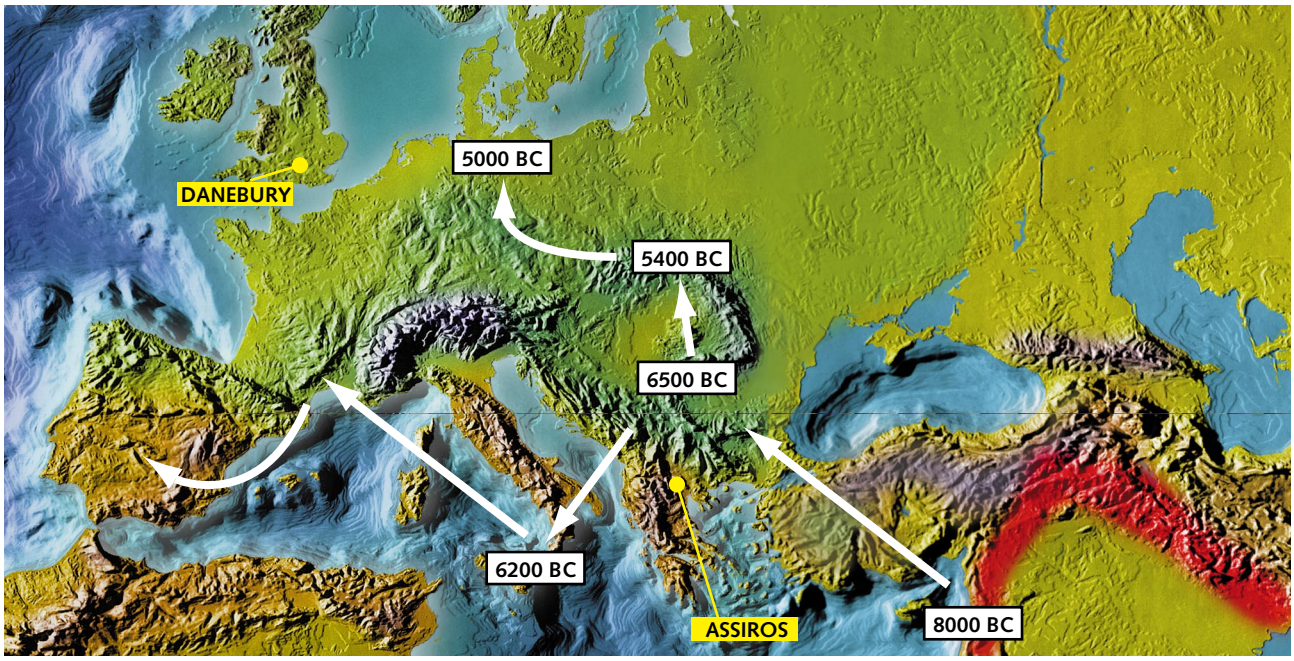
New ways with old wheats



The origins and spread of agriculture. The red shaded area is the Fertile Crescent, where agriculture began some 10,000 years ago. Danebury and Assiros are two archaeological sites where charred wheat remains containing ancient DNA have been recovered.

Agriculture began about 10,000 years ago in the 'Fertile Crescent', a region of the Middle East comprising the plains of Mesopotamia, the deserts of Syria and Palestine, and some of the mountainous areas to the east of Anatolia. Here human communities first began to cultivate crops (wheat and barley were among the first) rather than simply collecting plants from the wild. This was one of the most important events in the human past, as it was the first time that we learnt how to shape the environment to our own ends.

Agriculture had far-reaching effects on human society, spreading across Eurasia and leading to increased populations and eventually to civilisations such as those of classical Greece and Rome. But most of this happened centuries before the invention of writing, so it is only through archaeology that we can try to understand prehistoric agriculture.

Why was farming adopted in the first place? How did it spread? Did the early farmers migrate across Europe, displacing the hunter-gatherers that they found, or was there a more peaceful transfer of the new technology from village to village?

Our project has opened up an exciting new way for studying prehistoric agriculture. We have discovered that it is possible to obtain small traces of DNA from preserved wheat seeds, some dating back to the earliest stages of agriculture. We found that one Bronze Age wheat from Greece contains a gene thought to confer good bread-making quality. This was surprising because prehistoric wheats are not thought to make good bread. We also found that cultivated wheats are more genetically diverse than previously thought.

This suggests that wheat might have been domesticated twice, in two different places, rather than just once as archaeologists believed.

An interesting spin-off is that our method can be used to test the purity of modern flour and pasta. Some products described as being made from durum wheat are adulterated with bread wheat, which is cheaper. Our DNA test can distinguish durum from bread wheat.

Emmer wheat grains c.6mm long from Bronze Age Assiros

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.
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Natural Environment Research Council

New ways with old wheats: the science in detail

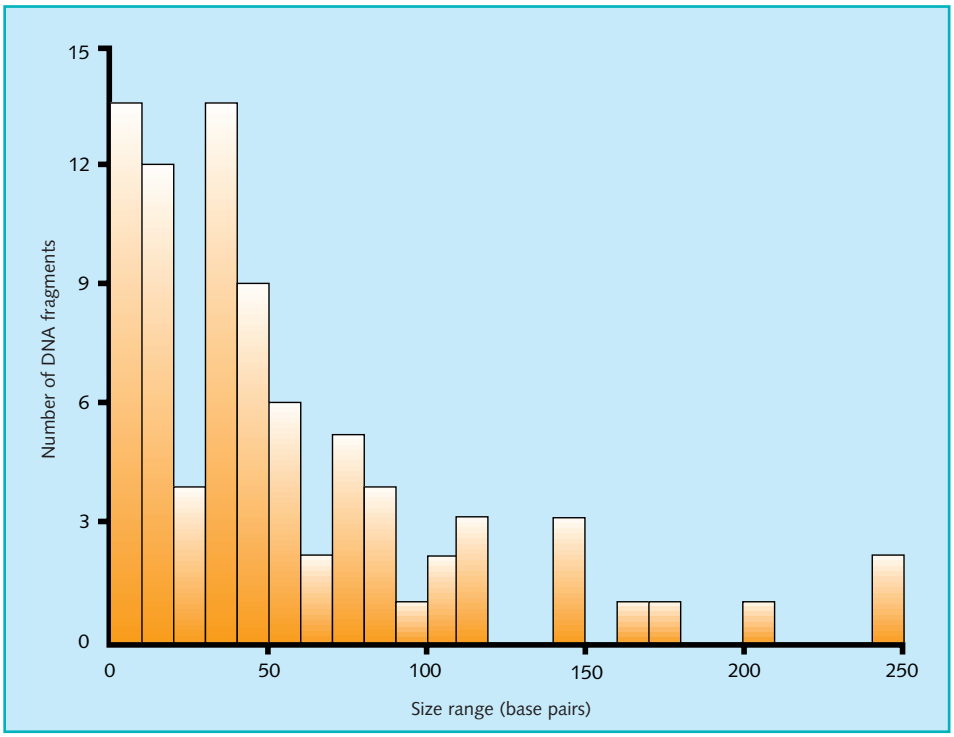
The earliest farming communities grew primitive wheats such as emmer, but as agriculture progressed these were replaced by bread wheat and other modern varieties. Bread wheat is a hexaploid species, each cell containing six sets of chromosomes, rather than the four sets found in the tetraploid emmer. The two extra sets of chromosomes (called the D chromosomes) include genes that confer good bread-making quality on flour produced from the grain, which means that bread wheat is of greater culinary value than emmer. We can deduce the agricultural status of a prehistoric population, with wide cultural and social implications, by identifing the types of wheat preserved at an archaeological site. However, this analysis is not always possible by conventional means. Preserved wheat grains are frequently obtained from archaeological sites but the grains are often burnt and distorted, making it difficult to determine whether they come from a tetraploid or hexaploid wheat.

Our aim was to devise new methods of studying prehistoric wheats, making use of the ancient DNA that is present in some preserved grains. We devised a method to distinguish between primitive tetraploid varieties of wheat (emmer wheats) and modern hexaploid forms (bread wheats). The DNA is very fragmented: rather than the immensely long molecules (tens of millions of nucleotides long) found in living cells, we are only able to isolate fragments of a hundred or so nucleotides (see graph). But modern molecular biology techniques are very powerful and we have devised ways of working out DNA sequences from these small pieces of ancient DNA.

Base of burnt basket (about 1.5m across) and bins for grain storage at Late Bronze Age Assiros.

We made two unexpected discoveries. First, we found that, according to its gene content, one of the Bronze Age wheats we examined would have had excellent bread-making properties. This was surprising because prehistoric wheats are not thought to give rise to particularly good quality bread, though some archaeolinguists hold that Linear B texts from Bronze Age Greece refer to bakers. The second discovery is that cultivated wheats are more genetically diverse than previously thought. This suggests that wheat might have been domesticated twice, in two different places, rather than just once as currently believed by archaeologists. We are exploring this possibility further in our current experiments.

Histogram showing the estimated sizes of DNA molecules in the 3,300-year-old wheat from Assiros. The DNA ia very fragmented.



Methods

Our new test involves analysis, by DNA sequencing, of the genes coding for the glutenin proteins. Both tetraploid and hexaploid wheats contain glutenin proteins, but the genes on the D chromosomes have special features which we can recognise by examining their DNA sequences. By looking for these features in ancient DNA from burnt seeds we can tell if a grain comes from emmer or from a bread wheat.

This was a joint project between molecular biologists Terry Brown, Robert Sallares and Robin Allaby (UMIST) and archaeobotanist Glynis Jones (University of Sheffield).

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