Human evolution and migrations

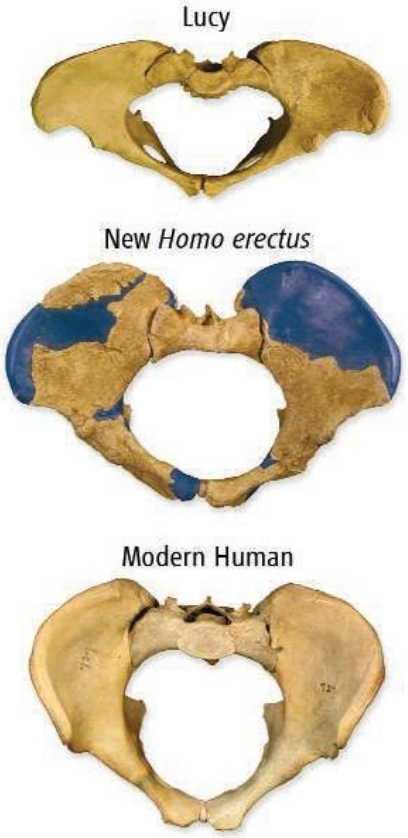
Culture and migration in the Middle Palaeolithic of southern Africa (*January 2009*)

The period between 300 and 30 ka was critical for the evolution of modern humans. Our mitochondrial DNA indicates that fully modern humans emerged around 200 ka. Projectile weapons that help define the epoch first appeared. Clear signs of self-adornment and symbolism also turn up during the Middle Palaeolithic. All of these developments took place in Africa, and the last two are reflections of the increased efforts by archaeologists in the continent from which we all originated. There is a long way to go to match the density of sites from which later periods in human history have been outlined in Europe, but progress is accelerating. One great hindrance has been dating sites, for the Middle Palaeolithic lies in a time zone where the Ar-Ar and ^{14}C methods are ineffective. A developing chronological 'workhorse' for this difficult period depends on the way in which exposure of sand grains to sunlight 'heals' the defects in their molecular structure formed when radioactive isotopes in soils emit ionising radiation. Artificial illumination of sand grains containing these defects causes them to luminesce. The degree of luminescence is related to the time over which the defects have built up. Optical dating relies on grains having been exposed at the surface for a time to 'reset' the luminescence clock, and then being buried so that new defects can accumulate. Having lots of sunlight and a superabundance of bare sand, Australia has become a hotbed of research into optical dating of events associated with its peopling during the last ice age. Expertise developed there has been applied to many Middle Palaeolithic sites in Southern Africa (Jacobs, Z. *et al*. 2008. Ages for the Middle Stone Age of Southern Africa: Implications for human behaviour and dispersal. *Science*, v. **322**, p. 733-735; DOI: 10.1126/science.1162219).

Archaeological work in South Africa and Namibia has revealed two distinct stone industries in the Middle Palaeolithic, both of which made hafted weapons that would have made hunting more efficient than the whatever weapons were used in earlier times – the most distinctive of the preceding Lower Palaeolithic tools was the bifacial hand axe, whose use is obscure. Both cultures involved the earliest recognisable ornamentation, such as shell beads and materials engraved with symbols, together with indirect evidence for the use of hematite and goethite pigments for body painting (see *When and where 'culture' began* November 2007). Genetic evidence famously places modern human origins and their global migration out of Africa within this time frame. So, dating the archaeological sites as accurately as possible is a crucial importance, and a tremendous start has been made by the multinational team lead by Zenobia Jacobs of the University of Woolangong in Australia. Optical ages span 90 to 30 ka, with clusters between 71.9 to 71 ka and 64.8 to 59.5 ka, with a statistically significant gap of about 6.7 thousand years between them. When compared with climatic-change indicators from the Antarctic ice record the developmental episodes do not seem to correlate clearly with any specific warm of cool periods, though the earlier spans the time of the Toba super-eruption in Indonesia and the later one was a period of warming. So any environmental cause for the technological and cultural changes is unclear. However, both fall within the estimated time span of the genetic 'bottleneck' between 80 and 60 ka, and the most likely times for the initial 'Out of Africa' migrations, probably across the Straits of Bab el Mandab linking Eritrea and Arabia across the Red Sea shallowed by ice-cap linked falls in global sea level.

Childhood and families (*January 2009*)

Human females are unlikely to break 10 seconds for the 100 metres because of their sashaying gait. It can't be helped, being due to the evolution of the pelvic girdle of bipedal females to deal with birthing of infants with increasingly large heads. Supposedly, the human female pelvis is now close to the limit that will permit walking on two legs. Such problems do not plague other living primates partly because their young have small heads relative to their bulk, and pelvic anatomy is not constrained by an habitually upright gait. It seems not to have been an 'issue' for australopithecines either: they did not possess 'child-bearing hips'. The intermediate species, *Homo erectus*, despite having a 1 Ma fossil record (maybe as long as 1.8 Ma for the Asian form) only recently provided substantial pelvic remains (Simpson, S.W. *et al*. 2008. A female *Homo erectus* pelvis from Gona, Ethiopia. *Science*, v. **322**, p. 1088-1092; DOI: 10.1126/science.1163592). In the words of the authors, this pelvis is 'obstetrically capacious' and demonstrates that female skeletal evolution responded to increasing foetal brain size: it would have permitted infants with heads 30 to 50% of the adult size to have been born. *Homo erectus* has been widely supposed to have had a tall willowy frame analogous to that of fully modern human inhabitants of tropical savannahs, yet the Gona woman was stocky. So, environmental influences seem to have had less of an evolutionary role than the advantages of greater brain development before birth. That places *H. erectus* even more firmly on the human line; indeed greater *in utero* brain development seems to have taken place than in modern humans.



Female pelvises of *Au. afarensis, H. erectus* and *H. sapiens.* (Credit, Gibbons 2008)

The Gona pelvis demands re-evaluation of how foetal and childhood development has progressed over the last two million years (Gibbons, A. 2008. The birth of childhood. *Science*, v. **322**, p. 1040-1043 DOI: 10.1126/science.322.5904.1040), the unique attributes having appeared during the evolution of our own genus. Among chimpanzees, infants can fend for themselves, with a little help from elders, after 3 years old. Street children from Asia and South America need to be 6 before they can survive without parental care. Growth lines on teeth that appear week by week reveal that previous age estimates for a number of immature australopithecines whose first adult molars had erupted were large overestimates: instead of 6 they point to 4 years old. Another signal feature of human development is the lengthy period to full development (marked by the eruption of the 3rd molar as well as the end of significant growth in stature). The average age when human child bearing begins is around 19, while chimpanzees start at about 11. A fresh examination of the famous Turkana Boy's skeleton, an *H. erectus*, that uses tooth microstructure reduces his age at death from 13 to 8, suggesting an earlier onset of independence than in modern children. He grew much more quickly too, and would have reached adulthood somewhat earlier: around 14.5 years old. The picture with Neanderthals is not completely clear, some tooth studies suggest that their children grew significantly more quickly than modern ones, other studies point to the same rates or even longer development if adult brain sizes of Neanderthals are taken into account (larger on average than those of modern humans). Using average life expectancy of gatherer-hunter humans and chimps who survive dependent childhood – 45 and 70 years respectively – along with evidence for child development, suggests that australopithecines could have reached 45 while *H. erectus* adults could have expected to reach 60 years old.

There are other differences that begin to slot into space with the new data. Both human and chimpanzee females have a similar child-bearing period of around 20-25 years. The difference is that, on average, the natural interval between births is about half as long for human mothers as for chimpanzees. The greater number of human offspring gives a greater chance of the survival of some to reproduce themselves. On the other hand, slower child development places a greater burden on mothers, even after weaning. So there is quite a contradiction between the evolutionary effects, if only child-mother relationships are taken into account. This contradiction was resolved, to some extent, by a seminal paper in the late 20th century by a group of anthropologists from the Universities of Utah and California (O'Connell, J.F. *et al*. 1999. Grandmothering and the evolution of *Homo erectus*. *Journal of Human Evolution*, v. **36**, p. 461-485). They focussed on the potentialities of the early onset of infertility or the menopause among women relative to its appearance among female chimpanzees, which gives, on average, a 30 year non-child-bearing period to older women. This approximately coincides not only with child-rearing periods for their daughters, but for their granddaughters as well. The 'grandmothering' hypothesis for human development centres on the great evolutionary advantages of post menopausal women assisting with child rearing. O'Connell *et al*. suggested that this arose among *H. erectus*, as far back as 1.8 Ma, and the Gona pelvis together with other new views of *H. erectus development* add considerable weight to that concept. As well as freeing younger women for food gathering, the cultural significance of older women caring for children adds another dimension that may link to the advantages of delayed post-weaning development that we see today, albeit in many annoying contexts!

Deeper roots of culture (*March 2009*)

There has long been a pervasive aroma of eurocentrism in cultural palaeoanthropology, encouraged by the spectacular cave paintings in southern France and northern Spain that are no more than 40 ka in age and the first to be discovered. This undoubted flowering of art as we appreciate it today has been linked to much more than figurative expression. Some have argued that *Homo sapiens* only became fully human after Europe was colonised. Thankfully, the archaeological record is rapidly being set straight by more and more discoveries of symbolic representation from elsewhere (Balter, M. 2009. On the origin of art and symbolism. *Science*, v. **323**, p. 709-711; DOI: 10.1126/science.323.5915.709). Blomberg Cave In South Africa is a repository for 100 ka old inscribed ochre artefacts (Balter, M. 2009. Early start for human art? Ochre may revise timeline. *Science*, v. **323**, p. 569; DOI: 10.1126/science.323.5914.569), which represent symbolism of some kind and the imagined uses to which the ochre was put – ritual or cosmetic body painting? But there are tantalising objects that push art back even further. In 1999 a cache of stone tools at Tan-Tan in Morocco was found to include a 6 cm quartzite chunk that looks like a rough version of the 'Aurignacian Venuses' of later times, yet the find dates back to 300 to 500 ka. Something similar turned up in the 250 ka site of Berekhat Ram in the Israeli-occupied Golan Heights of Syria. Both predate the evolution of fully modern humans. And what of the tear-drop shaped biface 'axes' associated with *H. erectus* and *H. ergaster* as far back as 1.6 Ma? These are extremely odd objects, for several reasons: it is hard to visualise their use; many finds are in pristine condition, as if never used; to make one demands a mental model of what potentially lies within a rock; they are more difficult to make than later blade tools that are more utilitarian. Arguably, the 'Acheulean hand axe' may be more of a symbol than a tool.

The reason for renewed discussion in print of these matters is, of course, the bicentenary of Charles Darwin's birth and the 150th anniversary of publication of his *Origin of Species*. Darwin drew a link between tool making and language in his *Descent of Man*. He would have been delightedly surprised to learn details of the emergence of new tool-making skills in Africa, from where he insisted we all came (Morgan, L.E. & Renne, P.R. 2009. Diachronous dawn of Africa's Middle Stone Age: New $^{40}Ar/^{39}Ar$ ages from the Ethiopian Rift. *Geology*, v. **36**, p. 967-970; DOI: 10.1130/G25213A.1). Morgan and Renne, of the University of California at Berkeley, discovered that the oldest sites in the Main Ethiopian Rift that contain the novel tools that mark the onset of the Middle Stone Age (MSA) span a much greater interval than assumed hitherto. In one site such tools date to 276 ka, whereas at another such objects appear only at 183 ka. The more delicate work to make MSA points and blades, and a much diversified 'tool kit' has been called the Levallois technique, thought to have been associated with a cognitive leap from the Lower Palaeolithic Oldowan and Acheulean techniques. For some it came to signify more: the appearance of fully modern humans. But the new ages do not tally with the fossil record of *H. sapiens* or with estimates from mitochondrial DNA molecular clocks. All in all, culture, whether art or technology, seems to be characteristic of the genus *Homo*. Given a push bike, could *H. ergaster* have ridden it and, more important, had fun? What would a Neanderthal, male or female, have done with a tube of lipstick?

The Neanderthal genome is coming! (*March 2009*)

Some computer owners take part in the search for extraterrestrial intelligence, allowing SETI to combine their processing power with that of hundreds of others, on the off chance that the meaning of π (pi) pops up in a systematic burst of non-static microwaves. Personally I would far rather wait for a message from a relative than from some seriously weird being whose motives we might never guess. A Neanderthal lady – more precisely her leg bone – from Croatia is very close to speaking volumes about our own history. Two teams of DNA sequencers are putting the finishing touches to her genome. That it would ever happen was a fevered dream not so long ago. That it will opens up a revolution in understanding our origins. To keep in touch, read Elizabeth Pennisi's account of the pending revelations (Pennisi, E. 2009. Tales of a prehistoric human genome. *Science*, v. **323**, p. 866-871; DOI: 10.1126/science.323.5916.866 ·). Svante Paabo gave a glimpse of his team's rough draft of the genome at the AAAS annual meeting in February 2009. When analyses are finished palaeoanthropology will explode onto the news channels, blogs, and among the twittering classes. Should SETI get a result, I would first eat my trousers and then prepare to be eaten myself. As for Darwin, maybe you have noticed his prominent brow ridges…

Flirting with hand axes (*May 2009*)

A biface, Acheulean hand axe is more than object of beauty produced by great skill. This industrial genre was invented by African *Homo ergaster* around 1.6 Ma ago, became a central feature of Palaeolithic archaeology, and lasted until the last few hundred thousand years. Nobody doubts that production of these objects implies an intellect able to visualise a complex shape within a shapeless lump of rock and to devise a way of achieving it. Moreover, its longevity spanning several species of *Homo* to our own shows that skills were efficiently passed down through hundreds of thousand generations: possible evidence for linguistic skills. But what was it for?

Unwieldy hand axe (40 cm long) from Furze Platt, Berkshire UK (Natural History Museum)

Experts have been at a loss to agree on a function: too heavy and shaped wrongly for hafting to a spear; more awkward for cutting than earlier Oldowan pebble fragments; produced with careful three-dimensional symmetry when a hand tool needs none; time consuming to make yet often found in great abundance; and sometimes apparently hardly used. One idea is that they were in fact for throwing, in the manner of a discus, yet broken biface axes are rare. A more appealing hypothesis is that they were made for 'show' as an element in human sexual selection (Kohn, M. & Mithen, S. 1999. Hand axes: products of sexual selection? *Antiquity*, v. **73**, p. 518-526; DOI: 10.1017/S0003598X00065078). Kohn and Mithen argued that the primary function of hand axes was to advertise a maker's "good genes": an indicator of the knapper's geographic knowledge of suitable resources; his ability to execute a plan; his dexterity and patience; and his social awareness. Those are all attractive qualities in a potential mate. They also suggested that the axes' often near-pristine quality and occurrence in great numbers at some sites indicate that once their purpose was served, they were thrown away: 'That man is so cool, he must be good at surviving'. Ten years after Kohn and Mithen first mooted the hypothesis it has come under criticism by April Nowell and Melanie Lee Chang, of the universities of Victoria, Canada and Oregon USA, respectively (Nowell, A. & Chang M.L. 2009. The case against sexual selection as an explanation of handaxe morphology. *Paleoanthropology*, v. **2009**, p. 77-88).

The critique begins by examining Kohn and Mithen's interest in symmetry as an element in attractiveness, that Nowell and Chang concede, but consider to have arisen not in a sexual context but in development of vision, despite vision being an evolutionary 'given' vastly older than hominins. After a discussion of how fully modern human females base their sexual choices on non-physical attributes of potential mates, such as "niceness," intelligence, sense of humour, compatibility, willingness to work hard and evidence that the partner in question is attracted to them, Nowell and Chang examine available archaeological evidence. Much of this concerns the 'absence of evidence'. For instance, there is no evidence to suggest that females did not make hand axes and living females in gatherer-hunter societies do make tools. Other criticisms include: the absence of hand axes from Asia until migration there by *H. sapiens* [but the biface axe had not been invented when *H. ergaster* migrated there from Africa around 1.8 Ma]; not all biface axes are symmetrical [but they are nonetheless impressive]; and axes in large numbers generally occur where prey has been butchered, as at Boxgrove, and may have accumulated by hundreds of years of use and loss at such sites by seasonal hunting. The most serious criticism is that some hand axes do show minute patterns that indicate that they were used; although most axes have never been examined for wear patterns.

My own conclusion is that the critique is based on absence of evidence for biface axes as ritual objects in sexual selection, but that is not evidence of absence, and I wonder if the 10 years taken to bring together contrary evidence has a bit to do with casting doubt on a not quite 'PC' idea. There are many intriguing facets of the fossil and archaeological records of hominins, none more so than those which may have a cultural connotation, like ochre caches (see *Deeper roots of culture* above) and the tear-shaped Acheulean axe. For most we may never know their true context, but can be sure that any curiosity and imagination we apply are reflections of imaginative and curious forebears.

Homo erectus in a cold climate (*May 2009*)

The famous Zhoukoudian Cave, where Peking Man, now thought to have been *Homo erectus,* was first found in 1929, is a lugubrious place. It seems the hominin fossil remains of at least 40 individuals were dragged there and eaten. They are by no means the oldest Asian hominins at less than 1 Ma, and their ancestors, probably African *H. ergaster*, migrated that far around 1.6 to 1.8 Ma ago. Until this year, decent ages from Zhoukoudian were a problem: the errors on estimates of around 500 ka were too large (the likely time lies in a 'datability gap' between the capabilities of Ar-Ar and ^{14}C dating methods) to see if the hominins were living at such high latitude (40ºN) during warm or cold conditions. The latter would be of great interest as it suggests both the use of fire and clothing. In fact, even in the current interglacial episode Beijing gets mighty cold in winter. However, cosmic-ray bombardment can produce unstable isotopes that are suited to dating in that gap, provided materials have been exposed to them. The fossil-containing sediments in Zhoukoudian Cave contain quartz that was exposed at the surface and washed in at the same time as *H. erectus* individuals were dragged in. Decay of cosmogenic ^{26}Al to ^{10}Be and measurement of parent and daughter isotopes in quartz grains have yielded ages of 770±80 ka, somewhat older than earlier estimates (Shen, G. *et al*. 2009. Age of Zhoukoudian *Homo erectus* determined with $^{26}Al/^{10}Be$ dating. *Nature*, v. **458**, p. 198-200; DOI: 10.1038/nature07741). This age roughly correlates with layers in the western Chinese windblown loess deposits that were deposited during the dry conditions of a minor glacial episode.

See also: Ciochon, R.L. & Bettis, E.A. 2009. Asian *Homo erectus* converges in time. *Nature*, v. **458**, p.153-154; DEOI: 10.1038/458153a. Gibbons, A. 2009. Ice age no barrier to 'Peking Man'. *Science*, v. **323**, p. 1419; DOI: 10.1126/science.323.5920.1419a.

Walking with the ancestors (*May 2009*)

From time to time the most evocative hominin trace fossils come to light, such as the *Australopithecus afarensis* footprints fount by Mary Leakey at Laetoli in Tanzania. A recent one is of footprints of a probable *H. ergaster* dating back to 1.5 Ma near Lake Turkana in Kenya, not far from the site of the famous 'Turkana Boy' skeleton of the same species (Bennett, M.R. and 11 others 2009. Early hominin foot morphology based on 1.5-million-year old footprints from Ileret, Kenya. *Science*, v. **323**, p. 1197-1201; DOI: 10.1126/science.1168132). Not only does the trackway reveal details of flesh, skin and bones of the feet, but careful analysis of 3-D scans of the prints, in the context of the mechanical properties of the material walked upon, allows the authors to show that the person who left them moved in essentially the same way as do we when walking through soft mud. They are distinctly different from the Laetoli prints, showing arches and very distinct big toes that are so necessary for 'springiness' and bipedal balance respectively.

See also: Crompton, R.W. & Pataky, T.C. 2009. Stepping out. *Science*, v. **323**, p. 1174-1175; DOI: 10.1126/science.1170916.

African genes (*July 2009*)

Much of the interpretation of the growing database of human genetic variability has so far focused on migration out of Africa and across the habitable continents. To some extent the

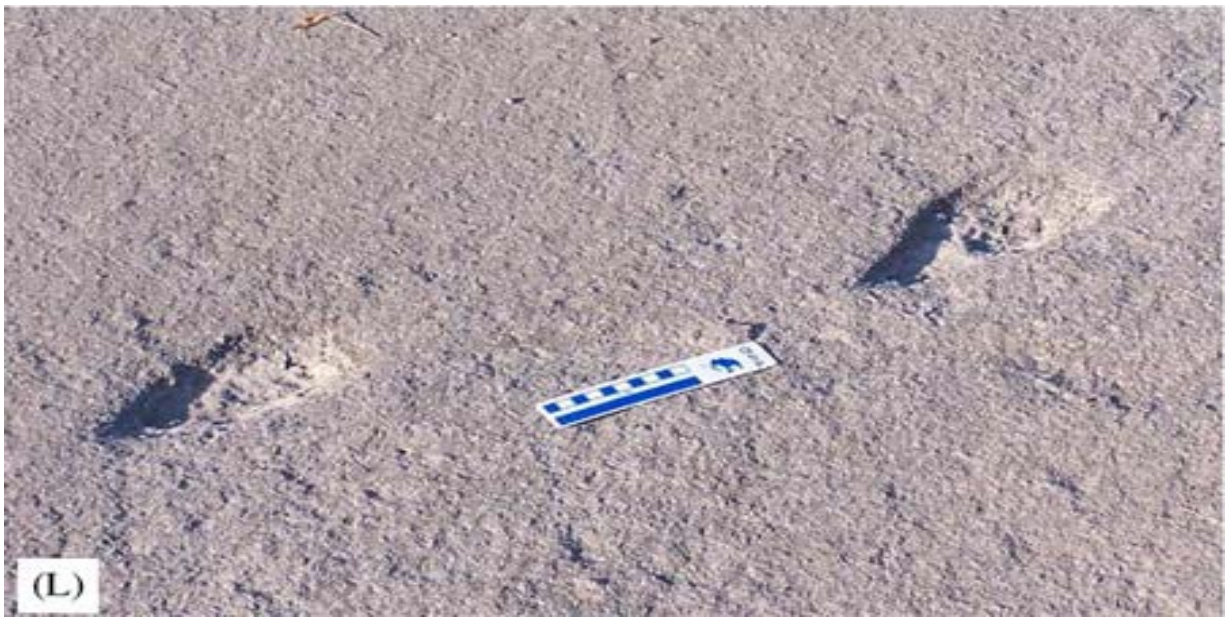
largest variability, of Africans themselves, has been undersampled, but a multinational team of Africans and non-Africans has now begun to redress the balance (Tishkoff and 24 others 2009. The genetic structure and history of Africans and African Americans. *Science*, v. **324**, p. 1025-1043; DOI: 10.1126/science.1172257) partly to study genetically-linked epidemiology and partly anthropology. The study centres on African's own ideas about their identity/ethnicity as well as documented cultural and linguistic division, and covers 3194 individuals from 121 populations in the continent, African-American populations in 4 US cities and 60 other populations from outside Africa. The team expands knowledge tremendously, as expressed by the many intricate diagrams. They use the statistical method of Bayesian clustering to tease out the ancestral bases for the genetic patterns preserved by Africans, which appear to be based on 14 major ancestral groups that mostly tally with cultural and linguistic divisions.

Overall, the picture is one of repeated mixing of populations through migrations within the continent, many within historic times such as the shift of West Africans south-eastwards, but also much earlier movements such as the ancestors of the San people of southern Africa. These remaining gatherer-hunter people together with central African pygmies and the Hadza and Sandawe of Tanzania share ancestry and also, except for pygmies, language that involves click-sounds – the pygmies abandoned their original language in favour of that of the groups that now surround them in the Equatorial rain forests. Of the three groups, the Hadza most maintain the genetic structure of the earliest ancestors on the continent, but all three shared a common ancestor about 35 Ka ago. Interestingly, comparison with people outside Africa confirms earlier studies that indicated a source population for the out-of-Africa migration in East Africa close to the Red Sea. The paper is necessarily condensed and so difficult to follow, but clearly opens up great vistas in understanding intricacies at which anthropologists have previously only guessed. Like the physical landscape of Africa, that of its population reflects the range of factors that have shaped human evolution and hence a great deal of its destiny.

See also: Gibbons, A. 2009. African's deep genetic roots reveal their evolutionary story. *Science*, v. **324**, p. 575; DOI: 10.1126/science.324_575.

Very old human footprints in Mexico? (*July 2009*)

In 2006 palaeoanthropologists in the Americas, already at loggerheads about evidence for pre-Clovis (pre 13 ka) colonisation, were rocked to their boots. A team from Liverpool John Moores University, Bournemouth University and the Mexican Geophysics Institute claimed to have found human footprints more than 40 ka old in a volcanic ash deposit (Gonzalez, S. *et al*. 2006. Human footprints in Central Mexico older than 40,000 years. *Quaternary Science Reviews*, v. **25**, p. 201-222; DOI: 10.1016/j.quascirev.2005.10.004). The extensive site exposed by quarrying carries many apparent footprints, both human and non-human. Moreover, some of the prints are in convincing-looking trackways. The very old date was obtained by optically stimulated luminescence dating of quartz-grains that measures the time since the grains were last exposed to sunlight or thermal baking. Were it not for that result probably little fuss would have been made. Now this remarkable find is under serious challenge (Feinberg, J.M. *et al*. 2009. Age constraints on alleged 'footprints' in the Xalnene Tuff near Puebla, Mexico. *Geology*, v. **37**, p. 267-270; DOI: 10.1130/G24913A.1).

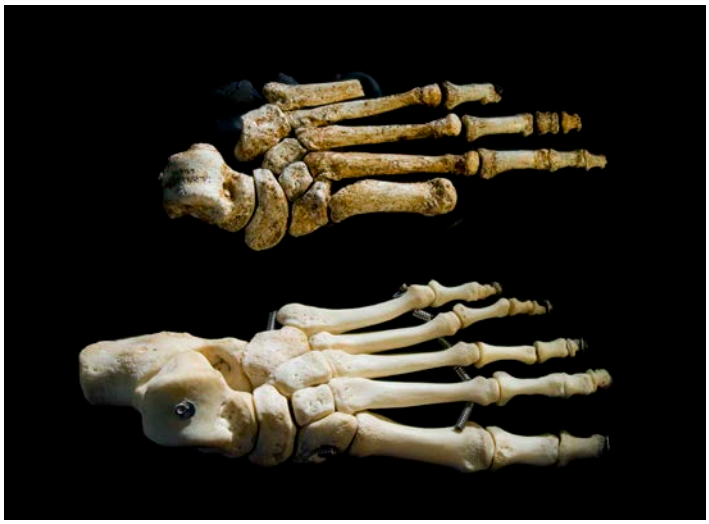


Examples of the Xalnene Tuff footprints (Credit: Gonzalez *et al*. 2005; Fig. 2)

This US-Mexican team applied Ar-Ar dating to the ash and found an age of about 1.3 Ma, confirmed by its association with reversed magnetic polarity in the deposit – at 40 ka the geomagnetic field was as it is today. On that basis, Feinberg and colleagues claim to have refuted the identification of human footprints, and claim that they are merely quarrying marks degraded by later weathering. The Xalnene Tuff in which the footprints were found was deposited in a lake that has been periodically filled and dried out. If the disputed features can be shown irrefutably to be footprints, then there are only two possibilities: either they date from a 40 ka lowstand when the tuff was rewetted and soft, or they are of *Homo erectus* who somehow found their way to the Americas after leaving Africa around 1.7 Ma ago and crossed the drying lake bed shortly after the tuff was ejected from a nearby volcano.

'Hobbit' news (*July 2009*)

Bones of at least 6 or 7 small people have turned up in the now famous Liang Bua cave on the island of Flores, Indonesia. Their stratigraphic positions span the period from 95 to 17 ka. There have been numerous claims that they do not represent a dwarfed human species – i.e. *Homo floresiensis* – but individuals who suffered from some form of pathological condition. The strongest evidence supporting that sceptical view is that the one near-complete skull does not fall on the well-established brain –body-size distribution that covers many species: it seems too small for either a normal pigmy modern human or a similarly diminutive *H. erectus*. Now crucial new anatomical evidence seems set to swing the balance. (Jungers, W.L. *et al*. 2009. The foot of Homo floresiensis. *Nature*, v. **459**, p. 81-84; DOI: 10.1038/nature07989. Weston, E.N. & Lister A.M. 2009. Insular dwarfism in hippos and a model for brain size reduction in Homo floresiensis. *Nature*, v. **459**, p. 85-88; DOI: 10.1038/nature07922). The foot bones of the most recent and most complete specimen are not like those of humans but more ape-like, although they show clear evidence of bipedalism. Interestingly, they seem to be more primitive than those of *H. erectus*, raising the possibility of an undocumented dispersal of perhaps from Africa into Eurasia as an ultimate ancestor.



Feet of *Homo floresiensis* (top) and *Homo sapiens* (bottom). (Credit: anthropology.net)

Curiously, the foot is disproportionately long compared with the rest of the skeleton; another bonus for 'hobbit' fans. Not having a snout, *H. floresiensis* certainly was no ape, indeed the skull is best expressed as a scaled-down version of either *H. erectus* or *H. habilis*. As to extremely small brain size in relation to the body size of *H. floresiensis*, insular dwarfism of fossil hippos in Madagascar provides a useful analogue, as Weston and Lister suggest. In adulthood they also have disproportionately small brains. As with many puzzles in human evolution, the stir caused by these new discoveries maintains *H. floresiensis* as a 'hot topic' and further excavations are inevitable – Flores has plenty of caves, as do many islands in the Indonesian chain.

See also: Lieberman, D.E. 2009. *H. floresiensis* from head to toe. *Nature*, v. **459**, p. 41-42; DOI: 10.1038/459041a.

Fire and tool making (*September 2009*)

Native people in Australia have been spoiled for choice of materials from which to make superb stone tools, all kinds of silica rock being available in the bedrock and the widespread tropical soils, including multicoloured chalcedony and even opal. Their master craftsmen developed a form of heat treatment that subtly modifies silica's internal structure so that gentle application of pressure to the edges of lumps removes small flakes to give intricate sharp edges, including barbs for fishing spears. This pyrotechnology leaves easily recognised signs in stone tools: colour changes and a pearly lustre.

A large team of archaeologists and geoscientists from South Africa, Australia, the UK and France have sifted through tools collected from the 35 to 280 ka African Middle Stone Age (defined differently from the European Mesolithic) in search of evidence for fire treatment (Brown, K.S. and 8 others 2009. Fire as an engineering tool of early modern humans. *Science*, v. **325**, p. 859-862; DOI: 10.1126/science.1175028). Like signs of symbolic behaviour (see *Technology, culture and migration in the Middle Palaeolithic of southern Africa* and *Deeper roots of culture* above) fire-worked silica tools appear as early as 164 ka ago. However, this is the first paper that reports a search for such technology, and since fire was definitely used by even earlier humans, such as *Homo antecessor* around 790 ka (see Early,

microscopic evidence for human control of fire November 2008) expect earlier finds to be announced.

See also: Webb, J. and Domansski, M. 2009. Fire and stone. *Science*, v. **325**, p. 820-821; DOI: 10.1126/science.1178014.

Neanderthals few on the ground (*September 2009*)

Analysis of DNA from Neanderthal bones is gathering pace as cheaper and more reliable methods for sequencing emerge. The latest breakthrough is by a team working in Svante Pääbo's lab at the Max-Planck Institute for Evolutionary Anthropology in Leipzig, Germany, which has defined full mitochondrial DNA sequences for five individuals (Briggs, A.W. and 17 others 2009. Targeted retrieval and analysis of five Neandertal mtDNA genomes. *Science*, v. **325**, p. 318-321; DOI: 10.1126/science.1174462). The samples are from almost the full geographic range known for Neanderthals, from Spain in the west to the eastern shore of the Black Sea in Russia, and are from 38 to 70 ka old; i.e. probably pre-dating the main influx of fully modern humans into Europe. The results show that the range of genetic diversity in the female line was only one third that found in humans today. That suggests that, compared with the modern human diaspora from Africa, total numbers of Neanderthals was low over the period analysed, and perhaps since their first colonisation of Europe and the Eurasian steppes around 400 ka.

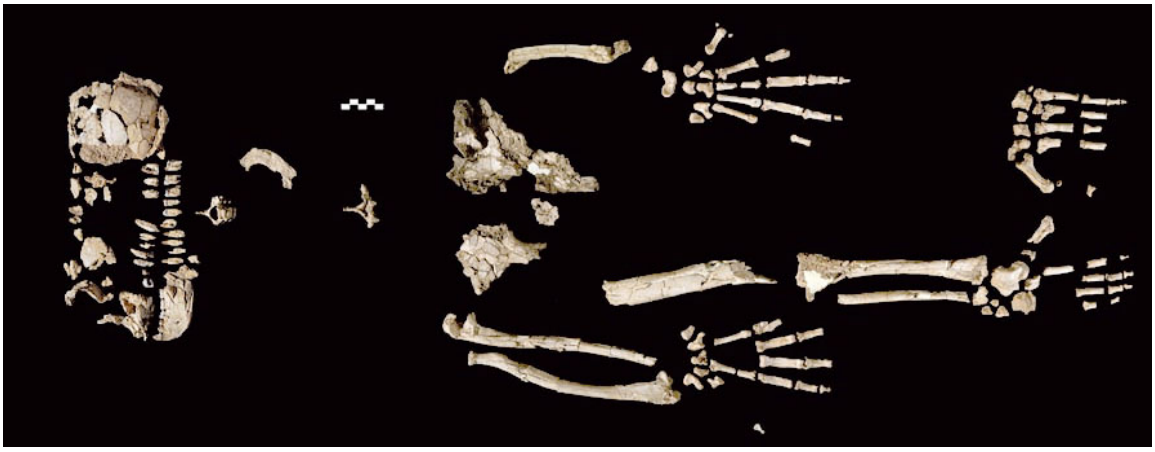
See also: Wong, K. 2009. Twilight of the Neandertals. *Scientific American*, v. **301** (August 2009), p34-39.

Klondike gold rush pays dividends for Pleistocene (*September 2009*)

The 1896 discovery of gold in the Yukon Territory, Canada triggered the Klondike gold rush, which led to environmental wreckage that continues to this day. The placer deposits are in permanently frozen, but fragile alluvial sediments dating back as far as 700 ka. But as well as gold washed in by the Yukon's rivers, the permafrost contains exceptionally well preserved records of the area's late Pleistocene flora and fauna. The reason why that was possible at such high latitude (65ºN) through 6 or 7 glacial interglacial cycles is that it remained free of ice sheets for most of the Pleistocene. Fossils finds in the placer deposits therefore document the conditions on the western edge of the Bering Straits land bridge, or Beringia, which emerged each time that sea level fell during glacial maxima (Froese, D.G. *et al*. 2009. The Klondike goldfields and Pleistocene environments of Beringia. *GSA Today*, v. **19** (August 2009), p. 4-10; DOI: 10.1130/GSATG54A.1). Beringia was the route presented to the earliest Asian human migrants into the Americas, possibly even before the Last Glacial Maximum 22 ka ago. Much of the evidence comes from wind-blown loess deposits that are prone to permafrost development. Also, being close to a number of active volcanoes the area was sporadically blanketed by ash deposits that are dateable by radiometric means, so a stratigraphy is possible even in the irregular and ice-disturbed sediments. During glacial episodes the area was steppe dominated by herds of bison, mammoths and horses; clearly a hunters paradise, despite the harsh conditions.

Early hominin takes over Science magazine (*November 2009*)

I first mentioned *Ardipithecus ramidus* in the Human evolution diaries in 2002 (*Taking stock of hominid evolution* February 2002). In 1994 Tim White and colleagues reported an Ardipithecus ramidus fossil, which they first considered to be a species of *Australopithecus*. Fifteen years on, and having amassed fragments of at least 36 individuals (and thousands of vertebrate, invertebrate and plant fossils) – Owen Lovejoy of Kent State University remarked, 'This team seems to suck fossils out of the ground' – it's pay day! A total of 54 pages of the 2 October 2009 issue of *Science* (v. 326, Issue 5949) are devoted to this diminutive and very old (4.4 Ma) hominin. Such mounds of data wrested from the cauldron of the Afar Depression needed a long incubation period, and what is presented in *Science* is a summary rather than being comprehensive: much more is available online, and yet to come. The now hugely experienced, 47-strong academic team built up by Tim White and his original colleagues deserve massive congratulations. But they depended on the eagle-eyed, mainly Ethiopian fossil finders, many of whom are Afar pastoralists who took to field palaeontology as ducks to water. Science in general owes a massive debt to all those who have wrested such a wealth of anatomical information from every aspect of the fossils and their environmental context. What they have achieved is more worthy of Nobel-status than the fumbling of gaggles of annual economist-laureates who still cannot grasp why the world economy continually does grave disservice to humanity. The *Ar. ramidus* team also have a lot more worth saying to us than those physicists who seek the grail of a theory of everything – racked by such hubris that they are both unintelligible and unrealistic in the most literal way. A video that summarises the articles is worth watching. A more detailed account is also available (White T.D. *et al*. 2009. Ardipithecus ramidus and the paleobiology of early hominids. *Science*, v. **326**, p. 64-86; DOI: 10.1126/science.1175802).



The most complete skeleton of *Ardipithecus ramidus* (Credit: White *et al*. 2009; Fig. 3)

I cannot do adequate justice to all the work in that issue of *Science*, but there are some general points that will leave any interested person breathless. As regards previous assumptions about the environment under which hominins emerged, it was woodland not open savannah. Though upright and capable of walking, as revealed by pelvis remains, *Ardipithecus* had feet with opposable big toes: sort of foot-thumbs. So they would have been as comfortable on trees as on the ground. Yet, their foot-architecture shows signs of having evolved from monkey-like feet rather than any lin=ke those of modern gorillas and chimps. A degree of certainty accompanies anatomical discussions, for one individual female *Ar. ramidus* is represented by a large proportion of a full skeleton, rivalling the later remains

of ‘Lucy’, an *Australopithecus afarensis*. Her skull, reconstructed from a badly crushed state using co0mputed tomography and digital piecing-together, gives a brain size around the same as bonobo chimpanzees, and less than that of australopithecines. The feet clearly show a walker able to clamber, rather than swing and knuckle walk. Hands, though primitive, are more human-like than those of living apes are. From that can be concluded that a common ancestor a million of so years earlier was not ape-like in manual terms: chimps have evolved in this respect perhaps a lot more than those on the human line. Teeth shape, wear and isotopic signatures suggest a broad diet, rather than specialisation, from which grasses and grass-eating prey seem absent. Moreover, there is no sign of large canines, that could indicate minimal social aggression. Males and females were of similar size, as are we, rather than showing the sexual dimorphism that characterised later australopithecines and both chimps and gorillas. This also seems to point backwards in time to the last common ancestor of ourselves and chimps being very different from both living genera. Yet in many respects chimps seem to have evolved more than hominins. Because of the work on *Ar. Ramidus*, a chimpanzee-centric view of our shared forebears and therefore of hominin evolution can now be rejected. Perhaps thankfully, speculation about aspects of our behaviour stemming from those of chimpanzees is probably worthless.

The mass of data concerning this small, Pliocene hominin holds out a promise of yet more to come, both further back in time, and to populate the gaps in time and morphology that currently plague palaeoanthropology. The terrestrial sediments in which White *et al*. found *Ar. Ramidus* are 300 m thick, cover 5.5 to 3.8 Ma and are exposed over a large area. The stratum from which most data were recovered represents at most about 10 thousand years. Elsewhere in the Afar-Danakil Depression are other sediments laid down in river and lake systems that go back as far the Miocene (the estimated time of the last common ancestor of other primates and humans), and are still being deposited today. If anything characterised this triumph of the human intellect, it combined patience, determination and an attention to detail that was shared by every participant.