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## Forensic archaeology and illegal familial repatriation and burial of a fallen WW1 soldier, Nièvre, central-east France

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### ABSTRACT

The context of past conflicts, especially World War I or World War II, is treated differently in various countries. In France, the discovery of military human remains falls under the responsibility of the Ministry of the Armed Forces. Collaborations between the Ministry and national Universities allow for interdisciplinary studies that meet international scientific standards. This case report highlights the importance of interdisciplinary approaches to achieve the identification of skeletonized individuals. An abandoned grave vault in a small town of Nièvre, central-east France, uncovered three skeletons associated with *militaria*. Initially, the remains were believed to belong to three Senegalese Riflemen executed nearby in 1940, but some of the evidence appeared contradictory. The aim of this study is to determine whether these three skeletons were the three Senegalese Riflemen or other individuals. Through an interdisciplinary approach, combining the position of the bodies in the vault, anthropological analysis of the human remains, and archival research, it was determined that the three bodies belonged to the same family. The remains were those of an illegally repatriated body of a soldier from the battlefields of WW1, together with his parents. It is suggested that they illegally repatriated him from the battlefield/cemetery and then buried him in the family vault, and later, when the parents passed away, they were also buried alongside him. This case illustrates the profound violence of the First World War and the many family losses.

*Simple summary:* The identities of three skeletons discovered buried together in a graveyard were investigated due to the presence of *militaria* artefacts associated with one of them, revealing a rare case of illegal World War I fallen soldier familial repatriation.

### 1. Introduction

Forensic science aims to bring a scientific interpretation and understanding of specific contexts. Some cases, unusual, require the adjustment and the use of a specific protocol that differs from the classical methodological process. In past major conflicts, especially World War I or World War II, an interdisciplinarity approach is prioritised over new technologies as materials are not always available for such analysis (e.g. conservation, lack of antemortem medical data for comparison). Some cases are also entrenched in historical and social issues, mixing duty of remembrance with recognition for war remains.

Unlike the Franco-Prussian war of 1870, the First World War mobilised and involved every French household. The social cohesion resulting from this national generalisation of loss and mourning led families to

claim the bodies of soldiers, whose numbers reached over 310,000 in the first four months of the conflict [1]. The First World War marked a turning point in the way war dead were managed and perceived. This was clear from the very first months of the war, as the violence and overwhelming number of corpses strained the organisational networks at the front: bodies were pouring in, and the state was unable to arrange for soldiers to be repatriated, or to authorise families to collect them from the front [2,3].

The sheer number of deaths raises questions about the perception of individuality in war: it's no longer a single body that dies, but of death creating a mass of bodies. This manmade catastrophe prevents families from mourning properly, and the issue of returning their bodies remains a widely debated issue. The relentless pressure from the home front led, after a year of war on July 2, 1915, to the creation of the notion of 'Died

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for France' (*'Mort pour la France'*), honouring and recognising each soldier's sacrifice through the prism of his dying for the nation. This was soon followed by the individual burial law enacted on December 29, 1915 [4]. The reality at the front did not, however, conform to the expectations of those at home or the state, as burial conditions were responding to numerous external factors inherent to the context of war [5].

In 1918, the end of the war did not immediately signal the return of soldiers' bodies from the battlefields to their final resting place. With the new status of 'Died for France', the state considered the bodies of its soldiers to be its responsibility and overrode the families' desire to recover them. Families, starting from the beginning of the war but increasingly after the conclusion, employed private contractors to illegally repatriate the bodies of soldiers. Social pressure, supported by the media, eventually gave a voice back to the bereaved. In 1920, 2 years after the end of the war, the state offered families a choice: burial at public expense in a national necropolis, for perpetuity, or burial in a family vault, with only transportation of the fallen soldier remains covered by the state [2].

Today, the question of the bodies of soldiers from the First World War remains a topical issue, with 700,000 soldiers of all nationalities still unaccounted for, including 250,000 French. Several factors can explain this staggering figure: some dead soldiers were forgotten on the battlefield, others were buried by the enemy with or without proper documentation, and many others were victims of mercenaries [2], some were in isolated graves, and some soldiers' bodies were also not able to be recovered by the violence of war (e.g. dismemberment), etc.

Even today over 100 years on, around twenty more soldiers from WWI are discovered every year and legally registered with the Ministry of the Armed Forces, through the ONACVG (*Office National des Combattants et Victimes de Guerre*). Their services include an archaeo-anthropologist, Marine Meucci Duly, who leads both the excavation and identification efforts, as it is also the case for the Commonwealth War Graves Commission (CWGC).

Since the Second World War is a different kind of conflict, bodies that are discovered tend to be 'hidden' bodies, resulting from massacres or executions. Many testimonies have been recorded, especially concerning the fate of German bodies, often revealed as an end-of-life confessions. A recent case was encountered when a former member of the French Resistance confessed to having taken part in the execution of prisoners of war in Meymac (Corrèze). This confession led to an investigation for recovering 40 bodies, led by the war graves commission of Germany (*Volksbund Deutsche Kriegsgräberfürsorge*) and the ONACVG.

According to the law (R521-4 of the Code of military invalidity and war victims' pensions and 2021's interministerial circular on the discovery of war remains), if unknown remains are determined as military remains by authorities ("*Procureur de la République*"), the ONACVG is responsible for their management.

### 1.1. Case context

The presented case here is a little out of the ordinary, involving the chance discovery of World War I soldiers during land-use planning or as a result of testimony.

In France, in communal cemetery vaults and graves are reclaimed by the city hall if they have not been maintained for at least 30 years (Art L. 2223–17 of the General Code for Local Authorities). If no family member comes forward, the vault or the grave is declared 'abandoned' and the remains are placed in a common grave. In 2023, in the communal cemetery of the town of La Machine (Nièvre), the city hall ordered the reclamation of a vault belong to the X family (anonymised). The funeral services (*Services des pompes funèbres*) opened the vault in its whole to transfer the remains to the common grave. The city hall had no record of use for this grave and, therefore, believed it to be empty. In France, all burials in vaults are recorded and archives are kept at the city hall. However, no records or archives were found for this vault, none of the

family members were alive, and the vault had been acquired in July 1918. The funeral service agent was stunned to find remains in the vault upon opening it, and even more so when military objects (*militaria*) were discovered with the remains.

The city hall had no explanation for the remains or the *militaria*, but according to records, three Senegalese Riflemen (*Tirailleurs Sénégalais*) were executed by the nazis in 1940 and buried in the communal cemetery. On June 25, 1940, the authorities of La Machine discovered three Senegalese soldiers' bodies from the French Army at Le Bois de La Noblesse, on the outskirts of the town. These soldiers were a part of a column of war prisoners walking north. Their bodies were unearthed on November 19, 1940, and buried. Their identities were confirmed through their individual booklets. This event left its mark on the local population, who later built a post-war monument in memory of the three Senegalese Riflemen at the site of their execution (Fig. 1). Rumours surrounding this execution suggest that the three soldiers were initially buried by locals, but the location of the graves remains unknown.

The city hall declared that the remains associated with *militaria* for which they had no record, were those of the three Senegalese Riflemen. They made a public announcement to the local press, and the local authorities contacted the ONACVG. An investigation was launched, particularly concerning their right to be buried in the national necropolis with the status of 'Died for France'. However, the ONACVG found exhumation and transport certificates for these three soldiers, documenting their transfer to the Fleury Les Aubray necropolis in 1959 (Loiret, France).

The ONACVG then applied the usual process for identifying war remains, which involves establishing a biological profile and cross-referencing archive and artefact data. Additionally, it was necessary to analyse archives to determine if any contemporary information was available about the burials.

The aim of this study is to determine whether these three skeletons are those of the three Senegalese Riflemen or not, considering two major



Fig. 1. Photograph of post-war monument in memory of the three Senegalese Riflemen, at the place of their execution, Nièvre, central-east France. Photograph taken by Julien Fargettas.

hypotheses:

- The three skeletons belong to the three Senegalese Riflemen. If so, who are those buried in the national necropolis, and how did the mix-up occur?
- The three skeletons do not belong to the Senegalese Riflemen. In that case, who are these individuals, and why are they associated with *militaria*?

To address this, we will apply methods we have already implemented in similar contexts. Over the past two years, these methods have been improved into a new, extensive procedure for managing remains from the world wars in France [6–8].

## 2. Materials and methods

Biological and artefacts materials were collected at the site, although the exhumation was carried out by the funeral services. The research involved different types of sources, including anthropological, archaeological and archival materials.

### 2.1. Sitework

Since the funeral services operated before the ONaCVG's involvement, an interview was conducted with the agent responsible for the vault opening to understand the taphonomic and stratigraphic mechanism that took place within the grave. A photograph of the abandoned vault was however taken on site (Fig. 2).

The interview was carried out by phone, focusing on the organisation of the vault, the location of the remains and the placement of artefacts (Fig. 2). Questions also addressed the way in which the vault was opened and the methods they used to remove the remains.

### 2.2. Biological and materials analysis

The skeletons exhumed by the funeral services were placed in two bags and later transferred to the laboratory for further analysis, in accordance with the standard procedure established for war remains [7]. The initial step involved determining the number of individuals and separating them, since two skeletons were placed together in bag 2 by the funeral services. Commingled remains were distinguished using age-related markers, such as youthful or degenerative features on each bone [9].

The second step involved evaluating the preservation and representation of the skeletons [10], while the third step focused on establishing the biological profile for each skeleton.

Age at death estimation was performed using Schmitt's 2005 method [11], a morphoscopic method based on rating the degree of degeneration of the auricular surface of the coxal bones. The auricular surface represents a physiological and mechanical advantage, as it is protected from abnormal or accelerated (non-pathological) degeneration. This method provides an interesting double reading for these contexts: the first reading estimates a broad age range with over 95 % reliability, while the second reading shows a narrower age range through posterior probability analysis.

Height was estimated based on Olivier's method [12], which calculates stature from the length of the long bones, with the use of a mathematical regression formula. This method was chosen for its consistency with the study collection and its high accuracy.

Sex was estimated using the DPS2 morphometric method [13], which measures 10 dysmorphic variables on the coxal bone. This method has a reliability rate superior to 95 % and DPS2 also has the advantage of requiring only 4 of the 10 variables to give an estimate. In contexts where bodies have been buried for many years – around 100 years for this study collection – and are therefore subject to taphonomic alteration, this parameter is a considerable advantage.

Any other analysis regarding pathologies or traumas was conducted by macroscopic investigation.

Regarding the artefacts associated with the skeletons, an inventory was compiled, and *militaria* materials were analysed macroscopically, and a comparative analysis of the artefact typology was made using a *militaria* reference database.

### 2.3. Archivistic data

The ONaCVG provided the exhumation and burial records for all three Senegalese Riflemen. Several death and birth certificates were retrieved, and a search was conducted in the city hall records and the grave's deed of ownership.

A complementary search was then carried out in military registers, and both 'Died for France' documents and departmental register archives were consulted.

The search for archives was divided into three stages:

- The initial search took place within the ONaCVG archives at the Military Registry Office (*État Civil Militaire*). In this service, the ONaCVG keeps all their records of transport, discoveries, and exhumation of soldiers' bodies since WW1. Some archives are stored locally, while others are centralised in Metz.
- Another search focused on information regarding the vault. The family's name was inscribed, and it allowed for a search of documents such as death records or tomb acquisition papers. These

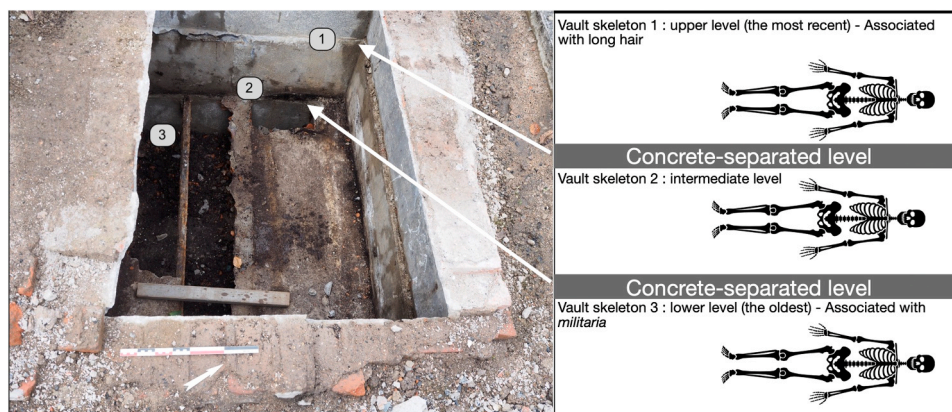


Fig. 2. On the left, photograph of the open abandoned vault that was the focus of this study, Nievre, central-est, France. We can see the 3 different burial levels (1–3) and the separation made by the concrete slabs are clearly visible – Photograph taken by Marine Meucci Duly. On the right, schematic showing the organisation of the discovered human remains within the abandoned vault.

records were searched by the city hall services, as their archives are kept at the municipal level.

- Lastly, a search was conducted within military records. These records contain identity cards for each soldier, with data such as age at death, stature and physical characteristics. For the riflemen, military records had to be requested from the Military Personnel Archive Centre in Pau, which holds the records of colonial army soldiers. Other records could also be accessed online on the government's *Mémoire des Hommes* website, which holds the 'Died for France' records. These records inform the soldier's birth department, which is required for locating their military register, also accessible online via their birth department.

### 3. Results

#### 3.1. Sitework

After interviewing the funeral services, it appeared that the grave had three distinct levels, separated by concrete slabs (Figs. 2 and 3). When the funeral services retrieved the remains, they noted the following:

- The first (upper) level contained the most recent interment (skeleton 1). It corresponds with the last individual buried, and long ginger hair was found on the skull.
- The second (middle) level contained the second individual to be buried (skeleton 2).
- The third (lower) level contained the oldest burial (skeleton 3). It was the first individual to be buried, and was the only skeleton associated with *militaria* artefacts.

#### 3.2. Biological and materials analysis

The number of individuals was determined by observing and counting the bones, confirming that three individuals were present in the two recovered archaeological bags. This result matches the description of the vault that was provided by the funeral service.

All three skeletons were in relatively poor condition with significant deterioration and incomplete representation of skeletal elements. As the remains were buried in a concrete vault within wood coffins, the bones were porous, incomplete and brittle due to water infiltration, exposure to oxygen and atmospheric changes (e.g frost, heat, humidity).

The biological profile was incomplete due to several indeterminate estimation. For Skeleton 1, sex and age could not be estimated due to the lack of pelvic bones. However, the overall aspect was gracile (Fig. 3 - A), and we observed the presence of degenerative features such as osteophytes/vertebral fusion spine (thoracic), rarely found on individuals under 40 years old (Fig. 3 - C). Long ginger hair was present on the skull.

Skeleton 2 provided an age estimation of over 50 years old and was determined as male.

Skeleton 3 did not have enough skeletal element to estimate age or sex. However, the aspect of the remains did not present any sign of immaturity and could be determined as an adult individual.

No further analysis of the remains could be conducted due to the lack of a legal requisition, absence of any family consent, the procedure exceeding the ONaCVG's standard protocols, and scope of such research for identifying war remains.

#### 3.3. Associated artefacts

The artefacts associated with the three skeletons were mostly coffin handles, religious artefacts and an abundance of fabric. *Militaria* artefacts were only found in bag 2, which contained two individuals. These artefacts included shoes, wool stockings, and several 8 mm Lebel cartridges.

The archaeological *militaria* artefacts provided precious information regarding the timeframe. The boots (Fig. 4 - B) and wool stockings (Fig. 4 - A) were typical of French military equipment, especially during World War I. One of the Lebel cartridges was stamped and could provide details regarding its time of manufacture, 1916 (Fig. 4 - C). It may also suggest that the soldier died in combat with his standard French army ammunition allocation.

#### 3.4. Archivistic data

The archival search gave several key pieces of information on this case:

- Regarding the three Senegalese Riflemen:

Through the ONaCVG archives, all records of exhumation and re-inhumation were obtained, dated the 23rd of March 1959 for exhumation and the 27th of March 1959 for re-inhumation for all three soldiers. The three bodies were transported and buried in the Fleury Les Aubray's military cemetery (Fig. 5 - A). Biological information was also retrieved through the military record for two out of three riflemen. One soldier had died at the age of 35, and the other at 31 years old. The year of birth for the third soldier could not be obtained.

- Regarding the potential owner of the vault:

Through the city hall archive, records showed that the grave was acquired by Mr. and Mrs. X in July 1918, but no other records were found (Fig. 5 - B). However, birth and death certificates revealed that Mr. and Mrs. X had a son, who died in action during World War I, in June 1918. The death records also stated that Mr. X died at age 55 after his son, and Mrs. X was the last to die at age 76.

- Regarding the archives from World War I:

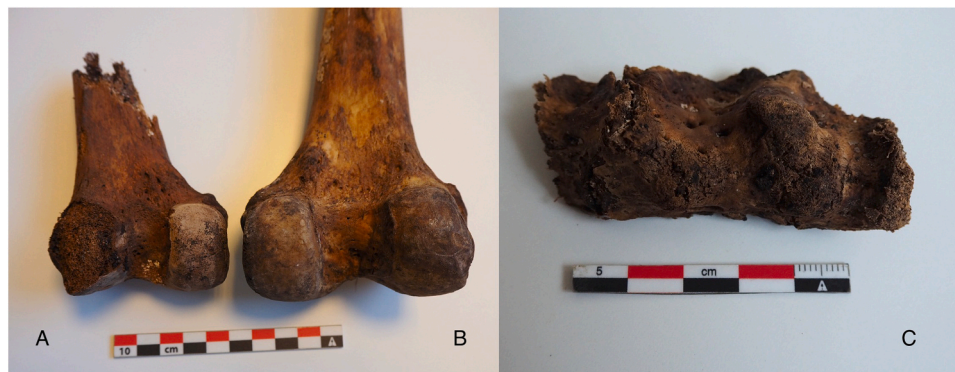


Fig. 3. Photograph of skeletal elements from vault individuals 1 and 2. (A) Gracile aspect of the femur for the individual 1. (B) Robust aspect of the femur of individual 2. (C) Fused thoracic vertebral bodies of individual 1 - Photograph courtesy of Marine Meucci Duly.

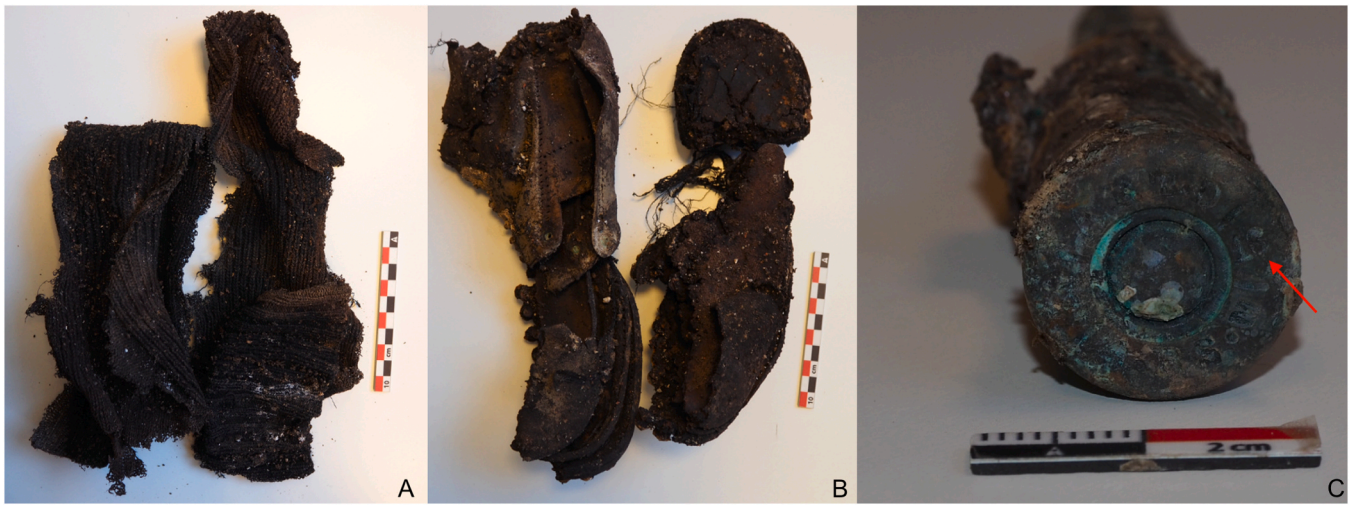


Fig. 4. Photographs of wool stockings (A), French Boots (B) and Lebel cartridge dated 1916 (stamped with the year of manufacture, see arrow) (C) from World War I - Photograph courtesy of Marine Meucci Duly.

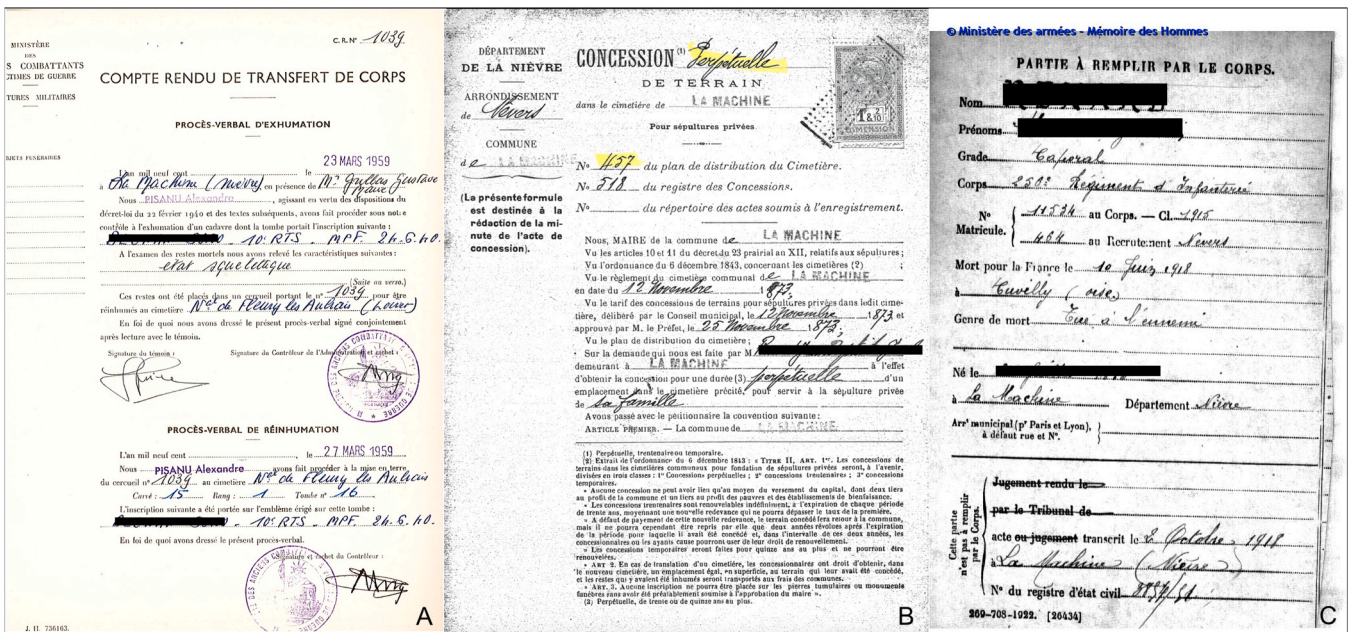


Fig. 5. Exhumation and re-inhumation record for one of the three WW2 Senegalese riflemen (A); Vault acquisition title in the name of family X in July 1918 (B); Military archives of family X's son who died in June 1918 (C).

The military registration records indicated that Mr. and Mrs. X's son was 22 and 1m66 tall at the time of death (Fig. 5 - C).

4. Discussion

To answer the first question about whether these remains belong to the three Senegalese Riflemen, we can state that they do not, due to inconsistencies in age. Two of the skeletons are over 40 years old, with one exceeding 50 years old (displaying typical degenerative features), whereas two of the Senegalese Riflemen were under 40 years old at the time of death. Height could have been considered as a factor, but we were unable to estimate the height for one skeleton, and height data for one of the Senegalese Riflemen is missing. Additionally, the presence of long ginger hair should also be taken into consideration - not only because of its rarity among the Senegalese population, but more importantly due to the colonial army's recruitment process [14].

Indeed, the recruitment of Senegalese during World War I was violent, as they were forced to enrol and adapt to French culture. Given this, it is unimaginable that the army would have allowed them to wear long hair during war. Archives also provided a lot of valuable information, notably that all three Senegalese Riflemen were already buried elsewhere. By the time of their initial exhumation by the city hall in November 1940, all three had been identified based on their respective military booklets. Furthermore, the vault and the associated artefacts do not support the hypothesis that these were the three Senegalese Riflemen. Funeral services explained that each skeleton was placed on a separate level, distinguished by concrete slabs, which contradicts the idea of a simultaneous burial, as it was the case for the three Senegalese Riflemen.

Last, the presence of World War I *militaria* in the vault can be addressed. Only one skeleton was found with *militaria*, which is unusual. Some colonial soldiers were issued with World War I *militaria* even in

World War II (such as shoes and uniforms), but the discovery of a 1916 Lebel cartridge is unusual, given the high volume of cartridges used during World War I. It would be hard to believe that a 1916 cartridge was left over and later issued to soldiers in the 1940s.

It can thus be confirmed that the three skeletons excavated from the vault do not belong to the Senegalese Rifleman. A summary of all data and sources has been listed in Table 1.

To answer the second question – who are these remains? – archives revealed that, although no record showed the vault was in use, all members of the X family had died with unknown burial location. More importantly, the son of the X family died one month before the family acquired this vault in June 1918, at a time when repatriating bodies from the front was still illegal. The dates of death for each family member match the position of the remains in the vault.

According to the death certificate, the last person to die was Mrs. X, which is compatible with the remains in the upper part of the vault, displaying significant degenerative features (with an age estimate of over 50 years and an actual age of 76 years old at time of death) and long red hair on the skull. The first to die was the son, which is compatible with the remains in the lowest part of the vault, given also the associated World War I *militaria* and height estimation (1m66–1m72, with the military register listing him as 1m66). Lastly, the remains in the middle are compatible with Mr. X, who was the second to die, with an age estimation of over 40 years (his actual age at death was 55 years) (Table 2).

This case is unusual in terms of war remains management because no archaeological excavation took place, and the remains were found in a vault within a communal cemetery. Since only one skeleton had *militaria*, the agents from the funeral services had already exhumed all the remains before alerting the authorities and placed two skeletons in the same bag, leading to a significant loss of information regarding individualisation and taphonomic understanding. As the case was initially treated as war remains, standard procedures were followed, and the remains were analysed by the ONaCVG. The remains turned out to include both civilian and military individuals, no further investigation could be done for two major reasons:

- The Public Prosecutor (*Procureur de la République*) could have initiated an investigation under Article R53–11 of the French Penale Code, which pertains to the identification of an unknown deceased person. However, since the remains are more than 50 years and do not present any evidence of crime, it could not be ordered as a judicial case.
- In France, if a case is not judicial, DNA analysis on non-archaeological remains can only be performed at the request of, or with authorisation from, the family. Since no living family members exist in this case, DNA testing was not possible.

Nevertheless, DNA analysis could have provided answers, such as determining the sex of Skeleton 1 and establishing familial relationship between the remains, highlighting a limitation in this case.

One question remains: why was there no burial record for the vault? It is important to note that World War I introduced a new dimension of death in conflict. With the introduction of new artillery, the death tolls were significantly higher than expected, and bodies piled up during

**Table 1**  
Biological profiles of each skeleton.

	Skeleton 1	Skeleton 2	Skeleton 3
Sex	ND	Male	ND
Age	ND	>50 y.o.	ND
Height	ND	164 cm (+/- 3.17 cm)	169 cm (+/- 3.35 cm)
Observation	Osteophytes and vertebral fusion	Osteophytes	/

**Table 2**  
Summary of data and sources.

	Data	Sources
WW2 Senegalese rifleman 1	Place and date of death: on the 26th of June 1940 near La Machine Age at death: 31 years old Stature: 1m70 Notable fact: Exhumed on the 23rd of March 1959 and reburied on the 27th of March 1959 in the Fleury Les Aubray necropolis	Exhumation report from the Military Registry Office and military registration records
WW2 Senegalese rifleman 2	Place and date of death: on the 26th of June, 1940 near La Machine at Age at death: 35 years old Stature: 1m72 Notable fact: Exhumed on the 23rd of March 1959 and reburied on the 27th of March 1959 in the Fleury Les Aubray necropolis	
WW2 Senegalese rifleman 3	Place and date of death: on the 26th of June, 1940 near La Machine. Notable fact: exhumed on the 23rd of March 1959 and reburied on the 27th of March 1959 in the Fleury Les Aubray necropolis	
Vault skeleton 1	Age at death: probably > 40 years old Notable fact and features: presence of osteophytes and vertebral fusion, long red hair. Found in the upper level of the grave. Associated with coffin handles.	Excavation by the funeral services and anthropological analysis.
Vault skeleton 2	Sex: Male, Age at death: > 50 years old Stature: 164 cm (+/- 3.17 cm) Notable fact and features: presence of osteophytes. Associated with coffin handles.	Excavation by the funeral services and anthropological analysis.
Vault skeleton 3	Age at death: adult individual Stature: 169 cm (+/- 3.35 cm) Notable fact and features: associated with <i>militaria</i> from WW1. Found in the lower level of the grave. Associated with coffins handles	Excavation by the funeral services, anthropological and artefact analysis.
Mr. X	Age at death: 55 years old Notable fact: owner of the grave since July 1918. No information on his burial location in records	City hall archives: death and birth certificates
Mrs. X	Age at death: 76 years old Notable fact: owner of the grave since July 1918. No information on his burial location in records	City hall archives: death and birth certificates
Mr. and Mrs. X's son	Age at death: 22 years old Stature: 1m66 Special features: died in action during WW1 in June 1918. Son of the grave's owners. No information on his burial location in records	City hall archives: death and birth certificates + military registration records

constant attacks, leaving the troops, who had initially believed in a ‘three-month war’, in shock [15]. The French government responded to this context of horror by prohibiting the repatriation of soldiers’ bodies to their families in Novembre 1914, and the dead were buried by their

comrades at the front. In 1915, the creation of the status 'Died for France' marked a significant shift in how the conflict dead were perceived. Soldiers were individually honoured for their sacrifice, rather than being seen as part of a mass. After the war, the French government maintained the ban on repatriation, believing that the soldier's bodies belonged to the Ministry of Armed Forces, reinforced by the new 'Died for France' designation. However, from 1918 to 1920, illegal body repatriation started to occur, as societies, individuals or families sought to search and bring back soldiers' bodies from temporary cemeteries or front lines [2].

Since this was a case of illegal body repatriation, no records were made for these cases of burial. And each time a family member died, no records were added, likely due to the fear that the authorities would discover the illegally repatriated soldier's body.

This case reveals a new dimension in the duty of remembrance, highlighting the complex issues surrounding representation, management and treatment of bodies in times of conflicts. It also underscores the importance of adopting a new historical perspective that combines archaeological and forensic evidence with death studies to better understand past societies that continue to have a profound impact today. The human aspect of these complex events brings forth complex notions of ethics, law, emotions and representation. Recent interest in these contexts, especially management of the dead and body treatment, has emerged in various scientific, artistic and cultural forms. Ethical concerns towards the prohibition of body repatriation and its impact on families have been the main subject of artwork like 'Au revoir là-haut' by Pierre Lemaitre [16] and 'La Vie et rien d'autre' by Bertrand Tavernier [17]. Grieving, during World War I, appears in an all-new form and for many families, having their soldiers' bodies in family graves became a necessity, despite official prohibitions [4].

## 5. Conclusions

The study presented here highlights the discovery of an illegal repatriation of a WWI fallen soldier's body by his family, providing a rare example of a past social issue in the aftermath of World War I. All available sources and analysis were utilised to conduct a forensic investigation, allowing to either confirm or disprove the original hypothesis. This investigation proved the need for an interdisciplinarity approach in conflict and forensic contexts. Cross-checking all the sources and analysis allowed for a better and thorough understanding of such complex cases. Historical, archival, anthropological, archaeological and other analyses provided valuable information. This special case illustrates that these analyses must be considered an integral part of the methodological process in forensic sciences, especially in contexts of conflict. Additionally, the association and interpretation of artefacts within an anthropological context need to be associated with meticulous excavation and thorough documentation need to be systematic. In this case, the initial hypothesis regarding Senegalese Riflemen was dismissed through interdisciplinary investigation, without the need for DNA testing.

Regarding the overall management of war remains, each country has different approaches, which can also vary depending on the conflict.

In France, a new procedure is moving closer to what is called 'forensic archaeology', which combines archaeological methods with forensic analysis. This approach already used in several countries to manage war remains [18]. The main difference between the handling of war remains in France and other countries is that, in France, war remains are usually discovered accidentally – bodies forgotten after the war. As the search for missing soldiers ceased in 1952 (World War I and World War II), the Ministry of Armed Forces does not conduct proactive searches for missing soldiers, unlike in other countries such as the USA, Cyprus, or Colombia [19]. These remains, which legally belong to the Ministry of Armed Forces, cannot be investigated by other institutions. As a result, when discoveries occur, there is an urgent need to gather as much information as possible from the site for identification in a very

limited timeframe. No prior investigation or hypothesis about the identity of the remains can be made, as it is all these discoveries are accidental or part of a rescue operation [8,20].

In other countries, war remains may be the result of planned research, archaeological excavations and forensic analysis conducted on longer periods. However, the more casualties a conflict produces, the less likely it is that the remains are managed systematically or forensically over time. This is notably the case in Germany, especially at the Eastern European front, where war remains are often exhumed, rather than retrieved through archaeological excavations. In France, the discovery of World War I soldiers has never ceased, and the ONaCVG continues to manage these remains as they did at the end of the war – much like funeral services. The French government has called upon anthropologist or archaeologists from various institutions (both private and public) to handle complex or large discoveries. However, the specific nature of human remains, particularly the potential for identification, requires caution, confidentiality, and knowledge of legislation, which has often not been respected.

Since 2022, ONaCVG has employed an archaeo-anthropologist through a CIFRE PhD program to oversee these discoveries and implement forensic archaeological methods. Alongside this important restructuring, the present study also demonstrates the value of collaboration between experts and academic researchers. As scientific discoveries continue to enrich the protocols and methods, it is essential to develop these further to continue identifying the remains of soldiers – a task that becomes increasingly complex as time passes. In some countries, DNA testing is a part of the identification process, as was the case with the graves at Fromelle, where 250 soldiers were recovered, and a significant DNA comparison effort was launched to identify as many of them as possible [21,22].

In France, DNA comparison is not the 'gold standard' for identifying war remains and it can only be requested by the family [6].

As is often the case, one of the primary obstacles to DNA testing for identification is the cost of such procedures. DNA and isotope analyses are expensive, but beyond the cost, they are not always necessary. It is therefore reasonable that such procedures should only be considered on a case-by-case basis.

The case involving the X family was closed with the identification of the remains. Typically, when war remains are discovered, families are given the option, since 1920, to either keep the remains in the family vault or have them buried in a military cemetery at the state's expense. In this case, the World War I soldier could have been buried in a military cemetery, but because his body had been repatriated illegally, the state could not assume responsibility for his grave. In some cases, such burials are allowed upon request by the family, which was not possible in this case. War veterans' associations such as *Le Souvenir Français* can take charge of these burials, as was done, here, for the son of the X family. Mr. and Mrs. X were initially destined for a common grave, but a request was made to the city hall to keep the family together in the same grave, as they had been for over 50 years.

Today, the ONaCVG, the CWGC and the VDK are working in close partnership to research and identify soldiers from more recent conflicts on French soil. A common methodology for methodology for exhumation, excavation, sampling and laboratory analysis is currently being developed. This international collaboration is a welcome initiative to achieve the shared goal of honouring the memory of these fallen soldiers.

## CRedit authorship contribution statement

**Caroline Costedoat:** Writing – review & editing, Visualization, Validation, Supervision, Methodology, Conceptualization. **Marine MEUCCI DULY:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Julien Fargettas:** Writing – review & editing, Validation. **Emeline Verna:** Writing – review & editing, Writing

– original draft, Validation, Supervision, Methodology, Conceptualization.

### Institutional Review Board Statement

Not applicable

### Informed Consent Statement

Patient consent was waived due to death more than 50 years ago.

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### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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