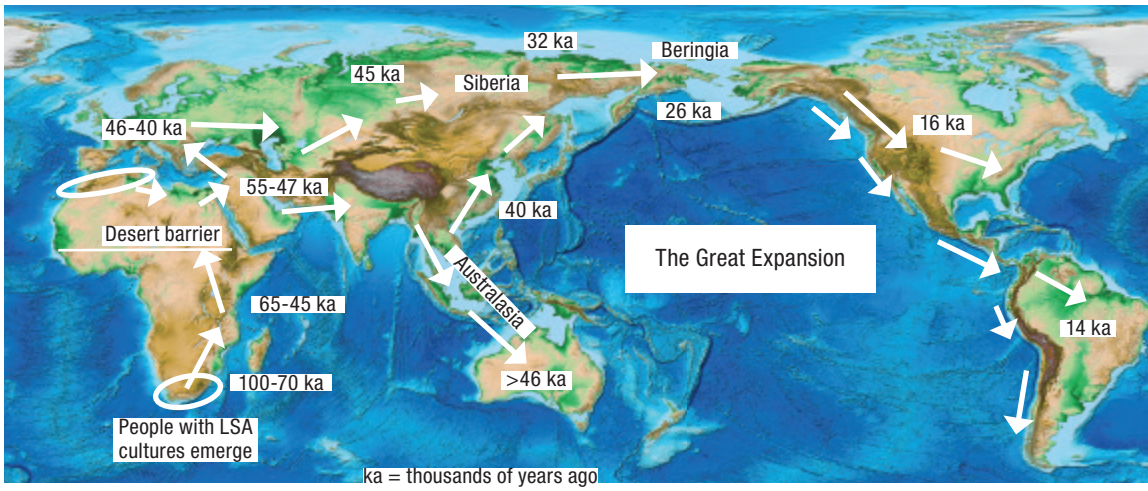
8 Conquering the world

Veni, vidi, vici (I came, I saw, I conquered).

Julius Caesar

It comes as no surprise to most of us that our species would expand beyond Africa and conquer the world. What is surprising is why it didn't happen sooner than it did. Our species, *H. sapiens*, emerged as anatomically modern humans (AMHs) widespread in sub-Saharan Africa by 160 thousand years ago, but only successfully expanded beyond Africa in the last 50 thousand years. If *H. erectus* did it 1.8 million years ago and *H. heidelbergensis* did it 400 thousand years ago, then why didn't our species – having the biggest, cleverest brain yet – similarly expand beyond Africa soon after appearing? AMHs did disperse out of Africa into the Middle East at the earliest greening of the Sahara 130 thousand years ago, and had expanded as far as China by 120 to 80 thousand years ago. However, this initial foray by AMHs into Eurasia doesn't appear to have ever amounted to much. The reason AMHs failed to make significant, lasting inroads into Eurasia may be that they were unable to displace their Neanderthal and other cousins living there at the time – cousins who had independently evolved a big brain and tools of their own. In that case, our successful move out of Africa may have had to wait for the emergence of modern hunter-gatherers, people in possession of Later Stone Age (LSA) cultures. (Here, members of our species *H. sapiens* with LSA cultures are referred to as people, while those of our species without LSA cultures are referred to as AMHs.) The versatile and sophisticated LSA tools and weapons, and the shared beliefs expressed by symbolic items, may have allowed people to spread and displace older cultures throughout Africa and beyond.



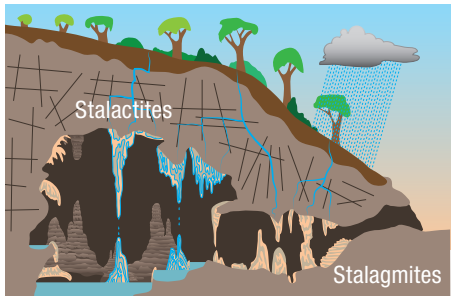
All it took was for several thousand people to cross over the Sinai Peninsula, the only land bridge out of Africa, during modest episodic greening of the Sahara between 60 and 45 thousand years ago. This brief, small decanting of highly mobile and adaptable groups of people rapidly multiplied and dispersed, reaching Australasia by at least 46 thousand years ago, Europe 46 to 41 thousand years ago, Siberia 45 to 32 thousand years ago, and the Americas 16 to 14 thousand years ago. Although those who left Africa did not consciously set out to conquer the world, it is effectively what they did. Many large animals, including all other members of our human lineage, became extinct in people's wake as they filled every habitable corner of the globe. How did this rapid peopling of the world known as the Great Expansion unfold?

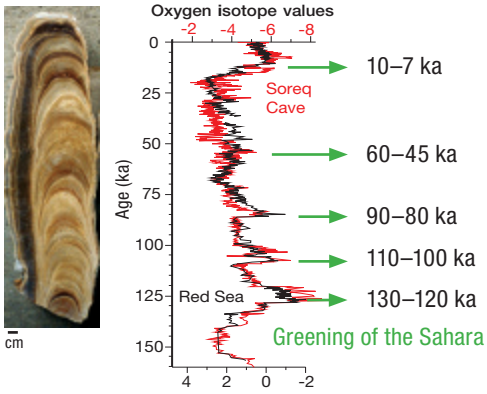
Africa uncorked

People having modern hunter-gatherer, LSA cultures were bottled up in sub-Saharan Africa and the Great Expansion could get started only once Africa was uncorked – that is, once the formidable Sahara-Arabian Desert barrier was relaxed enough to let them out. Three lines of evidence provide estimates of when and where the Great Expansion commenced. Climate records indicate when rainfall may have been sufficient to transform the desert into grassland, allowing those animals, and the people chasing after them, to cross the Sahara. Some may have then inadvertently crossed over the Sinai Peninsula land bridge into Eurasia, while others possibly crossed over intentionally by boat. DNA studies provide estimates of when people left, how many left, and to what extent they interbred with their Eurasian cousins along the way. And finally, remnants of the distinctive LSA cultural items people made can provide a trail indicating when and by what route they expanded beyond Africa.

Going global: possible pathways and timing of the Great Expansion, when people filled the world

Water transforms the desert



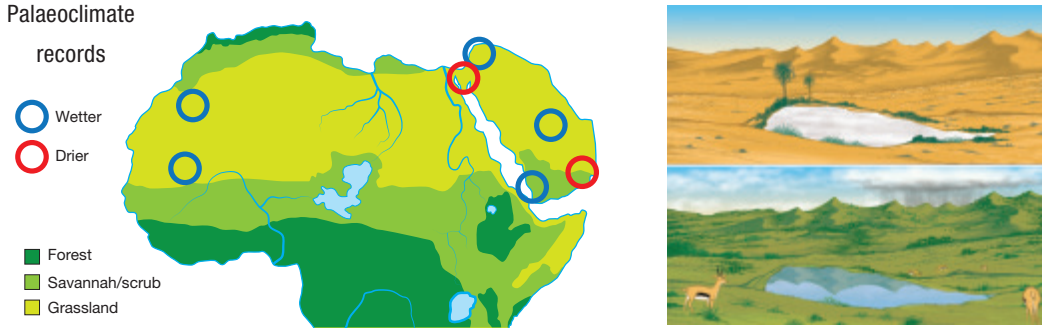


Evidence for when the Sahara–Arabian Desert received more rain comes from ancient climate records archived in sediment deposits. For example, changes in the type of plant pollen blown out to sea recorded in marine sediment cores from offshore of northwest Africa indicate a rapid shift to wetter conditions from 55 to 45 thousand years ago. Climate records on land include speleothems, whose calcareous columnar structures – stalagmites and stalactites – are built up gradually over time, layer upon layer, as water percolates through limestone caves. Speleothem records from caves in Israel indicate generally wetter conditions from 60 to 50 thousand years ago. However, the absence of speleothems in caves located further south in the severe Negev Desert, as well as in caves located in Oman, suggests these desert areas remained dry throughout this time. But speleothems may require even wetter conditions to form than existed at this time. Rather than speleothems, ancient episodic flash-flood deposits may provide a more sensitive record of the slight increases in rainfall that occurred. Sediment deposits in central Saudi Arabia, located between the Negev and Oman cave sites, indicate a peak in episodic flood deposits around 54 thousand years ago.

These results are consistent with records that generally indicate a strengthening of the African

Speleothems can include stalactites and stalagmites, such as those from the Soreq Cave in Israel, whose layered deposits (far left) provide isotopic evidence of when climate was perhaps wet enough for movement between Africa and Eurasia (ka = thousands of years ago)

monsoon and delivery of more moisture to northern Africa between 60 and 45 thousand years ago. However, the climate archives are not complete, and available records reveal that the pattern of climate change over this extensive desert region was complex. The vast area of the Sahara–Arabian Desert doesn't appear to have become uniformly wetter; rather, different areas experienced greater amounts of rainfall at different times. Despite these complications, the evidence available from areas surrounding the Sinai land bridge suggests that conditions were potentially wet enough to permit limited passage out of Africa along vegetated corridors for brief periods between 60 and 45 thousand years ago.



In addition to ancient climate records, the timing of when people left Africa can be estimated using the DNA molecular clock. Refinement of the mitochondrial DNA clock, in particular, estimates an exodus sometime between 87 and 57 thousand years ago. The only marginal overlap with climate records indicating when movement out of Africa was possible may reflect uncertainties in the mutation rate assumed to calibrate the DNA molecular clock, as well as possible mixing (introgression) of DNA from interbreeding with AMH holdouts in Eurasia. Some minor mixing with AMHs is suggested by the DNA data, and supports other evidence that the exodus of AMHs into the Levant 130 to 80 thousand years ago was not as big a failure as first thought.

The recovery of AMH teeth from a cave in southern China, along with other, less-well-dated fossils of AMHs from Asia, implies that AMHs had expanded well beyond the Levant throughout the MIS 5 interglacial period from 120 to 80 thousand years ago. AMHs may have left Africa during warmer and wetter intervals when the Sahara–Arabian Desert barrier transformed to grassland 130 to 120, 110 to 100, and 90 to 80 thousand years ago. While some AMHs may have persisted in Eurasia as holdouts to exoduses during any one of these earlier greening episodes, stone tools

Palaeoclimate records indicate when a stronger African monsoon transformed the Sahara into grassland