Terry Brown – Adapting to a new climate

The origins and development of prehistoric agriculture is one of the main topics studied by the Biomolecular Archaeology group led by Terry Brown. This subject is interesting not only to archaeologists – understanding the genetic changes accompanying domestication of a plant is critical to the design of breeding programmes aimed at improving the modern crop. The problem of sustaining agricultural productivity in a changing climate is high on the agenda at present, and knowing how crops adapted to past climate change can help address this issue.

Wild barley grows naturally in warm, dry areas of Turkey and southwest Asia, but after agriculture spread to northern Europe, cultivated barley became adapted to a much cooler and wetter climate. Part of this adaptation was a change in flowering time. Wild barley flowers early in the year, so that seeds are produced before the conditions get too hot and dry for further growth. In northern Europe, the growing season is longer. Wild barley will grow in northern Europe, but it still flowers early in the season and so is less productive than it might be. Many types of cultivated barley have become better adapted to the northern European climate by flowering later in the year, enabling a longer period of vegetative growth and increased resource storage before setting seed.

The barley *Photoperiod-1* gene is the main locus associated with the change from early to late flowering. As part of his PhD, Huw Jones sequenced this gene in 194 varieties of cultivated barley from across Europe and 72 wild barley plants from the Fertile Crescent, where agriculture began some 10,000 years ago. By carrying out an association study, in which the phenotype of each plant is compared with its DNA sequence, Huw found that the mutation reported as being responsible for the flowering change was not in fact the right one. The correct causative mutation was in a different part of the gene and had previously been overlooked. Phylogenetic analysis of the sequences of the genes in all these different plants showed that the flowering time mutation originated in Iran, probably in wild barley growing in the foothills of the Zagros mountains, where the growing conditions might be similar to those of northern Europe.

This result is surprising as it places the mutation some 1000 km to the east of the main centre for barley domestication, which was in the Israel-Jordan region. Early farmers in Iran also domesticated barley from their local wild populations, but these domesticates were not thought to have contributed to the modern European genepool. The genetic data also suggest that the photoperiod mutation did not enter the cultivated genepool until some time after agriculture became established in northern Europe. One possibility is that late flowering domesticates moved from Iran through Transcaucasia and north of the Black Sea during the Bronze Age, four to five thousand years ago, a period when European agriculture was supplemented with some specialised crops from central Asia. Whatever the explanation, the work has shown that the introgression of wild genes into cultivated plants enabled barley to adapt to the climate change forced on it by the spread of agriculture, raising hope that breeders can adapt barley to future climate change in a similar way.