THE UNIVERSITY OF WARWICK

The Value of Variety
Stories from the past: how crops have evolved

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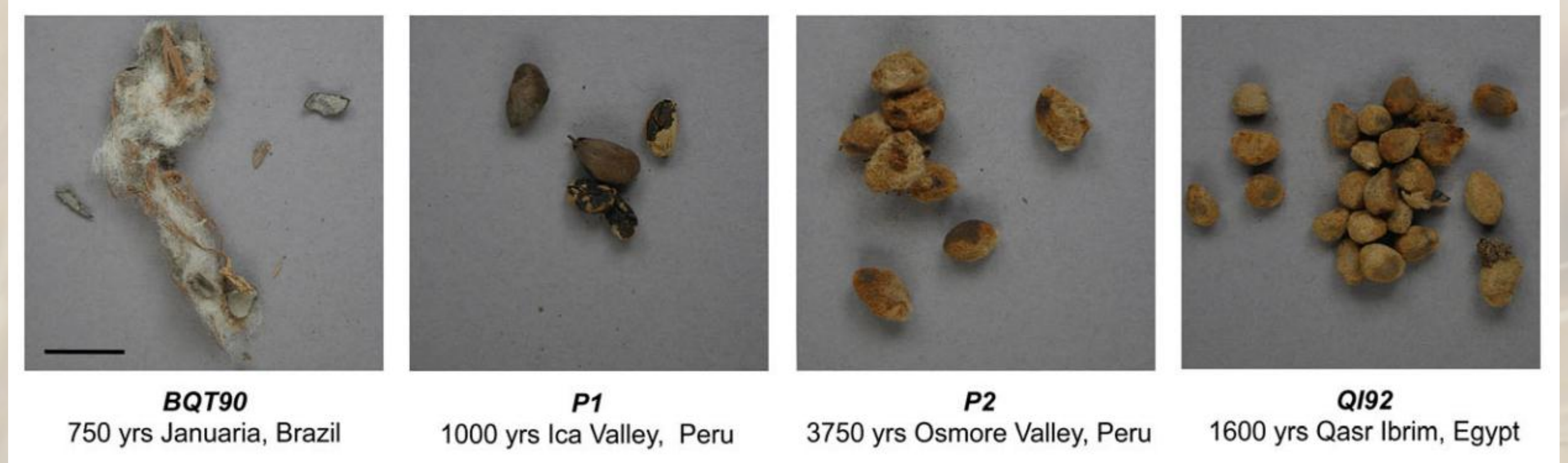
Both archaeological and modern samples of crop plants can be used to study the complex evolutionary system that gives rise to the patterns of genetic diversity we observe in crops today. Using genetic approaches, we are able to ask questions about where crops come from, and how they become locally adapted to environmental conditions. Such information may help us in the future to produce crops that are better adapted to a wider range of conditions: the key to a sustainable future is to understand the past.

HOW DO CROP GENOMES EVOLVE?

Domestication of cotton genomes in Egypt and South America



Archaeological cotton used for ancient DNA analysis

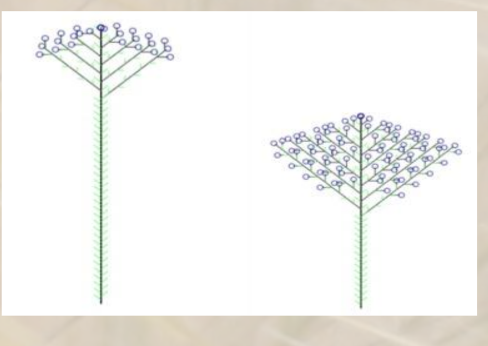
Ancient DNA analysis has generated an unprecedented amount of genomic information from cotton samples from ancient Egypt and South America of up to 4,500 years of age. Not only has this facilitated species identification, but it has also allowed us to study the organisation of ancient cotton genomes. Our analysis of South American *Gossypium barbadense* and Nubian (Egyptian) cotton (*G. herbaceum*) has directly shown that considerable genomic reorganization has occurred within the history of a domesticated plant species. This is as a result of retrotransposon activity; retrotransposons are genetic elements that copy themselves from one place in a genome to another. This observation is important to understanding the process of evolution under domestication.

HOW HAVE CROPS BEEN SELECTED FOR DIFFERENT LATITUDES?

Linking flax adaptation to the European textile revolution and climate

Flax as an oil crop
In addition to being grown as a fibre crop, flax can be grown for its seed, from which linseed oil is derived.

Around 5,000 years BC in Central Europe, Neolithic people began specialising in textile production. This was a result of new agrarian and production technologies and, importantly, new varieties of flax (*Linum usitatissimum*). By examining the genetic diversity of modern cultivars, historic landraces and wild relatives of flax, we have found that fibre varieties are the subpopulation associated with Northern latitudes. Additionally we have found that the gene *LuTFL1* might have contributed to flax adaptation in the European climate and could also have had an impact on the emergence of fibre varieties. The Northern form of this gene was acquired from wild flax relatives that already inhabited Europe, rather than being introduced with flax varieties from the Near East.



Modelling flax evolution
Computer models are helping to understand the relationship between genes and plant architecture (branching patterns) in flax. Flax cultivars grown for fibre (left) tend to have longer, unbranched stems with fewer flowers, whereas those grown for oil (right) tend to have many branches and flowers to maximise seed – and therefore oil – production.

HOW DO CROP GENOMES CHANGE THROUGH TIME?

Millennia of barley evolution in Egypt

Barley spikelet morphology from Qasr Ibrim, Egypt
Abbreviations: fs (fertile spikelet), slb (sterile lateral bract), g (glume), r (rachis). Scale: divisions = 1 mm.

Spikelet and bract attached to rachis. The central fertile spikelet contains a barley grain, sterile lateral bracts do not. The ventral groove of the grain remains untwisted, typical of two-row barley rather than six-row. The resulting barley ear has only two rows of grains.

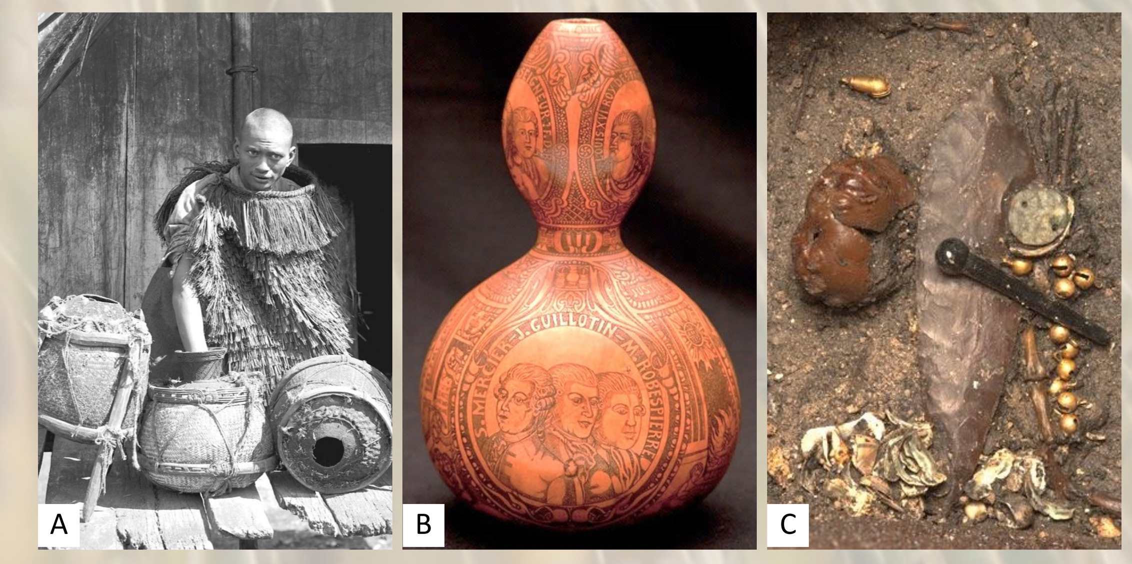
Barley (*Hordeum vulgare*) was the first of the cereal crops to become domesticated, probably because its rapid growth and development suited the short spring and high summer temperatures of the early Holocene period. The rapid growth of barley helps to ensure it completes its lifecycle before experiencing extreme drought stress.

We are studying barley samples from multiple strata in Qasr Ibrim, an archaeological site in Egypt, which span several thousand years. The crop here shows peculiar morphological traits throughout the strata that may be related to environmental conditions, such as drought stress, or genetic control. We are examining the genes that determine the morphology in order to help elucidate which of these two factors could have caused the change in this crop. This will help us to understand how selection under drought stress conditions in the past has helped shape this crop.

HOW HAVE CROPS SPREAD AROUND THE WORLD?

The dispersal of bottle gourd – the world's first global crop

The bottle gourd (*Lagenaria siceraria*) has been cultivated for at least 10,000 years and was the world's first global crop. Its durable fruit shells are used for containers, apparel and musical instruments. Despite its importance and distribution across many cultures, very little is known about the origins and dispersal of this crop. Using archaeological remains of bottle gourd from around the world and cutting-edge ancient DNA techniques, we are reconstructing the evolutionary history of this crop. This will allow insights into the early domestication of plants, the spread of agriculture, and the mapping of prehistoric human migration.



Bottle gourds in diverse cultures

A. Gourd containers for preserving wood pigeons, New Zealand, ca 1903.
B. Late 18th century engraved gourd containing the blood of the executed Louis XVI of France.
C. Aztec gourd filled with tobacco (on left) with a flint knife, obsidian sceptre and gold bells, recovered from the 14–16th century Templo Mayor in Mexico City.

Barley field image courtesy of Bert Lubbers, http://www.flickr.com/photos/bertl/4767551700/