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PALAEOANTHROPOLOGY

An early modern human outside Africa

Analysis of two fossils from a Greek cave has shed light on early hominins in Eurasia. One fossil is the earliest known specimen of *Homo sapiens* found outside Africa; the other is a Neanderthal who lived 40,000 years later. SEE ARTICLE P.500

ERIC DELSON

The origin and early dispersal of *Homo sapiens* has long been a subject of both popular and scholarly interest[1]. It is almost universally agreed that *H. sapiens* (modern humans) evolved in Africa, with the earliest known fossil representatives of our species dated to around 315,000 years ago in Morocco (at a site called Jebel Irhoud)[2] and approximately 260,000 years ago in South Africa (at Florisbad)[3]. Stone tools comparable to those found with both of these fossils have been excavated in Kenya (at Olorgesailie)[4] and dated to about 320,000 years ago. On page 500, Harvati *et al.*[5] describe their analysis of a fossil from Apidima Cave in southern Greece that they report to be an early modern *H. sapiens* at least 210,000 years old. This fossil is the oldest known modern human in Europe, and probably in all of Eurasia, and is more than 160,000 years older than the next oldest known European fossil of *H. sapiens*[6].

The Apidima Cave complex was excavated in the late 1970s. Two partial crania (skulls without the lower jaw), named Apidima 1 and Apidima 2, were recovered in a single block of a type of rock called breccia. Neither fossil was previously described in detail. Apidima 2 includes the facial region of the skull and had been identified as a Neanderthal[7]. Apidima 1 consists of only the back of the skull and had not been previously allocated definitively to a species. Harvati and colleagues used computed tomography to scan the fossils, and generated a 3D virtual reconstruction of each specimen. They analysed each fossil to assess aspects of its shape, and thus to determine the fossils' similarity to those of other species.

Apidima 2 is badly damaged owing to previous breakage and distortion. Analyses of all four generated reconstructions of the fossil were consistent with it being an early Neanderthal. Apidima 1 is also damaged, but the specimen is not too badly distorted, so mirroring its right and left sides yielded a good reconstruction. The authors' extensive comparative analysis indicates that this fossil is an early member of *H. sapiens*. The posterior part of the cranium is rounded like that of *H. sapiens*, and it lacks classic Neanderthal features, such as the distinctive occipital 'chignon' — a bulge at the back of the skull that is shaped like hair tied in a bun.

Earlier dating[8] of a fragment of Apidima 2 using a method called uranium-series analysis indicated a minimum age of around 160,000 years. Harvati and colleagues report a more extensive set of uranium-series dating analyses, which surprisingly reveal that Apidima 1 and Apidima 2 are of different ages, even though they were found in close proximity. Apidima 2 is around 170,000 years old — well within the age range of other Neanderthal fossils found across Europe (Fig. 1). Apidima 1 is dated to be at least 210,000 years old, which is much older than any other widely accepted *H. sapiens* fossils found outside Africa.

This finding reveals that at least two species of hominin (humans and human relatives from the branch of the family tree after our split from chimpanzees) inhabited southeastern Europe approximately 200,000 years ago. The discovery of an *H. sapiens* fossil in Apidima raises questions about what happened to this population. Given that this *H. sapiens* existed at a time when there is substantial evidence for a Neanderthal presence at other European sites, was it part of a population that was unable to compete successfully with Neanderthals, especially in the unstable climate of that time? Perhaps one or more times, the two species replaced each other as the main hominin group present in this region.

Such patterns of replacement characterize the distribution of modern humans and Neanderthals in the Levant region of the Middle East between 250,000 and 40,000 years ago. *Homo sapiens* replaced Neanderthals across Europe between approximately 45,000

50 Years Ago

By the time the lunar samples brought back by Apollo 11 have been wrung dry of scientific information, the second American expedition to the Moon will have already been mounted … [T]he next landing will be at one of the two sites in the eastern hemisphere which have been chosen as smooth enough for a landing … This way by the end of the year NASA will have recovered samples of typical mare regions in both the eastern and western hemispheres of the visible face of the Moon. What the Apollo 12 astronauts … will be instructed to look out for will depend on the first-hand descriptions of the surface radioed by Armstrong and Aldrin on Monday morning (BST) and on preliminary analyses of the samples … Armstrong's first description that "the surface appears to be very finely grained as you get close to it, it's almost like powder" matches the Surveyor results which point to a matrix made up of finely divided particles sometimes aggregated in lumps.
From *Nature* 26 July 1969

100 Years Ago

The possibility of growing New Zealand flax (*Phormium tenax*) on a commercial scale in the British Isles has for many years been under consideration, and the publication of an important paper on the subject … is of considerable interest… The article, which mainly consists of an account of Lord Ventry's successful experiments in co. Kerry, is illustrated by several photographs of New Zealand flax under cultivation in Ireland showing a remarkably vigorous growth … It is pointed out in the article that only certain parts of the United Kingdom are suitable for the growth of New Zealand flax … but as the results so far obtained are promising, it is to be hoped that every encouragement will be given to the enterprise.
From *Nature* 24 July 1919

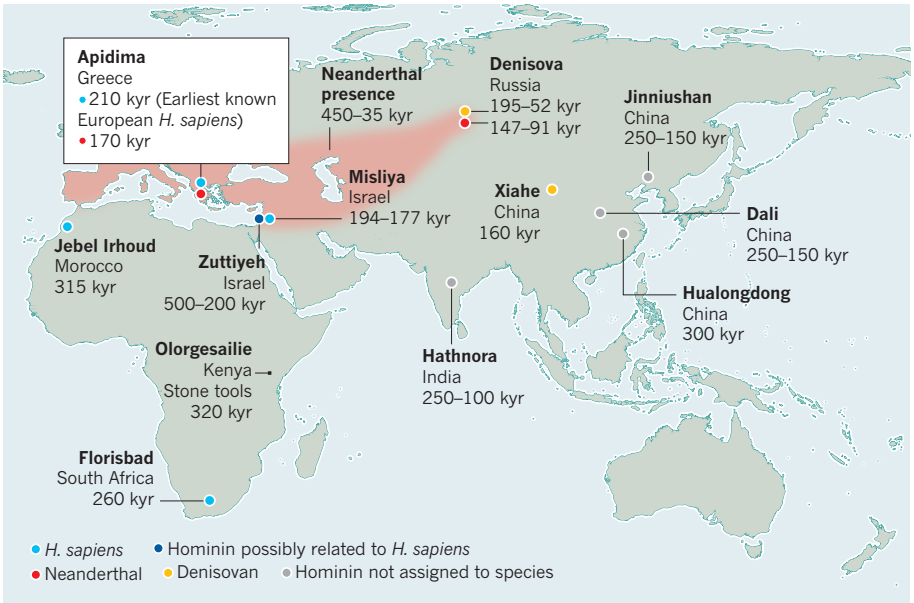

Figure 1 | Some key early fossils of *Homo sapiens* and related species in Africa and Eurasia. Harvati *et al.*[5] present their analyses of two fossil skulls from Apidima Cave in Greece. They report that the fossil Apidima 1 is an *H. sapiens* specimen that is at least 210,000 years old, from a time when Neanderthals occupied many European sites. It is the earliest known example of *H. sapiens* in Europe, and is at least 160,000 years older than the next oldest *H. sapiens* fossils found in Europe[6] (not shown). Harvati and colleagues confirm that, as previously reported[7], Apidima 2 is a Neanderthal specimen, and they estimate that it is at least 170,000 years old. The authors' findings, along with other discoveries of which a selection is shown here, shed light on the timing and locations of early successful and failed dispersals out of Africa of hominins (modern humans and other human relatives, such as Neanderthals and Denisovans). kyr, thousand years old.

and 35,000 years ago[6], eventually giving rise to the ancestral population of Europeans alive today[1]. This evidence from Apidima, along with other discoveries, demonstrates that, on more than one occasion, modern humans kept pushing north and westwards from Africa and the Levant into Europe. Rather than a single exit of hominins from Africa to populate Eurasia, there must have been several dispersals, some of which did not result in permanent occupations by these hominins and their descendants.

There is immense interest in understanding the timing and location of both the successful and failed dispersals of hominins (including modern humans) from Africa. The first hominin dispersal out of Africa is thought to have been when members of the species *Homo erectus* exited some 2 million years ago. The second wave of departures occurred when the ancestral species that eventually gave rise to Neanderthals moved into Europe around 800,000–600,000 years ago.

A third group of migrations out of Africa were those of *H. sapiens*. Many key fossil discoveries from Israel document early examples of these dispersals. A fossil that includes the forehead region of a skull found there, at a site called Zuttiyeh, is dated to between 500,000 and 200,000 years ago, and analysis of the fossil's shape indicates that it is either an early Neanderthal or from a population ancestral to both Neanderthals and *H. sapiens*[9]. The Zuttiyeh fossil shows similarities to the Florisbad and Jebel Irhoud fossils[9], and an earlier study[10] suggested that Zuttiyeh might be an early *H. sapiens*. This is a view that I favour, given its similarity to the shape of the forehead of the Florisbad fossil. Future analysis might reveal that Zuttiyeh is an even older modern human than Apidima 1; nevertheless, it is not from Europe.

A jaw of an early modern human from Misliya Cave in Israel has been dated to approximately 194,000–177,000 years ago[11]. Other early modern human fossils have been found at Skhul and Qafzeh in Israel, dated to around 130,000–90,000 years ago[12]. All of these early Eurasian human fossils seem to represent what might be called 'failed' dispersals from Africa — they reached the Middle East and southeastern Europe, but did not persist in these regions. There is evidence that these populations were replaced at these or neighbouring sites by Neanderthals.

Farther east, fossils of early *H. sapiens* in Asia, dated from between at least 90,000 and 50,000 years ago, have been found in regions ranging from Saudi Arabia to Australia[13]. These Asian fossils, like the European specimens of *H. sapiens* from between 50,000 and 40,000 years ago, might have come from populations that achieved persistent, successful dispersals and contributed to the ancestry of some living humans.

Given that the Apidima 1 fossil and those from Misliya and Zuttiyeh are only partial skulls, some might argue that the specimens are too incomplete for their status as *H. sapiens* to be certain. Could molecular approaches be used to determine the species they are from? It is not always possible to recover DNA from ancient fossils. However, analysing ancient proteins preserved in fossils, a method termed palaeoproteomics, is starting to be used to identify species (see go.nature.com/2xkosom). Compared with analysis of ancient DNA, palaeoproteomics requires less specialized handling of the fossil to prevent contamination. It was recently used[14] to analyse a fossilized jaw found in China that is approximately 160,000 years old, enabling the specimen to be identified as an enigmatic hominin called a Denisovan, whose scarce fossils have also been found at Denisova Cave in Siberia.

Perhaps palaeoproteomics can be used to verify the identity of the Apidima fossils. It might also be possible to apply this method to contemporaneous fossils from Asia (estimated to be 300,000–150,000 years old) that have not yet been definitively assigned to a species. These fossils are of interest for their potential to reveal how many hominin species might have lived during this time. Perhaps some of them are also *H. sapiens*, although I doubt it. Among the most complete of these specimens are crania from India at a site called Hathnora[15], and from China at Dali[16], Jinniushan[16] and Hualongdong[17]. Until such fossils are studied using palaeoproteomics, analyses such as those of Harvati and colleagues provide our best handle on the complex history of our species and our close relatives as these populations dispersed out of Africa — from the early, unsuccessful dispersals to the migrations that eventually succeeded. ■

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