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2023-24 Annual Report Feature –

Forensic Investigative Genetic Genealogy

DNA technology was in its infancy when the VIFM opened its doors in 1988. The Molecular Biology Laboratory (MBL) was established in the late 1980s and during the last three decades has developed DNA analysis methodologies to establish the identity of deceased persons who cannot be identified visually or through dental or fingerprint comparisons. Today, this form of identification is employed in approximately 10 per cent of the more than 7,000 deaths that are reported to the coroner each year.

DNA analysis for the identification of deceased persons is particularly challenging, given the potential degradation of DNA due to the state of the human remains, for example, where remains are decomposed, incinerated, skeletal or submerged in water. The VIFM's MBL has successfully improved its techniques through ethically approved research, resulting in new DNA methodologies allowing DNA analysis of aged and degraded bones, bladder swabs and toenail clippings.

The identification of the deceased through traditional methodologies of DNA analysis relies on the availability of a comparison sample – either a direct sample from the deceased or more commonly from a close relative. In many routine cases, a close relative is based on a 'believed to be' identity from circumstantial evidence such as the location of the body, or identifying items found with the body. If a close relative is identified, a one-to-one comparison with the deceased is undertaken. When there is no such information, the identification of the deceased through DNA analysis requires comparison to established DNA databases.

DNA Databases

The VIFM's involvement in the Disaster Victim Identification (DVI) response to the 2009 Victorian bushfires led to the establishment of the VIFM's internal DNA repository for DNA profiles from unidentified human remains and the relatives of missing persons – the Victorian Missing Persons DNA Database (VMPDD).

Immediately following the fires, the INTERPOL DVI[1] process was initiated and the VIFM assumed responsibility for the reconciliation and identification of nearly 300 DVI cases. These cases were formally identified as 163 individuals; with a further nine people who died in hospital and the remains of one person were never found.

During the bushfire DVI response, the VIFM was provided with specialised software for DNA kinship and direct matching. This enabled a large number of DNA profiles from the deceased to be compared with reference samples from a large number of relatives, as well as victims' neonatal screening cards. The VIFM's DNA profile analysis resulted in the identification of 67 of the bushfire victims.

Having acquired this capability, the VIFM, in collaboration with Victoria Police, established the VMPDD to serve as an internal, stand-alone repository for all DNA profile information for family reference and unknown deceased samples for the state of Victoria[2]. The database facilitates the blind screening of all DNA profiles provided by relatives of missing persons against all DNA profiles for unidentified human remains samples and identifies direct or kinship matches for nuclear (nDNA) and mitochondrial (mtDNA) DNA.

The VMPDD was the first missing persons DNA database of its kind in Australia and has resulted in three identification successes to date, including two cold-hits and one targeted match, as well as the reconciliation of dispersed human remains.

1 Disaster Victim Identification is the method used to identify victims of mass casualty incidents, either man-made or natural. Interpol publishes the *Disaster Victim Identification Guide*, which is the unique globally accepted standard for DVI protocols. First produced in 1984, it is updated every five years; and was most recently published in 2023.

2 The VMPDD is not a database regulated by the Crimes Act 1958 (Vic) (Crimes Act) (see definition of a DNA database under section 464(2) of that Act).

Victorian Attorney General visit to the VIFM (May 2022): Dr Dadna Hartman, Professor Noel Woodford and Attorney-General, the Honourable Jaclyn Symes MP

There are two national databases operated by the Australian Criminal Intelligence Commission that relate to missing persons and unidentified human remains identification – the National Missing Persons Victim System (NMPVS) and the National Criminal Investigation DNA Database (NCIDD) (including the NCIDD Integrated Forensic Analysis (NCIDD-IFA).

The NMPVS houses the post-mortem biological data (that is, sex, age, height and weight) and identification data (that is, dental records, fingerprints, tattoos and DNA availability) about the unidentified human remains and ante-mortem biological data for missing persons, to facilitate the interjurisdictional matching of this information.

The NCIDD is regulated by the *Crimes Act 1914 (Cth),* as well as corresponding state and territory legislation, and facilitates the inter- and intra-jurisdictional matching of DNA profiles. In 2018 an additional matching capability was added to NCIDD to create the NCIDD-IFA. It enabled enhanced inter- and intra-jurisdictional kinship matching of DNA profiles for missing and deceased persons and familial searching for criminal investigations.

PHENOTYPING AND BIOGEOGRAPHICAL ANCESTRY

Additional DNA analysis in the form of forensic DNA intelligence can be undertaken to infer biogeographical ancestry and externally visible characteristics such as eye and hair colour of the individual. This information, together with anthropological and odontological examinations, can be used to compare with information from known missing person cases, potentially resulting in an investigative lead. Such leads can be confirmed using conventional DNA testing where investigators are able to seek a family reference sample for the missing person to compare with the unidentified human remains DNA profile.

FORENSIC INVESTIGATIVE GENETIC GENEALOGY

Forensic Investigative Genetic Genealogy (FIGG) is the latest emerging forensic DNA intelligence tool, combining DNA testing with traditional genealogical methods to infer familial relationships between individuals. As FIGG has only recently been utilised in Australia, most of what we know of its use has come from law enforcement in the United States of America, where it is being used to assist with cold case and missing persons investigations. It is most widely known for its success in identifying the offender, Joseph DeAngelo, in the case of the Golden State Killer.

Internationally, the use of FIGG for the identification of unidentified human remains cases and the resolution of missing persons cases is growing. Most notably is the DNA Doe project, which aims to identify 'Jane' and 'John Does' in the USA using genetic genealogy through a novel DoeFundMe program and volunteer work of genetic genealogists. Early success stories included the announcement in April 2018 that a Jane Doe discovered In Ohio USA, who become known as the Buckskin Girl, had been identified. This followed the use of genetic genealogy of DNA recovered from a blood sample that had been in storage since 1981. The DNA Doe project currently lists 120 cases as success stories where genetic genealogy has assisted in the identification of unknown deceased persons.

It has been in the national interest for the forensic and law enforcement community in Australia to undertake research to investigate the application of FIGG, with the view to generating the data required for policy and law makers to have informed discussion regarding recommendations for the use of FIGG in Australia.

The VIFM has participated in ethically approved research projects to validate the FIGG investigative method in the Australian context as part of the 'Australian Forensic Genetic Genealogy Collaboration', currently comprised of the Australian Federal Police (AFP), NSW Police Force (NSWPF) and the VIFM. The aim of the research was to assess the scientific validity, and legal and ethical considerations of FIGG, to determine if the methodology was suitable for Australian forensic or humanitarian casework. In particular, the VIFM investigated the use of degraded DNA extracts for FIGG, given that many of our unidentified human remains cases comprise skeletonised and decomposed remains.

EC 11-2019 – Genetic Genealogy and Victoria's John and Jane Does

In collaboration with the AFP, NSWPF and Victoria Police (VICPOL), this was the first published evaluation of FIGG, using whole genome array (WGA) data generated from Australian samples. It demonstrated the utility of FIGG in generating lists of genetic relatives for Australian cases, as well as the limitations of using WGA as the sequencing tool when dealing with degraded DNA samples.

This research resulted in the first investigative ID lead to be developed using FIGG for a Victorian unidentified human remains case.

EC 1151 – Forensic Genetic Genealogy Methodology Assessment

In collaboration with the AFP, NSWPF and VICPOL, a large study was conducted to:

- further evaluate the utility of WGA for the generation of the DNA data required for upload to genealogy databases
- evaluate various service providers of whole genome sequencing (WGS)
- conduct a family study to evaluate the Kintelligence platform as an alternative for the generation of the DNA data.

Furthermore, the study was designed to investigate:

- the impact the donor's ancestry plays in the successful generation of list of genetic relatives
- mock casework samples
- artificial degradation.

This research resulted in the first investigative ID lead to be accepted in the identification of a Victorian unidentified human remains case.

At present, there are hundreds of long-term missing cases in Victoria, with families waiting many years for knowledge of what has become of their loved-one. This is a similar scenario across Australia.

There are more than 100 unidentified human remains cases in Victoria who have not been identified to date. Although DNA may not be available for all these cases, when it can be recovered, FIGG is a technique that makes it possible to reconcile these unidentified human remains with long-term missing persons cases.

The VIFM successfully applied FIGG in the case of skeletal remains found submerged in ocean water at Sandy Point.

THE SANDY POINT MAN

On Christmas Day in 2017, a recreational snorkeler discovered a human skull lying on the seafloor at Shallow Inlet, a marine inlet opening onto Waratah Bay on the western side of the Yanakie Isthmus in South Gippsland, Victoria, south-eastern Australia.

The snorkeler alerted local police and the Victoria Police Search and Rescue Squad recovered a near-complete skeleton lying supine on the seafloor buried under approximately 20 cm of sand. No clothing or personal effects were discovered with the remains. The death of the individual was reported to the Coroner, and the remains were transferred to the VIFM for examination where a number of steps were undertaken to try to identify the person.

Forensic Anthropology

VIFM's forensic anthropologist reported that the completely skeletonised remains were very well preserved, with an estimated 91.14 per cent of the skeleton present, and only the mandible, sternum, patellae and select hand and foot bones being lost post-mortem. There was some evidence of bioerosion, as well as black staining (characteristic of contact with a sandy matrix) and green staining (characteristic of contact with organic material such as algae).

The deceased individual was estimated to be a male of European ancestry, aged between 21 and 37 years, with a stature of 169.7 ± 3.27 cm. There was no evidence of skeletal trauma or pathology.

Forensic Odontology

VIFM's forensic odontologist reported several interesting features in the deceased's dentition. The left third molar was impacted, and the right first molar had been extracted. There was a gold restoration as well as four amalgam restorations and a partial root canal. The style of these restorations was not typical of contemporary Australian dental practice which indicated that the individual likely either had dental work undertaken overseas, or the dental work had been done in Australia, but was of some antiquity.

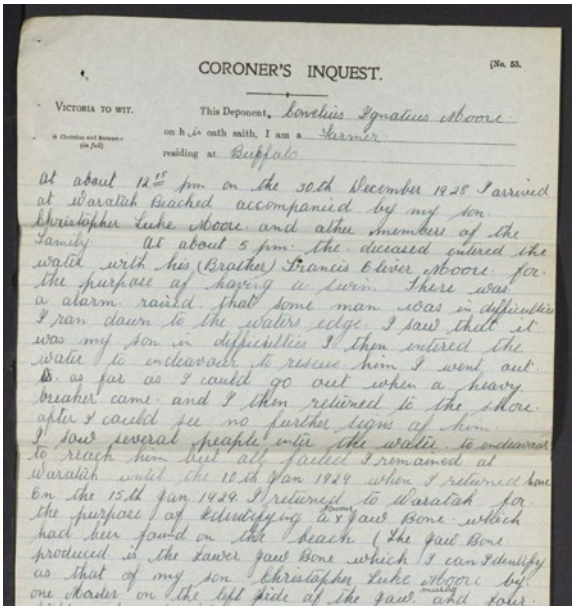
Molecular Biology

A sample of bone was collected from the right femur for DNA testing. Remarkably, given the remains had been under water for some time, complete nDNA and mtDNA profiles were obtained. At this time, it was noted that the mtDNA profile was indicative of the individual having a European maternal ancestry.

These profiles were uploaded and searched on the VMPDD and when no match was obtained, uploaded to the National equivalent (NCIDD-IFA). Again, no match was obtained.

Forensic DNA Intelligence – Forensic DNA Phenotyping and Biogeographical Ancestry

As no DNA matches were obtained following comparisons with the state and national missing persons DNA databases, additional DNA analysis in the form of forensic DNA intelligence was undertaken. The biogeographical ancestry results indicated that the individual's ancestry was 95 per cent European and 5 per cent South West Asian. The phenotyping results showed that the individual most likely had blue eyes and hair that was a dark shade of brown. Further, the biogeographical ancestry (from a maternal point of view) was corroborated by the mtDNA haplotype.



CORONER'S INQUEST. [No. 53.

VICTORIA TO WIT. This Deponent, Lovelius Ignatius Moore

on h is oath saith, I am a Farmer

residing at Buffalo

At about 12[15] pm on the 30th December 1928 I arrived at Waratah Beached accompanied by my son Christopher Luke Moore and other members of the family. At about 5 pm the deceased entered the water with his (Brother) Francis Oliver Moore for the purpose of having a swim. There was a alarm raised that some man was in difficulties I ran down to the waters edge. I saw that it was my son in difficulties I then entered the water to endeavour to rescue him I went out as far as I could go out when a heavy breaker came and I then returned to the shore after I could see no further signs of him I saw several people into the water to endeavour to reach him but all failed I remained at Waratah until the 10th Jan 1929 when I returned home On the 15th Jan 1929 I returned to Waratah for the purpose of identifying a Jaw Bone which had been found on the beach (the Jaw Bone produced is the Lower Jaw Bone which I can identify as that of my son Christopher Luke Moore by one Molar on the left side of the Jaw and four

Shallow Inlet – Sandy Point

This intelligence, together with information obtained from the anthropology and odontology examinations, was compared with known information for missing persons cases. However, there were no reported missing persons in Victoria that appeared to be a match to this individual.

Radiocarbon Dating

Given the unusual dental findings, the team considered the possibility that the remains were of some antiquity. It is not possible to reliably estimate the time since death from a visual examination of skeletonised remains and so radiocarbon dating was undertaken using samples taken from a molar and femur.

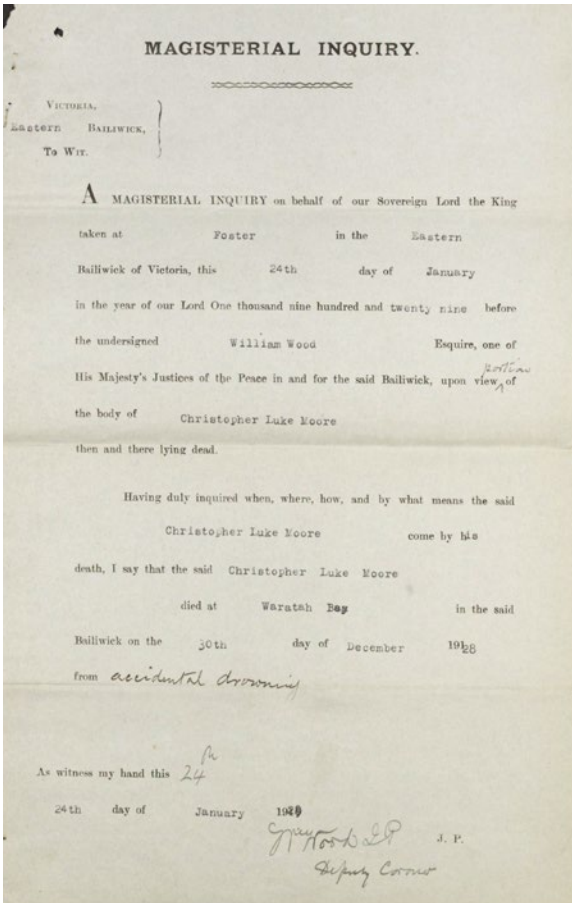
The results indicated that collagen in the tooth was formed prior to 1955. Further, both the tooth and bone sample contained a fraction modern (F14C) concentration that correlated with pre-bomb curve radiocarbon levels[3]. These levels essentially indicated the bone and tooth were formed somewhere between 1666 and 1955, but it was only possible to say with accuracy that the remains were pre-bomb pulse (1955).

Historical Research

Sandy Point is a small township near Wilsons Promontory, a region where the traditional owners of the Gunaikurnai Nation have lived for thousands of years, hunting and fishing in the coastal waters. The early 19th century saw the arrival of European whalers and sealers, followed by the settlement of pastoralists, who ran cattle. Today the town has a permanent population of around 250, which swells to more than 1,000 in summer.

Given the forensic anthropology, odontology and radiocarbon findings, it was anticipated that the case was historic, and the likely cause of death was drowning in Shallow Inlet or in the adjoining Waratah Bay. While today a long sandy spit narrows the entrance into Shallow Inlet, in 1901 this spit was broken through and the entrance to Shallow Inlet, where there is a strong tidal flow, was significantly widened. Consequently, it was possible that a person who drowned in Waratah Bay could have been washed into Shallow Inlet with the incoming tide, and subsequently been buried in the sand. This might explain the rarity of finding an almost complete skeleton in the ocean after a significant period of time.

3 The bomb pulse is the sudden increase of carbon-14 (14C) in the Earth's atmosphere due to the hundreds of aboveground nuclear bombs tests that started in 1945 and intensified after 1950 until 1963.



MAGISTERIAL INQUIRY.

VICTORIA,
Eastern BAILIWICK,
To WIT.

A MAGISTERIAL INQUIRY on behalf of our Sovereign Lord the King taken at Foster in the Eastern Bailiwick of Victoria, this 24th day of January in the year of our Lord One thousand nine hundred and twenty nine before the undersigned William Wood Esquire, one of His Majesty's Justices of the Peace in and for the said Bailiwick, upon view of the body of Christopher Luke Moore then and there lying dead.

Having duly inquired when, where, how, and by what means the said Christopher Luke Moore come by his death, I say that the said Christopher Luke Moore died at Waratah Bay in the said Bailiwick on the 30th day of December 1928 from accidental drowning

As witness my hand this 24th day of January 1929

J. P.

This hypothesis prompted historical research to identify any young adult men who had drowned in or near Waratah Bay in the 19th or 20th century, through a search of newspaper articles in the National Library of Australia's online 'Trove' and in resources found at the Foster and District Historical Society Museum.

This research discovered that there were quite a number of drownings in Waratah Bay.

Bass Strait was, and still is, a major shipping route. In the 19th century, Waratah Bay provided shelter to sailing vessels travelling between Melbourne, Hobart and Sydney, where stormy weather would force boats into the Bay to wait for calmer waters. Unfortunately, many ships ran aground, or took on water, losing their crew, passengers, and cargo in the Bay, including *The Domain* (1846), *The Spencer* (1854) and *The Bertha* (1870).

A total of 18 adults drowned in these incidents, with only one body being recovered.

Further research into the history of dentistry suggested that the Sandy Point man, who had four amalgam restorations, had likely attended a dentist sometime after 1880. Dental amalgam was introduced into the United States in 1833 under the name of 'Royal Mineral Succedaneum', however its use was highly contested and not adopted as the predominant restorative material until the late 1880. Therefore, the recovered skeleton was unlikely to have been one of the crew or passengers who drowned in Waratah Bay following the shipwreck of *The Domain*, *The Spencer* or *The Bertha* between 1846 and 1870.

A search of the historical newspaper reports identified at least four other young adult men who drowned in the area in the 19th and early 20th century. The first was a notorious escaped criminal Martin Weiberg, who had stolen 5,000 gold sovereigns from the steamer *Avoca* in 1877. In 1883, his wife and children were living at Walkerville, where the lime kilns provided a local industry, and Weiberg was planning to pick them up in his dingy and to sail to the Glennie Islands where his brother was waiting in his sailing boat, the *Nova*. Weiberg was convinced not to take his family with him, as the weather was too rough and he was reportedly quite drunk. Weiberg never made the 'Glennies' and wreckage from his dingy was found on Yanakie beach. His body was never recovered.

Weiberg provided a plausible fit with the forensic profile of the unidentified skeletal remains, his prison records giving his height as 5 foot 6 and half inches (168 cm), ancestry as Norwegian and his eyes grey. As Weiberg was employed as a ship carpenter in the 1870s, it may have been possible for him to have dental restorations in overseas ports. However, his prison record also described Weiberg as having light brown hair, where the phenotyping results indicated that the individual had dark brown hair.

The second individual was a fisherman from Tarraville, John Jacobson, who drowned in 1911, his boat reported to be found anchored in Shallow Inlet. The ancestry of Mr Jacobson, born in Sweden, was a match to the biogeographical ancestry results, however Tarraville is east of Wilsons Promontory, and it is much more likely that he drowned near Port Albert or in Corner Inlet (a significant fishery established in the late 1800s), rather than in Shallow Inlet which is on the western side of the Yanakie Isthmus.

The third man, Christopher Luke Moore, was a 29-year-old farmer and World War I veteran from Buffalo, who was reported to have drowned in Waratah Bay on 30 December 1928 during a family picnic at a popular swimming spot called 'The Gap'. Although no newspaper reports were found to suggest that his body had been recovered, a gravestone at the nearby Meeniyan Cemetery included Christopher Moore's name, together with his wife and parents, which possibly eliminated him as being the unidentified individual.

Finally, the air-liner *Miss Hobart* disappeared off Wilsons Promontory when flying from Launceston to Melbourne in 1934 with a seat from its wreckage being found at Sandy Point Beach. Among the nine passengers and two crew who drowned, which included nine men, was a dentist from Launceston, Mr. Colin Jones.

The historical research provided some possible leads as to the identity of the unidentified remains, however, without mtDNA analysis from a maternal descendant for each contender, it was not possible to confirm an identification.

Forensic Investigative Genetic Genealogy[4]

FIGG relies on the use of single nucleotide polymorphism (SNP) data which is then uploaded to commercially available genealogy databases for familial searching. The DNA data set is in the hundreds of thousands or millions of SNPs, depending on the methodology used to generate the SNP profile. In conventional DNA profiling, approximately 21 DNA markers are analysed (depending on the commercial kit utilised), allowing direct or kinship matching to close (1st degree) relatives. However, FIGG enables kinship matching to occur to more distant relatives (for example, 2nd, 3rd, 4th and 5th degree).

A sample of DNA from the recovered skeleton was analysed using WGS, with the generated SNP profile uploaded to the two genealogy databases accessible to law enforcement (GEDmatch PRO and Family Tree DNA). Comparisons with the DNA profiles on these databases returned a list of potential relatives of the unknown deceased, making family tree building possible. Information about the DNA links allowed both the maternal and paternal sides of the family tree to be built back in time, until the team was able to identify the most-recent common ancestors. Many of the potential relatives identified in the family tree-building lived in Southeast Gippsland, indicating that the skeletal remains belonged to a local man. Once the most-recent common ancestors were established, the team was able to identify the 'union couple' – who linked the maternal and paternal family trees and is the deceased's likely parents. The union couple was established to be Cornelius and Charlotte Moore, parents of Christopher Luke Moore.

4 FIGG work, by nature, is complex, resource intensive, and time consuming. The FIGG effort for Sandy Point Man was undertaken with contributions from external collaborators Dr Nathan Scudder (AFP), Dr Jennifer Raymond and Alison Sears (NSWPF), and Dr Colleen Fitzpatrick (Identifinders International) under the leadership of Dr Runa Daniel (University of New Haven).

Moore family gravestone at the Meeniyan Cemetery.

Identification

The identification hypothesis that the remains may be that of Christopher Moore was strongly supported by the historical record.

On 24 January 1929 a coronial inquest was held following the discovery of a mandible at Shallow Inlet on 15 January 1929.

In the inquest document, Constable Hitch describes attending the beach on the night that Christopher Luke Moore had drowned and, together with 18 men, searching for him from The Darby to Walkerville (38 miles) – but to no avail.

And yet only two weeks later on 15 January 1929, a local pastoralist, Mr Pilkington, reported that a mandible (jawbone) had been found at Shallow Inlet 4 miles east from where the drowning had occurred.

Constable Hitch attended the site and searched the area, but failed to locate any further remains. He wrote:

'It would be possible for the remains to wash up on the beaches at Waratah, and would not be found, except, if you were there to pick them up as soon as they came ashore, as the sand on this beach keeps moving about owing to the heavy surf caused by the ocean swell.'

In his statement to the inquest, Mr Cornelius Moore, Christopher's father, described visiting Waratah Beach with his son and family on 30 December 1928 when alarm was raised that some man was in difficulties. He ran to the water's edge and saw that it was his son. He entered the water to try to rescue him but was forced back to the shore by heavy breakers. He stayed at Sandy Point searching for his son for 10 days before returning home to Buffalo.

On 15 January 1929 he returned to Waratah for the purpose of identifying a lower jawbone which had been found on the beach. He states:

'The jawbone produced is the lower jawbone which I can identify as that of my son Christopher Luke Moore by one molar on the left side of the jaw missing and four fillings of vulcanite, two of which are on each side of the jaw. I have no doubt that that is the lower jawbone of my son Christopher Luke Moore.'

Christopher and Elizabeth Moore

The Deputy Coroner determined that Mr Christopher Luke Moore died from accidental drowning at Waratah Bay on 30 December 1928.

The mandible was one of the few skeletal elements missing post-mortem from the deceased and 'the Gap' at Waratah Bay where Christopher Moore drowned was geographically close to where the skeletal remains had been recovered. The mandible was later buried with Christopher Moore's wife and parents at Meeniyan cemetery, explaining the inclusion of his name in the inscription on the gravestone.

Christopher Luke Moore had enlisted with the Australian Imperial Force in 1917 and was a gunner, serving in France with the 10th Field Artillery Brigade. He survived the war, and hospitalisation with the flu, to return to Australia in August 1919. Christopher's military records confirmed that he was born in February 1899, was 5 feet 9 ¼ inches tall (1.76 m), with blue eyes and black hair. This information was consistent with the anthropological findings, radiocarbon dating, biogeographical data, and DNA phenotyping of the skeletal remains.

While the FIGG results and the historical record strongly indicated the deceased was Christopher Luke Moore, a direct DNA comparison would provide further confirmation of the identification. Ancestry research indicated that Mr. Moore had three living descendants (a grandniece and two grandnephews) on his maternal side. Christopher Moore's grandniece was contacted by a local police officer, who informed her of the possible identification of the skeletal remains. She agreed to provide a DNA sample and the mtDNA profile obtained was compared to the mtDNA of the human remains. The results of this DNA comparison supported the proposition that the grandniece was a maternal relative of the deceased. Consequently, the remains were formally identified by the State Coroner on 27 July 2023 as Mr. Christopher Luke Moore.

Incredibly, the identification of the skeletal remains recovered from Shallow Inlet in 2017 was made 95 years after Christopher Luke Moore tragically drowned while swimming in Waratah Bay in 1928. In late 2023, his remains were finally returned to his family for burial at the Meeniyan Cemetery near the grave of his wife and parents, and with his daughter, Mary Moore.

Following the successful validation of FIGG in the Australian coronial context, this novel DNA technique is being applied to other unsolved unidentified human remains cases in the hope that they can be matched with long term missing persons. Ultimately FIGG may be able to solve these intractable cases, giving the families of missing persons some relief from the devastating trauma of not knowing what has happened to someone they love.

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