Human evolution and migrations

Neanderthals and dental hygiene (*March 2017*)

Teeth are the most likely parts of skeletons to survive for long periods because of their armour by a layer of enamel made of hydroxyapatite ($Ca_5(PO_4)_3(OH)$). Dental enamel is the hardest material in the bodies of vertebrate animals and lies midway between fluorite and feldspar on Moh's scale of hardness (value 5). Like the mineral apatite, teeth survive abrasion, comminution and dissolution for long periods in the surface environment. Subdivision of fossil hominin species and even among different groups of living humans relies to a marked extent on the morphology of their teeth's biting and chewing surface. Although there are intriguing examples in Neolithic jawbones of dental cavities having been filled it is rather lack of attention to teeth that characterises hominin fossils. As well as horrifying signs of mandibular erosion due to massive root abscesses, a great many hominin remains carry large accumulations of dental plaque or calculus made of mineralised biofilm laid down by oral bacteria. Even assiduous brushing only delays the build up. Grisly as this inevitability might seem, plaque is an excellent means of preserving not only the bacteria but traces of what an individual ate. As fossil DNA is a guide to ancestry and relatedness among fossil hominins, so far going back to about 430 ka in the case of a Spanish *Homo heidelburgensis*, plaque potentially may reveal details of diet and to some extent social behaviour elaborating beyond the possibilities presented by carbon isotopes and dental wear patterns.

Plaque deposits have already shown that Neanderthals had a very varied vegetable diet (see *Neanderthal diet, gait and ornamentation* March 2011) and that they cooked their food, the sugars thereby released encouraging bacterial biofilms. There have even been hints that they used medicinal herbs, such as yarrow and chamomile (see Neanderthal 'high-carb' diet and self-medication August 2012). Now a large multinational team of scientists has taken this fascinating line of study a step further using short DNA fragments to identify the actual oral microbes and even plant and animal species that dominated the diets of 8 cave-dwelling Neanderthals found in Spain, Belgium and Italy (Weyrich, L.S. and 30 others 2017. Neanderthal behaviour, diet, and disease inferred from ancient DNA in dental calculus. *Nature*, v. **543**, p. 357-361; DOI: 10.1038/nature21674). The Spanish individuals found in El Sidrón cave seem to have been mainly vegetarian (mushrooms, pine nuts and edible moss) whereas two from the Spy cave in Belgium feasted on woolly rhinoceros and mouflon sheep. One of the El Sidrón Neanderthals had a dental abscess, and was probably in great pain, and whose calculus contained evidence of ingestion of tissue from poplar trees, known to contain salicylic acid (the active ingredient in aspirin): an example of self-medication. The unfortunate individual was also suffering from acute diarrhoea brought on by a eukaryote parasite (microsporidium). Astonishingly, DNA from several plant fungi, including *Penicillium rubens* (penicillin) also occurred in this individual's calculus, from eating mouldy plant material: predating modern antibiotics by more than forty-five thousand years!

More predictable findings from the ill El Sidrón individual was a spectrum of common plaque colonising bacteria. But another surprise was *Methanobrevibacter oralis*, an archaea common in the human mouth ecosystem, for which a complete genome was reconstructed.

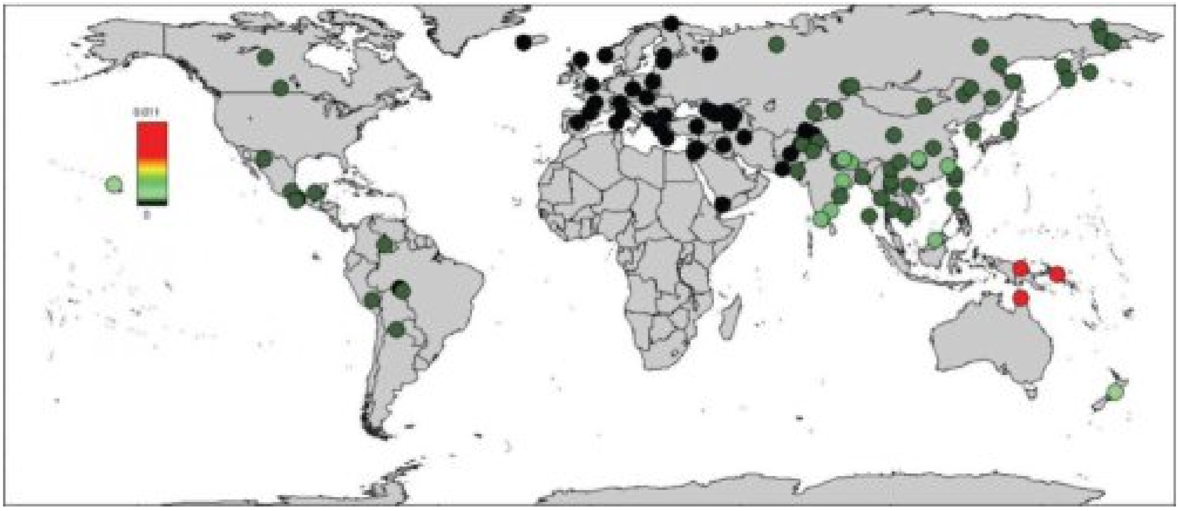
It is different from that in the *Methanobrevibacter oralis* found in living humans and the team were able to use a molecular clock approach to date the divergence between the two sub-species. This seems to have occurred between 112-143 ka ago, long after the divergence of Neanderthals and anatomically modern humans, judged to be around 450 to 750 ka ago. The authors suggest that '*commensal microbial species were transferred between the two hosts during subsequent interactions, potentially in the Near East*'. Two alternative 'interactions' occurred to one commentator: kissing or exchange of chewed food (Callaway, E, 2017. Plaque DNA hints at Neanderthal lifestyle. *Nature*, v. **543**, p. 163). Intriguingly the date, albeit imprecise, overlaps with estimates for the timing of Neanderthal – modern human interbreeding as the latter began to leave Africa: not only do living non-Africans share genes with Neanderthals, they may also share oral bacteria.

For more information on recent human evolution see here.

Denisovan(?) remains in a Chinese garden (*March 2017*)

On the edge of the small town of Lingjing near Xuchang City in Henan Province, China, local people have long practiced intensive vegetable gardening because the local soil is naturally irrigated by the water table beneath the flood plain deposits of the Yinghe River. In the mid 1960s they began to find dozens of small stone tools around a small spring, together with animal bones. Only in 2005, after the spring had stopped flowing, did systematic excavation begin (Li, Z.-Y. *et al*. 2017. Late Pleistocene archaic human crania from Xuchang, China. *Science*, v. **355**, p. 969-972; DOI: 10.1126/science.aal2482) About 3.5 m below the surface tools and bone fragments, including one with a carved representation of a bird, occurred just above the base of the modern soil profile. Radiocarbon dating of charcoal from the layer clustered around 13 500 years ago, just before the start of the Younger Dryas cooling episode; probably products of modern humans, although no human remains were found in the layer. Continued excavation penetrated sediments free of fossils and tools down to a depth of 8 m, when stone tools and bone fragments began to turn up again through the lowest 2 m of sediment. Optically stimulated luminescence (OSL) dating of mineral grains, which shows the last time that sediments were exposed to sunlight, produced much older dates between 78 to 123 ka. The thousands of stone flakes and cores, and cut marks on the animal bones found through the fossil-rich layer suggests that this was a site long used for tool making and food preparation, that had begun in the last interglacial period. Among the bones were fragments of the crania of as many as five individual humans.

Who were they? Their age range is tens of thousands of years before anatomically modern humans began to migrate into east Asia, so they are likely to have been an earlier human group. *Homo erectus* is known to have inhabited China since as early as 1.6 Ma ago and may be a possibility. The other possible group are the Denisovans, known only from their DNA in a small finger bone from a cave in eastern Siberia. Fragments of Denisovan DNA are famously present in that of many living indigenous people from eastern Asia, Melanesia and the Americas, but hardly at all in west Asians and Europeans. They also interbred with Neanderthals and may share a common ancestor with us and them, who lived about 700 ka ago.



Map showing the proportion of the genome inferred to be Denisovan in ancestry in non-Africans. The color scale ranges from black – 0, through greens – present to red – highest . (Credit: Sankararaman et al 2016; Fig 2a)

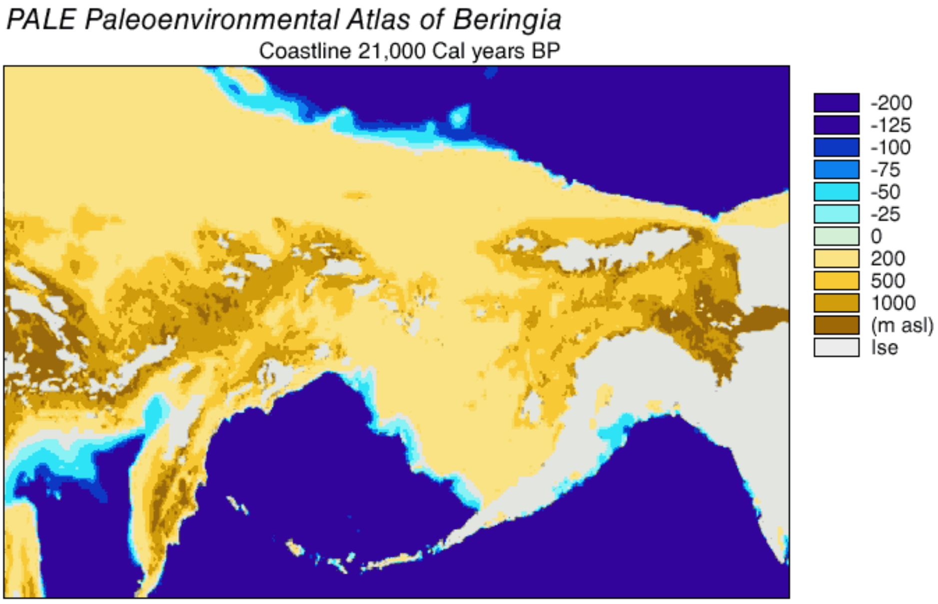
Unfortunately the human bones are completely fragmented and lack any teeth, jaw bones or elements of the face. However, the Chinese-US team used sophisticated computer refitting of CT-scanned fragments to reconstruct two of the crania, revealing one individual with prominent brow ridges and a flat-topped skull extended towards the back, similar to that of Neanderthals but with a much larger brain than *H. erectus*. The semi-circular canals associated with the ears, but used in balancing, are well preserved and also resemble those of Neanderthals. Yet east Asia has yielded not a single Neanderthal fossil. Could these be the elusive Denisovans? Even if more diagnostic bones turn up, especially teeth, such is the state of late hominin taxonomy that only DNA will provide definitive results: the Denisovans are defined entirely by DNA. The authors, perhaps wisely, do not speculate, but others may not be able to resist the temptation.

For more information on recent human evolution see here.

Related articles: Sankararaman, S. *et* al. 2016. The Combined Landscape of Denisovan and Neanderthal Ancestry in Present-Day Humans. *Current Biology*, v. **26**, p, 1241-1247; DOI: 10.1016/j.cub.2016.03.037. Gibbons, A. 2017. Close relative of Neandertals unearthed in China. *Science*, v. **355**, p. 899; doi: 10.1126/science.355.6328.899

Yukon colonised during Last Glacial Maximum (*March 2017*)

For many years anthropologists were certain that the Americas remained outside the human realm until the great ice caps of North America had begun to melt. This view stemmed partly from the only conceived route being across the exposed floor of the Bering Sea when sea-level had fallen to leave it as a landmass known as Beringia. The other literal stumbling block had been the glacial blockage of the only lowland corridor from Alaska to the Great Plains which roughly follows the Alberta – British Columbia border in Canada. There is abundant evidence that the corridor did not become ice-free until about 13 ka, an important fact that for a long while bolstered the Clovis-First hypothesis, from the eponymous and highly distinctive stone tools that date back to just after that time. Following a long rearguard action by its devotees that view was transcended by finds of earlier tools with dates as old as 15.5 ka that extend close to the southernmost tip of South America (see *Clovis-First hypothesis refuted* May 2011). Studies of Y-chromosome DNA from living First Nations men that suggested that all early Americans stemmed from 4 separate colonising populations who may have entered via Beringia by different routes, including along the Pacific coast (see *The origins of the first Americans* November 2013). A possible common ancestor of all Native Americans has turned up from the mitochondrial and Y-chromosome DNA of a fossil skeleton from near Lake Baikal in Siberia who lived about 24 ka ago. But yet another twist has emerged from the Yukon Territory of Northern Canada.



Beringia Land Bridge. Animation of its development since 21 000 BC. (Credit: NOAA)

Since 1987 it has been known that animal bones with clear signs of butchery occurred in the Bluefish Cave on the Yukon – Alaska border. Dating of the bones by the ^{14}C method seemed to support human occupation there during the Last Glacial Maximum; highly controversial at the time, in the absence of any other sites of that age in the whole Americas. The material has now been re-examined and dated by a more advanced radiocarbon method (Bourgeon, L. *et al*. 2017. Earliest human presence in North America dated to the Last Glacial Maximum: new radiocarbon dates from Bluefish Caves, Canada. *PLoS ONE*, v. **12**; DOI:10.1371/journal.pone.0169486). This work has confirmed the earlier view because the ages of bones range from 24 to 12 ka. But the discovery of what seems long-term occupation under the most arduous glacial conditions is not the only outcome of the research. One hypothesis for the genetic diversity among living indigenous people of the Americas is that their forebears, the first people of the Americas, may have been from genetically isolated populations stranded on Beringia, yet surviving eventually to migrate southward once climate warmed. The 'Beringian standstill hypothesis' suggest that the small population underwent genetic drift for about eight thousand years, their descendants inheriting the genetic diversity produced by this process. Bluefish Cave is probably where some of those pioneers waited-out the Ice Age.

Related article: The Bering Land Bridge Theory: Not Dead Yet (activehistory.ca)

Detecting the presence of hominins in ancient soil samples (*April 2017*)

Countless herbivores fertilise the soil of grassland by continual urination and defecation. A friend's sheep are doing just that in the small field that came with my current home, although they are keeping the grass under control. Millions of hectares of prime agricultural land in China are kept fertile through daily disposal of human night soil by 'honey wagons'; it is even fed to fishes in small ponds. Such a nice economy also donates the DNA of the animal and plant inhabitants to the soil system. In 2015 analysis of environmental DNA from permafrost in Siberia and Alaska produced 'bar codes' for the now vanished ecosystems of what was mammoth steppe during the climate decline to the last glacial maximum and the subsequent warming (see *Pleistocene megafaunal extinctions: were humans to blame?* August 2015). The study revealed DNA from mammoths and pre-Columbian horses and changes in the steppe vegetation, from which it was concluded that the steppe underwent regional extinction pulses of its megafauna linked to rapid climate ups and downs connected with Dansgaard-Oeschger cycles. It was but a small step to see the potential for studying distribution and timing of various hominins' occupation of caves from the soils preserved within them, without depending on generally very rare occurrences of human skeletal remains.

Tourists at the entrance to Denisova Cave, Russia (Credit: Wikipedia)

The Max Planck Institute for Evolutionary Anthropology in Leipzig, now famous for extracting DNA from Neanderthal, Denisovan and possibly *H. antecessor* fossils, has applied the environmental DNA approach to sediments from 7 caves in France, Belgium, Spain, Croatia and Russia that span the period from 550 to 14 ka (Slon, V. and 30 others 2017. Neandertal and Denisovan DNA from Pleistocene sediments. *Science*, v. **356** (online publication); DOI: 10.1126/science.aam9695). The sites had previously yielded fossils and/or artefacts. All of them contained mitochondrial DNA from diverse large mammals, four yielded archaic human genetic material supplied by Neanderthal individuals and Denisovans in the case of the Denisova cave. A key finding was Neanderthal mtDNA in one sedimentary layer that contained no skeletal remains – decay of a body was probably not involved. In two cases the DNA was from more than one individual. A variety of tests showed that surprisingly large quantities of DNA survive in soil and that it is spread evenly in sediment rather than being present in spots – an indication of derivation from urine, excreta or decayed soft tissue.

Although the study does not add to knowledge of hominin genetics, it confirms that the methodology is sufficiently advanced and efficient to detect hominin presence in fossil-free sediment. So this approach seems set to become a standard for many sites, such as that from California reported below, which suggest a human influence, or any cave sediments for that matter. Although skeletal remains are essential for reconstruction of bodily characteristics, hominin phylogeny may perhaps cut loose from fossils. Hitherto suspected species' presence in the time period where DNA analysis is feasible may be detected, such as Asian *H. erectus*. It may become possible to map or extend the geographic ranges of Denisovans and Neanderthals. Species new to science may emerge.

More on late Pleistocene hominin genetics here

Related articles: Wade, E. 2017. DNA from cave soil reveals ancient human occupants. *Science*, v. **356**, p. 363; DOI: 10.1126/science.356.6336.363. Ancient humans identified through DNA left in cave soil (cosmosmagazine.com)

Did pre-sapiens hominins reach North America? (*April 2017*)

Artist's impression of American mastodon. (credit: Wikipedia)

In 1991-2 palaeontologists excavated a site near San Diego, California where broken bones had been found. These turned out to be the disarticulated remains of an extinct mastodon. One feature of the site was the association of several large cobbles with bones of large limbs that seemed to have been smashed either to extract marrow or as source of tool-making material. The cobbles showed clear signs or pounding, such as loss of flakes – one flake could be fitted exactly to a scar in a cobble – pitted surfaces and small radiating fractures. The damage to one cobble suggested that it had been used as an anvil, the others being hammer stones. Broken pieces of rock identical to the hammer stones were found among the heap of bones. No other artefacts were found, and the bones show no sign of marks left by cutting meat from them with stone tools. The breakage patterns of the bones included spiral fractures that experimental hammering of large elephant and cow bones suggest form when bone is fresh. Other clear signs of deliberate breakage are impact notches and small bone flakes. Two detached, almost spherical heads of mastodon femora suggest that marrow was the target for the hammering and confirmed the breakage was deliberate.

Since the sediment stratum in which the remains occurred consists of fine sands and silt, typical of a low-energy river system, the chances that the cobbles had been washed into association with the mastodon are small. The interpretation of the site is that it was the result of opportunistic exploitation of a partial carcase of a young adult mastodon by humans. In the early 1990s attempts were made to date the bones using the radiocarbon method, but failed due to insufficient preserved collagen. That the site may have been much older than the period of known occupation of North America by ancestors of native people (post 14.5 ka) emerged from attempts at optically stimulated luminescence dating of sand grains that can suggest the age of burial. These suggested burial by at least 60 to 70 ka ago. It was only when the uranium-series disequilibrium method was used on bone fragments that the full significance of the site emerged. The results indicated that they had been buried at 130.7±9.4 ka (Holen, S.R. and 10 others 2017. A 130,000-year-old archaeological site in southern California, USA. *Nature*, v. **544**, p. 479-493; DOI: 10.1038/nature22065)

Not only is the date almost ten times that of the earliest widely accepted signs of *Homo sapiens* in the Americas, the earliest anatomically modern humans known to have left Africa are around the same age, but restricted to the Levant. The earliest evidence that modern humans had reached East Asia and Australasia through their eastward migration out of Africa is no more than 60 ka. The date from southern California is around the start of the interglacial (Eemian) before the one in which we live now. It may well have been possible then, as ~14 ka ago, to walk across the Bering Straits due to low sea level, or even by using coast-hugging boats – hominins had reached islands in the Mediterranean and the Indonesian peninsula certainly by 100 ka, and probably earlier. But whoever exploited the Californian mastodon marrow must have been cold-adapted to achieve such a migration. While the authors speculate about 'archaic' *H. sapiens* the best candidates would have been hominins known to have been present in East Asia: *H. erectus*, Neaderthals and the elusive Denisovans.

Surely there will be reluctance to accept such a suggestion without further evidence, such as tools and, of course, hominin skeletal remains. But these long-delayed findings seem destined to open up a new horizon for American palaeoanthropology, at least in California.

You can find more information on hominin migration here.

Related articles: Humans in California 130,000 Years Ago? Get the Facts (news.nationalgeographic.com); First Americans may have been Neanderthals 130,000 years ago (www.newscientist.com)

Homo naledi: an anti-climax (*May 2017*)

In September 2015 a barrage of publicity announced the remarkable unearthing of the remains of 15 diminutive hominins, dubbed *Homo nadeli*, from the floor sediments of an almost inaccessible South African cave, part of the equally hyped 'Cradle of Humankind' UNESCO World Heritage Site near Johannesburg (see *The star hominin of South Africa* September 2015). An international team of lithe women speleo-archaeologists was recruited for the excavation, for which the original discoverers were incapable because of their size. The remains included numerous examples of still articulated intricate bones, such as those of feet and hands, and none show signs of dismemberment by large scavengers. Indeed the discovery chamber was so far from the cave entrance that such animals probably were unaware of their presence. These features and the sheer complexity of the system strongly suggested that cadavers had been deliberately taken to the chamber; implying that the deep penetration had been accomplished using fire-brand illumination. What seized the headlines was the possibility of ritual burial, although sanitary disposal or panicked refuge from predators seem equally, if not more likely.

Lee Burger and the reconstructed skull of Homo *naledi*

Now yet more fossils have been reported from a separate chamber at a crawling distance about 150 m away from the original but closer to the system's main entrance (~85 m). These add at least other 3 individuals to the *H. nadeli* association, with sufficient similarity to indicate that all 18 belong to *H. naledi*. This wealth of detail enabled the team of authors (Hawks, J. and 37 others 2017. New fossil remains of Homo naledi from the Lesedi Chamber, South Africa. *eLife*, v. **6**, e24232; DOI: 10.7554/eLife.24232) to perform a detailed comparative anatomic analysis of the species. The results are a mosaic, showing some post-cranial affinities with australopithecines, *H. habilis*, *H.floresiensis*, *H. erectus*, Neanderthals and anatomically modern humans, and others, such as the hands and shoulders that are not well matched with other hominins. Their crania show a similar broad spectrum of resemblances, and as regards dentition they are distinctly primitive. They are also on the small-brained side of the hominin clade. Despite the astonishing abundance of fossil material, not a single artifact was found in the cave system, despite the apparent similarity of its hands to those of ourselves and Neanderthals.

With plenty of scope for speculation, *H. nadeli* remains enigmatic. The big question looming over the 2015 announcement of the species was its age, the discoverers suggesting about 2 Ma, and placing on the direct line of human descent. On the same day as the fossil description there appeared a multi-method dating analysis (Dirks, P.H.G.M. and 19 others 2017. The age of *Homo naledi* and associated sediments in the Rising Star Cave, South Africa. *eLife*, v. **6**, e24231; DOI: 10.7554/eLife.24231.001), which showed that, with little doubt, the *H. nadeli* association was deposited between 236 ka and 335 ka; around the time when anatomically modern humans first emerged and stone tools had undergone a >2 Ma technological evolution. To me, the only sensible conclusion at present is that *H. nadeli* is another addition to the 6 species living and in some cases coexisting across the late Pleistocene world, and that expansion of ideas beyond that must await DNA analysis; a definite possibility considering the age of the fossils, their seemingly good preservation in a relatively dry cave system and the new possibility of cave soils as well as bones yielding genetic materials. The leader of the research team, Lee Berger of the University of the Witwatersrand now maintains, together with four other members of the research team, that *H. nadeli* may be a coelacanth-like survivor of *Homo*'s earliest diversification and that '*we cannot exclude that this lineage was responsible for the production of Acheulean or Middle Stone Age tool industries*'.

Related article: Barras, C. 2017. Homo naledi is only 250,000 years old – here's why that matters. *New Scientist*, 6 May 2017 Issue

Origin of anatomically modern humans (*June 2017*)

How evolution proceeds and species arise are affected by many different processes. But, if members of every generation of the clade that led from the probable common ancestor of ourselves, Neanderthals, Denisovans and other hominins of the last 700 ka or so – widely thought to have been *Homo heidelbergensis* – were found as perfectly preserved fossils they would show gradually shifting anatomical features that diverge to distinct groups that anatomists would assign to different species. If, also, every specimen was accurately dated then the last part of the human evolutionary bush could be laid out in a 3-D graphic. That is never going to be possible. Human fossils are rare and there are few of them that are well-preserved. So the field of human origins throws up surprises on a regular basis. If palaeoanthropologists were more dogmatic than most of them actually are, there would be equally frequant, public displays of the eating of hats.

As regards early modern *H. sapiens*, fossils from a couple of sites in Ethiopia have been the oldest known for the last 15 years, at between 160 to 195 ka. However, in the 1960s quarry workers at Jebel Irhoud in SW Morocco exposed the infill of a cave network in which were found numerous items of the Levallois stone-tool technology, some human bone fragments that included a brain case and many dismembered and cut bones of prey animals. Initially they were thought to date from about 40 ka and to represent an African form of Neanderthals. Subsequently, re-evaluation of the remains revealed a greater likelihood that they were from modern humans, but too young to be of great interest. An upgraded date of ~160 ka caused them to be considered as peripheral to the core group of Ethiopian early modern humans.

DNA analyses have suggested modern humans to have split from Neanderthals about 500 ka ago. Members of the French-Moroccan team that did the original work at Jebel Irhoud, accompanied by other scientists, recently re-excavated the site and exhumed a much richer fossil haul that pin-pointed an anatomically modern human (AMH) provenance, albeit with some archaic characteristics (Hublin, J.-J. and 10 others, 2017. New fossils from Jebel Irhoud, Morocco and the pan-African origin of Homo sapiens. *Nature*, v. 546, p. 289-294; DOI: 10.1038/nature22336), which can be referred to as 'pre-modern' *H. sapiens*. The bombshell stemming from their work was the precise dating of the fossils and their stratigraphic context by other members of the team (Richter, D. and 11 others. The age of the hominin fossils from Jebel Irhoud, Morocco, and the origins of the Middle Stone Age. *Nature*, v. **546**, p. 293-296; DOI: 10.1038/nature22335), which yielded 315±34 ka from fire-heated flint fragments and 286±32 ka from a human tooth. Both dates are far older than the previously accepted maximum of 200 ka for AMH.

The early evolution of fully modern humans seems to have spanned the whole of Africa, rather than being set in an Ethiopian heartland, a view partly supported by a fragmentary 260 ka fossil from South Africa bearing close resemblance to the Moroccan individuals. Interestingly, Levallois stone tools, as their name suggests, are widespread in both Africa and Europe at around 300 ka, although that is not proof that AMH migrated out of Africa around 300 ka, for Neanderthals may also have been using a similar flint flaking method (another space to be watched).

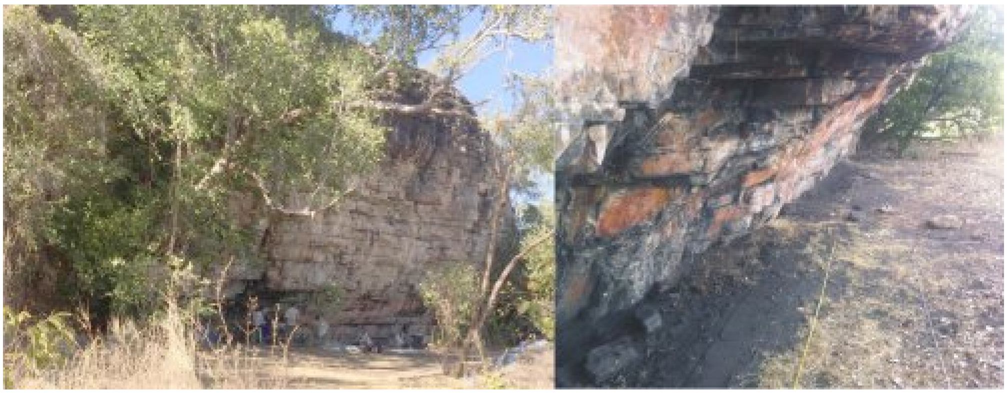
See also: Stringer C. & Galway-Witham, J., 2017. On the origin of our species. *Nature*, v. **546**, p. 212-215; DOI: 10.1038/nature 546212a.

Find more information on migration of modern humans.

New dates for earliest human occupation of Australia (*July 2017*)

When modern humans first reached Australia has an importance beyond the starting date for the island continent's archaeology and confirmation that their ancestors are the oldest known migrants from Africa. The first indigenous Australians carried within their genome important information about the minimum date at which some non-Africans interbred with more archaic Neanderthal and Denisovan humans, traces of whose DNA are present in that of living Australian aborigines. Most dating of when modern humans first reached different parts of the non-African world has relied on the radiocarbon method, which is suspect from beyond 40 to 45 ka as ^{14}C produced earlier has decayed to levels that are now below the practical limit of detection and measurement. It is therefore no accident that the bulk of 'first-arrival' dates for Eurasia and Australasia are around 45 ka. In fact, any accurate age, however old, for the earliest skeletal remains only indicates the minimum date of arrival until other remains are discovered.

Reliable dating of earlier events in the Pleistocene relies on other methods, the most important for settings other than speleothem from caves being optically stimulated luminescence (OSL) applied to soil minerals that estimates their time of burial. Briefly, molecules of soil grains made of a mineral such as quartz are 'charged-up' with energy by radiation emitted by unstable isotopes in the soil. Exposure to light releases that stored energy in the form of luminescence, so they lose it as quickly as it is induced unless the grains become buried. Measuring the amount of luminescence emitted by grains exposed to a strong light source therefore gives a measure of the time since they were buried and ceased to be exposed to sunlight.



The Madjedbebe rock shelter in Arnhem Land, Northern Territories, Australia. (Credit: Chris Clarkson, University of Queensland)

A re-evaluation of the Madjedbebe rock shelter in the Northern Territory, widely accepted as having yielded Australia's oldest artefacts in 1989, takes back human occupation more than 20 thousand years before previous estimates (Clarkson and 27 others 2017. Human occupation of northern Australia by 65,000 years ago. *Nature*, v. **547**, p. 306-310; DOI: 10.1038/nature22968). The soil profile at the Madjedbebe site turns out to be littered with artefacts – including hearths, tools and blocks of ochre and reflective mica pigments, plus remnants of plant foods – to a depth of ~2.5 m, with three particularly dense accumulations. Carbon-rich remains are also present throughout the profile which provided a means of accurate calibration and confirmation of OSL dates back as far as the radiocarbon method allows, giving confidence in the older OSL dates that extend to 65.0±5.7 ka in the earliest zone of dense artefact finds. Because the modern DNA of Australia's first native people shows no sign of mixture with other modern humans, this places the timing of modern human interbreeding with archaic people before this time. The age also predates the range when the continent's megafauna began to decline to eventual extinction, which supports the view that it was anthropogenic.

See also: Marean, C.W. 2017. Early signs of human presence in Australia. *Nature*, v. **547**, p. 285-287; DOI: 10.1038/547285a.

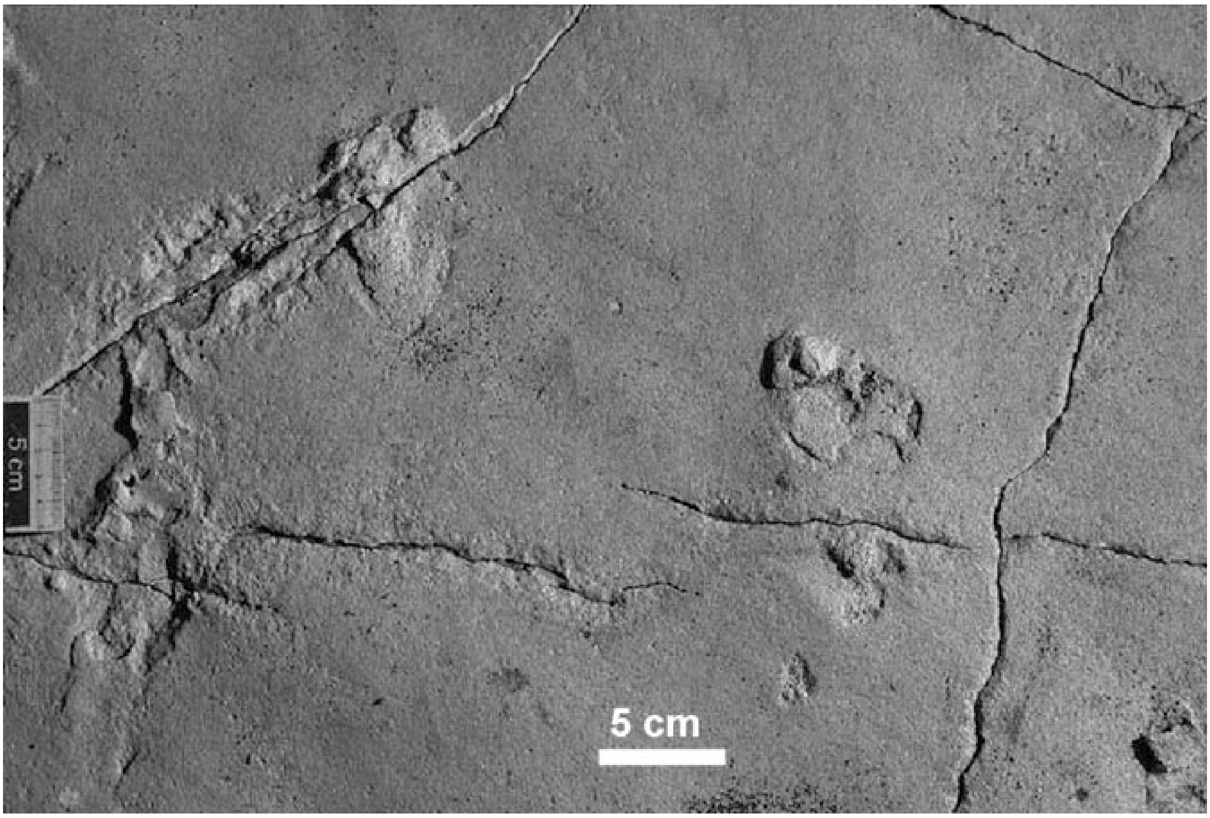
Early modern humans in Sumatra before the Toba eruption (*August 2017*)

In late July 2017 news emerged that modern humans first reached Australia at least 65 thousand years ago (see above). Confirming that the date of departure from Africa to end up in SE Asia and Australasia was considerable earlier than previously believed, deposits in Sumatra that contain remains of early *Home sapiens* have yielded even older ages (Westaway, K.E. and 22 others 2017. An early modern human presence in Sumatra 73,000–63,000 years ago. *Nature* v. **548** online; DOI: 10.1038/nature23452). This resulted from a re-examination of material from the Padang Caves first excavated more than a century ago by Eugène *Dubois,* famous for his discovery in Java of the first *H. erectus* remains. A richly fossiliferous breccia in the Lida Ajer cave yielded a fauna characteristic of a rainforest biome and included two teeth that Dubois considered to be human. Several later palaeontologists confirmed his identification as have hominin specialists in the present Australian-Indonesian-American-British-Dutch-German team. The fossil assemblage has long suggested great antiquity for the site, but only now has it been dated precisely. The dating employed three methods: optically stimulated luminescence dating of quartz grains from the breccia (85±25 to 62±5 ka); uranium-series dating of speleothem including fragments of hollow 'soda-straw' stalactites(84±1 to 71±7 ka); uranium-series dating of gibbon and orangutan teeth found together with the human teeth (86±13 to 76±7 ka). Statistical analysis of the age data suggests 73 to 63 ka for the fauna, with a maximum age for deposition of the breccia of 84±1 ka.

Stone tools which may have been carried by anatomically modern humans into the area have previously been used to suggest a minimum date of the arrival of migrants, though they may have been carried by *H. erectus.* Remarkably, such tools have been found beneath a thick bed of volcanic ash found throughout southern Asia and in Indian Ocean sediment cores. This has been dated at 71.6 ka and represents the explosive collapse of the caldera now containing Lake Toba in NW Sumatra that was the largest volcanic event in the entire history of the genus *Homo.* The new age data from Lida Ajer suggests that modern humans were present in its vicinity before the eruption, a view also supported by 'molecular-clock' dating of the range of mitochondrial DNA carried by living SE Asian people (79 to 75 ka). So, despite the stupendous magnitude of the Toba eruption is seems likely that some of the migrants survived (see *Could the Toba eruption have affected migrating humans* May 2013). Together with the dating of the earliest Australians, the Sumatran evidence is at odds with the view, widely held by palaeoanthropologists, that the 'Out of Africa' exodus began by crossing the Straits of Bab el Mandab between 74 and 58 ka when global sea-level fell markedly during marine oxygen-isotope Stage 4 (MIS4). A problem with that hypothesis has been that climatic and ecological conditions in southern Asia during MIS4 were unfavourable. But is seems that modern humans were already there and capable of adapting to both the climate shift and to the devastation undoubtedly caused by Toba.

Ancient footprints (*September 2017*)

To see traces of where our forebears walked, such as the famous *Australopithecus afarensis* trackway at Laetoli in Tanzania, the footprints of Neanderthal children in 350 ka old Italian volcanic ash (see *The first volcanologists?* March 2003) or even those of Mesolithic families in estuarine mud is about as heart stopping as it gets for a geologist or anthropologist. But imagine the astonishment of members of a multinational team working on Miocene shore-line sediments on Crete when they came upon a bedding surface covered with what are almost certainly the footprints of another bipedal animal from 5.7 Ma ago (Gierliński, G.D. *et al*. 2017. Possible hominin footprints from the late Miocene (c. 5.7 Ma) of Crete? *Proceedings of the Geologists' Association*, v. **128**, p. 697-710; DOI: 10.1016/j.pgeola.2017.07.006). Trackways preserve a few moments in time however old they are, and the chances of their being preserved are very small, yet they can supply information that is lost from even the best preserved fossil, such as gait, weight, speed and so forth.



Left and right footprints in Miocene sediments on Crete (Credit: Gierliński, *et al*. 2017; Fig. 8)

The tracks clearly indicate that whatever left them was bipedal and lacked claws, and closely resemble those attributed to *A. afarensis* at Laetoli in a 3.7 Ma old volcanic ash. What they do not resemble closely are those of non-hominin modern primates, such as chimpanzees. They are diminutive compared with adult modern human prints, being about 12.5 cm long (equivalent to a UK child' shoe size 4 – US size 4.5, EU 20) and about a third to half the size of those at Laetoli. Were they around the age of those at Laetoli or younger there seems little doubt that they would be widely interpreted as being of hominin origin. But being from an island in the Mediterranean as well as far from sites in Africa that have yielded Miocene hominins (*Ardipithecus kadabba* from Ethiopia*,* *Orrorin* from Kenya and *Sahelanthropus* from Chad), such an interpretation is bound to create controversy. Somewhat less controversial might be to regard them as having been created by a late-Miocene primate that convergently evolved a hominin-like upright gait and foot. Being preserved in what seem to be coastal marine sediments, there is probably little chance of body fossils being preserved in the exposed horizon. Since foot bones are so fragile, even if a primate fossil is discovered in the late Miocene of Crete the chances of resolving the issue are pretty remote. Yet fossil primate specialists will undoubtedly beat a well-trodden path to the Trachilos site near Kissamos on Crete

Neanderthal development (*September 2017*)

Despite the lingering public image that Neanderthals were not as bright as fully modern humans some had significantly larger brains than we do, albeit with most of the difference being in the rear part of the brain region. So they may have had different powers, such as enhanced vision and awareness of position (proprioception). Because there are few cranial fossils of immature Neanderthals and, for them, little evidence of ages, not much is known about how they developed from birth. A common assumption has been that because their brain was larger post-natal development must have been faster than in modern humans. Set against our slow post-natal development and the faster pace in chimpanzees this assumption has been used in support of limited Neanderthal cognitive abilities.

The El Sidron Neanderthal boy, including a reconstruction of his skull and brain cast. (Credit: Rosas *et al*. 2017; Fig. 1))

The El Sidron cave in Asturias region of northern Spain has yielded fossil remains of a dozen Neanderthals dated at between 49 and 37 ka, the time when anatomically modern humans were also present in Europe. They are among the best studied examples of this human group. Three were of boys, the best preserved of whom is estimated to have died at 7.7 years old from analysis of his dental development (Rosas, A. and 10 others 2017. The growth pattern of Neandertals, reconstructed from a juvenile skeleton from El Sidrón (Spain). *Science*, v. **357**, p. 1282-1287; DOI: 10.1126/science.aan6463) Analysis of signs of the maturation stage that he had reached, including that of his brain, show no fundamental difference from modern human juveniles in his overall pace of growth. Other workers have found that a similarly aged *Homo erectus* boy from Kenya had indeed developed more quickly than modern human juveniles.

It's not much to go on, but the El Sidron boy supports the view that Neanderthals were not much different from us.

Related article: DeSilva, J.M. 2018. Comment on "The growth pattern of Neandertals, reconstructed from a juvenile skeleton from El Sidrón (Spain)". *Science*, v. **359**, eaar3611; DOI: 10.1126/science.aar3611. Rosas, A. *et al*. 2018. Response

Human genetic archaeology roundup (*October 2017*)

Vindija cave near Varazdin in Croatia. (Credit: Tomislav Kranjcic, Flickr)

Work on Neanderthal genomes continues, as expected. The latest news comes from remains of a Croatian female, whose genome has been determined by a team led by members of the Max Planck Institute for Evolutionary Anthropology in Leipzig (Prüfer, K. and 35 others 2017. A high-coverage Neandertal genome from Vindija Cave in Croatia. *Science*, v. **358**, p. 655-658; DOI: 10.1126/science.aao1887). Her full genome is of higher quality than those previously published for Neanderthals. Dated at around 52 ka, her genetics is likely to be closer to those who mated with the ancestors of modern Eurasians. Kay Prüfer and his colleagues suggest that Neanderthals passed on to modern Eurasians genes associated with plasma levels of LDL cholesterol and vitamin D (mainly produced by skin exposure to sunlight, Vitamin D is essential for healthy bones and supports the immune system), together with risk factors for eating disorders, accumulation of visceral fat, rheumatoid arthritis and schizophrenia. Two other interesting possibilities stem from reconsidering genetic data from other Neanderthals, in the light of the new Croatian analysis. Ancestors of an older Neanderthal (122 ka) from the Altai region of Siberia had interbred with genetically modern humans as long ago as 130 ka. Yet the genomes of the Altai and Croatian Neanderthals are surprisingly similar, suggesting that both lived in isolated small groups around three thousand strong (Gibbons, A. 2017. Neanderthal genome reveals greater legacy in the living. *Science*, v. **358** p. 21; DOI: 10.1126/science.358.6359.21}).

Also published on-line by *Science* is a study of the genomes of 7 individual anatomically modern humans from KwaZulu-Natal in South Africa (Schlebusch, C.M. and 11 others 2017. Southern African ancient genomes estimate modern human divergence to 350,000 to 260,000 years ago. *Science* online; DOI: 10.1126/science.aao6266). They are three 2000 year-old hunter-gatherers (probably San) and four Iron Age farmers, similar to modern Bantu speakers, from 300 to 500 years ago. Although genomes from modern Khoe-San suggest up to 30% admixture from East Africans and Eurasians, comparison between the two ancient groups suggest a very old divergence among African anatomically modern human (AMH) populations, of the order of 350 to 260 ka ago. This is long before the remains from Ethiopia, widely accepted as the oldest known AMH (190 ka), but roughly the same as recently described fossils from Jebel Irhoud in Morocco (325 to 286 ka) reckoned to be early AMH (see *Origin of anatomically modern humans* above). The Moroccan humans and now the genetic analysis from much more recent South African skeletons point to a pan-African early evolution of modern people rather than some kind of 'cradle of humanity'.

Adult male in a 28 to 30 ka burial at Sunghir, Russia. (Credit: J-M.B. Álvarez)

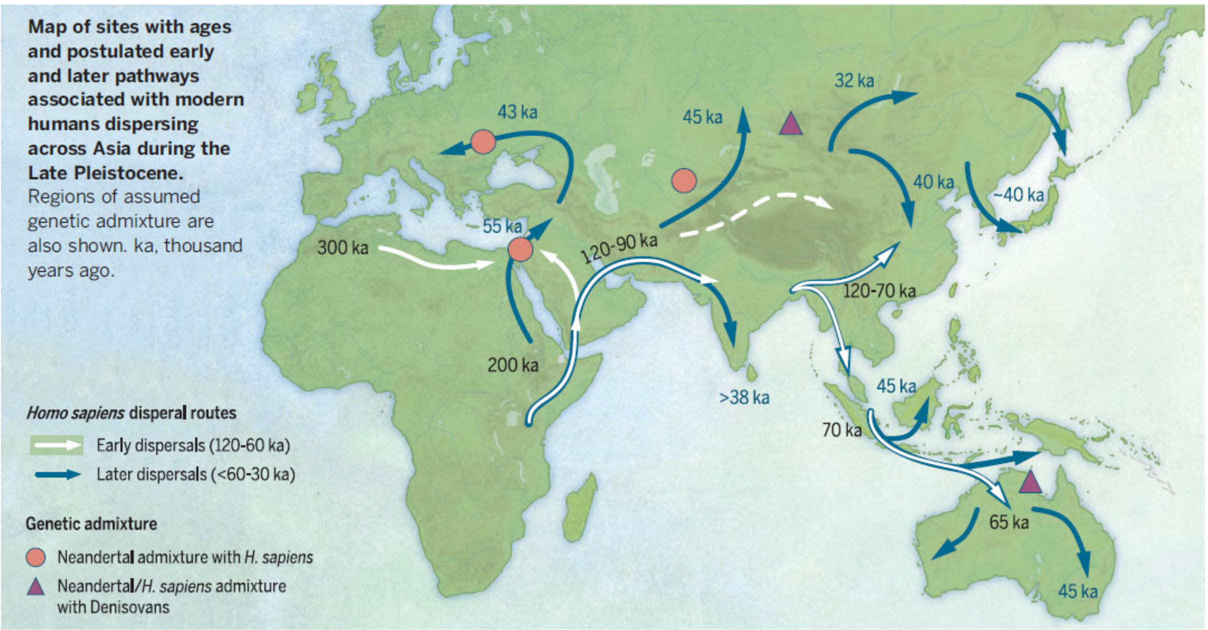
More ancient AMH hunter-gatherers (~28 to 30 ka) occur at Sunghir, about 200 km east of Moscow, a settlement that includes several burials – one of which contained a boy and a girl – many with abundant, ornate grave goods. It seems likely that all the interred individuals were related and so an excellent target for DNA analysis. Four individuals with roughly the same ^{14}C age did yield enough for genome sequencing (Sikora, M. and 26 others 2017. Ancient genomes show social and reproductive behavior of early Upper Paleolithic foragers. *Science*, v. **358**, eaao1807; doi: 10.1126/science.aao1807). It turned out from their mtDNA that none were more closely related than first-cousins or great-grandchildren. The data suggested a relatively small breeding population (~300) that avoided inbreeding and its often negative consequences, possibly through exogamy (a wide mating network) as practiced by living hunter-gatherers. Remarkably, the data also hinted at relationship with earlier (36 ka) individuals from Kostenki about 300 km to the south-west. DNA from several Siberian Neanderthal individuals does suggest that inbreeding had been an issue. Had it been widespread among Neanderthals – risky to infer from such scanty information – that may account for their lack of competitiveness with AMH and eventual demise.

Early human dispersal through Asia (*December 2017*)

When first mooted, the Out of Africa model for the spread of anatomically modern humans (AMH) centred on a single exodus from African to Eurasia, which researchers broadly agreed to have occurred about 60 thousand years ago. That was when an advance of continental glaciers and a corresponding fall in sea level narrowed the obstacle presented by the Red Sea to manageable proportions. The only archaeological drawback was that AMH had occupied the Levant at around 110 ka. That was formerly considered to have been a temporary occupation corralled by hyperarid conditions immediately to the east and a mountain barrier to the north, with the Mediterranean Sea to the west. Yet, during humid periods there was every chance that the eastern barrier would occasionally have been permeable. Accepting the 60 ka model for a complete break-out was a conservative view, alternatives being stifled by a lack of high-quality dates for scattered suggestions of an Asian AMH presence, such as occurrences of stone tools resembling those of early moderns and even rarer, incomplete and often ambiguous skeletal remains. ‘Modern-looking’ tools that occurred both above and below the 74 ka Toba ash deposit in southern India were disposed of as ‘advanced’ tools of earlier migrants; such as *Homo erectus*. In retrospect, the established fact of earlier occupation of Eurasia by such ‘primitive’ African migrants, as long ago as ~1.8 Ma in the case of *Homo* fossils in Georgia, should have encouraged the view that culturally better-endowed AMH would have had fewer problems in diffusing eastwards once they found an escape route from Africa.

Whatever, the flurry during the last couple of decades of more skeletal and archaeological remains of AMH in Asia, genetic evidence for their interbreeding in the west and east with earlier human groups and, principally, improvements in dating ancient sites suggests a more complex geographic flow. Christopher Bae of the University of Hawaii and colleagues based in the UK, Germany and the US have reviewed this growing wealth of new data to put forward various scenarios for Out of Africa dispersal through Asia (Bae, C.J. *et al*. 2017. On the origin of modern humans: Asian perspectives. *Science*, v. **358**, p. 1269 (summary); online full paper DOI: 10.1126/science.aai9067). They highlight growing evidence for at least one pre-60 ka dispersal, and possibly several, to reach the Levant, Arabia, India, China, Laos, Indonesia, the Philippines and Australia before that date. This tallies with Neanderthal and Denisovan DNA segments within the genomes of living Eurasians that indicate interbreeding before 60 ka.

Bae and colleagues also assemble data that bear on where AMH managed to move out of Africa. They resolve the dispute between routes around the northern shores of the Red Sea and crossing the southern Straits of Bab el Mandab by concluding, quite logically, ‘why not both’. Where the migrations went to is currently suggested by the distribution of sites that reveal either pre- or post-60 ka occupancy. The earlier dispersals may have been dominated by following coastlines along the Mediterranean in North Africa to the Levant and via Bab el Mandab across the Persian Gulf, along the northern Indian Ocean littoral to south-east and east Asia. The later, more ‘adventurous’ movements using both routes led to Europe and deeper into continental Asia and thence to its north east.



Possible dispersal paths for AMH migration from Africa (Credit: Bae *et al*. 2017)

The review conveniently covers in seven pages much the same geoarchaeological and anthropological ground as these diaries have visited bit-by-bit as it has unfolded since 2000. Clearly, great swathes of Asia have not been explored by palaoanthropologists. As in most geographic sciences there is a tendency to follow up known sites year after year – often decade after decade – to ensure publishable results, and that will consume lots of economic and human resources. It is more risky to try and fill in the gaps, but that basic field work is urgently needed to supply new material.