rainfall) many fish and other forms of sea life are found at much shallower depths than normal. Black coral more prominent at greater depths is also found near the surface making for excellent diving.

The Maori people have there own story as to how Milford Sound was formed. They say that a Maori God called Tua wanted to become a great carver and for this needed to learn his trade. He fashioned an axe out of Greenstone and started carving through the rocks along New Zealand's South west coast starting at the bottom and working his way north. As he formed each fjord he was still an apprentice and left Islands in the middle of some of the fjords and slopes that were not as vertical as he would have liked. But he steadily improved and on his fourteenth attempt carved out Milford sound and achieved perfection. The folklore says that when one of the Sea Gods witnessed this creation she felt that Milford sound was so beautiful that if people came to see it that they would not want to leave again so she created two giant sand flies which bred to produce millions more to guard over the place. If anyone has been to Milford Sound they will put some credit to this story as Milford sound is an amazing place but the sand flies (which make our own midge pale in comparison) will make sure you don't linger for too long there...........

Where did we come from?

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If your answer to the question in the title includes references to lust, powercuts, the quality of TV programming, or improbable conjugations between feathered vertebrates and honey-making insects, then you are answering a different question to the one intended. The question is not asking where we as individuals came from, but where we as a species came from.

Until fairly recent times the question was unproblematic, at least for those brought up in a Judeo-Christian tradition: God made Adam in His own image, then He made Eve from a few leftovers, and then left them to it. And so, a short while later (estimated by biblical scholars as about 6,000 years), after a bit of begatting, here we all are. To suggest otherwise was considered blasphemous, and even in certain parts of the United States today it would not be smartest way to boost your promotion chances in the teaching profession. However, in more enlightened parts of the world, the notion of evolution, which had been proposed in both Ancient Greece and China, was revived in the nineteenth century by scientists such as Jean-Baptiste Lamarck, Alfred Russel Wallace (the 'father of biogeography') and, most notably, Charles Darwin.

Lamarck, in a series of publications in the early 1800s, put forward the idea that organisms adapted to their environment and that these changes could be transmitted to the next generation. He also argued for the transmutation of species – the idea that one species could evolve into a new species. These ideas were refined by Darwin and Wallace who, independent of one another, developed the idea of natural selection, the basic premise of which is encapsulated in Herbert Spencer's famous phrase 'survival of the fittest'. In other words, individuals within each species have different traits, some of which confer a natural advantage over other members of the species in the Malthusian competition for resources. The better equipped individuals consequently have a greater chance of surviving to adulthood, and therefore of passing on the beneficial traits to their offspring. Each species will consequently tend to evolve to become better adapted to its environment through the weeding out of individuals having the less useful traits. Any changes to the environment, however, will tend to tilt the balance in favour of individuals having traits more suited to the new environment. Evolution and environmental change are therefore intimately linked.

Darwin did not understand how the successful traits were transmitted from one generation to the next. This awaited an understanding of genetics. It is now known that the traits of individuals are programmed by DNA. The nucleus in almost every one of the 10^{14} or so cells in your body contains an identical copy of your DNA, organised into 23 pairs of chromosomes (i.e. 46 in total). These chromosomes contain the genes that provide the instructions for 'manufacturing' your body. Unless you happen to have an identical twin, your DNA is different from everyone else's DNA and therefore so are you. During sexual reproduction (meiosis) a fertilised egg cell receives half its DNA (i.e. one set of 23 chromosomes) from the father and half from the mother. Siblings also receive half their DNA from their father and half from their mother, but not the same halves, so each sibling will be genetically different. If an individual by chance receives DNA that provides a competitive advantage, then that individual is more likely to survive into adulthood, reproduce and transmit the beneficial DNA to the next generation.

As the theory of evolution gained acceptance, the hunt began for the 'missing link' between humans and our distant ancestors. Fossils provided the primary source of evidence throughout the 19th and most of the 20th centuries. By examining skeletal remains, and associated artefacts, archaeologists and physical anthropologists were able to reconstruct our origins by identifying past species that were either our ancestors or represented an evolutionary dead end. This evidence has been supplemented in recent decades by the analysis of DNA. DNA is found in some skeletons but rarely survives in skeletons more than a few thousand years old. However, the DNA of living persons provides an alternative source of invaluable information, due to the fact that it contains a record of their ancestry.

If half your DNA is inherited from each of your parents, it follows that one quarter is inherited from each of your grandparents, and so on for previous generations. Given that you do not know which chromosomes are inherited from which parent, you do not need to go back very many generations before most of your DNA becomes impossible to disentangle. So how does DNA help?

Fortunately, there are two types of DNA that are not hopelessly jumbled. Although most chromosomes form matching pairs (one from each parent), there is one pair which do not necessarily match. These are referred to as the sex chromosomes. There are two types, called X and Y. The Y chromosome is much smaller than the X chromosome, so they cannot exchange DNA. Females carry two X chromosomes, and everyone (male or female) inherits one of these X chromosomes from their mother. Males carry an X and a Y chromosome, either of which may be inherited by their offspring. If you inherit an X chromosome from your father, giving you two X chromosomes, then you will be female; whereas if you inherit a Y chromosome, giving you an X and a Y, then you will be male. What this means is that males can only inherit their Y chromosome from their father, who inherited it from his father, and so on through the male line to the beginning of our species.

The other useful source is mitochondrial DNA. Mitochondria are tiny structures that reside in the cytoplasm that surrounds the nucleus in each cell in your body. Their function is to combine glucose molecules with oxygen in chemical reactions that release the energy that we require to survive. However, they contain small quantities of DNA (which do not form part of the 46 nuclear chromosomes). Everyone has mitochondria, but when a female sex cell (or egg) is fertilised by a male sex cell (i.e. sperm), the mitochondrial DNA in the male sex cell is destroyed. As you are derived by cell division (mitosis) from this single fertilised egg, this means that all your mitochondrial DNA, whether you are male or female, is inherited from your mother, who inherited it from her mother, and so on up the female line to the beginning of our species.

So, how does this help us understand our ancestry? If all males inherit their Y chromosome from their father, who inherited it from his father, and so on, then each male should have inherited their Y chromosome from the first male human (usually dubbed 'Adam'). However, if every male inherited their Y chromosome from Adam, then every male would be expected to have exactly the same Y chromosome DNA, which would be of no help to us. Fortunately (at least for tracing our origins), mistakes known as mutations occasionally occur when DNA is copied. These mutations are extremely rare, but if they occur in the Y chromosome of a sex cell, then they may be transmitted to the next generation. Provided they do not confer a major disadvantage in terms of survival, the new mutated DNA may then be transmitted to future generations. Thus, minor differences have emerged in the DNA in men's Y chromosomes. Where the DNA of two men differs by a single mutation, then it may be inferred that they are more closely related than if there are several differences in their DNA. By taking DNA samples from around the world, one can build up a picture of who is more closely related to whom. Also, by assuming a average rate for mutations, one can provide a guesstimate of when different groups separated from one another. By mapping these DNA 'families', one can build up a picture of past migrations.

The same applies to mitochondrial DNA. Indeed, mitochondrial DNA was studied before the Y chromosome DNA because it is less complex and has a faster mutation rate. One

slight problem is that the first woman ('Eve') seems to have lived a lot earlier than the first man, suggesting that the method of dating may not be totally reliable. However, there are other plausible explanations. Also, past movements of males and females do not always correspond, but this might indicate situations where male armies conquered new areas and mated with the local women.
So, going back to the original question: where did we come from?

Our nearest relatives in the animal world are the great apes (i.e. gorillas and chimpanzees). It would appear that we shared common ancestors until about 9-11 million years ago, at which point the gorillas followed a separate evolutionary path. Sometime later, somewhere between 4 and 9 million years ago, our human ancestors split from the chimpanzees. Estimates of the timing vary because the fossil record is extremely sparse before about 4 million years ago. Also, whilst some earlier remains may be our ancestors, we cannot be certain. The earliest definite hominin remains (which may be referred to as archaic hominins) date to around 4 million years ago. Several different species, representing either different evolutionary paths or different stages in the same path, have been identified. Many of these belong to the genus *Australopithecus* ('southern ape man') or *Paranthropus*. Around about 2 million years ago, some of these evolved into forms that are more distinctly human and are therefore classified in the same genus as ourselves (i.e. *Homo*) - e.g. *Homo habilis* ('handy man') and *Homo erectus* ('upright man').

Given that the earliest fossil remains are only found in Africa, and given that gorillas and chimpanzees are only native to Africa, there can be little doubt that we initially evolved in Africa. *Homo erectus* was the earliest to be found outside Africa. The fossil evidence suggests that some *Homo erectus* groups initially moved into the Middle East and then subsequently migrated eastwards across southern Asia and westwards across southern Europe sometime between 2 and 1 million years ago.

These pre-modern *Homo* evolved differently in different parts of the world. For example, *Homo neanderthalensis* ('Neantherthal man'), found in Europe between about 100,000 and 30,000 years ago, is descended from a pre-modern Homo (probably *Homo heidelbergensis*) but was replaced by *Homo sapiens* (i.e. modern humans). It was once thought that we may have evolved from the neanderthals, but DNA evidence has now confirmed that the neanderthals were a totally different species. Besides the earliest *Homo sapiens* in Europe (referred to as Cro-Magnon man) date to about 40,000 years ago, whereas the earliest *Homo sapiens* in Africa (where there were no neanderthals) date to about 200,000 years ago. The remains of *Homo sapiens* are found in almost every part of the world, but the oldest remains are all found in Africa, leaving little doubt that Africa was not only the source area for the first hominins, but also for the first modern humans. This is confirmed by the DNA evidence.

There is more genetic diversity within Africa than in the rest of the world added together, confirming that Africa has a much longer history of human habitation than anywhere else.

DNA has identified the most likely home of the original Adam and Eve as east Africa. Further, not only is the entire human race descended from Africans, but our ancestors would have been black and only acquired other skin tints when they moved to temperate countries where they did not require skin pigmentation to protect them against the sun's harmful rays - an unpalatable truth for the average white supremacist creationist!

DNA evidence now allows us to piece together a picture of past population movements. After spending the first half of their existence in Africa, *Homo sapiens* began to cross the land bridge at Suez into the Middle East no later than 90,000 years ago. By 60,000 BP they had moved east across southern Asia into India, and by 40,000 they had spread westwards into Europe. By 45,000 the Asiatic branch had reached Australia by sea (albeit a narrower sea than at present), whilst another branch (with the benefit of improvements in clothing and housing technologies) had migrated northwards into colder climes, reaching Siberia by about 20,000 BP. Sometime before 12,000 BP they crossed the narrow Baring Straits (which may have been frozen over) into Alaska, from where they migrated southwards into the Americas – the last continents to be populated.

This diffusion occurred over a long period of time, during which there were many technological advances. The development of spears with sharp heads, for example, allowed our ancestors to hunt large dangerous animals from a relatively safe distance. However, there are indications that this may have upset the balance in nature, because the arrival of *Homo sapiens* in many areas was followed shortly after by the extinction of most of the major game species. Indeed, over-hunting may have been a major factor driving our hunter-gatherer ancestors to push into ever more hostile environments.
Finding ways to compensate for the depletion in game species also provided a major spur in the development of agriculture, which was 'invented' in the Middle East about 11,000 BP (although there is evidence to suggest it was also invented, possibly even earlier, in other parts of the world). Archaeological evidence shows that it slowly diffused into Europe, reaching northwestern Europe (including Ireland) about 5,000 BP. However, it was unclear whether this diffusion was due to migration (i.e. farming peoples moving into new areas) or a cultural diffusion (i.e. the transfer of farming technologies to neighbouring peoples). There was probably an element of both, but DNA evidence has settled the debate and has confirmed that it was primarily a cultural diffusion.

Many questions still remain (e.g. why did the neanderthals become extinct soon after the arrival of humans?), but DNA evidence allows us to solve many of the mysteries about our prehistoric ancestors. However, there is one serious problem. To deconstruct the past, we need to be know the genetic characteristics of 'pure' populations, but populations are now becoming increasingly mixed due to migration and intermarriage. As this will presumably escalate with further globalisation, it means that the window of opportunity for establishing our deep ancestry may be rapidly closing.

DGP