GENOMICS

Bronze Age 'Beaker folk' invaded Britain

Famous bell-shaped pots are associated with a genetically distinct group that may have displaced Neolithic farmers.

LANMAS/ALAMY

Bell-shaped pottery from Segovia, Spain, that is characteristic of the Bronze Age 'Bell Beaker' culture.

BY EWEN CALLAWAY

Around 4,500 years ago, a mysterious craze for bell-shaped pottery swept across prehistoric Europe. Archaeologists have debated the significance of the pots — artefacts that define the 'Bell Beaker' culture — for more than a century. Some argue that they were the Bronze Age's hottest fashion, shared across different groups of people. But others see them as evidence for an immense migration of 'Beaker folk' across the continent.

Now, one of the biggest ever ancient-genome studies suggests both ideas are true. The study, posted on bioRxiv on 9 May[1], analysed the genomes of 170 ancient Europeans and compared them to hundreds of other ancient and modern genomes. In Iberia and central Europe, skeletons found near Bell Beaker artefacts share few genetic ties — suggesting that they were not one migrating population. But in Britain, individuals connected to Beaker pots seem to be a distinct, genetically related group that almost wholly replaced the island's earlier inhabitants (see 'Bell Beaker fashion').

If true, this suggests that Britain's Neolithic farmers (who left behind massive rock relics, including Stonehenge) were elbowed out by Beaker invaders. "To me, that's definitely surprising," says Pontus Skoglund, a population geneticist at Harvard Medical School in Boston, Massachusetts, who was not involved in the research. "The people who built Stonehenge probably didn't contribute any ancestry to later people, or if they did, it was very little."

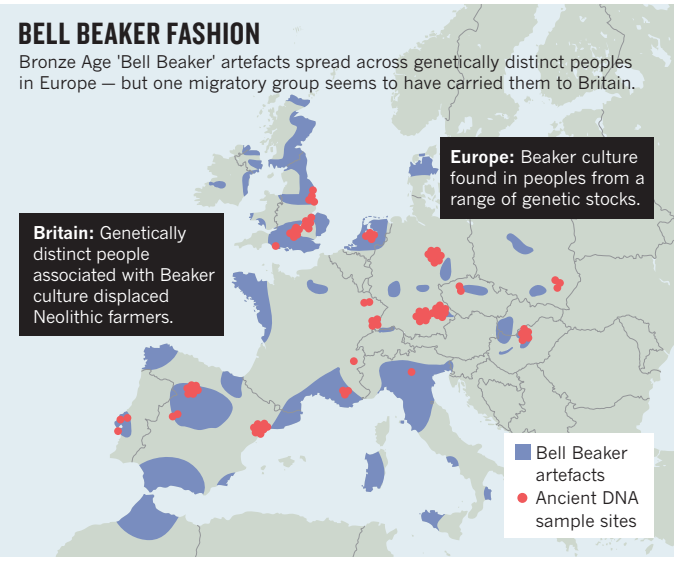
Some archaeologists say that the study does not prove the scale of the British Beaker invasion, but agree that it is a major work that typifies how huge ancient-DNA studies are disrupting archaeology. It's "groundbreaking", says Benjamin Roberts, an archaeologist at Durham University, UK.

THE BELL BEAKER PHENOMENON

The variety of Beaker artefacts makes it hard to define them as emerging from one distinctive culture: many researchers prefer to call their spread the 'Bell Beaker phenomenon', says Marc Vander Linden, an archaeologist at University College London. The distinctive pots, possibly used as drinking vessels, are nearly ubiquitous; flint arrowheads are common, too. But there are regional differences in ceramics and burial style. And the immense, yet discontinuous, geographical range of Beaker sites — from Scandinavia to Morocco, and Ireland to Hungary — has sown more confusion. After a few hundred years, the pots vanish from the record.

A 2004 analysis of strontium isotopes, which vary according to regional geochemistry, suggested that some Beaker-associated individuals did migrate in their lifetimes[2]. Past ancient-DNA studies have also hinted at a huge migration, linking Beaker-associated individuals in central Europe to an influx of 'Steppe' peoples from what is now Russia and Ukraine[3].

The latest work, led by geneticists Iñigo Olalde and David Reich at Harvard Medical School, involved 103 researchers at dozens of institutions, including Bronze Age archaeologists. Reich's team analysed more than 1 million DNA variants across the genomes of individuals who lived in Europe between 4700 and 1200 BC. The team declined to comment because the paper has not been peer reviewed.



SOURCE: M. VANDER LINDEN *ANTIQUITY* **81**, 343–352 (2007)

The analysis seems to dispel the idea of one 'Beaker people' arising from a specific source. Individuals in Iberia (which has been proposed as the wellspring for the culture) shared little ancestry with those in central Europe. Even Beaker-associated people in the same region came from different genetic stock. That pattern contrasts with earlier upheavals in Europe driven by mass migrations, says Skoglund. Bell Beaker "is the best example of something that is pots and not people" that are spreading, he says.

But in Britain, the arrival of Bell Beaker pots coincided with a shift in the island's genetics. Reich's team analysed the genomes of 19 Beaker individuals across Britain and found that they shared little similarity with those of 35 Neolithic farmers there. The pot-makers were more closely related to 14 individuals from the Netherlands, and had lighter-coloured skin and eyes than the people they replaced. By 2000 BC, signals of Neolithic ancestry disappear from ancient genomes in Britain, Reich's team find — largely replaced by Beaker-associated DNA. Such turnover is "pretty striking", says Garrett Hellenthal, a statistical geneticist at University College London who has studied Britain's genetic make-up. More data could reveal surprises, but the team makes a good case that Beaker folk replaced the region's early farmers, he says.

Reich's team calculates that Britain saw a greater than 90% shift in its genetic make-up. But Roberts says he doesn't see evidence for such a huge shift in the archaeological record. The rise of cremation in Bronze Age Britain could have biased the finding, he cautions, because it might have eliminated bones that could have been sampled for DNA. Although archaeologists are excited to see ancient DNA yield breakthroughs in problems that have vexed their field for decades, says Linden, he expects some push back against the latest study's conclusions. "It's not at all the end of the story." ■

1. Olalde, I. *et al.* Preprint at bioRxiv http://dx.doi.org/10.1101/135962 (2017).
2. Price, T. D. *et al. Eur. J. Archaeol.* **7,** 9–40 (2004).
3. Haak, W. *et al. Nature* **522,** 207–211 (2015).

PLANT PATHOLOGY

Engineered virus in line to battle citrus disease

Geneticists search for ways to attack the bacterium laying waste to US orange harvests.

BY HEIDI LEDFORD

Fruit farmers in the United States have long feared the arrival of harmful citrus tristeza virus to their fields. But now, this devastating pathogen could be their best hope as they battle a much worse disease that is laying waste to citrus crops across the south of the country.

The agricultural company Southern Gardens Citrus in Clewiston, Florida, applied to the US Department of Agriculture (USDA) in February for permission to use an engineered version of the citrus tristeza virus (CTV) to attack the bacterium behind citrus greening. This disease has slashed US orange production in half over the past decade, and threatens to destroy the US$3.3-billion industry entirely.

The required public comment period on the application ended last week, and the USDA will now assess the possible environmental effects of the engineered virus.

Field trials of engineered CTV are already under way. If the request is approved, it would be the first time this approach has been used commercially. It could also provide an opportunity to sidestep the regulations and public stigma attached to genetically engineered crops.

"There's a real race on right now to try to save the citrus," says Carolyn Slupsky, a food scientist at the University of California, Davis. "This disease is everywhere, and it's horrible."

The engineered virus is just one option being explored to tackle citrus greening. Other projects aim to edit the genome of citrus trees using CRISPR–Cas9 to make them more resistant to the pest, or engineer trees to express defence genes or short RNA molecules that prevent disease transmission. Local growers have also helped to fund an international project that has sequenced citrus trees to hunt for more weapons against citrus greening.

"There are great scientific opportunities here," says Bryce Falk, a plant pathologist at the University of California, Davis. "We need to take advantage of new technologies."

Citrus greening is caused by species from the candidate bacterial genus *Candidatus* Liberibacter. Spread by sap-sucking, flying insects called Asian citrus psyllids (*Diaphorina citri*), the bacteria cause citrus trees to make bitter, misshapen fruits that have green lower halves. The disease is also widely known by its Chinese name, *huanglongbing*. ▶