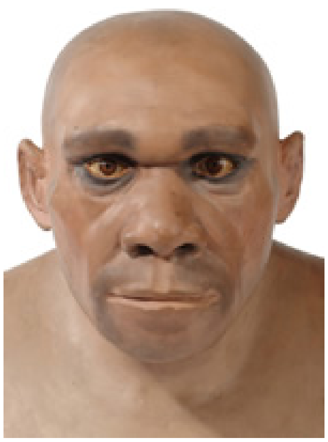
Researchers Probe Links Between Modern Humans and Neanderthals

September 19 2009, By Jeffrey Norris



Model head of a Neanderthal man. Image: Natural History Museum

Which genes make us uniquely human? Scientists are looking at DNA in old bones to find out. The focus now is not so much on our own species, *Homo sapiens*. Instead, scientists are probing DNA in well-preserved pieces of bone from our closest extinct relative, the Neanderthal.

Homo neanderthalensis nearly made it through two Ice Ages in Europe, only to disappear roughly 30,000 years ago. That's about 15,000 years after our own ancestors arrived and settled the continent. For most of our own species' time on Earth, Neanderthals were around, too. Some people even suspect that our own ancestors did them in.

Many wonder if there was interbreeding. Might some of us have a few distinctly Neanderthal genes?

Richard “Ed” Green, PhD, studies Neanderthal DNA at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. Green is part of a lab team headed by Svante Pääbo, a Swedish scientist internationally renowned for studies of Neanderthal genes. Green visited UCSF’s Mission Bay campus in late July and gave a seminar talk highlighting the lab team’s recent discoveries.

You Say Neandertal, I Say Neanderthal

English speakers favor the term Neanderthal, but Germans and many scientists refer to these ancients as Neandertals, according to Green, whose talk was titled “Recent Human Evolution as Revealed by the Neandertal Genome.”

To make genetic comparisons with modern humans, researchers previously mapped the genome of the chimpanzee, the living species to which we are most closely related. Projects also are underway to obtain complete genetic maps for the gorilla and orangutan.

“We would like to be able to map the things that are genetically unique about humans to the behavioral and physiological differences between humans and chimpanzees,” Green says. “But because there are so many genetic and biological differences, it’s hard to make this map.”

In evolutionary terms, it is estimated that human ancestors and chimp ancestors went their separate ways about 5 million or 6 million years ago. Green says this date is “highly contentious.” The debate is informed by the fossil record, and now by comparisons of DNA sequences among species. The measurement of the accumulation of changes in the genetic code serves as a kind of evolutionary timekeeper.

Neanderthals and humans are believed to have first evolved separately from a common ancestor a few hundred thousand years ago. There are many fewer genetic and physical differences between the two hominids than there are between modern humans and chimpanzees. DNA sequences that have changed in humans — but that are the same in chimps and Neanderthals — might more easily be linked to their physical or behavioral manifestations and provide clues to the most recently evolved human traits.

'No One's Mother Was a Neanderthal'

Thanks to the Human Genome Project and to research conducted in its wake, there is an expanding database of human genomes and a growing record of genes known to vary from person to person.

But there have been great technical challenges in sorting out and mapping what's left of Neanderthal DNA in ancient bone. The first Neanderthal DNA was extracted from bone in 1997. Most of the DNA in Neanderthal bone samples comes from contaminating bacteria and ancient decay, but the hominid DNA can be sorted out using modern laboratory techniques.

The majority of our DNA resides on 23 pairs of chromosomes inside the nucleus of every living cell. This DNA is inherited from both parents. But initial studies of Neanderthal DNA instead focused on the small percentage of DNA that resides in compartments within cells called mitochondria. Mitochondrial DNA tracks only maternal inheritance.

Mitochondrial DNA is passed from female to offspring through the egg. The DNA has evolved quickly and there are many copies of it in each cell, making it easier to study.

In July the Svante lab reported Neanderthal mitochondrial DNA studies from five individuals in the journal Science. The researchers observed limited DNA diversity. This indicated that the Neanderthal population in Europe was small, and may have included fewer than 3,400 females, they reported.

The mitochondrial DNA of thousands of living humans already has been examined. The Neanderthal mitochondrial DNA examined to date is distinctly different from that of humans, Green says. No mitochondrial DNA sequences from Neanderthals have been encountered in modern humans.” This makes it less likely that there was some genetic interchange with Neandertals,” Green says. “No one’s mother was a Neandertal.”

Complete Neanderthal Genome Expected Soon

Maybe not. But to rule out interbreeding will require mapping the wealth of DNA in the cell’s nucleus, says Jeff Wall, PhD, a researcher with the UCSF Institute for Human Genetics. Wall, who develops mathematical methods to analyze genetic data, has a keen interest in this research.

The mitochondrial DNA represents “just a fraction of the information,” Wall says. Mitochondrial DNA mapping is less challenging but also less informative than mapping the DNA on chromosomes. “The real answer is going to require the kind of data they have gathered now but not yet published,” he says.

Green and colleagues have in fact been mapping nuclear DNA from Neanderthals. In February, Pääbo reported that the team already had mapped at least one DNA sequence to cover more than 60 percent of the entire Neanderthal genome, using DNA from the ancient bones of three different individuals.

During his talk at UCSF, Green noted a few specific chromosomal genes of interest to researchers. One is FOXP2, which plays a role in speech. The human gene differs from the chimp gene. But so far, humans and Neanderthals appear to share the same variants of this gene. A few other genes thought to encode uniquely human attributes also were the same in the Neanderthal samples. The lab team has identified some genetic variants that do differ between the two hominids, but Green did not speculate on how they might function.

As for interbreeding, Wall says that even if it occurred rarely, it should be detectable through analysis of the complete genome.

“If you have even two percent of Neanderthal genes finding their way into the modern gene pool, then we know they may have interacted in the same area for a substantial period of time. If you look at the whole genome, you’re going to find it.”

“There’s a huge difference between a few percent and zero percent,” Wall says. “Zero percent would suggest that they never coexisted or that they could not reproduce.”

Source: University of California, San Francisco, By Jeffrey Norris