Emma Brown

Science on the Western Front

Identifying the missing from the Great War 1914-1918

In the years 1914-1918, troops from Britain and its Dominions, as well as men and women from France, Belgium and eventually the United States, were at war with Germany and Austria-Hungary. The Western Front saw some of the fiercest fighting with huge numbers of casualties. Emma Brown of Bradford University describes the part played by science when new graves of the war dead are found.

The Western Front in 1917 from a map of the time

The total number of military dead in WW1 is estimated at 8.5–10 million. In the mud and confusion, many of the dead did not have proper burials. Many temporary graves were destroyed by later shellfire. There are some 100 000 missing and assumed buried on the fields of the Somme alone, so it is not surprising that the remains of soldiers of the Great War are occasionally recovered during archaeological investigations.

Key words
DNA analysis
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Archaeologists digging by hand at the mass grave, Fromelles

The No Man's Land Archaeology team discovered three soldiers from trenches around Serre in 2003 and the Plugstreet soldier in 2008 (see Box). Then, in 2009, 250 mostly Australian men were also found buried in a mass grave in Pheasant Wood, near the French town of Fromelles. With the aid of scientists, archaeologists, historians and organisations such as the Commonwealth War Graves Commission, every effort is made to identify the missing and re-bury them in war cemeteries.

Historical records

Several different approaches can help us to identify the individuals whose remains we find. Firstly, the service records of men who enlisted to serve in the Great War contain information that may be of use in the identification process, such as the soldier's age, place of birth, occupation and height. He would have also undergone a medical examination to ensure he was fit for service. In some cases, previous injuries were noted. Occasionally dental records exist, as was the case with the Plugstreet soldier.

Box: The Plugstreet Soldier

Private Alan James Mather was born in Inverell, New South Wales, Australia, in 1879. He was a prize-winning winemaker. He enlisted in the Australian Infantry in January 1916 and was killed in action on 7th June 1917 at Messines. He was 37. He was described by his commanding officer as 'one of my best and most trusted men'. Alan was discovered by the No Man's Land team during the excavation of the German front lines near Ploegsteert Wood in 2008. A combination of scientific techniques established his identity.
Private Mather was reburied with full military honours at Prowse Point Cemetery, near Ploegsteert, Belgium on 22 July 2010.

Private Alan James Mather

The full military funeral of Private Alan James Mather at Ploegsteert Cemetery

The quality of information available from service records varies. In the case of Australian soldiers, extensive and thorough service records survive and are free to access online via the National Archives of Australia. Sadly, the service records of men from the UK are in a very poor condition as they were severely damaged during the Blitz of 1940-41.

The chemistry of personal effects

A useful starting point for the identification of unknown soldiers is the examination of their personal effects. Metal items, such as shoulder titles and other regimental insignia can tell archaeologists the nationality of the force the solider served with, which was the case with the Plugstreet Soldier, who was found with intact 'Australia' shoulder titles and the 'Rising Sun' general service badge.

The Rising Sun badge of the Australian Army found with the Plugstreet soldier and in use during WW1

These badges were made of brass, an alloy of copper and zinc. Corroding copper alloys can preserve organic material, such as wool and cotton, when in close association. As the alloy corrodes, copper ions build up in the organic material. High levels of copper ions act as a biocide, inhibiting the process of microbial decay, resulting in fragments of preserved material. The pH of surrounding soil affects how well clothing items are preserved. For instance, wool (keratin) degrades rapidly in alkaline conditions, whilst cotton (cellulose) degrades more rapidly in acidic conditions. Other materials, such as leather, are more resistant to decay. It is not unusual to find a body wearing only leather boots as the wool and cotton materials have degraded.

The Rising Sun badge and an Australia badge are set up for X-ray.

X-ray of the Rising Sun badge.

Anthropology

Obtaining a biological profile of an unknown body is an important step in the identification process. Males and females look different. This is known as sexual dimorphism, and is evident in the skeleton. This is most evident in the pelvis. The female pelvis is designed for childbirth, so is wide in comparison to the male pelvis.

It is also possible to tell age from the skeleton. When we are born our bones are not fused; this allows for growth. As we age, the ends of the bones (epiphyses) fuse to the bone shaft (diaphyses) at predictable times. The pattern of fused bones can help establish age. The last bone to fuse is the clavicle (collar bone), at around 30 years.

To age older individuals, patterns of age-related changes in the bones are used. The deterioration of the joint between the two pubic bones, known as the pubic symphysis, is well documented and can be used to estimate age to within a few years. Anthropologists can also estimate height by taking measurements from long bones. Old injuries, such as fractures, and pathological changes, such as osteoarthritis and dental disease, may also be helpful in establishing identity.

Isotope analysis

Isotopes of an element are atoms whose nuclei contain the same number of protons but different numbers of neutrons. Stable isotopes are those that do not decay or that have extremely long half lives. Strontium has four stable isotopes. One of these, ^{87}Sr, is formed from the radioactive decay of ^{87}Rb (Rb = rubidium, half life: 4.88×10^{10} years). In very old rocks, such as granite, the ratio of $^{87}Sr/^{86}Sr$ is high. In younger rocks, such as basalt, the ratio of the two isotopes is low. As rocks are weathered, strontium is released into plants and drinking water. Since strontium has a relatively large mass it does not fractionate (i.e. the ratios of the different isotopes remain constant).

Human teeth form during childhood and strontium from the biosphere is incorporated into the developing teeth. Therefore the ratio of $^{87}Sr/^{86}Sr$ in tooth enamel mirrors the strontium isotope composition of the geology of the area in which a person spent their childhood. Bone on the other hand changes – it 'remodels' in 7-10 year cycles. As a result, the strontium composition of bone reflects the geology of the area in which the person spent the last decade of their lives.

Archaeologists have compared strontium isotope ratios from tooth enamel and bone to investigate ancient migrations. The same techniques were also used by archaeological scientists to help identify the Plugstreet Soldier. As Australia is extremely geologically diverse, scientists from the University of Oxford were able to narrow down the area this man spent his childhood to two areas: the Sydney Basin or the Hunter Valley in New South Wales, Australia.

DNA – genetic analysis

Deoxyribonucleic acid is present in the cell nucleus. It is unique to every individual. DNA analysis has a number of applications in forensic science. One of them is the identification of unknown bodies. However, DNA is very susceptible to breakdown and it is often impossible to get DNA profiles from old or decomposed remains.

Instead of genomic DNA from the cell nucleus, scientists can use mitochondrial DNA (mtDNA), for identification purposes. Mitochondria are the organelles in the cell that are responsible for energy production. Their DNA is separate from genomic DNA and is passed from a mother to her children, so mtDNA can be used to trace maternal lineages. It has been used successfully in a number of high profile cases, including the identification of the last Empress of Russia and her children who were executed by firing squad in 1918.

DNA sampling procedures are discussed on site.

Males have both an X and Y chromosome as part of their genomic DNA. The Y chromosome can be used to trace paternal lineages, which may also be helpful in identification if no suitable mtDNA donors are available.

Both of these techniques have been used to help identify the missing of the Great War. As part of the identification process of the 250 men buried at Pheasant Wood, both mtDNA and Y chromosome profiles were obtained for all of the men. However, not all were identified, as families have to provide a DNA sample for comparison. In some cases it was not possible to obtain samples from a suitable donor.

Emma Brown is a doctoral student in Archaeological Sciences at the University of Bradford.

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