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The Beaker revolution

Britain's Bronze Age DNA decoded

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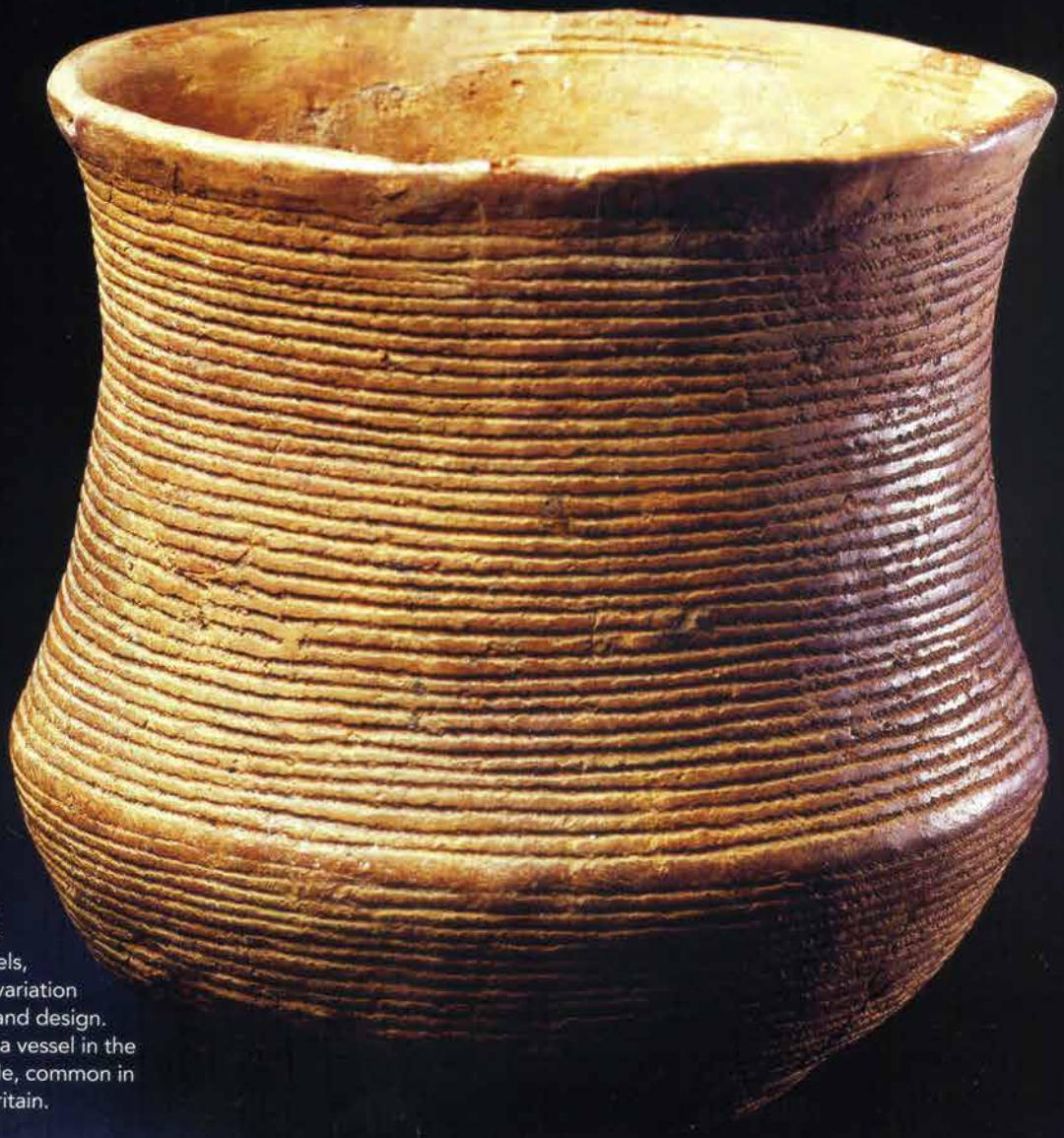
Prehistoric pop culture

Deciphering the DNA of the Bell Beaker Complex

More than 4,500 years ago, a hugely popular cultural phenomenon – today known as the Bell Beaker Complex – captured the prehistoric imagination, flourishing across much of Europe. Archaeologists are still deliberating over how this Complex, first identified in the 19th century, developed so quickly and effectively. Now the largest ancient DNA study to-date has shed revolutionary new light on the question, with surprising implications for our understanding of ancient populations – particularly that of Britain, which seems to have undergone an almost complete genetic turnover in just a few centuries. **Kathryn Krakowka** reports.



RIGHT The Bell Beaker Complex was an immensely popular cultural phenomenon that swept through Europe and Britain in the middle of the 3rd millennium BC. It is characterised by its 'beaker'-shaped vessels, which show regional variation in both manufacture and design. This is an example of a vessel in the 'All-Over-Corded' style, common in central Europe and Britain.

PHOTO: National Museums Scotland

At the start of the 3rd millennium BC the peoples of Europe were, for the most part, technologically and socially disparate: in the eastern and southern reaches of the Continent, metallurgy had begun in earnest, while in Britain and other areas of northern Europe flint was still king. By the middle of that millennium, however, the region had been swept – and largely united – by a cultural package known as the Bell Beaker Complex.

Archaeologically, this movement is defined by the presence of 'beaker'-shaped vessels that are generally found in funerary contexts and often next to crouched human burials. Originally considered a 'culture', in recent years the Bell Beaker phase has instead been referred to as a 'Complex' or 'Phenomenon' due to the wide range of variations seen in the design of the artefacts it produced. While the pottery always retains its distinctive 'beaker' shape, the patterns with which the vessels are decorated can differ greatly.

Among these, a key group is the 'Maritime' beaker vessels, which are found predominantly in Iberia, but also along the Atlantic and Mediterranean shores. This style, defined by repeated patterns of horizontal bands over the entire surface of the pot, is thought to have originated early in the Beaker period. In central Europe, though, we are more likely to find 'All-Over-Corded' vessels, which, as the name implies, are adorned with cord-like impressions. While both types have been found in Britain, this latter style seems to have been more dominant.

Archery also seems to have been a defining aspect of the Complex, with paraphernalia including stone wrist-guards, flint arrowheads, and sometimes even bows found in Bell Beaker graves. Other artefacts commonly associated with such burials include copper daggers and buttons with V-shaped holes. In Britain, the most famous Bell Beaker grave is that of the Amesbury Archer from Boscombe Down in Wiltshire (see *CA* 184 and 265), but these burials have been found throughout Britain, from Orkney to Cornwall.

It is not just new material culture that seems to have spread so effectively across Europe. Presumably these artefacts were also accompanied by a set of practices, beliefs, and other intangible aspects of culture that cannot be elucidated through the archaeological record. It is this assumption that makes the Bell Beaker period so significant: the development of the Complex marks the first time archaeologically that we can see such large-scale cultural diffusion.

A COMPLEX PHENOMENON

While we can unpick its material components, the geographical origins of the Complex remain elusive. The earliest radiocarbon date for a Bell Beaker site (*c.*2750 BC, at Leceia in the lower Estremadura region of Portugal) suggests possible beginnings among the people of Copper Age Iberia, but other theories propose the Lower Rhine area instead. Unfortunately, an inconsistent radiocarbon resolution for this period means that such evidence ➡

ABOVE A double Beaker grave from Trumpington Meadows in Cambridgeshire, excavated by the Cambridge Archaeological Unit. It contained two individuals in their late teens, one male and one female, as well as two distinctive Beaker vessels. Such pots are commonly found next to crouched human burials, giving these graves their name.

IMAGES: Dave Webb, Cambridge Archaeological Unit

ABOVE Artefacts associated with the Bell Beaker Complex include flint arrowheads, stone wrist bracers, and copper knives.

IMAGES: Wessex Archaeology

can only provide broad date ranges and is not capable of resolving the issue.

What is clear about the Beaker Complex, though, is that from *c.*2600 BC until *c.*2000 BC it was extremely popular, rapidly diffusing through large swathes of the Continent. At its peak, it encompassed the vast majority of Europe, as well as parts of northern Africa. The juxtaposition of this fast transmission of ideas and practices with the clear regional variation seen in the design and manufacture of Beaker artefacts is a puzzle, however, sparking fierce debate among archaeologists. The key question is whether this cultural diffusion was driven by the large-scale migration of people across the region, or by the communication of ideas through social interactions.

Recently, the largest ancient human DNA project to-date – carried out by an ambitious international team of over 100 archaeologists and geneticists – set out to address this issue. By sequencing the genomes of hundreds of Neolithic, Copper Age, and Bronze Age Europeans and mapping the relatedness of different populations, they hoped to document the movement of these prehistoric people. The project's outcomes have game-changing implications not only for our understanding of prehistoric populations, but also for the future prospects of ancient DNA in wider archaeological research.

Ancient DNA advances

Ancient DNA (aDNA) analysis is a well-established technique, first conducted on zooarchaeological remains in the 1980s. But it is only in the past decade that archaeological scientists have been able to successfully and consistently sequence the genome of ancient humans, with the biggest improvements to the technique being seen in just the past few years.

There had been many pitfalls in ancient human DNA analysis, including cost, risk of contamination with modern DNA from those who handled the sampled remains, and inconsistent preservation of aDNA in the burial environment.

Recent advances, though, have overcome many of these problems. The first crucial innovation was the development of methods, many of them in the laboratories of Svante Pääbo and Matthias Meyer at the Max Planck Institute for Evolutionary Anthropology in Leipzig, that made the extraction of DNA and its conversion into sequenceable parts far more efficient than it was a decade ago.

Second was the demonstration, by Professor Ron Pinhasi and his colleagues, that the petrous bone, which contains the inner ear, preserves ancient DNA remarkably well. Due to its location deep inside the cranium, it is largely protected from the burial environment and can contain up to 100 times more DNA than other bone samples.

A third advance was the development of technology that makes it possible to enrich aDNA samples of approximately one million information-abundant Single Nucleotide Polymorphisms (or SNPs – pronounced 'snips') and then sequence them for analysis, instead of the entire genome. SNPs are nucleotide changes that occur at specific positions in the genome and which reflect variations between different populations. This advance, in conjunction with the development of more efficient machinery, has made the whole process much quicker and less costly.

IMAGE: Wetwang Garton Slack

ABOVE A typical 'beaker' pot from a grave in East Yorkshire.

DNA DETECTIVE WORK

As recent scientific advances have made it possible to carry out large-scale aDNA analyses (see box opposite), the opportunity finally arose to answer how the Beaker Complex spread. Dozens of archaeologists and geneticists, from across Europe and the United States, compared the DNA of different populations associated with the phenomenon, as well as those dating to just before and after the period. In doing so, they were able to draw a map of genetic relatedness – or lack thereof – between these groups.

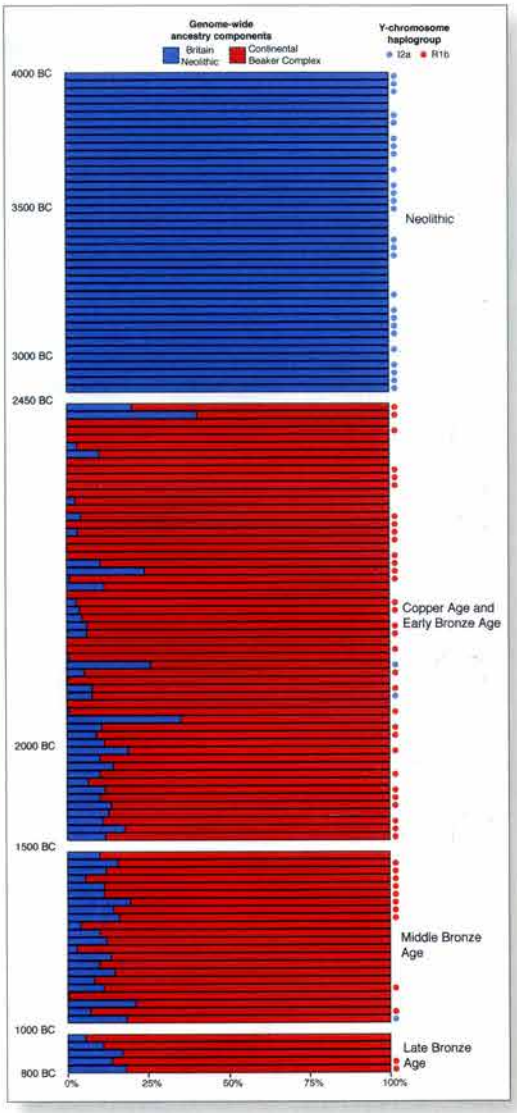
It was an undertaking on an unprecedented scale: the team sequenced the entire genome of 400 prehistoric Europeans whose remains had been excavated at 136 different sites across the Continent, spanning *c.*4700-800 BC in date; of these, 226 of the individuals sampled were associated with the Beaker Complex. The British dataset was particularly robust, encompassing 37 Beaker Complex-associated individuals and 118 who lived at either end of the period. The researchers then combined their findings with previously published aDNA sequences to form a new database some 683-strong. To help further pin down the timeline, they also directly radiocarbon-dated 111 samples.

To supplement the whole-genome data, the team also used mitochondrial DNA (or mtDNA) and the Y-chromosome to identify haplogroups, or populations with a shared common ancestor. While mtDNA is found within the mitochondria of each cell (rather than in the nucleus, where the majority of DNA is stored). It is a separate form of DNA that is only passed on through the mother, and therefore provides an excellent resource for tracing matrilineal ancestry. (It is this technique that was used to confirm the identity of Richard III, through descendants on his mother's side – see *CA* 277 and 294.) The Y-chromosome provides the same information for patrilineal descent, although this is more limited since it is only passed on from father to son, instead of to all offspring regardless of sex, as is the case with mtDNA. By using information from the whole genome, and the tens of thousands of independent lineages represented within it, in conjunction with Y-chromosome and mtDNA haplogroup information, the team was able to make very precise assessments about population changes over time.

Wherever the team looked, throughout the various populations of Continental Europe, the results painted a striking picture: despite some genetic mixing, for the most part the Beaker-practising groups ➡

BELOW The ring ditch found at the Canada Farm site in Dorset (see *CA* 279). Seven burials (including one cremation) were excavated here in 2009; the aDNA from two of them was sequenced for this project, including the individual found in the primary burial from the site – a man in his late twenties, who was characteristically buried with a Beaker vessel.

PHOTOS: Martin Green



LEFT This figure from the *Nature* paper that recently published the results of this project starkly illustrates the rapid integration of Continental Beaker Complex-associated groups into the British population. Each bar represents the entire genome of one sampled individual from Britain: blue indicates the proportion of Neolithic ancestry, and red the proportion of central European-associated lineages.

in Iberia were unrelated to those in central Europe or Britain. This indicates that the Beaker Complex predominantly spread across the Continent not through the migration of a homogenous group of people, but through social interactions and the transmission of ideas. If so, this would be in direct contrast to other earlier and contemporaneous cultures like the early Bronze Age Yamnaya of the Eurasian steppe and the Corded Ware Complex of central and eastern Europe (which overlapped both geographically and chronologically with the Bell Beaker Complex). These appear to have expanded primarily through population movement.

BEAKER BRITAIN

Over in Britain, the plot thickens. Due to the amazing preservation of aDNA from ancient British individuals, the team was able to examine the region in minute detail. Rather than maintaining the genetic profile of their Neolithic predecessors (who were closely related to Iberian early Neolithic farmers), the results showed that British Bell Beaker populations were in fact more closely related to those from central Europe. This suggests that, although the Beaker Complex spread between Iberia and central Europe through the movement of ideas, in Britain its expansion occurred through the movement of people, and in some numbers.

As mentioned before, both the 'All-Over-Cord' and 'Maritime' Beaker designs are known in Britain, suggesting cultural influences from both central Europe and Iberia. It would seem logical that these two separate, although linked, styles would have been introduced to the region by different groups – but the new genetic results seem to indicate that this was not the case. Rather, regardless of pottery style, all the sites studied suggest a shared origin with central European Beaker populations, with no evidence for the migration of Iberian Beaker people into Britain at all.

This central European population movement into Britain was swift and hugely successful, DNA analysis suggests. After 2450 BC, when the Beaker Complex first arrived in the region, all sampled individuals from Britain show an abrupt change in their genome, with central European Bell Beaker-associated lineages suddenly accounting for the vast proportion of their overall ancestry. Over the next few hundred years, the proportion of this migrant DNA continued to vary slightly, indicating that some mixture with local Britons was ongoing – although it still accounted, on average, for at least 90% of ancestry. But by the end of the Beaker period the population had completely homogenised, and it seems that the Neolithic peoples of Britain – the ones who built Stonehenge, traversed the Sweet Track, and settled Skara Brae – had all but disappeared.

What could have caused such a rapid disappearance of Neolithic Britons? For now, the answer remains unknown, and opens up a lot of new questions.

BELOW The Amesbury Archer, at Boscombe Down, Wiltshire, was discovered with a plethora of Bell Beaker-associated grave goods (some are shown on p.18).

© WANHS, Wessex Archaeology; IMAGE, Nature and I Olalde et al

How did a seemingly thriving population evaporate from the gene pool? There is no evidence to suggest a hostile invasion, although it does, of course, remain a possibility. Other scenarios include an environmental change or catastrophe that the indigenous population could not adapt to, or new diseases that the Beaker migrants may have brought with them against which the local people had no natural resistance. Additionally, the Neolithic British population might have declined when they were forced to shift to a more pastoralist lifestyle after a period of unsuccessful crop farming.

We must also ask, where did these newcomers migrate from? The aDNA project found that the British Bell Beaker groups, particularly those in the south, were most closely related to individuals whose remains were recovered from the Oostwoud-Tuithoorn site in the West Frisia region of the Netherlands. The parallels were striking: both groups presented with an almost identical percentage of steppe-related ancestry. This does not necessarily mean that people from Oostwoud were the ones migrating into Britain, but it does suggest that they had a shared common ancestor. Whoever settled Oostwoud, most likely moved on to settle in Great Britain too.

Widening this picture, as the team also analysed the genetic profiles of Neolithic and later Bronze Age populations, they were able to draw a timeline of different genetic traits and their entry into Britain. Among these, the researchers noticed that between the Neolithic period and the start of the Beaker period the genes for lighter skin and eye pigmentation significantly increased in frequency – before this, Britain's inhabitants seem to have had much darker skin and hair. (The Mesolithic population, exemplified by the individual known as Cheddar Man, was darker still – see *CA* 337.) The arrival of the Beaker Complex seems, therefore, not only to have completely altered the genetic makeup of the British peoples, but also transformed their physical appearance. One trait that the wave of incomers did not introduce to any great extent, however, was the ability to digest lactose. The gene was not found with any frequency for this period, meaning that dairy consumption would not have become widespread in Britain, or indeed Europe, until some time within the last 3,500 years (see *CA* 335).

NEW FRONTIERS

Perhaps, then, the Bell Beaker Complex should be seen as one of the earliest examples of what could be described as 'popular culture'. Like the spread of democracy, the Beatles, or the internet, there was something inherently appealing about the Complex that enabled it to expand so successfully. While we may never know the intangible beliefs of the phenomenon that made it so popular to Copper Age Europeans, we do at least now have a solid understanding of how its practices spread through the region. And, as with more modern examples of cultural diffusion, its success was down to a complex mix of the spread of ideas and the movement of people.

Just as the Bell Beaker phenomenon revolutionised early Bronze Age Europe and Britain, so too is aDNA revolutionising archaeological research. The research featured in this article has not only been successful in providing strong evidence for the development of a prehistoric culture, it has also clearly demonstrated the capabilities of aDNA analysis. Large-scale ancient genome projects such as this one are redefining how we look at long-standing archaeological debates, opening up possibilities of analysis that had before been seen as impossible.

The impact of this project cannot be overstated: in sequencing the genomes of 400 prehistoric individuals, the international research team, in a single paper, has increased the previous number of sequences available from ancient human remains by more than 50%. It also illustrates just how quickly this area of research has grown: in 2013, only ten samples from ancient humans had been sequenced. This flourishing field is set to make significant waves in the world of archaeology. ❙

BELOW An artist's impression of how a Bell Beaker-practising individual might have looked.

IMAGE: Manuel Rojo-Guerra/Luis Pascual-Repiso

Acknowledgements

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Further reading

- Olalde *et al.* (2018) 'The Beaker phenomenon and the genomic transformati on of north-west Europe', *Nature* 555: 190-196.
- Mathieson *et al.* (2018) 'The genomic history of south-eastern Europe', *Nature* 555: 197-203.