Human evolution and migrations

Evidence for early journeys from Africa to Asia (*January 2010*)

A fragile consensus has developed concerning the date when fully modern humans left Africa then migrated to all habitable continents. It is based on genetic comparisons among living people, very sparse occurrences of *H. sapiens* remains that have been dated and on the environmental pressures in Africa to migrate during the highly erratic deterioration of climate since the Eemian interglacial. The last included a series of abrupt cooling and drying episodes around 118, 110, 86, 75, 71 and 67 ka. That fully modern humans entered the Middle East from time to time between 130 and 75 ka is backed up by actual fossils, but most palaeoanthropologists currently believe that they moved no further, because of the growth of surrounding deserts, and probably did not return until around 45 ka. The consensus for the decisive move out of Africa to Eurasia is that it was via the Straits of Bab el Mandab at the entrance to the Red Sea, when sea level fell to a level that would have allowed a crossing by rafting over narrow seaways. The most likely was during the brief 67 ka cool/dry episode that coincided with an 80 m fall in global sea level: the largest since the previous glacial maximum. This would fit the earliest dates of fully modern human remains in Asia and Australasia. There had been falls of more than 50 m around 110, 86 and 75 ka, each followed by rising sea level. Each of them accompanied by cooling and drying in Africa conceivably could have allowed earlier migrations from Africa to southern Arabia. Emerging data seems set to complicate matters.

At a conference in Gibraltar during September 2009 (Balter, M. 2009. New work may complicate history of Neandertals and *H. sapiens*. *Science*, v. **326**, p. 224-225; DOI: 10.1126/science.326_224) there were further reports of stone tools, which apparently resemble those of a similar age from Africa, beneath the 74 ka Toba ash in South India, and dated between 70 to 80 ka old in the Yemen and United Arab Emirates. Even more challenging are reports of archaic *H. sapiens* teeth and a jawbone with a chin – a sure sign of a fully modern human – from cave sediments in southern China that yield a date of about 110 ka (Stone, R. 2009. Signs of early *Homo sapiens* in China. *Science*, v. **326**, p. 655; DOI: 10.1126/science.326_655a). Given an opportunity and a need humans do tend to move in order to survive, a proclivity that would undoubtedly be boosted by our insatiable curiosity: after all *H. erectus, antecessor and neanderthalensis* all made tremendous migrations starting more than 1.6 Ma ago.

Neanderthal 'bling' (*March 2010*)

Led by João Zilhão of the University of Bristol, UK, a team of British, French, Italian and Spanish archaeologists and anthropologists have at a stroke rid our former companions in Europe, the Neanderthals, of the popular and academic stigma of being uncultured (Zilhao, J. and 16 others 2010. Symbolic use of marine shells and mineral pigments by Iberian Neandertals. *Proceedings of the National Academy of Sciences*, v. **107** p. 1023-1028; DOI: 10.1073/pnas.0914088107). They wore jewellery in the form of necklaces and pendants of bivalve shells, remains of which have turned up in large numbers in caves and rock shelters in the interior of southeast Spain. Some of the perforated shells show clear signs of having

been painted, and a few show grooves worn by string. They found even a paint container and painting tools made of small bones from a horse's foot. The container and tools retain distinct traces of pigment made from the common iron colorants goethite, jarosite and hematite. One large, perforated scallop shell shows that its white interior was painted to match its reddish exterior.

It has often been commented that Neanderthal adornments (a few possible finds precede this work) and intricate tools were simply copied from those of fully modern humans. The deposits containing this ornamentation are around 50 thousand years old: preceding modern human occupation of the Iberian Peninsula by at least 10 ka. Evidence for artistic work by early *H. sapiens* comes from South Africa as far back as 165 ka (see Technology, culture and migration in the Middle Palaeolithic of southern Africa January 2009, and *When and where 'culture' began* November 2007). Iron-based pigments are still widely used for body painting in many societies, but obviously that use will not feature directly in archaeological finds. Association of lumps of potential pigments with hominin tools go back even further in Africa, beyond the presence of fully modern humans, but to ascribe pieces of say hematite to cultural practice needs evidence for scraping or grinding. There seems no reason why Neanderthals and modern humans maintained an ancient cultural tradition.

Archaeology and the Toba eruption (*May 2010*)

Depending on when fully modern humans left Africa – and that itself depends on evidence that is at odds with any definite resolution – the forebears of the eventual colonisers of the rest of the world may, or may not, have had to survive the effects of the biggest volcanic eruption of the past 2 million years. At around 74 ka the huge, elliptical caldera lake at Toba in Sumatra was formed by a stupendous eruption that threw out 800 km^3 of ash (see Ash Wednesday in Geohazards 2010) to put this in perspective). Toba deposited a 15-centimetre ash layer over the entire Indian subcontinent. Toba has taken on a near iconic status among some palaeoanthropologists as a possible means of reducing the entire human population to a mere few thousand: a genetic 'bottleneck' that could have led to rapid evolution among surviving generations that shaped such things as language and culture. Unsurprisingly major efforts are underway to get hard facts about the relationship of fully modern humans to the Toba event, a lot of the work-in-progress being outlined here.

See also: Balter, M. 2010. Of two minds about Toba's impact. *Science*, v. **327**, p. 1187-1188; DOI: 10.1126/science.327.5970.1187-a.

Yes, it seems that they did… (*May 2010*)

Perhaps now the myth of brutish Neanderthals will finally be laid to rest. Thanks to the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, we have a nuclear genome of *H. neanderthalensis*; in fact a composite based on bones of three individuals from a Croatian cave. Carbon-14 dating shows that the bones are between 44 to 38 ka old: about the time of the first arrival of fully modern humans in Europe. Only ten years on from the publication of the first human genome, the team inspired by Svante Paabo (actually the last of 56 authors, but the founder of the lab and its superb facilities) has engineered a scientific triumph that matches the achievement in 2000 led by James D. Watson at the U.S. National Institutes of Health and Craig Ventner of Celera Corporation (Green, R.E. and 55

others 2010. A draft sequence of the Neandertal genome. *Science*, v. **328**, p. 710-722; DOI: 10.1126/science.1188021). Let's be frank, to get to know another member of our genus nearly as well as ourselves, albeit in terms of A, C, T and G – the nucleotide bases of DNA adenine, cytosine, thymine and guanine – puts the rest of science in somewhat distant perspective. It forms the basis for learning what, if anything, sets us apart from earlier humans, what we share with them and potentially how we came to be what we are.

Apart from a geologically brief period since 80 ka when fully modern humans and Neanderthals occupied the Mediterranean fringe of the Middle East, both had probably developed separately since forebears of the Neanderthals left Africa to arrive in Europe about 400 ka ago while ours seem to have stayed in Africa. Earlier genetic results show that both species shared a common ancestor, perhaps *H. heidelburgensis*. From the time when the main wave of African people ventured into Arabia, Asia and Europe, perhaps around 60 to 75 ka, chances are that encounters were inevitable, until the last Neanderthals met a lonely end on the Rock of Gibraltar around 25 ka. Variations in mtDNA data seem to show that the two species have little genetic overlap, but mitochondria hold only a small part of DNA. The 4 billion base pairs of nuclear DNA occur in thousands of segments that have evolved independently, and in us continue to do so: a source for very detailed comparisons indeed. The issue centres on how alike and how different such segments are, when compared with DNA from different modern human genomes. If similarities and contrasts are more or less the same in comparison with all modern human groups, then it is most likely that although Neanderthals and modern humans did meet they did not exchange genetic materials; i.e. they did not mate successfully. The new data show beyond much doubt that Neanderthals were more similar genetically to modern Europeans and Asians than they were to modern Africans. There was successful mating and the progeny entered the fully modern human population of Asia and Europe, to the extent that Asians and Europeans host 1 to 4% of Neanderthal ancestry.

The most famous human in genetics, simply because he arranged sequencing of his own DNA, which is the comparator used by the team, Craig Ventner can be highly confident that he contains segments of Neanderthal DNA. We must await his reaction in a mood of solemn gaiety, and react he most probably will: I did and I feel quite cheerfully proud. Interestingly, Neanderthals are as closely related to individuals from New Guinea and China as they are to a French person. Such uniformity among non-Africans suggests that the gene exchange (*viz*. sexual intercourse) took place shortly after fully modern humans migrated out of Africa. But who did what to whom under which circumstances will remain a mystery, although it appears that the gene flow was from Neanderthal to human and not *vice versa*. With a small colonising group of Africans, there need not have been a great deal of 'sharing' of bodily fluids for introduced genes to 'surf' throughout succeeding generations to reach us. So what is it that we lucky ones share with Neanderthals? This is a topic fraught with possible overtones, though they probably will not suit the outlook of those with a prejudiced racist tendency. The results suggest 15 genomic regions that include those involved in energy metabolism, possibly associated with type 2 diabetes; cranial shape and cognitive abilities, perhaps linked to Down's syndrome, autism and schizophrenia; wound healing; skin, sweat glands, hair follicles and skin pigmentation; and barrel chests. Some may have been beneficial others not, but they have been retained through thousands of fully modern human generations.

Analyses of the genome are at a very early stage, but the sequencing technique and associated checks for contamination with modern DNA are sufficiently advanced that other Neanderthal remains and bones of ancient Europeans and Asians will surely add to the excitement. Just how far back analyses can be pushed remains to be seen, but it is now quite clear that human evolution was a great deal more complicated than the simple Out-of-Africa model that is currently almost universally accepted.

See also: Gibbons, A. 2010. Close encounters of the prehistoric kind. *Science*, p. 680-684; DOI: 10.1126/science.328.5979.680.

Other rich hominin pickings (*May 2010*)

March and April 2010 were indeed exciting times for palaeoanthropology, with publication of evidence for two new species of hominin. Cave systems in the Archaean limestones of north-eastern South Africa have yielded so many fossil remains related to human evolution that the area liberally dotted with them has UN World Heritage status. The caves formed beneath a now-eroded plateau, and are so rich because creatures fell into surface sink holes, died and remained little disturbed by scavengers. The latest find has an unusual story behind it (Balter, M. 2010. Candidate human ancestor from South Africa sparks praise and debate. *Science*. v. **328**, p. 154-155; DOI: 10.1126/science.328.5975.154). The cave system was first explored by lime-kiln workers around the early 1900s, who brought out blocks which litter the ground around cave mouths. It was in one of these chunks that the 9-year old son of a South African palaeoanthropologist found bone that turned out to be a hominin lower jaw. Sadly, young Matthew Berger had to be excluded from the list of authors of the two important papers that ensued from his find, because of *Science* magazine's rules for authorship (Berger, L.R. *et al*. 2010. Australopithecus sediba: a new species of Homo-like australopith from South Africa. *Science*, v. **328**, p.195-204; DOI: 10.1126/science.1184944. Dirks, P.H.G.M. and 11 others 2010. Geological setting and age of Australopithecus sediba from southern Africa. *Science*, v. **328**, p.205-208; DOI: 10.1126/science.1184950). Nevertheless, he can be well satisfied as the full set of bones points to a new species, one that may arguably share more features with *Homo* species of about the same antiquity than any other australopithecine. Being coeval with *H habilis*, *A. sediba* cannot be ancestral but may have shared a common ancestor with the earliest known human species. Fitting the new find into the long and variously disputed cladistics of hominins will run and run, but at least it should re-emphasise one thing: there were several cohabiting hominin species in Africa around 2 Ma ago.

Such a multiplicity of co-existing hominins seemingly continued until quite recent times, as a remarkable piece of evidence from a Siberian cave has confirmed. Between about 30 to 48 ka, the cave was a popular venue for Neanderthal hunters who left tools and bones of their prey. Russian archaeologists combed the cave deposits for human remains but came up with only fragmentary finds of bone. One of these was the tip of someone's little finger. The possibility of obtaining genetic material from relatively young finds in caves that have remained cold and untouched encouraged the excavators to handle their finds carefully. It's just as well they did for the results from the Max Planck Institute for Evolutionary Anthropology in Leipzig Germany, famous for its work on Neanderthal DNA, held a surprise. The finger's owner was neither a Neanderthal nor a fully modern human (Krause, J. *et al*. 2010. The complete mitochondrial DNA genome of an unknown hominin from Southern

Siberia. *Nature*, v. **464**, p. 894-897; DOI: 10.1038/nature08976). The evidence for this is overwhelming. Fully modern human mtDNA ranges from 0 to about 100 differences in nucleotide positions, the difference between human and Neanderthal mtDNA is just over 200, but the pinky bone revealed almost 400 differences from ourselves and almost as many from Neanderthals. Such differences suggest that ancestors of the unknown Siberian separated from the line of descent to Neanderthals and modern humans about a million years ago. Yet all three were in Asia a mere 40 ka ago. Add to that the diminutive *H. floresiensis* who survived to cohabit Flores with modern humans until about 9ka, and some evidence that *H. erectus* was also around in Java up to 25 ka, gives possibly 5 species of human in Asia who may have met and goodness knows what else.

See also: Dalton, R. 2010. Fossil finger points to new human species. *Nature*, v. **464**, p. 472-473; DOI: 10.1038/464472a.

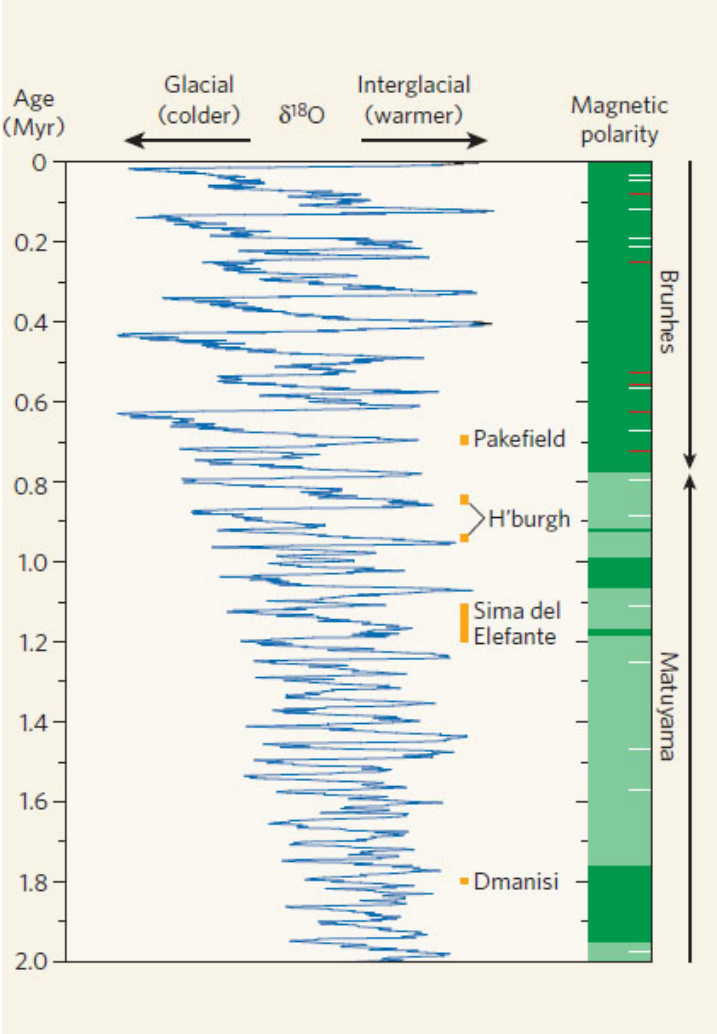
A male relative of 'Lucy' (*July 2010*)

Many people know of the amazing skeleton of a possible ancestor to humans discovered in NE Ethiopia by Donald Johanson in the late 1970s, and they know why it was dubbed 'Lucy'. That type specimen of a female Australopithecus afarensis still figures in the media, but little appears concerning males of the species. That is not surprising for they are represented by only fragmentary and ambiguous remains. So a report on a 40% complete fossil male A. afarensis that includes limb and pelvic bones, and those of the neck, shoulder and arm is sure to cause a stir (Haile-Selassie, W. and 8 others 2010. An early *Australopithecus afarensis* postcranium from Woranso-Mille, Ethiopia. *Proceedings of the National Academy of Science USA*, v. **107**, p. 12121–12126. DOI: 10.1073/pnas.1004527107). For starters, he is much bigger than 'Lucy', standing between 1.5 and 1.7 m tall, and fragments of other individuals suggest that some males were larger still and within the modern human range. The conclusion must be that A. afarensis was sexually dimorphic: big males and diminutive females, which is the norm for chimps, orang utans and gorillas. Legs longer than arms suggest an upright walking posture, but the shoulder assembly is more gorilla-like than human. Yet ribs that indicate a barrel chest show a more human form than would other great apes. The authors suggest that the lack of consistent resemblance to any one of the living hominids may indicate that the last common ancestor that we share with the others may not have closely resembled any of the living forms. The big problem with the find is its antiquity: at 3.6 Ma it is older than 'Lucy'. Without teeth or at least part of a skull, assigning it to the same species carries no certainty.

Earlier colonisers of northern Europe (*September 2010*)

The Pleistocene of East Anglia in England is a rich source of the high-latitude flora and fauna from early interglacials of the 1 Ma long series of 100 ka climate cycles. Eyed by archaeologists for decades as a potential source of human remains, a coastal site at Pakefield in Suffolk finally yielded stone tools in 2005 (see Earliest tourism in northern Europe January 2006). The enclosing sediments, to widespread excitement, turned out to be around 700 ka old, establishing the earliest known human colonisation at that latitude (52ºN). At that time East Anglia was connected to Europe during both glacial and interglacial periods, and was crossed by a now-vanished river system draining the Midlands and Wales

into the proto-North Sea. Stone artefacts have now emerged from similar interglacial terrestrial sediments on the shore below the village of Happisburgh (pronounced 'Haze-burra') further north still, in Norfolk (Parfitt, S.A and 15 others 2010. Early Pleistocene human occupation at the edge of the boreal zone in northwest Europe. *Nature*, v. **466**, p. 229-233; DOI: 0.1038/nature0911). Magnetostratigraphy pushes back the human influence here to more than 800 ka, maybe as far back as 950 ka. As yet no human remains have been turned up, and the site is below high-tide level and liable to be destroyed by winter storms so work proceeds as fast as possible. Yet cliff erosion will inevitably reveal new material each spring.



Happisburgh and O-isotope and palaeomagnetic records (Credit: Roberts 2010; Fig. 1)

Fauna and flora from Happisburgh indicate a slow flowing river flanked by coniferous forest with grassed clearings. Beetle fossils suggest summer temperatures slightly warmer than those in modern southern Britain, but with winters some 3ºC colder than now. The climate was analogous to that in southern Norway today, at the transition from temperate to boreal vegetation zones; certainly tough in winter for people without shelter. Yet the permanent connection with continental Europe would have permitted easy seasonal migration across great plains that extended to warmer southern climes. The tool-using people were not the earliest Europeans, for several archaeological sites in Spain, southern France and Italy extend back to 1.3 Ma. Who or rather what hominin species they were needs bones,

preferably those of the head. The discovery that there were at least 4 hominin species cohabiting Eurasia during the last glacial epoch encourages caution in any speculation.

See also: Roberts, A.P. & Grűn, R. 2010. Early human northerners. *Nature*, v. **466**, p. 189-190; DOI: 10.1038/466189a.

Survival by the seaside (*September 2010*)

Increasingly, hominins have survived swings of climate by their wits and by chance. Neither underpin the instinct to migrate when times are hard, but where one ends up depended, until the Holocene, more on chance than design. Early migrations must have been more by diffusion than purposeful, especially in the vastness of the African continent. Yet groups of hominins found their way into Eurasia several times and thrived there. Far more of them would have met the coast far from a continental exit route, such as the Levant or the Straits of Bab el Mandab. However, in stressful glacial episodes reaching the coast was a key to survival as its food resources are almost limitless (see Human migration and sea food May 2000). Our own species found refuge by the sea not long after we originated (Marean, C.W. 2010. When the sea saved humanity. *Scientific American*, v. **303** (2), p. 40-47; DOI: 10.1038/scientificamerican0810-54). Around 195 ka climate began to cool and dry to reach a glacial maximum at roughly 123 ka. Curtis Marean (Arizona State University, USA) was one of the first scientists to look for signs of coastal refuges in Africa during the early 1990s, particularly at its southern tip. With co-workers he found several caves on the coast of South Africa that yielded the evidence on which he has based a review of littoral survival opportunities and the skills that we developed. This particular coastal stretch has a huge diversity of plant life, most unique to it, and many of which store carbohydrate in tubers, bulbs and corms. They are adapted to dry conditions and need only the simplest technology – digging sticks and fires for cooking – to exploit starchy, easily digested energy resources, along with the more obvious animal protein sources present on all shorelines. Marean's review puts in plain language all the discoveries made by his group over the last 20 years, including evidence of the use of fire treatment to improve flaked stone tools and the development of art based on iron-oxide pigments, plus his own take on their anthropological significance.

Another big surprise (*September 2010)*

The discovery from the Neanderthal genome that people outside Africa have such a muscular bloke in their distant ancestry (see *Yes, it seems that they did…* above) ought to be quite enough of a shock for one year, but hard on its heels comes another. Animal bones from Ethiopia in sediments dated at more than 3.4 Ma show clear signs of having flesh cut from them with a sharp blade (McPherron, S.P. *et al*. 2010. Evidence for stone-tool assisted consumption of animal tissues before 3.39 million years ago at Dikika, Ethiopia. *Nature*, v. **466**, p. 857-860; DOI: 10.1038/nature09248). The oldest known stone tools date back only 2.4 Ma (none were found at Dikika), and those associated with a known hominin (*H. habilis*) to half a million years later than that. No species of the genus *Homo* is known to have been living 3.4 Ma ago, so a likely candidate for making and wielding stone tools then might be *Australopithecus afarensis*: Lucy's genus. In fact the infant *A. afarensis* named Selam (see

'Peace' (Selam) disturbed October 2006) was found a mere 300 m away from the cut-marked bones.

There are several problems that arise from these butchered bones, as regards their implications. Do hominin specialists reserve the genus *Homo* exclusively for tool makers? If so, do Lucy and Selam become *H. afarensis*? But without actual tools associated with the bones, it is impossible to decide whether they were specifically made to deflesh prey or carrion, or were just sharp, naturally occurring bits of stone that some creature with insubstantial teeth happened to use to snaffle a quick snack from competing carnivores. Even more intriguing, in the light of the immense rarity of hominin remains, was there some creature more advanced than *A. afarensis* roaming the stifling plains of Ethiopia's Awash valley 1.4 Ma before the first known tool maker? The various Awash projects will run and run after this new and startling discovery.