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Ancient DNA

Bronze Age genomes reveal migration to Britain

Daniel G. Bradley

The genomes of hundreds of individuals who lived in Great Britain and in continental Europe during the Bronze Age provide evidence for a migration of people from the continent to southern Britain between 1000 and 875 BC.

Around the year 2300 BC, a man now nicknamed the Amesbury Archer was buried with exceptional riches near the ancient stone monument Stonehenge in southern England. The Amesbury Archer and the items buried with him provide a snapshot of a culture in the south of Britain that used metal and created distinctive ceramics, known as Bell Beaker pottery. This man was also an immigrant: analysis of oxygen isotopes in the enamel layers of his teeth that had formed in childhood suggested he originated from the Alps in central Europe[1]. Writing in *Nature*, Patterson *et al.*[2] analyse his genome and those of hundreds of other ancient individuals buried across Britain, as well as in continental Europe, to unravel Britain's migratory past with unprecedented granularity.

For decades, the idea that large-scale migrations explained changes in a region's culture had fallen from favour[3], mostly because reconstructions of massive, unidirectional migrations were exploited by destructive political movements in the early twentieth century. The concept of migration is still a source of discussion among geneticists and archaeologists, who can ascribe slightly different meanings to the term. For archaeologists, it has usually meant a large, one-way movement during a circumscribed period of time[4]. For geneticists, it can also encompass something more subtle — a process by which the genetics of a population can be gradually altered through the movement of a few migrants at a time.

By piecing together the contributions of different ancestries to the genetic backgrounds of hundreds of pre-Roman British genomes, Patterson *et al.* clearly describe evidence of both sharp and more gradual migrations. First, the time of the Amesbury Archer marks a genetic 'turning point' in the Neolithic–Chalcolithic transition at around 2450 BC. Second, the authors uncover, for the first time, a large-scale migration of people from continental Europe to southern Britain between 1000 and 875 BC.

The Archer's genome is from the end of the Neolithic period (3950–2450 BC), when individuals in Britain uniformly had what the authors call majority 'early European farmer' (EEF) ancestry. This ancestry was carried to Europe thousands of years earlier by agriculturists from Anatolia, in what is now Turkey[5,6]. Changes in the proportion of this EEF ancestry in the British population are a powerful indicator of inward migration. From the Archer's time onwards, the proportion of EEF ancestry among British individuals drops steeply (Fig. 1). This decline is associated with what is known as the Bell Beaker horizon, when we know that the westward movement of people originating from the Pontic–Caspian Steppe in Asia, across much of northern Europe[7,8], found its way to Britain and Ireland[9,10].

Once the EEF ancestry in southern Britain was diluted, its contribution to the genetic background of individuals in that region fluctuated a little before stabilizing for around a millennium. It then rose again between 1000 and 875 BC — in the Late Bronze Age — reaching a steady state that persisted through the Iron Age, which spanned from about 800 BC to AD 43 (Fig. 1). The previously unknown

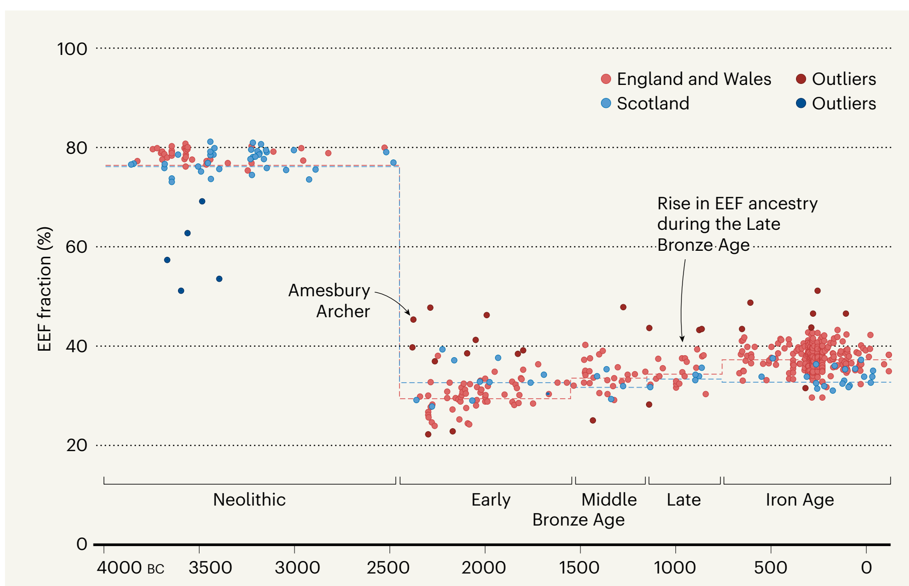

Figure 1 | The contribution of early European farmer ancestry to individuals in ancient Britain. Patterson *et al.*[2] assessed the genomes of ancient individuals living on the island of Britain and in continental Europe between about 4000 BC and AD 43, including the genome of a man nicknamed the Amesbury Archer. After a rapid decline in early European farmer (EEF) ancestry in southern Britain at around 2450 BC, the proportion of EEF ancestry fluctuated for about a millennium. The authors' data suggest that there was then a substantial increase in genomic contributions of EEF ancestry in southern Britain between 1000 and 875 BC, during the Late Bronze Age, probably owing to migration from continental Europe. Data points represent individuals in southern Britain (England and Wales; red) or Scotland (blue), with outliers in southern Britain and Scotland shown in dark red and dark blue, respectively. Dashed lines represent average EEF contribution to individuals in England and Wales (red) and Scotland (blue). Many of the outliers found in southern Britain were in Kent (a county on the British south coast that is nearest to France) and showed an exceptionally high proportion of EEF ancestry — supporting the idea that EEF ancestry arrived in Britain through migration.

change in ancestry during the Late Bronze Age is probably due to migration from the nearby continent.

Patterson and colleagues' modelling of admixture (the mixing of genetic lineages) suggest that the most likely source populations for this renewed influx of EEF ancestry derive from sites in France — although pinpointing its origins is difficult, because the regions closest to Britain remain undersampled. Indeed, the exceptionally high proportion of EEF ancestry found in several individuals from Kent (a county on the British south coast that is closest to France) probably offers a glimpse of migratory streams across the narrow Strait of Dover, which would have been busy with trade and traffic during the Late Bronze Age[11].

The westward introduction of Steppe ancestry into Europe in the third millennium BC was profound but varied, resulting in an unevenness in the retention of EEF ancestry, with more of this ancestry persisting in southern populations than in those in the north of Europe. The rise of EEF ancestry in Britain over the centuries after 1000 BC is part of a wider homogenization, in which the relative proportions of the ancestral contributions to populations in different regions across much of Europe became increasingly similar. Intriguingly, the exceptions to this homogenization are geographical outliers; the ancestry of populations living on the Mediterranean island of Sardinia and (according to Patterson and colleagues' study) in Scotland remained relatively unchanged despite this broad convergence.

The migration to southern Britain during the Late Bronze Age was probably gradual and — over some hundreds of years — contributed about 50% to individuals' ancestry. The contribution of this migratory ancestry decreases from south to north, with estimates of only 8–20% for its influence in Scotland. Interestingly, this Scottish particularity mirrors the effects of other migrations to the island of Britain; for example, only a handful of genomes sampled from fourth-millennium BC, Neolithic individuals in Britain show evidence of input from hunter-gatherer groups from thousands of years earlier, and those genomes were from people found at the western edge of Scotland[12]. In recent millennia, the more-fertile lowlands of southeast Britain (very roughly mapping to the country of England) were the focus of Roman influence, plus later migrations of Angles, Saxons, Frisians and Danes[13,14] from northern continental Europe.

Patterson and co-workers' findings demonstrate the power of fine-grained temporal sampling of ancient genomes, and reveal a previously unsuspected, major migration to Britain that was not detectable using previous, sparser data[10]. The authors' study also enables the timing of the strongest recent gene selection in western Europe. Specifically, the authors' data suggest that the proportion of adults who were still able to digest lactose (the sugar found in milk) after childhood, by producing the enzyme lactase, rose sharply during the Iron Age, presumably because of increased reliance on dairying.

Similarly dense sampling will be needed in other European regions to interpret the homogenization of their populations during the Late Bronze Age — for example, to test for an association with the spread of what is known as the Urnfield group of cultures of central Europe[11]. Ireland and Wales were relatively unaffected by the Anglo-Saxon influx to Britain that led to language changes in England after the fifth century AD (ref. 13). Very few Iron Age individuals have been sampled in Wales, and none in Ireland. It will be intriguing to see how these regions were included in this early European homogenization.

Notably, the Amesbury Archer shared a foot-bone anomaly with a younger man buried metres away, suggesting that they were relatives. Their genomes do not support this, but Patterson *et al.* did find 123 other people belonging to 48 families in their broad sample. Further genomic parsing of the genetic relationships of the dead will surely provide fresh inferences of the diverse manifestations of kinship, marriage and social organization in the dynamic world of Bronze Age Britain[15].

Moreover, the Amesbury Archer and some Late Bronze Age individuals from Kent have non-local isotopic signatures and are probably directly sampled migrants. The occasional appearance of such individuals in the archaeological record is surely not unexpected. However, rather more surprising is the scale of the two episodes of continental influx that Patterson *et al.* have determined from the genetics of the descendants of such voyagers. Reconciling these migrations with the archaeology of Bronze Age Britain is a task that will need close attention[15].

Daniel G. Bradley is at the Smurfit Institute of Genetics, Trinity College Dublin, Dublin 2, Ireland.
e-mail: dbradley@tcd.ie

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