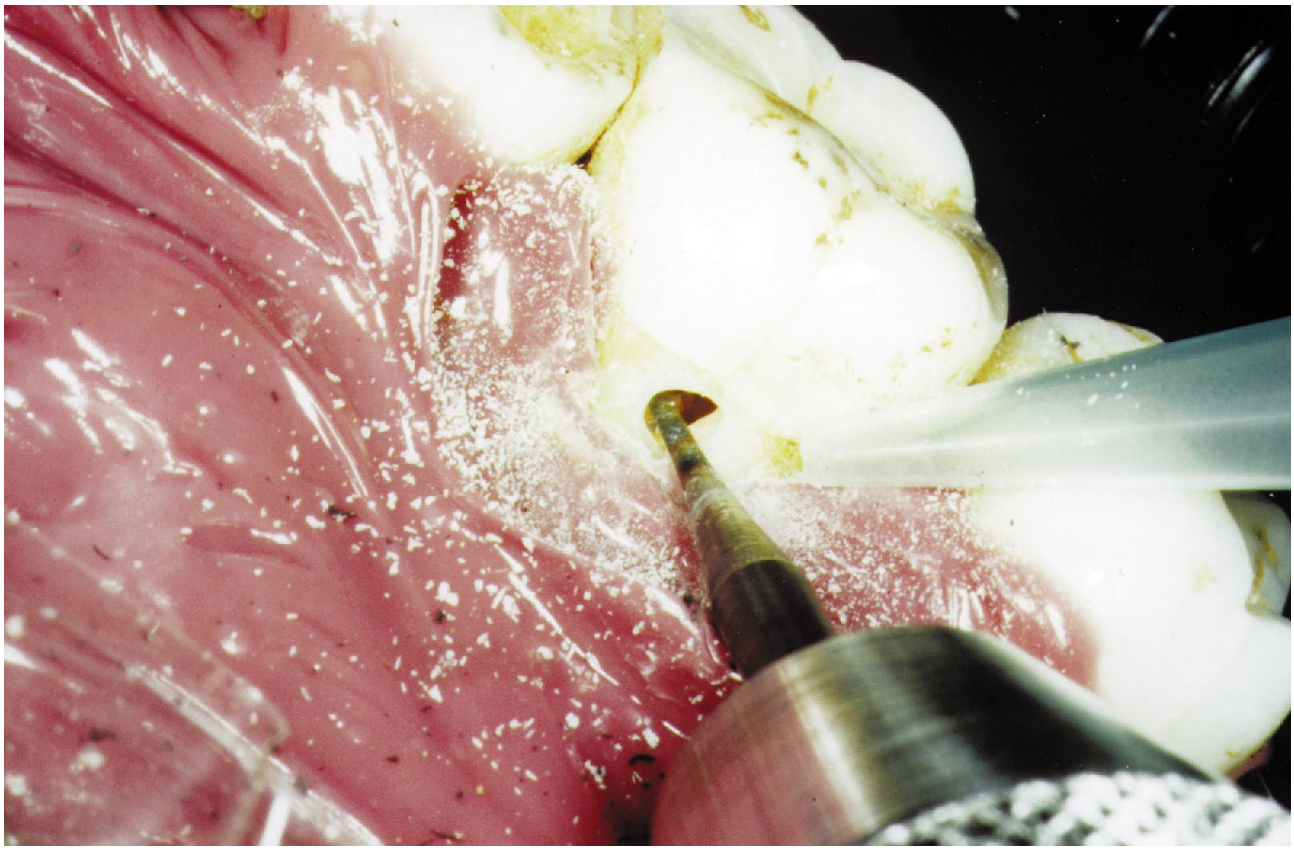
ANCIENT BIOMOLECULES INITIATIVE

Molecular Signatures from the Past

Who were our ancestors?



We used a dental bur and a suction device to remove dentine from this 12,000 year-old molar tooth without removing it from the jaw. The pink material is dental silicone which we use to protect the jaw and prevent contamination. The jaw is from Gough's Cave in Somerset.

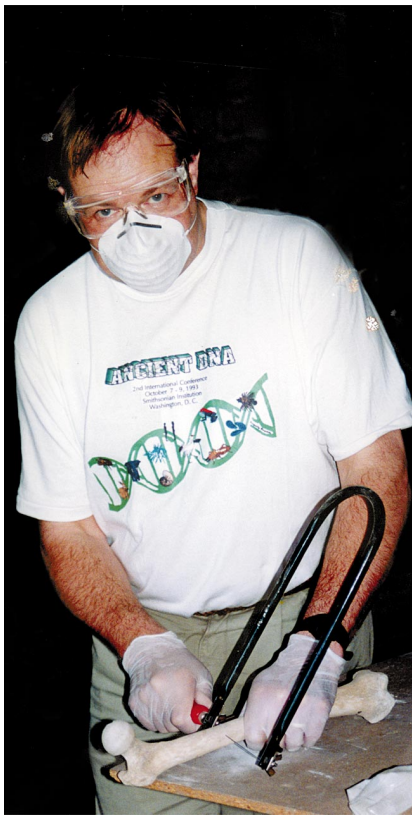
We have been using ancient DNA to find out if modern Europeans are descended from Palaeolithic hunter-gatherers, like 'Cheddar Man', or from early farmers bringing agriculture from the Middle East.

Many anthropologists believe that the early farmers spread from the Middle East into Europe, displacing the hunter-gatherers who lived there. Our earlier survey of DNA from modern Europeans suggested that, on the contrary, most of our ancestors were hunters, not farmers. This suggests that the hunters learned to farm, and that only a few Middle-Eastern pioneers (whose genes we can recognise) introduced the technology to Europe. We need to look at the DNA of ancient Europeans to confirm our hypothesis.

We spent the summer of 1996 collecting teeth from 30 skeletons excavated from early farming sites of Neolithic age in France and Germany as well as much older Palaeolithic cave sites in Britain which were used by ancient hunters. Although we have only obtained usable DNA from four Neolithic and two Palaeolithic specimens so far, the results from this tiny sample fit our hypothesis. DNA from two out of the four early farming sites was of the predicted Middle Eastern type, while both Palaeolithic hunters were of a modern European type. These are not statistically significant results but they do show that ancient DNA can test hypotheses arrived at from larger modern surveys.

What can these findings tell us about our ancestors? They had eked out a living hunting game and gathering roots for 30,000 years, but were still flexible enough to learn how to farm.

If we are descended from hunters rather than farmers, does this explain why we have difficulties with a rich 'agricultural' diet and even why some of us find modern urban living such a strain?



Bryan Sykes removes a section of femur from a 2,000 year-old human skeleton: ancient biomolecule work does not always involve high technology!

The Ancient Biomolecules Initiative is a five-year programme to understand the fate of biological molecules in archaeological and fossil materials, and to explore the applications of this new knowledge. The Initiative is funded by the Natural Environment Research Council.

Natural Environment Research Council

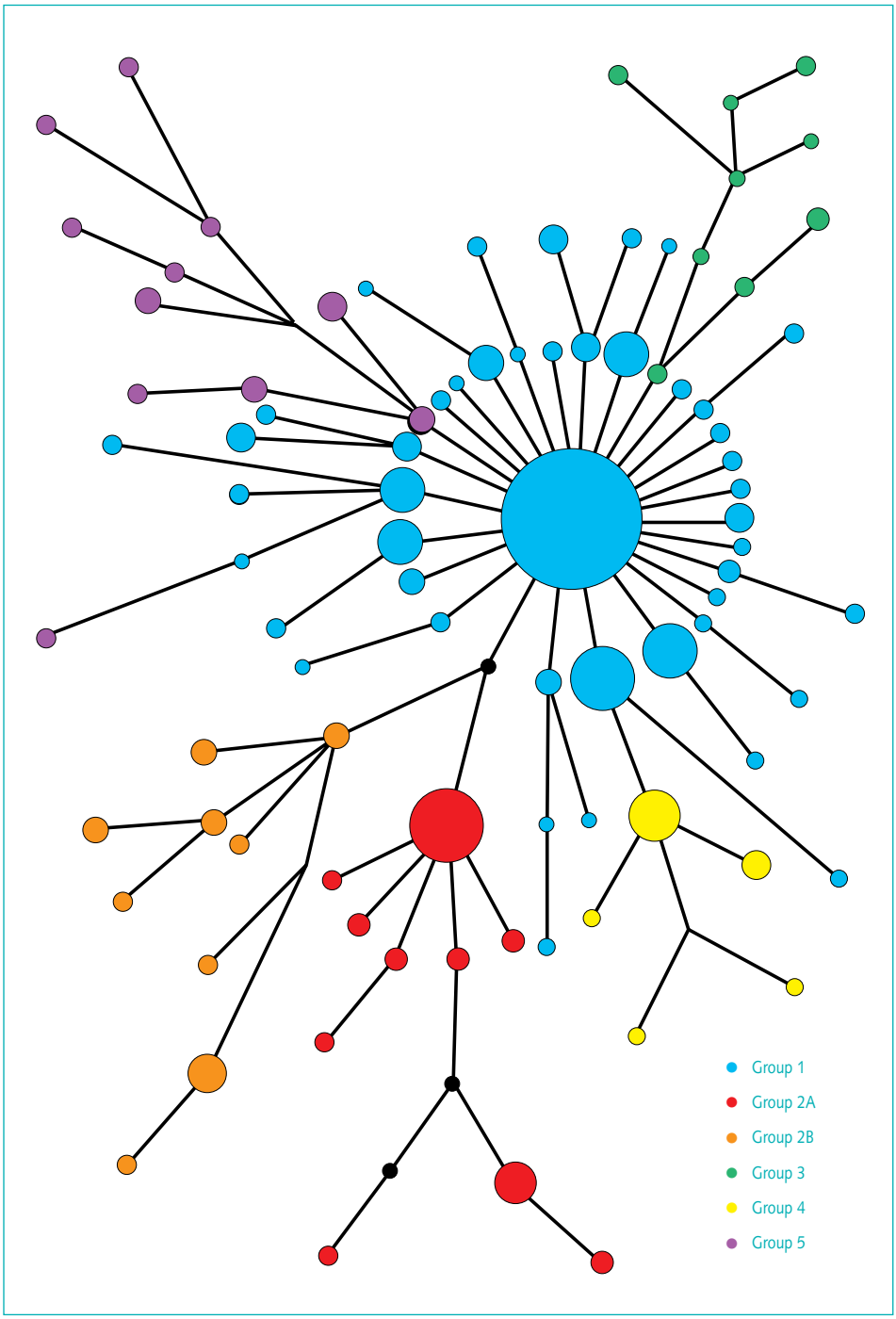
Who were our ancestors: the science in detail

Mitochondrial DNA (mtDNA) has the advantage over classical methods that it provides information on actual maternal lineages (mtDNA is maternally inherited), and their genealogies can be dated by the mutation rate. Our mtDNA analysis of modern Europeans suggests that most present-day Europeans are descended from the ancient hunter-gatherer populations, and that agriculture was brought by small numbers of pioneer colonists from the Middle East. They penetrated the continent by two routes: up the rivers of Central Europe, and along the Mediterranean and Atlantic coastline (see map on sheet 09), and eventually the local populations were persuaded to follow their example and take up farming.

This theory is attractive because it not only seems to explain better the patterns of sequence variation in modern Europeans, but also fits the archaeological evidence better than the traditional view. But many aspects of mtDNA analysis are very new, and the dating method by number of mutations is controversial (Howell et al, (1996) Am J Hum Genet 59, 501-509). This is where ancient DNA comes in: the theory makes very specific predictions about what one would expect to see in the mtDNA from ancient Europeans. The mtDNA in skeletons from prehistoric Palaeolithic hunter-gatherers should resemble the majority of modern Europeans whereas the mtDNA in skeletons from people at the early, pioneer Neolithic sites should look very different because they carried distinctive Middle Eastern lineages, distinguishable by a suite of specific variants in the mitochondrial control-region DNA.

Methods

We have perfected a way of extracting dentine from molar teeth, without removing them from the jaw, and recovering DNA in ultra-clean conditions. Even so we still expect some contamination from modern DNA. To sort out what is genuine from what is modern, we sequence up to fifty clones from each extract. Knowing the mtDNA sequences of the people who have been in contact with the specimen allows us to recognise which clones are most likely to be genuinely ancient sequences.



From the four skeletons that have so far yielded results, two have characteristic sequences we associate with the Neolithic arrivals from the Middle East. In the modern population we would expect to find these sequences in about one person in twenty. There are too few ancient samples to make this a statistically significant result but it shows the overall approach is successful. We are currently recovering DNA from more of these remains.

A skeleton network of mitochondrial haplotypes of living Europeans. Mitochondrial DNA is inherited exclusively through the maternal line. If you go back far enough, any two people alive today can be connected through their common maternal ancestor - the only question is, how long ago did she live ? This can be estimated by the number of mutations that have accumulated in mtDNA. Plotted here is our best estimate of the network which connects modern Europeans to one another. Each circle represents an mtDNA haplotype, defined by its DNA sequence; its area is proportional to the number of individuals who share that haplotype. There were nearly 900 people in the study but, for reasons of clarity, we show only haplotypes which occur more than once.

We see six groups emerging - Group 1 ●, Group 2A ●, Group 2B ●, Group 3 ●, Group 4 ● and Group 5 ●. We think Group 2A lineages are the descendants of pioneer farmers who brought farming to Europe from the Levant. DNA from two out of four skeletons from early agricultural sites fit into this otherwise uncommon group, while both Palaeolithic sequences, predating Neolithic farming by at least 6,000 years, are found in Group 1 - the commonest amongst modern Europeans.

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