



December 7, 1999

Genes Tell New Story on the Spread of Man

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By NICHOLAS WADE

Two genetic surveys of human populations bring new evidence to bear on a pivotal event in prehistory, the first dispersal of modern humans from Africa.

One study, based on analysis of people in East Africa and India, suggests that the first emigration of modern humans was eastward, toward Asia, and not northward through the eastern Mediterranean.

New theories on the direction of the first African

A second, drawing on DNA data from 50 ethnic groups around the world, concludes that the ancestral population from which the first emigrants came may have numbered as few as 2,000 people.

Both studies suggest that the most recent common ancestor of the



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emigration.

recent common ancestor of the emigrants lived 60,000 to 40,000 years ago.

Previous genetic studies have suggested 100,000 years or so for the most recent common ancestor, and about 10,000 for the ancestral population size.

The younger date of about 50,000 years seems to tally much better with an emerging synthesis of the archaeological data relating to human origins.

"A combination of fossil and genetic evidence locates the ancestral population in Africa, and archaeological discoveries imply an initial dispersal out of Africa about 50 ky years ago," Dr. Richard G. Klein of Stanford University writes in the latest edition of his book "The Human Career." The term 50 ky means 50,000 years ago.

Dr. Klein believes an important distinction can be discerned in the archaeological record between what he calls anatomically modern humans and behaviorally modern humans. Though the fossil remains of each type look the same, a more advanced set of stone tools appears with human remains dating back to 50,000 years or so.

Modern human sites older than this have a more primitive set of stone implements, similar to those used by archaic humans like the Neanderthals.

Dr. Klein and others believe that some major genetically based neurological change, like the development of language, occurred about 50,000 years ago. This transformation, he infers, was the spur that led behaviorally modern humans to innovate their characteristic suite of more advanced stone implements, develop the first forms of art and spread throughout the world.

Remains of modern humans dating to about 100,000 years ago have been found at a well-known archaeological site called Skhul in Israel. The finding has been interpreted as evidence of the first human migration out of Africa, and it fit with the old genetic data of a modern human origin.

But the Neanderthals occupied Europe and the eastern coast of the Mediterranean at that time, and they or the cold climate might have blocked any further advance in that direction.

Dr. Klein's data suggest that the humans of 100,000 years ago, anatomically modern but not like modern people in their

behavior, did not spread out of Africa at that time.

A new genetic study, by Dr. A. Silvana Santachiara-Benerecetti of the University of Pavia in Italy and colleagues, confirms the view that the first dispersal of modern humans was not until about 50,000 years ago, and that the direction was eastward toward Asia.

The study, published in *Nature Genetics* last week, is based on mitochondrial DNA, the genetic material of the small energy-producing organelles inside every cell. Because mitochondria are inherited with the egg, from the mother alone, their DNA escapes the shuffling that occurs in sexual reproduction, and any changes reflect the occasional random mutation in the DNA.

On the basis of these mutations, biologists can construct a family tree of mitochondrial lineages and, by estimating the mutation rate, figure out the time that has elapsed since the mutation at the root of the tree.

Dr. Santachiara-Benerecetti and her colleagues studied a particular pattern of mitochondrial DNA that is well known in India. They found an earlier form of the pattern among people in Ethiopia, suggesting that East Africa was its place of origin.

Signs of the pattern also exist among many people in Saudi Arabia, but not among inhabitants of the eastern Mediterranean.

This provides the first genetic evidence, the Italian biologists say, that the human migration route out of Africa was from eastern Africa along the coast toward Southeast Asia and Australia.

Another new genetic study, by Dr. Marcus Feldman of Stanford University and others, makes an interesting counterpart to the Italian study because it is based on a different kind of DNA but reaches similar conclusions.

Dr. Feldman and his colleagues looked at segments of the Y chromosome, another part of the human genome that escapes the usual shuffling of the reproductive process. Studying Y chromosomes from around the world, they concluded that the most recent common ancestor of all these Y's was carried by a man who lived only 40,000 years or so ago.

Even though all Y chromosomes can be traced back to a single individual, this does not mean a single Adam was the species'

only male representative. The founding population from which the world's present population is derived consisted of about 2,000 individuals, according to the new data, Dr. Feldman said.

One Y chromosome in such a population will eventually dominate in the descendants after all the other Y lineages are brought to a halt, whether because their owners have no children or beget only daughters.

The 40,000-year date, which has a large range of uncertainty, is much more recent than others, in part because the earlier estimates were forced to assume, quite unrealistically, that the size of the human population remained constant throughout prehistory. Dr. Feldman assumed an exponentially expanding population, which yields a more recent date of origin. His study is published in the current issue of the journal *Molecular Biology and Evolution*.

The two new studies represent a convergence of the genetic and archaeological data bearing on modern human origins, said Dr. Luca Cavalli-Sforza, a leading population geneticist at Stanford University, who was not an author of either study. The two independent lines of evidence support the idea that behaviorally modern humans arose in Africa around 50,000 years ago from their anatomically modern forebears.

These behaviorally modern humans "had three big improvements in culture -- language, boats or rafts, and Aurignacian technology," Dr. Cavalli-Sforza said, referring to the more sophisticated stone implements.

Shortly after they had acquired these innovations, they burst forth to inhabit the rest of the globe. The Neanderthals who may have blocked the human advance out of Africa 100,000 years ago were now rapidly displaced in Europe, presumably by behaviorally modern people invading Europe from Asia. There are convincing dates, Dr. Cavalli-Sforza said, that humans reached Europe by 40,000 years ago and Oceania and New Guinea by 40,000 to 50,000 years ago.

Although no boats from this period have yet been recovered, such craft would have been essential transport for the early people who reached Australia, and Dr. Cavalli-Sforza said he was convinced that "the people who went from Africa to Asia knew how to use some simple navigational means."



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