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From ashes to interpretation: Fragmented, commingled and cremated human remains in Estonian Roman Iron Age (50–450 CE) *tarand* cemeteries

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Author contribution: conceptualization, data curation, methodology (osteological), validation, writing the original draft, review and editing, visualisation.

1. INTRODUCTION

Archaeological material is rarely preserved in its entirety; therefore, archaeologists frequently deal with fragments and missing pieces. I have always enjoyed puzzles, and as the youngest, I often had to assemble puzzles with a few missing pieces. Most of the time, the blank spots did not distort the overall picture but rather presented challenges and opportunities for creativity in deducing the missing parts. I find similarities in fragmented archaeological material, where the puzzle guide is also missing, allowing for the assembly of many different pictures. This thesis focuses on the prospects and limitations of studying cremated human remains that are fragmented and commingled.

1.1. *Tarand* cemeteries

The material analysed in this thesis originates from *tarand* cemeteries – monumental graves with stone constructions dating from 8th centuries BCE to 450 CE, mostly corresponding to the Early Iron Age in Estonian prehistory, but the first *tarand*s were built already in the Late Bronze Age. Estonian *tarand* cemeteries are classified into early and typical types, with the early type having many subgroups based on grave construction (Lang 2007a, 170). The distinction between early and late (or typical/classically joint) *tarand* cemeteries is more pronounced.

Early *tarand* cemeteries (8th – 5th/3rd centuries CE) are somewhat irregular, but still mostly rectangular stone-built burial places with sides up to 9 metres (Lang 2006b, 55; Lang 2007b, 107), often near existing stone-cist graves (Lang 2007a, 179).

The classically joined or late *tarand* cemeteries resemble the early ones mainly due to their specific rectangular grave areas and the presence of commingled human remains (Lang 2007b, 126–145; Jonuks 2009, 171; 2022, 196; Article I). The most pronounced difference between early and late *tarand* cemeteries is that the early ones were more irregular and built for one or a few bodies per *tarand*. In contrast, each rectangle surrounded by stone walls in the late ones was clearly a collective burial place (Lang 2006b, 55). This thesis focuses on late *tarand* cemeteries, but due to the small amount of comparative material, some parallels are drawn with early *tarand* cemeteries as well.

These cemeteries feature interconnected rectangular above-ground stone walls or fences called *tarand*s (Estonian for "fence") (Fig. 1.1.). The sites are using locally available limestone or fieldstone (Laul 2001, 193), the size of these structures varies, with some being single *tarand* cemeteries and others comprising rows of interconnected enclosures (Fig. 1.1). The number of *tarand*s varies; there may be one or several dozen. If there are multiple *tarand*s, they are usually connected, although new separate *tarand* structures might be constructed (Lang 2006b, 55). The reasons for building new *tarand*s are unclear, but it is commonly understood that each household had its own cemetery, or the *tarand*s belonged to households while the cemetery belonged to the whole community. Each new generation was "given" a new *tarand* (Ligi 1995, 223; Lang 1993, 57; 1999, 76–77; 2000, 212–213; Article II; Jonuks 2022, 194). At several sites, some *tarand*s on the edge of the cemetery were found empty, indicating new structures were added before actual burials took place (Laul 2001, 193).

Human remains and artefacts found there are partly cremated, often fragmented, and mostly commingled among the stones. *Tarand* cemeteries, also known as *tarand* graves (fin. *tarhakalmisto,* de. *Tarandgrab*, lv. *akmeņu krāvuma kapulauks*, rus. *каменный могильник с оградками*), are collective burial sites with rectangular above-ground stone wall constructions. Traditionally, the term has been *tarand* grave, but as a *tarand* or a row of *tarand*s never is a single grave, the term *tarand* cemetery has lately also been in use. In this thesis *tarand* grave and *tarand* cemetery are used as synonyms. Initially, these cemeteries predominantly contained inhumation burials, with one rectangular area assigned to one or a few bodies (Lang 2007a, 179). However, during the Early Iron Age (*ca.* 500 BCE – CE 450), cremation became the prevalent method of disposing of the dead and in typical *tarand* cemeteries most of the bone material has been cremated (Lang 2007a, 188–206; Article I).

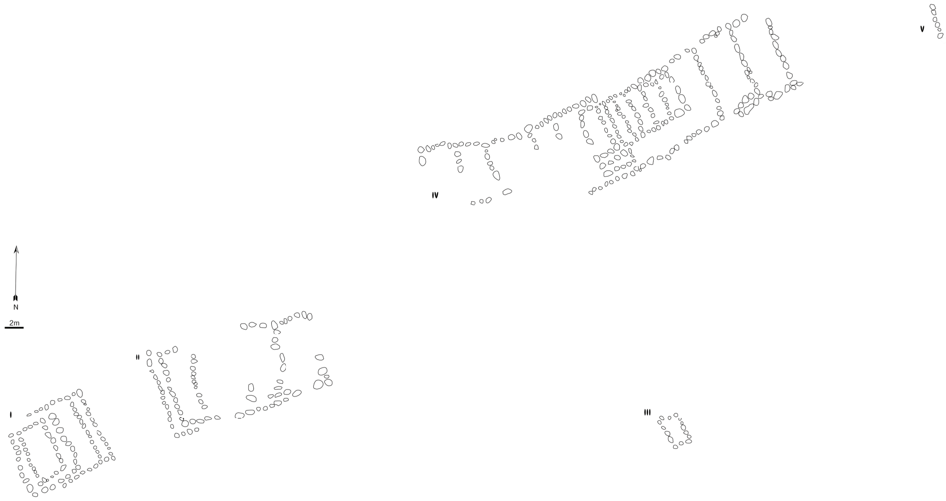

Fig 1.1. Virunuka *tarand* cemetery complex with five separate conjoined structures of different sizes and preservation. A. Lillak after Laul 2001, Fig 18.

This cemetery type is regional, with similar graves found along the borders of the Gulf of Finland: Ingria, Southern Finland, Latvia, and Estonia (Ekholm 1939, 1944; Salo 1968, Fig. 9.; Vasks 2003; Lang 2006b, 69; 2007a, 191, fig. 116; Yushkova 2011; 2016). Some *tarand* graves date to the Early Iron Age, making them contemporary with the Estonian ones, e.g., Kroggårdsmalmen in Finland dating to Early Roman Iron Age (Salo 1968, 13, Fig. 9) and Stradze, Lazdiņi *tarand* cemeteries in Latvia to Pre-Roman Iron Age and Lielrenda to Roman Iron

Age (Vasks 2003, 141–146) (*ibid.*). In Estonia, most *tarand* cemeteries are dated based on grave goods, with only a few radiocarbon dated. The earliest known *tarand* cemetery is Kunda Hiiemäe, dated to 730–410 BCE (Lang 2007a, 174; Oras et al. 2016; Saag et al. 2019).

In addition to human remains, faunal remains are also found in *tarand*s (Lang 2000, 215–216; Maldre 2000; Lang 2007a, 111; Ehrlich et al. 2021). Lagomorphs and rodents likely burrowed into the graves, while domesticated animals were either deliberately placed, consumed in the cemetery, or their bones arrived later (Maldre 2000, 417–421; Laneman 2012; Jonuks 2009, 245; Ehrlich et al. 2021; Laneman 2021a, b; 2022). These activities resulted in stone-filled structures with fragmented and commingled human and faunal remains.

The cemetery areas were often cleared of vegetation, possibly for ritual or practical reasons (Lang 2000, 210; Laul 2001, 65, 68; Vassar 1943, 14; Lang 2007b, 141). Cemeteries were built on areas without high vegetation, with signs of ground clearing by fire (Vassar 1943; Moora 1972; Lang 2000, 210; Laul 2001, 65, 68), suggesting a ritual purpose. Burials are not confined to the space between the walls; there are also burials outside the visible grave constructions (Vassar 1943, 12; Laul 2001, 196; Lang 2007a, 177, 194–195). Stone formations or ruins of unidentified structures outside the visible *tarand*s (Est. äärevare) are common and may have served as burial or grave goods deposit areas, as seen in Viimsi I, Tõugu IIB, and Pada (Lang 2007a, 177, 194–195). However, they were not always used for burials, sometimes containing only a few bones, such as in Sadrametsa I or Virunuka II (Laul 2001, 63, 70).

Various ritual activities have been noted in *tarand* cemeteries, including the placement of bones or material offerings under the corners of *tarand* walls or in pits below the cemetery area, indicating a ritual purpose (Vassar 1943, 14; Kalman 2000b, 395; Lang 2000, 105, 111, 211; 2007a, 241–242; Jonuks 2022, 167–170, 194, 198). The absence of certain bone elements suggests a selection of bones prior to final burial (Kalman 2000b, 395). Bones may have been cooled quickly for better collection from the pyre (Kalman 2000d, 438; Lang 2000, 214).

The construction of *tarand* graves was a significant communal achievement (Lang 2011). Because of their monumentality and richness in finds, *tarand* cemeteries are often regarded as elite burial sites (Lang 2007, 239; Article II, 273; Jonuks 2009, 236). Elite or not, based on current calculations (Lang 1990b; Ligi 1995, 222; Lang 2011) the entire population was not interred into *tarand*s, and the "others" remain traceless. Lang (2011) estimates there are approximately 500 *tarand* cemeteries, with a population of around 30,000 people during their use (Lang 1990b; Ligi 1995, 222). This suggests only about 17% of communities constructed and utilised *tarand* cemeteries, with higher prevalence on the mainland and lower in western Estonia and the islands (Lang 2011). Limited osteological analysis may underestimate the number of individuals interred due to diverse burial customs or missing contemporary sites (Lang 2011; Article III).

Most material from *tarand* cemeteries was excavated decades ago, presenting challenges in preserved documentation. Not all excavated sites have osteological material in repositories, and many collections were excavated with different documentation standards, affecting the quality of contextual information for modern applications (see Chapter 5).

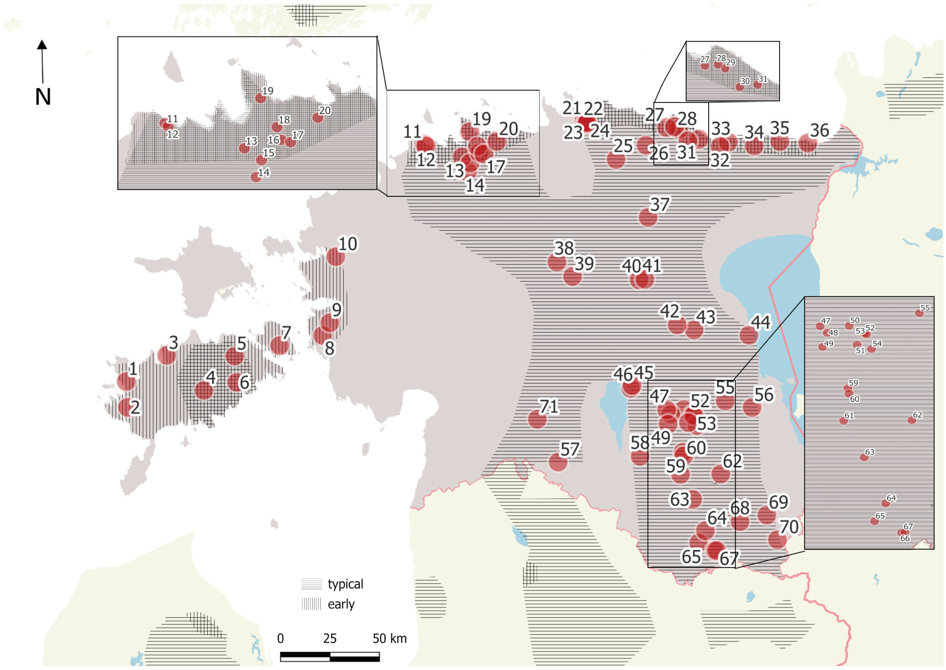

Fig. 1.2. Map representing excavated early and typical *tarand* cemeteries and their spread in present-day Estonia based on Laul 2001, Lang 2007a, Olli 2019, Mandel 2022: 1 Kurevere I, II, III; 2 Lümanda III, V; 3 Võhma Mustjala; 4 Liiva-Putla; 5 Kuninguste; 6 Tõnija Tuulingumägi; 7 Mäla Ussimätas; 8 Kõmsi I, II, IV; 9 Poanse I, II; 10 Taebla I; 11 Ilmandu III; 12 Rannamõisa I, III; 13 Mõigu; 14 Kurna I, II; 15 Lehmja-Loo I; 16 Lagedi IX, X, XI, XII, XIII; 17 Saha; 18 Proosa; 19 Viimsi I, II; 20 Rebala Presti; 21 Tõugu II; 22 Võhma Tandemägi; 23 Uusküla II; 24 Võhma X; 25 Ojaveski; 26 Essu; 27 Kunda Hiiemäe; 28 Kuura; 29 Iila; 30 Pada; 31 Aseri; 32 Purtse-Matka; 33 Jäbara C; 34 Kohtla-Järve I, II; 35 Toila I, II; 36 Türsamäe; 37 Triigi; 38 Tarbja; 39 Nurmsi; 40 Kärde; 41 Ripuka; 42 Nava; 43 Kõrenduse; 44 Lahepera; 45 Verevi-Sandimärdi; 46 Verevi-Läätsa; 47 Meeri; 48 Jaagupi; 49 Tamsa I; 50 Aiamaa; 51 Unipiha I, II, III; 52 Kambja; 53 Tatra; 54 Paali A, B; 55 Mäletjärve I; 56 Kõnnu; 57 Ülpre; 58 Aakre Kivivare; 59 Ala-Pika I, II; 60 Pikkjärve; 61 Truuta I, II; 62 Põlgaste; 63 Hargi; 64 Virunuka I, II, III, IV, V; 65 Kõrgepalu I; 66 Sadrametsa; 67 Pundi; 68 Hannuste; 69 Loosi; 70 Kure-Pulli; 71 Sammaste.

Cremation, fragmentation, and commingling of human remains were not limited to Roman Iron Age *tarand* cemeteries but were also prevalent in Estonia during the Middle and Late Iron Ages, and even in some Medieval and Early Modern cemeteries (Tvauri 2012, 251–284; Valk 1993, 2001; Valk et al. 2014, 62–75). Similar practices have been found globally, such as in Mesolithic Scandinavia, Bronze Age and Early Medieval England, and Late Bronze and Early Iron Age Belgium (Petersen & Meiklejohn 2003; Larsson 2009, 280; Engbring 2011; Parker Pearson et al. 2009; Stamataki et al. 2021).

Most studies of *tarand* cemeteries have focused on artefacts or structures, often neglecting the human remains, which are central to understanding these sites and rituals (Lang 2007a, 206; Olli 2019, 23). Recent reanalyses of fragmented, commingled, and cremated (FCC) remains have either supported previous arguments or provided new insights (Kivirüüt 2014; Varul 2016; Engbring 2011; Kama & Konsa 2016; Saag et al. 2019; Article III; Konsa in prep). This indicates progress in the study of FCC remains in Estonia.

This thesis focuses on bone material and its multifaceted analysis, highlighting the potential of osseous material. By gathering data from excavation reports, reanalysing human remains, identifying patterns, and seeking parallels, I aim to demonstrate best practices for working with these challenging datasets. As a case study, material from two *tarand* cemeteries in Estonia – Viimsi I and Aakre Kivivare – has been analysed. These sites, from the same era but different geographical areas, exhibit similarities and differences due to variations in location and recovery practices. This analysis provides a fuller understanding of Early Iron Age burial rituals and socio-cultural perceptions in Estonia. Hopefully, this dissertation will accelerate the use of modern methods in researching FCC remains, leading to the collection and recording of more information on such material.

1.2. Outline and aims of this dissertation

This study has its roots in my BA research in the University of Tartu where I stumbled on the Viimsi *tarand* cemetery material as this was one of the few collections ticking the boxes of availability, suitable size and adequate documentation for the BA dissertation (Kivirüüt 2011). My work with *tarand* cemeteries continued during MA and MSc courses in the University of Tartu and University of Sheffield where I found new facets of the material, dug deeper in the theoretical background and started to see the bigger picture as well as the need to enhance the documentation of bones to be able to gain the information from the sites (Kivirüüt 2013, 2014).

The papers in this thesis focus on FCC material that has often been overlooked in archaeological analysis and interpretations in Estonia. These excavation and research practices continue to some extent even today. In many cases, excavation reports or publications include interpretations of the osteological material (Kalman 2000a, b, c, d; Laul 2001; Mandel 2023), but do not provide a list of the bones, whereas the finds list is thorough and exhaustive (Lang 2000; Laul 2001; Mandel

2023). During my work in the heritage management sector at the Estonian National Heritage Board, I have seen several research plans where the treatment of FCC human remains is not aligned with current scientific knowledge on the informativeness of the material. This can potentially lead to some loss of data. My work emphasises the importance of documenting findings and highlights the valuable information that can be obtained from the dataset on burial rituals and society.

The first goal of this thesis is to demonstrate the unique characteristics of fragmented osseous material and the valuable information that can be obtained from these seemingly compromised remains. The second goal is to introduce the simplest methodologies that are most beneficial when analysing fragmented, commingled, and often cremated bone material. This will help identify the essential data needed for detailed osteological analysis and outline what should be considered during excavation and when compiling reports.

This dissertation constitutes four articles:

- I Kivirüüt, A., & Olli, M. 2016. Archaeological research on Aakre Kivivare *tarand*-grave. Archaeological Fieldwork in Estonia 2015, 59–70.
- II Olli, M., & Kivirüüt, A. 2017. Individual and collective burial places: an analysis of the Viimsi *tarand* graves of northern Estonia. In A. Kannike & E.-H. Västrik (Eds.), Body, Personhood and Privacy: Perspectives on Cultural Other and Human Experience. Approaches to Culture Theory (7th volume). University of Tartu Press, 271−292.
- III Lillak, A., Tõrv, M., & Oras, E. 2022. Fragmented Bones Tell Stories: Viimsi I Early Iron Age *Tarand* Grave. Estonian Journal of Archaeology, 26(1), 3−26. DOI: https://doi.org/10.3176/arch.2022.1.01.
- IV Lillak, A; Thompson, T., Tõrv, M; Oras, E. 2025. FTIR spectroscopy and VSC-based colour assessment dataset for comparative analysis of cremated bones. Data in Brief 62, 112019.
  DOI: https://doi.org/10.1016/j.dib.2025.112019.

The first article (I) focuses on the excavation results of Aakre Kivivare *tarand* cemetery in 2014 and 2015. The excavations were undertaken to test contemporary excavation and documentation methods and profit from their informativeness in interpreting the findings (McKinley 2004). The analysis was conducted keeping in mind the best practices available at that moment, e.g., recording the finds with GPS coordinates and in clusters and layers, where possible, preparing and picking out the samples already on the site, creating a 3D model of the excavated *tarand*, recording all of the found fragments in the excavation report. The bones and items were analysed based on their context and location in the grave site.

The second article (II) is an in-depth analysis of Viimsi *tarand* cemeteries from northern Estonia. The sites were excavated in the early 1990s, and the documentation was not digital. The manually drawn plans were digitised and the data analysed with the goal to connect the bones with the finds and burial structures, looking for clustering or connections to be able to identify individuals hoping to shed more light on the life and customs of the community behind the cemetery.

The third article (III) is based on the osteological analysis of the Viimsi I cemetery. The in-depth focus on the fragmented bone material showed all the information that can be acquired from partially compromised dataset. Even though the site was partially bulldozed, the bottom layers of the cemetery were partially intact. The patterns in the disturbed and undamaged layers were still observable and informative about the buried individuals and multi-staged burial practices.

The fourth article (IV) introduces, describes, and compares the possibilities and limitations of the visual assessment of cremation temperature of osseous material using Fourier Transform Infrared Spectroscopy (ATR-FTIR) and Video Spectral Comparator (VSC). The paper is based on a selection of cremated human bones from Aakre Kivivare *tarand* cemetery and describes the data acquired from these analyses.

The goal of each excavation should always be to gather as much information as possible about the people of the era through detailed documentation of the features in the field. However, continuous neglect and malpractice when dealing with FCC remains is becoming a problem in both archaeology and heritage management. To address this issue, the papers in this thesis demonstrate simple but effective methods to maximise the information potential of FCC human remains. They outline what can and should be done during the excavation process, what is essential to publish alongside the excavation report, and what details or specialist analyses can be conducted later. The papers and the following discussion also highlight the limitations of material that has not been, or is no longer, recorded according to contemporary standards.

Building on the highlighted challenges of analysing fragmented burial material, **this dissertation aims to synthesise the best practices for documenting and analysing fragmented, commingled and cremated human remains in archaeological research.** My goal is to reduce the stigma often associated with this challenging material and to establish standards for the essential information that should accompany these remains during excavations and in archives.

The dissertation aims to answer three specific research question:

- **What methods to use** to study fragmented, commingled, and cremated human remains?
- **What are the challenges and limitations of the methods** used in the study of fragmented, commingled, and cremated human remains?
- **What are the implications of thorough documentation in maximising the future potential** of fragmented, commingled, and cremated human remains?

To answer these questions, I will discuss the research history of *tarand* cemeteries in Estonia/broader region and building on the experience and good practices abroad outline the opportunities and limitations of the research on FCC osseous material (Chapter 2). I will provide a theoretical background on how the FCC remains are perceived (Chapter 3). While reviewing material (Chapter 4) and methods (Chapter 5), it is emphasised what is essential to document on site and on the osteological material to expand our understanding on the people buried in *tarand* cemeteries and other sites where the bone material is either commingled, fragmented, cremated or any combination of the three. Two case studies on *tarand* cemeteries of Viimsi I (Chapter 4.1) and Aakre Kivivare (Chapter 4.2) are explored more thoroughly. Finally, I will synthesise and discuss the results of the comparative analysis of the two case study sites and outline the methods, challenges, limitations and implications for studying FCC human remains while keeping in mind the future potential of the material (Chapter 6).

1.3. Acknowledgements

I would like to express my heartfelt gratitude to all those who have supported me throughout my PhD journey. It has been a long process and there are many people who have helped me on the way. I am grateful to each and every one of you.

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Thank you all for being part of this journey.

2. HISTORIOGRAPHY

The history of the research of *tarand* cemeteries in Estonia and beyond has been summarised in Maarja Lillak's PhD dissertation (Olli 2019). I will not re-summarise it in detail here as the information published in 2019 is still relevant. Instead, I will focus on the history of the research of fragmented and cremated osteological remains in Estonia with implications to wider contexts. I will bring examples from not only *tarand* cemeteries, but different burial places containing FCC bones.

2.1. Osteology of fragmented, commingled and cremated remains

This dissertation mainly focuses on cremated human remains, but cremation is always accompanied by fragmentation and a degree of commingling. Therefore, the concepts of fragmentation, commingling and cremation (FCC) constitute a focal point in my thesis. Although the research of FCC remains is intertwined, studies often focus more on one of the characteristic traits of the material (e.g., Chapman 2000; Adams & Byrd 2014; Thompson 2015; Ellingham et al. 2023).

Van Vark (1974, 64) estimated the amount of already excavated cremated human remains in Europe to at least 100 000 individuals. Yet, the common perception of cremated and fragmented human remains prior to the pioneer works of the mid-20th century can be summarised in the words of the Swedish anthropologist C.M. Fürst in 1930s: "I would straight away place on record my considered opinion, based on experience, that cremated remains of human bones in burial urns are almost always devoid of any anthropological interest, especially in cases of such in a mass cemetery. From an anthropological point of view, therefore, these bones are of no scientific value, and I consider that nothing is lost if they are neither submitted to nor preserved in the Museum" (Gejvall 1969, 468). The Museum, nevertheless, found that the cremated bones should be collected and kept in hope that new methods in the future would allow the use of the bones in research (*ibid.*).

Recognising the value of cremated, fragmented, and commingled bones as sources of information has taken time. The initial efforts in this field date back to the mid-20th century, when researchers began to emphasise that the incompleteness of the material should not deter anthropologists. They highlighted the best diagnostic features for age and sex assessment and clearly expressed the research potential of these remains (Dzierżykray-Rogalsky 1966; Gejvall 1969; van Vark 1974; Stewart 1979).

In the 21st century, there has been increased focus on the study of FCC human remains, summarised in several comprehensive publications (Chapman 2000; Schmidt & Symes 2008, 2015; Tarlow & Stutz 2013; Adams & Byrd 2014; Thompson 2015; Ellingham et al. 2023). Techniques that were once considered unsuitable for cremated bone material, such as radiocarbon dating and chemical analyses, have now become feasible (Parker Pearson 2008, 202; Lanting & Brindley 2008; Naysmith et al. 2007; Ellingham et al. 2015b; Snoeck et al. 2015; Veselka et al. 2021; Sabaux et al. 2024; Thompson & Nannetti 2025).

Today, many advances in the field are related to forensic sciences, as several methods used to address modern mass fatality events are also suitable for archaeological material (e.g., Schmidt & Symes 2008; Adams & Byrd 2014; de Boer 2022). The field is still evolving, and it has been noted that new studies tend to focus more on the methods rather than on what the results reveal about archaeological material and the people of the past (Thompson 2015, 11–12; Williams et al. 2017, 4–5; Thompson 2023).

Research on FCC remains near Estonia and the distribution area of *tarand* cemeteries began in Scandinavia in the mid-20th century. The bones were collected, and the first analyses were conducted as part of pioneering work that continues to this day. In his pilot study, Nils-Gustaf Gejvall (1947) analysed cremated bones from Kyrkbacken and noted that morphological assessment was often sufficient to estimate the age and sex of the buried individuals without examining the associated grave goods. Tarja Vormisto analysed the bones from grave 2 of Ketohaka that were excavated already early 20th century (Hirviluoto & Vormisto 1984). Vormisto (1985) also conducted osteological analyses on 37 graves dating from the Bronze Age to the Viking Age, determining that bones from all body parts were present and that the cremation process was efficient. Berit Sigvallius (1994) studied cremated human and faunal bone material from North Spånga, conducted cremation pyre experiments, and discussed the limitations of demographic studies in prehistory. Per Holck (2008) republished a supplemented osteological assessment of Norwegian and Danish cremation burials, creating criteria for assessing cremation temperatures and investigating the technological aspects of cremation. Sari Mäntylä-Asplund and Jan Storå (2010) reanalysed material from the Rikala cemetery, originally excavated and analysed in the 1970s, emphasising the importance of analysing bone material and obtaining radiocarbon dates in cremation cemeteries. Tarja Formisto (formerly Vormisto) (1996) continued osteological analyses of the Vainionmäki cremation cemetery, finding evidence of the use of animal skins in burial rituals. Lise Harvig and colleagues (2012) used computed tomography and radiography to investigate the contents of a burial urn before micro-excavations. Sebastian Warmländer and colleagues (2019) successfully estimated the temperature of a small sample of cremated bone using machine learning algorithms.

The research on FCC remains in Latvia and Lithuania started later and gained momentum in the 21st century. During Soviet Occupation – 1940s to 1990s – anthropological material was not collected or stored properly or simply ignored due to its presumed limitations (Zariņa 2010; Kurila 2015a, 68; Ērkšķe 2020). Nevertheless, many osteology-related studies on archaeological cremations have been conducted since the 2000s. Rimantas Jankauskas (2002) published an osteological and paleodemographic study of Iron Age inhabitants of Lithuania. Laurynas Kurila (2009) discussed the social organisation in Eastern Lithuania in the 3rd to 12th centuries CE while the dataset consisted mostly of cremation burials. Gunita Zariņa (2010) analysed the social status of women in Latvia in 7th–13th centuries CE and included cremation burials to the dataset. Kurila (2015a) demonstrated that cremation is not necessarily a limitation for macroscopic and paleodemographic analysis of human remains. Kurila (2015b) also tested the accuracy of sex determination of cremated bones with gendered grave goods and discovered that there were more errors in sex determination by gender-related grave goods for biologically male individuals rather than females. Inga Doniņa and colleagues (2020) thoroughly analysed a western Latvian cremation cemetery where osteological methods combined with palynology and charcoal analysis provided new results on the site. Aija Ērkšķe (2020) provided a discussion on the underrepresentation of children's bones in Latvian cemeteries including osteologically already analysed cremation burials. Lijana Muradian's (2022) radiocarbon dating of cremation burials from Lithuanian barrows indicated the possibility that the barrows were used later than thought based on the dates of the artefacts but also stressed that the number of radiocarbon dates of cremated bone is scarce and groundbreaking conclusions cannot be made yet.

2.1.1. Osteology of fragmented, commingled and cremated remains in Estonia

Estimating the number of cremated individuals unearthed from Estonia is challenging, but over 70 *tarand* cemeteries have been excavated since the 19th century (Lillak 2025). Until the 1970s, bones were collected randomly, with some preserved with artefacts and others not reaching archaeological collections at all (Fig. 2.1.; Tvauri 2012, 254; Article I). Even when cremated bones were recorded, they were not analysed osteologically or contextually (e.g., Moora 1970; Mandel 2022, 35). This was likely due to the Iron Curtain preventing the spread of new methodologies and a lack of understanding of the potential of fragmented, commingled, and cremated (FCC) osseous material. Despite this, archaeologists provided general descriptions of the bones, noting whether they were burned, if there were bone assemblages or undisturbed skeletons, and sometimes the age at death (e.g., Sitzka 1897; Vassar 1943; Шмидехельм 1955, 191; Lõugas 1970; Laul 2001).

Methodologically grounded analysis of FCC bones began in the 1990s and gained momentum in the 21st century. The first thorough osteological analyses of cremated bones in Estonia were conducted in 1993 by Ken Kalling on the Viimsi *tarand* cemeteries. Subsequently, osteologist Raili Allmäe and archaeozoologist Liina Maldre studied the Viking Age Piila cemetery, publishing a detailed bone catalogue (Mägi et al. 1998). Osteologist Jonathan Kalman later analysed osseous material from Läänemaa *tarand* graves and other sites, assessing the number of individuals, their biological profiles, and burial customs (Kalman 2000a, b, c, d). Valter Lang (2000) incorporated Kalman's results into his work on the cultural landscape of northern Estonia. Allmäe (2003) published osteological analyses from Iron Age cemeteries in western Estonia, focusing on the number of individuals and burial practices. She continued her work with case studies and comparisons of cemeteries with FCC bones (Allmäe, 2006, 2013, 2017; Allmäe & Maldre 2005; Allmäe et al. 2007). I have also contributed to this field, starting with my BA studies on Viimsi I cemetery and continuing with research on Aakre Kivivare cemetery (Kivirüüt 2011, 2013, 2014; Article I).

Osteologists have consistently included references to their methodologies, even in initial assessments of FCC bones (Kalling 1993; Kalman 1993/1995; 2000a, b; Allmäe 2006). They determined the bones, calculated the minimum number of individuals (MNI), assessed age and sex, and described the bones' characteristics and derivations (fragmentation, colour, pathologies, cremation practices, burial practices) (Kalling 1993; Kalman 2000a, b, c, d; Allmäe 2006; 2013).

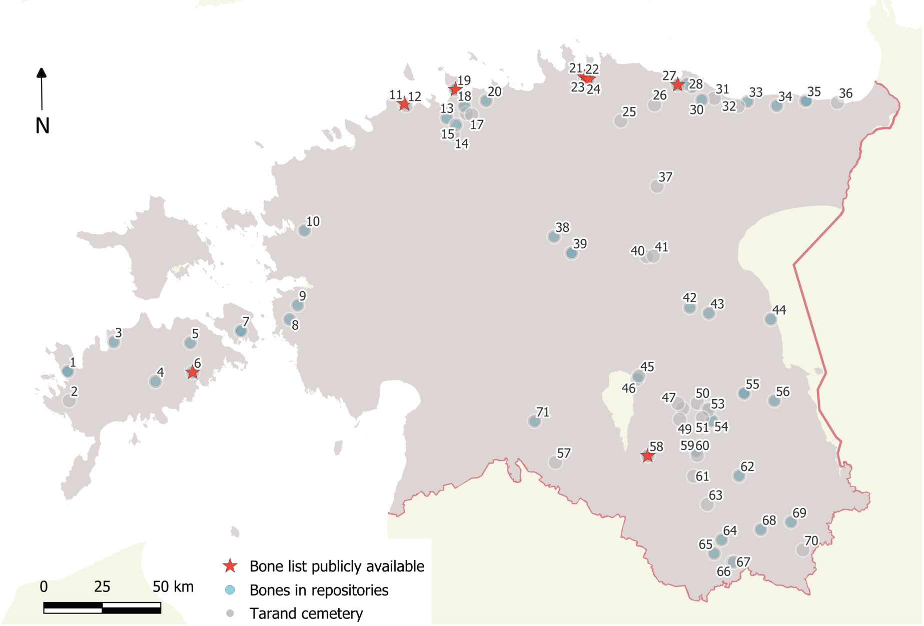


Fig. 2.1. Excavated *tarand* cemeteries with at least some bone material in bone repositories and cemeteries that are equipped with a bone catalogue. Based on Lillak 2025.

Despite the known methods and possibilities, the number of published studies on human remains from *tarand* cemeteries remains small compared to artefactual studies. Marta Schmiedehelm (1923) created a typology of crossbow and cross-ribbed brooches. Artur Vassar (1943) studied the Nurmsi *tarand* cemetery, focusing on constructions and rituals. Lang (1996) analysed the Roman Iron Age landscape in northern Estonia, arguing that the main settlement unit was a single farmstead. Silvia Laul (2001) catalogued *tarand* cemeteries in southeastern Estonia, analysing finds and discussing the ethnicity of the buried people. Mari-Liis Posti (Rohtla 2005) revisited the typology of crossbow brooches and their symbolism. Maarja Lillak (Olli 2019) studied regional differences based on ornamentation and discussed individuality and collectivity in *tarand* cemetery material. Most studies have focused on artefacts and cemetery structures, with human remains often neglected due to historical excavation methodologies and incomplete collections (Fig. 2.1; Lillak 2025). Some bones may still be found through re-sieving and shifting through already excavated material (e.g., Valk 2002, 2014; Pauts 2024).

One issue behind the low number of analyses is the infrequent presence of osteologists during fieldwork. The need for osteologists to determine the exact context of burials and ensure detailed documentation was highlighted in Estonia over 25 years ago (Allmäe 2003, 247–248, 257; Kalman 2000b, 397). As the number of osteologists in Estonia was and still is scarce, many excavations of sites with fragmented, commingled, and/or cremated remains have proceeded without osteologists, despite archaeologists recognising the importance of studying bone material thoroughly (Mandel 2022, 237). This results in incomplete conclusions about the osteological material and its funerary context, as it has not been documented or analysed *in situ* by an osteologist (e.g., Mandel 2003, 147–148; Mandel & Allmäe 2022). *In situ* documentation (or removing the burial in block) allows osteologists to describe the relationships between bones and detect the character of the deposit (White & Folkens 2005, 15–16). Brittle cremated bones can be damaged during excavation, and some details may not be visible in photographs or noticed by archaeologists without osteological training (Keating 2024, 9, 19). Even when osteologists are consulted but not on site, some data may be lost if not recorded according to best practices for documenting fragmented, commingled, and cremated human remains (McKinley & Smith 2023; McKinley 2023).

In addition to on-site recording shortcomings, the material has not been regularly studied in a viable way. Many results lack reproducible data, and papers often do not state all methods or grounds for conclusions, making it difficult to understand interpretations without re-analysing the bone material (Fig. 2.1). Missing bone reports prevent full appreciation of the workload involved in articles (Kalling 1993; Kalman 2000a, b, c; Mandel & Allmäe 2022; Mandel & Allmäe 2023). Researchers may want to revisit or photograph specific bones with diagnostic features, but this is impossible without comprehensive bone catalogues, hindering additional analyses. Despite these shortcomings, early comprehensive osteological reports, such as Kalman's (1993/1995) work on Tõugu cemetery, provided enough information for archaeological purposes, though not for in-depth osteological analysis. Later works have included extensive osteological information and full lists of analysed fragments (e.g., Engbring 2011; Olli & Kivirüüt 2015; Kama 2016; Oras & Kriiska 2016).

The disparity between excavations and osteological analyses means our understanding of the communities behind *tarand* cemeteries and other burial places with FCC remains is mainly based on grave goods, constructions, and locations (Lang 2006a, 97). This issue is not unique to Estonia and has been discussed in other contexts (e.g., McKinley 2006, 81). One goal of this thesis is to emphasise that FCC bones are a valuable archaeological source, and no cemeteries should be excavated without proper documentation and investigation of osseous material alongside other findings.

3. THEORETICAL BACKGROUND

Research on fragmentation, commingling and cremation in archaeology are embedded in several methodological and theoretical approaches examining past human behaviours, cultural practices, and social dynamics (e.g., Chapman 2000; Pollard 2001; Crellin 2020). I will focus on the practices that are transferable or relevant to osteological material found from *tarand* cemeteries with more specific focus on cremation.

3.1. Fragmentation

Fragmentation of the substance is written in the essence of archaeology, there is always a certain incompleteness of material whereas archaeologists must decipher as much as they can of what may have been in the gaps or "white patches" between the known fragments of archaeological information (Olivier 2011, 186). Archaeologists re-articulate the disarticulated info always from their own viewpoint meaning the interpretation depends on inference to the past from things found in the contemporary world (Gomes 2017, 2; Binford 1983, 23).

Fragmentation of archaeological material is evident everywhere, but it may be hard to specify the initial driving force behind the fragmentation. Here I will discuss the fragmentation of (cremated) bone material and divide fragmentation into either (1) **incidental** and (2) **intentional** based on the objective of the series of events resulting in fragmented human remains and (3) **taphonomic** based on the agency of the changes.

(1) **Incidental fragmentation** refers to objects that have been broken accidentally, e.g., by the item falling on a hard surface or by other means during its use (Chapman 2000, 23). In archaeological material, it may be difficult to assess whether the fragments result from an unfortunate inadvertent event, or the setting was staged. From the osteological point of view, some of the fragmentation, e.g., changes caused by scavengers and weathering (Nikita 2017, 80–81) can be classified as incidental as there is no direct human agency. In archaeological material, any brittle object in fragments could be classified as something that has been incidentally fragmented. For example, pottery shards in *tarand* cemeteries have been considered as grave goods based on their position in the cemetery for sites dating to the Pre-Roman Iron Age and as the leftovers of ritual activities for most of the *tarand* cemeteries (Lang 2007a, 187, 216). It is hard to define the ritual activities, though, as, e.g., the pottery shards may originate from accidentally broken pots or vessels that were left just on the site, or they may have been intentionally broken and spread in the cemetery area (Lang 2007a, 187, 216).

(2) **Intentional fragmentation** refers to a deliberate act where the depositor is delivering items that are defective, no longer intact (e.g., Knüsel 2014; Jonuks 2022, 198, 240). The reasons behind deliberate fragmentation vary, but the most

common interpretation is a ritual associated with the (killing of the) artefact (Moora 1938, 15; Chapman 2000, 23; Jonuks 2022, 240), any fertility (Chapman 2000, 23) or ritual action (Kaliff 1997; Kaliff & Østigård 2013, 110; Jonuks 2022, 240) or pure commodity of transporting the artefact from one place to another (Jonuks 2022, 240). In later *tarand* cemeteries the FCC bones may be accompanied by items that have been deliberately broken prior to their deposition into the cemetery, e.g., folded or twisted metal artefacts or ceramic vessels where shards of the same pot have been found several metres apart (Lang 2007a, 187, 216; Jonuks 2022, 240).

(3) **Taphonomy** investigates decay of organisms and helps to distinguish between natural and cultural aspects that have affected the archaeological material post-depositionally (Efremov 1940; Garland & Janaway 1989, 16; Lyman, 2001, 3–4; Bello & Andrews 2006; White & Folkens 2005, 49; Nikita 2017, 77). The taphonomic factors can be divided into two groups: physical and chemical (Lyman, 2004, 3–4; White & Folkens 2005, 50). The changes may be barely visible, but it is possible that due to taphonomic influences, the bones have become brittle or unrecognisable (Nikita 2017, 80, 91). Taphonomic process is natural and normal, and the degree of changes depends on many factors, e.g., material of the deposit, the environment surrounding it, the climate, the handling of the material, and later disturbances (Efremov 1940; Garland & Janaway 1989, 16; Lyman, 2001, 3–4; Bello & Andrews 2006; White & Folkens 2005, 49). A thorough understanding of the causes and nature of taphonomic change can allow for valuable insights in the study of mortuary practices as human-related or cultural taphonomic changes can often be differentiated from the natural processes (White & Folkens 2005, 49; Konigsberg & Adams 2014, 194). Nikita (2017, 83) divides cultural taphonomic changes into three: 1) tool marks, 2) fractures, 3) thermal alteration which may have been caused by violent actions, (ritual) steps as part of the mortuary practices or cannibalism. In addition to Nikita's division (2017, 83) it must be pointed out that natural taphonomy may have been triggered by cultural processes, e.g., when human remains are left uncovered or have been displayed or have been moved from one environment to another. In the material of *tarand* cemeteries, there are many cultural taphonomic changes from tool marks, fractures to thermal alteration, but also several markings from natural processes (Kalman 2000b; Kivirüüt 2014; Article III).

Fragmentation of the material (see Fig. 3.1.) sets limits to its interpretation. Fragmentation of the body may have occurred during the cremation process, but it must be kept in mind that not all the body may have been brought to the pyre and/or cremated remains from one body may have been deposited differently post cremation (Thompson 2015, 7). The data is lost and fragmentation of the material rises with every step of the burial and excavation process (Harvig 2017, 233). Therefore, understanding the burial process and knowing how the site was excavated aids us in comprehending how and why the material may have fragmented. With suitable theoretical approaches, the mechanisms and objectives behind the changes can be determined, interpreted accordingly, and produce new information on the material. The next subchapters are dedicated to two intentional taphonomic processes: commingling and cremation that in the context of *tarand* cemeteries are key characteristics of the bone material.

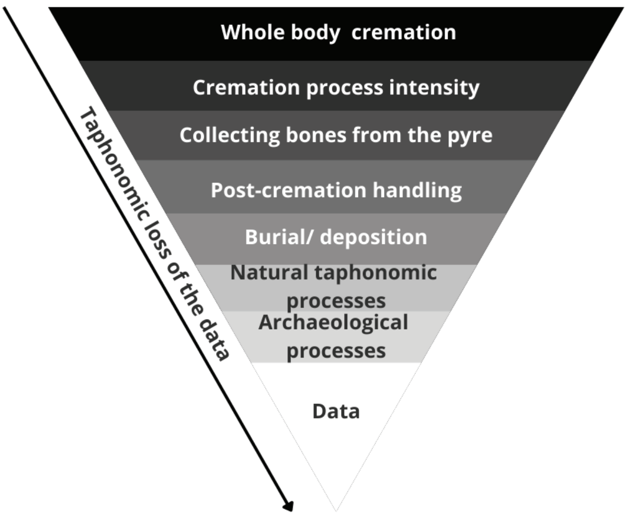


Fig. 3.1. Taphonomic loss of cremated bone material from the cremation pyre to the interpreted data. All the processes augment fragmentation and some of the processes also aid in fragmentation. Adapted from Harvig 2017, Fig. 12.1.

3.2. Commingling

Commingling is the result of several natural and cultural taphonomic processes, where archaeological material has been disturbed to the point where bones of different individuals are mixed (Nikita 2017, 91). So, the key definer of the commingling is the mix of the cremated and/or fragmented remains of different individuals. Commingling of the remains needs to be addressed separately from fragmentation and cremation as it characterises very different burial practices of past communities. The commingling of human remains in archaeological contexts may occur either deliberately, as part of ritual or communal burial practices, or accidentally, due to post-depositional processes or the reuse of funerary spaces (McKinley 1997; Thompson 2015, 8). In cremation contexts, accidental commingling is particularly prevalent and often results from the repeated use of pyre sites, where residual bone fragments from previous cremations may remain *in situ* and become incorporated into subsequent deposits (McKinley 1997; Harvig 2015, 58; Fülöp 2019, 306). Commingling does not have to co-occur with fragmentation and cremation of human remains. Inhumated and fragmented bones can be commingled as in Jõelähtme stone-cist cemetery (Varul 2016, 35–36), bones may be fragmented and (partially) cremated but not commingled as in a child burial of Keblaste or the triple burial from Pärnu road 41 (Mandel & Allmäe 2022; Niinesalu-Moon et al. 2023). In many prehistoric cemeteries in Estonia bones are cremated, fragmented, commingled at the same time, e.g., Tõugu II, Uusküla II, Viimsi, Põlgaste, Aakre Kivivare (Kalling 1993; Kalman 2000c, 425; 2000d, 438; Allmäe 2013; Article I). Commingling of the bones co-occurring fragmentation and cremation is also evident elsewhere, e.g., Polichni in Macedonia, Herstal in Belgium, Neolithic Scandinavia (Larsson 2009, 280; Stamataki et al. 2021; Chatzikonstantinou et al. 2022; Salesse et al. 2021). Severe commingling of the archaeological material offers additional limitations, but also possibilities as deliberate commingling may refer to collectivity of the society using the cemetery (Jonuks 2022, 212–213). In *tarand* cemeteries, not only bones are mixed, but the items are also commingled in between the stone layers of the burial area (Lang 2007a, 196; Article I). There remains a possibility that some of the bone or artefact fragments can be reassembled, although considering also the quantity of the material from *tarand* graves, rejoining some of the fragments would be a lucky coincidence (Lang 2007a, 187).

In most cases where the bones cannot be reassembled, it is possible to detect individuals based on recurrent bone elements and, sometimes, this is done in combination with age-specific differences (Article I; Nikita 2017, 91; McKinley & Smith 2023). The results of the analysis of each of the fragmented commingled bones are combined into the MNI (minimum number of individuals) and MLNI (most likely number of individuals) (Nikita 2017, 92). The greater the loss of material, the less accurate the estimation of the number of commingled individuals becomes (Nikita 2017, 94–95). It should also be noted that in the case of cremated remains, where bone preservation is poor, the MLNI is not calculated (Konigsberg & Adams 2014, 195). In the case of commingled remains from *tarand* cemeteries where bone preservation is not good and sample size is big, each individual is represented solely by that one recurrent or age-specific fragment, all the other (identified) bones can be assigned to specific individuals merely with some probability (Article III).

Commingling of fragmented and cremated remains also offers additional questions and difficulties as the morphological assessment of the bones is somewhat troubled (see Chapter 6.2), even the fact of commingling may be hard to determine. Osteological analysis may reveal that the remains of a single individual are put in some kind of container and not commingled with skeletal material of other individuals as it was determined for Danish urns (Harvig et al. 2012). Even though morphological assessment of the burial material may suggest the presence of merely one individual, recent multidisciplinary study based on radiocarbon dating and strontium isotope analyses has detected several individuals in urns that have been thought not to be commingled (Sabaux et al. 2024). This means that commingling may be hidden with traditional, visual methods, and be discovered only after more specialised tests, e.g. radiocarbon dating or strontium isotope analysis are carried out.

Nevertheless, field recovery and documentation of commingled remains is of utmost importance to maximise the potential of commingled remains (Naji et al. 2014, 39; Nikita 2017, 91; McKinley & Smith 2023). Still today, however, their recovery and documentation methods vary in detail (e.g., Squires 2011, 46;

Waltenberg et al. 2023). Adequate on-site and post-excavation documentation allows the researchers to assess many features important in the archaeological record, e.g., the MNI or MLNI, precombustion body position, burial structure, state of the body prior to the construction, degree of tampering of the remains (Naji et al. 2014, 53). Considering some of the material is always lost between the find situation, excavation, packaging and transportation, e.g., when some of the brittle fragments break or pulverise (see Fig. 3.1.), the presence of an osteologist on the excavation site is essential.

3.3. Cremation

Cremation refers to the intentional treatment of a dead body (or parts of it) by fire (White & Folkens 2008, 421). While modern European cremations take place in controlled and enclosed environments, archaeological cremations took place outdoors and possibly in public (Williams et al. 2017, 2–3; McKinley 2023).

The multiple stages and (re)moving of the bone material during the funeral leads to the problem that not all the bones have reached the burial site (McKinley 2023). The only way to assess the completeness of the skeletal remains at a site is compiling a full inventory of the bones. In cases where we do not have corresponding pyre and/or cult site(s) and cemeteries we may not have all the bones of the buried individuals. Therefore, when suspecting "missing burials" and focusing solely on the research of the known burial sites, we are lacking data as the bones of one individual may be left or placed in different locations (McKinley 1997; Williams 2008, 242; Lang 2011; Kaliff & Østigård 2013, 109; Duday et al. 2022, 268; Henriksen 2022, 577).

The remains of an average adult individual weigh ca 2–2.5 kg after the cremation process (Gejvall 1981, 16; Bass & Jantz 2004; White & Folkens 2005, 33). Even in cases with seemingly abundant volumes of cremated human remains, it must be kept in mind that what we see archaeologically is merely a fraction of a fraction. Cremation procedures are often multi-stage as the body is usually collected from the pyre site and buried elsewhere (Williams 2008, 242; Duday 2022, 264). The materiality associated with those different cremation practices can be unearthed from several sites, mainly the burial deposit and the pyre sites (Williams 2008, 242).

When the cremated bone material is scarce, the symbolism behind cremation as one of the ways to dispose of the dead can still be analysed. Cremation is considered one of the best ways to destroy all of the materiality of the corpse (Parker Pearson 2008, 7, 49; Williams 2008, 248; Cerezo-Román & Williams 2014, 250; Nilsson Stutz & Kuijt 2014, 143). The bones change during the cremation process in shape, colour, size. This means that the person – once a living agent – transforms from a corpse reminding the deceased to something completely different (DeHaan 2008; Gonçalves et al. 2011; Goldstein & Meyers 2014, 208).

A successful technical process of cremation requires skill and experience. For combustion, combustible material, enough oxygen and adequate ignition temperature are needed whereas in the human body, the combustible materials are mainly fat and protein (Holck 2008, 27). Additionally, it is imperative to have proper conditions, which comprises choosing the suitable place and material for cremation pyre (Jonuks & Konsa 2007; Holck 2008, 29). A successful cremation means that the community conducting the cremation knew what they were doing and how to fix things if something started to go awry, with one possibility to conduct cremations in a pyre or smithy (Gansum 2004; Goldhahn & Oestigaard 2008, 217, 219; Oestigaard 2015, 80; Thompson 2015, 7). It also must be kept in mind that the act of cremation is a spectacle – the transformation of the human body to a pile of calcined bones offers an unforgettable visual, auditory and olfactory experience (Jonuks & Konsa 2007; Cerezo-Román & Williams 2014, 250; Nilsson Stutz & Kuijt 2014, 143).

The whole complexity of funerary rites, of which only fragmented archaeological evidence is available for us today, can be derived from some of the rare written descriptions of those multi-stage burial rituals. For example, written descriptions of cremation rituals from the 1st century CE where Tacitus mentions that the funerals of the Northerners take place without any ceremony, but the firewood is chosen carefully and the warrior's weapons are always with him whereas his horse is on the pyre occasionally (Holck 2008, 13 and references therein). Many 5th century CE Edda-poems contain references to magnificent cremation rituals (Holck 2008, 13–14 and references therein). The most detailed description of a Viking cremation burial is by Ibn Fadlan from the 10th century CE where the funeral rites were elaborate (Holck 2008, 15–17 and references therein). Unfortunately, most of the described ritual actions have no response in the archaeological record (McKinley 2013, 149).

In terms of symbolism, there are many plausible actions that could have taken place in conjunction with the cremation ritual from breaking the body (Holck 2008, 126), fueling the smithy (Goldhahn & Oestigaard 2008, 225–226), spreading the bones or freeing the soul to the elements of the nature (Kaliff 1997, 81; Kaliff & Østigård 2004), offerings to deities (Kaliff & Østigård 2013, 89) to cannibalism (Holck 2008, 126; Kaliff & Østigård 2013, 89). It is impossible to fully reconstruct the whole prehistoric burial ritual based on archaeological data and the scarce written record. Nevertheless, comparison is a forceful tool that can bring unfamiliar entities together to form new information based on analogies from archaeological and carefully selected ethnographic records as well as from contemporary reality (Gomes 2017, 9–10). At the same time the uniqueness of each site must not be forgotten and in cases where the site does not fit the narrative, there are always analogies and details that can be compared (May 2017, 135). Therefore, when interpreting cremations, it must be kept in mind that in addition to the loss of physical data (Fig. 3.1.), there may have been many burial events that have left no physical trace. Therefore, the few existing descriptions or parallels from other sites can help us understand more about what may have taken place on the sites.

3.3.1. Cremation-related structures

Understanding the physical premises (such as sites, pyre locations, and storage or burial structures) where human bones may be found is essential, but it is also necessary to discuss the variability and function-based division of cremation-related architecture. The perception of the sites is immensely relevant to the interpretation of the bone material to understand the context and to interpret when and how the bones may have ended up where they were found from. In *tarand* cemetery material, the bones were not cremated on the site, but elsewhere (Jonuks 2022, 196–197). In Western Estonia, there are some signs of cremation sites from the stone-built cemeteries, e.g. from Uugla I and Kõmsi III where extensive charcoal and brittle stones from extensive heat were found from the grave area (Mandel 2003, 153). Cemeteries with stone-built structures also have been suggested to mimic buildings during the Early Iron Ages, especially *tarand* cemeteries have been interpreted as houses for the dead that were thought to reflect the architecture of the living (Vassar 1943, 160–163; Mägi 2005). Alternatively, they have been suggested to symbolise the chambers of ancient field systems (Vassar 1943, 134; Lang 1999; Mägi 2005; Jonuks 2022, 195). The will to compare the cremation structure with other known architecture from the period is relevant and should be kept in mind.

Here, I focus on the relationship between the site and the cremated human remains, exploring why the bones were found in these specific contexts. I divide the cremation structures into three groups based on its relation to the act of cremation by Wessman and Williams (2017, 180–183): 1) Pre-cremation structures, 2) Peri-cremation structures, 3) Post-cremation structures.

Pre-cremation structures are the places where the corpse was held prior to cremation and they are hard to detect in archaeological material as this could have been the deceased's house, another dwelling, ritual site, a temporary or even mobile structure (Wessman & Williams 2017, 180–181). There are no definite pre-cremation structures known from Estonia, but the evidence suggests that in Viimsi I, the dead may have been inhumated to the *tarand* until most of the soft tissues were decomposed and cremated while the bones were bare, but still fresh (Mägi 2005; Article III). Also, Lang (2000, 213) has noted that in case the dead were not cremated fresh, there had to be a place where the dead "waited" to be buried into the cemetery. This means that *tarand* cemeteries may have had several functions – to house the dead both prior to and after their (partial) cremation.

The peri-cremation structures refer to the sites where the cremation took place (Wessman & Williams 2017, 181). This could have been a simple pyre, but could have included large elements, e.g. furniture, vessels, that bore a symbolic value and served as fuel to the pyre (*ibid*., 181). The excavation and analysis of pyre sites allows archaeologists to assess the material that has been left to these sites intentionally or accidentally and have not been included in the final burial.

Archaeological pyre sites can be complex containing several individual pyres. In the context of European prehistory different pyre structures have been observed: the pyres have either been built on the ground, on a pit in the ground (a *bustum* or a pyre-grave) and/or on a platform (McKinley 2013, 152; McKinley 2017, Duday et al. 2022, 264; Monetti 2022, 125; Jonuks 2022, 197). The cases where cremation pyres were constructed directly on the ground, the archaeological evidence of the pyre site is scarce as merely a few centimetres of soil below the ground is affected and later disturbances (e.g., ploughing) will destroy this evidence (Jonuks & Konsa 2007; McKinley 2013, 152).

Post-cremation architecture serves as the place where the cremated remains are placed (Wessman & Williams 2017, 181–182). It must be kept in mind that the versatility of permanently fragmented cremated remains allows many more actions to be undertaken than with inhumated non-fragmentary bones (Williams 2008). While previously mentioned pyre-graves can be considered as primary burial places, most cremation graves are secondary deposits, where the pyre material along with cremated bones and artefacts collected from the pyre site has been brought into (Duday et al. 2022, 264; McKinley 2013, 154).

In addition to the previous division of pre-, peri-, and post-cremation structures, Wessman and Williams (2017, 182–183) have noted the cumulative nature of the three types of structures. Pyre sites have often remained unchanged and along with post-cremation architectures have seen several successive depositions of cremated remains making the grave sites cumulative and communal (*ibid.,* 182). The cumulativeness and collectiveness are definitely the case for *tarand* cemeteries as the sites have been in use for several centuries (Lang 1993, 54–55; Jonuks 2022, 212–213; Article II) and in some cases, it is argued that the cemetery and pyre site may have been close by (Lang 2000, 153; Article I). For example, in the Uusküla II *tarand* cemetery in Northern Estonia, a gravel heap with extensive signs of heat induced changes was found along with charcoal and cremated bones (Lang 2000, 153). It was interpreted as a cumulative pyre site as the heap contained brittle heated stones, the iron ore particles in the soil had transformed to magnetite, but based on radiocarbon it was in use at some time in between late 8th and mid-12th centuries CE, much later than the Uusküla II *tarand* cemetery (*ibid.*). Some cremations under stone cists may also represent previous burial sites (Lang 2000, 211).

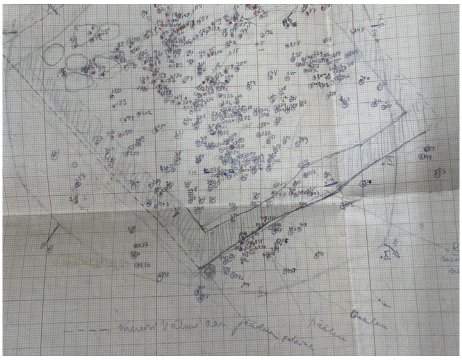
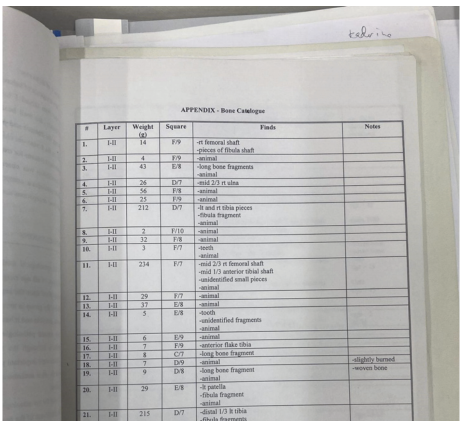
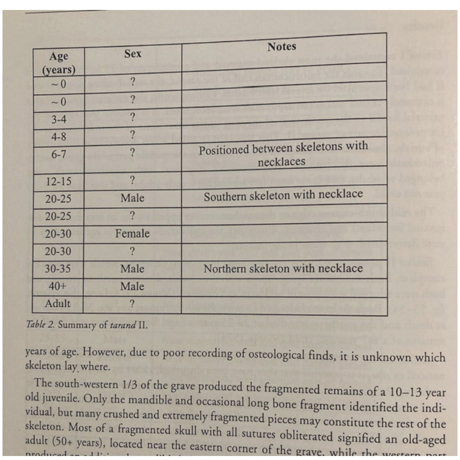
This division of cremation-related structures should be within the framework of all cremation-related fieldwork. First, it is essential to determine the type of site being excavated. Additionally, it is important to consider whether the quantity of bones and the characteristics of the context (such as the presence of charcoal, brittle stones, or ash) suggest the existence of nearby sites related to the excavated burial. This information can provide further insights into the individual and the burial rites.

4. MATERIAL

The sites chosen for case studies are Early Iron Age communal *tarand* cemeteries – Viimsi I and Aakre Kivivare. Viimsi I material was excavated in 1990 and has been on my table since BA studies. The more I have been learning how to look for characteristic traits on the bones, the more specific the analysis has become. It has been a constant replenishment of the analysis. This is reflected in the dataset from Viimsi I where the documentation is slightly erratic, and not all the data might be easily re-visitable. The material from Aakre Kivivare cemetery was excavated by myself and Maarja Lillak and the bone fragments were documented by the standards I had developed during the years based on read reports and personal experience working with older datasets (see Article I; Table 4.1.) based on foreign guidelines (Buikstra & Ubelaker 1994; McKinley 2004; Nikita 2017). This resulted in a dataset that can be readily mapped, re-visited and re-interpreted. Most of the bones from both sites are fragmented, commingled, and cremated, fragmented bones were mostly scattered in between the stone filling of the graves, accompanied with artefacts, mostly pottery shards, but also items of personal adornment, a few weapons, and utensils.

Viimsi I and Aakre Kivivare bear several similarities but encompass differences that make them excellent case studies to highlight the potential and challenges of the study of cremated, fragmented and commingled human remains. Differences are: 1) situated in different (culture)geographical localities, 2) the building material and style of the graves were different, 3) Aakre Kivivare was excavated with and Viimsi I without an osteologist on site, 4) Viimsi I was largely destroyed due to bulldozing prior to excavations, while Aakre Kivivare was partially excavated in the 19th century, 5) Viimsi I has been wholly excavated, but from Aakre Kivivare we only have an excavated section of *ca* ⅛ of the site (Article I). Similarities are: 1) they are roughly from the same era, 2) they entail severely fragmented, commingled cremated and inhumated human remains together with artefacts, 3) the location of bones was recorded, 4) all the artefacts found from the sites have been thoroughly studied (Lang 1993, Article I; Article II). The sites are more different than similar, but the similarities help us to compare burial structures from the same era, and the contents of the cemeteries complement each other enlarging the sample size. The geographical distance between the sites adds more spatial scope to the study. The similarities and differences in how the material has been treated has allowed me to analyse what went well and what not and how to overcome the limitations that the material has in the context of the possibilities that modern science has to offer. These main case studies will be compared with other analysed bone assemblages and datasets that are available to the author.

Table 4.1. The data sources mentioned in text and the information they bear.

<table>
<tr><th>Data type</th><th>Illustration</th><th>Why is it necessary?</th></tr>
<tr><td>Excavation plans</td><td>
(Schmiedehelm 1927)</td><td>If not already digitised, these records can be. They contain valuable data on the context of the find. Sometimes, comments on raw plans are very useful for interpretation or filling in gaps caused by lost data over the years. These records form the basis of any spatial analysis.</td></tr>
<tr><td>Bone catalogue = documen-tation of osteological analysis in a table or a database</td><td>
APPENDIX - Bone Catalogue
<table>
<tr><th>#</th><th>Layer</th><th>Weight (g)</th><th>Square</th><th>Finds</th><th>Notes</th></tr>
<tr><td>1.</td><td>I-II</td><td>14</td><td>F/9</td><td>-rt femoral shaft
-pieces of fibula shaft</td><td></td></tr>
<tr><td>2.</td><td>I-II</td><td>4</td><td>F/9</td><td>-animal</td><td></td></tr>
<tr><td>3.</td><td>I-II</td><td>43</td><td>E/8</td><td>-long bone fragments
-animal</td><td></td></tr>
<tr><td>4.</td><td>I-II</td><td>26</td><td>D/7</td><td>-mid 2/3 rt ulna</td><td></td></tr>
<tr><td>5.</td><td>I-II</td><td>56</td><td>F/8</td><td>-animal</td><td></td></tr>
<tr><td>6.</td><td>I-II</td><td>25</td><td>F/9</td><td>-animal</td><td></td></tr>
<tr><td>7.</td><td>I-II</td><td>212</td><td>D/7</td><td>-lt and rt tibia pieces
-fibula fragment
-animal</td><td></td></tr>
<tr><td>8.</td><td>I-II</td><td>2</td><td>F/10</td><td>-animal</td><td></td></tr>
<tr><td>9.</td><td>I-II</td><td>32</td><td>F/8</td><td>-animal</td><td></td></tr>
<tr><td>10.</td><td>I-II</td><td>3</td><td>F/7</td><td>-teeth
-animal</td><td></td></tr>
<tr><td>11.</td><td>I-II</td><td>234</td><td>F/7</td><td>-mid 2/3 rt femoral shaft
-mid 1/3 anterior tibial shaft
-unidentified small pieces
-animal</td><td></td></tr>
<tr><td>12.</td><td>I-II</td><td>29</td><td>F/7</td><td>-animal</td><td></td></tr>
<tr><td>13.</td><td>I-II</td><td>37</td><td>E/8</td><td>-animal</td><td></td></tr>
<tr><td>14.</td><td>I-II</td><td>5</td><td>E/8</td><td>-tooth
-unidentified fragments
-animal</td><td></td></tr>
<tr><td>15.</td><td>I-II</td><td>6</td><td>E/9</td><td>-animal</td><td></td></tr>
<tr><td>16.</td><td>I-II</td><td>7</td><td>F/9</td><td>-anterior flake tibia</td><td></td></tr>
<tr><td>17.</td><td>I-II</td><td>8</td><td>C/7</td><td>-long bone fragment</td><td></td></tr>
<tr><td>18.</td><td>I-II</td><td>7</td><td>D/9</td><td>-animal</td><td>-slightly burned</td></tr>
<tr><td>19.</td><td>I-II</td><td>9</td><td>D/8</td><td>-long bone fragment
-animal</td><td>-woven bone</td></tr>
<tr><td>20.</td><td>I-II</td><td>29</td><td>E/8</td><td>-lt patella
-fibula fragment
-animal</td><td></td></tr>
<tr><td>21.</td><td>I-II</td><td>215</td><td>D/7</td><td>-distal 1/3 lt tibia
-fibula fragments</td><td></td></tr>
</table>
(Kalman 1993/1995)</td><td>Provides an overview of the skeletal inventory. It forms the basis for any characteristics describing the individuals and calculations describing the community. Modern bone catalogues should be digital, and published as a (preferably open access) database in an online repository. This should be part of the bone report.</td></tr>
<tr><td>Bone report</td><td>
<table>
<tr><th>Age (years)</th><th>Sex</th><th>Notes</th></tr>
<tr><td>~0</td><td>?</td><td></td></tr>
<tr><td>~0</td><td>?</td><td></td></tr>
<tr><td>3-4</td><td>?</td><td></td></tr>
<tr><td>4-8</td><td>?</td><td></td></tr>
<tr><td>6-7</td><td>?</td><td>Positioned between skeletons with necklaces</td></tr>
<tr><td>12-15</td><td>?</td><td></td></tr>
<tr><td>20-25</td><td>Male</td><td>Southern skeleton with necklace</td></tr>
<tr><td>20-25</td><td>?</td><td></td></tr>
<tr><td>20-30</td><td>Female</td><td></td></tr>
<tr><td>20-30</td><td>?</td><td></td></tr>
<tr><td>30-35</td><td>Male</td><td>Northern skeleton with necklace</td></tr>
<tr><td>40+</td><td>Male</td><td></td></tr>
<tr><td>Adult</td><td>?</td><td></td></tr>
</table>
Table 2. Summary of *tarand* II.
years of age. However, due to poor recording of osteological finds, it is unknown which skeleton lay where.
The south-western 1/3 of the grave produced the fragmented remains of a 10–13 year old juvenile. Only the mandible and occasional long bone fragment identified the individual, but many crushed and extremely fragmented pieces may constitute the rest of the skeleton. Most of a fragmented skull with all sutures obliterated signified an old-aged adult (50+ years), located near the eastern corner of the grave, while the western part
(Kalman 2000c)</td><td>A summary of the findings of the osteological analysis provides an overview to grasp the main characteristics of the analysed sample. It should offer enough information for the reader to assess the relevance of the sample to the research question. This summary should be part of the excavation report and serves as a good basis for further publications.</td></tr>
</table>

In the following subchapters, *tarand* cemeteries and the case studies will be introduced in depth and the main contributions as well as limitations of the material and its analytical results are outlined. Further, I will place the datasets from these two case study sites into a wider context of *tarand* cemeteries in their region and discuss the opportunities and limitations of the osteological material they entail.

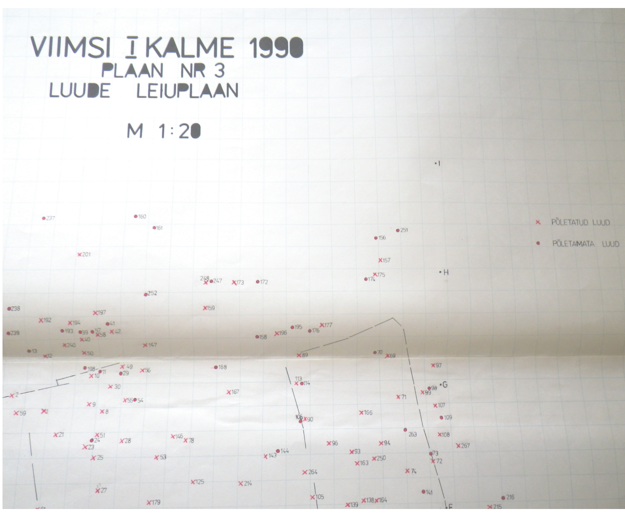
4.1. Viimsi I

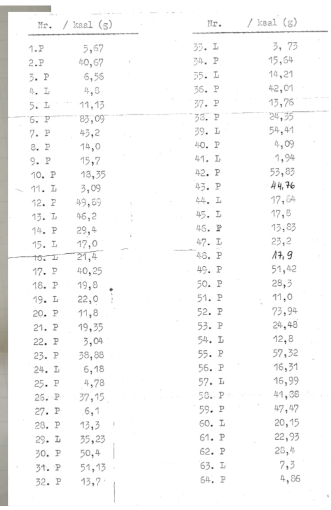
Viimsi I and II *tarand* cemeteries were discovered in the outskirts of Tallinn in the 1970s by local historian Oskar Raudmets and archaeologist Vello Lõugas (Fig. 4.1.). As the site was not under state protection and not known about by the local community, it was disturbed in 1988 during the construction of an orchard (Lang 1993, 5). In 1990 Valter Lang conducted salvage excavations on the remainder of the burial place unearthing two typical *tarand* cemeteries, Viimsi I and Viimsi II (Lang 1993, 5). Since the human remains from Viimsi II cemetery were not available at that time for analysis (Article II), my study focuses on the Viimsi I burial place. The cemeteries are dated based on the artefacts and were used from approximately the second half of the 4th century to the end of the 5th century CE (Lang 1993, 54–57). As is typical of the *tarand* cemeteries of north-western Estonia, e.g. Mõigu, the Viimsi cemeteries were mostly built of limestone slabs and contained both cremation and inhumation burials (Kalling 1993, 67–68; Lang 1993, 10–13; Lang 2007, 196).

Fig. 4.1. Viimsi I cemetery (red triangle), its surroundings and area plan (modified from Lang 1993, 9).

The bulldozer had shifted the soil on the Viimsi I cemetery from southwest to northeast. Prior to the excavations the ground was levelled, and the construction of the cemetery was not clear. In 1990 the site was cleared of rubble and then the constructions were excavated *tarand* by *tarand*. The first *tarand* to be excavated was A (see Fig. 4.1), *tarand* B was the following and the most disturbed area in the mid-section of the cemetery, *tarand*s C and D were excavated last. The bones and artefacts were marked on the plans and lists were compiled with information on the finds, but as standard methods of the era were used, they were described briefly (Lang 1990a). Sieves were not used, sieving was introduced in 1995 at Ala-Pika settlement site (Valk 2002).

During fieldwork the bones were collected as small deposits that later were described as 264 contexts (Lang 1990a). The bones were retrieved from the temporary bone depot in Keila (Archaeological Research Collections of Tallinn University) in early 2011 and it turned out that during the years and transportation, the material had commingled inside the boxes (Kivirüüt 2011; 2014). Also, the depth of the human bones was not noted neither on the grave plans nor the finds' list (Lang 1990a, 1993). This has complicated the further interpretation of the bone fragments as it is known the top layers of the cemetery were bulldozed off, it is impossible to determine the stratigraphy of the bones coming from the bulldozed soil and below them. It could be assumed that the bone deposits with bigger numbers were in deeper and later excavated layers, but comparing the data for finds where depths have been recorded, the cemetery area plans and context numbers seem to have been compiled differently or have been redrawn and reorganised based on the finds' map and the find catalogue (Lang 1990a; Lang 1993, 9, 18–29).





Nr.	/ kaal (g)	Nr.	/ kaal (g)
1.P	5,67	33. L	3, 73
2.P	40,67	34. P	15,64
3. P	6,56	35. L	14,21
4. L	4,8	36. P	42,01
5. L	11,13	37. P	13,76
6. P	83,09	38. P	24,35
7. P	43,2	39. L	54,41
8. P	14,0	40. P	4,09
9. P	15,7	41. L	1,94
10. P	18,35	42. P	53,83
11. L	3,09	43. P	44,76
12. P	49,69	44. L	17,64
13. L	46,2	45. L	17,8
14. P	29,4	46. P	13,83
15. L	17,0	47. L	23,2
16. L	21,4	48. P	17,9
17. P	40,25	49. P	51,42
18. P	19,8	50. P	28,3
19. L	22,0	51. P	11,0
20. P	11,8	52. P	73,94
21. P	19,35	53. P	24,48
22. P	3,04	54. L	12,8
23. P	38,88	55. P	57,32
24. L	6,18	56. P	16,31
25. P	4,78	57. L	16,99
26. P	37,15	58. P	41,38
27. P	6,1	59. P	47,47
28. P	13,3	60. L	20,15
29. L	35,23	61. P	22,93
30. P	50,4	62. P	28,4
31. P	51,13	63. L	7,3
32. P	13,7	64. P	4,86

Fig. 4.2. Documentation of Viimsi I cemetery bones in 1990 – a section of the excavation plan and bone catalogue (Lang 1990a).

Most of the bulldozed soil was heaped into the northeastern area outside the cemetery walls; the artefacts found from that area have been marked on the finds plan showing that they were from the disturbed layer. The bone deposits that came from the disturbed heap (230–236) were not drawn on the plan, but it was mentioned in the report that these contexts were from the bulldozed soil (Lang 1990a). Some of the bone contexts were marked on the northeastern area outside the walls that corresponded with the bulldozed area without the note that they had been bulldozed there. Lang (1993, 13) has mentioned that most of the finds east, north and northeast from the cemetery walls were probably bulldozed, but sometimes it was hard to notice the difference between the initial construction of the cemetery and its disintegration and the more recently disturbed layers (*ibid.*).

The finds were marked on the excavations plans and the list contained the material, interpretation and the depth of the artefactual finds (Fig. 4.2.; Lang 1990a). The items from Viimsi I have been thoroughly analysed by Valter Lang (1993), Toomas Mägi (1993), Jüri Peets (1993) and Maarja Lillak (Article II) and these analyses support the osteological analysis in my thesis.

Bones from Viimsi I cemetery have been analysed twice – in 1993 and 2011 with brief revisit by the author in 2014 (Kalling 1993, Kivirüüt 2011, Kivirüüt 2014). The determinations from 2011 and 2014 have been added to my BA and MA dissertations (Kivirüüt 2011, Kivirüüt 2014), but have not been formed to a separate report. To enhance the availability of the data, MS Excel spreadsheet containing the osteological determinations has now been published on Zenodo (Lillak 2025).

The osseous material from Viimsi I comprised both cremated and inhumated bones (Kalling 1993; Kivirüüt 2011; 2014). The data was transferred to a table based on 274 contexts (cremated and inhumated bones were documented in different rows i.e. one context became two in the table) in 2014, not all of the information was recorded the way that should have been and this has created challenges in later work. For example, the bones with specific and diagnostic features are hard to be sorted out from the material and not all of the data is recorded by fragment (e.g., colour and cremation stage).

The analysis showed that the MNI for cremations was 29, based on the number of adult petrous portions of the occipital bone ($n_{right} = 26$; $n_{left} = 21$) and non-adult bones. Based on the development of the cremated teeth, and cremated infant bones (fragment of ulna, rib and mastoid process of the temporal bone) there were at least three cremated juveniles: an infant, a child aged 6–10 years and an adolescent aged 14–17 years. The MNI of inhumations in Viimsi I *tarand* cemetery was determined by fifth metatarsals ($n_{right} = 6$; $n_{left} = 10$) with no evident signs of fire. Seven of the bones belonged to adults and two to children, one was too damaged to be aged. The material contained at least six juvenile inhumations based on long bone measurements, dental development and bone fusion stages: a new-born, two children aged 0.5–5 and 4–12 years and two adolescents aged 11–18 and 16–20 years (Table 4.2.). The material also contained at least one new-born whose bones were not present among the metatarsals and teeth of at least three different juvenile individuals. Therefore, the MNI of inhumated individuals was 14. It must be kept in mind that the bones were dispersed, the burial practices are not fully known, and one body may have received differential burial treatment. Therefore, it could have been that the cremated petrous portions and inhumated 5th metatarsals belonged to the same individuals. Thus, the total MNI buried in Viimsi I *tarand* cemetery is 31, adding two inhumated immature individuals of distinct age to the group of cremated individuals (Table 4.2.).

The sex of the individuals was assessed by the robusticity of the cranial features which is rather vague and therefore the following must be taken as indications, not determinations (White & Folkens 2005, 386). Large muscle attachments on the nuchal crest of the occipital bone (robusticity 5, Buikstra & Ubelaker 1994) indicated five possible cremated male individuals and the same bone element of minimal robusticity (grade 1, Buikstra & Ubelaker 1994) hinted the presence of three probable cremated females (Table 4.2.). The sex of the inhumated individuals was assessed by the robusticity of mandibular fragments (grades 1–5, Buikstra & Ubelaker 1994). Also, as it was not possible to confidently assign several bones to one person, the sex assessment relies on one bone fragment per individual, and it remains suggestive that the cemetery contained individuals of both sexes.

Table 4.2. The individuals with age and/or sex determination in Viimsi I *tarand* cemetery. Based on Article III table 1, i.e. Kivirüüt 2014, 19, 22.

Bone context no	**Age (years)**	**Sex estimation**	**Basis for determination**	**Treatment**
72	4–9	unknown	dental development (age)	Cremated
161 (cluster IV)	6–10	unknown	dental development (age)	Cremated
72, 264	7–14	unknown	epiphyseal growth (age)	Cremated
30–32, 34, 35	14–17	unknown	dental development (age)	Cremated
167	8–18	unknown	epiphyseal growth (age)	Cremated
8	adult	female ?	nuchal crest robusticity 1 (sex)	Cremated
28	adult	female ?	nuchal crest robusticity 1 (sex)	Cremated
227	adult	female ?	nuchal crest robusticity 1 (sex)	Cremated
95	adult	male ?	nuchal crest robusticity 5 (sex)	Cremated
110	adult	male ?	nuchal crest robusticity 5 (sex)	Cremated
137	adult	male ?	nuchal crest robusticity 5 (sex)	Cremated
162 (cluster I)	adult	male ?	nuchal crest robusticity 5 (sex)	Cremated
203	adult	male ?	nuchal crest robusticity 5 (sex)	Cremated
111, 114, 199	0 (new-born)	unknown	long bone measurements (age)	Inhumed
118	0.5–5	unknown	fusion of cranial bones (age)	Inhumed
155, 239	1–3	unknown	fusion of cranial bones; long bone measurements (age)	Inhumed
207, 233, 236, 238	4–12	unknown	dental development; fusion of cranial bones; fusion of vertebra (age)	Inhumed
251, 172	11–18	unknown	immature metatarsals (age)	Inhumed
19, 160	16–20	unknown	immature phalanges; dental development (age)	Inhumed
81	adult	female	robusticity of the mandible 1 (sex)	Inhumed
237	adult	female	robusticity of the mandible 2 (sex)	Inhumed
222, 223, 225, 228	adult	male	robusticity of the mandible 5 (sex)	Inhumed
237	adult	male	robusticity of the mandible 5 (sex)	Inhumed
252	adult	male	robusticity of the mandible 4 (sex)	Inhumed

Pathological conditions noticed on the bones from Viimsi I were scarce (Kivirüüt 2014; Lillak 2025). The inhumated bones showed typical signs of possible stress, work-related trauma and degeneration: Schmorls' nodes and spondylosis and ankylosis of thoracic and cervical vertebrae (Ortner & Putschar 1985, 357–359; Waldron 2009, 45, 51, 58). The material also showed some cut marks that may reflect interpersonal violence, trauma or burial customs. These include scratches and a cut mark on a cremated cranial vault fragment of a temporal bone, a 4 mm diagonal cut mark on the posterior side of the mandibular ramus, a centimetre-long cut-mark on the posterior superior side of a cervical vertebra and a diagonal cut-mark on the posterior side of a right ramus (Fig. 4.3.; Article III). Cremation often destroys the weakened bone tissue with disease markers (Holck 2008, 130).

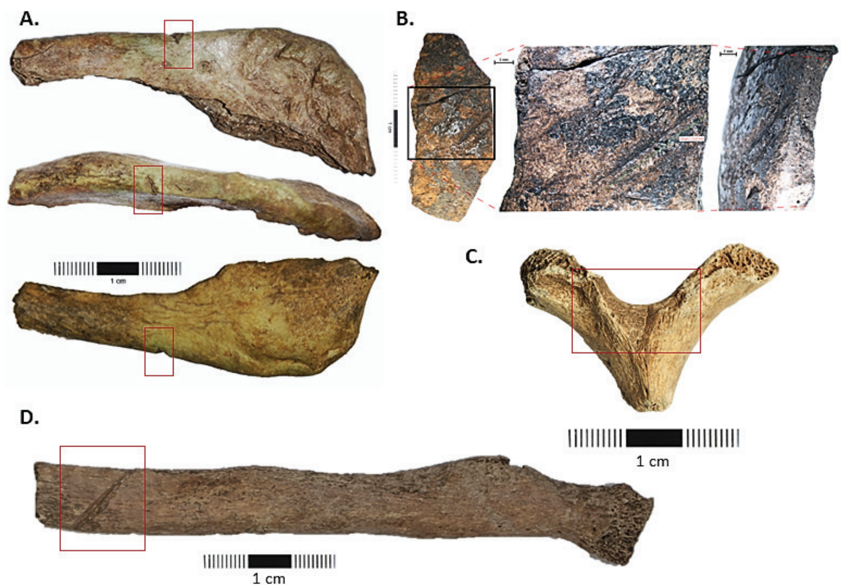


Fig. 4.3. Examples of cut-marks from Viimsi I *tarand* cemetery. A – inhumated mandible with a cut-mark on the posterior side of the ramus (context 238); B – cremated parietal bone fragment with cut-marks on outer surface (context 167); C – inhumated fragment of a cervical vertebra with a centimetre-long cut-mark on the posterior superior side (context uncertain due to further commingling in the storage); and D – a diagonal cut mark on the posterior side of a inhumated right radius (context 237). (Article III, Fig. 6.)

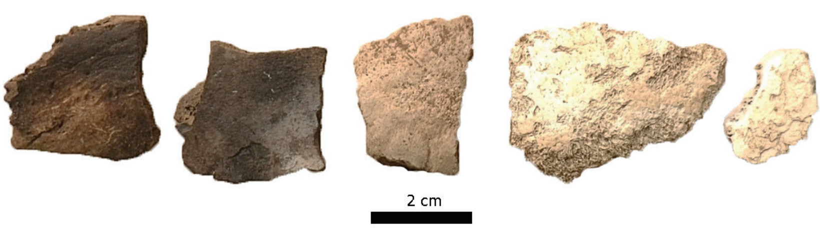


Fig. 4.4. A variation of cremated bone colours from Viimsi I *tarand* grave.

The cremation of the bone fragments varied (see Fig. 4.4.) – there were many bones with no visible signs of heat-related modifications, and these were recorded as parts of possible inhumation burials. Additionally, there were bones of many different hues and qualities: yellowish white, brown, black, greyish blue, white and chalklike white (Kivirüüt 2014). Some of the cranial bones had a glistening sooty appearance on the inside of the fragment possibly indicating that the bones were cremated fresh with organic material present (Holck 2008, 96). On many of the long bones there was warping, longitudinal splitting and checking of the bone material also possibly referring to the cremation of fresh bones (Buikstra and Ubelaker 1994, 96). On some long bones there were old transverse breaks some of which also showed a protruding prominence on one end of the break (see Fig. 4.5., Article III). This may indicate quick cooling of the bones (Binford 1972, through Stewart 1979, 61–62).

Fig. 4.5. Example of a bone with a protruding prominence from Viimsi I *tarand* grave.

To be able to analyse the spatial organisation of Viimsi I cemetery, the bone and find plans were digitised and analysed in 2014 and 2017 (Kivirüüt 2014; Article III). The locations of the bones and artefacts were recorded in a local grid system and on plans separate from the grave construction detailed plan. Additionally, there were 15 of the bone deposits (33, 63, 66, 88, 91, 142, 145, 148, 178, 199, 212, 220, 249, 256, 263) not marked on the map with no explanation found from the report. Five deposits (74, 78, 125, 129, 172) were marked on the plan twice, but not necessarily in the same area of the grave. For example, deposit 78 was on or in between the stones of the NW wall corner of the *tarand* A and at the same time ca 6 metres southwest in the mid-section of the cemetery next to one of the pits dug for an apple tree (Lang 1990a). As the site was partially bulldozed and the depth of the bones was not recorded, it is hard to determine which deposits were in their original location and which were from the bulldozed soil. Even though the report states merely seven bone deposits (230–236) coming from the disturbed heap in the northeast side of the cemetery, it is also mentioned that merely the bottom layers of the cemetery were found intact (Lang 1990a). Due to the disturbances and the discrepancy of the data, it is not suitable to conduct more advanced spatial analysis. Nevertheless, the plans together with descriptions in the excavation report (Lang 1990a) and the publication (Lang 1993) still allow to draw some conclusions on the usage of the cemetery area.

First, the concentration areas of cremated and inhumated bones were compared (Fig. 4.6.). The bone deposits with a marked spot on the cemetery map were assigned the weight of the bones from that context. The double-marked contexts except number 172 were removed from the analysis as there were no means to determine where the bones were exactly from. Deposit 172 had a cremated and inhumated bone deposit and the deposits were marked so on the excavation plan. The bones had also commingled in the storage boxes and in case of boxes where it was no longer possible to sort the bones, they were analysed as a single unit. The units remained on the map only in cases when all the mixed deposits were in the same cemetery structure or were less than a metre apart.

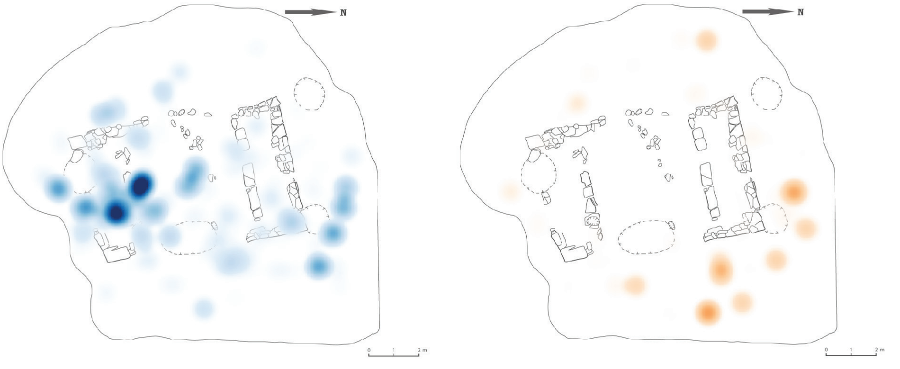


Fig. 4.6. Bone concentration areas in Viimsi I. Cremations are represented by blue and inhumations by orange colour.

The material needed some work with contextual information and digitising some of the data to be usable with modern approaches, but in Estonian background, the documentation of the material was exceptional for the era. Most of the bones with diagnostic features were accompanied with enough information for them to be placed in the larger context of the cemetery and to be included in the further analysis.

4.2. Aakre Kivivare

Aakre Kivivare *tarand* cemetery is in the south-western part of Otepää uplands, in Rõngu parish, Palamuste village near a hill fort dated to Pre-Roman Iron Age and the Pre-Viking and Viking Age (Fig. 4.7.; Valk et al. 2012). The hill fort forms a complex site with a Viking Age settlement site excavated in 1972 and 1973 (Aun 1992, 25). There are no known settlements concurrent with the burial site, but in 2015, a new undated settlement site was found 300 metres north-west towards the River Purtsi that could have been the site where the people using the *tarand*s lived (Olli 2015).

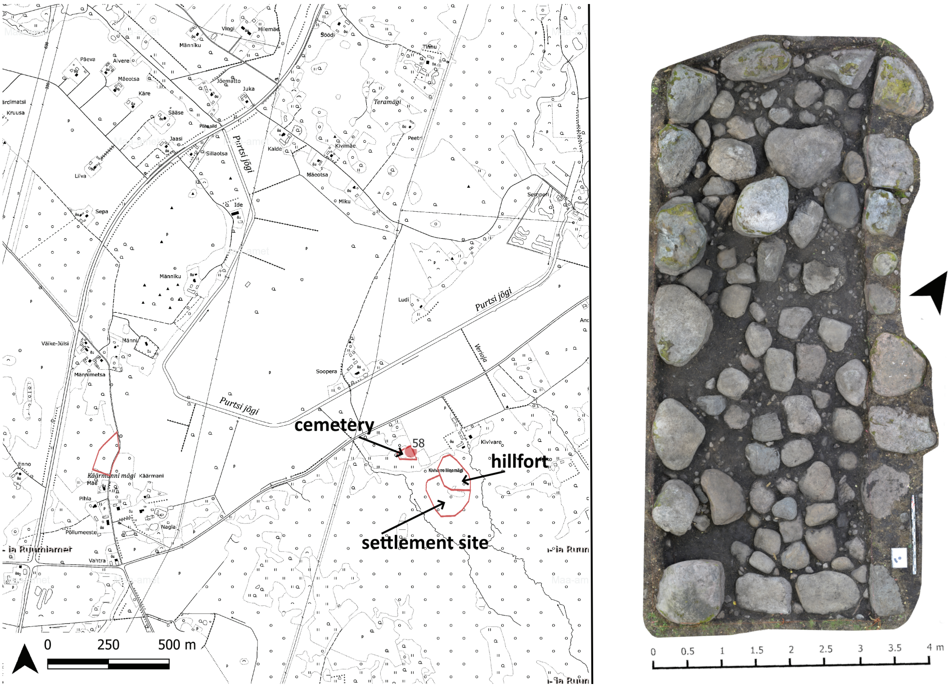


Fig. 4.7. Aakre Kivivare cemetery, its surroundings, and the recently excavated *tarand* B.

Aakre Kivivare *tarand* cemetery was partially excavated at the end of the 19th century by a student Johann Sitzka (1897) from the University of Tartu. His findings have been shortly described (Sitzka 1897) and explain that as during his stay the site was already being robbed, he excavated most of the eastern end of the site as he thought the west end was already too disturbed (Fig. 4.8.). Sitzka did not collect human bones and even if he documented the find locations, no find plans have been preserved. He did put some effort into osteology – he excavated the site with medical student Hans Leesment and showed animal bones to Professor Alexander Rosenberg for determination (Sitzka 1897). Some items and a few human bones are kept in the Archaeological Research Collections of Tallinn University (AI 2011), but considering the size of the excavated area, most of the finds did not reach the depot. According to this early analysis the cemetery contained inhumated bones, mainly of horse, cattle, sheep, hare and mice (determined on site by prof. Rosenberg), but also a lot of cremated bone material and human teeth (Sitzka 1897).

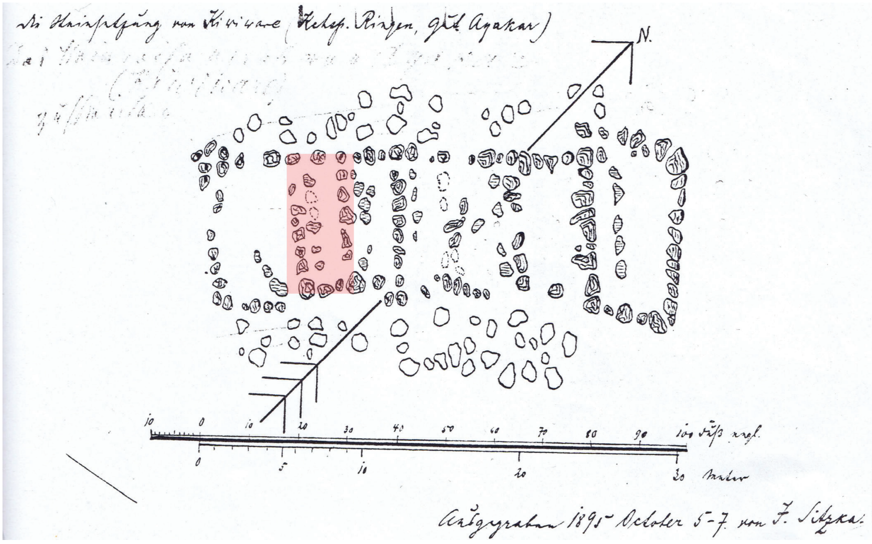


Fig. 4.8. Aakre Kivivare cemetery by J. Sitzka, the recently excavated *tarand* B is indicated with pink colour by M. Lillak. Fig. 2 from Article I.

Aakre Kivivare *tarand* cemetery was partially excavated in 2014–2015 (Article I). The goal of the excavations was to gain more information on the site, the buried individuals, the items and their relationships inside the cemetery (Olli & Kivirüüt 2015). On site it was evident that the eastern side of the cemetery was disturbed, a few bone fragments were visible on topsoil and several boulders from the grave constructions were heaped close to that side of the cemetery. This disturbance on the eastern side was most probably induced by the excavations of J. Sitzka. The western *tarand*s were well visible on the landscape and seemed intact with no visible archaeological finds on the topsoil (the turf layer did contain a few archaeological finds and bones as was found out later). Therefore, the excavations took place in *tarand* B as this was the section with the least visible disturbances, of reasonable size, good accessibility and served best the researchers' main objectives (Olli & Kivirüüt 2015; Article I). There were only a few human bone fragments in the finds' depot of Tallinn University Archaeological Research Collections from the 19th century excavations, (AI 2011). The material collected in 2014 and 2015 was indexed, analysed and packaged and is stored in University of Tartu collections (TÜ 2140).

In the 2014–15 campaign, the site was excavated based on stratigraphic units – each layer of the inner filling stones was documented, removed and the soil in between the layers was carefully excavated. All positions of the finds were recorded with GPS coordinates or if the item or bone was found on the sieve, the corresponding ca 1×1 m square and layer were noted. Each layer and context was recorded with a set of photos merged together into 3D models that were later used as bases for the distribution plans of the artefacts and bones. All the soil was dry sieved on site with a 1×1 cm mesh. The objects found on the sieve were later randomly dispersed (in each square, the program randomly placed a number points corresponding to the number of sieve finds) in the area of each corresponding square to ensure all the material could be visualised on the distribution plans. (Fig. 4.9.; Olli & Kivirüüt 2015; Article I)

The bones were morphologically analysed one by one and recorded in an MS Excel table (Lillak 2025). The data table is organised by context and anatomical elements. Rows are subdivided in cases where a single context contains bones from multiple body parts, diagnostic fragments, or several unidentified bone fragments. Therefore, several bone fragments can be recorded within the same data row and the table contains both human and animal bones. Each context is stored in a single bag, with diagnostic elements typically packaged separately within the same bag for easier identification and analysis.

Altogether there were 2434 bone fragments weighing slightly more than 2 kilograms, human bones have all been analysed, whereas most identified animal bones are still waiting for a complete analysis. In general, the number of animal bones was smaller than the number of human bones. Among the animals, there were bones from horse, hare, cow, pig and small rodents (information from zooarchaeologists Eve Rannamäe and Mairi MacLean), but the list of faunal remains and taxa is not complete (Olli & Kivirüüt 2015). The quantity of the human bones is also rather small as an average adult individual weighs *ca.* 2–2.5 kg after the cremation process (Gejvall 1981, 16; White & Folkens 2005, 33). Even though experiments show that what remains after cremation varies in age, sex and even region (Bass & Jantz 2004), the exceptionally small weight of the bones suggests that not many individuals or not all the bones may have been buried in the *tarand*. Given that the primary layers containing bone material were located approximately 15 cm beneath the topsoil, significant loss of material due to truncation seems unlikely. However, the use of a relatively coarse mesh may have resulted in the loss of smaller bone fragments during sieving. The extent of this potential loss could be assessed by re-sieving a sample of the excavated soil.

The minimum number of individuals (MNI) was assessed by the number of recurrent bone fragments combined with age assessment. As the number of inhumated bone fragments was low, lacked diagnostic features, and I had knowledge from Viimsi I analysis that the bones of one individual may have received differential handling, the treatment of the bones was disregarded in the evaluation of MNI. The handling of the bones may have also been one of the reasons behind the low weight of the bones as it is possible the remains of one individual were dispersed in different *tarand*s and the MNI would not rise significantly when excavating more of the site.

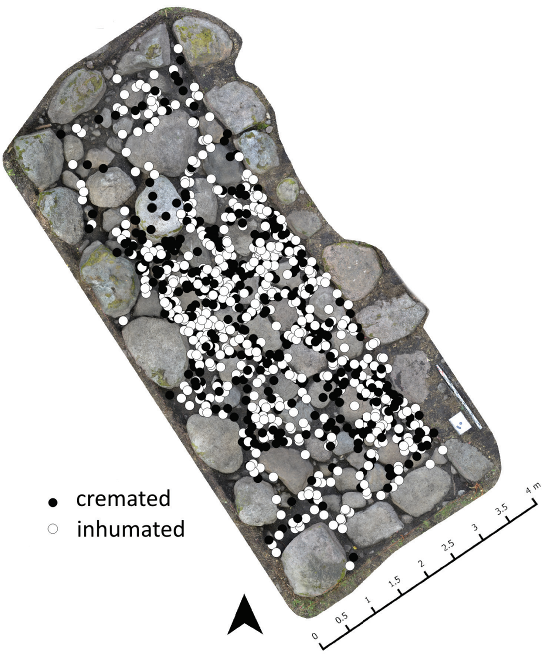


Fig. 4.9. Bones (including the possibly unidentified faunal remains) found from Aakre Kivivare cemetery.

Based on the count and assessment of right petrous portions (n_{right} = 9; n_{left} = 6), there were nine adult individuals and one juvenile individual. Recurrent teeth and several tiny bones indicated the presence of at least three children aged 1–5 years and a foetus aged 16–24 weeks. This means that there were the remains of at least fourteen (n=14) different individuals buried in *tarand* B of Aakre Kivivare cemetery. (Table 4.3.; Olli & Kivirüüt 2015; Article I)

Table. 4.3. Age composition of individuals buried in Aakre Kivivare *tarand* B. (Fig. 2. from Article I)

Prenatal	Children	Juvenile	Adult
1 individual; aged 16–24 weeks gestation	3 individuals; aged 1–5 years	1 individual; subadult	9 individuals; 20 + years, exact age unknown

The cremation of the bones from Aakre Kivivare was rather uniform compared to Viimsi I (see Fig. 4.10.). A sample of bones from Aakre Kivivare *tarand* cemetery were analysed with Video Spectral Comparator (VSC) and Fourier Transform Infrared Spectroscopy (FTIR) to assess the bone colour and cremation-related changes in the bone composition (Article IV). The data of the analyses has been published, but the in-depth analysis and comparison of the results needs to be carried out in the future.

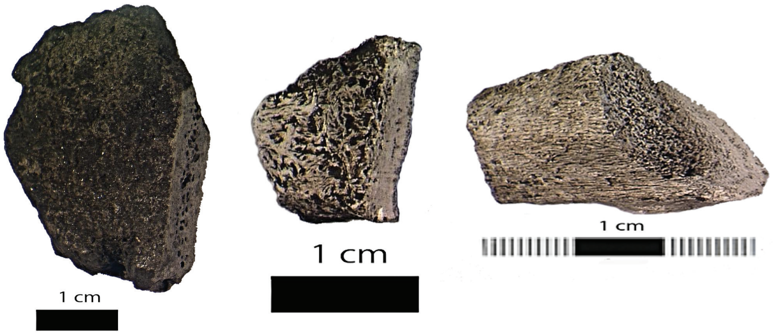


Fig. 4.10. An example of typical cremated bones from Aakre Kivivare cemetery.

Based on excavations of other *tarand* cemeteries, we expected to find small bone assemblages as in Viimsi, Kõnnu or Loosi (Lang 1993, 10, 17; Laul 2001, 81, 84). However, there were no identifiable bone clusters noted during or after the excavations (Article I). The absence of noticeable bone clusters could be the case for only the excavated *tarand* B but could also characterise the whole cemetery as bone clusters were not noted by Sitzka (1897) either.

The site was dated with ^{14}C and several of the dates were surprising (Table 4.4.). The two charcoal samples showed that there had been burning activities on the site before the building of the cemetery *ca*. 6th–2nd centuries BCE. Charcoal from between the II and III stone layers showed activity *ca.* 17th–19th centuries CE indicating that the few top layers were at least partially disturbed. A bovine tibia from below the cemetery also originated from the Pre-Roman Iron Age, *ca*. 3rd–1st centuries BCE. The only dated human bone (inhumated) from bottom layers of the cemetery was probably from 2nd–1st centuries BCE and based on the nitrogen and carbon isotope values the person followed a typical C3 plant eating local diet (Aguraiuja-Lätti et al. 2022). The carbon and nitrogen isotope values of the Aakre Kivivare individual are similar to the ones acquired from the humans buried into Kunda and Ilmandu *tarand* cemeteries (Laneman & Lang 2013; Oras et al. 2016).

Pre-Roman Iron Age and more recent marks of habitation were expected as the nearby hillfort was used during Pre-Roman Iron Age and Viking Age (Valk et al. 2012). It was surprising that in 2014, some fragments of worked flint and quartz were unearthed in the top layers of the cemetery (Article I) in addition to the two pieces of flint, one of which was worked, that Sitzka (1897) found. It is stratigraphically impossible for a Stone Age occupation layer to be on top of the Iron Age cemetery, but it is possible that there was something on the site or nearby already in the Stone Age (Article I) or these finds may reflect some ritual activities that took place during the building and use of the cemetery as similar quartz and flint lumps or flakes have been found from other *tarand* graves, e.g. from Uusküla II, Võhma Tandemägi (Lang 2000, 159–160).

Table. 4.4. Radiocarbon dates from Aakre Kivivare *tarand* cemetery. Based on Article I, Table 3.

Sample number	Radio-carbon date (BP)	$\delta^{13}C$	$\delta^{15}N$	C:N	Calibration ranges (Reimer et al. 2013)	Sample type and its context
Tln 3593	2306±60 BP	–	–	–	BCE 550–200 (94.8%) BCE 725–720 (0.2%) BCE 705–695 (0.4%)	Charcoal, squares F and L, on top of virgin soil.
Tln 3594	155±55 BP	–	–	–	1660–1895 CE (78.8%) 1905–1950 CE (16.6%)	Charcoal, square G, between stone layers II and III.
UBA-27959	2140±26 BP	–21.9	6.0	3.27	BCE 350–300 (18.2%) BCE 230–220 (0.48%) BCE 210–90 (79.55%) BCE 75–60 (1.72%)	Bovine tibia, on top of virgin soil; under a boulder.
UBA-27961	2051±27 BP	–21.3	11.3	3.30	BCE 165–130 (11.6%) BCE 120–10 CE (87.5%) 10–15 CE (0.9%)	Fragment of adult lumbar vertebra, inhumated, between stone layers III and IV.

Aakre Kivivare *tarand* cemetery is merely partially excavated, hence the data is not complete and considering the methodology of the 19th century, we have properly documented info only from *tarand* B. Compared with the newly excavated *tarand,* the amount of finds unearthed in 1895 was scarce and the leftover soil probably contains many more finds that were not noted or collected in the 19th century (AI 2011, Olli & Kivirüüt 2015). It is hard to determine without additional fieldwork how much of the northeastern part of the site was excavated during the first campaign in 1895. The amount of information gathered during the new excavations was notably higher, but there remains the question how representative of the whole cemetery is the material from one *tarand*. The site has potential to unearth more information on the building order of the *tarand*s and on the absolute dating, the possible usage period of the structures as well as on the buried individuals. This is also a place where the methods of 19th century and today can be compared as Aakre Kivivare is one of the few sites that was only partially excavated, and we have the possibility to assess the informativeness of the early and modern excavations. This helps us understand how to address other similar sites that have been excavated in the late 19th or early 20th centuries and what kind of additional information can be acquired when applying modern methodology.

5. DEVELOPMENT OF METHODOLOGICAL RECOMMENDATIONS

This chapter describes different methods used in recording and analysing FCC human remains and pointing out the potential and limitations of those approaches. Drawing on my practical experience with FCC osteological assemblages, combined with insights from current archaeological and bioarchaeological literature I have developed a set of methodological recommendations for the excavation and analysis of FCC human remains within the Estonian archaeological context. These methodological recommendations aim to address the specific challenges posed by local preservation conditions, recovery methods, and analytical limitations, while aligning with broader methodological standards in cremation studies. The analysis of FCC osseous material does not allow us to recreate whole events or patterns of thought of the Early Iron Age individuals, but the pieces of information the analyses proposed here will allow archaeologists to get closer to the reality by testing their theories or synthesising new approaches.

Here, the analysis of FCC human remains is divided into three sections based on the methods used and their application sequence:

- Osteological methods – “Puzzle-methodology”;
- Spatial analysis;
- Specific laboratory analysis.

It is clear that the selection of methods applicable to FCC remains is much wider. The methods presented here were chosen based on their relevance of analysing archaeological material and the emphasis is on the methods that give the maximum of information with minimal cost and labour and including minimal further damage to the fragments themselves. Based on the latter, the proposition for best practices for archaeological surveys on sites with FCC human remains (Chapter 6.6) was designed to set local standards. Hence, the majority of the suggested methods are proposed as the absolute minimum with a few of more advanced methods that are well accessible, provide a lot of information on the bone material and how it has been treated, and may sometimes be applicable already during the compilation of the initial excavation report (Table 5.1.).

Considering the decade that has taken to materialise this thesis and all the new methods that have emerged/become available since, it is certain that there will soon be even more ways to sample and analyse FCC human remains. The array of new methods that can be used vary from analysing a section of calcined petrous portion of the temporal bone for strontium isotope ratios used in provenance studies (Veselka et al. 2021) to determining body position on the pyre by assessing the temperature reaching different anatomical areas of the corpse (Paba et al. 2021) or reconstructing some dietary patterns (incl. salt consumption) through combined strontium isotope analysis (Knudson et al. 2010; Dalle et al. 2022). However, as these are more specialised approaches needing further expertise knowledge, I will focus on methods basically available to all (osteo)archaeologists and excavators.

Table 5.1. An overview of the mentioned methods in Chapter 5, how these methods affect the bone and potential outcome of the methods.

Method	**Amount of bones needed**	**How is it affecting the bone**	**Outcome**
Osteology	All the bones	Minimal damage due to handling of the bones	Ostelogical analysis: minimum number of individuals; age and sex determination and list of pathologies, where possible; list of the bones; postmortem treatment of the bones; colourimetric assessment of the bones and their degree of burning.
Demo-graphy	All the bones	Based on osteological analysis, usually no extra damage	Age and sex of some of the determined individuals. NB! Composition and size of the community who used the cemetery is very unlikely to be determined!
Spatial analysis	All the bones	Based on osteological analysis, usually no extra damage	Allows us to see and illustrate the relationships of the bones, artefacts and grave constructions.
Statistics	All the bones	Based on osteological and spatial analysis, usually no extra damage	Understanding whether the trends and/or connections are statistically significant and interpretable as deliberate actions.
Radio-carbon dating	Carefully selected few bones; 1.5–3 g [1]of cremated bone	Selection is based on osteological analysis, requires damage to the analysed bone element, the bone may be destroyed during the process	Absolute dating of the bone.
FTIR	Carefully selected few bones; a few mg of bone powder	Selection is based on osteological analysis, requires scraping off some bone powder, but the bone remains intact	Understanding changes in bone structure and chemical composition and based on that determining the temperature of the pyre.
Isotope analyses	Carefully selected few bones; at least 10–200 mg of bone	Selection is based on osteological analysis, requires damage to the analysed bone element, the bone may be destroyed during the process	May indicate the source of the food, migration. Also gives hints on the pyre technology.

[1] ^{14}CHRONO laboratory website

5.1. Osteological methods

5.1.1. Documentation in the field

Documentation to support osteological analysis in the laboratory starts already in the field. The archaeologist planning to excavate or stumbling upon FCC remains should consult an osteo(archaeo)logist (Keating 2024, 9). The osteologist should be present when excavating FCC remains to ensure efficient and adequate documentation as this information is important in the later interpretation of the burial (McKinley 2023; Keating 2024, 17). It is advised that uncontained (not placed into a container) cremation burials should be excavated in layers no thicker than 5 cm, whereas each layer must be recorded and bagged separately (Keating 2024, 17), in cases where excavation in the field may compromise the remains, it is advised to remove the burial in block (McKinley 2023). Urned burials should be removed within the vessel and carefully excavated in the laboratory with the help of ceramics specialists; prior CT-scans may be performed on the urns, if needed (McKinley 2023; Keating 2024, 17). All the finds from bones, artefacts to ecofacts must be: 1) documented with GPS coordinates; 2) associated with their context of origin; 3) photographed with and without a scale; 4) packaged with enough information allowing to reassociate the packaged material with the context (McKinley 2023; Keating 2024, 17).

The analysis of FCC bone material in the laboratory starts with basic bone analysis. This is what I call the "puzzle methodology" as usually there are only small fragments available and, if lucky, the bones can be joined as pieces of a puzzle, but most of the fragments remain unmatched. The bone fragments are determined, where possible, a list (e.g. Lillak 2025) of the found bones with their contextual information and any special characteristics of the fragments, including weight, fragmentation, colour, markings or age/sex assessment ought to be recorded (McKinley 1994; Thompson 2015; McKinley 2023). Basic osteological analysis is essential as it is not possible to use the more specific methods (Chapter 5.3.) without knowing which feature or individual is being sampled and analysed.

Basic morphological (Fig. 5.1.) osteological assessment of the FCC bone material can be based on the standard guidelines by McKinley and Roberts (1993), Buikstra and Ubelaker (1994), Brickley and McKinley (2004), Holck (2008), Schmidt & Symes (2008), Schaefer and colleagues (2009), Ubelaker (2009) and Mitchell and Brickley (2023) and may be conducted in basic conditions with minimal specialist equipment. The methods have to be used with caution as the fire has fragmented and altered the bone making many morphological and metric methods unusable and some of the diagnostic features may have not survived (Thompson 2023, 137–140). The limitations of the material are evident, but we should not forget that even though there may not be as much information left in FCC bone material as it is in complete skeletons, data on the age, sex, number of individuals and some pathological traits can still be gathered (Rodriguez et al. 2020; Thompson 2023, 142). In the following chapter I will concentrate on the

1) MNI, 2) sex, 3) age, 4) health of the buried individuals based on FCC remains to highlight the possibilities of these methodologies and their limits in the context of my material.

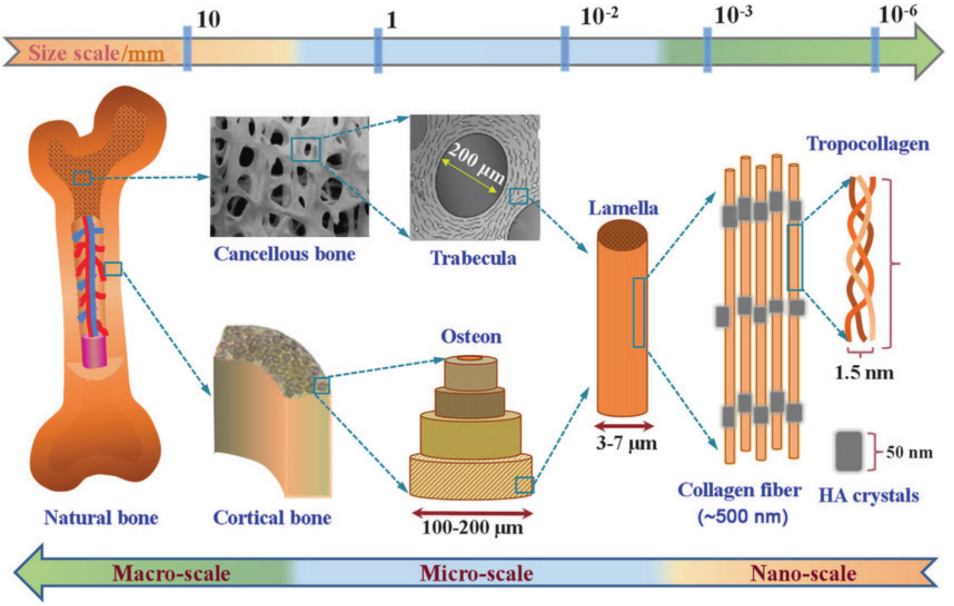


Fig. 5.1. The chemical composition and multi-scale structure of natural bone (Fig. 1. from Gao et al. 2017).

The analysis of FCC bones will never provide 100% precise results. The visual assessment of any skeletal remains is biased, this is something that must be acknowledged (Nakhaeizadeh et al. 2014; Bailey 2018, 114; Henson et al. 2020). Also, not all the age and sex determination methods that have been developed for inhumation burials can be used for FCC bones as not all of the bone elements are present any more for the correct use of these methods (Acsadi & Nemeckeri 1970; Gowland 2007; Naji et al. 2014, 42–43). In the case of compromised human remains overconfident determinations (e.g., stating the sex of the individual when the traits are not absolute) should also be avoided as this could lead to false positive identifications and misguide the next interpreter of the remains (Naji et al. 2014, 42–43).

Even if there are many diagnostic features identified, the number of individuals in sites with commingled material may remain ambiguous. In most cases, the MNI can be stated based on the recurrent bone fragments (Nikita 2017, 92). Nevertheless, for more accurate determination of buried individuals, morphological analysis of FCC remains works the best when combined with other specialist techniques (e.g., Van Vark et al. 1996; Salesse et al. 2021; Sabaux et al. 2024). This means that morphological analysis is informative, but there is much more information that can be gathered.

In cases where it is not certain whether the remains are human or faunal, it is possible to look at the histology. The presence of plexiform bone is widely recognised as a strong indicator of non-human origin, particularly in large mammals (Urbanová & Novotný 2005; Nor et al. 2015). However, its absence alone is not sufficient to confirm human origin, and it must be noted that plexiform structures may also appear in juvenile human bone or in cases of pathological bone remodelling (Lagacé et al. 2020). Therefore, while the identification of plexiform bone can rather effectively exclude human origin, a more comprehensive histological assessment is necessary to confirm human status.

The bone matter that has undergone heat induced alteration exhibits some changes, but the bone structure under the microscope can still be distinguishable (Mayne Correia et al. 2023, 264–267). Nevertheless, there are no good predictions how the bone will behave under specific conditions for quantitative assessment, i.e. osteons have shown both shrinkage and expansion under experimental conditions (Thompson 2005; Mayne Correia et al. 2023, 266).

5.1.2. Demography estimations

Despite all the uncertainties, osteological analysis always helps to set the focus on the people who have been buried into the cemeteries. This avoids cases where conclusions on the societies burying their dead in a way that leaves us with FCC remains, are solely based on the composition of grave goods and parallels with inhumation burials from the same time periods (Lang & Ligi 1991, 224). In the 1990s there was no-one in Estonia to study cremated bones, thus other material was used to determine the number of individuals in the grave; it was argued that the quantity of specific grave goods corresponded to the number of the individuals buried in the *tarand*s (*ibid.*, 221). Even though one may discuss whether the estimates based only on grave goods proposed by Lang and Ligi (1991, 224) are just as good as calculations based on osteological material, I dare to say they are not entirely compatible, but in the context of the era it was the best estimate that could have been reached. It is true that even for large non-commingled cemeteries, demographic analysis may be inconclusive and biased (Wood et al. 1992; Chamberlain 2006, 4, 179; White & Folkens 2008, 415).

However, the demographic reconstructions are not straightforward with osteological material either. Here we must consider the Osteological Paradox – we are analysing the dead to study the living populations of previous historical periods, and this has created several problems that Wood and colleagues (1992) pointed out. There are three core questions that the osteological paradox addresses: 1) hidden heterogeneity in frailty meaning that people have unequal susceptibility of different diseases; 2) selective mortality indicating that the representativeness of the dead is biased when studying living populations; 3) demographic nonstationarity stressing that the people were migrating and the population in question may have experienced temporal changes in mortality or fertility (Wood et al. 1992).

In archaeological demography it is known that the sample never represents the whole population, even for inhumation cemeteries with rather complete skeletons, and there always is an uncertainty in age and sex determination, but osteological analysis in population estimation is more accurate than attributing a certain number of items to members of the buried community (Wood et al. 1992; Chamberlain 2006, 4, 179; White & Folkens 2008, 415). FCC bone material is by its definition very fragmentary and the primary skeletal indicators used to determine age and biological sex, such as the pelvis, skull, and teeth, may be missing or too damaged to analyze reliably (Thompson 2023, 137–140). Additionally, cremation often reduces the amount of bone material available, making assessments based on bone size and strength more difficult. Therefore, FCC material should not be used in demographic estimations, but in cases where we have the analysed bone material, we can learn a bit about the people buried into the cemetery (e.g., their age, sex, MNI, some of the pathologies).

5.1.3. Cremation practices

The colour of the bones is recorded to assess the cremation temperature and efficiency (van Vark 1970; Shipman et al. 1984). Usually, the colour of the bone is assessed by visual methods and only for cremated bones (Shipman et al. 1984; Walker et al. 2008; Wahl 2008; Holck 2008). Inhumated bones are classified as inhumated or unburned (stage 0), but it must be kept in mind that the visual aspect of unburned and very lightly burned bones can be the same (Holck 2008, 92–100; Walker et al. 2008, 136). For references, cremation colour charts by Walker and colleagues (2008, 136–137) and the colour descriptions by Holck (2008, 92–100) and Wahl (2008, 149–150) are often used. Colour of the bones can be described either as yellow, brown, black/sooted, grey, blue grey, chalky white (in cases where the bone surface was soft), old white, white or calcined (Holck 2008, 99; Wahl 2008). Based on the applied methods, cremation temperatures and grades can be used to assign a cremation stage to each bone element, taking into account its colour and physical characteristics (Fig. 5.2.; Holck 2008, 90; Wahl 2008, 149–150; Walker et al. 2008, 136–137). In cases where the number of individual bone fragments is very high, focusing on every piece separately may be impractical. Therefore, a general or several cremation stages may be assigned for contexts with numerous fragments.

The various ranges of greys and whites of the cremated bones may be confusing to the human eye. To have a more objective assessment of the bone colour, the aid of Munsell colour charts can be used, but that is also prone to observer bias (Munsell Color 2010; Shipman et al. 1984; Ellingham et al. 2015). As the human eye is subjective, in cases where very accurate colour spectra are needed, they can be measured with Video Spectral Comparator (VSC), which is a machine that uses different light sources to examine the colour of the target area. The instrument is often used in forensic science to assess the validity of documents. VSC provides a spectrum that can be transferred to colour codes and allows researchers to assess the colour objectively. It is a non-invasive method where the subject only needs to be cleared of any debris for the colour to be correctly assessed (Ellingham et al. 2015b). It must be noted that the VSC analyses a small portion of the material and is very sensitive, but bones are rather colourful meaning that each “dot” on the bone may have a different colour spectrum. This method may aid in colourimetric assessment of heat-induced changes as it helps differentiate very similar colours, e.g., different hues of white. Comparable data is needed, though, to see any clustering in the colour spectra and bones of similar treatment. Therefore, VSC should be considered when there are not many fragments to be analysed, and the accuracy of colour determination is very important.

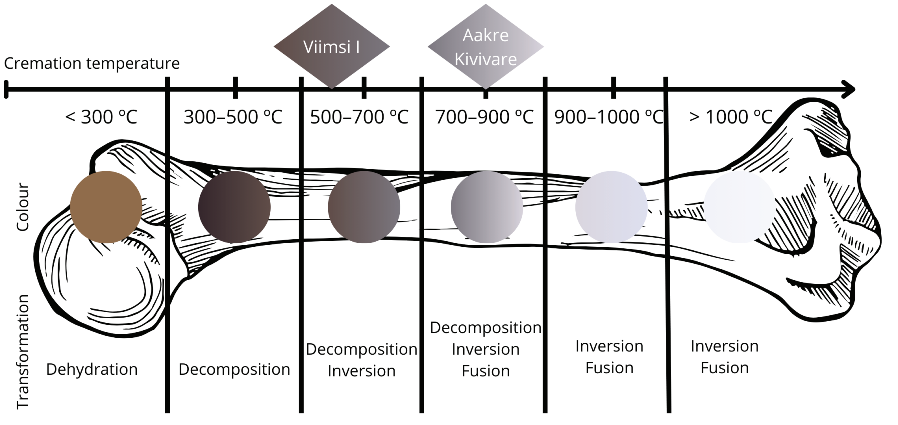


Fig. 5.2 The changes occurring in bones during cremation with the most common cremation in Viimsi I and Aakre Kivivare pointed out. Combination from Walker et al. 2008, 136; Mamede et al. 2017; Monetti 2022, Fig. 20.

In my analysis of FCC bones, I employed colourimetric assessment to support interpretations of cremation temperature and efficiency. For Aakre Kivivare, visual colourimetric observations were complemented by FTIR (see Chapters 5.3.2, 6.4.1, and Article IV) and VSC analyses (see Chapter 6.4.1 and Article IV). As no significant discrepancies emerged between the methods, their correspondence was not explored further in this study.

Nevertheless, it is also important to consider that the colour of cremated bone is influenced not only by the temperature of the fire but also by its position on the pyre and the surrounding cremation environment (Symes et al. 2008, 32–33; Walker et al. 2008). Post-cremation factors, such as the burial context (its chemical composition, pH levels, leaching etc), can further alter bone colour, for example, manganese staining may be mistaken for heat-induced discolouration (Devlin & Herrmann 2008; Thompson & Nannetti 2025). Additionally, fragmentation and commingling of remains introduce further limitations, as it becomes nearly impossible to reassemble individual bodies. Consequently, the colourimetric interpretation of FCC remains reflects a complex sequence of funerary practices rather than a singular cremation event. Visual estimation is generally sufficient for assessing individual cremations. However, instrument-based methods that rely on data clustering may be more appropriate for large-scale analyses. In such contexts, the application of colourimetric analysis tends to be less nuanced than in single burials, due to the complications introduced by bone fragmentation and commingling.

5.2. Statistics and spatial analysis

Since the processual archaeology quantitative methods have been utilised in archaeology to detect the similarities, differences, and outliers in the material records to draw reliable conclusions from the samples we have (Thomas 1978). How to choose suitable methods and test for any kind of archaeological data, can be learned from many publications, some of which are dedicated solely on archaeological material, e.g., Baxter (2010) or Shennan (1997). The main indicator of significance in statistical analyses is the significance level or p-value representing the probability of the occurrence of a given phenomenon (Shennan 1997, 53). If the probability of the occurrence of the given event is very low (usually less than 0.05), but the phenomenon still occurs, it may reflect intentionality (*ibid.*). Statistical analyses help us to remain more objective and determine whether the trends and discrepancies we see in the material are statistically significant or whether it merely seems significant to our subjective eyes. For example, in *tarand* cemetery context, if cremated fibulae seem to co-occur with cremated bone fragments, the probability of such occurrence can be tested. It may turn out that the probability of co-occurrence of the cremated fibula with cremated bones is very low and when they do co-occur, it cannot be explained by regular variation, it is statistically significant and may reflect deliberate actions by the mourners. Cremated fibulae may also co-occur with any other finds' class meaning the co-occurrence of cremated fibulae and bones can be explained by regular variability and is not statistically significant. This suggests that the cremated fibulae and bones were probably not intentionally placed together. The importance of the p-value has been put to test several times as statistical significance does not correspond with absolute truth, but if there are no better instruments to assess the probability of the events, this has remained in use (Lane-Getaz 2017, Ioannidis 2019). Statistics is also important to complement any spatial analysis, to see whether the distribution can be seen as a random dispersion or the probability of such dispersion to occur is lower than the set p-value.

In cases where the on-site documentation is sufficient, morphological bone assessment may be followed by a spatial analysis whereas the more information and the more precisely recorded, the more methods of spatial analysis can be used. First, GIS-based recording of fragmented and commingled bone elements and their distribution may help in the de-commingling process of the remains (Herrmann et al. 2014, 228). The method by Herrmann and colleagues (2014) uses the principles of GIS on bones to create a coordinated osteological information system of bone fragments and their location in the skeleton to understand which of the fragments have overlapping elements. Second, mapping and visualisation of the bone elements allows archaeologists to detect and recognise patterns, leading to interpretations of the funeral rituals (Naji et al. 2014, 45). Third, spatial analysis and statistics may aid demographical and bioarchaeological reconstructions. Cemetery areas can be explored with GIS to visualise the data, understand the trends and intra-site spatial relationships, and statistics helps to point out significant spatial patterns for different features, e.g., age and sex of the individuals, artefacts associated with the individuals, burial type etc. (Šmejda 2004; Elsalam 2011). Fourth, the relationships revealed through spatial analysis and statistical methods can enhance our understanding of social structures and burial customs, offering deeper insights into the lives of the individuals being studied. However, it is important to acknowledge that due to the limitations of the archaeological material, demographic interpretations remain estimative, even when supported by spatial or statistical approaches. Co-existence or absence of body parts may be significant and shed light on the secondary burial rites, e.g., removal of some bones or bone elements or carefully sorting the bones prior burial. This has been the case in Tõugu where child bones had been put under *tarand* corners as well as showed grouping in some areas (Kalman 2000b).

The methods of spatial analysis and statistics can be used for micro-excavations as well. Documenting blocks in laboratory conditions layer by layer creates spatial information on the presence of different body parts as well as the order in which they were placed inside the block sample, e.g., pit or urn. For example, Jaskulska (2019) has determined that the placement of lower limb bones to the bottom and cranial fragments on top of the urns was statistically significant. Also, in Cottbus urnfield in Germany, it has been recorded that the urns have contained one cremated individual, and the bones were put into the burial urn even in anatomical order – the feet first and head last (Gramsch 2013, 468). Locally, a few burial pits have been discovered, but the on-site documentation lacks data disabling the definite determination of any kind of anatomical systematisation of the deposit. E.g., the most recent discovery in Keblaste, or the cremation burials 190 and 191 in Siksälä from 14th century CE that were presumably anatomically reassembled in coffin (Valk et al. 2014, 148; Mandel & Allmäe 2022). Even though the general degree of documentation is good, the burials have not been documented with the help of an osteologist on site and the recording of the bone material does not allow us to revisit the excavation situation.

In my studies I have used spatial analysis for mapping and contextualising the bones and cemeteries and statistical testing to learn whether there were any statistically significant patterns in the distribution of bones, their elements, and finds (Articles I, II and III). It must be said that there were many limitations for both sites. The analysis for Aakre Kivivare *tarand* cemetery was conducted merely on one section of the burial place and therefore the results cannot characterise the whole cemetery. Viimsi I was severely damaged prior to the excavations and due to the lack of the depth info of the bone material and contradicting information on the volume of compromised bone contexts from the report and the archaeologist, the interpretations can remain merely general.

Spatial analysis methods can be more elaborate than spatial distribution and contextual analysis. In archaeological contexts involving FCC human remains, statistical spatial analysis offers a robust framework for interpreting complex depositional environments. Nearest neighbor analysis can be used to detect clustering of bone fragments, which may indicate individual groupings, distinguish intentional placement from random scatter, especially in cremation contexts where bones are highly fragmented (Herrmann et al. 2014). Tuller and colleagues (2008) coded articular points of a Serbian mass grave and were able to rearticulate a portion of the bones and map the position of the bodies based on the idea that the closest "missing match" is the correct match.

It is important to integrate spatial data with osteological and contextual information to improve identification of individuals or deposits and interpretation. Statistical approaches integrated with GIS modelling and osteological analysis enable archaeologists to reconstruct cremation practices, identify individual remains within commingled assemblages, and interpret mortuary behaviour with greater precision.

5.3. Specific laboratory analysis

Laboratory methods can assist when the human eye is insufficient, providing more definitive results when needed. Natural scientific methods are consuming time and other resources (Rosa et al. 2023) and often are followed by statistical and spatial analysis to make sense of the data. Selecting the right and most telling bone materials based on osteological and spatial analyses is essential for the success of these more advanced analytical approaches. There are more specialist analyses that can be conducted on FCC bones than described in detail in this thesis, e.g., scanning electron microscope energy dispersive x-ray spectroscopy (SEM-EDX) (Ellingham et al. 2018), thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) (Ellingham et al. 2015a), Raman spectroscopy (Khan et al. 2013) or even DNA (Zapico & Stone-Gordon 2023) for bones heated in low temperatures or short period (Ellingham & Zapico 2023, 196, 200–205). This thesis focuses on the easiest and more available methods that can be useful already for the initial study when compiling an excavation report.

5.3.1. Dating

In archaeology, dating is divided into relative and absolute dating (Renfrew & Bahn 2008, 121). Many methods for absolute dating are rather new and require specialist equipment (Renfrew & Bahn 2008, 133). Most prehistoric cemeteries in Estonia have been dated based on their 1) construction (Laul 2001, 27) or 2) the artefacts found from there, e.g., Jaagupi (Laul 2001, 48), and Nurmsi *tarand* cemeteries (Vassar 1943, 58). However, during the last decades, more and more prehistoric material in Estonia has been radiocarbon dated to obtain the absolute chronologies of the burial sites (e.g., Lõhmus et al. 2011; Laneman 2012; Allmäe 2013; Laneman & Lang 2013; Tõrv & Meadows 2015; Tõrv 2019; Laneman 2021a, b; Laneman 2022; Niinesalu-Moon et al. 2023). The absolute dates have brought along several surprises, since some of the burial places have been more recent than initially thought. For example, in Riigiküla I and Kivisaare burials have been thought to originate from Stone Age based on the context and artefacts nearby (although not presented as grave goods), but the dating of the bones showed that the burials from Riigiküla I and some of the burials from Kivisaare were from Early Bronze Age (Tõrv & Meadows 2015). This demonstrates that in cases where burials are not accompanied with datable grave goods, radiocarbon dating is the only method to provide any reliable results (*ibid.*). In the case of Kaseküla stone-cist cemetery, infant burials had been buried into the grave several centuries after the initial use of the site (Allmäe 2010; Laneman 2012). Even though relative dating allows archaeologists to relate the burial sites with certain time periods (and there are even time periods where the typology or historical data proves to be more efficient than absolute datings) (Roberts 2009, 215; Langley 2018), there can always be outliers or surprises in the datasets.

In the context of *tarand* cemeteries and cremated bones it must be noted that many of the local prehistoric graves containing mostly cremations have not received absolute dates as the methods to radiocarbon date almost or fully calcined bones were only developed in the early 2000s (Lanting et al. 2001; van Strydonck 2005; Naysmith et al. 2007; van Strydonck et al. 2010; Snoeck et al. 2014). Even though dating the bones is a destructive method (bones with diagnostic features should not be chosen for dating), considering the lack of radiocarbon dates of cremated bone material in Estonian archaeology, it should always be considered when the context of the bone is of an uncertain date. Dating allows us to associate monuments from the same period, gather more data on the individuals (e.g., where and how they lived, and were buried, where were their workshops or fields) painting us a fuller picture of prehistoric ways of life. For *tarand* cemeteries we still do not know why and when new *tarand*s or cemeteries were built, whether the *tarand*s or cemeteries became "full" at one point or the whole cemetery area or the whole complex may have been in use at the same time. Systematic radiocarbon dating of the bone material helps us to calibrate the dates of accompanying artefacts and gives us more certainty in dating the usage periods of the cemeteries and give more insight even on the size of the communities that may have used the cemeteries. In case of *tarand* cemeteries, the usage period of several *tarand*s should be estimated to e.g., test whether the building order corresponds to the periods of burial for each enclosed area.

During the start of my PhD, dating of cremated bones was somewhat novel, especially in Estonia and therefore it was not included in the research proposal for Aakre Kivivare excavations (Lanting & Brindley 1998; Lanting et al 2001; Allmäe 2013; Laneman & Lang 2012). There were four radiocarbon dates analysed from this site: two from charcoal, one from an animal bone from below the cemetery and one from an inhumated human bone (Article I). Due to budgetary reasons and the fact that Viimsi I cemetery was rather narrowly dated by artefacts, the material from Viimsi I was not radiocarbon dated during this study. Nevertheless, for any more specific future analysis, radiocarbon dating should be included in the research proposal. This will help to acquire a few absolute dates from the site, determine when the burials took place and create an internal chronology of the cemetery to be able to place the cemetery and the people buried there into broader context.

5.3.2. FTIR

Fourier-transform infrared (FTIR) spectroscopy in Attenuated Total Reflectance (ATR) mode investigates chemical and structural components of the bone material (Thompson et al. 2009). The position and intensity of the absorption bands of the infrared spectra characterises chemical characteristics depicting the changes that the bone material has undergone (Thompson et al. 2009; Ellingham et al. 2015b; Stamataki et al. 2021).

ATR-FTIR analysis is an (minimally) invasive method – the instrument requires a few milligrams of powdered bone substance for the analysis. In most cases, the bones are not destroyed during the process, merely an edge of the bone is used to scrape off some micrograms of the material with a scalpel (Thompson et al. 2009; Ellingham 2015). Nevertheless, ATR-FTIR analysis is a rather quick and easy way to understand more on the heat induced chemical changes of the bone material.

Characteristics of the ATR-FTIR spectra are used to compare specific absorbance wavelengths and interpret the results (Table 5.2.; Thompson et al. 2009; Roche et al. 2010; Ellingham et al. 2015b, 2016). There are more indices that can be assessed in case of further interest (Stamataki et al. 2021; Ellingham & Zapico 2023, 198–200). I have pointed out the most common and beneficial ones for the study of FCC remains. Carbonyl-to-carbonate ratio (C/C) provides information on the ratio of organic material to inorganic assessing the presence of collagen in the sample (Thompson et al. 2009). Carbonate-to-phosphate ratio (C/P) characterises the changes to the carbonate showing the intensity or completeness of the cremation (Thompson et al. 2013; Piga et al. 2015, 110). Amide-to-phosphate ratio (Am/P) shows whether there still is some water or organic substance left relative to the phosphate content also characterising the intensity of the cremation (Roche et al. 2010; Stamataki et al. 2021). Cyanamide-to-phosphate ratio (CN/P) can be used to detect low oxygen availability during the cremation process and can potentially indicate the presence of clothing in the cremation process (Zazzo et al. 2013; Salesse et al. 2021; Stamataki et al. 2021).

During cremation bone becomes less receptive to external influences (Salesse et al. 2021). Crystallinity index (CI or "splitting factor") will rise during the cremation process as the crystallinity of the bone also rises (Thompson et al. 2009). The results of the ATR-FTIR analysis characterise the decomposition of the organic material and increase in crystallinity providing information on whether there could be some organic substance, resp. collagen, still present in the bones (Ellingham et al. 2016; Stamataki et al. 2021). This can be useful in deciding whether the osseous material is suitable for any further analysis requiring the presence of collagen. The ATR-FTIR analysis also provides information on the temperatures that have affected the bone material characterising pyre efficiency (Ellingham et al. 2015b).

Table 5.2. Characteristics from ATR-FTIR analysis and their use in interpreting the cremation process. Based on Thompson et al. 2009, Roche et al. 2010; Thompson et al. 2013; Zazzo et al. 2013; Ellingham et al. 2016; Salesse et al. 2021 Stamataki et al. 2021; Ellingham & Zapico 2023.

Characteristic	**What it shows**
Crystallinity index or splitting factor (**CI**) Absorption peaks at 605 cm^{-1} and at 565 cm^{-1} summed and divided by the height of the minimum at 590 cm^{-1} between them.	Decomposition of the organic material of the bone
Carbonyl-to-carbonate ratio (**C/C**) Absorption peak at 1455 cm^{-1} divided by absorption peak at 1415 cm^{-1}.	The ratio of organic material to inorganic material in the bone
Carbonate-to-phosphate ratio (**C/P**) Absorption peaks at 1415 cm^{-1} (type B) or at 1540 cm^{-1} (type A) divided by absorption peak at 605 cm^{-1}.	Changes to the carbonate of the bone material
Amide-to-phosphate ratio (**Am/P**) Absorption peak at 1650 cm^{-1} divided by absorption peak at 605 cm^{-1}.	Presence of water of organic components in the phosphate content of the bone
Cyanamide-to-phosphate ratio (**CN/P**) Absorption peak at 2010 cm^{-1} divided by absorption peak at 605 cm^{-1}.	Oxygen availability during cremation process

Additionally, analysing characteristic peaks on the ATR-FTIR spectra can help us differentiate the heat that has affected the bones based on experimental work on bones cremated at known temperatures (Thompson et al. 2009; Ellingham et al. 2015b, 2016). The alterations that the bone undergoes during the heating process are reflected in the changes in molecular bonds. When infrared radiation passes through the sample, peaks are formed at the locations of specific absorption bands based on the frequency of corresponding molecular bond vibrations (Ellingham & Zapico 2023, 198). The formed peaks of the specific bands on the spectra characterise the organic and inorganic components of the bone and allow researchers to detect the heat-induced changes the bone has undergone to learn about pyre technology (Ellingham & Zapico 2023, 200). This is a method that can be used as a complementary and more objective method to visual colour assessment of the cremated bones in order to understand the pyre technology. A selection of bones from Aakre Kivivare *tarand* cemetery were analysed with ATR-FTIR (See Article IV).

5.3.3. Isotopes

Several isotope-based methods allow us to study the persons' diet, mobility and time of death from archaeological bones (Makarewicz & Sealy 2015). However, many of these methods require the presence of collagen, which is destroyed during the cremation process (Makarewicz & Sealy 2015; Price 2015; Stamataki et al 2021; Dalle et al. 2022; Snoeck 2023, 274). Nevertheless, there are several chemical elements that are deposited in bone apatite, e.g., oxygen, lead, strontium and carbon (Price 2015; Stamataki et al 2021; Veselka et al. 2021; Snoeck 2023, 279, 281).

Some more experimental work is needed to understand how exactly the burning environment affects the carbon and oxygen isotope values from cremated bones (Dalle 2022; Snoeck 2023, 280). Nevertheless, there have been great advances in measuring strontium isotope ratios from thermally altered bones (Snoeck et al. 2015, 2016, 2018; Veselka et al. 2021; Snoeck 2023, 279–281). It has been shown that the $^{87}Sr/^{86}Sr$ ratio does not show measurable fractionation through the food chain and cremated bone is immune to post-depositional strontium exchange (Giblin 2009; Snoeck et al. 2015). Strontium isotope is usually used to detect the geological area where people have sourced their foods from as Sr is incorporated through the food chain (Giblin 2009). For example, 25 cremated individuals from the "Aubrey Holes" of Stonehenge were analysed, compared with the biologically available strontium baseline of Britain and it was found that at least 10 of the individuals were not local, i.e. had consumed non-local food for the last decade of their life (Snoeck et al. 2018). Also, Dalle and colleagues (2022) discovered, combining the analyses of $^{87}Sr/^{86}Sr$ ratio and Sr concentration in the natural environment, the elevated salt consumption of Gallo-Roman communities compared to Metal Ages individuals from the same area.

The determination of food sources and migration studies are not the only uses for strontium isotope analyses. Typical fragmented and commingled nature of cremated bone deposits means that even after determining the MNI based on the morphology of the bones (see Chapter 5.1), it is not certain how many people have been buried in the deposit. Strontium isotope studies can aid in resolving this issue. Sabaux and colleagues (2024) have proven that the combination of osteological methods with radiocarbon dating, and strontium isotope ratios improves the assessment of MNI. The difference of radiocarbon dates from the same deposit can be caused by the old-wood effect, but the sharp difference of the $^{87}Sr/^{86}Sr$ can confirm the presence of several individuals (Sabaux et al. 2024). This combined method is very useful for smaller cremation assemblages, as the quantity of commingled bones in *tarand* cemetery contexts would be too much to sample reasonably, but in case of any smaller bone pits or assemblages, this multidisciplinary approach should be tested in Estonian context.

Oxygen and carbon isotopes are heavily affected by the cremation fuel, the corpse and the surrounding environment of the cremation pyre, their analysis cannot be used for studying the cremated individual's life but are useful to study the pyre (Stamataki et al. 2021). Oxygen isotope ratios may shed light on the oxygen and fuel availability during the cremation process (Stamataki et al. 2021). Oxygen availability combined with cremation density of different body parts may indicate the position of the body on the pyre (Symes et al. 2008, 30–33; Salesse et al. 2021; Stamataki et al. 2021). This information gives us more tools to interpret the pyre-related burial customs.

As the isotopic methods described here became more widely available after I had started my PhD and their usage requires substantial additional resources with dedicated expert knowledge, no isotopic analyses were incorporated in the research proposal or carried out during this study. This demonstrates how fast the field is developing and how much more information can be "squeezed out" from cremated bone material. The material from Aakre Kivivare and Viimsi I would have greatly benefited from both oxygen and strontium isotope analyses, which could have provided deeper insights into pyre conditions and the provenance of food sources consumed by the buried individuals. In particular, the presence of several bone clusters at Viimsi I raises intriguing questions – radiocarbon dating and comparisons of the $^{87}Sr/^{86}Sr$ ratios could have revealed whether the bones within each cluster could have originated from the same individuals or represented distinct burial events.

In Estonian archaeological material, the on-site and post-excavation documentation of FCC burials has some room for improvement. First the need for the involvement of a trained osteologist to all the stages of documentation must be acknowledged. Data for spatial analysis of FCC remains can be created only when the documentation in the field is sufficient. To achieve adequate on-site documentation with enough time, it must be pre-planned and integrated to the field protocol (Naji et al. 2014, 39; McKinley 2023). Including osteologist to the fieldwork planning process is essential and the need of an osteologist on site must be assessed based on the character of the burial assemblage(s) to maximise the data retrieved from the excavations and ensure the quality of the data (Keating 2024, 9, 17, 19). When a research plan includes a budget for material analyses, the osteologist can help in choosing bones suitable for any additional testing already during the osteological analysis.

6. COMPARATIVE ANALYSIS AND DISCUSSION

My research has focused on FCC archaeological bone, the challenges and limits of this material and outlining some relatively simple methodologies that allow to maximise the future potential of this material for studying ancient burial practices in Estonia, and elsewhere. This chapter presents the results of my two case studies – Aakre and Viimsi I *tarand* cemeteries – and synthesises and discusses these in the context of analysing and understanding cremated, commingled and fragmented burial materials in archaeology.

The reanalysis of the Viimsi I and Aakre *tarand*-grave has created new datasets as well as new ideas of how the data can be (re)interpreted. Osteological material has been analysed considering all the available contextual information as well as artefacts found from the graves. The position of the finds inside and outside the *tarand* walls and their relations to each other gives a more comprehensive picture of Early Iron Age burial customs and beliefs.

The difference in the detail of the data comes partially from the fieldwork methodology and is reflected in the results of what can be argued based on the said data with using simple methodology. Therefore, to test what kind of information can be obtained and omitted depending on the detailness of documentation of FCC material, the two main case studies were compared based on their material, the analyses conducted, and the results obtained. It must be noted that the remainder of Viimsi I after the bulldozing was fully excavated whereas at Aakre Kivivare, only one *tarand* was opened. Both sites were documented with the best knowledge of the time. The final documentation is somewhat different (Lillak 2025) and reflects my own development and gradual understanding of what is really necessary to make the dataset as reusable as possible. Viimsi I has been my "training project" since my BA studies, and unfortunately, the material reflects most of the mistakes I have made during the learning curve. Besides my own errors, I have noted what should have been done to make the material more usable for further analyses. Conversely, Aakre Kivivare, has been the site where I have tried to escape all the mistakes I had seen on my previous journey.

The quantity of the bones from Viimsi I is larger than the quantity from Aakre Kivivare which is expected as the latter was excavated only partially. The material from Viimsi I *tarand* cemetery was recorded in 264 bone contexts, 255 of which were recorded as dots on the excavation plans. The grave was disturbed by a bulldozer and altogether circa 10 000 bone fragments were recorded. The bones have been recorded in a list, they have been matched together, where possible (Kivirüüt 2014, Appendix 3). The excavated osseous material from Aakre Kivivare *tarand* cemetery comprises 850 contexts (smaller in size and bone quantity than in Viimsi I) with 2434 bone fragments. The bones have been recorded in a list in an MS Excel table, they have been matched together, where possible. Based on the excavation data, all the bones and their characteristics have been placed on a modern mapping programme (Quantum GIS version 3.34) to be spatially analysed. The spatial data for Viimsi I was digitised, but not georeferenced whereas the spatial data from Aakre Kivivare comprises x, y and z coordinates enabling stratigraphic analysis as well (Kivirüüt 2014; Kivirüüt & Olli 2015). The precision of documentation is also hinted at in the number of bones per unit – the number bones per context was notably higher in Viimsi I noting that bones were recorded in larger units.

The papers presented in this thesis combine traditional and newer methods to maximise the informative potential of fragmented, commingled, and cremated human remains (Fig. 6.1). It must be noted that the analyses used in this study require just a trained osteologist without any special equipment. At the same time, I have pointed out how specialist methods can "squeeze out" even more information from the data, if found necessary. The combination of different methods helps interpreting the material but also creates new hypotheses. The wider aim of this chapter is to pave the way to describe best practices, the deficiencies of different approaches and analyses, and highlight the opportunities that lie in that kind of fragmented material. The last section of this chapter proposes best practices for documenting and analysing fragmented, commingled, and cremated human remains in Estonia.

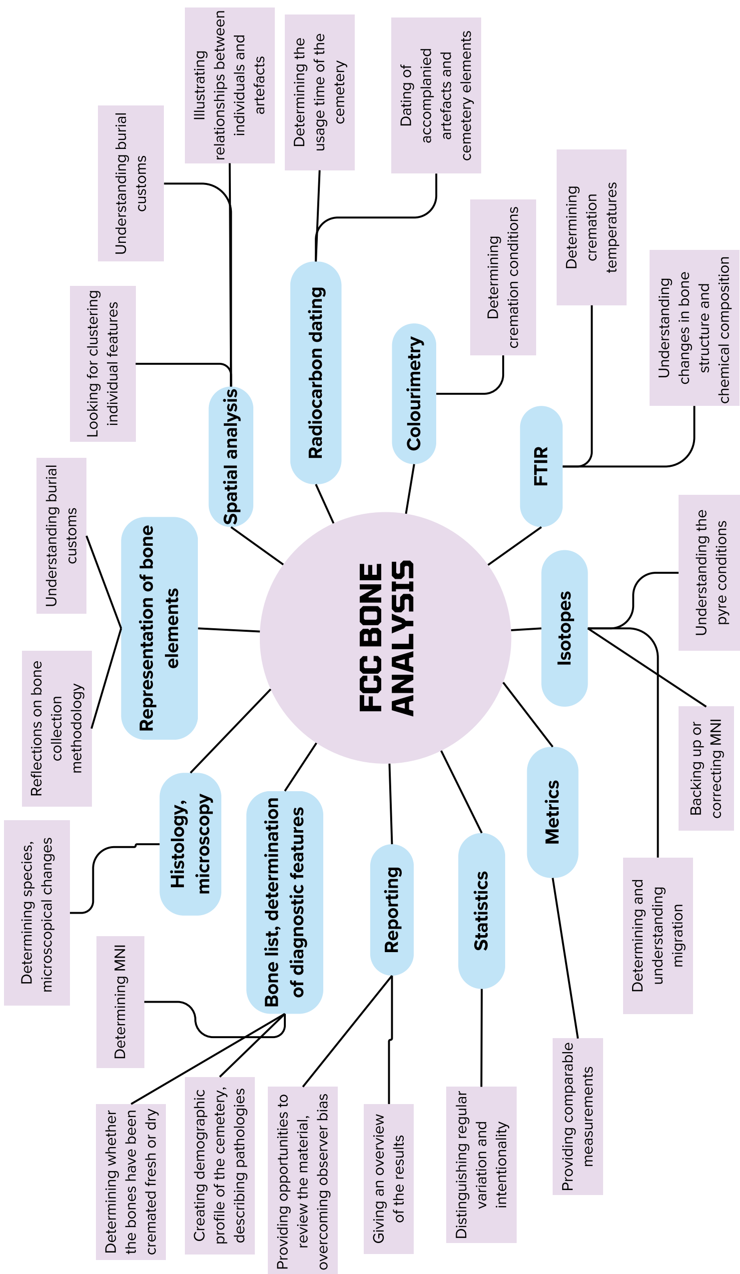


Fig. 6.1. Comprehensive, but not definitive, framework for studying fragmented, commingled and cremated human remains. This framework illustrates the questions that can be addressed using the methods employed in this study, highlighting the overall research potential of the study of FCC remains.

6.1. New analysis of legacy collections

This PhD project has primarily focused on the reanalysis of legacy collections and older materials. Beyond providing a second opinion on a series of subjective decisions (as osteology often is), new analysis may offer the same or very similar information but supported by better-documented data and transparent methods, ensuring the outcome is verifiable and reproducible. In Viimsi I the MNI of the initial and last analyses differed merely by one individual: 32 (Kalling 1993, 68) or 31 (Article III). However, the methods and reasoning for how these results were reached varied significantly (Lang 1993, Kalling 1993, Kivirüüt 2014, Article I and III). Previous osteological analyses often lack comprehensive reports and detailed methodology descriptions (Kalman 2000a, b, c, d; Laul 2001; Mandel 2023), making the re-evaluation of some bone fragments challenging. Depending on the material and its documentation, reassessing the bones and ensuring proper documentation can take days, weeks, or even months (Engbring 2011; Kivirüüt 2014; Varul 2016; Konsa *in prep*; Laneman 2022). Additionally, it is important to note that the brittle bone material may deteriorate with each new analysis, causing some features observed during the initial assessment to become less visible in subsequent reanalyses. Therefore, it is crucial to document the excavated material promptly and repackage the bones safely to preserve their condition and contextual information for future analyses.

New analysis of previously excavated material can be beneficial in many ways. Osteological analysis of fragmented cremated human remains began in Estonia only in the 1990s (pilot works Kalling 1993; Kalman 2000a–c) and it has unfortunately not yet become a norm, except long cooperation between some archaeologists and osteologists (e.g., Allmäe 2003; Mandel & Allmäe 2023). There are no established standards or official guidelines for excavating cremated and/or commingled human remains. However, it is advised to follow the best practices available, ensuring minimal disturbance to the archaeological matter (clause 3 of § 46 of the Heritage Conservation Act; clause 6 § 9 Regulation no. 25 of the Minister of Culture, dated 15.05.2019). This has resulted in several examples where fragmented bone clusters have been removed from the ground and reached the repositories without osteological analysis.

Visual analysis of skeletal assemblages is never reproducible with the exact same results. New or recurrent analysis of the same material is useful as it provides a second or even third opinion as morphological assessment of bones, especially of fragmented and cremated material, is biased. Intra- and interobserver error has been studied in forensic archaeology where it remains unclear how much training is needed to reduce the interobserver error (Henson et al. 2020). It has been stated that expert results can also be biased based on the observer's expectations, time pressure, volume of contextual information irrelevant to the task (Nakhaeizadeh 2014 and the literature cited). Considering the time pressure of most archaeological (development-led) surveys, it is plausible that the initial assessment of the osteological material for the report may need some reassessment for the key features or findings. New analysis of the material (also by other specialists) helps to point out and overcome the observer bias in cases where several expert opinions agree upon.

Reanalysis of the bones might also be necessary due to new methodologies requiring a specific measurement or assessment of a specific bone feature that have not been recorded before. Again, there is a tremendous difference whether the new analysis must tackle the material from the whole site, or the researchers can retrieve the specific bones based on the bone report and re-measure or reassess just a selection of the osseous material. Current developments in the analysis of the cremated bone material are fast as there are research groups dedicating their time to the development of specialist methods on cremated osseous remains, and testing these developments on large datasets, e.g., CrumBel; or "TEFRA" Archaeological Research Project (Annaert 2020; Tefra Project). Similar projects could be conducted in Estonia as our collections have plenty of material, but the lack of published reports may hinder the wider awareness of those collections. Any research group working on a new method creates new knowledge on the material and usage of our collections in such projects should be encouraged to gain more information of our past. In cases where the bone material has been well documented, it is easy to pick out suitable bones for any new laboratory procedure and set the focus on further scientific questions. This minimises the immediate need to reanalyse the "old" material, saves time and resources, but also fragile material itself.

6.2. Interpretation of osteological datasets

Archaeologists are mostly interested in humanistic questions highlighting the value and agency of human beings during (pre)history. These questions include how people lived, what they ate, how they were buried, were the populations rather hierarchical or equal, collective or individual etc. All methods concerning osseous material can be classified as osteological. In this subchapter, I will represent my results of osteological analysis of Viimsi I and Aakre Kivivare *tarand* cemeteries and discuss the very basic morphological methods that can be applied with simple visual estimation, a ruler or a calliper.

6.2.1. Demography

The bones from Aakre Kivivare were analyzed once in 2015 (Article I), whereas the bones from Viimsi I have undergone multiple examinations (Kalling 1993; Kivirüüt 2011; 2014). Viimsi I is the only site I have reanalyzed, and over three years of practice, my skills in identifying bone elements and diagnostic features have significantly improved. One reason I chose the bones from Viimsi I cemetery for my BA studies in 2010 was the lack of a comprehensive finds list from the 1990s. At that time, I did not anticipate the frustration of encountering slightly different results without understanding the origins of these discrepancies. A bone catalogue from the 1990s would enhance the analysis and interpretation, as I may have overlooked traits that Kalling identified and vice versa.

Table. 6.1. Representation of body parts in Viimsi I and Aakre Kivivare *tarand* cemeteries illustrating also the difference in data collection. Based on Kivirüüt 2014 and Olli & Kivirüüt 2015.

	Viimsi I		Aakre Kivivare	
Body part	Number of contexts where present	How many contexts contained these bones	Number of fragments	What proportion of fragments these bones constitute
Cranium	211	77%	378	15.5%
Teeth	51	18.6%	83	3.4%
Axial skeleton	71	25.9%	48	2.0%
Upper extremities	93	33.9%	76	3.1%
Lower extremities	68	24.8%	90	3.7%
Undetermined	234	85.4%	1721	70.7%
Total number of contexts/fragments	274		2434	

The bones from both sites were fragmented and commingled, yet all body parts were present among the cremated and inhumated material (Table 6.1.). This suggests that mourners brought bone material from all body parts to the cemetery. However, discrepancies emerged when comparing cremations and inhumations separately. Spatial analysis at Viimsi I revealed that cremated bone fragments were primarily concentrated inside the walls, while inhumated bones were mostly found outside the bordered stone structures (Fig. 4.5.). In contrast, no specific patterns were observed in the placement of bones or body parts at Aakre Kivivare, indicating no designated areas for different types of remains (Olli & Kivirüüt 2015). This lack of pattern may reflect merely the excavated and documented section of the cemetery, but it could also suggest general regional differences in burial practices, as similar grouping of remains has been noted mainly in Northern Estonian *tarand* cemeteries, such as Võhma Tandemägi and Rebala (Kalman 2000d; Laneman 2021b).

One common observation in the case studies was the relatively low weight of the bones compared to the MNI. The bones from the Viimsi I cemetery weighed over 10 kg, while those from Aakre Kivivare weighed slightly more than 2 kg (Kivirüüt 2014, 15; Article I). The MNI, based on recurrent bone fragments, was 31 for Viimsi I and 14 for Aakre Kivivare (Kivirüüt 2014, 43; Article I), which is higher than the MNI based on the average weight of a cremated skeleton (1.8–3.7 kg, with 3233.2g ± 581g for males and 2238.3g ± 482g for females, van Deest et al. 2011). This suggests that not all bones were collected, preserved, or brought to the *tarand* cemetery. However, the material from both sites included all body parts, small bones (*sic*! even without using the sieve in Viimsi), and cancellous bone fragments, indicating the former presence of quickly decomposing porous bones, such as patellae and sterna (Kivirüüt 2014, Appendix 3; Olli & Kivirüüt

2015). Therefore, there is no reason to believe that only certain body parts were selected for burial in the *tarand*. Instead, it appears that all bones of the people to be buried into the *tarand*s were brought to the cemetery, but the treatment of some bones differed from others.

The bone material was too fragmented to firmly distinguish between men and women among the adult individuals, being yet another proof of complications relating to demographic estimations. However, the presence of both robust and gracile traits in several fragments suggests that both men and women were present at Viimsi I and Aakre Kivivare (Article I; Article III). Additionally, both cemeteries contained juvenile individuals (Article I; Article III). The osteological evidence suggests that the graves served as burial places for individuals of all age groups and both sexes. If any selection criteria were applied, they likely related to characteristics that are not detectable through the present analysis or the available archaeological material.

Osteological analysis greatly improves our understanding of demographics. For many years, conclusions about societal composition were based on artifacts and comparisons with inhumation burials from the same periods or similar graves (Lang & Ligi 1991, 221). Lang and Ligi (*ibid*.) used a common population size formula (population size equals MNI divided by mortality rate that is multiplied with usage period of the site, Ambrosiani 1973) alongside a complex deduction method because cremated bones had not been analyzed. They argued that the number of certain personal adornments matched the number of individuals buried in the *tarand*s. A few years later, the *tarand* cemeteries of Viimsi were excavated, and for the first time in Estonia, cremated bones were analyzed (Kalling 1993; Allmäe 2017, 18). This allowed for the first assessment of the population size of a cremation burial site by counting the identified individuals. It was found that the site was likely used by a group of 8–10 individuals, which aligns well with the idea of a single family unit (5–9 individuals), as earlier artifact-based calculations had suggested (Lang & Ligi 1991, 221; Lang 1993, 55–56). This example brilliantly illustrates how different materials and methods were used to compare and support the hypothesis, clearly indicating that bone-based data is more reliable, while artifact-based calculations are indirect (Lang 1993, 56). Later analysis (Article III) indicated that the group using the *tarand* cemetery was probably egalitarian. However, due to our limited knowledge of their society and beliefs, it is difficult yet to determine whether this group was part of the elite or a typical Early Iron Age family. The desire to understand the communities that were buried in the *tarand* cemeteries has led to similar demographic studies. These studies show that, depending on the usage period of the site, the life expectancy of Early Iron Age people, the size of the community using the Poanse I *tarand* cemetery may have varied from 3 to 22 individuals (Kalman 2000a, 56).

Although bone material is the best proxy for assessing population structure and demographics, the estimates must always be taken with caution, as pointed out in Article III. For Viimsi I the possible size of the community using the cemetery was 8–10 individuals as the MNI of 32 individuals was "rounded" up to 50–60 individuals based on the estimation that there were probably more children buried in the grave, but not showing up in the osteological material (Lang 1993, 55). Using the same formula and parameters (Lang 1993, 55) on the new MNI of 31, the size of the community in Viimsi was 5–6 individuals that also aligns well with the idea of a single family cemetery (*ibid.*). For Aakre Kivivare, such calculations have not been made as only a section of the cemetery has been excavated and the usage period of the site is a bit more complicated (Article I).

Neither of the sites were solitary. From Viimsi we know two *tarand* cemeteries in close vicinity and for Aakre Kivivare there was local lore that there were more cemeteries nearby (Lang 1993; Sitzka 1897). Therefore, it is possible that the individuals buried in *tarand* cemeteries were not as elite as has been thought, since we have only studied a portion of the sites, and the bones found there. It is plausible that at least some of these traceless dead from the Early Iron Age will be found from *tarand* cemeteries when digging deeper into the bone repositories and using more modern technologies on the material. Some of the individuals are likely lost along with the long-lost cemeteries, as seen in Aakre. The osteological paradox and the lack of knowledge about the actual context, including the fact that not all contemporary cemeteries are known or have survived, pose additional significant limitations. Therefore, even in cases where osteological and material analyses align, the hypotheses rest on limited evidence.

The Viimsi I case study demonstrated that the reuse of previous studies is only feasible when those studies have been properly documented using standardized methods to ensure data comparability. This has also been noted in studies on Anglo-Saxon cremation cemeteries (Squires 2011, 8). While it is generally important in archaeology to determine and publish the number, age, and sex of buried individuals, it is even more crucial to compile a standardized report of this data. The more comparable material available, the more insights can be gained about the communities and society of that era.

The accuracy of osteological methods on FCC human remains, the usage period of the site (especially if it is not radiocarbon dated), and the estimated life expectancy are all factors that can influence the outcome of demographic estimations. Given that laboratory methods have proven the commingling of seemingly non-commingled individuals (Sabaux et al. 2024), it is important to remember that the Minimum Number of Individuals (MNI) does represent only the absolute minimum count. There were probably more individuals, meaning the community we are researching was possibly larger than estimated. With this critique, I do not intend to discourage paleodemographic studies; my goal is to highlight that the numbers may be subject to change and that the limitations of the methods should be acknowledged when reusing data from previous studies.

6.2.2. Distinguishing the human remains from the faunal

In addition to human bones, several animal bones were found among the osteological material from Viimsi I and Aakre Kivivare. Some of these animal bone fragments were identified by the author and some with the help of zooarchaeologists Mairi MacLean and Eve Rannamäe. Although the focus of this study was elsewhere, the presence and type of animal bones were noted in the bone catalogues, but not all faunal remains have yet been identified to the taxonomic level. Most of the animal bones were not cremated, but there may also be more animal bones among the unidentified cremated bone fragments, but these were not microscopically analyzed during this study.

Some of the faunal and human bone material could be differentiated using methods described by Mayne Correia and colleagues (2023, 264–267) and Cuijpers (2006). Most of the animal bones belong to lagomorphs and rodents, but domesticated animals were also found (Kivirüüt 2014, Appendix 3; Olli & Kivirüüt 2015). The depth of the bones from Viimsi I is not known, but animal bones from both small and large mammals were found in most layers of Aakre Kivivare, including below the cemetery layers (Olli & Kivirüüt 2015). Since the faunal remains from these sites have not yet been thoroughly analyzed, it is unclear whether the animals were deliberately placed in the cemetery, their meat was consumed in the area, or the bones arrived at the sites in later periods (Laneman 2012; Jonuks 2009, 245; Ehrlich et al. 2021; Laneman 2021a, b; Laneman 2022). A more detailed analysis of faunal remains can provide valuable insights into the relationship between humans and animals (both in the realms of the living and mortuary practices), as well as the community's food sources. Understanding these aspects can help reconstruct past diets, economic activities, and even social and cultural practices related to animal use and consumption. Furthermore, distinguishing human and animal remains is a crucial first step in further analysis of burial customs and socioarchaeological interpretation such as demographic reconstruction.

6.2.3. Pathologies and modifications

The cremation process primarily affects and destroys bones with pathologies, as disease often weakens bone tissue (Holck 2008, 130). This may explain why pathological traits are scarcer and less visible on cremated remains. Inhumated human remains from Viimsi I showed minimal health problems, with only a few cases of dental caries and signs of work or skeletal stress-related trauma, such as Schmorl's nodes, spondylosis, and ankylosis on thoracic and cervical vertebrae (Article III). In Aakre Kivivare, the only specific pathological trait observed was the fusion of the middle and distal foot phalanx (Olli & Kivirüüt 2015). About a dozen bones, both cremated and inhumated, showed some periosteal porosity (Olli & Kivirüüt 2015) that is physiological to growing children, but can be a sign of many different conditions from trauma and infections to tumours (Waldron 2009, 116).

Some of the bones showed signs that could be associated with either burial customs or interpersonal violence. Among the cranial fragments from Viimsi I (context 167), a fragment of parietal bone had shallow scratch marks (Kivirüüt 2014; Article III). The largest scratch is a cut mark, possibly indicating the cutting of something on the cranium, such as the temporalis muscle. On the inhumated bones from Viimsi I, there were three cut marks: 1) on the posterior side of the ramus of a mandible; 2) on the posterior superior side of a cervical vertebra; 3) on the posterior side of a right radius (Article III). The first two cut marks may suggest decapitation (Roberts & Manchester 2005, 63; Tucker 2012, 236) or perimortem trauma (Hatch 2017). The third cut mark may indicate a defensive wound (Brickley & McKinley 2004, 41). Although the bones from Aakre Kivivare were analyzed with the possibility of such traits in mind and with extra attention in that field, no cut marks were noted (Olli & Kivirüüt 2015).

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When exploring large-scale archaeological topics, the Osteological Paradox must be acknowledged as the cemetery sample never fully represents the living population. The key to overcoming the Osteological Paradox is multidisciplinarity, reaching multiple (alternative) interpretations of the material, understanding their context and focusing on the people, not their skeletal material (Milner & Bolsden 2017). It is also important to understand that visible stress markers on archaeological bone may indicate that the person was not frail, but healthy to battle the stress or disease long enough for the lesions to form on the bones (Wood et al. 1992). I have found it useful to think of the Osteological Paradox when placing the results of osteological analysis in a wider context to evaluate what the material has to say about the living rather than about the dead.

6.3. Archaeological and statistical analysis – cemetery structures and usage period

To fully grasp burial practices, it is crucial to identify the locations of all burial-related structures associated with the discovered individuals (see Chapter 3.3.1.). Besides understanding the type of bone deposit being analyzed, it is important to place the site within a broader context. Additionally, spatially examining the site's internal structure and features, and dating them, is essential.

6.3.1. Defining and contextualising the structures

The case studies represent post-cremation structures where bones have been deposited. There are no known pyre sites near Viimsi and Aakre Kivivare cemeteries. Viimsi I is built of limestone on the limestone clint (Lang 1993, 6, 9), yet no "molten" clumps like those found at Türsamäe were discovered. It is possible that the cremation site for Viimsi cemeteries was destroyed during nearby building and landscaping, or the pyre building technique was different from that in Türsamäe.

Near Aakre Kivivare cemetery, a cremation site was searched for in the soil of molehills, nearby arable land, and test pits, but no pyre sites were found, as the process is like looking for a needle in a haystack. Comparing findings from the pyre site with cemetery finds would enhance our understanding of what was taken from the cremation site, providing further knowledge of Early Iron Age burial customs.

The use of sites where cremated human remains may be found has varied, and some material may have been left behind in each of those places. Therefore, it cannot be ruled out that the remains of one person may have ended up in several pre-cremation repositories, may have been placed on several pyres (peri-cremation structures), and may have been buried in different places (post-cremation structures) (Williams 2004, 268).

Only a few pyre sites are known and even less have been studied, e.g., in Uusküla II, Väike-Rakke, Piila and Keblaste (Moora 1970, 136; Mägi & Rudi 1999; Lang 2000, 153; Mandel 2022) in Estonian archaeological material. Elsewhere in Europe, pyre sites have been found in the same place as the bone deposit or in a close vicinity (less than 100 metres) (Arcini 2005, 70; Duday 2022, 264), but *tarand* cemeteries in Estonian context are lacking contemporary pyres as the studied sites were probably used in Middle and Late Iron Ages (Lang 2000, 153; Jonuks 2022, 197; Mandel 2022). Considering that all of the structures relating to cremation are informative to interpret burial customs, the search of Early Iron Age pyre sites should be a focal point in further research on *tarand* cemeteries.

Another indicator of pyre sites may have been the presence of limestone clumps containing bones and artefacts as has been found, e.g., in Türsamäe *tarand* cemetery where Jonuks (2022, 196–197) suggests that these clumps may have been formed when the pyres were built on limestone slabs. Based on the excavated pyre site descriptions (Moora 1970, 136; Mägi & Rudi 1999; Lang 2000, 153; Mandel 2022) there is no conformity in our pyre sites and any kind of sooty patch with charcoal and signs of fire in the vicinity of cemeteries containing cremated bones should be considered as a possible pyre site. The findings should be thoroughly analysed to either confirm or reject the hypothesis.

Pyre sites often disappear from the landscape or go unrecognized in archaeological material. Small cremation burial patches may be remnants of pyres (Williams 2004, 268; Arcini 2005, 63; Tvauri 2012, 274). Even when sites survive, specialist help is needed to identify all features during fieldwork for proper documentation. Arcini (2005, 71) notes that mistaking pyre sites for burial sites can lead to overestimating the number of individuals. Including an osteologist in fieldwork helps identify bones based on their characteristics. For example, without an osteologist, only one of 29 pyre sites would have been discovered during Gualöv excavations (Arcini 2005, 70–71). Continuous consultations with osteologists enhance the discovery of cremation-related structures.

Understanding pyre sites and debris can reveal the choice of firewood and resource gathering practices. Wood for pyres was usually collected nearby (McKinley 2006, 84; Deforce & Haneca 2012; Vaz et al. 2021). The choice of firewood could be practical or symbolic as furniture or other wooden items might also have been used as fuel (Holck 2008, 35; Kreutz 2000, 47–50; Vaz et al. 2021). Understanding pyre fuel helps assess its calorific and symbolic value (Thompson 1999; O'Donnell 2016). The choice of fuel can also indicate the pyre experience, such as aromas and sounds (Williams 2004; O'Donnell 2016). In Estonia, few anthracological analyses have been done on cremation-related material. Merle Soots (2012) found that most wood used in Madi Late Iron Age cemetery was from deciduous trees (Soots 2012). Adequate field documentation is essential for further research on cremation fuel.

6.3.2. Cemetery – inner structures and dating

The excavated area in Viimsi I included not only the inside of the walls but also the stone setting outside the enclosure (Lang 1993, 11). In Aakre Kivivare, the area outside the *tarand* walls was not excavated due to time and budget constraints (Article I). In Viimsi I, it is certain that some individuals were buried in the stony ruins outside the walls, indicating that the cemetery was not limited to the visibly enclosed area (Lang 1993, 12–13). Based on analogies with other similar sites in South Estonia, such as Jaagupi or Virunuka cemeteries (Laul 2001, 45, 65) or in central Estonia, such as Nurmsi (Vassar 1943, 22), there are likely burials in the stony ruins outside the *tarands* in Aakre Kivivare as well. However, considering that no closed complexes or clusters were detected in *tarand* B in Aakre Kivivare (Article I), even though they were expected, there may be more surprises in the usage pattern of the cemetery territory. There were a few areas inside *tarand* B that contained more bones or pottery shards (Kivirüüt & Olli 2015).

In Viimsi I, a few complexes were noticed during excavations (Lang 1993), and the existence of complexes or bone clusters observable in both osseous and artifactual material was later reconfirmed by spatial analysis (Article II). This illustrates how the degree of preservation and the extent of excavation affect interpretations. Viimsi I has some limitations due to the documentation from the early 1990s, while Aakre Kivivare suffers from the small area excavated and documented.

Aakre Kivivare cemetery has been dated using both artifacts and radiocarbon dates. Based on the broad dating of the fibulae, the site was used from the 2^{nd} to the 5^{th} centuries CE (Article I). Radiocarbon dates showed more variability: dates from the bottom layers of the cemetery and an inhumated human bone fragment from between the third and fourth stone filling layers indicated activity during the Late Bronze and Pre-Roman Iron Age, while charcoal from between the second and third stone filling layers dated to later than the 17^{th} century CE (Article I).

The radiocarbon dating of Aakre Kivivare complicated interpretations, highlighting that artifact-based and radiocarbon dating can differ significantly. This underscores the need to model the most probable use time of these cemeteries by integrating the sequences of cemetery structures, artifacts, and radiocarbon dates of bones and other materials. A similar issue was observed in Põlgaste *tarand* cemetery, where radiocarbon dates (1^{st} century BCE – 2^{nd} century CE) were earlier than artifact-based dates (3^{rd} – 5^{th} century CE) (Allmäe 2017, 50–51). Viimsi I cemetery has so far been dated only based on artifacts (Lang 1993, 54) and would benefit from radiocarbon dating to complement the current typology-based determination.

6.4. Merging osteological and archaeological analysis – burial customs

The burial customs in Viimsi I and Aakre Kivivare show some differences. These variations may be due to Viimsi I being partially bulldozed, which caused many items to move from their original spots. Additionally, we only have data from one excavated *tarand* in Aakre Kivivare. Despite these challenges, the cremation techniques, the placement and relationship of bones and artifacts, and the different treatments of some materials provide valuable insights into the burial practices at both sites. This subchapter explores what we have learned about these customs and highlights areas for future research.

6.4.1. Cremation practices

The analysis on cremation of the corpses was mostly done with visual methods. Cremation in Aakre Kivivare *tarand* cemetery was rather uniform and strong, there were not many inhumated bones (Olli & Kivirüüt 2015). In Viimsi, there were numerous unburned bones, and the cremation of the bones was more varied, many different colours as well as cremation stages were present (Kivirüüt 2014). Some of the cremated bone contexts presented a minimum cremation stage of 0 (see Fig. 5.2.) which indicates that the bones did not show definite signs of burning and looked as if they were unburned but did show sooty stains or denser surface, this was more common among the bones from Viimsi I as the majority of human bones from Aakre Kivivare showed signs of heat-induced changes (Kivirüüt 2014, 17; Olli & Kivirüüt 2015; Article IV). Although no distinct cremation patterns for specific body parts were evident, there was a noticeable and possibly significant tendency at Viimsi I: cremated bones were more commonly found within the *tarand* walls, whereas unburned bones tended to be located outside the walls (read more Chapter 6.4.3.; Kivirüüt 2014, pp. 32–35; Olli & Kivirüüt 2015).

Specific straight transverse breaks with a small peak in one end on cremated long bone fragments in Viimsi I suggests that the bones from the pyre may have been cooled down quickly (Kivirüüt 2014, 38, Article III). This may have been intentional or incidental due to weather (rain or snowfall) and may have made collection of the bones easier as well as may have hindered a complete cremation process (Kivirüüt 2014, 38, Article III). There were no such marks found from the bones of Aakre Kivivare cemetery suggesting that the quick cooling of the bones in Viimsi may have been rather intentional or the people from Aakre may have been able to choose the weather for the cremation process.

Based on the colourimetric analysis, the bones in Viimsi I were incompletely cremated, not calcified as most of the bones were black or dark grey. There were bones with hues of blue or brown as well, but the general impression of the bones was black and dark grey and calcined bones were scarce. This corresponds to Grade 1 or lower limits of Grade 2 by Holck (2008, 94) indicating the pyre temperatures may have been around 400–500ºC (Holck 2008, 99). The description of the bones corresponds to Grades II and III by Wahl (2008, 149) indicating similar cremation temperatures of 300–550 °C and incomplete cremation. Whereas there were no statistically significant differences in the presence of cremated bones and body parts inside or outside the *tarand* walls, there was a statistically significant difference in where the inhumated bones were found (Kivirüüt 2014, 31–32). Most of the inhumated bones were found from outside the *tarand* walls meaning that the inhumated bones were rather not buried inside the *tarand* walls or they were in the top layers that were bulldozed off (Kivirüüt 2014, 32). Considering there was an inhumated fragmented male cranium found from cluster III just outside the *tarand* walls (Kalling 1993, 67; Lang 1993, 12), it is plausible that inhumated bones were mostly intentionally placed outside the walled *tarand*s. There was also a statistically significant difference in the cremation of cranial fragments outside the *tarand* walls – most of the cranial fragments found from outside were visibly uncremated (Kivirüüt 2014, 30–31). This suggests that the crania in Viimsi I were treated differently than other parts of the body.

None of the bones from Aakre Kivivare were cremated at high temperatures either. Most of the cremated bones were (light) grey or greyish white and many fragments showed sooty black patches (Olli & Kivirüüt 2015; Article IV). This corresponds to Grade 1 or lower limits of Grade 2 and early Grade 3 by Holck (2008, 94) indicating the pyre temperatures may have been around 400–800 °C (Holck 2008, 99). The description of the bones also corresponds to Grades III and IV by Wahl (2008, 149) indicating cremation temperatures of 550–700 °C. This suggests that some of the bones from Aakre Kivivare were calcified, completely cremated and some were not. 78 bones from Aakre were analysed with ATR-FTIR in Teesside University and the different coloured bone spectra corresponded to temperatures of at least 400 °C (sample 242), 500 °C (sample 433), 600 °C (sample 441), and 700 °C (sample 449) based on the method by Ellingham and colleagues (2015; 2023, 199–200) (Article IV). ATR-FTIR spectra of sample 449 showed distinct peaks to the left of 1200 cm-1 that is characteristic to bones cremated at a temperature less than 800 °C. The ATR-FTIR results also suggest that the bones were cremated at the temperature of 400–800 °C (Article IV). These ranges of pyre temperatures obtained correspond well and the ATR-FTIR spectra measures confirm what was previously obtained by visual methods. Although there is no reason to believe the ATR-FTIR spectra measurements would show different info on the cremation affecting the bones from Viimsi I cemetery, it would be interesting to know how well the interpretations of the spectra correspond with colourimetric assessment of bones.

In general, the cremation of the bones from Aakre Kivivare was slightly higher than that of Viimsi I cemetery (Fig. 5.2.). Compared to Põlgaste *tarand* cemetery, the cremation in Viimsi I was similar as the bones from Põlgaste were cremated in temperatures of ca 300–650 °C (Allmäe 2013, 39). In Võhma Tandemägi *tarand* cemetery, the most common cremation was Grade 2 by Holck (2008, 99) and some of the bones had reached Grade 4 indicating that the pyre temperatures reached similar temperatures to other *tarand* cemeteries, ca 400–750 °C not always enabling complete calcification (Holck 2008, 99; Kivirüüt 2014, 22–23). The cremation of the bones from Viimsi I and Aakre Kivivare was rather different compared to later sites in Estonia where bones have been completely cremated and temperatures may have mostly reached over 800 °C (Valk & Allmäe 2010; Engbring 2011). This could suggest that cremation efficiency rose over time as also Kalman (2000d, 439) has noted, but as the number of cemeteries where cremation has been studied is still low, more data is needed to study more general trends and reach conclusions.

6.4.2. Placement and correlation of bone material and artefacts

No patterns were observed in the way bones or different body parts were scattered over the *tarand* area in Aakre. However, artifacts showed a concentration of metal items in the mid-section of the *tarand* (Article I). Additionally, pottery shards were concentrated in the outer (southeast and northwest) sides of the excavated area. This differentiation may have resulted from deliberate actions, with metal artifacts placed in the central area and pots left in the outer areas of the *tarand* (Article I). No correlations between any items or bones were found in Aakre Kivivare cemetery (Article I). This could indicate that the community using Aakre Kivivare cemetery was more collective than Viimsi I, as no individuals stood out from the commingled "pool of ancestors" (Articles I, II). This supports Jonuks' (2022, 196) suggestion that during the main usage era of *tarand* cemeteries, the individual was not important, but the dead ancestors were seen as a unity. In Viimsi I cemetery, there seems to have been more effort put into the placement and replacement of bones, while in Aakre Kivivare, the placement of artifacts was more intentional.

Both collective and individual traits have been observed also in Finnish Merovingian and Viking Age cremation cemeteries (Wickholm & Raninen 2006). It was discussed that, even though most of the identified individuals are male from weapon graves, the reasons behind some individuals standing out from the generally collective ancestral soul may not be reflected in the material remains (Wickholm & Raninen 2006).

Even though this thesis does not focus on artefacts, it must be stressed that bone analysis cannot be complete without researching all the artefacts accompanying them. These items help date and contextualise the burials within the cemetery on a microscale and facilitate intersite comparisons and broader cultural context on a macroscale. Artefacts also shed light on burial customs, and in some cases, personal items of these FCC individuals may be identified. The artefacts associated with cremation burials provide insights into the belief systems of Early Iron Age people. Why did these items end up in the cemetery, and what was their purpose? The continuous use of the cemetery sites poses another problem in interpretation – how much of the deposition reflects a primary or a secondary deposit or a ritual arrangement and when in the course of the cemetery usage was the find situation "staged" (Thompson 2016, 7–11; Rebay-Salisbury 2017, 61–63, 69).

The artefacts in Viimsi I (Peets 1993) and Aakre Kivivare (Article I) are often fragmented or show signs of having been in the fire. In our study (Article II), we grouped the artefacts from Viimsi I and II cemeteries into four categories based on their purpose and association with mourning and/or remembrance: 1) items of personal adornment, 2) utensils, 3) weapons, and 4) ceramics. We demonstrated the importance of examining items and bones together, as there may be surprising relationships even in cemeteries with fragmented, commingled, and partially cremated contents. For instance, the analysis revealed a possible link between a robust clavicle and 1st rib with green-coloured staining and a nearby crossbow fibula (Article II, 284). Unfortunately, for many of the clusters, it was difficult to determine whether the items belonged to the deceased, were in use, or were symbolic offerings to specific individuals or the general collective "pool of ancestors" (Article II, 289). Nevertheless, the Viimsi I cemetery exhibited both individual and collective features – most of the bones and items were commingled, but some individuals stood out (Article II, 285–287). In other studies, some items have been identified as ritualistic, such as in Tõugu II, where some vessels may have been placed on the *tarand* walls and broken due to natural processes, while others were intentionally broken and scattered in the cemetery area (Lang 2000, 117), likely as part of burial or commemorative rituals.

In most studies of *tarand* cemeteries, the focus has been on items and cemetery structures, partly because research on *tarand* cemeteries began in the early days of Estonian archaeology due to the diverse grave goods (Lang 2007a, 206; Olli 2019, 23), and partly because archaeologists did not have sufficient knowledge and/or skills to deal with bone material. Although a few closed finds complexes have been noted in some *tarand* cemeteries besides Viimsi I (Lang 1993, 10), such as in Jaagupi (Laul 2001, 48), in most of these sites, all the finds – including bones and artefacts – are dispersed throughout the cemetery area (Lang 2007a, 206).

Most of the *tarand* cemeteries have not been radiocarbon dated, with artefacts serving as the primary means of dating the sites. The item series found in the cemeteries have been placed on a timeline based on closed finds complexes, where the repeated co-occurrence of items with a known date also dates the accompanying items (Godłowski 1970, 8). The issue with *tarand* cemetery material has been the lack of closed finds complexes – contexts where the finds have not been disturbed prior to excavation (Olli 2019, 44). Nevertheless, parallels with similar complexes elsewhere and the development of local object types and decorations have provided the currently used timeframe for *tarand* cemeteries and their subtypes (Laul 2001, 184–185; Lang 2007a, 192–203; Olli 2019, 44–45).

Radiocarbon dating can now specify the dates, but it must be remembered that some sites were in use during later periods as well, such as Uusküla II dating from *ca.* 2nd century BC to the 2nd half of 1st century AD (Lang 2000, 153). The commingled nature of these cemeteries will always leave room for uncertainties. How many of the bones and artefacts are from the same time? How commingled are the sites really? The typology of the items is the quickest way to date these cemeteries, but to analyse the site as a whole, dates should be taken from bones as well as charcoal, if possible. This PhD project did not have the funds to conduct many radiocarbon dates, so the refinement of cemetery chronology remains a major problem that needs to be established through elaborate dating campaigns in the future.

6.4.3. Differential treatment

The presence of find complexes at Viimsi I suggests that not the entire cemetery area was communal and/or that there may have been several stages in the burial process (Article II). Additionally, the discrepancy between the number of cremated and thermally untreated cranial vault fragments indicates a strong possibility that the bones or body parts of a single individual may have been treated differently (Article III). The bones of one individual may have ended up in the cemetery both with and without thermal treatment (Kivirüüt 2014, 40; Article III). Kalling (1993, 68) also suggested that the bones from Viimsi I may have been cremated later, after being buried for some time. The material from Viimsi I strongly suggests that cremation and inhumation were not necessarily used during different time periods and that both practices may have had their own place in the mortuary rituals of the users of *tarand* cemeteries (Kivirüüt 2014, 40; Article III). Interestingly, no such traits were observed in Aakre Kivivare.

Similar practices have been noted before. Kalman (2000c, 427) observed at Võhma Tandemägi that the cremation was not uniform, with the inner surfaces of the bones more cremated than the outsides, suggesting that the bones were cremated after the soft tissues had decayed. Kalman (2000b, 398) also noted that the only cremated human bones in *tarand* IIC:1 of Tõugu cemetery were cranial fragments, indicating differential treatment. The bones from Tõnija Tuulingumägi *tarand* cemetery were also cremated after the bodies had been stored unburied, with most of the cremated bones being skull fragments (Mägi 1999, 11–12). Hence, differential treatment of individuals seems to be written into *tarand* cemeteries. Based on the current data, not all the individuals were buried into *tarand* cemeteries during Early Iron Age (Lang 2011, 115; Niinesalu-Moon et al. 2023, 148). *Tarand* cemeteries often contain both cremated and inhumated bones whereas most of the bone material is fragmented, even in the case of inhumation burials, e.g., in Võhma Tandemägi and Pada (Schmiedehelm 1955; Moora 1974). From several sites, there are notes that most cremated bones were found from inside the *tarand*s (Tõnisson 1957, 8) whereas in some cases inhumated bones were found mainly from the area outside the *tarand* walls such as in Jäbara E (Schmiedehelm 1927, 3). As these inhumated bones and burials have not been dated, it is not yet certain how they relate to the general burial site.

Another trait that has been observed and recorded for several *tarand* cemeteries is the presence of longitudinal splitting, cracking and warping on long bones. It is interesting that the first analysis of Viimsi I bones (Kalling 1993, 68) suggested that the bones were probably cremated after the flesh had decayed, but Kalling did not specify the basis for this conclusion. New analyses noted warping, longitudinal splitting, and checking in the cremated bone material from Viimsi I, indicating that the bones were likely cremated fresh (Kivirüüt 2014, 18). However, as numerous cranial vault fragments showed the strongest cremation on the inside surface, it is possible that the skulls were cremated after initial burial and decomposition (Kivirüüt 2014, 19). The cremation of the bones from Aakre Kivivare was more uniform. Although there was some longitudinal and transverse cracking as well as curved fractures (Olli & Kivirüüt 2015), this suggests that the bones were probably cremated fresh. Since no more specific features were observed, it cannot be determined whether the bones were cremated fresh and fleshed or just fresh.

There are many discussions on how to assess the state of bone material during their cremation. Parabolic fractures and warping are indicators that the dead were cremated while the flesh was still on the bones or the osseous material still contained collagen (Buikstra & Ubelaker 1994, 96; Whyte 2001; Gonçalves et al. 2011). Warping can also occur on bones cremated dry, after the flesh has decayed (Buikstra & Swegle 1989). Larsson and Nilsson Stutz (2014, 61) note that long bones surrounded by soft tissue in pyres develop deep checkered cracks laterally and longitudinally, while the diaphysis and epiphysis meeting areas develop curved and elliptical cracks. Defleshed but fresh bones are calcined more evenly, have fewer curved cracks, and exhibit a more even color. Black patches often appear when bones are cremated with flesh (Larsson & Nilsson Stutz 2014, 61–62). All of these features can only be observed and documented through a thorough osteological analysis.

Unlike Aakre Kivivare, Viimsi I showed more features that can be interpreted as ritual activities, many of which relate to crania. Differential treatment of body parts is known from several other archaeological sites, and the fragmentation of the human body was widely practiced during the Iron Age, as well as in the Mesolithic and Neolithic periods.

In the British Neolithic, bone deposits were placed in different burial deposits, and some body parts were moved from one context to another. For example, skulls were removed from the West Kennet chambered tomb but were found in abundance in a nearby ceremonial enclosure (Parker Pearson 2008, 51–52). Ian Armit (2012) dedicated a book to the significance of the head in different Iron Age communities, discussing customs such as headhunting, head veneration, and other ritualistic behaviors related to the head.

Over- and underrepresentation of skull and/or mandible fragments has also been noted in Stone Age Estonia (Tõrv 2018, 239–240, 244). Eriksen (2020) studied osseous remains found in domestic environments of Iron Age Scandinavia and noted that crania are the most frequent bones in these deposits. She also pointed out several headless burials and crania from wetland contexts (Eriksen 2020). These examples show that in prehistory, there were various ritual approaches to the wholeness of the body and the treatment of crania.

It must be noted that the under- or overrepresentation of some body parts may be reasoned by the fact that not all the human remains were collected from the pyre and buried (McKinley 2006, 85; Parker Pearson 2008, 7; Joy 2011, 409). Another plausible explanation could be excavation bias. Namely, cranial fragments can be more easily recognised than other bone fragments, especially to people with no osteological training. Even though excavation bias may affect the representation of some bone elements, it is unlikely to have been the main reason for the relatively high prevalence of cremated cranial fragments. This also adds to the possibility that at least in Viimsi I skulls had a special meaning for the people burying the deceased and the head was treated differently from the body (Jonuks 2009, 173–179; Article III).

Considering the theory that *tarand* cemeteries may be burial places of the elite, the differential treatment of the individuals is represented by the burial place itself as well (Lang 2007b, 190; Article II). Therefore, the fact that the bones were found from a *tarand* cemetery suggest these individuals were treated differently from the other Early Iron Age individuals whose bones we have not found yet (Lang 2011).

6.5. Best practices for recording fragmented, commingled, and cremated human remains

The need to thoroughly document FCC remains is not my personal eccentricity, it has been pointed out by several other local researchers (Allmäe 2000, 247–248, 257; Kalman 2000b, 397; Mandel 2022, 237) as well as in international guidelines (Nikita & Karligkioti 2019; Mitchell & Brickley 2023; Keating 2024; Squires 2025). Additionally, Estonia has committed to treating cultural heritage as a valuable resource and ensuring that archaeological excavations and surveys are conducted scientifically by joining the Valletta Convention in 1996 (Council of Europe, 1992) and the Faro Convention in 2021 (Council of Europe, 2005). In national legislation (Heritage Conservation Act, 2019) recording standards are not set, but it is considered that the best practices available in archaeology at the time must be used.

The best methodologies are always evolving and therefore they cannot be described in the legislation more in detail. However, the best available practices should always be used when dealing with such perishable resources as archaeological heritage. In cases dealing with discussions on how to record FCC human remains our own experience and notes (e.g., Allmäe 2000, 247–248, 257; Kalman 2000b, 397) and the standards elsewhere have been used as an example (e.g., Brickley & McKinley 2004; Mitchell & Brickley 2023; Squires et al. 2025). Nevertheless, the need to set a basic norm for excavating, recording/documenting and storing the cremated, commingled and fragmented human remains in Estonia is evident. Written standards about archaeological study of various archaeological objects and/or materials are still relatively a new concept in Estonia (e.g., Lõugas 2018). Thus, due to time and financial restrictions it is often argued that we should record human remains selectively or not at all.

To grant the best possible handling of cremated, fragmented and commingled human remains I will propose the following steps to be included in the excavation and recording of these remains. I will base my propositions on the set standards (Buikstra & Ubelaker 1994; Buckley 2004; Ervynck 2018; Nikita & Karligkioti 2019; Mitchell & Brickley 2023), available methodology (see Chapter 5) and my analytical experience from personal and other shortcomings and fit them with the archaeological contexts in Estonia. Although these principles are perhaps best suited for the needs of Estonian material, some of these are applicable irrespective of the temporal span and geographical area of the study material.

1) A trained osteologist (a specialist with either an osteology degree or a complete osteology-related course with apprenticeship) with previous experience with fragmented and cremated bone material must be involved in the excavation and documentation of the FCC human remains. This ensures that the bones are documented in a manner that allows a fully contextualised osteological report to be conducted. The small fragments may remain unidentifiable to the untrained eye and any kind of information is best documented on site. They must compile an initial osteological report; a textual description of the findings is imperative and the raw data (the results of the described and any additional analyses) backs it up. This is the basis for any further specialist analyses and an absolute minimum that should be done. It must be noted that in some cases, the fragmented, commingled, and cremated material requires extra research already during the initial analysis, e.g., there are no diagnostic fragments referring to either human or animal bones and histology may help to verify it or the block needs X-ray or a CT-scan prior to the *ex-situ* excavations.

2) The bones and finds must be recorded *in situ* layer by layer or by three-dimensional coordinates (x, y, z). The relationships between the bones and the finds must be expressed in photographs, drawings, and written descriptions. 3D scans and/or photogrammetry can also be used where possible and practical.

a. For each *in situ* found bone fragment three coordinates must be recorded. To grant the accuracy of the x, y and z coordinates the excavations must be equipped with a Total Station Theodolite or Global Navigation Satellite Systems receiver.
b. Bones found from the sieve must be recorded by sections where the sieved material originated from. The sieving sections (or squares) should not be larger than 1 m^2, 50 × 50 cm or smaller collection areas are advised. When the bone quantity is large, it is useful to consult the osteologist to figure out the optimal way of recording and packaging – the more the material is sorted in the field, the easier it is to analyse and sort the material later in the lab.
c. Do not forget to sample the soil according to the recommenations (see Archemy[2] or English Heritage[3] guidelines).

[2] https://www.archemy.ee/methods-in-a-nutshell/

[3] https://historicengland.org.uk/advice/technical-advice/archaeological-science/environmental-archaeology/

d. To document the cemetery structures a 3D laser scanner is advised to be used, but hand-drawn plans, abundant photography and usage of the techniques of photogrammetry is also enough.
e. The separately found bones must remain and be packaged separately, and the bone assemblages must remain and be packaged together. In cases where the bones are fitted together, their contexts must remain attached to the bones during the analysis and afterwards, when back in the repository. Otherwise, the contextual information will be distorted or lost, and this will affect the further analysis as well as interpretation.

If the researcher needs to distinguish any kind of special bones from an assemblage, they should be packaged in a separate zip-lock bag with a note. In the repository the bone should be reconnected with other bones from that context either in a separate box or a larger zip-lock bag. In cases where the bones from different contexts are "poured" together without carefully providing contextual information for each fragment, they will instantly lose some of the data.

3) When possible and necessary, blocks of cremated, commingled and fragmented bones should be taken from the grave to the laboratory. On-site recording may be time-consuming and not supported by weather conditions. In cases where the bone assemblages are large enough to hinder the excavation timeline and/or it is impossible to maintain recording standards *in situ*, the assemblage must be excavated in the laboratory. This requires a special toolkit for preparing blocks in the excavation. The need to take the assemblage to the laboratory should be discussed with the osteologist of the project who can assess whether it can be excavated *in situ* or should be excavated as a block. If fragmented, commingled, and cremated human bones are stored in a container, the assemblage must be removed from the site as a block, investigated with X-ray or CT scans and excavated in the laboratory.

4) The decision regarding how to clean the FCC bones should be made in consultation with the project's osteoarchaeologist. Depending on the condition of the material, cleaning may involve wet or dry sieving or gently brushing off sediment using a soft brush. If any of these methods result in further fragmentation, the cleaning process must be halted immediately. Once cleaned, the material should be thoroughly dried to prevent moisture retention and the potential development of mould. It should then be packaged appropriately, following the guidelines outlined in Section 6.

5) All of the collected human remains must be examined osteologically. This includes weighing the bone fragments and measuring a characteristic sample of the collection (some of the larger bones and diagnostic fragments); while the measurements may be done with a sieve (e.g., 1 mm and 5 mm meshes), larger fragments can be measured with a calliper. All the bone fragments must be recorded in a table or database with the accuracy of the skeletal element, where possible, (see Lillak 2025 proposed tables) and divided additionally into skeletal

areas (skull, axial skeleton, upper and lower limb). Any demographic or pathological data (description of traits and observed lesions on the bones) must be added to the table or database. In case of cremated bones, the colour of the bones must be assessed, and the degree of cremation must be described (see Holck 2008, 99; Walker et al. 2008, 136). All used methods must be referenced in the table.

In case of very small unidentifiable bone fragments, their general description (fragmentation, colour and type, if possible) must be recorded.

For smaller-scale excavations or field work campaigns, e.g., test pits, the material may be scarce and fragmented to the point of bones being morphologically unidentifiable. In these cases, histology (Cuijpers 2006) may become handy and will allow the researchers to determine whether there were any human bones at all or were all the remains faunal.

The table or database is comparable to the finds' list. The tabular information must be followed by a brief written report based on the list of skeletal elements where the MNI must be assessed and the age and biological sex of the individual determined, where possible. The report is also the place where any other characteristics of the dataset can be mentioned.

Considering archaeology is financed by public money, the data must be public and must not be stored in personal or any other inaccessible archives. We have put resources and effort into carefully excavating and documenting those bones, therefore, a comprehensive list of the found bone fragments and their description must be added to the public report.

6) Packaging should be executed by context and in a way that prevents further commingling. Zip-lock bags are an easy and accessible form of packaging, but care must be taken when placing those bags into storage boxes. Brittle bones should be boxed separately to prevent damage to or even pulverisation of the bones. In cases with a lot of osseous material, the identified bones should be packed separately from the unidentified fragments and any kind of grouping of the bones is welcome to enable easier access for further analysis. Any bones with special features (e.g., diagnostic bones, pathological traits or the best bones for any kind of natural scientific analysis) should also be packed in a different zip-lock bag.

All the zip-lock bags must contain the contextual information of the contents and in case the bones from one context have been packed in separate smaller bags, a suitable indexing system must be created (e.g., context 11 bag 1, context 11 bag 2). For easier access all of the bones from the same context have to be stored together either in a larger bag containing all of the smaller packets or in a separate box.

7) All of the recorded bones (even the small material) must have contextual information in the table or database that allows the researchers to re-access the corresponding bones in the depot. The table or database of the osseous material (= finds' list) must be handed to the bone depot with the bone material and must remain an integral part of the collection. In case of reassessments of the bones,

the new analyses with corresponding finds' lists must also be added to the data repository complementing the bone assemblage.

There is always more that can be done when excavating and analysing FCC human remains, but that depends on the objectives of further research projects on the said material. Following these previously described steps ensures that the bones are recorded sufficiently, and the material is useful for the foreseeable future.

7. CONCLUSIONS

Fragmented, commingled and cremated bones are valuable and important archaeological sources and they should not be disregarded in any fieldwork and research. There are historical periods where a great part of our archaeological information comes from cemeteries. The knowledge gathered from the artefacts represents just one part of the cemetery material. The analysis of the bones complements the results, either supports or contradicts the artefact analysis and allows us to analyse the people themselves alongside their material culture accompanying them in death. FCC bone material links us directly to the Early Iron Age people enabling archaeologists to assess several aspects of their life.

This thesis focused on the analysis of FCC remains, both in legacy collections and new excavations. The reanalysis of FCC remains is beneficial as it provides new insights and helps overcome biases in initial assessments. Contemporary methodologies can give us information on the people who were buried to the cemetery (e.g., osteology and zooarchaeology, see Chapters 5.1. and 6.2.2.), where they were from (e.g., isotope analyses, see Chapter 5.3.3.), what they consumed (e.g., isotope analysis, see Chapter 5.3.3), when they died and how long was the site in use for (e.g., radiocarbon dating or artefact studies, see Chapter 5.3.1), give us insight about the burial customs (e.g., cremation studies, FTIR, isotope and spatial analysis, see Chapters 5.1.3., 5.2., 5.3.2., and 5.3.3.) and the possible identities of the buried (e.g., artefact studies and differences in mortuary teatments, see Chapters 6.4.2. and 6.4.3.). Therefore, proper documentation is essential to ensure sustainable and reproducible results (Fig. 6.1.). Nevertheless, it is not necessary to start bone analysis with the most modern specialist equipment. Basic osteological study that can be conducted with merely a trained set of eyes of FCC bones allowed me to have information on the MNI, the sex and age at death of the deceased, some of their pathological traits, and first insights on the pyre technology and burial customs. Additional laboratory analysis could reveal even more information about the cemetery and the people using it: whether they were local, when they died, what wood was used for the pyre, how the bones may have been brought from the pyre to the cemetery, etc. Maybe, one day we will understand who were the people buried into the *tarand*s, when and why a *tarand* or the cemetery became full, what initiated the construction of a new *tarand* cemetery close by.

Analyzing different sites helps understand burial customs and regional differences in cremation practices. This study compared two case studies: Viimsi I, fully excavated in 1990 after the initial large-scale bulldozing with a vast amount of human bone material, and Aakre Kivivare, a partially excavated *tarand* grave with less bone material that has been documented more precisely. Viimsi I has served as a training project for me as an osteologist, while Aakre Kivivare excavation campaign aimed to avoid previous mistakes at field work: do less, but properly. Both case studies demonstrate that the FCC material is a valuable resource, whether from partially or fully excavated cemeteries, whether the excavations took place recently or some time ago, provided it is adequately documented.

The Viimsi I cemetery analysis revealed that burials may have occurred in multiple stages, with individual bones treated in various ways. The under-representation of cremated cranial fragments suggests that heads might have received special treatment, possibly serving as focal points in *tarand* cemetery rituals. Viimsi I exemplifies how a single cemetery can display both individual and collective features of the Early Iron Age society reflected in the burial customs. Although the cemetery was generally severely commingled, some distinct bone clusters stood out, indicating a degree of order within the apparent chaos. This highlights the versatility of these burial customs. Additionally, bone cremation at Viimsi I was conducted at relatively low temperatures, around 550ºC.

Aakre Kivivare was analysed partially as the bone material excavated in the late 19th century had not reached archaeological collections and the new campaign focused only on one *tarand.* Interestingly, no specific patterns in the spatial distribution of the FCC bones were recorded and no bone clusters stood out. This could mean that the burial customs in Aakre Kivivare were different than in Viimsi I or just the single *tarand* did not present any individual features, bone clusters. The overall cremation in the recently excavated Aakre Kivivare *tarand* B was up to 800ºC, considerably higher than in Viimsi I (Fig. 6.2.). The differences may be the reflection of varied traditions in geographically different locations but could also be due to the lower percentage of the excavated area of the cemetery in Aakre Kivivare.

Both of the cemeteries showed that *tarand*s were built for all members of the community as there were people of different ages and there was evidence of sexual dimorphism as well. Nevertheless, we do not know whether the community using the *tarand*s was just a (possibly elite) part of the whole society and if it was, then where are the others? Early Iron Age burial customs may have been complex and may have caused loss of some bone material already during the burial process. Viimsi I strongly suggests multi-stage burial customs. This should make us cautious in interpreting osteological information, especially in demographic calculations as in addition to the challenges relating to the Osteological Paradox, the bones of one individual may have ended up in the cemetery both cremated and inhumated.

Tarand cemeteries show differential treatment of individuals, and the case studies partially support that. Not everyone was buried there during the Early Iron Age. These cemeteries contain both cremated and inhumated bones, often fragmented, even in inhumation burials. Cremated bones are usually found inside *tarand*s, while inhumated bones are often outside; it is not coincidental, but the cause of this phenomenon is unknown. More defined find complexes at Viimsi I suggest non-communal areas and multiple burial stages. Differences in cranial fragments also indicate varied treatment of body parts. Similar practices have been noted at other sites. Bones from Viimsi I may have been cremated after burial. At Võhma Tandemägi, bones were cremated after soft tissue decay. Tõnija Tuulingumägi also demonstrates cremation after storing the bones, mainly of skull fragments. This suggests cremation and inhumation were part of the same mortuary sequence and inhumated and cremated bones should be analysed together, as both practices coexisted.

FCC bone material provides insights into Early Iron Age cemetery and pyre construction techniques. Over the past century, archaeological methodologies have significantly evolved, particularly in the study of FCC bones. New technologies and techniques, such as radiocarbon dating and strontium isotope analyses, have proven extremely useful in understanding past migration and mortuary behaviors. The rapid development of methods for FCC bone research continues to advance.

Despite all of the technical advances, the limitations of the FCC bone material remain, as not all constraints are not eliminated by new methods. The limitations, e.g., fragmentation, commingling, cremation must be acknowledged, but they should not hinder us from the research of FCC human remains as there still is a lot of information to be gained and synthesized.

To facilitate future research and maximise the potential of FCC human remains, it is crucial to document FCC bone material appropriately according to the best practices. Proper documentation ensures that findings can be reproduced and verified by other researchers. Implementing the guidance of recording FCC remains from Chapter 6.5 enhances the integrity of the gathered data and contributes to collective archaeological knowledge. The research on FCC bone material and *tarand* cemeteries is a continuous process and the more quality data we gather and record, the more we can determine and learn. Currently, the amount of comparable data is quite limited, but future archaeologists will likely have access to more information and advanced methods.

In conclusion, FCC bone material is invaluable for understanding Early Iron Age communities as well as many other societies where commingling, fragmentation and cremation of the ancestors' bone material was common. While advancements in methodologies are rapidly evolving and providing more information, the limitations must be acknowledged. There is more to analyse also in legacy collections due to observer bias and the constantly evolving methods. Proper documentation and standardized methods are crucial for making osteological data comparable and reusable. This ensures that even if recording standards change, existing data can be partially reassessed rather than requiring complete reanalysis. That way future research can build on the current findings, ultimately enriching our knowledge of the past.

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SUMMARY IN ESTONIAN

Tuhast tõusnud tõlgendused: fragmenteerunud, segatud ja põlenud inimluud Eestis rooma rauaaja (50–450 m.a.j) tarandkalmete näitel

Käesolev doktoritöö on põhjalik uurimus Eesti rooma rauaaja (50–450 m.a.j.) tarandkalmetest ja seal leiduvatest fragmentaarsest, segatud ning põletatud inimluudest. Töö eesmärk oli analüüsida seniseid ja **edendada fragmentaarsete, segatud ning põletatud luumaterjali uurimise praktikaid**, et saada põhjalikumat teavet tolleaegsete inimeste, nende matmisrituaalide, muude tavade ja ühiskonna kohta. Väitekirja eesmärk oli **välja tuua ka materjali ja selle uurimiseks kasutatavate meetodite võimalused ning piiratus** ja **välja töötada parimad praktikad fragmentaarsete, segatud ja põletatud luumaterjali dokumenteerimiseks ja analüüsimiseks, et maksimeerida tulevaste uuringute potentsiaali**. Uurimuse peamine fookus oli tarandkalmetel ja põletatud luudel, kuid et põletatud luud kalmistutes on enamasti ka fragmentaarsed ja segatud, käsitlesin ka neid aspekte.

Taust ja uurimislugu

Tarandkalmed on Eesti põhja- ja lääneosas levinud kivikonstruktsioonidega matmispaigad, mis olid kasutuses alates 8. sajandist e.m.a. kuni 5. sajandini m.a.j. Tarandkalmete ehitamise ja kasutamise kõrgaeg oli rooma rauaajal, mil matmiskombestiku oluline osa oli surnute põletamine tuleriidal. Rooma rauaaja e tüüpilistest tarandkalmetest leitud inimluud on enamasti fragmentaarsed, segatud ning põletatud.

Põlenud, fragmenteerunud ja segatud inimluid leiab ka teistsugustest kalmetest. Mõnes kalmes on luud fragmenteerunud, mõnes nii fragmenteerunud kui ka segatud ja mõnes on luuda lisaks eelnevale ka põletatud. Samas on ka matmispaikasid, kus ühe inimese säilmed on küll põletatud ja selle tõttu ja fragmenteerunud, kuid näivad olevad asetatud ühte lohku või anumasse ega ole segatud kellegi teise säilmetega. Põlenud, fragmenteerunud ja segatud luumaterjali teaduslik potentsiaal on olnud pikalt alahinnatud. Lääne- ja Põhja-Euroopas on taolist materjali põhjalikumalt uuritud juba pool sajandit, kuid Eestis hakati teemaga tõsisemalt tegelema pärast iseseisvuse taastamist.

Eestis on raske hinnata arheoloogiliselt välja kaevatud põletusmatuste arvu, kuid alates 19. sajandist on kaevatud üle 50 tarandkalme. Kuni 1970. aastateni jõudsid luud kaevandist hoidlasse pigem juhuslikult ja neid ei analüüsitud osteoloogiliselt ega kontekstuaalselt. Pigem keskenduti tarandkalmetest pärit esemete või kalmete endi struktuuride uurimisele. Põlenud luude metoodiline analüüs algas Eestis 1993 aastal Viimsi I tarandkalme luude uurimisega. Hiljem on uuritud teisigi põletusmatustega matmispaiku ja üle vaadatud varasemalt kaevatud kalmete luid, kuid avaldatud uuringute arv on endiselt väike ning avalikult kättesaadavate luunimekirjade kogus veelgi väiksem.

Kaevamiste ja osteoloogiliste analüüside arvu erinevus tähendab, et meie arusaam tarandkalmete ja teiste fragmenteerunud, segatud ja põlenud inimluudega matmispaikadesse matnud kogukondadest põhineb peamiselt hauapanuste ja -konstruktsioonide analüüsil. Sellest murekohast koorus ka üks selle doktoritöö eesmärkidest – rõhutada, et fragmenteerunud, segatud ja põlenud luud on väärtuslik arheoloogiline allikas ja ühtegi kalmistut ei tohiks uurida ilma luumaterjali kaasamata. Sealjuures peab dokumentatsioon olema jätkusuutlik, et tagada andmete kättesaadavus ja võrreldavus tulevasteks uuringuteks.

Teoreetiline taust

Lisaks põlenud, fragmenteerunud ja segatud luude uurimisele on oluline mõtestada, mida erinevad ilmingud võivad tähendada, kuidas neid interpreteerida. **Fragmenteerunud** materjali juures on vajalik teada, mis põhjustas luude purunemise, kas tegu oli loodusliku või tahtliku, eesmärgistatud protsessiga. Laguprotsesside uurimisega tegeleb tafonoomia, mille abil on võimalik eristada, mis on organismi mõjutanud ning kuidas ja seeläbi hinnata, kas tegu on loomuliku loodusliku lagunemisega või on protsessis näha ka kultuurilisi mõjusid. Näiteks, luud võidi purustada meelega, selleks, et need paremini matmiseks mõeldud anumasse mahutada. Tuleb meeles pidada, et fragmenteerumine võis toimuda ka kogemata, näiteks kui õrna luud transporditi. Fragmenteerumise tekkepõhjuse tuvastamine arheoloogilise materjali põhjal võib olla keeruline ning eriti komplitseeritud on mõista, kas inimese tekitatud vigastused luudel on seal kogemata või mingi konkreetse eesmärgiga.

Segatud luumaterjali on mõningatel juhtudel võimalik taas kokku sobitada. Kui luude hulk ja kalmistu ala on suured, saab osteoloogiliste meetodite abil kindlaks teha minimaalse indiviidide (MIA, ingl. k. MNI) arvu ning koguda ka lisateavet maetute soo, vanuse ja tervise kohta. Lisaks annab segatud luumaterjali uurimine infot matmiskombestiku kohta – kus ja millised luud paiknesid võib viia nii uute järeldusteni kui ka kinnitada seniseid tõlgendusi. Samas tuleb olla ettevaatlik, sest ka pealtnäha mitte segatud luud võivad olla segatud. Näiteks, matuseurnidest, milles osteoloogilise analüüsi järgi on võimalik eristada vaid ühe indiviidi säilmeid, on põhjalikumate laboriuuringutega avastatud, et urni on kasutatud mitmel ajaperioodil mitme inimese säilmete matmiseks.

Arheoloogilised **põletusmatused** annavad samuti rohkem teavet kui vaid osteoloogilist infot. Surnute põletamise komme nõuab tehnilisi teadmisi, nii et edukalt põletatud matusest saame teha järeldusi ka matjate oskuste ja mõttemaailma kohta. Samuti tuleb meeles pidada, et põletusmatuste puhul võime suure tõenäosusega leida sama indiviidi luid mitmest kohast, sest surnuid ei ole reeglina põletatud kalmel. Millised olid ja kus on asunud vanema rauaaja tuleriidad, ei ole teada, sest Eestis ei ole seni leitud samaaegse tarandkalme ja tuleriida kompleksi.

Materjal

Keskendusin kahele juhtumuuringule: Viimsi I ja Aakre Kivivare tarandkalmetele ning sealsele luumaterjalile. Mõlemas kalmes on luud tugevalt fragmenteerunud, segatud nii omavahel kui ka esemeleidudega (nt savinõude killud, ehted, üksikud tarberiistad) ja sageli ka põletatud. Viimsi I tarandkalme uuriti läbi 1990. aastal, luumaterjal oli läbi vaadatud mõni aasta hiljem, ent avaldatud oli vaid luu-uurimise tõlgendused ilma luude nimekirjata e osteoloogilise analüüsi dokumentatsioonita. Aakre Kivivare tarandkalme kaevati osaliselt 19. sajandi lõpus ning seejärel 2014. aastal kaasaegsete dokumenteerimise põhimõtete järgi.

Meetodid

Töös keskendusin ressursi piiratuse tõttu peamiselt **osteoloogilisele analüüsile**, kuid tutvustasin ka teisi meetodeid (demograafia, statistika, ruumianalüüs, radiosüsinikdateerimine, FTIR e Fourier' teisendusega infrapunaspektroskoopia, erinevad isotoopanalüüsid), mida olen kasutanud või mida on mujal põletusmatuste uurimisel edukalt rakendatud (Tabel 5.1). Selleks, et põlenud, fragmenteerunud ja segatud luid saaks võimalikult põhjalikult analüüsida, tuleb juba välitöödel materjal võimalikult täpse kohainfoga dokumenteerida. Samuti tuleb igal juhul läbi viia esmane osteoloogiline analüüs, mis kirjeldaks põgusalt iga leitud fragmenti ning võimalusel oleks tuvastatud luu, selle omaniku sugu ja vanus ning kirja pandud muud tähelepanekud näiteks patoloogiate või luude põletuse kohta.

Osteoloogiline analüüs on omakorda aluseks teistele analüüsimeetoditele. Luude nimekirja alusel saab välja valida sobilikud luukatked edasisteks põhjalikumateks laboriuuringuteks. Välitööde dokumentatsiooni ja luude analüüsi kombineerides saab, näiteks, kasutada nii **statistilise**- kui ka **ruumianalüüsi meetodeid**. Samuti võib luude **strontsiumi isotoopväärtuste** ja **radiosüsinikdateeringute** võrdlemisel osteoloogilist analüüsi täpsustada, eristada rohkem indiviide kui see on võimalik visuaalsete meetoditega. Luude täiendav analüüs võimaldab ka täpsustada luude põletust, näiteks **FTIR spektroskoopia** abil kuumusest tingitud muutuseid jälgides.

Tulemused

Seni uuritud tarandkalmete, sealhulgas kahe juhtumuuringu põhjal näib, et surnute põletamine toimus sageli väljaspool kalme ala. Tuleriida asemeid on Eesti arheoloogilises materjalis teada vähe ning kindla rooma rauaaegse dateeringuga tuleriidad seni puuduvad. Luud on tuleriida platsilt kokku kogutud ning kalmesse toodud. Mõlema kalme luude kogus oli minimaalse indiviidide arvu kohta väike. See tähendab, et osa inimluudest võib olla nende mitmesse kohta liigutamisel, sh hilisemate pinnasetööde käigus, hävinenud või ei ole kõiki luid tuleriida platsilt kokku korjatud. Samas, kalmete materjalis olid esindatud kõikide kehaosade luud, nii et matjad ei olnud matmisel eelistanud mõnda kehaosa teistele. Varase rauaaja matmiskombed võisid olla keerukad ja osa luumaterjali võis kaduda juba matuse käigus.

Mõlemad kalmistud näitasid, et tarandkalmed ehitati kogu kogukonna liikmetele, kuna neis oli erinevas vanuses inimesi ja esines ilmselt ka nii meeste kui ka naiste luid. Samas jääb lõpliku selguseta, kas tarandeid kasutanud kogukond oli vaid ühiskonna (elitaarne) osa ja kui oli, siis kus on ülejäänud surnud? Viimsi I ja Aakre Kivivare tarandkalmete võrdlus näitab ka mõningaid piirkondlikke erinevusi kalmete kasutuses ja matmispraktikates. Viimsi I luude analüüs näitas, et luud olid tõenäoliselt põletatud värskelt e mitte pikka aega pärast surma, kuid koljuluud olid tuleriidale jõudnud alles pärast mõningast lagunemist kas kivikalmes või mõnes muus hoiukohas. Aakre Kivivare luude põletus oli ühtlasem, viidates, et luud olid tõenäoliselt põletatud värskelt.

Viimsi I viitab mitme-etapilisele matmiskombestikule, mis peaks muutma uurijaid ettevaatlikuks tarandkalmete ja teiste põlenud, fragmenteerunud ja segatud luumaterjaliga kalmete osteoloogilise teabe tõlgendamisel. Ühe inimese luud võisid sattuda kalmistule nii põlenult kui ka põlemata kujul. See teeb omakorda keerulisemaks minimaalse indiviidide arvu määramise – kogu kalmest leitud materjali tuleb vaadelda tervikuna, põletatud ja põletamata leidude eristamine võib tähendada, et loetleme ühte indiviidi topelt. See omakorda võib mõjutada seni tehtud arvutusi populatsioonide suuruse kohta.

Aakre Kivivare uuringu põhjalik dokumentatsioon (GPS-koordinaadid, kihtide kaupa kaardistamine) näitas muuhulgas, et täpsem info väliuuringutel tähendab ka põhjalikumat luude nimekirja, mis omakorda lihtsustab luumaterjali edasisi analüüse – luud leiab üles lihtsalt ja lisa-analüüsideks sobiliku materjali eelvaliku saab teha juba nimekirja põhjal.

Parimad praktikad

Vajadust fragmentaarseid, segatud ning põletatud luid põhjalikult dokumenteerida on rõhutanud mitmed kohalikud teadlased ning rahvusvahelised juhised. Riiklikus seadusandluses ei ole dokumenteerimise standardeid küll kehtestatud, kuid on rõhutatud eeldust, et tuleb kasutada parimaid kättesaadavaid praktikaid. Samas on Eesti riik võtnud kohustuse tagada, et arheoloogilised kaevamised ja uuringud viiakse läbi teaduslikult, liitudes 1996. aastal Valletta konventsiooniga ja 2021. aastal Faro konventsiooniga. Tuginedes mujal kehtestatud standarditele, kättesaadavale metoodikale (vt peatükk 5, jn 5.3) ja oma analüütilisele kogemusele, olen koostanud Eesti materjalide vajadustele kohaldatud juhendmaterjali, mis kirjeldab fragmentaarsete, segatud ning põletatud luude uurimise parimat praktikat.

1) Kaevamisse ja dokumenteerimisse peab olema kaasatud osteoloog e luu-uurija (spetsialist, kellel on kas osteoloogiakraad või läbitud osteoloogia-alane praktiline täiendõpe). See tagab, et luud dokumenteeritakse viisil, mis võimaldab koostada põhjaliku osteoloogilise aruande. Osteoloogi kaasamine on oluline ka seetõttu, et väikesed fragmendid pinnases võivad jääda koolitamata silmale tuvastamatuks.

Osteoloogi kohustuseks on ka koostada esialgne osteoloogiline aruanne e sisuliselt leitud luude nimekiri, mis on aluseks edasiste analüüside jaoks materjali valimisele. Mõnel juhul nõuavad fragmentaarsed, segatud ning põletatud luud juba esialgse analüüsi käigus täiendavat uurimist, nt kui puuduvad diagnostilised fragmendid, mis viitaksid kas inimese või looma luudele või monoliit tuleks enne lahti puhastamist pildistada röntgeni või kompuutertomograafiga.

2) Luud ja leiud tuleb dokumenteerida *in situ* kihiti või kolmemõõtmeliste koordinaatide (x, y, z) järgi ning luude ja leidude omavaheline paiknemine tuleb dokumenteerida fotode, jooniste, 3D-skaneeringute ja/või fotogramm-meetria abil.

Iga *in situ* leitud luufragmendi jaoks tuleb registreerida kolm koordinaati (z-koordinaadi asemel võimalik ka kihi number). X, y ja z koordinaatide täpsuse tagamiseks peab kaevamiste varustusse kuuluma tahhümeeter või täppis-GPS seade. Sõelalt leitud luud tuleb dokumenteerida alade, kust sõelutud materjal pärines, kaupa. Sõelumise ruudud ei tohiks olla suuremad kui 1 m², soovitatavad on 50 × 50 cm või väiksemad kogumisalad.

Kalmistu struktuuride dokumenteerimiseks on soovitatav kasutada 3D-laser-skannerit, kuid piisavad on ka käsitsi joonistatud plaanid, rohked fotod ja foto-gramm-meetria tehnikate kasutamine.

Eraldi leitud luud peavad jääma ja olema pakitud eraldi ning luukogumid peavad jääma ja olema pakitud kokku. Juhtudel, kui erinevate kontekstide luud on "kokku kallatud" ilma iga fragmendi kontekstuaalset teavet hoolikalt säilitamata, kaotavad need luud osa infoväärtusest.

3) Kui võimalik ja vajalik, tuleb fragmentaarsed, segatud ning põletatud luud eemaldada pinnasest monoliidina ja puhastada lahti laboris. Kohapealne dokumenteerimine võib olla aeganõudev ja ilmastikutingimused ei pruugi seda toetada. Seega, kui luukogumid on asetatud anuma(te)sse, piisavalt mahukad, et takistada väliuuringu ajakava ja/või on dokumenteerimise standardeid *in situ* kaevamisel võimatu säilitada, tuleb kogum lahti puhastada laboris.

Monoliidi võtmise vajadust tuleks arutada projektiga seotud osteoloogiga, kes oskab hinnata, milline viis on luukogumile parim ning kes saab vajadusel ette valmistada monoliidi võtmise vahendid.

4) Kõik kogutud inimjäänused tuleb osteoloogiliselt läbi vaadata. Esmane osteoloogiline analüüs hõlmab luufragmentide kaalumist ja mõõtmist, nt sõela või nihikuga. Kõik luufragmendid tuleb kanda tabelisse või andmebaasi, võimaluse korral täpsusega skeleti elemendi kohta ja jagada täiendavalt skeleti piirkondadeks (kolju, luustiku kesktelg, ülemine/alumine jäse). Kõik demograafilised või patoloogilised andmed (soo või vanuse tunnuste ja luudel täheldatud kahjustuste kirjeldus) tuleb lisada tabelisse või andmebaasi. Põlenud luude puhul tuleb hinnata ka luude värvust ja selle põhjal luude üldist põletusastet. Kõik kasutatud meetodid peavad olema tabelis viidatud.

Väga väikeste tuvastamatute luufragmentide puhul tuleb dokumenteerida nende üldine kirjeldus (katke suurus, värv ja luu tüüp, kui võimalik).

Väiksemahuliste kaevamiste, nt proovikaevamiste või leirete puhul võib leitud materjal olla napp ja niivõrd fragmentaarne, et luud on morfoloogiliselt tuvastamatud. Nendel juhtudel võib inim- ja loomaluude eristamisel osutuda kasulikuks histoloogia.

Luude tabel või andmebaas on võrreldav leidude nimekirjaga. Tabelile peab järgnema lühike kirjalik aruanne, mis põhineb skeletielementide loendil, kus hinnatakse MIA ning määratakse võimalusel isiku vanus ja bioloogiline sugu. Arvestades, et arheoloogiat rahastatakse avaliku rahaga, peavad andmed olema avalikud ja neid ei tohi hoida isiklikes või muudes ligipääsmatutes arhiivides.

5) Luud tuleb pakendada viisil, mis väldib edasist segunemist. Soonkinnisega kotid on lihtne ja kättesaadav pakendamisviis, kuid nende hoiukarpidesse paigutamisel tuleb olla ettevaatlik. Haprad luud peaksid jääma ülemistesse kihtidesse või olema eraldi karpides, et vältida luude kahjustamist või isegi purunemist. Luumaterjali suure hulga korral tuleks tuvastatud luud pakkida tuvastamata fragmentidest eraldi ehk igasugune luude rühmitamine on teretulnud, et hõlbustada edasist analüüsi. Kõik eriliste omadustega luud (nt diagnostilised luud, patoloogilised tunnused või parimad luud edasisteks analüüsideks) tuleks samuti pakkida eraldi.

Samas tuleb meeles pidada, et kõikide, ka eraldi pakendatud luude juures peab säilima nende konteksti-info. Näiteks, juhul, kui ühe konteksti luud on pakitud eraldi väiksematesse kottidesse, võib luua sobiva indekseerimissüsteemi (nt kontekst 11 kott 1, kontekst 11 kott 2). Kõik sama konteksti luud tuleb hõlpsama juurdepääsu tagamiseks hoida koos kas suuremas kotis või eraldi karbis.

6) Kõik dokumenteeritud luud (isegi pisikeste fragmentide kogumid) peavad tabelis või andmebaasis olema seotud konteksti-infoga, et neid oleks võimalik hoidlast uuesti leida. Luude tabel või andmebaas (= leidude nimekiri) tuleb koos luumaterjaliga üle anda luuhoidlasse. Luude ülevaatamise korral tuleb uued tulemused koos vastava dokumentatsiooniga lisada luukogumit puudutava arhiivimaterjali juurde.

Kokkuvõte

Fragmentaarsete, segatud ning põletatud luude uurimisel saab tihtipeale teha rohkem, põhjalikumalt ja paremini, kui võimalusi on. Iga fragmenteeritud, segatud ja põletatud luudega matmispaiga uurimisel on aga vältimatu, et dokumenteeritakse põhjalikult nii leiud kui ka nende ruumiandmed, luud (ja esemed) kantakse nimekirja, nimekiri on kättesaadav dokumenteeritud. Sedamoodi on materjal kasutatav ka tulevikus. Juba selle doktoritöö kirjutamise ajal ehk viimase *ca* kümne aastaga on tekkinud mitmeid uusi põlenud luude analüüsivõimalusi. Seega, suure tõenäosusega pöörduvad arheoloogid uute küsimuste või samade küsimuste ja uute meetoditega luuhoidlate materjali korduvalt uuesti analüüsima. Meie ülesanne siin ja praegu on teha kõik enesest olenev, et fragmentaarsed, segatud ning põletatud luud oleksid jätkusuutlikult dokumenteeritud.

PUBLICATIONS

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Other Scientific Publications:

Lillak, A; 2024. Kalana kabelikoha ja kalmistu kaardistamine. Muinsuskaitse aastaraamat, 2023.

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