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PERSPECTIVE

The role of the forensic archeologist and anthropologist in recovery of human remains from fatal fires

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Email: l.hackman@dundee.ac.uk**Edited by:** Leslie E. Eisenberg, Editor**Abstract**

Fatal fires pose complex challenges for responders due to the requirement to investigate all aspects of the fire using methods that maximize evidence recovery and integrity, including optimal and respectful recovery of the deceased. In this article, the authors consider the value of the inclusion of both forensic archeologists and forensic anthropologists in circumstances of fatal fire, identifying some of the challenges posed by these environments and what each can contribute.

This article is categorized under:

Crime Scene Investigation > Crime Scene Examination

Forensic Anthropology > Forensic Archaeology

Forensic Anthropology > Taphonomic Changes and the Environment

KEYWORDS

fatal fire scenes, forensic anthropology, forensic archaeology

1 | INTRODUCTION

The roles and definitions of forensic anthropologists and archeologists vary by country and jurisdiction, with detailed consideration of this variability and the roles of each provided by the contributions within edited volumes such as Groen et al. (2015) and Blau and Ubelaker (2016). Forensic Anthropologists are experts in human osteology allowing them to assist with the identification of the deceased. They can also assist with the location and recovery of the deceased and the interpretation of circumstances that might have contributed to their death. Forensic Archeologists apply specialist archeological methods to assist with the interpretation of crime scenes which can include the location and recovery of human remains. Forensic archaeology and anthropology can be considered distinct disciplines, although it is possible to be dually qualified in both specialties, as is common in countries where archaeology is closely aligned with anthropology, for example, the United States of America. Practitioners can be involved in the recovery of victims of fatal fires, however, in the United Kingdom there is no current requirement to involve either of these disciplines in the response, although they can be asked to assist. Where the deceased has been extensively damaged by exposure to the effects of fire, specialists who are dual or singly qualified in these disciplines can add to both the recovery of the deceased and efficient evidence recovery, this article outlines some of the ways in which they can contribute to ensure robust evidence recovery and recording. It is hoped that by outlining some of the key challenges and their resolution by including specialists in archaeology or anthropology or both will help promote their involvement and enable those without prior experience of the fire scene to know what to expect and what might be required from their areas or expertise.

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In combination with other forensic specialists in attendance at a fatal fire, the inclusion of the forensic archeologist and forensic anthropologists can play a significant role in supporting extensive recording of the scene as well as assisting with the dignified recovery of the deceased, meaning that the forensic pathologist has a complete understanding of the events post fire, when it comes time to undertake the post-mortem.

2 | FATAL FIRES

Fatal fire scenes encountered by forensic archeologists and anthropologists can include deliberate disposal of a decedent to hide evidence of a crime, or accidental or deliberate building fires, vehicular collisions (Correia & Beattie, 2002) or stationary vehicle fires (Porta et al., 2013), and natural disasters, such as bush and forest fires (Blau & Briggs, 2011; Haynes et al., 2010), and so on potentially resulting in a mass fatality situation. While it may not be clear at the outset whether there is criminality involved in a fatal fire, each scene should be approached as if this were the case. The skillset of both forensic archeologists and anthropologists ensure that they can assist with the location and recovery of the deceased in a manner that maximizes the recovery of the remains for analysis and identification without compromising the integrity of, or contaminating, the scene.

3 | ARCHEOLOGICAL THEORY AND APPROACHES TO FATAL FIRES

The role of the forensic archeologist at a fire scene is often characterized as the direct application of “archaeological field techniques” (Blau, 2005), which is related to Cooke and Ide’s (1985) comparison of the “systematic excavation of debris” with “the work of archeologists,” a refrain commonly repeated in the forensic literature (Harding et al., 2022; Harrison, 2019). The crossover between forensic and traditional archaeology is further evidenced by articles addressing the application of forensic techniques to archeological fire scenes (Harrison, 2013; Kreimerman et al., 2022).

Certainly, in some circumstances the application of systematic, stratigraphic excavation of burnt debris can assist with determining the location of the fire, point of origin and different “episodes” of burning (Brickley, 2007). Indeed, many archeological techniques can be successfully transposed to the fire scene, including excavation by hand trowel and sieving of debris, mapping and gridding of scenes, the application of context numbers and the Harris Matrix to record separate phases of deposition, and the identification and recording of burnt bone and remains in-situ. Furthermore, techniques used in traditional archaeology can have a direct application in fatal fire investigations. For example, magnetometry can determine origin and spread of a fire in forensic arson investigations (Bruschlinsky et al., 1997) and fluorescence and luminescence from alternate light sources can detect burnt bone, however, as with many of these techniques the fire scene itself can impose restrictions on the utility of the method. For fluorescence and luminescence, as identified by Barreiro et al. (2022), the bone and therefore its luminescence might be obscured by non-osseous debris as debris comes to lie on and over the body. The determination of which of these techniques should be applied at each scene should be undertaken by the forensic archeologist in collaboration with investigators at the scene and in mass fatality contexts through the appropriate decision making system.

A key contribution of the forensic archeologist is the mapping and recording of the location and distribution of remains to facilitate an understanding of the circumstances of death. Tools and techniques used for this include using both manual recording involving tapes and theodolites or digital recording with total stations, 3D laser scanners, and Global Positioning Systems (GPS) (Márquez-Grant & Roberts, 2021; Wilson et al., 2018). Using these tools, the forensic archeologist can assist with creating strategies for excavation, allowing the creation of safe access corridors, for example, as well as the systematic excavation of the scene itself. However, the depth and irregular distribution of debris (Correia & Beattie, 2002) and conglomeration of wet deposits into a single stratigraphic layer following fire suppression create a challenging environment (Hunter et al., 2013). Additionally the need to work in confined spaces and damage to the structural integrity of a building, can limit the application of some of these techniques. In addition to bodies, building contents and structures shifting during the fire, damage to the structural integrity of the surroundings can mean that movement or access is limited or dangerous (Hunter et al., 2013).

As noted, there are no requirements for the involvement of forensic archeologists or anthropologists at a fatal fire scene. Other professionals who may not be as familiar with potentially highly fragmented and variously preserved burnt human remains will be attendant at the scene of the fatal fire including, but not limited to; law enforcement, building engineers and fire investigators and care needs to be taken not to create further damage during the process of making

the building safe, or recording and other investigation of the scene. Any potential damage to human remains by non-specialists in these circumstances can be limited by the presence of the forensic anthropologist to view any areas of concern and immediately identify the presence of bone or human tissue.

On the more useful side, floor plans are often available for buildings, for example, the metric survey that had been completed for Windsor Castle prior to the fire in 1992 (Kerr, 2008), which can be used for recording the location and distribution of burnt remains and inform search strategies. The authors utilized the positioning of shelving units from a store floor layout plan in a large commercial unit fire to determine the perimeters for search areas.

Sieving of debris is a process direct from traditional archaeology and can be employed in forensic fire investigations (e.g., Harrison, 2019; Krants, 2018). However, there are potentially large quantities of debris that need to be sorted, meaning that this can be a time intensive process that sometimes requires coarse sifting to occur at the location of the fire and further fine sifting and sieving to be undertaken at a separate location for several weeks or months following the initial incident (Dirkmaat et al., 2012; Kerr, 2008). Also, great care must be taken as sieving can result in extreme fragmentation of friable bone (Brickley, 2007). Damage can be partially avoided by hand sifting of material to remove large objects and pieces of bone prior to sieving if it is required (Correia & Beattie, 2002; Kerr, 2008). In domestic situations or fatal car fires, where there is only one, or perhaps two victims and limited debris, consideration of whether sieving for bone or other human tissue is required should be undertaken on a case-by-case basis, most typically of material from the immediate area surrounding heavily burned remains (Dirkmaat et al., 2012; Porta et al., 2013). It may be that sieving will assist in locating the presence of other potential evidence required by the fire investigators and if so, this can be included in the search strategy and undertaken under the guidance of the forensic archeologist. The potential timescales involved in processing collected material means it is advantageous if the location of remains can be determined quickly and efficiently, sometimes informed by eyewitness testimony, to reduce the quantity of material that needs to be transported and processed from the scene. Archeological techniques can be used to quantify the amount of debris, to predict timescales that would be involved in excavation, as the 3D laser scan data from the salvage process in the Mackintosh library at Glasgow School of Art was used in exactly this way after the 2014 fire (Wilson et al., 2018).

4 | CHALLENGES FACED IN THE RECOVERY OF REMAINS FROM FATAL FIRES

4.1 | Structural safety and collapsed rooms and buildings

Fatal fire scenes often involve structures in an unstable condition or where internal load bearing walls and floors have become damaged. Access is not safe until the building has been declared to be so by a structural engineer. To overcome this and begin the search process, the initial scene evaluation and excavation planning while awaiting access, the authors have used hydraulic platforms to view the internal environment in both a domestic house fire and the interior of a commercial building.

In the latter, the hydraulic platform provided by the Scottish Fire Service enabled the forensic archeologist and anthropologist to view the interior via skylights and areas of collapsed roofing (Figure 1). As the missing person was out of the eyeline from this view, drones were also deployed by Police Scotland which enabled greater visibility in real time footage. An extensive knowledge of the typical features of burnt human remains is vital in these scenarios to maximize identification from a distance. This is doubly important since traditional search techniques can often not be implemented due to damage to the building, or the risks to investigative personnel. Such an approach can inform the search and recovery strategy. The extent of potential debris is shown in Figure 2.

Where fire damage is substantial, the absence of walls and windows exposes the remains, the scene and those working on the scene, to inclement weather which can impose time constraints and increase the risk of disturbance and loss of evidence. Where windows are boarded up to reduce the impact of the weather, for privacy or because the building is vacant, there is a concomitant impact on the working environment due to the lack of natural light, amplified by the lack of electricity and therefore artificial light. This restricts the recovery of remains to daylight hours or causes reliance on the use of temporary, portable electric lighting, which casts shadows and alters natural colors, increasing the challenge of distinguishing bone from the rest of the homogeneously colored debris and reducing the effectiveness of photographic recording of the bones in situ, which is an important component of the recording process of orientation and positioning the deceased (Correia & Beattie, 2002; Devlin & Herrmann, 2017). This increases the importance of detailed and accurate written notes and scene mapping on the condition of the remains in-situ as well as having an expert in the identification of bone on site.



FIGURE 1 Overhead photo taken through a gap in the collapsed roof taken from a hydraulic platform.



FIGURE 2 Extent of structural collapse and burnt debris in a commercial retail unit fire.

4.2 | Disturbance and modification of the scene by fire services and other personnel

Burnt bone is extremely friable and brittle, making it prone to further destruction and fragmentation by the collapse of the building or falling debris (Brickley, 2007). Destruction and fragmentation can be caused by persons not trained in the recognition of bodies or body parts, using search techniques that involve walking through the scene or the actions of the perpetrator tending the fire or checking for complete destruction of identifiable bone fragments (Brickley, 2007; Chrysostomou, 2015; Correia & Beattie, 2002).

Extinguishing the fire can also cause fragmentation and movement of burnt bone through the high water pressure used by fire suppression systems. The ability to understand how remains may have been impacted by fire suppression activities can be vital to supporting the subsequent search. The skillset of the forensic anthropologist to locate and identify elements as they are mapped can inform of the direction of the water pressure and therefore the expected distribution of the remains to ensure all elements are recovered.

4.3 | Presence of materials that influence the burning process

The condition of the remains can range from charring with preserved organs and soft tissue through calcination to complete thermal amputation and, depending on the way that the fire has progressed, all of these may be found in the same body (Brickley, 2007; Coty et al., 2018). Waterhouse (2010) identifies that fires in trailers, comparable to static caravans in the United Kingdom, result in more severe burning than in house fires due to higher temperatures associated with building materials and a concentrated area of burning (MacTavish et al., 2006). These, as with vehicle fires, often result in thermal amputation. Also, these environments mean that the potential differential preservation resulting from exposure to the immediate environment of the deceased has to be taken into account. For example, a decedent recovered several days after an indoor fire exhibited almost complete calcination of one side of the upper body where it had been in contact with conductive metal, whereas the rest of the body evidenced no fire damage, just slightly increased decomposition due to the elevated ambient temperature. The role of the forensic anthropologist is important in explaining how and why this differential preservation might have occurred, both for the fire investigation and for the later analysis of the body at the postmortem examination.

4.4 | Problems specifically requiring input from forensic anthropologist

4.4.1 | Materials that look like bone

The problems arising from not involving someone with a forensic anthropology skillset in the recovery are well documented (Brickley, 2007; Chrysostomou, 2015; Dirkmaat, 2002; Porta et al., 2013). Many man-made materials can be mistaken for bone when burnt, with examples in the literature including “sheet rock,” more commonly known as plasterboard in the United Kingdom (Devlin & Herrmann, 2017) and melted insulation from train carriages (Correia & Beattie, 2002). Correia and Beattie (2002) consequently advise on the value of collecting all unidentifiable burnt materials from the scene and subsequently sorting and identifying them in the laboratory or mortuary environment over the return to the scene to re-search and sieve, which has high financial and time costs, and is often not possible. Brickley (2007) has reported that a forensic anthropologist trained and experienced in the morphology of bone should be able to identify bone fragments as small as 1 cm in diameter, therefore, their presence at the locus would maximize recovery in a timely manner and minimize collection of non-skeletal material by the body recovery team. This role extends to the post-mortem examination where the forensic anthropologist can assist by developing a biological profile if required, analysis of post-mortem imaging such as CT (computed tomography) which can aid location and analysis of trauma, and the identification of bone fragments.

4.4.2 | Distinguishing animal and human remains

Fatal fire scenes may have animal bone present, either from food consumption or the presence of domestic animals who are not able to escape the fire. It is important to be able to identify animal remains to assist with the narrative of the fire and to expediate the process of locating and identifying human remains. The remains of both dogs and cats have been encountered, with full excavation of the latter in one instance necessary to distinguish them from human remains and to demonstrate that, even in severe and prolonged fires, it can be possible to identify and recover victims justifying further on scene search. If the remains are too damaged to assess morphology on scene, further analysis in the laboratory may be required as misattribution of species can have significant impacts on criminal investigations or repatriation when animal remains are mistaken for human remains, potentially misinforming investigators or resulting in animal remains being returned to families.

4.4.3 | Number of individuals, comingling, and trauma

There are two common forms of comingling in instances of fatal fire. One can result from the recovery and transportation of remains (Type I) and the other can result from the circumstances of death (Type II) (Mundorff, 2012). Both complicate and impede the process of identification (de Boer et al., 2019). A forensic anthropologist at the scene can recognize comingling and assist in the separation of comingled individuals at the scene and advise on packaging procedures to minimize further inter-mixing and damage of fragments.

The ability to identify skeletal and dental elements and record them *in situ* makes for a quicker, more efficient and comprehensive recovery and later re-association of remains. Scientific identification and individuation can aid in potentially understanding cause and manner of death (Blau, 2005; Márquez-Grant & Roberts, 2021; Porta et al., 2013).

The potential for trauma, over and above the fire damage that the remains have been subjected to, must be a core consideration. Trauma may occur because of criminal activity occurring in the ante or perimortem period but may also result from the fire itself, for example, from falling furniture, or the collapse of structures, or from fire suppression activities. Since, as noted, bones become fragile and can be damaged in transit, the identification and comprehensive recording of any potential trauma that might have contributed to the cause of death at the scene is vital and requires the presence of a forensic anthropologist.

4.4.4 | Documentation and recovery of burnt human remains

Careful recovery by the forensic anthropologist can avoid further damage or even post-recovery fractures to the body (Herrmann & Bennett, 1999; Ubelaker, 2009), which can create problems in the post-mortem examination.

Consideration has to be given to the fact that due to fire suppression activities, any exposed bone may be waterlogged, requiring the use of double layers of article or cardboard packaging. As with the recovery process, packaging should be undertaken with care, ensuring that any fragments are contained securely and are not subject to “transport trauma” resulting from bones or dental fragments shifting or moving and damaging each other. Consideration must be paid to packaging fragments separately and labeling all bones or bone fragments that have been identified, in case of further fragmentation in transit. This recording should be reflected in the contemporaneous notes. Finally packaging, labeling, and recording should also reflect any and all recovery information to assist with resolving comingling that might not have been identified at the scene. The chain of custody must remain intact throughout the process.

In some instances, if the body has taken on the pugilist pose it may not fit into a standard body recovery bag. In these cases, a bariatric body bag can be used to ensure no pressure is placed on the remains, which could also result in further situational fractures.

The presence of a forensic anthropologist at the scene and their involvement in the recording and recovery enables the identification of perimortem trauma prior to any disturbance of the remains, assisting the role of the forensic pathologist in the differentiation between situational damage and fractures that might have contributed to the cause of death.

5 | SUMMARY AND RECOMMENDATIONS FOR FORENSIC ANTHROPOLOGY

It is probable that there will be bone and bone fragments that can be identified at the scene, but fragmentation occurring during fire suppression, recovery and transport means the remains may not be identifiable at a later point. It is paramount that any archeologist attending a fatal fire, has a good knowledge of the chain of custody, experience of identifying burnt complete and fragmented skeletal remains and works in conjunction with a forensic anthropologist who has experience in handling and identifying burnt bone and “differentially preserved human remains” (de Boer et al., 2019, p. 304). Correia and Beattie (2002) emphasize the importance of a systematic recovery to save time later at the mortuary if everything is packaged to prevent further damage and location is well documented. Such an approach also maximizes the initial recovery of remains so there is no need to conduct a search twice, reducing financial and time expenditure and the very real possibility that any previously unrecognizable skeletal elements or items of evidentiary value may be trampled upon.

BOX 1 Effects of fire and heat on the body

When exposed to extreme heat, bodies assume what is known as the “pugilistic pose” where the arms flex at the elbows, the hands form into fists and the legs flex at the knee. This is caused by dehydration of the soft tissues of the limbs, which in turn causes the tissues to shrink, drawing the limbs up and causing flexion at the joints. As the fire destroys soft tissues and bones become exposed, they can weaken and fracture. Fractures can also be caused by collapsing structures that impact the body as they fall and by fire suppression activities when cold water makes contact with the body.

BOX 2 Importance of working as a team

When working to recover the victims of fatal fires, the forensic anthropologist and forensic archaeologist must work with fire investigators, who in turn are recovering information about the cause of the fire. The body can assist with additional information in this regard, for instance, the burn pattern may assist with indicating where the locus of the fire was situated in relation to the body. It is important that all members of the team are in constant contact to ensure that all information is shared throughout the process and that the recovery efforts do not result in loss of information for the fire investigators.

Formal training is necessary for all who are interested in contributing archeological, osteoarchaeological, or biological anthropology approaches to forensic investigations, especially those involving fatal fires (Blau, 2005). Such training needs to include, not only the recognition of burnt and fragmentary bone, but also the legal framework within which they will be working and the physical environment of the fire and its related challenges.

Ultimately, the forensic anthropologist will be the responsible for determining the number of deceased individuals present, creating the biological profile if required, and recording any trauma related to the life or death of the decedent or decedents. They hold the responsibility for ensuring body parts and bone fragments are attributed to the correct individual. Consequently, an on-scene presence maximizes the chance of a successful recovery. This is the case for traditional archaeology, where an on-site osteoarchaeologist (Historic England, 2018) will be present for excavations of cemeteries and burial grounds, and the excavation of mass graves where both forensic archeologists and forensic anthropologists are typically present (López & Umana, 2007) (Boxes 1 and 2).

AUTHOR CONTRIBUTIONS

Diana Swales: Conceptualization (equal); formal analysis (equal); writing – original draft (equal); writing – review and editing (equal). **Lucina Hackman:** Conceptualization (equal); writing – original draft (equal); writing – review and editing (equal).

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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