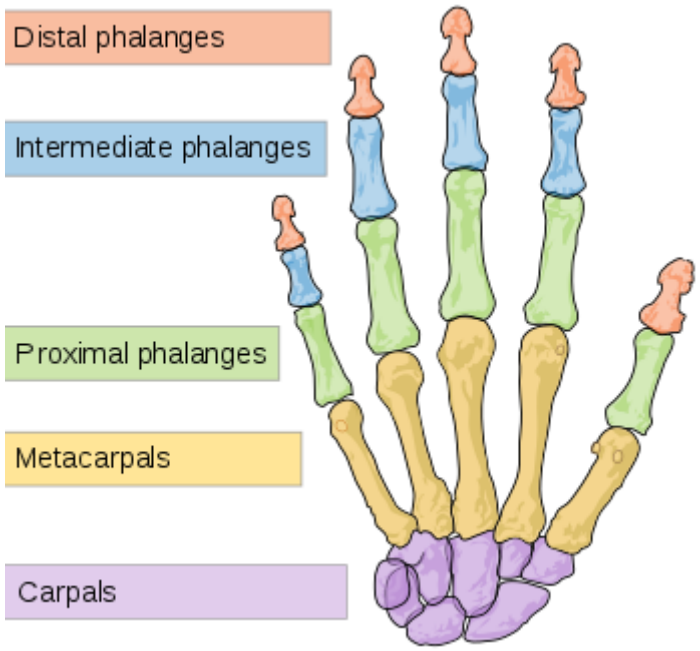
Human evolution and migrations

Convincing, indirect evidence for early toolmakers (*February 2015*)

A surprising number of animals pick up items from their surroundings and use them, mainly to get at otherwise inaccessible foodstuffs. What sets humans apart from such tool users is that we *make* them and for a long time part of our repertoire has been tools used to make other tools; effectively 'machine tools'. An example is a piece of antler used to pressure-flake flint to give a stone blade a better edge, a more recent one is the increasing use of robots on assembly lines. Making a tool is impossible for a bird with only its beak and ill-adapted feet, while even a chimpanzee lacks various forms of grip needed for precisely directed force and manipulation. It was Frederick Engels who first focussed on the importance of the hand being freed to evolve the capacity for manual labour by the permanent adoption of an upright posture and gait, in his essay *The Part Played by Labour in the Transition from Ape to Man* written in 1876.

The earliest tools known turned up in 2.6 Ma old sediments at Gona in NE Ethiopia, while evidence for tool use is well accepted from cracked and sliced bones found in sediments dated at 2.5 Ma from Bouri in the same region near to finds of *Australopithecus garhi*. In neither case can the finds be tied to fossil remains of the makers and users, the earliest direct link emerging from famous Olduvai Gorge in western Tanzania, where crude Oldowan tools and worked bones occur with incomplete remains of a hominin, dubbed *Homo habilis* ('handy man') because of this association. Somewhat more controversial are bones that show cuts and scrape marks plus signs of having been cracked open that were found in a 3.4 Ma context at Dikika, also in Ethiopia, within the same sedimentary horizon as the young *Australopithecus afarensis* known as Selam ('Peace'). The Dikika material is little different from 0.9 to 1.2 Ma younger bones at Bouri and Olduvai: the controversy seems to stem more from its much greater age and association with hominins deemed by some to have been incapable of creating tools.



Bone structure of the (right) human hand

An entirely novel approach to the issue of the first tools and their makers, which no doubt would have tickled Engels no end, is a careful anatomical and physiological examination of fossil hominin hand bones in comparison with those of chimps and living humans (Skinner, M.M. *et al*. Human-like hand use in Australopithecus africanus. *Science*, v. **347**, p. 395-399; DOI: 10.1126/science.1261735). The bones being scrutinized are the five metacarpals that form the links in the palms from muscles of the forearm to finger and thumb movements and thus to various kinds of grip. In humans there are a host of ways of gripping objects from the precision of opposed thumb and finger pinching, especially that using the forefinger, to the squeezing power grip that wraps thumb and all fingers around an object and makes a fist. The best a chimp can do is grabbing a branch, to which its knuckle-walking hands are well adapted. The tips of the metacarpals are mechanically loaded according to the types of grip used repeatedly in life and that works to modify the physical density of the tips' spongy bone tissue in patterns that vary according to habitual usage of the hand and its digits. This new approach is reputedly far more diagnostic than the actual shape of metacarpal bones, and requires high-resolution CT scanning.

Known early human and Neanderthal tool-makers show very similar patterns: in fact they suggest far more heavy loading through various kinds of grip than the metacarpals of humans from the modern period. In 1.8 to 3.0 Ma old *A. africanus* and *Paranthropus robustus* (a gorilla-like but bipedal australopithecine) from South Africa metacarpals suggest that both were habitually using a tree-climbing grip, much as chimpanzees do, but more closely resembled modern human and Neanderthal committed tool users. Both were certainly capable of using forceful precision grips to make and use tools up to 0.5 Ma earlier than the date of the earliest known tools. So far the technique has not been applied to the palm bones of earlier hominins such as *A. afarensis* (2.9-3.9 Ma) and *Orrorin tugenensis* (~6 Ma). Despite the suggestion of tool-making *capability*, agreeing that it did take place in non-*Homo* hominins must await finds of tools, as well as signs of their use, in close association with fossil remains of their makers. The Dikika association is simply not enough. Yet, some bipedal being must have made tools before the date of the earliest ones (~2.6 Ma) discovered at Gona. Look at it this way: it is a lucky archaeologist who discovers every piece of evidence for a fundamental social change at one site. The fact that the vast bulk of Pliocene and Pleistocene sediments that may contain the key evidence is either buried by younger material or was a victim of erosion, means that the chance of resolving the origin of the fundamental feature of human behaviour is tiny. The chance that scientists will continue looking is astronomically higher.

Human-Neanderthal cohabitation of the Levant (*February 2015*)

The earliest known remains of anatomically modern humans outside of Africa were unearthed from the Skhul and Qafzeh caves in what is now northern Israel. Their context was that of deliberate burial at a time when climate was cooling from the last interglacial, between 90 to 120 ka. The Levant was also the repository for a number of well-preserved Neanderthal skeletons, most dating to between 35-65 ka, including ten individuals at Shanidar in today's northern Iraq. Some of them were also deliberately buried, including one whose grave reputedly contained evidence for a floral tribute. The 25 ka gap between the two populations has previous been regarded as evidence for lack of contact between

them. However, the Tabun Cave in modern Israel has yielded tools attributed to the Neanderthal Mousterian culture that may indicate their intermittent presence from 200 to 45 ka, and fossils of two individuals dated at ~122 and ~90 ka. The remains at Skhul and Qafzeh are significantly more rugged or robust than African contemporaries and have been considered possible candidates for Neanderthal-modern human hybrids. But whatever their parentage, it seems they became extinct as the climate of the Levant dried to desert conditions around 80 ka.

Entrance to the Shanidar Cave, northern Iraq, occupied by Neanderthals between 35-65 ka (credit: Wikipedia)

A more promising overlap between modern human and Neanderthal occupation comes with the discovery by a group of Israeli, US, Canadian, German and Austrian scientists of a much younger anatomically modern human cranium from the Manot Cave, also in northern Israel (Herschkovitz, I. and 23 others 2015. Levantine cranium from Manot Cave (Israel) foreshadows the first European modern humans. *Nature*, v. **520**, p. 216-219; DOI: 10.1038/nature14134). The cranium has a U-Th radiometric age of ~55 ka, well within the time span of Neanderthal occupation. Moreover, Manot Cave is one of a cluster of occupied sites in northern Israel, with separations of only a few tens of kilometres: undoubtedly, this individual and companions more than likely met Neanderthals. The big question, of course, is did the neighbours interbreed? If so the Levant would be the confirmed as the probable source of hybridisation to which the DNA of non-African living humans points. There may be an insuperable difficulty in taking this further: it is thought that the high temperatures of the region, despite its dryness, may have destroyed any chance of reconstructing ancient genomes. Yet one of the first Neanderthal bones to yield useful genetic material was from Croatia, which is not a great deal cooler in summer.

Wet spells in Arabia and human migration (*March 2015)*

In *Arabia: staging post for human migrations?* (September 2014) I reported how remote sensing had revealed clear signs of extensive fossil drainage systems and lakes in what is now the hyper-arid Empty Quarter (Rub al Khali) of the Arabian Peninsula. Their association with human stone artefacts dated as far back as 211 ka. Those with affinities to collections from East Africa cluster between 74-90 ka and support the sub-continent possibly having been an early staging post for fully modern human migrants from Africa. Member of the

same archaeological team based at Oxford University have now published late Pleistocene palaeoclimatic records from alluvial-fan sediments in the eastern United Arab Emirates that add detail to this hypothesis (Parton, A. *et al*. 2015. Alluvial fan records from southeast Arabia reveal multiple windows for human dispersal. *Geology*, v. **43**, p. 295-298; DOI: 10.1130/G36401.1).

The eastern part of the Empty Quarter is a vast bajada formed from coalesced alluvial fans deposited by floods rising in the Oman Mountains and flowing westwards to disappear in the great sand sea of dunes. Nowadays floods during the Arabian Sea monsoons are few and far between, and mostly restricted to the east-facing mountain front. Yet, older alluvial fans extend far out into the Empty Quarter, some being worked for aggregate used in the frantic building boom in the UAE. In one of the quarries, about 100 km south of the Jebel Faya Upper Palaeolithic tool site (see *Human migration: latest news* March 2011), the alluvial deposit contains clear signs of cyclical deposition in the form of 13 repeated gradations from coarse to fine waterlain sediment, each capped by fossil soils and dune sands. The soils contain plant remains that suggest they formed when the area was colonized by extensive grasslands during humid conditions.

Dating the sequence reveals that 6 of the cycles formed over a 10 thousand-year period between 158 to 147 ka, which coincides with a peak in monsoon intensity roughly between 160 and 150 ka during the glacial period that preceded the last one. Three later cycles formed at times of monsoon maxima during the last interglacial and in the climatic decline leading to the last glacial maximum, at ~128 to 115 ka, 105 to 95 ka, 85 to 74 ka. So, contrary to the long-held notion that the Arabian Peninsula formed a hostile barrier to migration, from time to time it was a well watered area that probably had abundant game. Between times, though, it was a vast, inhospitably dry place.

Jebel Faya in the United Arab Emirates (Credit: A. Parton, Oxford Brookes University)

The authors suggest that the climatic cyclicity was dominated by a 23 ka period. As regards the southern potential migration route out of Africa, via the Straits of Bab el Mandab, which has been highly favoured by palaeoanthropologists lately, opportunities for migration in the absence of boats would have depended on sea-level lows. They do not necessarily coincide with wet windows of opportunity for crossing the cyclically arid Arabian peninsula that would allow both survival and proceeding onwards to south and east Asia. So far as I can judge, the newly published work seems to favour a northward then eastward means of migration, independent of fluctuations in land-ice volume and sea level, whenever the driest areas received sufficient water to support vegetation and game. In fact most of NE Africa is subject to the Arabian Sea monsoons, and when they were at their least productive crossing

much of Ethiopia's Afar depression and the coastal areas of Eritrea, Sudan and Egypt would have been almost as difficult as the current challenge of the Empty Quarter.

Genus Homo pushed back nearly half a million years (*March 2015*)

Bill Deller, a friend whose Sundays are spent reading the Observer and Sunday Times from cover to cover, alerted me to a lengthy article by Britain's doyen of paleoanthropologists Chris Stringer of the Natural History Museum. (Stringer, C. 2015. First human? The jawbone that makes us question where we're from. *Observer*, 8 March 2015, p. 36). Stringer's piece sprang from two Reports published online in *Science* that describe about 1/3 of a hominin lower jaw unearthed from the Afar Depression of Ethiopia. The discovery site of Ledi-Geraru is a mere 30 km from the most hominin-productive ground in Africa: Hadar and Dikika for *Australopithecus afarensis* ('Lucy' at 3.2 Ma and 'Selam' at 3.3 Ma, respectively); Gona for the earliest-known stone tools (2.6 Ma); and the previously earliest member of the genus *Homo*, also close to Hadar.

On some small objects mighty tales are hung, and the Ledi-Geraru jawbone and 6 teeth is one of them. It has features intermediate between *Australopithecus* and *Homo*, but more important is its age: Pliocene, around 2.8 to 2.75 Ma (Villmoare, B. And 8 others. Early Homo at 2.8 Ma from Ledi Geraru, Afar, Ethiopia. *Science*, v. **347**, p. 1352-1355; DOI: 10.1126/science.aaa1343). The sediments from which Ethiopian geologist Chalachew Seyoum of Arizona State University, extracted the jawbone from floodplain sediments. Other fossils suggest open grassland rich with game, similar to that of the present Serengeti in Tanzania, with tree-lined river courses. The sediments were laid down at a time of climatic transition from humid to more arid conditions that several authors have suggested to have provided the environmental stresses that drove evolutionary change, including that of hominins (DiMaggio, E.N. and 10 others 2015. Late Pliocene fossiliferous sedimentary record and the environmental context of early Homo from Afar, Ethiopia. *Science*, v. **347**, p. 1355-1359; DOI: 10.1126/science.aaa1415).

Designating the jawbone as evidence for the earliest known member of our genus rests almost entirely on the teeth, and so is at best tentative awaiting further fossil material. The greatest complicating factor is that the earliest supposed fossils of *Homo* (i.e. *H. habilis, H rudolfensis* and others yet to be assigned a species identity) are a morphologically more mixed bunch than those younger than 2 Ma, such as *H. ergaster* and *H. erectus*. Indeed, every one of the fossils has some significant peculiarity. That diversity extends to the earliest humans to have left Africa, found in 1.8 Ma old sediments at Dmanisi in Georgia (*Homo georgicus*), where each of the 5 well-preserved skulls is unique. The Dmanisi hominins have been likened to the type specimen of *H. habilis*, but such is the diversity of both that is probably a shot in the dark.

The Ledi-Geraru jawbone (Credit: Kay Reed).

Coinciding with the new Ethiopian hominin papers a study was published in *Nature* the same week that describes how the type specimen of *H. habilis* (found, in close association with crude stone tools and cut bones, by Mary and Lewis Leakey at Olduvai Gorge, Tanzania in 1960) has been digitally restored from its somewhat deformed state when found (Spoor, F. *et al*. 2015. Reconstructed *Homo habilis* type OH 7 suggests deep-rooted species diversity in early *Homo*. *Nature*, v. **519**, p. 83-86, DOI: 10.1038/nature14224). The restored lower jaw and teeth, and part of its cranium, deepened the mysterious diversity of the group of fossils for which it is the type specimen, but boosts its standing as regards probable brain size from one within the range of australopithecines to significantly larger –~750 ml compared with <600 ml – about half that of modern humans. The *habilis* diversity is largely to do with jaws and teeth: it is the estimated brain size as well as the type specimen's association with tools and their use that elevates them all to human status. Yet, the reconstruction is said by some to raise the issue of a mosaic of early human species. The alternative is an unusual degree of shape diversity (polymorphism) among a single emerging species, which is not much favoured these days. An issue to consider is: what constitutes a species? For living organisms morphological similarity has to be set against the ability for fertile interbreeding. Small, geographically isolated populations of a single species often diverge markedly in terms of what they look like yet continue to be interfertile, the opposite being convergence in form by organisms that are completely unrelated.

Palaeontologists tend to go largely with division on grounds of form, so that when a specimen falls outside some agreed morphological statistics, it crosses a species boundary. Set against that the incontrovertible evidence that at least 3 recent human species interbred successfully to leave the mark in all non-African living humans. What if the first humans emerging from, probably, a well-defined population of australopithecines continued to interbreed with them, right up to the point when they became extinct about 2 Ma ago?

On a more concrete note, the Ledi Geraru hominin is a good candidate for the maker of the first stone tools (see *Convincing, indirect evidence for early toolmakers* above) found 'just down the road' at Gona!

Related articles: Oldest human fossil found, redrawing family tree (jnationalgeographic.com); The skull that chews up theories of human ancestry (newscientist.com)

Stone tools go even further back (*May 2015*)

Shortly after it seemed that the maker of the earliest stone tools (2.6 Ma) may have been *Australopithecus africanus*, thanks to a novel means of analyzing the capabilities of hominin hands, some primitive tools have turned up from even earlier times (Harmand, S. and 20 others 2015. 3.3-million-year-old stone tools from Lomekwi 3, West Turkana, Kenya. *Nature*, v. **521**, p. 310-315; DOI: 10.1038/nature14464). Their age is comparable with that (3.4 Ma) of animal bones from Dikika, Ethiopia that show cut marks and signs of deliberate breaking, which had previously been controversial as they suggested that local *Australopithecus afarensis* of a similar age had made them. What the authors claim to be '*a new beginning to the known archaeological record*' almost a million years earlier than the first appearance of Homo fossils in the Lake Turkana area also seems to point in that direction. But *A. afarensis* has not been found in that area, although a hominin known as *Kenyanthropus platyops* with roughly the same age as the tools has.

Almost 150 fine-grained basaltic artefacts turned up at the Lomekwi site, which may have been where knappers habitually worked as many of them were fragments or debitage. The cores from which flakes had been struck are large, weighing on average 3.1 kg. It seems that the tool makers may have been forcefully pounding out edged tools for a variety of uses, unlike the single-use hammer stones used by chimpanzees today. Compared with the well known Oldowan tools, however, these are cruder and made by a different knapping technique that seems not to have focused on exploiting the conchoidal fracturing that produces the sharpest tools and is a feature of the later Oldowan tools.

Oldowan 'chopper' from Melka Kunture, Ethiopia. (credit: Wikipedia)

Frederick Engels, whose 1876 essay *The Part played by Labour in the Transition from Ape to Man* was among the first works to take Darwin's ideas on human origins forward, would have had a field day with the new evidence. For him the vital step was freeing of the hands by a habitual bipedal gait and their manipulation of objects – together with changes to the hands that would arise by such a habit. What the first tool maker looked like, doesn't really matter: the potential that act conferred was paramount. Nevertheless, there is a big step between early hominins and humans, from relatively small brains to those of *H. erectus* that were on the way to modern human capacity. The Lomekwi tools and the improved Oldwan

artefacts spanned 1.7 Ma at least before *H. erectus* revolutionised manufacture to produce the bi-facial Acheulian hand 'axe', and going beyond that took almost a million years of little change in both tools and anatomy until the emergence of archaic modern humans.

Note added 28 May 2015: Within a week palaeoanthropologists' focus shifted to the Afar Depression in Ethiopia where a new species of hominin has emerged from Pliocene sediments dated to between 3.3 and 3.5 Ma (Haile-Selassie, Y *et al*. 2015. New species from Ethiopia expands Middle Pliocene hominin diversity. *Nature*, v. **521**, p. 483-488. DOI: 1038/nature14448). *Australopithecus deyiremeda* is represented by fragments of two lower- and one upper jaw plus several other lower facial specimens. So the species is differentiated from other hominins by dentition alone, but that is unmistakably distinct from extensive data on *Au. afarensis* which lived within a few kilometres over the same period. Until the last 15 to 20 years it was thought that *Au. afarensis* was the sole hominin around in the Middle Pliocene of East and Central Africa, but now it seems there may have been as many as five, the three mentioned above, plus *Au. bahrelghazali* from Chad and an as yet undesignated fossilised foot from Afar. For possibly three closely related species to coexist in Afar is difficult to understand: perhaps they occupied different niches in the local food web or employed different strategies (Spoor, F. 2015. The middle Pliocene gets crowded. *Nature*, v. **521**, p. 432-433; DOI: 10.1038/521432a). But did they all make and use tools? For the Lomekwi tools *K. platyops* is a candidate, but for the cut marks on bones at Dikika in Afar there are at least two: *Au. afarensis* and *Au. deyiremeda.* So multiple tool makers living at the same time suggests some earlier originator of the 'tradition'.

Note added 4 June 2015: Add southern Africa into the equation and there is yet more breaking news about coeval hominin diversity. US, Canadian, South African and French collaborators have finally started to resolve the achingly complex stratigraphy of the fossil-rich Sterkfontein cave deposits in South Africa by using a novel approach to estimating ages of materials' last exposure to cosmic rays (Granger, D.E. *et al*. 2015. New Cosmogenic burial ages for Sterkfontein member 2 Australopithecus and Member 5 Oldowan. *Nature*, v. **522**, p. 85-88; DOI: 10.1038/nature14268). Specifically, they managed to date the tumbling into a deep sinkhole of a recently found, almost complete skeleton of an australopithecine. It still resembles no other some 70 years after a less complete specimen was found by Raymond Dart in the mid 1940s. It was first informally dubbed 'Little Foot' and then *Au. prometheus* and up to now has been regarded as an odd contemporary of 2.2 Ma old *Au. africanus*. The new dating gives an age of about 3.7 Ma: so at least 6 hominids occupied Africa in the Middle Pliocene. It is beginning to look like a previously unsuspected time of sudden diversification.

Related articles: Oldest tools pre-date earliest humans (bbc.com)**;** Who were the mysterious species who used the world's oldest tools? (ibtimes.co.uk)**;** New human ancestor species from Ethiopia lived alongside Lucy's species (phys.org)

The 'star' hominin of South Africa (*September 2015*)

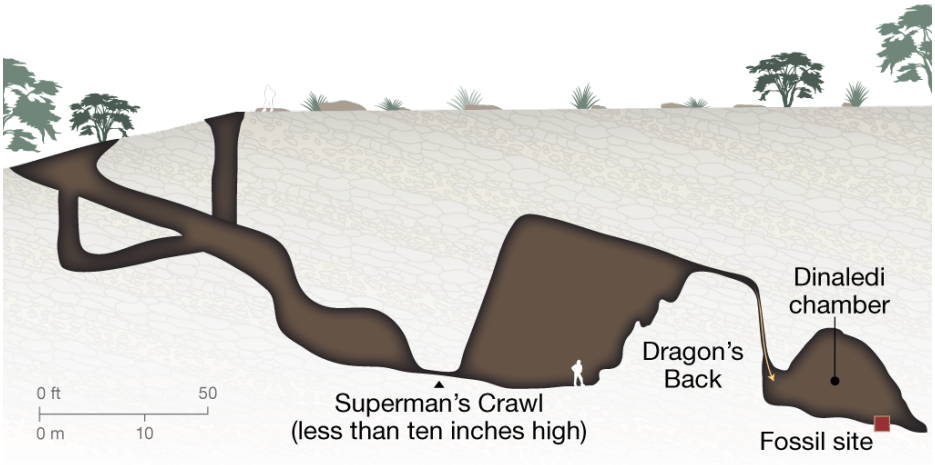
The week of 7 to 11 September 2015 was one of the most news-rich of the year. To name but two issues: the plight of tens of thousands of refugees fleeing Africa and the Middle East to Europe was made worse by total confusion, little action and downright obstruction by some of the most privileged governments on Earth; in Britain one of the most exciting political dramas in decades – the leadership elections of the Labour Party – were reaching a

climax of press and political skulduggery because of the unexpected direction both had taken. Something else burst onto the media scene that was, if anything, even more out-of-the-blue to the majority of people on Thursday 10 September: the remains of at least 15 individuals of a new hominin species found in a near-inaccessible cave were announced by a multinational team of geologists and anthropologists. The feature that ensured its wide publicity in competition with some pretty serious political and humanitarian developments was the suggestion that the corpses had been ritually laid to rest by beings that lived maybe 2 million years ago. This major scientific stir arose from the publication of two lengthy papers by the open-access, electronic journal *eLife* (Berger, L. R. and 46 others 2015. *Homo naledi, a new species of the genus Homo from the Dinaledi Chamber, South Africa*. *eLife* DOI: 10.7554/eLife.09560. Dirks, P.H.G.M. and 23 others 2015. Geological and taphonomic context for the new hominin species *Homo naledi* from the Dinaledi Chamber, South Africa. *eLife,* DOI: 10.7554/eLife.09560).

Artist's reconstruction of the face of Homo naledi (Credit: John Gurche artist, Mark Thiessen photographer, National Geographic)

Homo naledi (naledi means 'star' in the Sotho language: the find was in the Rising Star cave system near Johannesburg) is known in more anatomical detail than any early hominin, and most closely resembles *H. habilis* and *H. rudolphensis* discovered 3 to 4 thousand miles away in Tanzania and Kenya. The Dinaledi deposit remains undated but likely to come out at around 2 Ma or older. The sheer wealth of anatomical detail, including complete foot- and hand-bone remains from individuals, evidence for a range of ages at death, and plenty of dental and cranial information, actually poses a taxonomic problem of comparison with remains of other early hominins. Most of them are fragmentary, and it seems likely that once a precise date is obtained *H. naledi* will assume greater importance in comparative

anatomy. Comparison with australopithecines is easier because of their abundant remains, and *H. naledi* is clearly distinct from that clade as regards gait, chewing, overall physiognomy (see reconstruction video) and cranial dimensions, but does have some australopithecine affinities. They were certainly different from their near geographic neighbour *Au. sediba*, also found in a cave deposit within the great swath of Palaeoproterozoic limestones near Johannesburg, where the Cradle of Humankind UNESCO World Heritage Site is situated. The brain of *Homo naledi* was on a par with those of australopithecines as regards volume, yet larger than that of *H. floresiensis*: it does seem that brain size is not necessarily related to the uses to which it is put.



The route into the Dinaledi Chamber where bones of at least 15 individual members of Homo naledi were found (Credit: National Geographic)

Interestingly, it is reported that only the most diminutive members of the research team were able to enter the chamber where the remains were found because of the narrowness of the connecting passage. Also, access from the main cave system involved an upward 'U-bend', so that although water could – and did from time to time – enter the chamber in the past, it is unlikely that coarse material such as large bones could simply have been washed in, the more so as the chamber is on a minor spur from the main system and its outlet is through small floor drains that could not sustain torrential flow. Nor is there any direct access from the ground surface to this part of the system. Some of the more fragile body parts, such as a hand, are still articulated, which suggests a non-violent movement to the chamber. There are no signs of physical trauma to any of the bones, ruling out action by carnivores, nor any indicative of de-fleshing as by cannibalism. However, before fossilisation, many of the bones had been gnawed by beetles and snails. This combination of features leads to the possibility that corpses may have been deliberately placed in the chamber. If they had been, then to get to deepest recess of the cave system and find the Denalidi Chamber required illumination: fire brands. That the chamber was actually a living space is highly unlikely because of its remoteness from the surface. One big question that cannot be answered is whether or not such probable disposal was by ritual or simply for sanitary arrangements. Another possibility, not considered by the authors is seeking refuge from predators and becoming trapped in the desperately constricted space.

The possibility of ritual burial is clearly what has seized headlines. Yet few palaeoanthropologists will accept that: only Neanderthals and anatomically modern humans

are definitely considered to have adopted such a practice, in the last hundred thousand years. The association of a bifacial stone tool with 350 ka old *H. heidelbergensis* remains at Atapuerca in northern Spain has been suggested to be the earliest evidence for ritual burial, but is not widely accepted. There are no reports of artefacts in the Dinaledi Chamber.

Our ancestors parted from other humans earlier than expected (*September 2015*)

Despite the excitement raised by the discovery of remnants of 15 individuals of *Homo naledi* in a South African Cave (see above) the richest trove of hominin fossils remains that of Sima de los Huesos ('pit of bones') in northern Spain. In 2013 a bone from one of 28 or more individuals of what previously had been regarded as *H. heidelbergensis*, dated at around 400 ka, yielded mitochondrial DNA (Meyer, M. *et al*. 2014. A mitochondrial genome sequence of a hominin from Sima de los Huesos. *Nature*, v. **505**, p. 403-406; DOI: 10.1038/nature127880). It turned out to have affinities with mtDNA of both Neanderthals and Denisovans, especially the second. The data served to further complicate the issue of our origins, but were insufficient to do more than throw some doubt on the significance of *H. heidelbergensis* as a distinct species:, palaeo-geneticists of the Max Planck Institute for Evolutionary Anthropology in Leipzig hoped that nuclear DNA would do better. Now a small fragment of those data (about 1 to 2 million base pairs) have been presented to a London meeting of the European Society for the Study of Human Evolution (Meyer, M. and 13 others. Nuclear DNA sequences from the Middle Pleistocene Sima de los Huesos hominins. *Nature in press*). Anne Gibbons summarised the formal presentation in the 18 September 2015 issue of *Science* (Gibbons, A. 2015. Humanity's long, lonely road. *Science*, v. **349**, p. 1270; DOI: 10.1126/science.349.6254.1270-a).

A well-preserved cranium from Sima de los Huesos, Atapuerca (Spain).

The partial nuclear DNA is a great deal more like that of later Neanderthals than it is of either Denisovans and modern humans. It seems most likely that the Sima de los Huesos individuals are early Neanderthals, which implies that the Neanderthal-Denisovan split was earlier than 400 ka. That might seem to be just fine, except for one thing: Neanderthal and Denisovan DNA are much more closely related to each other than to ours. That implies the last common ancestor of the two archaic human species must have split from the ancestral line leading to modern humans even further back in time: maybe 550 to 765 ka ago – 100 to 400 ka earlier than previously surmised. This opens up several interesting possibilities for

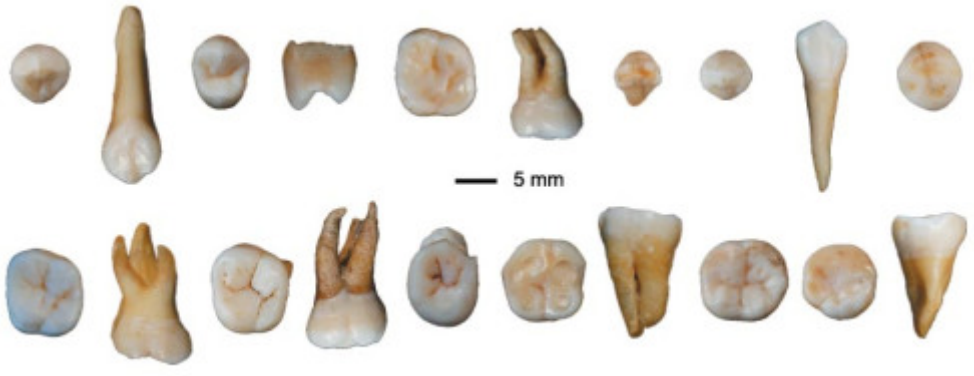
our long and separate development. Since Neanderthals and perhaps Denisovans emigrated from Africa to Eurasia several glacial cycles ago, perhaps groups genetically *en route* to anatomically modern humans did so too.

The Neanderthal and Denisovan genomes suggest that they interbred with each other and that union could have been at any time after the genetic split between them. Famously, they also interbred with direct ancestors of living Eurasians, but there is no genetic sign of that among living Africans. The evidence suggests that the insertion of archaic genetic material was into new human migrants from Africa around 100 to 60 ka ago at different points along their routes to Europe and East Asia. But, obviously, it is by no means clear cut what passed between all three long-lived groups nor when. It is now just as possible that surviving, earlier Eurasians on the road to modern humans passed on their own inheritance from relationships with Neanderthal and Denisovan to newcomers from Africa. But none of these three genetic groups ever made their way back to Africa, until historic times.

More on Neanderthals, Denisovans and anatomically modern humans

Surprising modern-human migrations into China and Africa (*October 2015*)

Caves figure highly in discoveries of hominin remains, fossil riches from those near Johannesburg in South Africa and at Atapuerca in northern Spain having set the world of palaeoanthropology reeling in the last few months. Such caves may have been chosen by hominins for day-to-day living, refuge or ritual; places where carnivores dragged some of our early relatives; or into which they fell accidentally Caves form most commonly in limestones. There are few places so well endowed with karst features than southern China, a fair number of caves in them having rich deposits of bat guano to which farmers have beaten well-trodden paths to dig it out for fertiliser. One such is Fuyan Cave in Daoxian County, Hunan. Manure mining there had done a great deal of the heavy work faced by archaeologists, having stopped when it reached a hard layer of calcite speleothem or flowstone that underpaves more or less the entire cave floor. Initial trial investigations found three clearly human teeth at the surface, encouraging further work. Digging through the flowstone revealed sediments rich in fossils, mainly teeth which preserve better than other remains in humid conditions. As well as teeth from a variety of mammals, large and small, 47 human teeth emerged. Close study revealed dental features that are irrefutably those of anatomically modern humans (Liu, W. and 13 others 2015. The earliest unequivocally modern humans in southern China. *Nature*, DEOI: 10.1038/nature15696). Remarkably, many of the teeth are in far better condition than my own.



Some of the Daoxian human teeth. (Credit: Song Xing and Xiu-jie Wu of the Key Laboratory of Vertebrate Evolution and Human Origins at the Chinese Academy of Sciences)

The true significance of the excavation emerged only when ^{230}Th dating revealed the age of the flowstone cap to the old cave sediments. A small stalagmite protruding from its surface yielded a minimum age of ~80 ka: by far the oldest date for anatomically modern human remains outside of Africa and the eastern Mediterranean. The dating produced older ages around 120 ka with equally good precision. Before this discovery the date of migration of Africans to populate Eurasia was thought to be about 60 ka from imprecise dating based on genetics of a range of living Eurasians and Africans – a 'molecular clock' – and the earliest sign of humans found in Australia. Consequently, finds in South India of artefacts beneath 74 ka ash from the super-eruption of the Mount Toba caldera have been regarded by many, other than the finders, as having been made by *Homo erectus*. Dates of 100 ka for modern human occupation of the Levant were thought to represent a failed attempt at migration out of Africa by a northern route. Both these important findings now take on renewed significance. Yet a 30 to 40 ka time gap between the Fuyan people and the previous dates for the earliest signs of migration into China, Borneo and Australia (40-50 ka) begs the question, 'Did this early group of far-travelled migrants survive to become ancestors of modern Chinese people?' There are many possible scenarios that only future discoveries might validate: simply going extinct; failure to survive the encounter with earlier migrants, such as *H. erectus* or the Denisovans; assimilation into those older populations.

As if to counter this, a multinational group of collaborators have sequenced and analysed the genome from a 4500 year-old male skeleton discovered in the Mota Cave of the Gamo highlands of southern Ethiopia (Llorente, M.G. and 18 others 2015. Ancient Ethiopian genome reveals extensive Eurasian admixture throughout the African continent. *Science*, DOI: 10.1126/science.aad2879). Comparison with living human genomes showed that this man's genetic make-up most closely matched that of the Ari, a tribe living in the area today. What was most interesting is that part of the modern Ari genome – between 4 to 7% – is not present in the 4500 year-old sequence. Instead, it matches those of modern Sardinians and a prehistoric German farmer. Yet it occurs in people living not only in Ethiopia, but also in central, western and southern Africa to varying degrees. There seems to have been a 'backflow' of people into the whole of Africa from Eurasia, estimated to have occurred some 3500-4000 years ago and probably involving a large influx. By that time farming was already established in Africa, so the migrants may have had some advantage, either culturally or physically, to encourage their wide distribution through the continent.

In tropical climates, DNA is likely to break down quickly and little if any fossil DNA has been recovered from prehistoric Africans. In this case, burial in a cave at high elevation may have helped preserve it, but also the target for extraction was the petrous bone from the inner ear whose density seems to allow DNA a better change of long-term survival. With continually improving DNA analysis and sequencing techniques more news is surely going to emerge from past African populations.

More on human migrations

Related articles

Gibbons, A. 2015. Prehistoric Eurasians streamed into Africa, genome shows. Science, v. **350**, p. 149; DOI: 10.1126/science.350.6257.149.