Human evolution and migrations

Interbreeding: louse study leads to head scratching (*January 2005*)

A challenging question about the origin of fully modern humans is whether or not *Homo sapiens* interbred with archaic species, such as the Neanderthals or *H. erectus*. That modern humans occupied the same territory as both, at the same time, is well established for Europe and Asia. The likely time for the first major migration of moderns from Africa is about 70 to 100 thousand years ago, and archaic humans did not become extinct in Eurasia until 30 ka at the earliest. Genetic material from extinct humans is rare and difficult to analyse because of degradation. A couple of mtDNA samples from Neanderthal remains give results that are sufficiently different from ours to rule out retention in modern human populations of the genetic outcome of any interbreeding between ancestral moderns and the population to which the two Neanderthals belonged. Yet it does not rule out such interactions with other archaic groups. We have no idea of the genetic diversity of Neanderthals, whose lineage probably split from that of our own (through that of *H. heidelburgensis*) as long ago as 700 ka. If they lived in isolated bands of a small population, that diversity could have become substantial over such a long time. So far, no genetic material has been recovered from *H. erectus* remains. Another approach to the matter has emerged from a genetic study of human head and body lice - *Pediculus humanus* (see *Anthropological nit picking* October 2004). This louse is unique to humans, and genetic comparison with that which infests chimpanzees suggests that the two species diverged at about the same time as the split that led to modern humans and chimps, at about 5.6 Ma. That is remarkably similar to molecular timing that uses primate DNA. The interesting feature of the louse genetic analyses by the team from the Universities of Florida, Utah and Glasgow is that there are differences between the lice that leap on us. There are two strains which originated before 1 Ma ago, according to the molecular clock. One has a global distribution, and infests both head and body, whereas the other is exclusively a head louse and only occurs in the Americas.

Around 1 Ma there seems also to have been a major divergence among early humans between a strand of *H. erectus*, which survived until as recently as 20 ka in Asia, and one that led to European Neanderthals and the modern humans who began to migrate from Africa to Eurasia around 100 ka. The unique occurrence of the head-only louse in the Americas (along with the other strain) suggests that the modern humans who crossed the Bering Straits to colonise the Americas came into direct physical contact with beings who carried that particular strain, *en route*. The likely candidates would have been Asian *H. erectus*. Contact had to be direct, because, unlike the flea, the louse cannot leap, and it can only survive on humans. The lack of the New World *Pediculus humanus* in Eurasia suggests two things: if moderns were “in touch” with archaics, the latter carried the other variant (Neanderthals?); the present Asian population (and that of New Guinea and Australia) possibly did not have close contact with archaics who were alive at the time of colonisation (were there by then very few?). All very interesting, but it does not resolve the question of interbreeding; intimate contact could have been through fighting, trading *or* interbreeding. There is another, very different human-only louse, *Pthirus pubis*, which infests pubic hair only, and about which there is very little genetic information, so far…

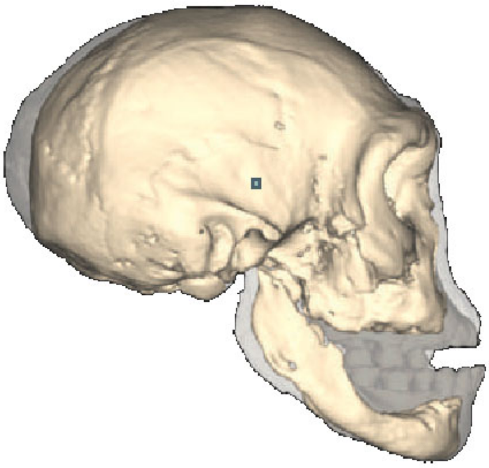
Tiny Indonesian hominids get the SciAm treatment (*February 2005*)

The tiny adult remains of *Homo floresiensis* reported in 2004 (see *The little people of Flores, Indonesia*, November 2004) astonished the palaeoanthropological community more than any discovery since René Dubois' found the first *H. erectus* remains on nearby Java almost a century ago. Their recent geological age (about 13 ka), together with evidence for cohabiting the island of Flores with fully modern humans and legends of the *ebu gogo* – "the grandmother who eats anything" spice up the find no end. So it is not surprising that *Scientific American* has commissioned an excellent popularised account of where things stand with the little people only a few months after the discovery was announced in *Nature* (Wong, K. 2005. The littlest human. *Scientific American* February 2005 issue, p. 40-49). It is not just the sheer tinyness of *Homo floresiensis* that draws our attention, but the fact that with a brain no larger than 2 Ma old australopithecines, the species crafted tools that are far more sophisticated than those of their most likely ancestor, *H. erectus*. They also found their way across a seaway that could never have dried out during glacial maxima, used fire, and just as important survived competition with fully modern humans for around 20 ka. Yet, as the article is at pains to point out, the find is so new that it is easy for specialists to kid themselves into believing a great deal more than may eventually turn out to be likely. With two cultures on one small island, there may well have been mixing of artefacts, and also occupation of the site – a large cave – by both over the long period when they shared the island. Opinion of many leading figures in the field is related by Kate Wong, and it is very clear that there is a lot of puzzlement.

The oldest modern humans (*February 2005*)

For a long time it has been known that the "front line" between fully modern humans and European Neanderthals was in the Middle East, with fluctuating occupation of highly productive sites since around 100 ka. It is also well established that the ancestors of all of us outside Africa began to migrate some 70 to 80 thousand years ago, driven by the pressure of the continent's drying as global climate cooled. The route taken is not at all well defined, but one possibility is across the Straits of Bab el Mandab at the entrance to the Red Sea as islands became exposed when sea level began to fall. So, fully modern humans originated in Africa, but where and when? Unsurprisingly because of the intensity of research there since the discovery of Lucy, the Afar Depression of Ethiopia has provided most remains of *Homo sapiens*. Volcanic ash layers there in sediments that contain specimens give ages up to about 160 ka. But Ethiopia as a whole has other hominid-rich sequences, including ones that have yielded anatomically modern humans. The most notable is the Late Pleistocene Kibish Formation of the Omo River basin in southern Ethiopia, a deltaic sequence that formed when Lake Turkana had higher levels. Human remains occur in the lower part of the Kibish Formation, and as luck would have it, they occur between two volcanic ash horizons and can be accurately dated (McDougall, I *et al*. 2005. Stratigraphic placement and age of modern humans from Kibish, Ethiopia. *Nature*, v. **433**, p. 733-736; DOI: 10.1038/nature03258). For the moment, they are the oldest proper humans at 195 ka. That age has interesting connotations as regards the climatic conditions of their lives. The Omo basin shares watersheds with drainages into the Blue and White Nile system. At 195 ka increased deposition of organic matter characterised the sediments beneath the Nile delta, which suggests greatly increased rainfall in the uppermost reaches of the Nile system. That coincides with the onset of deposition of the Kibish Formation when Lake Turkana stood much higher than at present. The area would have been lush.

Homo erectus and social care (*April 2005*)



Toothless hominin skull from Dmanisi, Georgia: grey - missing material. (Credit: Lordkipanidze *et al*. 2005; Fig. 1)

Dmanisi in Georgia provided one great surprise in human evolution by yielding abundant remains of 1.7 Ma old *Homo erectus* where they might be least expected: north of the Caucasus mountains that would have formed a tremendous barrier to any migration from further south. The archaeological sites have provided another surprise in the form of a well-preserved skull of a completely toothless individual. It is clear from the regrowth of bone into the sockets that this "masticatorily impaired" individual survived for years after losing all their teeth (Lordkipanidze, D. *et al*. 2005. The earliest toothless hominin skull. *Nature*, v. **434**, p. 717-718; DOI: 10.1038/434717b). It is impossible to believe that the individual could have survived without special preparation of softened food. Although the person's survival cannot prove that other individuals helped out, that is a distinct possibility. Losing teeth through dental disease or trauma would have been immensely painful and debilitating, yet the individual did survive. We have to move forward to around 40 thousand years ago for compelling evidence that Neanderthal society cared for disadvantaged people, when several near-complete skeletons show evidence of long-term, crippling damage. But altruism seems to have a far longer and distinguished history

The route and the pace out of Africa (*May 2005*)

Tool-making hominid species left their African homeland several times in the past, the earliest being shortly after the appearance of *Homo erectus*, about 1.8 Ma ago. Those early migrants ended up in eastern Asia, where they thrived until as recently as 12 thousand years ago (if indeed *Homo floresiensis* proves to be a miniature *H. erectus*). Europe was reached by at least three waves: possibly advanced *H. erectus* around 0.5 Ma; Neanderthals as early as 0.25 Ma; modern humans around 40 thousand years ago, at the earliest. The fully modern human record in Asia begins at 67 thousand years ago, suggesting an exodus from Africa at between 80 and 70 thousand years. There is an oddity here: geography suggests that Europe should have been colonised first in each wave out of Africa, because it is closer. But the Nile – Middle East – Europe route was not successfully used by our immediate forebears until long after they had moved eastwards, although there is evidence of temporary occupation of parts of Palestine by *H. sapiens* between 100 to 80 thousand years. Several reasons for this have been suggested, including the possibility of direct competition with Neanderthals who occupied the same 100 ka sites in the Middle East, and the relative difficulty of passage along the Nile compared with a coastal route in NE Africa.

Eritrean and US archaeologists have shown that around 100 ka the Eritrean coast was occupied by humans who subsisted on seafood; always available whatever the climate, whereas terrestrial game potential fluctuates (Walter, R.C. Early occupation of the Red Sea coast of Eritrea during the last interglacial. *Nature*, v. **405**, p. 65069; DOI: 10.1038/35011048. That has led to the suggestion that Africans who colonised Asia and Australasia left by island hopping across the narrow Straits of Bab el Mandab when sea-level began to fall around 70 ka. A coastal route, well stocked with food items would have allowed rapid movement eastwards. That seems intuitively likely, because an eastward route through the Middle East is barred by deserts, which would have been even more arid as glacial conditions developed. Moreover, a Middle Eastern route would have led more directly to Asia Minor and ultimately Europe. The conundrum deepens, since the Straits of Bab el Mandab would have been even easier to cross at the time of the last glacial maximum, around 20 ka, yet there are no archaeological signs of populations of that age in Yemen and Oman, though research has hardly begun there. Unravelling routes is possible, just, by analysing modern population genetics (Macaulay, V. *et al*. 2005. Single, rapid coastal settlement of Asia by analysis of complete mitochondrial genomes. *Science*, v. **308**, p. 1034-1036; DOI: 10.1126/science.1109792). People living in the Andaman islands and the Malaysian Peninsula include groups who differ substantially from their neighbours and may be descendants of the original colonisers. Mitochondrial DNA from these groups indicates a branching from an original type around 65 ka, remarkably suggesting a single founding woman. That cannot be taken exactly at face value, but does suggest that only a small band migrated to these two areas, perhaps no larger than a few hundred. The fact that they reached the Andaman islands may indicate that theirs was a boat-using culture. Whatever, movement was rapid, possibly as high as 4 km per year, thereby allowing the early colonisation of Australia.

Analyses of mtDNA in Africa suggest that about 85 ka ago there was a major expansion of people, whose descendants make up more than two thirds of modern Africans. Could it be that this expansion reflected climate and ecological change, so that migration from elsewhere drove inhabitants of the Red Sea coast to cross the daunting Straits of Bab el Mandab because of severe competition? Perhaps it was the driving force as late as 40 ka, when modern humans reached Europe itself, undoubtedly along the Middle East route.

See also: Forster, P. & Matsumura, S. 2005. Did early humans go north or south? *Science*, v. **3308**, p. 965-966.

Climate change and human evolution (*September 2005*)

One clear character of the record of investigations into human evolution is that, rather than becoming clearer as data increase, our origins become more of a puzzle. With every major fossil find the hominin clade or bush of descent acquires what appears to be another branch. With the recent publication of the genome of our closest living relative, the chimpanzee – and its earliest fossil remains - (*Nature*, v. **437**, p. 47-108), it will hardly be surprising if the assumptions about a gene-based time of separation of the two clades (5-7 Ma) comes into question. Studies of the Y-chromosomes of living human males have suggested 'bottlenecks' in our recent evolutionary past, interpreted to indicate near-catastrophic declines in numbers to perhaps that of a few scattered bands. One such 'near-extinction' seems to have occurred about 70 thousand years ago, which has been linked to the huge explosion of the Toba 'supervolcano' in Indonesia in whose ash are poignantly preserved biface axes. Toba would have had a global climatic effect at a time when fully modern humans were migrating rapidly from Africa across Eurasia; thinly spread and easily isolated by disaster. What followed was an explosive development of both material and aesthetic culture, perhaps enabled by some serious selection amongst those who endured Toba's global blast.

It is always tempting to restrict hypothesizing with the 'Just gimme the facts' outlook. That is, ideas based on hominin remains alone. Yet all evolution takes place within a wider environmental context; for much of our history that of East Africa. Scanty knowledge of tropical climates there and a reliance on distant deep-sea records had led to the widespread belief that this centre of most hominin evolution gradually became drier since the late Miocene. Lake beds in the East African Rift system have held the key to a useful record, and now some of the detail is emerging (Trauth, M.H. *et al*. 2005. Late Cenozoic moisture history of East Africa. *Science*, v. **309**, p. 2051-2053; DOI: 10.1126/science.1112964). Lakes in the Rift are handy for climate study because they span 8 degrees of latitude north and south of the equator, the spread helping to isolate more local effects of volcanism and tectonics on their sedimentary record from those of regional climate change. Many have little outflow and a local supply of water, so their levels depend mainly on the amount of local precipitation compared with evaporation. The actively subsiding basins in which they form have the opportunity to preserve unbroken, thick records of both lake and river sediments.

Trauth *et al*. compile environmental and chronological information from sediments in seven Rift basins, going back to about 3 Ma. Volcanic events provide plenty of dating opportunities to calibrate and correlate the sedimentary evidence. They show three rift-long episodes of deep lakes spanning broad periods from 2.7-2.5, 1.9-1.7 and 1.1-0.9 Ma. A few sections reveal lake-level fluctuations on Milankovich timescales. The longer episodes link in time to the intensification of Northern Hemisphere glaciation, to a shift in east-west air circulation over Africa and to the switch from the dominant glacial cyclicity of 41 ka to one of 100 ka, respectively. Wisely, they consider the climatic information to be crucial to studies of human evolution, but still too coarse to be used with confidence in relation to details of the fossil record. Long humid periods would have been 'easy', whereas the separating drier periods may have experienced ups and downs in humidity on Milankovich timescales. Fluctuating conditions would have been more stressful and likely to witness speciation. One very odd feature is that the 1.9-1.7 Ma period of deep rift lakes is the time when *H. erectus* became the first tooled-up being to migrate far beyond Africa. Many have regarded migration as a response to environmental stress, but just as likely is an expansion of opportunity.

Growing evidence for 'hobbits' (*October 2005*)

Various shenanigans within the Indonesian palaeoanthropology community have hindered evaluation of all the evidence surrounding the diminutive adult female skeleton found in Liang Bua cave on Flores in 2003. Her skull was damaged after prolonged examination by a leading national figure in the science, and now further excavation in the cave has been blocked indefinitely. Whether she is indeed a member of new species of hominin, *Homo floresiensis*, or merely an individual modern human dwarfed by some genetic defect, as some claim, seems closer to resolution (Morwood, M.J. and 10 others 2005. Further evidence for small-bodied hominins from the Late Pleistocene of Flores, Indonesia. *Nature*, v. **437**, p. 1012-1017; DOI: 10.1038/nature04022). During the 2004 field season at Liang Bua the Australian-Indonesian team unearthed remains of nine other individuals of similarly diminished stature. They included another jaw bone that is virtually identical to that of the first 'hobbit': neither have the chins that unify all fully modern humans. Significantly, the new piece of lower jaw is dated at some 3 ka older than the original, so the chances of both being from physiologically unfortunate modern humans are remote.

The new finds also include stone tools, more advanced than any found in association with one of *H. floresiensis's* possible ancestors, *H. erectus*. Whoever they were, the 'hobbits' also butchered prey and cooked meat. There is negative evidence in support of the new species hypothesis too: compared with human sites of the Late Pleistocene, Liang Bua is conspicuously lacking in evidence for any form of art. But the idea is not proven. It would take a definite association between fossils and tools, as for instance in a burial, to show that the implements belonged to 'hobbits' rather than having been introduced by a fully human visitor. Moreover, should any evidence for moderns be found in Liang Bua or other caves of interest, the possibility of mixture of cultures and fossils would leave things up in the air.

It is worth noting that Indonesian scientists are not the only ones prone to obstructive tactics as regards hominin sites. They have long been a bone of contention throughout Africa, where both local and visiting scientists have tried to throw spanners in their colleagues' research ambitions.

See also: Dalton, R. 2005. More evidence for hobbit unearthed as diggers are refused access to cave. *Nature*, v. **437**, p. 934-935;DOI: 10.1038/437934a. Lieberman, D.E. 2005. Further fossil finds from Flores. *Nature*, v. **437**, p. 957-958; DOI: 10.1038/437957a.

Congenital disease, human migration and population growth (*October 2005*)

The way in which genetic features are inherited has become a key feature in distinguishing human populations, the time and route of their migrations as separate groups, and when they merged with other groups. The most familiar outcomes are those based on mitochondrial DNA and lines of female descent that show with little room for manoeuvre, that all of us descend from Africans alive around 150 to 200 ka. Studies of the male Y chromosome help fine tune the record to show short periods when either populations fell so low that human survival passed through only a few small bands (e.g. around 70 ka) or Big

Men corralled most women for their own purposes (the now famous case of Ghengis Khan's genes still dominating the genetics of Central Asian people). Dennis Drayna of the US NIH outlines yet another revealing feature of genetics with historical connotation in the October 2005 issue of *Scientific American* (Drayna, D. 2005. Founder mutations. *Scientific American*, v. **293(4)**, p. 60-67).

Disabling congenital diseases, such as cystic fibrosis and sickle-cell anaemia, together with adverse reaction to alcohol and the ability of adults to tolerate the lactose in milk, are all passed down generations in different ways. Understanding the genetic processes involved obviously stems from medical research on genetic mutations so as to identify groups that are at risk. From it has emerged details on the structure and location of the responsible genes in chromosomal DNA. The feature that unites the four examples above is a special repetition of the same kind of mutant structure. Inherited conditions involve either different mutations in a single gene, or the identical change at a specific location. Of the latter, it seems the most common is an innate tendency in DNA for the same mutation to affect a specific gene – so called 'hot-spot' mutation, which occurs in unrelated individuals. More rare is a defect that is embedded in a length of DNA (a haplotype) whose structure is identical in all those who carry the mutation. That common identity suggests that the mutation arose once and has been passed down subsequently; a 'founder' mutation.

Since a 'founder' mutation arose at some time in the past it can potentially be used to trace population history, and so passes into the realm of palaeoanthropology. The fascinating and most useful feature is that the greater the separation in generations from the individual in whom the mutation occurred, the more restricted becomes the haplotype, in terms of its relative length in DNA. That phenomenon is a consequence of sexual recombination among descendants. In the founding individual, the whole chromosome is the haplotype, and the mutated part becomes increasingly 'diluted' with time. Measuring its length today harks back to the time of foundation. What has become clear is that not all founder mutations have any obvious consequence, and instead of being in as few as one millionth of a population, the general case for those causing disability and therefore conferring an adverse effect on natural selection, a few percent of people can carry them. Such abundance indicates either neutral effects or some subtle benefit to fitness. Diseases ascribed to them appear when both parents contribute the mutation: most are recessive.

A good example is a mutation of the HFE gene that confers above normal iron absorption, which is a decided advantage in protection against anaemia from iron-deficient diet. An individual with two copies vastly overcompensates and iron accumulates to deadly levels in their cells. Studies of its incidence in global populations indicate that it arose in Ireland, western Britain and Brittany and then spread south-eastwards. It appears to be a Celtic trait, although not from their original heartland in Central Europe but at the limit of their original migration more than 2000 years ago. Its haplotype is quite long and suggests a founder around 800 AD. There are no records of significant late Celtic migrations, and quite possibly the spread was through wide-ranging Vikings who dominated parts of the western British Islands at that time. A more fascinating case is the founder mutation that prevents people who carry it from tasting bitterness. Most people do experience bitter tastes, and that is very handy for avoiding toxic plants. About 25% do not. Maybe the mutation involved conferred some advantage, but the fact is that the haplotype is exceptionally short, representing a foundation at about 100 ka. It occurs in Africa along with 6 variants of the bitter-taster gene, yet beyond that continent only one taster and the non-taster forms occur commonly. That tallies with the hypothesis of the major movement out of Africa to populate the rest of the world with modern humans, around 75 ka ago. The surveys go intriguingly further: should descendants of those African migrants have bred successfully and regularly with earlier Eurasian hominins (Neanderthals and Erects), then non-African versions of the bitterness detecting gene ought to be present among non-African populations. Not one 'alien' haplotype has been detected, and this novel approach seems to have lain to rest that particularly intriguing bit of sociology.

Culture and human evolution (*December* 2005)

Culture in the most general sense that encompasses tools, clothing, habitation and fire has increasingly set humans and their ancestors apart from the rest of the natural world. It might seem that becoming more 'human' cushions our line from Darwinian natural selection since we have created our own 'nature' and carry it with us. And, of course, that 'nature' changes with circumstance in that we change it as we change our world and our social being. Setting fully modern humans adrift in the environment, without that culture, would undoubtedly result in rapidly extinguishing the species. In that hypothetical context, we are far from 'fit' in Darwin's sense. However, the development of humanity's cultural milieu has itself provided a continually changing, increasingly pervasive, artificial set of conditions for natural selection. Culturally, the most dramatic step in human evolution, for which we have tangible evidence, emerged with the explosive appearance of graphic art and a complex 'toolkit' around 35 thousand years ago in Europe. That huge advance will undoubtedly be traced back maybe tens or even hundreds of millennia when archaeological finds in Africa and Australia, for instance, are more precisely dated, and as more is unearthed. Evidence from the DNA in male-carried Y chromosomes indicates that a profound genetic shift occurred around 70 ka, perhaps resulting from a decline in global human numbers to a very small population after the climatic disaster wrought by the explosive eruption of the Toba volcano in Indonesia (see *Super-eruptions and climate* January 2004**).**

That too was a time when fully modern humanity distributed itself more thinly by a decisive exodus from Africa. Some specialists have speculated that the cultural explosion stemmed from that evolutionary 'bottleneck'. There are genetic signs of adaptation to cultural practices and selective pressures that accompanied them after the rise of agriculture and settlement (See *Has human evolution stopped?* above). Recent work on the whole human genome gives an inkling that even more pervasive evolutionary changes took place in the last 50 thousand years (Wang, E.T. *et al*., 2006. Global landscape of recent inferred Darwinian selection for *Homo sapiens*. *Proceedings of the National Academy of Science*, v. **10**, p. 135-140; DOI: 10.1073/pnas.0509691102).

Wang and colleagues from the University of California studied the occurrence of single-letter differences in the genetic code (single-nucleotide polymorphisms – SNPs). Scattered across all human chromosomes are about 1.6 million of these SNPs. They appear not to do anything, but can be linked to nearby genes. When natural selection favours a particular mutated variant of a gene, the associated SNPs can be selected as well. The approach used by Wang *et al*. is a statistical search for pairs of SNPs that occur together more often than could be possible by chance 'reshuffling' that occurs from generation to generation. Their analysis suggests that around 1800 genes, a remarkable 7% of the whole genome, have changed over the last 50 thousand years. Interestingly, that is similar to the degree of genetic change in maize since its domestication from its wild ancestor. As well as genes connected to protein metabolism that could have changed as new diets followed the rise of agriculture, some that are involved in brain function have been selected as well.

Although at an early stage, this kind of research confirms that we are indeed still evolving along Darwinian lines, perhaps unwittingly domesticating ourselves. It is easy to assume that ideas, skills and artistic sensibilities are passed on through language and learning and thereby grow and diversify, but in order for any of these to stimulate the deep feelings that they foster suggests that some aspects have become ‘hard-wired’ in all of us. Everyone unconsciously taps their feet to rhythm, can be moved to a vast range of emotions by music, words and visual stimuli, and can ‘sense’ an environment captured, even in abstraction, by a talented artist. They inspire further development. Until around 50 ka human culture, insofar as we can see evidence for it, remained fixed for more than a million years through several species and subspecies of the genus *Homo*. Appearing between 1.6 and 1.4 Ma ago the bi-face stone axe endured as humanity’s highest known achievement until those very recent times. Yet so much of human culture, even today, is ephemeral; unless committed in some way to stone, in the form of tools, buildings and rock art, it becomes increasingly difficult to find evidence of culture further back in time.

See also: Holmes, R. 2005. Civilisation left its mark on our genes. *New Scientist*, 24/31 December 2005 issue, p. 8.

Earliest tourism in northern Europe (*December* 2005)

Some years ago British palaeoanthropologists were in a state of high excitement about finds of stone tools, evidence of prolonged human habitation and fragmentary skeletal remains from a sandpit at Boxgrove on England’s southern coast. They showed the earliest presence of humans at high latitudes around 400-500 ka. The date of early colonisation has now been pushed back more than half as long before that to 700 ka by finds in a shoreline exposure of riverine sediments on the coast of Suffolk on England’s east coat. The Cromer Forest Bed of Middle Pleistocene age has been know since Victorian times as a rich source of the flora and fauna from one of the earliest interglacials of the current period of 100 ka climate cyclicity. At that time the North Sea had yet to establish a connection that would eventually separate the British Isles from Europe, and the site at Pakefield would have been the estuary of a now-vanished river system draining the Midlands and Wales. So far no human bones have turned up in the excavations, which have to be conducted at low tide. But many flint tools pepper the organic-rich sediments (Parrfitt, S.A. *et al*., 2005. The earliest record of human activity in northern Europe. *Nature*, v. **438**, p. 1008-1012; DOI: 10.1038/nature04227). As with most terrestrial deposits, establishing the age of human occupation posed the greatest difficulty. A careful documentation of magnetic polarity combined with fossils – including distinct voles - and a new technique that relies on assessing the degree of protein degradation in bivalve shells helped tie-down the age precisely.

Around 800 ka human occupation had begun in Spain and the Pakefield site shows that migration northwards of flora and fauna following a glacial epoch was swift, to establish conditions considerable warmer than in the Holocene. It seems that this Mediterranean climate encouraged such northward penetration by humans, most likely during a short period of particular warmth. Long eyed by archaeologists as a potential source of human remains, patience has paid off in the Cromer Forest Beds. Sadly coastal exposures of unconsolidated sediments are soon eroded by waves and tides. Yet around the world there are many other, equally promising strata or Pleistocene age that have not had such undivided attention for so long, A glance at the distribution of keynote sites for palaeoanthropology shows how narrow the search for human origins and migratory destination has been up to now. Though it is understandable that once finds have been made, funds and scientists cluster where progress is best guaranteed. Very rarely, either a 'shot in the dark' pays off or something surprising turns up at a site being excavated for other purposes. Broadening the search may well have high financial and career risks, yet the more discoveries are made at well-trodden sites the greater the likelihood that the full story of human evolution and migration will be revealed by breaking new ground,

See also: Roebroeks, E. 2005. Life on the Costa del Cromer. *Nature*, v. **438**, p.921-922; DOI: 10.1038/438921a.

Biogeochemical evidence for vegetation change when hominins evolved (*December* 2005)

A long-held theory that concerns the background to hominin evolution, is that the freeing of hands by bipedalism was triggered by a shift in the ecology of East Africa from forest to more open grassland. That might well have happened as the Neogene uplift associated with development of the East African Rift transformed the regional wind and rainfall patterns to the way they are today, thereby creating the conditions for the modern savannahs and semi-deserts in the area long associated with human origins. The lakes of East Africa are ephemeral in the context of Neogene climate change, and so their sediments are not much use in charting long-term shifts in flora. However, the modern wind systems shift dust and organic particles consistently towards the Gulf of Aden, so sediment cores there potentially provide a continuous record of vegetation change. That is, if they contain 'biomarkers' that distinguish the debris of trees from that of grasses. The first biomarker records from the Gulf of Aden seabed powerfully confirm the notion of vegetation change as a possible driver for hominin evolution (Feakins, S.J. *et al*., 2005. Biomarker records of late Neogene changes in northeast African vegetation. *Geology*, v. **33**, p. 977-980; DOI: 10.1130/G21814.1).

Up to about 3.5 Ma the cores contain plant-derived waxes that are characteristic of trees that use C3 metabolic processes, but thereafter evidence for increasing C4 grasses predominates. Coinciding with that broad trend is an increase in ^{13}C in soil carbonates on land, which probably reflects increased grassland too. Although records of hominin diversity before about 3 Ma are scanty, later times saw the rise of several bipedal species, grouped as the powerfully jawed paranthropoids and the more daintily chewing members of the lineage that led to modern humans. Detail in those sections of marine core that were used – presumably costs prevented continuous measurements – shows that the carbon-isotopic signals in the waxes varied in harmony with evidence for climate change, so the proportions of savannah and woodland probably shifted quite rapidly. However, because cold-dry periods have tended to be longer than those which were warm and more humid, savannah would have had more influence over faunas than ephemeral woodland. Fascinating as this empirical relationship between hominin evolution and vegetation change is, what Africa lacks – as indeed does most of the planet – is data that chart accurately how topography has changed with time. Cosmogenic and U-Th/ He apatite thermochronology, on which so much hope and funding have been invested, has proved spectacularly ineffectual compared with careful work on the likely effects of changing landforms.