Climate and the making of a **GLOBAL SPECIES**

Humans are very special animals when it comes to the range of environments in which we survive and thrive. From the sands of the desert to the frozen arctic, we have proven ourselves able to adapt to and manipulate our surroundings so that geographically we are the most widely distributed mammal.

It is usual to put such success down to our brains, the ability to plan ahead and bring technology to bear on problems of survival. It is also tempting to see us as de-coupled from the natural world although every year there are stark reminders, such as the Asian Tsunami and Hurricane Katrina, that this is not the case. Moreover, there is the constant reminder of climate change that works at much smaller scales but which, as is the case with coastal erosion, affects many of us.

Archaeologists, working closely with quaternary scientists (who study the last two million years on Earth), can now put these issues into evolutionary perspective by asking: what exactly was the legacy of the ice ages during which much of human evolution took place? We now know that only 60,000 years ago the world was a very empty place. Before that time people just like us inhabited only a portion of the Old World. They also shared it with other closely related species, most notably the Neanderthals of Western Asia and Europe and the tiny *Homo floresiensis* from Indonesia. Several human species living at any one time has been the pattern of human evolution ever since we split from the chimpanzees about five million years ago. However, this shared world was eventually to change.

One legacy of the Pleistocene ice ages (1.8 million - 11,000 years ago) was that we became a single species, globally distributed. It is this legacy that has been investigated over the past four years by NERC's EFCHED programme: Environmental Factors in the Chronology of Human Evolution and Dispersal. EFCHED boils down to examining the role of changing climates in human evolution. We wanted to know more about those human species that have become extinct and in particular to investigate what selective role the environment played that led to change, both biological and cultural. Eleven projects were selected for funding in 2002 with research conducted across the globe from the Far East to Central America, and from Europe to southern Africa.

It is generally agreed that *Homo sapiens* evolved from *Homo erectus*, or a very similar hominid, in central or southern Africa around 200,000 years ago. The Sahara desert formed a formidable barrier to movement. How did our ancestors survive the heat as they moved north? Simon Armitage of Oxford University studied the palaeoclimate record of the Sahara. He found that, although mostly uninhabitable due to present day aridity, there is evidence that both Chad and Libya once had two very large lakes, of the order of 350,000km^2 and 76,000km^2. If we compare this with the surface area of the UK of just under 245,000km^2, we see that the presence of these lakes may have provided a crucial humid corridor across the Sahara, allowing the migration of hominid populations northwards out of central Africa. Providing dates for these episodes is crucial. Geoff Duller at Aberyswith has developed techniques to date sediments from 200,000-65,000 years ago, a period crucial to our understanding of the behaviour and spread of *Homo sapiens* within Africa.

Around 100,000 years ago we see the first evidence that *Homo sapiens* were leaving Africa. The three possible crossing points are the Straits of Gibraltar, from modern day Egypt to Israel across Sinai, or the Horn of Africa at the southern end of the Red Sea from modern day Djibouti across to Yemen. The potential of these routes as corridors for both humans and large mammals were investigated by Nick Barton of Oxford, Alan Turner of Liverpool John Moores, Geoff Bailey of York, and Mike Petraglia of Cambridge. All four have assessed the ability of *Homo sapiens* to cross these narrow channels and the archaeological signatures of the potential launch and landing sites. The scientists placed particular emphasis on modelling volcanic and earthquake activity, and sea-level change which would have reduced or increased the widths of the channels. The consensus at present is that *Homo sapiens* are unlikely to have crossed the Straits of Gibraltar, while Sinai would appear to be the most likely transit route.

Later expansion across the globe of anatomically and behaviourally modern humans took place amidst deteriorating climatic conditions from around 80,000

Human development timeline

Pliocene
5 – 1.8 million years ago
Earth's climate begins to cool

Pleistocene
1.8 million – 11,000 years ago
Ice ages become longer and more severe. The climate is dry and very cold. Deforestation and extensive grasslands appear in the tropics.

5 million	3 million	2.5 million	1.8 million	1.5-1 million	300,000	225,000	200,000	130,000	80,000
A split occurs between chimpanzees (our closest living relative) and our ancestors.	Some ice sheets form on northern continents. Sea levels fall by up to 40 metres.	The oldest stone tools – simple struck flakes and cores – are used in Europe.	*Homo erectus* found on plains of East Africa.	Well-worked stone bifaces (hand axes) appear. These Acheulean tools are found all over the Old World.	Steady seasonal rain in the Sahara. *Homo erectus* controls fire.	Neanderthals evolve from *Homo erectus* in Europe and south-west Asia.	*Homo sapiens* evolve from *Homo erectus* in Africa south of the Sahara.	*Homo sapiens* move out of Africa to the Middle East and Asia.	Start last

An ambitious programme to investigate the environment's role in our ancestors' rapid expansion out of Africa has come to a close. **Clive Gamble** and **Gilbert Marshall** discuss a remarkable journey.

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years ago, getting much colder after 40,000. But modern humans were not moving into an empty landscape and would have encountered populations of Neanderthals across much of western and central Europe. We need to know more about the nature and extent of this long interaction that ended some 25,000 years back with the extinction of the Neanderthals in southern Spain. Exactly how and why this happened remains one of the great puzzles in human evolution, but research by Rupert Housley of Glasgow University has indicated that they were successfully living on the Russian Steppes after 40,000 years ago, which suggests that they were as well suited to living in cold conditions as the incoming modern humans.

Homo sapiens' colonisation of the globe really took off 40,000 years ago. New radiocarbon dates by William Davies of Oxford University document the development and spread of stone tools of the Aurignacian tradition – an ancient culture that produced ornate jewellery and cave art – across Europe from the Black Sea to Portugal 30-40,000 years ago. Further eastward expansion of *Homo sapiens* led to the colonisation of the Americas. Silvia Gonzalez of Liverpool John Moores University has dated skulls from Mexico to approximately 13,000 years ago, pointing to a somewhat earlier entry into North America than previously thought. Excitingly but still controversially, Silvia and her team have found evidence for a much earlier human presence in the Americas. They believe they have discovered fleeing human footprints preserved in volcanic ash in the Valsequillo Basin south-east of Mexico City. These paint a picture of humans living along the banks of a large lake some 40,000 years ago, in the shadow of a live volcano. Intriguingly, the volcanic activity corresponds with a significant extinction of many large animals in central Mexico, including mammoths and sabre toothed cats. Whether or not these possible early human colonies met the same fate is unclear.

EFCHED has been an enormous success not only in terms of its scientific results, but also in establishing an interdisciplinary approach to the study of human origins. By successfully integrating new methods of dating and genetic profiling, with traditional archaeology and anthropology, EFCHED has been able to investigate the relationship between the natural world, and the nature and direction of human evolution. The legacy of the programme will be more discoveries about our earliest ancestors and a better understanding of how, over the long term, repeated changes in climate helped make us who we are.

An end of programme event for EFCHED took place at the British Museum on 10-11 November 2006. You can order a free brochure highlighting many of the programme's findings at www.nerc.ac.uk/publications.

Holocene
11,000 years ago – today
Last major ice age ends heralding the start of a relatively stable climate.

of the ice age.	A major Atlantic Ocean circulation slowed and stopped, temperatures in Europe plummeted. Humans found in Europe, south-east Asia and Australia. On the island of Flores in Indonesia they would have encountered a one-metre tall hominid *Homo floresiensis*, a distant descendant of a much earlier migration, possibly as old as Out of Africa One. Possibly our ancestors arrived in the Americas.	Neanderthals disappear in Europe.	Ice age reaches a peak. 30m drop in sea level. Extensive tropical deserts.	The ice age ends possibly opening up land routes across the Bering Strait between northern Russia and North America. Sea levels similar to present levels. First agriculture develops, soon followed by the earliest civilisations.	Dramatic and abrupt, but temporary cooling caused by a slowdown of a major Atlantic Ocean circulation.