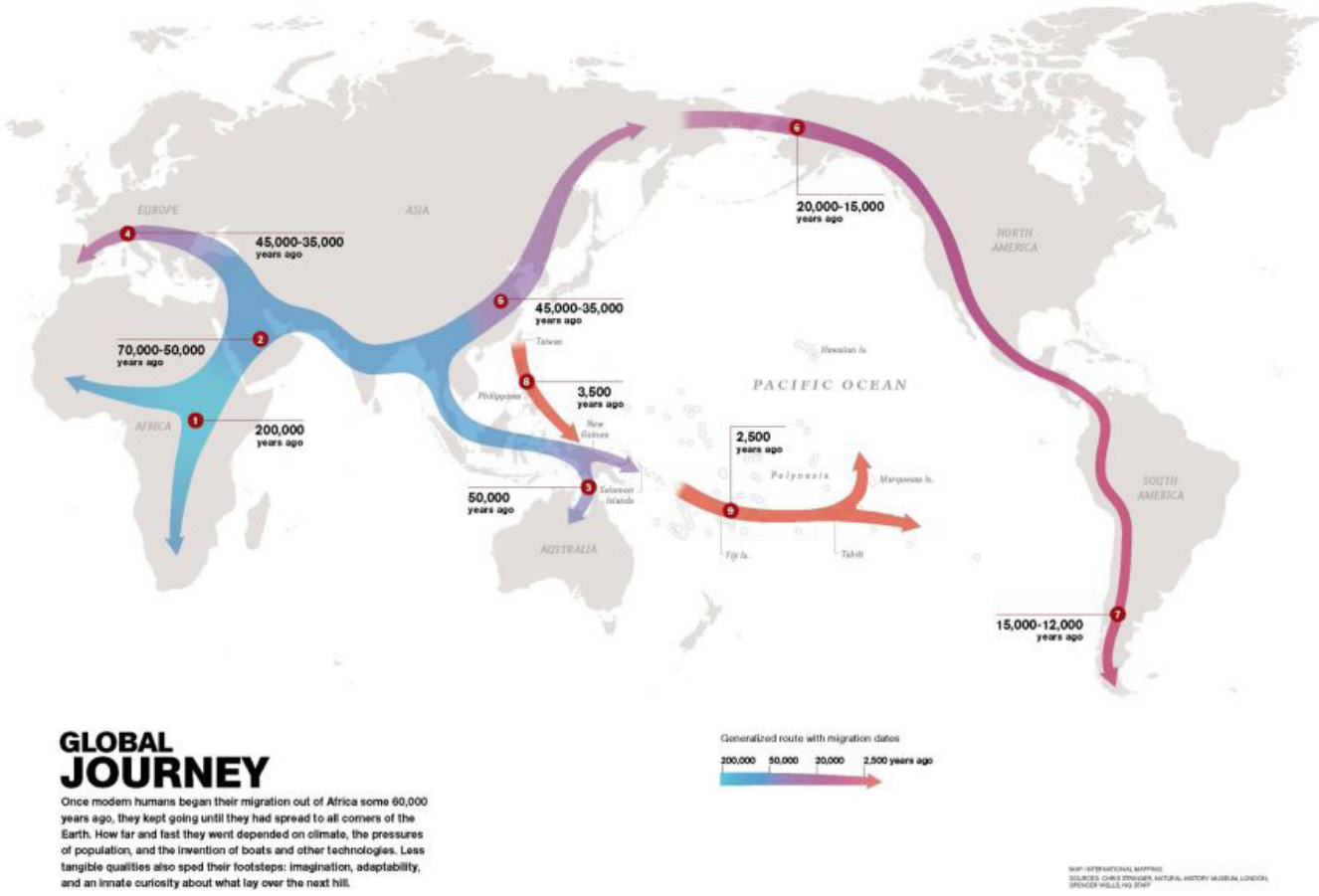
Can we see the full diversity of human species and determine which human species co-existed?

Hominin species are now known to be diverse, with up to 25 species identified--half found in the last 30 years. When *H. sapiens* emerged in Africa at least 315,000 years ago, there were 8 co-existing hominin species in different parts of the world. *H. erectus* (also known as *H. ergaster* in its African form) overlapped in time with 13 species, the most known, and no doubt encountered several on its global travels.

Early hominins. L-R: Ardipithecus kaddaba, Australopithecus africanus, Australopithecus garhi, Paranthropus boisei.
Source: Alchetron, the free social encyclopedia.

Can we track past migrations across the world?

Migrations of our ancestors out of Africa have been occurring for more than 2 My. There is seemingly little time between *H. erectus*' apparent arrival in Georgia 1.8 My ago and its arrival in Yuanmou, China, 1.7 My ago and in Java, Indonesia, 1.5 My ago. By 1 My ago, *H. erectus* had spread across Eurasia, although was restricted to latitudes south of the 50th parallel north . The presence of human remains in Indonesian islands is evidence for seafaring by *H. erectus,* with navigation appearing by 1 My ago, possibly to exploit offshore fishing. Early humans arrived in Europe from Southwest Asia about 1.2 My ago, where they prospered in a relatively warm and wet interglacial climate. Several human species may have been there, but the dominant one appears to have been H. antecessor. There were at least several "out-of-Africa" dispersals of *H. sapiens*, possibly beginning as early as 270,000 years ago via northern Africa and the Arabian Peninsula. From the Recent Out of Africa migration, *H. sapiens* spread across the entire globe, reaching Australia 50,000 years ago, Europe 45,000 years ago, and the Americas by 20,000 years ago. DNA evidence shows our human ancestors were always on the go – moving forwards and backwards across the globe, interacting with other human species and on occasions interbreeding.



Global journey map. Source: Global Human Journey (nationalgeographic.org)

Can we understand why we are the only surviving human species and what happened to the others?

By around 40,000 years ago, all human species had become extinct except *H. sapiens*, who, one way or another, replaced them. How and why this happened is uncertain, but one theory is that *H. sapiens* were out-competing other species for food, other key resources and territory by being more adaptable and having better technology. It is also theorised that *H. sapiens* may have out-competed other species in combat and/or assimilated other species by interbreeding. Another possibility is that other species went extinct of their own accord, for example due to their inability to cope with a changing climate and environment, or vulnerability from interbreeding in small populations.

Can we determine which other human species contributed genes to our make up today?

In addition to our ancestral species, interbreeding occurred between *H. sapiens* and Neanderthals, Denisovans and at least one additional unknown species. These species have contributed to the genetic make-up of humans today in varying amounts, depending on geography, and have a range of interesting effects on our functioning, for example in health aspects. Neanderthal-derived DNA has been found in the genomes of most contemporary populations but it varies by region. Outside Sub-Saharan Africa, it accounts for 1–4% of modern genomes, while those in Sub-Saharan Africa have 0.0-0.3% Neanderthal-derived DNA. Neanderthal-derived DNA is highest in East Asians, intermediate in Europeans, and lower in Southeast Asians. Ethiopians, with a large portion of their ancestry derived from West Eurasians, have ~1% Neanderthal-derived DNA. Denisovan-derived DNA generally does not appear in African, Western Asian and European populations. The highest rates occur in Oceania and some parts of Southeast Asia. An estimated 4–6% of the genome of modern Melanesians is derived from Denisovans, while the highest amounts are found in Philippines Negrito populations. Significant amounts of Denisovan DNA have also been found in Aboriginal Australians, Polynesians, Fijians, and eastern Indonesians.

What risks of predation did we face?

Early hominins retained arboreality, in addition to bipedalism, in part for protection against predators. They were known to be preyed upon by leopards, lions, tigers, cougars, jaguars, eagles, snakes, constrictors, wolves, hyenas, bears, sabre-toothed cats, Komodo dragons, crocodiles, and sharks! The Au. Africanus 'Taung Child' was likely killed by an eagle. Once living more on the savannahs, *H. habilis* and its descendants faced new predators which demanded better fighting implements, grouping into larger numbers for defence, and use of fire to attempt to keep predators at bay. Ultimately, when Homo established itself as the apex predator, it progressively eliminated its competitors to the point today that most have become extinct or only survive in small, remote locations

How close has the human lineage come to extinction?

We now know that all other human species, possibly 25 or more, have become extinct – suggesting extinction is the norm. Our direct human ancestors have been decimated at times; a fact discoverable by genetic bottlenecks. In one study, researchers in China have found evidence that the ancestors of modern humans suffered a massive population crash 930,000 years ago, possibly due to a drastic change to the climate. Before the bottleneck, the population of our ancestors included an estimated 98,000 breeding individuals, which shrank to fewer than 1,280 individuals, and stayed small for over 100,000 years before the population rebounded. The 98.7% population drop brought our human ancestors close to extinction.

Fundamental questions: Who are we? How did we come to behave as we do? Why are we here?

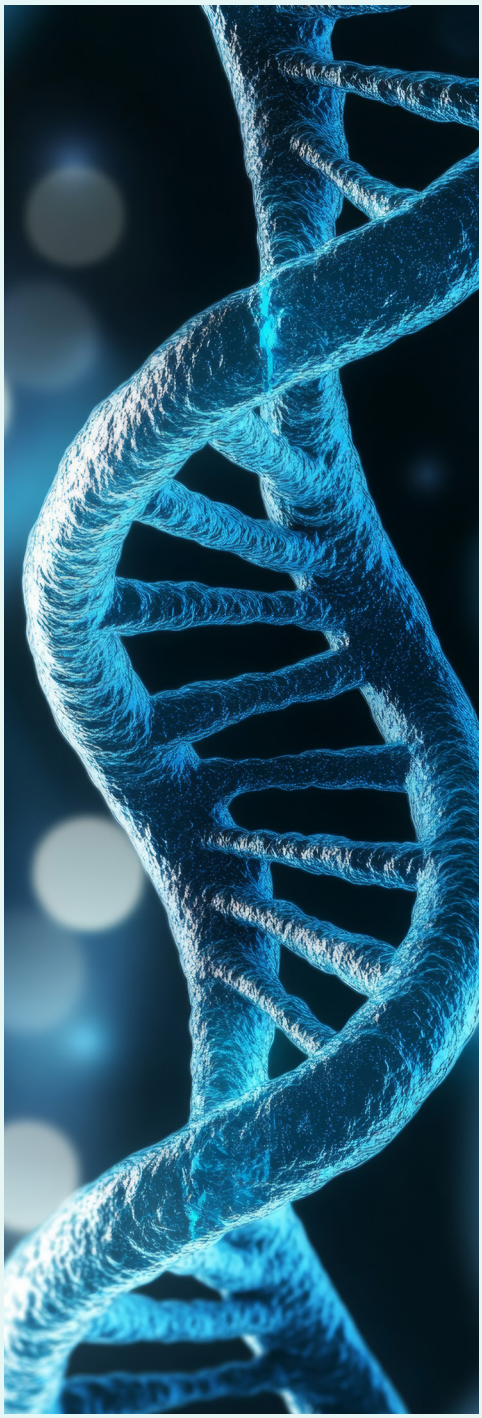
This Insight also set out to answer these more fundamental, philosophical questions, or at least consider what the science of human origins can contribute?

When we come to the question, ***'Who are we?'***, we know we are one of possibly millions of species of life on planet Earth, but the only known advanced intelligence and technological civilisation in the universe. Biologically we are an animal, one of the great apes, sharing 98.8% of our DNA with our closest ape cousins the chimpanzees. Whilst we share traits with other animals, we have some distinct features that have really set us apart--most notably a large and clever brain, our social ability to co-operate and create advances as a whole community, sophisticated expression in arts and culture, and our development of powerful technologies.

Our second key question, ***'How did we come to behave as we do?'*** highlights how we inherited the traits and instincts we bring to our behaviours today from our ancestors, largely to enhance our prospects for survival. We know many of these instincts are hard-wired in our brains and can be used to explain, but not perhaps justify, some of our seemingly irrational actions. Examples of these instincts often relate to our biological imperative to survive – and include fight or flight from predators, protecting family and tribe members, procreating, co-operating for the tribal good, competing for resources, territoriality, warfare and colonising new realms. Our 'tribal mind', that largely evolved through 2 My of hunter-gatherer societies, emphasises following one leader, adopting the group norms for more success in the group, and punishing those who go against the norms. This behaviour plays out strongly in our cultures, societies and nations today. Our complex minds can all at once be instinctual, tribal, spiritual and rational, and can operate in either of these modes as the occasion suits.

Our final question, ***'Why are we here?'*** is a perennial concern for philosophers and theologians, but from a scientific perspective, we are here because evolution of life on Earth produced us, largely by chance. We are but one of possibly millions of species on Earth now, and a latecomer. But what is perhaps more intriguing is that we are endowed with unique attributes, including a clever brain and ability to co-operate, that has made us the apex predator and dominant animal species on planet Earth. Going forward we seem destined to continue our biological imperatives by embedding rapid technological advances into our future design, including creating a potentially superior artificial intelligence in the coming decades. This unrelenting drive to evolve is part of who we are at our core. We 'evolved to evolve'.

"We are here because evolution of life on Earth produced us, largely by chance"



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