Gabriel's Gully, Tuapeka [J.T. Thompson, 1861, 92/1289 from Hocken Collections, Uare Taoka o Hākena, University of Otago]

Forensic science can be tasked with identifying the identity of human remains. And the process is fascinating. ***Guest author Mike Stone*** *explains how scientific analysis of these remains can provide interesting insights into our history.*

Unknown remains

When bodies have been in the ground for a while they often cannot be identified using soft tissues (e.g. fingerprints, blood) due to their extensive damage. Bone may survive but its DNA is difficult to test due to its structure (cells embedded in a hard matrix) and the effects of decomposition (the DNA is often degraded and in low quantity) – and this makes it expensive.

Bones

Careful observation of bones can reveal some general characteristics of the unknown person. For example:

- Gender: based on shape of pelvic bones and some features of the skull
- Age: based on the stage of growth plate development in the bones when young, wear and tear in adults over 20 (for whom scientists can only estimate a broad age group)
- Height: based on the length of long bones
- Build: muscle markings on bones can show a slight, medium or large build
- Disease: some diseases are evident in the bones, eg syphilis, arthritis, gout
- Trauma: damage from the past (e.g. healed fractures) or related to the cause of death

Isotopes

All elements come in different forms called isotopes, each with different amounts of neutrons eg C-12, C-13, C-14. These isotopes enter the food chain when plant roots absorb dissolved minerals along with water. We take in isotopes with food and water and it ends up in our tissues. As certain isotopes are more abundant in some materials and places than others their presence can identify something about where that element came from. Also different tissues will provide isotope data from different life stages - eg. teeth provide info on childhood (when they were being formed), bones provide more recent (remodelling every 10 years or so) and hair the most recent information. Key isotopes are:

- Strontium - identifies the geology in the area where tissue formed
- Oxygen - indicates the climate a person was in, e.g. dry or wet, warm or cold.
- Carbon & Nitrogen - show the type of plants and animals being eaten or if the person was starving

Nuclear DNA

DNA can be extracted from bone fragments, teeth, blood and other tissue and then multiple copies need to be made.

DNA degrades over time. In any remains which are not fresh, the DNA is said to be ancient. This DNA is often found in short pieces of less than 100 base pairs, which is too small for the usual method of copying, Polymerase Chain Reaction. So to make copies of ancient DNA scientists tend to use a process called Next Generation Sequencing.

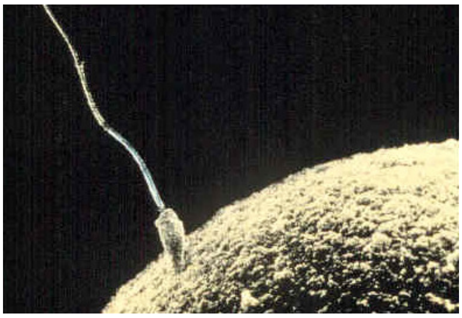
Next, this DNA is analysed, focussing on special regions called gene markers to build a DNA profile.

Historical records can sometimes show possible identities for an unknown remains (eg a missing person whose characteristics match). If living relatives can be located, a DNA sample taken from them can be compared with the DNA profile to confirm identity.

Mitochondrial DNA

The mitochondria, found in all cells, contain their own DNA, in a small circle rather than a long strand, but still as a double helix.

When the sperm and egg join, their nuclei fuse so the fertilised egg nucleus has ½ its DNA from mum and ½ from dad. However, at fertilisation the sperm's mitochondria stays outside the cell, so the baby only has mitochondria from its mother. The DNA in our mitochondria then has information from our mother and her mother's mother and so on down the generations – what is called the matrilineal line.



The sperm nucleus enters the egg cell but the mitochondria & tail stay behind.
Courtesy: Wikipedia Commons

Mitochondrial DNA (mtDNA) is more abundant than nuclear DNA in cells and can survive in situations where nuclear DNA becomes degraded. mtDNA can also be found in hair without roots.

The whole mtDNA is sequenced to tell us about where the matrilineal line originated.

Otago Goldfields

In 1861 Gabriel Reid found gold in inland Otago, starting a gold rush that attracted many from around the world in search of a fortune. They worked in the goldfields and were buried in the local cemeteries when they died.

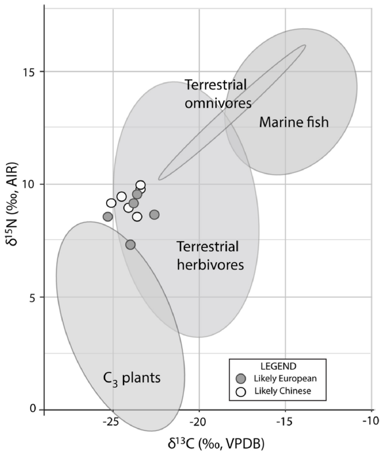
Starting in 2016, communities near the Otago goldfields (Milton, Lawrence and Drybread) asked a team of scientists to identify the remains in unmarked graves from their cemeteries. The remains were exhumed for analysis and laid to rest again in 2023.

Māori were less common on the Otago fields. They traditionally placed no worth on gold – pounamu was their taonga – but would sell gold once the value to Pākeha was realised. Māori had their own urupā and are therefore not represented in this study.

Left, Gabriels Gully at its peak in the 1860s, and right, present day.
Courtesy: Wikipedia Commons. Taken from the Information Board of Historical Gold Mining Area, Otago Region by Ulrich Lange, Bochum, Germanys

Scientific Analysis

Isotopic analysis of teeth gave an idea of childhood diet, while hair gave information about the diet of the person's last few months. Mitochondrial DNA evidence provided detail about where the maternal line originated.



C and N isotopes in the bone show the food eaten by Chinese & European miners.
Courtesy: King et al 2023

Acidic ground water had degraded the bones, so only teeth and hair could be analysed and nuclear DNA was not recoverable. The mtDNA results showed most came from UK or Europe, and a few from China (and teeth isotopes could often pinpoint the region).

There were a couple of anomalies: one person buried in the Chinese cemetery came from South East Asia; one person's maternal line came from Europe but they were buried with Chinese artefacts.

Other evidence showed

- The Chinese had a better diet, with more meat. This was unexpected. However, being seen as outsiders they lived in a separate camp as a cohesive community, sharing food stores. They had a good supply of dried meats & also ate hens, birds & rabbits.
- Most had mercury in their tissues, some to toxic levels. In compound form, this element was used to extract gold from dross but was also taken as medicine for many ailments.
- Many had rotten teeth – cavities, abscesses, ulcers.
- Some had lesions on their bones suggesting scurvy. This indicated they ate little fresh fruit & veges, which were scarce, having to be carted in from the coast.

Some of the remains were identified (eg. from name tags or by matching injuries to historical records) but many remained anonymous. All gave an idea of life in the goldfield, however.

References

King, C. et al (2023). Seeking their fortunes on the Otago goldfields – Constructing isotopic biographies of colonial goldminers. Journal of Archaeological Science, 157, 105836.

North & South 13.08.2022 The Goldfield Gravediggers

Otago News 22.09.2023 Remains bring stories of the Otago goldfields to life

Police: Facial reconstruction of unidentified body

Royal Society 12.04.2021 Research identifies new cultural threads in early colonial goldfield

Te Ara

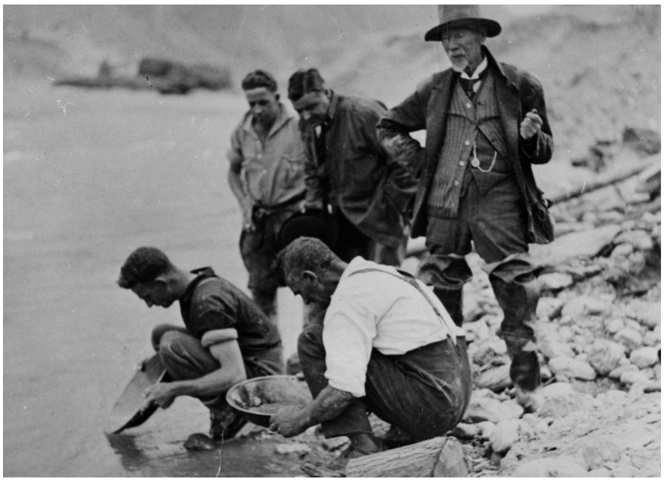
Useful Classroom References

Readings on Otago gold (SJ L3 May 2015)

Chinese NZers (SJ L4 Nov 2019)

SS Ventnor (SJ L3 May 2021)

Lisa Matisoo Smith on mtDNA, with other videos and resources



Men panning gold from the rivers in Otago.
Courtesy: Central Otago

Ngā Kupu

ira tangata: human gene, life principle
kōiwi: human bone, corpse
pounamu: greenstone
taonga: treasure
urupā: burial ground, cemetery, graveyard
whakapapa: genealogy, lineage, descent
whenua: land, country, ground, territory; also placenta
Source: Te Aka Māori Dictionary