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In this work, a combination of bioarchaeological and forensic taphonomic methods are used to address the question of what processes have shaped mortuary contexts. Specifically, these questions are raised in relation to the peri- and postmortem circumstances of the dead in the Iron Age ringfort of Sandby borg; about the rate and progress of human decomposition in a Swedish outdoor environment and in a coffin; how this taphonomic knowledge can inform interpretations of mortuary contexts; and of the current state and potential developments of forensic anthropology and archaeology in Sweden.

The result provides us with information of depositional history in terms of events that created and modified human remains deposits, and how this information can be used. Such knowledge is helpful for interpretations of what has occurred in the distant as well as recent pasts. In so doing, the knowledge of peri- and postmortem corporeal circumstances and how it can be used has been advanced in relation to both the archaeological and forensic fields.
The Corporeality of Death

Bioarchaeological, Taphonomic, and Forensic Anthropological Studies of Human Remains
THE CORPOREALITY OF DEATH

Bioarchaeological, Taphonomic, and Forensic Anthropological Studies of Human Remains

CLARA ALFSDOTTER

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Abstract

The aim of this work is to advance the knowledge of peri- and postmortem corporeal circumstances in relation to human remains contexts, as well as to demonstrate the value of that knowledge in forensic and archaeological practice and research. This article-based dissertation encompasses papers in bioarchaeology and forensic anthropology, with an emphasis on taphonomy. The studies include analyses of human osseous material and human decomposition in relation to spatial and social contexts, from both theoretical and methodological perspectives.

Taphonomic knowledge is vital to interpretations of the circumstances of peri- and postmortem deposition, with a concern for whether features were created by human hand or the result of decomposition processes and other factors. For example, taphonomic knowledge can aid interpretations of the peri- and postmortem sequence of events, of the agents that have affected human remains, as well as for estimations of time since death. When integrated with social theories, taphonomic information can be used to interpret past events.

In this dissertation, a combination of bioarchaeological and forensic taphonomic methods are used to address the question of what processes have shaped mortuary contexts. Specifically, these questions are raised in relation to the peri- and postmortem circumstances of the dead in the Iron Age ringfort of Sandby borg, and about the rate and progress of human decomposition in a Swedish outdoor environment and in a coffin. Additionally, the question is raised of how taphonomic knowledge can inform interpretations of mortuary contexts, and of the current state and potential developments of forensic anthropology and archaeology in Sweden.

The result provides us with information of depositional history in terms of events that created and modified deposits of human remains. Furthermore, this research highlights some limitations in taphonomic reconstructions. The research presented here is helpful for interpretations of what has occurred in the distant as well as recent pasts, to understand potentially confounding factors, and how forensic anthropology can benefit Swedish crime scene investigations. In so doing, the knowledge of peri- and postmortem corporeal circumstances and how it can be used has been advanced in relation to both the archaeological and forensic fields.

Keywords: Taphonomy; mortuary archaeology; bioarchaeology; forensic anthropology; forensic archaeology; Sandby borg; human decomposition; crime scene investigation; archaeothanatology.
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List of papers


1. Introduction and aim

The aim of this work is to advance the knowledge of peri- and postmortem corporeal circumstances in relation to human remains contexts, and to demonstrate the value of that knowledge in forensic and archaeological practice and research. The papers that together make up this dissertation include analyses of human osseous material and human decomposition in relation to spatial and social contexts. The research is dedicated to the interpretation of human remains in relation to their mortuary contexts in both archaeological and forensic settings. The combination of studies serves several goals; to shed light on how peri- and postmortem Iron Age corporeal treatment can be understood by bioarchaeological means; to integrate forensic taphonomic and mortuary archaeological perspectives to advance interpretations of postmortem depositional corporeal circumstances from human remains; and to develop a new knowledge base concerning conditions for developing forensic archaeology and anthropology in Sweden. The taphonomic studies included in this dissertation add knowledge about human decomposition in relation to skeletal remains contexts, and can thus help facilitate the reverse: a reconstruction from skeletal remains to the corpse. This introduction serves to briefly present the intersection of these perspectives as a means to situate the focus of this dissertation, as well as outline the work included.

From an osteoarchaeological perspective, taphonomy — the embedding processes of organic remains (Efremov 1940; Lyman 1994) — form a basis of how we can analyze peri- and postmortem corporeal circumstances from skeletal remains and their immediate context. Taphonomic knowledge is vital to interpretations of perimortem events and the postmortem depositional environment, with questions including whether features were created by human hand or the result of other taphonomic processes (e.g. Haglund & Sorg 1997; Lyman 1994; Stodder 2019).

Since the biological death of a person is the very reason for a social response (the staging of social activities surrounding death), contextual analyses of human remains can be a means to gain insights about death and corporeality, alongside mortuary practices (Knüsel &
The interdependence between archaeology and osteology for improved taphonomic and theoretical interpretations has not always been recognized (Appleby 2016; Knüsel & Robb 2016; Manchester 1989; Robb 2013; Schotsmans et al. 2017). Historically, archaeologists were mainly concerned with the field investigations of burials and objects, while osteologists and forensic anthropologists primarily worked with skeletal remains in a laboratory setting (e.g. Soafer 2006:3). Robb (2013) argued that an ‘archaeology of death’ deserved more attention, as the focus had primarily been on burial architecture, grave goods, and the reflection of the living in the grave (Manchester 1989; Nilsson Stutz 2008a; Robb 2013; Tarlow 1999). Death itself had according to Robb (2013) mainly been addressed in narrow taphonomic fields, such as archaeothanatology which was developed in France, that include decomposition dynamics as a factor in ostearchaeological interpretations of mortuary treatment (Duday 1978, 1987, 2009; Duday et al. 1990). However, some other noteworthy taphonomic contributions to mortuary archaeology should be mentioned in this context, such as those by Wilder and Whipple (1917) and Wilder (1923). As with archaeothanatology which was developed later, Wilder discussed the importance of understanding the effects of decomposition processes that act on bone displacements in order to trace the position of the corpse at the time of interment, which he referred to as ‘necrodynamics’ or ‘necrokinetics’ (Wilder 1923). Parallel to the development of archaeothanatology, taphonomic bioarchaeological research that focused on death was again brought to the fore in the anglophone world, with key publications included in books edited by Boddington and colleagues (1987), and Roberts and colleagues (1989).

The last two decades have seen a surge in archaeological and bioarchaeological studies addressing death (for example through publications in Baadsgaard et al. 2012; Crandall & Martin 2014; Devlin & Graham 2015; Fahlander & Oestigaard 2008; Tarlow & Nilsson Stutz 2013). An increased recognition of the interdependency of field and laboratory analyses for theoretical and taphonomic understandings is evident (Dirkmaat & Adovasio 1997; Dirkmaat et al. 2008; Haddow et al. 2020; Haglund 2001; Schotsmans et al. 2017;
Over time, taphonomy has developed from its mother-discipline paleontology through many other disciplines such as archaeology, osteology, geology, biology, pathology, and chemistry to name a few (e.g. Nawrocki 2016). A complex relationship between environmental, individual, and behavioral factors affects the taphonomy of human remains, and therefore the use of interdisciplinary methods and theories can help develop knowledge of peri- and postmortem corporeal processes and environments further (e.g. Nawrocki 1996, 2009, 2016; Schotsmans et al. 2017; Wescott 2018).

The biological processes of death have been thoroughly addressed within forensic anthropology (as well as within fields such as forensic pathology) that developed as a subdiscipline to physical anthropology (in Sweden, physical anthropology corresponds to human osteology). Forensic taphonomy has emerged as a paramount aspect of forensic anthropology and related fields of research (e.g. Dirkmaat & Adovasio 1997; Dirkmaat et al. 2008; Haglund & Sorg 1997, 2002; Micozzi 1991; Nawrocki 1996; Pokines & Symes 2013; Wescott 2018). Adding to osteological and archaeological taphonomy, forensic taphonomy includes knowledge of human decomposition (e.g. Haglund & Sorg 1997; Nawrocki 2016; Pokines 2013). The processes affecting organisms after death in a forensic context form the basis of forensic taphonomy (e.g. Schotsmans et al. 2017). Decomposition research can include both experimental studies that allow longitudinal observations of decomposition and site formation process under controlled circumstances, as well as studies based on forensic casework (e.g. Simmons 2017). This research is valuable not only to forensic enquiries, but knowledge of human decomposition can also advance osteological and archaeological interpretations of mortuary treatment in the past (Boquin et al. 2013; Junkins & Carter 2017; Knüsel & Robb 2016; Mickleburgh 2018; Mickleburgh et al. in press; Nelson 1998; Schotsmans et al. in press; Stodder 2019). If factors such as decomposition processes and their effect on skeletal remains contexts is not well understood, this can lead to erroneous interpretations of how the dead were processed and deposited, and what their peri- and postmortem environment looked like (e.g. Duday
Likewise, forensic taphonomic interpretations can benefit from archaeological perspectives (e.g. Dirkmaat & Adovasio 1997; Groen & Berger 2017; Harrison & Cline 2017; Junkins & Carter 2017).

The overall difficulty with interpretations of archaeological site formation processes is equifinality: that multiple factors could have caused the pattern seen at excavation (e.g. Lyman 2004). This led many zooarchaeological and palaeobiological researchers to conduct experimental studies of osteological traces, predominantly from the 1960s onwards, including skeletal traces of decomposition and disarticulation (Hill 1979a,b; Toots 1965), cooking and burning (Buikstra & Swegle 1989; Shipman et al. 1984), butchery and marrow extraction (Isaac 1967; Shipman & Rose 1983), scavenging (Blumenschine 1986; Shipman & Phillips 1976), digestion (Dodson & Wexlar 1979), gnawing (Brain 1980), weathering (Behrensmeyer 1978; Hill 1976), trampling (Courtin & Villa 1982), and transport (Behrensmeyer 1975; Voorhies 1969), to name only a few publications in some of the areas that have been subject to experimental taphonomic analyses (review in Denys 2002).

In terms of mortuary archaeological inquiries, archaeological scholars have incorporated forensic taphonomic knowledge to advance the interpretation of decomposition and contextual factors that affect archaeological contexts (e.g. Boquin et al. 2013; Duday 2009). Furthermore, experimental studies addressing mortuary archaeology have been conducted by using animal proxies as human analogues in for example cremation (Henriksen 2016) and burial (Jonuks & Konsa 2007) experiments. Studies of animal proxies can complement, but not substitute, human decomposition research (Connor et al. 2018; Dautartas et al. 2018; Dawson et al. 2020; Knobel et al. 2019; Miles et al. 2020). During the work with this dissertation, novel experimental studies of human decomposition that aim to advance our ability to reconstruct archaeological human remains deposits further have been published (e.g. Mickleburgh 2018; Mickleburgh & Wescott 2018; forthcoming studies by Mickleburgh et al. in press; Schotsmans et al. in press). Experimental studies allow observations of taphonomic processes of human decomposition and human remains contexts, which can inform interpretations of
taphonomic patterning of archaeological skeletal remains (e.g. Mickleburgh 2018; Mickleburgh et al. in press; Schotsmans et al. in press; Sorg & Haglund 2002). Such detailed knowledge of how human remains interact with the depositional environment cannot be obtained from archaeological material alone (Mickleburgh 2018; Mickleburgh et al. in press; Mickleburgh & Wescott 2018; Schotsmans et al. in press).

While the possibility for experimental studies became a reality with the development of the forensic anthropology centers (the first one formed on the initiative of William Bass in Tennessee in 1981 (e.g. Jantz & Jantz 2008)), other examples of observations of human taphonomy as a means to advance interpretations of archaeological remains exists. One such example is that Gejvall, a Swedish osteoarchaeologist, studied modern cremations to inform the analyses of archaeological cremated bones (Stjernquist 1992). Another form of contributions are the studies by Oestigaard (1999, 2000a,b, 2004) that link observations of modern mortuary corpse treatment to both current and archaeological cosmological beliefs.

1.1 Research areas

The ambition to increase the understanding of mortuary corporeal circumstances from human remains contexts is shared by all research conducted within the framework of this dissertation. The overall aim of this dissertation — to advance the knowledge of peri- and postmortem corporeal circumstances in relation to human remains contexts and to demonstrate the value of that knowledge in forensic and archaeological practice and research — is approached through the following research areas:

- The peri- and postmortem circumstances of the individuals whose remains have been excavated in Sandby borg, an Iron Age ringfort on Öland, Sweden. Analyses include interpretations of the cause and manner of death, postmortem corporeal treatment, perpetrator behaviour, and what this peri- and postmortem treatment can have meant in this Iron Age community (papers I–III).
• Corporeal postmortem circumstances as traced through taphonomic methods. Studies include applications of a range of taphonomic methods applied to the Sandby borg skeletal material (paper II), human taphonomy in an experimental coffin study with a focus on archaeothanatology (paper IV), as well as the rate and characteristics of outdoor human decomposition in Sweden (paper V).

• Current conduct and potential development of investigations of skeletal, burned, and buried human remains by the Swedish police and the National Board of Forensic Medicine, in relation to forensic archaeology and forensic anthropology in Sweden (paper VI).

1.2 The rationale behind the papers

This article-based dissertation contains six papers (I–VI) that together comprise the conjunction of work that was conducted in two phases, separated by an examination of the first half — the licentiate dissertation (Alfsdotter 2018). Three of the four papers that formed the licentiate thesis are included in this final PhD dissertation (papers I–II). In the licentiate publication, these papers were included as manuscripts as the peer-review processes were not then completed. Here, they are included as revised and published papers (summary in section 4).

Papers I–III explore the case study Sandby borg on Öland, Sweden. In an Iron Age ringfort, skeletal remains that display signs of interpersonal perimortem violence have been excavated (Alfsdotter et al. 2018; Victor 2015; Wilhelmson 2017:143–148). These papers are structured as a three-step bioarchaeological analysis that together amount to a holistic interpretation of what the material represents and what the peri- and postmortem treatment can have meant in the society of that time.

Papers I & II demonstrate how osteological analyses can inform peri- and postmortem corporeal treatment from skeletal remains and spatial context. Analysis of skeletal trauma (paper I) and taphonomy (paper II) are mutually dependent for substantial osteological and taphonomic interpretations, and consequently for interpretations of peri- and postmortem chains of events, including cause and manner...
of death (e.g. Nawrocki 2009). Possible motives behind the attack in Sandby borg are discussed in paper I in relation to a detailed analysis of how the individuals left in the ringfort were killed, as well as their demography. In paper II, the postmortem environment and any traces of postmortem human interaction with the remains are studied from a taphonomic perspective. A combination of archaeothanatological, fracture, weathering, and stratigraphic analyses were conducted. The results indicate that the dead were not given postmortem treatment other than being left where they died, and that they decomposed in open space.

The knowledge about postmortem treatment obtained from papers I and II provided the basis for an interpretation of what the treatment of the dead meant in relation to the Öland Iron Age society. In paper III, the social implications of the postmortem corporeal treatment in Sandby borg were analyzed. A theoretical framework was developed to interpret why the dead in Sandby borg were left behind and what this might have meant in the contemporary society, both for victims and perpetrators. This paper demonstrates an example of how social theories can be used to contextualize death, corpses, and postmortem agency from osteoarchaeological analyses.

During the course of working with Sandby borg, I was faced with new taphonomic questions. Questions regarding the effect of human decomposition on skeletal remains were raised in relation to the concept of archaeothanatology, and how skeletal remains in open space can be interpreted in the light of decomposition factors in general (paper II). The limited comparative archaeological studies of subaerial disposal of the dead (especially in cool to temperate climates) made me engage in forensic taphonomic research. This was done to further the knowledge of how human remains and their context can inform interpretations of mortuary contexts (papers IV–V).

Consequently, two studies of gross human decomposition and skeletonization were initiated. One study (paper IV) was constructed as a qualitative longitudinal experimental study of human decomposition carried out in the US at the Forensic Anthropology Center, Texas State University (FACTS). In early 2019, an experiment was set up to address archaeothanatology and decomposition in different voids, with a focus on human taphonomy.
in coffins. While the study aimed to analyze the disarticulation and decomposition progression in a semi-buried coffin (the lid could be opened at ground level), a buried coffin, and a larger trench, the ambitions had to be adjusted due to the COVID-19 pandemic travel ban. The final data collection was originally planned to take place in April 2020 but had to be postponed. Consequently, paper IV focuses on observations of human decomposition in a semi-buried coffin, as the data collection from this experiment was not affected by the travel ban. The study is included as a manuscript. To the best of my knowledge, this is the first longitudinal experimental study of human decomposition in a coffin. The study sets out to add to archaeological knowledge about interpretations of human intention in the burial record versus decomposition dynamics and other taphonomic processes, specifically in relation to coffin burials and archaeothanatology.

The last taphonomic study is retrospective, analyzing already existing material, in this case autopsy and police reports including images. Human decomposition in Sweden was analyzed and interpreted from a forensic-anthropological perspective (paper V). This research contributes to a demand for regional forensic-taphonomic knowledge (e.g. Haglund & Sorg 1997; Myburgh et al. 2013; Wescott 2018). Studies of gross human decomposition in Sweden has hitherto focused exclusively on indoor decomposition (Ceciliason 2020; Ceciliason et al. 2018). Hence, paper V presents the first quantitative study of human outdoor decomposition in Sweden. This advance knowledge of taphonomic processes in the Swedish environment which can benefit future taphonomic interpretations of corpse decomposition and disposal in both archaeological and forensic investigations.

The value of forensic-anthropological and forensic-archaeological contextual, methodological, and theoretical knowledge has proved beneficial in forensic and humanitarian endeavors in other parts of the world (e.g. Groen et al. 2015a,b), while this knowledge is yet to be fully recognized in Sweden. Due to this, a study (paper VI) that scrutinizes how investigations of skeletal, extensively burned or buried human remains are conducted by the Swedish police and the National Board of Forensic Medicine is included. Apart from an analysis of the current situation, the paper addresses potential
forensic-anthropological and -archaeological developments in Sweden. As my research focuses on peri- and postmortem corporeal circumstances, emphasis is placed on outdoor and fire scenes that contain human remains. Paper VI is the first extensive review of how these assignments are investigated and analyzed within Swedish CSI, and how forensic archaeology and anthropology are used within Swedish police investigations. It is hoped that this knowledge and the suggestions presented will inform future decisions about developments in this area, create a larger awareness of the potential benefits of the subject(s), and benefit future collaborations between law enforcement and archaeology-related disciplines. This study furthermore serves as an assessment of potential forensic implementation of results from the forensic-anthropological studies presented here, and osteoarchaeological knowledge in general.

1.3 Outline of this introductory chapter

The purpose of this introductory chapter (Sw. kappa) is to frame the research presented in the six papers. While methodological and theoretical departures are presented in the individual papers that are situated in the respective fields of research, the next section (Points of departure) expands on some theoretical and terminological positions that have not been fully addressed in the individual papers. This introductory chapter is structured as follows:

- Points of departure
- Ethics and human remains
- Summary of the individual papers with author contributions
- Concluding discussion and future prospects
- Swedish summary
2. Points of departure

2.1 Terminology of the scientific study of bones

Osteology, the scientific study of bones, is related to various disciplines depending on the academic structure in the country of study. Osteology can for example be found in disciplines such as medicine, archaeology, anatomy, anthropology, biology, or forensics, and the focus of osteology depends on the area of study (Duday 2009; Groen et al. 2015b; Hunter 1996; Roberts 2006; Scott & Connor 2001; Skinner et al. 2003). In Sweden, osteology is a sub-discipline of archaeology, and the two have been closely linked since the 1960s (Ahlström et al. 2011; Stjernquist 1992). Combined osteological and archaeological approaches were stressed by Gejvall (1960), and this line of thought has subsequently been applied by several of his students (Iregren 2003). Osteologists educated in Sweden are generally also trained archaeologists, osteoarchaeologists. The osteological training includes both human and animal osteology (Ahlström et al. 2011), while specializations are part of career development.

In paper VI, which among other subjects discusses the use of archaeological and osteoarchaeological expertise in Swedish law enforcement, I use the term osteoarchaeology. Since osteology is intertwined with archaeology in Sweden, the concept of osteology is often understood in relation to archaeology. The expression allows clarity as it describes the material of study (skeletal remains) and in what context the material is studied (archaeology). As the paper focuses on human remains contexts, there was little need to separate the (sub)disciplines for the purpose of the study.

In the papers that discuss prehistoric material (I–III), I use the internationally recognized term bioarchaeology to describe the discipline that merges skeletal biology with archaeology (thus including social theories) in both method and theory (Agarwal & Glencross 2011; Armelagos 2008; Baadsgaard et al. 2012; Buikstra 1977; Buikstra & Beck 2006). However, it should be noted that bioarchaeology can be viewed as encompassing a broader scope of research than osteoarchaeology. As scholars identifying as
bioarchaeologists can come from various professional backgrounds, the perception of what bioarchaeology constitutes varies over geographical and scholarly areas (Baadsgaard et al. 2012; Clark 1972, 1973; Knüsel 2010; Rakita 2014; Zuckerman & Armelagos 2011). For example, Buikstra (1977) connected the term with an integration of osteology and archaeology, while Clark (1972, 1973) connected it to archaeozoology and what would later become environmental archaeology (reviews in Knüsel 2010; Little & Sussman 2010). Here, the term is used synonymously with osteoarchaeology, and refers to the study of skeletal remains in relation to the archaeological context and social theories.

The term forensic anthropology is the established international term for the subject developed from human skeletal research that has been adapted to the forensic field. The field emerged as a sub-field of physical anthropology (also known as biological anthropology) which constitutes one of the four anthropology fields is the US (while archaeology is another) (Armelagos 2008; Larsen 1987; Little & Sussman 2010; Martin et al. 2013; Tersigni-Tarrant & Shirley 2013; Ubelaker 2019). In paper VI, forensic anthropology is introduced as a field developed from osteology. This is a simplification where physical anthropology has simply been translated to osteology in order to avoid using too many terms in the paper that focuses on the Swedish situation, where osteology is the terminology generally used (instead of physical/biological anthropology and zooarchaeology).

While forensic anthropology is a well-established term, nothing in the name reveals that the subject is based on osteology, or human remains in general. Márquez-Grant (2018) proposed that a more suitable term would be forensic physical anthropology and Scott & Connor suggested forensic osteology (2001). While I would prefer either of the latter options for explicitness, I have chosen to stay with the term of forensic anthropology as it is widely recognized.

2.2 Terminology connected to death

In archaeology, research has often been directed towards funerary or burial research (Knüsel & Robb 2016). Klevnäs (2016) suggested that the term mortuary should be favored over funerary to push the development of the field from a focus on burial (one of many possible
post-mortem treatments of human remains) to a focus of death (as a complex of social actions with consequences for treatment of those remains). Furthermore, mortuary can apply to all human remains contexts, whereas funerary indicates mortuary contexts that are intentional and suggestive of ritual behaviour in connection to the disposal of the dead. Based on these thoughts, I use mortuary as an all-encompassing term for human remains contexts in this dissertation, while funerary is reserved for discussing depositions of remains that include ritual behaviour. On the same grounds, disposal and deposition are used as general terms to describe human remains contexts (following Sprague 1968), while burial is reserved specifically for burial contexts. Funerary taphonomy (Knüsel & Robb 2016) has been used to describe taphonomy of mortuary contexts in archaeology, but I have preferred to use human taphonomy (e.g. Schotsmans et al. 2017) to allow for a wider application of the concept.

2.3 Terminology of dead human beings

The thought that the mind has no physical extension but can think, whereas the body has a physical dimension but lacks the ability to think has dominated the Western intellectual discourse for centuries (Scheper-Hughes & Lock 1987; Strathern 1996:1–3,41–42). This way of thinking can be traced back to Greek philosophy but was reinforced in the seventeenth century through Descartes’ philosophy (e.g. Manning Stevens 1997:265). This perceived body-mind duality is in itself culturally created (e.g. Malafouris 2008, 2012; Scheper-Hughes & Lock 1987; Strathern 1996:1–8; Turner 2008:8,50). In present Western culture, the biological death is often regarded as a clear break from the living world, while in many other cultures, the biological death does not equal a social death (Pérez 2012; Robben 2000). Perceptions of death varies over time and space, which also affect how we perceive dead humans (Fahlander & Oestigaard 2008; Kaliff 2004; Nilsson Stutz 2003b, 2008b; Nilsson Stutz & Tarlow 2013; Oestigaard 2000a, 2004; Robb & Harris 2013; Tarlow 1999). The common use of dead body is connected to our cultural perception of the body as a container of a (previous) consciousness, which assumes a mind and body dichotomy. Graham has discussed the archaeological
perceptions of the labels *corpses, bones* and *bodies* (Graham 2015). She observed that skeletal remains are often referred to as *bodies* while disregarding the transition to a corpse, and subsequently to skeletal remains.

Archaeological interpretations are sometimes written in such a way as to suggest that the skeletons which we uncover, and therefore usually associate with past funerary practices, were what was deposited in graves, rather than articulated corpses. In these instances ‘body’ essentially means ‘skeleton’ and we have developed a collective tendency to think of the dead body in terms of bones and the living in terms of flesh and fluids. Even studies which prioritise a body-centered approach to funerary remains might still give disproportionate attention to the skeletal evidence and think primarily of the ‘bodies’ under scrutiny in such terms. (Graham 2015:4)

In the research presented here, I have intended to bring the corpse into light, as a means to highlight the process of the dead corporeality, and to acknowledge that skeletal remains are but the final stage. The nature of dead human beings is thus specifically addressed, not just for clarity but also for the sake of recognizing that ‘the dead’ is a special materiality distinct from that of ‘the living’ (Kristeva 1980; Nilsson Stutz 2003b, 2008a; Oestigaard 2004).

Therefore, I use *corpse, cadaver,* and sometimes *body,* the latter particularly in cases where I discuss both the living corporeality and the dead one, or for example when discussing *body positions* or thermal alterations around the time of death (papers III & VI). *Deceased* is here used synonymously with corpse, while *donation* is sometimes used when discussing the ‘whole body donation’ as per the terminology used at the Forensic Anthropology Center at Texas State university (paper IV) that receive deceased humans for research, see section 3.1 for information about the program. *Skeletal remains, bones* and *bone elements* are used to describe dry remains, while the term *human remains* is used throughout the papers when I need to allow for the entire spectrum of human dead matter to
be included. I find the term useful because it can apply to all parts and states of a deceased, including fleshed remains, body parts, skeletal remains, and semi-skeletonized remains.

2.4 Definition of taphonomy

The concept of *taphonomy* was developed in paleontology by Efremov in 1940 and was originally constructed to advance understanding of the transition of dead organisms (originally animals) from the biosphere to the lithosphere (i.e. fossilization) (Efremov 1940; Lyman 1994:1, 2010). The transition was later divided into two stages, where *biostratinomy* takes place between death of the organism and the final burial (however complex this phase is), and *diagenesis* (which can have some variations in definition, not discussed here) that occurs between the final burial up until the event of recovery (Lawrence 1979a,b,c; Lyman 1994:16–17, 2010). This distinction was created in paleontology to distinguish mainly biological taphonomic processes from mainly geological ones. Taphonomy thus includes both the transitions of the organism(s) themselves and the surrounding matrix (e.g. Domínguez-Rodrigo 2008). Over the last 40 years, taphonomy has become an integral part of several disciplines, among those osteology, archaeology, and forensic anthropology. The concept has been modified to fit the fields of studies (e.g. Domínguez-Rodrigo *et al.* 2011; Haglund & Sorg 1997; Lyman 1994:12–40, 2010; Nawrocki 1996).

Within forensic taphonomy (see definition paper VI), *biotaphonomy* relates to the taphonomic signatures on the human remains themselves (Nawrocki 2016), and *geotaphonomy* refers to geological and sedimentological environment in interaction with the decomposing corpse (note that no distinction between sediment and soil is made in this dissertation, they are used interchangeably) (Hochrein 1997a,b, 2002). These concepts are associated since the microenvironment created through the combination of ecology and decomposing human remains is in constant change and exchange (Sorg & Haglund 2002).

Taphonomy as a concept fitted well into the archaeological discipline as site formation processes and human modification of material have been of central interest in archaeology since the
As archaeological formation processes not only include the transitions of animal and plant remains into the geological record (as in palaeontology), but also remains of material culture, the original concept of taphonomy has often been adjusted to fit the material of study (Lyman 2010). Lyman criticized the inclusion of non-organic material (such as lithics and ceramics) into the concept of taphonomy, as it diverges from the original concept. Importantly, the incorporation of material culture skews the concept of reconstruction. Lyman explained this as

[...] living tissue has a different mode of natural occurrence than lithics or clay or metal, and this in turn means the two kinds of material have a different starting point in their respective histories with regards to formation of the archaeological record. In particular, [...] a mammal skeleton provides a natural model to which a prehistoric bone can be compared. There is no similar natural model for a lithic or clay specimen that is the artifact. (Lyman 2010:11–12)

Lyman has a point in arguing that the existence and transition of organic material differs from inorganic material. However, there is no consensus of how taphonomy is defined (Domínguez-Rodrigo et al. 2011; Knüsel & Robb 2016). It should be mentioned in this context that some archaeologists and forensic anthropologists include the recovery, sampling, transport, curation, data archiving and analysis as part of the taphonomic history (e.g. Stodder 2019).

I use taphonomy as the concept of the transition of organic remains from point of death to point of recovery (Lyman 1994:1, 2010). In this understanding of the subject, taphonomy is only part of the archaeological site formation processes that need to be regarded in archaeological enquiries. Furthermore, it is recognized that taphonomic changes can lead to both information gain and information loss (Behrensmeyer & Kidwell 1985), see for example paper III where taphonomic changes both limit the information
obtainable from skeletal remains, but also aid in reconstructing the peri- and postmortem processes in Sandby borg.

2.5 Peri- and postmortem in osteology and taphonomy

One important taphonomic inquiry is the question of the timing of sustained alterations to human remains, not least in terms of whether bone fractures were caused by perimortem trauma or postmortem taphonomic processes (Sorg 2019; Symes et al. 2013; Ubelaker 2015). There is no consensus on whether perimortem trauma is part of the taphonomic process or not. Some scholars include it as part of taphonomy (Stodder 2019; Ubelaker 1997), others only include alterations that occur postmortem as part of the taphonomic history (while that could still be in bone that appears perimortal, see discussion below) (Dirkmaat et al. 2008; Lyman 2010; Sorg 2019). I understand taphonomy and trauma as described by Marcella Sorg

The term ‘trauma’ refers to injury that occurs before or at the time of death, when the victim is still living. Taphonomic modifications, on the other hand, are defects in the remains that occur in the postmortem period. They may be due to human agency, such as dismemberment, or a whole host of other taphonomic agents, including for example scavenger modification, fire, water transport, geological forces, or weathering. (Sorg 2019:1)

Definitions aside, researchers generally agree that analyses of trauma and taphonomy are interdependent as the distinction of timing itself is part of the taphonomic analysis. In terms of osteological taphonomy, this inquiry is complicated by the concept of perimortem. Skeletal fracture morphology is dependent on the bone moisture and organic components. Therefore, the transition from perimortem (green bone) to postmortem (dry bone) — also known as the perimortem interval — is a prolonged process heavily dependent on the depositional context, as opposed to forensic pathology where perimortem refers to the somatic death (Cunha & Pinheiro 2009; Dirkmaat & Adovasio 1997; Nawrocki 2009). Both peri- and
postmortem are used to describe the death event within osteology, as skeletal alterations with perimortem appearance may either be interpreted to have occurred around the time of somatic death or in the early postmortem period (Dirkmaat & Adovasio 1997; Haglund & Sorg 1997; Sorg 2019; Symes et al. 2013). The interpretation of what has caused the perimortem fracture and the sequence of events is therefore helped by knowledge of the taphonomic context (Dirkmaat & Adovasio 1997; Haglund & Sorg 1997; Sorg 2019; Symes et al. 2013). Consequently, laboratory analysis and field observations are interdependent when studying human remains. For example, taphonomic processes might have created a perimortem pseudo-trauma in a bone (i.e. a perimortem lesion that is ‘naturally’ induced but could be interpreted as induced by a human agent) (Symes et al. 2013; Ubelaker 1997). Without knowledge of the context of the find, such inferences are difficult to make (Nawrocki 2009). Summarizing, bone lesions need to be considered in relation to cause and timing of events. Apart from analysis of bones and context, the interpretation includes aspects of cultural or assailant behavior (Nawrocki 2009).

The close connection between find context, bone appearance and interpretation of death events and corporeal treatment demonstrate why taphonomy needs to be part of holistic investigation of human remains. Even if questions posed to the material would only target postmortem (in terms of somatic death) body treatment, this treatment will at least partly take place during the ‘skeletal perimortem period’. When a taphonomic analysis has been conducted, this knowledge can be used to interpret the chain of events and the human agency behind it (here mainly exemplified in paper II and III) (e.g. Nawrocki 2009).

2.6 Human decomposition

This dissertation includes studies of human decomposition (paper IV & paper V). The papers provide descriptions and discussions of decomposition processes in the samples, but a background survey into general human decomposition progression is limited. Therefore, an overview of general human decomposition is provided to give the reader a basic understanding of the subject.
At death, when respiration stops, the cellular breakdown starts as metabolic activity is halted by the cessation of oxygen transport (e.g. Damann & Carter 2013; Forbes et al. 2017; Tsokos 2004) The self-digestion of cells and organs caused by escaping intracellular enzymes is called autolysis (DiMaio & DiMaio 2001:30; Forbes et al. 2017). The intrinsic biochemical processes trigger algor mortis (change of the corpse temperature to the ambient temperature), livor mortis (pooling of blood) and rigor mortis (stiffening of muscles) (Clark et al. 1997; DiMaio & DiMaio 2001:21–29). These processes generally begin within 24 hours (Damann & Carter 2013).

Putrefaction is caused by (mainly anaerobic) bacteria and causes tissue to transform into liquid, gas, and salt (Forbes et al. 2017; Gill-King 1997; Janaway et al. 2009; Pinheiro 2006; Vass et al. 2002). The corpse undergoes a range of discoloration, skin slippage and bloat, the latter caused by the buildup of fermentative gases (Gill-King 1997; Love & Marks 2003; Vass et al. 2002).

Body mass reduction is related to the liquefaction of soft tissue, which to a large extent is initiated by the bacterial enzymes from the gastrointestinal tract (Janaway 1996; Janaway et al. 2009) Liquified soft tissue and other body fluids escape the body through orifices and postmortem skin rupture (e.g. Forbes et al. 2017). The composition of the liquified byproduct changes throughout the postmortem period. While initially neutral in pH, ammonia released from insects feeding off the remains increases the alkalinity of the liquefied mass (Comstock 2014). When insects no longer feed on the remains, the liquified mass decreases in alkalinity again (Comstock 2014; Forbes et al. 2017).

Advanced decomposition is characterized by extensive loss of body mass and subsequently skeletonization (e.g. Galloway 1997; Mann et al. 1990; Megyesi et al. 2005; Rodriguez & Bass 1985). Skeletal degradation continues throughout the postmortem process (while the onset of degradation is still debated), including loss of organic components and microbial bioerosion (e.g. Bell 2012; Booth & Madgwick 2016; Jans et al. 2004; Turner-Walker 2019).

The rate of decomposition is influenced by multiple, sometimes interrelated, factors. These are both intrinsic to the corpse and environmental, and include (but are not limited to) age, body mass, health status, clothing, wrapping material, bacterial/insect and
scavenger activity, temperature, moisture, oxygen supply, soil type and pH, vegetation, and seasonality (e.g. Carter & Tibbett 2008; Damann & Carter 2013; Forbes 2008; Giles et al. 2020; Janaway 1996; Junkins & Carter 2017; Mann et al. 1990; Swift et al. 1979).

Ambient temperature is generally regarded as the most influential factor in decomposition rate, on which several other environmental factors depend (e.g. Damann & Carter 2013; Hopkins 2008; Mann et al. 1990). Insect presence or absence is another factor described as paramount (Simmons et al. 2010).

Several retarding processes can affect decomposition, such as freezing (Micozzi 1986, 1991:12–13, 1997), desiccation (e.g. Galloway 1997; Galloway et al. 1989), and saponification (e.g. Mant 1950, 1987; review in Ubelaker & Zarenko 2011). Decomposition can be retarded temporarily or long-term. These processes are not mutually exclusive but can appear in the same corpse in different regions, as well as co-exist with active putrefaction as the microenvironment of the same corpse can vary (e.g. Hamilton & Green 2017; Pinheiro 2006).

2.7 Archaeothanatology

Archaeothanatology integrates human decomposition dynamics into taphonomic reconstructions of archaeological skeletal remains (e.g. Duday 1978, 2009). Archaeothanatology (previously l’anthropologie de terrain) address corpse treatment through analysis of spatial relationships of bone elements, burial context and objects (Duday 1978, 1987, 2006, 2009; Duday et al. 1990; 2014; Duday & Guillon 2006). Archaeothanatology aims to

[...] reconstruct the attitudes of ancient populations towards death by focusing on the study of the human skeleton and analysing the acts linked to the management and treatment of the corpse. (Duday 2009:6)

The in situ analysis is reliant on the disarticulation sequence of joints and the distribution of bones, which is used to reconstruct peri- and postmortem chain of events through separating the ‘natural processes’ from human actions in order to interpret the original corporeal
treatment at deposition and any subsequent manipulation (Duday 2006, 2009).

Through the work of Henri Duday and colleagues, archaeothanatology started to develop in France in the 1980s (Duday 1978, 1987; Duday & Masset 1987) as related to in situ documentation of bones (see also Wilder & Whipple 1917; Wilder 1923 as mentioned in the introduction). The archaeothanatological method was introduced to anglophone academia in the early 2000s (Duday 2009; Duday & Guillon 2006; Nilsson Stutz 2003b; Roksandic 2002) when an integration of archaeothanatological analyses and social theories of ritual practice was developed by Nilsson Stutz (2003a,b, 2008a,b, 2009).

Archaeothanatology is now increasingly used outside of France as a means of reconstructing past corporeal postmortem treatment in connection to contexts of skeletal remains (Appleby 2016; Blaizot 2014; Boquin et al. 2013; Castex & Blaizot 2017; Green 2018; Harris & Tayles 2012; Knudson & Stojanowski 2008; Mickleburgh 2018; Ortiz et al. 2013; Peyroteo Stjerna 2016; Tõrv 2016; Willis & Tayles 2009).

While Knüsel (2014) suggested that archaeothanatology is broader than taphonomy, archaeothanatology is often considered a taphonomic method (Duday 2009; Nilsson Stutz 2003b; Roksandic 2002) which combined with social theories can advance interpretations of mortuary behaviour (Nilsson Stutz 2003a,b, 2008b, 2009). To strengthen archaeothanatological in situ analysis, archaeothanatology is ideally combined with other analytical methods to further increase information about the burial record and site formation process (Wilhelmsen 2017:188).

Archaeothanatology has been influential in advocating that skeletal remains do not necessarily reflect the initial corpse placement and that analysis of spatiality of bones in archaeological contexts can inform this interpretation (Duday 2009; Knüsel 2014; Nilsson Stutz 2003b). The archaeothanatological methods for reconstructing corpse treatment were developed from repeated archaeological observations of skeletal remains, knowledge of human decomposition, and joint biomechanical properties in life (Duday 2006; Duday et al. 1990). Several researchers have called for experimental studies of human decomposition as a means of improving archaeothanatological
hypotheses, including Henri Duday himself (Appleby 2016; Duday et al. 1990; Knüsel 2014; Knüsel & Robb 2016; Mickleburgh 2018; Mickleburgh & Wescott 2018). At an early stage, Duday integrated knowledge gained from forensic taphonomic studies into his archaeothanatological work with archaeological contexts (Duday et al. 1990; Duday & Guillon 2006). Experimental archaeothanatological studies have thus far been conducted through pioneering studies by Mickleburgh and Wescott (2018), Mickleburgh (2018), Mickleburgh and colleagues (in press) and Schotsmans and colleagues (in press). These studies have shown that joints disarticulation is complex, with varying disarticulation sequences and multiple factors affecting the rate and sequence of joint disarticulation. Paper IV provides another such experimental study that addresses supine decomposition and disarticulation in a wooden coffin. The rationale behind experimental studies as a means of advancing archaeological knowledge is based in analogous reasoning (e.g. Mickleburgh 2018; Mickleburgh et al. in press; Schotsmans et al. in press), for which the premises are outlines below.

2.8 Analogies in taphonomic research

According to some, archaeological knowledge is based on analogues between the present and the past (Binford 1981; Gifford-Gonzalez 1991; Wylie 1985, 1988). Analogues are used to understand behavior and processes that have shaped the archaeological record through modern knowledge of similar processes and materials (e.g. Domínguez-Rodrigo 2008; Gifford-Gonzalez 1991). Analogous reasoning is intertwined with the concept of uniformitarianism which assumes that natural laws are invariable over time and space (for discussions about uniformitarianism see for example Baker 2014; Domínguez-Rodrigo 2008; Gifford-Gonzalez 1991; Gould 1965). This might be applied here by the interpretive argument that a process observed to result in a particular signature in human remains may have occurred in the past and produced a similar signature in archaeological remains. Change does, however, not occur at a constant rate, and the agents behind certain signatures cannot be proved when making analogies between past and present. A uniform understanding nevertheless allows observations of modern processes
that shape modern material, which can then be used as a source for creating explanatory frameworks to interpret past processes as manifested as past traces in material (Domínguez-Rodrigo 2008; Gould 1965). In the case of human taphonomy, uniformity means that natural processes that influence human remains today occur in the same way as they did in the past. It is however recognized that taphonomy includes both uniform processes and (more or less known) context-specific aspects (Haglund & Sorg 1997; Lyman 1994:52–69), and that past and present ecologies cannot be easily or directly compared (Gifford-Gonzalez 1991; Lawrence 1971). Furthermore, human decomposition is reliant on intrinsic factors, which can, for example, relate to body composition or medications and medical conditions to name only a few (Zhou 2011).

When conducting experimental taphonomic research to gain knowledge of processes which have shaped past material, both observations and inferences are needed as some factors can be observed (such as signatures created on bones and the agent causing it), while others need to be inferred (such as the past behavioural and ecological context) (Domínguez-Rodrigo 2008; Lyman 2004; Wylie 1988). In other words, analogies between the present and the past are incomplete which is why it is important that the assumptions and premises that underlie analogous reasoning are outlined (Domínguez-Rodrigo 2008; Wylie 1988). Different taphonomic pathways might result in the same outcomes (equivacency), and therefore experimental studies need to be evaluated with caution (Gifford-Gonzalez 1991; Haglund & Sorg 1997; Lyman 2004; Micozzi 1991). Through longitudinal studies where taphonomic processes are observed, the taphonomic signatures can ideally be linked to probable causative agencies behind a visible trace (Gifford-Gonzalez 1991; Haglund & Sorg 1997; Lyman 1994:60; Mickleburgh 2018; Sorg & Haglund 2002). Haglund and Sorg wrote that

*Because we cannot prove [archaeological] analogically based inferences, such conclusions are only probabilistic; if we can carefully demonstrate causal relations between processes and effects in the present, however, the inferences become highly probable.* (Haglund & Sorg 1997:15–16)
Modern experiments of, for example, scavenging can shed light on processes causing skeletal modifications. The static results then need to be compared and evaluated in relation to past contexts. Both results that confirm and contradict initial hypotheses of the experiment need to be considered (e.g. Haglund & Sorg 1997; Lyman 1994:66; Simmons 2017). When evaluated thoroughly, knowledge from actualistic studies can strengthen inferences from retrospective or cross-sectional taphonomic studies as valuable knowledge of site formation processes as the taphonomic agents behind the modifications of the context can be observed (e.g. Haglund & Sorg 1997; Mickleburgh 2018; Simmons 2017).

Both retrospective and experimental taphonomic studies have their strengths and weaknesses (Simmons 2017). For example, experimental studies allow unique observations of a sequence of events but are somewhat restrained by their applicability to ‘natural’ taphonomic scenarios (Haglund & Sorg 1997; Hanson 1980; Mickleburgh 2018; Miles et al. 2020). Retrospective studies on the other hand can be conducted in various geographical areas, represent a wider variety of scenarios, and allow for larger samples, but demand more levels of inferences as the entire taphonomic processes cannot be observed (Haglund & Sorg 1997; Simmons 2017; Sorg et al. 1997). Both types of taphonomic studies are presented here (papers IV & V), with limitations discussed in relation to the methods and material used.

2.9 Forensic archaeology and anthropology in Sweden

The state of forensic archaeology and anthropology within the Swedish police force and the Swedish National Board of Forensic Medicine (NBFM, Sw. Rättsmedicinalverket) are analyzed in paper VI. The study includes a section on the development of the subject(s) within the police which starts with an initiative to incorporate archaeology into police work in the 1990s. The initiative resulted in a working group consisting of crime scene investigators (some with a background in archaeology and osteology) and external osteological and archaeological specialists. This gave rise to some CSI
investigations where osteoarchaeological expertise was consulted in the Stockholm area (e.g. Kjellström 2013). Despite this initiative, the development of forensic archaeology and anthropology has been slow nationally (but increasing, see paper VI). While the police-led development is discussed in paper VI, the analysis does not address forensic archaeology and anthropology in Swedish academia, which is why a short description of known efforts in the subject is provided here. Ultimately, no program in forensic archaeology or anthropology is currently offered in Sweden. However, an online part-time course in ‘The Archaeology of the Crime Scene’ (Sw. Brottsplatsens arkeologi) was given by Umeå University for about four years (with a start in 2010). The course primarily focused on entomology and geoarchaeology, and attracted students from archaeology, the police, medicine, the military and the law (Philip Buckland, palaeoentomological researcher at Umeå University, pers. comm. 2021-02-04).

As discussed in paper VI, osteoarchaeologists are often consulted in police cases, not least for species determination. Few publications address such cases, but there are some notable exceptions. Two early Swedish ‘forensic osteological’ publications were written by Gejvall (1975) and Gejvall and Johanson (1977), the latter a forensic odontologist. They address two cases of identification of deceased individuals from skeletal remains, as per a request by the police. Gejvall was throughout his career in contact with forensic pathologists and odontologists and gave some osteology-related training at the Police Academy (Stjernquist 1992).

There are also rare examples of Swedish bioarchaeological publications that are the result of collaborations with forensic experts, such as that by Carlie and colleagues (2014) which address drowning in the Neolithic period.

The work related to forensic archaeology and anthropology conducted as part of this dissertation (papers V and VI) provides new knowledge that can hopefully benefit development of the subjects in Sweden. Future perspectives on forensic archaeology and anthropology are provided in the discussion at the end of this introductory chapter.
3. Ethics and human remains

This research has been conducted in line with scientific ethical research practice defined by the Swedish Research Council (Vetenskapsrådet 2017). Apart from general research ethics such as transparency and truthfulness, dissemination of results, and consent (ALLEA 2017; Vetenskapsrådet 2017), the research presented in this dissertation has demanded ethical considerations related to research on human remains specifically (both ancient and modern). The ‘correct’ way to handle the corpse or the skeleton is intertwined with cultural perceptions of death and how the treatment of human remains will affect the afterlife as well as the living society (e.g. Scheper-Hughes & Lock 1987; Nilsson Stutz & Tarlow 2013; Verdery 1999:42). Debates about the use of human remains for research plays out in relation to different value systems (Lambert & Walker 2019; Walker 2007). Verdery (1999) and Masterton (2010) discussed the contradiction that the dead cannot be harmed, yet the legacy and perceived identity of individuals can be altered. As we conduct research on human remains, we change the narrative of the once living. The balance between values is constantly negotiated, and ethical aspects revised.

I here situate the different case studies presented in my papers in terms of ethical and legal frameworks, and the choices that have been made throughout the research. For the interview-based paper VI, decisions related to anonymity and consent are presented in the paper.

3.1 Experimental longitudinal human decomposition study

At the Forensic Anthropology Center at Texas State University (FACTS), I investigate the decomposition of donated deceased human individuals that are part of FACTS’ Whole Body Donation program. FACTS exclusively accepts human deceased bodies that are donated with informed consent. The donations are voluntarily willed, either by the deceased prior to death, or by the legal next of kin following death, to FACTS for forensic, taphonomic, and skeletal research.
body donations’ to FACTS do not exclude the possibility for prior organ donation, and the donors are not compensated financially. Following decomposition at the Forensic Anthropology Research Facility (FARF), the donated remains become part of the Texas State University Donated Skeletal Collection for osteological research.

FACTS’ Whole Body Donation program follows the Texas Revised Universal Anatomical Gift Act (National Conference of Commissioners on Uniform State Laws 2009). In the research presented here, the donations have been treated in compliance with the description stated by FACTS.

*FACTS uses gifted bodies for scientific research related to human decomposition and skeletal biology. The gifted body is usually either placed on the surface or buried to decompose and the process of decomposition is documented.* (Texas State Forensic Anthropology Center n.d.-a)

Prior to research at FACTS, research requests are reviewed by the FACTS director and coordinator. The scientific foundation and the plan for implementation of the proposed project are thoroughly evaluated (Texas State Forensic Anthropology Center n.d.-b). A respectful treatment can be obtained when the will of the donors is respected. The donor program aims to

[...] Facilitate interdisciplinary (e.g., forensic anthropology, archaeology, odontology, botany, entomology, biology, chemistry, and others) research and study [...] that advances forensic anthropology and other forensic sciences. (Texas State Forensic Anthropology Center n.d.-c)

Research and research dissemination is thus a key factor legitimizing the work with the human corpses donated for this purpose, and only for this purpose. This entails publishing the scientific studies conducted so that the knowledge gained from the human donations benefits the scientific community. Furthermore, the body donations are to be used in the way specified prior to the donation, i.e. in
accordance with the description provided by FACTS, which is in line with the prior knowledge of the donors. As the donations are to be used for science, the deceased body is the research subject, meaning that the individual’s lived identity is not for researchers to address (apart from the ante-mortem medical and demography data provided by the donors, if it would advance the scientific study). Any personal data is to be safeguarded by the researcher (Texas State Forensic Anthropology Center n.d.-b). Only personal information that might affect the outcomes of the current study was collected from the personal information that was provided by the donor in the donation forms. In paper IV, the data that was identified as crucial for transparency and reproducibility was limited to age-at-death, height, weight, and sex as these factors show important sample properties. The data is coded, and donors are only addressed by their donation number which is allocated by FACTS during the intake of the files and the donor. The original antemortem data is stored in the FACTS archive, which is where the raw data of the study included here will be archived for future research projects.

The donation of one’s body after death is an invaluable gift, and therefore the study was planned and implemented as thoroughly as possible. Dissemination of material that addresses the donations is limited to scientific publications and presentations of the study. The information and photo documentation included in this work is provided for scientific knowledge dissemination and are not to be reused for other purposes.

### 3.2 Retrospective human decomposition study

The retrospective study conducted in collaboration with the NBFM investigates human decomposition and skeletonization in the Swedish climate. The material analysed consists of photos and descriptions of deceased individuals and their find context that were retrieved from the NBFM digital database, combined with climate data. The human remains were in other words not studied physically. Consequently, there was no conflict between mortuary treatment and the research conducted in this study.

The study serves to improve the knowledge about human decomposition in Sweden and can thus aid future investigations of
what has happened, peri- and postmortem, to individuals whose remains are found outdoors, as well as improving assessments of the postmortem interval in Sweden. Together with Anja Petaros (NBFM) the study was planned with the aim of providing valuable information while working ethically in addressing both respect for the dead and the potential discomfort of living relations of the deceased.

Before initiating the study, a research application was sent to the Swedish National Ethics Board (Sw. Etiknämnden) for evaluation application number 2019-04275). The board chose not to test the study since 1) no procedure that affects living or deceased human bodies would be conducted (Swedish Government 2003:60 §4), and 2) the law on personal data protection does not apply to deceased individuals (Swedish Government 2003:60 §3). The study does, thus, not conflict with legal frameworks, but the material analysed is nevertheless of a sensitive character.

The human remains data collected by NBFM differs from the data collected in the experimental human decomposition study, in the sense that the data we use in the retrospective study was not primarily collected for scientific research. Rather, it was collected for medicolegal purposes. However, the NBFM has a research assignment from the Swedish Government (2007:976), which means that this data can be used for scientific purposes under certain circumstances. For me, as an external researcher, to access the data at NBFM, a confidentiality agreement for disclosure of information with reservations was created by NBFM (in accordance with Swedish Government 2009:400:10 14§). The agreement requires that personal data is not disclosed or used in the study, and that such data can only be handled while present at the NBFM facility. Furthermore, the data available to us was limited to our pre-defined selection criteria (paper V) prior to my participation to guarantee that no cases other than those relevant for this particular study were handled during data analysis. The identification of cases relevant to our study was conducted by NBFM statistics personnel. During the time spent at NBFM, all cases included in the study were stripped of personal data through coding before being used for further analysis. The code key is stored on a separate USB stick at the National Board of Forensic Medicine, and only the authors of the study (CA and AP, see paper V) were engaged in the coding. In dissemination of the study, the results are mainly
presented quantitatively to reduce the possibility of identifying specific cases. In the few instances where individual cases are described, no personal data that will lead to an identification of a single individual is shared.

3.3 Archaeological human remains studies

Over the last decades, ethical considerations in bioarchaeology have been widely discussed. Some organisations provide codes of ethics that address osteological work. Human remains research guidelines state that 1) human remains needs to be treated with respect; 2) the wishes of the dead and living relatives should be considered; 3) in order to understand the history of humanity, respect for research on human remains that show scientific value is paramount (AAPA 2003; BABAOP 2019; Lambert & Walker 2019; Riksantikvarieämbetet 2020a; WAC 1989).

Repatriation and ownership of the dead are controversial topics that have come to the fore, especially in cases of remains that stem from indigenous groups or the recently dead with living descendants (e.g. Jacobs 2009; Kakaliouras 2008; Nilsson Stutz 2013; Squires et al. 2019a; Svestad 2019). In relation to Swedish museum collections, guidelines for repatriation are provided by the Swedish National Heritage Board (Riksantikvarieämbetet 2020b).

Other frequently debated subjects are the historical use of human remains from social outcasts for scientific research and anatomical collections (e.g. Claes & Deblon 2018; Svanberg 2015; Walker 2007), the relationships between physical anthropology, race biology and racialized thinking (e.g. Cartmill 1998; Caspari 2003; Górny 2018; Johnson 2016; Kjellman 2016; Redman 2016; Svanberg 2015; Watkins 2020), the exhibition of human remains in museums (e.g. Joy & Farley 2020; Overholtzer & Argueta 2018; Swain 2002), and destructive analyses of archaeological human remains (e.g. Squires et al. 2019b). These subjects have been discussed by others and will not be elaborated on here. Instead, I will discuss the perception of prehistoric human remains without known descendants in a Swedish context, as this relates to the bioarchaeological research included here.

Swedish legislation does not address archaeological human remains specifically, but they are protected in the sense that they are finds from
an archaeological context that are covered by the National Cultural Heritage Law (Ahlström et al. 2011; Iregren 2010; Kaliff 2004; Swedish Government 1988). Finds recovered from archaeological sites are to be managed by museums (Iregren 2010; Riksantikvarieämbetet 2011), and recently published guidelines by the Swedish National Heritage Board provide guidelines for such praxis, including ethical and scientific considerations (Riksantikvarieämbetet 2020a).

In terms of burial sites, those that were abandoned before 1850 are protected by the law. This means that if these graves are to be affected by development projects, the burials are to be excavated and treated as an archaeological material, regardless of burial customs (Redin 1994). If cemeteries are still in use however, they are under the church authority, even if they stem from medieval times (Redin 1994).

In a guideline from 1983, the Swedish National Heritage Board and the Swedish Museum of National Antiquities stated that reburial of archaeological human remains can only be conducted under certain circumstances (e.g. Ahlström et al. 2011; Iregren 2010). Skeletal material that might be subject to reburial is to be examined by osteologists to evaluate the scientific value of the material. If such a value is recognized, the material is to be preserved (Iregren 2004). If reburial is to take place, demands on the facility where they are reburied (such as a crypt) holds that they must be secure, accessible for researchers, and uphold a good preservative environment (Iregren 2004). In Sweden, requests for reburial of prehistoric skeletal remains have been relatively few (Ahlström et al. 2011). Reburials and repatriations of prehistoric (and historic) human remains in Sweden have largely concerned indigenous remains, not least from the Sápmi area (review of Sámi repatriations and reburials in Fjellström 2020:43–69).

Another category of requested reburials in Sweden concerns Christian skeletons (Ahlström et al. 2011; Iregren 2010; Kaliff 2004). These requests are sparse, which Iregren (2010) suggested was due to Sweden being highly secularized (religion as well as value systems in general are however subject to change over time). The scientific value of remains are often regarded as more important than reburial (Iregren 2010). However, it is clear that distance in time and cultural expressions related to death practices affect the emotions connected
to archaeological work with human remains, where treatment of
Christian human remains are generally of more concern to the public
than prehistoric remains (Kaliff 2004). The understanding of human
remains is often influenced by Christian cultural ethics, which
Oestigaard (2016) identified as perceptions of death as an end, and
that integrity of the corpse is important. These notions cannot be
assumed to be the same for a distant past, but the emotional response
to human remains treatment is still influenced by contemporary
cultural norms (Oestigaard 2016). Petersson (1995) pointed out that
the perception of the importance of the integrity of the corpse varies
within Christian belief too. While the biblical resurrection
encompasses the body of Jesus, later belief is often associated with
the deceased being buried in consecrated ground in order to release
the soul from the earthly body rather than that the physical body will
be resurrected (Petersson 1995).

Despite a relatively low grade of critique towards the scientific
investigation of prehistoric human remains in Sweden, a respect for
the long dead is nevertheless a common feeling (de Tienda Palop &
question of when the perception of mortuary contexts changes from
sensitive and perhaps sacred to become exclusively an object of
cultural historical significance. This may not only be connected to
religious practice as such, but to the materiality of the remains
themselves. Cremated human remains do not generally evoke the
same emotions as a complete skeleton, which is probably intertwined
with emotional distance to the fragmented materiality that was once a
human being (Kaliff 2004). Kaliff (2004:258) argued that “There can
be no sound ethical arguments for this reasoning, and it should rather
be seen as an unconscious behavior”. This same phenomenon is
discussed here in relation to how the police investigate and handle
burned and fragmented human remains compared to more complete
human remains (paper VI). We thus seem to have two culturally
influenced thoughts of human remains in Sweden that are to some
extent intertwined with Christian ethics; that Christian human remains
are more sacred than prehistoric ones, and that remains that resemble
a living body are more controversial than non-recognizable (to a non-
expert) human remains. Petersson (1995) highlighted that this also
applies to the preservation of the grave itself, even with regards to
how the church views human remains. Graves that are old, decayed and nameless are often reorganized to make space for new graves (Petersson 1995).

As scholars, we cannot make ethical distinctions between Christian and prehistoric graves (e.g. Petersson 1995), as scientific ethical perspectives cannot rely on Christian ethics (Kaliff 2004). It has been proposed that a scholarly ethical position should include the right to knowledge about the human past and human behaviour (e.g. Iregren 2004; Oestigaard 2016). As osteologists and archaeologists, we have a responsibility for knowledge production as well as education (Iregren 2010). Scarre (2003) argued that the knowledge produced about past life through archaeology is a strong incentive in relation to preserving past graves. Archaeological knowledge production can furthermore constrain historical revision. It has also been suggested that archaeological studies hinder oblivion of the ‘forgotten dead’ (de Tienda Palop & Currás 2019; Scarre 2013).

Burials are frequently excavated to counteract their loss and complete destruction, as human remains are to be excavated if the archaeological site is to be used for new infrastructure. As the Sandby borg excavations (papers I–III) were not conducted due to destruction by development, but for scientific purposes, we certainly need to consider the scientific and pedagogical outcomes of this project. The scientific publication of the material is thus paramount from an ethical perspective. I have throughout this work tried to shed light on the fate of the individuals whose remains have been excavated, in the belief that the scientific findings are of value to our understanding of human behaviour in general, and past life and death in particular. The human remains are in accordance with Swedish legislation regarded and managed as archaeological finds, as discussed above (Kaliff 2004; Swedish Government 1988).
4. Summary of individual papers

This section provides summaries of the individual papers included in the dissertation. Some papers are single authored while others are authored by two or more collaborators. The papers authored by more than one person include a specification of author contribution. The author contribution terminology follows the CrediT (Contributor Roles Taxonomy) system following Brand et al. (2015).

**Paper I.**

**Author contributions**
*Both authors*: Conceptualization, methodology, writing — original draft; reviewing and editing, visualization, formal analysis (trauma).
*Clara Alfsdotter*: Formal analysis and investigation (demography, underlying osteological analyses) data curation, project administration.

The paper builds on osteological analyses previously conducted by Alfsdotter (in Gunnarsson et al. 2016; Papmehl-Dufay & Alfsdotter 2016; Papmehl-Dufay et al. 2020).

**Summary of paper**
In the Iron Age ringfort of Sandby borg (AD 400–450), human remains displaying perimortem trauma have been excavated. The knowledge of the violent event, the perpetrators, and the victims is expanded in this paper. We present the demography of the dead, trauma patterns, trauma type and body positions. Since violence is culture-specific, the results are contextualized in an attempt to discuss the event, the perpetrators, and the possible motives that prompted the violence.

Human skeletal remains were analysed following standard osteological protocol. The trauma pattern was compared to previously published archaeological osteological trauma studies. Comparative
archaeological sites are discussed as well as weapons and weapon tactics. The results are briefly discussed in comparison to research on modern mass violence.

The results show that skeletal remains from at least 26 individuals were identified. These remain stem from children and adults. Of the adults, males are predominant. Perimortem sharp, blunt, and penetrating trauma consistent with interpersonal violence was identified on eight of the skeletons (31%). The location and body positions of the remaining skeletal remains imply that these individuals were killed during the same event. In some cases, the lesions were found at the back of the bodies, and no typical defence injuries have been identified. Taken together, the perimortem trauma distribution suggests a surprise attack where the victims were not in a position to defend themselves. The perpetrators were seemingly plentiful and organized.

This Sandby borg massacre (Victor 2015) was carried out efficiently judging from the economic distribution of trauma, the non-modification of the bodies after death, together with a range of uncollected valuable items left behind in the ringfort. Though most injuries were inflicted on crania, a clear trauma pattern could not be established. If compared to recent mass killings, the effective Sandby borg killing could be the result of a dispassionate killing stirred by sociopolitical instability. The decision to kill the Sandby borg inhabitants might have been a decision based on a feeling of past injustices and the understanding of the Sandby borg group as a threat. The choice to kill children indicates that a fear of future conflict was felt by the attackers. The motive behind the massacre was likely to gain power and control.

Paper II.


Author contributions

*Both authors:* Conceptualization, methodology, writing — original draft; reviewing and editing, visualization. *Clara Alfsdotter:* Formal
analysis (archaeothanatology, contextual analysis, burn pattern analysis), investigation (underlying osteological analyses), data curation, project administration. Anna Kjellström: Formal analysis (fracture and weathering analyses).

The paper builds on osteological analyses previously conducted by Alfsdotter (in Gunnarsson et al. 2016; Papmehl-Dufay & Alfsdotter 2016; Papmehl-Dufay et al. 2020).

Summary of paper
Through analyzing the taphonomic conditions at Sandby borg, the aim was to understand the postmortem fate of the human remains. Different techniques were applied to facilitate the understanding of the postmortem setting by separating environmental factors affecting the body from possible human actions.

The analysis of the human remains from Sandby borg was conducted through different taphonomic techniques: the preservation of femora and humeri in accordance with the zonation system by Knüsel and Outram (2004), degrees of weathering of femora and humeri by Behrensmeyer (1978), fracture analysis of femora and humeri (Outram 2002), and archaeothanatological analysis (e.g. Duday 1978, 2009). Analysis of thermal alterations of bones and stratigraphic interpretation was integrated in the study to understand the taphonomic processes.

The results from the taphonomic analysis of the Sandby borg skeletons excavated thus far indicate that the dead were not manipulated postmortem. The corpses in Sandby borg decomposed in open space. The thermal alterations identified on some of the skeletons seemingly stem from limited perimortal burning, judging from the analysis presented here. We interpret the modest heat-induced alternations as the result of active hearths and a smouldering roof (Heimdahl 2016) that was probably lit in connection with the assault, but that eventually self-extinguished. We interpret extensive dry fractures in bones as an indication of that the house structures disintegrated late in the postmortem period.

In line with previous research, we argue that abduction of limbs can indicate bloat (e.g. Roksandic 2002). We suggest that this can be indicative of a primary deposit of the corpse and void decomposition. Discrepancies between some of the archaeothanatologically often
observed supine void disarticulation patterns (opening of the pubic symphysis, lateral displacement of ilia, lateral rotation of the femoral heads, fall of the patellae (e.g. Duday 2009:35; Duday & Guillon 2006)) and the semi-articulated skeletons in Sandby borg were discussed. We proposed that the discrepancy from common disarticulation patterns in Sandby borg might be due to varying decomposition and post-decomposition processes in different types of voids, and that different drainage results from confined versus unconfined voids. For example, buried remains in a coffin could produce a different disarticulation pattern than a corpse skeletonizing above ground. It was suggested that the skeletal displacements often observed in void burials might partially be the effect of gravity in combination with other factors such as submersion of the corpse in rising ground water or liquefied soft tissue rather than the result of gravity alone. More research into this hypothesis was proposed.

Paper III.


Summary of paper

In this paper, the social response to the biological deaths in Sandby borg is explored to understand the contemporary implications of leaving the corpses from the massacre unburied. This research demonstrates an example of how postmortem agency (Crandall & Martin 2014) can be studied in the deeper past, with a particular focus on Sandby borg and lethal conflict.

This paper combines theories of mortuary ritual with theories of violent death as well as bioarchaeological results from papers I and II to create a theoretical framework that allows a possible explanation of the Sandby borg postmortem treatment. The framework was constructed through integrating Sandby borg empirical material with strands of previous research within the humanities and social sciences: death corporeal practices in the Migration period on Öland, social implications of lethal intergroup conflicts, the liminal phase of the corpse, the ontology of death, and postmortem agency.
Postmortem rituals in the Migration period on Öland generally include corporeal treatment, and that the dead are often buried away from the domestic sphere (Fallgren 2006:120–121). This contrasts with the postmortem conduct in Sandby borg.

The corpse carries strong political and symbolic capital and is therefore useful in the process of social change (e.g. Pérez 2012; Verdery 1999:27–33,109–110). It evokes strong emotions as the biological death demands a social response. The response in the case of the Sandby borg massacre, where the victims were left behind, was probably one of disgrace and terror. The gain for the perpetrators was likely political power through redrawing the biography of the victims, the spatial memory, and the political landscape. A ‘bad death’ (Weiss-Krejci 2013) and the denial of corporeal passage rites might have led to eternal separation from sympathizers and the end of regeneration for the defeated. The assault might have been the response to previous wrongdoing or diverging political opinions. Possibly, the attack was not politically sanctioned but rather infused by political discordance. Sandby borg was likely left as a monument inducing terror.

By combining theories of postmortem agency, biocultural response to dying and death, and of violence as a social and political tool, this study demonstrates an example of how we can gain insight into how collective violence can be organised to achieve consequences beyond the violence itself while also gaining a deeper understanding of the biocultural process of dying. The theoretical framework put forward enhances the bioarchaeological understanding of social processes and analysis of lethal collective violence in general, and postmortem agency of unburied corpses from intergroup conflicts in particular.

**Paper IV.**


The study was set up to include three experiments analyzing human decomposition in two coffins (one semi-buried coffin and one completely buried coffin) compared to decomposition in a large trench. Due to the COVID-19 enforced U.S. travel ban, the final data
collection of two of three experiments has thus far not been possible. In this dissertation, comprehensive results from the semi-buried coffin are presented, i.e. the experiment in which data could be satisfactory collected, and what those results indicate in relation to coffin taphonomy and disarticulation.

Author contributions
Clara Alfsdotter: Conceptualization, methodology, formal analysis, resources, data curation, writing — original draft; review and editing, visualization, supervision, project administration, funding acquisition. Megan Veltri: Investigation, data curation, writing — review and editing, visualisation, project administration. Crystal Crabb: Investigation, data curation, writing — review and editing, visualisation. Daniel Wescott: Investigation, writing — review and editing.

Summary of paper
This paper presents a qualitative, experimental decomposition study that addresses human taphonomy in a coffin, with emphasis on archaeothanatology. The archaeothanatological framework has played a crucial role in building archaeological knowledge by shifting the focus from skeletal remains to considerations of the corpse at the time of death and interment, as well as highlighting mortuary practices and mortuary taphonomy. The knowledge of relative disarticulation sequence of joints and bone distribution is used within the archaeothanatological framework to discern the timing and mode of burial and any post-depositional interaction with human remains (e.g. Duday et al. 1990; Duday & Guillon 2006). As the knowledge of disarticulation was developed from detailed and repeated archaeological observations, some archaeothanatological objectives regarding the disarticulation sequence of human remains can and has benefitted from experimental studies (Mickleburgh 2018; Mickleburgh et al. in press; Mickleburgh & Wescott 2018; Schotsmans et al. in press).

The study presented here is, to the best of my knowledge, the first longitudinal experimental study of human decomposition in a coffin. It adds knowledge regarding human decomposition, disarticulation, and spatial distribution of bones where the deceased was placed.
supine within the confines of a container, which is a frequent archaeological scenario. A willed donated deceased individual was placed in a wooden, semi-buried coffin at the Forensic Anthropology Research Facility, Texas State University. Through in situ observations of the decomposition process, the decomposition and skeletonization process inside the coffin was documented for approximately two years.

In accordance with results from previous actualistic archaeothanatological studies of other types of deposits (Mickleburgh 2018; Mickleburgh et al. in press; Mickleburgh & Wescott 2018; Schotsmans et al. in press), the current study supports that decomposition and disarticulation processes can be variable and more complex than can be deduced from skeletal remains alone (Mickleburgh 2018; Mickleburgh et al. in press; Mickleburgh & Wescott 2018; Schotsmans et al. in press).

The results from this coffin study demonstrate that the collection of decomposition byproducts can affect postmortem movement as well as stabilize skeletal elements in a container. In line with previous research, the effect of water on skeletal displacement is highlighted as an important taphonomic factor in coffins (e.g. Duday & Guillon 2006; Garland & Janaway 1989; Green 2018:197). The results are consistent with the archaeothanatological argument that the reconstruction of the type of burial environment is paramount in order to interpret what potential taphonomic factors have affected human remains (e.g. Duday et al. 1990). The importance of deducing what type of open space the deceased was placed in is emphasized in the study, since different open space contexts allow for a variability of potential taphonomic processes. The results confirm the importance of a holistic understanding of how human remains interact with their surroundings, which is paramount for reconstructions of past mortuary treatment.
Paper V.


Author contributions

Both authors: Conceptualization, methodology, writing — original draft; review and editing, visualization, project administration, data curation. Clara Alfsdotter: Formal analysis (temperature data), investigation (decomposition). Anja Petaros: Formal analysis (statistic data), resources.

Summary of paper

Knowledge of forensic taphonomy is essential for interpretations of peri- and postmortem circumstances and estimations of time since death. Since decomposition is dependent on multiple factors, comparative studies of human decomposition from various climates and geographical contexts are essential to improve methods for assessing the postmortem interval (PMI), and to advance current knowledge that underlies interpretations of human peri- and postmortem history (e.g. Wescott 2018).

From Sweden and Scandinavia in general, no quantitative outdoor human decomposition study has, to the best of our knowledge, previously been presented. Gross human taphonomy and PMI has recently become subject to research in Sweden but has hitherto addressed indoor decomposition (Ceciliason 2018, 2020). Additionally, a Swedish case study of outdoor decomposition and entomology has previously been published (Fremdt et al. 2012).

In this paper, a quantitative retrospective study of gross human decomposition in central and southeastern Sweden is presented. This study advances the existing knowledge of both terrestrial and aquatic gross human decomposition in outdoor contexts. Evaluations of the applicability of methods developed abroad for estimation of PMI from decomposition morphology and ambient temperature are provided (methods by Heaton et al. 2010; Megyesi et al. 2005), together with
analysis of general decomposition trends in cases of surface, hanging, buried and submerged human remains.

The study uses data from past forensic cases included in the NBFM database. Police and autopsy reports with images were assessed in terms of decomposition changes and information about postmortem circumstances. Ninety-four cases are included in the study (43 terrestrial and 51 aquatic), the median PMI is 48 days.

While the results show that initial and partial saponification and desiccation of soft tissue can occur during surface decomposition in a Swedish outdoor context, decomposition is seemingly not halted. Remains eventually skeletonize completely. In the present study, all surface remains exposed longer than 22 months were completely skeletonized. In aquatic cases, adipocere formation seems to inhibit skeletonization to a greater extent. Only one case showed complete skeletonization (PMI 77 years). Remains of adipocere were visible on the bones. Extensive saponification was present in 4 of 5 aquatic cases with PMI between 1 to 6 years.

When using the original formulae by Megyesi et al. (2005) and Heaton et al. (2010) to calculate estimated accumulated degree-days (ADD) as a means to assess time since death, it is evident that they do not work well on the current sample. However, the correlation between actual ADD and decomposition progression in terms of total body score (TBS) in surface cases is high, which holds promise for regional formulae using TBS and temperature as a tool to estimate time since death.

In terms of model fit, r² results show that 80% of the decomposition variation in surface cases can be explained by ADD, meaning that the regression model predicts the outcome in a satisfactory way. In aquatic cases, only 43% of the total decomposition variation could be explained by ADD. While this may be explained by problems in obtaining reliant aquatic temperature data or an insufficient scoring system for decomposition of aquatic remains, aquatic decomposition may be highly dependent on factors other than temperature and time alone and needs further research. Lastly, scoring methods should incorporate saponification to fit forensic taphonomy in Swedish environments.
**Paper VI.**

**Summary of paper**
Forensic archaeology and forensic anthropology (FAA) have proved useful in forensic and humanitarian investigations across the globe (e.g. Groen *et al.* 2015a,b), while the incorporation of the subject(s) in Swedish law enforcement remains limited.

The aim of the study is to analyze the field of FAA in Sweden in relation to outdoor and fire crime scene investigations where human remains are encountered. Based on qualitative interviews, the state and future developments of FAA within the Swedish police and the National Board of Forensic Medicine are analyzed and discussed.

The results show that Swedish outdoor and fire CSI containing skeletonized, buried, or burned human remains are non-standardized, both in terms of investigation and analysis. No protocols address how scattered, burned or buried human remains are to be investigated and what expertise that is to be involved. Thus, individual CSIs carry a great responsibility in choosing how the scene and the associated human remains are to be investigated. Several interviewees questioned the general quality of previously conducted recoveries and analyses of fragmentary human remains. When specialists are involved in casework, they are often consulted on a case-to-case basis which is seldom visible in the statistics. Essentially, the FAA development that has taken place thus far is due to initiatives by single individuals employed within Swedish law enforcement, and FAA in Sweden is in want of development in order to improve fire outdoor crime scene investigations. Despite these shortcomings, numerous interviewees expressed that FAA is positively perceived among colleagues, that the police are open to collaborations, and that fire scenes, outdoor crime scenes, and DVI scenes can benefit from FAA competence. However, several concerns need to be resolved if FAA and outdoor CSI is to be advanced. Essentially, the issues raised in the analysis are closely connected to a lack of knowledge,
acknowledgement, infrastructure, and quality of FAA on a national level. There is also a question of how large the demand for FAA expertise is. Based on the results of interviews and previous research, the author argues that key steps to further development of forensic archaeology and forensic anthropology within the police and NBFM in Sweden are to 1) identify the quantity and type of cases that could benefit from FAA; 2) establish FAA as an independent subject within the police and at the NBFM; 3) develop a national infrastructure that can provide similar expertise nationally, with minimum requirements, experience and accreditation for FAA practitioners; 4) offer professional education in the subject(s); and 5) develop national standards and best practices for outdoor CSI and FAA in order to advance evidence collection and legal security in cases of skeletal, buried or fragmentary human remains investigations.

In order to argue for FAA expertise to be sanctioned by the police to a greater extent, FAA practitioners must demonstrate that FAA is a holistic framework that can benefit and advance various investigations. A sustainable FAA infrastructure is expected to feed new knowledge back into CSI and DVI work, and hopefully create a large enough workload to sustain FAA competence within the police authority and the NBFM on a permanent basis. This would enable archaeological and osteoarchaeological professionals to develop into forensic professionals in a way that an ‘ad-hoc’ FAA system would not.

An ongoing accreditation of crime scene investigations will likely benefit the development of FAA within the Swedish law enforcement and the Swedish police, and according to these results, indicates their openness for collaborations and development of FAA. This suggests a promising outlook for the future advancement of FAA in Sweden.
5. Concluding discussion and future prospects

The aim of this work is to advance the knowledge of peri- and postmortem corporeal circumstances in relation to human remains contexts, and to demonstrate the value of that knowledge in forensic and archaeological practice and research. In the six papers that follow, this aim has been achieved in relation to the treatment of the dead in Iron Age Sandby borg; through studying human decomposition in a coffin as well as in Swedish outdoor forensic cases; and in relation to how information regarding peri- and postmortem circumstances are and can be obtained by the Swedish law enforcement (as limited to the police and the NBFM) in relation to forensic anthropology and archaeology. This concluding section situates the findings from the individual papers in relation to one another and to new questions and future prospects.

5.1 Death in Sandby borg and the Migration period on Öland

The three-step bioarchaeological analyses of Sandby borg were conducted to advance the understanding of the peri- and postmortem treatment of the individuals and their remains, as well as what it might have meant in this Iron Age society. The hypothesis that a massacre took place in Sandby borg (Alfsdotter et al. 2018; Victor 2015) is supported by the interpersonal trauma identified in the skeletal remains of eight of the partially preserved skeletons of the twenty-six individuals excavated so far. Taphonomic analyses in combination with stratigraphy and spatial relation to artefacts, show that the assault was contemporary with the Migration period material record (as also proposed in Alfsdotter et al. 2018; Victor 2015). The course of events during the assault can in some cases be traced, such as individuals falling over one another, a male falling over an active hearth and the probable succession of three perimortal blows to one male’s body. The perimortal fire alternation on some skeletons indicates a limited
fire outbreak in one of three fully excavated houses, likely in connection with the massacre.

The osteological results show that the killing was indiscriminate with regard to age and that the victims had limited opportunities to defend themselves, indicating a surprise attack (paper I). The perpetrators were seemingly numerous and organized as the massacre was carried out efficiently, without traces of overkill. If compared to recent mass killings, this may indicate that the Sandby borg massacre was dispassionate, perhaps ordered. Massacres seldom happen during peaceful times but rather during continuous social turmoil (e.g. Dutton et al. 2005). The motives behind the Sandby borg attack were probably to gain local power and control.

The taphonomic results imply that the deceased individuals were not manipulated after death but were left where they died without corporeal mortuary treatment (paper II). This connects to the analysis of theoretical aspects of postmortem agency (Crandall & Martin 2014) (paper III). The Sandby borg corpses were plausibly not treated according to the contemporary normative mortuary practice. This might have led to an eternal liminal phase for the Sandby borg inhabitants, affecting the local community. The corpse carries strong political and symbolic capital and is therefore useful in the process of social change (e.g. Pérez 2012; Renshaw 2011:27,32–34; Robben 2000; Verdery 1999:27–33,109–110) (paper III). The denial of mortuary corporeal treatment probably affected the way in which the inhabitants were perceived in the contemporary society. The lack of installation of a proper death probably led to a hindering of regeneration and an eternal separation from the living, not only physically but also mentally. The denial of rites of passage can be seen as a last act of violence. Metaphorically speaking, the dead bore witness to the end of life inside the ringfort and thus the extinction of networks, wealth and power connected to Sandby borg.

Through the bioarchaeological studies, integrating osteology, archaeology, taphonomy and social theories, the peri- and postmortem corporeal treatment in Sandby borg was explored in relation to postmortem agency following a prehistoric intergroup lethal conflict. It was theorised that the social implications of violence go beyond the act of physical violence in terms of agency exerted
through the materiality of the unburied corpse (Pérez 2012; Robben 2000).

5.1.1 A unique event?

During the work on the Sandby borg project, questions of whether the lethal attack on Sandby borg was unique have been raised. Apart from Sandby borg, human remains are known from two of eight partially (and in one case completely) excavated Öland ringforts (e.g. Papmehl-Dufay & Alfsdotter 2016:16). Recently, it has been concluded that human remains that were found in the completely excavated Eketorp ringfort show traces of lethal interpersonal violence (Ylva Telldahl, osteologist, pers. comm. 2020–11–15). Detailed reports of these human remains are lacking, even though the ringfort was excavated in the 1960s. In contrast to Sandby borg, Eketorp was inhabited also in medieval times (Stenberger 1965). The majority of the human remains were believed to stem from this later period (Stenberger 1965), but current osteological analyses by Telldahl will among other things shed new light on the question of the temporality of the human remains.

In addition to the Eketorp remains, human bones were found during a late 1980s minor excavation (in total 3 m²) of another Öland ringfort, ‘Löt’. At the time of excavation, it was hypothesized that these bones either stemmed from burials proceeding the construction of the ringfort (that was seemingly first in use during the early Iron Age or the Migration period), or that the ringfort was used as a refuge for plague-infected individuals at a later time (Schulze 2006). During a recent revisit of the material by Papmehl-Dufay however, it seems as though this skeletal material was in fact part of the Iron Age remnants. Results from ¹⁴C analysis indicate that the skeletal material is most likely from the late Roman Iron Age or early Migration period (Papmehl-Dufay, archaeologist, pers. comm. 2020–02–11). Future studies of other Iron Age ringforts and settlements on Öland can hopefully shed light on whether the Migration period attack on Sandby borg is unique, or if the massacre only represents part of a larger Öland event.
5.1.2 Questions of mortuary treatment

On a related matter, the mortuary treatment of the dead in Sandby borg may be re-evaluated as new excavations and analyses are conducted. While the abandonment of the dead in Sandby borg currently appears deviant from the known mortuary praxis (paper III), much is yet to be learnt about Migration period mortuary treatment as dated Migration period graves are underrepresented in the current archaeological burial record (e.g. Fallgren 2006:139). One difficulty in studying periodic changes in Öland Iron Age burial customs is related to the fact that reburial in older graves is common, thus impairing dating possibilities (e.g. Fallgren 2006:138–140; Näsman 1994; Rasch 1994; Wilhelmson 2017:66–67).

In the Iron Age Southern Swedish settlement of Uppåkra, a burnt down house contained partial articulated skeletal remains from three humans. The house is believed to have been in use during the 5th century, corresponding to the Migration period (Lenntorp 2008). The burned human remains were analyzed by Magnell (2008), who discussed whether the house could be interpreted as a grave, given the common contemporary mortuary practice of cremation. He concluded that this was unlikely, given the continuous use of the space, in combination with the observation that the remains were not protected from disturbance. Magnell (2008) suggested that it was possible that some elements of the burned remains had been collected and transferred to a grave site since only parts of the skeletons were found. It is not uncommon that Iron Age cremation graves only contain parts of the skeleton (for a recent review see Therus 2019:210–213). In light of the Uppåkra findings, it may be pertinent to ask if Sandby borg could be considered a grave given that remains of a burnt roof, items of inventory, and partially burnt skeletal remains were found in house 40. To elaborate on this further, it needs to be considered what a cremation serves in terms of ritual treatment, and how this compares to the remains found in Sandby borg. Oestigaard (2004) argued that ritual cremations rid the dead from the flesh, that consumption by fire can be regarded as a means to liberate the ‘soul’ from the decaying body. If a ritual transformation by fire was intended in Sandby borg, this attempt was limited and clearly not successful, as the dead were left to decompose. Judging from the material excavated thus far, only a section of one of the houses show signs of burning (that is not
connected to hearths). The human remains therein that have been affected by fire are only burned to a very limited extent. Taken together with the interpretation that the dead have not been moved or manipulated after death (paper II), and that the contemporary funerary custom was to bury the dead away from the domestic sphere (e.g. Fallgren 2006:120–121), it thus far seems unlikely that Sandby borg was regarded as a burial site for the victims of the massacre. To the best of our current knowledge, the remains in Sandby borg were not granted a mortuary transitional ritual, at least not one that involves the remains of the deceased. Future studies will hopefully add new knowledge about Migration period mortuary treatment and postmortem agency, as well as the extent of burning and any signs of postmortem interaction with the dead in other parts of Sandby borg, and what this might signify in terms of mortuary corporeal treatment.

5.2 Taphonomy and corporeal postmortem circumstances

5.2.1 Forensic taphonomy and mortuary archaeology

The bioarchaeological taphonomic study (paper II) raised a series of questions that were further explored in papers IV and V. These studies have informed one another, as discussed in the following.

In paper II, a hypothesis regarding above ground versus underground open space decomposition was put forward. We suggested that forces acting on common bone displacement in open space (opening of the pubic symphysis, lateral displacement of ilia, lateral rotation of the femoral heads, fall of the patellae (e.g. Duday 2009:35; Duday & Guillon 2006)) may be enhanced in contexts allowing the collection of liquid, such as coffins. This was given as a possible explanation as to why some of the supine Sandby borg skeletons only showed modest versions of the specific skeletal displacements that are often seen in void burials (e.g. Duday 2009:35), and why the pattern differed from archaeothanatological finds in buried open spaces.

To further the knowledge of void decomposition in a confined space, paper IV explores the effect of liquid collection on decomposition and disarticulation in a coffin. While it was observed
that liquid indeed affected movement of the remains, it did not lead to increased lateralization of elements (as hypothesized in paper II). This may be due to several factors. Either the hypothesis put forward in paper II is not valid, or increased lateralization is dependent on more time to pass between deposition of the deceased and extensive lateralization of skeletal elements. As decomposition byproducts solidified in the base of the coffin in the experimental study (paper IV), the mass seemingly supported skeletal elements, restricting extreme movement during the observed postmortem period. Hopefully, the process of skeletal movement in coffins can be further illuminated when the buried deceased individual can be excavated (after pandemic travel restrictions are lifted). Furthermore, it is hoped that future research sheds new light on questions of above ground skeletal displacement patterns, as lateralization of skeletal elements in above ground deposition has not been further investigated in this dissertation. The discussion about the expected skeletal displacement and partial lack thereof in the Sandby borg material is in need of further development and evaluation.

Following the Swedish decomposition study presented here, some new information regarding what can be expected in a Swedish southeastern climate has been obtained. This information is not only of value in finds of recently deceased individuals but can also shed some light on what decomposition processes may have looked like in the past. We now know that partial saponification and desiccation can occur in above ground decomposition in this geographical region, co-existing with putrefaction and skeletonization (paper V). However, decomposition is seemingly not halted. It should, in light of this, be considered that the decomposition processes in Sandby borg may have been influenced by partial desiccation and saponification in addition to putrefaction. While the taphonomic Sandby borg study did not address the human remains found in the street area from an archaeothanatological perspective (due to lack of articulation), it should be considered that the deceased left outdoors may have been subject to increased desiccating factors as Öland is arid. In terms of the (once) indoors human remains, extensive desiccation is not as likely since there was presumably less air circulation and sun exposure indoors, but knowledge of human decomposition in relation to Scandinavian Iron Age houses is limited. A complicating factor in
the case of Sandy borg is that we cannot be certain of how quickly the houses caved in, what the substrate of the deceased individuals was (apart from in the cases where they are located on top on stone paved floors), and if doors were open or closed.

It cannot be ruled out that partial desiccation and/or saponification was present in indoor remains during the period of decomposition and might have affected the skeletal disarticulation. There are however indications of early advanced skeletonization in the material, such as ‘individual 15’ whose mandible and cranium were still in articulation while separated from the postcranial skeleton (Papmehl-Dufay et al. 2020). This indicates that the skull separated from the postcranial remains when soft tissue still kept the mandible and cranium together. However, several cervical vertebrae from this skeleton are missing, which means that decapitation cannot be ruled out as a possible taphonomic factor.

In Sandby borg, we have thus far seen differences in both the preservation of human remains as well as differences in cultural layers between subsections of houses (paper II). There are signs of parts of one house (mainly the roof) being burnt during the skeletal perimortem period (paper II), and other structural remains (beams?) were in this section charred. This signifies that parts of at least the one house were seemingly partially open to the elements following a initial fire destruction of the roof. Consequently, we can expect a variety of decomposition micro-environments in Sandby borg, even within the same houses, with different access to air, water, animals etc. Another factor that can hopefully be answered in future studies of Sandby borg is the presence or absence of clothing. This too can be a desiccating factor as fabric absorbs moisture from the decomposing body, where different types of fabrics will affect the decomposing remains differently (e.g. Card et al. 2015; Janaway 2002; Ueland et al. 2019). Clothing and wrapping may also directly affect disarticulation (e.g. Boquin et al. 2013; Duday 2009:45), as well as insect access and thus rate of decomposition (e.g. Card et al. 2015). Regardless of these factors, our study on decomposition patterns in Sweden (paper V) indicates that above ground decomposition (with a high prevalence of modern clothing) results in skeletonization within two years. This is thus likely to have occurred in Sandby borg as well. It is known from previous research that desiccation affects
disarticulation patterns (e.g. Duday 2009:27; Maureille & Sellier 1996). However, it is currently unknown how a combination of putrefaction and partial saponification and/or desiccation affects bone distribution. Ongoing taphonomic studies can hopefully clarify some of these question marks, such as a study by Schotsmans and colleagues who observe above ground decomposition and disarticulation that involve superficial desiccation (Schotsmans et al. in press).

Consequently, more research into decomposition and disarticulation in Sweden is pertinent to inform future archaeological interpretations, as well as future studies of Sandby borg and any similar taphonomic sites that may come to light. The seasonality of the killing will likely further help assess the rate of postmortem processes. Efforts into finding pollen in sinuses to derive a closer approximation of the season of the massacre have been made (by paleoecologist Jonas Bergman), but thus far it has been unfruitful. We currently think that the attack occurred during the summer half of the year, based on age estimations of what are interpreted as newly slaughtered lambs at the time of the assault (Alfsdotter et al. 2018).

Despite the discussed shortcomings in reconstructing the postmortem environment in Sandby borg, the taphonomic study indicates that the dead decomposed in open space and that they were not moved following initial decomposition.

Moving on to coffin taphonomy, paper IV contributes to knowledge of decomposition dynamics and disarticulation in a coffin, and the knowledge gained could be useful to mortuary archaeology. The study showed that skeletal movement and disarticulation can be affected by the constraint of a container in respect to that collected decomposition products can both act on body parts to move during decomposition and stabilize skeletal elements once solidified. This has a bearing on the interpretation of archaeological skeletal remains as the position of bones at excavation does not necessarily reflect the body position at interment, as has been argued by archaeothanatological researchers (e.g. Duday 1978, 2009; Roksandic 2002), and found in actualistic studies (Mickleburgh et al. in press; Mickleburgh & Wescott 2018; Schotsmans et al. in press). Paper IV reveals some similar limitations as the previous actualistic studies in terms reconstructing decomposition and disarticulation sequences.
from skeletal remains, since complex decomposition dynamics observed in the experimental studies would not have been discernable from osteological remains alone (Mickleburgh et al. in press; Mickleburgh & Wescott 2018; Schotsmans et al. in press). Archaeothanatological theories of decomposition dynamics can thus be enhanced by experimental human taphonomic studies, and the value of such studies in general can be paramount to archaeological mortuary interpretations (Mickleburgh 2018; Mickleburgh et al. in press; Schotsmans et al. in press).

Paper IV also includes a discussion of research that has shown that liquid collection in coffins is common (e.g. Dent & Knight 1998; Ferreira & Cunha 2013; Garland & Janaway 1989; Janaway 1996; Mant 1987) and can result in extensive skeletal disarray (Duday & Guillon 2006; Green 2018:51,197; Rodwell 2007). This may have a bearing on archaeological taphonomic studies that have suggested that skeletal disorder in coffins may be the result of ‘bone tumble’ during transport of extensively decomposed remains to cemeteries (Boddington 1987; Brothwell 1987). With new knowledge of decomposition dynamics in coffins, such interpretations may be re-evaluated. We empathized the importance of deducing what kind of open space the deceased was placed in to be able to assess what taphonomic factors that may have influenced the deposit (paper IV). The excavation of the buried coffin at FACTS will eventually be able to shed some light on how much the semi-buried coffin taphonomic progression differs from decomposition in a completely buried coffin, given that oxygen supply, moisture levels, ambient temperature and insect presence are likely to differ between the contexts (e.g. Mant 1987; Rodriguez 1997; Rodriguez & Bass 1985).

Future experimental human taphonomic studies of decomposition in coffins and directly in sediment will further inform what taphonomic processes can be expected to have occurred in archaeological mortuary contexts, which can subsequently illuminate interpretations of changes caused by human agency from other taphonomic processes, as well as the sequences of events. To this end, the author plans to continue and expand experimental studies of human decomposition in coffins, both in terms of macroscopic and microscopic taphonomic methods. A collaborative histologic study of bones from all three original contexts (the two coffins and the trench)
was planned to take place in 2020 but was delayed due to COVID-19. It may also prove pertinent to use knowledge produced through experimental taphonomic coffin studies (in addition to previous retrospective studies) to inform modern cemetery coffin burial practices, as many cemeteries suffer from halted decomposition and thus difficulties in providing space for new burials (e.g. Ferreira & Cunha 2013; Fiedler & Graw 2003).

Furthermore, quantitative actualistic studies into decomposition and disarticulation of deceased individuals placed above ground (Mickleburgh et al. in press; Schotsmans et al. in press) and in mass graves (Mickleburgh et al. in press) are underway. This will hopefully inform both forensic and mortuary archaeological knowledge, as larger samples have the advantage of statistical analyses and the potential to study taphonomic variation in replicated experiments (Mickleburgh et al. in press). While such actualistic studies cannot currently be conducted in Europe (but for buried individuals in the Netherland’s ‘ARISTA’ facility), some disarticulation information could be obtained through studies such as the retrospective study presented here (paper V). However, such studies are limited by the fact that the remains can only be observed at one point in time and thus taphonomic agents cannot be witnessed throughout the decomposition process (Simmons 2017). While animal proxy studies can contribute to aspects of general decomposition knowledge, disarticulation is species dependent (Hill 1979a, b; Knobel et al. 2019).

### 5.2.2 Outdoor forensic taphonomy in Sweden

To analyze human remains in terms of peri- and postmortem circumstances, and in relation to human interaction with human remains, a baseline for what can be expected in terms of decomposition dynamics is paramount as taphonomic analyses serve to separate natural from artificial processes (e.g. Pokines 2013). In order to reconstruct one or several feasible peri- and postmortem circumstances, natural causes for taphonomic signatures needs to be excluded before assuming human agency (Pokines 2013). As human decomposition varies over climates and environments, regional studies are essential for improved taphonomic reconstructions (Forbes et al. 2014; Humphreys 2013; Pokines 2013; Wescott 2018). Not only
do studies from different geographical regions serve to advance knowledge in the country of study, but also as comparative datasets for an international development of forensic taphonomic methods and theories (Haglund & Sorg 1997; Schotsmans et al. 2017). Such Swedish regional human taphonomic knowledge was sought in paper V, where outdoor decomposition in southeastern Sweden was analyzed in terms of general decomposition patterns and progression, as well as the applicability of postmortem interval estimation methods developed abroad to Swedish circumstances. This regional forensic-taphonomic knowledge can be useful for interpretations of postmortem circumstances in forensic, humanitarian as well as archaeological mortuary contexts.

As paper V constitutes the first quantitative study of outdoor decomposition in Sweden, it gives new insights about what can be expected in terms of decomposition changes and progression. For example, we found differences in decomposition patterns between surface, hanged, buried and aquatic remains, and discussed the time needed for occurrence of decomposition changes such as desiccation, saponification, and skeletonization. The applicability of a terrestrial postmortem interval estimation method (by Megyesi et al. 2005) worked well in terrestrial cases when the equation for postmortem interval was adjusted to the sample. However, the Heaton et al. (2010) aquatic method had a lower model fit, even when the equation was adjusted for the sample. We suggested that one of the explanations behind the lesser model fit for aquatic decomposition is that much is yet to be learnt about how corpses are affected by factors inherent to aquatic environments (paper V), an area of importance in future forensic taphonomy research.

In paper V, a national study of forensic taphonomy was proposed as a next step in creating a wider baseline for forensic taphonomy in Sweden, that is hoped to, among other things, provide a greater knowledge of decomposition patterns and progress in different settings, not least hanging and buried cases, as those were few in the current sample. Furthermore, such a study can hopefully advance general knowledge of human taphonomy in cool to cold climates. While not the focus of this dissertation, a natural next step in Swedish forensic taphonomy research and practice would be to collaborate with forensic crime scene practitioners as well as specialists from
other fields engaging in taphonomy. The present studies have focused on biotaphonomy (Nawrocki 2009, 2016), see ‘Definition of taphonomy’. Ideally, more focus on geotaphonomy (Hochrein 1997a,b, 2002) could be incorporated in future research. Perspectives that can aid the understanding of decomposition environment, site formation processes and postmortem interval include microbiology (e.g. publications in Carter et al. 2017) and carrion ecology (e.g. publications in Benbow et al. 2016). In order to advance knowledge of factors affecting aquatic decomposition specifically, incorporation of knowledge from aquatic ecology (e.g. Brönmark & Hansson 2012) and hydrology could prove valuable in terms of disentangling which external factors that affect Swedish aquatic decomposition to large extents.

In order to include such perspectives in Swedish human taphonomic research, actual access to forensic scenes containing human remains (for sampling) would be valuable, in addition to experimental longitudinal studies of animals as human proxies. It may also be pertinent to study whether a forensic taphonomy and anthropology facility would be of benefit to the Swedish and Scandinavian research and practice fields, and whether such a facility could comply with ethical and judicial Swedish frameworks, as well as popular opinion.

5.2.3 Final taphonomy remarks

The taphonomic inquiries in different fields of research into skeletal or decomposing remains (such as zooarchaeology, bioarchaeology, forensic anthropology) are not separated by different needs to understand biological death and the factors creating and influencing the mortuary record. They all benefit from an analysis that spans the range from field investigation or excavation to post-fieldwork analyses and interpretation. Therefore, all professionals engaged in skeletal or other postmortem enquiries can benefit from collaborative taphonomy development. Taphonomy lends itself as an excellent research field for a interdisciplinary research and development, while the social theories combined with taphonomic results needs to be adjusted to the field of research or enquiry. The theoretical and legal frameworks that are combined with taphonomic data to interpret a mortuary deposits thus depend on the field of enquiry, whether that
demands bioarchaeological, criminological or zooarchaeological theories (Boyd & Boyd 2011, 2018; Groen 2018; Groen & Berger 2017; Melbye & Jimenez 1997). Here for example, the three-step Sandby borg bioarchaeological analyses terminate with a paper that demonstrates a case where the bioarchaeological results of trauma, taphonomy and demography are combined with social theories of intergroup lethal conflict, death practices, the liminal phase of the corpse, and postmortem agency, to advance understanding of human behavior in relation to the mortuary context of Sandby borg.

It has been stressed by others (Schotsmans et al. 2017) that forensic taphonomy is currently a multi- rather than interdisciplinary field, meaning that instead of working jointly, specialists in forensic taphonomy often work next to one another. The authors suggested that the development of forensic taphonomy as a multidisciplinary field may be aided by seeing the field as a separate one rather than intertwined with forensic anthropology, as other professionals engaging in forensic taphonomy come from fields such as chemistry, soil science, microbiology, archaeology, entomology, and more (Schotsmans et al. 2017). Pokines (2013) proposed that less emphasis is placed on ‘forensic’ and more on ‘taphonomy’ in general, as knowledge from the fields engaging in taphonomic research and practice are relevant to one another. With the emergence of diverse taphonomic forums such as the Taphos-Nomos conference that was held for the first time at University of Central Lancashire in 2018, the future of an interdisciplinary taphonomic development is facilitated.

5.3 Forensic archaeology and anthropology in Sweden

The benefit of integrating FAA in forensic as well as humanitarian investigations has gained increasing acknowledgement over the last decades, but the use of forensic archaeology and anthropology remains sparse in Sweden. The current state of law enforcement investigations of skeletal, burned and buried human remains was addressed in paper VI, and the results suggest that several areas of investigations can be enhanced through incorporation of FAA perspectives and expertise to a greater extent. For such an endeavor to be feasible, several steps were suggested (paper VI), including
identification of the quantity and type of cases that could benefit from FAA; to establish FAA as an independent subject within the police and at the NBFM; to develop a national infrastructure that can provide similar competences nationally, with minimum requirements and experience for FAA practitioners; offer professional education in the subject(s); and develop national standards and best practices for outdoor CSI and FAA in order to advance evidence collection and legal security in cases of burnt, buried and skeletal human remains investigations.

To this end, some recent initiatives should be mentioned. The CSI program will henceforth include a one-day orientation in FAA (Jesper Olsson, forensic archaeologist at the Swedish National Forensic Center, pers. comm. 2020-11-10) to create awareness of the subject(s) and their potential in CSI and DVI. The initiative to include forensic archaeology as a working description in forthcoming ISO accreditation of CSI work is another police initiative that shows great promise for the incorporation and standardization of FAA in police work. At the NBFM, a protocol for analysis of skeletal remains at the NBFM is under development (paper VI). Furthermore, the national ForArk network (of which the author is currently chair) serves as a basis for networking and collaboration, with many participants from both law enforcement and academia. Currently, ForArk is planning to apply for membership of the ENFSI archaeological working group to enhance exchange with European colleagues. While these initiatives are promising strides towards official recognition of FAA in Sweden, some areas need to be addressed in order to motivate further investment in FAA development. A crucial aspect is to assess the frequency of cases that can be aided by FAA practitioners (discussed in paper VI). A recent unpublished survey of cases where police employees with FAA skills have been requested showed that over 300 cases have been assisted over the last four years, with the number of requests for FAA expertise steadily increasing (survey by Ben-Salah, Molnar and Olsson; communicated to me through Olsson pers. comm. 2020-11-10). It is recognized that a past use of this expertise does not necessarily correlate to the number of cases that could benefit from FAA, as the request for such services are dependent on the recognition of what FAA could be used for (paper VI). Thus, if the breadth of FAA becomes further recognized, the number of cases that could
benefit from such expertise will likely rise (which is seemingly already happening in some police regions).

In addition to this survey, paper V provides some basis for statistics of the frequency of outdoor cases of human remains (exposed longer than a week) that have been assigned to the NBFM Linköping over the past ten years. While not the focus of paper V, the data contain some information about the frequency of extensively decomposed and skeletonized remains in the NBFM Linköping region, which can serve as a basis for information about the number and type of cases that can benefit from forensic-anthropological analyses. It should be noted that (indoor) burned remains are not included in the sample, which is another venue of cases where FAA skills can benefit forensic investigations. However, it should be noted that cases where external osteoarchaeological expertise is consulted do not end up in the NBFM database.

It is hoped that the regional taphonomic study (paper V) can be extended to a national study of Swedish outdoor forensic taphonomy. As Sweden extends over several climate zones, a national study will further advance the knowledge of human taphonomy and its variability in Sweden. This would benefit assessments of postmortem interval, as well as forensic and archaeological knowledge of how decomposition can be expected to occur in different mortuary contexts. Such a study can also be valuable for assessments of how often these cases occur which can thus be used as one source to assess the need for forensic anthropology. As described in paper VI, data on how often external expertise is contacted for forensic skeletal remains analysis would also be valuable for a more complete statistical basis. This could for example possibly be obtained by conducting a survey among practicing osteoarchaeologists.

Given the variety of contacts for FAA assignments (see paper VI), the need for accreditation of FAA practitioners is likewise an important question. Ideally, accreditation demands for internal and external practitioners of forensic archaeology and forensic anthropology should come into place to ensure a minimum of best practice. European organizations that provide such certifications could be used either for certification needs, or as guidance for future national accreditation systems.
An aspect not explored in paper VI but of paramount importance is academic programs in forensic archaeology and anthropology. The need for such an educational program will hopefully be clarified by surveys of the need for such expertise, but single courses addressing these subjects could be developed today. As current praxis has it, many osteoarchaeologists are at some point contacted for forensic assessments of bones, and a basic understanding on how to deal with such requests would be of value when such cases arise. Furthermore, a fostering of interdisciplinary studies in forensic subjects will hopefully benefit future CSI and DVI work through exchange of knowledge, as well as an interdisciplinary taphonomic research and practice collaboration.

Lastly, as proposed in paper VI, the police and the NBFM will hopefully invest in more fulltime FAA positions to ensure a holistic national infrastructure and expertise in these subjects. In order to create a bridge between academic and archaeological development with forensic practice, FAA employees within the police and the NBFM would ideally engage in both casework and research. This would facilitate collaborations and interdisciplinary research projects that advance FAA as well as outdoor crime and disaster scene investigations. Platforms such as ForArk can serve as a network where such interdisciplinary collaborations can be sought.
6. Svensk sammanfattning (Swedish summary)

Den här sammanläggningsavhandlingen syftar till att skapa ny kunskap om kroppsliga omständigheter i samband med och efter döden samt att visa på värden av denna kunskap inom det forensiska och arkeologiska fältet. Dessa aspekter utforskas utifrån mänskliga kvarlevor och deras sammanhang. De sex artiklarna inkluderade i avhandlingen innefattar studier som relaterar till osteoarkeologi, forensisk antropologi och tafonomi (läran om de processer som organismer genomgår efter döden):

Eftersom fysiska lämningar som hittas vid utgrävningar är resultatet av många formationsprocesser som inte kan studeras i sin helhet vid utgrävningstillfället så har arkeologer och osteologer länge arbetat med tafonomiska studier för att öka kunskapen om formationsprocesser (översikt i Denys 2002). I den här avhandlingen kombineras perspektiv från osteologi, arkeologi och forensisk antropologi för tafonomiska och teoretiska tolkningar av mänskliga kvarlevor och deras sammanhang (t.ex. Haglund & Sorg 1997, 2002; Mickleburgh 2018; Schotsmans et al. 2017). I kappans första kapitel presenteras de teman som utforskas i relation till hur vi kan rekonstruera processer som påverkat mänskliga kvarlevor, samt varför sådan kunskap kan vara av värde.

Kapitel två ger en inblick i de metodiska och teoretiska utgångspunkter som inte har utvecklats i respektive artiklar, men som är viktiga för helheten. Det innefattar terminologi i relation till discipliner baserade på osteologi, terminologi kopplad till döden och döda, definition av tafonomi, osteologiska analyser av peri- och postmortala förändringar, en översiktlig introduktion till arkeothanatologi, analogier som metodik i tafonomiska studier, och slutligen en översikt av tidigare forskning relaterad till forensisk antropologi och arkeologi i Sverige.

Kapitel tre belyser etiska frågor och ställningstaganden i relation till forskning på mänskliga kvarlevor, både i fråga om arkeologiskt skelettmaterial och nyligen avlidna personer. I kapitlet diskuteras etiska överväganden för samtliga studier av mänskliga kvarlevor som ingår i avhandlingen.

I kapitel fyra presenteras översiktliga sammanfattningar av de sex artiklarna som ingår i avhandlingen. Dessa utgörs av tre studier av skelett från Sandby borg, vilka baseras på analyser av trauma (artikel I), tafonomi (artikel II) och sociala aspekter som kan förklara varför de döda lämnades i borgen (artikel III). De tafonomiska studierna av Sandby borg-materialet väckte frågor om hur nedbrytningsprocesser påverkar skelettmaterial och vad som kan förväntas ske i olika typer av tomrum där lik bryts ner. Detta ledde till studier i forensisk tafonomi (artiklar IV och V) som gav kunskap om vad som sker när ett lik bryts ner i en kista (artikel IV) samt hur nedbrytningsprocesser ser ut i svenskt klimat (artikel V). Artikel IV handlar om ett projekt
vid Forensic Anthropology Center vid Texas State University i USA, som tar emot frivilligt donerade avlidna för förensisk och tafonomisk experimentell forskning (se etiska överväganden i kapitel tre). Svårigheter med att slutföra alla delar av projektet uppstod i och med COVID-19. Studien presenteras här som ett manus som utforskar en av tre kontexter som ingår i forskningsprojektet. Detta då den kontext som analyseras och presenteras i avhandlingen (en delvis begravd kista) inte påverkades av begränsningar i datainsamlingen som följe av reserestriktioner som infördes på grund av COVID-19. Övriga två kontexter (vilka utgörs av en avliden i en helt begravd kista och en avliden i ett schakt) som ingår i det experimentella projektet om mänsklig nedbrytning kommer att presenteras i andra sammanhang framöver. Artikel IV adresserar tafonomiska förändringar överlag, men har särskilt fokus på arkeothanatologi och disartikuleringsssekvens.


Resultaten från de osteoarkeologiska analyserna av Sandby borgmaterialet stärker tidigare hypoteser om att en massaker har ägt rum i borgen under Folkvandringstid (t.ex. Alfsdotter et al. 2018; Victor 2015). Människor i alla åldrar har dödats, och offren tycks inte ha varit i stånd att försvara sig. Tillsammans med skadebilden indikerar resultaten ett överraskningsanfall. Händelseförlopp kan i vissa fall spåras, som när en individ har fallit över en eldstad vid dödstillsfallet, eller vid förekomsten av en trolig sekvens av skador hos en annan individ. Vid tidpunkten för anfallet har taket på ett av husen sannolikt
börjat brinna (Heimdahl 2016), vilket lett till att delar av kroppen (av sannolikt redan avlidna individer) har svetts av elden. Tafonomiska analyser indikerar att de döda inte har hanterats på annat sätt än att de lämnats där de dog. Sammantaget med resultaten från studien om vad det kan ha fått för konsekvenser i det dåtida samhället (artikel III), tyder detta på att de döda i Sandby borg nekats kroppliga övergångsritualer, vilket kan ha lett till de hamnat i ett evigt limbo. Eftersom hanteringen av lik har stort politiskt och symboliskt värde och därmed inverkan på samhällen (t.ex. Verdery 1999:27–33) så kan en dylik behandling i konflikter användas som maktmedel av förövarna för att etablera makt och terror (t.ex. Pérez 2012; Robben 2000:85). Detta kan ha varit ett motiv bakom (icke-) hanteringen av de döda i Sandby borg.


Hur tolkningen av Sandby borg-materialet påverkas utifrån resultaten av nedbrytningsstudien i svenskt klimat diskuteras även det i kapitel fem. Där lyfts också fram nya kunskaper om hur lik i kistor påverkas av vätskeansamling, och hur benens läge påverkas av olika tafonomiska faktorer. Denna tafonomiska kunskap kan vara värdefull för arkeologiska tolkningar av kistgravar, men visar även på vissa begränsningar när det gäller att kunna rekonstruera hur ett lik har deponerats utifrån skeletterade kvarlevor.
Genom studier av mänsklig nedbrytning i olika klimat skapas kunskap om regionala förutsättningar och skillnader vilket bidrar till både internationell och regional kunskapsutveckling. Den svenska studien presenterad här (artikel V) visar att metoder utvecklade utomlands för att uppskatta när en avliden dog ger varierande resultat inom studiematerialet. Metoderna (Heaton et al. 2010; Megyesi et al. 2005) använder sig av nedbrytningsstadium tillsammans med ackumulerad dygnstemperatur för att räkna ut en uppskattning av hur länge sedan en person avlidit. I fråga om avlidna som legat på marken indikerar vår studie att metoden fungerar väl när beräkningen anpassas efter det svenska studiematerialet. För avlidna som legat i vatten fungerar metoden sämre, och vi föreslår att fler studier på detta område utförs, gärna tillsammans med hydrologer och/eller mikrobiologer för att ta reda på vilka andra faktorer som kan vara avgörande för nedbrytningshastighet i vatten. Annan kunskap från studien består i att skelettering tycks ske inom två år på land, medan det tar längre tid i vatten där lik i flera fall upptäckte bestående saponifiering. Partiell saponifiering tillika uttorkning iakttagits på land, men detta i kombination med pågående aktiv nedbrytning. Studien ger en fingervisning om vad vi kan förvänta oss i form av tafonomiska processer i Sverige, vilket kan vara av värde både arkeologiskt och forensiskt. Framtida studier bör ha ett nationellt fokus för att få ett större mer representativt material samt för att ta reda på hur nedbrytning skiljer sig i olika delar av landet.

När det gäller utvecklingen av forensisk arkeologi och antropologi (FAA) i Sverige visar artikel VI att en del initiativ för att förbättra dessa fält har tagits genom åren, men att ansvaret ofta ligger på enskilda individer då ämnet saknar tydlig förankring inom myndigheterna. I studien ges förslag på steg som kan tas för att utveckla verksamheterna. Förslagen innefattar identifiering av den typ och antal fall som kan främjas av implementering av FAA; att etablera FAA som ett (eller flera) fält inom rättsväsendet; att skapa en infrastruktur som tillhandahåller liknande kompetens nationellt; att certifiera personal som ska arbeta med dessa frågor för att garantera kvalitet och rättssäkerhet; och slutligen att utveckla manualer för denna typ av undersökningar. Både brottsplatsundersökningar samt undersökning och identifiering av avlidna vid katastrofer skulle kunna gagnas av en utveckling av FAA. Frågan kvarstår dock om hur stort
behovet är, och framtida studier bör fokusera på att ta fram underlag för detta. Sådana initiativ är redan på gång inom polisen, och data från artikel V ger viss information om frekvensen av denna typ av fall. Slutligen diskuteras svensk akademisk utbildning i FAA, vilket saknas i dagsläget. Frågan om akademisk utbildning har inte undersömts närmare i avhandlingen, men kan med fördel övervägas i eventuella framtida satsningar.

Sammantaget avhandlar detta doktorandarbete olika aspekter av hur vi kan förstå vilka processer som har påverkat kontexter av mänskliga kvarlevor, både i modern och tid och i det sedan länge förflutna. Resultaten bidrar förhoppningsvis till att skapa bättre förutsättningar för att framöver utveckla forensisk arkeologi och antropologi i Sverige utifrån ny kunskap om nuläget.
References


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