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To my father, husband, and son

ABSTRACT

The thesis “Persistent practices. A Multi-Disciplinary Study of Hunter-Gatherer Mortuary Remains from c. 6500–2600 cal. BC, Estonia” focuses on the question of how death was handled within and among hunter-gatherer communities in Estonia. The study departs from the human remains – both intact skeletons and loose human bones in occupation layers – bringing the human body to the foreground to detect mortuary practices through the lens of archaeo-thanatology, and to recreate the primary identities of these people by the application of osteological methods and stable isotope studies. The time depth is provided by the radiocarbon dates of bone collagen.

It is shown that all the human remains belonged to inland fishers and coastal hunters of marine mammals, indicating the importance of hunting and gathering subsistence until the mid of 3rd millennium cal. BC. Burials contained the remains of both females, males, and adults and children of all age groups.

The long temporal perspective allowed observing the continuum and change of practices. As indicated by the archaeothanatological analyses, a range of practices were considered as norm. Only a fraction of the population received archaeologically observable handling; the vast majority of these constitute primary inhumations in a variety of body positions either with or without grave goods. Also, clear evidence of practices in multiple episodes was demonstrated. The deceased had been placed in the ground of contemporary settlement sites, cemeteries, and solitary graves close to the hunter-gatherer pathways. However, instead of stressing the differences in grave goods, or in places for the dead, and/or variability in body positions, it is stressed that a unchanging pattern of underlying norms of mortuary practices persisted from the first evidence of mortuary remains in c. 6500 cal. BC until the mid 3rd millennium cal. BC. This core of practices was formed by the immediate handling of the dead, primacy of the corpse, absence of clear separation between life and death, and open character of the mortuary practices that allowed the maintenance and gradual change of mortuary rituals within and among hunter-gatherer communities.

Key words: mortuary practices, practice theory, body as material culture, archaeothanatology, carbon and nitrogen stable isotopes, radiocarbon dates, hunter-gatherers, Stone Age, Estonia

Käesoleva töö “Persistent practices. A Multi-Disciplinary Study of Hunter-Gatherer Mortuary Remains from c. 6500–2600 cal. BC, Estonia” [“Praktikate püsivus. Multidistsiplinaarne uurimus küttide ja korilaste matustest Eestis, ajavahemikul 6500–2600 eKr“] keskmes on küsimus, kuidas kohtlesid kiviaja kütid ja korilased surnuid. Lähtun surnukehast, õigemini selle materiaalsetest jäänustes, milleks siin on terviklikud luustikud ja üksikud inimluud asulate kultuurkihtides. Matmispraktikaid rekonstrueeritakse arheotanatoloogia abil

ning surnute esmaseid identiteete osteoloogiliste meetodite ja stabiilsete isotoopide analüüside kaudu. Luu kollageenist tehtud radiosüsiniku dateeringud annavad uurimusele ajalise sügavuse.

Stabiilsete isotoopide uuringud näitavad, et vaadeldud inimluud kuuluvad sisemaa kalastajatele ja ranniku küttidele. See omakorda näitab, et kuni 3. aastatuhande keskpaigani eKr oli püügimajanduslik elatusviis määrava tähtsusega, lubades töös vaadatud surnuid koondada ühisnimetaja kütid ja korilased alla. Arheoloogiliselt nähtavad matmispraktikad said osaks nii naistele, lastele, kui ka meestele.

Pikk ajaline perspektiiv lubab jälgida nii praktikate püsivust, kui ka muutusi. Arheotanatoloogiline analüüs näitab, et aktsepteeritava normi moodustas hulk erinevaid praktikaid. Kusjuures suur osa toonastest rituaalidest jääb tabamatuks. Arheoloogiliselt jälgitavatest praktikatest domineerib esmane laibamatus, samas tõestati ka mitme-episoodiliste matuste olemasolu Eestis. Surnuid sängitati nii asula kultuurkihti, kalmistutele, kui ka üksikmatustena asustusest eemale. Hoolimata mitmetest erinevustest rõhutatakse töös, et matuserituaalide põhisisu säilis ajavahemikus 6500–2600 eKr suures osas muutumatuna. Selleks muutumatuks tuumikuks võib pidada kohest tegutsemist surma ilmnemisel, surnukeha kesksust praktikate läbiviimisel, elevate ja surnute maailma ranget eraldamatust ja praktikate avatud iseloomu, mis võimaldas nende säilimise ja järk-järgulise muutumise ligi nelja aasta tuhande jooksul.

Võtmesõnad: matmispraktikad, praktikate teooriad, keha materiaalse kultuuri osana, arheotanatoloogia, süsiniku ja lämmastiku stabiilsed isotoobid, radiosüsiniku dateeringud, kütid ja korilased, kiviaeg, Eesti

Die vorliegende Promotionsschrift “Persistent practices. A Multi-Disciplinary Study of Hunter-Gatherer Mortuary Remains from c. 6500–2600 cal. BC, Estonia” [dt. „Beständige Praktiken. Eine multidisziplinäre Studie zu den Bestattungsüberresten von Sammlern und Jägern von ca. 6500–2600 cal. BC in Estland“] stellt die Frage in den Mittelpunkt, wie mit dem Tod in und zwischen Jäger-Sammler-Gemeinschaften in Estland umgegangen wurde. Die Studie nimmt ihren Ausgang in den menschlichen Überresten – sowohl in Form intakter Skelette als auch einzelner menschlicher Knochen aus Besiedlungsschichten. Sie rückt dabei den menschlichen Körper in den Vordergrund, um aus dem Blickwinkel der Archäothanatologie den Praktiken in der Totenbehandlung nachzugehen und um auf diese Weise durch die Anwendung von osteologischen Methoden und Studien zu stabilen Isotopen die ursprünglichen Identitäten dieser Menschen nachzuzeichnen. Die zeitliche Tiefe der Studie wird durch Radiokarbondaten von Knochenkollagen unterstützt.

Es kann gezeigt werden, dass alle menschlichen Überreste zu Fischern des Binnenlandes und zu küstenbezogenen Jägern von Meeressäugern gehören; dies deutet auf die wichtige Rolle hin, die der Jäger-Sammler-Subsistenz bis zur Mitte des 3. Jahrtausends cal. BC. zufiel. Die Bestattungen enthielten die Reste

sowohl von Frauen als auch von Männern, darunter Erwachsene und Kinder aller Altersgruppen.

Die lange zeitliche Perspektive ermöglichte die Betrachtung von Kontinuum und Wandel von Praktiken. Wie durch die archäothanatologische Analyse angedeutet, wurde eine Reihe von Praktiken als Norm aufgefasst. Nur ein Bruchteil der Population erhielt nach dem Tod eine Behandlung, die archäologisch fassbar ist; die überwiegende Mehrheit davon stellen dabei Körperbestattungen in primärer Lage dar, die eine Vielzahl an Körperpositionen aufweisen und mit oder ohne Grabbeigaben versehen sein konnten. Ebenso können Nachweise für Praktiken, die sich aus mehreren zeitlichen Abschnitten zusammensetzen, aufgezeigt werden. Der oder die Verstorbene war in den Boden eines gleichzeitig genutzten Siedlungsareals, eines Bestattungsplatzes oder als Einzelgrab in der Nähe zu den von den Jägern und Sammeln genutzten Pfaden eingebracht worden.

Anstelle jedoch das Gewicht auf die Unterscheide in den Grabbeigaben, in den Orten für die Verstorbenen oder in den Körperpositionen zu legen, wird vielmehr betont, dass ein sich nicht veränderndes Muster von zugrundeliegenden Normen von Praktiken im Umgang mit den Verstorbenen von den ersten Nachweisen von Bestattungen ca. 6500 cal. BC bis zur Mitte des 3. Jahrtausends cal. BC fortbestand. Der Kern dieser Praktiken wurde durch die folgenden Punkte geformt: die unmittelbare Behandlung der Verstorbenen, die Vorrangstellung des menschlichen Körpers, das Fehlen einer klaren Trennung zwischen Leben und Tod sowie die offene Ausprägung der Bestattungspraktiken, die sowohl den Erhalt als auch den graduellen Wandel der Bestattungsrituale innerhalb und zwischen den Jäger-Sammler-Gemeinschaften ermöglichten.

Key words: Praktiken der Totenbehandlung, Theorie der Praxis, Körper als materielle Kultur, Archäothanatologie, stabile Kohlenstoff- und Stickstoffisotope, Radiokohlenstoffdaten, Jäger und Sammler, Steinzeit, Estland.

(German translation by dr. Andreas Rau)

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Many of the above-acknowledged people have become friends of mine. However, there are some friends and colleagues whose help may not have been *so straightforward, nevertheless, I feel grateful to them of being part of my journey. I am thankful to all my colleagues with whom I have had conversations during the lunch breaks in the kitchen of AZA. Among others I thank Aikaterini Glykou, Susan Harris, Carl Heron, Wolfgang Lage, Harald Lübke, Elena A. Nikulina, Kenneth Ritchie, Krzysztof Patalan, Ulrich Schmölcke, Tereza Štolcová, Markus Wild, and Katja Winkler. I will be missing these chats! Helge Erleknkeuser, Amy Gray Jones, Fredrik Hallgren, Isabella von Holstein, Rachel Howcroft, Ulla Kadakas, Liis and Taavi Kahju, Åsa Larsson, Aimée Little, Liis Livin, Lembi Lõugas, Kristiina Mannermaa, Reet Marits, Sven-Erik Peterman, Triin and Keijo Preem, Kristel and Raido Roog, Doris Rohwäder, Antero Ronk, Kristjan Sander, Maarja Savan, Anti Selart, Alicia Ventresca-Miller, Anna Wessmann, Ilga Zagorska, and Joanna Zygo, have all influenced or helped me in one way or another. Thank you for that!*

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It has been an adventurous journey. As a researcher I am delighted to present the results of this journey in the book that you are holding. As a person I am grateful to the opportunity to have met each one of you during this journey.

I hope you enjoy the book.

Tartu, 13th November 2015

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CHAPTER 1. INTRODUCTION

Then, in a loud, clear voice he made a sudden announcement:
"The council and I have arrived at a decision."
The chief paused as if to find the strength to voice his next words.
"We are going to have to leave the old ones behind."
(Wallis 2013[1993], 12)

The story about two elderly Athabascan Indian women abandoned and left to die by their own people during a winter famine, written by Velma Wallis (2013[1993]), first attracted my attention with its vivid and realistic, yet heart-warming descriptions about the lives of mobile hunter-gatherers. I was astonished by the tough decision made by the council and the chief, yet admired the strength and wisdom the women possessed to deceive death. I have had this story in the back of my mind for years now. Although the two old women survived the winter, it seems appropriate to return to it here in my thesis about mortuary practices of Stone Age hunter-gatherers. The scenes that Wallis depicts in her story could have easily been part of the everyday practices of Stone Age hunter-gatherers, whom have been my fascination in archaeology since the time I decided to become an archaeologist.

1.1. From the pioneer studies of hunter-gatherers to the onset of the thesis

Many researchers before me have taken interest in hunter-gatherer societies in Estonia. Thus, this thesis is by no means the first study of Stone Age burials from Estonia[1]; quite the contrary I will re-analyse the work done by previous generations to reach a more dynamic understanding of hunter-gatherer mortuary practices. Despite the abundance of the works conducted previously, this is the first attempt to describe single mortuary practices and through these approach the core of the hunter-gatherers' mortuary repertoire. Due to the availability of summarising works about the research history of Stone Age (Jaanits 1991; Kriiska 2006; Kriiska & Lõugas 2006; Lang 2006; Lang et al. 2010; Johanson et al. 2013; Johanson & Tõrv 2013), and burials more specifically (Indreko 1935a; Lõhmus 2005), I will only highlight the general trends in the study of burials. However, as the burial data derive mostly from the works of preceding studies, making them integral to following analyses of practices, several aspects of previous research will be discussed separately within each case study.

1 Clearly modern borders were irrelevant for past hunter-gatherers but for the development of research histories, these borders were sometimes significant, and often the availability of material also depends on these constructions. Here, the study area is chosen within the limits of the modern state of Estonia, which is henceforth referred to simply as Estonia.

The beginning of the research of Stone Age burials (inhumations) in Estonia reaches back to the last decades of the 19th century. However, the majority of the studies can be dated to the 20th century; foremost, to the first half of it (Figure 1). Although burials have been studied for more than a century, their interpretations have always been middling compared to other elements of material culture. The focus of Stone Age research in Estonia, as in other places in Europe (since Clark 1952; Conneller 2011, 358), has been on technological, economical, and settlement archaeology (see Kriiska 2006).

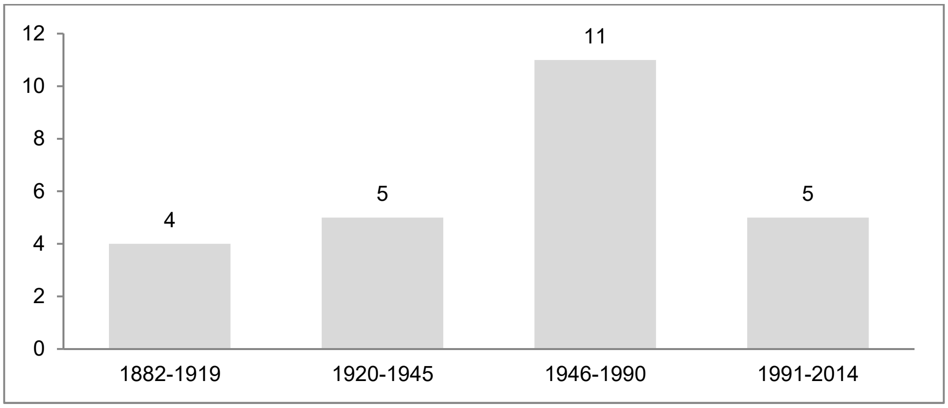

Figure 1. The number of excavations on hunter-gatherer burial sites over time.
The total number of sites does not correspond to the known sites with human remains as several sites were excavated by various researchers and through several decades.

The research on Stone Age inhumations has been positivistic in its essence; therefore, mostly quantitative methods have been applied. The focus has been on describing burial data (Hausmann 1904; Indreko 1935a; Jaanits 1957a), on artefact typologies (Jaanits et al. 1982; Ots 2006), questions related to (ethnic) identities (Moora 1935; Jaanits 1956a; Mark 1956; 1970a, b; Lang 2001), and on religion (Jaanits 1961a; Kulmar 1992a–c; 1994; Jonuks 2009). Thus, mortuary practices as such have not been studied thoroughly yet, except my own first attempts to do so (Lõhmus 2005; 2007; 2008).

Unlike in Anglophone mortuary archaeology, there has not been a clear paradigm change in Estonian archaeology. Estonian mortuary archaeology has developed among similar trends as those in German speaking world (see Härke 1997; 2000; Hofmann 2013). Despite the rather homogenous theoretical background of the previous research, three separate research epochs based on the main focus of the studies could be differentiated:

(1) The period between the end of the 19th century to the 1920s is characterised by descriptive approaches. The beginning of the research of Stone Age hunter-gatherer burials is related to the Baltic German

intelligentsia both associated to the University of Tartu and learned Estonian societies. As Baltic Archaeology was not part of the curriculum at the University of Tartu[2] at the end of 19th century and beginning of the 20th century (Lang 2006, 15), the researchers engaged with archaeology during the period under discussion, thereby, had no professional background in archaeology. The first hunter-gatherer burials were found in 1882 at Kivisaare (excavated by several scholars: Martin Bolz, Richard Hausmann, Max Ebert, and Benno Ottow); the sites of Külasema Metsikumäe and Kõljala at Saaremaa were discovered at the beginning of 20th century by local landlords (Table 12). Unfortunately, the majority of these burials has not been excavated meticulously, but rather just documented based on the statements of locals, who had made the discoveries or had heard about the finds from their relatives. Not only were the recovered materials documented archaeologically, but the pioneering archaeologist co-operated with medical doctors (Carl Fürst, Eduard Glück, Eber Landau, Aleksander Rosenberg, and Richard Weinberg) who determined the age and sex of the skeletons (see Weinberg 1904; Ottow 1911; Fürst 1914; Bolz 1914). The outbreak of World War I ended the research conducted by Baltic German scholars as all the German societies were closed in Russia, which Estonia formed part of, from 1914 onwards (Lang 2006, 19).

The study of graves at the beginning of 20th century played an important role in the development of Stone Age archaeology. The work of the scholars concentrated on data collecting through archaeological excavations or documenting the oral statements of locals. Despite the fact that most graves were described retrospectively, a documentation canon was established that in some cases was more careful than the ones used by the following generations (in more detail *Chapter 4.2.*). The inclusion of anthropological analyses and the lack of grave goods enabled a more balanced presentation of skeletons and the grave inventory accompanying them (e.g. Ottow 1911; Bolz 1914; but see Hausmann 1904).

(2) The following phase, which started with the establishment of the archaeology professorship at the University of Tartu, entails the years of independent statehood, Soviet occupation, and regained independence, extending from 1920 to 2000. Despite the long duration and varying political background, all studies on Stone Age burials could be characterised as descriptive-classifying. The classifying aspect of the research is tightly related to the archaeological excavations and the resulting increase in the source material.

From here on, the study of Stone Age burials was conducted by professional archaeologists. However, the number of archaeologist was

[2] Archaeology was understood primarily as classic archaeology, and it was taught together with Greek and Roman philology (Lang 2006, 15).

small – only one or two were engaged with Stone Age research per generation. The first professional archaeologist dealing with Stone Age burials was Arne Mikaël Tallgren, the first archaeology professor at the University of Tartu. He continued excavations at Kivisaare (Tallgren 1921) and wrote a miscellany about the prehistory of Estonia suggesting that due to the scantiness of the sources and lack of educated personnel the study of Stone Age graves should be undertaken in the future (Tallgren 1924, XIII). The main contribution of Richard Indreko, the disciple of Tallgren, was the discovery of the Tamula burial site and its first excavations (Indreko 1939a; 1942; 1943; 1945), the systematisation of Stone Age graves (Indreko 1935a), and while in exile (see Johanson & Tõrv 2013), the introduction of the Estonian material to western archaeology (Indreko 1964; in more detail about Indreko's research see Johanson et al. 2013). Lembit Jaanits was the next who dealt with Stone Age (about his research and career see Tõnisson & Kriiska 2000; Kriiska 2006, 64pp). The burial sites that Jaanits excavated most in comparison to other researchers, however, formed only a small portion of his legacy. During the last decades of Soviet Era and the beginning of the regained independence, research on hunter-gatherer burials was almost entirely neglected (excl. Kulmar 1992a–c; 1994).

The period between 1920 and the end of the previous millennium was the most extensive era of excavations; moreover, research excavations outnumbered rescue excavations. The documentation canon established by the pioneering researchers was taken over by the professional archaeologist, and despite the absence of textbooks for modelling, these remained the same throughout this period. The emphasis was mainly put on documenting the spatial relations of grave goods.

The increase of material and engagement of anthropologists (Juhan Aul, Karin Mark, Georg Martinoff, and Richard Weinberg) diversified the research; the focus here was on the social and religious aspects of the burial data. The chronological relations of various types of burials became important: a clear distinction between Combed Ware and Corded Ware burials was made (Indreko 1935a; Jaanits 1956a). The dissimilarities of these two groups encouraged discussion over the origin (i.e. ethnicity) of these people (Tallgren 1922; Moora 1936; Ariste 1956; Jaanits 1956a; Mark 1956; 1970a, b; Moora 1956; Jaanits et al. 1982; Jaanits 1992). Also the questions of religion (Jaanits 1961a; Kulmar 1992a–c; 1994), typological relations of grave goods (Indreko 1945; Jaanits 1957a), and questions about the local fauna (Lõugas 1997) were addressed.

(3) Investigating material found from graves rose to the focus of researchers again during the 2000s. Differently from the two preceding periods, excavations played only a minor role here (excl. Kivisaare: Kriiska & Johanson 2003; Kriiska et al. 2004; Veibri: Johanson et al. 2006–2011; Kriiska et al. 2007; Allmäe 2011), thus data unearthed

previously were re-analysed. Together with the increased number of researchers, also the topics of interest shifted and became more focussed on particular subjects. Mirja Ots analysed the amber inventory of graves (Ots 2003; 2006), Kristiina Mannermaa incorporated bird bones from Estonian Stone Age graves into her study about the importance of fowling in the Baltic Sea region (Mannermaa 2008), and Tõnno Jonuks (2009) focussed on the reconstruction of prehistoric religion based mostly on grave inventory. The work conducted by anthropologists has mostly been initiated by archaeologists, thus these still concentrate on the sex and age determinations (Allmäe 2006); only in one article have pathologies been discussed (Allmäe 2011). The interest on the origin of the people was largely neglected (Lang 2001; Kriiska 2004). A common denominator to the approaches of this period could be explanatory-interpretive.

Despite the long and eventful research history of the Stone Age burials in Estonia, mortuary practices have never been the focus of these studies. Thus, my thesis has a twofold aim: firstly, it will provide a comprehensive understanding about single mortuary practices of Late Mesolithic and Neolithic hunter-gatherers in Estonia, introducing relatively unknown material to a wider academic audience. Further, the consistent methodological basis of the analyses (*Chapter 3.1.*) allows for a more rigorous comparison between other hunter-gatherer burials in Europe and elsewhere. The 'thick description' of single practices is the departure point for further discussions about the attitudes towards the body, and mortuary rituals in general.

Secondly, I would like to stress the potential and value of old excavation data (see e.g. Schulting 1996; Konsa in prep.) through a critical evaluation and application of a range of approaches to bring more dynamics to our understandings about past practices, people, and societies in general. Despite the incompleteness of our sources, we should not be frightened to re-analyse old materials, instead we should value this kind of analysis due to their non-destructive nature.

1.2. Research questions

To fulfil the first aim, the question of how death was handled in hunter-gatherer societies during the Late Mesolithic and Neolithic in Estonia is posed. What was the norm throughout the c. 4 millennia time span? Did it change and if so, how? To get to the core of this question, the research question is divided into smaller sections. Thus, the following questions will be discussed in this thesis:

- What kind of burial practices could be distinguished in hunter-gatherer societies?
- How was the body handled during the mortuary practices?

- Which were the primary identities of the individuals treated in the ways that left material evidence in the archaeological record? Did different people receive different mortuary practices?
- Whether and to what extent mortuary practices change during the c. 4 millennia under study here.

1.3. Outline of the thesis

To answer these questions the thesis is divided into six core chapters (*Chapter 2–7*) and summary. Here in the introduction I will provide the background and outline the study.

In the second chapter the theoretical standpoints that have influenced the choice of research questions will be discussed. I will elaborate on the concept of the human body as part of material culture and its relation to human remains and thereto to mortuary practises and primary identities (sex/age and diet). Moreover, the analytical category of hunter-gatherer and its application to the here-observed human remains will be discussed briefly. As the aim of the thesis is to grasp the normative practices in handling the deceased, one cannot avoid discussing the relation between single practices described through an archaeo-thanatological lens and a more general understanding of mortuary repertoire of hunter-gatherers during the Late Mesolithic and Neolithic. The mechanisms behind the cultural dynamics (*status quo* or change) in that respect will be discussed.

In the third chapter, the methods of studying human remains are introduced, together with a discussion about the potential of re-analysing old excavation data and the limitations in doing so. The osteological and biochemical methods help reconstruct the physical qualities of the human remains together with their temporal setting, revealing answers about the interred people. The post-excavational archaeothanatological work provides a 'thick description' of single mortuary practices, being crucial in addressing the main question of the thesis.

In the fourth chapter, I will introduce the background of the source material by giving an overview of all the sites with human remains – both intact burials and loose human bones – known in Estonia. The available sources are evaluated critically and thus not all the sites introduced there will be subsequently analysed in depth either in *Chapter 5* and/or *Chapter 6*. However, the neglected sites serve as a background to the discussion over general patterns and norms in hunter-gatherer mortuary rituals (*Chapter 7*).

The fifth chapter presents the physical characteristics of the human bone collection. The preservation of the osteological material, together with age and sex assessments and the estimations about minimum number of individuals, are presented. Moreover, the dietary identities of the people are discussed in light of stable carbon and nitrogen isotope analyses. The results of these analyses provide a primary identity – physical and biological – of the deceased, whom were treated in a way that leaves material traces in the archaeological record.

This chapter also includes a discussion over the radiocarbon dates of single burials in order to provide the readers with a more coherent chronology of mortuary practices.

The sixth chapter is without any doubt the most exhaustive one, as single practices that become observable through archaeothanatological analysis are presented. The qualitative analysis of single features with human remains provides us with the details of differences in the handling of the corpses, and the presence of the additional structures in graves is demonstrated by relevant examples. One, however, should bear in mind from the beginning that the most often discussed grave goods are not considered as part of mortuary practices here (about their significance see Jaanits 1961a, 51, 59, 62; Lõhmus 2005; Jonuks 2009, 122, 125pp). This does not mean that they did not have their role in hunter-gatherer burials, but the majority of them probably were part of the funerary dress and thus need a different approach than the one chosen here (but see Duday 2009, 21pp).

The final chapter situates the practices described in *Chapter 6* along a time scale and tries to bridge the gap between the single practices evidenced through archaeothanatological analyses and the general ideas that structured the core of the mortuary rituals of hunter-gatherers. The final discussion focuses on the norm of mortuary rituals and their dynamics over the c. 4000 years. How was death handled in the hunter-gatherer communities? Were the observed variations temporal? Were these variations dependent on the primary identities of hunter-gatherers highlighted in *Chapter 5,* and, if so, to what extent? The main focus, however, is on establishing a list of structuring principles or a "common thread" that has previously been argued to be absent within the framework of hunter-gatherer mortuary rituals (e.g. Spikins 2010[2008]).

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Returning to the scenery described by Wallis, we could argue that the decision to leave people behind, even if rare, could have helped shape the outcome of the archaeological record and thus our understanding about the mortuary repertoire of hunter-gatherers. What if the abandonment of old and weak members of the group was not that rare at all? Had these two women died instead of surviving, what would have remained of them? Would we at all be aware of this story if they had not been strong enough to fight for their lives? One can pose more "what if" questions here, but the only way to find out whether such decisions might have been part of the handling of death in Stone Age hunter-gatherers communities at the eastern shores of the Baltic Sea is to get a comprehensive picture about the mortuary practices observable in the archaeological material. The latter can only be established when the method, theory, and chosen source material are in accordance.

CHAPTER 2. THEORETICAL OUTLINE OF THE STUDY – FROM MATERIALISED BODIES TO CORE OF PRACTICES

Despite the more than a century of research into human remains and other grave features in archaeology, I tend to agree with John Robb (2013, 441) who alleges that we have not had an archaeology of death. Interestingly enough, the most obvious and fundamental character of the mortuary remains – the mortuary rituals that created them – has been largely neglected in archaeology. The concept of death has not been theorised as an event or process (Robb 2013, 441); instead, archaeologists have discussed the socio-cultural aspects of the lives of past people based on their earthly remains. The research done within the framework of the culture-historical school of thought concentrated mostly on grave goods and craniometrics to establish the borders of various cultures or ethnic groups, while processual archaeology derived their interpretations from the Saxe-Binford hypotheses (Saxe 1970; Binford 1971) to reconstruct the social rank of the people during their lifetimes.

There has been a considerable shift from the positivist concept of mortuary remains that simply mirror the life of the deceased (*Spiegel des Lebens*; Haffner 1989 referred in Härke 1997) to a post-processual view that recognises how the burial data gives a distorted reflection of past societies (*Zerrspiegel des Lebens*) (Härke 1997; 2000), but questions about the concept of death and dying in prehistoric societies have arisen only recently (Nilsson Stutz 2003; Berggren & Nilsson Stutz 2010; Tarlow & Nilsson Stutz 2013). This is not to say that the research highlighting, for example political relations, social statuses, the gender and social age of the deceased, or questions about the perception of landscape through the analysis of mortuary data are of no importance. But discussing the structuring principles behind the mortuary deposits, i.e. the handling of the dead and mortuary rituals, opens up another avenue about past people and their societies.

Thus, to reconstruct the mortuary rituals of Stone Age hunter-gatherers some key concepts have to be discussed first. Because archaeology, with its common interest toward humans and their culture, is considered a social science, it would be rational to take a look at how death and its handling is described in other social sciences, mainly in anthropology. The findings in anthropology are based on the observations of lived customs and interviews with the participants, a possibility that we do not have in archaeology, which allows for a more thorough picture about mortuary rituals. In order to understand which concepts need to be clarified, let us consider a recent ethnographic example of the rural mortuary rituals of eastern Estonia at the end of 19th century and beginning of 20th century studied by Merike Lang (2004). In these rituals, traditional folk beliefs and customs were intertwined with the ecclesial norms associating the whole process with various omens and predictions.

The starting point of rituals is not the appearance of a deceased individual, but the time s/he is dying. The process of dying may take a long time and should preferably be accompanied by a neighbour or relative next to her/his death bed.

Immediately after the death the eyes and the mouth of the deceased needed to be closed to avoid the devil entering into the deceased body and to protect the mourners from the deceased to choose her/his follower. Moreover, all mirrors in the house needed to be covered to prevent the reflections of the deceased that would have trapped the soul of the deceased. Washing and dressing of the deceased were important aspects while preparing the body for its final journey.

After the preparation of the body the deceased was not immediately buried, but was kept in her/his home at least three days. According to assigned norms and practices (e.g. singing, playing, making jokes, eating special dishes, etc.) her/his body was guarded throughout this time. This intermediate time allowed the preparation of the coffin. The deceased was placed into it at least a day before the burial. Some artefacts (e.g. coins, tobacco bag, liquor etc.) were given to the deceased.

The whole family and village were engaged during the funeral day, making it the most important part of the of the mortuary ritual sequence. However, not all the relatives attended the procession and final interment of the deceased; instead they stayed at home, cleaned the house and prepared the funeral feast. Leaving home and the procession to the church and the cemetery were bound to several beliefs and preventive practices (e.g. putting a nail on the door sill, an animal sacrifice to the dead, misleading the deceased during the procession – e.g. turning the cart or cutting crosses into trees in southern Estonia). After the procedures in church, the procession continued to the cemetery where an open grave dug by some of the family members awaited. The coffin was opened before it was interred to ascertain that the deceased had not been turned during the procession. The procedure was led by the priest following the ecclesiastical norms. After the grave was backfilled it was important to seal the dead in the grave, and thus one pressed three times with one's heel to the grave mound. On occasions food was offered to the mourners at the cemetery. The funeral ceremony was completed with the ritual feasting at the house of the deceased in the same evening.

M. Lang's description above suggests that mortuary rituals should be considered as a dynamic process. A fuller understanding of these is obtained only when one begins the analysis with dying and death as these are part of the mortuary cycle. Archaeologists are capable of observing only fragments due to the specific nature of our sources; therefore, a comparative approach to the anthropological data is needed. The responses to death are acted out during the mortuary rituals that in the present work are seen through the lens of the practice theory approach of ritual practices established by Catherine Bell (1992; 2009[1997]) and elaborated by Liv Nilsson Stutz's archaeology of death (2003). Mortuary rituals are expressions of individual practices by which the norms behind the cultural practices can be observed. The key in understanding both the death and mortuary rituals is the deceased body itself that is characterised as being part of the material culture (Sofaer 2006), which grants the access to the deceased's primary identities (biological sex, age, and subsistence) and allows the reconstruction of mortuary practices. To understand the concepts of death and the deceased's body as the medium of this undertaking, one has to abandon the constructivist divide between biology (i.e. nature) and culture. Instead, through the body as a medium, the biological and cultural aspects are barely inseparable. Through the analysis of the body, the question of the dynamics between the *status quo* and the changes in mortuary rituals and their underlying norms throughout the four millennia will be discussed.

Before moving on with the theoretical concepts of body and mortuary practices let us consider the notion of 'hunter-gatherer' and the spatio-temporal frames of the present study.

2.1. Mesolithic and Neolithic hunter-gatherers

The studied area is located in north-eastern Europe on the eastern coast of the Baltic Sea and is delimited to the political borders of Estonia covering 43 432 sq. kilometres. By 2015, altogether 18 sites with human remains, including more or less intact skeletons (earlier referred to as burials) and loose human bones, have been found. This relatively small region allows exhaustive analyses to be conducted on single burials, and together with the less representative data and a general understanding about hunter-gatherer mortuary practices in Europe (however, parallels for archaeothanatological analysis come only from Skateholm I and II in Sweden, Vedbæk Bøgebakken in Denmark, and Zvejnieki in Latvia), a firm cultural context is formed to interpret the results of the analysis.

The time frame of the present study extends from 6500–2600 cal. BC (Figure 2), that is four millennia or roughly 160 generations. The time frame was established based on the radiocarbon dates of all the available human remains known from the primary study area that are not considered Corded Ware Culture burials. The beginning of the period was determined by the oldest dated human bone finds from Narva Joaorg. The end date derives from the corrected radiocarbon dates at Tamula and Naakamäe hunter-gatherer sites. It does not coincide with the emergence of the Corded Ware Culture or end of the Early Neolithic, but is c. 200 years younger. This indicates that two different traditions of mortuary rituals must have at least partly co-existed. However, this puzzle needs to be solved separately.

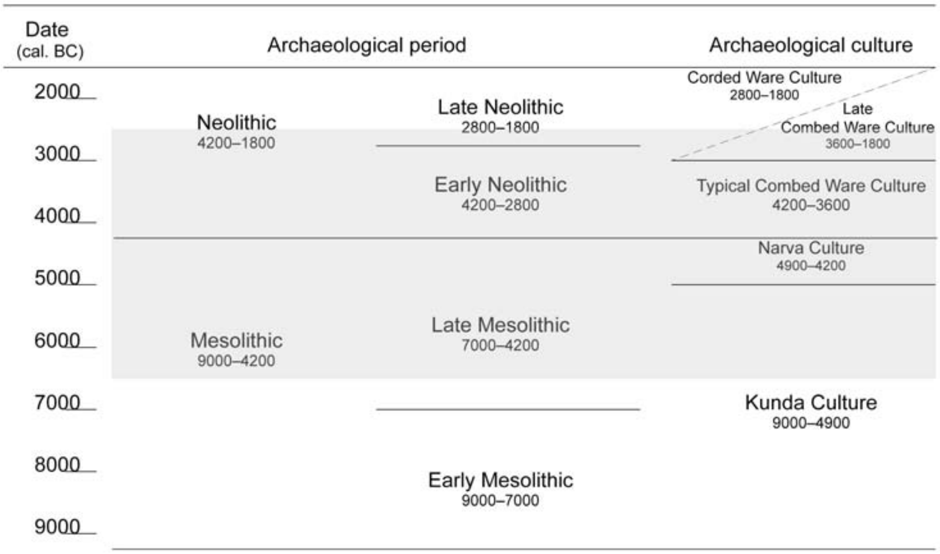

Figure 2. Current Estonian Stone Age chronology (after Kriiska 2009).
The grey area marks the time frame of the present study.

According to the current chronology of the Estonian Stone Age (Kriiska 2009; for other contemporary chronologies in the Baltic States see Antanaitis-Jacobs & Girininkas 2002; Zagorska 2006; Antanaitis-Jacobs et al. 2012), the study overlaps the borders of various archaeological periods and cultures. Burials from the Late Mesolithic and the Early/Late Neolithic periods, from Kunda and Narva Culture, and Typical and Late Combed Ware Cultures are observed. The main reason the long temporal perspective has been chosen is because a superficial glimpse on the mortuary deposits indicates similarities in the underlying structures behind the mortuary practices throughout this period. The chronology published by Kriiska in 2009, as all the previous ones (Grewingk 1865; 1871; 1874; Tallgren 1922; Moora 1932; 1935; Indreko 1932; 1940; Jaanits 1955a; Jaanits et al. 1982; Jaanits 1992; Kivimäe et al. 1998; Kriiska 2001; Lang & Kriiska 2001; Kriiska et al. 2007; Lõugas et al. 2007), is not based on the changes in the mortuary practices. Instead, the basis is formed by the environmental data, material culture (e.g. stylistic variation in Neolithic pottery, settlement pattern, subsistence and economy), and radiometric dates from dwellings. Burials and their material culture are merely fitted into the given frames. Burials have rarely been considered as a basis for the Stone Age chronology in Estonia (excl. Tallgren 1922, 48–52; Lang & Kriiska 2001, 92; Kriiska et al. 2007) due to their small number compared to the settlement sites and their relatively modest analysis (excl. grave goods). This in turn means that neither the current chronometric time scale, nor the previous ones reckon the invariability and changes of mortuary practices. This may artificially stress the differences in the material culture of mortuary practices and ignore the underlying similarities (e.g. Kriiska et al. 2007). Moreover, these 'cultural entities' are our constructions, thus are present frameworks of time, and therefore, can only be considered as analytical scales. This is illustrated by the fact that most of the archaeologists working with Estonian Stone Age have presented their chronologies. Thus, these are neither about how the past was nor how time was experienced by past people. Marek Zvelebil (1993, 54) has phrased the duality of time in archaeological record appositely: *"The past and present frameworks of time are reflected in archaeological record: the first in the creation of its structure and the second in interpretations; it is important to us to understand the relationship between those two."*

I agree with the medievalist Marek Tamm, who pointed out that historians (among them also archaeologists) create their sources through the creation of the time scale of history (Tamm 2008, 15), which subsequently affects and determines the patterns we detect in our research (Bailey 2007). Thus, the long temporal perspective allows observing whether these temporal/cultural constructions are valid while talking about mortuary practices. Moreover, to be able to distinguish between norm and variability in hunter-gatherer mortuary practices in Estonia a broader time scale is a necessity.

A common designator – 'hunter-gatherer' – is used here about the people buried in the ways that have left material traces. Applying this concept in the context of the study of mortuary practices within a time frame of c. 6500–2600 cal. BC might seem controversial for several reasons. From the archaeological perspective assumingly no one disagrees with its application in the context of Mesolithic. However, it takes more to justify the affiliation 'hunter-gatherer' during the period of the Early and the Late Neolithic. This is especially the case if we consider the wider European context where the Neolithic package was introduced with the *Linearbandkeramik* (LBK) and Funnel Beaker Culture (TRB; Germ. *Trichterbecherkultur*) during the 7th to 5th millennium cal. BC (Thorpe 1999; Price 2000). However, the distinction between Mesolithic and Neolithic respectively representing hunter-gatherer lifeways or agro-pastoral societies is not that clear-cut in the eastern Baltic region (Jaanits 1955a; Zvelebil 2010[2008]; Nordqvist & Herva 2013). Already from the Late Mesolithic Narva Culture ceramic vessels are known (Jaanits 1955a; Kriiska 2001; Piezonka 2008) and the first evidence of *ceralia*-type pollen in the territory of Estonia (Poska 1994; Königsson et al. 1998; Veski 1998; Poska & Saarse 2002) have evoked discussions about the possibilities of marginal agriculture in the region already around 4000 cal. BC (a more thorough discussion in *Chapter 5.4.2.*). Archaeologically, the justification of the common designator 'hunter-gatherer' is primarily provided by the results of the stable isotope analyses (*Chapter 5.2.*) and further supported by the commonality of the mortuary practices (*Chapter 6*).

Not only are the concepts Mesolithic and Neolithic in the eastern Baltic region ambiguous but the use of the concept 'hunter-gatherer' in the anthropological studies is not straightforward and has its own history (Barnard 2014; Jordan & Cummings 2014). The discussion over the term 'hunter-gatherer' has been an integral part of the anthropological research done on modern hunting and gathering societies since the first symposium *Man the Hunter* held in 1966 (Lee & DeVore 1987[1968]a). Back then the general term ‘hunter’ was proposed, but not in its evolutionary sense, which *“would confine hunters to those populations with strictly Pleistocene economies – no metal, firearms, dogs, or contact with non-hunting cultures”* (Lee & DeVore 1987[1968]b, 4). To encompass all the contemporary hunting and gathering societies the definition involved all kinds of hunting and gathering groups irrespective to their social structure or their relative importance of hunting to other modes of subsistence of the group. These groups have proven to be historically very variable. There are no studies about hunter-gatherer mortuary practices that determines the group belonging.

While most of the contemporary hunting societies do not subsist primarily on meat (e.g. Lee 1987[1968], 41pp; Lee & DeVore 1987[1968]b, 7; Kelly 2013, 41–43, Table 3–1) but on plants and fishes, ‘gatherer’ seems a plausible addition to the concept. Moreover, the genuine or spurious nature of the hunting and gathering groups is subject to discussion (Solway & Lee 1990; Layton 2001). Referring either to the economic or social background of various communities (e.g. Panter-Brick et al. 2001, 2; Kelly 2013, 2) might cause misunderstandings.

The affiliations of the Mesolithic and Neolithic people have varied in the works of archaeologists combining the key words ‘hunting’, ‘gathering’, ‘fishing’, and ‘foraging’ (e.g. Zvelebil 1986; Spikins 2010[2008]; Kriiska 2009 and references therein). As the anthropological studies show, a variety of groups of people can be considered as hunter-gatherers; there is no single defining characteristic. Following the lines of argumentation put forward by anthropologists (Panter-Brick et al. 2001; Kelly 2013), the concept of ‘hunter-gatherer’ is adopted as an umbrella-term to denote economic, social, and cultural commonalities of Mesolithic and Neolithic peoples. As a synonym ‘forager’ has been proposed (Lee & DeVore 1987[1968]a; Panter-Brick et al. 2001; Kelly 2013). Moreover, the so-often used additional term ‘complex’ used to refer to the Mesolithic hunter-gatherers is not used here as it indicates that something simpler existed before that (see critique in Rowley-Conwy 2001). This, however, does not mean that no cultural variance existed in the subsistence strategies and/or other affairs of various smaller groups, quite the contrary. But these differences only become observable after the analysis is undertaken, and only then a more group specific designator could be applied (*Chapter 5.2.* and *5.4.*).

2.2. Body as material culture

"The body is man's first and most natural instrument. Or more accurately, not to speak of instruments, man's first and most natural technical object, and at the same time technical means, is his body."
(Mauss 1973, 75)

The body is a nexus between nature and culture, thus forming the key concept in understanding the hunter-gatherers whose material remains are the basis of the present study and in the reconstruction of their mortuary rituals. Being a "migratory term" in the social sciences, the meaning of 'body' is ambiguous (Noormets 2011); it is not different in archaeology. Although what we regard as a body in archaeology is associated with the theoretical discussions and paradigm shifts in other social sciences, the following is a non-exhaustive insight into the concept of 'body' in archaeology.

The perception of the body in archaeological practice has undergone considerable changes through the development of the discipline. Archaeologists have been engaged with the physicality of the human body since the beginning. As seen above, already the first Baltic German archaeologists who conducted research on Estonian Stone Age burials co-operated with medical doctors who examined the skeletal material (mostly crania) to determine the age, sex, and race of the deceased. A more conscious approach toward the concept of 'body' arose during the emergence of processual archaeology in the 1960s and 1970s. At that time, the three most principal research domains were defined. First, with the emergence of the ethnographic parallels, living bodies became the focus of the research; secondly, the body – in archaeology mostly skeletal remains of it – became a research object for osteologists who abandoned the former focus on racial identity, and concentrated on biological age, sex, and pathologies of the deceased; and lastly the grave goods accompanying the deceased (seen as an extension of the body) and other grave features were considered to mirror the status of the person in life (e.g. Saxe-Binford hypotheses) (Sofaer 2006, 15–17). Post-processual archaeology neglected the biological aspects of the body, considering it instead as a culturally constructed entity and depicted it as being comparable with an artefact that was considered as text conveying cultural meanings, thus *"transforming it from biology to symbol or metaphor"* (Sofaer 2006, 19; examples of phenomenological approach and embodiment theories see e.g. Meskell 2000; Fowler 2002; Hamilakis et al. 2002). Further developments of the concept went hand-in-hand with feminist theories, especially with theorising the categories of 'sex' and 'gender' since the 1990s in archaeology (Joyce 2005, 141).

Until recently, osteological body research and constructivist approaches have remained clearly separated from one another; this divide has now been criticised by several researchers (e.g. Boyd 2002; Joyce 2005; Sofaer 2006; O'Brien et al. 2010 and references therein). Joanna R. Sofaer argues that there is no unrivalled way of observing and understanding the human body, but archaeological research cannot make a clear distinction between the physical and social or individual body since each is dependent on the other; these just are different aspects of the same phenomenon (Sofaer 2006, 30). There is no clear border to state where in one's body nature starts and where culture sets in (Joyce 2005; Sofaer 2006, 60; Gramsch 2013, 459). Thus, in the context of archaeology, the physicality of the body urges us to bridge the divide between nature and culture, dead and living, inside (unfleshed) and outside (fleshed), and atheoretical and theoretical (Sofaer 2006, 11, 31, 54). Already Marcel Mauss (1973, 73, 85) argued that to understand bodily techniques, i.e. habitus or acquired abilities of the 'total man' one needs not to stay inside the frameworks of a single approach, rather, it requires a triple viewpoint – physical, psychological, and sociological. In archaeology, that means combining the methods of osteology, which give insight to the physical and biological qualities of the body, with the theoretical approaches from social sciences, which stress the cultural construction of the body, entailing bodily knowledge acquired through various practices throughout one's lifetime.

In the present study, human body is equated to material culture as proposed by Sofaer (2006). The body is a nexus between nature and culture, being a dynamic entity that undergoes frequent transformations throughout its lifetime and is created about the material world that includes objects and other people (Sofaer 2005, xv). The range of transformations is permitted and constrained by its plasticity (Roberts 1995 referred in Sofaer 2006, 71), which thereby help bridge the divide between the dead and the alive, and theory and practice (Sofaer 2006, 76). This approach changes the position of the body within archaeology, particularly within the archaeology of death, since it brings the body into the focus that has long been overshadowed by the analysis of grave goods. *"Identifying the body as material culture aims to access the particularities of the body in a specifically archaeological manner by understanding the development of individual bodies in contextually specific social settings. The emphasis is on the processes by which bodies are formed (considered analogous to processes involved in the production of other forms of material culture), agency and action, through the ways that the social lives of people are implicated in the creation of their bodies. The transformation of bodies over the life course involves acts of fabrication and destruction /.../ and one might add to Douglas's famous statement that 'what is carved in flesh is an image of society' (Douglas 1996, 116), that what is made in bone is also part of that image"* (Sofaer 2006, 87).

The materiality of the skeleton becomes obvious through the skeletal responses to culturally defined activities, and universal biological changes through growth and ageing (Sofaer 2006, 77). Thereby the cultural traditions and norms of the society are embodied (Sofaer 2006, 78). Here the embodied norms become most explicit in the stable isotope analyses reflecting the subsistence practices of various populations. However, the manipulation of the human body after death is an important technique to transform the dying person into a new kind of being; doing things to a body both accomplishes social operations and changes in physical state (Robb 2013, 450). Thus the body is also central in the practice theory approach being both a tool to carry out the ritual and a receptor for the ritual experience in the form of embodied memories, knowledge, and competence (Berggren & Nilsson Stutz 2010, 176). It allows a certain amount of variation in the core of practices without the core being altered.

Not only the body, but also the place and artefacts handled during the ritual take a central role in the process of structuration (Berggren & Nilsson Stutz 2010, 176). The questions about the location of burials in the cultural landscape further contribute to the understanding of the norms of mortuary rituals. In fact it is difficult to differentiate between the body and the grave goods in archaeology as the latter help delimit the borders of the body (Joyce 2005, 151; Sofaer 2006, 51 and references therein). Although grave goods are closely associated with the deceased body, these are not examined in the present thesis. These have been the focus of research of Stone Age burials previously (Jaanits 1957a; Ots 2003; Lõhmus 2005; Ots 2006; Jonuks 2009). Moreover, the character and placement of the majority of grave goods indicates that these were not proper grave goods but formed part of the funerary costume instead (i.e. were directly linked to the body). Although archaeothanatology provides valuable insights into the research of grave goods (e.g. Duday 2009, 21pp), this should be done hand in hand with trace-wear analysis of artefacts to determine their role in the context of burials and mortuary rituals.

The skeletal body forms the departure point of all the analyses undertaken in the present thesis. During the transformation from life to death, bodies change from subject to object. The corpse that emerges with death affects the practices and social relations of the people (Nilsson Stutz 2003; Gramsch 2013, 460). It is real, tangible, and material, and while it was a living body, it embodied emotions, memories of habitual behaviour, and social relations (Sofaer 2006, 67; Gramsch 2013, 416). Moreover, it alters the social order and needs to be treated accordingly. Due to the tension between culture and nature within the human body both its physicality (*Chapter 5*) and its cultural modification during mortuary rituals (*Chapter 6*) will be discussed. The physicality regards the primary identities (after Jenkins 2008) of the deceased including biological age and sex and the overview of the preservation of the body. Moreover, the dietary habits engraved into the bone tissue (i.e. collagen) will be detailed, and where possible the structural changes of these habits during individual life courses are marked separately (see Eriksson & Lidén 2013; discussion about individual biographies e.g. Robb 2002, 158–160). One part of body's biography is also mortuary rituals, i.e. how the deceased was handled, what was done to her or him? Similarly to other practices undertaken during one's lifetime ritual handling of the deceased body leaves traces on it, either direct (e.g. cut marks) or indirect in shape of body positions observable in the material remains. *Chapter 6* discusses single mortuary practices that build upon the physicality of the body and its change during the process of decomposition that in turn is core of the archaeothanatological analysis. This allows single mortuary practises to be reconstructed, and to make conclusions about the bodies that created, maintained, and changed the practices.

2.2.1. Processes of dying and handling the dead

The omnipresence of death has made it as an intrinsic attribute of humankind (Palgi & Abramovitch 1984, 385). A death of a woman, a man or a child in a hunter-gatherer community with a limited number of individuals must have been a critical event for the whole group. Malinowski (2004[1954], 22) even argues that *"Death in primitive society is, /…/ much more than the removal of a member."* As described by many researchers the occurrence of death evokes a wide range of emotions (e.g. Metcalf & Huntington 2010[1991], 43pp and references therein), breaks the normal course of life, and shakes the values of the society (e.g. van Gennep 1960; Ariès 2004[1987(1977)]; Malinowski 2004 [1954]; Veit 2013). Moreover, it is marked by the emergence of the corpse (Metcalf & Huntington 2010[1991], 72; Nilsson Stutz 2003, 81).

Death is an inevitable life crisis that needs a response from the community (Nilsson Stutz 2003). This is mostly acted out through the mortuary rituals that do not only commence with the emergence of the dead body but with a funerary cycle that starts even earlier involving the process of social dying (Weiss-Krejci 2011, 71). However, archaeologists do not dig up mortuary rituals as such but rather material objects that are considered as residues of these, suggesting that not the whole sequence of mortuary practices could be reconstructed. Even with more advanced techniques, we can never obtain the whole set of practices, nor the meaning behind these, as we rely on material culture. Thus, to understand the processual and culture-specific nature of death and dying, and the essence and underlying structures behind mortuary rituals, the concepts of dying/death and mortuary practices will be discussed in light of practice theory.

2.2.1.1. Death – from social persona to a corpse

Despite its inevitability, defining death is obscure; there is no cross-culturally universal apprehension of the setting in of death (e.g. Hertz 2010[1960], 197; Palgi & Abramovitch 1984, 400pp; Nilsson Stutz 2003, 141pp; Robb 2013, 445; Oestigaard 2015, 66–67 and references therein). Even medically there is no single rationale to declare someone's death. We can determine one as being dead either by the complete and irreversible loss of all brain functions or the irreversible cessation of circulatory and respiratory functions of the body (Uniform Determination of Death Act, 3). Furthermore, death cannot be considered as something purely biological; quite the contrary, culture sets in already when someone is dying. The ways of how people perceive its occurrence and respond to it vary considerably, differing cross-culturally, diachronically, and even within a single society (e.g. Hertz 2010[1960], 197; Ariès 2004[1987(1977)]; Malinowski 2004[1954]; Metcalf & Huntington 2010 [1991]; Robb 2013).

An individual's transformation from life to death is a process, not a solid moment on one's life cycle. It is a process where the social persona becomes a corpse. This however, does not mean that s/he no longer possesses agency (Robb 2013) or as Richard Jenkins (2008, 17) has put it *"not even death freezes the picture"*, as after death one becomes an ancestor or is elevated to sainthood for example. Through making a clear distinction between the words 'death' and 'dying', Allan Kellehear (2007) shows the dual nature of death. Despite his classical constructivist way of dividing the biological death defined by medicine and social construction of death (i.e. dying) that is a social act undertaken at the presence of other people (Robb 2013, 445), it is a good example of the complicated nature of death. However, instead of observing these two sides of death separately, i.e. cultural anthropologists and folklorists dealing with its cultural aspects and physical anthropologists and medical researchers with its physicality, these two are inseparable. Dying responds to and integrates the biological changes that appear at death and at the same time integrates the notions of the body and its composition, identity and cosmology (Robb 2013, 449). For instance in many cultures the physicality of the body creates a fear towards a corpse. As a result, certain restrictions emerge about who is allowed to get involved in the handling of the deceased and/or taboos about the objects involved in the preparation of the body. In the Estonian village funerals described above, at the beginning of the 20th century only neighbours were allowed to wash the corpse, not the immediate kin as the direct contact of the relatives to the polluted body was considered harmful for the survivors (Lang 2004, 81–82). At the same time, the family was obliged to give some impost to the washers to protect them against the impurity of the corpse. Taboos existed about the handling of the soap, warm water, and sauna whisk that were used to wash the deceased (either in a bath or sitting on a chair) as these were in immediate contact to the corpse and its harmful power. For example the washing water was not to be poured out on a tree as it was believed to cause the tree to die; additionally the sauna whisk and soap might have been placed into the coffin as a grave goods to prevent their circulation among the survivors (Lang 2004, 82; medieval examples from sauna whisks in graves see Lavi 1974, 24).

Together with the various identities of an individual, the world view and cosmology of the group prescribes the reactions of the community to their death and the manner in which her/his body will be treated during the succeeding mortuary rituals. Effie Bennan has listed the properties that influence the content of rituals as follows: *"rank, sex, age, social organization, status, environment, moral, religious differences and myth conceptions, the location of the realms of the dead, the physical condition of the deceased, totemic considerations and kind of life after death"* (Bennan 1930, 280 referred in Palgi & Abramovitch 1984, 388). Whether and to what extent these qualities really affect the consequent treatment of the corpse or the mortuary rituals in general depends on the culture (e.g. Ucko 1969, 265). Moreover, these define 'good' and 'bad' deaths which again vary diachronically and culturally. For instance those who die violent or accidental death, women dying in childbirth, people who commit a suicide, or even children are often given a different mortuary treatment than the rest (e.g. Hertz 2010[1960], 211; Ucko 1969, 265–268, 270p; Scheper-Hugher 2010[1992]; Hayden 2009). We cannot define what is considered a 'good' or a 'bad' death a priori in the Stone Age hunter-gatherer communities, but the fine-grained time scale enables focus on single mortuary rituals and thus insights into the structuring principles behind the treatment of the dead.

To summarise, archaeologically death becomes visible through the emergence of a corpse (or the onset of putrefaction (Ucko 1969, 269)). This evokes various responses of the survivors that are usually formalised in mortuary rituals. The aim of mortuary rituals is twofold: (1) to remove the body from the living community to the death realms in a proper manner, and (2) to re-establish the social order by bringing the bereaved out of the shock and sorrow of the loss through the proper means of dealing with their social loss (Hertz 2010[1960]; Palgi & Abramovitch 1984, 395). The first aim leads us to the focus of the present thesis elaborated above, the body of the deceased, which will be discussed in the following sub-chapter, where the theoretical background of mortuary practices observable on the human body is brought forward.

2.2.1.2. Mortuary rituals in the light of practice theory

Mortuary rituals consist of various ritual practices. Their processual nature is well epitomised in the classic text *"The Rites of Passage"* wherein Arnold van Gennep argued that mortuary practices last throughout the mourning period (van Gennep 1960, 11, 147). During this transitional period, the mourners and the dead, who passes from one status to another, constitute a liminal group separated from the world of the living and that of the dead. This period, which often means suspension from the quotidian life (van Gennep 1960, 147–148; Weiss-Krejci 2011, 71), could be divided into three separate stages (van Gennep 1960). During the time of preliminary rites, the individual whose status is to be changed is separated from her/his previous status (which could entail physical separation from the group but not necessarily); the separation rites are followed by transition rites where the person stays in between the old and new; the whole process is terminated through the rites of incorporation whereby the person gains her/his new status. Although all the life-cycle rites from birth to death are connected to biological and physical changes in one's body, these links are rather loose and overlain by sociocultural order (Bell 2009[1997]).

To stress the dynamics of mortuary rituals, I will employ a theoretical framework of practice theory-driven (Bourdieu 1977) approaches in cultural anthropology and archaeology (Bell 1992; 2009[1997]; Nilsson Stutz 2003; Berggren & Nilsson Stutz 2010). Practice theory has been applied to the archaeological material in a plethora of studies during the last two decades (e.g. Fogelin 2007; Bradley 2008). Most of these studies adopt the concept as an interpretational framework. However, Åsa Berggren and Nilsson Stutz (2010; also Nilsson Stutz 2003) have shown that archaeology not only receives ideas from this theoretical approach, but due to its focus on material culture, contextual analysis, subjectivity of interpretations, and an assumption of certain amount of universality in human actions, archaeology also contributes to the theoretical discussion about ritual practices in other social sciences, strengthening the aptness of the interdisciplinary dialogue in archaeology. Differently from previous approaches, the one posed by Bell allows a more dynamic view of rituals implying a shift to perceiving activity as something that makes and accommodates cultural patterns rather than expressions of such patterns (Bell 2009[1997], 82). Moreover, it allows turning the focus away from the meaning of things and acts that have been elaborated elsewhere (e.g. Jaanits 1961a; Ots 2006; Jonuks 2009) and on to cultural practices, and instead of accentuating the extraordinary and variations (e.g. Jaanits et al. 1982; Kriiska et al. 2007) it concentrates on the essential, i.e. the core of practices.

Why and to what extent is the concept of ritual practices outlined by Bell valid in the context of archaeology of death? The same characteristics that allow active involvement of archaeology in the discussion of the ritual theory in social sciences justify its use in analysing past mortuary remains with the aim of reconstructing mortuary practices and the handling of the death in hunter-gatherer societies. Firstly, the assumption of certain amount of universality in human actions allows utilising the theoretical framework together with ethnographic analogies to pose new questions, propose alternative methods, and widen the horizons of our interpretations (Ucko 1969, 262). While comparing past and present human experiences one should not expect cultural or temporal continuity between the traits studied and ethnological parallels, thus it could be argued that *"all ethnology is relevant to archaeology and all archaeology is relevant to ethnology"* (Saxe 1970, 2). Secondly, material culture is about practices, i.e. what and how people have done (Bell 1992, 81; Nilsson Stutz 2003, 13, 51). Practices should be the departure point in archaeological research; the questions about the meaning of acts could only be answered subsequently (if at all) as these are created over and over during the practices (Berggren & Nilsson Stutz 2010, 176). Thirdly, the emphasis on the human body allows a direct link between the theory, the archaeological material, and archaeothanatological analysis.

However, despite the obvious advantages of the practice theory approach in the analysis of archaeological mortuary remains, there are some shortcomings. To get a full understanding of the norms and their dynamics within a culture, one should be able to juxtapose the practices and cultural texts that create the underlying structures (Raud 2013, 414). As there are no texts available from the prehistoric hunter-gatherer communities the analysis of practices can never be complete. Moreover, the acts of individual agents about the norms are difficult to distinguish (Nilsson Stutz 2003, 51). Thus, the role of single agents behind the change of cultural norms is not fully understood and might be under-estimated. Despite these difficulties, practice theory seems to be the best approach to answering questions about the handling of death in hunter-gatherer communities.

As the history of the development and research on ritual practices in archaeology and anthropology are profoundly summarised by Bell (1992) and Nilsson Stutz (2003), I will only outline the most important aspects with a focus on its implications to the study of past mortuary practices based on material culture. Regarding the subsequent discussion about the ways death was handled in the hunter-gatherer societies in the eastern coast of Baltic Sea the following aspects will be looked at: (1) the general definition of cultural and ritual practices, (2) the role of individual bodies in the maintenance and change of practices and their underlying structure, and (3) the maintenance and change of norms underlying mortuary rituals.

2.2.1.2.1. Ritual as one of the cultural practices

Rituals, among these mortuary rituals, could be categorised as cultural practices. Thus, mortuary practices share a range of characteristics with other cultural acts. Cultural practices require active commitment of agents who engage in rule-govern actions that create, interpret, and circulate meanings and texts (Raud 2013, 47). These are strategic, manipulative, and pragmatic ways of acting in the community (Bell 1992, 82). We acquire the underlying norms of practices, which form our cultural competency, through enculturation (e.g. partaking rituals). According to French sociologist Pierre Bourdieu (1977), cultural practices are connected to the notion '*habitus*'. It is a term borrowed from Mauss for whom it designated acquired abilities (Mauss 1973, 73), describing the system of the cultural habits and tendencies of an individual, acknowledging at the same time the structures of the society, and allowing the realisation of individual strategies (Barnard & Spencer 2005[1996], 607). It is a concept that permits people to create a comprehensible, and common-sense world imbued with meaning (Knapp & van Dommelen 2008, 22). A direct link between theory and the archaeological material here is created through the primacy of a human body that moves about within a specially constructed space, simultaneously defining and experiencing the values ordering the environment (Bell 2009[1997], 82). In sum, cultural practices amongst rituals are activities that construct particular types of meanings and values in their specific ways (Bell 2009[1997], 82).

By answering the question about what was done during the rituals using practice theory and the consequent analytical scheme introduced by Rein Raud (2013, 402pp), one can explore the (1) the functions and objectives, (2) participants and the status of the practices in contrast to other cultural practices (e.g. openness and accessibility), (3) their materiality, and (4) the mechanisms that enable their maintenance, transmission, and change. While relying exclusively on material culture helps address the question of the function of the practices in general, and thereby the practices' purpose in the greater cultural context, it does not address the practices' objectives, as the latter are declared by the participants and may vary in every single event. When considering the participants one should look for differences between active agents and a more passive audience, as well as for whether a ritual specialist was involved in the undertaking of the mortuary rituals. The questions about the function and the status of the mortuary rituals and participants can only be answered tentatively by drawing on universality of human experience (social theory and ethnographic analogues). The materiality of the practices is the part that archaeology can access directly; however, not all the practices leave material traces, and thus our sources are biased, which has to be taken into account before drawing any conclusions. Every part of the norm will be elaborated subsequently, with a focus on the maintenance and change of the practices, but also the role of individual and the role of single practices reflecting the norm.

2.2.1.2.2. Creation, maintenance and change of norms

The word 'norm' comes from the Latin word *norma*, and its general meaning according to Oxford English Dictionary (OED) is a model or pattern or standard. Culturally it refers to *"standard or pattern of social behaviour that is accepted in or expected of a group"*, thus being culture-specific. Cultural practices are part of a dialectical relationship with structure that contributes to change and continuity within the society (Bell 1992; Nilsson Stutz 2003; Berggren & Nilsson Stutz 2010, 173). All practices have underlying rules and norms, which are known to the participants, allowing some repetition, meaning that when various people perform the same practices at different times and places the general patterns that the practices create and contain remain invariable (Raud 2013, 47). On the one hand, the rules maintain the practices in the way it has been agreed in the community. This, however, does not mean that changes do not occur. Quite the contrary, meta-rules set the norms that allow variances in the practices and also provide the accepted basis for change (Raud 2013). The dialectical relationship between the structure and the practice always enables reinterpretation and change (Berggren & Nilsson Stutz 2010, 177; Nilsson Stutz 2014, 713).

The questions about the norms and variances in mortuary practices became a critical part of processual burial archaeology (Aspöck 2008, 25). The question of 'norm' has been discussed in contrast to deviant/unnatural burials (e.g. Aspöck 2008; 2009; Murphy 2008; Weiss-Krejci 2011; Müller-Scheeßel 2013) that are somehow extraordinary in contrast to the normative mortuary ritual of a respective period, culture, and/or cemetery (Aspöck 2008, 17). The focus here is on the exceptionality of the burial. The normative handling, however, is defined only casually and usually not problematised. Unlike these approaches, practice theory shifts the focus from extraordinary to the core of practices that allows approaching the underlying cultural structures that define the norm. However, the German notion *Sonderbestattung* (i.e. special or exceptional burial; non-normative burial), coined to signify two separate aspects of non-normative mortuary rituals (Aspöck 2008, 23–24 and references therein), is relevant in the context of hunter-gatherer mortuary practices as it stresses the invisible burials in the population sample (i.e. a palaeodemographic explanation) and visible burials that differ from the norm (archaeological explanation; Aspöck 2008, 19–20). The term *Sonderbestattung* is useful because it incorporates both the archaeological paradox of the biased nature of our sources and also the various ways of approaching the deceased. Furthermore, it enables a discussion about whether the archaeologically observable practices should be considered the only possible normative handling of the deceased or whether there were multiple norms in hunter-gatherer societies.

The tempo at which various cultural features change varies (Ucko 1969, 273; Lotman 2001, 23). Thus changes in other cultural areas (e.g. the form and decoration of ceramics; the forms and function of stone tools; see also Kroeber 1927 referred in Ucko 1969, 275) might not be reflected as changes in mortuary rituals. The founder of the Tartu-Moscow semiotic school Jüri Lotman (2001) has made a clear distinction between the 'outbreak' and 'gradual change' in culture that are in dialectical relation to one another, exist parallel in the cultural space and/or could alternate from one to another (Lotman 2001, 17pp, 131). The continuity of underlying structures means that the people follow the predicted norm; its antithesis is unpredictability, which occurs abruptly. Therefore, gradual changes are less obvious in culture and one might even think that nothing changes at all, or these changes are less important (Lotman 2001, 17). Despite the fact that the majority of cultural characteristics develop through gradual changes (Lotman 2001, 17), archaeologists tend to highlight abrupt changes (e.g. Neolithic revolution; however see *Chapter 5.4.*). This is probably due to the biased character of our sources. However, whether the change in hunter-gatherer mortuary practices could be considered as one of these cultural features that change slowly (e.g. Valk 2001; Jonuks 2009) or rapidly as suggested by ethnographic cases (Ucko 1969, 273) needs to be discussed. Thus, to be able to understand the gradual changes or to locate the outbreaks in mortuary rituals these need to be investigated within a long time period.

Moreover, various elements of practices may change with varying tempo. Thus, two dimensions of time are discussed here: (1) long-term processes (time span of c. 4 millennia) to detect continuity and/or change in the core of practices, and (2) short-term processes to distinguish between cultural and natural taphonomies in order to talk about single mortuary practices (Nilsson Stutz 2003; Duday 2009). Whereas long-term processes tend to be discussed in terms of continuities (=similarities), short-term processes are usually discussed in terms of variations (=differences) instead. In a sense it seems that similarities correspond to the 'time of structure' (Hodder 1990) and differences to 'the time of event' (Barrett 1994). Jan Harding has shown that these two opposing views are inseparably part of social discourse, and past people can be meaningfully studied only if both of these temporal scales are taken into account (Harding 2005; opposite view see Lucas 2008).

2.2.1.2.3. Single practices reflecting cultural norms

One of the values of the present study is the 'thick description' of mortuary practices that help reconstruct single acts during these rituals (*Chapter 3.1.* and *Chapter 6*). However, as stated above, the aim of the thesis is to see behind these bodily practices and give a description of norm(s) within the mortuary repertoire of hunter-gatherers. Thus, to what extent do single practices represent common or normative way of handling the deceased during the c. four millennia under discussion? Is the sample analysed representative?

The chosen theoretical approach provides us with a world view in which every action is linked to the whole (i.e. systemic context) in a dynamic process through the concept of 'habitus' (Nilsson Stutz 2003, 13, 52–53; Knapp & van Dommelen 2008, 23). As stated by Bernard Knapp and Peter van Dommelen (2008, 23) of particular relevance for archaeology is the fact that habitus is about the relations between people and their social context. Mortuary rituals are part of the structuring process whereby everything and everyone is tied together into a whole that is perceived as objective and true (Berggren & Nilsson Stutz 2010, 176). Thus, even if we describe only a handful of mortuary practices examining how these acts or single events may be conditioned and constrained by the underlying social structures grants access to wider generalisations about norm(s).

2.2.1.2.4. The relevance of context and archaeological evidence

All the cultural practices should be analysed and thus understood in their context, the same is valid for rituals (Bell 2009[1997], 81). Following the ideas of the founder of behavioural archaeology Michael B. Schiffer (1972; 1996 [1987]), there are two types of contexts that one should take into account while analysing past actions and practices on the basis of material culture: (1) the systemic context and (2) the archaeological context. These are interlinked by the formation processes of archaeological data. The systemic context refers to how material culture was actively involved in the actions of people that is the character of the society being examined (Schiffer 1996[1987], 3–4). According to practice theory, material culture is never a passive component of culture but is actively engaged into the creation, maintenance, and change of cultural structures. The archaeological context is the material culture recovered and investigated by archaeologist and its immediate context connected to non-cultural features, such as the technical details of the environment, etc. (Schiffer 1972, 156–157; 1996[1987], 7), which leads to the reconstruction of the systemic contexts.

In the present study, the archaeological context comprises the remains of human bodies – articulated skeletons and loose human bones – and their immediate surroundings. This data are too fragmentary, incomplete, partial, conceptual and selective to address questions about the systemic context (Härke 1997) of the core mortuary practices comprehensively. We cannot trace the majority of the small gestures and practices described above (Lang 2004) in the material culture, especially the practices that precede the final burial, but also the funerary feast at the home of the deceased. Thus, each burial is an in-complete and partial representation of once-elaborate mortuary rituals. For the most part, archaeologists are only able to observe the practices physically linked to the burial event that took place at some point in between the death of an individual and the veneration rituals of that individual (but see e.g. Wessmann 2010; Williams 2013; Schulting 2015).

Usually archaeologists recognise a feature as being the outcome of mortuary rituals when human remains are present. Despite that, the vast majority of early studies in burial archaeology focused on grave goods or grave structures to reconstruct the social life of past communities (overview see: Parker Pearson 2012[1999]). Large differences exist between the known mortuary practises making the material culture diachronically and spatially varied; however, archaeologically one can access (1) archaeological, (2) skeletal, (3) environmental, (4) biochemical, and (5) technical data (modified after Härke 1994). In the following discussion only the technical data is irrelevant, all the other aspects contribute to the osteological/biochemical and archaeothanatological analyses.

(1) Archaeological data includes the material information about the deposit, i.e. grave (e.g. structure, orientation, dimensions of the pit), information about the grave goods (types, quantity, quality, spatial position in the grave), and other general information (e.g. spatial distribution of single graves in a cemetery, in the landscape) (Härke 1994).
(2) In contrast to Heinrich Härke's (1994) view, for whom the archaeological data is primary in giving information about the burial, here the skeleton is the source of the characteristics of the burial. Ethnographic examples indicate that archaeologists should expect the remains of mortuary practices to range from complete and articulated bodies to disarticulated minute fragments of burnt or unburnt bones (Weiss-Krejci 2011, 76). Thus, in the present thesis both articulated skeletons and loose human bones are taken into account. Loose human bones are defined as being disarticulated human remains that could be an outcome of various kinds of practices that can be determined through the analysis of the deposits. Similarly to other studies of the European Mesolithic (Conneller 2005, 145; 2009, 690–693; excl. Gray Jones 2011) and other periods (Weiss-Krejci 2011, 69) these have rarely been considered part of separate mortuary practices before. Thus, the questions about the type and nature of the burial are the qualities observable on the skeletal material. This further suggests that skeletal data has a dual nature not only intentional as well as functional as proposed by Härke (1994). The position of single bones and their relation to one another enable the reconstruction of mortuary practices based on archaeothanatological analysis (see *Chapter 3.1.*). Moreover, the objectives behind the absence of single limbs (the biology and anatomy of the human body; Härke 1994) in the mortuary context should be ascertained during the archaeothanatological analysis as these could reflect cultural norms. However, skeletal data has a dual nature due to its biological character, allowing the assessments of biological sex, age at death, and pathological history. Yet, the position and completeness of skeletal remains should undergo an archaeothanatological analysis first in order for the traces to be classified as either 'intentional' or 'functional'.

(3) Biochemical data can also be considered as a sub-division of the skeletal material, as the possibility of various analyses is dependent on the preservation of a skeleton in its immediate environment. Although Härke (1994) argues that only skeletal data capture the past realities, making it crucial for the analysis and interpretation of burials, both stable isotope analyses and radiometric dating from human bone collagen are not as straightforward; their limitations are discussed in *Chapter 3.2.2.4.* and *3.3.2.*).
(4) Härke (1994) argued that environmental data play a less significant role in analysing mortuary rituals and have an ambiguous nature because both intentional and unintentional acts could be read from these data. Historically speaking, he is right as this kind of data have only rarely been included in the discussion (excl. e.g. food offerings, macrofossils of plants, pupae of larvae in exposed bodies). However, in the context of archaeothanatological analysis (*Chapter 3.1.*), the immediate environment (e.g. soil type, fraction etc.) of the grave plays an important role.

The systemic context for establishing the core of mortuary rituals on the other hand is both created during the practices themselves, but is also given by other aspects of the social life of hunter-gatherers. The cultural background could be determined by the animistic worldview and noninstitutionalised shamanism proposed by Jonuks (Jonuks 2009; see also Jaanits 1961a; Strassburg 2000; Zvelebil 2003; 2010[2008]); the subsistence based on hunting terrestrial and marine mammals, and fishing and gathering wild plants (*Chapter 5.2.* and *5.4*); the ratio between the known settlement sites and burials, and the general social organisation of the communities with the estimated size of single populations, and the mobile or sedentary nature of the lifeway. All the aspects of systemic context are bound with a general premise in archaeological research that a certain amount of universality exists in human actions. Although these actions are formalised in an ample of ways in various situations and cultures, the use of ethnographic analogies and theoretical concepts to understand the archaeological record is justified (Berggren & Nilsson Stutz 2010, 174–175). This tension between universality and particularity, however, means that together with changing one link within the chain the interpretation will be altered, too.

2.2.1.2.5. Ritualisation of practices

If various cultural practices ranging from birth rites to food culture and from gardening to attending a funeral have several common characteristics outline above, then why do we need to distinguish ritual practices at all? What differentiates ritual practices from other cultural activities? As Bell puts it (1992, 88pp), the inherent significance of these practices is their ability to ritualise in contrast to other cultural practices. Ritualisation of a particular practice happens when practices are performed; moreover the cosmology of a particular culture is created then (Berggren & Nilsson Stutz 2010, 175). This brings the focus on the questions of how a particular culture ritualises, when and why ritualisation is an effective thing to do (Bell 1992, 74; 88pp; 2009[1997], 81). The goal of ritualisation is circular, which on the one hand creates ritualised agents, actors with a form of ritual mastery, but on the other hand the ritualised agents embody flexible sets of cultural schemes and can expand them effectively in multiple situations to restructure those situations in practical ways (Bell 2009[1997], 81; see also *Chapter 2.2.1.2.5.*).

Categorising a particular practice under ritual is an interpretational undertaking (Berggren & Nilsson Stutz 2010, 174). The question of whether a cultural practice involves ritualisation or not can only be addressed during the analysis and thus can be identified as a characteristic of a cultural practice only posteriorly. Recently the ritualising ability of depositional practices has been shown (Berggren 2015 and references therein). Even if ritualising character is not as straightforward for various kinds of archaeological deposits, the ethnographic analogies indicate that the vast majority of societies handle their dead during rituals. Thus, following the lead of Berggren and Nilsson Stutz (2010, 180) and assuming that mortuary practices possess the ability to ritualise we should look at them as privileged, significant and powerful in contrast to many other cultural practices that create, maintain and circulate cultural meanings and cosmologies. Moreover, archaeologically it has been demonstrated that the treatment of the dead became ritualised from the Middle or Upper Palaeolithic (Bahn 2011, 344–348; Pettitt 2011, 337, 339). This shows that the mortuary ritual as such was not an invention of Mesolithic hunter-gatherers (see Nilsson Stutz 2014, 713–714), but is something inherent to the majority of hunter-gatherers and others.

2.3. Conclusions – from materialised bodies to people and mortuary practices

The departure point for understanding mortuary practices and people behind the burials is the 'body' of a hunter-gatherer. The body is understood as material culture that incorporates its dual character being a historical and cultural construct, but also a biological and physical reality. This intertwined duality allows seeing the body as a medium by which one perceives, experiences, and changes the surrounding world. The maintenance and change of the world comes about through practices or as Mauss (1973, 85) has put it *"in every society, everyone knows and has to know and learn what he has to do in all conditions."* This has not been different in Stone Age hunter-gatherer communities. They must have had to learn how to handle the death of a group member, and acquired the proper abilities through practises. Mortuary rituals were on one hand enacted by the bodies, but on the other hand formed and (re)shaped the bodies. The above-sketched understanding of body, together with the practice theory approach and the application of archaeothanatology, should surmount the seemingly impassable chasm between biology and culture and allow a more dynamic view of the hunter-gatherer mortuary repertoire.

CHAPTER 3. APPROACHING MORTUARY DEPOSITS – TRACING PRACTICES AND PUTTING FLESH ONTO BONES

Reconnoitre une sépulture, ce n'est jamais une simple constatation; ce ne peut être qu'une interprétation des vestiges (Leclerc 1990).

In this chapter, I will give an overview of the analytical tools that are applied to reconstruct single practices both in inhumations and loose human bone assemblages. In addition to these people behind them, i.e. to whom these practices were devoted, are a focal point of the study. Therefore, the methods that aid to put flesh onto the bare bones that archaeologists excavate are presented here, too.

The study of the taphonomy of the mortuary practices, i.e. archaeothanatology, will be introduced first. I will discuss the terminology and suggest that archaeothanatology should be taken as a two-levelled description of the mortuary record consisting of a detailed description of the skeleton and its single elements and a 'thick description' of mortuary practices. To make this concept intelligible, I will point out the most relevant principles of archaeothanatological analysis. My own contribution is the discussion over the opportunities and limitations of the approach in re-analysing old excavation documentation.

Osteological methods used in analysing the skeletal collections that form the basis of the present study will be discussed second. Finally, the principles of isotopic analysis together with radiocarbon dating of human bones are elaborated.

3.1. Archaeothanatology – operational sequence of mortuary practices

Archaeothanatology (Fr. *l'anthropologie du terrain*) is a holistic and cross-disciplinary approach – combining archaeology, osteology, and taphonomy – to the study of mortuary record. One should not confuse it with the meta-concept thanato-archaeology (Germ. *Thanatoarchäologie*) developed by Kerstin P. Hofmann (2008). In her doctoral thesis about Bronze and Early Iron Age cremations at the Elbe-Weser-Triangle in northern Germany, Hofmann uses the term thanato-archaeology as a multi-disciplinary concept that deals with death and dying by engaging psychology, sociology, cultural anthropology, and history, and further combining it with a semiotic theory of burials as a "cultural text" (Hofmann 2008, 140pp). Returning to archaeothanatology proper, the pioneering works conducted in late 1970s and early 1980s by Henri Duday were carried out in the context of rescue excavations. The very first paper on archaeothanatology was published in 1978, wherein the main principles were discussed (Duday 1978). At the present, the approach has become common practice among French archaeologists and is applied to the study of human remains invariably (e.g. Leclerc & Masset 1980; Duday 1987a, b; 1990; Crubezy et al. 1990). During the last decades, the approach has also been applied outside of Francophone archaeology (e.g. Nilsson Stutz 2003; Roksandic 2004; Nilsson Stutz 2006; Roksandic 2006; Willis & Tyles 2009; Richter et al. 2010; Harris & Tyles 2012; Peyroteo Stjerna 2016), albeit sporadically.

Initially, the complex of methods applied to the study of mortuary deposits was named *l'anthropologie du terrain*, which means 'field anthropology'. At first the term was justified as the approach was applied during excavations, allowing osteologists or anthropologists to be engaged with human remains already in the field not only in the lab, as it has been common in Anglo-American and European (Estonian/Soviet archaeology among them) archaeology (see Sofaer 2006). Soon its roughness became obvious: although the first observations are made in the field, the full and further analysis of the deposit is carried out in the lab. Therefore, the concept did not convey the true content of the analysis (see Nilsson Stutz 2003, 158; Duday 2009, 3). This became even more problematic when the approach spread outside Francophone academic circles in the late 1990s and early 2000s (e.g. Roksandic 2002; Nilsson 1998; Nilsson Stutz 2003; Nilsson 2006; Nilsson Stutz 2006) due to the cross-culturally different meanings of the term 'anthropology' (Duday 2009, 3). To avoid confusion between the various disciplines, Boulestin and Duday (2005) proposed the new term 'archaeothanatology', which has been more comprehensively used since 2009 when the book *"The Archaeology of the Dead"* was published.

Archaeothanatology is an approach that bridges the humanities and the natural sciences. This makes it difficult to position the field in the general research agenda of archaeology. Boulestin and Duday (2005; 2006) equated archaeothanatology to the 'archaeology of death' concept proposed by Robert Chapman and Klavs Randsborg in 1981. Others have seen it as a research branch of bioarchaeology (Knudson & Stojanowski 2008) as it departs from human remains and focuses mostly on the analysis of the biological aspects of past human life. To my mind it is neither one nor the other. It shares the interest toward cultural aspects of death with the 'archaeology of death', yet similarly to bioarchaeology it considers the human body as a departure point in the analysis of mortuary practices. I think that it is important not to equate 'archaeology of death' with archaeothanatology; instead its strength as a toolset should be stressed. Thus, I will use archaeothanatology as a method for analysing mortuary deposits to arrive at a conclusion about past practices, which further allows insights into the people's attitudes toward death and dying and the world view in general.

3.1.1. Two phases of archaeothanatological analysis and description

Archaeothanatological analysis is a process-oriented approach toward mortuary remains that follows strict guidelines. Essentially the method is a *chaîne opératoire* of mortuary practices. The fundamental part of the study is the decay of the corpse, which both influences its close surroundings and is immediately influenced by its surroundings in return. Via an elaborated description of the whole skeleton and each of its elements by anatomical means, its spatial relation toward the accompanying artefacts, and other burial features in the field, a chronology of the effects of various taphonomic agents is established. It is not just a description; it also explains the position of any single element with the engagement of taphonomic agents. Eventually, it leads to the distinction of the culturally meaningful practices from the natural processes (see Duday et al. 1990; Duday 2009).

To understand the nature of a field of research it is essential to understand what the researcher does (Geertz 2007[1973], 79). So, how are the operational sequences of the mortuary practices analysed and reconstructed? To make the research process comprehensible I have distinguished two levels within an archaeothanatological analysis: (1) the description of the deposit and (2) the interpretation or 'thick description' of the practices (Figure 3). It has been argued that description and interpretation cannot be separated strictly; they are intertwined (Hodder 1999, 67). However, to my mind it is important to make a clear distinction between the observation of the bones and their position to one another (description) in the deposit and the interpretation formed from this observation. The latter encompasses the description of cultural practices and cannot be seen exempt from the researchers' prejudices and expectations. These two parts are connected through reasoning process that in archaeothanatology means moving from the observation of single elements of bones to the interpretation involving the taphonomic analysis of the deposit. The latter derives from the assumption that every deviation from an anatomical articulation has an explanation that should be explored and reasoned through (Nilsson Stutz 2003). Via the reasoning process, it is possible to reach conclusions about the mortuary practices in past societies.

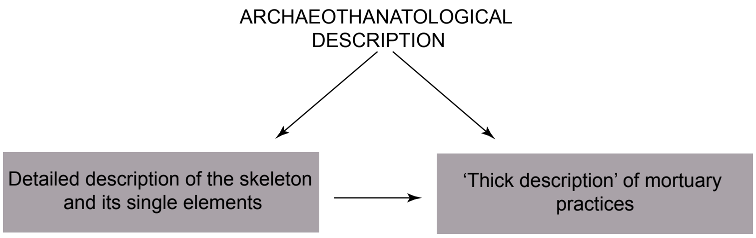

Figure 3. Two dimensions of archaeothanatological description.
The first step is to conduct detailed descriptions of single skeletal elements that allow distinctions between cultural and non-cultural processes in the formation of the archaeological record. The second step is to present a 'thick description' of the mortuary practices.

These two dimensions of the description were also recognised by Boulestin and Duday (2005; 2006) with one exception. Namely, they differentiated between three levels: (1) observation of bones and their relations to each other; (2) description of practices, i.e. initial burial arrangements (corpse, deposit); and (3) the interpretational level that connects the practices with the intentions behind them (burial) (Boulestin & Duday 2006, 166). I argue that it is not possible to distinguish between the second and the third step that Boulestin and Duday have put forward. Even though the description of practices derives mostly from the facts available on the skeleton, it also involves explanations and interpretation. The description of practices is not a pure description and thus resembles more the concept of 'thick description'. To clarify this seemingly arbitrary assertion, I will describe the process of archaeothanatological analysis and point out the similarities and differences of these two ways of analysing culture. By this comparison, I hope clarify how archaeothanatological analysis is conducted and show how it relates to other approaches in (cultural) anthropology.

3.1.1.1. First step: lateralising and localising the bones in the field

Before we can move on to the 'thick description' of the practices as a second step in the analysis, the basis for that has to be laid. The following description of the process is summarised mainly after Duday (2009[2006]; 2009) and Nilsson Stutz (2003). The first thing to do is to give a detailed technical description of single bone elements, their orientation, and their relation to each other. This description is given on the anatomical position irrespective of the actual position of the skeleton. The anatomical position is regarded as a position where an individual stands erect and faces forward. The lower limbs are together, the feet parallel, and the toes point forwards. The upper limbs hang loosely by the sides, with palms facing forward and the thumbs lateral. The whole description of the skeleton and/or its elements follows the international anatomical nomenclature for the human skeleton (about the terminology of the skeletal elements see e.g. White & Folkens 2005; Duday 2009, 156 Appendix; Table 1).

The fundamental part of the detailed description of the skeleton involves the lateralisation of the bones in the field. This means that the side of the appearance of the bone is identified. The side of the appearance is defined by the side of the bone exposed in the plan view. The side of appearance of the bone can be single face (e.g. anterior side of the femur) or a combination of sides, for instance if the bone is rotated (e.g. anterior and lateral side of the femur). The anatomical directions used in the analysis – anterior/posterior, superior/inferior, lateral/medial, and proximal/distal – are explained in Table 1. Left and right are also defined according to the anatomical nomenclature, meaning the left and right side of the body, not the left or right from the observer's perspective. Together with lateralisation three coordinates (x, y, and z) in whatever form for each bone element are documented.

Table 1. Anatomical nomenclature for describing the position of single bones on the skeleton.
After Palastanga et al. 2008; White & Folkens 2005.

Planes	Sagittal/median (midline)	Passes through the body from front to back and divides the body into right and left halves
	Coronal/frontal	Perpendicular to the sagittal plane, divides the body into anterior and posterior parts
	Transverse	Divides the body into upper and lower parts
Directions	Anterior	To the front or in front (ventral)
	Posterior	To the rear or behind (dorsal)
	Superior	Above (cranial)
	Inferior	Below (caudal)
	Lateral	Away from median plane or midline
	Medial	Towards the median plane or midline
	Distal	Away from the trunk or root of limb
	Proximal	Nearest to the axial skeleton (most frequently used for limb bones)
Movements	Flexion	Bending of adjacent body segments in a way that their surfaces come together
	Extension	Moving apart of two opposing surfaces; opposite to flexion
	Abduction	Movement of a body segment away from the midline of the body
	Adduction	Movement of a body segment towards the midline of the body
	Lateral flexion	Bending of the trunk to one side of the midline
	Medial rotation	Rotation of a limb so that the anterior surface faces the midline
	Lateral rotation	Rotation of the limb in so that the anterior surface faces away from the midline
	Supination	Forearm: movement of the forearm in a way that the palm of the hand comes to face anteriorly Foot: turning of the forefoot in a way that the sole faces the midline (accompanied by abduction)
	Pronation	Forearm: movement of the forearm in a way that the palm of the hand comes to face posteriorly Foot: turning the forefoot in a way that the sole faces laterally (accompanied by supination and adduction)

Each bone should be localised in relation to other parts of the body and features of the grave. The location of a bone about other parts of the body means that it should be stated whether and to what extent (tight articulation – intermediate/loose articulation – disarticulation) the articulation of various joints is maintained (Courtaud 1996, 162). These descriptions are conducted relative to the body, not following the structures of the grave or the stratigraphy of the feature. For example, an amber ornamentation common to Early Neolithic graves in Tamula placed "under" or "on top of" a bone will be described as being placed behind/in front of the bone (Table 1). As Nilsson Stutz puts it, it might seem confusing to the majority of archaeologists, but in the end the systematic use of anatomical nomenclature provides a basis for the orderly description of the deposit (Nilsson Stutz 2003, 206). Also, using this kind of vocabulary means that we do not present the essential conclusions *a priori*; rather, these facts will guide us in the following reasoning process and allow us to make the whole description coherent (Boulestin & Duday 2006, 164).

In addition to the observations about the lateralisation and position of the bones the completeness and fragmentation of the skeleton, and any modifications to the bone surface are described (Boulestin & Duday 2006, 165; *Chapter 3.2.1.1.*). To compare the results of single skeletons within an assemblage, the surface preservation is evaluated after the criteria published by Megan Brickley and Jacqueline McKinley in the *"Guidelines to the Standards for Recording Human Remains"* (2004, 16, Fig 6.). Comprehensively these criteria were only possible to observe on the burials that bones are still present in storage (Table 13).

An outcome of the first phase is a detailed description of the deposit in respect of the position of every single bone (lateralisation and localisation), their relation to the grave structures, and the overall state and preservation of the deposit. This description forms the basis for the following taphonomic analysis and interpretation of the mortuary practices.

3.1.1.2. 'Thick description' of the mortuary practice

Regardless of the specificity of archaeothanatology, I argue that its process may be compared to a prominent concept in anthropology and social sciences that is 'thick description'. The concept was brought to the wider audience by the American anthropologist Clifford Geertz (2007[1973]), who borrowed it from a British philosopher Gilbert Ryle, while describing the work of an anthropologist. The applications of this concept in humanities are far from being unambiguous. I will depart from Geertz (and Ryle) to whom the adjective 'thick' in this kind of description involved ascribing intentionality to people's behaviour (Geertz 2007[1973]). 'Thick description' is something that the researchers do; they write it down. It is an interpretative tool that enables the microscopic observation and description of the social discourse (Geertz 2007 [1973], 100), thereby providing the audience with explanations. Archaeothanatological description about the past practices serves the same purpose – to describe the acts of past people based on the position of human body in the grave and arguing for the most reliable explanation by using the taphonomic knowledge of the decomposition of the corpse in a particular environment. This description is as explanatory and interpretative as the 'thick description' in ethnology and anthropology. Ethnologists aim to reveal the conceptual structures of human culture, i.e. the most important aspects that form the daily life of people, the essential (Geertz 2007[1973]). The same goes for archaeothanatological analysis in that it aims to identify meaningful practices to reconstruct the essence of the mortuary behaviour of a particular group of people.

Before the subsequent explanation of archaeothanatological 'thick description', I will clarify what an archaeothanatological description is not. In recent years, it has become more common for osteologists to attend the archaeological field work and draft onsite descriptions of the burials. Even though the expertise of osteologists allows them to gather significant data from the skeletons without archaeothanatological training, their descriptions may lack the depth necessary for conclusions about the treatment of the body during the initial mortuary rituals. To illustrate the point I will quote the whole description of the Veibri quadruple burial, with the emphasis on the body positions, conducted by the osteologist Raili Allmäe (2011, 183):

> *"The bodies have been buried as follows: body of an adult* [skeleton no. II] *was placed in the extended supine position, upper extremities straight next to the body. The facial part of the skull had been destroyed and removed, probably during earlier earthworks, and there was also a dig into the burial – the bones of the lower part of the skeletons were mixed and some bones bear traces of fire (Fig. 2). Probably some fishermen or hikers have built a fire on this place. The body of a child at the age of four* [skeleton no. IV] *was placed next to the adult, but in opposite direction. The body of a child at the age of five was placed next to the adult (in the same direction)* [skeleton no. III], *also in extended supine position, its lower extremities on top of the body of the four year old child. The knees of the five year old child were on top of the four year old child's knees. It refers to a careful burial technique. The last body placed into the grave was of a 12 year old child* [skeleton no. I]. *The skeleton was not complete, some bones of the right body side had been removed or destroyed, probably during earlier construction works. The body was placed next to the four year old child (shoulders on the same line) in supine position; its lower extremities – left tibia and fibula – were extended on the chest of the five year old child. The body of the twelve years old child was lying more on its left hipbone; right hipbone was slightly higher, maybe due to the shape of the grave. It also may explain the absence of the fragments of right tibia and fibula, these bones could have been removed during some former excavation works as well as the facial part of the skull of the adult. On the basis of the placement of the skeletons and the way in which bones were entangled we may suppose the bodies have been buried at the same time."*

I find it positive that osteologists contribute to the description of the skeletal assemblages. It has also been a prerequisite for archaeothanatological descriptions (Duday 1978, referred in Roksandic 2002, 101), yet commonly left to the archaeologists. I do not aim to discredit the work of Allmäe, but would like to show that despite the fact that the above given physical description is conducted by an osteologist whose background is in osteology and anatomy, it does not meet the requirements of an archaeothantological description as it does not follow its rigid guidelines. The absence of coherence in the descriptions is the most substantial missing criterion for archaeothanatology. Moreover, it does not make a clear distinction between description and interpretation, i.e. the author shifts from a description of the deposit to the interpretation and *vice versa*.

The description provided by Allmäe is neither a technical description of the skeletons unearthed by the archaeologist in the field nor a clear 'thick description' of the burial; it is rather something in between. Moreover, Allmäe's description lacks details about single bone elements (the basis of archaeothanatology), leaving the readers wondering on what basis it was concluded that all the skeletons were laid on supine positions. While describing the deposit anatomical nomenclature is applied (e.g. *left tibia and fibula*), allowing the reader to understand which parts of the body are exactly meant, yet without consistency (e.g. *The body* […] *was placed next to the adult*; instead: the body of a child was placed to the lateral left side of the adult; *The knees […] were on top of* […]; instead: the knees were in front of) which makes it difficult to follow. Thus, it does not only take an osteologist, but one trained in archaeothanatology to conduct an archaeothanatological description and obtain qualitatively different information from a burial deposit. However, it is a common mistake made both by archaeologists and osteologists while describing mortuary deposits. I am not different. I had the will to apply archaeothanatology, but lacked the necessary background. Thus, I took courses on human osteology, anatomy, and bioanthropology at the University of Sheffield (2012–2013) and had personal tutorials from my supervisor Liv Nilsson Stutz during the analysis of the burials presented here. The examples of archaeothanatological descriptions 'proper' may be found in *Chapter 6.1.* and also Nilsson Stutz 2003 (Appendix); possible description sheets of all the skeletal elements are available in Courtaud 1996, Duday 2009[2006], and Knüsel 2014.

3.1.2. Describing initial practices

In the second level the reconstruction of practices, which led to the constitution of the described deposit, is accomplished. The aim is to move retrospectively from the description of the deposit, through the engagement of taphonomic agents, to the meaningful practices of the initial mortuary rituals. First, one has to assess whether the deposit under study is at all an outcome of mortuary rituals. In this stage of description (1) the nature and (2) the type of the burial are described, (3) the space of decomposition is examined, and the (4) initial body position of the deceased is given. There is a clear resemblance to the model of forensic taphonomy that includes four dimensions (objects i.e. human remains, space, modification of the objects, and the cultural dimension) (Haglund & Sorg 2006[1997], 18). The following chapter is written according to the model set by Duday et al. 1990, Nilsson Stutz 2003, Duday 2009[2006], and Duday 2009.

The 'nature of the burial' (Table 2) refers to the treatment of the body that preceded the final burial. This marks how the deceased was treated during the mortuary rituals and thus reveals the concept and perception of the dead body (see also Nilsson Stutz 2003, 207). Archaeothanatology distinguishes between 'primary burial/deposit' (Fr. *Sépulture primaire*) and 'funeral in multiple episodes' (Fr. *funérailles en plusieurs temps* or *funérailles decallées;* also referred to as 'secondary burial'). The third concept important here is the process of 'reduction'.

Table 2. Summary of the fundamental characteristics about nature of burial.
After Duday et al. 1990; Duday 2009; 2009[2006];
Boulestin & Duday 2005, 2006; Roksandic 2002.

Nature of burial		***Characteristics***	***Archaeothanatological key observations***
Primary burial/deposit		Single ceremony during which manipulation of corpse or part of a corpse takes place; deceased is placed to its final resting place, whereas ceremony takes place soon after death ('fresh' body)	Positive evidence for: • Maintenance of anatomical connections between the joints that break down more rapidly • Presence of small bones • Preservation of the topography of the burial Refutation for all later interventions to the burial
Multiple-episode burial/ deposit = double-burial ritual = multiphase burial	Secondary burial	Human remains are manipulated at least two different times; temporary burial place and final resting place; analytically important to show whether the subject was a corpse or loose bones when deposited to site where the remains were found; deposition of human remains partly or completely disarticulated	Negative evidence of: • Maintenance of anatomical connections Diagenesis of the burial environment Give sound evidence for later interventions on the burial
	Provisional burial	The first stage of multi-episodic burial; during this step the corpse may be inhumed, or kept in a defined container, it may also be exposed	Difficult to distinguish from the primary deposit, wider archaeological context might give some insights
Reduction		re-arrangement of bones of an individual inside a space that disposes primary burial; creating more room to accommodate a new burial	Same characteristics as in the case of secondary burial, but inside single space (container) The degree of integrity of individual corpses

A primary deposit in archaeology refers to a permanent placement of a 'fresh' corpse into its final resting place. 'Fresh' designates a relatively rapid burial after the death of the individual and thus purports that the entire process of decomposition is hidden and takes place after the final burial. The identification of a primary deposit requires the recognition of the presence of the anatomical articulations, meaning that all the bone elements are in proper anatomical position (Duday 2009[2006], 33). Movements of bones within the initial body volume are allowed; moreover, individual bones may move outside it, too. These kinds of displacements are dependent on the treatment of the body and burial environment. Nevertheless, the presence of all bone elements (c. 206 bones) should be possible to observe.

The most pertinent indicator arguing for primary deposit is the maintenance of labile articulations. These articulations indicate the integrity of the corpse and are presented in Figure 4. Based on the example of animal carcasses it may be assumed that the greater the cross-sectional area of the soft tissue associated with a particular joint the longer the joint will remain intact after animal's death (Lyman 2001[1994], 38). These findings are largely applicable to the human body, too. Nevertheless, some archaeological studies have indicated that it is more than the masses of soft tissue that prolong the maintenance of the joint (Duday 2009, 102). Despite that, in general, the amount and type of connective tissue influence the disarticulation process significantly (Lyman 2001[1994], 38). Thus, it is important to observe and document the presence or absence of the (1) scapula-thoracic junction, (2) articulations between the cervical vertebrae (cranium and mandible are documented to be the first to separate from the axial skeleton (Roksandic 2002, 102)), (3) the costo-sternal articulations, (4) articulations between acetabulum and the head of the femur, (5) articulations of the knee, (6) articulations between the bones of the hand, and (7) phalanges of the foot (Figure 4). Still, the absence of connections between labile joints does not constitute satisfactory evidence for secondary deposit (Duday 2009, 28; see below). The time of the decomposition of these articulations varies greatly and is dependent on the burial environment, which means that it is not possible to establish a common chronology of destruction of articulations for all types of burials (Duday 2009[2006], 33).

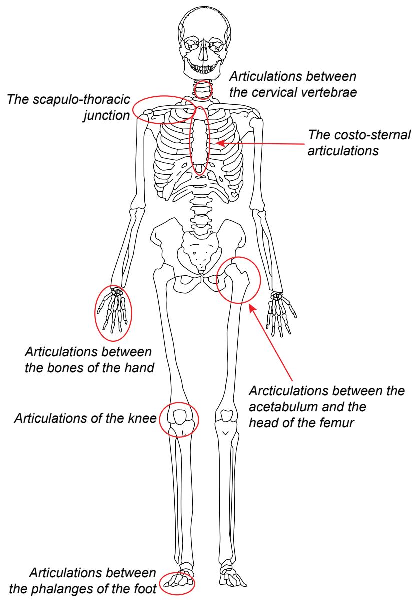

Figure 4. Labile articulations shown on a human skeleton.
After Duday et al. 1990; Roksandic 2002; Nilsson Stutz 2003; Duday 2009[2006]; 2009.

The second characteristic that allows alleging for primary burial is the overall anatomical order of the skeleton (Duday 2009, 28). Therefore, the majority of the c. 206 bones are present and irrespective to the anatomical position have obtained their articulations with one another. In the case of re-analysing old excavation data, one may come across cases where not all the smaller bones (e.g. carpal bones, phalanges of hand and foot), or bones with a greater quantity of spongy compartment (e.g. pelvis) are present. Then the excavation techniques have to be evaluated, too.

The 'funeral in multiple episodes' refers to a variety of practices where the body goes through the process of decomposition before the burial into its final resting place. It is also referred to as deposit of 'dry' bones (Duday 2009[2006], 45) or 'twice-deposited bones' (Duday 2009[2006], 46) and 'double burials' (e.g. Hertz 2010[1960]). Two intrinsic keywords may be associated with funerals with multiple episodes: (1) delay of the final interment and (2) the movement of body or parts of it (Andrews & Bello 2009[2006], 17). There is a range of ethnographic examples about the practices preceding the final burial, extending from the cremation in a funerary pyre to the active or passive defleshing of the corpse. Contrary to the positive evidence that enables the recognition of a primary burial the diagnostic features of the mortuary ritual in multiple episodes relies on negative arguments. Here one has to be able to distinguish between the initial deposit and later interventions. When arguing for a secondary deposit, the later interventions that were not part of the initial burial have to be repudiated (Duday 2009[2006], 46). It is also essential to demonstrate the disarticulation of various joints. At the same time, however, anatomical connections may survive in a secondary burial if the defleshing of the corpse was not completed in its temporary location (e.g. grave 13 in Skateholm: Nilsson Stutz 2003, 220; a karst shaft at La Boucle, Corconne (Gard, France): Duday 2009, 114–115). This demonstrates the interpretative limits of archaeothanatology and points out that the only thing that can be determined with certainty is the stage of decomposition of the corpse during its manipulation (Duday 2009[2006], 47).

In the context of a secondary deposit, the concept of 'reduction' must be discussed. Reduction entails collecting, re-arranging, or bundling the bones of an individual inside a space that contains a primary burial (Duday 2009[2006], 47; 2009, 72). In the act of reduction more than one deceased is involved and it takes place within a single container. Moreover, in archaeothanatology, a reduction "inside the same container" and one "inside the same structure" are distinguished (Duday 2009, 72). The reduction proper, i.e. placement of the corpses into the same container over a longer period, is met in Late Neolithic collective tombs where the previously placed skeletons or bones are re-arranged during the new additions (Beckett & Robb 2009[2006], 60), and also in the case of sarcophagus that is re-opened with the aim of adding a new corpse (Duday 2009[2006], 47; 2009, 72). In the present era many cemeteries of large cities lack sufficient amount of space for new burials. Thus the time of the usage of burial slots is limited. For example in Estonia the law allows the earliest reuse of a previous primary burial after 20 years (Kalmistuseadus § 9, 11). Then the bones of an older burial will be gathered and placed to a corner of a grave before the interment of a new burial. There are discussions about whether the reduction process is part of mortuary repertoire or is it merely a necessity. Boulstein and Duday (2006, 164) argue that reduction is outside the scope of mortuary ritual, yet Jennifer Kerner and colleagues (2014) disagree, stating that reduction reflects the community's attitudes towards death and deceased. I agree with Kerner that deposits that are the outcome of reduction have to be included to mortuary analysis to get a fuller understanding about mortuary practices.

The description of the 'initial body position' has been an important component of funerary archaeology from its beginning. Based on it (most often the position limbs), ethnic groups, social differentiation, and religious affiliations have been distinguished. Usually in these studies the taphonomic agents and their effects – possible post-depositional movements – on the body have been neglected, i.e. the meanings have been assigned to the position of the skeleton, not to the initial body positions. It is true that often the position of the skeleton corresponds to the initial body position of the deceased. This is usually the case within pit graves where the soil immediately fills the empty voids created during the putrefaction of soft tissues. As stated above, even here slight movements of the bones within the initial body volume may occur (most frequently in the areas where the masses of soft tissue are larger, e.g. area of abdomen, pelvic region, and thighs). Hence, it is important to make a clear distinction between the position of the skeleton and the initial position of the body.

3.1.3. Relative chronology within 'burials containing several individuals'

Time is the key element in understanding burials with several individuals. It is commonly accepted that single burial denotes a grave where the remains of one individual are placed. Unfortunately, the terminology concerning 'burials containing several individuals' is not that explicit (e.g. Sprague 2005; Boulestin & Duday 2005, 18; 2006, 150; Duday 2009, 13). The variety of terms that from time to time are used synonymously in archaeology comprise of the following: 'multiple', 'group', 'communal', 'collective', 'mass burials/graves', and 'ossuary'. By the number of individuals interred into the same structure, these may be tagged as 'double'[3], 'triple', 'quadruple' etc. burials (see e.g. Roksandic 2002, 110; Nilsson Stutz 2003, 305; Duday 2009, 98). In German-speaking archaeology the burials with several individuals are divided with the respect of the number of the deceased (Germ. *Bestattungsform → Anzahl der Toten → Einzelbestattungen/Doppelbestattungen/Mehrpersonenbestattungen*) or dis-

[3] To make it even more confusing, the term 'double burial' has been used for multi-episodic burials since the publication of the famous essay by Robert Hertz (2010[1960], 198).

tinguish a diachronic interment (Germ. *Kollektivbestattung,* 'collective burial' in English (see below)) within a single structure (Eggert 2012, 62). Boulestin and Duday (2005, 18; 2006, 150) criticise the use of these terms in funerary archaeology. I agree with them that to be intelligible we have to accord our terminology with social, cultural, and/or religious realities arguing that the terminology has to be restricted. However, we have to be conscious of the time gap between anthropology and archaeology and be aware of their meaning when adopting these (Boulestin & Duday 2006, 152).

In archaeothanatology the 'multiple' and 'collective burials' (Fr. *sépultures multiples et collectives*) are already the outcome of the analysis, i.e. loaded with interpretation (see Duday 1987b; Leclerc 1990). Thus, these terms should only be used after the relative chronology of the deposit is reconstructed. Based on the dictionary entry at *"Dictionnaire de la Préhistorie"* (1988) Duday proposes that the neutral term about burials containing several individuals is 'plural burials' (Fr. *sépultures plurielles*) (Duday 2008, 50). In the present thesis the longer, yet more accurate and a descriptive term such as 'burials containing several individuals' (see Nilsson Stutz 2003) is used synonymously with the term 'plural burials'. Therefore, one should consider discussing 'burials containing several individuals' on two different levels. On an analytical level, before the relative chronology of the deposit has been demonstrated, the non-interpretational term 'burials containing several individuals' should be used. This term is broad enough to incorporate various practices while reckoning the fact that more than one individual is placed to the same context/structure. Likewise, it does not indicate the exact number of individuals buried, nor the nature of the burial, nor refers to the time of the deposition of single individuals.

The analysis of 'plural burials' determines whether the deceased were interred simultaneously or successively. 'Multiple burials' contain several individuals who are placed in the same structure/context simultaneously or within short time intervals (Table 3). Duday (2008, 50) adds that the synchronicity of the deposition *ipso facto* demonstrates the simultaneity or proximity of the death of these individuals. However, this synchrony in the archaeological context might reflect a hiatus of no less than several weeks, which is the time necessary for a corpse to have its first disarticulations (Duday 2008, 50). Moreover, in some contexts – extremely dry and cold conditions or a specific pre-burial treatment of the body – the putrefaction can be prolonged (Duday 2008, 50). Therefore, the 'multiple burial' may incorporate secondary deposits of articulated corpses (see Beckett 2011, 403). This indicates that simultaneous deaths do not require a 'multiple burial', and theoretically a possibility of non-catastrophic event, causing the death of various individuals, remains. For example, a delayed burial was practiced in Finland during the years 1751–1850 where the corpses were kept fresh over winter and only transported to cemeteries in remote areas when the ground was no longer frozen (Núñez 2015). Hence, archaeologically it is only possible to argue for a simultaneous interment; the question of the simultaneous death must be investigated separately. 'Collective burials' contain several individuals who are placed in the same structure or context successively (Table 3). Neither of these terms entails information about the nature of the burial. This means that the question of whether the deposit is primary or secondary must be specified separately (*Chapter 3.1.2.*).

Table 3. Summarising the terminology and characteristics of burials containing several individuals.

Burials containing several individuals (plural burials)	
↓	↓
Multiple burial	**Collective burial**
Same structure/context Two or more individuals	
Simultaneous/successive deposit over a short time period	Successive deposit over a long time period

Archaeothanatology provides researchers with tools that allow a clear distinction between simultaneous and consecutive burials. Instead of assuming that we are dealing with either of them, certain attributes have to be demonstrated in every single deposition under discussion. Again one has to bear in mind that the conditions that demonstrate the synchrony of the deposition depend on the mortuary practices (Duday 2008, 51). The classical archaeological methods like stratigraphy and dating of single features within the grave are important; however, in addition to these, the observations of osteological data supplement relevant information about the properties of the deposition. The various absolute dating techniques currently do not allow the precision needed in archaeothanatology, and stratigraphy can aid only in rare cases (Duday 2008, 51).

A 'burial containing several individuals' in one structure should meet four main criteria to be considered a simultaneous event, i.e. 'multiple burial'. First and foremost, in the case of primary multiple burials the articulations of every single individual should be maintained (Duday 2009[2006], 50). However, this is not a straightforward quality of 'multiple burial' as disarticulations may occur (see above; Duday 2009[2006], 50). Secondly, the remains of two or more individuals must be shown to be tightly connected or intermingled with one another (Nilsson Stutz 2003, 305). The articulated and intertwined bodies within a structure are the most straightforward evidence of a 'multiple burial'. The observations about the space of decomposition are relevant in clarifying the chronology of multiple and collective burials. It is less likely to reopen graves with filled space for reuse than it would be to conduct succeeding interments in a burial with an empty volume without disturbing the previous depositions. Moreover, archaeologically one should be able to demonstrate the absence of disturbances of the grave.

The diagnostic features for 'collective burials' rely on the absence of the characteristics just presented. Consequently, one should be able to demonstrate that interferences in the grave did occur, that the bones are disarticulated, and bones from various individuals lack direct contact. Again these negative considerations cannot be generalised. In the case of 'collective burial' into an empty volume, the newly placed cadaver may not disturb the previous deposition, meaning that the articulations of the older burial are maintained. Moreover, the nature of the deposition affects the course of analysis more substantially in 'collective burial' than in the case of 'multiple burial'. For instance, the taphonomic history of human remains in a secondary context is more difficult to reconstruct than in the primary deposit (see Haglund & Sorg 2006[1997], 18). Also, the reduction process has to be considered here (Duday 2009[2006], 49).

The approach has its limitations. Even if it allows distinguishing single events, one cannot conclude with certainty that the seemingly well-articulated individuals within a single structure were placed there during a single event. "*It is not possible to differentiate among deposits when the period that separates them is less than the time necessary for disarticulation of the unstable articulations"* (Duday 2009[2006], 50). There is an interval of one to two weeks that we have to account for while speaking about primary multiple burials, since the ligaments of the joints have not disappeared yet (Duday 2008, 52; 2009, 73–75). A modern experiment with animal corpses in Estonia demonstrated that the putrefaction of ligaments may occur even later, being mostly dependent on the characteristics of the burial environment, climate, and space of decomposition (Jonuks & Konsa 2007, 99, 102). By all means, these consequences are not directly valid for human burials, but they exhibit how different contexts affect the decomposition processes. We cannot surmount this time gap, but we can argue in the scale of probability.

Another shortcoming in the ability of archaeothanatology to distinguish between 'multiple burials' and 'collective burials' becomes apparent when we observe no direct physical contact between the bodies within the same structure. As the analysis departs from the detailed observation of the articulation and disarticulation of various joints about all the individuals within the single structure, archaeothanatology cannot determine the temporal relations of individuals where the number of bodies is low concerning the area of the deposit (Duday 2008, 52).

As the above-listed characteristics about a primary 'multiple burial' taken individually can be misinterpreted (e.g. disarticulation of bones in empty volume), the studied deposition should meet more than one criteria to be interpreted as such. The same is valid for a 'collective burial'. Thus, these properties should be treated as guidelines and their significance evaluated separately in every case. Strong arguments in favour of either of these interpretations can only be built if the presence of various aspects is demonstrated.

3.1.4. Space of decomposition

The term 'space of decomposition' refers to the environment immediately surrounding the corpse during decomposition and putrefaction (Nilsson Stutz 2003, 252). The variety of structures where deceased have been placed throughout prehistory is vast, expanding from caves to pit graves (i.e. earth graves), and from ceramic vessels to megalithic tombs. All these structures create different spaces for the cadaver to decompose, affecting the position of the unearthed remains substantially. Thus, the observations about the position of the skeleton permit reconstructing the initial structure of the burial. In general, the distinction between (1) decomposition in an empty space and (2) decomposition in a filled space is made. The space of decomposition is also connected to the infilling of the grave. The factors contributing to the analysis of the space of decomposition are summarised in Table 4.

Table 4. Summarising the characteristics and key observations of the space of decomposition.
After Duday et al. 1990; Roksandic 2002; Boulestin & Duday 2005; 2006; Duday 2009[2006]; 2009.

Space of decomposition		***Characteristics***	***Archaeothanatological key observations***
Empty space	Inside the initial volume of the cadaver	Space that emerges during the putrefaction of soft tissue	Limited movement of disarticulated skeletal elements inside the initial body volume
	Outside the initial volume of the cadaver	Additional spaces in the burial structure that existed from the moment of ritual deposition (e.g. coffin)	The range of movements of the bones is large and expands outside the initial body volume
		Spaces that formed during decomposition (e.g. decomposed organic materials) = delineated empty space	Dislocation of bones, allows ascertaining initial grave features
Non-delineated empty space		Environments that do not involve burial (e.g. caves, crypts)	Dislocation of skeletal elements that might result a collapse of thoracic cage, rotation of vertebral segments relative to each other, or disjunction of the iliac-sacral articulation
Wall effect		Presence of support on which a skeletal element can lean as the body decomposed and the spaces were replaced by sediment	May prevent movement of disarticulated skeletal elements (e.g. constriction of shoulder or pelvic girdle)
Delayed infilling		Filling occurs long after the cadaver has decomposed and disarticulated	Various movements of the bones occur
Progressive infilling		The soft tissue that is decomposed will be replaced by sediment (porous and fluid) before any considerable empty spaces are formed	Even the most labile articulations are preserved; still slight movement within the initial volume of the body allowed

In the case of decomposition in an 'empty space', it is important to distinguish between 'original empty space' and 'secondary empty space' (Duday 2009 [2006], 41). Original empty space refers to a grave structure without filling at the moment of deposition (e.g. caves, megalithic tombs, chamber tombs, stone-cist graves, coffins, etc.). The secondary empty space in the grave refers to voids created outside the initial body volume during and/or after the decomposition of additional structures within the feature. These structures may have been made of perishable materials and may decompose before the putrefaction of the cadaver is finished. For instance structures for raising the head of the deceased (e.g. wooden poles or pillows) tend to decompose entirely; their presence, however, can be observed from the dislocation of the cranium, the mandible, and the cervical vertebrae (Duday 2009[2006], 41). A 'non-delineated empty space' implies a burial environment where an actual burial of a corpse/bones does not take place (Roksandic 2002).

Decomposition in a 'filled space' usually refers to an earthen grave where the corpse is put either into an existing hole or a specially dug pit and covered immediately with the soil. If a corpse decomposes in an environment like this its labile articulations should be maintained; only slight movements of bones within the initial body volume are possible to observe, if any at all.

Depending on the space of decomposition and grave features (e.g. coffin, wrappings, etc.) the infilling of the grave with the covering sediment can differ. When the corpse has not been placed into a container and the soil is relatively granular, the grave may be in-filled immediately after the decomposition of the soft tissues (i.e. progressive infilling). If the body has been covered with something or sealed into a container, infilling of the grave is delayed. Depending on the volume of the container more substantial movements of the bones may occur.

3.1.5. Post-excavational archaeothanatology

Similarly to other archaeological sources the act of removing the human remains from the soil entails a great data loss, i.e. the potential to reconstruct past human acts. Therefore, ideally, archaeothanatology is applied in the field, which ensures high-resolution data about the burial. Moreover, information about the skeleton is documented by someone with a firm background in osteology and/or anatomy, and archaeothanatology. This is an ideal case. What happens if the procedures for archaeothanatological analysis were not applied in the field? Does the method lose its feasibility? Duday (2009[2006], 30) claims that only rarely can detailed information about the burial be obtained afterwards, regardless of the quality and/or abundance of the excavation archives. Based on my own experiences with the Veibri quadruple burial I can attest that this is true. At the time of the excavations, we lacked the skills to conduct an archaeothanatological analysis in the field. Nevertheless, the documentation of this burial is far more abundant and explicit than all the other Stone Age burials studied in Estonia. Moreover, the excavations were visited by a trained osteologist. There are aspects that were not properly recorded. For instance, the position of the cervical vertebrae, a requisite while reconstructing the initial position of the head, has not been documented, nor is it visible in the photographs or drawings.

However, I argue that the old excavation data should not be excluded from an archaeothanatological analysis. Instead of being discouraged by the absence of an ideal case-scenario, one should take it as a challenge to re-analyse and interpret old excavation data (Tõrv & Peyroteo Stjerna 2014; Tõrv 2015). This idea is also supported by several studies (e.g. Nilsson Stutz 2003; Nilsson 2006; Willis & Tayles 2009; Beckett 2011; Harris & Tayles 2012; Tõrv 2015; Peyroteo Stjerna 2016), which have shown the applicability of this approach to previously excavated burials.

Applying archaeothanatological principles to the analysis of old excavation data adds a sequence to the relative chronology of the reconstruction of mortuary practices. As discussed above a set of rules have to be followed during the analytical process to establish a chronology of effects of various taphonomic agents. First, a detailed description of human remains has to be given, which is followed by a reasoning process to determine all the taphonomic agents responsible for possible movements of the deposit. After that, a 'thick description' of cultural practices is written. While working with old excavation records, another component must be added to this step by step analysis. This is the contextualisation of the excavations and data creation (Figure 5). Successful application of archaeothanatological principles to the old excavation data requires a source critical analysis of the excavation archives. Following the definition of archaeological data, which is *"a set of dynamic, dialectical, unstable relations between objects, context and interpretations"* proposed by Hodder (1999, 84, figure 5.2) it becomes clear why it is necessary to include research history of the site, the excavation techniques, and even the underlying theoretical thought of the excavator. The observations and documentation that archaeothanatological analysis relies on are highly dependent on the researchers' pre-understandings, the questions asked, and the interpretations done in the field. Moreover, archaeologists tend to find only what they can anticipate, and what they eventually find depends on the field techniques. To comprehend the old excavation data, one should analyse the applied field techniques and the course of excavation. How were the burials excavated? Who excavated the site and for what reason? How were the drawings, photographs, and written descriptions created? Regrettably the field reports from the 20th century usually do not contain information about the aims of the excavations, and the field methods are only rarely discussed in detail.

Field reports alone do not hold the information necessary for understanding the process of field work, the excavation techniques, and the influences on the interpretations. In addition to these, visual materials such as drawings, photographs, and sketches, field diaries, notes, parish descriptions from the beginning of the 20th century, and even interviews and e-mail correspondence with researchers who excavated the sites are included to reconstruct the 'field situation' (Figure 6). Publications about the burial places give insights about the theoretical background of the researchers and the argumentation behind their interpretations that in many cases were formed already during the excavations. Only by intertextual analysis of different sources can we get closer to the background of old excavations. Thus, in addition to the understanding of the post-mortem formation processes of the corpse, one has to be able to describe and comprehend the formation processes of the source material. The research history together with the description of applied excavation techniques and former research is highlighted in *Chapter 1.1.* and *Chapter 4*, and partly within the description of single deposits (*Chapter 6*).

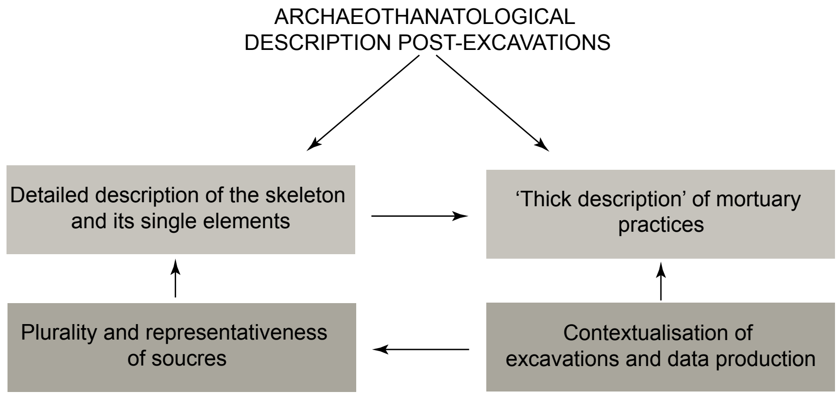

Figure 5. The key differences between post-excavational archaeothanatology and the method applied in the field.

In re-analysing the excavation archives from a new standpoint, the representativeness of the sources should be evaluated. Does the material answer the particular questions the researcher has in mind, and if so, to what extent? Is the material gathered sufficient? Which are the possibilities and limitations of the source material? As the aim of the analysis is to reconstruct the relative chronology of the decomposition of the skeletal articulations, the sources should allow to capture key information about the surrounding environment and grave structures; three coordinates (in whatever form) for each bone; exact position of every single bone, and the presence or absence of bones with labile articulations (Duday et al. 1990, 31; Duday 2009[2006]; 2009). So, to what extent do my sources meet the strict requirements of archaeothanatology and what should be done with the data that does not meet these criteria?

Information about burials is scattered around and is composed of (1) archaeological collections, (2) archival materials that are further divided into textual and pictorial sources, and (3) scientific publications. The archaeological collections contain human remains, grave goods, and other features from graves. Archival sources consist of parish descriptions from the beginning of

20th century, field diaries, and excavation reports. The latter is usually supplemented with plans, drawings, and photographs. Due to the re-use of old excavation data, previous scientific publications are available about the burials discussed here. One may find specific publications dedicated to the matters of burials as well as more general approaches where burials are mentioned among other features. Due to the different purposes of their existence, information gathered from the described sources varies in their content (quantity and quality). To conduct the archaeothanatological analysis there are three main sources that one could account for: (1) written description (either in a field diary, excavation report, or publication), (2) photographs and drawings (incl. sketches) (Konsa in prep.). Lastly, the physical remains of the corpse, despite the fact that they are no longer *in situ*, contribute to the post-excavational archaeothanatological analysis. Additionally, the find material from the whole site provides a context to understand mortuary rituals.

It has been suggested that instead of relying primarily on written descriptions, one should focus on visual material such as photographs and detailed drawings (Nilsson Stutz 2003). Peter Burke warns that the concept of 'the camera never lies' tempts us to mistake photographs for reality (Burke 2001, 21; discussion in archaeology see Konsa in prep. and references therein). However, an archaeologist has to make decisions about when, how, and why to make a photograph, and what s/he wants to present. Moreover, photographs, as drawings, translate three-dimensional information into two-dimensional images (Roskams 2001, 120), thus still not presenting the totality of the feature captured. About archaeothanatology, Duday rightly points to a serious problem: often the unearthed bones have been first taken up and only then posed in their 'correct' anatomical positions for photographing (Duday 2009[2006], 40). Thus, this picture represents the prescriptive view of the archaeologist, not the *in situ* skeleton as it was first discovered. This further implies to the importance of the historical context of the images: one should be able to ascertain at what stage of the excavation of a particular burial the photograph was taken. Who took the photograph and what was the photographer attempting to capture? I admit that this kind of metadata is sometimes difficult to grasp from the field documentation. However, it is important to remember that photographs are not more objective in their essence; they just are a different aspect of the field documentation. They are both evidence of history and they are historical, thus source criticism is essential (Burke 2001, 23, 25).

For archaeothanatology small details mean everything. One should be able to identify the presence or absence of labile articulations of the skeleton from photographs, as well as the side at which it appears. To extract these details from a photograph, quality, i.e. the resolution of photographs (light, sharpness, composition, angle of photograph) plays an important role. The overall rule is that more details lead to a more reliable reconstruction of initial mortuary practices. Despite the fact that the sources derive from the late 19th and 20th century when photography was indeed available, not many burials were photographed (Table 13). There is no photographic record about the early excavations from the late 19th century up till the 1920s. The first ones appear during Indreko's excavations in Tamula, yet until the 1990s taking photographs was not a standard practice. The resolution of the photographs, mostly the light and sharpness, poses another problem. The quality of photographs was especially poor during the Soviet Era. Due to the technology of the time, the photographer would not be assured of the quality of the image until the photograph was developed; at times there were no images or they were superimposed on one and other, thus they were not informative (Jaanits 2013).

The composition and angle of the photograph contribute immensely to the understanding of the *in situ* position of the skeleton and might sometimes be distorting. Present field manuals and guidelines provide detailed instructions about the correct techniques for photographing skeletons both in the field (e.g. Kinne 2006, 55–56) and in the lab (e.g. Buikstra & Ubelaker 1994, 10–14; Brickley 2004, 6). We even have specialists responsible for taking photographs. It was not the case with the burials analysed herein. The archaeologists themselves were the photographers. Rarely were planar views taken; the majority of the photographs were taken from either the foot or head end of the grave or the lateral sides of the skeleton. To reduce the errors that one could make while analysing this kind of photographs, these should be compared to the planar drawings of the graves. Nevertheless, in the case that photographs are present, they are treated here as a primary source, or at least a starting point, for describing the *in situ* position of the skeleton, yet evaluated critically and supplemented by information from other sources.

Similarly to the photographs one should be able to extract the metadata about the drawing. At what stage of the excavation was the drawing done? Was the whole skeleton cleaned before drawing it? The field drawings from the analysed sites are mainly schematic. As the planar views of graves should be one of the most important sources providing detailed descriptions of the skeletons and their single elements, the schematic style of drawing poses a problem. The drawings are in most cases not granular enough to fulfil the requirements of archaeothanatological analysis. Since these do not refer to the single features of the bones, the drawings cannot illustrate the bones' lateralisation in the grave. However, they do allow conclusions to be drawn about the articulations of the skeleton.

Detailed written descriptions cannot be ruled out either in an archaeothanatological analysis. The graves, work process, and field techniques are presented in a formal way. Burial descriptions often are too general in their description of the skeleton (orientation of the burial, extended/flexed position, lying on the back/one side). Most of them do not contribute the detailed information needed about the side of appearance of single bones nor about the maintenance of various articulations (although exceptions do occur, e.g. Ottow 1911). In these cases, we cannot conduct a comprehensive archaeothanatological analysis. Sometimes this is all that we have. Furthermore, textual sources serve as supporting information about the visual material available for every single burial.

The skeletal assemblages in storage complement the analysis carried out based on the visual and textual sources. It is important to document the completeness of the skeleton (see *Chapter 3.2.1.1.*) and be aware of the formation of the collection to account for any data losses that might have occurred after the excavations.

In the best case scenario, all of the above-mentioned documents complement and do not contradict each other (see also Konsa in prep.). However, as seen below this is not always the case. Even though the visual material has been considered primary in the archaeothanatological analysis, it is important to state that the hierarchy of the sources is not that straightforward. Thus, the only way to overcome these contradictions between sources is to emphasise them during the reasoning process. Moreover, in every single case it has to be articulated why a particular source has been considered primary.

As stated above, specific criteria should be observed in burial record to conduct archaeothanatological analysis (Figure 6). Not all documentation fulfils these requirements. Thus not all the burials can be treated alike. During the source critical analysis of each burial, it was observed whether and to what extent their documentation meets these criteria (Table 13). It is referred to as the representativeness of the source. Accordingly the burials were divided into three categories that determined the depth of the further analysis. Unfortunately, the field archive about the vast majority of the burials discussed here is not granular enough to carry out full archaeothanatological analysis. Thus, these cases represent burials with 'moderate' and/or 'poor representativeness'. The burials with moderate representativeness may be used as case studies since parts of the initial practices can still be reconstructed. Burials with sources that are graded with 'poor representativeness' are not discarded entirely; these provide the general background and context for the case studies. Burials with sources that meet most of the criteria belong to the third group. In these cases, the full analysis is conducted, and initial practices reconstructed.

The archeaothanatological approach has no spatiotemporal boundaries. It can be applied to the analysis of human remains in the field and old excavation archives. However, there are two main differences that post-excavational archaeothanatology has in comparison to the application of the method in the field. It is fundamental to consider a plurality of sources and avoid the use of 'the one good source'. As discussed above, none of the sources – photographs, field drawings, nor written descriptions – meet the requirements of archaeothanatology on their own. Thus, cross-references to each of them is a must during the analysis. Moreover, the field archive should be analysed critically to make the contradictions between sources explicit, and if possible, to eliminate these to proceed with the analysis. Also, the context and background of archaeological excavations where the analysed burials derive from have to be considered. This part of the analysis forms an additional step in the reconstruction of post-mortem processes through archaeothanatology. Thereby, the excavations and the production of data can be critically contextualised. Of course, due to the varying quality of data, the interpretations of the material may remain open or incomplete. However, we should not be concerned when we do not find complete solutions to each case. As Rita Peyroteo Stjerna and I have argued (2014), this should not be seen as a limitation of the method, but instead an opportunity and a research challenge. Following that perspective, the positive program for post-excavational archaeothanatology should include continuous comparisons with other graves analysed from multiple spatio-temporal contexts. Thus, conventional protocols should be used; the comparative materials made explicit, clear, and published. Only a growing body of knowledge assures the reliability and strength of post-excavational archaeothanatology for the study of mortuary rituals from the almost immeasurable source material stored in collections (Tõrv & Peyroteo Stjerna 2014).

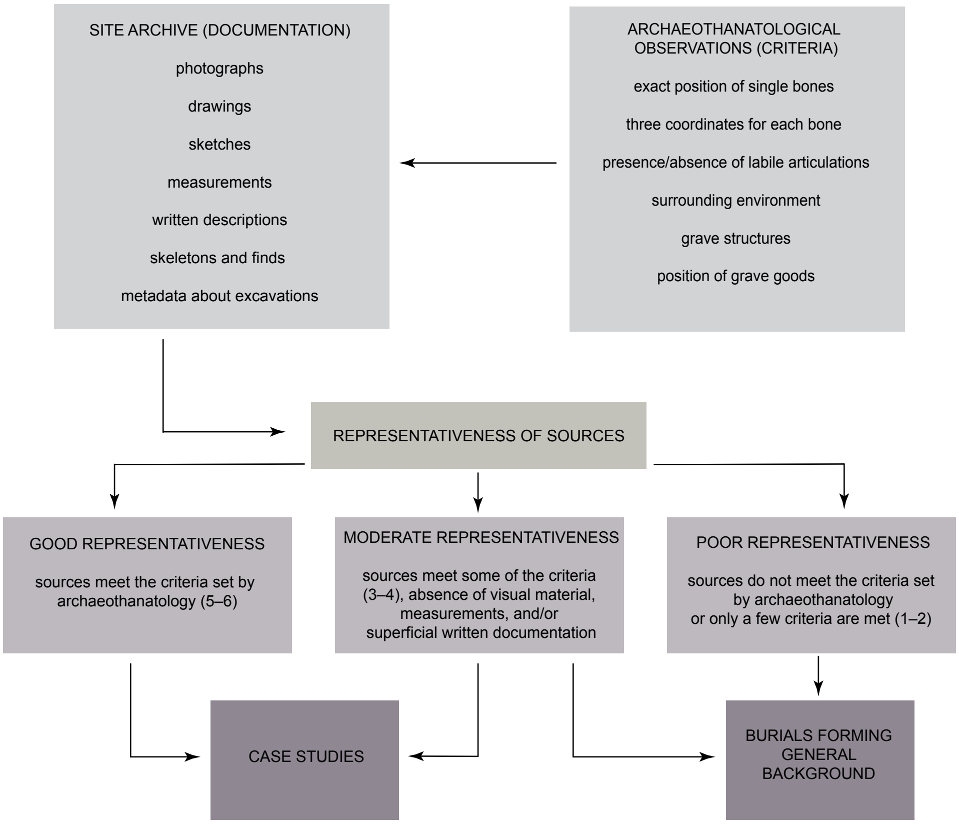

Figure 6. The relationship between the observation criteria of archaeothanatology and field documentation.
Based on the representativeness of the sources single burials in are divided into three groups, which determine the way each burial is regarded.

3.2. Putting flesh onto bones – identifying the deceased

The secondary objective of the thesis is to explore who were buried in an archaeologically observable way and whether the differences in mortuary practices are related to differences in primary identities of the deceased. Identities of the dead are examined through osteological and biochemical analysis. In the following chapter, the applied osteological methods together with stable isotope studies and radiocarbon dates from human collagen will be discussed. I acknowledge that biological sex is far from being gender, and biological age says less about the person's social or chronological age, and the concept of "you are what you eat" does not represent the totality of person's identity. However, these characteristics can serve as a departure point for further discussion.

3.2.1. Osteological analyses

The majority of the skeletons analysed here have been subjected to osteological analysis previously (*Chapter 1.1.*). Regardless, it is important to re-analyse all the skeletons, since previous studies have not provided sufficient methodological background for their age-sex determinations to subject them to critical analysis. The reassessment of osteological samples was mostly undertaken to get an overview of the preservation of the skeletal material (invaluable for archaeothanatological analysis), and to calculate the minimum number of individuals represented in the tangible mortuary practices of Stone Age hunter-gatherers. The insights about the age-at-death and biological sex determinations were by no means of lesser importance. The osteological analyses were subjected to a standard methodology to make the results comparable. Also, the surface preservation of bones, cut-marks, and animal gnawing marks were recorded in cases of complete skeletons and loose human bones alike. Pathological changes, degenerative changes, dental diseases, and evidence of trauma were documented, but without consistency and thus these would not be discussed here. The latter should be analysed more thoroughly and thus treated separately in another study.

3.2.1.1. Preservation of skeleton and preservation of bone surface

The completeness (expressed in %) of the skeleton was assessed, and the data was recorded on the inventory sheet proposed in Brickley & McKinley 2004. To express the frequency of each bone in the sample, the "Bone Representation Index" (BRI) was used in the context of loose human bones (Bello & Andrews 2009[2006]). This is the ratio between the actual number of bones excavated (number of observed bones = No. obs.) and the number of bones that should have been present according to the minimum number of individuals (MNI) of the sample (theoretical total number of bones = No. theor.):

$$BRI = 100 \times \Sigma \text{ (No. obs. /No. theor.)}$$

The recording of the completeness of the skeletal inventory is essential to determine the range of methods that can be applied in further analyses. It is not only valuable for assessing the representativeness of the results of the below-described osteological analysis, but it also influences the completion of archaeo-thanatological analysis. For instance, the way the skeletons are lifted from the sediment and the range of the areas that are screened afterwards determines the success in finding small bones such as infant bones, or hand and feet bones of adults (Stodder 2008, 77 and references therein). Thus, to detect the changes that have taken place during the curation or archiving of the skeletons, the bone assemblages available for osteological analysis were compared to the information in the excavation record (diaries, reports, photographs, and drawings). Detected differences allow source critical conclusions about the initial burial practices.

The condition of the bone itself – together with the presence or absence of bones – is often the key to understanding the formation processes that have affected the deposit, including natural and cultural agents. Thus, erosion and abrasion of the bone surface were recorded based on McKinley 2004 (Table 5). In the case of intact skeletons, the general score about the whole skeleton was recorded, but in the case of single bone elements, instances of substantial differences in their surface preservation were reported. Surface preservation was recorded in each of single loose human bone.

Table 5. Surface preservation of bones (after McKinley 2004, 15–16).

Surface preservation score	*Description of bone surface*
0	No modifications, surface morphology is clearly visible with fresh appearance of bone
1	Slight and patchy surface erosion
2	More extensive surface erosion than grade 1, deeper surface penetration
3	Most of the bone surface affected by some degree of erosion, general morphology is maintained, but parts of surfaces are masked by erosion
4	All of bone surface is affected by erosion, but varying depths; general bone profile is maintained
5	Heavy erosion across whole surface, completely masking normal surface morphology with some modification of bone profile
5+	As grade 5 but with extensive penetrating erosion resulting in modification of profile

Additionally, cut marks were documented. Their position, number, and average length were recorded based on the guidelines given in Brickley and McKinley 2004. Microscopic analyses of cut-marks (e.g. Haidle & Orschiedt 1995) were not undertaken and were left for the future research.

3.2.1.2. Estimation of biological age at death and biological sex

Age and sex are theory-laden terms that have provoked debates since the emergence of feminist approaches in archaeology in the 1980s (e.g. Yates 1993; Nilsson Stutz 2003; Schmidt 2004; Sofaer 2006; Stodder 2008; Fahlander 2013). The interplay between gender and biological sex, and/or biological and chronological or social age are complex and will not be discussed here any further. Here age and sex are regarded as primary identities defined by the individual's biology and should not be confused with culturally specific age categories nor to gender. Biological age reflects the physiological changes of the body that occur during the maturation and degeneration of the body and become obvious in distinct parts of the skeleton (Sofaer 2006, 117pp; Nawrocki 2010, 80; Ubelaker 2010). Sex is defined by differences between male and female based on a fundamental chromosomal difference, but hormonal change is the means whereby sexual differences become visible in the skeleton (Chamberlain 2006, 92; Mays & Cox 2010, 117).

Similarly to how pottery sherds are the basis for reconstructing whole vessels, the physical characteristics of human remains provide insights about once living people, i.e. about their biological sex, age at death, physical activity, and pathologies. However, both pottery sherds and human remains – here skeletons or fragments of them – provide us with inevitably erroneous results. The precision and resolution of osteological assessments are mostly affected by the (1) character of the sample and (2) the range of methods applied to determine various parameters on human remains. Before moving to the ageing and sexing methods applied to the sample here, I will briefly discuss some fundamental constraints of osteological analysis and in interpreting the perceived results within a wider context.

The most considerable limitation of osteological analyses conducted on Stone Age human remains is the absence of a large and carefully selected reference population (see also Nilsson Stutz 2003). The methods applied in ageing and sexing prehistoric skeletons are developed based on skeletons of modern people whose age and sex is known (e.g. Lovejoy et al. 1985; Brooks & Suchey 1990; Buckberry & Chamberlain 2002), not on the scanty Stone Age material. However, despite the universality of human biology, inter-population differences are clear (White & Folkens 2005, 326–327; see also Nilsson Stutz 2003, 165pp; Robb 2010, 479). Not only does the reference population affect the age and sex estimates, but its structure further influences demographic calculations about prehistoric populations (Chamberlain 2010).

The character of the osteological assemblage determines the choice of methods and the resolution and precision of the analyses (Ferembach et al. 1980, 527, 533). Archaeological samples are never perfectly preserved as several taphonomical aspects act upon them. Thus, analyses of human remains should not be conducted separately from the knowledge about their environmental and cultural background (Nawrocki 1991). Taphonomy is *"the study of the transition /.../ of organics from the biosphere into the lithosphere or geological record"* (Lyman 2001[1994], 1), providing us with variable processes and events that have affected the content and state of skeletal assemblages. Taphonomy forms a core behind the understanding of mortuary practices here, being especially important while investigating loose human bones and plural burials (Stodder 2008, 72). Ann L.W. Stodder (2008, 73 Table 3.1) has summarised the taphonomic processes that affect the formation of osteological collections. Besides the environmental conditions of the burial and the cultural practices of past populations affecting the formation of skeletal assemblages, archaeological recovery, excavation, and curation also play their role. To accomplish a reliable picture of the mortuary practices, the excavation methods and site histories are included in the thesis (*Chapter 4*). The size of the fragments of bones directly affects the determination of a single element and the overall estimate about a loose human bone assemblage (Stodder 2008, 79) affecting further the NISP, MNE, and MNI. The age and sex estimations are also affected by the preservation of the assemblage.

It is commonly agreed that multiple elements should be analysed before a conclusion about the age-at-death or biological sex of an individual is made. However, the validity of this practice has also been questioned. For instance, Margaret Cox (2010, 63) stresses that the results of osteological analysis are more comparable and verifiable when a single method is applied. While using a variety of methods, it is not entirely clear how these multiple characters should be weighted. Which trait should be privileged and why? However, while assessing the sex of an adult, the whole skeleton should be used. The pelvis and skull are elements where sexual dimorphism is most considerably marked; therefore, the sexual indices of these should be accorded the most weight (Fehrembah et al. 1980; Schmidt 2004, 105; Mays & Cox 2010, 118). Both of these prerequisites require well-preserved skeletons, which is usually not the case with Stone Age human remains and becomes especially problematic in the context of loose human bones. The reality is that even if one tries to utilise a single (set of) method(s) the sample determines how and to what extent it (these) can be used. The consequence is that a range of methods that might not even be comparable to one another are applied and interpreted within a same theoretical framework.

Another general problem with osteological analysis is the precision and accuracy of the estimates. For instance, while converting the biological age into a chronological age, biological anthropologists, tend to underestimate the individual variations (Narwocki 2010, 85) and instead of introducing larger uncertainties to the age ranges of single individuals they allow for a deviation of 5–10 years. However, while increasing the precision of estimates, the accuracy of the measurements gets lost. It has been shown that the error ranges are rarely less than 15–20 years per phase and increase with the age of an individual (Narwocki 2010, 85, 88). Despite these shortcomings, research with high precision ages are still published in the eastern Baltic (e.g. Zariņa 2006; Allmäe 2011). To partly overcome the problem I have applied a wide error range to age determinations. The precision of sexing of the skeletons, on the other hand, depends on the marked sexual dimorphism of male and females. However, in the western European Mesolithic populations, these differences are not as marked in comparison to the populations from later periods (Schmidt 2004, 101–102 and the references therein), which may cause problems in assessing the biological sex.

All the above-listed shortcomings of osteological analysis together with the possible inter-observer biases should be born in mind while reading *Chapter 5.1.* about the results of the analysis of the Stone Age hunter-gatherer skeletal assemblages.

3.2.1.2.1. Biological sex

Biological sex was only assessed on adult skeletons as the secondary sexual changes occur during and after puberty, ranging from 10–14 years in girls and 12–16 years in boys (Scheuer & Black 2000, 9; Chamberlain 2006, 93). Therefore, the physical differences between male and female, i.e. sexual dimorphism, only develops at the beginning of adulthood (Chamberlain 2006). Morphological changes in skull and pelvis are the primary sources for determining sex (Buikstra & Ubelaker 1994, 15; Brickley & McKinley 2004, 23). Pelvic morphological traits were preferred in assessing sex (Buikstra & Ubelaker 1994) as this is the only skeletal region that shows morphological adaptions to the different reproduction capacity of male and female sexes (Chamberlain 2006, 95). Secondarily, the traits on cranium and mandible were used in sexing the skeleton (Ferembach et al. 1980; Buikstra & Ubelaker 1994; Schwartz 1995; Loth & Henneberg 1996). Other characteristics that distinguish female skeletons from males (e.g. overall size and robustness) act only as general indications of sex without reference material from the same population. Where possible, the results of different regions were compared to obtain more accurate results. When neither of these elements was present, the sex was reported as undetermined.

3.2.1.2.2. Biological age

A range of methods allows determining an individual's age at death (i.e. biological age; see e.g. Latham & Finnegan 2010). Fundamental to all ageing techniques is the fact that bone is constantly renewed, remodelled, and repaired during one's lifetime. As these changes are more rapid during the childhood, ageing of sub-adult skeletons is relatively straightforward. Ageing skeletal material becomes more problematic after maturation since no significant growth patterns can be followed then; age estimates are instead based on degenerative features visible on various joint attachments of bones (e.g. Fehrembah et al. 1980; Chamberlain 2010; Mays & Cox 2010). This further suggests that the age determinations of sub-adults are more accurate than those of adults.

Osteologists establish the biological age by referring to the physical appearance of the analysed skeletal remains relative to the skeletons used to create the scoring system (Nawrocki 2010, 80). As the aim of age estimations is just to get a general profile of the people interred, a range of standard macroscopic techniques were applied, as outlined in Buikstra and Ubelaker (1994) for adult and Schaefer et al. (2009) for sub-adult skeletons.

In ageing adult skeletons, the grading of characteristics of pubic symphysis (Brooks & Suchey 1990) and auricular surface were preferentially used (Lovejoy et al. 1985; Buckberry & Chamberlain 2002). In some instances, dental attrition was used to determine the age-at-death (Brothwell 1981). However, it has to be considered that tooth wear traces are largely affected by the diet of the individual or cultural practices (e.g. Larsen 2003[1997], 258pp; Molnar 2008) and the applicability of the method to hunter-gatherer populations has not been demonstrated (Gray Jones 2011, 65). Even though dental attrition may mislead us, the age categories outlined in Table 6 were made concerning the possible inaccuracy of the estimations and normal range of variation in skeletal indicators.

Table 6. Categories for biological age at death estimation.
Compiled after Buikstra & Ubelaker 1994; Scheuer & Black 2000; Gray Jones 2011.

Description		***Age***
Sub-adult / juvenile (<18 years)	Inter-uterine/neonate	<4 weeks
	Infant	1–11 months
	Young child	1–5 years
	Older child	6–11 years
	Adolescent	12–17 years
Adult (>18 years)	Young adult	18–25 years
	Middle adult	26–45 years
	Older adult	>46 years
	Undetermined (UD)	Not known

The age estimations of sub-adult skeletons are more accurate and are based on the development of maturation of the skeleton. However, difficulties in assessing the sex of these individuals also increase the range of error (Scheuer & Black 2000, 12; Saunders 2008, 125). Also, a range of variability is seen between different populations and individuals of the same population (Scheuer & Black 2000, 11). Estimates of age at death in sub-adults were undertaken according to the fusion of epiphyses (Scheuer & Black 2000) and diaphyseal length of long bones (Schaefer et al. 2009). The choice of the method depended on the completeness of the skeleton. Dental development was also used to assign the age of death for sub-adults (Moorrees et al. 1963a, b; Ubelaker 1979).

Where possible, various techniques were applied and the results compared. This was mostly the case with more complete skeletons from discrete graves. Contrary to the case of intact skeletons, the age determination of disarticulated human remains was only possible for elements with relevant indicators. But even in these cases the fragments could only be broadly categorised as belonging to an adult or sub-adult.

3.2.1.3. Identification of loose human bones

It has been shown that screening material from non-mortuary contexts or inspecting bones collected as faunal remains could significantly impact our understanding of past mortuary practices (Stodder 2008, 77; e.g. LKB site Herxheim in Germany: Pechtl & Hofman 2013, 124). Thus, the present thesis is the first attempt to analyse human bones scattered around occupation layers of settlement sites in Estonia. The aim is to get an overall impression of these fragments and identify any patterns. Moreover, differentiations between pre- and post-depositional taphonomic agents were made to detect relevant mortuary practices.

Even though it has been argued that loose human bone assemblages are more similar to those of faunal collections at settlement sites and thus should be treated similarly, no such quantification methods were used (see e.g. Outram et al. 2005; Gray Jones 2011). This would be the next step in analysing loose human bones. In the present thesis, each bone fragment was identified regarding which skeletal element and, if possible, side it belonged. All the bones were examined separately; due to time constraints no refitting between various contexts was undertaken. In the case of the specimens that were undetermined as to its skeletal element, it was still possible to record whether the fragment belonged to a skull, axial, or appendicular skeleton.

Quantification was made by the number of identifiable specimens (NISP), the minimum number of elements (MNE), and the minimum number of individuals (MNI). NISP represents the raw data. MNE accounts for bone fragments that could come from the same bone. MNI was calculated based on the same principle as for MNE, meaning that any repetition of a bone element accounts for another individual.

3.2.2. Stable carbon and nitrogen analyses

Stable isotope analyses became part of bimolecular archaeology already in the 1970s; the field has grown since and has secured its place in archaeology. As the history of development and application of isotope analysis in archaeology has been reviewed several times (see e.g. Schoeninger & Moore 1992; Ambrose 1993; Koch et al. 1994; Pate 1994; Katzenberg 2008[2000]) space will not be devoted to that here. Hereinafter, I will only review the fundamental principles, concepts, and limitations of the method.

Here stable carbon and nitrogen isotope analyses of bone collagen and tooth dentine were carried out to provide information about the dietary patterns of the here-observed populations. In general, the $\delta^{13}C$ and $\delta^{15}N$ values from collagen provide dietary information, primarily indicating protein intake (Ambrose & Norr 1993; Jim et al. 2006). Questions about both individual biographies, variances in intra- and inter-site ratios were of importance. It was also examined whether differences in diet correlate to different mortuary practices. This aim also defined the selection of the sample material.

3.2.2.1. Carbon and nitrogen isotopes

All elements consist of atoms that further consist of protons (+) and neutrons (0) surrounded by a cloud of electrons (-). The chemical characteristics of an element are determined by the atomic number that reflects the number of protons. For every single element, the number of protons is invariant, but different atoms of the same element may have a varying number of neutrons, which lead to different atomic masses of an element. The different versions of an element are called isotopes. Additionally, some isotopes are radioactive, meaning that they decay steadily (e.g. ^{14}C). Other isotopes are not radioactive, and/or their atomic masses do not decrease, or their half-life is insignificant; these isotopes are considered stable (e.g. Katzenberg 2008[2000], 415). Most elements exist in two or more isotopic forms. Out of the list of hundreds of stable isotopes, ten elements have two isotopes with biological significance; in turn, two of these – carbon (C) and nitrogen (N) – have gained the most attention in reconstructing ancient diets (Larsen 2003[1997], 271).

Carbon and nitrogen isotopes make up two-thirds of bone collagen by weight, approximately 35% carbon and 11–16% nitrogen by weight (van Klinken 1999, 691). Based on their mass, carbon and nitrogen occur in two stable isotopic forms each (^{12}C and ^{13}C; ^{14}N and ^{15}N). These differences in mass represent the fractionation of isotopes in natural processes, further indicating that stable isotope ratios may differ in various environments and biological substances (Howcroft 2013, 45). Thus, fractionation of isotopes is the core principle that allows the reconstruction of prehistoric dietary patterns based on bone collagen and tooth dentine, thereby affirming the principle of "you are what you eat". The continuous fractionation of isotopes allows differences between various food groups to be traced, as well as their origin and position on the food web.

Stable isotope abundance ratios are set against the ratios of the same isotopes in standard materials (Katzenberg 2008[2000]). The difference between the stable isotope contents of standards and biological fractions is a few parts per thousand (‰). As the majority of biological substances contain less ^{13}C than the standard material (a marine limestone PeeDee Belemnite (PDB)), the $\delta^{13}C$ ratios are negative. Most of the biological tissues contain more ^{15}N than the standard (atmospheric nitrogen, i.e. air) hence the $\delta^{15}N$ is larger than zero. The notation used to describe and to calculate this difference is following:

$$\delta^{x}Z = \left(\frac{R_{sample} - R_{standard}}{R_{standard}} \right) \times 1000 \text{ ‰}$$

where Z is the analysed element, x the atomic mass of the heavier isotope that is analysed, and R is the ratio of the heavier to lighter isotope.

Carbon has three naturally occurring isotopes: ^{12}C and ^{13}C are stable, and ^{14}C is radioactive. Before the utilisation of fossil fuels, the atmospheric CO_2 had a $\delta^{13}C$ value of approximately –7‰ (Katzenberg 2008[2000], 423). Fractionation during photosynthesis leads to the enrichment of the lighter isotope in the organism the range of which is dependent on the photosynthetic pathway (Katzenberg 2008[2000], 423). Two main pathways – C_3 or C_4 photosynthetic pathways – are responsible for different values for plant $\delta^{13}C$. The majority of plants from temperate zones are C3 plants being depleted in ^{13}C with the $\delta^{13}C$ values ranging between –20‰ to –35‰ (Katzenberg 2008[2000], 423). The research area – Estonia – belongs to a temperate environmental zone. Hence the C_3 plants form the only group present in the region during Late Mesolithic and Neolithic. The $\delta^{13}C$ values of tropical/subtropical plants using the C_4 pathway (e.g. maize and millet) range from –9‰ to –14‰ (Katzenberg 2008[2000], 423). Due to the variations in carbon sources, the values of marine plants remain between the values of C_3 and C_4 terrestrial plants (Schoeninger & Moore 1992).

Stable carbon and nitrogen ratios in animal tissues have demonstrated a correlation between the consumed foodstuffs and the consumer (DeNiro & Epstein 1981), whereby, the ratios in the consumer increase in comparison to the foodstuff. The enrichment of $\delta^{13}C$ that occurs due to the fractionation between plant and consumer quantifies around 5‰ for large herbivores while for smaller mammals the shift seems to be lesser (e.g. Ambrose & Norr 1993). Moreover, the isotope ratios of various tissues of a single organism also vary (e.g. Minagawa et al. 1986; Schoeller et al. 1986; Hedges et al. 2009). One may see significant differences in the $\delta^{13}C$ values of terrestrial and marine organisms (Schoeninger & DeNiro 1984). The latter arises because marine plants obtain most of their carbon from dissolved bicarbonate that has higher $\delta^{13}C$ ratio than atmospheric CO_2. Thus, the marine food webs have elevated $\delta^{13}C$ compared to terrestrial C_3 food webs (Smith & Epstein 1971).

Nitrogen has two stable isotopes: ^{14}N and ^{15}N. Atmospheric nitrogen enters the food web via nitrogen fixation by bacteria and soil microorganisms (Dawson et al. 2002; Fornander 2011, 27). Succeeding processes result in soil and plant $\delta^{15}N$ ratios being higher than atmospheric N_2 (0‰). The $\delta^{15}N$ values for terrestrial plants are 4‰, which is lower than the values for marine plants (Katzenberg 2008[2000]). The plants accessing atmospheric N_2 through symbiosis with N_2-fixing bacteria have $\delta^{15}N$ values closer to 0‰ (Peterson & Fry 1987; Ambrose 1991).

Nitrogen ratio increases to 3–4‰ $\delta^{15}N$ when ascending in the food chain (Minagawa & DeNiro & Epstein 1981; Schoeninger & DeNiro 1984; Minagawa & Wada 1984; Katzenberg 2008[2000]). Depending on the tissues within the same organism and among different taxa, variations occur in the size of the trophic-level effect on stable isotope ratios (Vanderklift & Ponsard 2003). Recently, empirical observations suggested that the fractionation level for human diet and collagen may be 6‰ (O'Connell et al. 2012). The constant fractionation of nitrogen isotopes in the food web permits the differentiation between terrestrial carnivores and herbivores (Minagawa & Wada 1984; Schoeninger & DeNiro 1984). Moreover, based on the $\delta^{15}N$ values, one can discriminate between aquatic and terrestrial food webs. As the food webs in aquatic ecosystems are longer, the $\delta^{15}N$ values for aquatic vertebrates are also enriched with ^{15}N compared to the values of terrestrial animals (Schoeninger & DeNiro 1984). Due to its substantial trophic level fractionation nitrogen isotope analysis can also be applied in studies of weaning (Howcroft 2013; Reynard & Tuross 2015 and references therein). Moreover, given that climate influences nitrogen isotope signatures and variations exist in the magnitude of trophic-level effects on different tissues and among different species (see e.g. Katzenberg 2008[2000] and references therein), local baseline data is essential. For instance, soils from cool environments have depleted $\delta^{15}N$ values, and soils from hot savannahs or deserts have enriched $\delta^{15}N$ ratios (Ambrose 1993). Terrestrial animals living in arid conditions have higher $\delta^{15}N$ values than marine animals (Larsen 2003[1997], 284).

3.2.2.2. Sampling strategy and materials

In selecting the samples three main factors – geographical, temporal, and practice-related representativeness – were taken into consideration. Attempts were made to include samples from all burial places representing various time periods, and a variety of practices. As seen from the results (*Chapter 5.2.1.*; Table 17) not all the initially selected samples yielded collagen, or had other limitations to performing a final analysis, thus the results are necessarily biased. Besides the temporal and intra- and inter-site variability, several samples were taken from the same individual to detect the intra-individual changes. The principle of dietary biography of the deceased is summarised in Eriksson and Lidén 2013. For that purpose, in addition to bones, the dentine of three molars was subjected to isotope analysis where possible. Considerable individual variability occurs in the timing of tooth formation (Hillson 2005), thus the values should be taken as approximations. However, the use of three molars is justified since the time of their development does not overlap (Moorrees et al. 1963a; Hillson 2005), but follows a sequence, which enables three different time periods of subject's life to be distinguished. Most of the effort was put into sampling humans, but the need for the local faunal baseline data is acknowledged and discussed below.

Collagen of human bone and tooth dentine was subjected to stable isotope analysis. Bone is a connective tissue of which one-third by weight is organic and two-thirds is a mineral matrix (Burton 2008, 443). The organic portion consists of protein, collagen that constitutes approximately 85–90% of the organic content of cortical bone (Pate 1994, 163; Katzenberg 2008[2000], 416); the rest consists of non-collagenous proteins, carbohydrates, and lipids (Pate 1994, 163). The principal inorganic part of the bone is hydroxyapatite, expressed as $Ca_{10}(PO_4)_6OH_2$ (Katzenberg 2008[2000], 416), however, other minerals are also present (Burton 2008, 444). In order to maintain and form the bone tissue it is gradually modelled and remodelled throughout lifetime; amino acids needed for the formation of collagen primarily are derived from the ingested protein (Katzenberg 2008[2000], 417). As the remodelling process is slow, the chemical composition of adult human bone reflects long-term dietary averages (Pate 1994, 164) up to 20 years prior to death (Hedges et al. 2007); the turnover rates of child and adolescent bones are more rapid. Modern samples indicate that the turnover rates in different bones of the same individual, sexes, and ages during adulthood vary (Pate 1994, 165; Eriksson 2003, 15; Hedges et al. 2007; Hakenbeck 2013, 111).

The tooth root and core composes of dentine and is covered by cementum; the tooth crown has an enamel coating (Hillson 2005). Enamel consists almost entirely of well-crystallized hydroxyapatite with less than 1% organic material (Burton 2008, 433). Similarly to bone, dentine forms from mineralised organic mesh consisting of collagen and hydroxyapatite. Unlike bone, teeth are inert, meaning that once fully formed in the mandible or maxilla, dentine is not remodelled, or the turnover rate is insignificant. (Howcroft 2013, 41 and references therein). This allows investigating the dietary preferences of a person during her/his childhood and adolescence. The formation times of molar teeth are given in Table 7. The inclusion of teeth samples to the analysis not only allows tracing intra-individual variances but expands the population analysed incorporating the children who survived childhood (see Eriksson & Lidén 2013).

Table 7. The collagen of bone and the various teeth form at different times.
Thus samples from different parts of a skeleton represent different ages in the life of the person analysed, thereby allowing to reconstruct the intra-individual dietary pattern. Formation of tooth dentine after Hillson 2005, where M1, M2 and M3 refer to first, second, and third permanent molar. The time of tooth formation here is limited to the formation of crown and initial root, which also corresponds to the sampling location.

Bone element	*Time of formation*	*Age category*
M1	3±1 years	Young child
M2	7±1 years	Older child
M3	13.5±2.5 years	Adolescent
Bone	average of several years prior death	Adult

The constant remodelling of bone tissue and the inert chemical composition of teeth enable the dietary biography of a person to be analysed. Yet the limitations, for example the presence of adolescent collagen component in adult bone or various turnover rates of different bones in body, should be taken into consideration while interpreting the results.

Based on the availability of the skeletal elements various bones were targeted for collagen extraction. To produce minimal damage to the prehistoric bones and teeth, all the samples (excl. samples for AMS-dating) were drilled with a dental drill and 60–100 mg of bone powder was extracted. The teeth were drilled directly below the crown to obtain a sample that represents as limited of a timespan of tooth formation as possible. The location of the sample is in accordance with the morphology of human teeth as the dentine is laid in angled layers starting from the crown continuing to the root (Hillson 2005, 118–125; Eriksson 2003, 14–15, fig. 2).

3.2.2.3. Collagen extraction and isotopic analysis

After the sampling (bone powder and crushed bone), the isotope analyses were conducted. These were performed in several sequences and different laboratories: at the Archaeological Research Laboratory at Stockholm University (Sweden), the Centre for Baltic and Scandinavian Archaeology (Germany), the Kiel Leibniz-Laboratory for Radiometric Dating and Isotope Research (Germany), and the 14CHRONO Centre at Queen's University Belfast (United Kingdom). In general, the collagen extraction was conducted following a modified Longin method (Brown et al. 1988; Table 8).

In 2011, 54 samples were pretreated at the Archaeological Research Laboratory at Stockholm University and the isotopic analysis were performed using a Carlo Erba NC2500 elemental analyser connected to a Finnigan MAT Delta+ isotope ratio mass spectrometer running in a continuous flow at the Department of Geology and Geochemistry, Stockholm University (see Tõrv & Eriksson in press). Typical measurement errors of ±0.15 ‰ are quoted for both $\delta^{13}C$ and $\delta^{15}N$ in both samples and standards. The collagen extraction followed a modified Longin method (Brown et al. 1988), which included demineralisation of the samples in 0.25 M HCl for approximately 48 hours followed by removal of the solution and inorganic material through filtration. Organic material was then dissolved in 0.01 M HCl, at 58 °C for c. 16 hours. Subsequently, the fragmented collagen chains and humic substances were removed via a 30 kDa ultrafilter. The residual solvent was frozen to approximately –80 °C and freeze dried.

In 2014, 57 samples were pretreated in the Centre for Baltic and Scandinavian Archaeology. The protocol was modified after the Brown et al. 1988 and the protocol used in Kiel Leibniz-Laboratory for Radiometric Dating, leaving out the ultrafiltration step. The demineralisation was performed in a 0.5 M HCL for approximately 24 hours, followed by rinsing the samples in distilled water. After that, the organic material was dissolved in 0.02 M HCL, at 58°–70°C approximately 16 hours. To remove insoluble materials the samples were then filtered through Whatman cellulose Nitrate membrane filters (5.0 µm). The remaining solvent was freeze dried and the aliquot was sent for Elemental Analysis-Isotope Ratio Mass Spectrometry (EA-IRMS) at the School of Life Sciences, University of Bradford, UK, where carbon and nitrogen concentrations (%C, %N), and $^{13}C/^{12}C$ and $^{15}N/^{14}N$ ratios ($\delta^{13}C$ and $\delta^{15}N$) were measured using a Thermo Flash 1112 Elemental Analyser coupled to a Thermo Delta plus XL mass spectrometer. Typical measurement errors of ±0.2‰ are quoted for both $\delta^{13}C$ and $\delta^{15}N$ in both samples and standards.

Table 8. Overview of the three extraction protocols and subsequent EA-IRMS analysis of bulk collagen samples.

Pre-treat-ment	***Laboratory***	***Archaeological Research Laboratory, Stockholm University***	***Centre for Baltic and Scandinavian Archaeology (ZBSA)***	***14CHRONO Centre, Queen's University Belfast***
	Sample material	Bone powder	Bone powder	Crushed bone
	Demineralisation	0.25 M HCl for c. 48 h	0.5 M HCl for c. 24 h	2% HCl and 0.1 M NaOH for c. 19 h
	Gelatinisation	0.01 M HCl, at 58 °C for c. 16 h	0.02 M HCl, at 58°–70°C for c. 16 h	pH2–pH3 solution at 70°C for 15 h
	Ultrafiltration	Yes (30 kDa ultrafilter)	No	Yes (>30kD ultrafilter)
	Reference	Brown et al. 1988	Tõrv & Meadows 2015	Reimer et al. 2015
Analysis	EA-IRMS analysis	Stable Isotope Laboratory (SIL), Department of Geological Sciences, Stockholm University	School of Life Sciences, University of Bradford	14CHRONO Centre, Queen's University Belfast
	Instrumentation	Carlo Erba NC2500 elemental analyser Finnigan MAT Delta+ isotope ratio mass spectrometer	Thermo Flash 1112 Elemental Analyser Thermo Delta plus XL mass spectrometer	Thermo Delta V elemental analyser – isotope ratio mass spectrometer
	Measurement error ($\delta^{15}N$ and $\delta^{13}C$)	±0.15‰	±0.2‰	±0.1‰

Additionally, 23 samples were processed at Queen's University Belfast. Their bone pretreatment procedure follows (after Reimer et al. 2015, 4) Longin's gelatinisation method (Longin 1971) and ultrafiltration (Brown et al. 1988) with a Vivaspin filter cleaning method (Bronk Ramsey et al. 2004). Samples (0.5–1.0 g crushed bone) are first treated with 2% hydrochloric acid, then with 0.1 M sodium hydroxide, and then again with 2% hydrochloric acid. After the final acid is rinsed, the collagen is gelatinised in a pH2–pH3 solution at 70°C for 15 hours. The gelatine solution is filtered using micron filters and micron glass filters. The resulting filtrate is transferred into an ultra-filter and centrifuged until 0.5–1.0 ml of the >30kD gelatine fraction remains, which is then freeze-dried. Carbon and nitrogen concentrations (%C, %N) and $^{13}C/^{12}C$ and $^{15}N/^{14}N$ ratios ($\delta^{13}C$ and $\delta^{15}N$) were measured using a Thermo Delta V elemental analyser – isotope ratio mass spectrometer (Reimer et al. 2015, 8). Typical measurement errors of ±0.1‰ are reported for both $\delta^{13}C$ and $\delta^{15}N$ (Reimer et al. 2015, 9).

3.2.2.4. Methodological considerations and interpreting the results

Stable isotope analyses do not provide straightforward answers to questions about the dietary preferences of past populations. There are several methodological considerations to bear in mind while interpreting the carbon and nitrogen ratios of human bone collagen and dentine. The biases and granularity of the analysed data are furthermost influenced by the preservation of collagen, the representativeness of the sample, and also by the available reconstruction of local isotope ecology, i.e. baseline data.

Considerations for collagen degradation and diagenesis play a crucial role in the formation of the data. After the death and burial of a cadaver the natural processes in the body (here: bone) do not stop. Bone undergoes biological alterations including microbiological attack, uptake of cations and circulating of organics, exchange of ions, breakdown and leaching of collagen, alteration of mineral matrix, and infilling with mineral deposits (Nielsen-Marsh & Hedges 2000, 1139; Hedges 2002, 319–320; Jans et al. 2004, 88). The above-mentioned factors may cause alternations in collagen and in stable isotope values. These processes are primarily not influenced by the age of the deposit; under ideal conditions bone collagen may survive without degrading for millennia. Instead, the post-mortem environmental conditions have a substantial effect (DeNiro 1985; van Klinken 1999; Hedges 2002). Furthermore, as isotopic ratios can be altered by heating (DeNiro 1985), only unburnt bones are targeted for stable carbon and nitrogen analysis.

An appraisal of bone diagenesis is essential in evaluating the reliability of biogenic signals in archaeological bone (e.g. Turner-Walker & Jans 2008, 227). There are several quality criteria that have to be met for the results obtained from stable isotope analysis of bone collagen and dentine to be considered reliable. In the present study, criteria such as collagen yield (%), C:N ratio, and C and N concentration were used. Compared to modern, fresh bone that contains approximately 22 wt % collagen, prehistoric samples have lower collagen yields; however, in Europe the losses are relatively slow (van Klinken 1999). For samples that are several millennia old this becomes an issue. Empirical studies have shown that when the collagen content drops below 0.5% (used as a threshold) it is difficult to remove the contaminants and thus all samples with collagen content from 2 to 0.5% should be checked for further indications of breakdown of sample integrity (van Klinken 1999). For modern animals and humans the acceptable C:N ratio is considered 2.9–3.6 (DeNiro 1985), yet at the Oxford radiocarbon laboratory, a slightly narrower range is applied (3.1–3.5) (van Klinken 1999).

Regarding the representativeness of the sample three aspects are observed. First, with regard to the question of collagen degradation, the bias of the analysed samples should be considered. Do all initially targeted samples yield collagen to proceed with the analysis, and if not to what extent do the gained results allow answering the research questions posed? Also, the selection of the data – which individuals and why were selected – affects the final analysis and interpretation. Secondly, it is important to be aware of that the stable isotope analysis performed on human collagen represent the protein component of the diet (Ambrose & Norr 1993), not the whole diet as suggested earlier (e.g. van der Merwe 1982; Schoeninger 1989). Thus, the food stuffs low in protein (e.g.

plants) are under-represented in the collagen isotope data. Furthermore, based on van Klinken et al. (2000), Elin Fornander (2011, 30) points out that this does not only affect the $\delta^{15}N$ value, but in case of mixed marine-terrestrial diet where the terrestrial component comes from plant food, the $\delta^{13}C$ value may misleadingly suggest a higher proportion of marine food-stuffs in the diet.

Thirdly, as three different collagen extraction protocols were employed, the question of the inter-laboratory comparability has to be addressed. As shown above, both the pretreatment protocols and machinery of the laboratories varied (Table 8), which both contribute to the inter-laboratory variability (Pestle et al. 2014). In Stockholm and Belfast, the removal of degraded collagen was ensured through the ultrafiltration step; only the intact collagen chains remained. The extraction protocol in Schleswig did not include this step. The possible contaminants were removed through the mechanical elimination of the outermost layer of the analysed bone/tooth and via filtering the samples through cellulose filter.

An experimental study (Pestle et al. 2014) showed statistically significant differences between the $\delta^{13}C$ and $\delta^{15}N$ values of bulk bone collagen from a variety of laboratories. The average pairwise difference between any two laboratories was reported to be only 0.2‰ for $\delta^{13}C$ and 0.4‰ for $\delta^{15}N$ (Pestle et al. 2014). However, it was pointed out that neither the choice of demineralising agent nor the potential removal of humic acids engendered any significant differences in the resulting isotopic signatures (Rumpelmayr 2012; Pestle et al. 2014). Thus, in general, bulk collagen stable isotope data deriving from different laboratories can be meaningfully compared.

The best practice in interpreting carbon and nitrogen stable isotope values of human collagen would be to juxtapose these to the faunal (and floral) data representing the local isotope ecology. To comprehend and analyse the isotope ratios in any particular site in detail, one should use a spatiotemporal baseline (Eriksson 2003), yet the question of how close is close enough remains (Hedges & Reynard 2007). However, the focus of the present study was set to humans, and the few faunal samples targeted for isotope analyses failed to yield collagen. Thus, no local baseline data for interpreting human samples was gathered during this study. Rightly, a question arises about the reference data for the here analysed and interpreted sites. What kind of material has been used to create the environmental background of the study? The situation becomes even more complicated as no stable isotope studies have been carried out on Estonian Late Mesolithic and/or Neolithic faunal collections. However, there are single $\delta^{13}C$ values of various specimens (Table 9) that have been measured together with AMS-dating of the bones (Lõugas et al. 1996; Åkerlund et al. 1996; Jonuks 2013; in prep.). These samples represent only five sites and a few taxa; moreover, no $\delta^{15}N$ are available, which restrains their usefulness for local baseline values.

For contextualising the data of inland sites, a faunal reference is developed after the published values from Zvejnieki complex in northern Latvia (Eriksson & Zagorska 2003; Eriksson 2006); furthermore the human samples constitute a valuable comparison to individuals analysed here (Eriksson et al. 2003; Eriksson 2006). The fish data and some of the data about terrestrial herbivores derive from Riņņukalns, also on the shore of Lake Burtnieks (Bērziņš et al. 2014; Schmölke et al. 2015). Zvejnieki and Riņņukalns are suitable for several reasons. First, their occupation phases coincide with the temporal frames of the present study. Zvejnieki was continuously used from the Mesolithic to the Neolithic (Zagorska 2006), and several occupation phases over a long time span – Mesolithic to the Late Neolithic – have been observed in Riņņukalns (Bērziņš et al. 2014, 726–727). Furthermore, the environmental and ecological background of these sites allows parallels to be drawn with the inland sites of Estonia (especially with Tamula, Kivisaare and Veibri). At a very general level, both Estonia and Latvia are situated on the eastern shore of Baltic Sea at the East-European Plain having a flat landscape. The temperate climate zone and the changes in the Baltic Sea basin during the Holocene have ensured similar climates over time, providing the sites with similar environments. Zvejnieki and Riņņukalns are situated at the shore of the shallow Lake Burtnieks, which lies in northern Latvia in the central part of the Burtnieks Drumlin field (Eberhards 2006). All the Estonian sites are also located on the shores of shallow freshwater bodies. The bedrock of the area is formed of Devonian sandstone and siltstones, which is overlain by various glacial and meltwater deposits as well as Holocene deposits (Sandgren et al. 1997; Eberhards 2006).

Table 9. The $\delta^{13}C$ values of faunal data from Estonian Late Mesolithic and Neolithic sites.

Site name	*Lab Code*	*Taxa*	*Bone element*	*$\delta^{13}C$*	*AMS date (BP)*	*Lab code for date*	*Reference*
Kudruküla	Est 17	Ringed seal	temporal bone	-17.1	4750±100	Ua-4826	Lõugas et al. 1996
Kudruküla	Est 18	Harp seal	temporal bone	-15.5	4835±100	Ua-4827	Lõugas et al. 1996
Kudruküla	Est 19	Elk/Bovine	tubular	-22.6			Lõugas et al. 1996
Kunda	KUNDA 1	Elk	calcaneous	-22.26	8260±90	Ua-3000	Åkerlund et al. 1996
Kunda	KUNDA 2	Elk	humerus	-21.6	8485±90	Ua-3001	Åkerlund et al. 1996
Kunda	KUNDA 3	Elk	humerus	-20.74	8515±100	Ua-3002	Åkerlund et al. 1996
Kunda	KUNDA 4	Elk	tooth dp	-21.89	8040±75	Ua-3052	Åkerlund et al. 1996
Kunda	KUNDA 6	Elk	mandible	-20.77	9085±100	Ua-3003	Åkerlund et al. 1996
Kunda	KUNDA 7	? (terrestrial)	not known	-21.0	3805±130	Ua-3004	Åkerlund et al. 1996
Kunda	KUNDA 8	Elk	metatarsal	-20.77	9330±120	Ua-3005	Åkerlund et al. 1996
Kunda	KUNDA 9	White-taled eagle	phalanx	-26.62	3555±55	Ua-3053	Åkerlund et al. 1996
Loona	Est 11	Harp seal	temporal bone	-15.1			Lõugas et al. 1996
Loona	Est 12	Harp seal	vertebra	-14.9	4270±75	Ua-4824	Lõugas et al. 1996
Loona	Est 13	Wild boar	not known	-20.9			Lõugas et al. 1996
Loona	Est 14	Wild boar	not known	-20.8	4050±80	Ua-4825	Lõugas et al. 1996
Loona	Est 15	Ringed seal	temporal bone	-15.0			Lõugas et al. 1996
Naakamäe	Est 8	Ringed seal	temporal bone	-16.0			Lõugas et al. 1996
Naakamäe	Est 9	Harp seal	temporal bone	-16.0			Lõugas et al. 1996
Pärnu		Elk	antler	-22.7	7040±40	Beta-286994	Jonuks 2013
Pärnu		Elk	antler	-21.4		Beta-317861	Jonuks in prep.

Inland and coastal/island sites differ significantly, both in their material culture and also in their stable isotope values (*Chapter 5.2.*). Thus, the isotope data from Zvejnieki and Riņņukalns are not the best reference points for sites in Saaremaa. In contextualising these sites the abundant isotope data from the islands of Gotland and Öland in Sweden will be used, which originate from similar geomorphological and environmental settings to Saaremaa. As the changes in the Baltic Sea during the Holocene affect the isotope values, sites from similar time frames – the faunal data from Early/Middle Neolithic[4] Västerbjärs and Ire (Eriksson 2004), and Köpingsvigk and Resmo (Eriksson et al. 2008) will be utilised as reference to the isotope values from Saaremaa.

Despite the usefulness of the reference material from Latvia and Sweden, the absence of a local faunal baseline restricts the analysis and limits the range of research questions. Due to the lack of local isotope ecology (regarding the importance of its inclusion in analysing human samples see e.g. Eriksson 2003; Eriksson et al. 2003; Fornander et al. 2008; Fornander 2011), detailed analyses of populations cannot be made. For instance it is not possible to establish precisely which reservoirs were utilised. I acknowledge the importance of local isotope ecologies to comprehend the values within and among populations. But the establishment of local isotope baseline is a unique research theme that needs to be addressed elsewhere, and serves as a future research project. However, the present study may be taken as a starting point for future contextual analysis.

3.3. Radiocarbon dates of human remains – establishing a chronology of practices

Chronologies – chronometric and diachronic views to the past – are an integral part of archaeology. Or as James McGlade (1999, 141) has said: *"Archaeology is dominated by chronocentric discourse /…/ – a discourse /…/ in search of the perfect, coherent temporal ordering"*. Stone Age research in Estonia is no exception, where a trend away from typologically grounded relative chronologies toward absolute chronologies based on radiocarbon dates is observed. But one should bear in mind that these 'orderings' – whether relative or absolute – are our constructions, thus current frameworks of time and, therefore, can only be considered as analytical scales.

Stone Age chronologies have rarely included the changes of mortuary practices as the basis for their establishment. However, the availability of radiocarbon dating has made skeletal material more likely to be dated.

[4] Presently valid general Stone Age chronology in Sweden is the following: Mesolithic (8200–4000 BC), Early Neolithic (4000–3300 BC), Middle Neolithic (3300–3200 BC), and Late Neolithic (2300–1800 BC) (Eriksson et al. 2008), whereas at some cases narrower periods during Early and Middle Neolithic are distinguished (Linderholm et al. 2011; Fornander 2011).

Previously only 13 human collagen samples from the period under discussion have been dated (Kriiska et al. 2007).

3.3.1. Sampling strategy and materials

The present work attempts to establish a more dynamic view of the changes in mortuary practices in the Estonian Stone Age. The aim was to date single burials that should ideally form a solid archaeological event. The latter is especially true in the case of primary burials. In the case of multi-episodic burials, the time of death and the time of final deposition are not concurrent. Thus, three more solid categories were followed while selecting the material. First, samples that represent full geographical coverage of the dated human remains in the territory of Estonia were selected. Secondly, burials that represent various practices were dated. Additionally, the extended and flexed burials were dated to verify temporal and/or cultural variations in the position of the deceased that was proposed by the culture-historical school of thought. If possible, several samples were gathered from one site. This was especially important in the case of the two larger sites – Tamula and Kivisaare – as the development of these burial grounds was to be observed.

As sample material, human bone tissue and tooth dentine were selected. In addition to human bone, in several instances animal bones from the same context were targeted to collagen extraction to quantify local reservoir offsets in human bone collagen. Unfortunately, several obstacles occurred while dating faunal samples. First, it was impossible to establish the context of the animal and thus their relation to the graves remained unclear (e.g. animal bones were recorded with the precision of an excavation plot). The grave goods tend to be rather small (mainly tooth pendants) or derive from omnivorous or carnivorous terrestrial species, raising the question of reservoir age. Moreover, the procedures of handling the bone artefacts during the 20th century required varnishing the bone items. As the documentation about the used mixtures is ambiguous, one cannot eliminate the possible contaminants entirely. The majority of the sampled animal bones did not yield any collagen to be analysed.

Samples were processed at the Kiel Leibniz-Laboratory for Radiometric Dating and Isotope Research (KIA), the ^{14}CHRONO Centre at Queen's University Belfast (UBA), and the Tandem Laboratory in University of Uppsala (Ua; Sweden). The protocols of the pre-treatment of samples and the succeeding analysis will not be explained here, as these are published elsewhere (Brown et al. 1988; Reimer et al. 2015; Tõrv & Meadows 2015).

3.3.2. Methodological considerations

The results of radiocarbon dates are not straightforward. There is interpretation woven into radiocarbon analysis already from the beginning of the research as one needs to state what kind of events one dates.

There are several time scales that one could pick. The AMS ^{14}C dates themselves come in radiocarbon years BP. As the story about the practices themselves is about human culture, these dates should be given in calendar years (cal. BC). Thus, one needs to translate radiocarbon years into calendar years. The precision of the translation depends on the source of the carbon in the analysed sample. For samples that get their carbon directly from the atmosphere, the calibration from radiocarbon years to calendar years is no problem as the calibration curve provides us with the information about the reliability of the sample. There are other reservoirs from which the carbon of the sample could derive. Marine and freshwater organisms are depleted in ^{14}C about the contemporaneous atmosphere, and thus these reservoirs may produce considerable offsets in radiocarbon ages, being markedly older compared to the terrestrial organisms (e.g. Olsen & Heinemeier 2007; Olsen et al. 2010). This difference is called reservoir age (RE), and an equation is needed to quantify the reservoir offset of every single reservoir:

$$RE = {}^{14}C \text{ age of the sample} - {}^{14}C \text{ age of atmosphere}$$

As the stable isotope values for the humans analysed here show either a significant intake of freshwater or marine food stuffs, the question of possible reservoir ages has to be taken into account. Both the marine and freshwater reservoir effect to the present sample will be elaborated in *Chapter 5.3*.

3.4. Conclusions – from bare bones to people and practices

This multi-disciplinary approach to Stone Age mortuary rituals and the people themselves demonstrates the potential information to be found in long-forgotten human remains. The application of post-excavational archaeothanatology, together with the application of a range of biochemical methods, provides more comprehensive insights about hunter-gatherers and their mortuary rituals over a long time.

CHAPTER 4. SOURCES AND BEING CRITICAL ABOUT THEM

Archaeologists create their source material by themselves in field. I have had the opportunity to excavate two sites under discussion here (Kivisaare (2003–2004) and Veibri (2006)). Thus, the vast majority of the following analysis and interpretations are based on old excavation data: (1) physical remains of the settlements and the humans and (2) excavation documentation that is value-laden and has to be associated with the research history in general and with the sites in particular (*Chapter 3.1.5.*). Old excavation data may limit us in asking new questions, one might face problems with documentation and has to consider the previous interpretations. In making sense of the old excavation data, source criticism is an inevitable tool to reach for. Therefore, to understand why material culture is interpreted the way it is; one has to comprehend her sources. What are the sources of the present study and how were they created?

The starting point for source criticism is the addressed research questions. As stated above (*Chapter 1*), I will focus on the analysis of mortuary rituals of hunter-gatherers, with the aim of detecting single practices and mapping the temporal changes in them. This kind of question placement requires dual evaluation of the sources. In the present chapter a more general evaluation is conducted. The sites themselves are introduced, and the sources on which the present knowledge in Estonian archaeology are based on are analysed to discern whether these shed light on the mortuary practices of hunter-gatherers. Using external source criticism (see Eggert 2012, 103–124) the quality of the creation of one's sources is evaluated (motivation, aim, when, where, who conducted the research). Regarding the microanalysis of the practices, each burial is evaluated separately taking the principles of (post-excavational) archaeothanatology into account (*Chapter 3.1.5.*). This means that here principles of inner source criticism are applied, as the value of every single burial regarding the research question is addressed. Also, the relationships between various sources are discussed, and their consistency tested.

Conditionally, the history of discovery and research of the Stone Age burials in Estonia may be divided into two: of the large proportion of burials that have been discovered accidentally (Jalukse, Kivisaare, Külasema, Kõljala, Kõnnu, Sindi-Lodja, and Võru), burials found during earth works (gravel mining, and tillage) predominate. They are either documented (1) according to the descriptions of local villagers (especially at the end of 19th century and the beginning of 20th century) or (2) by the (amateur) archaeologists at the finding places. However, in a number of sites, archaeological excavations have been carried out resulting in finding human remains (at Akali, Kivisaare, Kõnnu, Kääpa, Naakamäe, Narva Joaorg, Pikasilla, Tamula I, Tooma, Valma, and Veibri).

In the following chapter, a brief overview of the hunter-gatherer sites with human remains in Estonia will be given. The circumstances of the discovery and excavations, the cultural attributes, and environmental conditions of each site are presented based on the available literature and archival sources. Here all the sites that have been considered to be representative of mortuary rituals of the period under discussion are described. I have not included the human remains from Riigiküla I and III settlements that were previously dated to Stone Age based on the artefact typology. The human remains from Riigiküla I were dated to Early Bronze Age during the present study (Tõrv & Meadows 2015). Through the description of the background of the sites, the available sources are evaluated and their relevance in the following analysis and discussion indicated. Based on the availability of the sources and their content, burials are divided into three groups: (1) case studies – in case of these the initial mortuary practices can be reconstructed, i.e. the representativeness of the material is good, (2) intermediate cases – not all the aspects of initial mortuary practices can be reconstructed, yet parts are available to detect, i.e. the representativeness of the material is moderate, and (3) background information – these are burials where the sources do not enable any archaeothanatological analysis, yet they belong to the period under discussion, i.e. the representativeness of the material in the sense of archaeothanatological analysis is poor.

4.1. Sources: Sites with features with human remains

Altogether 18 sites with either intact inhumations or loose human bones are known from Estonia (Figure 7). All the sites with features of human remains are open air settlement and burial sites. The number of internments spans from a few (2–3) to nearly 30 individuals.

Three types of sites may be distinguished: (1) sites with burials in associated cultural layers – in several of these, inhumations and loose human bones occur simultaneously, (2) sites with loose human bones in settlement layers, and (3) solitary graves or cemeteries. It is important to note that this tripartite division does not reflect the character of mortuary practices undertaken in these sites, instead it represents the character of the skeletal material; these will be returned to in *Chapter 5*.

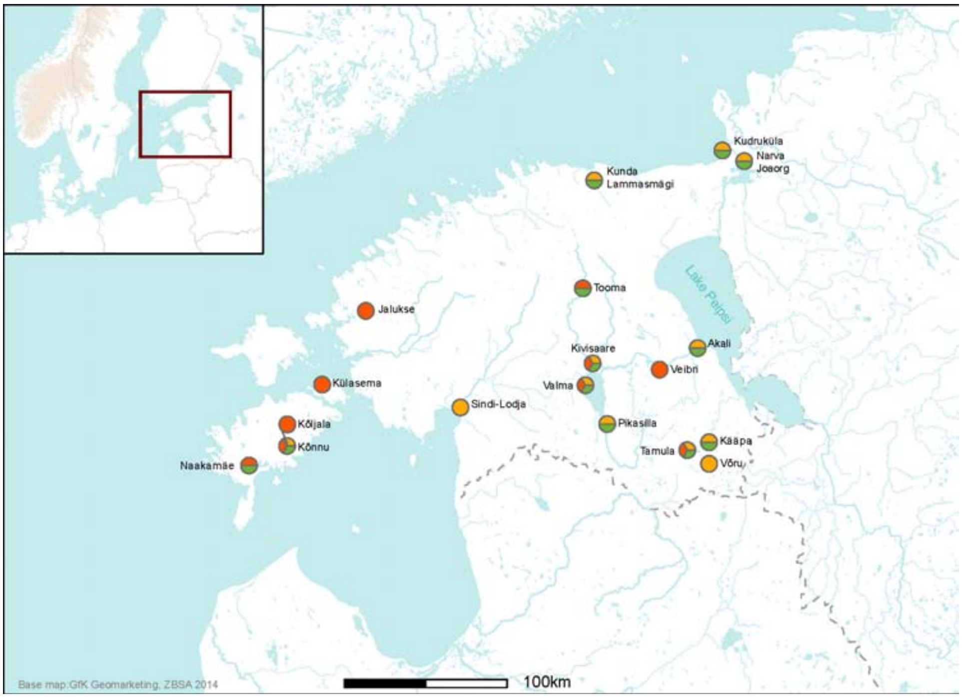

Figure 7. All hunter-gatherer sites with human remains in Estonia.
Red – inhumation burials, green – settlement layer, and yellow – loose human bones.

4.1.1. Sites with burials in associated settlement layers

4.1.1.1. KIVISAARE

Archaeological background

Kivisaare is located in central Estonia on the northern shore of Lake Võrtsjärv, 6 km from its present coast and 1.5 km from the Põltsamaa River. The settlement and burial site are located on a NW–SE oblong gravel drumlin (36–38 m a.s.l.), whereas the dwelling area and the burials are located on the south-eastern tip of the drumlin.

This is one of the few sites that were first and foremost treated as a cemetery. Only recently, during the last studies on the site, did the presence and importance of the occupation layer become obvious. Similarly to several other sites, Kivisaare was discovered during gravel mining already at the end of 19th century. The first skeletons that were the first Stone Age burials found from the Baltic countries were discovered in 1882 by the local landowner Jaan Pekk (Jung 1989, 240; Bolz 1914, 17). This and the subsequent accidental skeletal finds in 1903, and in 1908–1910 initiated several field surveys at Kivisaare.

The first archaeological excavations took place in 1910 when Hausmann discovered six skeletons (Ottow 1911, 154–155). During the excavations led by Ebert in 1913, one burial was unearthed (Bolz 1914, 27); Tallgren excavated a skeleton during a field trip in 1921 with archaeology students (Tallgren 1921, 1). Indreko returned to the site in 1931 and excavated the remains of two individuals (Indreko 1931). In 1962, during the preliminary surveys aiming to locate more burials (Jaanits 2013), Jaanits unearthed two skeletons. Three years later in 1965 he conducted excavations resulting with the discovery of the remains of two individuals (Jaanits 1965a)[5]. In 2002–2004 Kriiska excavated the site in order to prove the existence of a Mesolithic dwelling, make corrections about the date of the cemetery, and gather more substantial information about the Corded Ware settlement (Kriiska & Johanson 2003, 42). Together with settlement finds, a considerable amount of loose human bones were documented *in situ* (Kriiska & Johanson 2002/2003). These excavations allowed concluding that the site is multi-layered: (1) the prepottery Mesolithic settlement site, (2) the Late Mesolithic settlement site (Narva-type pottery), (3) the Early Neolithic habitation (Combed Ware), and (4) the Late Neolithic habitation (Corded Ware) (Kriiska & Johanson 2003, 51–52; Kriiska et al. 2004; Kriiska & Lõhmus 2005). This makes the relative dating of the burials more complicated, which will be discussed in more detail in *Chapter 5.3.1.1.2.* Unfortunately, the exact area of the excavations is unknown, yet as the higher part of the drumlin has been removed during gravel mining, one could assume that at least half of the site has been excavated (Figure 8).

Even though Indreko was the first one to state that the burials and occupation layer are contemporaneous (Indreko 1964, 119), the latter was investigated more extensively during the field seasons of 2002–2004. As the drumlin has both been used as field and gravel mine, the upper horizons of the cultural layer are heavily disturbed. This has affected the preservation of the burials, too. However, the lower part of the cultural layer was intact[6] (Kriiska et al. 2004, 29; Kriiska & Lõhmus 2005, 31). No considerable structures have been found. A large part of the finds were of stone, whereof flint of poor quality and local origin predominates (Kriiska et al. 2004, 29–30). Flakes form the bulk of the material; blades are represented in fewer quantities (Kriiska et al. 2004, 33). The chopping tools (Kriiska et al. 2004, 34; Kriiska & Lõhmus 2005, 38) and the bone artefacts were a very small portion of the finds (Kriiska et al. 2004, 40; Kriiska & Lõhmus 2005, 39 – tooth pendants). Only a few sherds of ceramics were found at the site, and the majority of them were too small for type determination. The few belonged to Corded Ware (Kriiska & Lõhmus 2005, 39) and Narva Type vessels (Kriiska & Johanson 2003, 50). The flakes and debris have the greatest similarity to the Mesolithic complexes of central and SW Estonia (Kriiska et al. 2004, 34, 35). Previously only one radiocarbon date has been obtained from Kivisaare, derived from the IV burial excavated in 1965 (Kriiska et al. 2007) and corresponds to the latest chronology of the site.

[5] One of the burials (III according to the numeration of Jaanits) was discovered already in 1964 (Jaanits 1965a, 4).

[6] In 2003 from an area of 24 m^2 1236 finds were gathered (Kriiska et al. 2004, 29) – this means 51.5 finds per m^2.

Figure 8. The magnitude of gravel mining at Kivisaare in 1931, viewed from W.
(Photo: Indreko 1931, Pilt 5)

The absence of culture-specific grave inventory and the lack of absolute dates have brought about debates on the date of the site. It has been dated to the Mesolithic (Tallgren 1922, 49), the Neolithic (Bolz 1914, 15; Indreko 1935a, 220–222), and also to the Late Neolithic and the Bronze Age (Indreko 1935b, 10, 12, 30; Juurik 2013, 50, 59). Recent studies confirm that the various stages of the site date from the Mesolithic, Neolithic, and Early Bronze Age (Kriiska & Tvauri 2002, 35; Kriiska & Johanson 2003; Kriiska et al. 2004; Tõrv & Meadows 2015). The discussion about the concurrence of the settlement and the graves is still topical and could not be entirely resolved with the present thesis since the majority of the skeletal inventory is not preserved. Before the publication of the present thesis, only a single burial was dated to the Late Mesolithic (Kriiska & Lõhmus 2005, 40). The new dates make the situation a bit more complicated (see discussion in *Chapter 5.3.1.1.2.*).

Human remains
Altogether the remains of 26 individuals are known. Also, loose human bones were found at Kivisaare. From these only four complete skeletons (XVIII–XXI) and loose human bones from the field seasons 2002–2004 are stored in the repositories (Table 13).

Despite the relatively good documentation of the burials, the overall number of them was somewhat difficult to establish. This is dependent on the research history and the applied excavation techniques. Beginning with the accidental discovery of the remains and ending with the severe fragmentation of the bones, which does not allow a person without special training to determine the minimal number of individuals in the excavated feature; it is difficult to differentiate between intact inhumations and loose human bones that are the causes of other practices. Another issue is the varying numeration conventions of the graves that have been used (Ebert 1913 vs. Bolz 1914) and their partly contradicting information about the exact number of individuals unearthed. For example, in an excavation report by Indreko, one finds the description of two features with human remains (Indreko 1931, 4, 7), yet in the corresponding publication about the Neolithic burials in Estonia, Indreko states that he had found the remains of at least five individuals (Indreko 1935a, 220). The minimal number of individuals buried into Kivisaare is a complicated matter and will be discussed more thoroughly in *Chapter 5.1.* To sum it up here, I have been able to distinguish 26 more or less intact inhumations and a number of features with loose human bones. Whether the latter form a separate set of practices or reflect the abundance of later human activities on the site is a question of analysis and will be discussed later (*Chapter 6.2.1.2.2.* and *6.2.2.*).

Sources and source criticism

The quality of the source material about the burials in Kivisaare varies. The first years of excavations are not covered by field reports, and none of the skeletons are stored. These were never brought to the archaeological collections, and as far as it has been possible to determine, are also absent from the medical collections of the University of Tartu. It might be that some of the skeletons were reburied at the same drumlin, as indicated by a bundle of bones unearthed in 2003–2004 (*Chapter 6.2.2.1.*). Unfortunately, there are no pictorial sources about the early excavations. Thus, for the burials I to XIV, primary sources are absent; all the information is published in various articles (Ottow 1911; Ebert 1913; Bolz 1914).

All the other researchers wrote field reports with more or less detailed descriptions of the burials (Tallgren 1921; Indreko 1931; Jaanits 1965a; Kriiska & Johanson 2002/2003; Kriiska & Lõhmus 2003/2004; Kriiska & Lõhmus 2004). The first excavation report by Tallgren contained a written description of the burial and a sketch of it. For the excavations conducted by Jaanits also his field diaries are available (Jaanits 1961/1962; 1965b). However, these field diaries do not contain any additional information about the burials.

The pictorial material is insufficient and not many photographs are available (except burials XX and XXI from 1965). Some additional information about the depth and orientation of the graves and position of the skeleton may be obtained from maps and drawings. All the human bones from the excavations conducted by Tallgren are stored, which adds a supplementary information level to the present analysis.

Due to the varying quality in documentation, only some graves are used in the in-depth analysis. The graves recovered during the early excavations only serve as background information (Table 13).

4.1.1.2. KÕNNU

Archaeological background

Kõnnu is located on the present island of Saaremaa at the Kõnnu village. The site was situated on a gravel ridge at the Litorina Sea shore on the altitude of c. 16–17.5 m a.s.l. (Kriiska 2007b, 16; Poska & Saarse 2002, 567; Saarse et al. 2009a, b). During its habitation period it was a separate island a couple of kilometres south-east from the larger island of Saaremaa (Jaanits 1979, 366; Jaanits 1995, 247; Saarse et al. 2009b, 61 Fig. 2). It is suggested that the site was abandoned as the sea coast retreated (Poska & Saarse 2002, 567). Unfortunately the site was demolished entirely during gravel mining in the 1970s–1980s (Lõugas & Selirand 1989, 52, 212; Figure 9).

Figure 9. The destroyed area of Kõnnu Stone Age settlement site in 1977.
(Photo: SMF-3390-4)

The site was discovered during gravel mining for road construction in the spring of 1977, which was first followed by a survey carried out by Vello Lõugas as it was assumed to be an Iron Age cremation cemetery (Lõugas, V. 1977, Lisa nr 1). Since the topsoil of the ridge was removed during the mining, it was only possible to examine the lower part of the cultural layer and various depressions and pits reaching down to the virgin soil. The 13 depressions of cultural layer, surveyed by Lõugas, demonstrated that the site belonged to the Stone Age (Lõugas, V. 1977, 1), and thus Jaanits took over the lead of the excavations in 1977 and 1978. As the gravel mining continued after these two years, artefacts, animal bones, and human bones were continually gathered in the following years: 1979 to 1986 (E-mail correspondence with K. Rikas, 3.10.2013). These excavations were screened by an archaeologist (Jaanits 1995, 247).

The first two field seasons resulted in the investigation and documentation of 141 (labelled 1–138) depressions of the cultural layer (Figure 67). The majority of these were the results of the actions of human agents (Jaanits 1979, 364). Jaanits distinguished between hearths (with and without stones), storage pits, and the lower part of the cultural layer (Jaanits 1977; 1978). According to him, half of the depressions were hearths with stone constructions (Jaanits 1979, 364), whereas in some hearths animal bones were found, proving that meat was cooked under the hot stones (Jaanits 1979, 364). Jaanits suggested that one of the depressions belonged to a house pit (111; Jaanits 1979, 364). This is a relatively regular depression 3.5 × c. 2 m in size with its long-axis oriented NE–SW. Compared to other depressions, it was large with few stones, yet with an abundant find material (AI 4951: 840–921) (Jaanits 1978). The depression 92 and 104 were of similar character, but smaller and with fewer finds (Jaanits 1979, 364). Whether these represent houses remains unclear.

Most of the find material consisted of quartz artefacts, wherein small artefacts dominated (Jaanits 1977; 1978; 1979, 365). The only flint artefacts distinguished were scrapers, the rest were debris. As was the case in other island sites, porphyry was used for making small artefacts (Jaanits 1979, 365; Kriiska 2002a). In addition to the stone finds, various types of ceramics were present. The find material allows dating the site to the Late Mesolithic and Early Neolithic, being correspondent with the Narva and the Combed Ware Culture (Jaanits 1979, 367). This time frame corresponds to the new AMS-dates obtained from the graves (*Chapter 5.3.1.1.4.*). Based on the faunal material it has been suggested that Kõnnu was used as a camp for seal hunting (Lõugas 1996a, 105).

<u>*Human remains*</u>

Two of the depressions contained the remains of four individuals labelled as graves I, II, and III (Jaanits 1979, 365–367). In addition to these 'proper' burials I have been able to discern seven depressions (102, 111, 122, 127, 131, 135, and 138) with loose human bones (*Chapter 6.2.1.3.*). Loose human bones were also gathered during the field seasons in 1979, 1981, and 1984 (Table 33). Unfortunately, they lack a clear context as the soil of the settlement site was moved several times before the remains of the cultural layer could be investigated. Gravel mining was conducted on the same ridge already before World War II just E from the present road. Since people have some vague memories about skeleton finds during these activities (Lõugas, V. 1977, 2), the initial number of burials in Kõnnu may have been larger than it is known today.

<u>*Sources and source criticism*</u>

The sources about Kõnnu are relatively good despite the fact that the excavation report is only available for the preliminary surveys conducted by V. Lõugas

(1977). Nevertheless, field diaries with the description of features from the excavations conducted by Jaanits in 1977 and 1978 (Jaanits 1977; 1978) may be employed. From 1979 onwards we lack any kind of written descriptions about the activities that took place in Kõnnu and the discovered features. The only thing that hints about the proceeding work on site are lists of participants in TLU AI and the comment about the continuous growth of the collection. Külli Rikas was one of the archaeologists on the site, and according to her, there was no point in documenting the find situation in any detail as the heaps of soil (cultural layer) were re-deposited several times: *"There was no point in documenting the find situation in Kõnnu, as the soil/cultural layer was repeatedly re-deposited from one place to another. First the cultural layer was shifted to high heaps and afterwards these heaps were taken to the bottom of the depleted gravel mine in smaller heaps."*[7] (E-mail correspondence with K. Rikas, 3.10.2013). Yet the written descriptions from the first two years are accompanied by detailed drawings of the excavated area. All the finds, among them human and animal bones, are stored at the TLU Institute of History and Saaremaa Museum.

4.1.1.3. NAAKAMÄE

Archaeological background

Naakamäe is located in the south-western part of the island of Saaremaa on the western coast of the former sea (Jaanits 1965c, 28; Jaanits et al. 1982, 83; Saarse et al. 2009a, b). It is situated on a gravel ridge at the altitude of 13–15 m a.s.l.[8] The site was first recognised at the end of 19th century when an adze was found; locals came across to the next finds – flint flakes – in 1922 (Vaas 1922, 1; Vaas 1924, 81), yet the site was forgotten for decades. It was rediscovered in 1958 during the construction of a new road. Four field seasons (1958, 1959, 1961, and 1962a), led by Jaanits, followed the discovery and altogether 430 m^2 of the site was excavated (Jaanits 1965c, 28).

The upper part of the cultural layer was destroyed by tillage, but the lower part of it was still intact consisting of fine granular gravel and sand (Jaanits 1965c, 28). The find density was highest at the N part of the excavated area (Figure 10). Various features like hearths without stones, four intact vessels (Figure 10), and a single burial were unearthed. Based on the numerous ceramic finds – vessels with mineral admixture and pit and dimple ornamentation (Rappu 2011, 60) – Naakamäe has been dated to the Typical and Late Comb Ware Culture (Jaanits 1965c, 30; Jaanits et al. 1982, 85; see also Rappu 2011, 52pp). According to the shore displacement chronology it has been assumed

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[7] *"Leiusituatsiooni fikseerimine Kõnnus oli mõttetu tegevus, sest seda mulda/kultuurkihti oli korduvalt ühest kohast teise teisaldatud. Kõigepealt lükati kultuurkiht kõrgetesse vallidesse ja seejärel veeti see tagasi väiksematesse hunnikutesse ammendatud kruusa-karjääri põhja."* (E-mail correspondence with K. Rikas, 3.10.2013).

[8] According to that the site must have been underwater during the Litorina Sea period as the beach formations of the Litorina Sea are located between 20.5 to 25.5 m above the present sea level (Saarse et al. 2009a, 59).

that the site dated from the period of 3800–3500 cal. BC (Jussila & Kriiska 2004, 14). However, the radiocarbon date from the burial is considerably younger (4152±85 BP (Ua-4822); Lõugas et al. 1996).

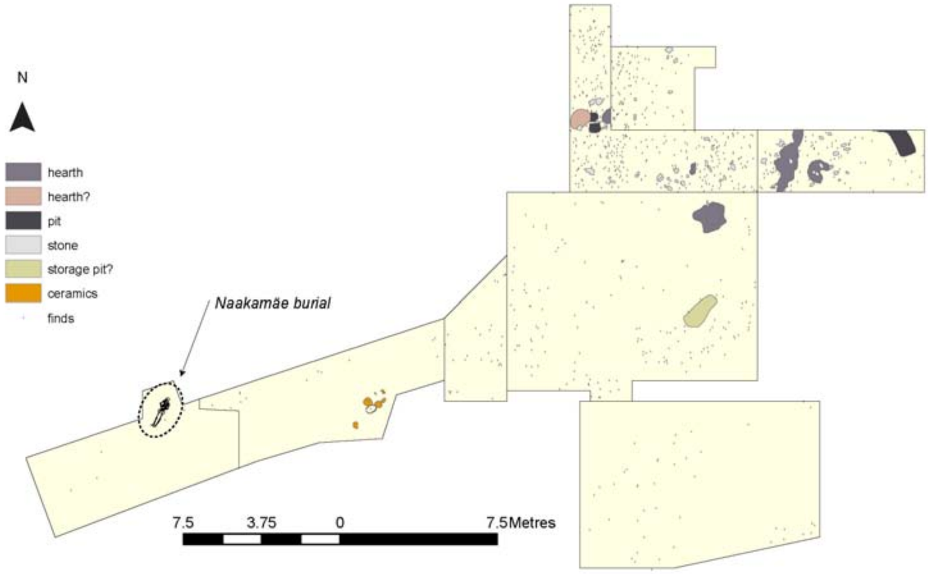

Figure 10.The whole excavation area of Naakamäe settlement site and the location of the burial.
The location of the burial is shown on the SW area of the excavation plot. (Drawing after TLU AI, 4-1-20-1; K. Göbel, N. Binkowski & M. Tõrv)

The faunal assemblage (Paaver 1965; Lõugas 1996a; Lõugas et al. 1996, 416) and isotope analysis (*Chapter 5.2.*) show that seals and marine fish were important sources for subsistence, which strongly indicates a hunting and fishing community. At the same time, based on the pollen data from Pitkasoo marsh, it has been suggested that the inhabitants of Naakamäe could have used slash-and-burn cultivation (Poska & Saarse 2002, 566). I argue that the changes in the pollen diagram – an increase in cultivated species that demanded more light, accompanied by a well-developed maximum level of charcoal – cannot directly be connected to the settlement at Naakamäe. These indications can easily be connected to an archaeologically unknown site. However, if slash-and-burn cultivation was performed in Naakamäe, it must have been marginal in the subsistence of this population. Therefore, the burial from Naakamäe representing hunter-gatherers is included in the present analysis.

Human remains

On the periphery (its SW part) of the settlement site, a single grave was found. According to the locals, another grave with tooth pendants was previously recovered from Naakamäe (Jaanits 1958; 1965c, 29; Jaanits et al. 1982, 83). No details are known about this burial, neither are the locations of the cranium and tooth pendants known. Nevertheless, this suggests that initially more than one individual was buried at Naakamäe.

Sources and source criticism

Despite the fact that there is no excavation report about the fieldwork in Naakamäe, the overall quality of the sources is good. All the finds and bones (AI 4211), drawings, photographs, excavation diaries (Jaanits 1958; 1959a; 1962a), and the find catalogue (Jaanits 1959b) are stored at the TLU AI. Unfortunately there is no written description available about every single field season: only the seasons of 1958 and 1962 are covered; for the year 1959 only the list of finds is provided. In addition to the primary sources, a short overview of the site is provided in a paper about Soviet Estonian Stone Age research (Jaanits 1965c) and in a miscellany about Estonian prehistory (Jaanits et al. 1982). Several photographs about the inhumation are available, thus this grave is one of the case studies in the archaeothanatological analysis. The accessibility of the skeleton itself adds depth to the analysis.

4.1.1.4. TAMULA I

Archaeological background

Tamula I (hereinafter: Tamula) is located in south-eastern Estonia between Lake Vagula and Tamula on the area where the Vahejõgi River runs into Lake Tamula. During the Stone Age occupation the water level in Lake Tamula was lower than today (Jaanits 1984, 183). The pollen data suggests that the site was inhabited during the subboreal climate stadium (Liiva et al. 1966, 433; Jaanits 1984, 183).

Tamula is one of the most investigated and published hunter-gatherer burial site from Estonia. It was discovered by a local photographer, Ida Kepnik, in 1938 and determined as a Neolithic settlement site at the same year by Indreko (Indreko 1939a). The first excavations in 1942 and 1943 were led by Indreko (1942; 1943). After World War II, in 1946, Moora conducted fieldwork on the site (Moora 1946) and in 1955–1956, 1961, 1968, and finally in 1988 to 1989, Jaanits excavated there. Altogether 657 m^2[9] of the site has been investigated (Figure 11).

The cultural layer is located in peat and sand mixed with peat. Altogether four hearths were found, which according to Jaanits were located inside former dwellings (Jaanits 1984, 184). Despite the abundance of wooden poles that are

[9] The work invested in the investigation of the site was even larger as some parts of the cultural layer have been excavated twice. The latter was due to the fact that the borders of previous excavations plots were not possible to establish from above ground.

argued to be part of the dwellings (Jaanits 1957a; Jaanits et al. 1982, 82; Jaanits 1984, 184) no outlines of single houses were possible to determine.

Figure 11. The excavation plots of all field seasons from Tamula.
The striped areas represent the excavation plots for which plans are absent.
(Drawing after TLU AI, 4-1-1-29-1, 4-1-29-2, 4-1-29-3, 4-1-29-4. 4-1-29-5;
K. Göbel, N. Binkowski & M. Tõrv)

The find material of the site is plentiful. The good conditions for the preservation of organic materials allow us to observe numerous bone artefacts (e.g. arrow heads, harpoons, fish hooks) (Jaanits 1984, 186 Abb. 4; 187 Abb. 5). The majority of the stone finds are flint artefacts, whereas the amount of debris is remarkably scant (Jaanits 1984, 185). In addition to flint artefacts, many stone adzes from other stone material were found (Jaanits 1984, 196). Various anthropomorphic and zoomorphic figurines from bone and also amber have been collected, too (Jaanits 1984, 189 Abb. 7; Ots 2006). The majority of them are grave inventory. In proportion to other finds, ceramics are represented relatively poorly but are Late Combed Ware (Jaanits 1984, 192) and Corded Ware (Jaanits 1984, 190) design.

The main hunting resources in Tamula were elk and beaver; the minority of the bones belonged to the wild boar, aurochs, marten, otter, bear, deer, roe deer, badger, and hare (Paaver 1965, 439–440). Pike and perch predominate among fish bones (Jaanits, K. 1991, 27).

The site was first dated according to the artefact typology belonging to Early and Late Neolithic and corresponding to the Late Combed Ware and Corded Ware traditions. Jaanits argues that unlike the other sites dated in the 1970s, Tamula had a relatively short occupation period – a couple of centuries (Jaanits & Liiva 1973, 159). This Late Neolithic date comes from a wooden pole that cut through the cultural layer (3600±180 BP (TA-10); although it is not known from which stage of the habitation this pole was stuck to the sediment), an elk bone (4050±180 BP (TA-28)), and the wooden bedding of grave XXII (4080±100 BP (TA-219); Jaanits 1965c; Jaanits & Liiva 1973; Ilves et al. 1970; 1974). As the exact context of the wooden pole and the elk bone are not known, it is difficult to delimit the habitation of the site based on these dates. One of the peat samples (4300±70 BP (TA-237)) pre-dates these finds (Punning et al. 1971, 82). The dating of Tamula settlement and burial site causes several problems due to the discrepancy between the dates obtained from human bones and other samples. Thus, it will be discussed in more detail in *Chapter 5.3.1.1.1.*

<u>*Human remains*</u>
The most outstanding structures from Tamula I are without doubt the 25 more or less intact burials (Indreko 1945; Jaanits 1957a). These are located within the cultural layer, and several groups of burials can be observed. Several of the graves were accompanied by a variety of grave goods (Jaanits 1957a; Lõhmus 2005). Being one of the key sites, many of the burials will be analysed in depth in the present study (*Chapter 6*).

<u>*Sources and source criticism*</u>
Even though Tamula has evoked a variety of interpretations the sources about the site (especially about the burials) are with varying quality, extending from poor to good (Table 13). From the first excavations site reports with plans and few photographs (Indreko 1942; 1943; Moora 1946), find material and skeletons (excl. II individual) are present. In analysing the materials from the field seasons led by Jaanits, one has to rely on the excavation diaries (Jaanits 1955b, 1956b, 1961b), which are accompanied by several photographs and drawings. No written information about the last excavations (years 1968, 1988–1989) in Tamula is known and only the plans and finds are in the repository. Jaanits explained the latter with the fact that the excavations in the 1980s aimed to collect environmental samples to trace domesticated crops (Jaanits pers. comm. 8.5.2014).

Thus, depending on their coverage by the source material, several of the burials are described in detail while the others serve merely as background information in the present study.

4.1.1.5. VALMA

Archaeological background

Valma is located in mid-Estonia on the north-western shore of Lake Võrtsjärv, at the village Valma. The site was discovered in 1948 and Jaanits conducted excavations there in 1949, 1950, and 1953–1955. Altogether 992 m^2 has been excavated, which constitutes nearly the entire middle area of the settlement site (Jaanits 1955a, 188; Jaanits 1959c, 35; Jaanits 1965c, 16). The whole settlement area is not determined, but Jaanits states that the dwelling site must have been relatively small in size (Jaanits 1965c, 16).

The occupation area (35–36.5 m a.s.l.), which sits higher than its surroundings, has been used as a field; thus the upper part of the cultural layer (25–50 cm from the topsoil) is mixed due to ploughing. The lower parts of the cultural layer have been preserved intact (Jaanits 1955a, 188). The 40–50 cm thick (up to 100 cm on the shore formation) cultural layer was a mix of sand and gravel with larger stones that were especially abundant on the shore formation (Jaanits 1955a, 188). Despite the fact that the majority of the settlement area is excavated no other constructions than c. 10 hearths were found (Jaanits 1955a, 188). Based on these, Jaanits has estimated that three to five contemporaneous houses must have been part of the settlement (Jaanits 1965c, 16). Also, six hearths with stone packing were found on the upper horizon of the cultural layer; these could either belong to the Typical Combed Ware or the Corded Ware Culture (Jaanits 1965c, 16) or even to the Late Iron Age (Jaanits 1955c, 24).

The vast majority of the find material is Typical Combed Ware sherds (Jaanits 1955c, 24; Jaanits 1955a, 188; Jaanits 1959c, 66–68, Таблица III, IV, V; Jaanits 1965c, 19 Abb. 8). In addition to the ceramics, small stone tools from local flint were abundant: scrapers, knives, burins and various points, as well as spearheads and arrowheads (Jaanits 1955a, 188; Jaanits 1959c, 64, Таблица I; Jaanits 1959c, 74–75, Таблица XI, XII; Jaanits 1965c, 29 Abb. 9), and various kinds of adzes (Jaanits 1955a, 189; Jaanits 1965c, 21 Abb. 10). The preservation of bone – both artefacts (e.g. fishhooks, harpoons; Jaanits 1959c, 71–72, Таблица VIII, IX; Jaanits 1965c, 21 Abb. 10) and unprocessed animal bones – is rather poor; they have been only preserved at the lower horizons of the cultural layer. The animal bones – elk, aurochs, deer, beaver, bear, otter, fox, and hare, various fishes, birds[10] and even some seal bones – from the lower horizons (TCW) indicate a wide range of subsistence (Jaanits 1955c, 25), yet from the upper layers also bones of domesticates have been found (Jaanits 1955c, 25).

Three Neolithic pottery types are present in Valma: (1) Typical Combed Ware, (2) Late Combed Ware, and (3) Corded Ware. The pottery indicates that the site was also inhabited during the 12^{th}–13^{th} century AD (Jaanits 1955a, 188). All attempts to date the burials have failed due to the poor collagen preservation

[10] Determined by Kalju Paaver (Jaanits 1955c, 25).

(Table 17). Thus, we have to be content with the relative dating of the site based on the typology of the ceramics.

Human remains

From the periphery of the settlement area (NW part) two individuals – an adult male (III) and a young female (II) – were found. These more or less wholly preserved skeletons were adorned with grave goods (Jaanits 1955c, 23; Jaanits 1959c, 39–40; Jaanits 1965c, 17–18). Another grave with the remains of a child (I) in a depth of 115 cm from the topsoil was found on the SE part of the settlement. In this case only the skull and some other bones (Jaanits 1955c, 16; Jaanits 1959c, 39; Jaanits 1965c, 18; Jaanits et al. 1982, 68) were detected and thus the position of the body and other specific features of the grave were not documented in the field. It was only noted that above the cranium an area with some charcoal and ashes at the width of 20 cm and thickness of 10 cm was found (Jaanits 1965c, 18), and some additional cranium fragments were present (AI 4022: 5411[11]; Jaanits 1955c, 16).

Sources and source criticism

The source material about Valma burials is good. There are field reports, associated plans and drawings available, as well as photographs of the individual III *in situ*. All the bones and artefacts are stored in a repository. This allows a detailed description of the remains of the two individuals and presenting Valma as one of the case studies (*Chapter 6.1.3.1.1.* and *6.1.5.2.*).

4.1.2. Sites with loose human bones in settlement layers

4.1.2.1. AKALI

Archaeological background

Akali is situated in south-eastern Estonia on the right bank of the Akali River, at the tributary of the Suur Emajõgi River (Figure 12). The site is located on the NE–SW oblong drumlin with the altitude of 30.5 to 31 m a.s.l. Akali was discovered in 1937 by a local farmer (Indreko 1938, 1). During the field seasons 1938–1939 (Indreko 1938; 1939b; the site was then known as Konsa), 1949–1952, and finally 1966 (Jaanits 1949; 1950b; 1951; 1952; 1966) altogether 542 m^2 were excavated. This represents solely c. 4% of the whole area of the settlement (Jaanits 1955a, 180; Jaanits 1965c, 9)[12].

[11] These fragments of the skull are not present in the collections at the Institute of History in Tallinn University.

[12] The range of the whole settlement (17 000 m^2) was established with phosphate analysis (Jaanits 1942, 2).

Figure 12. View to Akali settlement site from the NNE and emptying the excavation plot Q from water in 1952.
(Photos: TLU AI, f 12)

The site was dwelled in for several millennia. However, the habitation area moved according to the rise of the groundwater level, being demonstrated by the distribution of various ceramic types (Jaanits 1950b, 13) and the covering peat layer, which left the oldest habitation layers under maximal two-metre-thick peat (Jaanits 1955a, 180). The cultural layer itself was relatively thick, ranging between 70 cm and 100 cm: the upper layers were partly mixed with peat, and the lower ones consisted of gray sand (Jaanits 1950b, 3–4; Jaanits 1952, 15) where only rarely small stones were present (Jaanits 1952, 5). Similarly to the majority of settlements in Estonia, no house structures were found in Akali. Nevertheless, hearths with and without stones (Jaanits 1950b, 4, 7; Jaanits 1952, 3; Jaanits 1966, 3–7), a storage area for stones (Jaanits 1951, 4), and storage pits of various sizes (Jaanits 1951, 5; Jaanits 1952, 2, 11–12) were found. Similarly to the dwelling site at Tamula vertically positioned stakes were found (Jaanits 1949, 9; Jaanits 1950b, 6). However, their location did not allow any further conclusions about the construction they were once part of to be drawn.

Due to the covering peat layer the preservation of organic materials was relatively good (e.g. Jaanits 1949, 12; 1950b, 11; 1951, 5). Bark, wood, and bone (e.g. bone needles, chisels) are exceptionally well preserved. Still, the vast majority of the finds come from ceramic vessels (e.g. Jaanits 1950b, 10), whereas Narva Ware, Typical Combed Ware, and Late Combed Ware, together with Corded Ware and textile ceramics, are represented (Jaanits 1955a, Tahvel XLIV–XLVI). Small flint items – scrapers, knives, thrills, burin – are also numerous (around 1000 exemplars). The great amount of debris and nuclei indicate that the stone tools were produced on site. The number of examples of fishing and hunting gear is relatively small and consists mostly of flint arrowheads. Only small fragments of bone harpoons and spearheads have been found. As for wood chopping tools, adzes and axes without shaft holes were present (Jaanits 1955a, 182–183). In addition to the utilitarian artefacts, small sculptures (e.g. clay human figurine), and pendants from tooth and amber were present in the cultural layer (Jaanits 1955a, 182; Ots 2006, 25 Tabel 2, 44). The abundance of the material culture and the diversity of faunal material[13] (mammals: elk, aurochs, bear, beaver, wild boar, roe deer, deer, horse, dog: fish: pike and catfish; avians: sea eagle and mallard duck) (Indreko 1938, 2; Jaanits 1949, 9; Jaanits 1950b, 11) suggests that the site was inhabited throughout the year.

Akali was inhabited from the Late Mesolithic to the beginning of Iron Age (Jaanits et al. 1982, 43, 60). However, the abundant ceramics finds form one basis for the relative chronology of the Neolithic archaeological cultures in Estonia (Jaanits 1955a, 190–191; Jaanits 1965c, 12). In Akali the majority of the sherds come from the Typical Combed Ware type, with the Late Combed Ware type being the second most common (Jaanits 1950b, 12). All the other types are represented in lower quantities. Although various types of ceramics were spread all over the cultural layer, Jaanits argues that it was possible to divide them stratigraphically (Jaanits 1950b, 11), and chronologically (oldest to youngest): (1) Narva-type, (2) Typical Combed Ware type, (3) Late Combed Ware type, (4) Corded Ware type, and finally (5) textile ceramics (Jaanits 1950b, 11–12; Jaanits 1955a, 181). Moreover, the occurrence of the Typical Combed Ware and the Corded Ware types in Akali were connected to the migration of new people (Jaanits 1955a, 181). There are several radiocarbon dates available for the early stage of the dwelling both from charcoal (6255±100 BP (TA-103); Punning et al. 1968, 379) and food residues of the pottery

[13] Animal bones were determined by Johannes Lepiksaar and V.J. Tsalkin; fish bones were determined by D. Lebedev.

(4055±40 BP (Hela-752), 4155±65 BP (Hela-761); Kriiska et al. 2005). Due to the poor preservation of human bones no absolute dates from them have been obtained. The dating of the features with human bones is based on the relative chronology.

Human remains

No articulated skeletons were found from Akali. However, loose human bones from five contexts at different sequences in the cultural layer were discovered (Table 10).

A few dozen skull fragments were recorded from the central part of the settlement, close to a hearth packed with a single layer of stones (Jaanits 1950b, 4), yet considerably higher (Table 10: 1; Jaanits 1950b, 5). A single fragment of a cranium was discovered from the same excavation plot (Jaanits 1953, 46; Table 10: 2). Two years later a feature with a dozen fragments of human cranium was located above a storage(?) pit (Table 10: 3) at the periphery of the settlement (Jaanits 1953, 58). As none of these features contained post-cranial skeletal elements Jaanits concluded that these are not an outcome of mortuary practices (Jaanits 1952, 8)[14] or are evidence of destroyed inhumations in the settlement layer (Jaanits 1953, 49, 68).

In 1966, Jaanits returned to the site and located new features with fragments of human skeletons. Single human teeth and small fragments of poorly preserved bones were located (Table 10: 4); close to these, but slightly lower, where the soil became lighter, a more compact assemblage of bones was documented (Table 10: 5).

Table 10. Loose human bones from Akali settlement site.

No.	*Bone elements*	*No. of elements*	*Collection no.*	*Year*	*Context*					*Archaeo-logical culture*	*Re-ference*
					Cultural layer	*Exca-vation plot*	*Square*	*Distri-bution diameter (cm)*	*Depth (cm from topsoil)*		
1.	Fragments of parietal bone	21	AI 4013: 3412	1950	Middle part of cultural layer	I	c/63, c/62	10	133	Typical/ Late Combed Ware	Jaanits 1950b; Jaanits 1953
2.	Fragment of a skull	?	AI 4013: 6975	1950	Middle part of cultural layer	I	c/24	Spot find	65	Typical/ Late Combed Ware, Corded Ware(?)	Jaanits 1953
3.	Fragments of parietal bones, left orbit and frontal bone	11	AI 4013: 8345, 8355, 8368, 8339	1952	Upper part of cultural layer, above a storage pit in squares g_2–h_2/74	O	h_2/74, g_2/74	20	160–165	Typical/ Late Combed Ware	Jaanits 1952

[14] *“Kuna kõik need moodustavad osa koljukaanest, muid inimluid sellest kaevandist aga ei leitud, siis nähtavasti on sellel kohal matust ei olnud*” (Jaanits 1952, 8).

No.	Bone elements	No. of elements	Collection no.	Year	Context					Archaeo-logical culture	Re-ference
					Cultural layer	Exca-vation plot	Square	Distri-bution diameter (cm)	Depth (cm from topsoil)		
4.	Teeth and fragments of bones	26(?)[15]	AI 4013	1966	Upper part of cultural layer	Z	$ö_1$–$ü_1$/3–4	Not specified	40–50	Late Corded Ware to Bronze Age	Jaanits 1966
5.	Cranium and single bones from the post-cranial skeleton	8(?)	AI 4013	1966	Upper part of cultural layer	Z	$ö_1$/3, $ü_1$/3–4	Not specified	55–56	Late Corded Ware to Bronze Age	Jaanits 1966

As none of the features with human bones contained any (diagnostic) grave goods, their relative dating is entirely dependent on the stratigraphy of the site. However, the latter is not as straightforward as the case in Narva Joaorg, because the cultural layer has been distinguished as a single entity (Jaanits 1953). Nevertheless, the horizontal distribution of various pottery types in the cultural layer permits conclusions. The first two features should be concurrent with Combed Ware (Jaanits 1953, 156). However, Corded Ware became abundant at the south-western part of the excavation plot 'I' (Jaanits 1953, 186), making the dating of the second feature more problematic. Without absolute dates it is not possible to solve this problem entirely. The third one is concurrent with Combed Ware (Jaanits 1953, 157). The features found in 1966 did not penetrate the lower horizons of the cultural layer, thus Jaanits suggested that the disturbed graves are concurrent with the later phase of the settlement (Jaanits 1966, 9). These were found from excavation plot 'Z' representing an area settled later than the riverside, and are thus dated to Late Corded Ware to Bronze Age.

Sources and source criticism

The process of excavations and the discovered features are described in field reports (Indreko 1938; 1939b; Jaanits 1949; 1950b; 1951; 1952; 1966). As primary sources about the burials, loose human bones are preserved in a repository. The quality of the written descriptions, as well as overview plans, is satisfactory. However, as the features with human bones were considered to be disturbed graves, these were not documented in detail, and no photographs or detailed drawings were made. Due to this and the lack of absolute dates for the human remains, these are not included in the detailed analysis of mortuary practices but serve as background information. The human remains found during the field season in 1966 are entirely excluded because the stratigraphy of the site indicates that these belong to later prehistoric periods.

15 The bones in the osteological collection derive from the squares "$ö_1$–b/3–5", which is not identical to the contextual information received from the excavation report. Thus it is impossible to estimate the exact number of bone elements retrospectively.

4.1.2.2. KUDRUKÜLA

Archaeological background

Kudruküla is located in north-eastern Estonia on the right bank of the Kudruküla stream mouthing into the Narva River. It is an exceptional site as it is not located directly on top of the beach ridge like the majority of the coastal sites, but is instead buried under c. 3 m thick cap of sand (Tšugai et al. 2014, 225).

The site was discovered in the 1960s by Eldar Efendijev and during the following decade archaeological finds were repeatedly collected (AI 5041; Kriiska 1994, 9). In 1980 and 1981 an approximately 200 m^2 excavation plot was opened under the guidance of K. Jaanits and Efendijev[16] (Jaanits, K. 1981; Efendijev 1983). In 2010 Kriiska returned to the site and carried out test excavations (TÜ 1876), and in 2011–2013 conducted rescue excavations (Kriiska 2012). In 2010 and 2013 additional ground-penetrating radar surveys complemented by core descriptions and a small (3.24 m^2) test pit were carried out (Tšugai et al. 2014). Due to the re-deposited nature of the cultural layer, it is impossible to estimate the exact size of the site, and therefore also the percentage excavated by archaeologists.

The location of the cultural layer of Kudruküla site has raised the question of its originality (Jaanits, K. 1981; Efendijev 1983; Kriiska 1994; Kriiska 1995, 58; 1996a, 366; Kriiska & Nordqvist 2010, 25–26). K. Jaanits and Efendijev have suggested that the cultural layer represents several occupation episodes and reaches the depth of c. 2 m (Jaanits, K. 1981, 385). The neighbouring settlement sites for Kudruküla are Narva-Jõesuu I–IV. These are located on the beach ridges at the altitude of 8–9 m a.s.l. (Kriiska & Nordqvist 2010; 2012), whereas Kudruküla is located at the altitude of 1.25 to 1.60 m a.s.l. (Tšugai et al. 2014, 228). According to the recent studies it may be concluded that the cultural layer of Kudruküla (original altitude >6 m a.s.l) has been re-deposited. This is proven by the radar pattern and silicious macrofossil data, being further supported by the fact that artefacts occur within fluvial sediments and meander scroll topography, i.e. a succession of swales and ridges (Tšugai et al. 2014). As the artefacts are well preserved, researchers propose that the dwelling was originally located on the top of coastal ridges of the Narva-Jõesuu system facing a lagoon in the Litorina Sea (Rosentau et al. 2013, 929). Due to the erosive activity of the river the outer bank suffered slides (several such events). The re-deposited cultural layer was covered fast, likely within a year (Tšugai et al. 2014, 233).

Due to the re-deposited cultural layer no structures were found. Ceramics, the most abundant find material, has been in the focus of several studies (Kriiska 1995; 1996a; 1996b; Rappu 2011). Typical and Late Combed Ware sherds have been found at Kudruküla; the vessels were made both with mineral and organic admixture (Kriiska 1995, 75, 86), and the variety of ornamentation is remarkable (Rappu 2011, 38pp). The vast majority of ceramic sherds belong to the Late Combed Ware type (c. 80%; (Kriiska 1994, 10; Kriiska 1995, 59, 86). The radiocarbon dates

[16] The finds gathered in 1981 (excavations led by Efendijev) are stored at Narva Museum, but are not numbered (Kriiska 1995, 106).

obtained from human and seal bones (4860±60 BP (Cams-6266), 4835±100 BP (Ua-4827), 4770±60 BP (Cams-6265), 4750±100 BP (Ua-4826); Lõugas et al. 1996) delimit the occupation of the site to the middle of the 4th millennium and also determine the border between Typical and Late Combed Ware pottery types (Lang & Kriiska 2001, 92). Only a single date from an animal bone falls out of this range, which is considerably younger than the rest (4180±70 BP (Tln-495); Rosentau et al. 2013). Due to the mixed character of the cultural layer it is difficult to establish a clear cause of that discrepancy.

Taking all the evidence together, Kriiska interprets the site as a village, not just a seasonal hunting camp (Tšugai et al. 2014). Nevertheless, the high proportion of seal bones among the faunal remains (53.2%; Rosentau et al. 2013, 924, fig. 6), being twice as frequent as in other sites in the area (Kriiska 1999, 180), indicates a specialisation toward seal hunting.

Human remains

Among other finds, remains of two individuals were found (MNE = 5). As the whole cultural layer is re-deposited, nothing substantial can be said about these.

Sources and source criticism

The primary sources about that site, especially about the first excavations, are sparse. From the very first excavations, where also loose human bones were found, neither excavation reports nor pictorial source are available. The artefacts, animal bones, and human bones are stored at the Narva Museum (NLM 1304; AI 5041). Nevertheless, the results of field surveys have been published in several articles (Jaanits, K. 1981; Efendijev 1983; Kriiska 1995; 1996a; Kriiska & Nordqvist 2010; Tšugai et al. 2014), which, together with the maintained human bones, enables at least biochemical analysis to be carried out. Regarding mortuary practices, these only serve as background information in the present study.

4.1.2.3. KUNDA LAMMASMÄGI

Archaeological background

Kunda Lammasmägi is located in north-eastern Estonia at the village Linnuse. The site is situated on a small island on a former shallow lake (Karukäpp et al. 1996, 223; Moora 1998, 26–31). The Kunda Lammasmägi site was discovered already in the 1870s during industrial mining of marl, which was followed by trial excavations by Grewingk (1881) who located the settlement site (about the early research at Kunda Lammasmägi see Indreko 1948, 44pp). Since then, several researchers have returned to conduct field work: 1933–1937 by Indreko, 1949 and 1961 by Jaanits, in 1981 by Tanel Moora and K. Jaanits, in 1992 by K. Jaanits and Agneta Åkerlund, and in 2012–2014 by Kriiska and Kristjan Sander. Altogether c. 1500 m^2 of the site has been excavated (Sander 2014).

No structures have been documented in the multi-layered Kunda Lammasmägi site. However, the thick cultural layer (for discussion over stratigraphy see Sander 2014) at Kunda is characterised by the abundance of bone material;

among these are spearheads, arrowheads, ice picks, net floaters, and harpoons (Indreko 1948, 201pp, 315pp; Jaanits et al. 1982, 36–38; Sander 2012). The small stone tools such as scrapers, burins, arrowheads, and spearheads are made both of flint and quartz; quartz clearly dominates as a raw material (Indreko 1948, 108pp). Also, stone axes, adzes, and grinding stones were found at Kunda Lammasmägi (Indreko 1948, 130–133; 140pp).

Elk was the most dominant species through all the epochs (Lõugas 1996b, 279), whereas the fish and seal bones were rare, which indicates a subsistence dominated by terrestrial mammals (see also Indreko 1948, 75–76). The characteristics of faunal material indicate that the site was in use during the autumn to spring, yet this cannot be concluded with certainty (Lõugas 1996b, 288–290; Lõugas 1997). The characteristics of the finds (Indreko 1948, 298) supports the possibility of the winter occupation, and the environmental conditions of the island further suggest that the site was only used during the drier seasons when the water level of the ancient lake was the lowest (Moora et al. 1996, 248–250). Although there is no consensus about the exact time of usage of the site, all the studies suggest that it was not a perennial village (Kriiska & Tavuri 2002, 23; see also Grewingk 1882; Raukas 1992, 26).

Although the site gave its name to the Mesolithic Eastern European Kunda Culture, the radiocarbon dates from charcoal (8340±280 BP (TA-14); Liiva et al. 1966), elk bones (6015±210 BP (TA-16); Liiva et al. 1966; 8260±90 PB (Ua-3000), 8485±90 BP (Ua-3001), 5151±100 BP (Ua-3002), 9085±100 (Ua-3003), 9330±130 BP (Ua-3005), 8040±75 (Ua-3052); Åkerlund et al. 1996), and a mammoth tusk (9780±260 BP (TA-12); Liiva et al. 1966) demonstrate that the island was inhabited during different times ranging from Early Mesolithic to Late Neolithic (8600–1800 cal. BC (Åkerlund et al. 1996, Table 1)) and even to Late Iron Age (Indreko 1948, 51). Åkerlund et al. (1996, 269) have proposed that the site was not continuously inhabited; instead three more solid epochs during the Stone Age could be distinguished: (1) 8590–8030 cal. BC, (2) 7530–6820 cal. BC and (3) 2490–1780 cal. BC.

Human remains

Referring to Indreko (1948), Lõugas and Jonuks state that in addition to faunal remains some human remains were gathered during the excavations Indreko conducted in 1933–1937 (Lõugas et al. 1996, 400; Jounks 2009, 98). Indreko's field reports do not contain this information (Indreko 1934a; 1934b; 1935b; 1936, 1937). As the faunal remains from Kunda were packed to be transported to the new repository, I was unable to go through the boxes of animal bones to verify this information. However, I did find a human tooth among the finds.

Form Kunda only three fragments of human bones are known: a mandible, a humerus (Lõugas 1996b, 273; Lõugas et al. 1996, 405), and a maxillary second molar. Their exact locations in the cultural layer are not known. For the maxillary second molar, the find context was documented simply as "Kunda 1949". As Kunda Lammasmägi is a multi-layered site, it is also possible that these bones do not derive from the Mesolithic and Neolithic layers.

Sources and source criticism

Even though there are primary sources – e.g. reports, plans, drawings, and photographs – about the excavations, these do not provide sufficient information about the single bone finds from the cultural layer. It is evident that these bones have not drawn the attention of the researchers in the field and thus, will not be included in the archaeothanatological analysis. These bones will form part of the discussion about the findings of loose human bones from settlement layers serving as background information while only a single bone is available to examine in the collection[17].

4.1.2.4. KÄÄPA

Archaeological background

Kääpa is a settlement site located on the left bank of the Võhandu River, c. 5–10 km north-east of the Tamula settlement and burial site. The site was discovered in 1958 during the construction work of a bridge (Aun 1963, 9), and excavated in 1959–1962 and 1974 by Jaanits. Altogether an area of 795 m^2 was opened (Jaanits 1976, 45–48).

Similar to Tamula and Akali, the cultural layer at Kääpa is covered with peat, which indicates that during the habitation of the site, the water level at Võhandu River was lower than it is today (Aun 1963, 10; Jaanits 1968, 14–15). Despite the findings of wooden poles, no clear structures have been documented. However, the find material is plentiful, being mostly represented by Narva Ware, but also Typical Combed Ware sherds have been found (Aun 1963; Jaanits 1968; 1976; Piezonka 2008). These two ceramic traditions are stratigraphically separable within the cultural layer (Jaanits 1976, 47). The favourable conditions for organic preservation have provided a wealth of bone material – both unworked fauna (Jaanits 1968; 1976) and artefacts (Aun 1963; 1965; Jaanits 1968; 1976; Ööbik 2014). In addition to bone artefacts, also stone tools (i.e. quartz and sandstone) are represented (Jaanits 1968, 19; 1976, 47), but unlike from other Early Neolithic sites the flint material is less representative at Kääpa (Jaanits 1965c, 12; 1968, 19).

The ceramic typology and radiocarbon dates (4350±220 BP (TA-4); 4865±235 BP (TA-5); 4480±255 BP (TA-6); Liiva 1963, 60; Liiva et al. 1966, 431; 3460±80 BP (TA-478); 4740±60 BP (TA-724); 4640±100 BP (TA-815); Antanaitis-Jacobs & Girininkas 2002, 26–29; 6540±40 BP (KIA-35897); 5985±35 (KIA-33921); Piezonka 2008, 76) indicate both Early and Late Neolithic habitation of the site. As the composition of the food remains on the pottery were not determined (Piezonka 2008), one should regard these as the maximum dates. Thus, the maximum span of the habitation at Kääpa was c. 5500–4800 and 3900–2600 cal. BC.

[17] I went through the find collection AI 3263, AI 3263, AI 3308, AI 3359, AI 3410; AI 3575, AI 4011, AI 4284. Animal bones were not available due to the preparations for moving the bone collection.

Human remains
During the excavations in 1962, single human bones and cranial fragments were found from Kääpa (Aun 1963, 12). An almost complete cranium is stored in the archaeological research collections at the Tallinn University (AI 4245), and a single cranial fragment has been reported (VM 3000: 756). The latter was not present in the collection, so nothing further can be said about this bone and its depositional circumstances.

Sources and source criticism
The absence of excavation reports does not allow any subsequent contextual analysis to be carried out. Moreover, the fragmentary nature of the skeletal material omits the inclusion of the Kääpa human remains in a more detailed analysis. Therefore, these will be used as background information in the present thesis.

4.1.2.5. NARVA JOAORG
Archaeological background
Narva Joaorg is located near the present town of Narva on the eastern border of Estonia (Figure 13). The site is situated on a gravel and sand ridge at the altitude of 7.5 to 14 m a.s.l. of the western bank of the Narva River. Narva Joaorg was discovered in 1953 by a local history teacher, V. A. Zubov (Zubov 1953; Jaanits 1954, 1). In 1954 and 1957 Jaanits carried out preliminary surveys that were followed by extensive excavations in 1960 and 1962–1964. Altogether an area of 448 m^2 was opened (Jaanits 1965c, 37), which according to the overall size of the platform (c. 4000 m^2 (Jaanits et al. 1982, 43)) forms c. 10% of the estimated size of the settlement site.

Narva Joaorg is a multi-layered and multi-cultural site consisting of three pre-ceramic Mesolithic layers and a Mesolithic/Early Neolithic layer with both Narva Ware and Typical Combed Ware present[18]. Due to the alluvial sediments separating different habitation layers, the stratigraphy can be easily observed (Jaanits 1954; Jaanits 1965c, 37–42; Jaanits & Liiva 1973, 158; Jaanits et al. 1982, 44) (from the youngest to the oldest layers): (1) mixed topsoil with finds from the Neolithic to the 1950s[19]; (2) Early Neolithic cultural layer with Narva and Typical Combed Ware; and, in some parts of the excavation area, (3) a layer of sterile sand was observable. Rosentau and colleagues (Rosentau et al.

[18] According to the chronology that Jaanits adopted, he dealt with three Mesolithic layers and a single Neolithic layer. The beginning of the Neolithic in this case is determined by the introduction of ceramics. The Stone Age chronology developed by Jaanits (Jaanits 1965, 45–46) consists of: Kunda Culture (7th–4th millennia BP), Narva Ware (1st half to the mid-3rd millennia BP), Typical Combed Ware (2nd half of the 3rd millennium BP), Late Combed Ware (1st half of the 2nd millennium BP), Corded Ware (1st half of the 2nd millennium BP), and textile ceramics (2nd half of the 2nd millennium).

[19] Kriiska et al. (in prep) have labelled these stratigraphic units accordingly: (1) mixed topsoil = layer A; (2) Early Neolithic with Narva and Typical Combed Ware and dark cultural layer patches filled with charcoal and Narva type pottery = layer B; (3) I Mesolithic layer = layer C; II Mesolithic layer = layer D; III Mesolithic layer = layer E.

2013, 928) proposed that this layer was established due to the water-level rise during the Litorina Sea transgression.This is followed by (4) dark cultural layer patches filled with charcoal and Narva-type sherds (Kriiska 1995, 55), which was followed by (5) sterile sand. The following layers all represent pre-pottery and pottery Mesolithic: (6) a dark-grey cultural layer, i.e. the I Mesolithic layer with only quartz and bone finds and unworked animal bones; (7) sterile sand; (8) and the II Mesolithic layer, which is foremost characterised by stoneless hearths (Jaanits 1965c, 37–40) was described. On the northern part of the excavation area, (9) sterile sand and below that the (10) III Mesolithic layer was identified (Jaanits 1965, 37–40). The oldest settlement layer was situated directly above the limestone bedrock. The radiocarbon dates from the Mesolithic layers (5300±250 BP (TA-7); 6020±210 BP (TA-17); 7580±300 BP (TA-25); 5820±200 BP (TA-33); 6740±250 BP (TA-40); 7090±230 BP (TA-41); 7375±190 BP (TA-52); 7640±180 BP (TA-53); Jaanits 1960; 1963; 1964; 1965c; Liiva et al. 1966 ; Jaanits & Liiva 1973; Ilves et al. 1974) date the site to c. 6600–4200 cal. BC, being the earliest known human occupation in the Narva-Luga region (Rosentau et al. 2013, 927).

Figure 13. Excavations at Narva Joaorg.
In the foreground, the excavation plot of the 1962 field work at Narva Joaorg on the left bank of Narva River is visible. On the opposite side of the river the medieval fortress of Ivangorod, Russian Federation is seen. (Photo: TLU AI, f12)

The main structures from the Mesolithic and the Neolithic layers were hearths with and without limestone packing. Whereas in the I Mesolithic layer the hearths with limestone packing were more abundant (Jaanits 1960, 7; Jaanits 1965c, 37), the II Mesolithic layer was characterised by hearths without stones (Jaanits 1965c, 37–40). The dominating raw material on the site was quartz, but single flint tools were present. In addition to the stone finds from the Late Mesolithic/Early Neolithic layer, Narva type pottery (Kriiska 1995, 65; Kriiska 1996b), Typical Combed Ware (Kriiska 1995, 75; Kriiska 1996b), and also Late Combed Ware (Kriiska 1995, 86; Kriiska 1996b) pottery have been found[20]. Few finds of the Late Neolithic pottery types have been found, too (Kriiska 1995, 95, 102). According to the faunal remains, the main subsistence for the earlier occupants of the site were elk and beaver (Paaver 1965, 437–438), and the utilisation of marine resources is proven by the presence of seal bones (Paaver 1965, 437–438).

<u>*Human remains*</u>
Altogether four features with loose human bones were found from the Mesolithic layers (Table 11). From the I Mesolithic layer fragments of two individuals: an adult (I[21]; Jaanits 1962b, 5–7) and a child (III; Jaanits 1963, 9; Jaanits et al. 1982, 45), together with a tooth pendant (AI 4264: 2207) were recorded. The third deposit with human bones (II) – fragments of cranium – was found from the II Mesolithic layer at the very bottom of the excavation plot (on the natural limestone bedrock) (Jaanits 1962b, 12). The last feature with loose human bones (IV) was found from the III Mesolithic layer together with tooth pendants (AI 4264: 2286, 2272). Being on the corner of the excavation plot, it was hoped that it was an intact burial, which was to be unearthed during the last field season in 1964. Unfortunately, only more fragments of the cranium of the same individual were found in 1964 (Jaanits 1964, 8). In addition to these four Stone Age features with loose human bones, two almost complete and articulated skeletons (Narva Joaorg V and VI) were found in 1963 at the uppermost mixed layer (Jaanits 1963, 2–3). These do not belong to the Stone Age and thus are out of the scope of the present study. Despite the fact that Jaanits came across several features with human bones, these are not thoroughly discussed in any of the former publications. Only the child burial (III) has been published; the rest of the remains were only briefly referred to (Jaanits et al. 1982, 45).

[20] Differently from the Riigiküla I and III sites, the exact number of various types of ceramics in Narva Joaorg is not known (see Kriiska 1995).
[21] The deposits with human bones are numbered according to their order of appearance.

Table 11. Loose human bones from Stone Age layers from Narva Joaorg.

No.	*Label of the feature*	*Bone elements*	*Collection no.*	*Year*	*Context*			*Archaeological culture*	*Reference*
					Cultural layer	*Square*	*Depth (cm from reference point)*		
1.	Narva Joaorg I	Chapter 6	AI 4264	1962	I Mesolithic layer/C layer	u–v/97–98	116–124	Narva	Jaanits 1962b
2.	Narva Joaorg II	Chapter 6	AI 4264: 1409	1962	II Mesolithic layer/D layer	õ/98	–	Kunda	Jaanits 1962b
3.	Narva Joaorg III	Not in the collection	AI 4264	1963	I Mesolithic layer/C layer	x/98	144	Narva	Jaanits 1963
4.	Narva Joaorg IV	Chapter 6	AI 4264	1963–64	III Mesolithic layer/E layer	ü–y/86–89	–	Kunda	Jaanits 1963; 1964

<u>Sources and source criticism</u>

The primary sources about Narva Joaorg are representative, consisting of the finds (AI 4101; AI 4246), human and animal bones (AI 4246), drawings, plans (AI-4-1-21-1), photographs, excavations reports (Jaanits 1954; 1957b; 1960; 1962b; 1963; 1964), and diaries (AI-12). The excavation reports of the later years were written in collaboration with T. Moora (Jaanits 1960, 1). In the collection of the TLU there are two boxes of bones deriving from Narva Joaorg. These bones belong to the burials I, II, and IV; the bones of the individual III were not present in the collections. As only burials II and IV are documented on photographs, these will be discussed more thoroughly; the other two serve as background information.

4.1.2.6. PIKASILLA

<u>Archaeological background</u>

Pikasilla is located on a moraine hillock at the altitude of 48 to 49 m a.s.l. on the S tip of the Lake Võrtsjärv in the vicinity of the estuary of the Väike-Emajõgi River. During its habitation during the Mesolithic, the moraine hillock must have been a small island on the Suur-Võrtsjärv Lake (Veldi 2010, 8). Additionally, a Neolithic cultural layer with Typical and Late Combed Ware was located by test pits at the foot of the hillock.

The site is foremost known as a medieval hill fort used as a trading center or a toll post (Veldi & Valk 2010, 93). The first evidence of Stone Age occupation – a flint flake – was found during the field survey in 2007 (Konsa & Ots 2008, 235). During the excavations in 2009, two distinct Mesolithic layers were located on the plateau of the hillock: (1) a dark grey ashy sand layer and (2) a red sand layer (Veldi 2010, 8). These layers are dated to Mesolithic based on the find material –the absence of any ceramics and the characteristics of flint finds (Veldi 2010, 8–9). The majority of the flint finds are by-products and debris; only some flakes and artefacts were found (Veldi 2010, 9). Even though the overall area of the Mesolithic occupation is not determined, it could be concluded that only a marginal area of it has been excavated so far.

Human remains

Among other finds, human teeth were found from the II Mesolithic layer, i.e. red sand layer (VIII technical layer), from squares 13 and 14 (Veldi 2010). No structures were observed in connection with them. As the teeth were too small and did not yield enough collagen for radiocarbon dating, the find is dated according to the stratigraphy of the site. Thus, at this stage of the research it may be concluded that these teeth belong the pre-pottery Mesolithic.

Sources and source criticism

The sources about Pikasilla hill fort are abundant, starting with the thorough excavation report (together with all the photographs and drawings), and ending with artefacts and bone material, among which also the human teeth were found. Nevertheless, as the main focus of the investigations has been the determination of the extent and character of the cultural layer of the hill fort, there is not much written on the human teeth finds. They are listed together with animal bones (TÜ 1772: 240–246) and have been determined as human by me (Table 14). The Stone Age occupation layers are briefly discussed in an overview article about the excavation results (Veldi & Valk 2010, 93).

Despite the lack of detailed contextual information about the teeth, they will be involved in the analysis as background information. They will also be referenced in the discussion about whether all human remains are the outcome of burial practices.

4.1.2.7. SINDI-LODJA (previously referred to as Pärnu)

Archaeological background and human remains

Pärnu is a modern town located south-western Estonia, where the banks of the lower reach of the Pärnu River and the estuary of the Reiu River have played important roles for the hunter-gatherer people of Estonia (e.g. the oldest settlement Pulli). This area has been the focus of archaeological research since the 19th century, being connected to the Pärnu Society of Antiquities (Alterturmforschende Gesellschaft zu Pernau; Kriiska 2006, 56–68). Several representatives of the Baltic German intelligentsia collected archaeological artefacts from a range of approximately 10 km of the lower reaches of the Pärnu River (Kriiska & Roio 2011, 58). The first Stone Age artefacts were found in 1904 and 1905, when Eduard Glück (1866–1905) collected various bone and antler items from the gravel mined from the bottom of the Pärnu River (Kriiska 2006, 57). Among these, human bones (23 fragments) were found (Glück 1906, 275). These finds were probably washed out from cultural layers of various settlement sites (Kriiska & Roio 2011, 58). Jaanits has suggested that some of these bones might have belonged to the Stone Age, more specifically that they were fragments of once-intact inhumations (Jaanits 1957a, 98).

Sources and source criticism

There is no precise contextual information available about these finds. Unfortunately, the bones themselves are not preserved in the repository of Pärnu Museum (E-mail correspondence with Samorokov 23.11.2011), where the collections of the Pärnu Society of Antiquities are otherwise stored. As the information about the loose human bones from the lower reaches of the Pärnu River and the mouth of the Reiu River are indirect, and the bones themselves are also not preserved, this material will only provide a wider background.

4.1.2.8. TOOMA

Archaeological background

The Tooma settlement and burial site is located in central Estonia at Tammemäe hillock in Endla marsh in Tooma village, where the rivers Nava and Põltsamaa join (Figure 14). Tammemäe hillock is c. 84 m long and 45 m wide with an altitude of 77 m a.s.l., rising only c. 1.4. m above the surrounding marsh landscape.

Figure 14. The location of Tooma (Tammemäe küngas) settlement and burial site.
(Map: Maa-amet)

The Stone Age habitation of Tooma was determined during the field survey in 2011 (Tõrv & Ots 2012; Vindi 2015). Only four test-pits were dug in the hillock; three of these contained finds. The layer of dark humus-rich soil containing finds reached a depth of 20–50 cm (Vindi 2015). According to the find material (flint flakes and ceramics: TÜ 1936), the site was inhabited during various prehistoric periods, among these also the Stone Age. One ceramic sherd was determined to belong to the Corded Ware type (TÜ 1936: 7; Vindi 2015). The dimensions of the cultural layer and character of the site are to be determined in the future.

Human remains

From the 4th shovel-width test pit, at the depth of 20 cm, fragments from teeth and crania were found. As soon as the excavators realised that these belonged to a human, digging was stopped (Tõrv & Ots 2012, 270, 276; Vindi 2015). Thus, we do not know whether an entire body or a partial skeleton was placed there. However, the radiocarbon date from the skull fragment (4840±30 BP (KIA-48841); Table 20) demonstrates that the human remains found at Tooma belong to the period under study here.

Sources and source criticism

Only a survey report (Vindi 2015) and finds, together with single fragments of skull are available. This site serves as a background material within the present study as no archaeological excavations have been conducted there. Tooma has the potential to be a burial site to be investigated in future.

4.1.3. Solitary burials and/or cemeteries without associated settlement layer

4.1.3.1. JALUKSE

Archaeological background and human remains

Jalukse is one of the few sites where only burials without a cultural layer of a settlement site have been found. The site itself is located on the oblong gravel drumlin, called Suistemägi or Tiinamägi, at the village of Jalukse in western Estonia. Today only the northern part of the drumlin is preserved; the rest of it has been carried away during the mining activities (Mandel 2014). Differently from Kõljala, Kõnnu, and Metsikumäe, Jalukse was farther from the coast and probably related to some smaller river or stream.

In 1925 eleven skeletons – both entire and partly preserved – were found during gravel mining (Jaanits et al. 1982, 100). As no archaeological surveys/excavations have been carried out on the site, the following information is based on the statements written down two years after the discovery of the graves by local peasant Johannes Õunapuu. According to Õunapuu the graves emerged at the depth of 60 cm from the topsoil. A minimum of four intact burials were found, which were placed in the graves on their backs (Est. *kummuli*) with heads oriented southwards (Veitmann 1927, 4–5). Additionally, seven skulls were unearthed with their anterior sides facing up (Est. *kummuli*; Indreko 1935a, 207). The latter were extremely poorly preserved, breaking apart after they were lifted (Veitmann 1927, 4–5). Next to one of the skulls, 13 perforated tooth pendants (AI 2695) were discovered (Veitmann 1927, 4–5; Jaanits et al. 1982, 100). According to the determinations by Johannes Lepiksaar, these were of dog (*Canis familiaris*; 2) and bovine (*Bos Taurus*; 1) (Indreko 1935a, 207). The documented finds and the information about skeletons (Veitmann 1927, 4) indicate that in Jalukse a formal burial site, i.e. cemetery, may have existed. This hypothesis, posed at the beginning of 20th century, was confirmed during the field surveys at the beginning of the 1990s led by Mati Mandel (Mandel 1993, 20).

Sources and source criticism

Due to the inadequately conducted excavations and insufficient documentation of the material from Jalukse – neither excavation reports (i.e. detailed written descriptions of the deposits) nor pictorial sources are available, not to mention the absence of all the skeletons – its chronological frames are hard to determine. One may even argue that without absolute dates from the site it should be discarded from the present study. The tooth pendants, the location of the site, the position of the skeletons, and the depth of the graves indicate a hunter-gatherer burial site. Thus, due to the insufficient source material these burials will be treated as contextual information to the case studies presented in the thesis.

4.1.3.2. KÕLJALA

Archaeological background and human remains

Kõljala is a burial site at the southern part of the island of Saaremaa. Burials of three individuals were uncovered at the NE part of the drumlin at the height of c. 12.5 m a.s.l. (Karu 1922, 2; Karu 1924, 110–111; Indreko 1935a, 204). This drumlin formed part of the main island of Saaremaa during the Litorina Stage of the Baltic Sea[22] (Saarse et al. 2009a).

In 1901 and 1903, the skeletons of three individuals were discovered during gravel mining (Hausmann 1904, 78). Even though no archaeological surveys were carried out on site, the skeletons (AI K 35) and artefacts are in a repository. A short description by Hausmann (1904) and a published report of the skeletal analysis (Fürst 1913) are available for further analysis. Nevertheless, the existing data does not reveal further details about the nature of the site and burials. Hausman, who assembled the information from the locals, writes: *"Die Knochen des Skeletts sammelten die Arbeter und vergruben wieder, der Schädel sei nicht heil gewesen. Die Ringe und Tierzähne hoben sie auf"* (1904, 78) and *"Der offenbar intelligente Bauer hat gut beobachtet, und die spätere Untersuchungen ist mit seiner Unterstützung erfolgt"* (1904, 80). The vast majority of research interest has been concentrated on the slate rings that were found together with one burial.

Thus, in the literature the site is referred to as a formal burial area, as the possible occupation layer was not observed. Moreover, it has been proposed that these three skeletons represent only a minor part of the former cemetery, because, according to the locals, more skeletal remains had been found there during gravel mining (Indreko 1935a, 205). Nevertheless, taking the wider context of cemeteries into account, and especially the research history of the

[22] According to this, the site must have been underwater during the Litorina Sea period as the beach formations of the Litorina Sea are located between 20.5 to 25.5 m above the present sea level (Saarse et al. 2009a, 59).

Kivisaare, it could be argued that similarly to other burial sites in Estonia there must have been a settlement layer in close proximity to the graves, or the graves must have been dug into the occupation layer. At the beginning of the 20th century, Alice Moora suggested that a dwelling site was at the same spot with the burials, and the deceased placed in these graves had lived there (Moora 1924, 110–111). As no material proof for the settlement layer is available, this hypothesis cannot be verified without further fieldwork and thus Kõljala is here treated as a burial site without settlement layer.

Hausmann dated the site broadly to the period before the birth of Christ (Hausmann 1904, 81). The accompanying slate ring ornaments from one of the graves have allowed the succeeding researchers to date the graves to the second half of the 3rd millennium (Jaanits et al. 1982) or more broadly to the Late Neolithic (Kriiska 2007a). The AMS dates obtained during this study date the Kõljala burials to 4th millennium (*Chapter 5.3.1.1.5.*).

<u>*Sources and source criticism*</u>
No archaeological excavations were conducted in Kõljala, thus all the contextual information about the burials derives from secondary sources. Despite the preserved bones and the description made by Hausmann, these three graves are used as background information in the analysis about mortuary practices. However, they are included in the isotope analysis and in the building of a chronological model of Stone Age mortuary practices.

4.1.3.3. KÜLASEMA METSIKUMÄE

<u>*Archaeological background and human remains*</u>
Külasema Mestikumäe is located one kilometre north of Külasema village on the island Muhu. The burial site, which is a gravel and sand dune 2 to 3 metres higher than the surrounding area, was located directly along the former sea coast.

In 1900 a single grave together with perforated tooth pendants was found during gravel mining (Indreko 1935a, 206). Similarly to the sites of Jalukse and Kõljala, no archaeological excavations were conducted there. Thus, the information about the burial originates from the statements of the local villagers. Aleksander Tiitsmaa described the find 22 years after the discovery during the second Estonian-wide inventory and registration of archaeological sites. He states that the position of the skeleton was not observed nor documented, but the orientation of the remains was noted. The skeleton was E–W oriented with the head toward the E (Tiitsmaa 1922, 22; 1924, 129). The perforated tooth pendants had been lying in front of the chest of the deceased (Tiitsmaa 1992, 22; 1924, 129; Jaanits et al. 1982, 100). Right next to the skeleton a large granite stone was found (Tiitsmaa 1924, 129). Similarly to Jalukse, the lack of sufficient information about the site does not allow us to position the burial chronologically. This is further complicated by the fact that the tooth pendants, which could be dated now, have gone missing (Tiitsmaa 1922, 22; Jaanits et al. 1982, 100), and the skeleton had not been preserved nor stored. Nevertheless, the location of the burial site and the perforated tooth pendants allow suggesting that this is a Stone Age hunter-gatherer burial.

Sources and source criticism
The scarcity of sources allows referring to Külasema Mestikumäe only as background information in a wider discussion about mortuary rituals.

4.1.3.4. VEIBRI
Archaeological background
Veibri is situated in southern Estonia on a flood plain on the northern shore of the Suur Emajõgi River. This relatively low area (32 m a.s.l.) is composed of beige fine-grained sands, i.e. river sediments; the direction of the sands imply that during their deposition the river flew from south-east to north-west, which is opposite to the current flow (Lõhmus et al. 2011, 92–93).

The site was discovered in 1997 and identified as a Corded Ware Culture and Medieval settlement site (Kriiska 1997). In 2003, Kalle Lange from the National Heritage Board found some human bones in the vicinity of the known settlement site (Johanson et al. 2006–2011). Due to these being exposed above the ground in 2006, rescue excavations were carried out by the author, Kristiina Johanson, and Jonuks (Johanson et al. 2006–2011). In 2010, new excavations were conducted as was a ground penetrating survey for detecting more burials (Lõhmus et al. 2011).

Human remains
In 2006 a quadruple grave (L[23] I–L IV) was found and instead of the preliminary assumption of the grave being from Late Neolithic Corded Ware Culture, the burial is dated to Late Mesolithic (Johanson et al. 2006–2011; Kriiska et al. 2007, Tab. 1; Lõhmus et al. 2011, 89). In addition to this burial, remains of another individual were found (L V), and a mass grave of 10 men was unearthed in 2010 (Lõhmus et al. 2011).

The mass grave was dated to the 13th century AD (Lõhmus et al. 2011, 100, Fig. 7). Additionally, the surveys with ground penetrating radar did not give any results about more graves in the area. This, however, may not indicate a lack of graves because of the effects of the upper shadow area of the electromagnetic waves and their resolution of the GPR used (GPR of Radar System Inc., frequency 500MHz) (Lõhmus et al. 2011, 91, 93). In addition to the geological information, plough marks were found and the depression of the mass grave recognised after it was localised with the soil drill (Lõhmus et al. 2011, 92, Fig. 3). Thus, at this stage of the research only the quadruple burial from Veibri is dated to the Late Mesolithic (*Chapter 5.3.1.1.3.*). The individual labelled L V is not considered here as the mass grave from the 13th century AD complicates the whole picture and thus the remains of this individual might also belong to a later prehistoric period.

[23] L stands for *'luustik'*, which is the Estonian equivalent for skeleton.

Sources and source criticism

This is the only Stone Age burial site that has been excavated during the last decade, allowing a more detailed insight to the mortuary deposit and giving a valuable experience to me to understand the previous researchers and analyse all the other deposits in the present study. There are field reports, plans, and digital photographs available for analysis. Differently from all the other sites, here the single bones are provided with three coordinates necessary for archaeothanatological analysis. The skeletons themselves are stored at the repository of the University of Tartu (TÜ 1424). All this allows presenting Veibri as one of the case studies in the present thesis.

4.1.3.5. VÕRU

Archaeological background and human remains

At Võru, a single cranium together with an ice-pick made of an animal bone were found. The site was discovered accidentally in 1973 during the digging of a drainage trench in Karja Street in the town of Võru (Jaanits 1973). The exact location of the find is difficult to ascertain as it is only schematically indicated on the report; however, it is known that the cranium and ice-pick were found from the northern end of the street, i.e. near the Koreli stream (VM admission report no. 35).

Several months after its discovery, Jaanits carried out small-scale excavations at the find place. He made two test trenches that allowed observing the stratigraphy of the site. Two distinct layers were distinguished: (1) a relatively thick peat layer (90–140 cm from the topsoil) and (2) clay-rich sand sediment. The cranium and the ice-pick were found at the depth of c. 150 cm from the topsoil that coincided with the border of these two stratigraphic units. Samples for radiocarbon dating and pollen analysis were gathered from both of the test trenches. As far as I know no further analysis were conducted on these samples.

The site has been interpreted as a drowning place of an adult individual since the geological background indicates that the find was initially deposited in a water body (Jaanits 1973, 3; Jaanits et al. 1982, 53). This hypothesis is further validated by the fact that neither the axial skeleton of the deceased nor the traces of cultural layer were found. Jaanits believes that the skull belonged to a drowned person whose axial skeleton had been diffused during or after the decomposition of the soft tissue in the water (Jaanits 1973, 3).

Sources and source criticism

There are not enough sources to conduct further archaeothanatological and/or isotopic analysis of the finds from Võru. Only the intake report and the excavation report by Jaanits (1973) are available. Both the cranium and the ice-pick are absent from the collections. Thus, this find serves only as background information to the present study.

4.1.4. Conclusions

The majority (13) of the sites are located on the mainland of Estonia; four of them are known from the islands of Saaremaa and Muhu in the Baltic Sea (Table 12). Similarly to the quotidian settlements, the sites with human remains from the period of 6500–2600 cal. BC are open air sites located directly along the water. A larger part of them are either on the banks of rivers or lakes, but also lagoon shores and the direct vicinity of the sea coasts were inhabited. However, the find material and the discovered structures vary, indicating tentatively that the characteristics of these sites might have been different. As shown above, most of the human remains – either intact inhumations or loose human bones – derive from settlement layers; only five sites may be treated either as separate formal burial places (Jalukse?) or solitary graves (Kõljala?, Külasema Metsikumäe, Veibri, and Võru).

Table 12. Summarising the main characteristics of the hunter-gatherer sites with human remains from Estonia.

No.	*Site name*	*Type of site*	*Site location*	*Archaeological period*	*Archaeological culture(s)*	*Excavated area (m^2)*[24]	*Year of excavation*	*Archaeologist(s)*
1.	Akali	Settlement, LHB	Inland, river	Late Mesolithic to Bronze Age	Narva, TCW, LCW, Corded Ware	542	1938–1939, 1949–1952, 1966	Indreko, L. Jaanits
2.	Jalukse	Burials	Inland, sea coast	Late Mesolithic/ Early Neolithic	Narva(?)	?	1925	-
3.	Kivisaare	Settlement, burials, LHB	Inland, river, lake	Late Mesolithic to Bronze Age	Narva, TCW, LCW, Corded Ware	?	1882, 1903, 1908–1910, 1913, 1920–1921, 1931, 1962, 1964–1965, 2002–2004	Bolz, Ebert, Ottow, Tallgren, Indreko, L. Jaanits, Kriiska & Johanson, Kriiska & Lõhmus
4.	Kudruküla	Settlement, LHB	Inland, lagoon	Early Neolithic	TCW, LCW	c. 200	1980–1981, 2010–2011	K. Jaanits, E. Efendijev
5.	Kunda Lammasmägi	Settlement, LHB	Inland, lake, river	Early Mesolithic to Late Neolithic	Kunda, Narva, TCW, LCW, Corded Ware	c. 1500	1933–1937, 1949, 1961, 1981, 1992, 2013–2014	Indreko, L. Jaanits, K. Jaanits & T. Moora, K. Jaanits & Åkerlund, Kriiska & Sander
6.	Kõljala	Burials	Island, sea coast	Early Neolithic	TCW, LCW	?	1901	Hausmann

[24] It would be more informative if I would give the information how large percentage of the site has been excavated. Unfortunately there is relatively little information available about the size and structure of the settlement sites (see also Kriiska 2002b, 238). This has not changed since 2002.

No.	Site name	Type of site	Site location	Archaeo-logical period	Archaeo-logical culture(s)	Exca-vated area (m^2)[24]	Year of excavation	Archaeologist(s)
7.	Kõnnu	Settlement, burials, LHB	Island, sea coast	Late Mesolithic/ Early Neolithic	Kunda/Nar va	c. 7000	1977–1978, 1979–1986	V. Lõugas, L. Jaanits
8.	Kääpa	Settlement, LHB	Inland, river		Narva	795	1959–1962, 1974	L. Jaanits
9.	Külasema Metsiku-mäe	Burials	Island, sea coast	Early Neolithic	?	?	1900	-
10.	Naakamäe	Settlement, burial	Island, sea coast	Early/Late Neolithic	TCW, LCW, Corded Ware	430	1958–1959, 1961–1962,	L. Jaanits
11.	Narva Joaorg	Settlement, LHB	Inland, river	Late Mesolithic	Kunda, Narva	448	1954, 1957, 1960, 1962–1964	L. Jaanits
12.	Pikasilla	Settlement, LHB	Inland, river	Mesolithic/ Early Neo-lithic	Kunda, TCW	10	2009	Veldi
13.	Sindi-Lodja	LHB	Inland, river	Mesolithic/ Neolithic	?	?	1904–1905	Glück
14.	Tamula I	Settlement, burials, LHB	Inland, lake, river	Early/Late Neolithic	LCW, CWC	657	1942–1943, 1946, 1955–1956, 1961, 1968, 1988–1989	Indreko, Moora, L. Jaanits
15.	Tooma	Settlement, burial	Inland, lake	Early/Late Neolithic	CW	4 test pits	2011	Vindi
16.	Valma	Settlement, burials	Inland, lake	Early Neo-lithic	TCW, LCW, CWC	992	1949–1950, 1953–1955	L. Jaanits
17.	Veibri	Burials	Inland, river	Late Meso-lithic/Early Neolithic	Narva(?)	9	2006	Johanson, Jonuks & Tõrv
18.	Võru	LHB	Inland, river(?)	Late Meso-lithic/Early Neolithic(?)	Kunda(?)	?	1973	L. Jaanits

The general analysis of sites with either intact inhumations or loose human bones revealed that not all the sites can be included in the present study equally due to the varying quality of the source material provided about the discovery and excavations of the burials. Jalukse, Kudruküla, Kunda Lammasmägi, Kõljala, Kääpa, Külasema Metsikumäe, Sindi-Lodja, Tooma and Võru do not contribute to the archaeothanatological analysis and therefore do not contribute to the discussion about single practices. However, these are not entirely excluded from the analysis and discussion because their characteristics provide insights to the questions about the mortuary locales and general patterns of hunter-gatherer mortuary repertoire. Graves from other sites allow a more detailed discussion about single practices; however, as shown subsequently (also in *Chapter 6*), there are several obstacles to be considered there, too.

4.2. Skeletal material: inhumations and loose human bones

As indicated above, not all the sites with human remains provide high-quality sources for discussing single practices. Moreover, even in the cases where we can conduct archaeothanatological analysis, questions related to the field techniques (Figure 15), documentation, and subsequent storing arise. As discussed in *Chapter 3.1.5* the success of the description about the presence or absence of articulations and the representation of bones is highly dependent on the available sources.

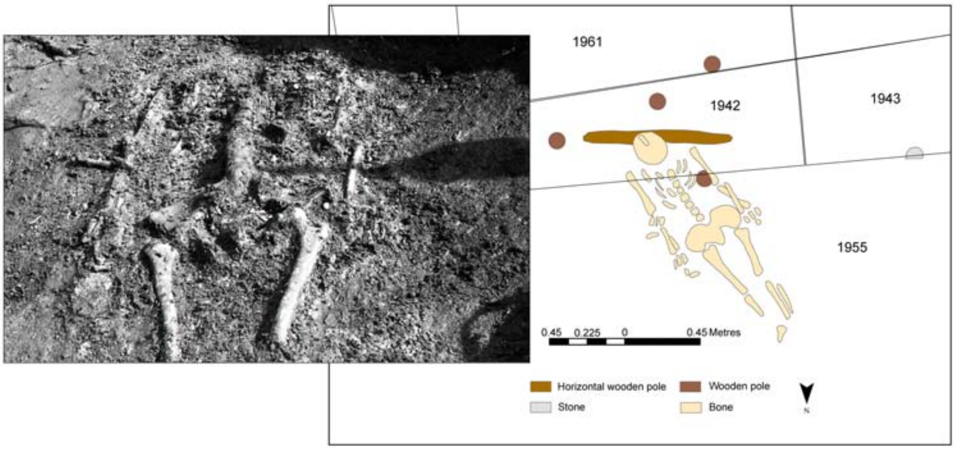

Figure 15. Tamula VIII burial.
A good example of how the excavation techniques together with the knowledge about the exact borders of previous excavation plots might influence our analysis and subsequent interpretations. The field situation here, where different excavation plots have intersected and thus might have caused movements of bone and grave goods, make interpretations of the initial practices based on the position of the bones at the level of head and thoracic area unreliable.
(Photo: TLU AI, 4-1-29-3 and f12)

The results of the critical evaluation of the sources about every single burial are presented in Table 13. It becomes clear that the majority of the sources do not meet the requirements for archaeothanatological analysis, lacking written descriptions, and/or visual representations or bones themselves; only in single cases three coordinates about single skeletal elements or parts of bodies are available. The analysis reveals that photographs are the most valuable for establishing the side of appearance of the bones; drawings can only contribute if articular surfaces are clearly indicated. As this has not been the case here, drawings alone do not fulfil the requirements for archaeothanatological analysis. However, the general body position and the presence or absence of articulations usually can be followed from the field drawings, too. Just as a remark for field archaeologists, the analysis of the sources suggests that the effort put on drawing the skeletons without any references to the articular surfaces (good examples: Duday 2009[2006]; Nilsson Stutz et al. 2013, 1020, Fig. 3) is a waste of time. Instead, a good sketch together with thorough written description (see e.g. Courtaud 1996; Duday 2009[2006]; Knüsel 2014) and photographs should be made.

Table 13. The representativeness of the sources for osteological and archaeothanatological analysis.
1 – source present, number in the brackets indicates the number of available photographs in archive; 0 – source not present.
Strikethrough – not included to the analysis of hunter-gatherer mortuary practices due to later dates.

Burial no./ Context (original label)	***Archaeologist***	***Year of excavation***	***No. of collection***	***Report description***	***Excavation diary***	***Drawing(s)***	***Photograph(s) (no. of photos)***	***Skeleton***	***Z-value(s) (cm)***	***Outline of grave fill***	***Grave goods***	***Orientation of head***	***Metadata about excavations***	***Publication***	***Representativeness of the sources***
Akali I	L. Jaanits	1950	AI 4013: 3412	1	0	1	0	1	0	0	0	0	1	Jaanits 1953	moderate
Akali II	L. Jaanits	1950	AI 4013: 6975	1	0	0	0	0	1	0	0	0	1	Jaanits 1953	poor
Akali III	L. Jaanits	1952	AI 4013: 8345, 8355, 8368, 8339	1	0	1	0	1	0	0	0	0	1	Jaanits 1953	moderate
Jalukse (1–11)	0	1925	0	0	0	0	0	0	0	0	1	0	0	Indreko 1935a; Jaanits et al. 1982; Veitmann 1927	poor
Kivisaare I	0	1882	0	0	0	0	0	0	0	0	0	0	0	Bolz 1914	poor
Kivisaare II	0	1882	0	0	0	0	0	0	0	0	0	0	0	Bolz 1914	poor
Kivisaare III	0	1882	0	0	0	0	0	0	0	0	0	0	0	Bolz 1914	poor
Kivisaare IV	0	1882	0	0	0	0	0	0	0	0	0	0	0	Bolz 1914	poor
Kivisaare V	0	1882	0	0	0	0	0	0	0	0	0	0	0	Bolz 1914	poor
Kivisaare VI	Bolz	1903	0	0	0	0	0	0	0	0	0	0	0	Bolz 1914	poor
Kivisaare VII *(I; Grab 1)*	Bolz/Pekk	1908	0	0	0	0	0	0	0	1	1	0	1	Ebert 1913; Bolz 1914	poor
Kivisaare VIIIa/b *(II; Grab 2, 3)*	Bolz	1909	0	0	0	0	0	0	1	0	1	0	1	Ebert 1913; Bolz 1914	poor
Kivisaare IXa/b *(III; Grab 4)*	Bolz	1909	0	0	0	0	0	0	1	1	1	a: NW; b: SSE	1	Ebert 1913; Bolz 1914	poor
Kivisaare Xa/b *(Kivisaare I, Ia)*	Ottow	1910	0	0	0	1	0	0	1	1	0	SSW	1	Ottow 1911	poor
Kivisaare XIa/b *(Kivisaare II, IIa)*	Ottow	1910	0	0	0	0	0	0	0	1	0	a: S	1	Ottow 1911	poor
Kivisaare XIIa/b *(Kivisaare III, IIIa)*	Ottow	1910	0	0	0	0	0	0	0	1	0	0	1	Ottow 1911	poor
Kivisaare XIII *(XII; Grab 5)*	Pekk	1910	0	0	0	1	0	0	1	1	1	NW	1	Ebert, 1913, 506; Bolz 1914, 23–25, 28	poor
Kivisaare XIV *(XV)*	Ebert	1913	0	0	0	0	0	0	1	1	0	N	1	Bolz 1914, 26–27	poor
Kivisaare XV	Tallgren	1920/21	AI 2435	1	0	1	0	0	1	0	1	NWW	1	0	moderate
Kivisaare XVIa/b	Indreko	1931	AI 2758	1	0	1	0	1	0	0	0	0	1	0	moderate
Kivisaare XVIIa/b	Indreko	1931	AI 2764	1	0	1	0	1	1	0	1	0	1	0	moderate
~~Kivisaare XVIII~~	~~L. Jaanits~~	~~1962~~	~~AI 4379~~	~~1~~	~~1~~	~~1~~	~~1 (2)~~	~~1~~	~~1~~	~~0~~	~~0~~	~~NNW~~	~~1~~	~~0~~	~~good~~
~~Kivisaare XIX~~	~~L. Jaanits~~	~~1962~~	~~AI 4379~~	~~1~~	~~1~~	~~1~~	~~1 (2)~~	~~1~~	~~1~~	~~0~~	~~0~~	~~NNW~~	~~1~~	~~0~~	~~good~~
Kivisaare XXa/b *(luustik 3)*	L. Jaanits	1964/65	AI 4379	1	1	1	1 (6)	1	1	1	1	SSW	1	0	good
Kivisaare XXI *(luustik 4)*	L. Jaanits	1965	AI 4379	1	1	1	1 (3)	1	1	1	0	SSW	1	0	good
Kivisaare XXII *(y_1–b/12–13)*	L. Jaanits	1965	AI 4379	1	1	0	0	1	0	0	0	0	1	0	poor

Burial no./ Context (original label)	***Archaeologist***	***Year of excavation***	***No. of collection***	***Report description***	***Excavation diary***	***Drawing(s)***	***Photograph(s) (no. of photos)***	***Skeleton***	***Z-value(s) (cm)***	***Outline of grave fill***	***Grave goods***	***Orientation of head***	***Metadata about excavations***	***Publication***	***Representativeness of the sources***
Kivisaare XXIII *(y_I–h/12–17)*	L. Jaanits	1965	AI 4379	1	1	0	0	1	0	0	0	0	1	0	poor
Kivisaare XXIVa/b *(f–k/6–11)*	L. Jaanits	1965	AI 4379	1	1	0	0	1	0	0	0	0	1	0	poor
Kivisaare XXVa/b *(ä–ö/42–44)*	L. Jaanits	1965	AI 4379	1	1	0	0	1	0	0	0	0	1	0	poor
Kivisaare XXVIa/b *(f–h/18–20)*	L. Jaanits	1965	AI 4379	1	1	0	0	1	0	0	0	0	1	0	poor
Kivisaare XXVII *(Close to burial 3 (1965))*	L. Jaanits	1965	AI 4379	1	1	0	0	1	0	0	0	0	1	0	poor
Kivisaare XXVIII *(y_I–a/16–17 (black soil depression))*	L. Jaanits	1965	AI 4379	1	1	0	0	1	0	1	0	0	1	0	poor
Kivisaare XXIX a–c *(luustik 1)*	Kriiska, Lõhmus	2003-2004	TÜ 1113	1	0	1	1 (11)	1	1	1	0	0	1	Kriiska et al. 2004; Kriiska & Lõhmus 2004	good
Kivisaare XXX *(loose soil in 1931)*	Indreko	1931	AI 2758	1	0	0	0	1	0	0	0	0	1	0	poor
Kudruküla I	K. Jaanits, Efendijev	1980/81	NLM 1304: 65, 77, ?	0	0	0	0	1	0	0	0	0	0	Jaanits, K. 1981; Efendijev 1983	poor
Kudruküla II	K. Jaanits, Efendijev	1980/81	NLM 1304: 198, ?	0	0	0	0	1	0	0	0	0	0	Jaanits, K. 1981; Efendijev 1983	poor
Kunda Lammasmägi	Indreko	1933-1937	AI 3262/ 3308	1	0	0	0	0	0	0	0	0	1	Indreko 1948	poor
Kunda Lammasmägi	L. Jaanits	1949	AI 4011	1	0	0	0	1	0	0	0	0	0	0	poor
Kõljala I	Hausmann	1901	AI K35	0	0	0	0	1	1	1	1	SE	0	Hausmann 1904	poor
Kõljala II	Hausmann	1901	AI K35	0	0	0	0	1	0	0	0	0	0	Hausmann 1904	poor
Kõljala III	Hausmann	1901	AI K35	0	0	0	0	1	0	0	0	0	0	Hausmann 1904	poor
Kõnnu I	L. Jaanits	1977	AI 4951	0	1	1	0	1	1	0	1	NE	1	Jaanits 1979	moderate
Kõnnu II	L. Jaanits	1977	AI 4951	0	1	1	0	1	1	1	1	SSW	1	Jaanits 1979	moderate
Kõnnu IIa	L. Jaanits	1977	AI 4951	0	1	0	0	1	0	1	0	0	1	Jaanits 1979	poor
Kõnnu III	L. Jaanits	1977	AI 4951	0	1	1	0	1	0	0	1	NW	1	Jaanits 1979	moderate
Kõnnu pit no. 102	L. Jaanits	1977	AI 4951	0	1	1	0	1	0	1	0	0	1	Jaanits 1979	moderate
Kõnnu pit no. 111	L. Jaanits	1977	AI 4951	0	1	1	0	1	0	1	0	0	1	Jaanits 1979	moderate
Kõnnu pit no. 122	L. Jaanits	1977	AI 4951	0	1	1	0	1	0	1	0	0	1	Jaanits 1979	moderate
Kõnnu pit no. 127	L. Jaanits	1977	AI 4951	0	1	1	0	1	0	1	0	0	1	Jaanits 1979	moderate
Kõnnu pit no. 131	L. Jaanits	1977	AI 4951	0	1	1	0	1	0	1	0	0	1	Jaanits 1979	moderate
Kõnnu pit no. 135	L. Jaanits	1977	AI 4951	0	1	1	0	1	0	1	0	0	1	Jaanits 1979	moderate
Kõnnu pit no. 138	L. Jaanits	1977	AI 4951	0	1	1	0	1	0	1	0	0	1	Jaanits 1979	moderate
Kõnnu year 1979a/b	L. Jaanits	1979	AI 4951	0	0	0	0	1	0	0	0	0	0	0	poor
Kõnnu year 1981	L. Jaanits	1981	AI 4951	0	0	0	0	1	0	0	0	0	0	0	poor
Kõnnu year 1984a/b	L. Jaanits	1984	AI 4951	0	0	0	0	1	0	0	0	0	0	0	poor
Kõnnu without context	L. Jaanits	0	AI 4951	0	0	0	0	1	0	0	0	0	0	0	poor
Kääpa (AI 4245)	L. Jaanits	1959–1962	AI 4245	0	0	0	0	1	0	0	0	0	0	0	poor
Kääpa (VM 3000:756)	L. Jaanits	1974	VM 3000: 765	0	0	0	0	0	0	0	0	0	0	0	poor
Külasema Mestikumäe	0	1900	0	0	0	0	0	0	0	0	1	W	0	Tiitsmaa 1922; 1924; Indreko 1935a; Jaanits et al. 1982	poor

Burial no./ Context (original label)	Archaeologist	Year of excavation	No. of collection	Report description	Excavation diary	Drawing(s)	Photograph(s) (no. of photos)	Skeleton	Z-value(s) (cm)	Outline of grave fill	Grave goods	Orientation of head	Metadata about excavations	Publication	Representativeness of the sources
Naakamäe	L. Jaanits	1962	AI 4211	0	0	1	1 (6)	1	1	1	1	SW	1	Jaanits 1965c	good
Narva Joaorg I/Ia	L. Jaanits	1962	AI 4264	1	1	1	1 (21)	1	1	1	0	0	1	0	good
Narva Joaorg II	L. Jaanits	1962	AI 4264	1	1	0	0	1	1	0	0	0	1	0	moderate
Narva Joaorg III	L. Jaanits	1963	AI 4264	1	1	1	1 (2)	0	1	1	1	SW	1	Jaanits et al. 1982	good
Narva Joaorg IV	L. Jaanits	1963/ 64	AI 4264	1	1	0	0	1	1	0	1	0	1	0	moderate
Pikasilla I/II	Veldi & Valk	2009	TÜ 1772	1	0	0	0	1	1	0	0	0	1	Veldi & Valk 2010	moderate
Sindi-Lodja	Glück	1906	0	0	0	0	0	0	0	0	0	0	0	Glück 1906	poor
Tamula I	Indreko	1942	AI 3932	1	0	1	1 (3)	1	1	0	1	NE	1	Indreko 1945	good
Tamula II	Indreko	1942	AI 3932	1	0	1	1 (1)	0	1	0	1	NE	1	Indreko 1945	moderate
Tamula III	Indreko	1942	AI 3932	1	0	1	1 (1)	1	1	0	1	NE	1	Indreko 1945	good
Tamula IV	Moora	1946	AI 3960	1	0	0	0	1	1	0	1	0	1	0	poor
Tamula V	Moora	1946	AI 3960	1	0	0	0	1	1	0	1	0	1	0	poor
Tamula VI	Moora	1946	AI 3960	1	0	1	0	1	1	0	1	SSE	1	0	moderate
Tamula VII	Moora	1946	AI 3960	1	0	1	0	1	1	0	1	N	1	Jaanits et al. 1982	good
Tamula VIII	L. Jaanits	1955	AI 4118	0	1	1	1(1)	1	1	0	1	SE	1	Jaanits 1957a	moderate
Tamula IX	L. Jaanits	1955	AI 4118	0	1	1	1 (5)	1	1	0	1	SSE	1	Jaanits 1957a	good
Tamula X	L. Jaanits	1955	AI 4118	0	1	1	0	1	1	0	1	SSE	1	Jaanits 1957a	moderate
Tamula XI	L. Jaanits	1955	AI 4118	0	1	1	0	1	1	0	1	SSE	1	Jaanits 1957a	moderate
Tamula XII	L. Jaanits	1955	AI 4118	0	1	1	0	1	1	0	1	SSE	1	Jaanits 1957a	moderate
Tamula XIII	L. Jaanits	1955	AI 4118	0	1	1	0	1	1	0	1	SE	1	Jaanits 1957a	poor
Tamula XIIIa	L. Jaanits	1955	AI 4118	0	0	0	0	1	0	0	0	0	0	0	poor
Tamula XIV	L. Jaanits	1955	AI 4118	0	1	1	1 (4)	1	1	0	1	S	1	Jaanits 1957a	good
Tamula XV	L. Jaanits	1955	AI 4118	0	1	1	1 (1)	1	1	0	1	SSE	1	Jaanits 1957a	good
Tamula XVI	L. Jaanits	1955	AI 4118	0	1	1	0	0	1	0	0	0	1	Jaanits 1957a	poor
Tamula XVII	L. Jaanits	1956	AI 4118	0	1	1	0	1	1	0	1	SSE	1	Jaanits 1957a	moderate
Tamula XVIII	L. Jaanits	1956	AI 4118	0	1	1	0	1	1	0	0	SSE	1	Jaanits 1957a	moderate
Tamula XIX	L. Jaanits	1956	AI 4118	0	1	1	0	1	1	0	1	SW	1	Jaanits 1957a	moderate
Tamula XIXa	L. Jaanits	1956	AI 4118	0	0	0	0	1	0	0	0	0	0	0	poor
TamulaXX	L. Jaanits	1956	AI 4118	0	1	1	0	1	1	0	0	NW	1	Jaanits 1957a	moderate
Tamula XXI	L. Jaanits	1956	AI 4118	0	1	1	0	1	1	0	0	NNW	1	Jaanits 1957a	moderate
Tamula XXIa	L. Jaanits	1956	AI 4118	0	0	0	0	1	0	0	0	0	0	0	poor
Tamula XXII	L. Jaanits	1961	AI 4118	0	1	1	1 (10)	1	1	0	0	NNW	1	Jaanits et al. 1982	good
Tamula XXIII	L. Jaanits	1961	AI 4118	0	1	1	0	1	0	0	0	E	0	0	poor
Tamula XXIV	L. Jaanits	1961	AI 4118	0	1	1	0	1	0	0	1	S	0	0	poor
Tamula XXIVa	L. Jaanits	1961	AI 4118	0	0	0	0	1	0	0	0	0	0	0	poor
Tamula XXV	L. Jaanits	1961	AI 4118	0	0	1	0	1	0	0	0	0	0	0	poor
Tamula (year 1956)	L. Jaanits	1956	AI 4118	0	0	0	0	0	0	0	0	0	0	0	poor
Tamula (year 1961)	L. Jaanits	1961	AI 4118	0	0	0	0	0	0	0	0	0	0	0	poor
Tamula (year 2007a)	Ots	2007	AI 6861	1	0	0	0	1	0	0	0	0	0	0	poor
Tamula (year 2007b)	Ots	2007	AI 6862	1	0	0	0	1	0	0	0	0	0	0	poor
Tooma	Vindi	2011	TÜ 1936	1	0	0	0	1	0	0	0	0	1	0	poor
Valma I	L. Jaanits	1954	AI 4022	1	0	0	0	1	1	0	1	0	1	Jaanits 1955a; 1959c	moderate
Valma II	L. Jaanits	1954	AI 4022	1	0	1	0	1	1	0	1	SEE	1	Jaanits 1955a; 1959c	good
Valma III	L. Jaanits	1954	AI 4022	1	0	1	1 (5)	1	1	1	1	NW	1	Jaanits 1955a; 1959c	good
Veibri I/I	Johanson, Jonuks & Tõrv	2006	TÜ 1424	1	1	1	1 (∞)	1	1	0	0	SE	1	Kriiska et al. 2007; Allmäe 2011	good
Veibri I/II	Johanson, Jonuks & Tõrv	2006	TÜ 1424	1	1	1	1 (∞)	1	1	0	0	NW	1	Kriiska et al. 2007; Allmäe 2011	good
Veibri I/III	Johanson, Jonuks & Tõrv	2006	TÜ 1424	1	1	1	1 (∞)	1	1	0	0	NW	1	Kriiska et al. 2007; Allmäe 2011	good
Veibri I/IV	Johanson, Jonuks & Tõrv	2006	TÜ 1424	1	1	1	1 (∞)	1	1	0	0	SE	1	Kriiska et al. 2007; Allmäe 2011	good
Võru	L. Jaanits	1973	0	1	0	0	0	0	0	0	1	0	1	Jaanits et al. 1982	poor

In general the written descriptions of the burials are rather laconic; however, these should not be neglected while carrying out the analysis. Despite the fact that manuals describing field methods, among those the description of features with human bones, have not been available, the records made by different researchers are unvaried. This could be explained by the prevailing mode of passing on the knowledge during the generation of the first professional archaeologist until the beginning of the1990s in Estonian archaeology. Due to the small number of archaeologists, the fieldwork methods were transmitted from master to apprentice during excavations. Thus, only slight changes in the field methods and documentation were undertaken.

The methodology for excavating and documenting burials was established by Tallgren who was the teacher of the first generation of professional archaeologists in Estonia (Jaanits 1995, 21; Lang 2006, 21). From the here-observed burials, Tallgren himself excavated a fairly well preserved child grave at Kivisaare (XV; Figure 16) describing it as follows: "*/.../ and then a relatively well preserved corpse, the same that skull was found previously. The deceased laid on sterile sediment oriented WNW–ESE, with its head toward WNW. It lay on its back, lower limbs extended, heels together. As grave goods flint flakes (next to the right wrist) (1), right knee and shoulder (2), 10 cm lateral to the right leg (3), beneath the thorax (5) and between the knees (6)), and a fragment of bone arrowhead and another bone artefact together with unworked animal bone – all from next to the right patella. The height of the deceased was:* [not marked]. *Right tibia was 32 cm, right femur 37 cm, right humerus 29 cm"* (Tallgren 1921, 2–3).

Figure 16. An excerpt from the field report of Tallgren (1921) about the excavations of Kivisaare XV burial.
This illustrates the sketchy nature of his hand drawing. The numbers indicate grave goods listed in the field report. (Drawing reproduced after Tallgren 1921)

Moora and Indreko followed Tallgren's lead and this pattern was also adapted by Jaanits. His main teacher was Moora; however, he also gained field experience from Indreko while excavated the settlement site at Tamula in 1943. Jaanits accomplished his most thorough description of a burial during the excavations at Tamula in 1946 led by Moora. There he excavated and described burial VII (Moora 1946; Jaanits 1948), although still focusing mostly on the spatial distribution of the grave goods about the skeleton. Usually the documentation included the general position of skeleton (supine extended or flexed/ crouched on either of the lateral sides), its whole length or lengths of single bones, the orientation of the head regarding the cardinal points, the width of the shoulders and pelvis, and the height of the cranium/pelvis relative to the level of the topsoil or reference point. When something unusual or exceptional occurred, e.g., the position of the hands placed beneath the pelvis, it was marked in the documentation, too. As stated above the most effort was put on the documentation of grave goods in relation to the skeleton. To illustrate the case in point here is an average description of the graves at Tamula (XI) conducted by Jaanits: *"Skeleton XI was on its back in an extended position. The length of the skeleton 171 cm, [width] of pelvis 31,* [width] *of shoulders 33 cm; depth (shoulders) 33 cm. /.../ Beneath the skeletons nos. IX–XI two layers of wooden branches – one crosswise and the other one along [the long axis of the grave] – was placed. /.../ The right upper limb was around the child* [XII]*, left beneath the pelvis. Grave goods XI and XII:* [AI 4118]: *841–847*" (Jaanits 1961b).

The descriptions by Baltic German scholars from the beginning of the 20th century vary, being sometimes so precise that their documentation is helpful when applying archaeothanatological principles. For example, the description of Kivisaare X/Xa (*Skelett I*) burial given by Ottow (1911, 154) is exceptional as he uses anatomical nomenclature to describe the position of the skeleton in the feature: *"/.../ Der zertrümmerte, mit seinen ungerührten Bruchstücken, jedoch die Form noch wahrende Schädel lag mit der Occipitalschuppe dem Boden auf, so dass das Gebiet der Stirn und der abgesprengten arcus superciliares den höchsten nach gerichteten Teil desselben ausmachten.*" Although the description does not follow the archaeothanatological canon, it allows establishing the severe fragmentation and exact position of the cranium (exhibiting its anterior side of appearance (facial bones)) in the deposit. This kind of comprehensive example can also be found in the descriptions of Bolz (e.g. Kivisaare XIII; Bolz 1914). Hausmann (1904) and Ebert (1913), on the other hand, were more superficial while describing the skeletons; instead they focused on the artefacts as was also typical of the professional archaeologists. The variances in their approaches could be explained by their varying professional backgrounds.

For these reasons the representativeness of the burials covered only by drawings and/or written descriptions is moderate to poor and does not allow a full application of archaeothanatology. These graves enable general observations about the position of the skeleton (usually no single elements) and sometimes also the spatial relation of articulations. At the same time, together with the archaeological information about the grave pit and heights of various parts of skeletons, these burials still allow new interpretations. Thus, burials with ‘moderate’ and ‘poor’ representativeness will not be neglected from the analysis entirely; instead, some of these are presented in more detail, while form a general background to the case studies presented in depth. Solely 21 graves were graded as having ‘good’ representativeness, yet of these, two (Kivisaare XVIII and XIX) are excluded because they are dated to the Early Bronze Age. Thus, inhumation graves analysed in depth and presented as case studies under various aspects of the mortuary practices are Kivisaare XIII, XX, XXI, Naakamäe, Tamula I, III, VII, VIII, IX, XIV, XV, XXII, Valma II and III, and the Veibri quadruple grave. Conflicts and constraints of the source material will be further elucidated case by case in *Chapter 6*.

The question of the representativity of the loose human bones is striking in the present research. Do we have all the human bone fragments documented or does the available picture only present the tip of the iceberg? The following example illustrates the case neatly. In 1931 Indreko used 1.4 hours to excavate 1 m^2 in Kivisaare and collected 200 finds from an area of c. 1931 m^2. During the excavations in 2002, led by Kriiska and Johanson, an area of 61 m^2 was opened, 40 hours were employed to excavate one m^2, and altogether 2712 finds were gathered (Johanson et al. 2013, 102). Despite the decades dividing these two excavations the methods and techniques used did not differ much. In both cases small spades were used for excavating and a grid system was employed for documenting. The most striking difference was the utilisation of a sieve during the excavations of 2002. This allowed the archaeologists to collect even very small fragments of loose human bones. Mays et al. (2012) have shown how significant the difference is between the unsieved and sieved soil. As sieving has not commonly been used during the excavation of Stone Age settlement sites during the Soviet Era, it could also explain the lack of loose human bones from the cultural layers of sites researched during that period. At the same time it is notable how many small bones were still recognised. A study by Mays et al. suggests further that even if sieving increases the number of small bone fragments, the amount of morphologically identifiable bones does not increase significantly (Mays et al. 2012, 3252). Although not all the features with loose human bones were graded as ‘moderate’ or ‘good’, the majority of them are included in the analysis and discussion to clarify whether these bones are part of the mortuary repertoire of hunter-gatherers at all.

4.3. Conclusions

In this chapter, all the sites under study were presented. From the source critical point of view it was stressed that every single site must be viewed separately and the representativeness of its material evaluated case-by-case. It was shown that the quality and quantity of finds depends on a variety of factors including the discovery of the site, the excavation of the site, and the post-excavation treatment of the finds. The old excavation data raises questions and not all the features with human remains could be re-analysed by the application of archaeothanatology. However, these old finds are valuable in answering the posed questions, and the restrictions given by the source material should not be seen as limitations but as a challenge that could be faced with proper discussion about the source criticism of every single site and burial.

4.3.1. Geographical representativeness

The sites under discussion derive from various parts of Estonia. Even though the study area is relatively small, these sites do not cover the entire area of Estonia. There are three practical reasons and one more theoretical reason behind this. First, as seen from the research history of the Estonian Stone Age, the focus has been on the settlement history, technology, and economy (*Chapter 1.1.*). For decades, the discovery of burials has been merely by-products of these studies. Secondly, the majority of the sites have been discovered accidentally. Thus, no systematic surveys to locate new sites with burials have been carried out. The third cause derives from the scale of excavations. In the beginning of 20th century and especially during the Soviet Era the areas that were opened during fieldwork were at times as large as during the independence period in Estonia (since 1991; see Table 12). This means that even if there are burials related to the excavated settlement sites, these are not found with this kind of excavation techniques (or, at least, not when the focus is on other questions).

The theoretical aspect behind the situation is that so far only the intact burials were considered part of hunter-gatherer mortuary practices. Thus, the loose human bones were not recognised or even if they were they were not included in the analysis. This has created a biased understanding about the mortuary practices of hunter-gatherers.

4.3.2. Chronological representativeness

Previous studies have discussed burials from single archaeological cultures separately. This is the first attempt to take a look at the hunter-gatherer mortuary rituals throughout the Mesolithic and Neolithic. In the course of the study, several graves were directly dated and the obtained chronology (*Chapter 5.3.1.*) demonstrates that hunter-gatherer human remains that are related to mortuary rituals are known to us from the period of c. 6500–2600 cal. BC. However, these new dates show the period under discussion is not equally covered with burials. The wide temporal time scale allows a discussion over the change in mortuary rituals.

4.3.3. Single practices representing the general picture

Aside from the old excavation data being representative enough to reconstruct single practices and the chronological and geographical representativeness of the data, a more theoretical questions raised. Do the burials presented here represent the whole population? A simple mathematical exercise indicates that the buried population represents only a small proportion of the people once present. We have either not found all the graves or there were other more common ways of handling deceased bodies that do not preserve in archaeological contexts. This further leads me to discuss the representativeness of these burials in the context of underlying ideas of mortuary practices in general (*Chapter 2* and *Chapter 7*).

CHAPTER 5. FROM SKELETONS TO PEOPLE IN TIME

The question of the people and their identities is not novel in the context of the burials observed in this thesis. Previously two main lines of research may be distinguished. Throughout the 20th century, a part of the research was on the ethnic origin of the studied people (Indreko 1945; Ariste 1956; Jaanits 1956a; 1957a; 1992; Jaanits et al. 1982), wherein the skeletal material contributed to the discussion (Mark 1956). The more recent research, however, has either neglected this topic and concentrated on a more tangible research agenda (e.g. Kriiska 2004) or abandoned it, arguing that the present theoretical approaches toward ethnicity and ethnic identities do not conform to the ethnic affiliation of Stone Age peoples (Lang 2001). The second branch of research concentrated on the distinctiveness of the deceased, which warranted the special burial, departing from the analysis of grave goods and stressing their good hunting skills (Jaanits 1961) or shamanistic abilities (Jaanits 1961; Jonuks 2009). Interpreting the people buried in pit graves as someone extraordinary has remained central until today.

In the present chapter, I intend to move away from the grand narrative about the common ethnic affiliation toward the recognition of single individuals behind the skeletons. Differently from previous research, human remains and their morphological qualities are brought into the focus to give an insight on the primary, i.e. biological identities of these people. Likewise, the preservation of the sample will be discussed to establish the minimum number of individuals and build a more solid foundation for archaeothanatological analysis (*Chapter 6*). In addition to ageing and sexing the skeletons, the background of these people is unfolded in the light of the results of stable carbon and nitrogen isotope analyses. These justify the utilisation of a common denominator of 'hunter-gatherer' about the deceased in the discussed burials. Together with stable isotope data, also the radiocarbon dates from human collagen are discussed to provide a firm time frame for the discussion about temporal changes in dietary preferences and mortuary rituals (see *Chapter 5.4.* and *Chapter 7*).

5.1. From fragments to women, men and children – results of osteological analyses

Without any doubt, human remains provide the most direct evidence of once lived people. Despite the fact that the morphological traits of modern humans have remained alike over the millennia, which suggests that biological anthropologists are in a favourable position compared to archaeologists studying artefacts, the results of osteological analysis are far from being unambiguous (see discussion in *Chapter 3.2.1.*). Instead of being solid facts, these are plausible interpretations of the osteological material restricted by the completeness of the sample and methods applied. Nevertheless, the results of the osteological analysis undertaken here give a general overview of those of the hunter-gatherer population who were treated in ways that leave archaeological evidence. These results serve as background information in the present thesis and deserve a more careful and detailed study of its own.

5.1.1. Description of the osteological sample

Information is available on 83 individuals in graves, of which the remains of 48 were accessible for re-analysis, along with 476 loose human bones (Figure 17; Table 14). Although more than half of the individuals in graves (n=28) come from Tamula, for unknown reasons two skeletons (II and XVI) from Tamula are absent from the collection (information from: Indreko 1945; Jaanits 1957a). It seems plausible that the single tooth (li) of a c. 6-year old (Moorrees et al. 1963b) found from the storage box of the infant skeleton XV belongs to individual XVI. As the skull of the child XVI was heavily fragmented (Jaanits 1955b) it appears possible that it was not brought to the collection. The majority of the human remains from Kivisaare are not preserved; only five of them were available for osteological analysis, three of which are included in the present study; the information about the remaining comes from the literature (Ottow 1911; Ebert 1913; Bolz 1914; Indreko 1931; Tallgren 1921). The skeletal material from Jalukse and Külasema (Metsikumäe) has not reached the collections either. Thus, the information about their presence is based on the literature (Veitmann 1927; Indreko 1935a; Jaanits et al. 1982). The rest of the skeletal material is available and was targeted for osteological analysis.

Loose human bones from occupation layers have rarely been studied osteologically (excl. Kriiska et al. 2004). Thus, in addition of the intact burials, altogether 476 (n=760 if fragmented burials – IV, V, XIII, XV, XXIII, XXIV, and XXV – of Tamula are taken into account) fragments of loose human bones from cultural layers and inhumation burials of 11 sites were recorded during the undertaken osteological analyses. Although, a re-assessment of all loose human bones from Kivisaare 2002 field season (results of previous analysis Kriiska et al. 2004) was undertaken, these will not be included to the thesis, due to the complex research history of the site. Firstly, several researchers conducted their excavations on the same spot at the south-eastern part of the drumlin without being able to determine the limits of previous excavations (Ottow 1911; Bolz 1914; Tallgren 1921; Jaanits 1965a; Kriiska & Johanson 2002). This makes it impossible to reconstruct the initial situation, which restrains the subsequent analysis. Details about loose human bones assemblages are given in *Chapter 6.2.*

In sum, the following analysis is based on the osteological assessment of 48 intact skeletons present in the collections; additionally the 19 skeletons with on-site determinations of age and/or sex available are used as background information, making it possible to discuss the biological identities of 67 individuals from intact graves. Additionally the features with loose human bones are included in the analysis and discussion. The results of the osteological assessments of both intact burials and loose human bones are presented in Table 14.

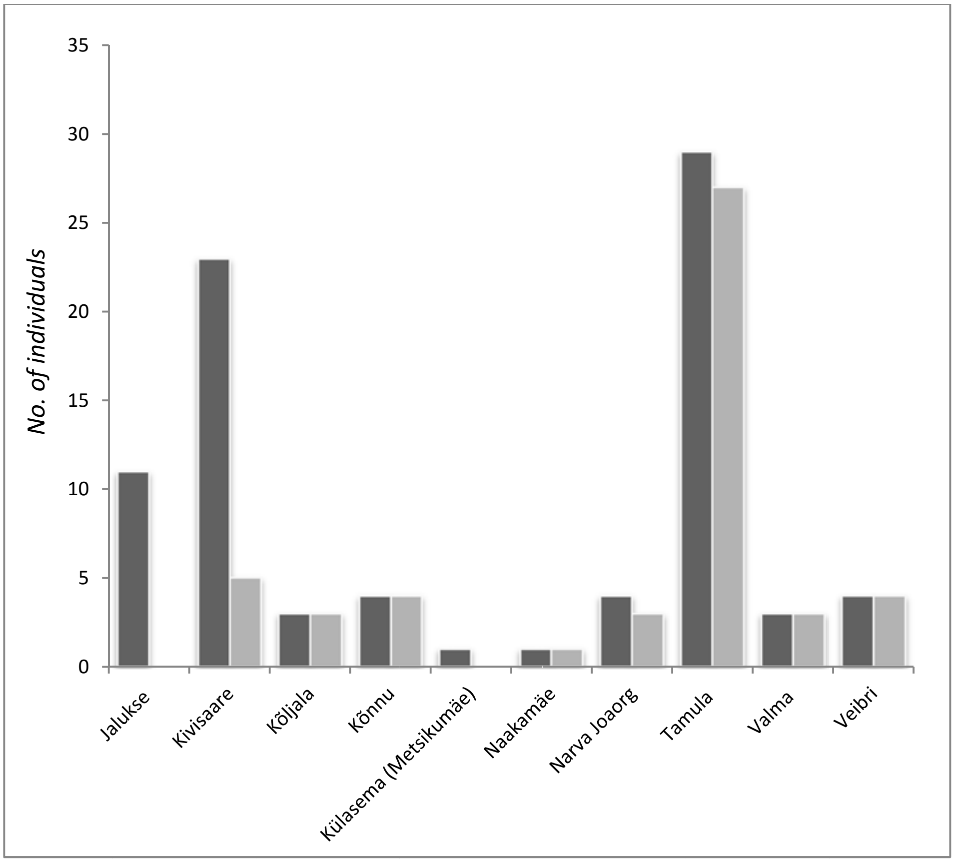

Figure 17. A column chart of the known number of individuals placed in inhumation graves by site (dark grey) compared to the number of individuals available in collections for osteological analysis (light grey).
The light grey bar for Kivisaare represents all the available skeletons in the collection, but only three of them are used in the present study due to the complex research history of the site.

Table 14. Age and sex determinations of the individuals present in osteological collections and those of only known through literature.

Age and sex determinations of all the individuals represented in osteological collections, and archival and published sources.

IS – intact skeleton; LHB – loose human bones; 0 – not present, 1 – present, F(?) – female (probably female), M(?) – male (probably male),UD – undetermined.

No.	***No. of skeleton***	***No. of collection***	***Bones available in collection***	***IS/LHB***	***Completeness (%)***	***Surface preservation***	***Biological sex***	***Biological age category***	***Basis for osteological determinations***
1.	Akali I	AI 4013: 3412	1	LHB	<25	3	UD	Sub-adult?	Age determined based on the size of cranial fragments
2.	Akali II	AI 4013: 6975	0	LHB	<25	3	UD	UD	
3.	Akali III	AI 4013: 8345, 8355, 8368, 8339	1	LHB	<25	3	UD	Adult?	Age determined based on the size of cranial fragments
4.	Jalukse (1–11)	0	0	UD	UD	UD	UD	UD	Information about the skeletons from publications (Indreko 1935a; Jaanits et al. 1982; Veitmann 1927)
5.	Kivisaare I	0	0	UD	UD	UD	UD	UD	Age and sex determination based on the published data (Bolz 1914, 27–28)
6.	Kivisaare II	0	0	UD	UD	UD	UD	UD	Age and sex determination based on the published data (Bolz 1914, 27–28)
7.	Kivisaare III	0	0	UD	UD	UD	UD	UD	Age and sex determination based on the published data (Bolz 1914, 27–28)
8.	Kivisaare IV	0	0	UD	UD	UD	UD	UD	Age and sex determination based on the published data (Bolz 1914, 27–28)
9.	Kivisaare V	0	0	UD	UD	UD	UD	UD	Age and sex determination based on the published data (Bolz 1914, 27–28)
10.	Kivisaare VI	0	0	IS	UD	UD	UD	Adult	Previously it was not pointed out that the skeleton belonged to a sub-adult. Thus, I assume that the skeleton belonged to an adult (Bolz 1914, 18)
11.	Kivisaare VII *(I; Grab 1)*	0	0	IS	UD	UD	UD	Adult	See the comment on Kivisaare VI burial (Bolz 1914, 18–19, 27; Taf I; Ebert 1913, 506)
12.	Kivisaare VIIIa *(II; Grab 2, 3)*	0	0	IS	UD	UD	UD	Adult	See the comment on Kivisaare VI burial (Bolz 1914, 18–19; Taf I, II; Ebert 1913, 506)
13.	Kivisaare VIIIb *(II; Grab 2, 3)*	0	0	LHB	UD	UD	UD	Adult	See the comment on Kivisaare VI burial (Bolz 1914, 18–19; Taf I, II; Ebert 1913, 506)
14.	Kivisaare IXa *(III; Grab 4)*	0	0	IS	UD	UD	UD	Young child	Age determination based on the published data (Bolz 1914, 20; Ebert 1913, 506)
15.	Kivisaare IXb *(III; Grab 4)*	0	0	IS?	UD	UD	UD	Adult	See the comment on Kivisaare VI burial (Bolz 1914, 20)
16.	Kivisaare Xa *(Kivisaare I)*	0	0	IS	UD	UD	UD	Adult	See the comment on Kivisaare VI burial (Ottow 1911, 154)
17.	Kivisaare Xb *(Kivisaare Ia)*	0	0	IS?	UD	UD	UD	Sub-adult	Age determination based on the published data (Ottow 1911, 155)
18.	Kivisaare XIa *(Kivisaare II)*	0	0	LHB	UD	UD	UD	Adult	See the comment on Kivisaare VI burial (Ottow 1911, 154)
19.	Kivisaare XIb *(Kivisaare IIa)*	0	0	LHB	UD	UD	UD	Sub-adult	Age determination based on the published data (Ottow 1911, 155)
20.	Kivisaare XIIa *(Kivisaare III)*	0	0	IS	UD	UD	UD	Adult	See the comment on Kivisaare VI burial (Ottow 1911, 155)
21.	Kivisaare XIIb *(Kivisaare IIIa)*	0	0	LHB	UD	UD	UD	Sub-adult	Age estimation based on the published data (Ottow 1911, 155)
22.	Kivisaare XIII *(XII; Grab 5)*	0	0	IS	UD	UD	UD	Adult	The size of the grave and the fact that it was determined as a sub-adult uggest the grave belonged to an adult (Bolz 1914, 23–25, 28; Ebert, 1913, 506)
23.	Kivisaare XIV *(XV)*	0	0	IS	UD	UD	UD	Young child	Age determination based on the published data (Bolz 1914, 26–27)
24.	Kivisaare XV	AI 2435:6–8	0	IS	UD	UD	UD	Sub-adult	The femoral length provided by Tallgren provides the age estimation of an under 10 years old sub-adult; according to the length of the right humerus the child can be aged 12–13 years of age (Tallgren 1921; Schaefer et al. 2009)
25.	Kivisaare XVIa	AI 2758	1	LHB	<25	2	UD	Sub-adult	Age determination based on the size of the bones
26.	Kivisaare XVIb	AI 2758	1	LHB	<25	2	UD	Sub-adult	Age determination based on the size of the bones
27.	Kivisaare XVIIa	AI 2764	1	LHB	<25	1	UD	Adult	Age determination based on the size of the bones
28.	Kivisaare XVIIb	AI 2764	1	LHB	<25	2	UD	Sub-adult	Age determination based on the size of the bones

No.	No. of skeleton	No. of collection	Bones available in collection	IS/LHB	Completeness (%)	Surface preservation	Biological sex	Biological age category	Basis for osteological determinations
29.	Kivisaare XXa *(luustik 3)*	AI 4379	1	IS			M?	Adult	Sex is determined based on the several features of cranium; age is based on the tooth wear, thus has to be treated with caution (Brothwell 1981; Miles 1962). The post-cranial skeleton present during the excavations was absent in the collection.
30.	Kivisaare XXb *(luustik 3)*	AI 4379	1	LHB	<25	1	UD	Adult	Only mandible is present in the material
31.	Kivisaare XXI *(luustik 4)*	AI 4379	1	IS	<25	1	UD	Older child	Age is estimated based on tooth eruption (Ubelaker 1979)
32.	Kivisaare XXII *(y_1–b/12–13)*	AI 4379	1	LHB	<25	1	UD	Adult	Age estimation based on the bone size; no dimorphic features present on the bones to determine the biological sex
33.	Kivisaare XXIII *(y_1–h/12–17)*	AI 4379	1	LHB	<25	1	UD	Sub-adult	Age estimation based on the bone size
34.	Kivisaare XXIVa *(f–k/6–11)*	AI 4379	1	LHB	<25	2	UD	Adult	Age estimation based on the bone size; no dimorphic features present on the bones to determine the biological sex
35.	Kivisaare XXIVb *(f–k/6–11)*	AI 4379	1	LHB	<25	2	UD	Sub-adult	Age estimation based on the bone size
36.	Kivisaare XXVa *(ä–ö/42–44)*	AI 4379	1	LHB	<25	1	UD	Adult	Age estimation based on the bone size and teeth; no dimorphic features present on the bones to determine the biological sex
37.	Kivisaare XXVb *(ä–ö/42–44)*	AI 4379	1	LHB	<25	1	UD	Sub-adult	Age estimation based on the bone size
38.	Kivisaare XXVIa *(f–h/18–20)*	AI 4379	1	LHB	<25	1	UD	Adult	Age estimation based on the bone size; no dimorphic features present on the bones to determine the biological sex
39.	Kivisaare XXVIb *(f–h/18–20)*	AI 4379	1	LHB	<25	2	UD	Sub-adult	Age estimation based on the bone size
40.	Kivisaare XXVII *(Close to burial 3 (1965))*	AI 4379	1	LHB	<25	1	UD	Adult	Age estimation based on the bone size; no dimorphic features present on the bones to determine the biological sex
41.	Kivisaare XXVIII *(y_1–a/16–17 (black soil depression))*	AI 4379	1	LHB	<25	1	UD	Adult	Age estimation based on the bone size and teeth; no dimorphic features present on the bones to determine the biological sex
42.	Kivisaare XXIXa *(luustik 1)*	TÜ 1113	1	LHB	<25	1	UD	Adult	Age estimation based on the bone size; no dimorphic features present on the bones to determine the biological sex
43.	Kivisaare XXIXb *(luustik 1)*	TÜ 1113	1	LHB	<25	1	UD	Sub-adult	Age estimation based on bone size
44.	Kivisaare XXIXc *(luustik 1)*	TÜ 1113	1	LHB	<25	1	UD	Adult?	Age estimation based on the bone size; no dimorphic features present on the bones to determine the biological sex
45.	Kivisaare XXX *(loose soil in 1931)*	AI 2758	1	LHB	<25	1	UD	UD	Bone fragments are too small for any further determinations
46.	Kudruküla I	NLM 1304: 65, 77, ?	1	LHB	<25	1	UD	Adult	Age estimation based on the bone size; the biological sex could not be estimated as only skull fragments were present
47.	Kudruküla II	NLM 1304: 198, ?	1	LHB	<25	1	UD	Sub-adult	Age estimation based on the bone size
48.	Kunda Lammasmägi	AI 3262/ 3308	0	LHB	UD	UD	UD	UD	
49.	Kunda Lammasmägi	AI 3262/ 3308	0	LHB	UD	UD	UD	UD	
50.	Kunda Lammasmägi	AI 4011	1	LHB	<25	0	UD	UD	Only a maxillary 2nd molar is present
51.	Kõljala I	AI K 35	1	IS	<25	1	M?	Adult	Due to the absence most of the skeleton no detailed observations of the exact age could be done; the sex determination based on various features on the cranium (Ferembach et al. 1980; Loth & Henneberg 1996; Schwartz 1995)
52.	Kõljala II	AI K 35	1	IS	<25	1	F?	Older adult	Sex and age are determined by the various characteristics on the cranium (Ferembach et al. 1980; Lovejoy et al. 1985; Schwartz 1995)
53.	Kõljala III	AI K 35	1	IS	<25	1	M?	Adult	No sex and age specific characteristics are present on the cranium; the sex determination is based on the overall robustness of the cranium (Schwartz 1995)
54.	Kõnnu I	AI 4951	1	IS	50–75	2	UD	Adolescent	Age of the individual is determined by the sum of various state of epiphyseal fusions (Schaefer et al. 2009)

No.	No. of skeleton	No. of collection	Bones available in collection	IS/LHB	Completeness (%)	Surface preservation	Biological sex	Biological age category	Basis for osteological determinations
55.	Kõnnu II	AI 4951	1	IS	<25	2	UD	Older child	Age is determined by the formation of teeth (Schaefer et al. 2009)
56.	Kõnnu IIa	AI 4951	1	LHB	<25	2	UD	Young child	Age is determined by the formation of teeth (Schaefer et al. 2009)
57.	Kõnnu III	AI 4951	1	IS	25–50		M?	Middle adult	Sex is difficult to determine as the pelvis and cranium are heavily fragmented, due to the robustness of the bones in general it is more likely a male; age is estimated based on the deformation of the auricular surface of the ilium (Buckberry & Chamberlain 2002; Lovejoy et al. 1985)
58.	Kõnnu pit no. 102	AI 4951	1	LHB	<25	1	UD	Adult	Age determination based on the size of the bone; no dimorphic elements present of biological sex determination
59.	Kõnnu pit no. 111	AI 4951	1	LHB	<25	1	UD	Adult	Age determination based on the size of the bone; no dimorphic elements present of biological sex determination
60.	Kõnnu pit no. 122	AI 4951	1	LHB	<25	2	UD	Adult	Age determination based on the size of the bone; no dimorphic elements present of biological sex determination
61.	Kõnnu pit no. 127	AI 4951	1	LHB	<25	1	M?	Adult	Age determination based on the size of the bone; sex determination based on the sciatic notch of pelvis
62.	Kõnnu pit no. 131	AI 4951	1	LHB	<25	0	UD	Adult	Age determination based on the size of the bone; no dimorphic elements present of biological sex determination
63.	Kõnnu pit no. 135	AI 4951	1	LHB	<25	2	UD	Adult	Age determination based on the size of the bone; no dimorphic elements present of biological sex determination
64.	Kõnnu pit no. 138	AI 4951	1	LHB	<25	0	UD	Adult	Age determination based on the size of the bone; no dimorphic elements present of biological sex determination
65.	Kõnnu year 1979(1)	AI 4951	1	LHB	<25	2	UD	Adult	Age determination based on the size of the bone; no dimorphic elements present of biological sex determination
66.	Kõnnu year 1979(2)	AI 4951	1	LHB	<25	2	UD	Sub-adult	Age determination based on the size of the bone
67.	Kõnnu year 1981	AI 4951	1	LHB	<25	1	UD	Adult	Age determination based on the size of the bone; no dimorphic elements present of biological sex determination
68.	Kõnnu year 1984(1)	AI 4951	1	LHB	<25	1	UD	Adult	Age determination based on the size of the bone; no dimorphic elements present of biological sex determination
69.	Kõnnu year 1984(2)	AI 4951	1	LHB	<25	1	UD	Sub-adult	Age determination based on the size of the bone
70.	Kõnnu without context	AI 4951	1	LHB	<25	1	UD	Sub-adult	Age determination based on the size of the bone
71.	Kääpa (AI 4245)	AI 4254	1	LHB	<25	1	UD	Adult	Age determined based on the features on cranium
72.	Kääpa (VM 3000: 756)	VM 3000:756		LHB	<25	UD	UD	UD	Bone not present in the collection
73.	Külasema (Metsikumäe)	0	0	IS	UD	UD	UD	Adult	Age estimation based on the published data (Indreko 1935a, 206)
74.	Naakamäe	AI 4211	1	IS	25–50	2	F?	Adolescent	Sex is determined based on the various characteristics on cranium; age is determined based on various epiphyseal fusions (Ferembach et al. 1980; Krogman et al. 1986; Loth & Henne-berg 1996; Schwartz 1995; Schaefer et al. 2009)
75.	Narva Joaorg I	AI 4264	1	LHB	<25	1	M?	Adolescent	Due to the heavy fragmentation of the bones more precise aging of the individual is not possible, age estimation after prominent supraorbital ridge, marked temporal ridge and nuchal area (Ferembach et al. 1980)
76.	Narva Joaorg Ia	AI 4264	1	LHB	<25	1	UD	UD	A fragment of glenoid fossa of a scapula present
77.	Narva Joaorg II (AI 4264: 1409)	AI 4264	1	LHB	<25		UD	Adult	Age estimation based on bone size
78.	Narva Joaorg III	AI 4264	0	LHB	UD	UD	UD	Sub-adult	Bones not present in the collection, the age estimation is based on the determination done on site (Jaanits 1963, 8–9)
79.	Narva Joaorg IV	AI 4264	1	LHB	<25	0	UD	Adult	Only fragments of both parietal and frontal bone are present; age estimation based on bone size
80.	Pikasilla I	TÜ 1772	1	LHB	<25	1	UD	Young child	Age estimation based on tooth development (Schaefer et al. 2009)

No.	No. of skeleton	No. of collection	Bones available in collection	IS/LHB	Completeness (%)	Surface preservation	Biological sex	Biological age category	Basis for osteological determinations
81.	Pikasilla II	TÜ 1772	1	LHB	<25	0	UD	UD	A permanent maxillary 1st molar present
82.	Sindi-Lodja	0	0	LHB	UD	UD	UD	UD	No bones preserved, only published information available
83.	Tamula I	AI 3932	1	IS	50–75	2	F	Middle adult	Although the sex related characteristics on pelvis and cranium were evenly represented, the birth scar proves that the individual is a female (Buckberry & Chamberlain 2002; Brooks & Suchey 1990)
84.	Tamula II	0	0	IS	UD	UD	UD	Adult	Age determination based on the observations done in the field (Indreko 1942)
85.	Tamula III	AI 3932	1	IS	<25	2	M?	Middle adult	Sex determination based on various characteristics on cranium; age is determined by the deformation of the auricular surface of the ilium (Buckberry & Chamberlain 2002; Ferembach et al. 1980; Schwartz 1995)
86.	Tamula IV	AI 3960	1	LHB	<25	2	M?	Adult	Sex is estimated based on the overall robustness of cranium
87.	Tamula V	AI 3960	1	LHB	<25	2	UD	Infant	Age determined based on tooth development and size of the mandible (Schaefer et al. 2009)
88.	Tamula VI	AI 3960	1	IS	<25	3	UD	Adolescent	Age is estimated by several epiphyseal diffusions (Schaefer et al. 2009)
89.	Tamula VII	AI 3960	1	IS	<25	2	UD	Older child	Only single fragments of the cranium are stored, bones of the axial skeleton are absent; age estimated based on tooth eruption (Schaefer et al. 2009)
90.	Tamula VIII	AI 4118	1	IS	>75	2	F	Middle adult	Age and sex are determined by the characteristics on pelvis (Buckberry & Chamberlain 2002; Loth & Henneberg 1996; Brooks & Suchey 1990; WEA 1980)
91.	Tamula IX	AI 4118	1	IS	50–75	2	M?	Middle adult	Age and sex determined by the characteristics on cranium and teeth; pelvis is not preserved teeth (Brothwell 1981; Ferembach et al. 1980; Krogman et al. 1986; Loth & Henneberg 1996; Schwartz 1995)
92.	Tamula X	AI 4118	1	IS	50–75	2	F?	Middle adult	Sex determined by the characteristics on cranium (male features dominate, due to fragmentation not all the traits can be taken into account) and the pelvis (female features dominate); age is determined based on both auricular surface Buckberry & Chamberlain 2002; Ferembach et al. 1980; Schwartz 1995)
93.	Tamula XI	AI 4118	1	IS	50–75	2	M?	Middle adult	Sex determined based on the various characteristics of cranium; the age is determined by the teeth (Brothwell 1981; Ferembach et al. 1980; Krogman et al. 1986; Loth & Henneberg 1996; Schwartz 1995)
94.	Tamula XII	AI 4118	1	IS	25–50	2	UD	Young child	Age determined based on eruption of teeth and diaphyseal length of the left radius (Schaefer et al. 2009)
95.	Tamula XIII	AI 4118	1	LHB	<25	2	UD	Young child	Age determined by tooth eruption (Scheafer et al. 2009)
96.	Tamula XIIIa	AI 4118	1	LHB	<25	2	UD	Adult	Only single bones are present: distal fragment of right radius, a fragment of left temporal bone, and fragments of long bone
97.	Tamula XIV	AI 4118	1	IS	50–75	2	UD	Sub-adult	Age determined based on the disphyseal fusions (Scheafer et al. 2009).
98.	Tamula XV	AI 4118	1	LHB	<25	2	UD	Infant	Age is determined by the diaphyseal length of the right femur and left tibia (Schaefer et al. 2009). In addition a tooth of a c. 6-year old were found (see below)
99.	Tamula XVI	AI 4118	1	LHB	UD	UD	UD	Older child	The cranium is absent, but a deciduous left incisor of a c. 6-year old was present (Morrees et al. 1963), placed in the same box as the bones of skeleton XV. As skeletons XIII, XV, and XVI were located close to one another (Jaanits 1957) it is likely that this tooth represents the XVI skeleton
100.	Tamula XVII	AI 4118	1	IS	50–75	2	F?	Middle adult	Sex of the individual is determined by variety of features on the cranium, the age is determined on the teeth (Ferembach et al. 1980; Loth & Henneberg 1996; Miles 1962; Schwartz 1995)

No.	*No. of skeleton*	*No. of collection*	*Bones available in collection*	*IS/LHB*	*Completeness (%)*	*Surface preservation*	*Biological sex*	*Biological age category*	*Basis for osteological determinations*
101.	Tamula XVIII	AI 4118	1	IS	>75	2	F?	Older adult	Sex determined by the features on cranium and age determined by the degradation of auricular surface of the pelvis (Buckberry & Chamberlain 2002; Ferembach et al. 1980; Lovejoy et al. 1985; Schwartz 1995)
102.	Tamula XIX	AI 4118	1	IS	50–75	2	M?	Middle adult	Sex determined by the features on cranium and aged determined by teeth. Bones of another individual were found from the box (XIXb) (Brothwell 1981; Ferembach et al. 1980; Krogman et al. 1986; Loth & Henneberg 1996; Schwartz 1995)
103.	Tamula XIXa	AI 4118	1	LHB	<25	2	UD	Adult	Fragments of fibula and right 1st metatarsal; no age and sex specific characteristics were available for more precise determinations
104.	Tamula XX	AI 4118	1	IS	50–75	2	M?	Middle adult	The individual is sexed based on the features on cranium and aged based on tooth wear (Brothwell 1981; Ferembach et al. 1980; Krogman et al. 1986; Loth & Henneberg 1996; Schwartz 1995)
105.	Tamula XXI	AI 4118	1	IS	50–75	1	M?	Middle adult	Sex is based on the characteristics on cranium; age based on tooth wear (Brothwell 1981; Ferembach et al. 1980; Krogman et al. 1986; Loth & Henneberg 1996; Schwartz 1995)
106.	Tamula XXIa	AI 4118	1	LHB	<25	2	UD	Adult	An additional 2nd cervical vertebra was found in the boxes (XXIa); no age or sex could be determined
107.	Tamula XXII	AI 4118	1	IS	50–75	2	M?	Older adult	Sex is based on the characteristics on cranium, age based on tooth wear (Brothwell 1981; Ferembach et al. 1980; Loth & Henneberg 1996; Schwartz 1995)
108.	Tamula XXIII	AI 4118	1	LHB	<25	2	UD	Adult	No direct age and sex specific characteristics are available
109.	Tamula XXIV	AI 4118	1	LHB	<25	1	UD	Young child	In addition to the skeleton of the child single bones of an adult were found from the box (XXIVb) (Ubelaker 1979)
110.	Tamula XXIVa	AI 4118	1	LHB	<25	1	UD	Adult	Only a 1st maxillary molar and a small fragment of a long bone was found (Brothwell 1981)
111.	Tamula XXV	AI 4118	1	LHB	<25	2	UD	Sub-adult	The absence of the post-cranial skeleton does not allow any further osteological determinations
112.	Tamula (1956)	AI 4118	1	LHB	<25	2	UD	UD	The poor preservation of bones does not allow any further analysis
113.	Tamula (1961)	AI 4118	1	LHB	<25	2	UD	Adult	Age determined based on the bone size
114.	Tamula (2007a)	AI 6861	1	LHB	<25	2	UD	Adult?	Age determined based on the bone size
115.	Tamula (2007b)	AI 6862	1	LHB	<25	2	UD	Sub-adult	Age determined based on the bone size
116	Tooma	TÜ 1963	1	UD	<25	2	UD	UD	
117.	Valma I	AI 4022	1	LHB	<25	1	UD	Young child	Age is determined based on diaphyseal fusions (Scheafer et al. 2009)
118.	Valma II	AI 4022	1	IS	50–75	2	F?	Young adult	Sex is determined by various characteristics on cranium, age based on the tooth wear (Brothwell 1981)
119.	Valma III	AI 4022	1	IS	50–75	2	M?	Middle adult	Sex is determined by the various elements on cranium, age on the tooth wear (Lovejoy et al. 1985)
120.	Veibri I: I	TÜ 1424	1	IS	25–50	2	UD	Adolescent	Age is determined based on diaphyseal fusions (Schaefer et al. 2009)
121.	Veibri I: II	TÜ 1424	1	IS	>75	2	F	Middle adult	Sex determination is based on the shape of greater sciatic notch; age is determined based on the auricular surface of the pelvis (Buckberry & Chamberlain 2002; Ferembach et al. 1980; Lovejoy et al. 1985; Schwartz 1995)
122.	Veibri I: III	TÜ 1424	1	IS	25–50	2	UD	Young child	Age is determined by the various fusions of diaphysis and teeth (Schaefer et al. 2009; Ubelaker 1979)
123.	Veibri I:IV	TÜ 1424	1	IS	50–75	2	UD	Young child	Age is estimated based on various diaphyseal fusions and the lengths of the epiphysis of the right ulna, radius, and tibia (Schaefer et al. 2009)

5.1.1.1. Preservation of skeletal material

In archaeological collections one rarely finds a complete skeleton; this has not been different with the hunter-gatherer sample here. As seen from Table 14, the overall preservation of intact skeletons remained between 25–75%, whereas only in single cases it did exceed 75%. Features with loose human bones ranged from single bone fragments (Kivisaare XVIIa, XXIII, and XXb; Kunda Lammasmägi; Kõnnu pit 122, 131, 138; Narva Joaorg Ia; Pikasilla II; Tamula XVI, XXIa, and XXIVa) to almost complete skeletal remains (Tamula XV, in field). The osteometric and morphological analysis of the loose human bone assemblage were more restricted due to the heavy fragmentation of the bones (ranging from single element fragments of c. 2 cm diameter to whole diaphysis of long bones). The poor preservation of inhumation burials cannot solely be explained by decomposition factors. These reflect applied excavation techniques and different mortuary practices, too (*Chapter 6.2.2.*).

It is well known that the size, shape of the surface area, and density of the bone affect its preservation (Stodder 2008, 81). From the analysed assemblages, smaller (such as hand and feet bones) and spongy bones (such as vertebrae, pelvises) were absent most frequently, which corresponds to the general trends (Waldron 1987 referred in Stodder 2008, 82). Only skulls and single long bones are available from Kõljala. This does not reflect mortuary practices but is a research bias, as not all the bones were collected by archaeologists. Despite its volume, the pelvis is fragile consisting of rather large parts of spongy flat bone, and thus tends to preserve poorly (e.g. at Skateholm and at some extent at Vedbæk-Bøgebakken (Larsson 1989[1985], 317; Nilsson Stutz 2003, 177)). Its absence in the graves III, VII, IX, XI, XII, XV, and XXI at Tamula, and in II and III graves at Valma restricts the biological sexing of these skeletons and complicates the archaeothanatological analysis.

The preservation and fragmentation states of the skeletons do not allow ageing and sexing every single individual: biological sex could not be determined for c. 1/3 of the adult population of intact burials; in many cases only a distinction between sub-adult and adult was possible. Despite the low representativeness of skeletal elements in a feature and the heavy fragmentation of loose human bone assemblages, the bone surfaces were only slightly eroded, sometimes with a deeper surface penetrations, but nothing extreme (grades 0–2; after McKinley 2004). No remarkable difference between the loose human bones assemblages and intact burials was observed. However, the fragmentation of bones and surface erosion in all loose human bone assemblages (except Narva Joaorg) prevented the documentation of osteometric data.

5.1.2. Minimum number of individuals

The minimum number of individuals (MNI) gives an estimate of the number of people subjected to tangible mortuary rituals. Table 15 presents the results of osteological analysis undertaken here together with published data (about

Jalukse, Külasema Metsikumäe, Sindi-Lodja, and Võru, and partly about Kivisaare and Naakamäe). The MNI in the pit graves was assessed by the presence of a whole skeleton in a single context. Repetitions of bone elements (e.g. two right humeri) accounted for an additional individual in the single context. In most cases, the MNI in the grave has been determined properly during the field work. This is especially the case with articulated skeletons, both with single and several individuals in a feature. Nevertheless, in addition to the below-listed loose human bones found in cultural layers, the osteological analysis of more-or-less complete skeletons revealed single bones of six additional individuals with the designations Tamula XIIIa, XIXa, XXIa, and XXIVa, Kõnnu IIa, and Kivisaare XXb (Table 14). The overall number of individuals represented in features with loose human bones has not been known previously, but if the results of osteological analysis are compared to contextual information, some implications can be made.

Table 15. MNI across all the sites.
Both the data from the osteological analysis undertaken for the present thesis and published previously are included.

No.	*Site name*	*MNI of complete skeletons*	*MNI of loose human bones*	*MNI total*
1.	Akali	0	3	3
2.	Jalukse	11	0	11
3.	Kivisaare	22	15/18	37/40
4.	Kudruküla	0	2	2
5.	Kunda Lammasmägi	0	3	3
6.	Kõljala	3	0	3
7.	Kõnnu	4	7/14	11/18
8.	Kääpa	0	2	2
9.	Külasema Metsikumäe	1	0	1
10.	Naakamäe	1/2	0	1/2
11.	Narva Joaorg	0	5	5
12.	Pikasilla	0	2	2
13.	Sindi-Lodja	0	?	?
14.	Tamula	25	6/12	31/37
15.	Tooma	0	1	1
16.	Valma	2	3	5
17.	Veibri	4	0	4
18.	Võru	0	1	1
	Total	**74/75**	**49/65**	**123/140**

At Tamula, the loose human bones derive either from occupation layers or inhumation graves. The grave XIII from Tamula was previously assigned to a sub-adult (*"eines kleinen Kindes"*; Jaanits 1957a, 85) or more precisely to a 2–3 year old child (Allmäe 2006). In addition to the poorly preserved bones of the child (XIII), single bones of an adult (XIIIa) were distinguished. Single bones of additional individuals were also recorded in graves XIX, XXI, and XXIV. These loose bones from the otherwise intact graves increase the number of individuals known at Tamula from 25 to 29. In addition to these bones from inhumation graves (MNI=4), 12 bones from various contexts were recorded (years 1956, 1961, and 2007; Table 14). Based on the repetition of bone elements the MNI would be two individuals. However, as the context of these finds is unclear, it might also be that the adult bones represent separate individuals, and thus the MNI would be eight. All in all the number of individuals at Tamula remains between 31 and 37.

An additional mandible belonging to another adult (XXb) was found during the osteological analysis with the skeleton of the adult male (XXa) found at Kivisaare in 1964/1965 (Jaanits 1965a, 6). This mandible was not mentioned in the excavation report, nor is it possible to locate on the drawings nor photographs. From the field seasons 1931 and 1956, in addition to intact skeletons, the bones of altogether 15 individuals were found at Kivisaare (Table 14). The bone cluster excavated in 2003 and 2004 contained the remains of three individuals (Table 14).

The Kõnnu settlement site was heavily demolished during the Soviet Period, and thus even the inhumations were only partly preserved. Kõnnu II is an older child from whom the upper part of the body was preserved; together with it a young child (IIa) represented only by deciduous teeth, fragments of cranium, vertebral column and ribs was found. Their presence was already noticed in the field (Jaanits 1978; 1979, 366); however, the young child was not labelled separately. In addition to the graves mentioned by Jaanits, the remains of seven individuals from more solid contexts were recorded during the analysis undertaken here. Additionally, loose human bones representing another seven individuals, without any references to the context, were gathered in 1979, 1981, and 1984. As the contextual data about these finds are insufficient, one cannot estimate the exact number of individuals represented in loose human bones at Kõnnu. However, the overall MNI must have remained between 11 and 18. At Naakamäe in addition to the skeleton present in the collection, the supplementary information about a previously found burial (Jaanits 1958; 1965c, 29; Jaanits et al. 1982, 83) was was taken into account in the analysis.

Burial II and IV at Narva Joaorg contained the remains of single individuals; based on the literature the cranial bones of skeleton III also derived from one individual (Jaanits 1963; Jaanits et al. 1982). The latter, however, could not be confirmed as the bones were not present in the collection. In case of burial I, the majority of the bones belonged to an adolescent. Fragments of three different scapulae (glenoid fossa) indicate that at least one of these belonged to another individual. Therefore, the MNI in Narva Joaorg (including III) was five.

Based on the osteological analysis, the MNI found at pit graves is 48 (Figure 17); adding the information from published sources the number increases to 78/79. All but four burial sites (Tamula (n=29), Kivisaare (n=22), Kõnnu (n=11/18), and Jalukse (n=11)) contain less than ten individuals, ranging from one to eight. Loose human bones of 49–65 individuals from 12 sites were distinguished. This increases the MNI of known individuals to 123–140. However, if we regard the six additional individuals recorded during the osteological analysis of intact skeletons one might speculate that the initial number of individuals in the known graves might have been larger. Such a speculation could add another individual to all the 35 graves known from literature, which would increase the number of people buried during the period under discussion to 157–174. Without any doubt, this has not been the case, as probably the majority of the graves have been single burials and only few might have contained several individuals. The osteological analysis and the re-analysis of the published material allow concluding that the overall MNI remains somewhere between 123 and 174.

5.1.3. Biological sex and age at death

The age at death is presented in Table 14 and Figure 18. Compared to previous age-at-death estimations, some differences occur because formerly the age categories were not accurately described or the age ranges varied (Bolz 1914; Fürst 1914; Aul 1945; Mark 1956; Jaanits 1957a; Allmäe 2006; 2011). Thus, the age ranges presented here should not be directly compared to the previous assessments. Unlike the previous estimations (Ottow 1911; Ebert 1913; Bolz 1914; Tallgren 1921; Veitmann 1927; Indreko 1931; 1935a; 1942; Jaanits 1957a; 1963; Jaanits et al. 1982) the skeletons were categorised into more distinct age groups, thereby allowing a larger uncertainty range. In several instances only a distinction between sub-adult/adult could be made. For loose human bones, the distinction was usually made based on the size of the bone, but where possible the thickness of cranial vault, the character of the joint surfaces, and the development of teeth were taken into account.

As seen in Figure 18, a cross-section of all age groups is represented in the inhumation graves. Based on the osteological analysis (excluding published data) the majority of graves belong to adults (58%); sub-adults constitute 42% of the whole population buried into pit graves whose age could be determined. The ratio does not change if we consider the published data (Ottow 1911; Ebert 1913; Bolz 1914; Tallgren 1921; Indreko 1935a; Jaanits 1963); however, the age at death remains undetermined in 19% of the cases. The adult/sub-adult proportions observed here are on the whole comparable to other hunter-gatherer cemetery populations from the northern European forest zone and at the region of Baltic Sea (Persson & Persson 1984; 1988 and Alexandersen 1988 referred in Larsson 1989[1985], 317; Zariņa 2006, 135, Fig. 1; Molnar 2008; 136, Fig. 2; Kostyleva & Utkin 2010, 14, Table 1, 31–32 Table 2; Wallin 2015, 53; but see Sakhtysh IIa and VIII: Kostyleva & Utkin 2010, 51–53 Table 5, 64–65 Table 9).

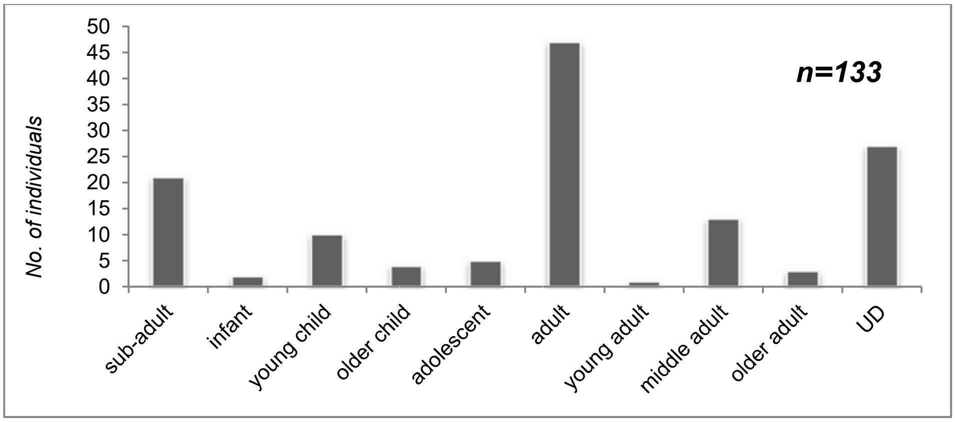

Figure 18. The population structure in pit graves and loose human bones divided by age categories.
The chart represents the whole sample where both the age estimates of osteological analysis and literature are combined.

Both adults and sub-adults are represented in the loose human bones assemblages (Figure 18). At Kõnnu the vast majority of the remains appear to derive from adults; only three probably belong to sub-adults (found in 1979, 1984, and from a soil heap). All the bones at Narva Joaorg belonged to adult individuals; however the bones of individual III were not present in the collection, and according to the excavation report and published data, the skull bones belonged to a sub-adult (Jaanits 1963; Jaanits et al. 1982). At Kivisaare and Tamula burial sites, adults and sub-adults are represented, whereas in burials with several individuals at these sites, mainly an intact skeleton of an adult and partial remains of a sub-adult were observed (Kivisaare IXa/b, Xa/v and XIIa/b, and Tamula XIII/XIIIa, XXIV/XXIVa). Akali (excl. Akali III), Pikasilla and Valma stand out from the rest in that the isolated human bone assemblages consist mostly of teeth or cranial fragments of sub-adult individuals. On the contrary, the cranium found at Kääpa belongs to an adult, the origin of the other one remains unknown; the cranial fragments and mandibles at Kudruküla to an adult and sub-adult.

In comparing the ratio of adults to sub-adults (Figure 19) among intact burials and loose human bone assemblages, we observe that in both cases adults exceed the number of sub-adults. However, sub-adults are more frequently found in the features with loose human bones (44%), but adults clearly outnumber them in intact burials (66%). In general, the lower number of sub-adults in the sample could be explained by the putrefaction and decomposition rates of their corpses as child skeletons tend to be more fragile. Whether this slight difference between inhumations and loose human bone assemblages reflects different attitudes toward various age groups while performing mortuary rituals cannot be determined conclusively because one cannot establish the initial burial practices for the majority of the loose human bones (see *Chapter 6.2.*). Moreover, to my knowledge, there are no comparative studies undertaken on loose human bones vs. intact burial assemblages of Mesolithic/Neolithic hunter-gatherer populations of the Baltic Sea region, which makes it difficult to place the results into a wider context.

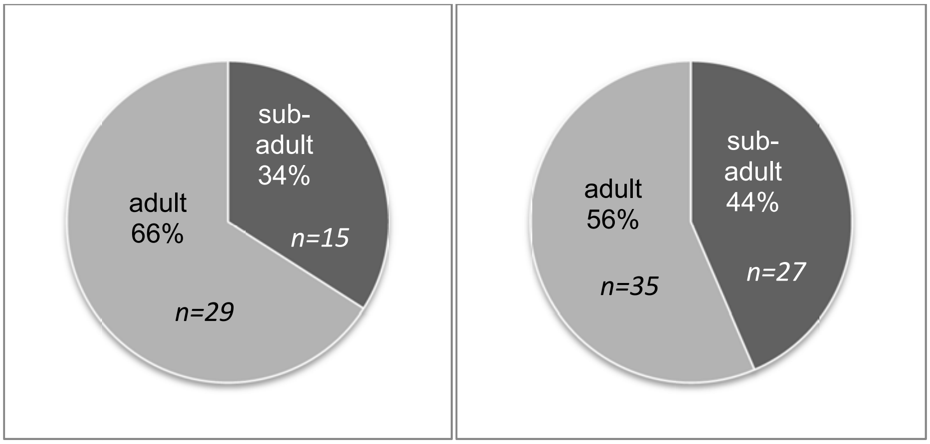

Figure 19. The representativeness of adults and sub-adults in intact burials (left) and loose human bone features (right).
Both the results of osteological analysis and published data are considered.

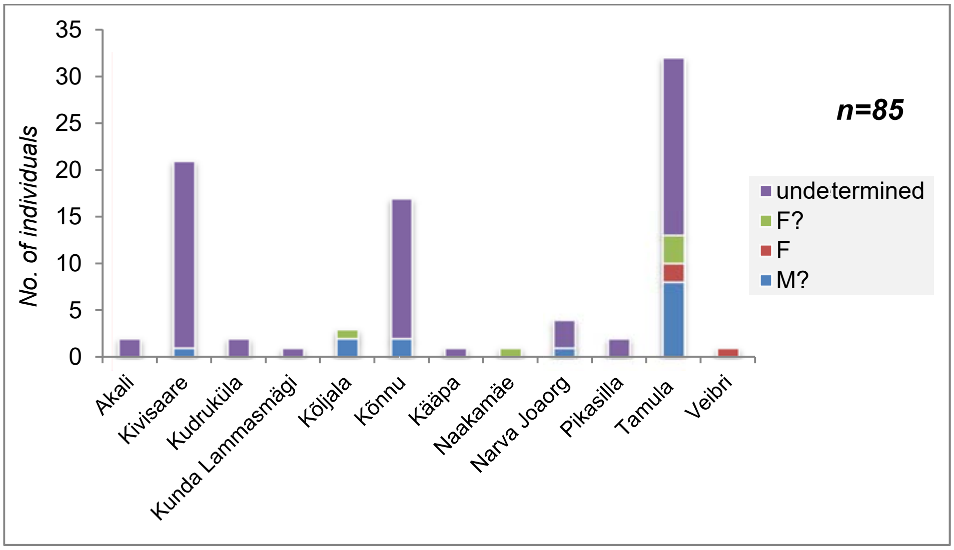

Figure 20. The biological sex distribution of adults and adolescents based on the here-conducted osteological analysis.
Both intact inhumations and loose human bones are included.

Biological sex was only estimated on adult skeletons and adolescents of intact burials, when possible. The results of sex determinations are presented in Table 14 and Figure 20. Although several dimorphic traits on the pelvis and skull have been regarded in sex assessments, the results should be taken with caution as it has not been possible to compare the analysed skeletons to a known population. If only a skull was present, the sex of an individual was only indirectly determined. Before moving on with intact skeletons, it is important to note that the fragmentation and lack of elements with dimorphic features within loose human bone assemblages allowed only limited sex assessments. The fragment of os coxae in feature 127 at Kõnnu might have belonged to a male based on the sciatic notch; various dimorphic features on the cranium of Narva Joaorg I suggest that these bones belonged to a probable male; the overall robustness of the cranium of Tamula IV suggests a probable male.

The thirteen adult skeletons assigned to possible males (males?) were not determined based on the elements on pelvis, but instead on cranial features (Table 14). Seven skeletons were determined as females, among these only three (Tamula I, VIII and Veibri I:II) were determined based on various features of pelvises; the rest were regarded as possible females (females?). In the case of Tamula X, the dimorphic traits on the cranium and pelvis provide contradictory information. However, as the dimorphism of male and female pelvis is determined by its dramatically different function, its sex-specific traits have been considered more reliable. Thus, it has been assumed that Tamula X belonged to a female. From Kõljala II only a skull was available for osteological assessment; moreover, not all the sex-specific traits were observable. The overall shape of the cranium fits with female characteristics (Fürst 1914), yet some other traits – ridged nuchal area, mastoid process, and the rectangular shape of orbits – are indicative of male origin. The absence of the post-cranial skeleton means no pelvis is present to confirm the biological sex determination; the comparison with the rest of the population in Kõljala (n=2) does not help any further either.

The biological sex determinations coincide largely with the results of previous studies. To illustrate the case, the sex determinations of Tamula individuals are given in Table 16. The only grave that has puzzled researchers is Tamula IX, which has been assigned both to male and female. Based on various traits of the cranium, specifically the ridged nuchal area, large external occipital protuberance, and mental protuberance of the mandible, this individual has been assessed as a possible male in the present study.

Table 16. The biological sex assessments of the adults from Tamula burial site.

Grave no.	*Mark 1956*	*Jaanits 1957a*	*Allmäe 2006*	*Present study*
Tamula I	F	F	F	F
Tamula II	UD	UD	UD	UD
Tamula III	UD	UD	M	M?
Tamula IV	UD	M	UD	M?
Tamula V	UD	UD	UD	UD
Tamula VI	UD	M	UD	UD
Tamula VII	UD	UD	UD	UD
Tamula VIII	M	F	F	F
Tamula IX	M?/F?	M	F?	M?
Tamula X	F	F	F	F?
Tamula XI	M	M	M	M?
Tamula XII	UD	UD	UD	UD
Tamula XIII	UD	UD	UD	UD
Tamula XIIIa	UD	UD	UD	UD
Tamula XIV	M	M	UD	UD
Tamula XV	UD	UD	UD	UD
Tamula XVI	UD	UD	UD	UD
Tamula XVII	F	F	F	F?
Tamula XVIII	F	F	F	F?
Tamula XIX	M	M	M	M?
Tamula XIXa	UD	UD	UD	UD
Tamula XX	M	M	M	M?
Tamula XXI	M	M	M	M?
Tamula XXIa	UD	UD	UD	UD
Tamula XXII	UD	UD	M?	M?
Tamula XXIII	UD	UD	M?	UD
Tamula XXIV	UD	UD	UD	UD
Tamula XXIVa	UD	UD	UD	UD
Tamula XXV	UD	UD	UD	UD

In comparison with previous biological sex assessments, the determinations presented here are more prudent; altogether ten adolescent and adult skeletons remained with undetermined sex. Despite the problems highlighted in *Chapter 3.2.1.2.*, one could conclude that both biological sexes were present in the pit grave population; however, their proportion to one another cannot be estimated accurately. The male and female ratios at Tamula and Kivisaare burial sites are comparable to the results of other sites around the Baltic Sea, where mostly males dominate in pit graves (e.g. Jacobs 1985; Constandse-Westermann & Newell 1990, 97; Kozlovskaja 1996, referred in Zariņa 2006, 137; Patolla & Henke 2007, 357; Molnar 2008; Butrimas 2012, 199; Wallin 2015, 53). At Sakhtysh II and VIII in Russia, however, females are more frequent (Kostyleva & Utkin 2010, 31–32 Table 2, 64–65 Table 9) and at Sakhtysh IIa both sexes are equally represented (Kostyleva & Utkin 2010, 51–53 Table 5). However, the sample does not allow observing any sex-based preferences within the described mortuary practices.

5.1.4. Conclusions about the osteological analyses

The osteological analyses presented above form a basis for the succeeding isotope analysis and provide additional information for archaeothanatological analysis. It was shown that the sample is far from being perfect in applying multiple ageing and sexing methods for each individual. The collection of loose human bones only allowed the biological sex of a small number of individuals to be determined; however, it was possible to distinguish sub-adults from adults. The estimated MNI suggests that only a handful of people were provided tangible mortuary rituals. However, both males and females from the whole life circle are represented in the sample, similarly to other known hunter-gatherer burials sites in eastern Europe and more specifically the Baltic Sea region. Also corresponding to this data is the low number of sub-adults in intact burials. Based on the samples of Kivisaare and Tamula – c. 2/3 of the population being adults and 1/3 sub-adults – it could be argued that these represent attritional mortality profiles. This assumption is also in accordance with ethnographic studies, which indicate that c. 50–60% of children within hunter-gatherer populations survive to the age of 15 (Kelly 2013, 200).

These general observations about biological sex and age allege that mortuary rituals were carried out irrespective of the primary identities of the deceased. No archaeologically observable practices (excl. funerary dress and grave goods) were particular to one of the two biological sexes nor restricted to age categories (see also Tõrv & Eriksson in prep.). However, the higher frequency of sub-adult bones in loose human bone assemblages might indicate a slight age-related differentiation in mortuary practices. But at this stage of the research a clear correlation between different age-groups and mortuary practices cannot be established explicitly and thus this statement remains a pure hypothesis needing further research.

5.2. Fishers, gatherers, and hunters – analysing and interpreting isotope data

Stone Age populations have mainly been defined by their subsistence. In the context of western Europe it has been argued that during the Mesolithic-Neolithic transition, people turned their back on marine resources and adapted a terrestrial mode of subsistence together with the implementation of early farming and land cultivation (e.g. Tauber 1981; Bonsall et al. 1997; Richards et al. 2003; Milner et al. 2004; Richards & Schulting 2006; Brinch Petersen & Egeberg 2007). The change from foraging to agriculture was not that straightforward and rapid in the eastern Baltic region and will be discussed in the light of stable isotopes. This pilot study of stable carbon and nitrogen isotopes on human collagen opens up an additional aspect of the identity of the people of Estonian Stone Age. So far only single carbon isotope ratios have been measured: at Tamula X (Est 20), Tamula XI (Est 21), Narva Joaorg IV (Est 6), Naakamäe (Est 7), Kudruküla (Est 1–3) and Kõljala (Est 16); also, three radiocarbon dated burials from Tamula and one from Veibri are accompanied by δ^{13}C values (Kriiska et al. 2007; Mannermaa 2008). Single faunal samples have been analysed previously (Table 9).

5.2.1. Sample and its limitations

The results are presented in Table 17, and partly published together with Gunilla Eriksson (Tõrv & Eriksson 2014; Tõrv & Eriksson in prep.). Altogether 111 samples representing 56 individuals were processed, among which 40 are from inhumation graves and 16 are from loose human assemblages. Some data were excluded from the final analysis due to varying collagen preservation: out of 111 initial samples, 42 yielded no collagen (Figure 21). Individuals in graves Narva Joaorg I, Tamula I, IV, VI, XI, XII, XX and XXV, Valma I, II, and III were entirely omitted; the rest are represented at least with one sample per person. Eight samples (n=5) were omitted due to deviant C:N ratios, which implies altered collagen, and three samples due to measurement errors caused by the machinery (Kõnnu I: KIA-49481, III: KIA-48480, and Tamula VI: KIA-48956). The differences between the initially processed samples and final sample size are given in Figure 21.

Regarding all the biases, the following analysis is based on 61 original human collagen samples, representing 33 individuals. As appears from Table 17, the majority of the data derive from inland sites (n=48) either on lake depressions (Kivisaare, and Tamula) or riversides (Kudruküla, Narva Joaorg, and Veibri). The less numerous (n=13) sample from the island of Saaremaa (Kõljala, Kõnnu, and Naakamäe), however, does not prohibit preliminary conclusions about the dietary preferences of these people and comparison with inland values. Previously available carbon data is included in the analysis, adding three individuals from Kudruküla (n=3), Kõljala (n=1) and single samples of other individuals analysed during the present study (Lõugas et al. 1996; Kriiska et al. 2007; Mannermaa 2008).

Faunal materia l (n=14) was initially included in the analysis, yet the poor collagen preservation, contextual ambiguity, and small size of the contextually relevant animal bones restricted their use in the analysis and interpretation of the human data. Only two (n=2; Table 18) samples yielded enough collagen to measure their isotope ratios. Therefore, in addition to general faunal values (DeNiro 1985; Lidén & Nelson 1994; van Klinken 1999; Katzenberg 2008 [2000]), a more local baseline grounded on the data sets of samples from Zvejnieki (Eriksson et al. 2003; Eriksson 2006) and Riņņukalns (Bērziņš et al. 2014; Schmölke et al. 2015) in Latvia, and Västerbjärs, Ire, Köpingsvigk and Resmo on the islands of Gotland and Öland in Sweden (Eriksson 2004; Eriksson et al. 2008) are used to interpret the results of human data (Figure 23). The methodological considerations and limitations of the sample and the absence of local ecological baseline were elaborated in *Chapter 3.2.2.4*.

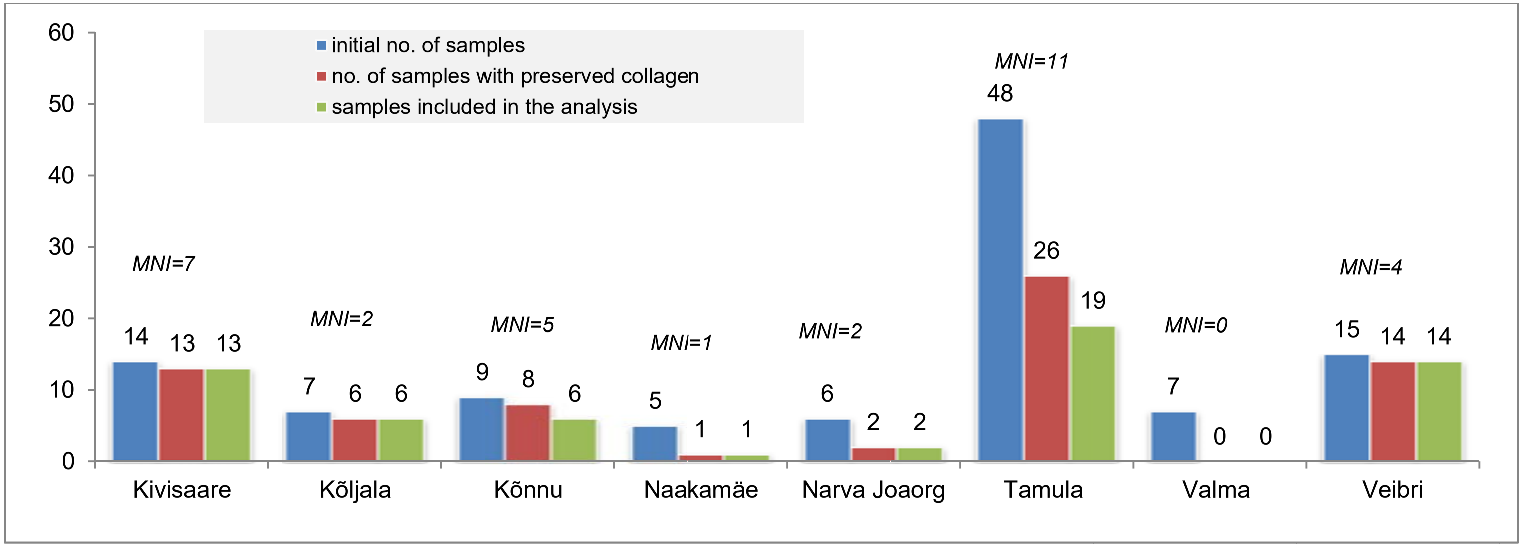

Figure 21. Initial sample size compared to the analysed sample at various sites.
The size of the analysed sample was furthermore affected by the poor collagen preservation, but also in several cases the C:N ratio deviated from the accepted range. MNI refers to the number of individuals included in the final analysis from each site.

Table 17. Summary of stable isotope data from human bone collagen of Stone Age sites in Estonia.

All the samples targeted for collagen extraction and published previously (Lõugas et al. 1996; Kriiska et al. 2007; Mannermaa 2008) are included. Data used for subsequent analysis is highlighted with grey. The rows that are strikethrough are omitted from the analysis for various reasons that are marked in comments column.

Grave no.	***Age/sex***	***Lab no.***	***Element***	***Collagen (mg)***	***Collagen (%)***	***δ^{13}C (‰)***	***δ^{15}N (‰)***	***% C***	***% N***	***C:N***	***Comments***	***Published data***
~~Kivisaare XVIII (*I; 1962*)~~	~~Older child~~	~~UBA-25991~~	~~Mandible (R)~~			~~-22.0~~	~~11.7~~			~~3.4~~	Excluded due to EBA date	Tõrv & Meadows 2015
~~Kivisaare XIX (*II; 1962*)~~	~~Adult~~	~~UBA-25992~~	~~Femur (L)~~			~~-22.2~~	~~11.8~~			~~3.4~~	Excluded due to EBA date	Tõrv & Meadows 2015
Kivisaare XXa (*III; 1965*)	Adult, M	KVS02	RM_1	4.2	5.8	-25.2	15.6	40.1	14.2	3.3	Measured in Stable Isotope Facility, Faculty of Life Sciences, University of Bradford (SIF, UB)	
		KVS03	RM_2	0.6	1.0	-23.8	15.6	38.0	12.9	3.4	SIF, UB	
		KVS01	RM_3	13.1	4.6	-20.4	15.0	40.3	14.1	3.3	SIF, UB	
		UBA-25993	Mandible (R)			-23.5	16.1			3.3		
Kivisaare XXI (*IV; 1965*)	Older child	KVS08	LM_1	5.3	5.1	-18.5	15.1	43.0	15.3	3.3	SIF, UB	
		KVS09	RM_2	0.8	1.0	-22.0	13.8	34.7	11.8	3.5	SIF, UB; even if the average C:N ratio for two measurements is in the quality range the C:N ratio for one of the measurements exceeded it (3.59) and thus this measurement is included to the final analysis	
		~~KVS10~~	~~Cranium~~								Failed to produce collagen	
Kivisaare XXVIII (*y_{1-a}/16-17*)	Adult	UBA-27670	Humerus (R)	2.8		-24.2	11.7			3.2	In the analysis the average of UBA-27670 and KVS07 is used (δ^{13}C=-24.5; δ^{15}N=11.8)	
		KVS07	Humerus (R)	2.2	1.2	-24.7	11.9	34.3	11.8	3.4	SIF, UB	
Kivisaare (TÜ1113:L18)	Adult	KVS04	Femur (L)	7.5	4.6	-22.1	11.1	41.8	14.5	3.4	SIF, UB	
Kivisaare (TÜ 1113:L28)	Adult	KVS05	Femur	5.5	4.4	-21.8	11.1	42.3	14.9	3.3	SIF, UB	

Grave no.	*Age/sex*	*Lab no.*	*Element*	*Collagen (mg)*	*Collagen (%)*	*$\delta^{13}C$ (‰)*	*$\delta^{15}N$ (‰)*	*% C*	*% N*	*C:N*	*Comments*	*Published data*
Kivisaare (TÜ 1113:L14)	Adult	KVS06	LC_2	4.8	4.3	-22.1	10.8	41.8	14.5	3.4	SIF, UB	
Kivisaare (TÜ1113:287)	UD	KVS11	Long bone	1.1		-23.8	14.7	37.8	13.4	3.3	SIF, UB	
Kivisaare (TÜ1113:705)	UD	KVS12	Long bone	0.4		-23.0	14.1	34.0	11.6	3.4	There was not enough collagen to make a double measurement of this sample	
Kudruküla	UD	Est 1/CAMS-6265	Mandible			-21.7						Lõugas et al. 1996
Kudruküla	UD	Est 2/CAMS-6266	Mandible			-20.4						Lõugas et al. 1996
Kudruküla	UD	Est 3	Mandible			-23.0						Lõugas et al. 1996
Kunda	UD	Est 4	Humerus			-21.1						Lõugas et al. 1996
Kõljala I	Adult, M	KOL04	RM_1			-15.2	14.6	33.4	12.1	3.2	SIF UB; there was not enough collagen to make a double measurement of this sample	
		UBA-27363	Mandible	2.5		-14.3	15.5			3.2		
		Est 16	Cranium			-19.1						Lõugas et al. 1996
		~~KOL05~~	~~RM_2~~								Failed to produce collagen	
Kõljala III	Adult, M?	KOL01	RM^1	3.9	5.8	-12.7	15.8	41.2	15.2	3.2	SIF, UB	
		KOL02	RM^2	3.6	4.9	-12.6	15.3	40.5	14.8	3.2	SIF, UB	
		KOL03	Maxilla	2.2	4.7	-13.2	15.9	40.0	14.1	3.2	SIF, UB	
		UBA-25996	Frontal bone	0.9		-12.7	15.9		3.2			
Kõnnu I	Adolescent	KON05	RM_1	2.7	3.4	-15.7	13.1	37.1	13.1	3.2	SIF, UB	
		KON01	RM_2	1.3	1.9	-16.5	12.1	37.1	13.2	3.3	SIF, UB	
		~~KIA-49481~~	~~Mandible~~								Measured in Berlin, machinery error	
Kõnnu II	Older child	UBA-25997	Cranium	1.8		-15.3	13.1			3.2		
		~~KON03~~	~~RM_2~~								Failed to produce collagen	
Kõnnu IIa	Young child	KON04	RM_1	2.2	3.0	-15.8	13.4	40.1	14.6	3.2	SIF, UB	
Kõnnu III	Middle adult, M?	KON02	Occipital bone	3.9	3.4	-17.9	12.3	41.4	14.8	3.3	SIF, UB	

Grave no.	*Age/sex*	*Lab no.*	*Element*	*Collagen (mg)*	*Collagen (%)*	*δ¹³C (‰)*	*δ¹⁵N (‰)*	*% C*	*% N*	*C:N*	*Comments*	*Published data*
		~~KIA-48480~~	~~Femur (R)~~	~~8.1~~		~~-14.3~~	~~12.9~~			~~3.4~~	Measured in Berlin, machinery error	
Kõnnu 111 (1)	UD	UBA-26077	Femur (R)	3.8		-15.7	12.3			3.2		
Naakamäe	Adolescent, F	NAAK02	LM[1]	0.4	0.6	-15.7	15.6	36.9	12.2	3.5	SIF UB; there was not enough collagen to make a double measurement of this sample	
		Est 7/Ua-4882	Femur			-16.0						Lõugas et al. 1996
		~~NAAK01~~	~~LM[2]~~								Failed to produce collagen	
		~~NAAK04~~	~~LM[2]~~								Failed to produce collagen	
		~~NAAK03~~	~~Mandible~~								Failed to produce collagen	
		~~NAAK03~~	~~Mandible~~								Failed to produce collagen	
~~Narva Joaorg I~~	~~Adolescent, M~~	~~UBA-27669~~	~~Femur (R)~~								Failed to produce collagen	
		~~KIA-50291/UBA-25080~~	~~Parietal bone (L)~~								Failed to produce collagen	
		~~UBA-27364~~	~~Femur (L)~~								Failed to produce collagen	
		~~UBA-27512~~	~~Femur (L)~~								Failed to produce collagen	
Narva Joaorg II	Adult	UBA-27357	Parietal bone	1.5		-22.1	15.9			3.2		
Narva Joaorg IV	Adult	UBA-26079	Parietal bone (R)	2.9		-23.3	16.2			3.2		
		Est 6	Cranium			-21.9						Lõugas et al. 1996
~~Tamula I~~	~~Middle adult, F~~	~~TAM09~~	~~Mandible~~								Stable Isotope Laboratory, Department of Geological Sciences, Stockholm University (SIL, SU); failed to produce collagen	
		~~TAM11~~	~~M1~~								SIL, SU; failed to produce collagen	
Tamula III	Middle adult, M	TAM26	RM_1	2.3	3.0	-24.2	14.0	39.4	14.6	3.2	SIL,SU	Tõrv & Eriksson in prep.
		TAM25	RM_2	1.4	2.0	-24.2	13.6	40.8	13.6	3.5	SIL,SU	Tõrv & Eriksson in prep.

Grave no.	*Age/sex*	*Lab no.*	*Element*	*Collagen (mg)*	*Collagen (%)*	*$\delta^{13}C$ (‰)*	*$\delta^{15}N$ (‰)*	*% C*	*% N*	*C:N*	*Comments*	*Published data*
		TAM08	Mandible	1.6	2.0	-24.7	13.5	39.4	13.3	3.5	SIL,SU	Tõrv & Eriksson in prep.
~~Tamula IV~~	~~Adult, M?~~	~~UBA-27668~~	~~Cranium~~								Failed to produce collagen	
~~Tamula VI~~	~~Adolescent~~	~~KIA-48956~~	~~Ilium (R)~~			~~-24.1~~	~~11.4~~				Measured in Berlin, machinery error	
Tamula VII	Older child	TAM12	M_1	1.4	2.0	-24.0	14.0	39.8	13.7	3.4		Tõrv & Eriksson in prep.
		Hela-1335	Mandible			-27.1						Kriiska et al. 2007; Mannermaa 2008
		~~TAM13~~	~~M_2~~								SIL, SU; failed to produce collagen	
		~~TAM07~~	~~Mandible~~								SIL, SU; failed to produce collagen	
Tamula VIII	Middle adult, F	TAM17	M1	0.7	1.0	-23.1	13.5	37.3	13.2	3.3	SIL, SU	Tõrv & Eriksson in prep.
		TAM15	M2	1.7	3.0	-23.9	12.7	39.3	14.3	3.2	SIL, SU	Tõrv & Eriksson in prep.
		TAM16	M3	1.0	2.0	-23.8	12.2	39.2	14.2	3.2	SIL, SU	Tõrv & Eriksson in prep.
		Hela-1336	Femur (L)			-25.8						Kriiska et al. 2007; Mannermaa 2008
		~~TAM14~~	~~M_2~~								SIL, SU; failed to produce collagen	
		~~TAM06~~	~~Mandible~~								SIL, US; failed to produce collagen	
Tamula IX	Middle adult, M	KIA-48838	Humerus			-24.4	13.5	51.3	18.4	3.3	SIF UB	
		~~TAM05~~	~~Mandible~~	~~0.6~~	~~1.0~~	~~-24.8~~	~~13.3~~	~~22.4~~	~~6.5~~	~~4.0~~	SIL, SU; excluded due to deviant C:N ratio	
		~~TAM18~~	~~M2~~								SIL, SU; failed to produce collagen	

Grave no.	*Age/sex*	*Lab no.*	*Element*	*Collagen (mg)*	*Collagen (%)*	*δ^{13}C (‰)*	*δ^{15}N (‰)*	*% C*	*% N*	*C:N*	*Comments*	*Published data*
Tamula X	Middle adult, F?	UBA-27362	Femur (L)	3.1		-25.1	12.7			3.3		
		Ua-4828	Nasal concha			-23.9						Lõugas et al. 1996
		~~TAM43~~	~~RM_1~~	~~3.0~~	~~3.0~~	~~-26.2~~	~~12.8~~	~~49.0~~	~~9.3~~	~~6.1~~	SIL, SU; excluded due to deviant C:N ratio	
		~~TAM19~~	~~M2~~								SIL, SU; failed to produce collagen	
		~~TAM04~~	~~Mandible~~	~~0.5~~	~~1.0~~	~~-26.1~~	~~12.6~~	~~44.7~~	~~10.9~~	~~4.8~~	SIL, SU; excluded due to deviant C:N ratio	
		~~TAMULA02~~	~~Tibia~~	~~0.9~~	~~0.4~~	~~-27.3~~	~~9.8~~	~~31.8~~	~~3.2~~	~~11.7~~	SIF, UB; excluded due to deviant C:N ratio	
~~Tamula XI~~	~~Middle adult, M~~	~~Est 21~~	~~Cranium~~								Failed to produce collagen	Lõugas et al. 1996
		~~TAM27~~	~~LM^1~~								SIL, SU; failed to produce collagen	
		~~TAM28~~	~~RM^3~~								SIL, SU; failed to produce collagen	
		~~TAM10~~	~~Cranium~~								SIL, SU; failed to produce collagen	
~~Tamula XII~~	~~Young child~~	~~TAM29~~	~~M_2~~								SIL, SU; failed to produce collagen	
		~~KIA-4839~~	~~Cranium~~								Failed to produce collagen	
Tamula XIV	Sub-adult	UBA-27361	RM_2	7.3		-25.5	14.5			3.2		
Tamula XVII	Middle adult, F	TAM24	M2	0.5	1.0	-23.5	14.1	34.2	11.1	3.6	SIL, SU	Tõrv & Eriksson in prep.
		~~TAM02~~	~~Mandible~~								SIL, SU; failed to produce collagen	
		~~UBA-27360~~	~~Long bone~~								Failed to produce collagen	
Tamula XVIII	Older adult, F	UBA-27359	Humerus (R)	4.4		-24.3	14.1			3.3		
~~Tamula XVIII~~		~~TAMULA01~~	~~RM_1~~	~~1.3~~	~~0.5~~	~~-26.0~~	~~14.1~~	~~42.5~~	~~8.1~~	~~6.1~~	SIF, UB; excluded due to deviant C:N ratio	
		~~TAMULA03~~	~~RM_2~~								Failed to produce collagen	
		~~TAMULA04~~	~~RM_3~~								Failed to produce collagen	

Grave no.	*Age/sex*	*Lab no.*	*Element*	*Collagen (mg)*	*Collagen (%)*	*$\delta^{13}C$ (‰)*	*$\delta^{15}N$ (‰)*	*% C*	*% N*	*C:N*	*Comments*	*Published data*
Tamula XIX	Middle adult, M	Hela-1337	Femur			-25.0						Kriiska et al. 2007; Mannermaa 2008
		~~TAM03~~	~~Mandible~~								SIL, SU; failed to produce collagen	
		~~TAM23~~	~~M2~~								SIL, SU; failed to produce collagen	
~~Tamula XX~~	~~Middle adult, M~~	~~UBA-26088~~	~~Cranium~~								Failed to produce collagen	
Tamula XXIa	Middle adult, M	UBA-25994	Humerus (R)			-25.3	13.4			3.4		
Tamula XXII	Older adult, M	TAM22	M1	1.3	2.0	-24.5	12.9	2.4	0.9	3.2	SIL, SU	Tõrv & Eriksson in prep.
		TAM20	M2	1.3	2.0	-24.8	13.1	38.8	13.6	3.3	SIL, SU; In the analysis the average of TAM 20 and TAM34 is used ($\delta^{13}C$=-24.8 and $\delta^{15}N$=13.0)	Tõrv & Eriksson in prep.
		TAM34	LM_2	2.8	3.0	-24.7	13.0	40.1	14.7	3.2	SIL, SU; cleaned with acetone	Tõrv & Eriksson in prep.
		TAM21	M3	2.2	3.0	-23.9	12.4	40.2	13.9	3.4	SIL, SU	Tõrv & Eriksson in prep.
		TAM01/Ua-43123	Mandible	4.4	5.0	-24.9	13.0	42.6	14.1	3.5	SIL, SU	Tõrv & Eriksson in prep.
Tamula XXIII	Adult	UBA-25995	Tibia (R)			-25.2	14.1			3.2		
~~Tamula XXV~~	~~Sub-adult~~	~~KIA-50305~~	~~Parietal bone (R)~~								Failed to produce collagen	
~~Valma I~~	~~Young child~~	~~VAL04~~	~~Cranium~~								Failed to produce collagen	
~~Valma II~~	~~Young adult, F~~	~~VAL01~~	~~LM_1~~								Failed to produce collagen	
		~~VAL02~~	~~LM_2~~								Failed to produce collagen	
		~~VAL03~~	~~LM_3~~								Failed to produce collagen	
		~~KIA-48954~~	~~Tibia (R)~~								Failed to produce collagen	
		~~KIA-49482~~	~~Mandible~~								Failed to produce collagen	
~~Valma III~~	~~Middle adult, M~~	~~KIA-48955~~	~~Femur (L)~~								Failed to produce collagen	

Grave no.	*Age/sex*	*Lab no.*	*Element*	*Collagen (mg)*	*Collagen (%)*	*$\delta^{13}C$ (‰)*	*$\delta^{15}N$ (‰)*	*% C*	*% N*	*C:N*	*Comments*	*Published data*
Veibri I/I	Adolescent	VEI09	M_1	0.8	1.0	-23.2	15.4	37.8	13.6	3.3	SIL, SU	Tõrv & Eriksson in prep.
		VEI10	M_2	1.5	2.0	-22.7	14.6	39.3	13.4	3.4	SIL, SU; in the analysis the average of VEI10 and VEI07 is used ($\delta^{13}C$=-22.7 and $\delta^{15}N$=14.8)	Tõrv & Eriksson in prep.
		VEI07	M_2	1.9	3.0	-22.6	15.0	39.7	14.3	3.2	SIL, SU	Tõrv & Eriksson in prep.
		VEI01/Ua-43124	Mandible	4.8	4.0	-23.5	15.1	41.8	14.1	3.5	SIL, SU; in the analysis the average of VEI01 and UBA-27355 is used ($\delta^{13}C$=-23.4 and $\delta^{15}N$=15.1)	Tõrv & Eriksson in prep.
		UBA-27355	Mandible	5.6		-23.3	15.0			3.2		
Veibri I/II	Middle adult, F	VEI06	M^2	0.5	1.0	-23.1	15.0	38.2	13.4	3.3	SIL, SU	Tõrv & Eriksson in prep.
		VEI11	M^3	1.4	1.0	-23.2	14.4	39.4	14.3	3.2	SIL, SU	Tõrv & Eriksson in prep.
		VEI02	Mandible	1.9	3.0	-23.5	14.4	39.9	13.6	3.4	SIL, SU	Tõrv & Eriksson in prep.
		Hela-1331	Radius (R)			-24.0						Kriiska et al. 2007
		~~VEI08~~	~~M_3~~								SIL, SU; failed to produce collagen	
Veibri I/III	Young child	VEI05	M1	1.8	3.0	-23.0	15.2	40.1	14.5	3.2	SIL, SU	Tõrv & Eriksson in prep.
		VEI03	Mandible	2.9	3.0	-23.5	16.1	40.2	14.0	3.3	SIL, SU	Tõrv & Eriksson in prep.
		KIA-48842	Femur (L)			-23.2	14.9	37.2	13.7	3.2	SIF, UB	
Veibri I/IV	Young child	VEI04	Mandible	3.2	4.0	-23.3	15.9	40.7	13.8	3.5	SIL, SU	Tõrv & Eriksson in prep.
		KIA-48843	Femur (R)			-22.9	15.8	42.0	15.2	3.2	SIF, UB	

Table 18. Summary of stable isotope data of faunal bone collagen of Stone Age sites in Estonia.

Grave no.	*Lab no.*	*Taxa*	*Element*	*Collagen (%)*	*$\delta^{13}C$ (‰)*	*$\delta^{15}N$ (‰)*	*% C*	*% N*	*C/N*	*Notes*
Tamula IX	TAM 38	Seal	C	1	-16.82	14.28	34.29	11.99	3.34	All the bones, if not stated otherwise, were measured in 2011 at Stockholm University; all the animal bones were determined by J. Storå, unless stated otherwise
Kõnnu IIa	KON06	Ringed seal	Temporal bone	0.72	-19.86	13.82	29.45	13.82	3.54	SIF, UB; the bone is determined by L. Lõugas
~~Tamula VIII~~	~~TAM 30~~	~~Elk~~	~~M 1 or 2~~	–	–	–	–	–	–	Failed to produce collagen
~~Tamula VIII~~	~~TAM 31~~	~~western capercaillie~~	~~Radius (R)~~	–	–	–	–	–	–	Failed to produce collagen
~~Tamula VII~~	~~TAM 32~~	~~Bear~~	~~RC, mandible~~	–	–	–	–	–	–	Failed to produce collagen
~~Tamula VIII~~	~~TAM 33~~	~~Dog~~	~~C~~	–	–	–	–	–	–	Failed to produce collagen
~~Tamula VIII~~	~~TAM 35~~	~~Elk~~	~~I~~	–	–	–	–	–	–	Failed to produce collagen
~~Tamula VIII~~	~~TAM 36~~	~~Dog~~	~~C~~	–	–	–	–	–	–	Failed to produce collagen
~~Tamula VIII~~	~~TAM 37~~	~~Wild boar~~	~~I, mandible~~	–	–	–	–	–	–	Failed to produce collagen
~~Tamula IX~~	~~TAM 39~~	~~Beaver~~	~~I, mandible~~	–	–	–	–	–	–	Failed to produce collagen
~~Tamula VIII~~	~~TAM 40~~	~~Beaver~~	~~I maxilla~~	–	–	–	–	–	–	Failed to produce collagen
~~Tamula VIII~~	~~TAM 41~~	~~Pine marten~~	~~Mandible (L)~~	–	–	–	–	–	–	Failed to produce collagen
~~Tamula X~~	~~TAM 42~~	~~Wild boar~~	~~Tooth (C?)~~	–	–	–	–	–	–	Failed to produce collagen

5.2.2. Two distinct groups – people subsisting on freshwater fish or marine resources

The stable isotope data from eight Stone Age sites indicate a clear distinction between the inland river bank or lake depression locales and island settlements (Table 17; Figure 22 and 23). Based on Swedish material, Lidén & Nelson (1994) reported δ^{13}C values of -16.29‰ to -14.25‰ for individuals from coastal sites with marine-based diets, and proposed a δ^{13}C range for human bone collagen with fully terrestrial diets in the Baltic Sea region during the Neolithic -20‰ to -21‰. The majority of δ^{13}C values from inland sites in Estonia are more depleted in carbon, extending from -18.5‰ to -25.5‰. The δ^{13}C values from the island of Saaremaa remain between -12.6‰ to -17.9‰.

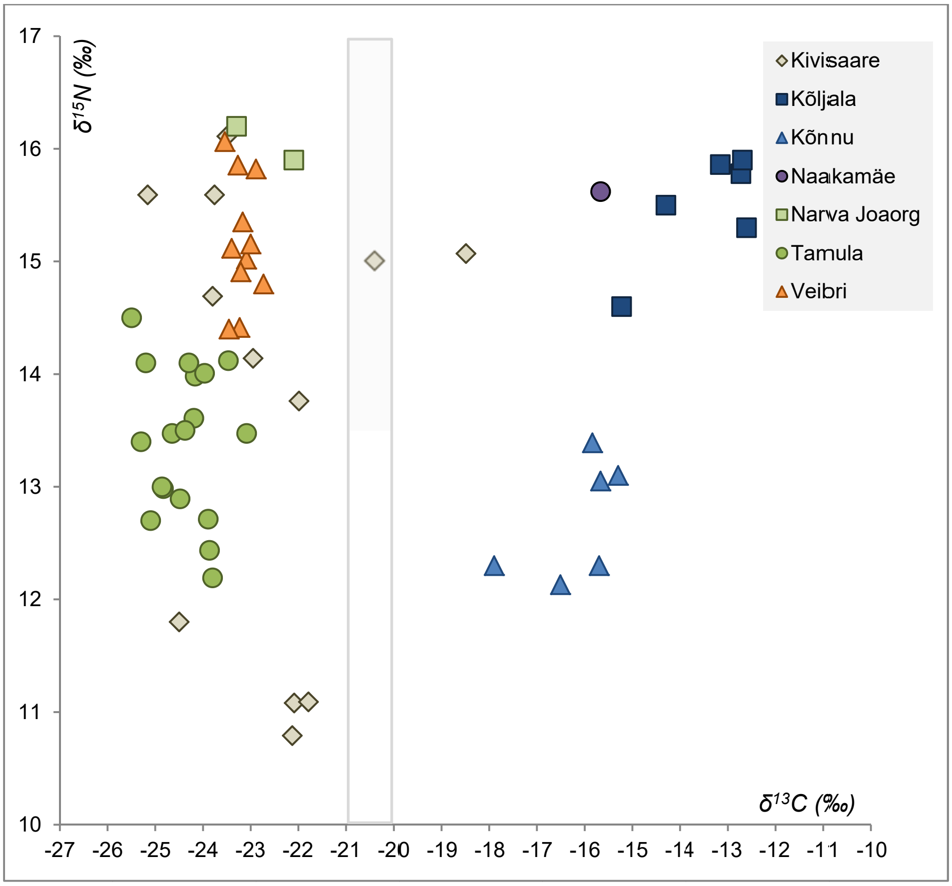

Figure 22. Summary of stable isotope data from all the Stone Age sites in Estonia included in the present study.
The grey area marks the δ^{13}C range for bone collagen from humans with fully terrestrial diets in the Baltic area during the Neolithic (after Lidén & Nelson 1994).

Figure 23. Stable isotope data from all the Stone Age sites in Estonia plotted against the faunal references.

The grey area marks the $\delta^{13}C$ range for bone collagen from humans with fully terrestrial diets in the Baltic area during the Neolithic (after Lidén & Nelson 1994), the isotopic ranges for fauna are described according to the Stone Age sites in Latvia and Sweden (Eriksson & Zagorska 2003; Eriksson 2006; Bērziņš et al. 2014; Schmölke et al. 2015; Eriksson 2004; Eriksson et al. 2008). As a reference also Early Bronze Age stable isotope data from Riigiküla I and III is added (Tõrv & Meadows 2015). Otter values derive from Zvejnieki, Latvia (Eriksson 2006).

Fernandes et al. (2014a) observed that collagen $\delta^{15}N$ in terrestrial herbivores from Late Mesolithic and Neolithic sites in northern Europe were 5.9±1.4‰, compared to 8.8±1.5‰ for fishes. Previously it has been argued that a significant intake of aquatic resources is indicated when the human collagen $\delta^{15}N$ is ≥12‰ (see the references in Fernandes et al. 2014a). Their study, however, showed that remarkable dietary radiocarbon reservoir offsets are reported with lower values of $\delta^{15}N$ in human collagen (Fernandes et al. 2014a); further suggesting that significant protein intake of aquatic resources should be considered with lower $\delta^{15}N$ values than ≥12‰. Thus, the elevated $\delta^{15}N$, ranging from 10.8‰ to 16.4‰ in adult samples, together with depleted $\delta^{13}C$ values are indicative of a subsistence based primarily on freshwater fishes within the inland populations. The $\delta^{15}N$ (12.1‰ to 15.9‰) and elevated $\delta^{13}C$ values from the island of Saaremaa refer to a considerable importance of marine fishes and mammals in the protein intake of these people (Figure 23). Regardless of the general trend pointed out here, noticeable intra-site as well as intra-individual variances occur (Table 17 and 19), as becomes clear from the following discussion.

Table 19. P-values for the one-way ANOVA for independent samples while detecting inter-site differences in $\delta^{13}C$ and $\delta^{15}N$.

Calculations are done with Past 3.11 (Hammer et al. 2001). Bold values represent sequential Bonferroni significance at the level of <0.05. MNI – minimum number of individuals and SD – standard deviation.

	n samples	MNI	mean $\delta^{13}C$ (‰)	SD (σ)	Kivisaare	Kõljala	Kõnnu	Narva Joaorg	Tamula
Kivisaare	12	9	-22.7	±1.8					
Kõljala	7	2	-14.3	±2.3	**<0.001**				
Kõnnu	6	5	-16.2	±0.9	**<0.001**	**0.005**			
Narva Joaorg	3	2	-22.4	±0.8	0.927	0.065	0.065		
Tamula	18	11	-24.4	±0.7	**0.001**	**<0.001**	**<0.001**	**0.037**	
Veibri	11	4	-23.3	±0.3	0.579	**<0.001**	**<0.001**	0.550	**<0.001**
	n samples	**MNI**	**mean $\delta^{15}N$ (‰)**	**SD (σ)**	**Kivisaare**	**Kõljala**	**Kõnnu**	**Narva Joaorg**	**Tamula**
Kivisaare	12	9	13.6	±2.0					
Kõljala	6	2	15.5	±0.5	0.054				
Kõnnu	6	5	12.7	±0.5	0.281	0.005			
Narva Joaorg	2	2	16.1	±0.2	0.055	0.124	0.064		
Tamula	18	11	13.4	±0.7	0.252	**<0.001**	0.045	0.027	
Veibri	11	4	15.2	±0.5	0.096	0.267	**0.001**	0.075	**<0.001**

The isotopic signatures of individuals at Kivisaare, -18.5‰ to -25.2‰ for $\delta^{13}C$ and 10.8‰ to 16.1‰ for $\delta^{15}N$, are most variable ($\sigma(\delta^{13}C)=\pm1.8‰$, $\sigma(\delta^{15}N)=\pm2.0$). These are indicative of mixed diets with a considerable intake of freshwater resources. Within the Kivisaare population, four more discrete groups could be distinguished:

(1) Six samples – three from the individual XXa, one from XXI and two loose human bones (TÜ 1113: 287, 705) presented broader $\delta^{13}C$ (-23.5‰ to -22‰; $\sigma=\pm1‰$) and $\delta^{15}N$ (13.8‰ to 16.1‰; $\sigma=\pm0.8‰$) ranges (Figure 24: blue). These values indicate terrestrial diets with a considerable protein intake of freshwater fishes.

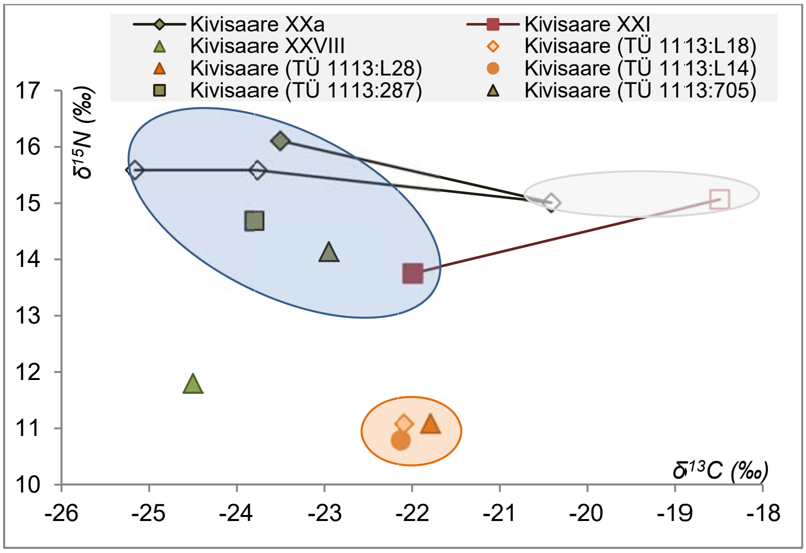

Figure 24. Stable isotope values from Kivisaare representing four more discrete groups.

Kivisaare XXa and XXI display moderate intra-individual changes, whereas the values of both individuals are plotted in the order of the sample formation, the last value being marked as a filled symbol.

(2) Two samples representing the childhood diets of individuals XXa (KVS01) and XXI (KVS08) have elevated $\delta^{13}C$ and $\delta^{15}N$ values (Figure 24: grey). These indicate a terrestrial/mixed diet. Compared to the first group, the protein input of freshwater resources is less obvious here. The adolescent value of individual XXa is the only data point that represents a fully terrestrial diet in the whole sample. From Figure 24 it becomes clear that there has been a considerable change in $\delta^{13}C$ value during the individual's lifetime. Most probably, this indicates a dietary shift from the consumption of freshwater

recourses during the childhood toward terrestrial food stuffs in adolescent years, whereas during the years prior death the diet becomes dominated by freshwater fish again.

(3) The third group comprises a sample of loose human bones assemblage from the context y1–a/16–17 (Figure 24: green). This is characterised by depleted $\delta^{13}C$ (-24.5‰) and $\delta^{15}N$ (11.8‰) values, which suggest a consumption of freshwater fish lower in the food chain compared to the samples within the first group (Figure 24: blue).

(4) The fourth group aligned to the area with slightly more elevated $\delta^{13}C$ (-22.1‰; -21.8‰ and -22.1‰) and depleted $\delta^{15}N$ (11.1‰; 11.1‰ and 10.8‰) values (Figure 24: orange), which indicate a terrestrial diet. These three samples derive from a single context that represents a reburial conducted at the end of 19th or beginning of 20th century (TÜ 1113: L14, L18 and L28; see *Chapter 6.2.2.1.*). The osteological analysis showed that these bones belong to three individuals (*Chapter 6.2.2.1.*). However, considering the isotope turnover rates within long bones, one could suggest that the fragments of femurs (TÜ 1113: L18 and L28) belonged to a single individual. But as we see a moderate intra-individual variation within the diets of individuals XXa and XXI (Figure 24), we cannot exclude the possibility that the third bone also derives from the same individual. This said, the isotope values do not aid in delimiting the minimum number of individuals from the feature. Moreover, none of these fragments is dated; however, their values are similar to the isotopic signatures from Early Bronze Age inhumations at Riigiküla I and Kivisaare (Tõrv & Meadows 2015, 648 Table 1; Figure 22 and 23), suggesting that these samples may not represent Stone Age diets. Without direct dates this could only be a reliable suggestion, not a proven fact, and serves further investigation.

The isotope signatures of two adults from Narva Joaorg are homogenous ($\sigma(\delta^{13}C)$=±0.8‰, $\sigma(\delta^{15}N)$=±0.2‰). These display the highest values for $\delta^{15}N$ (15.9‰ and 16.2‰) and are moderately depleted in $\delta^{13}C$ (-23.3‰ and -21.9‰), which indicate the consumption of freshwater fishes high in the food web. The poor collagen preservation and particularity of the mortuary practices (see *Chapter 6.2.2.2.*) prohibits further discussion over intra-individual variability. The inter-site analysis shows that Narva Joaorg samples cluster with single samples from Kivisaare (Figure 24: blue) and Veibri (Figure 22). Moreover, the $\delta^{13}C$ values at Narva Joaorg are rather similar to those obtained from the vicinity of Kudruküla and Kunda Lammasmägi (Lõugas et al. 1996, 405).

The isotope signatures at Tamula are indicative of an isotopically homogenous diet within the buried population, with $\delta^{13}C$ ranging from -25.5‰ to -23.1‰ (σ=±0.7‰) and $\delta^{15}N$ from 12.2‰ to 14.5‰ (σ=±0.7‰). The bulk of the protein intake derives from freshwater fish (Figure 22 and 23). Unlike at Kivisaare we do not observe distinct groups here. The most depleted $\delta^{13}C$

values derive from bones of probable males in graves X (-25.1‰), XXI (-25.3‰) and XXIII (-25.2‰), and from the sub-adult in grave XIV (-25.5‰). The latter also displays the most elevated $\delta^{15}N$ (14.5‰) value. The other samples showing elevated $\delta^{15}N$ values represent mostly childhood values (III, VII, XVII and XXII), only two deriving from an adult (XVIII and XXIII). Limited or moderate intra-individual dietary changes are observed in individuals III, VIII, and XXII (Figure 25). In all three cases the $\delta^{15}N$ values in M1 are consistently higher than in other molars or bone tissue. This might indicate a nursing effect, which is the trophic level difference between the nursing infant and her/his mother (Fogel et al. 1989; Reynard & Tuross 2015). As the formation of the initial root of M1 tooth ends when the child is several years old, one should not expect a full trophic level shift (3–4‰) when ascending in the food chain here (Schoeninger & DeNiro 1984; Minagawa & Wada 1984). Alternatively, the elevated $\delta^{15}N$ within the sub-adult samples could be due to the differences in collagen turnover rates in bone tissue. The observed limited or moderate differences (σ(III $\delta^{13}C/\delta^{15}N$)=±0.2/±0.2‰; σ(VIII $\delta^{13}C/\delta^{15}N$)=±0.4/± 0.5‰; σ(XXII $\delta^{13}C/\delta^{15}N$)=±0.4/±0.2‰) suggest that no substantial changes in diet over individual lifetimes occurred.

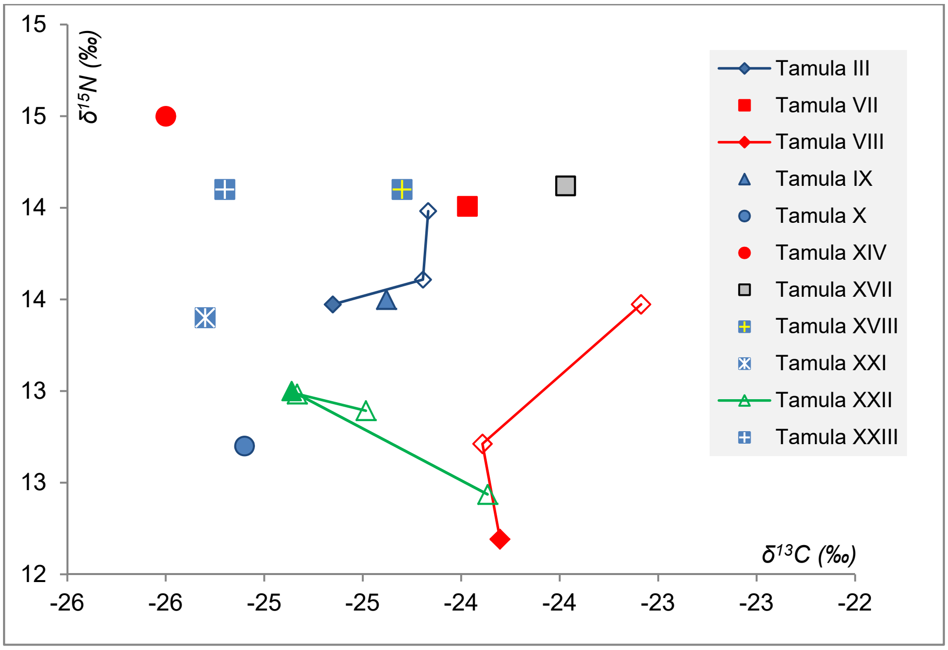

Figure 25. The summary of isotope signatures at Tamula.
Where possible – i.e. at graves III, VIII and XXII – limited intra-individual variations are displayed. There the values for each individual are represented in order of collagen formation, with the last value plotted with a filled symbol. Colour-coding gives a temporal perspective on the stable isotope values: blue – 3900–3500 cal. BC, red – 3500–3000 cal. BC and green – 3000–2600 cal. BC; grey marks an undated sample.

The Veibri isotope data represents a homogenous group ($\sigma(\delta^{13}C)$=±0.2‰, $\sigma(\delta^{15}N)$=±0.6‰) with depleted $\delta^{13}C$ (-23.5‰ to -22.7‰) and elevated $\delta^{15}N$ (14.4‰ to 16.1‰) values. The whole sample is indicative of a terrestrial diet with significant contributions from freshwater resources. The elevated $\delta^{15}N$ values within this population are most probably an outcome of a nursing effect, as the most depleted $\delta^{15}N$ value (14.4‰) represents the average diet of several years prior death of the adult. The intra-individual change of III is limited (Figure 26), indicating only a slight change during her/his early childhood. The limited or moderate intra-individual variations in general (σ(I $\delta^{13}C/\delta^{15}N$)= ±0.3/±0.3‰; σ(II $\delta^{13}C/\delta^{15}N$)=±0.2/±0.4‰; σ(III $\delta^{13}C/\delta^{15}N$)=±0.3/±0.5‰) are indicative of no noteworthy changes in the protein intake during the individual's lifetime.

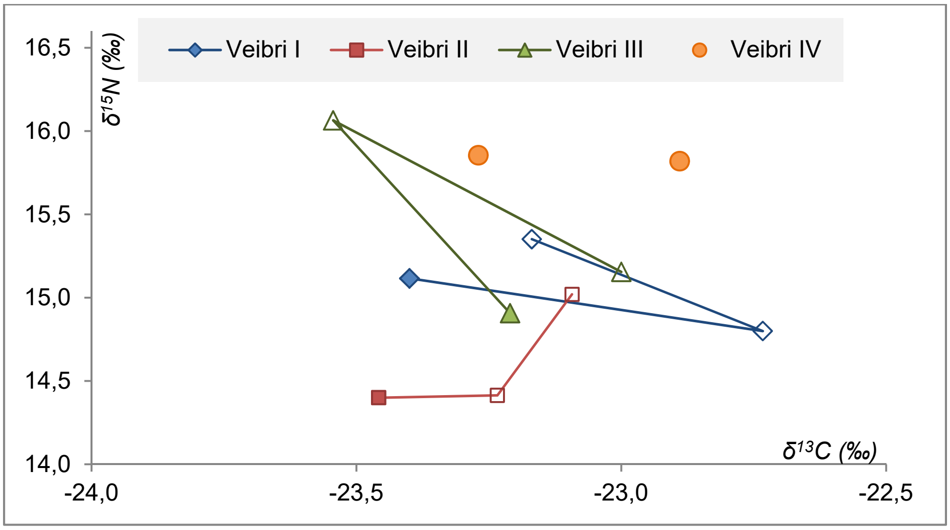

Figure 26. Stable isotope signatures of the Veibri quadruple grave.
The limited intra-individual dietary variations of individuals I, II, and III are displayed. The values for each individual are represented in order of collagen formation, with the last value plotted with a filled symbol. The two values from individual IV do not represent different time periods of one's life cycle, but represent different bone elements (mandible and femur) and could be indicative of different collagen turnover rates in different bone elements.

The isotope signatures of Kõljala present the most elevated $\delta^{13}C$ (-15.2‰ to -12.6‰) and $\delta^{15}N$ (14.6‰ to 15.9‰) values for island sites, indicating the high importance of marine mammals in the diet of these two individuals (Figure 23). Previously also a $\delta^{13}C$ value of one individual from Kõjala has been published (Lõugas et al. 1996, 405), which is markedly more terrestrial than the values obtained during the present study. Their $\delta^{15}N$ values show no significant intra-site differences (σ=±0.5‰), while their $\delta^{13}C$ values are more variable (σ=±1.1‰), marking a clear contrast between these two individuals. However, the limited intra-individual variations (σ(I $\delta^{13}C/\delta^{15}N$)=±0.5/±0.5‰; σ(III $\delta^{13}C/\delta^{15}N$)= ±0.2/±0.2‰) refer to no remarkable changes in diet over their individual lifetimes (Figure 27).

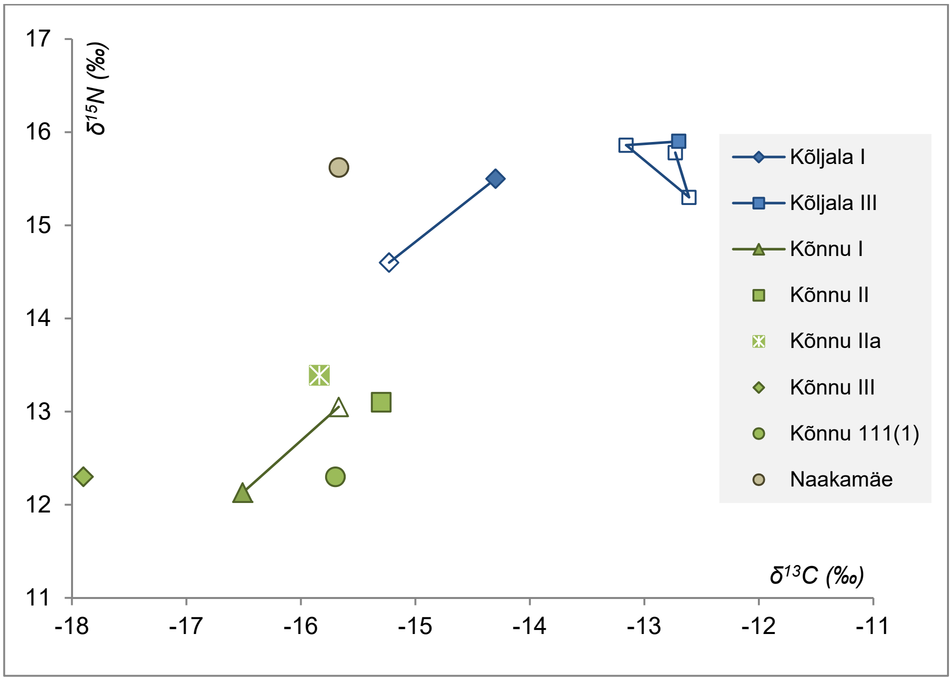

Figure 27. Stable isotope signatures of sites from Saaremaa island.
The limited intra-individual dietary variations of Kõljala I, Kõljala II, and Kõnnu I individual are displayed. The values for each individual are represented in order of collagen formation, with the last value plotted with a filled symbol.

The isotope signatures of Kõnnu individuals, ranging from -17.9‰ to -15.3‰ for $\delta^{13}C$ and 12.1‰ to 13.4‰ for $\delta^{15}N$, indicate the considerable importance of marine resources in the diet. Similarly to Kõljala individuals, the $\delta^{15}N$ values show no significant intra-site differences (σ=±0.5‰), but the $\delta^{13}C$ values are more variable (σ=±0.9‰) allowing two more distinct groups to be identified (Figure 27):

(1) Three samples – Kõnnu I, representing an older child, Kõnnu III, an adult, and an adult from feature 111 – are characterised by depleted $\delta^{13}C$ and $\delta^{15}N$ values;
(2) Three samples – Kõnnu I and IIa representing young children, and Kõnnu II an older child – have elevated $\delta^{13}C$ and $\delta^{15}N$ values. The elevated $\delta^{15}N$ values in the second group refer to a protein intake higher in trophic level compared to the first group. Similarly to Tamula the

elevated $\delta^{15}N$ values could be explained by a nursing effect, which is further supported by the limited intra-individual shift in the diet of the Kõnnu I individual (Figure 27).

Only one sample is available from Naakamäe that indicates a fully marine diet ($\delta^{13}C$ -15.7‰; $\delta^{15}N$ 15.6‰) clustering within the range of sea mammals (Figure 23 and 27). Here, however, one has to bear in mind that this sample represents the diet of a young child. Thus, the elevated $\delta^{15}N$ may also be explained by a nursing effect. The single $\delta^{13}C$ value from the femur indicates only a limited amount of intra-individual variation of the protein intake during her lifetime, further suggesting that marine fishes and mammals constituted a significant part of her diet.

5.2.3. Conclusions

A clear dietary distinction between inland and island sites is evident. Inland sites are characterised by the high consumption of freshwater resources. The samples from Kõnnu and Naakamäe, Saaremaa, correspond to the seal values from the Swedish coast and the two samples from the present study (Table 17 and 18). Thus, a large proportion of their diet must have come from marine fishes and mammals. The less depleted $\delta^{13}C$ and elevated $\delta^{15}N$ signatures from Kõljala show a markedly stronger reliance on the consumption of marine mammals i.e. seals (compatible values in Late Mesolithic Alby (Lidén et al. 2004) and Mesolithic/Middle Neolithic Köpingsvik (Eriksson et al. 2008) at Öland, Sweden). Moreover, in most cases, low intra-site and low to moderate intra-individual (Figure 28) variability was observed. This might suggest that the mobility among these hunter-gatherer groups in terms of food procurement was rather low, meaning that the majority of their food-stuffs derived from a single reservoir. However, as the local ecological data is not available at this point this statement remains inconclusive.

The hypothesis that these hunter-gatherer groups were sedentary might be further supported by the statistically significant differences between the mean isotope values of some of the inland and island sites. In applying Bonferroni post-hoc test for multiple comparisons to the raw p-values, the figures in Table 19 correspond well with the graphic representation of the stable isotope values from single sites (Figure 22). There is a clear differentiation between inland and island sites that become most obvious when p-values of $\delta^{13}C$ are compared (Table 19). Inter-site differences are most telling while comparing the spatially closest sites Tamula, Veibri, and Kivisaare on the mainland. The mean values of $\delta^{13}C$ of Kivisaare and Veibri do not differ, which also becomes visible in Figure 22; Tamula, however, differs statistically from Kivisaare ($p=0.001$), Veibri ($p<0.001$) and also from Narva Joaorg ($p=0.037$). One also observes a statistically significant difference between the Kõljala site and Kõnnu at Saaremaa ($p=0.005$). The mean values of $\delta^{15}N$ show fewer differences among these populations. The significant differences between Tamula and Veibri ($p<0.001$)

remain; all the other inland sites do not indicate any statistically significant differences. There are no statistically significant differences between the island sites in their $\delta^{15}N$ values (Table 19).

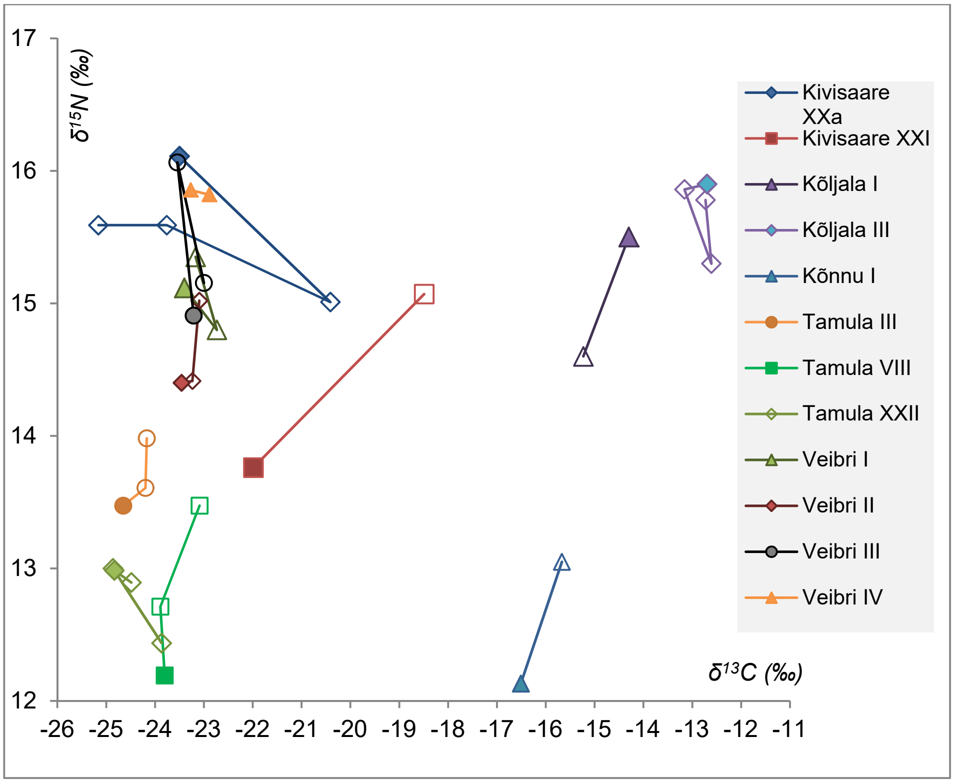

Figure 28. Comparative chart to display the low and moderate intra-individual variations within the analysed sample.

The values for each individual are represented in order of collagen formation, with the last value plotted with a filled symbol.

Radiocarbon data from Tamula suggest that the site was used for a long time (*Chapter 5.3.1.1.1.*), whereas the stable isotope values do not allow any substantial temporal dietary changes to be observed within this population (Figure 25 and 29). However, the low number of individuals involved in the analysis should be kept in mind. This becomes especially problematic when we look at the time range of 3000–2600 cal. BC where four out of the five samples represent various ages of individual XXII. Although all the inland sites are characterised by significant freshwater resource consumption, the inter-site differences between Tamula, Kivisaare, and Veibri, and the low intra-site variability, all suggest that people buried at these sites must have caught their food from different reservoirs.

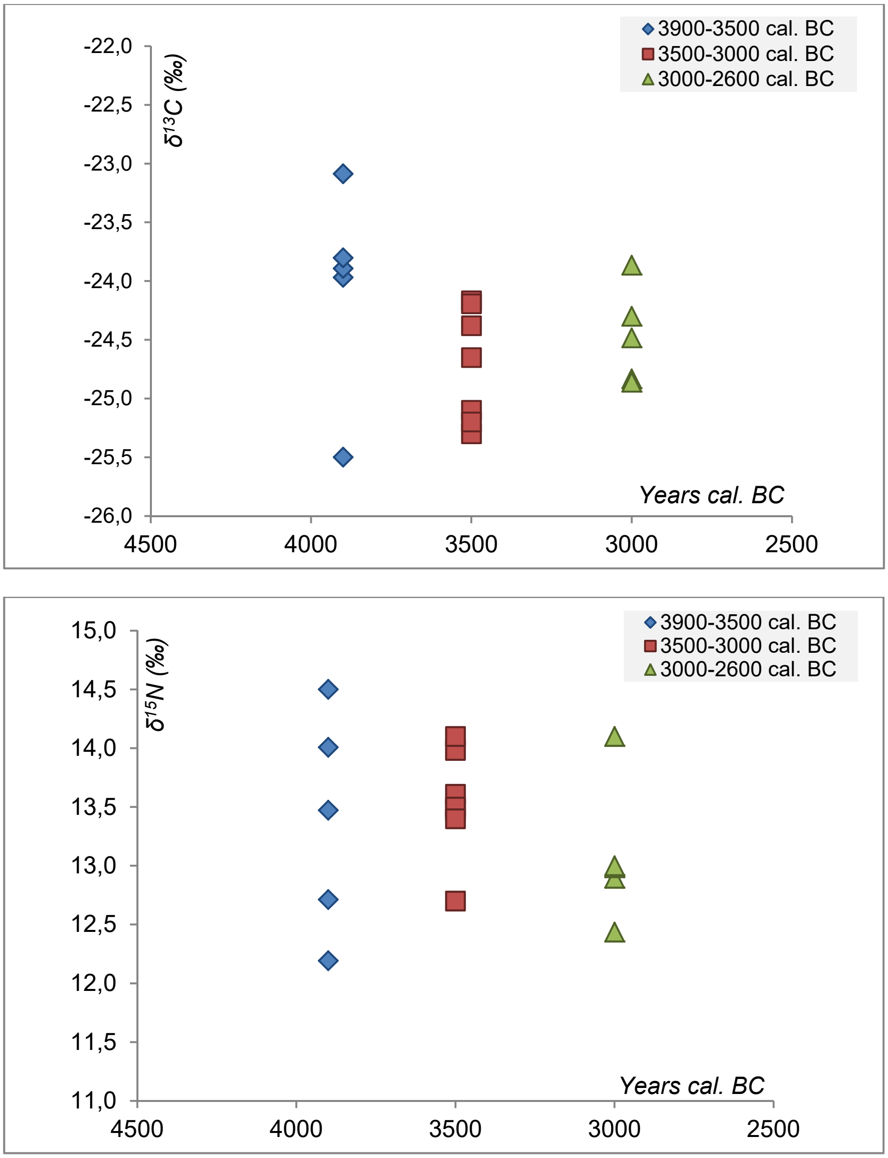

Figure 29. Carbon and nitrogen stable isotope data of the people buried at Tamula plotted against FRE corrected calibrated radiocarbon dates.

No statistically significant differences between various temporal groups were observed either in the $\delta^{13}C$ ($p_{(3900–3500/3500–3000)}$=0.12; $p_{(3500–3000/3000–2600)}$=0.37; $p_{(3900–3500/3000–2600)}$=0.38) nor $\delta^{15}N$ ($p_{(3900–3500/3500–3000)}$=0.70; $p_{(3500–3000/3000–2600)}$=0.57; $p_{(3900–3500/3000–2600)}$=0.17) values.

Moderate variability was observed within the Kivisaare population. The long-lived character of the site (Mesolithic to Early Bronze Age) suggests that this variability might be caused by the temporal changes in the baseline fauna. However, as not all the bones sampled are radiocarbon dated, this assumption remains merely a plausible hypothesis needing further investigation. The moderate intra-individual variations in Kivisaare XXa and XXI allow proposing another explanation. The values of the first individual indicate a shift from freshwater resources (child) toward terrestrial sources during the teenager years. This indicates an increase of animal protein at the expense of fish in the diet. The fish consumption of XXa increases again during the years prior to death. The isotope values of Kivisaare XXI reflect a rapid change within early childhood of the individuals (from 2±1 to 7±1 years). There has been a shift from mixed sourced diet to one where freshwater sources dominated. This could be indicative to the seasonal differences in the diet. The differences could have been caused by the (seasonal) mobility of the group as different ecosystems provided them with different foodstuffs. Also, considering the low intra-site variability of other inland populations, this child may have migrated from another group of hunter-gatherers with a mixed diet and adapted to the new mode of subsistence in Kivisaare. However, to build a solid case to prove either of these assumptions, the sample size has to be increased.

5.3. Dating the individual burials

Bones are also a source of information regarding direct dates to trace changes in mortuary practices and dietary identities of hunter-gatherers. Thus, before moving on with the general discussion about the background of the here-observed hunter-gatherers, the associated radiocarbon dates and their calibrations and implications to the chronology of practices is presented to provide time depth to the discussion.

5.3.1. Radiocarbon dates from graves

Forty-five burials from nine sites were selected for ^{14}C dating, with 15 failing and four turning to be Early Bronze Age, leaving us with 26 new dates (Table 20). The sample consisted mostly of human bones, but also two pine wood pieces[25] and an elk tooth[26] were included. Together with the four Early Bronze Age burials (Tõrv & Meadows 2015), 15 other bones, including the elk tooth, were omitted from the analysis as these did not contain enough collagen. In addition to human bones, animal bones from relevant contexts were targeted to collagen extraction (regarding problems with sampling see *Chapter 3.3.1.*). In sum, 26 new dates are available. Together with already published data (Lõugas et al. 1996; Kriiska et al. 2007; Mannermaa 2008), these give depth to the spatiotemporal dynamics of the mortuary practices, thereby allowing a more comprehensive discussion of the changes or maintenance of the *status quo* through the c. 4000 years.

[25] The determination of the wood species was done by Dr. Stefanie Klooß (16.01.2015).
[26] The determination of the species was done by Dr. Lembi Lõugas (7.05.2015).

Table 20. The ^{14}C dates from hunter-gatherer burials in Estonia.

The samples that have been stricken through will not be used in the following analysis. Some of these samples were dated to a considerably younger period, while others did not yield enough collagen to proceed with the dating. Yet, to indicate the initially sampled burials all of them are listed here. The dates are rounded to the nearest 10 after calibration and FRE correction.

Site	***Number of the burial***	***Lab no.***	***Sample material***	***Conventional radiocarbon age (^{14}C yrs BP)***	***AMS/ IRMS $\delta^{13}C$ (‰)***	***Maximum calibrated (IntCal13) date 68% (cal. BC)***	***Maximum calibrated (IntCal13) date 95% (cal. BC)***	***Reservoir correction***	***Calibrated and reservoir corrected date with 68% probability (cal. BC)***	***Calibrated and reservoir corrected date with 95% probability (cal. BC)***	***Comments***	***Source***
KIVI-SAARE	Kivisaare XXa (*III;1965*)	UBA-25993	Human, right mandible	5796±37	-23.5	4710–4600	4730–4540	-	-	-		This thesis
	Kivisaare XXI (*IV; 1965*)	Poz-10840	Human, cranium	5450±40	-	4350–4260	4370–4230	-	-	-		Kriiska et al. 2007
	Kivisaare XXI (*IV;1965*)	KIA-50905	Human, M1/M2	5705±35	-20.5	4590–4490	4680–4450	-	-	-		This thesis
	Kivisaare y_{1-a}/16–17 (1965)	UBA-27670	Human, right humerus	6233±48	-24.2	5300–5080	5320–5055	-	-	-		This thesis
KUDRU-KÜLA	Kudruküla (Est1)	CAMS-6265	Human, mandible	4770±60	-21.7	3640–3380	3660–3370	-	-	-		Lõugas et al. 1996
	Kudruküla (Est2)	CAMS-6266	Human, mandible	4860±60	-20.4	3710–3530	3785–3520	-	-	-		Lõugas et al. 1996
KÕLJALA	Kõljala I	UBA-27363	Human, mandible	5180±44	-14.3	4050–3950	4230–3810	279±100	3600–3350	3670–3200		This thesis
	Kõljala III	UBA-25996	Human, frontal bone	4914±32	-12.7	3710–3650	3770–3640	279±100	3240–2990	3340–2880		This thesis
KÕNNU	Kõnnu I	KIA-49481	Human, mandible	6297±29	-15.5	5320–5220	5320–5210	279±100	4980–4700	5110–4520		This thesis
	Kõnnu II	UBA-25997	Human, cranium	6222±33	-15.3	5290–5070	5310–5060	279±100	4770–4520	4870–4380		This thesis
	Kõnnu III	KIA-49480	Human, right femur	6896±27	-15.4	5800–5730	5840–5720	279±100	5440–5230	5520–5100		This thesis
	Kõnnu 111 (1)	UBA-26077	Human, shaft of femur	6277±45	-15.7	5310–5220	5360–5070	279±100	4870–4590	4990–4460		This thesis

Site	***Number of the burial***	***Lab no.***	***Sample material***	***Conventional radiocarbon age (^{14}C yrs BP)***	***AMS/ IRMS $\delta^{13}C$ (‰)***	***Maximum calibrated (IntCal13) date 68% (cal. BC)***	***Maximum calibrated (IntCal13) date 95% (cal. BC)***	***Reservoir correction***	***Calibrated and reservoir corrected date with 68% probability (cal. BC)***	***Calibrated and reservoir corrected date with 95% probability (cal. BC)***	***Comments***	***Source***
	~~Kõnnu 111 (2)~~	~~KIA-50298/UBA-26078~~	~~Wild boar, root of the canine toot (L. Lõugas)~~	-	-	-	-	-	-	-	~~Failed to produce collagen~~	~~This thesis~~
	~~Kõnnu 131 (1)~~	~~KIA-50299/UBA-26075~~	~~Elk, root of a tooth (L. Lõugas)~~	-	-	-	-	-	-	-	~~Failed to produce collagen~~	~~This thesis~~
	~~Kõnnu 131 (2)~~	~~KIA-50300/UBA-26076~~	~~Human, mid-shaft of the left ulna~~	-	-	-	-	-	-	-	~~Failed to produce collagen~~	~~This thesis~~
NAAKA-MÄE	Naaka-mäe	Ua-4822	Human, femur	4152±85	-16.0	2880–2630	2910–2490	279±100	2350–2020	2490–1960		Lõugas et al. 1996
NARVA JOAORG	~~Narva Joaorg I~~	~~KIA-50291/UBA-25080~~	~~Human, left parietal~~	-	-	-	-	-	-	-		~~This thesis~~
	~~Narva Joaorg I~~	~~UBA-27364~~	~~Human, left femur~~	-	-	-	-	-	-	-	~~Failed in %Nitrogen test (0.32%N), low collagen yield~~	~~This thesis~~
	~~Narva Joaorg I~~	~~UBA-27512~~	~~Human, left femur~~	-	-	-	-	-	-	-	~~Failed in %Nitrogen test (0.17%N), low collagen yield~~	~~This thesis~~
	~~Narva Joaorg I~~	~~UBA-27669~~	~~Human, right femur~~	-	-	-	-	-	-	-	~~Failed to produce collagen~~	~~This thesis~~
	Narva Joaorg II (:1409)	UBA-27357	Human, parietal	7531±48	-22.1	6460–6370	6470–6250	-	-	-		This thesis
	Narva	UBA-26079	Human, right	7681±45	-23.3	6570–6460	6605–6440	-	-	-		This thesis

Site	*Number of the burial*	*Lab no.*	*Sample material*	*Conventional radiocarbon age (^{14}C yrs BP)*	*AMS/ IRMS $\delta^{13}C$ (‰)*	*Maximum calibrated (IntCal13) date 68% (cal. BC)*	*Maximum calibrated (IntCal13) date 95% (cal. BC)*	*Reservoir correction*	*Calibrated and reservoir corrected date with 68% probability (cal. BC)*	*Calibrated and reservoir corrected date with 95% probability (cal. BC)*	*Comments*	*Source*
	Joaorg IV		parietal									
PIKA-SILLA	~~Pikasilla (TÜ 1772:240)~~	~~KIA-48837~~	~~Human, maxillary L/RM1 permanent)~~	-	-		-	-	-	-	~~Failed to produce collagen~~	~~This thesis~~
TAMULA	Tamula I	Poz-15645	Human, femur	4680±40	-	3520 –3370	3630–3360	-	3130–2750	3350–2630		Kriiska et al. 2007
	Tamula III	Poz-10826	Human, rib	4940±40	-	3770–3660	3800–3640		3480–2970	3630–2840		Kriiska et al. 2007
	~~Tamula IV~~	~~UBA-27668~~	~~Human, cranium~~	-	-	-	-	-	-	-	~~Failed to produce collagen~~	~~This thesis~~
	Tamula VI	KIA-48956	Human, fragment of right ilium	4417±20	-24.1	3100–3010	3270–2920	-	2910–2690	3030–2520		This thesis
	Tamula VII	Hela-1335	Human, mandible	5760±45	-27.1	4690–4550	4720–4500	-	4010–3530	4170–3370		Kriiska et al. 2007; Mannermaa 2008
	Tamula VIII	Hela-1336	Human, left femur	5370±45	-25.8	4330–4070	4335-4055	-	3880–3510	4040–3290		Kriiska et al. 2007; Mannermaa 2008
	~~Tamula VIII~~	~~UBA-27358~~	~~Elk, phalanx (L. Lõugas 7.5.2014)~~	-	-	-	-	-	-	-	~~Failed in %Nitrogen test, no collagen~~	~~This thesis~~
	Tamula IX	KIA-48838	Human, humerus	4995±22	-24.4	3800–3710	3910–3700	402±42	3500–3190	3510–3110		This thesis
	Tamula IX	UBA-28201	Pine wood, beneath the skeleton (S. Klooß 16.1.2015)	4593±36	-	3020–2920	3090–2910	-	-	-		This thesis

Site	*Number of the burial*	*Lab no.*	*Sample material*	*Conventional radiocarbon age (^{14}C yrs BP)*	*AMS/ IRMS $\delta^{13}C$ (‰)*	*Maximum calibrated (IntCal13) date 68% (cal. BC)*	*Maximum calibrated (IntCal13) date 95% (cal. BC)*	*Reservoir correction*	*Calibrated and reservoir corrected date with 68% probability (cal. BC)*	*Calibrated and reservoir corrected date with 95% probability (cal. BC)*	*Comments*	*Source*
	Tamula X	Ua-4828	Human, concha nasalis	5310±85	-23.9	4250–4040	4330–3970	-	-	-		Lõugas et al. 1996
	Tamula X	UBA-27362	Human, left femur	4902±52	-25.1	3750–3640	3890–3530	-	3370–2940	3620–2750		This thesis
	Tamula XI	UBA-28202	Pine wood, beneath the skeleton (S. Klooß 16.1.2015)	4377±29	-	3020–2920	3090–2910	-	3020–2920	3090–2910		This thesis
	~~Tamula XII~~	~~KIA-48839~~	~~Human, cranium~~	-	-	-	-	-	-	-		~~This thesis~~
	Tamula XIV	UBA-27361	Human, mandibular RP4	5331±44	-25.5	4240–4060	4330–4040		3760–3370	3930–3120		This thesis
	~~Tamula XVII~~	~~UBA-27360~~	~~Human, long bone~~	-	-	-	-	-	-	-	~~Failed in %Nitrogen test, no collagen~~	~~This thesis~~
	Tamula XVIII	UBA-27359	Human, right humerus	4696±39	-24.3	3630–3370	3640–3360	-	3130–2750	3350–2630		This thesis
	Tamula XIX	Hela-1337	Human, femur	4925±40	-25.0	3760–3650	3785–3640	-	3490–2970	3630–2790		Kriiska et al. 2007; Mannermaa 2008
	~~Tamula XX~~	~~KIA-50302/UBA-26088~~	~~Human, cranium~~	-	-	-	-	-	-	-	~~Failed to produce collagen~~	~~This thesis~~
	Tamula XXI	UBA-25994	Human, shaft of the right humerus	5132±35	-25.3	3980–3810	4040–3800	-	3640–3190	3750–2930		This thesis
	Tamula XXII	Ua-43123	Human, mandible	4830±39	-21.0	3660–3530	3700–3520	750±107	2900–2740	3010–2570		This thesis
	Tamula XXII	Ta-219	Wood, bottom of the grave	4080±100	-	2870–2490	2900–2340	-	-	-		Ilves et al. 1970, 248 ; Ilves et al. 1974, 177

Site	*Number of the burial*	*Lab no.*	*Sample material*	*Conventional radiocarbon age (^{14}C yrs BP)*	*AMS/ IRMS $\delta^{13}C$ (‰)*	*Maximum calibrated (IntCal13) date 68% (cal. BC)*	*Maximum calibrated (IntCal13) date 95% (cal. BC)*	*Reservoir correction*	*Calibrated and reservoir corrected date with 68% probability (cal. BC)*	*Calibrated and reservoir corrected date with 95% probability (cal. BC)*	*Comments*	*Source*
	Tamula XXIII	UBA-25995	Human, shaft of the right tibia	5189±34	-25.2	4040–3960	4060–3950	-	3670–3260	3800–2970		This thesis
	~~Tamula XXV~~	~~KIA-50305~~	~~Human, right parietal bone~~	-	-	-	-	-	-	-	~~Failed to produce collagen~~	~~This thesis~~
TOOMA	Tooma I	KIA-48841	Human, cranium	4840±30	-22.8	3660–3530	3700–3520	-	-	-		This thesis
VALMA	~~Valma II~~	~~KIA-48954~~	~~Human, right tibia~~	-	-		-	-	-	-	~~Failed to produce collagen~~	~~This thesis~~
	~~Valma II~~	~~KIA-49482~~	~~Human, mandible~~	-	-		-	-	-	-	~~Failed to produce collagen~~	~~This thesis~~
	~~Valma III~~	~~KIA-48955~~	~~Human, left femur~~	-	-		-	-	-	-	~~Failed to produce collagen~~	~~This thesis~~
VEIBRI	Veibri, I/I	Ua-43124	Human, mandible	5580±39	-23.8	4450–4360	4490–4340	-	4550–4480	4570–4450		This thesis
	Veibri I/I	UBA-27355	Human, mandible	5791±43	-23.3	4710–4590	4770–4530	-	4550–4480	4570–4450		This thesis
	Veibri, I/II	Hela-1331	Human, right radius	6090±45	-24.0	5200–4930	5210–4850	-	4550–4480	4570–4450		Kriiska et al. 2007
	Veibri I/III	KIA-48842	Human, left femur	5841±29	-23.2	4770–4680	4790–4610	-	4550–4480	4570–4450		This thesis
	Veibri I/IV	KIA-48843	Human, right femur	5940±22	-22.9	4850–4780	4900–4720	-	4550–4480	4570–4450		This thesis

5.3.1.1. Calibrating and correcting the dates from human collagen

The dominance of marine and freshwater resources on the diets of hunter-gatherers indicates that these people most likely did not assimilate carbon only from atmosphere but from other reservoirs. Marine reservoir offsets at the Baltic Sea and local freshwater reservoir effects are problematic while the aquatic food chains have been shown to be rather depleted in ^{14}C compared to terrestrial food chains (e.g. Pesonen et al. 2012; Philippsen 2012; Lougheed et al. 2013; Fernandes et al. 2014a; Meadows et al. 2014). This further suggests that the radiocarbon dates from human collagen could be too old and should be regarded only as maximum ages of the burials. This claim is further supported by the two paired samples of primary inhumations from the Tamula burial site. Moreover, these two paired samples clearly demonstrate that the reservoir offsets are not constant even within a single site. The modern and palaeolimnological indications of large reservoir effects in some hard-water lakes in Estonia (e.g. Olsson & Kaup 2001; Poska & Saarse 2002; Veski et al. 2005; Alliksaar & Heinsalu 2012), and other Mesolithic/Neolithic examples from Eurasia (e.g. Cook et al. 2001; Bonsall et al. 2004; Lillie et al. 2009; Wood et al. 2013; Bronk Ramsey et al. 2014; Fernandes et al. 2014a; Meadows et al. 2014; Pospieszny 2015; Schulting et al. 2014; 2015; Lübke et al. in print; Meadows et al. 2015) suggest that reservoir effects were applicable at other inland sites, too. As such studies have not been undertaken on the waterbodies in the immediate vicinity of the inland burial places (Kivisaare, Kudruküla, Narva Joaorg, and Veibri), the appropriate local reservoir effects in aquatic resources cannot be estimated.

The marine calibration curve estimates an overall surface average for oceans being depleted in ^{14}C by about 5% or 400 years BP (Stuiver & Braziunas 1993; Reimer et al. 2009; van der Plicht 2012; Bronk Ramsey et al. 2014). The measured pre-bomb reservoir offsets (Delta-R value[27]) of *Macoma* molluscs near the Estonian coast of the present Baltic Sea vary between 172±50 years BP the southern Finnish coast (Table 21: 1719) and 1096±51 years BP at the north-western coast of Gotland (Table 21: 1711; Lougheed et al. 2013); the average reservoir offset based on the 10 points designated in Table 21 would be 537±51 years BP. Taking the dataset of Ingrid U. Olsson (1980), and the development of the Baltic Sea into account, Pesonen et al. (2012, 665) proposed the average reservoir offset for the whole Baltic Sea during the Stone Age to be 279±100 years BP. Although the RE in the Baltic Sea varies spatially and both the closest reference point to the Saaremaa island (1716; RE=573±50; Lougheed 2013) and the average estimates (Pesonen et al. 2012; Lougheed 2013) were tested, in the final analysis only the average RE proposed by Pesonen et al. (2012) will be used to determine a more reliable age ranges for the burials at Saaremaa. This is

[27] Delta-R values for marine reservoir correction in the ^{14}CHRONO Marine Reservoir Database are calculated from the difference in the ^{14}C age of known-age, pre-nuclear marine samples and the 2004 calibration data set (Reimer et al. 2004), being identical to the 2009 marine calibration data set during the Holocene (Reimer et al. 2009) and also to the 2013 calibration dataset for the date ranges used here (Reimer et al. 2013).

due to the unreliably young dates of the burial at Naakamäe when applying the RE correction of the spatially closest locations to Saaremaa (Table 21: 1716).

Table 21. Ten nearest locations to Estonia with determined reservoir offsets in the present Baltic Sea.
The exact coordinates of the measurement locations are given in ^{14}CHRONO Marine Reservoir Database (http://www.calib.qub.ac.uk/marine/).

Map no. at ^{14}CHRONO Marine Reservoir Database	*Lab. no*	*Locality*	*RE±SD*	*Reference*
677	U-4179	Gulf of Finland	298±60	Olsson 1980
1711	LuS-9955	Gotland Coast	1096±51	Lougheed et al. 2013
1712	LuS-1018	Gotland Coast	866±51	Lougheed et al. 2013
1713	LuS-9963	Gotland Deep	381±51	Lougheed et al. 2013
1714	LuS-9958	Gotland Deep	866±51	Lougheed et al. 2013
1715	LuS-9959	Latvian Coast	741±50	Lougheed et al. 2013
1716	LuS-9971	Gulf of Riga	573±50	Lougheed et al. 2013
1717	LuS-9973	Stockholm archipelago	186±50	Lougheed et al. 2013
1718	LuS-9952	Åland	188±46	Lougheed et al. 2013

I have used OxCal v4.2.4 (Bronk Ramsey & Lee 2013), and where possible I have calibrated each ^{14}C date against IntCal13 curve with a defined mix of terrestrial and aquatic carbon inputs. The estimates of the contribution of single food groups are provided by the FRUITS (Fernandes et al. 2014b) model output as the freshwater or marine carbon contribution to the ^{14}C age must be the same as to δ^{13}C of aquatic resources of each consumer. Thus, the dates can be calibrated using the IntCal13 curve for the terrestrial contribution to the radiocarbon age; for individuals with clear marine diets the Marine13 curve with local ΔR estimates was used (Pesonen et al. 2012; Lougheed 2013; Reimer et al. 2013). As paired samples of terrestrial and aquatic origin from the same context are only rarely available, the reservoir corrections of each site will be discussed separately.

5.3.1.1.1. Limiting the time range of the usage of Tamula burial site
The chronology of the Tamula burial site has puzzled archaeologists for a long time, especially the temporal relation between the settlement layer and the burials (Indreko 1942, 2; Jaanits 1957a, 94–96; Jaanits et al. 1982, 81; Lõugas et al. 1996, 414; Lang & Kriiska 2001, 92; Kriiska et al. 2007, 109). The most recent analysis suggests that the burials either predated or occurred in the early phase of the settlement site (Kriiska et al. 2007, 109). However, the insufficient contextual information of the four available dates from the cultural layer (TA-10; TA-28; TA-237 and TA-238: Jaanits 1965c, 45; Punning et al. 1971, 382; Jaanits & Liiva 1973; Ilves et al. 1974, 177) do not allow the temporal relation between the occupation layer and the burials to be entirely resolved. Although

the focus will be on the dates of single burials and the overall time span of the burial activity, their probable relation to the settlement layer is proposed.

Already Kriiska et al. (2007, 107–110) noticed a disagreement between the ^{14}C date of the Tamula VII burial and the typology-based dates of its grave goods. The reason behind the age difference could not be explained fully. New dates and dietary information about the deceased at Tamula suggest that we should account considerable reservoir offsets there. The two paired samples of primary inhumations IX and XXII illustrate this claim clearly. The age difference between a pine wood pole (UBA-28201) and the human collagen (KIA-48838) from grave IX is 402±42 years BP, and from the bulk sample of wood (Ta-219) (Ilves et al. 1970, 248; Ilves et al. 1974, 177) and human collagen (Ua-43123) from grave XXII is 750±107 years BP. Moreover, these samples clearly demonstrate that the reservoir offsets are not constant within the site. The variance could be explained either by the different protein intake of aquatic resources by consumers or the varying mobility patterns of individuals that led to the utilisation of different reservoirs with varying RE.

To get more realistic date ranges for single burials and the time span of the Tamula site, it has been assumed that the overall FRE at the site is 1000±350 ^{14}C years, covering the offset ranges of burials IX and XXII. The large uncertainty allows a considerably larger offset compared to the ones measured in these two burials, reflecting the more ^{14}C depleted values of the reservoir (lake) (Figure 30). However, the testing and refining of the FRE is not the topic of my thesis; thus the proposed offset should be taken as a preliminary hypothesis; further research is needed. This range is also more-or-less consistent with the RE reported at Zvejnieki (Lübke et al. print; Meadows et al. 2014).

The phase model[28] in OxCal with a *Mix_Curve* function, together with the carbon values for each individual (for those burials where individual dietary data were not available, a mean value of the aquatic intake (50.7±10%) was applied) based on the FRUITS model output (Appendix 2) was used. The model (code in Appendix 1) indicates that the burial site was used from 640 to 1540 years with 95.4% probability (mean=1090 years). The burials began at Tamula around 3900 cal. BC (mean value) and ended around 2600 cal. BC. These results are arguably younger than the date ranges proposed previously of 4200–3495 cal. BC (Kriiska et al. 2007, 106). However, these fit better with the already established artefact typologies (Jaanits et al. 1982; Edgren 1984; Ots 2006).

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[28] Phase model (Bronk Ramsey 1998; 2001) groups all the dated burial events in a phase of burial activity that is constrained by the start and end of burial activity ('*start*' and '*end boundaries*') setting no other internal constrains to the relative order of the dated burial events. The model only assumes that all the dated events took place after the start boundary and before the end boundary.

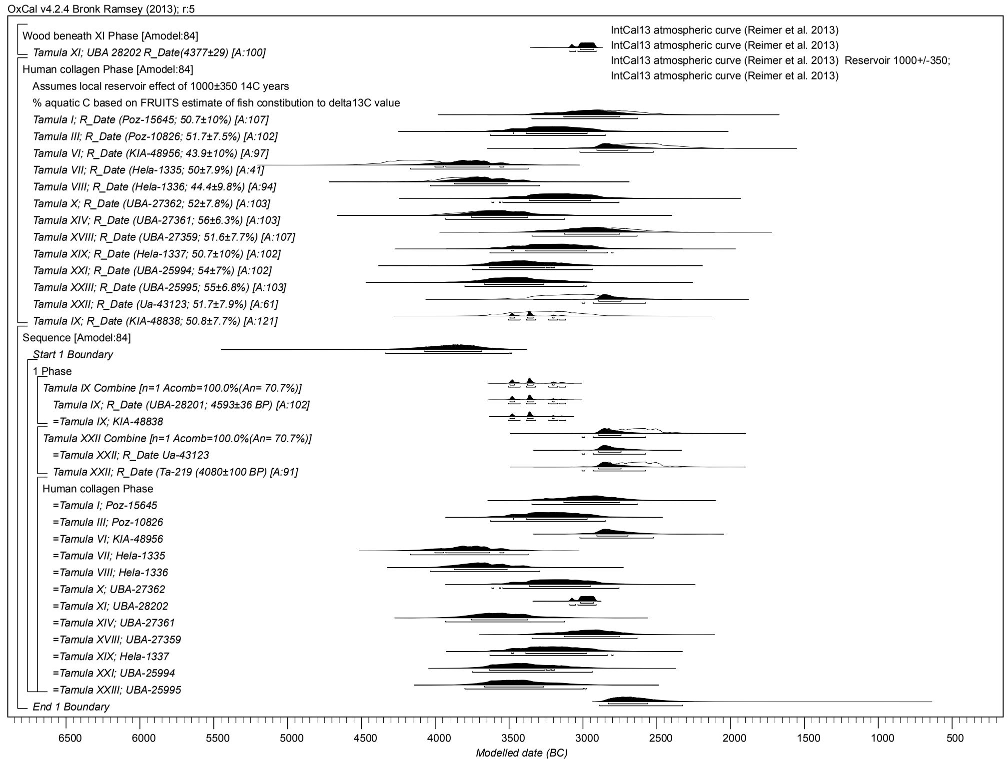

Figure 30. Calibration of ^{14}C dates of Tamula burials.

Calibrated against the IntCal13 curve; additionally it has been assumed that the overall FRE of the fish consumed is 1000±350 years BP.
The OxCal model-definition code is in Appendix 1;
the effect of FRE on individual dates has been estimated by the aquatic intake from FRUITS output (Appendix 2).
The calibrated uncorrected dates are given in Table 20.

Tamula VII burial acts as an outlier as it has a poor agreement with the model (A=40.3% instead of >60%; Bronk Ramsey 1995, 428). This might suggest that the child assimilated carbon from a different reservoir with a significantly different RE. Thus, as long as there is no paired date from a grave good of terrestrial origin, the Tamula VII burial date cannot be corrected properly. However, the modelled date of this burial (4170–3370 cal. BC, 95.4% probability) is more consistent with the known amber periodisation of the Baltic countries (Ots 2003, 96, 104; 2006, 29) and with the known date range of the fingernail-shaped adzes (Edgren 1984). Although one should expect at least slight changes to the amber chronology as there are indications of RE in Zvejnieki (Meadows et al. 2014; Meadows et al. 2015), that has not been taken into account while constructing the present chronology (Ots 2006; Zagorska 2006).

The model does not indicate any hiatus in the use of the burial site; instead the graves are distributed rather evenly throughout its usage. Burials VII, VIII, and XIV are the earliest, which took place in 3900–3500 cal. BC, followed by III, IX, X, XIX, XXI, and XXIII which took place in 3500–3000 cal. BC, and at the final stage (3000–2600 cal. BC) burials I, VI, XI, XVIII and XXII, took place (Figure 31) The end datum of the Tamula burial site corresponds to the mean date of the wood from Tamula XXII (Ta-219). However, in this kind of division a slight problem occurs, as the X and XI burial dates are inconsistent with the results of the archaeothanatological analysis that suggested that the double burial XI/XII should predate the X. However, the mean dates of these two burials differ by only 150 years, which again could illustrate the fact that without the knowledge of RE about each individual buried at Tamula, the chronology of the site cannot be more accurate than the estimates proposed here. In summary, the burial site was used over a longer period from c. 3900–2600 cal. BC and must have been concurrent with the settlement site.

Figure 31. The spatiotemporal relation of burials at Tamula.
The chronological borders are drawn based on the mean calibrated and RE corrected dates; depth information about the graves derives from Jaanits 1957 and 1961. Black lines designate borders of excavation plots of various field seasons.

5.3.1.1.2. Limiting the time range of the usage of Kivisaare burial site

As stated earlier, the chronology of Kivisaare settlement and burial sites is ambiguous. Previously it has been suggested that the site belongs to the Mesolithic (Kriiska et al. 2003; 2004; Kriiska & Lõhmus 2005), Neolithic (Bloz 1914; Tallgren 1922; Kriiska et al. 2003; 2004; Kriiska & Lõhmus 2005), and Bronze Age (Indreko 1935a; Tõrv & Meadows 2015).

The four radiocarbon dates from the graves excavated in 1965 do not allow conclusions to be made about the whole usage period of the site (Figure 32). The model proposes the start of the burial activity at Kivisaare to be around 6050–5010 cal. BC (95.4% probability). The earliest date from the site belongs to a loose human bone dated to c. 5310–5030 cal. BC (95.4% probability). However, the depleted $\delta^{13}C$ value of this bone indicates a considerable amount of protein intake of a freshwater origin, which further might result in an older date.

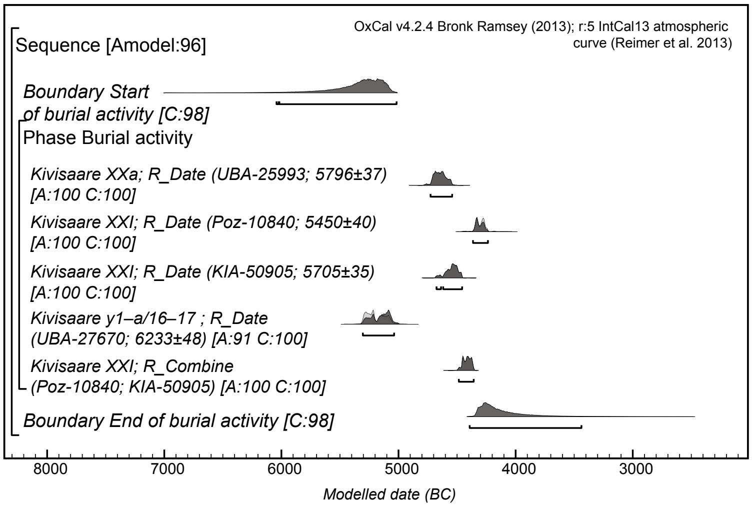

Figure 32. Calibrations of ¹⁴C dates of Kivisaare Stone Age burials.
OxCal model-definition code will be found in the Appendix 3.

The graves XXa and XXI are somewhat younger, dating to the 5th millennium (Figure 32). As there are two ^{14}C dates from individual XXa it is assumed that these represent a single event. However, the consistency test (*R_Combine*) between the uncalibrated dates from Kivisaare XXa burial fails, which indicates that these two dates are statistically different from one another (T=22.9; T'(5%)=3.8; ν=1; Ward & Wilson 1978). This suggests that one of the dates should be wrong. According to Christopher Bronk Ramsey (2009, 1023–1024) there are four main reasons behind the "wrong" radiocarbon dates including incorrect ^{14}C measurement of a particular sample, the measurement made for the calibration curve and for the sample have a systematic offset relative to one another, the radiocarbon ratio of a sample differs from that of the associated reservoir, or incompatibility of the sample measured and the event dated.

Although one cannot exclude measurement biases here (two different labs), the fact that one date derives from a bone and the other from a molar tooth representing different phases of an individual's life indicates that the inconsistency of the dates is probably due to the different collagen turnover rates in these tissues, or due to the individual's change of habitat, as the older date has a terrestrial $\delta^{13}C$ value.

At this point, we can say that Kivisaare has been used over several millennia. The model indicates that during the Mesolithic, Kivisaare was used for interments over a time span of 700–1030 years (95.4% probability), meaning that the burial activity ended around 4400–3430 cal. BC (95.4% probability). The most recent burials, however, were interred during the Early Bronze Age (Tõrv & Meadows 2015). Whether the site was continuously used as a burial ground cannot be said due to the insufficient dataset.

5.3.1.1.3. Asserting a more realistic date for the Veibri quadruple grave

The archaeothanatological analysis of the Veibri quadruple grave clearly indicates the simultaneous deposition of all four deceased. However, the five dates from these individuals are statistically inconsistent with a single ^{14}C age (T=92.54, T'(5%)=9.5, ν=4), i.e. single event. One cannot find a satisfactory agreement between the dates after excluding the youngest (T=31.49, T'(5%)= 7.8, ν=3) or both the youngest and oldest dates (T=13.37, T'(5%)=6.0, ν=2) from the final analysis. This discrepancy indicates that at least some of the dates must be "wrong" (see Bronk Ramsey 2009, 1023–1024). The importance of aquatic resources on the diets here allow suggesting that not all the dates were wrong due to the incorrect ^{14}C measurement, but also the admixture of carbon from various reservoirs could cause these discrepancies. However, one could neglect all the older dates and use the youngest date as the maximum age of the burial event. That is then 4490–4340 cal. BC, assuming that the youngest date is valid[29], but if we exclude this from the analysis the date of the burial would be 4770–4530 cal. BC (95.4% probability). At the same time, the dietary information about each individual allows for a more sophisticated modelling of the timing of the burial event.

[29] Note the discrepancy between the dates of the two samples taken from individual I's mandible (Ua-43124 and UBA-27335). At the moment one cannot explain this, thus only the UBA-27335 with an older ^{14}C age is used.

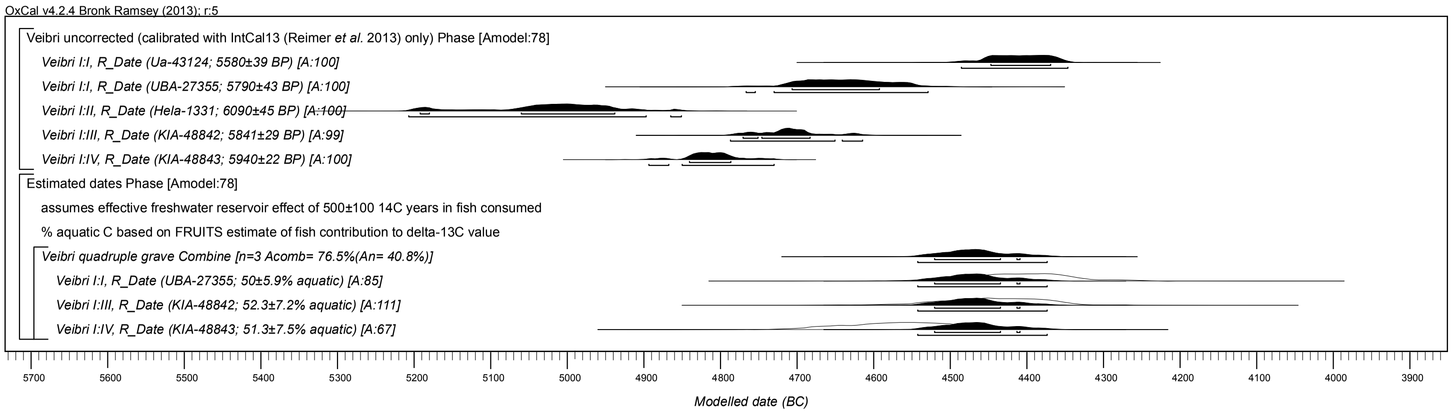

Figure 33. Calibration of ^{14}C dates from the Veibri quadruple grave.

Dates Ua-43124 and Hela-1331 have been excluded from the model and it is assumed that the minimum reservoir offset of the fish consumption of the children was 500±100 ^{14}C years (OxCal model-definition code in Appendix 4). The effect of FRE to individual dates has been estimated by the aquatic intake from FRUITS output (Appendix 5).

As stated above, the high proportions of freshwater fishes in the protein intake of the individuals must have had an effect to their dates; moreover, as we do not know the exact RE, this has to be assumed in the model. In modelling[30] the contemporaneous burial event (OxCal function *Combine*), I have excluded the two extreme dates from the analysis. Thus, if the ^{14}C ages of the three children are calibrated using the *Mix_Curves* function and a minimum FRE (500±100 years) added, these are compatible with a single date (n=3; A_{comb}=76.5%; A_n=40.8%), estimated by the model as 4550–4370 cal. BC (95.4% probability; Appendix 4; Figure 33). By adding the adult date to the model, we see that the model fails in the X^2-test and this date does not meet the threshold of the agreement index (A=7% instead of >60%; Bronk Ramsey 1995, 428); the same goes to the I individual (UBA-27355; A=44%). In order to get a satisfactory agreement index for the model (n=4; A_{comb}=67.8%; A_n=35.4%) indicating that the whole model works (Bronk Ramsey 2009, 1025) a common reservoir offset of 1500±100 ^{14}C years should be applied to all the four individuals. The possibility of such a large FRE should not be neglected entirely as >1000 year RE has been reported elsewhere (e.g. Fernandes et al. 2014a). Application of larger RE, however, pushes the burial event to 4250–3900 cal. BC (95.4% probability; Figure 34). Yet since the date of the II individual still has a poor individual agreement to the modelled date (A=47%), this should be rejected. It is reasonable to argue that the three children assimilated their carbon from the same or similar reservoir, as opposed to the adult. It could be that the ^{14}C measurement of the adult is incorrect or the reservoir the adult incorporated carbon from had a significantly different RE. The latter could be explained by the dissimilar mobility pattern of the individual; however, one cannot trace it with the stable isotope analysis undertaken here.

It can be concluded that the quadruple grave was established at the 1st half of the 5th millennium BC, around 4550–4370 cal. BC (95.4% probability), not at the beginning of the 6th millennium (Kriiska et al. 2007). As long as the exact reservoir age of the adult has not been established, this is the most reliable time range of the burial event. The date does not contradict the find of a Narva-type pottery fragment (TÜ 1424: 98) from the grave fill either, as the end limit of the Narva ceramics is regarded to be around 4200 cal. BC (Piezonka 2008; Kriiska 2009).

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[30] The same model, however, with a known FRE (Lübke et al. in print; Meadows et al. 2014), has been used to single out the corrected date for a multiple burial of five individuals (178–182) at Zvejnieki (Meadows et al. 2015).

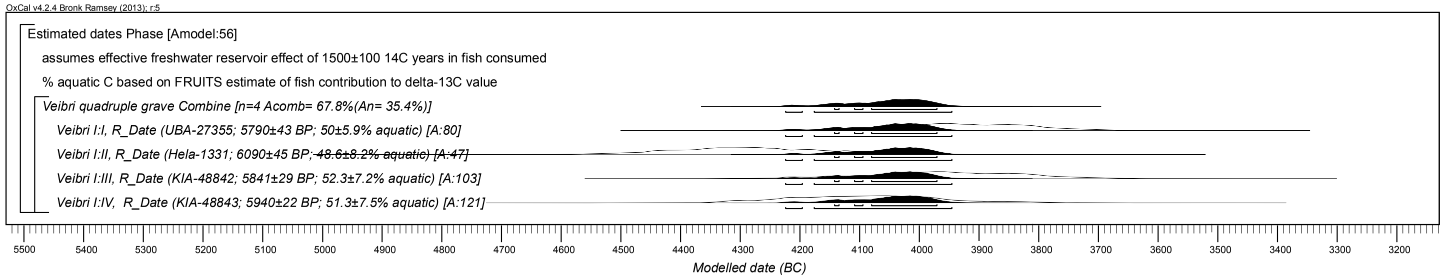

Figure 34. Calibration of ^{14}C dates of all four individuals of Veibri quadruple burial.

The youngest date (Ua-43124) has been left out from the analysis (OxCal model-definition code in Appendix 6). The effect of FRE to individual dates has been estimated by the aquatic intake from FRUITS output (Appendix 5).

5.3.1.1.4. Date ranges for sites at north-eastern Estonia

The radiocarbon dated burial II belongs to the II Mesolithic/D layer and the IV burial to the III Mesolithic/E layer both with three corresponding charcoal samples (Figure 35). However, one cannot use the previous bulk samples of charcoal (TA-7, TA-17, TA-25, TA-33, TA-40, TA-41, TA-52 and TA-53: Jaanits 1960; 1963; 1964; 1965c; Liiva et al. 1966; Jaanits & Liiva 1973; Ilves et al. 1974, 177) as direct equivalence in calibrating human bone collagen at Narva Joaorg, as their exact spatial relation to one another cannot be established more precisely than at the level of layer (both charcoal and human bones are found within the same stratigraphic unit). Moreover, the large uncertainties of the conventional dates suggest that the temporal difference between these two layers is almost negligible. However, the majority of the charcoal samples correspond to the two dates of human collagen, suggesting that the reservoir offset could not have been very large (as opposed to what we saw in Tamula and Veibri). Assuming that no reservoir correction is needed, the burial activity took place at least in two episodes, the first one dating 6650–6400 cal. BC (95.4% probability) and the second one 6500–6250 cal. BC (95.4% probability) (Figure 35). However, the dates of the charcoal also indicate that the layers distinguished in the field might have had a slight temporal overlap, which raises the question of the contemporaneity of these two burials. Their contemporaneity might also be supported by the fact that both of the features with human bones were found directly above the bedrock (Jaanits 1962b; 12; 1963, 10–11). To test the reliability of this assumption function *Combine* in OxCal was used. The poor indices of agreement (n=2; A_{comb}=41.9%; A_n=50%) of the model with uncorrected calibrated dates suggest that the deposition of these individuals is not simultaneous. However, when the *Mix_Curve* function together with an assumed minimal FRE of 300±50 ^{14}C years is applied, the individually calibrated dates are consistent with a single event (n=2; A_{comb}=68.2%; A_n=50%), giving a time range of 6430–6250 cal. BC (95.4% probability). Without assuming that these graves were simultaneous, but still taking the probable RE (300±50) into account, we could place these to 6400–6210 cal. BC (II) and 6490–6260 cal. BC (IV) with the 95.4% probability.

The analysis indicates that these two features with loose human bones (II and IV) occurred within a limited time period at the 3rd quarter of the 7th millennium, most probably c. 6500–6250 cal. BC. Moreover, the consistence of the charcoal dates with the human bone collagen dates suggest that the burials (I and III) from the I Mesolithic/C layer could be contemporaneous with the two hearths dated from that layer, and thus were most probably deposited sometime between c. 5250–4250 cal. BC or 4750–3600 cal. BC (95.4% probability).

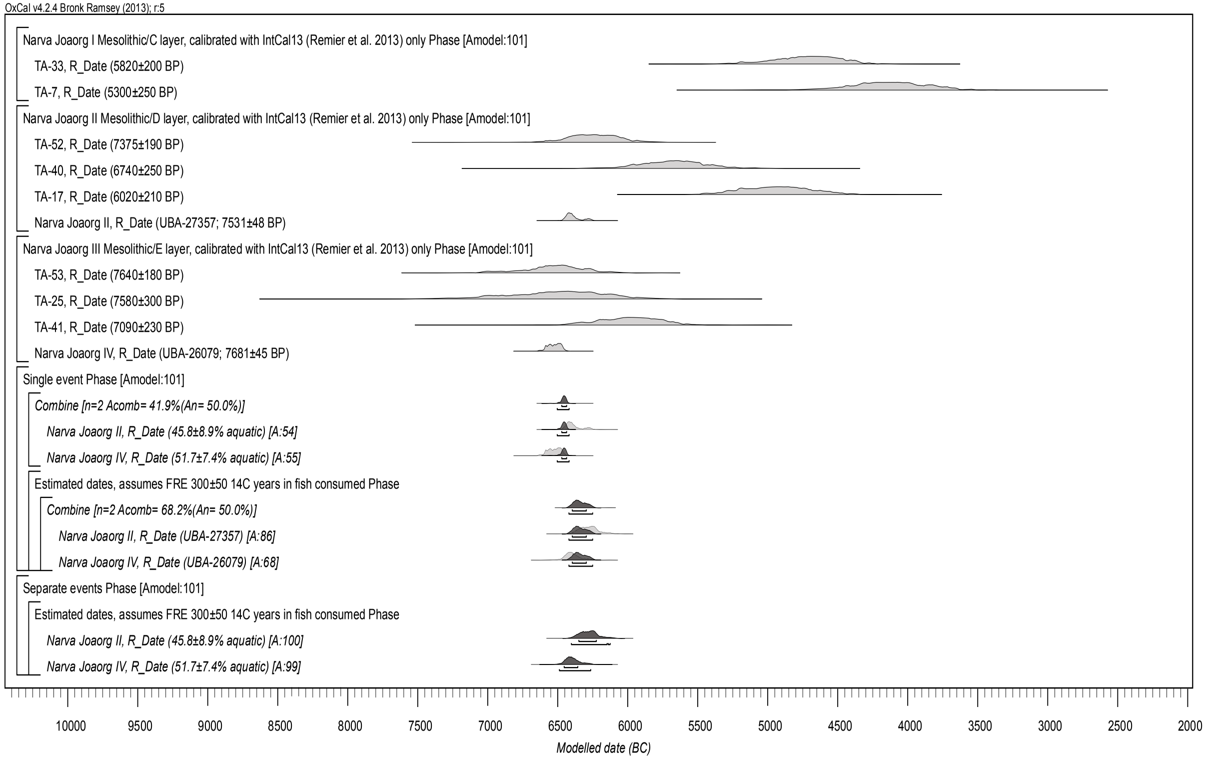

Figure 35. Calibration of ^{14}C dates from Narva Joaorg.

The models assuming that the two burials II and IV were simultaneous events and separate events are presented (OxCal model-definition code in Appendix 7). The dates of charcoal from the three layers obtained from Narva Joaorg (Jaanits 1963; 1964; 1965c; Liiva et al. 1966; Jaanits & Liiva 1973; Ilves et al. 1974; Lang & Kriiska 2001) act as references to the human collagen data, but their consistence with the dates from collagen indicates that a large RE has not affected the bones (FRUITS model in Appendix 8).

The burials at Kudruküla were conducted much later and these dates (Lõugas et al. 1996) should be regarded as maximum ages of the burials (Table 20), as no information about possible RE is available; however, the $\delta^{13}C$ data indicate a fairly terrestrial diet of these individuals, suggesting that if RE was present it must not have been as significant as we have seen in Tamula, for instance. Moreover, it is most likely that these burials took place over a relatively short time period, if not even representing a single event as suggested by the X-test in the *R_Combine* model (T=1.1, T'(5%)=3.8, ν=1) of the uncorrected uncalibrated dates. The maximum time of the interment of these two individuals was most likely (95.4% probability) around 3700–3510 cal. BC. Without applying any reservoir corrections to the date obtained at Tooma, this burial can be deemed as contemporary to the individuals at Kudruküla.

5.3.1.1.5. Island sites Kõljala, Kõnnu, and Naakamäe

Altogether three sites with seven dates are available from Saaremaa. As described above, a marine reservoir offset (Pesonen et al. 2012) was applied to get more reliable date ranges. Thus, the oldest of these sites is Kõnnu, dating roughly to the 6th–5th millennia cal. BC, while burials from Kõljala took place during the 4th millennium cal. BC, and the individual at Naakamäe was buried during the 3rd millennium cal. BC (Figure 36).

It seems that all the dated burials occurred within a relatively short time interval from the mid of the 6th millennium to the mid of the 5th millennium. The III burial is slightly older, dating to the 5520–5100 cal. BC (RE corrected 95.4% probability), while the other two inhumations and the loose human bone from feature 111 date on average between 4815–4625 cal. BC (RE corrected 95.4% probability). The spatial position of the three younger burials suggests that, at that time, the whole settlement area was used simultaneously.

Using the function *R_Combine* in OxCal, two burial events could be distinguished at Kõljala. This is indicated by the inconsistency of the uncorrected uncalibrated dates, suggesting that these dates are statistically different from one another (T=24.1, T'(5%)=3.8, ν=1). Therefore, burial I took place during 3670–3200 cal. BC (RE corrected 95.4% probability), and after a while, in 3340–2880 cal. BC (RE corrected 95.4% probability), burial III took place.

The reservoir corrected dates for Naakamäe are significantly younger, between 2490–1960 cal. BC (RE corrected 95.4% probability), than was suggested by the present typology-based chronology (Lang & Kriiska 2001). Thus, it is highly likely that no reservoir correction should be applied here and a maximum date range 2910–2490 cal. BC used instead as long as no direct paired dates from terrestrial fauna are available.

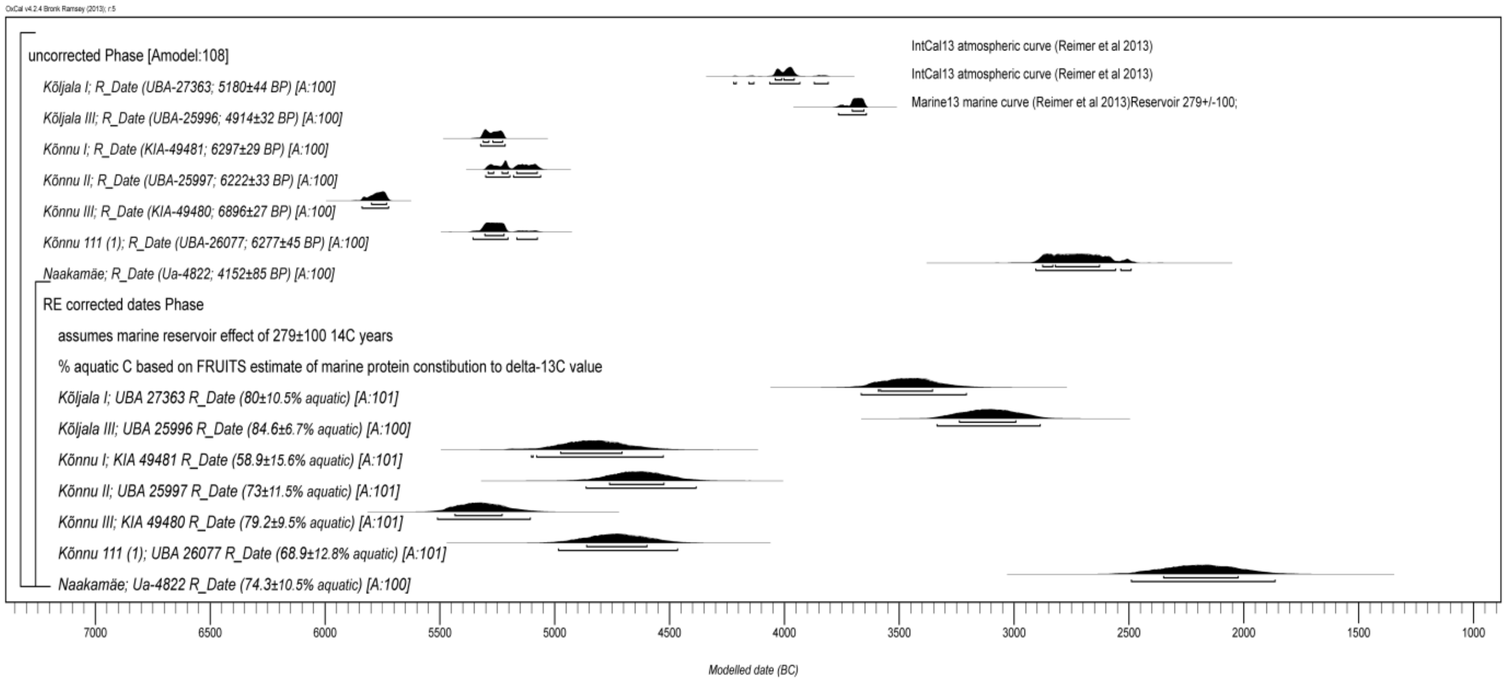

Figure 36. Calibrated and marine reservoir corrected dates from Saaremaa.

The dates are calibrated against the marine reservoir effect 279±100 radiocarbon years proposed by Pesonen et al. 2012 (OxCal model-definition code in Appendix 9 and FRUITS model in Appendix 10).

5.3.2. Conclusions about the radiocarbon dates from graves

The new radiocarbon dates show that the first burials took place at Narva Joaorg starting from the mid of the 7th millennium cal. BC and ending probably around the 4th millennium cal. BC, when the site was abandoned. Only two burials from Kõnnu and a Kivisaare are dated to the 6th millennium cal. BC, whereas both of these sites were also used as burial places during the 5th millennium cal. BC. Burial activities at Kõnnu ended with the 5th millennium cal. BC, but at Kivisaare some of the interments were made as late as during the Early Bronze Age. The Veibri quadruple burial dates to the 5th millennium cal. BC, namely to the first half of it. Burial sites at Kudruküla, Kõljala, Tamula, and Tooma were established during the 4th millennium cal. BC. The first two sites were used during a relatively short period and at Kudruküla one could even argue for a single event. The actual character of the Tooma site is to be investigated in the future, thus this date is not that telling at the moment. Tamula, however, was used as a burial place for a longer time period and its end date corresponds to the burial at Naakamäe, being c. 2600 cal. BC.

5.4. Contribution of stable isotope data and radiocarbon dates to our understanding of their identities: subsistence of hunter-gatherers

5.4.1. Sedentary fishers and coastal hunters

To a large extent, the above-exhibited isotopic data supports the present understanding of the subsistence of the Late Mesolithic and the Neolithic populations, mainly based on the faunal material from the cultural layers of settlement sites. However, the isotopic signatures of human collagen and the analysis of faunal collections have significant scalar differences. The latter gives a low-resolution impression about the subsistence over a large time frame (Milner et al. 2004, 12; but see Barberena & Borrero 2005, 192; Richards & Schulting 2006, 447) in populations while isotopic signatures allow exploring individual dietary histories (Eriksson & Lidén 2013). This means that one should not expect a complete overlap of these results.

The zooarchaeological analyses indicate the importance of elk and beaver at the beginning of the Mesolithic, while marine resources were not utilised (Paaver 1965; Lõugas et al. 1996; Lõugas 1997; Veski et al. 2005). During the Late Mesolithic, a shift towards more diversification in the subsistence took place and species like aurochs, deer, and wild boar appear in the settlement material (Lõugas et al. 1996; Veski et al. 2005; Kriiska 2009). From that period also marine resources became more important – especially marine mammals (Paaver 1965; Lõugas et al. 1996; Veski et al. 2005). Kriiska (2003; 2009) shows that this diversification of resource utilisation goes hand in hand with general changes in the settlement pattern and society (i.e. the decline of the catchment areas of a single community, the increased population, the increase in the role of central habitat such as perennial village-like settlements, and the probable emergence of large cemeteries). At around 7000 cal. BC, (1) inland sites on river valleys and lake depressions, and (2) sites on river estuaries in coast and island distinguish clearly. This trend of dual habitation is apparent in the isotopic signatures of inland sites (Kivisaare, Narva Joaorg, Tamula, and Veibri) as well as island sites (Kõljala, Kõnnu, and Naakamäe). It may have continued until the Late Neolithic, where marine mammals still play a crucial role in the subsistence of costal and island communities (e.g. Naakamäe; Lõugas et al. 1996). Noteworthy, however, is Narva Joaorg, which is located at a river estuary. According to the presented theory, Narva Joaorg should represent the same characteristics as the sites on islands and coastal areas (e.g. Kudruküla). Instead, the individuals from Narva Joaorg cluster with people from other inland sites, where a considerable amount of subsistence came from freshwater fishes, and not from marine mammals, even though these are also represented in the faunal collection (Paaver 1965, 437–438). Without values representing different local food groups one cannot solve this discrepancy entirely.

Besides large game hunting, aquatic resources played undoubtedly an important role in the subsistence of the Stone Age populations. Isotopic signatures, unlike the faunal data, stress the importance of freshwater fishes and marine mammals and fishes in the protein intake of the analysed individuals. The zooarchaeological analyses show that the catch differed according to the location of the site (Figure 37). During the Mesolithic, freshwater and brackish water fishes like pike, pike-perch, and bream (Lõugas 1997; Paaver & Lõugas 2003; Veski et al. 2005) dominated; however, compared to terrestrial animals they seldom occur in the faunal material (Lõugas et al. 1996). The true marine fishes that derive from the Litorina Sea period, e.g. cod and turbot, appear in the Neolithic settlement material (Lõugas et al. 1996; Paaver & Lõugas 2003). Similarly to the rest of the palaeofauna, a coastal-inland distinction becomes evident, with freshwater fishes dominating on the mainland and marine resources on island sites.

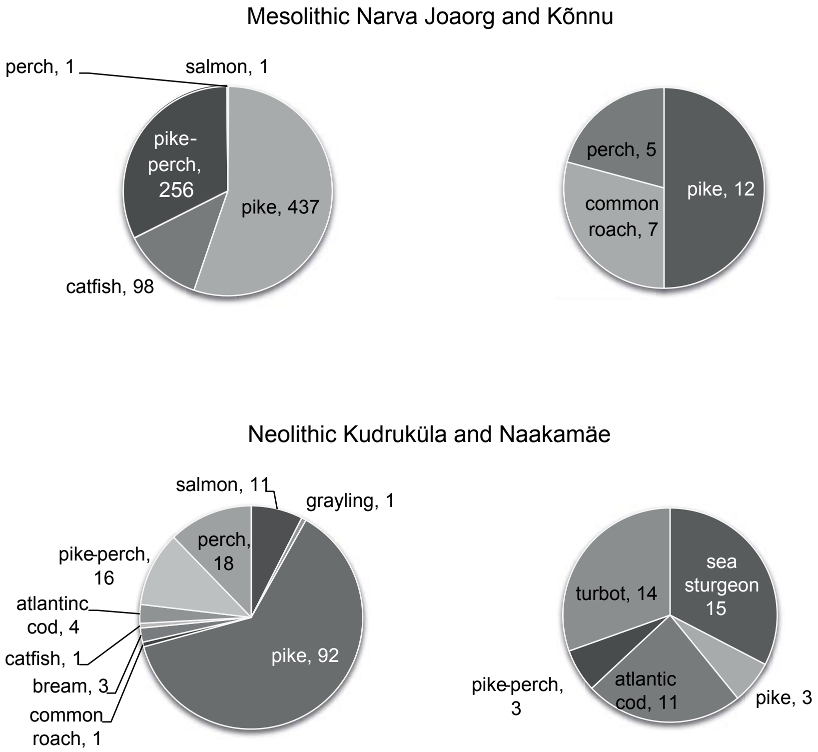

Figure 37. Fish species represented in the Mesolithic settlements Narva Joaorg and Kõnnu, and the Neolithic Kudruküla and Naakamäe settlements.
After Lõugas 1997, Table 2.

In addition to juxtaposing the human collagen data with the archaeologically known faunal values (Figure 23), the consumption of different protein sources was quantified with the multivariate Bayesian statistical package FRUITS (Fernandes et al. 2014b). The model assumes that three food groups were significant in the diets of hunter-gatherers: of inland sites it is presumed that plants, terrestrial animals, and freshwater fish were the main source of protein; on the island sites freshwater fishes have been replaced by marine mammals due to the elevated δ^{15}C and δ^{15}N values. Due to the absence of local faunal reference this quantification should be taken as a tentative exercise where the estimates for different food groups derive from published sources (Table 22). Similarly to the model proposed by Meadows et al. (in print) it is assumed that human collagen δ^{13}C derived 75±5% from protein and the balance form energy macronutrients. The parameters and values used in modelling are given in Table 22.

Table 22. The parameters used in the FRUITS modelling to quantify the consumption of single food groups in the diets of various individuals.

The sources for these parameters are: Cordain et al. 2000; Fernandes et al. 2014c; Richards & Trinkaus 2009; Stirling & McEwan 1975.

Food groups	*Calories form food group (%)*	*Calories from energy (%)*	*Protein ^{15}N (%)*	*Protein ^{13}C (%)*	*Energy ^{13}C (%)*
Plant	10±2	90±2	2±0.5	–25±0.5	–26±0.5
Animal	50±5	50±5	5±1	–24±0.5	–28±0.5
Freshwater fish	80±3	20±3	10±1	–29±1	–36±1
Marine mammals	44±5	56±5	15±2.5	–21±1.5	–26±1.5

The main outcome of the FRUITS modelling is that it demonstrates the significance of plant foods among the hunter-gatherer populations. Due to the low protein content of plants compared to other food stuffs (especially meat and fish), it has been established that the stable isotope analysis underestimates the consumption of plants (e.g. Schulting 2006; Fornander 2011, 30). In the context of inland sites – Kivisaare, Narva Joaorg, Tamula and Veibri – we observe that the diet must have mainly consisted of plant foods (c. 60% of protein intake). The consumption of freshwater fish remained between c. 30–40%, whereas meat contributed with less than 20% of the protein intake (Figure 38). In Saaremaa a slightly different picture can be observed as the mean proportion of marine protein in the diets of Kõljala individuals was over 70%, followed by plant (c. 20%), and less than 1/5 of their diet must have consisted of the meat of terrestrial mammals (Figure 38). As suggested also by the stable isotope analysis, the diets of Kõnnu and Naakamäe individuals was less reliant on marine resources than at Kõljala, remaining between 40–70% according to the FRUITS model output.

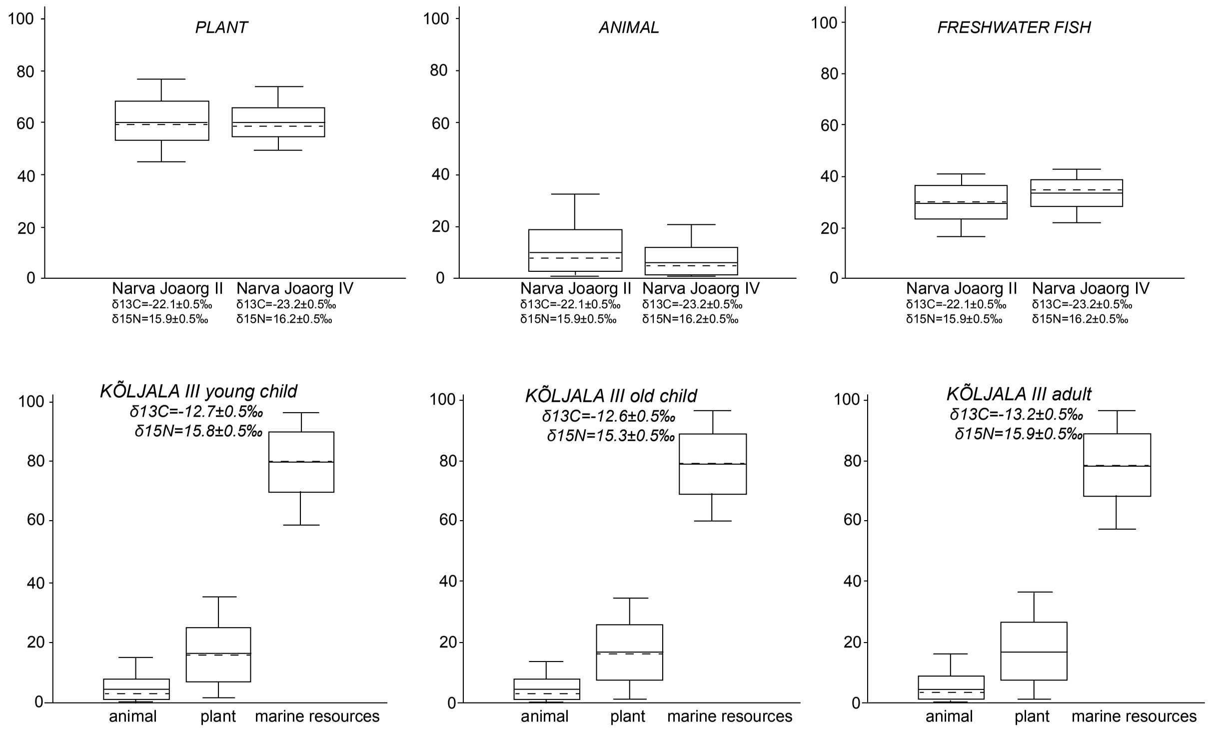

Figure 38. Credibility intervals of the concentrations of animal, plant, and freshwater fish / marine protein in the diet of the Narva Joaorg II, IV and Kõljala III individual given as an example.

The results of the FRUITS modelling of other sites are given in Appendices 8 and 10. Boxes represent 68% credible interval, the whiskers represent a 95% credible interval, the horizontal continuous line represents the estimated mean, the horizontal dashed line the estimated median (50%).

Thus, compared to the zooarchaeological analysis of the faunal material, the stable isotope analysis taken together with the quantification of various food groups demonstrate the importance of fish and plant protein in the diet of inland hunter-gatherers and the importance of marine resources to island dwellers.

As stated above, this does not necessarily contradict the results based on faunal remains since these datasets represent different scales of knowledge and are biased in their own way. First, it is highly questionable whether the proportions of large and small game reflect the reality in faunal samples (regarding the methodological/taphonomical considerations in the discovery of fish bones, see Ritchie 2010). The predominantly acidic and aerobic environmental conditions of these sites tend to conserve large and mostly cortical parts of the bones. This in turn leaves the bones of smaller mammals and fishes underrepresented in the sample (excl. bog sites like Tamula and Akali), not to mention the plant food (i.e. macrofossils and nuts). Furthermore, although the settlement system is based on perennial village-like habitats, smaller camp sites must have been exploited also. In the Estonian material, however, no functional analysis of the settlement sites has been conducted. This leads to the second critical point: the faunal sample does not necessarily reflect the whole spectrum of the subsistence of hunter-gatherers and in some cases may only mirror the subsistence of a limited group of people during a hunting trip. Although this could also be the case with the isotope analyses here (e.g. Hedges & Reynard 2007), these add an additional level of knowledge about the dietary preferences of single individuals and contribute in accentuating the importance of fish (and plants) in the diet.

Recently more robust arguments have been put forward to manifest a significant change around 4000 cal. BC in the eastern Baltic region (Kriiska 2009; Nordqvist & Kriiska 2015). It is shown that the change, i.e. Neolithisation, was expressed in different aspects of material culture and was accompanied by the early agriculture in the region, further stressing that the process of Neolithisation in the E Baltic did not necessarily stand separately from the developments taken place in western and north-western Europe (Nordqvist & Kriiska 2015). In the context of north-western Europe, it is claimed that the transition from Mesolithic to Neolithic meant a radical shift from marine to terrestrial diet (Tauber 1981; see the discussion: Hedges 2004; Lidén et al. 2004; Milner et al. 2004; 2006; Richards & Schulting 2006). Assuming these developments also occurred in the Baltic context, we should observe a similar dietary shift in the here-observed stable isotope data. However, neither the zooarchaeological analysis of faunal samples nor the isotopic data of hunter-gatherer populations in Estonia support the idea of an abrupt and rapid shift of diets during the transition from the Mesolithic to the Neolithic. The temporal comparison of $\delta^{13}C$ and $\delta^{15}N$ values demonstrates the continuous importance of marine and freshwater resources throughout the period under discussion (Figure 39 and 40). The increased proportion of the consumption of freshwater fish in the analysed populations could be explained by the bias in the sample toward inland sites. The only marine signature of the $\delta^{13}C$ values during the time span of 5500–4500 cal. BC is due to the fact that no other sites than Kõnnu are included. Instead of temporal differences, one observes a clear spatial divide when the δ[13]C values of both inland and island communities are available (i.e. 3500–2600 cal. BC). Only in a single case – a sample from Kivisaare (KVS08) – does the δ[13]C value from an inland site correspond to the δ[13]C values observed in island sites.

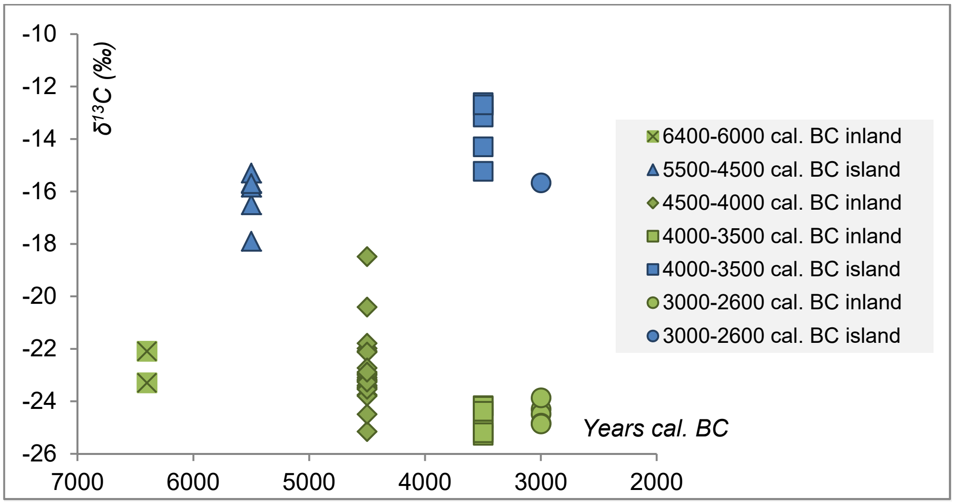

Figure 39. $\delta^{13}C$ values plotted against the calibrated radiocarbon dates from both inland (green) and coastal (blue) sites.

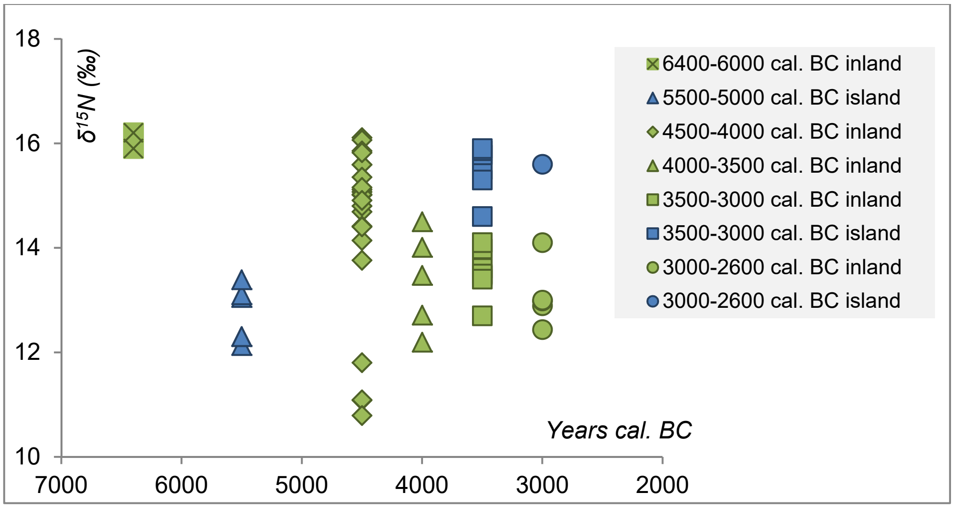

Figure 40. $\delta^{15}N$ values plotted against the calibrated radiocarbon dates from both inland (green) and island (blue) sites.

Unlike the case of the $\delta^{13}C$ values, the distinction between the $\delta^{15}N$ ranges of inland and coastal sites is quite subtle. However, when data from both inland and coastal sites is available the $\delta^{15}N$ values of island inhabitants are elevated compared to the values from inland sites. This probably demonstrates the fact that the food webs in marine environments were longer, and in addition to carnivorous fishes, these people had access to the marine mammals, too. The elevated $\delta^{15}N$ values from the period of 4500–4000 cal. BC derive from Veibri (*Chapter 5.2.2.*; Figure 26) and Kivisaare (*Chapter 5.2.2.*; Figure 24). In both cases this demonstrates a high consumption of freshwater fish, whereas in the case of Veibri the elevated $\delta^{15}N$ values could also be due to the high proportion of sub-adults in the sample.

The analysis demonstrates that the difference in the consumption of marine and terrestrial or freshwater foodstuffs in Estonia correlates with the region of the site instead of being a temporal characteristic. Although cultural norms must have played their role in the dietary preferences of hunter-gatherers, the results here are in accordance with ethnographic studies indicating that diet is highly dependent on environmental conditions (Kelly 2013, 44), as well as corresponding to the isotopic data from Mesolithic-Neolithic sites from southern Sweden (Lidén et al. 2004; Eriksson et al. 2008; Fornander et al. 2008) and Latvia (Eriksson 2006; Meadows et al. 2015). Moreover, the results of inland populations correspond to the modelled Palaeolithic hunter-gatherer diet – 35% animal products (either terrestrial or marine) and 65% of plant food (Eaton et al. 1996 referred in Jenkie 2001, 210). Although more variation is seen in the ethnographically studied hunter-gatherer populations (Kelly 2013, Table 3–1.), the mean consumption of animal products is calculated to be around 35% of the overall diet of hunter-gatherers (Cordain et al. 2000). This diversity is also reflected in the results of island populations, which show a significant use of marine resources, the mean values reaching to 80% at Kõljala and being compatible with ethnographic data on Inuit populations (Kelly 2013, Table 3–1).

5.4.2. From Mesolithic to Neolithic – incipient tillers?

Besides hunting, gathering, and fishing as subsistence resources, the origins of early agriculture and stock keeping – one of the major debates in Stone Age archaeology – in the forest zone of Europe becomes a relevant issue from around 4000 cal. BC. Traditionally, in south-eastern and central Europe, the transition to agricultural means of subsistence, together with the adoption of pottery production, the erection of massive house constructions and monumental graves, and the sedentary settlement pattern have been regarded as the onset of a new era – the Neolithic. The adoption of the 'Neolithic package' is not that straightforward in north-eastern Europe. Moreover, our understandings about these processes in the eastern Baltic vary considerably. Formerly, the beginning of Neolithic in Estonia was identified with the emergence of pottery production (Jaanits et al. 1982; Jaanits 1992). The subsistence did not change: both the Typical and Late Combed Ware eras represented foraging communities (Jaanits et al. 1982, 92;

Jaanits 1992, 44–46). Although no archaeological evidence of primitive farming was known during the succeeding Early Corded Ware phase, Jaanits argued that these small communities already cultivated crops and kept stock (Jaanits et al. 1982, 119–120; Jaanits 1992, 49; see also Veski 1998, 38, 107). Recent studies suggest that Narva-type ware occurred in hunter-gatherer societies (Figure 2); thus, the beginning of the Neolithic is no longer equated with the start of pottery production (Kriiska 2009). Instead, it is related to the very first evidence of agriculture that is supposed to be present among the communities producing Typical and Late Combed ware (Kriiska 2009; Nordqvist & Kriiska 2015). What are the lines of evidence behind this argument?

Recently a substantial amount of research based on palynological records from lake and bog mires has been conducted to prove the early existence of farming in the eastern Baltic (e.g. Seglinš et al. 1999; Vasks et al. 1999), Finland (e.g. Mökkönen 2010; Alenius et al. 2013; Nordqvist & Herva 2013), and in Estonia (Poska 1994; Veski 1998; Königsson et al. 1998; Poska 2001; Poska & Saarse 2001; 2006; Poska et al. 2004; Kriiska 2003; 2007; 2009). The earliest single cereal-type pollen – i.e. wheat – date to as far back as 5600 cal. BC and was found at Akali (Poska & Saarse 2006, 175). A continuous cereal-type pollen curve in Akali is seen since the 4900 cal. BC (Poska & Saarse 2006, 175), yet it is the only case that old. The quantity of palynological data increases during the time period of 4150–3200 cal. BC (Poska et al. 2004; Table 23). Compared to the data published by Kriiska (2003; 2007; 2009) the early samples from Lake Tõhela and Akali (Moora et al. 1988) are omitted due to not meeting the quality requirements set for the investigations of human impact (Poska et al. 2004; Poska & Saarse 2006). The *Cerealia*-type pollen from Kunda Arusoo is eliminated due to the possible contamination of the sample during coring that was undertaken in May 1992 (Poska & Königsson 1996, 300; Poska pers. comm. 30.3.2016). The samples from Lake Maardu are excluded due to their later dates: *Triticum*- and *Avena*-type pollen there were dated to the Late Neolithic (Veski 1998, 37; Poska et al. 2004, 45 Fig. 5). This leaves five locations with eight (n=8) scattered *Cerealia*-type pollen samples dated to the pre-Corded Ware period (Table 23) that might indicate an introduction of crop cultivation in Estonia (Poska et al. 2004).

Table 23. Scattered 'early cereal-type' pollen from Estonia that pre-dates Corded Ware period, c. 4150–3200 cal. BC.
Only the sites that meet the quality requirements (Poska et al. 2004; Poska & Saarse 2006) for investigating human impact based on palynological samples are included.

No.	***Find place***	***Region***	***Type of cereal***	***Comments***	***Reference***
1.	Akali[31], bog	E-Estonia	*Triticum,* *Cannabis* *Hordeum*	Scattered Continuous	Poska & Saarse 2006
2.	Velise, bog	W-Estonia	*Avena*	The cultivation indicator *Avena*-type includes some wild grasses, which makes it hard to differentiate between domesticated and wild grasses (Veski 1998, 66)	Veski 1998
3.	Kõivasoo, bog	Hiiumaa	*Hordeum*[32] *Avena*	Very few Few	Königsson et al. 1998
4.	Mustjärv, bog	W-Estonia	*Avena* *Triticum*		Veski 1998
5.	Vedruka, bog	Saaremaa	*Avena*		Poska & Saarse 2002

I agree with Karl-Ernst Behre (2007), however, that these data should be handled with caution. Except for the Akali Early Neolithic continuous pollen curve (Poska & Saarse 2006), the remaining represent single or a few pollen grains, and the continuous cereal curves in these sites start as late as the Bronze Age or the Iron Age (Poska et al. 2004, 45, Fig. 5). The critiques put forward by Maria Lahtinen and Peter Rowley-Conwy (2013) in the context of Finland and Behre (2007) in the context of 'Mesolithic agriculture' in general is also applicable to the Estonian material. First, they state that the presence of single grains in palynological samples should not be taken as evidence for early cultivation of cereals; moreover, they argue that small-scale crop cultivation cannot be investigated on palynological grounds at all. They refer to modern pollen dispersals (Hicks 1985; Hicks & Briks 1996 referred in Lahtinen & Rowley-Conwy 2013) that show no significant changes in pollen diagrams when a small-scale cultivation is performed. Poska and Saarse (2002) themselves have claimed that based on the scarcity and irregularity of the cereal-type pollen from Vedruka mire, it is impossible to conclude that the beginning of crop cultivation took place in the Neolithic; however, this possibility cannot be excluded either. Secondly, the grain size, which has been the basis of distinction between wild and domesticated plant pollen, cannot serve as a reliable criterion as there are several wild plants that produce as large grains as cereal-type pollen

[31] The pollen data published in Moora et al. 1988 and referred to in Kriiska 2003, 2007, and 2009 should not be used in the studies about human impact due to low pollen counts (Poska & Saarse 2006).
[32] No special measurements of larger grass pollen were made, nor were pore measurements practiced. Thus the pollen of *Hordeum*-type may include barley, but might also comprise millet pollen and some other large *Gramineae* pollen (Königsson et al. 1998, 6–7).

(especially common in coastal biotopes). For example Königsson et al. (1998, 14) also state that the finds of *Graminea* in Kõivasoo, among which also *Hordeum*-type was distinguished, may only possibly indicate cultivation (see below). They suggest that the pollen of *Avena*-type may be a more reliable cultural indicator (Königsson et al. 1998, 14). On the other hand, it has been argued that differentiating between wild grass and cultivated early *Avena*-type pollen is not straightforward (Moore et al. 1991, 100; Beug 2004, 84, 90; E-mail correspondence with Veski 29.3.2016), and thus one should be cautious when associating these with the introduction of crop farming. Behre (2007, 204) also shows that there are several wild grasses among the *Hordeum* and *Triticum*-type pollen, which means that the Late Mesolithic wheat pollen found at Akali may as easily have been a wild grass instead. Behre (2007, 208) himself finds this early date as a 'most unlikely' signifier of arable farming (i.e. foragers are acquainted with farming products) considering all the difficulties with the cereal-type pollen identification. Additionally, the possibility of long-distance transport of cereal-type pollen and contamination of the samples should be regarded in the cases of single pollen grains (Behre 2007).

Dating the early cereal-type pollen poses a problem of its own. The chronology of the early cereal-type pollen is based on radiocarbon dates that derive from bulk samples of peat and/or lake sediments. Although it has been argued that bulk samples give reliable dates (e.g. Punning et al. 1995; Blaauw et al. 2004; see also Moore et al. 1991, 14pp description of the formation of peat stratigraphy), several studies have demonstrated significant differences between the date of a bulk sample and the pollen analysed (Brown et al. 1989; Brown et al. 1992 and reference therein). Peat consists of a mixture of material of different ages (formation of peat: Mäkilä & Saarnisto 2008), making it difficult to establish what is exactly dated with a bulk sample. On the one hand the roots penetrating the lower horizons of peat may cause the resulting dates to be too young (e.g. Wohlfarth et al. 1998). At the same time, comparative studies have shown that bulk peat samples tend to be significantly older than other materials dated from the same sequence (e.g. Brown et al. 1989; reservoir offsets: Kilian et al. 1995; but see e.g. Blaauw et al. 2004). Without going into detail here it should be clear that dating bulk samples of peat and lake sediments are far from being unambiguous. In order to establish a reliable chronology for pollen samples macrofossils from the same layer or pollen concentrates (Brown et al. 1989; 1992; about its pitfalls see e.g. Kilian et al. 2002; Neulieb et al. 2013) should be dated instead. As this has not been done here, the dates of early cereal-type pollen from Estonia remain highly questionable.

Together with the first cereal-type pollen, also the decline of the forest front has been considered reliable evidence for crop cultivation. A recent study (Reitalu et al. 2013) about the climatic and human impact on forest composition combines palaeoecological and palaeoclimatic data with statistical analysis to show that during 3100–1900 cal. BC the human impact on the forest composition in Estonia was around 0%. Thus, from the Early Mesolithic (Veski et al. 2005) until the Late Neolithic (Reitalu et al. 2013) the human impact on the environment was small or non-existent. A rapid increase is seen during the period of c. 2500–1300 cal. BC and the human impact reach its highest peak during 1900–700 BC (14%). This again is followed by a slow decrease. Human impact was the dominant driving force for forest compositional changes during 1900 cal. BC–200 AD (Reitalu et al. 2013). This picture is supported by previous palynological evidence from Saaremaa, where the forest clearance has been connected to the Corded Ware period (Poska & Saarse 2002). Moreover, at coastal areas in Finland, it has been reported that forest clearances may occur naturally and frequently in conjunction with the wild grasses that produce large pollen grains (Lahtinen & Rowley-Conwy 2013). One should also be conscious of the errors that may occur in the dates (e.g. reservoir offsets in bulk sediment samples and stratigraphic misinterpretations). In most cases, the original authors pointed out that the dates are tentative, as there are lags in the sediment profile with unknown duration (e.g. Königsson et al. 1998, 16), but these reservations are ignored in the secondary literature.

Besides the palynological data, no other lines of evidence are available in Estonia to demonstrate agriculture in the Late Mesolithic to the Early Neolithic. Examples of these would include the carbonised remains of cultivated plants, which are the most reliable sources for detecting arable farming (Behre 2007), the bones of domesticated animals, field structures or artefacts directly linked to agriculture. The first carbonised crop (*Hordeum*) from a wall of pot sherd dates to 2700 cal. BC and was found at Iru (Kriiska 2007), the same potsherd had an imprint of another grain of *Hordeum* (Veski 1998, 38). The first reliably dated bones of domesticated animals – sheep/goat, cattle, and pig – derive from burials of Corded Ware culture (Lõugas et al. 2007; Kriiska 2007)[33]. Similarly to the earliest field systems, the first tools linked to crop cultivation in Estonia date from the Bronze Age (Lang 2007). However, from Latvia and Lithuania several examples of wooden, antler, and stone items – 'shovels', 'hand ards', 'hoes' and 'beaters' –, date to the 4th millennium have been tentatively regarded as evidence of first tools used in agriculture (Rimatienė 1999; Vasks et al. 1999). At the same time it has been suggest that these items could have easily been used for gathering wild plant roots instead (Vankina 1970, referred in Bērziņš 2008, 372; Vasks et al. 1999, 297; Kriiska 2009, 164).

In sum, the evidence regarding early agriculture among the communities analysed in the thesis is rather unconvincing. The only early evidence are the five pollen samples that allow palynologists to argue (Poska et al. 2004) that the introduction of cereal cultivation took place in the Neolithic around 4000 cal. BC. However, this introductory phase starting from the Estonian coastal areas around 4150/3800–3200 cal. BC (Poska et al. 2004; Poska & Saarse 2006) took 1000–3000 years until farming became the main source of subsistence (Poska

[33] I will leave aside the questionability of interpreting the bones of domesticated animals in funerary context as evidence for animal husbandry. There are other ways of explaining these bones in the graves (e.g. gift exchange), thus we should not take these as direct evidence of animal husbandry in the Stone Age of Estonia.

2001, 27; Poska et al. 2004). Archaeologists and palaeozoologists mainly support this idea by arguing that the adoption of the whole Neolithic package, i.e. the introduction of pottery, cereal cultivation, and stock keeping, was a long process lasting from c. 5000 to 2700 cal. BC (Zvelebil 2001; Kriiska 2003; 2007; 2009; Lõugas et al. 2007; Nordqvist & Kriiska 2015). They also stress that subsistence based purely on agriculture cannot be traced back earlier than the Middle Bronze Age (1000 cal. BC), as at the beginning of Bronze Age still some hunter-gatherer sites were inhabited (Jaanits 1992; Lang 2007). In general, this picture fits with the dates of the beginning of crop cultivation (4100–4000 cal. BC), along with other changes taking place in the Baltic region of Germany (Hartz et al. 2007; Hartz et al. 2011), and southern Sweden and Norway, as well as elsewhere in central Europe (Rowley-Conwy 1995; Poska 2001, 24–26; Behre 2007).

Although I disagree with the interpretation of early agriculture emerging around 4000 cal. BC in Estonia, as the current evidence is too weak (basically only cereal-type pollen), it is difficult if not impossible to contribute to this discussion by the means of stable isotope studies directly. First, as Estonia belongs to temperate environmental zone C_3 plants form the only group present in the region during Late Mesolithic and Neolithic. No change in the plant group occurs with the introduction of agriculture, wheat, barley, and oats have a photosynthetic pathway inherent to C_3 plants. Moreover, even if changes in cereal and land use were visible in the archaeological material (not the case here!), Hedges and Reynard (2007) have shown that these trends seem not to be reflected in the apparent dietary animal protein fraction. This might further indicate that the transition from subsistence based on foraging to agriculture at its early stage is not detectable in isotopic signatures. Based on the quantification of different food groups on the isotopic signatures it is only possible to argue that plant food was a significant component in the protein intake of Late Mesolithic and Neolithic hunter-gatherers (Figure 38; Appendices 2, 5, 8, and 10), whether they derived from wild or cultivated plants cannot be said. However, indirectly the stable isotope studies contribute to the discussion by their age – younger than 4000 cal. BC, and by demonstrating the importance of hunting and fishing among the groups engaged in this thesis.

5.4.3. Conclusions about stable isotope analyses and radiocarbon dates

Stable isotope data correlate well with the previously proposed cultural division between mainland and island sites in Estonia. Freshwater resources in mainland and marine mammals/fishes in islands constituted an important part of the protein intake of these populations, while plant food must have contributed considerably in both sites, too, and the significance of terrestrial animals varied site-by-site. Instead of temporal differences in dietary preferences suggested in other parts of Europe during the transition from Mesolithic to Neolithic, environmental variances, probably together with more local cultural norms and taboos, were responsible for these differences.

It is difficult to contribute directly to the discussion about the beginning of agriculture via the stable isotope analysis. The preferences toward aquatic resources, together with the lack of archaeological evidence of agriculture before the Late Neolithic and a critical evaluation of the palynological data, indicates that agriculture played at most a very marginal role in the subsistence of these populations, if any role at all. Fishing of freshwater fishes, hunting of marine and terrestrial mammals, together with a considerable intake of wild plant foods, were of importance for these groups instead. Thus, the early dates available for single cereal-type pollen from the region are either incidental or reflect the possibility of hunter-gatherer contacts with farming societies (i.e. availability phase according to Zvelebil and Rowley-Conwy (1984)). Borrowing the concepts of George Peter Murdock (1987), the inland communities belonged to the 'sedentary fishermen' category while the island populations were like the Inuits of the Baltic Sea with their high consumption of marine fishes and mammals (esp. Kõljala). The question of whether the people buried since c. 4100 cal. BC were the first agriculturalists – i.e. 'incipient tillers', whose main food supplies came from hunting and fishing, but who occasionally practiced tillage (Murdock 1987, 15), could not be answered with the study of stable isotopes. To argue in favour of this interpretation, one needs more solid archaeological evidence. Until these lines of evidence are available, all the people who received mortuary treatments that left archaeological traces should be considered hunter-gatherers with noticeable regional variances in their food culture.

5.5. Conclusion

In the present chapter, I have demonstrated that both sexes and all age groups were chosen to be inhumed or their bones scattered around settlement sites. It became clear, however, that these people do not represent the entire population, but make up only a small part (note the long time span: 6500–2600 cal. BC). Although sub-adults comprise 1/3 of the sample in the case of inhumations, this number is too low compared to ethnographic reports of infant mortality in hunter-gatherer societies. Even if we regard the natural and cultural modifications of landscapes throughout the millennia until the recovery of human remains the number of inhumations and features with loose human bones is low. This might further suggest that the individuals who received a mortuary treatment leaving archaeological evidence were somehow chosen. However, this selection was not based on their biological attributes such as sex and/or age. One could only observe a slight age-specific trend in the comparison of intact burials and loose human bone assemblages: sub-adults occur more frequently in loose bone assemblages than within intact burials. The relative homogeneity of stable isotope data within the population (except Kivisaare) implies that dietary differences did not correlate to this selection.

Stable isotope analyses suggest that two major groups with distinct dietary preferences co-existed. The protein intake of these populations must have been heavily dependent on the surrounding environment, i.e. local ecology; no significant temporal changes were observed. Moreover, clear differences among sites occur (mostly on the $\delta^{13}C$ values), referring to either variations in local ecologies or cultural norms/taboos.

Carbon and nitrogen stable isotope studies do not directly contribute to the discussion about the emergence of agriculture and whether the people interred since c. 4100 cal. BC onwards were the first agriculturalists or not. Indirectly, the homogeneity of these data site-wise refers to stable and sedentary populations, which is considered a prerequisite for agriculture. The high consumption of aquatic resources throughout the period under discussion, however, suggests no crucial changes in the dietary preferences of these populations. The low intra-site variability and the clear inter-site differences suggest that food procurement must have happened within clearly defined ecological backgrounds. We do not observe significant movements between coast and inland. Thus, together with the critical evaluation of the published palynological data, I argued that the populations involved in the present study, that is from 6500–2600 cal. BC as indicated by the radiocarbon dates from human collagen, were predominantly sedentary fishers (inland or island) and hunters of marine fishes and mammals (island), and only maybe and then occasionally ‘incipient tillers’. The latter, however, needs to be proven by more solid (archaeological) evidence.

CHAPTER 6. MORTUARY PRACTICES OF HUNTER-GATHERERS: RESULTS OF ARCHAEOTHANATOLOGICAL ANALYSES

The following chapter highlights the general patterns of mortuary practices through the analysis of representative case studies. The focus is on the question about how death was handled in the Stone Age hunter-gatherer societies in Estonia. The features without human bones that have been previously regarded as part of the mortuary repertoire (Bolz 1914, 25; Ebert 1913, 506–507; Jaanits et al. 1982, 82; Ots 2006, 83) will not be discussed here. The chapter is divided into two major parts reflecting the nature of the source material and variation in practices. The first part explores inhumation practices. The archaeothanatological analysis of the inhumations allows the nature of the burial, the space of decomposition, and the presence of additional structures and wrappings in the graves to be discussed in detail. Also, the initial body position of the deceased together with possible post-burial manipulations of the corpse will be discussed. Particular attention is given to the aspect of time in understanding the burials with several individuals. The second part of the chapter discusses the loose human bone phenomenon in the occupation layers of settlement sites. In this thesis, being the first effort to document loose bones in the context of Stone Age finds in Estonia, I try to understand this phenomenon more broadly. Thus different case studies will be presented illustrating the loose human bones as (1) being destroyed primary inhumations, or (2) the result of specific mortuary practices. Each subchapter presents a general pattern and conclusive tables that include arguments about all the analysed features with human bones. This is followed by a more thorough examination of representative examples about the discussed aspect to illustrate its situation at the site and demonstrate the sequence of the archaeothanatological analysis and reasoning.

6.1. Inhumation burials – from general patterns to single practices

The study of Mesolithic (i.e. hunter-gatherer) mortuary practices in Europe has been dominated by the research done on the inhumations of several larger cemeteries (e.g. Olenii Ostrov in the Russian Federation, Skateholm I and II in Sweden, Vedbæk Bøgebakken in Denmark, Zvejnieki in Latvia, and various sites at the Iron Gates). Estonia is no different here (Indreko 1945; 1964; Jaanits 1957a; Jaanits et al. 1982; Jonuks 2009; Kriiska & Tvauri 2002; Lõhmus 2005). I will follow the 'tradition' and begin the discussion over mortuary practices as shown by Stone Age skeletal finds in Estonia with the analysis of more-or-less complete skeletons. Destroyed inhumations or loose human bones are not included in this section as these will be discussed separately in *Chapter 6.2.*

Inhumations from the period of c. 6500–2600 cal. BC are found either from the central areas of settlements (Kivisaare, Kõnnu, and Tamula), at the periphery of occupation areas (Naakamäe, and Valma), or farther away from habitation sites (Jalukse, Kõljala, Külasema, and Veibri). In the majority of these sites the number of interred individuals does not exceed three or four; only two larger sites, Kivisaare and Tamula, have more than 20 deposits with human remains. However, according to the information gathered from local inhabitants, more burials from Kõljala, Kõnnu, and Naakamäe have been found (Indreko 1935a; Jaanits 1958; 1965c; Jaanits et al. 1982; Lõugas 1977), suggesting that the total number of burials was larger. The same general pattern can be followed elsewhere at the forest zone of north-eastern Europe (e.g. Gurina 1956; Edgren 1960; Zagorskis 1961; Edgren 1966; Zvetkova 1985; Vikkula 1987; Zagorskis 1987; Miettinen 1990; 1992; Räty 1995; Halinen 1999; Kostyleva & Utikin 2000; Zagorska 2006; Butrimas 2012), and the western and south-western shores of the Baltic Sea (Larsson 1989[1985]; 1999; 2000).

6.1.1. Nature of the burials

The 'nature of the burial' refers to the treatment of the body from the death to its final deposition. This can vary from simple interment of the fleshed body to the total destruction of the body, for instance during sky-burial or cremation. The results of the analysis are summarised in Table 24. Similarly to the study undertaken at Skateholm I, Skateholm II, and Vedbæk Bøgebakken (Nilsson Stutz 2003), I have distinguished four categories – 'primary', 'probably primary burial', 'burial in multiple episodes', and 'unknown' – to present the results about the nature of burials. Due to the insufficiency of the field documentation, the nature of the burial remained unknown in the majority of cases (n=60). The category *unknown* stands for burials where there is no direct evidence for primary burial or for burial in multiple episodes. Under this belong all the individuals whose existence in the archaeological records was only established during the osteological analysis carried out here. These are the additional individuals found in the graves (XIIIa, XIXa, XXIa, and XXIVa), or the cultural layer (from excavations in 1956, 1961, and 2007) at Tamula, and the loose human bones found among the faunal collection of Kõnnu (pits 102, 111, 122, 127, 131, 135, 138 and loose bones from years 1979, 1981, 1984). However, several of these are discussed as possibly being part of multi-episodic burial rituals based on the selection of the bone elements and their general context (*Chapter 6.2.*).

From the burials that could be analysed in more detail, primary ('primary', n=20) and probably primary ('primary?', n=17) burials prevail. One can argue for a burial in multiple episodes only once (Narva Joaorg I; see discussion in *Chapter 6.2.2.2.*). Also, several examples of probably primary burials will be discussed under the section about loose human bones, where the interpretation of these being an outcome of destroyed inhumations is discussed (*Chapter 6.2.2.1.*).

Table 24. Summary of the results of archaeothanatological analysis about the nature of the burial.

Grave/skeleton no. (original no.)	***Nature of the burial***	***Arguments***
Akali 1 (AI 4013: 3412)	unknown	only fragments of parietal bone present, no detailed information about their position in the deposit
Akali 2 (AI 4013: 6975)	unknown	single fragment of a skull present, no detailed contextual data
Akali 3 (AI 4013: 8345, 8355, 8368, 8339)	unknown	only fragments of skull present, no detailed information about their position in the deposit
Jalukse (1–11)	unknown	analysis impossible due to non-existing field documentation
Kivisaare I	unknown	analysis impossible due to non-existing field documentation
Kivisaare II	unknown	analysis impossible due to non-existing field documentation
Kivisaare III	unknown	analysis impossible due to non-existing field documentation
Kivisaare IV	unknown	analysis impossible due to non-existing field documentation
Kivisaare V	unknown	analysis impossible due to non-existing field documentation
Kivisaare VI	unknown	analysis impossible due to poor preservation – *"sehr morschen Skelett"* (Bloz 1914, 28) – and poor field documentation
Kivisaare VII *(I; Grab 1)*	primary?	no direct evidence available; the proximity of the cranium to the (cervical) vertebrae of the child; the surrounding black humus-rich soil
Kivisaare VIIIa / b *(II; Grab 2, 3)*	unknown	analysis impossible due to heavy destruction and poor field documentation
Kivisaare IXa / b *(III; Grab 4)*	unknown	analysis impossible due to heavy destruction and poor field documentation
Kivisaare Xa / b *(Kivisaare I, Ia)*	primary? / unknown	no direct evidence available; the overall intact position of the skeleton; a dry, black humus soil, which was only 2–3 cm thick (Ottow 1911, 154)
Kivisaare XIa / b *(Kivisaare II, IIa)*	primary?	direct evidence is absent; poor preservation conditions; however, the skeletons were found in humus-rich sediment differing from the surroundings (Ottow 1911, 155)
Kivisaare XIIa / b *(Kivisaare III, IIIa)*	primary?	no direct evidence; humus-rich soil; intact nature of the skeleton no. XIIa; black soil close to the two skeletons
Kivisaare XIII *(XII; Grab 5)*	primary?	the articulations between left and right leg bones are maintained; the humus-rich grave fill has no indications of later disturbances
Kivisaare XIV*(XV)*	unknown	analysis impossible due to poor preservation and field documentation
Kivisaare XV	primary?	no direct evidence due to poor field documentation; the overall position and completeness of the skeleton
Kivisaare XVI	unknown	poor preservation of the skeleton; lack of sufficient contextual data
Kivisaare XVIIa/b	unknown	poor preservation of the skeleton; lack of sufficient contextual data
Kivisaare XX *(luustik nr 3)*	primary?	the documentation does not allow observing any labile articulations; the overall distribution and intactness of the upper body, the maintained articulation between the acetabulum and head of the left femur
Kivisaare XXI *(luustik nr 4)*	primary?	the documentation does not allow observing any labile articulations; the overall intactness and distribution of the bones in the skeleton, however, point towards primary burial, further supported by the distinct grave cut without any later intrusions
Kivisaare XXII *(y_1–b/12–13)*	unknown	poor preservation of the skeleton; lack of sufficient contextual data
Kivisaare XXIII *(y_1–h/12–17)*	unknown	poor preservation of the skeleton; lack of sufficient contextual data
Kivisaare XXIVa/b *(f–k/6–11)*	unknown	poor preservation of the skeleton; lack of sufficient contextual data
Kivisaare XXVa/b *(ä–ö/42–44)*	unknown	poor preservation of the skeleton; lack of sufficient contextual data

Grave/skeleton no. (original no.)	*Nature of the burial*	*Arguments*
Kivisaare XXVIa/b *(f–h/18–20)*	unknown	poor preservation of the skeleton; lack of sufficient contextual data
Kivisaare XXVII *(Close to burial III (1965))*	unknown	poor preservation of the skeleton; lack of sufficient contextual data
Kivisaare XXVIII *(y_1–a/16–17 (black soil depression))*	unknown	poor preservation of the skeleton; lack of sufficient contextual data, however the solid grave cut and representativeness of the bones may indicate a destroyed inhumation
Kivisaare XXIX a–c *(luustik 1)*	unknown	re-burial
Kivisaare XXX *(loose soil in 1931)*	unknown	poor preservation of the skeleton; lack of sufficient contextual data
Kudruküla	unknown	no analysis possible due to the erosion of the cultural layer
Kudruküla	unknown	no analysis possible due to the erosion of the cultural layer
Kunda Lammasmägi (years 1933–37)	unknown	only a single human bone present in the cultural layer
Kunda Lammasmägi (year 1949)	unknown	only a single tooth present, identified during the osteological analysis carried out for this thesis
Kõljala I	unknown	analysis impossible due to no field documentation
Kõljala II	unknown	analysis impossible due to no field documentation
Kõljala III	unknown	analysis impossible due to no field documentation
Kõnnu I	primary	labile articulations of hand maintained, the overall completeness of the skeleton (skull removed during the destruction of site)
Kõnnu II	primary?	poor preservation; skull and cervical vertebrae in articulation
Kõnnu IIa	unknown	poor preservation
Kõnnu III	primary	the overall completeness of the skeleton, patellae and feet bones in articulation (skull removed during the destruction of site)
Kõnnu pit no. 102	unknown	only single fragments of bones found, no articulations preserved, the upper parts of the cultural layer were destroyed
Kõnnu pit no. 111	unknown	only single fragments of bones found, no articulations preserved; the upper parts of the cultural layer were destroyed
Kõnnu pit no. 122	unknown	only single fragments of bones found, no articulations preserved; the upper parts of the cultural layer were destroyed
Kõnnu pit no. 127	unknown	only single fragments of bones found, no articulations preserved; the upper parts of the cultural layer were destroyed
Kõnnu pit no. 131	unknown	only single fragments of bones found, no articulations preserved; the upper parts of the cultural layer were destroyed
Kõnnu pit no. 135	unknown	only single fragments of bones found, no articulations preserved; the upper parts of the cultural layer were destroyed
Kõnnu pit no. 138	unknown	only single fragments of bones found, no articulations preserved; the upper parts of the cultural layer were destroyed
Kõnnu year 1979	unknown	analysis impossible due to the absence of contextual information
Kõnnu year 1981	unknown	analysis impossible due to the absence of contextual information
Kõnnu year 1984	unknown	analysis impossible due to the absence of contextual information
Kõnnu without context	unknown	analysis impossible due to the absence of contextual information
Kääpa (AI 4245)	unknown	only single fragments of cranium
Kääpa (VM 3000:756)	unknown	only single fragments of cranium
Külasema (Metsikumäe)	unknown	analysis impossible due to no field documentation
Naakamäe	primary	labile articulations of hand bones in front of the pelvis maintained, the overall completeness of the skeleton
Narva Joaorg I	multiple episode	maintenance of the articulation between left tibia and fibula, cut-marks on the lateral side of the linea aspera of both femurs
Narva Joaorg II	unknown	analysis impossible due to poor field documentation
Narva Joaorg III	primary?	analysis limited due to the poor preservation of the deposit and poor field documentation, spatial relations of the cranium, clavicles and humerus
Narva Joaorg IV	unknown	analysis impossible due to the absence of contextual information

Grave/skeleton no. (original no.)	*Nature of the burial*	*Arguments*
Pikasilla	unknown	only teeth present
Sindi-Lodja	unknown	only loose human bones present, no contextual information available
Tamula I	primary	labile articulations of feet maintained, the overall completeness of the skeleton
Tamula II	primary?	overall completeness of the skeleton, feet bones in loose articulation in the photograph
Tamula III	primary	labile articulations of hand and feet maintained, the overall completeness of the skeleton
Tamula IV	unknown	only single loose human bones present, no articulations observable
Tamula V	unknown	only single loose human bones present, no articulations observable
Tamula VI	primary	labile articulations of hands and feet maintained, overall completeness of the skeleton
Tamula VII	primary	labile articulations of cervical vertebrae and hands are maintained, the overall completeness of the skeleton
Tamula VIII	primary	overall completeness of the skeleton, hand bones present and loosely articulated
Tamula IX	primary	labile articulations of hand maintained, feet bones present and loosely articulated, the overall completeness of the skeleton
Tamula X	primary	most of the labile articulations maintained
Tamula XI	primary	the overall completeness of the skeleton, patellae in articulation
Tamula XII	primary?	the overall completeness of the skeleton
Tamula XIII	unknown	only single bones present, no articulations nor the position of bones observable on the field documentation
Tamula XIIIa	unknown	only single loose human bones present, no articulations observable, identified during the osteological analysis carried out for the present thesis
Tamula XIV	primary	labile articulations of hand and feet maintained
Tamula XV	primary?	no articulations observable, the presence of the majority of the skeletal elements and the overall position of the bones
Tamula XVI	unknown	only a single tooth present
Tamula XVII	primary	labile articulations of hand bones maintained, the overall completeness of the skeleton, bilateral pressure to the whole body
Tamula XVIII	primary	labile articulations of hand and feet loosely maintained, the overall completeness of the skeleton
Tamula XIX	primary?	poor preservation, articulations between thoracic vertebrae and feet maintained
Tamula XIXa	unknown	only single bones present, identified during the osteological analysis carried out for this thesis
Tamula XX	primary?	poor preservation, but feet bones in articulation
Tamula XXI	primary	labile articulations of cervical vertebrae and feet are maintained, overall completeness of the skeleton
Tamula XXIa	unknown	only a single cervical vertebra present, identified during the osteological analysis carried out for this thesis
Tamula XXII	primary	labile articulations of feet bones maintained, the overall completeness of the skeleton
Tamula XXIII	unknown	single bones present, no precise contextual information available
Tamula XXIV	unknown	single bones present, no precise contextual information available
Tamula XXIVa	unknown	only two bone fragments present, no articulations observable, identified during the osteological analysis for the present thesis
Tamula XXV	unknown	only cranial bones present, no contextual information available
Tamula (year 1956)	unknown	analysis impossible due to the absence of contextual information
Tamula (year 1961)	unknown	analysis impossible due to the absence of contextual information
Tamula (year 2007)	unknown	analysis impossible due to the absence of contextual information
Tooma	unknown	analysis impossible due to the absence of contextual information

Grave/skeleton no. (original no.)	*Nature of the burial*	*Arguments*
Valma I	unknown	insufficient field documentation; only skull present
Valma II	primary?	overall completeness of the skeleton
Valma III	primary	labile articulations of hand and feet maintained, the overall completeness of the skeleton
Veibri I: I	primary	labile articulations of left hand maintained
Veibri I: II	primary	labile articulations of cervical vertebrae and hands are maintained, the overall completeness of the skeleton
Veibri I: III	primary?	poor preservation due to later disturbances of the grave, but bones of hand and feet present
Veibri I: IV	primary	labile articulations of right hand bones maintained, the overall completeness of the skeleton (excl. the areas of later disturbances)
Võru	unknown	poor preservation; no clear contextual information available

6.1.1.1. Primary/primary? inhumations

The ‘primary’ stands for burials that leave no doubt on their primary nature meaning that it has been possible to observe the maintenance of the labile articulations (Figure 4). These articulations are especially valuable because their preservation indicates that the disposal of the corpse must have been taken place rather soon after death (Duday 2009, 26). However, not all primary inhumations fit into the ‘primary’ category because in some cases these articulations deteriorate in the grave during the processes of decomposition. As explained by Nilsson Stutz (2003, 246), such cases can occur when, for example, the hands are placed in front of the abdomen where an empty volume is created during the decomposition of the soft tissue. This, along with gravity, will create a favourable situation for small hand bones to disarticulate and eventually collapse toward the bottom of the feature. The sources about Kõnnu I and III, Naakamäe, Tamula I, III, VI–XI, XIV, XVII, XVIII, XXI, and XXII, Valma III, and Veibri I:I, I:II, and I:IV burials enabled their primary nature to be established firmly through the application of archaeothanatological principles.

Probably primary (‘primary?’), refers to cases where direct evidence, such as the maintenance of the labile articulations, cannot be observed due to the poor preservation of skeletons or the insufficiency of the documentation of its excavation. At the same time the overall position of the skeleton and its completeness indicate that the remains were interred shortly after the death and during a single funerary episode (Duday 2009[2006], 33). Due to the above-discussed superficiality of their written descriptions and drawings, several graves without any photographic documentation fall under the category of probably primary. Overall 17 burials are assessed as being probably primary.

Due to the poor preservation of the skeletons, most of these burials have been assigned as ‘destroyed inhumations’ by earlier researchers. Therefore, these did not receive full attention in the field, meaning that no information about the side of appearance or the spatial relation of the bones is known, or the available records give only very sketchy details. Unfortunately the drawings do not complement the written descriptions either, as some of these ‘destroyed burials' have only been marked as spot finds (Narva Joaorg IV), or unrecognisable bone fragments are drawn (Tamula IV, V, XII, XVI, XXIV, and XXV). Only in rare cases are photographs available about these features (Tamula XV, Narva Joaorg I and III). The absence of photographs, however, cannot always be explained by insufficient recording techniques but rather by technical obstacles. For instance, Jaanits marked in the field diary of Tamula and Kõnnu that several features were photographed (Jaanits 1955b; 1956b; 1961b; 1979), but in the questionnaire that I sent to him he states that if these photos are not archived (TLU AI), technical problems must have occurred while taking and processing the photographs (Jaanits, pers comm.). In consequence, it is more difficult to re-assess the material properly.

6.1.1.1.1. Naakamäe – an example of primary burial

A good example of a primary burial is the grave of an adult female from Naakamäe, to whom a bone awl was given as a grave good. Her corpse was placed in the grave on its back with its upper limbs slightly abducted at the shoulder, the latter being projected upwards, arms medially rotated, and forearms flexed at the elbow and pronated. Although the side of the appearance of carpals, metacarpals, and phalanges cannot be observed in the field documentation, the position of the forearms and hands, in general, indicates that these are exhibiting their dorsal side and thus both hands are slightly flexed and abducted at the wrist. The position of the fingers could not be established as these bones are not visible in the documentation. As the hands were placed in front of the pelvis, it could be that the bones of the phalanges had destabilised and moved toward the bottom of the feature after an empty volume was created (after the putrefaction and decomposition of the intra-pelvic organs and buttocks muscles) in the area of the pelvis. As the skeleton was documented only in one level (not in successive plans as indicated in Duday 2009[2006], 39, Fig. 3.5), these bones could have been easily neglected; their presence in the initial feature was observed during the osteological analysis. As seen in Figure 41, the left lower limb and right foot are absent. According to the diary entry (Jaanits 1962a), these were accidentally lifted before recording. The position of the left lower limb (left unfilled in the drawing) has been established by the excavator. The right lower limb is extended at the hip and knee, as was the left lower limb. Due to the accidental removal of the feet bones, the position of the feet remains unclear.

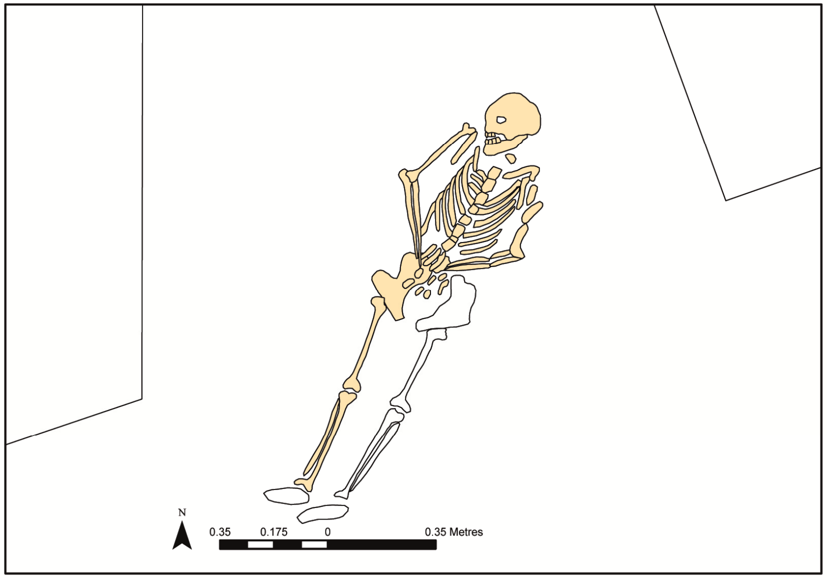

Figure 41. A primary burial of an adult female from Naakamäe.
The primary nature is clearly indicated by the maintenance of the labile articulations of hand bones positioned in front of the pelvis. This also suggests that the decomposition of the corpse took place in a filled environment. The overall completeness of the skeleton further supports this argument. The absence of the entire left limb, pelvis, and right foot (unfilled in the drawing) is due to the excavation techniques instead of being indicative of mortuary practices.
(Drawing and photos after TLU AI, 4-1-20-1 and f12)

Despite the shortcomings of the applied field techniques, which resulted in the accidental removal of the left lower limb and right foot during the excavations in 1962, it is possible to reconstruct the nature of the burial, space of decomposition, and initial body position of the deceased. The primary nature of the burial is best proven by the maintenance of the articulations of the metacarpals indicated clearly in the photographs (Figure 41). The overall completeness of the skeleton and the decomposition in the filled environment supports this argument. The latter is proven again by the maintenance of the labile articulations of the hand bones and also by the absence of any movements outside the initial body volume.

6.1.1.1.2. Kivisaare XIII – an example of a primary? burial

The field documentation about the graves at Kivisaare does not allow a very detailed archaeothanatological analysis and thus it has only been possible to state that burials VII, Xa, XIa/b, XIIa/b, XIII, XV, XX, and XXI were probably primary. Kivisaare XIII (Figure 42) provides an exemplary case here. This burial of an adult was excavated by Bolz on the 6th of April 1910 (Bolz 1914, 22). Unlike many other burials discovered and recorded at the beginning of 20th century, Kivisaare XIII has been documented thoroughly, being more comprehensive than the subsequent ones done by Tallgren, Moora, Indreko, or Jaanits. The level of detail of the written description and the granularity of the drawing – being the only one where significant features of every single bone element are drawn – allows the initial mortuary practices to be reconstructed.

Compared to other skeletons found in the beginning of the 20th century, Kivisaare XIII is more or less complete. All the long bones are present, though both femurs are broken. The hand and feet bones (except both tali and calcanei) – carpals, metacarpals, and phalanges – were not drawn; the cranium, scapulae, and clavicles, the bones from the thoracic cage and vertebral column, and the pelvis, patellae, and left humerus are also absent in the drawing. This, however, does not mean that all of these bone elements were originally not there. Bolz describes that the vertebral column, ribs, pelvis and at least some of the hand and feet bones were initially part of the deposit: "*Das proximale Stück* [von Femur] *lag an seiner normalen Stelle, doch waren Kopf, Hals und Trochanteren zertrümmert, ebenso das Becken, die Rippen und die Wirbelsäule, von der ausser dem Epistropheus nur ein Lendenwirbel intakt war*" (Bolz 1914, 23). The heavy decomposition and fragmentation of scapulae, vertebral column (excl. one vertebra), and pelvis could be explained by taphonomic processes. All these bones are considered to be less resistant to the post-burial taphonomic activities (Beckett & Robb 2006, 63; Gill-King 2006, 104) due to their spongy structures, and thus prone to decompose entirely or being very fragmented during the discovery.

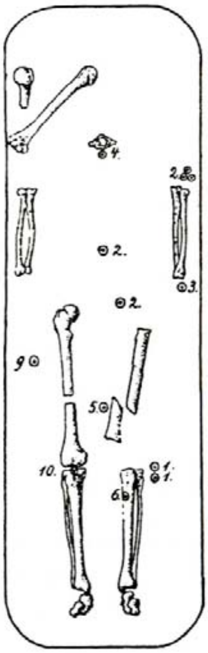

Figure 42. A probable primary burial of Kivisaare XIII (XII; Grab 5).
Although there are no labile articulations to observe, the overall completeness of the skeleton and the maintained articulations between the ulnae and radii and the leg bones, and between the talus and calcaneus, indicate that this is a primary burial. Bolz (1914, 23) also states in the field description that the vertebral column, ribs, pelvis, and some of the hand and feet bones were present, although poorly preserved. Furthermore, the argument is supported by the visible undisturbed grave cut filled with gravel and humus-rich soil.
(Drawing reproduced after Bolz 1914, Abb. 3).

The overall poor preservation of these skeletal elements applies to the here-observed osseous collections in general. The absence of pelvises of the (probably) primary burials at Tamula is notable. The analysis of the osteological material revealed that graves III, VII, IX, XI, XII, XV, and XXI lacked pelvises entirely, and in graves VI, X, XVII, XVIII, XIX XX, and XXII, these were only partially present (≤50%). The same tendency is clear in the osteological material at Valma, where the pelvises of skeletons II and III are absent. However, the field documentation – including the excavation reports of Indreko (1942) and Moora (1946), the field diaries of Jaanits (1955b; 1956b; 1961b) at Tamula, and the photographs about Valma burial (Jaanits 1955c) – clearly indicate that these were present during the excavation. The contradiction between the various sources, however, does not prohibit an archaeothanatological analysis of burials without pelvises, Kivisaare XIII amongst them. By integrating taphonomic knowledge and a critical assessment of the field notes, it becomes clear that the absence of several flat and spongy bones is not a result of multi-episodic mortuary practices, but rather an outcome of deficient field techniques. Thus, in general while analysing these cases the field documentation is favoured over the available osteological material (however, exceptions do remain).

Let us continue with the description of the Kivisaare XIII burial. As stated above, the skull was absent in the drawing. Both Bolz (1914, 23–25) and Ebert (1913, 506) stated that it was not present during the excavations either, omitting its full inclusion in the archaeothanatological analysis. Whether it was removed during the time of burial or later will be discussed below. Although one cannot ascertain whether the articulations between the right arm and shoulder are maintained, it is possible to establish that the arm is slightly abducted at the shoulder (i.e. medial axis of the body) and presents its anterior side. The articulations between the arm and forearm are not maintained. However, the articulations between the ulna and radius have abided. Due to the abduction of the arm and the position of the forearm bones – parallel to the medial axis of the body, ulna positioned medially, and radius on its right lateral side – it could be concluded that the forearm is slightly flexed at the elbow and pronated. Due to the absence of hand bones in the drawing, nothing can be said about the position of the wrist and fingers. The left humerus – at least its proximal part, which is visible in the drawing – is disarticulated and positioned at the right lateral side of the distal third of the right humerus. The bone exhibits its posterior side and is parallel to the medial axis of the body and perpendicular to the right humerus. The bones of the left forearm are intact, and the articulations between them are maintained. The position of the bones – radius on the left lateral side and ulna positioned medially – indicates that the forearm was pronated. Again no hand bones are present. Thus, the articulations of the wrist and hand could not be established. As seen from Figure 42, the vertebral column, thoracic cage, and pelvis are not displayed. Although these bone elements were present initially, their position could not be established due to both their poor preservation and insufficient field documentation.

The position of the lower limbs is well documented. The right femur, fragmented into two larger pieces, displays its anterior side and is extended at the hip. The articulation with the leg bones is maintained; however, the patella is missing. The right leg bones exhibit their anterior sides, and the leg is extended at the knee. Although not all the feet bones are present in the drawing, the intact nature and close spatial relation of the talus and calcaneus indicate a maintained articulation between the leg bones and foot. Based on the position of the bones it could be argued that both the talus and calcaneus are exhibiting their medial sides, thus the feet must be supinated. The left femur is also broken into two pieces, and neither of the articular ends are observable; however, these were present during the excavations (Bolz 1914, 23). The distal part of the femur has moved toward the medial axis of the body compared to the proximal part of the bone. While the epiphyses of the bone are not observable, the position of the femur cannot be established directly. The position of leg bones – both exhibiting their anterior surfaces and in articulation with one another – indicates that the femur was also displaying its anterior side. Although the articulation between the thigh and leg bones cannot be observed, the position of the leg bones – parallel to the medial axis of the body – indicates that the left lower limb was extended at the knee. Similarly to the right foot, only the talus and calcaneus are present; their position suggests that they display medial sides and thus the foot was supinated during the time of disposal.

From the above description it becomes clear that the most characteristic articulations to argue for a primary inhumation are not observable. Moreover, the position of the proximal part of the left humerus and the two fragments of the diaphysis of the left femur suggest movement of the bones. Yet, as Bolz (1914, 23–24) did not record any disturbances to the grave, these could be seen as either (1) taking place during the decomposition of the body or (2) are the outcome of the poor excavation techniques that did not allow later observations. While the movements of the left femur are minute – inside the initial body volume – and could be explained by the taphonomic processes involved in the decomposition of the corpse, the range of movements indicated by the position of the left humerus are immense and need an extrinsic explanation. This situation puzzled Bolz, too. However, at the end of his description of the deposit, Bolz (1914, 25) found a solution to the encountered problem. Although the drawing displays no disturbances to the grave, in his notes Bolz states that signs of this were present. It appeared that the same grave was first found already in 1903 by local landlord Jaan Pekk (Kivisaare VI). Thus, the disturbances of the upper part of the body – the missing skull(?) and the extreme movement of the left humerus, together with the slight movements of the left femur – are secondary intrusions caused during the road improvement in 1903 (Bolz 1914, 18). Pekk found nothing but a femur: "*Ausser 2–3 Fischwirbeln fand sich bei dem sehr morschen Skelett nichts, und wirklich war vom Schädel auch nicht ein Fragment zu entdecken*" (Bolz 1914, 18).The cranium appears not to have been deposited initially and the femur must have been deposited slightly higher than the rest of the skeleton. However, the disturbed nature of the whole drumlin does not allow any firm conclusions here. Thus, the question of whether we are witnessing a pre-burial decapitation or a post-burial manipulation of the cranium remains unanswered due to the deficiency of detail in the field documentation.

Despite the listed shortcomings, Kivisaare XIII appears to be a primary burial because the overall order of the skeleton is maintained (see also Duday 2009, 27–28). Primarily this is proven by the maintained articulations of the forearm and leg bones together with the retained articulations between the feet bones. The written description about the presence of the fragments of the vertebral column, thoracic cage, and hand and feet bones supports the argument even further. The humus-rich grave fill documented in other burials at Kivisaare strengthens the argument. According to Duday (2009[2006], 34), the black earth in the immediate vicinity of skeletons affirms that the putrefaction and decomposition of the corpse took place in the same spot. The space of decomposition is discussed in further detail in *Chapter 6.1.3.1.4.*

6.1.1.1.3. Tamula XIX and XX – examples of probably primary burials

Other examples of probably primary burials are Tamula XIX and XX. The descriptions of these burials are based on the field drawings; diary entries (Jaanits 1961b), together with the article (Jaanits 1957a), complement the visual material.

Burial XIX (Figure 43) belongs to a middle adult (probably male) who was adorned with two bird-shaped bone plates, some bird bone beads, and some tooth pendants (Jaanits 1957a, 88). Ots (2006, 66) suggests that the amber fragments and a single bead found dozens of centimetres from the skeleton are grave goods, interred at the lower part of the cultural layer (40–47 cm). This burial was found in 1956 at the border area of the excavation plot, and at first only the lower limbs were excavated. Jaanits describes the finding as follows: *"Only the limb bones are preserved, belonging probably to the lower limbs.* [The upper part of the skeleton] *reaches to the non-excavated area"* (Jaanits 1956b). Based on the information in the field diary, it seems that they did not extend the excavation plot immediately and continued with this burial slightly later, perhaps not until 1961 as indicated by the plan. Then the upper part of the body was cleaned: *"upper body on back, head rotated left, vertebral column curved right at the shoulders. Humeri were parallel to the body; at least one of them* [a forearm] *was flexed at the elbow crossing the abdomen (probably left). Bones were poorly preserved; as the lower limbs were found at the border of the previous excavation plot, these were partly destroyed. Thus one could not establish the position of the lower limbs. Taking the length of the skeleton into account the lower limbs were probably flexed somehow. Pelvis was not found. /…/ Head was pointing south-east* [actually south-west]. *The position of skull and vertebral column seems to indicate that lower limbs were flexed to the left lateral side. Feet bones and tibia in the square e–f/23 allow suggesting the opposite: legs had been on the right side"* (Jaanits 1956b).

As appears from the description, Jaanits had several problems in understanding the position of the skeleton already in the field. However, by the time of publishing the material, Jaanits was sure that the forearm flexed at the elbow really was the left limb, but nothing was said about the postition of the lower limbs (Jaanits 1957a, 88). Moreover, there are slight discrepancies between the drawing and diary entry. This can be due to the fact that I was not able to find the drawing from 1961 and thus in Figure 43 the upper part of the skeleton is drawn based on the published overview plan (Jaanits 1957a, Abb. 1). Obviously less attention is paid to small details on the overview plan (1:500) compared to the field drawings (1:20), thus in describing the upper part of the deposit one should prioritise the description. Despite the deficiencies of the description and drawing, some general observations can be made and we can assume that the burial was probably primary in its nature.

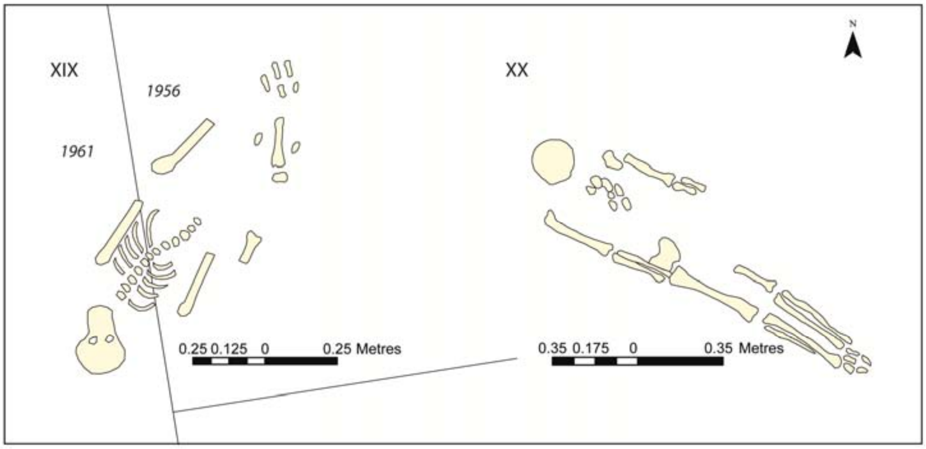

Figure 43. Excerpts of excavation plans from 1956 and 1961 with the probably primary burials Tamula XIX and XX.
The lines indicate the borders of excavation plots of different field seasons (1956 and 1961 respectively). The position of the skull and upper post-cranial skeleton of burial XIX are drawn after Jaanits 1957a, Fig. 1, as I was not able to locate the original plan from this excavation area. (Drawings after TLU AI, 4-1-29-3).

As stated by Jaanits, the cranium displayed its right lateral side, being rotated to the left. Unfortunately it is impossible to observe whether the articulation between the cranium and mandible were maintained. As the position of the cervical vertebrae was not documented, one cannot conclude whether the left lateral rotation of the cranium is indicative of the initial position of head or a result of taphonomic processes. Neither is it possible to establish whether and to what extent the articulations at the shoulder girdle are maintained. The sources indicate that both arms are adducted. The side of appearance cannot be determined. As the bones of forearm are not visible in the drawing, their articulation with the humeri cannot be established either. In the field diary, Jaanits notes that at least one of the forearms (left) was pronated, flexed at the elbow, and lying across the abdomen. The position of the other forearm (right) and both hands cannot be determined. The presence of hand bones in the initial deposit is assured by their existence in the osteological collection. The rib cage and thoracic vertebrae seem to have maintained their original shape and position. Articulations between single vertebral discs and ribs have maintained. As stated by Jaanits (1956b) the pelvis was not found. This, however, is a general problem at Tamula. Its absence here could be explained by poor excavation techniques and the circumstances of the discovery of the grave. The general position of the skeleton suggests that the pelvis remained in the area excavated in 1956; it must have been very close to the excavation border. This, and the confession by Jaanits about not entirely comprehending the situation in the field, further suggests that the excavators just did not notice the probably rather fragmented pelvis. The position of the lower limbs cannot be established at all. Their presence in the feature is confirmed in the diary entry. However, the close spatial relation of the right tibia and foot bones – the side of appearance cannot be observed – allows suggesting that the articulations were maintained.

This description does not allow any definitive conclusions about the nature of the burial, its initial body position, or the space of decomposition. Nevertheless, some general remarks can be made. The overall intactness of the thoracic region and vertebral column – despite the fact that the side of appearance of single bones cannot be determined – indicate that the body was placed into the grave in a fresh state. This is further supported by the loose articulation observed between the right tibia and foot bones. The same evidence could also be valid for decomposition in a filled space, indicating that the general position of the upper part of the skeleton demonstrates the initial body position; the position of the lower body cannot be reconstructed at all. Although there are several arguments suggesting this was not a primary inhumation, the confusions during the excavations do not allow this burial to be identified as the result of multiple burial episodes. So, tentatively, one could argue that Tamula XIX was probably a primary burial with its upper body lying on back, its arms adducted, and with one forearm pronated and flexed at the elbow.

Tamula XX burial belonged to a middle adult (probably male) without any grave goods. The body was placed into the lower part of the cultural layer on its back with both upper and lower limbs in extension. The skull was somewhat closer to the ground level – 37/38 cm below (Jaanits 1956b; Jaanits 1957a) – than the post-cranial body (54 cm). Beneath the skeleton several rather thick wooden branches that were perpendicular to the medial axis of the body were documented. Although the drawing of the grave suggests that parts of the bones from the left side are absent, this is not the case as proven both by the diary entry and the available bones in the osteological collection. It appears that the bones of the thoracic area, left forearm, and femur were dislocated, but otherwise present (Jaanits 1956b). The side of appearance of single bones cannot be established. Thus, the general statement about the supine position is taken into account while describing the deposit.

The position of the cranium, thoracic area, vertebral column, and left forearm together with hand bones cannot be established at all from the available documentation. It appears that both of the arms are adducted, and their close position to one another indirectly indicates that the articulations at the level of shoulder girdle must have been maintained (although these cannot be observed directly). Both arms have maintained their connection to the forearm bones; however, the side of appearance of the ulnae and radii cannot be observed. Although only proximal parts of the left ulna and radius are observable in the drawing, it can be concluded that both forearms have been extended at the elbow. Moreover, the right forearm has a tight connection to the right lateral side of the body. Although one can observe that the right part of the pelvis is present, its side of appearance cannot be established. Its close connection with the femurs also suggests that the articulation was maintained. Although the proximal part of left femur is not observable, one can state that both lower limbs were extended at the hip and knees. The feet bones have maintained their articulation with the leg bones, but neither their exact position nor side of appearance can be determined. The position of the bones at the right side indicates pressure from the right lateral side; due to the absence of bones this cannot be observed on left side.

Again we are not provided with much detailed information about this particular burial. Only rarely is it possible to observe the presence of the labile articulations (acetabulum and head of femur, feet), and a considerable amount of the bones from the left lateral side are not drawn at all (despite being present in the deposit). The overall completeness of the skeleton and the presence of small bones in the osteological collection indicate firstly the inferior excavation techniques, and secondly the possible disjunctions of bones during or after the process of decomposition brought about by the underlying wooden branches (see also *Chapter 6.1.3.2.1.*). Unfortunately, one cannot go into detail with the effects of wooden branches on the body here. In sum, the overall completeness of the body together with references to the maintenance of some labile articulations suggests that this probably was a primary burial. Moreover, the decomposition of the body took place in a filled environment; however, it might be that some empty voids were created by the wooden branches, as indicated by the dislocation of bones at the level of the thoracic area.

6.1.2. Space of decomposition for burials

In general, the graves have been simple shallow pits dug out of the ground and filled with sediment. Some of the graves at Kivisaare have been found rather close to the present surface (VIIIa/b, XIa/b, and XXa/b), others are some 20–40 cm below it (Bolz 1914; Ebert 1913; Indreko 1931; Jaanits 1965c; Tallgren 1921); at Tamula the depths of the graves remain mainly between 45–55 cm, with the shallowest being only 33 cm from the topsoil (XI and XXIII), and deepest over 70 cm deep (XXII and XXV) (Indreko 1942; 1945; Jaanits 1955b; 1956b; 1957c; 1961b; Moora 1946). Graves II and III at Valma remained at the level of 54–57 cm, and grave I was significantly deeper, at the level of 115 cm (Jaanits 1955c). The initial depth of the quadruple grave at Veibri was impossible to establish due to the removal of the topsoil (Johanson et al. 2006–2011; Lõhmus et al. 2011). The graves in Saaremaa at Kõnnu remain between 46–52 cm (the depth of grave III is unknown), although the graves may have been somewhat deeper initially as the topmost layers were removed during gravel mining; grave I at Kõljala was found at the depth of 90 cm (Hausmann 1904) but there is no further information about the depths of other graves at Kõljala, Jalukse, Metsikumäe, or Naakamäe. The depths of the features with loose human bones do not differ significantly from the above-described graves, being 40–190 cm at Akali (Jaanits 1950b; 1952; 1966), 116–144 cm at Narva Joaorg (Jaanits 1962b; 1963), 85–90 cm at Pikasilla (Veldi 2010), and c. 150 cm at Võru (Jaanits 1973). The extreme depths of the loose human bones at

Akali could be explained by the gradual overgrowth of the settlement layers with peat and at Narva Joaorg with the multi-layered nature of the site. Initially the deposits had been as shallow as the ones with complete skeletons.

In the majority of cases, no additional structures have been observed. Moreover, at Tamula, Veibri, and in many cases at Kivisaare (XV[34]) and Kõnnu (I and III), the grave feature does not differ from the surrounding sediment at all, making it impossible to assess the boundaries of the graves; no detailed information about the graves at Jalukse, Kõljala (II and III), or Külasema are available. However, at Naakamäe, Kõljala (I), Kõnnu (II), Valma (II and III), and Kivisaare, the grave cuts have been filled with humus rich soil or the borders of the graves become apparent due to red ochre spread around the skeletons or parts of them. The outline of all these graves is oval, or rectangular with rounded corners. Archaeological evidence from additional structures in the graves at Tamula are visible in the form of wooden poles and/or wooden branches beneath the corpses (Jaanits 1957a), and at Narva Joaorg (III), Valma (III), and Tamula (VII and XII), stones have been found; these will be discussed separately in *Chapter 6.1.3.2.*

The summary of the space of decomposition is given in Table 25. All the burials were divided between four categories: *filled*, *filled?*, *mixed,* and *unknown*. This indicates that the dominating pattern for the corpses to decompose, when it can be established, was in a *filled(?)* space (23). Only in five (Tamula IX–XI, XIV, and XXII) cases a *mixed* environment – indicating both decomposition in a space with immediate and delayed filling – could be argued for. However, in a relatively large number of cases (58) the space of decomposition could not be determined (*unknown*) due to the lack of proper field documentation and/or the poor preservation of human remains, including the features with loose human bones.

Table 25. Summary of the results of archaeothanatological analysis about the space of decomposition in graves and initial body position.

Grave/skeleton no. (original no.)	***Space of decomposition***	***Arguments***
Akali 1 (AI 4013: 3412)	unknown	only fragments of parietal bone present; no detailed information about position in deposit
Akali 2 (AI 4013: 6975)	unknown	single fragment of a skull present; no detailed contextual data
Akali 3 (AI 4013: 8345, 8355, 8368, 8339)	unknown	only fragments of skull present; no detailed information about position in deposit
Jalukse (1–11)	unknown	analysis impossible due to no field documentation
Kivisaare I	unknown	analysis impossible due to no field documentation
Kivisaare II	unknown	analysis impossible due to no field documentation
Kivisaare III	unknown	analysis impossible due to no field documentation
Kivisaare IV	unknown	analysis impossible due to no field documentation

[34] If the character of the sediment was recorded then it was marked as black humus-rich soil. Only once it was stated that the soil did not differ from the surroundings; in the rest of the cases characteristics of the sediment were not noted by the excavator.

Grave/skeleton no. *(original no.)*	Space of decomposition	Arguments
Kivisaare V	unknown	analysis impossible due to no field documentation
Kivisaare VI	unknown	analysis impossible due to poor preservation – *"sehr morschen Skelett"* (Bloz 1914, 28) – and poor field documentation
Kivisaare VII *(I; Grab 1)*	filled?	direct evidence is absent; close relationship between cranium and (cervical) vertebrae of the child, together with surrounding black humus-rich soil, indicate decomposition in a filled space
Kivisaare VIIIa / b *(II; Grab 2, 3)*	unknown	analysis impossible due to heavy destruction and poor field documentation
Kivisaare IXa / b *(III; Grab 4)*	unknown	analysis impossible due to poor preservation, heavy destruction, and poor field documentation
Kivisaare Xa / b *(Kivisaare I, Ia)*	filled?	direct evidence is absent; overall intact position of skeleton; dry, black humus soil only 2–3 cm thick (Ottow 1911, 154)
Kivisaare XIa / b *(Kivisaare II, IIa)*	filled?	direct evidence is absent; poor preservation conditions; however skeletons were found in humus-rich sediment differing from surroundings (Ottow 1911, 155)
Kivisaare XIIa / b *(Kivisaare III, IIIa)*	filled?	direct evidence is absent; humus-rich soil and intact nature of skeleton no. XIIa; black soil close to the two skeletons indicates action of biological agents during decomposition of cadaver
Kivisaare XIII *(XII; Grab 5)*	filled?	direct evidence is absent due to poor field documentation, overall anatomically correct position of skeleton and humus-rich black soil at immediate surroundings of skeleton indicate action of biological agents during decomposition of cadaver
Kivisaare XIV*(XV)*	unknown	analysis impossible due to poor preservation and poor field documentation
Kivisaare XV	filled?	no direct evidence due to poor field documentation; overall anatomically correct position of skeleton
Kivisaare XVI	unknown	poor preservation of skeleton; lack of sufficient contextual data
Kivisaare XVIIa/b	unknown	poor preservation of skeleton; lack of sufficient contextual data
Kivisaare XX *(luustik nr 3)*	filled	no movements outside initial volume of corpse; pubic symphysis is not opened
Kivisaare XXI *(luustik nr 4)*	filled	no movements outside initial volume of corpse
Kivisaare XXII *(y_1–b/12–13)*	unknown	poor preservation of skeleton; lack of sufficient contextual data
Kivisaare XXIII *(y_1–h/12–17)*	unknown	poor preservation of skeleton; lack of sufficient contextual data
Kivisaare XXIVa/b *(f–k/6–11)*	unknown	poor preservation of skeleton; lack of sufficient contextual data
Kivisaare XXVa/b *(ä–ö/42–44)*	unknown	poor preservation of skeleton; lack of sufficient contextual data
Kivisaare XXVIa/b *(f–h/18–20)*	unknown	poor preservation of skeleton; lack of sufficient contextual data
Kivisaare XXVII *(Close to burial III (1965))*	unknown	poor preservation of skeleton; lack of sufficient contextual data
Kivisaare XXVIII *(y_1–a/16–17 (black soil depression))*	unknown	poor preservation of skeleton; lack of sufficient contextual data
Kivisaare XXIX a–c *(luustik 1)*	unknown	re-burial
Kivisaare XXX *(loose soil in 1931)*	unknown	poor preservation of skeleton; lack of sufficient contextual data
Kõnnu I	unknown	analysis impossible due to heavy destruction and poor field documentation
Kõnnu II	unknown	analysis impossible due to heavy destruction and poor field documentation
Kõnnu IIa	unknown	analysis impossible due to heavy destruction and poor field documentation
Kõnnu III	filled	no movement outside initial volume of corpse; patellae in articulation

Grave/skeleton no. (original no.)	*Space of decomposition*	*Arguments*
Kõnnu pit no. 102	unknown	only single fragments of bones found; no articulations preserved; upper parts of cultural layer were destroyed
Kõnnu pit no. 111	unknown	only single fragments of bones found; no articulations preserved; upper parts of cultural layer were destroyed
Kõnnu pit no. 122	unknown	only single fragments of bones found; no articulations preserved; upper parts of cultural layer were destroyed
Kõnnu pit no. 127	unknown	only single fragments of bones found; no articulations preserved; upper parts of cultural layer were destroyed
Kõnnu pit no. 131	unknown	only single fragments of bones found; no articulations preserved; upper parts of cultural layer were destroyed
Kõnnu pit no. 135	unknown	only single fragments of bones found; no articulations preserved; upper parts of cultural layer were destroyed
Kõnnu pit no. 138	unknown	only single fragments of bones found; no articulations preserved; upper parts of cultural layer were destroyed
Kõnnu year 1979	unknown	analysis impossible due to absence of contextual information
Kõnnu year 1981	unknown	analysis impossible due to absence of contextual information
Kõnnu year 1984	unknown	analysis impossible due to absence of contextual information
Kõnnu without context	unknown	analysis impossible due to absence of contextual information
Kääpa (AI 4245)	unknown	only a cranium was found
Kääpa (VM 3000:756)	unknown	only single fragments of cranium found
Külasema (Metsikumäe)	unknown	analysis impossible due to poor field documentation
Naakamäe	filled	no movement outside initial volume of corpse; metacarpals and phalanges in articulation in front of pubic area
Narva Joaorg I	filled?	articulation between left tibia and fibula maintained; a fist-sized stone found beneath tibia and fibula
Narva Joaorg II	unknown	analysis impossible due to poor field documentation
Narva Joaorg III	filled?	direct evidence absent; the anatomically correct position of clavicles; archaeological evidence about grave cut without any later intrusions
Narva Joaorg IV	unknown	analysis impossible due to poor field documentation
Pikasilla	unknown	only teeth present
Sindi-Lodja	unknown	only loose human bones present; analysis impossible due to absence of contextual information
Tamula I	filled?	no movement outside initial volume of corpse; metatarsals and phalanges in articulation; disarticulation of thoracic area indicates empty volume behind upper body or secondary disturbances of grave
Tamula II	filled	no movement outside initial volume of corpse; maintenance of articulation between the acetabulum and head of femur
Tamula III	filled	no movement outside initial volume of cadaver; articulation of hand and feet bones; right patella fallen
Tamula IV	unknown	analysis impossible due to the presence of only single human bones; no grave cut observable
Tamula V	unknown	analysis impossible due to the presence of only single human bones; no grave cut observable
Tamula VI	filled	no movements outside initial volume of the corpse; hand and foot bones seem to be in articulation
Tamula VII	filled	no movements outside initial volume of corpse; foot bones in articulation, left forearm disarticulated at elbow
Tamula VIII	filled	no movement outside initial volume of corpse; no opening of the pubic symphysis
Tamula IX	mixed	no movement outside initial volume of corpse; hand and foot bones in articulation; dislocation of bones at level of thoracic cage and lateral movement of forearms
Tamula X	mixed	no movement outside initial volume of corpse; dislocation of bones at level of thoracic cage, lateral movement of left forearm
Tamula XI	mixed	no movement outside initial volume of corpse; lateral movement of ribs

Grave/skeleton no. (original no.)	*Space of decomposition*	*Arguments*
Tamula XII	filled?	no direct evidence due to poor documentation' absence of movement outside initial volume of cadaver at the level of lower limbs; space of decomposition of XI individual, with whom the child forms a simultaneous deposition
Tamula XIII	unknown	analysis impossible due to poor preservation and heavy fragmentation; no grave cut observable
Tamula XIIIa	unknown	only single loose human bones present; no articulations observable; identified during osteological analysis carried out for the present thesis
Tamula XIV	mixed	no movements outside initial volume of corpse; maintenance of articulations of hand and feet bones; opening of the pubic symphysis
Tamula XV	filled?	poor preservation and heavy fragmentation of bones limits analysis; overall position of the bones indicates decomposition in a filled space
Tamula XVI	unknown	analysis impossible due to poor preservation; no grave cut observable
Tamula XVII	filled	no movement outside initial volume of corpse; maintenance of articulations of hand and foot bones
Tamula XVIII	filled?	no direct evidence due to poor documentation; lack of movements outside initial volume of corpse, however, indicate decomposition in a filled space; rotation of ribs and movement of the left lower limb indicate open volume
Tamula XIX	filled?	absence of movements outside initial volume of cadaver at upper part of body; lower part of body is disturbed
Tamula XIXa	unknown	only single bones present, identified during osteological analysis carried out for this thesis
Tamula XX	filled?	no movements outside initial volume of corpse; disarticulation of bones at level of thoracic cage
Tamula XXI	filled	no movements outside initial volume of corpse
Tamula XXIa	unknown	only a single cervical vertebra present, identified during osteological analysis carried out for this thesis
Tamula XXII	mixed	no movements outside initial volume of corpse; extreme flection at level of knee and hyper-extension at level of pelvis together with disarticulation of bone at level of upper body
Tamula XXIII	unknown	analysis impossible due to poor preservation
Tamula XXIV	unknown	analysis impossible due to poor preservation
Tamula XXIVa	unknown	analysis impossible due to poor preservation
Tamula XXV	unknown	analysis impossible due to poor preservation
Tamula (year 1956)	unknown	only single loose human bones present; analysis impossible due to absence of contextual information
Tamula (year 1961)	unknown	only single loose human bones present; analysis impossible due to absence of contextual information
Tamula (year 2007)	unknown	only single loose human bones present; analysis impossible due to absence of contextual information
Tooma	unknown	analysis impossible due to absence of information
Valma I	unknown	analysis impossible due to poor field documentation
Valma II	filled	no movement outside initial volume of corpse
Valma III	filled	no movement outside initial volume of corpse; articulation of foot phalanges
Veibri I: I	filled	no movement outside initial volume of corpse
Veibri I: II	filled	no movement outside of initial volume of corpse; no opening of the pubic symphysis
Veibri I: III	filled	no movement outside of initial corpse; however, heavy distur-bance of the skeleton prevents examination of diagnostic features
Veibri I: IV	filled	no movement outside initial corpse; right hand phalanges in articulation
Võru	unknown	poor preservation, no clear contextual information available

6.1.2.1. Decomposition in a filled/filled? space

The category 'filled' refers to burials where the voids of the decomposed body were either immediately or gradually filled by sediment (Duday 2009[2006], 41–43; 2009, 38pp; Duday et al. 1990, 36pp; Nilsson Stutz 2003, 252pp). Graves assigned to this group possess evidence that leave no doubt about the decomposition of the corpse taking place in the filled space. In most cases, this means that no movements of bones outside the initial body volume can be detected. For burials in the supine extended position, the diagnosis is rather straightforward, depending on the articulation of pubic symphysis (not opened) and position of patellae and femurs (Nilsson Stutz 2003, 255). Moreover, the maintenance of the labile articulations such as hand and foot bones and bilateral pressure to the thoracic area provides additional support. Not all the diagnostic features must be present in every single case. For flexed burials on either of the lateral sides, the lack of thoroughly analysed references (but see e.g. Nilsson Stutz 2003, 265–266) means no characteristics diagnostic only for these kinds of burials can be given. However, generally the absence of movements outside the initial body volume and the overall maintenance of the labile articulations holds true here, too. The burials where the decomposition of the corpse took place in a filled space are known from Kivisaare, Kõnnu, Naakamäe, Tamula, Valma, and Veibri.

The category 'filled?' refers to cases where no direct evidence for the decomposition of a corpse in an environment filled with sediment could be found. This means that the documentation does not adequately describe the state of articulations and the presence or absence of bones in the field, or that the skeletons have been partly disturbed (Kivisaare XX, and Tamula XIX). Several graves from Kivisaare (VII, Xa/b, XIa/b, XIIa/b, and XIII) belong to this group. The character of the space of decomposition and the presence of additional structures of the latter is ascertained by evidence of clearly distinguishable black humus-rich sediment in the immediate vicinity of skeleton (Figure 44; discussion *Chapter 6.1.3.1.4.*).

Figure 44. A view from SE to the grave cut of the Kivisaare XXI burial excavated in 1965. *The grave is marked by dark colouration filled with humus-rich sediment. In the middle of the grave, the lower part of thoracic and lumbar vertebrae is visible. (Photo: TLU AI, 1-37-11)*

6.1.2.1.1. Bodies on their back with lower limbs in extension

The majority of the burials in the sample are those placed on their back with both upper and lower limbs in extension (Kivisaare VII, Xa/b, XIa/b, XIIa/b, XIII, XV, XXa/b, and XXI; Kõnnu I; Tamula VII, VIII, XII, XV, XVII, and XX; Valma II and III; Veibri I: I–IV), arms adducted with flexed forearms, hands either in front or behind the pelvis (Naakamäe; Tamula VI and XII), or upper limbs in extension and lower limbs slightly flexed at the knee (Tamula XVIII). As stated above, for these graves the decomposition in the filled environment is best proven by the maintained articulations of patellae, the closed position of the pubic symphysis, and the position of the femurs, together with the maintenance of the labile articulations. Due to the poor excavation techniques and poor field documentation, together with the poor preservation of bones in some instances, it has not been possible to observe the maintenance of the position of the patellae. Moreover, as discussed above (*Chapter 6.1.1.1.2.*) the rate of fragmentation and decomposition of whole pelvises is high in the analysed material, which makes it impossible to use the closed position of the pubic symphysis as a diagnostic feature in arguing for a decomposition taking place in a gradually filled environment. This means that the space of decomposition can only be determined indirectly, based on general assessments of the body, and only sometimes by the maintenance of the labile articulations.

However, a good example of a primary burial in a filled space with both upper and lower limbs in extension, moreover with observable labile articulations, is the grave Tamula VII (Figure 45). This grave belonged to a richly adorned child and was excavated in 1946 by Jaanits as an archaeology student. The grave was dug into the lower part of the cultural layer, being at the depth of 50 cm from the topsoil. This is the most meticulously cleaned and documented grave from Tamula: a drawing and the written description are suitable for archaeothanatological analysis (Moora 1946; Jaanits 1947). Due to the absence of photographs, the side of appearance of single bones cannot be established precisely. Although the skeleton was taken to the collection, now only its skull could be found. Jaanits suggests that the post-cranial skeleton probably went missing after the burial was exhibited (Jaanits, pers comm.). The skeleton was rather well preserved, with the exception of the skull that presumably was fragmented under the pressure of a c. 25 cm diameter stone that had been placed in front of it (Jaanits 1947, 22). However, despite their heavy fragmentation, all bones seem to be present, and the overall shape of the skull – presenting its right lateral and frontal side and being flexed to the chest – could be observed. The articulations between the mandible – displaying its right body – and the temporal bones seem to be maintained. Both arms are adducted and their proximal articulation at the level of shoulder girdle maintained. Both clavicles are recognisable, lying horizontally at their anatomical position. The articulation at the level of the right elbow is broken off and the radius is in front of and perpendicular to the ulna, which exhibits its medial side. The position of the right radius, the ulna, and the large bone of a common crane found behind the right upper limb suggest that initially the right forearm was in mid-supination. During or after decomposition, when the ligaments at the level of the elbow were broken off and the bird bone behind the forearm destabilised their position, the articulation both between the arm and forearm bones were lost. The exact position of the hand bones cannot be observed, but their presence is indicated on the drawing. The articulations between the left arm and forearm are maintained. The left forearm – ulna on the lateral side and radius placed medially – exhibits its anterior side of appearance, meaning that the forearm was supinated. Here one is unable to observe hand bones at all. On the left ulna, cut-marks perpendicular to the long axis of the bone were observed; Jaanits claims that these were artificial and made before the burial (Jaanits 1947, 22). One could not inspect these in detail as no post-cranial bones are available in the collection.

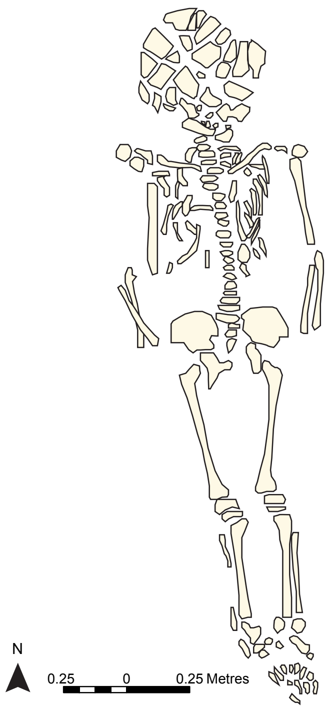

Figure 45. Tamula VII child burial.
(Drawing after TLU AI)

Although slight disturbances at the thoracic cage appear, the overall position of the ribs is maintained (this is especially clear at the left side). Remarkably, the whole vertebral column is preserved and displays no signs of movement. The movements of the ribs at the right lateral hemi-thorax could be explained by the presence of the bone of a common crane behind the right upper limb, which could have contributed in the creation of an additional empty void behind the right side of the upper body. The pelvis is intact and displays its anterior side, and although the exact maintenance of the articulations between the sacrum and ilium cannot be observed, their close spatial position supports the idea of them being maintained during the process of decomposition. Both lower limbs are extended at the hip and knee; the articulation between the femurs – exhibiting their anterior sides – and acetabulums are maintained. The articulations at the level of the knees are also maintained, although the patellae cannot be observed, and both legs – tibiae placed medially and fibulae laterally – exhibit their anterior sides of appearance. Remarkably, the articulations at the level of the ankles and feet are clearly observable, which indicates that these were upheld during the process of decomposition. As the side of the appearance of single bones cannot be observed, the exact position of the feet remains unclear.

The above description of the body indicates that it was placed in the grave still fleshed. This becomes evident from the upheld labile articulations at the level of the cervical vertebrae, between the acetabulum and femurs, and also at the level of the feet, being further supported by the presence of the right hand bones in their more-or-less anatomical position. The slight movements at the level of the right hemi-thorax and the right elbow/forearm could be explained by the grave good given to the child – a wing of a common crane. This has contributed to the creation of an additional void behind the right hemi-thorax and upper limb, which succeedingly led to the displacement of small and fragile bones. This does not disprove our argument about this burial having decomposed in a filled environment.

6.1.2.1.2. Bodies on back with lower limbs in flexion

The culture-historical school of thought attributed the flexed burials either directly or indirectly (diffusion) to the Corded Ware culture. Radiocarbon dating of the human bones and the isotopic signatures of these graves, however, do not support this idea (*Chapter 5.2.*). Most (excl. Kõnnu III and Tamula II and XXI) of these graves do not follow the 'sleeping position' characteristic to Corded Ware burials (Indreko 1935a; Loze 2006). These burials were placed on their back; variability occurs in the positioning of the upper limbs: these may be adducted at the shoulder and flexed at the elbow, crossing the abdomen (Tamula III), or one arm adducted and the forearm extended and the other one flexed at the elbow (Tamula III, XXII), or their position is impossible to reconstruct due to poor preservation and poor field documentation (Tamula XIX). The lower limbs have usually been flexed at the hip and knee, rotated right (Tamula I, III), remained on the midline of the body (Tamula XXII), or could not be observed (Tamula XIX).

Tamula III burial serves as an example of a primary inhumation (Figure 46). This grave (depth 48–56 cm) adorned with tooth pendants, and accompanied by fragments of spear heads, pottery sherds, and unworked oval stone, belonged to a middle adult male. My analysis is based on the photographs, drawing, and written description from the field report (Indreko 1942, 3–4); the information is complemented by the bones in the collection. Indreko does not go into details when describing the position of the skeleton; he just states that it was in a "sleeping position" (Indreko 1942, 3) in a relatively even bottom grave (skull 48 cm and lower limbs 55–56 cm from the topsoil). The rest of his description focuses on the position of the grave goods.

The overall position of the bones refers to the initial body position of the deceased. He was placed on his back with his lower limbs in flexion both at the hip and knee and with his feet rotated to the right lateral side and plantar-flexed. The head is facing upwards and both arms were initially adducted with the pronated forearms flexed at the elbow. Moreover, the position of the bones indicates that decomposition of the body took place in a filled environment.

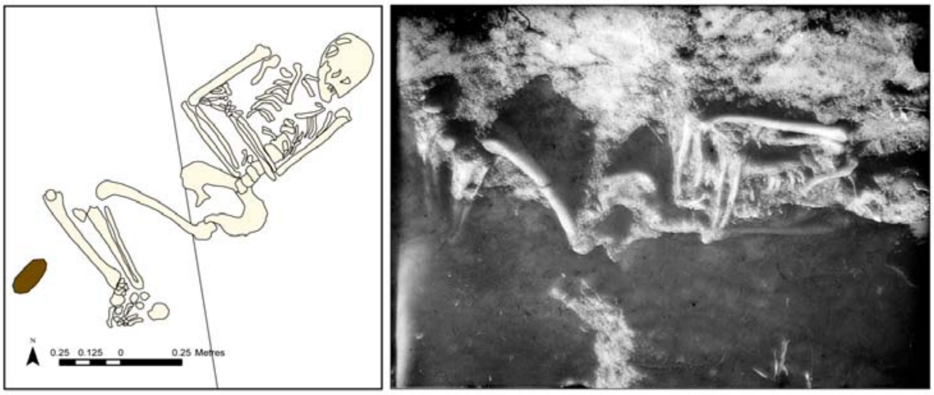

Figure 46. Tamula III burial of a middle adult male.
The voids formed during the decomposition were immediately filled by sediment as indicated by the overall intactness of the skeleton, bi-lateral pressure to the thoracic area of the body and maintenance of the labile articulations of the feet.
(Drawing after and photo TLU AI, 4-1-29-1 and fk 11138)

The overall completeness of the skeleton – the only large bone absent from the deposit is right femur[35] – and its maintenance of articulations indicate that the deceased was buried rapidly after death and the decomposition of the corpse took place in a filled space. The clearest evidence for the decomposition in a filled environment is the position of the left patella in its anatomical position. The right patella has also maintained its close spatial relation to the leg, but its relation to the femur cannot be assessed as this is the femur missing from the deposit. Moreover, the maintenance of the labile articulations of the feet bones indicates that the empty voids created during and/or after the decomposition were filled immediately by the sediment.

The idea of decomposition in a filled environment is also supported by the bilateral pressure observed in the upper part of the body, which could be caused by a narrow grave cut or an organic wrapping. Both upper arms are in adduction exhibiting their anterior sides and rotated medially. The articulation between the glenoid fossa and head of humerus of the left shoulder is maintained (seen in the photograph, but single elements cannot be determined). However, the disarticulation of the shoulder joint can be observed on the right upper limb. The volume inferior to the shoulder between the right lateral side of the hemi-thorax and right humerus, together with the disarticulation of the shoulder joint, suggest that an additional feature was present in the grave during the disposal of the body. One could argue that during the burial something rather angular was placed at the armpit (inferior and probably also beneath the right shoulder) that since distintegrated. The right clavicle displays its superior surface and is

[35] In addition not all the small bones were observable, but their absence can usually be explained by the rough excavation techniques.

loosely articulated with the right scapula, but the articulation with the sternum is not observable (sternum is not visible in the documentation); neither of the articulations of the left clavicle are observable in the documentation. Both clavicles are verticalised, which means that the shoulders were initially elevated and brought forward; this is the result of bilateral pressure to the upper body. Both of the forearms are flexed at the elbow and are pronated and perpendicular over the abdomen. The right hand bones are not entirely preserved; the ones observable in the sources are disarticulated, and the bones of the left hand have maintained a loose articulation at the level of wrist, palm, and fingers. Unlike the majority of the burials at Tamula, the restricted position of the upper body can also be observed through the position of the thoracic cage. Although no single element of the ribs can be observed in the photograph, their overall anatomical order supports the idea of decomposition in a filled burial environment.

6.1.2.1.3. Bodies on their lateral side with flexed upper and lower limbs

Under this category only three burials are included: Kõnnu III, Tamula II, and Tamula XXI. These could be regarded as examples of a genuine 'sleeping position' in contrast to the cases described in the previous subchapter. The Kõnnu III (Figure 47) burial has been placed on its right lateral side, whereas the burials from Tamula rest on their left lateral sides. Similarly to the body, their heads (not possible to observe at Kõnnu) have been placed on lateral sides. Characteristic to these burials is that their arms and forearms are flexed; for Tamula XXI it has been possible to establish that the hands are positioned behind the head (Jaanits 1956b; 1957a, 89). The latter could not be said directly about the Kõnnu III grave due to the destruction of the upper horizons of the cultural layer and the removal of the skull before any documentation was undertaken. For Tamula II, the position of the hands could also be established indirectly. The extremely flexed position of the right arm and forearm indicates that the right hand was placed behind the head; the position of the left forearm – only slightly flexed at the elbow (the left humerus cannot be observed on the documentation as it should be behind the body) – indicates that the hand must have been positioned behind the right elbow during the time of deposition (for parallel see Nilsson Stutz 2003, Photo 27; Duday 2009, 57, Fig. 42). The position of the lower limbs is more restricted in Tamula XXI, in full flexion at both the hip and knee, so that the thighs are placed immediately in front of the abdomen, which probably indicates that the deceased was wrapped before burial (see discussion *Chapter 6.1.3.1.*). The flexion of the lower limbs of Tamula II and Kõnnu III was not that extreme, resembling burials where the bodies were placed on their back with hips and knees flexed (*Chapter 6.1.2.1.2.*).

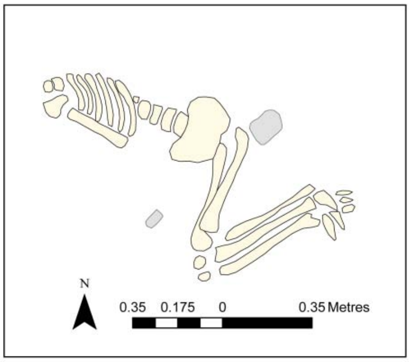

Figure 47. Kõnnu III burial on its lateral right side with limbs flexed in front of the body. *Decomposition of the body took place in a filled environment, as suggested by the position of the patellae and the maintained articulations of feet bones. The overall layout of the thoracic cage supports this argument. The labile articulations of the hand bones – otherwise good determinants for filled space – are not observable in the drawing as these were and the skull were detached during the removal of the upper horizons of the cultural layer. Their presence in the initial deposit is indicated by a single find of a metacarpal in the osteological collection. (Drawing after TLU AI, 4-1-57-1)*

The decomposition of the bodies in all of these three cases has occurred in a filled space, as indicated by the overall position and completeness of the skeletons and the maintenance of several labile articulations. This conclusion is further supported by the absence of movements outside the initial body volume and by the sediment where these bodies have been placed, allowing a gradual infilling of the empty voids created during and after the decomposition. To elaborate this a bit further, Tamula II will be discussed in more detail, mainly based on the analysis of the photograph (Figure 48), since the field description and drawing complement insufficiently.

For Tamula II, the main arguments for decomposition in a filled environment are the maintained articulations at the level of the thoracic cage and the lack of movement at the level of the pelvis. Considering the Tamula excavation as a whole, this burial stands out as an exceptional case since the ribs have been cleaned meticulously enough to observe their position. Due to the poor resolution of the photograph one cannot go into great detail; nevertheless, it becomes obvious that the thoracic cage has maintained its general outline and no movements in the area occurred. It is especially noteworthy as the left humerus should be placed behind the upper part of the body, as it is an extra destabiliser for the bones in the thoracic cage.

Figure 48. Tamula II burial on its left lateral side.
The skeleton is on its left lateral side with arms and forearms flexed in front of the body, the right hand probably behind the head, and the left hand behind the right elbow; the lower limbs are flexed at the hip and knee, the right limb resting in front of the left limb. Decomposition of the body has taken place in a filled environment, as demonstrated by the overall maintenance of the articulations and especially by the lack of movements in the thoracic area and at the level of the pelvis. (Photo: TLU AI fk 11137)

Although no z-values are available for the various parts of the body and the skeleton has been lying at a relatively even height (51–56 cm), one notices in the photograph that at least some centimetres remain between the right and left iliac crest, which indicates that the original volume of the pelvis was at least partly maintained. One should expect the left iliac blade to fall into the interior of the pelvic cavity (Duday 2009[2006], 35); as this has not happened (slight movement can be observed), this may indicate that the voids created during and after the decomposition of the muscle mass were filled by the sediment gradually. This means that the surrounding sediment replaced the perishable soft tissue of the body when they decayed step-by-step (Duday 2009[2006], 41). The position of the hand and feet bones is considered to be a good indicator that the decomposition took place in a filled environment. Here, however, the hands are not observable in the documentation (and are also not mentioned in Indreko 1942, 3), and as the skeleton is not present in the repository, one cannot check whether they were initially part of the deposit or not. However, the position of the forearms, together with the fact that their absence has not been noted by Indreko (1942), indirectly points to the possibility that the right hand was placed behind the skull and the left one behind the right elbow. Moreover, some of the metatarsals and tarsal phalanges are observable in the photograph, being loosely articulated.

In addition to the stability/movements of the bones, one also has to take into account the sediment where the grave was cut. It has been argued that the gradual infilling of the grave is only possible with a very fine-grained soil (fine sand and/or powdery ash) (Duday 2009[2006], 41; Duday 2009, 55–57). The case of Tamula II burial, however, seems to indicate that this kind of process can also be followed in peaty sediments mixed with sand and ash (Indreko 1942, 2) immediately connected to the body. Kõnnu III burial supports this observation, too. As the deceased interred at Kõnnu were placed into graves dug out of gravel with varying grain size – from fine sand to wrist size pebbles (Lõugas 1977; Väljal 1982) – it shows that gradual infilling of the empty voids created during or after the decomposition of the soft tissues does not necessarily require fine-grained sand sediment.

6.1.2.2. Decomposition in a mixed space

An archaeothanatological analysis revealed delayed infilling at Tamula graves IX–XI, XIV and XXII, in the voids created during or after the decomposition of soft tissues in the initial body volumes or to the areas where additional structures had perished entirely. In none of these burials can one conclude that the decomposition of the whole body took place in an empty volume; mostly the movements of bones indicative for delayed infilling appear at the level of the thorax and abdomen. In the case of Tamula XXII, archaeothanatological observations are supported by the archaeological evidence of birch and pine bark in front of the body. A more thorough discussion about the position of bodies in Tamula graves IX–XI will be given in *Chapter 6.1.3.2.1.* and about XIV in *Chapter 6.1.3.2.2.*

Tamula XXII is an exemplary case of a burial where the decomposition takes place in a mixed environment. The position of the bones in the grave is an outcome of movements (or lack of movements) further influenced by the immediate burial environment. The space of decomposition varied inside the feature: an empty space is located at the upper part of the body, which is indicated by series of movements in the area of skull, thoracic cage, and both upper limbs. The movement of the lower part of the body (i.e. the pelvis and the lower limbs) was restricted and no empty void outside the initial body volume formed during or after the decomposition.

The position of the cranium and the mandible clearly indicate that they moved during or after decomposition. The disarticulation and the noticeable distance between the cranium and the mandible imply that the cranium lost its connection to the cervical vertebrae before the disarticulation of the temporomandibular joint (see Duday 2009[2006], 36). The cranium has also rotated its side of appearance to the posterior and right lateral side. This position is anatomically impossible when compared to the position of the post-cranial skeleton. It would require either (1) a rotation during or after the process of decomposition, or (2) post-burial manipulation (see *Chapter 6.1.4.2.*). As stated, the mandible is disarticulated from the cranium and has fallen from its initial position to the area of the right shoulder. Both the cranium and the mandible have moved toward the right side of the upper part of the body. The possible movements toward the left side of the body were prohibited by the proximity of the grave structures – wooden poles – on the left lateral side of the upper part of the body. The proximal end of the left humerus maintained immediate contact with the smaller pole throughought the process of decomposition. Movements toward the NW end of the grave were also limited, as the superior side of the cranium was forced directly against the wall of the grave. The range of the movements of these bones indicates an empty space at the area of right lateral side of the cranium and right shoulder. In addition to the empty void at the area of the right shoulder and right hemi-thorax during the putrefaction of the muscle mass, an empty void outside the initial body volume was created. It seems likely that the void could have been created by an elevating structure (e.g. cushion or some other form of elevated head support) behind the head and the right shoulder (discussion *Chapter 6.1.3.2.3.*).

Despite the fact that both shoulder girdles are only partially observable, based on the position of the humeri and clavicles, the articulations of these were not maintained. The right humerus has moved to the right lateral side of the thoracic cage (i.e. movements both to distal and inferior). The left humerus has moved even more significantly. Its proximal end collapsed into the thoracic area following the same direction as the right humerus, i.e. toward the middle part of the right hemi-thorax. We can assume that the humerus got disarticulated from the scapula at a time during the process of decomposition when the connections between the vertebral column were still upheld (both are relatively stable articulations). The distal end seems to have remained in its original position, lodged between the lateral left side of the body and the wooden element to the left of the body. Again we see a movement toward the right as movements to the left are restricted by the proximity of the wooden elements. As described earlier, the clavicles have moved significantly during the process of decomposition. The position of right clavicle indicates that it has rotated from N–S to E–W, maintaining the superior side of appearance. The movements effectuated by the left clavicle are even more significant. It has moved into the middle of the right hemi-thorax where it lies close to the left humerus and in the same general axis with it. It appears from the drawing (Figure 55) that it is positioned partially (i.e. the sternal end of the left clavicle) behind the vertebral column. Similarly to the right clavicle, it verticalised and rotated from the superior to the inferior side of appearance during the process of decomposition. Its position behind the vertebral column is difficult to explain. Even though we have no good documentation concerning the ribs, we must assume that they once were present and engaged in the processes of decomposition and movement. One could suggest a possible scenario here. First, the position of the left clavicle behind the vertebral column means that it initially moved behind the thoracic cage. Both the costo-sternal and the scapula-thoracic junction, into which the clavicles are joined, are labile articulations (Duday 2009, 27). In order for the left clavicle to move behind the vertebral column, the costo-sternal junction must have been broken off before the articulation at the shoulder girdle. After the breakage of costo-sternal articulation, the clavicle could have detached from its anatomical position and moved behind the vertebral column. This would have made it possible for the left clavicle to move inside the thoracic area and finally behind the vertebral column.

The range of the movements described in the shoulder girdle and thoracic area suggests that there must have been an empty volume behind the thoracic cage into which the proximal portion of the left humerus and the left clavicle could move. Given the extreme position of the body, we know that a natural empty volume would have been present in the area of the lumbar and lower thoracic vertebrae. This would have contributed to the destabilisation of the deposit. We also know that the body was slightly elevated on the left side, as it was leaning up against the wooden poles. The current position of the left humerus suggests that in addition to these elements of destabilisation, an empty space might also have formed higher up at the thoracic region, possibly through the decomposition of features placed behind the back of the body. The presence of such supportive organic materials would have made the position of the body less extreme in the sense that it would maintain the upper part of the body in an elevated position, which would alleviate the degree of arching of the back due to the position of the lower limbs.

The articulations at the right elbow are loosely maintained. The initial position of the right forearm refers to slight movements at the level of the distal end of the radius and the ulna. The distance between the distal ends of the right ulna and the radius allow concluding that the movement could not have been limited to the initial body volume. To make this kind of shift at the level of the inferior radio-ulnar joint possible, an additional empty volume at the right lateral side of the abdomen and the pelvis must have existed during or after the process of decomposition.

None of the articulations of the left elbow are maintained. Considering the initial position of the left forearm, the ulna and the radius have moved significantly during or after the process of decomposition; they have mutually moved to opposite directions. The left radius is in extension at the elbow, and its distal half has moved behind the left iliac blade. The unidentified long bone lying perpendicular across the abdomen could be the left ulna. Due to the absence of reference material it is difficult to give a prudent explanation of the movements taken place at the level of the left forearm. Assuming that the left elbow rested on the pole at the left lateral side of the body and the forearm was in pronation, the radius must have been partially in front of the left ulna. This means that after the breakage of the inferior radio-ulnar joint, the bone beneath – the left ulna – had a greater range of movement, changing its initial orientation from NW–SE to NE–SW. As the movements of the bones toward the left lateral side of the body are restricted by the wooden poles, it is possible that the distal end of the left ulna points toward the SW. This and the stability of the proximal end of the left radius imply that the cadaver had immediate contact with the sediment in front of it, but only indirect contact with the sediment beneath it. The latter again refers to an empty space in the level of thoracic vertebrae and thoracic cage beneath the cadaver. After the inferior radio-ulnar joint had broken off, and the left ulna had rotated itself from the extended position to the full flexion, the distal end of the left radius might have moved behind the left iliac blade. The latter could be explained by an empty space behind the pelvis, which could easily form when the buttock muscles decomposed; moreover, the scale of the void was probably increased by the elevated position of the left side of the pelvis.

Unlike the upper body, no significant movements of the bones occurred in the region of the lower body. The persistence of the extension of the thighs at the hip and the flexion of the lower limbs at the knees suggests that no additional empty volumes at the level of the pelvis and/or thighs existed. However, the extreme contraction of the lower limbs doubles the volume of the muscle mass at the area of the thighs and the pelvis. The described situation could be possible within a space of decomposition with immediate infilling. The position could have also been maintained by heavier thighs that could have held the legs in their position with the help of gravity. The maintenance of the tight flexion at the level of the knees is also supported by the grave cut that narrowed down to 55 cm on the foot-end.

Traces of pine and birch bark in proximity to the skeleton were documented. From the photographs (Figure 56: c, d) a clear layer of bark behind the skeleton can be observed. Jaanits (1961) describes that the grave was bedded with bark; the cadaver was also covered with it. It appears based on the drawing that the bark layer beneath the body was spread to a larger area (dotted line; see also Figure 56: c) than the one covering the body (continuous line). The drawing also allows concluding that the layer in front of the body consisted of big segments, not single fragments of bark here and there. The archaeological evidence indicates that the body was initially placed into the grave, which was bedded with bark, and then the upper part of the body (from the cranium to the level of the pelvis) was covered again with a bark layer. These bark layers were sealed with wooden poles from both lateral sides of the body. The movements of the bones at the upper part of the body described above are in accordance with the archaeological facts. The movements observed at the left forearm suggest that the container was relatively close to the frontal plane of the body. The presence of the bark bedding at the grave also contributes to the creation of empty volumes as it decomposes after the body, thereby delaying the infilling of the grave by the surrounding sediment.

In summary, the decomposition of the body took place in a dual burial environment. The dislocation of bones and their subsequent movements in the upper body allow concluding that this area had a delayed infilling, and an empty space was created at the cranial region, thoracic cage, and lumbar vertebrae. The empty volume was more marked at the right side of the body since wooden poles were delimiting the grave at the left lateral side of the body. Noteworthy is that the empty volume was beneath the body. The empty volume beneath the back was created both by the initial position of the body – the extremely arched back created a 'natural' void beneath the lower part of the thoracic and lumbar vertebra, and the additional support beneath the thoracic cage and cranium helped stabilise the upper part of the body. The exact character of the additional elevation beneath the upper part of the body cannot be described. It must have been from an organic material that fully decays during the process of decomposition. As wood and bark were preserved in the burial environment, these materials should be excluded. The limited movements inside the initial body volume at the level of lower body indicate that the decomposition there took place inside a filled space. This is also supported by the absence of the bark layer, which made the successive infilling of the grave possible.

6.1.2.3. Cases that raise questions: Tamula I burial as an example

As usual with the re-analysis of old excavation material not all the questions can be answered, at least not with 100% confidence. This is also the case here, where the source material does not always meet the requirements of archaeothanatological analysis. However, weighing the available data and metadata, one could propose the most likely answer(s).

One such case where there is no single-valued answer about the space of decomposition of the corpse is Tamula I, the burial of an older female excavated by Indreko in 1942 (Figure 49). For an archaeothanatological analysis of this skeleton in a "sleeping position" (Indreko 1942, 3), photographs, a drawing, a written description (Indreko 1942, 3), and the skeleton itself are available. The overall representation of skeletal elements indicates that a whole body was initially placed into the grave. The analysis shows that the body was placed in the grave in a supine position, with its head facing upwards, arms adducted at the shoulders, right forearm extended and supinated, and left forearm flexed and pronated at the elbow and crossing the abdomen. The poor preservation of bones together with the incomplete cleaning of the skeleton restricts the accuracy of observations made about the position of hands. The thighs were flexed at the hip and knee and rotated to the right lateral side.

Despite the fact that in the context of flexed burials the position of the patellae is not usually used for arguing for a decomposition in a filled environment, here the close relation between the left patella and lower limbs (indicated in the drawing) seems to support this idea. The right patella, however, has moved slightly farther from the right lower limb. The Tamula I burial is exceptional in that the feet bones have been cleaned meticulously and the maintained articulations can be clearly observed, thus their position and side of appearance are documented. Both feet are in plantar flexion; the bones of the right foot exhibit their medial sides, while the bones of the left feet show their lateral aspects. Since the articulations between feet bones tend to break off rather rapidly, the maintenance of these articulations is a clear indication in favour of primary deposit in a filled environment.

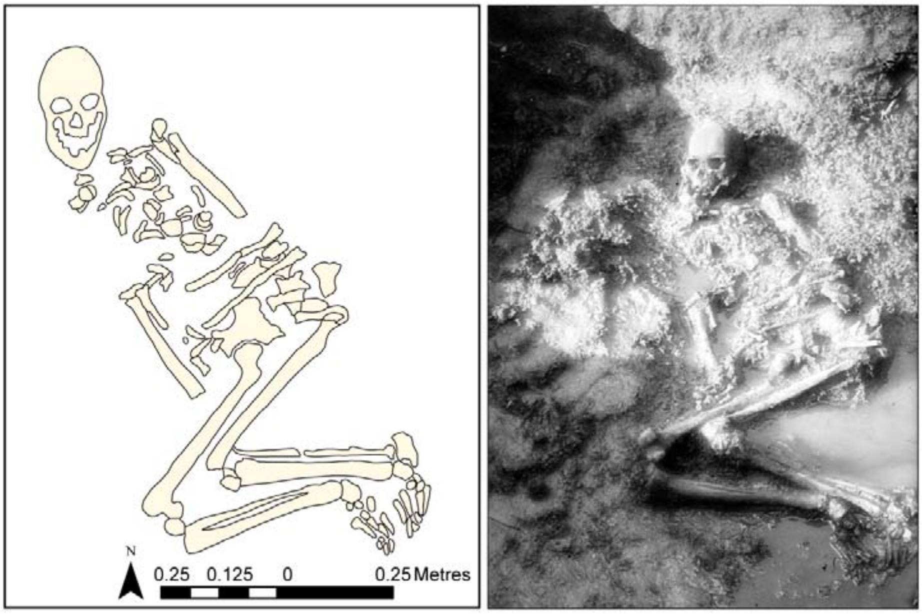

Figure 49. Primary burial of Tamula I.
The overall position of the skeleton implies the initial body position of the corpse: the body was placed in the grave on its back with the lower limbs flexed both at the pelvis and knee and rotated to the lateral right side. The arms are adducted, the right forearm extended at the elbow, and the left forearm flexed. However, the position of the right femur and the disarticulation of the right knee suggest that an additional empty volume must have been positioned behind the right lower limb allowing this kind of movement after the soft tissue and ligaments were gone.
The disarticulation of bones at the level of the thorax and abdomen, together with the absence of right humerus, clavicle, and scapula, hints at a reopening of the grave.
(Drawing after and photo from TLU AI, 4-1-29- 1 and fk 11136)

The overall intactness of the skeleton and the absence of movements outside the initial body volume strengthens the argument for decomposition in a filled environment. The cranium exhibits its frontal side and has not gravitated to either of its sides. The articulation of the temporo-mandibular joint is maintained, while the mandible has only slightly moved, exhibiting its mental protuberance and right body. As usual in the context of this material, the cervical vertebrae are not observable; solely one vertebral body is visible in the photograph, but its exact position remains undetermined. Due to that, the original position of the cranium can only be presumed. The exact position of the right humerus cannot be established either, as only its distal articular surface is visible in the photograph. The right forearm is extended; however, due to the poor resolution of the photograph, characteristic elements of the right radius and ulna could not be determined. However, their spatial relation to one another indicates that they exhibit their anterior side, meaning that the forearm is supinated. The articulation between the scapula and left humerus is maintained and the arm is adducted at the shoulder. The low resolution of the photograph does not allow observing the side of appearance of the left humerus directly; however, the position of the left ulna and radius indicate that it exhibits its anterior and lateral side, being slightly medially rotated. The forearm is flexed at the elbow and pronated; its articulation with the left humerus is not maintained and the articulation between left ulna and radius is also loosened. The position of the hand bones could not be established. Although the pelvis is heavily fragmented and its exact position cannot be described directly, the position of the upper body and lower limbs indicate that it displays its anterior surface. Despite the poor preservation of the pelvis, the articulations between both the acetabulum and the heads of the femurs are maintained. Both of the femurs are slightly flexed at the hip and rotated to the right lateral side. The right femur presents its medial posterior side and the left femur its lateral posterior aspect. Both of the legs are flexed at the knee and rotated to the right lateral side. The articulation between the right thigh and leg is only loosely maintained and the right patella has moved slightly farther. The right tibia and fibula present their medial sides and their distal ends are in front of the left tibia leaning against it; the right patella (as indicated in the drawing) maintained its position. The left tibia and fragmented left fibula both display their lateral sides and the left patella is intact. As stated above, the feet bones are still in articulation.

Similarly to several other burials at Tamula, the thoracic cage of this individual is poorly preserved and disarticulated. This restricts the determination of the side of appearance, position, and spatial relation of the clavicles, sternum, ribs, and vertebral column. One can only ascertain that some of the elements are no longer in articulation. As described above, the proximal part and mid-shaft of the right humerus are absent in the drawing and photograph; these are not present in the collection either. Although Indreko (1942, 3) does not note the absence of parts of the right humerus in his field report, it seems most plausible to suggest that these were not in the deposit during the excavations. Moreover, one is unable to identify other bones of the right shoulder girdle in the photograph and drawing; the right clavicle and scapula are also absent from the osteological collection. However, despite the fact that the position of neither the wrist nor the hand could be determined because carpals, metacarpals, and phalanges are not observable in the documentation, these were, in fact, present in the osteological collection. Whether the disarticulation of the bones at the level of the thoracic cage, right upper limb, and hand bones, together with the lateral rotation of the right femur and disarticulation of right patella, are all an outcome of rough excavation techniques and other complicating circumstances in field (e.g. excavating basically in water; see Figure 46), or whether these give insights about the initial practices cannot be said for sure. Two possible scenarios could be proposed.

The first explanation favours the idea of primary inhumation in a grave with immediate infill by the surrounding sediment. Thus, the disarticulations occurring in the region of the thoracic cage and right arm together with the lateral rotation of right femur could be explained by the poor excavation techniques applied in 1940s. However, according to the excavation report (Indreko 1942), excavating three graves with an area of 29 m^2 took 10 days, which would have given excavators plenty of time to work meticulously (also indicated by the cleaning of feet bones). Yet in the report Indreko states that the thoracic area was poorly preserved and sunken to the bottom of the feature (Indreko 1942, 3). This could have caused problems in cleaning the skeleton properly, and caused the misplacement of smaller bones or even the rotation of the right femur and dislocation of right patella. Unfortunately, the process of the fieldwork was not elaborated in the field documentation.

An alternative explanation for the above-described movements would be that the voids created during or after the decomposition of soft tissues at some areas of the body were not filled in immediately. This could also indicate that additional structures, which by now have perished, contributed to the movements. Archaeological evidence of additional structures in the grave has been discovered neither in front of the body nor behind it. Assuming that the position of the bones observable in the photograph and drawing were not moved by archaeologists, one could propose that two empty volumes existed behind the body. Moreover, the possibility of post-burial reopening of the grave could be considered.

The disarticulation of the bones at the thoracic and abdominal area could be a result of movements accelerated during or after the decomposition in an environment with delayed infilling. This idea could be supported by the overall disorder in the area, and the disarticulation of the arm at the elbow and between the ulna and radius. The latter could have been caused by an empty void created inside the initial body during or after the decomposition of the soft tissues in the abdominal area (e.g. Duday 2009, 45). If this is the case, the limits of the additional structure behind the body must have been rather restricted – in the area of right hemi-thorax and abdomen – as the left humerus was not affected by it. At the same time, the absence of right humerus and other bones of the right shoulder-girdle raise questions. Their absence in the grave could be explained by the reopening of the grave, after which the bones of the right arm and shoulder-girdle were carefully removed and the grave sealed again. As no later intrusions were observed during the excavations, this hypothesis cannot be proved archaeologically.

Also, some elevation must have been present behind the right pelvis and thigh up to the knee, which contributed to the creation of an empty volume and a medial rotation of the right femur and the dislocation of the patella. To make this movement possible, the articulation between the acetabulum and the head of the femur must have loosened when the additional structure was not yet entirely decomposed. After it had disintegrated, gravity acted upon the bones, and the right femur rotated slightly more to the right lateral side of the body and eventually collapsed to the bottom of the feature. However, the right knee could not have been raised very high as the right lower limb was at some extent laterally rotated when the body was placed into the grave. It has been observed elsewhere (Duday 2009, 34) that in the case of raised knees, the patella does not fall vertically; rather, after the muscles are destroyed, it maintains its connection to the tibial tuberosity through the patellar ligament. Subsequently, the patella falls toward the distal third of the leg. The initial right lateral rotation of the right lower limb is also supported by the position of the right leg and foot. It is impossible to determine the material or nature of the additional structure; however, as the articulation between the head of femur and acetabulum is considered to be one that decomposes rather rapidly (Duday 2009, 102), the initial elevations could have been made from something rather unstable in terms of preservation (e.g. hides). Due to the evidence of wooden structures that have persisted behind other skeletons at Tamula, wood and bark should be rejected (see *Chapter 6.1.3.1.3.*).

Regarding all elements, it is difficult to favour one particular scenario while each of them has its irresolution. Considering also the wider context (see *Chapter 6.1.4.* and *6.2.2.2.*; Gray Jones 2011 and reference therein; Nilsson Stutz 2003, 309pp), I suggest that initially an entire body was placed into the grave. A slight organic elevation was placed behind the right pelvis and femur to stabilise the flexion at the knee. On the area of the thorax and abdomen, no additional elevation was used. After the body had decomposed, the grave was reopened, and the right arm together with the clavicle and scapula was lifted from the grave. The reopening of the grave must have also caused the disturbances observable at the thoracic region.

6.1.3. Containers, wrappings, and additional structures of burials

Commonly there are not many physical remains of additional structures or soft containers found in inhumation graves during the Mesolithic. However, unlike other European examples (Nilsson Stutz 2003; 2006), there are several cases where these are archaeologically observable at Tamula. Wooden branches have been put behind the bodies both along and across the grave cuts. From other sites, no such structures have been identified due to the unfavourable environmental conditions that do not conserve the organic substances, except some stones from the graves at Narva Joaorg and Valma. The majority of soft containers and none of the wrappings have preserved archaeologically, thus their existence/non-existence during the initial burial could only be assessed through the application of archaeothanatological principles.

A summary about the additional structures, containers, and wrappings both indicated by archaeological evidence and by archaeothanatological analysis are given in Table 26 and includes 24 graves from Kivisaare, Kõnnu, Narva Joaorg, Tamula, and Valma.

Table 26. Summary of the additional structures, containers, and wrappings in graves.
Both archaeological evidence and archaeothanatolocical observations have been taken into account.

Grave/skeleton no. (original no.)	***Type of structure or container***	***Arguments***
Kivisaare VII *(I; Grab 1)*	wrapping?	archaeological evidence of humus-rich soil in the immediate vicinity of the skeleton; overall completeness of the skeleton and adducted arms and extended forearms
Kivisaare IXa *(III; Grab 4)*	wrapping?	archaeological evidence of humus-rich soil in the immediate vicinity of the skeleton; although disturbed, anatomical order maintained
Kivisaare Xa (*Kivisaare I)*	wrapping?	archaeological evidence of humus-rich soil in the immediate vicinity of the skeleton; overall completeness of the skeleton and adducted arms and extended forearms tightly at the lateral sides of the body
Kivisaare XIIa *(Kivisaare III)*	wrapping?	archaeological evidence of humus-rich soil in the immediate vicinity of the skeleton; overall completeness of the skeleton
Kivisaare XIII *(XII; Grab 5)*	wrapping?	archaeological evidencs of humus-rich soil in the immediate vicinity of the skeleton; overall completeness of the skeleton and adducted arms and extended forearms tightly at lateral sides of the body
Kivisaare XV	wrapping?	overall compressed nature of the skeleton; arms adducted and forearms extended at elbow, tightly next to the lateral sides of the body
Kivisaare XX *(luustik nr 3)*	wrapping?	bilateral pressure to the upper body; verticalised clavicles; dark humus-rich soil in immediate vicinity of the skeleton
Kivisaare XXI *(luustik nr 4)*	wrapping?	medial compression of right lower ribs; overall bilateral pressure less obvious
Kõnnu I	wrapping?	bilateral pressure to the whole skeleton
Narva Joaorg III	stones	archaeological evidence
Tamula III	wrapping?, additional structure	bilateral pressure at the level of thoracic cage, verticalised clavicles; disarticulation of right shoulder girdle
Tamula VII	large bird bones behind the upper limbs, stone in front of the skull	archaeological evidence of ulna and radius of common crane (*Grus g. Grus L.;* determined by L. Põder 29.10.1949 (Moora 1946, 5))
Tamula VIII	wooden pole behind the head, wooden branches behind the body	archaeological evidence
Tamula IX	wooden branches, soft container?	archaeological evidence; displacement of bones at the level of thoracic area and elbows
Tamula X	wooden branches, soft container?	archaeological evidence; displacement of bones at the level of thoracic area and left elbow
Tamula XI	wooden branches, soft container?	archaeological evidence; displacement of bones at the level of thoracic area
Tamula XII	stone in front of the upper limbs	archaeological evidence
Tamula XIV	additional structure behind the upper body	disarticulation of thoracic cage, segmented vertebral column, and rotation of the ribs to left lateral side
Tamula XV	wooden branches	archaeological evidence of wooden branches
Tamula XVII	wrapping?	bilateral pressure to the whole skeleton, especially marked on the level of upper limbs
Tamula XX	wooden branches	archaeological evidence; disarticulation at the level of thoracic area
Tamula XXI	crapping?, wooden pole	constrained position of the body, no movements inside or outside the initial body volume; archaeological evidence
Tamula XXII	bark container, additional structure behind the back	archaeological evidence of bark; position and disarticulation of the bones of the upper body
Valma III	wrapping, stones	bilateral pressure to the whole body, especially marked at the level of upper limbs and thorax; the border of the grave cut indicates a broader grave

6.1.3.1. Soft containers and wrappings

Following the definitions given by Nilsson Stutz (2003, 295pp) the term 'wrapping' refers to any packaging of the corpse into a soft material, i.e. leather, textile, hide, bark, or rope. Moreover, a body can be wrapped tightly or loosely. A 'soft container' on the other hand is any container made from soft material hindering the immediate contact between the corpse and sediment. I agree that these terms are partly overlapping and cannot always be distinguished from one another; however, archaeothanatologically a clear difference should be made. Wrappings of the body are particularly well observable based on the spatial relation of the bones when they were tight enough to cause pressure on a body when laid into the grave on its back with extended limbs. There are several obvious characteristics that allow ascertaining the presence of wrappings in such deposits (Duday 2009; Nilsson Stutz 2003; 2006): (1) bilateral pressure along all or parts of the body; (2) shoulders projected upwards and forward, which is indicated by the verticalisation of the clavicles and the outward rotation of the scapulae; (3) tightly adducted, medially rotated arms that are in immediate contact with the thoracic cage; (4) the thoracic cage is affected by bilateral pressure as indicated by the movement of the ribs toward the medial axis of the body; sometimes these are positioned in front of the vertebral column; (5) additionally, the position of lower limbs – close to the medial axis of the body – could complement the above-listed criteria; however, if there are no other indications, it is not a strong argument on its own.

While arguing for a wrapped corpse, not all the indications have to be present. But one has to be able to eliminate alternative explanations for the particular spatial distribution of bones such as narrow grave structures or the slope of the feature. Available information about the features suggests that the bases of the graves were usually rather even, indicating further that their contribution to the modification of the body positions was insignificant or even non-existent. However, one cannot eliminate the possibility that the spatial distribution of bones that are thought to indicate tightly wrapped bodies were caused by the feature, i.e. the narrow grave cut itself. The cases presented also do not allow determining the borders of the graves by the distribution of grave goods (see Harris & Tyles 2012), since these have been dug into the cultural layers of settlement sites or lack grave goods. If the spatial relations between the position of the skeleton and the grave feature are not clarified, archaeo-thanatological analysis is unable to demonstrate that the effects on the spatial distribution of the bones were caused by the wrappings of the body prior to the burial (Nilsson Stutz 2006, 221).

With soft containers it is somewhat more complicated, as its effects to the body can be similar to those of wrappings, or these can cause a rather different pattern in the spatial position of the bones. The latter effect is especially considerable when the soft container is slightly more resistant to putrefaction and decomposition than the soft tissue of the body, thereby preventing the immediate infilling of the empty voids appearing during the decomposition (e.g. Tamula XXII).

Here, only in a few cases could the presence of wrappings or soft containers could be argued for. Because wrapping can only be determined in cases of specific details about grave cuts, only one straightforward case of wrapping could be identified: Valma III. Several other burials from Kivisaare, Kõnnu, and Tamula, however, bear similar characteristics and will be discussed separately as possible examples of wrapped bodies.

6.1.3.1.1. Valma III – clear indications of wrappings

The Valma III burial, discovered during the excavations in 1955 from the periphery of the settlement (Jaanits 1955c, 21–23), is the only clear case where wrapping could be identified by applying archaeothanatolocical principles. This burial has been regarded as part of a double grave containing a young adult female (Valma II) and a middle adult male (Valma III) placed side by side 10–30 cm apart from one another (see discussion in *Chapter 6.1.5.2.*). The deceased, both adorned with amber or bone figurines and accompanied by flint tools, were placed into the grave on their backs with limbs in extension, but in opposite directions: the head of II was directed toward E and III toward W, and that of III was placed to the right lateral side of individual II. According to the field report, the bodies were placed on a relatively even bottom grave cut(s): II at 57 cm and III at 54 cm from the topsoil (Jaanits 1955c, 21–22). One was not able to distinguish the grave fill from the surrounding sediment in the case of burial II, but to the left of burial III, a clear distinction between the grave fill and surrounding soil was made. Jaanits describes the sediment in the immediate vicinity of both graves as a mixed layer of sand, gravel, and clay (Jaanits 1955c, 21). As the soil difference became clear at the area where burial III was placed, and since Jaanits assumed that he was dealing with a double grave, he further argued that the same grave cut continued to the area of skeleton II, the excavation was just not meticulous enough to observe its contours there (Jaanits 1955c, 22). As the outline of the feature is only partly observable, the discussion does not include Valma II burial and only allows undertaking a further investigation on the Valma III individual. The archaeothanatological analysis is based on the visual representation of the grave in a drawing (Figure 50) and in photographs (Figure 51); information available in the excavations report complements, too.

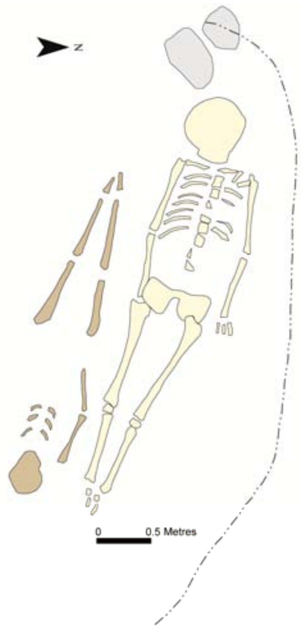

Figure 50. Valma II (beige) and Valma III (yellow) burials.
The dashing line superior, inferior, and at the left side of individual III indicates the border of the grave cut. The verticalised left clavicle of individual III indicates that at least the left shoulder was elevated and projected forward. One can follow the wall effect along the whole body; it becomes especially marked at the level of the lower limbs. Based on the spatial distribution of the bones and the distance between the left lateral side of the skeleton and the grave cut, one may argue that the body was wrapped before its final interment.
(Drawing after TLU AI, 4-1-41-1)

It is evident that the deceased was placed into the grave on its back with extended upper and lower limbs. Although fragmented and poorly preserved, the overall completeness of the skeleton, together with several labile articulations that have upheld on it, indicate that the body was placed into the grave shortly after death. The position of the bones indicates that the body was subject to bilateral pressure. The arms are projected upward and forward. This is indicated by the position of the bones in the shoulder girdle. Both clavicles are vertical (both are observable in the photograph (Figure 51), and only the left one in the drawing (Figure 50)). Both arms are adducted and lie against the lateral parts of the thoracic cage. From the photograph it appears that the right humerus exhibits its anterior and lateral side, as indicated by the deltoid tuberosity. This further suggests that the right arm was medially rotated. The side of appearance of the left humerus cannot be established as the bone was not exposed enough. The lack of details in the photograph and the sketchy nature of the drawing do not allow detailed observations about forearms or hands to be made. One is only able to see that the left forearm must have been supinated (based on the size differences of the ulna and radius) and that both forearms were extended at the elbow and positioned close to the lateral side of the body. However, while not all the details can be observed from the documentation, bilateral pressure obviously held the position of both upper limbs. One is unable to observe the position of the thoracic cage in detail; the ribs have not been exposed entirely and are only observable in the drawing, where indications for bilateral pressure were not observed. Despite that, the whole body appears to have been subject to bilateral pressure. This becomes most evident at the level of the knees, which clearly converge, and the feet, where we are able to observe their medial sides being in contact with one another.

Figure 51. Photographs of the Valma III burial further support the idea of the body being wrapped prior to the burial.
One is able to observe here that similarly to the left clavicle also the right clavicle was vertical, indicating an elevated and forward projection of the right shoulder, too.
(Photos: TLU AI, 1-101-20)

The combination of the elevated and medially rotated shoulders and the presence of the wall effect along the sides of the body indicate that the body was subject to bilateral pressure. The archaeological evidence about the outline of the grave supports this interpretation by clearly demonstrating that the walls of the grave were too far from the body to effectuate its position in a way described above.

6.1.3.1.2. Wrappings or narrow graves – Kõnnu I, Tamula XVII, and Tamula XXI

As shown in Table 26, the presence of wrappings in the majority of graves remains questionable. It has been impossible to observe grave features and inspect their relation to the contracted skeletons, thus, archaothanatology is incapable of distinguishing whether these bodies were wrapped prior the burial or the spatial distribution of the bones was effectuated by grave features. Tamula XVII and Kõnnu I are burials that exemplify the matter clearly. Tamula XXI will serve as an example of a possible wrapping of a tightly flexed body.

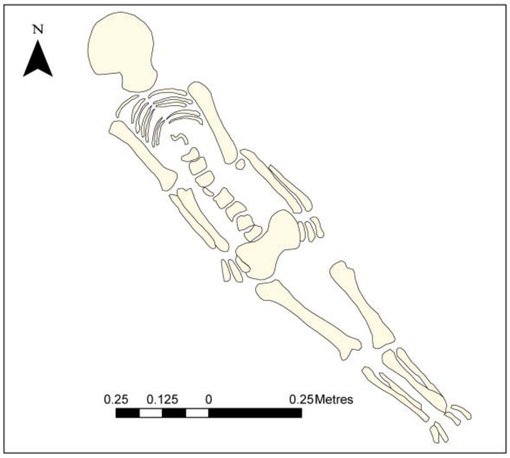

Figure 52. Tamula XVII grave is one where we cannot observe all the above listed criteria to argue for a wrapped body.

However, based on the drawing, the bilateral pressure on the whole body is clear. Despite the fact that the lateralisation of the humeri or the verticalisation of the clavicles is not observable, the close proximity of the upper limbs to the thoracic cage and its constrained position leave no doubt of a 'wall effect'. As there is no record about the volume of the grave cut, except that it was even-bottomed, on cannot argue with certainty that the bilateral pressure was caused by tight wrapping and not by the feature itself. (Drawing after TLU AI, 4-1-29-3)

The grave Tamula XVII of a middle adult, probably female, was excavated in 1956. The deceased was placed into the grave at the depth of 41–53 cm, and was adorned with tooth pendants and an amber pendant (Jaanits 1956b; 1957a, 88). As seen from Figure 52 – being the main source of analysis – the body was lying on its back with extended limbs tightly placed next to the lateral sides of the body. Although one is unable to observe single elements and their side of appearance in the drawing, the spatial distribution of the bones indicates that the whole body is affected by a 'wall effect'. Unfortunately the clavicles do not appear in the documents. However, bilateral pressure on the skeleton is indicated by the adducted arms, which were tightly placed at the lateral side of thoracic cage, the extended forearms and wrists, which lie tightly at the lateral sides of pelvis with the right hand being slightly in front of it, and the position of the lower limbs, with their converged knees and ankles.

Another example of what appears to exhibit characteristics of a tightly wrapped body is Kõnnu I, the burial of an adolescent (Figure 53). The grave, excavated in 1977, had an even bottom (46 cm from the topsoil), and the body was richly adorned with tooth pendants; additionally, a harpoon head, a bone ring, and fragments of amber, together with unworked animal bones, were deposited (Jaanits 1979; Lõugas 1997). Unfortunately, parts of the skeleton – its cranium and right upper limb – were removed during gravel mining and were only collected from the heaped sediment; however, the overall position of the rest of the skeleton was maintained.

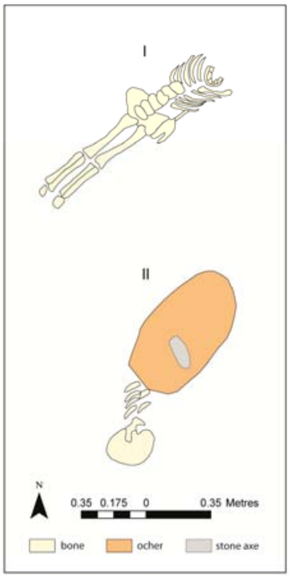

Figure 53. Kõnnu I and Kõnnu II skeletons.
The overall position of skeleton I – the deceased was placed into the grave on its back with both upper and lower limbs extended – allows suggesting that the body was tightly wrapped into a soft container during the time of burial. (Drawing after TLU AI, 4-1-57-1)

The archaeothanatological analysis relies on the information given by the drawing and written description (Jaanits 1977), and is also supplemented by the bones in the collection. The whole skeleton displays its anterior side of appearance, the left upper limb being adducted at the shoulder and extended at the elbow. Similarly to the case at Tamula XVII, one could observe the wall effect around the whole body. There is clear bilateral pressure observable at the level of the upper body. At the level of the thoracic cage, bilateral pressure is indicated by the position of the ribs, which project toward the midline of the body. The verticalisation of the left clavicle suggests the upward and forward projection of the left shoulder. Due to the accidental removal of the right upper limb, its original position cannot be observed. The position of the left forearm suggests that it was initially extended at the elbow, being slightly beneath the left lateral side of the thoracic cage. The position of the hand bones cannot be observed here either. The spatial distribution of the lower limbs – extended at the hip and the knee positioned close to the midline of the body – demonstrates clear bilateral pressure, too.

While there are many archaeothanatological studies about wrappings on bodies in supine extended positions, I have found none about human remains buried on their laterial side with flexed upper and lower limbs. However, several researchers have interpreted tightly contracted burials as tied together with rope or wrapped into hides (Jaanits 1948, 5; Jonuks 2009, 143; Nilsson Stutz 2003, 279 and references therein). These acts have been believed to be motivated by the fear of the living dead (Kulmar 1994) or by more practical means such as transportation from remote distances to the burial place (Jonuks 2009, 131).

The above-listed characteristics of wrapped bodies are not entirely valid for crouched burials. Only the general impression about the wall effect that prevents movements outside the initial body volume of contracted burials could be regarded as relevant. Moreover, studies have shown that if a body decays in a space with delayed infilling, volumes are created while or after the soft tissues closing of intersegmental angles of bodies decompose (Duday 2009, 53). This, for instance, could cause the tightening or flexion of the upper or lower limbs, which we could mistake for an indication for binding. However, this has not been observed when the joints are extended or only loosely flexed (Duday 2009, 54). Thus, to establish that a crouched body was wrapped during the funeral, one should also be able to demonstrate that the decomposition took place in a filled environment.

In the following section, the case of the Tamula XXI burial is presented to discuss the possibilities of the wrappings in graves where the deceased was placed on its lateral side. The remains of a middle adult, probably male without any grave goods, were excavated in 1956. The grave had a rather even bottom; the skull was found at the depth of 37–51 cm and the rest of the body at the depth of 47 cm from the topsoil. As it appears from the written descriptions (Jaanits 1956b; 1957a, 98) and drawing (Figure 54), the outline of the grave was not possible to determine; however, fragments of wooden branches were found in the vicinity and at the same level of the skeleton, and behind its back, west of the body, a wooden pole of 106/7 cm × 6–7 cm was placed. Considering the wooden pole behind the back of the body as part of the grave structure, we have at least one border of the grave visible, indicating that there was enough space between the walls of the grave and the body in order to exclude its effects on the spatial distribution of the skeleton.

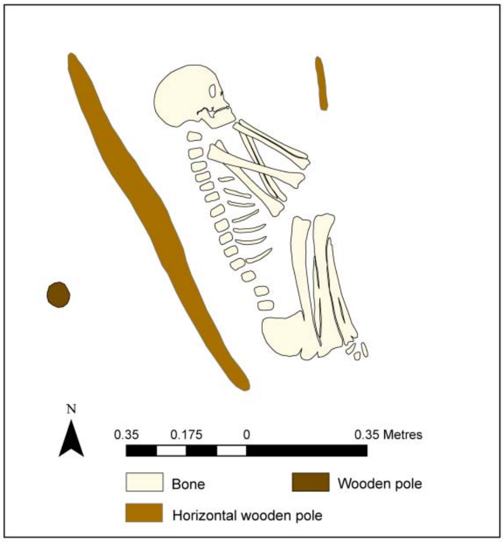

Figure 54. Tamula XXI is a primary inhumation on its left lateral side with the limbs flexed in front of the body.
The decomposition of the corpse took place in a filled environment. The restricted position of the skeleton further indicates that the deceased was wrapped into a soft material during the burial. However, as the outline of the grave cannot be distinguished stratigraphically, one cannot exclude the possibility that the grave was narrow and filled in gradually to permit any kind of movement of the bones both inside the initial volume of the corpse and outside of it. (Drawing after TLU AI, 4-1-29-3)

The skeleton itself was placed on the left lateral side with its upper and lower limbs flexed and positioned in front of the body. The cranium displays its right lateral side, and the drawing clearly indicates that the articulation of the temporo-mandibular joint has been upheld. Both arms are slightly flexed at the shoulder, and the forearms tightly flexed at the elbow. Although it does not appear in the drawing, the hands were placed beneath the head (Jaanits 1956b; Jaanits 1957a, 89). The whole thoracic cage and vertebral column have maintained their articulations, and no movements outside the initial body volume could be observed. The slight anterior curvature at the level of the lumbar vertebrae corresponds to the natural arching of the vertebral column. Both femurs are flexed at the hip, placing the thighs in front of the abdomen; the legs were also flexed at the knees and were located beneath the femurs (Jaanits 1956b). The exact position of the feet cannot be reconstructed, but Jaanits states that these remained partially beneath the proximal ends of the femurs (Jaanits 1956b). The overall completeness of the skeleton and the presence of small bones in the repository indicate that it is a primary burial. Moreover, the articulation of the feet bones and the stability at the level of the thoracic cage, together with no observable movements of larger bones, suggest that the decomposition of the corpse took place in a filled environment. The latter further indicates that one cannot take the constrained position of limbs to be the result of movements taken place in an empty volume after the soft tissue decayed. Thus the position of the limbs seen in the drawing refers to the initial position of the body.

A rather good parallel to the Tamula XXI burial concerning the distribution of bones can be found at the Neolithic Rouazi-Skhirat cemetery in Morocco (Lacombe et al. 1990). The skeleton of an adult male in grave 12 was severely contracted with its arms in adduction, forearms flexed in front of the abdomen, and lower limbs flexed in front of the body. Similarly to case of the supine bodies with extended extremities, the bilateral pressure here also effectuates the verticalisation of the clavicles; also, the contraction at the level of thoracic vertebrae and tight adduction of arms are observable on skeleton 12. The most notable characteristic of that skeleton is the extreme flexion of its thighs and legs (Lacombe et al. 1990, 58–59). Unfortunately, the position of the clavicles is unobservable in the case of the Tamula XXI burial, but other characteristics were present in the case studied here. This burial has been interpreted as being wrapped in a basket. This analogue could support the idea of extremely contracted burials being wrapped; however, more reference material together with the boundaries of grave should be known before firmly drawing this conclusion.

These three cases present the methodological constraints of archaeothanatology in re-analysing old excavation data. The interplay between the archaeological data – information about the outline and volume of the grave – and the constrained position of the bones is key to arguing for wrapped bodies. However, it is not enough to demonstrate the constrained distribution of bones, but also that the walls of the feature or v-shaped bottom of the grave did not encourage this constrained placement of bones (e.g. Duday 2009, 51). In cases in which no data exists about the grave features, one cannot eliminate the doubt that the position of bones observed was a result of the grave feature. Even though one could argue that Kõnnu I, Tamula XVII, and Tamula XXI were wrapped at the time of funeral based purely on the spatial distribution of the bones, this cannot be conclusively determined due to the insufficiency of the source material.

6.1.3.1.3. Bark container in Tamula XXII burial

Bark containers can be listed under the category of soft containers, enabling the movement of bones, yet restricting the range of it. Compared to containers made of hides or fabric, bark is slightly steadier, but similar to hide or fabric, bark prevents immediate contact between the corpse and the sediment. Thus, the infilling of the grave is delayed. This result in voids created by tissue decomposition and permits a larger range of possible movements within the initial body volume.

The Tamula XXII burial of an older male in which the rarely occurring favourable anaerobic conditions allowed the preservation of the bark container serves as an example here (Figure 55 and 56). The position of the bones (especially at the upper part of the body) and the presence of pine and birch bark in close proximity to the skeleton confirm Jaanits' (1961b; Jaanits et al. 1982, 82) initial interpretation that Tamula XXII is a burial in bark container.

The grave was directed NW–SE with the head of the deceased oriented toward the NW. The grave itself was trapezoidal (108 × 66/55 cm) and with an uneven bottom; the head-end was 77 cm under the topsoil, while the foot-end was only 67 cm deep. The posterior side of the cranium, however, became visible already at the depth of 58 cm. The grave was padded with birch and pine bark, so that in the corners of the grave, the bark layer descended vertically. The corpse was also covered by a layer of bark. The lateral boundaries of the grave were determined by the wooden poles; at the NE border a pole 6–7 × 106–107 cm became visible at the depth of 58 cm from the topsoil. A smaller pole (c. 35 × 3 cm) lay right next to it at the left lateral side of the upper body. The SW border of the grave was defined by a thinner pole of approximately the same length as the first one. Jaanits states that the bars on both sides of the grave were probably placed on top of the bark [to retain its position] (Jaanits 1961b). Unfortunately the stratigraphic relations of the skeleton and the wooden bars cannot be determined from the drawing nor from the photographs. No grave goods were found.

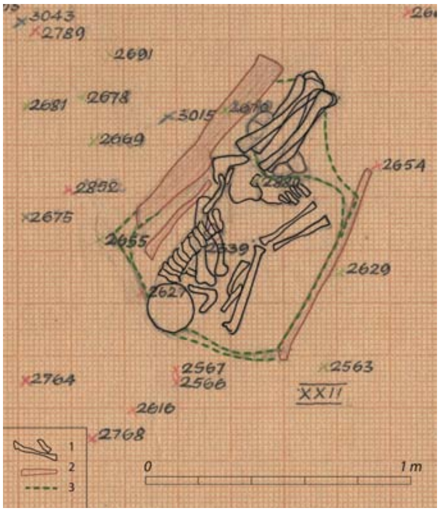

Figure 55. An excrept of the excavation plan (drawn by Jaanits) with the burial Tamula XXII. *Note the position of the vertebral column that could not be distinguished in the photographs, but is in accordance with the diary entry. The position of the mandible is described after this drawing: 1 – bones, 2 – wooden poles, 3 – borders of the birch and pine bark layers. (Drawing AI 4-1-29-3, modified by K. Roog, first published in Tõrv 2015)*

The results of the archaeothanatological analysis support the idea of a wrapped upper body. The drawing (Figure 55) allows suggesting that even if the bottom of the grave was entirely covered by bark, the layer in front of the corpse did not shroud the whole body, leaving the lower limbs uncovered. The latter allowed a gradual infilling of the empty volumes at the level of the lower body, which in turn helped maintain the articulations and restricted the movement of bones there. The range of the movement of the bones – the disarticulation at the level of the thoracic area and the left forearm caused by the additional elevation beneath the body, together with the maintenance of the position of the left humerus and the minimal movement of pelvis – suggests that the body was more or less immediately shrouded with bark (i.e. like a blanket).

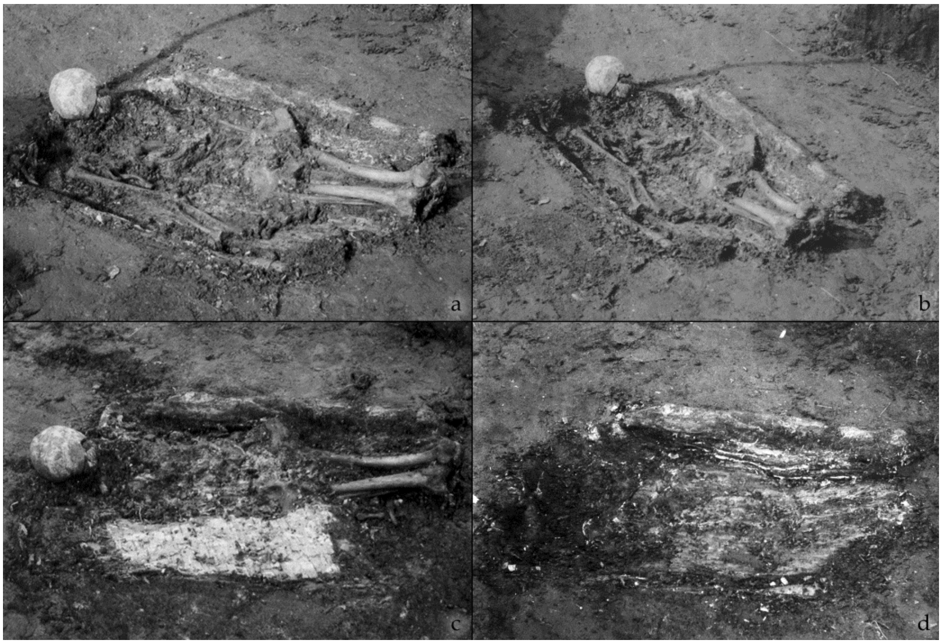

Figure 56. Photographs of the Tamula XXII burial made on site by Jaanits.
The sequence of them (A–D) illustrates the excavation process of this particular grave. Moreover, on pictures C and D, the underlying bark layer becomes clearly visible. (Photos: AI f 12; compiled by K. Roog, first published in Tõrv 2015)

In the cases of several northern and north-eastern European burials, the possibility of bark container has been suggested. However, cases in which bark is archaeologically preserved are few, and no further examples are known from any other site in Estonia either. This does not necessarily mean that Tamula XXII was the only grave where bark was used. This assumption is illustrated by the fact that fragments of bark were found at graves IX and XIV at Tamula (Jaanits 1955b; 1957a, 92). There are several cases from Scandinavia where the presence of bark containers could be argued for. Traces of wood in the immediate vicinity of burials IV and XX at Skateholm II, together with the results of archaeothanatological analysis, indicate that these did not derive from coffins because the corpses underwent decomposition in a filled environment

(Nilsson 1998; Nilsson Stutz 2003, 282–285). An example from Korsør Nor (Norling-Christiansen & Bröste 1945, referred in Schmidt 2004, 88), which is described as a burial where *"the deceased was enclosed, above and below, within layers of wood bark"* comes into mind, also. Bark was used in the Møllegabet II (Grøn & Skaarup 1991) boat burial, where the deceased was either wrapped in the bark or was covered by it. From a Latvian Mesolithic grave at Vendzavās, six parallel strips of completely amorphous black organic matter immediately covering the skeleton were documented (Bērziņš 2002). Valdis Bērziņš interprets these as reminiscent of decayed bark or similar material (pers. comm Valdis Bērziņš 23.3.2015). Although there is no archaeological evidence of the usage of bark in Zvejnieki, the archaeothanatological analysis suggests that burials wrapped during the Mesolithic and Middle Neolithic were not necessarily packed into hides; instead, bark might have been used (Nilsson Stutz 2006).

There is no unequivocal explanation for using bark containers during the burials. In general, bodies in constrained and hyper-flexed position have been considered to represent the fear of the living dead in the community (Kulmar 1994). Wrappings have been seen as countermeasures to assure that the dead remain in the grave. Jonuks (2009, 131) has proposed a more utilitarian purpose behind the extremely contracted body position and the presence of bark in the Tamula XXII burial. He argues that this burial and Tamula XXI as well were transported inside a bark container – a sack – from a remote distance. The idea of transportation also fits Jonuks' general interpretation about Tamula as unique place for burying significant people (Jonuks 2009, 131). However, the constrained position of the body and the distribution of the bark – the layer behind the body is larger compared to the covering layer – does not support the idea of transportation. Moreover, the overall idea of Tamula as central ritual place for several hunter-gatherer communities is questionable as the stable isotope signatures from humans at Tamula indicate a rather homogenous and sedentary population (Tõrv & Eriksson 2014; Tõrv & Eriksson in prep.). As described above, the decomposition of the body took place in a dual environment, where the upper part of the body was sealed in a layer of bark, which restrained the immediate infilling of the voids created during the decomposition, and thus allowing a range of movements of single bone elements; the lower body from pelvis up to the knees was not covered with bark, thus permitting the immediate infilling of the soil, maintaining the restricted position of the lower limbs. Thus, the spatial distribution of the remains, together with the dual environment for decomposition, seems to indicate that the corpse was not transported within a bark sack. Instead, after the grave was dug, it was padded with bark and then the deceased was laid on it and covered with a new bark layer. The edges of the bark were sealed with wooden poles at the longitudinal side of the grave.

6.1.3.1.4. Wrappings of the bodies at Kivisaare?

Kivisaare XXa, a primary burial belonging to a probably male adult who was adorned with several tooth pendants, represents a case where the body might have been tightly wrapped into some organic material (Figure 57). The grave was accidentally found in 1964 by gravel miners whose work removed the lower limbs. Jaanits excavated the rest of the skeleton in 1965. The adult was placed into the grave on its back, with arms adducted and rotated inward; the humeri displayed their antero-lateral sides, the forearms were extended at the elbow, the right forearm was pronated, and the left forearm was supinated. The position of hands cannot be observed because these were removed in 1964. The articulations at the level of shoulder girdle cannot be observed due to insufficient exposure, but the close spatial relation of the heads of the humeri and the clavicle suggest that these were maintained. The clavicles display their superior sides and are verticalised, which indicate elevated and forward projecting shoulders. The ribs exhibit their anterior side of appearance and are clearly pointing toward the midline of the body. The left iliac blade exhibits its anterior side, and the sacro-iliac joint is upheld. The head of the left femur suggests that the thigh was extended at the hip, exhibiting its anterior side of appearance.

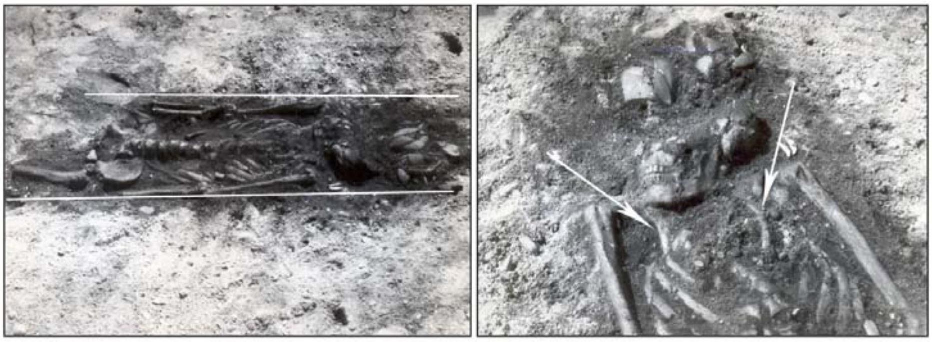

Figure 57. Kivisaare XXa burial.
The grave contained the remains of an adult placed on its back and tightly wrapped. The whole upper body displays clear bi-lateral pressure that becomes especially obvious on both of the verticalised clavicles (arrows) indicating the upward projection of the shoulders.
(Photo: TLU AI)

The position of the upper body as described above displays clear bilateral pressure. The wall effect becomes most obvious on the verticalised clavicles and the immediate closeness of the upper limbs to the thoracic cage. Also, the compressed nature of the thoracic cage where the anterior parts of the ribs are leaning toward the medial axis of the body and the dark humus-rich layer in the immediate vicinity of the body support the wall effect hypothesis. However, the application of archaeothanatological principles does not allow a straightforward interpretation of wrappings here, as the dimensions of grave feature might have affected the constrained position of the skeleton instead of wrappings.

I agree with Nilsson Stutz (2006, 219; see also discussion in *Chapter 6.1.3.1.2.*) that it does not suffice to argue for a wrapped body based on the overall constrained nature of the skeleton. Nevertheless, I will continue the discussion by speculating about the possibility of seeing the dark humus-rich layer in the immediate vicinity of several burials at Kivisaare and the restricted position of skeletons as an indirect indication about wrappings. I admit that this discussion is not going to have an unequivocal outcome, but it does allow wrappings to be considered one of the possible explanations behind the dark colouration of the soil we observe in the graves at Kivisaare.

The burials at Kivisaare stand out from those of other sites due to its clearly observable grave outlines. The graves are filled with dark and humus-rich soil (for example, the Kivisaare XXI burial in Figure 44; Ottow 1911; Ebert 1913; Bolz 1914; Jaanits 1965a). Duday (2009[2006], 34) argues that this phenomenon is noticed broadly in burial archaeology, and may be used as an additional argument for primary burial, as it indicates the decomposition of a fleshed body on the same spot where it was excavated. As this phenomenon has not been observed in every primary burial at Kivisaare, I argue that it could also be indicative of wrappings.

To understand the processes behind the discolouration of the sediment in the immediate vicinity of the corpse, I will hereby outline the post-mortem processes responsible for the putrefaction and decay of the corpse (Vass 2001; Fiedler & Graw 2003; Gill-King 2006; Manhein 2006; Pinheiro 2006). The decomposition of a human body is a complex process primarily dependent on temperature and moisture conditions and may be divided into pre- and post-skeletonisation. Although the diagenesis, i.e. post-skeletonisation phase, affects the results of biochemical analysis undertaken here, I will only concentrate on main phases of the pre-skeletonisation stage as these play an important role in understanding this question. I will regard two possible explanations here: (1) decomposition fluids and (2) natural preservation process, i.e. adipocere.

The onset of decomposition starts rapidly after death and begins with self-digestion or autolysis, led by enzymes found naturally in the body (Vass 2001). After enough cells are ruptured, putrefaction – the destruction of soft tissues of the body by micro-organisms such as bacteria, fungi and protozoa – can start. As an outcome of the degradation of the carbohydrates, proteins, and lipids into acids, gases, and other products, the body changes in colour and smell, and bloating appears (Gill-King 2006, 99, 101). After the purging of gases due to putrefaction, active decay accelerates. The electrolytes rapidly leach out of the body and both aerobic and anaerobic bacteria, together with insect colonies, are present. Decay caused by bacteria and fungi should lead to the overall skeletonisation of the corpse (Fiedler & Graw 2003). The time interval between the time of death and skeletonisation varies according to the environmental conditions (incl. the container) and pre-treatment of the body; it ranges from 6 to 12 months up to 3 to 12 years in the case of interred bodies (Pinheiro 2006).

Duday (2009[2006], 34) connects the discolouration of the soil in the immediate vicinity of human remains excavated archaeologically with the above-described processes. He points out that the organic fluids produced during the process of putrefaction enrich the surrounding sediment, which further attracts earthworms and various sarcophagic insects whose activities can be detected. There are also instances where the modifications of sediment can be detected with chemical analyses. This further could lead to the recognition of the volume and outline of the grave cuts.

In some instances, the process of decomposition is delayed, leading us to the second possible explanation for discolouration of the sediment around human remains. Under favourable conditions, the formation of adipocere (i.e. body-wax) occurs during the process of putrefaction and decay. Adipocere consists mostly of saturated fatty acids and is prone to develop in cases where the decomposition of the corpse is retarded. Although no conclusive analyses about the formation of adipocere are available, the general process is agreed upon (Fiedler & Graw 2003; Pinheiro 2006; Ubelaker & Zarenko 2011). Adipocere formation favours warm and moist environments and develops as a result of fat hydrolysis with the release of fatty acids (Vass 2001, 190; Feidler & Graw 2003, 292; Manhein 2006, 472). It is accelerated by the invasion of bacteria and takes from several weeks to months to form (Vass 2001, 191) and only rarely does it affect the whole corpse (Pinheiro 2006, 101). Through various chemical processes, the saturated fatty acids that are transformed from unsaturated acids through the action of bacterial enzymes crystallise. This subsequently leads to the solidification and hardening of soft tissues (Feidler & Grow 2003, 292).

Similarly to the overall process of decomposition, factors such as the pre-mortem condition of the body, season of death, and depth of the grave influence the formation of adipocere. Observations about the beddings made of plant material, the clothing of the deceased, and the soil conditions are especially topical when considering the burials at Kivisaare. In the first case, it has been argued that plant beddings prevent the formation of adipocere, and the clothing of the deceased impedes the decomposition of the corpse (Feidler & Grow 2003, 294). It has been observed that among others, loam-enriched moraine is favourable to the formation of adipocere. Additionally the humidity of the soil plays a role as adipocere has mainly been documented in moist, water-logged soils and soils with poor drainage. (Fiedler & Grow 2003, 295 and references therein) It is important to state that adipocere is not an end-product. It decomposes over a long time period and is dependent on environmental changes; an aerobic environment is a necessity (Fiedler & Grow 2003, 293).

Although the full list of favourable conditions for the formation of adipocere is ambiguous, its existence in the graves of Kivisaare could be assumed. The above description allows making some suggestions about the formation of adipocere at Kivisaare, which should be treated as hypotheses due to the absence of sediment samples from graves, the insufficient field documentation, and the lack of reference material from prehistoric periods. Kivisaare burial site is situated on a gravel drumlin that mostly consists of weakly podzolic loam and sand, but the south-western end of the drumlin where the graves are found consists of leached sand-loam-moraine that possesses neutral or weakly acidic pH (Maa-amet 2001). According to some studies referred in Fiedler & Crow (2003), these conditions could be favourable for the formation of adipocere. Secondly, the restricted position of some of the inhumations at Kivisaare suggests that the deceased were wrapped into a soft material prior to the burial; no organic materials (such as plant remains or branches) are found at the bottom of graves. Considering the wrappings of the body, one immediately connects it to historic examples of the preservative nature of clothing that also delay natural decomposition processes (Duday 2009, 34). Moreover, the changing water regime of the Lake Võrtsjärv (Moora et al. 2002; Raukas & Tavast 2002, 201) could explain the final decomposition of the body-wax.

As some unworked animal bones were found at several graves, one could argue that the backfill of the graves consisted of former cultural layer and thus could also be responsible for the discolouration of the sediment. This kind of practice is known at Zvejnieki, for instance (Nilsson Stutz et al. 2013). This counterargument, however, could be easily disproved as the Mesolithic and Neolithic cultural layer bears no colour differences from the virgin soil of the drumlin (Kriiska & Johanson 2002/2003; Kriiska & Lõhmus 2003; Kriiska & Lõhmus 2004). The depth of these discolourations also supports the idea of decomposition fluids being responsible for it. Usually, these are reported to be only 1–10 cm thick (Ottow 1911; Ebert 1913; Bolz 1914; Jaanits 1965a). Thus, it is plausible to suggest based on the above arguments that the graves with dark infill and reported adducted arms and extended forearms were wrapped in hides or textile at the time of deposition.

6.1.3.2. Additional structures in the graves: wooden "beddings" and perished supports behind bodies

Archaeological evidence for additional structures in the graves is scarce. However, from Tamula, graves with wooden branches have been documented (VIII to XI, XV, and XX) (Jaanits 1955b; 1956b; 1957a, 90–91; 1961b). These formed regular "beddings" beneath the corpses, some consisting of two layers of branches crossing each other (IX, X and XI), others partly covered with bark (IX), or having a less tight layer underneath (VIII, XV, XX) (Jaanits 1955b; 1957a, 92; 1961). Their presence in the graves has effectuated the spatial distribution of bones, too and these movements will be discussed below. Additionally, larger wooden poles were found at graves VIII, XXI, and XXII (Jaanits 1957a, 91–92). From Narva Joaorg III, Tamula XII, and Valma III, also larger stones have been found (Jaanits 1955c, 23; 1957a, 85; 1963, 9). In addition to the archaeological evidence, the position of single bones in the feature indicates structures being placed on the lateral side or beneath the bodies that have decomposed (*Chapter 6.1.3.2.2.*).

6.1.3.2.1. Tamula IX – effects of a wooden "bedding"

Although the "beddings" mentioned by Jaanits seem rather slight and flexible, the significant movements of the bones demonstrate this to not hold true. From all the three graves (Tamula IX–XI) where Jaanits has reported the tensest layer of branches, movements at the level of the thoracic area can be observed; however, in the graves where the "bedding" was not reported to be as tense, no significant movements could be observed (VIII, XV and XX). For all these cases the most characteristic is the lateral and inferior movement of the ribs (to the left lateral side of individual X, and to the right lateral side of individual XI, where the child XII was placed), the slight dislocation of vertebral column – including the enlargement of intervertebral spaces (Figure 58, IX: a, X: c and XI: d), and the abduction of one or both arms and subsequent flexion at the elbow. As these movements are most apparent at the Tamula IX burial, I have chosen to elaborate on this burial in detail.

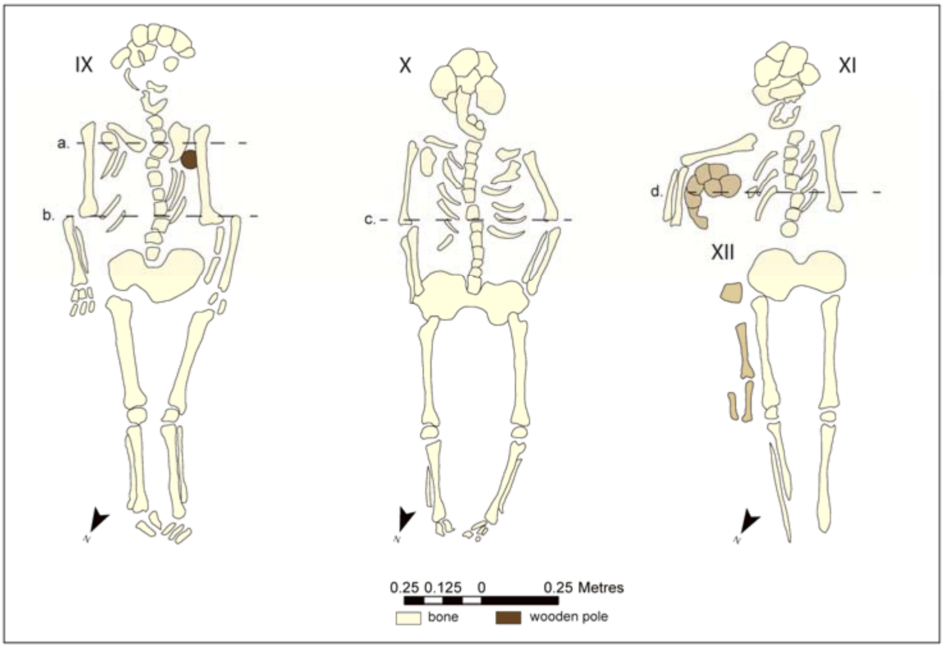

Figure 58. Primary burials of Tamula IX, Tamula X, and Tamula XI/ Tamula XII.
Burials IX, X, and XI show significant movements at the level of the thoracic cage (a–d); this together with the maintenance of the initial position of lower limbs (note the feet for IX and X), suggest that the decomposition of these corpses must have taken place in a mixed environment. All these graves were padded with wooden branches, and it appears from the abnormal curvatures of the vertebral columns (a–d), and the dislocation of forearms at elbow for IX (right only: b) and X (c), that the wooden "bedding" beneath these bodies decomposed and fractured at different times. Moreover, these movements become possible only in a void in which the filling of the grave is delayed. (Drawing after TLU AI, 4-1-29-3)

The analysis of the Tamula IX burial of a middle adult male is based on the drawing (Figure 58) and photograph (Figure 59); supplementary information is gained from the field diary (Jaanits 1955b) and an article (Jaanits 1957a). Despite the rather low resolution of the photograph, one can observe the side of appearance of the bones; their spatial relation to one another is also indicated in the drawing. The grave was located at the lowermost part of the cultural layer (53–60 cm); in addition to the wooden "bedding" described above, a vertical wooden pole was located behind the pelvis (Jaanits 1955b) and left shoulder. He was accompanied by few grave goods, among them a bird bone, tooth pendants, a small stone chisel, and an unworked animal bone (Jaanits 1957a, 84).

Figure 59. Tamula IX viewed from W.
The photograph illustrates the disjunctions at the level of the thoracic area and elbows. Contrary to the drawing, a slight disarticulation at the level of the knees – movement toward the right lateral side – is observed here. This might be due to the fact that the distal ends of the femora are not exposed entirely in the photograph; thus we are unable to determine the level of articulation. It could also indicate that the drawing captured some of the disarticulations seen on the skeleton by the researcher, and thus the legs were disarticulated from the thighs during or after the process of decomposition. This further indicates that the "bedding" beneath the body also had an effect on the position of the lower limbs. (Photo: TLU AI, f12)

The deceased was placed into the grave on his back, head facing upwards, arms adducted, and forearms in extension, with both lower limbs extended at the hip and knee and feet rotated toward the midline of the body. The primary nature of the burial is proven by the maintenance of the labile articulations of the hands and feet observable in the drawing and the maintained articulation of both patellae (as seen in both the photograph and the drawing); the overall completeness of the skeleton and close spatial relation of bones with more stable articulations (such as at the level of shoulder girdle, pelvis and femur) support this interpretation, too. The maintained articulations of the patellae, feet, and hand bones further indicate that the decomposition of the corpse took place in a space that was gradually filled in after the soft tissue decomposed. Despite the fact that the body was placed into the grave in a fresh state, and some of the bones are indicative of decomposition in a filled space, several movements of bones occur at the level of the upper body and probably also at the level of the knees (Figure 59).

In general the anatomical order of the upper body – the thoracic and abdominal area – is maintained. One is able to observe the close spatial relation of the right humerus, clavicle, and scapula, and the same holds for the left humerus as well. The side of appearance of the right humerus cannot be established, but the left humerus exhibits its posterior side, as indicated by the olecranon fossa. The position of the humeri indicates that the arms were adducted during the time of deposition. Unlike the proximal articulations of the humeri, the distal articulations with the forearms have been lost. Both of the forearm bones have moved laterally as seen from the drawing; however, it seems that the articulation between the right radius and ulna are still maintained, while the connections on the left forearm are slightly looser. The hands seem to have been maintained their close spatial relation to the forearms. The side of appearance of the right and left ulna and radius and their position (ulna lateral and radius medial) in the grave indicate that these exhibit their posterior sides, thereby suggesting that both forearms were pronated.

Two significant dislocations, together with a clear widening of intervertebral space, can be observed at the level of the upper thoracic vertebrae (Figure 58: a) and the lower thoracic and upper lumbar vertebrae (Figure 58: b). Although the side of appearance of the single vertebrae is not possible to determine, one can observe that the vertebral column breaks twice and that the segments of vertebral column move toward the right lateral side of the body. This kind of dislocation normally occurs whenever asymmetry between the ligaments engaged in the articulation of the spine appears (Duday 2009[2006], 34). Noteworthy is the position of the ribs; for a burial on its back, the ribs should have moved downward and inward (Duday 2009[2006], 34; Nilsson Stutz 2003, 288), but here the ribs have moved diagonally toward the right lateral side and inferiorly about the medial axis of the body. Possible movements to the left lateral and superior part of the body are probably restricted by the vertically placed wooden pole behind the left shoulder.

Due to the heavy fragmentation of the pelvis, the poor resolution of the photograph, and the sketchy nature of the drawing, the exact position of the pelvis cannot be observed; however, we may assume that it is exhibiting its anterior side, as indicated by the position of the upper body and lower limbs. This also means that one is not able to observe the status of the articulation of the pubic symphysis, which would have given insights about the space of decomposition. The articulations between the pelvis and femora were maintained. This becomes especially clear in the case of the left femur, which is in the foreground in the photograph. Both femora display their anterior sides; the right femur is parallel to the medial axis of the body, the distal end of the left femur has moved slightly inward (Figure 58). There is a clear contradiction between the sources about the articulations at the level of the knees. From the drawing, we observe that the articulations between the femora and leg bones – exhibiting their anterior sides – are maintained. Moreover, the patellae are at their original places. In the photograph, it appears that both right and left leg bones together with patellae have moved toward the right lateral side of the body. The movement of patella together with leg bones is logical. It has been observed elsewhere that patellae maintain their articulation with tibial tuberosity through the patellar tendon when the quadriceps muscle is decayed (Duday 2009, 34). Two possible explanations for the current discrepancy could be given. First, it could be that the excavator has levelled out some disarticulations of the bones in the drawing. This is rather questionable if we consider the details provided about the disjunctions at the level of the thoracic cage. Alternatively it could be that the photograph is taken before the drawing, as the distal ends of femora are not fully exposed there. The dislocation of the leg bones in the photograph could be ostensible due to the angle it has been taken from. The lack of background information does not allow a simple conclusion to be drawn here; two possible scenarios could be considered.

The description of the skeleton and accompanying movements do not allow straightforwardly indicate the volume of decomposition. However, similar cases at other sites allow clarifying the picture. Graves 8 and 10 in Vedæk-Bøgebakken should be mentioned as clear parallels. Nilsson Stutz (2003, 286pp) proposed that the dislocations at the level of the thoracic area were brought about by a structure behind the body that created a secondary void that acted upon the bones with the force of gravity. She argues that the dislocation of bones at the level of the thoracic and pelvic area could occur alongside the maintenance of the labile articulations of hands and feet, as the sediment penetrated from above to the empty spaces created during decomposition (Nilsson Stutz 2003, 288). Similar ruptures of a skeleton have been documented in a medieval burial site at Serris-de-Ruelles, France. Four dislocations of the skeleton were observed on burial 342: (1) displacement of cranio-facial region together with upper cervical vertebrae, clavicles, and scapulae; (2) disjunction at the level of the thoracic vertebrae and upper limbs; (3) widening of the intervertebral junction between L2 and L3; and (4) maintenance of the leg and feet bones in their initial position (Duday 2009, 36–37). These movements suggest (Duday 2009, 37) a wooden coffin where the body was initially placed had split among three fracture lines perpendicular to the medial axis of the body during the process of decomposition.

The disruptions of the skeleton and the information about the wooden "bedding" beneath the body, together with the above-given examples, suggest the following scenario about its space of decomposition for the Tamula IX burial. What becomes clear from the dislocations observable at the level of the thoracic region is that the wooden "bedding" beneath the body had an effect on the position of the bones during and after decomposition. Two distinct sections could be observed there: first, a collapse at the level of shoulders and upper thorax; second, a collapse at the level of lower thoracic area. Whether we can also observe a third place of dislocation at the level of knees, as also appears in the example provided by Duday (2009), remains questionable and primarily depends on the dimensions of the wooden "bedding". From the archaeothanatological point of view, the right lateral movement of both legs and patellae could have occurred when the "bedding" was present behind them, following the same principles as in the upper thoracic area. However, one should expect the lateral rotation of the femora when an additional empty volume is present in the area (Duday 2009[2006], 40). The sources do not allow observing this. The maintained articulations at the level of the knees seen in the drawing also follow the rules of decomposition and gravity, being explained by a quantity of soft tissue at the level of lower limbs, which is rather modest compared to the abdominal area. This subsequently allows less movement inside the initial body volume while being extended. Nevertheless, as the information available in the drawing and photograph contradict, one cannot estimate the original length of the wooden "bedding". Based on the maintained articulations of the hands and feet, one could suggest that the "bedding" was not as wide and did not cover the whole length of the grave.

Another question arises concerning the delayed infilling of the empty spaces at some parts of the body. The example provided by Duday suggests that direct contact between the body and surrounding sediment did not occur. Based on the archaeological evidence, nothing covered the body at the Tamula IX grave; only branches behind the body were documented (Jaanits 1955b; 1957a, 84). Moreover, no archaeological evidence of any shroud in front of the body is documented. But as in the case of the French medieval coffin burial, something must have restrained the gradual infilling of the grave when the soft tissue of the thoracic and abdominal area decomposed and the steady 'platform' made of branches behind the body broke off. As bark and even slender wooden branches tend to preserve in the inorganic environment offered by the peaty cultural layer at Tamula, one could suggest that the body was covered with a shroud (not tightly wrapped) that perished entirely. Alternatively, one could argue that the body itself sealed the volumes from the gradual infilling by the sediment (see also Nilsson Stutz 2003, 286pp). After the ligaments and the structure broke off, gravity acted on the bones that then collapsed to the bottom of the feature. Maybe the surrounding sediment – the grave was dug into the deepest horizon of the cultural layer – was not as granular to fill in the empty voids created during and after the decomposition of soft tissues (but see Tamula II, *Chapter 6.1.2.1.3.*).

In summary, the position of bones suggests that the "bedding" behind the body was rather steady. To enable the above-described movements of the bones, the body was either covered with a shroud that delayed the infilling of the empty voids created during or after the decomposition of the body, or the body itself acted as a seal.

6.1.3.2.2. Tamula XIV – entirely perished elevation beneath the body

Following the above discussion about additional structures behind the bodies at Tamula, grave XIV should be discussed. The richly adorned (Jaanits 1957a, 86) burial belongs to an adolescent, probably male, who was placed into a grave at the lower part of the cultural layer (overall the skeleton was at the depth of 50–60 cm; the pelvis at 55 cm) with extended extremities. Differently from the graves described in the previous chapter, no wooden branches or bark, or other archaeologically visible structures, were found (Jaanits 1955b; 1957a, 86). The succeeding description is based on the field drawing and photographs (Figure 60 and 61); only some information is supplemented by the field diary (Jaanits 1955b) and the article (Jaanits 1957a). As seen from the drawing and general plan of Tamula (Figure 61), Jaanits first found the skull, and then an extension to the excavation plot was made to excavate the rest of the skeleton, whereupon also graves XIII–XVI were found.

Figure 60. Lembit Jaanits drawing burial XIV at Tamula in 1955.
(Photo: TLU AI, f12)

The exact position of the head is difficult to establish; it was probably lifted before the final documentation was undertaken. As seen on a photograph, the skull is already gone when Jaanits draws the skeleton (Figure 60). However, one sees from the drawing (Figure 61) that it exhibits its facial side and the position of the mandible – displaying its mental protuberance and right body – further indicates that the head was rotated to left and slightly flexed frontally. The right humerus, which was rotated outward and seems to display its medial side of appearance, has maintained its articulation with the clavicle and scapula loosely, as indicated in the photograph. The left humerus was rotated inward and exhibits its posterior and lateral side. The articulations of the left shoulder girdle are maintained; noteworthy is the close contact between the humerus and scapula. Both arms are slightly abducted at the shoulders. At the level of elbows disarticulation occurs. The connection between the right humerus and forearm bones has maintained more-or-less intact; the ulna has lost its articulations with the humerus. The right forearm is slightly flexed at the elbow, and although the disarticulation of hand bones is seen in the photograph, their presence in their anatomically correct space indicates that hand was articulated when the body was deposited. Here the disarticulation could be regarded as a result of improper excavation techniques. The articulation between the left humerus and forearm bones is not maintained. The ulna exhibits its anterior side with its proximal end farther away from the medial axis of the body and distal end towards the medial line of the body (flexed at the elbow); this indicates that the right forearm was pronated. Considering the position of the humerus, this seems odd. The left radius has moved more significantly. It is in front of and perpendicular to the ulna, with the radial head pointing toward the middle axis of the body. Due to the poor resolution of the photographs one cannot determine the side of appearance of the left radius. The position of the hand bones and their articulation to the forearm cannot be observed from the documents.

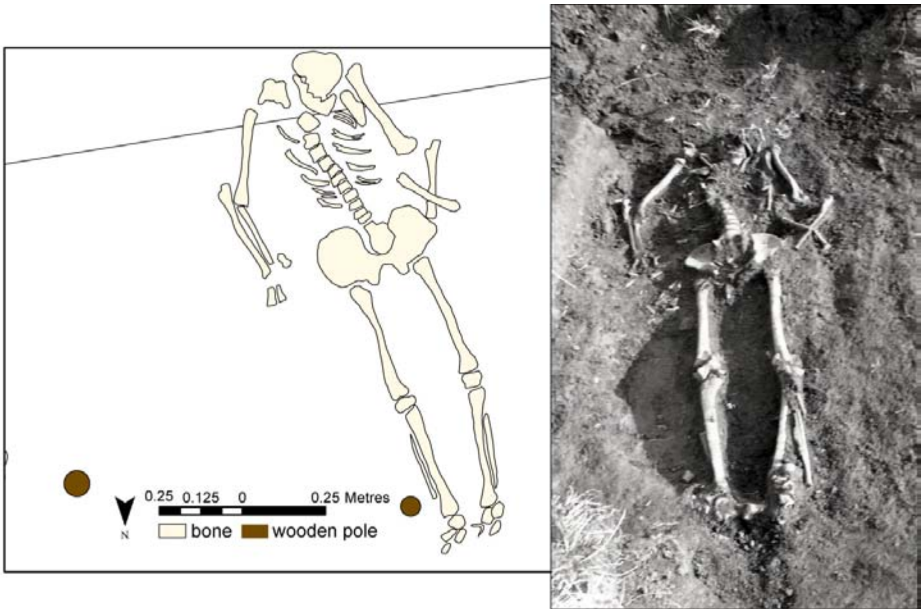

Figure 61. Tamula XIV is a primary burial.

The decomposition of the corpse has taken place in a mixed environment. The maintenance of the feet articulations and the overall intactness of the lower limbs and pelvis indicate decomposition in a filled environment. However, the disarticulation of the thoracic cage and the position of the upper limbs indicate the presence of a secondary empty volume in the grave.

(Drawing and photo TLU AI, 4-1-29-3)

The position of single bones at the thoracic area and upper thoracic vertebra cannot be observed in the photograph; the drawing, however, gives a good overview of this area. The thoracic vertebrae have remained intact, and no significant movements occur. The side of appearance of the ribs cannot be established. Contrary to what one could expect in a burial placed on its back – the medial and inferior movement of ribs – these direct toward the inferior and left lateral side of the body instead.

Remarkably, the pelvis is wholly preserved clearly exhibiting its anterior side. As expected from a burial placed on its back (Duday 2009[2006], 35) due to the decay of the sacro-iliac joints, both iliac blades have flattened and moved towards the bottom of the feature. As it appears from the photograph, the articulation of the pubic symphysis has opened. Moreover, the iliac blades have shifted laterally – a movement that points toward decomposition in an empty volume.

Both lower limbs are extended at the hip and the knee. The right femur, exhibiting its anterior side, has maintained its articulation with the hip and also with the leg bones. The left femur has also maintained its proximal and distal articulations; unlike the right femur, its anterior and lateral sides are shown in the photograph, indicating a slight inward rotation. The right leg bones also show their anterior sides of appearance, with the fibula being somewhat beneath the tibia. The articulation with the feet bones is also maintained, but as the feet bones are not clearly exposed in the photograph, nothing more can be said about their position; the drawing, however, indicates that the foot was laterally bent. The left tibia and fibula have lost their interosseous connection, and the distal part of the fibula has fallen laterally, displaying its medial side of appearance. Left tibia is not entirely exposed in the photograph, but it appears to exhibit its anterior side. Again the connection with the foot bones is upheld, being rotated medially, but it is impossible to see their side of appearance in the photograph.

Similarly to the above-described cases, the position of bones signals contradictory information about the space of decomposition of the body. The forward and left lateral flexion of the cranium, the ruptures observed at the level of the thoracic area, and the lateral movement of the right forearm and extreme disarticulation of left forearm, together with the lateral expansion of iliac blades, all point to decomposition in an empty volume. On the other hand, the maintenance of the labile articulations of the hand bones and feet, together with the absence of lateral rotation of femurs, are evidence for the decomposition in a grave gradually filled with sediment. These movements at the upper part of the body indicate that an additional elevation was originally behind the thoracic, abdominal, and pelvic areas. One cannot establish whether the elevation also reached the head. To determine the original position of the head in the grave, it is important to observe the position of cervical vertebrae (Duday 2009[2006], 35). As these excavated skeletons were lifted at once, without making any observations about the cervical area, we do not have this information. Thus, one can only tentatively argue that the skull moved during or after the process of decomposition.

The material of the additional elevation behind the body remains unknown; however, wooden branches and bark can be excluded, as these materials have preserved in other graves at Tamula. The volume of the structure can be tentatively reconstructed. If we agree that the head moved during or after decomposition, then the additional elevation behind the body must have extended from the head to the pelvis; on the lateral sides, the elbows mark the maximum width of the structure. The interior and left lateral movement of ribs indicate that the elevation must have been higher at the superior and right lateral side of the body.

6.1.3.2.3. Tamula XXII – facing downwards or upwards?

Another case in point is Tamula XXII. The position of the upper part of the body and the analysis of the space of decomposition indicates an additional elevation behind the lumbar and thoracic vertebrae. As in this grave also wooden poles and pine and birch bark have survived, the structure behind the upper body must have been from another material, one that could not survive in these environmental conditions.

The current position of the bones gives a general impression of the initial position of the body even if significant movements have taken place in the upper part of it:

> The cranium presents its posterior and lateral right sides, resting on the left zygomatic and frontal bone. The cranium became visible at the depth of 58 cm from the topsoil. Jaanits describes the superior part of the cranium as being in immediate contact with the wall of the grave (Jaanits 1961b). The mandible is disarticulated from the cranium, lying in the area of the right shoulder. It presents the inferior and posterior sides of its body, and is directed NW–SE, with its mental protuberance towards the NW, and the posterior sides of the vertical ramus toward the SE. It should be pointed out here that there are differences regarding the position of the mandible in the drawing (Figure 55) and the photograph (Figure 62). In the drawing, the mental protuberance is directed toward the SE. The analysis of the field documentation revealed that the burial was first drawn and then, after more studious cleaning, the photograph that I base most of my observations was taken. This indicates the initial position of the mandible in the deposit is presented in the drawing, i.e. its mental protuberance points toward the SE.

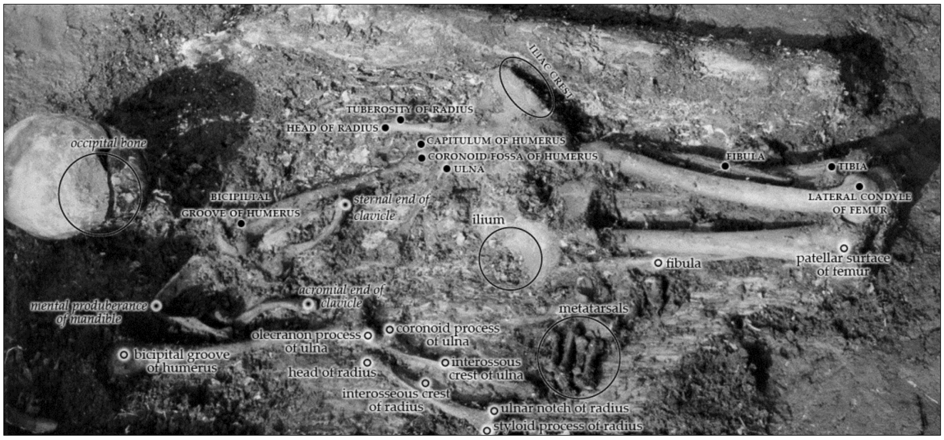

Figure 62. This photo forms the basis for the archaeothanatolocial analysis of the Tamula XXII burial.
All the identifiable bones and their single elements are marked on the photograph. Where possible, the bones have also been lateralised: open circle – right side; filled circle – left side; shaded circle – unidentifiable side. (Photo TLU AI, f12; modified by K. Roog, first published in Tõrv 2015)

The vertebral column is only partially documented. Its presence is indicated schematically in the drawing, but it is impossible to differentiate between the cervical, thoracic, and lumbar vertebrae, and the side of their appearance. In the diary entry, Jaanits just states that single vertebra were dislocated from their initial position in the vertebral column. There is little information about the thoracic cage. No ribs or sternum are visible in the photograph nor in the drawing. The presence of ribs is only mentioned in the diary to indicate the location of the mandible about them: *"Mandible lays south of the skull close to the ribs."* (Jaanits 1961b). The bones of the thoracic cage are also absent from the osteological collection. Both clavicles are observable in the photograph: the right one is lying vertically in the upper part of the right hemi-thorax and is oriented E–W with the acromial end toward the E. It presents its superior surface. The left clavicle is lying vertically in the middle of the right hemi-thorax. From the drawing and the photograph it appears to be lying very close to and in the same general axis as the left humerus. It is oriented NW–SE with the sternal end toward the SE, and it presents its inferior surface. It is indicated in the drawing that the vertebral column is in front of the sternal end of the left clavicle. This relationship cannot be studied from the photograph. Neither of the scapulae is observable in the documentation.

The right upper limb is partially articulated and is lying to the lateral right side of the thoracic cage, being adducted with its distal end directing toward the medial axis of the body. The right humerus is oriented NW–SE with the proximal end to the NW; it is slightly rotated inward and presents its anterior and lateral sides (based on observations of the intertubercular groove). Its position indicates a disarticulation from the glenoid fossa of the scapula. As the scapula cannot be observed, their exact relationship is unknown, but it seems likely that the proximal end of the humerus moved laterally during decomposition. The right radius and the right ulna are in close connection to the distal end of the right humerus. Their proximal ends are in loose articulation with one another, but their distal ends are separated by several centimetres and have drifted apart from one another during the process of decomposition. The right radius presents its anterior and the right ulna anterior-lateral side. The position of the hand bones is not observable. Their presence in the burial is affirmed by the fact that some of them were recognised and collected during the excavation of the burial and are now stored.

The left upper limb is only partially visible on the documentation. The left humerus is lying behind the vertebral column directed E–W, with its proximal end toward the W lying in the upper part of the right hemi-thorax. The distal end is positioned immediately to the lateral left side of the vertebral column (as indicated in the drawing) and to the immediate medial side of the wooden pole. It exhibits its anterior side (based on the observations of the intertubercular fossa, capitulum, and coronoid fossa of humerus). None of the articulations of the elbow are maintained. This position indicates a significant movement of the humerus during the process of decomposition. The left radius is directed NW–SE (i.e. in the general direction of the medial axis of the body), with the proximal end toward the NW. It presents its anterior side (note the head and tuberosity of radius), and its distal half is positioned behind the left iliac blade. The position of the left ulna is unclear. It is not observable in the drawing, but in the photographs a long bone that could be the left ulna can be observed lying N–S and perpendicular across the area of the abdomen. It is more than probable that the long bone described is the left ulna as other long bones of this individual can be identified from the photographs and the drawing. This allegation is further confirmed by the presence of the left ulna at the collections. No details, including the side of appearance, could be observed.

These movements became a key in understanding the initial body position, and they also explain the misinterpretation made by Jaanits that the deceased was placed into the grave facing down. Rather, the upper body was placed on its back with both of the upper limbs extended at the shoulder and forearms slightly flexed at the elbow; the right one supinated, and the left one pronated. Both of the lower limbs were extended at the hip and tightly flexed at the knees, bringing the feet behind the thigh and pelvis. Due to the insufficient documentation, the exact position of the cranium, hands, and feet were not possible to reconstruct with certainty. The body was slightly rotated to the right, as indicated by the position of the left iliac blade and both upper limbs; it is also affirmed by the position of the left femur, which is rotated medially. Unfortunately, no z-values about single elements of the skeleton are available.

The initial position of the head cannot be reconstructed with certainty; its movements will be discussed separately (*Chapter 6.1.4.2*). The information about the thoracic cage is fragmentary; therefore, the reconstruction of its initial position in the grave has to be based on the indirect evidence. Based on the position of the pelvis and lower limbs, we can argue that initially the body was placed into the grave on its back. The constrained position of the lower limbs elevated the upper body creating a 'naturally' arching back at the level of the lower thoracic and lumbar vertebrae. The significant movements of bones at the area of upper body – the shoulder girdle and the forearms – indicate that in addition to that 'natural' empty volume behind the lower part of the back, an additional elevating feature was used to stabilise the position of the body. Despite the fact that both of the upper limbs were dislocated during the process of decomposition, their initial position could be determined. The right arm was adducted and slightly laterally rotated. The right forearm was slightly flexed at the elbow and it was most probably supinated. The exact position of the hand cannot be determined; the presence of hand bones in the initial burial, however, is proven by their availability at the collection. The left arm was initially adducted, rotated inward, and slightly elevated at the shoulder. This is indicated by the position of the distal end of the left humerus, which has remained its initial position wedged between the lateral left side of the body and a wooden element immediately left of the body. The dislocation of the left ulna and the left radius, together with the presence of the wooden poles at the left lateral side of the corpse, indicate that the forearm was only slightly flexed at the elbow and pronated, following the course of the grave cut. Considering the wooden poles in the immediate vicinity of the left lateral side of the body, it is possible that the left elbow was at least partially resting on top of the smaller pole, raising the elbow higher than the forearm. These wooden poles also restricted the movements of the bones of the upper body toward the left side of the body. The exact position of the hands cannot be reconstructed; again their presence in the initial burial is confirmed by their availability at the collection.

To fully understand the processes taken place during or after decomposition, the relationship between the vertebral column and the left upper limb must be discussed. Jaanits states in his excavation diary (Jaanits 1961b) that the vertebral column is located in front of the left humerus. In the drawing, it becomes obvious that the left clavicle has collapsed behind the vertebral column. Unfortunately, the location of vertebral column is not observable on photographs; it was probably removed before the photographs were taken or due to its very poor preservation. This does not allow us to confirm the accuracy of the drawing. However, these movements could only have taken place in a burial environment with delayed infilling and a secondary empty volume behind the body.

The pelvis exhibited its anterior aspect with the left side slightly higher. Unlike the reconstruction of the initial body position here, Jaanits described the pelvis as presenting its posterior side (Jaanits 1961b). This was most probably due to the recognisable position of the cranium during the time of excavation (*Chapter 6.1.4.2*). The left iliac crest and the position of the lower limbs observed in the photograph disprove Jaanits' argument. Both of the lower limbs were extended at the hip, thereby presenting the anterior side of the thighs. The left thigh was medially rotated, which could have been caused by an elevated left side of the body. The legs were tightly flexed at the knees, with the legs behind the thighs and feet behind the pelvis. The exact initial position of the feet cannot be determined precisely; however, according to the diary they were behind the pelvis (Jaanits 1961b), and the four metatarsals of the right foot observable both in the photograph and drawing were bent laterally.

The position of several bones indicates that the body was rotated to the right. As described above, the left arm was elevated at the shoulder and so was the left elbow. The higher position of the cadaver at the level of the upper body is also confirmed by the movements of the bones toward the right side. Not only was the upper body rotated to the right, but the higher position of the left iliac blade observable in the photograph (Figure 56: a, b), and the medial rotation of the left femur assert that the lower part of the body was also rotated to the right. The body rotation is also supported by the presence of the wooden poles on the lateral left side of the body. The position of the bones at the left side of the body and their movements suggest that the left upper limb, the left side of the pelvis, and the left lower limb all leaned partially against these wooden elements.

The spatial distribution of the bones, especially at the level of upper body, suggests that in addition to the naturally arching back, an elevation was placed beneath the body to stabilise its position. All the other structures – bark and wooden poles – contributed to the movement of bones too and made the reconstruction of the initial body position more challenging.

6.1.4. Post-burial manipulation of corpses

The manipulation of bodies purports the controlled and skilful handling of the dead in the acts performed prior the final burial to the handling of the physical remains – partly decayed corpses or bare bones – after the final interment (Masterton 2015, 192pp). In arguing for post-burial manipulations from the archaeothanatological point of view, one should be able to prove that the movements of bones and/or missing body parts are clearly a result of human intervention and not an outcome of taphonomic processes. Moreover, one should be able to demonstrate at which point in the decomposition of the corpse the manipulation took place. Archaeologically it is important to demonstrate that the movements or destructions are not caused by later activities on the site, i.e. ploughing, gravel mining, or re-burial.

The general pattern suggests that primary inhumations were conducted rapidly after the death of an individual, and subsequent to their interment to a pit-grave, these bodies were left untouched. Most of the disturbances that we are able to observe are later intrusions and have nothing to do with the ways death was handled by hunter-gatherers (*Chapter 6.2.2.1.*). There are, however, three cases – Tamula I, Tamula III, and Tamula XXII – that raise questions due to holding characteristics that could be indicative of a secondary handling of the deceased during or after the process of decomposition.

6.1.4.1. Missing limbs in Tamula I and Tamula III burials

There is not a single primary inhumation in my sample where all the 206 and extra bones are carefully unearthed and taken to the collection. As seen from the various descriptions of the deposits, many cases occur where the whole skeleton is not cleaned meticulously enough or where disturbances of smaller bones can be observed. The most common overlooked bones during excavations are either small hand and feet bones, or more fragile ribs and extremely fragmented pelvises. As discussed elsewhere the pelvises at Tamula are poorly preserved (*Chapter 6.1.1.1.2.*). Thus, it seems that there is a lot of evidence to argue for post-burial manipulation if we were not to consider source criticism that allows us to observe that the majority of these movements or absences of bones is not an outcome of hunter-gatherer practices but reflect the excavation techniques applied decades ago.

The burials Tamula I, and Tamula III represent a different pattern. As argued above (*Chapter 6.1.2.1.2.* and *6.1.2.3.*) both of these are primary inhumations, and the overall position of skeletons clearly suggests decomposition in a filled environment. For both of them one could observe the presence of the pelvis, however fragmented, and the small bones of the hands and feet. The articulations at the level of the feet have upheld. There are no signs of secondary disturbances. For grave I we observe that the right humerus, clavicle, and scapula are missing. As argued earlier (*Chapter 6.1.2.3.*) one cannot reach a conclusion behind this discord. One tentative explanation could be that the grave was reopened after a while – when the ligaments were already decayed – and the proximal part of humerus together with the clavicle and scapula were removed from the grave. This, however, remains a hypothesis as none of the bones are present in the collection, prohibiting the examination of the characteristics of the fracture on the distal humerus, which otherwise would shed some light on the matter.

The right femur is absent from grave III. As the femur is the largest and most durable bone, one should exclude the possibility of this bone being entirely decomposed. The presence of the left femur in the feature makes this allegation even sounder. Alternatively one could suggest that the excavator removed it before documenting. This argument is supported by the fact that usually excavators mentioned when something unusual was observed on the skeleton, but Indreko (1942, 3–4) did not indicate that the right femur was absent from the deposit. On the other hand, we are not able to observe its presence neither in the drawing nor in the photograph. Of course a photograph only represents a single episode of the whole process of excavations. Thus, not all the details would be observable there. But drawings provide us with the understanding that the archaeologist in the field had while excavating the deposit. Thus, we expect that all the bones present in the deposit (even if removed before recording) were drawn, too. Taking it all together it seems likely that the right femur was not present at the time of excavation (Figure 63).

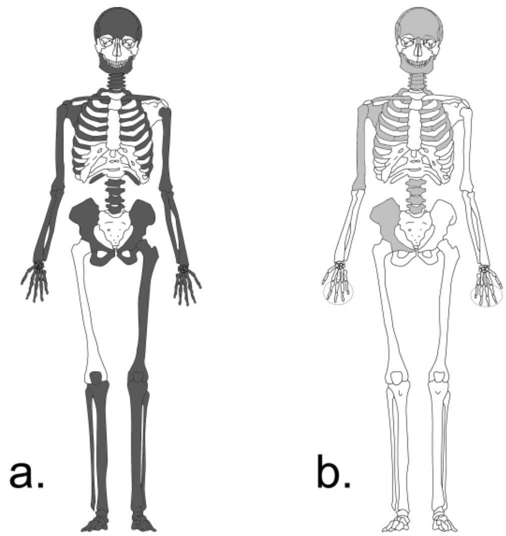

Figure 63. Bones represented in Tamula III.
A – bones observable on the field documentation,
b – bones available at the collection in TLU AI.

Assuming that the femur was not in the deposit during the excavations, one should look for any conditions associated with the deposit that would be favourable for the removal of single limb bone, and determine when it could have happened. The key to resolving this puzzle is the right patella, which could be observed both in the photograph and the drawing (Figure 46). The presence of the right patella and its maintained articulation with tibial tuberosity suggests that a whole body was placed into the grave, i.e. the right lower limb was present and articulated at its whole length. Thus, the removal of the right femur must have taken place later after the body was already defleshed and the ligaments that hold the right femur together with the leg bones had broken off. Moreover, the idea of reopening of the grave is supported by the results of archaeothanatological analysis concerning the presence of wrappings in the grave. The constrained position of the whole skeleton, the clearly observable bilateral pressure to the upper body (note the verticalised clavicles), and the neatly lined-up position of the lower limbs strongly suggest that the body was shroud in something. The fact that the body was covered with an organic material preventing immediate contact with the sediment would have eased the process of reopening.

6.1.4.2. Tamula XXII: post-burial manipulation or effects of taphonomic processes?

The position of the cranium of the Tamula XXII body contradicts the position of the post-cranial skeleton, which raises several questions that need to be discussed separately. However, one has to state that the initial position of the cranium cannot be determined with 100% certainty as the occipital bone, the atlas, and the rest of cervical vertebrae that are involved in the movement of the head (e.g. Duday 2009[2006], 35) are not observable in detail, and thus their side of appearance cannot be determined. Nevertheless, when considering the position of the post-cranial skeleton, which presents its anterior side, and the side of appearance (i.e. posterior and lateral right sides) of the cranium, the latter must have moved/had been moved significantly (rotated c. 270º) during or after the process of decomposition (Figure 64). Also, the mandible has lost its temporo-mandibular connection and is not in contact with the cranium. The mandible has moved significantly, lying in the area of the right shoulder with its mental protuberance directed toward the SE. Thus, two possible explanations about the post-depositional movements of the cranium are proposed and their reliability discussed.

Before continuing with the explanations, the sources have to be faced critically. Although excavators moved some bones before documenting them (as shown by the differences in the position of the mandible in the photograph and the drawing), it has to be stated that the cranium was not among them. The cranium was the departure point for Jaanits in describing and interpreting the deposit. Despite his misinterpretation of some of the bones in the field, Jaanits correctly recognised the position of the cranium. Therefore, the photograph and drawing can be taken as accurate depictions of the deposited position of the cranium.

The first explanation of the movement of the cranium and mandible is as an outcome of the decomposition of the cadaver in a space with delayed infilling and an initially elevated head (e.g. cushion), which could have created a secondary empty volume (*Chapter 6.1.3.2.3.*) behind the cranium and at the area of the right shoulder where the dislocation of cranium and mandible would have become possible. The movements at the level of the shoulder girdle and the position of the vertebral column also support the idea of an additional empty volume behind the body.

An alternative explanation for the post-depositional movements would include human interference after the initial burial. The bark layer covering the upper part of the corpse made the reopening of the grave possible. It is difficult to estimate the time interval between the initial burial and secondary manipulation of the body. It is known that under temperate climatic conditions skeletonisation takes 12 to 18 months to reach completely clean bones (Knight 1996 referred in Pinheiro 2006, 111). The decomposition of tendons and ligaments may take as long as three years (but see e.g. Galloway 2006[1997], 144–145). As the head is regarded to be one of the first body parts to decompose, the minimal time interval between the burial and reopening of the grave remains between one and three years. The sequence of actions must have been as follows: the grave was reopened and the bark coating removed, the skull was taken out (what was done with it cannot be reconstructed) and placed back into the grave facing downwards (presenting its posterior and lateral left side) as it was documented in the field, and the grave was sealed again. This interpretation could also be confirmed by the fact that Jaanits (1961b) described the superior part of the cranium as being pressed immediately against the NW wall of the grave cut, restraining any movements that were theoretically made possible by the empty volume behind the upper body. The reopening of the grave may also help to explain some of the extreme movements of the bones in the upper part of the body.

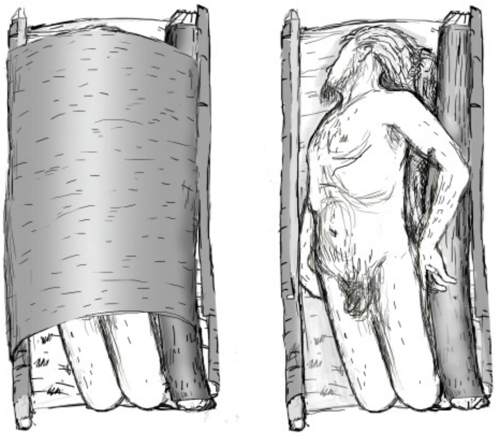

Figure 64. The reconstruction of the initial body position of the Tamula XXII burial.
As seen here, the head of the deceased is still intact, exhibiting its anterior and left lateral side. The covering bark layer made it possible to reopen the grave without causing much disturbance to the corpse. (Drawing by J. Ratas; first published in Tõrv 2015)

It is difficult to favour one of these explanations. First, the documentation leaves us with unanswered questions. For instance, no later disturbances of the grave, which could support the idea of reopening of the burial, were recorded. However, we may argue that the excavation techniques applied decades ago were not meticulous enough to note this and still hold that the body was handled after its interment. Whatever the situation in the field was, the present documentation does not allow making any conclusive interpretations here. Moreover, references arguing for the possibility of both of these explanations can be found in the literature. However, due to the insufficient application of archaeothanatological principles for analysing Stone Age graves in Europe in general, the presence of secondary empty volumes behind the cadaver, which allow extreme movements of various body parts, has so far been observed only in a single instance, i.e., at Skateholm II (grave XV; Nilsson Stutz 2003, 224).

On the other hand, evidence of the manipulation of crania/skulls and/or heads from Mesolithic and Neolithic burials in Europe (e.g. Andersson 2004; Orschiedt 2005; Edgren 2006; Bonsall et al. 2008; Fahlander 2010; Hallgren 2011; Borić et al. 2014; Schulting 2015; Wallin 2015) and elsewhere (Schulting 2015 and the references therein) has become more abundant during the last decades. The closest examples come from Zvejnieki in Latvia, where some of the faces of the deceased had been plastered with clay and amber rings placed on the eyes (e.g. graves 206, 225, 275 Zagorskis 1987; Zagorska 1997; 2006). Plastered skulls have also been reported in Finland at Kolmhaara, Hartikka Laukaa, and Kokemäki Pispa Combed Ware sites (Luho 1960; Miettinen 1990; 1992; Edgren 2006), and Torsten Edgren further suggests that amber buttons and slate rings (the skeletons are usually not preserved in these contexts) from various Combed Ware sites in Finland could indicate a similar phenomenon (Edgren 2006, 330–332). Moreover, the secondary removal of skulls has been found at the Mesolithic sites of the Iron Gates (Bonsall et al. 2008; Borić et al. 2014) and the Pitted Ware site Ajvide in Gotland (Andersson 2004; Wallin 2015). Moreover, these sites do not represent the totality of the available data, but instead demonstrate the importance of heads/skulls to hunter-gatherer communities in Europe.

The significance of the heads/skulls can also be seen in other burial contexts in Estonia. For instance the immediate vicinity of the skull of the Naakamäe female was covered with ochre, while the rest of the body was kept clean. Ochre was also found from other burials at Saaremaa (Kõnnu II, Kõljala I), but there it was not only connected to the head. Additionally, the Kivisaare XIII burial described at length above lacks its skull. The analysis of loose human bones, in general, indicates that fragments of skulls are amongst the most frequent bone elements (*Chapter 6.2.*). Thus, taking the taphonomic history of the burial and the wider contemporary context into account, to date it is more plausible that the Tamula XXII grave was reopened after the initial funeral, and something was done with the skull that was then placed back to the grave facing downwards, opposite to its initial position.

6.1.5. Time in the creation of burials with several individuals

In addition to single inhumations, graves with the remains of more than one individual have been found. The majority of these entail two individuals, such as the burials at Kivisaare (VIIIa/b, IXa/B, Xa/b, XIa/b, XVIIa/b and XXa/b), Kõnnu (II/IIa), Pikasilla (I/II), Tamula (XI/XII), and Valma (II/III). Only at Veibri were more than two individuals placed within a single grave. Additionally, the osteological analyses carried out for the present study of Tamula XIII, XIX, and XXIV single burials revealed the bones of another individual, and several other features were discovered with loose human bones (*Chapter 6.2.*), which may also be considered a burial with several individuals. The latter will not be discussed any further, however, due to the lack of contextual information.

Burials with several individuals have usually been considered an outcome of a catastrophic event resulting in the simultaneous interment of several individuals (Jaanits 1957a, 85; 1959c). However, as discussed in *Chapter 3.1.3.* this is not necessarily straightforward; the simultaneousness of the deposits has to be investigated. The results of the analysis are presented in Table 27. To illustrate the problem and demonstrate the importance of establishing the time of each interment in burials with several individuals, I will discuss three cases (Veibri, Valma II/III, and Kivisaare IXa/b) in more detail.

Table 27. Burials and features with several individuals.
Where possible differentiation between multiple and collective burials is made.

Grave/skeleton no. (original no.)	***Type of deposit***	***Arguments***
Kivisaare VIIIa / b *(II; Grab 2, 3)*	unknown	analysis impossible due to heavy destruction and poor field documentation
Kivisaare IXa / b *(III; Grab 4)*	collective?	poorly preserved skeletons; an intervention is observable at the grave cut
Kivisaare Xa / b *(Kivisaare I, Ia)*	multiple?	field documentation insufficient and poor preservation of individual no Xb; the description states that skeletons were tightly close to one another (Ottow 1911, 155)
Kivisaare XIa / b *(Kivisaare II, IIa)*	unknown	analysis impossible due to heavy destruction and poor field documentation
Kivisaare XIIa / b *(Kivisaare III, IIIa)*	unknown	individual XIIb poorly preserved; insufficient field documentation
Kivisaare XVIIa/b	unknown	analysis impossible due to the poor preservation and heavy fragmentation; no grave cut visible
Kivisaare XXa/b	unknown	only mandible is present from the other individual; no spatial references to its location in the grave pit
Kivisaare XXIX a–c *(luustik 1)*	unknown	the deposit is a reburial of primarily long bones of three individuals; this act has been dated to the end 19th or beginning of 20th century
Kivisaare XXIVa/b *(f–k/6–11)*	unknown	analysis impossible due to the poor preservation and heavy fragmentation; no grave cut visible
Kivisaare XXVa/b *(ä–ö/42–44)*	unknown	analysis impossible due to the poor preservation and heavy fragmentation; no grave cut visible
Kivisaare XXVIa/b *(f–h/18–20)*	unknown	analysis impossible due to the poor preservation and heavy fragmentation; no grave cut visible
Kõnnu II/IIa	multiple?	poorly preserved skeletons; close spatial relation to one another
Narva Joaorg I	unknown	no intrusions to the original deposit can be followed; due to the nature of the burial nothing certain can be said
Pikasilla I/II	unknown	due to the heavy fragmentation of the bones, nothing more substantial can be said

Grave/skeleton no. (original no.)	Type of deposit	Arguments
Tamula XI/XII	multiple	close spatial relation between the two bodies; right upper limb around the superior part of the child's body
Tamula XIII/XIIIa	unknown	analysis impossible due to the poor preservation and heavy fragmentation; no grave cut visible
Tamula XIX/XIXa	unknown	analysis impossible because the single bones of a second individual were observed during the osteological analysis undertaken for the present thesis
Tamula XXI/XXIa	unknown	analysis impossible because the single bones of a second individual were observed during the osteological analysis undertaken for the present thesis
Tamula XXIVa	unknown	analysis impossible due to poor preservation and the fact that single bones of the other individual were found during the osteological analysis undertaken for the present thesis
Valma II	collective?	no contact with one another, indicative of single burial; archaeologically observed similarity in grave fill
Valma III	collective?	no contact with one another, indicative of single burial; archaeologically observed similarity in grave fill
Veibri I: I–IV	multiple	close spatial relation of the skeletons, overlapping of child bodies

6.1.5.1. Veibri – a clear case of a simultaneous deposit, i.e. multiple burial

At Veibri I, a middle adult female and three children were placed together in a pit-grave directed NW–SE with the heads of skeletons I and IV directed toward the SE and those of II and III toward NW (Figure 65). As the grave fill – fine granular river sand – did not differ from the surrounding sediment, the exact shape and size of the grave could not be established archaeologically (the area with the skeletons measures 160 × 67 cm). The grave cut was with a more or less even bottom, being slightly deeper at the middle part; the relative depth of the crania of the skeletons I and IV are 47 cm, the crania at the other end of the grave – resp. II and III – were 54 cm and 46 cm. The middle part of the grave (the distal end of the right radius of skeleton IV) was at 57 cm – that is 10 cm deeper than the cranium. Only a Narva-type pottery sherd was found from the grave, but considering it as a grave good is doubtful (Kriiska et al. 2007; Lõhmus et al. 2011).

The following analysis is based on the field documentation: abundant photographs (with many details), a drawing, a written description, three coordinates of several single bones (Johanson et al. 2006–2011), and the bones of these individuals. Moreover, all the sources complement each other. The grave has been destroyed twice – first a fire pit had been dug into the grave ('destroyed area') during the 20th century, and this was followed by a removal of the upper layers of topsoil at the shore of the river Suur-Emajõgi.

Figure 65. Veibri quadruple burial of a middle adult female and three children.
The close spatial relation of the four skeletons and overlap at the level of lower limbs in children skeletons clearly indicate that all these individuals were placed into the grave simultaneously. (Drawing R. Rammo and K. Roog; photo M. Tõrv)

Before moving to the arguments about the simultaneousness of the deposit, I will give a detailed description of all four skeletons:

> The majority of skeleton I was preserved *in situ*, but due to the removal of the topsoil, some of the bones have gone missing or are displaced. The majority of the left humerus, the bones of the forearm and the hand, the frontal part of the cranium, most of the left femur, and the feet bones of both sides were removed during the topsoil clearance. Despite these movements, one can conclude that the skeleton was lying on its back with limbs in extension.
>
> The position of the mandible – exhibiting its anterior and right body – and the facing of the endocranial surface of the cranium suggest that the skull exhibited its anterior and right lateral side. The close spatial relation of the cranium and mandible indicates that the temporo-mandibular joint was maintained. The vertebral column is well preserved in its upper part – the maintenance of the articulations becomes most evident in the cervical vertebrae; single bodies of the thoracic vertebrae can also be observed, presenting their anterior surfaces. Lumbar vertebrae were not possible to observe due to the later disturbance. The outlines of the thoracic cage are observable even though some of the ribs and sternum are absent. The ribs present their anterior and superior sides. The lower ribs are extended laterally; however, due to the later disturbances, not all the details are observable. The articulations of both shoulder girdles are not entirely maintained. However, close spatial relations of the bones involved could be observed; movements are the result of later intrusions. The proximal part of the right humerus and the distal shaft of the right ulna are present; however, the position of ulna and the articulations between the upper limb bones cannot be observed in detail. The proximal part of the humeral shaft is

adducted and exposes its anterior side. The distal part of the shaft of the right ulna – exhibiting its anterior side – is on the right lateral side of the pelvis, indicating that the forearm was supinated and extended at the elbow. The position of the hand bones cannot be observed. The left arm – its humerus displaying its anterior side – is adducted and has a close spatial relation with the right upper limb of skeleton IV. The forearm – its radius exhibiting its anterior and ulna its medial side – was mid-supinated and extended at the elbow. The distal ends of the left ulna and radius are placed behind the left pelvis. Partly due to this and the poor preservation of small bones, the articulations of the left hand bones were impossible to observe; however, they were present as is affirmed by their availability in the collection. Despite heavy fragmentation, one can observe that the pelvis exhibits its anterior surface, being slightly rotated toward the left lateral side (right iliac blade -45 cm and left -54 cm) (Johanson et al. 2006–2011). The articulations between the sacrum and os coxae are maintained. It is also clearly visible that the articulations between the pelvis and both of the femurs are maintained indicating that the lower limbs were extended at the hip. Only a proximal part of the right femur is available from the right lower limb; the left femur exhibits its anterior side. The position of the right leg and feet cannot be reconstructed directly. Although the articulations at the level of the left knee are not well observable it is possible to conclude that the leg – its tibia and fibula exhibiting their anterior sides – was extended at the knee with their distal parts 7 cm higher than the left iliac blade (Johanson et al. 2006–2011). However, the articulations between the leg bones are broken off, while the left leg was in front of the abdomen of the child III. The empty volume created behind the left leg of individual I during or after the decomposition of the soft tissue of individual III allowed movements of the leg bones. The exact position of the feet bones is impossible to determine, but some of these were collected.

Despite heavy fragmentation the superior part of the body of individual II, it is well preserved, and all important articulations are observable. This skeleton has been destroyed twice – its lower body from the right iliac blade inferiorly has been cut through by a later pit and the anterior side of the cranium was destroyed by the topsoil removal. The frontal part of the cranium is absent; the cranium exhibits its endocranial surface, and the temporo-mandibular joint is maintained. The mandible presents its left ascending ramus and is rotated to the right. The position of the skull indicates that the head rests on its back side, slightly rotated toward the right lateral side. The single vertebrae at the level of the thoracic area are more or less disintegrated; single vertebrae are observable inferiorly and these present anterior sides. Due to the poor preservation there is a remarkable intervertebral hiatus at the level of lower thoracic vertebrae. The thoracic cage presents a symmetrical and regular pattern of distribution of the bones. The ribs present their anterior sides. Their position indicates clear bilateral pressure on the body. Both clavicles are placed vertically presenting their superior and anterior surfaces. The right clavicle is also in an elevated position pressed between the right lateral side of the mandible and the right humerus. Shoulders were at the same level (right: -48 cm; left: -47 cm) (Johanson et al. 2006–2011). Even though the scapulae are fragmented and poorly preserved, based on the proximity of the humeri, clavicles, and scapulae one can establish that the articulations of both of the shoulder girdles are upheld. The maintenance of scapula-thoracic junction supports the idea of a primary burial. The right arm is adducted – its humerus presents its anterior-lateral side – and slightly elevated. Due to the fragmentation of the bones, the articulation between the arm and forearm is not maintained. The distal part of the right forearm and the hand bones were removed during the 20th century intervention; however, one can establish that the forearm was extended at the elbow, slightly rotated inward and in mid-supination: the right radius, which presents its anterior-lateral surface, is located in front of the right ulna, which presents its medial side. The left arm is adducted and slightly rotated inward, with the humerus exhibiting its anterior-lateral side; the radius of the left forearm rests in front of the ulna and presents its lateral side while the ulna is only partially visible and is in mid-supination with the hand behind the left side of the pelvis. The left forearm was next to the right lateral side of individual III, with only 2 cm separating them (Johanson et al. 2006–2011). The left hand rested behind the left iliac blade, exhibiting its palmar side, and was extended at the wrist and slightly flexed at the metacarpal-phalangeal joints. The articulations between the phalanges could not be observed as the distal part of the hand was removed with the 20th century intervention. The pelvis is only partly preserved as the right part of the os coxae was dislocated with the later intervention. The left iliac blade presents its anterior surfaces, whereas the sacroiliac articulation and the articulation with the head of the left femur are upheld. The sacrum presents its antero-superior surface. The position of the sacrum, together with the position of lumbar vertebrae, points to an empty volume behind the lower back of the individual. The position of the lower limbs cannot be determined directly as they were removed during the 20th century intervention; however, all long bones were found at the pit. Nevertheless, the proximal part of the left femur – presenting its anterior side – is encountered in its initial place in perfect anatomical connection with the acetabulum, which indicates that the thigh was extended at the hip. This fact and the size of the grave suggest that both of the lower limbs were initially extended at the hip and the knee. The position of the feet cannot be reconstructed.

Skeleton III is the most poorly preserved as it suffered from later disturbances twice: first, its lower limbs inferior from knee were cut off with the 20th century intervention and then the anterior part of the body (from cranium to pelvis) was destroyed by the removal of topsoil. Similarly to others, its upper body (the mandible at a depth of -46 cm) was a bit higher than the lower body (the distal ends of the femurs at a depth of -54 cm). The cranium is heavily fragmented, and thus its position can only be reconstructed based on indirect evidence. The mandible seems to have remained in its initial position, presenting its superior surface, indicating that cranium was lying on its back presenting its anterior surface as was the case in the previously described two skeletons. Due to heavy fragmentation and disintegration of the bones of the upper part of the body – the thoracic cage, vertebral column, left upper limb and shoulder girdles – the position of this part of the body cannot be observed. The disturbances of these fragile bones are partly caused by the fact that the upper body of individual III was in front of the lower limbs of individual IV. The left foot of IV extended as far as the superior thoracic area of III. Due to this, the body of individual III was positioned higher. The right arm of III – its humerus exhibits its anterior side – is adducted, rotated slightly inward with its forearm extended at the elbow and supination. The articulations at the level of the shoulder and elbow could not be established. Only the medial shaft of the right radius and ulna are present, exhibiting their anterior sides; although the distal ends of the right forearm bones are not visible, the position of radius and ulna indicate that the right hand is placed beneath the right iliac blade. The pelvis is heavily fragmented; the left side is not entirely cleaned and is hidden behind the left leg of individual I. Nevertheless, one can establish that the pelvis presents its anterior side. The articulation with the right femur is still maintained, and both femurs present their anterior sides, being lightly rotated inward. As the left side of the pelvis and the upper part of the left femur of individual III are not entirely cleaned and remain behind the left lower leg of individual I, their articulation cannot be observed in detail. Both femurs are extended at the hip. The position of the legs and feet cannot be observed as they were removed during the 20th century intervention.

Individual IV is on the lateral left side of the skeleton I, being in close connection with it and oriented in the same direction. It is relatively well preserved; only its left upper and lower limbs and pelvis were removed by the 20th century intervention. The cranium is heavily fragmented, but its contours are well observable, indicating that it exhibits the left lateral side of the parietal and temporal bones. Its maxilla is preserved and presents its left lateral side; the mandible exhibits its left ascending ramus. The position of these bones indicates that the cranium is rotated toward the right lateral side (toward individual I) and slightly flexed anterior-laterally. The vertebral column is not entirely preserved; the exact position of the superior-most cervical vertebrae is not possible to determine as their position was not documented after the cranium was removed. Vertebrae C7 and T1 present their superior and anterior sides. The superior part of the thoracic cage is well preserved and the ribs present their anterior-superior sides; the inferior part of the thoracic cage is removed by the later intervention. The right clavicle presents its antero-superior side and is located perpendicular to the midline of the body; the left clavicle presents its antero-superior side with its acromial end superior and its sternal end inferior. The position of the left clavicle indicates lateral pressure from the lateral left side of the body. Both of the clavicles have maintained their articulation with the scapulae. The scapule present their anterior sides. The humerus of the right arm exhibits its lateral side and is adducted. The right forearm is extended at the elbow and supinated, and the right ulna and radius present their posterior sides with the dorsal side of the hand exhibited. The articulations of the hand cannot be observed as the majority of these bones were removed with the later intervention. The position of the left upper limb cannot be described as this was also removed with the later intervention to the grave.

As stated above, the pelvis and left femur were removed during the later disturbance; therefore their position cannot be established. The right femur exhibits its anterior side and is parallel to the middle axis of the body. The leg bones have preserved; therefore, it can be established that both the tibiae and fibulae display their anterior sides. The distal parts of the legs were brought together toward the midline of the body. Only the position of the left foot can be established directly. It reached the superior part of the thoracic area of skeleton III. The articulations between the foot bones were maintained, and the metatarsals and phalanges presented their anterior sides. The lower limbs of individual IV were beneath the body of the individual III.

The position of bones directly indicates that the deposition of the four individuals is a primary multiple burial where the putrefaction and decay of the bodies have taken place in a filled space. Although all the skeletons were fragmented, the maintenance of the labile articulations and the presence of the small bones strongly indicate that all of them were interred as fleshed bodies. First and foremost, the simultaneousness of the deposition is demonstrated by the careful arrangement of the corpses tightly close to one another and by the fact that the lower bodies of three children (I, III and IV) at the middle part of the grave are piled on top of each other. Moreover, the position of these bodies allows following the sequence of their placement into the pit. First the body of the adult, individual II, was placed into the grave on its back with adducted arms, extended and mid-supinated forearms, hands placed beneath the buttocks, and lower limbs extended at the hip and knee. The verticalised clavicles and medial rotation of humeri indicate bilateral pressure of the upper body that might have been caused by a tight wrapping or narrow grave cut (discussion in *Chapter 6.1.3.1.*). The placement of individual II was followed by individual IV, a child, being placed into the lateral left side of the adult in an opposite direction. This child was also placed on its back with both arms adducted, and right forearm extended at the elbow and supinated, its hand exhibiting its dorsal side was placed beneath the buttocks. The right thigh was extended at the hip and both legs extended at the knees, the right foot plantarflexed. Individual III, another child, was placed into the grave next, also to the left lateral side of the adult in the same direction with it, and partly in front of the inferior part (lower limbs) of the body of individual IV. Although poorly preserved, one could establish that it was also placed into the grave on its back with extended limbs; no other details could be observed. Individual I was placed into the grave last, oriented to the same direction as IV (in opposition to II and III), whereas it was slightly rotated to its left lateral side, and its lower body placed in front of individual III. Again this child was placed into the grave on its back with arms adducted, left forearm extended at the elbow in mid-supination, and left hand beneath the buttocks. Both lower limbs have been extended at the hip and knee.

Such a careful organisation of the bodies would have been impossible to achieve in a collective burial without disturbing the previous interments. The arrangement of the bodies demonstrates a close relationship between these four individuals wherein all the three children have maintained a physical connection (maintained labile articulations) throughout the decomposition processes. The space between the left lateral side of the adult body (II) and the right lateral side of the upper limb of child III is only 1–2 cm, referring to an area of the soft tissue of these individuals. The tight spatial relationship between the bodies is most likely the cause of the elevated and forward projection of the shoulders of the adult.

The infilling of the grave supports the idea of simultaneous deposit, too. The minor movements in the position of the bones and the character of the surrounding sediment indicate that the decomposition of the cadavers took place in a filled space. The fine sand and gravel successively filled in all the volumes created during or after the decomposition of soft tissue, allowing only minor movements of the bones. A burial in a pit with a filled space obstructs the possibility of reopening the grave without disturbing the previous depositions. This, however, does not rule out the possibility of subsequent depositions in a short period (discussion in *Chapter 3.1.3.*). To firmly establish the argument of simultaneous deposit, the archaeological record should demonstrate no later interventions of the grave. As seen on Figure 65, the middle part of the grave is remarkably destroyed. However, this intervention of the grave is not indicative of the activities of past hunter-gatherers and thus is not part of their repertoire of mortuary practices; instead the secondary disturbance is dated to the 20^{th} century by a brick at the bottom of the pit (Johanson et al. 2006–2011).

Therefore, the integrity of the burial of the four individuals was upheld throughout millennia until recent fishermen dug a part of it up. Taking all the above-listed characters and arguments together, I assert that the Veibri quadruple grave is a multiple burial in which all the deceased were placed simultaneously.

6.1.5.2. Valma – a case that raises questions

The temporal relations of the deposits at Valma II and III remain somewhat ambiguous, despite its general interpretation of being a multiple burial. Already Jaanits, who excavated the grave(s), gave contradictory interpretations about these two individuals. In the field report, he argues that most probably these people were placed into the same grave [at the same time], and their opposing head directions were deliberate (Jaanits 1955c, 23). In the first article about Valma he was a bit more modest, regarding these as two separate graves (Jaanits 1955a, 190); however, later he returned to his first interpretation arguing that these individuals had been placed into a single grave, representing a double burial (Jaanits 1965c, 17–18, Abb. 7).

Both of the bodies had been lying on their backs with extended upper and lower limbs (described in more detail in *Chapter 6.1.3.1.1.*); no remarkable movements outside the initial body volume or secondary intrusions could be observed. According to the field report, the bodies were placed on a relatively even bottom grave cut(s): II at a depth of 57 cm and III at a depth of 54 cm from the topsoil (Jaanits 1955c, 21–22). The grave fill was not distinguishable from the surrounding sediment in the case of individual II, but on the left lateral side of individual III a clear outline of the grave was observed (Figure 50). Jaanits describes the sediment in the immediate vicinity of both graves as a mixed layer of sand, gravel, and clay (Jaanits 1955c, 21; Figure 66). As this soil difference was only possible to establish at the area where individual III was placed, and Jaanits assumed that this was a double grave, he argued that the same grave cut continued to the area where skeleton II was, one was just not meticulous enough to observe it there (Jaanits 1955c, 22).

Figure 66. Excavating Valma III.
The skeleton of individual II was removed before individual III one was excavated.
This also makes it more complicated to assess the spatial relation of these two individuals.
(Photo: TLU AI, 1-101-20)

The archaeothanatological analysis of these two interments does not support the initial interpretation proposed by Jaanits. There is no evidence to argue for a simultaneous deposition here, as the two skeletons lack the extreme closeness characteristic of a double burial, nor is there the expected overlapping or inter-mingling of bones of these skeletons. Thus, the only argument to support the idea of simultaneous interment is the claim of similar sediment surrounding both of these interments. However, as it has not been possible to observe the border of this pit in its whole length, this argument also remains tentative. Thus, relying on the evidence available at the moment one could not state with 100% certainty that these two individuals were placed into the same grave cut simultaneously. Moreover, the spatial relation of burials X, XI, and XII at Tamula (Figure 67), show that there are individual graves where an even smaller spatial distance exists. There is no doubt about the simultaneous interment of individuals XI and XII, which is demonstrated by their close spatial relation and the position of the right arm and forearm of the adult around the head of the child. However, while the left foot of individual X is only some centimetres away from the arm of individual XI, it lacks immediate contact. This suggests that this double grave and the single grave of individual X were accomplished in a relatively short time interval, so that the double burial was established first and only after some time was individual X interred, as indicated by the inward rotation of the left foot. One could also suggest that the different way of burying these individuals – III wrapped and the II without any wrappings – suggests a temporal distance in their funerals. There are cases from Zvejnieki where double burials have embodied one individual tightly wrapped and the other one without any indications to this practice (grave 254/255 in Nilsson Stutz 2006, 228).

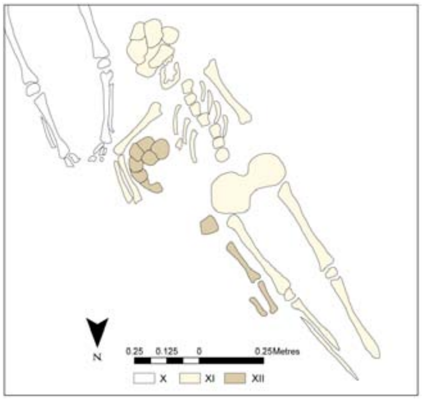

Figure 67. Tamula XI and XII is a double burial.
The simultaneous deposition is indicated by the close spatial relation between the adult and the child on its right lateral side. Their simultaneous interment to the grave becomes even more marked due to the position of the right upper limb that is abducted at the shoulder and flexed at the elbow to hold the body of the child close to its right lateral side. The inward rotation of the left foot further indicates that the double grave was accomplished before the X burial; however the exact position of the double grave must have been known when grave X was dug.
(Drawing after TLU AI, 4-1-29-3)

Valma burials II and III represent cases where a single-valued interpretation could not be given. On the one hand, it is likely that the two individuals were deposited separately but close to one another. However, the time interval between these two funerals must have been rather limited as their close spatial relation suggests that the first burial must have been known by the mourners. The stones found superior to the head of the male (III) could have served as grave markers. This further suggests that individual III was buried first and only then was individual II interred. If this is what happened millennia ago, we could also say that this is a collective burial. On the other hand, the insufficiency of the field documentation (Figure 50) – i.e., the unfortunate removal of burial II before photographing it – does not rule out the possibility of these two individuals being placed into the same grave simultaneously (i.e. multiple burial).

6.1.5.3. Kivisaare IXa/b – a case of possible collective burial or reduction?

The presence of collective burials in hunter-gatherer cemeteries in Estonia is a far more difficult task to prove. This is partly due to the absence of granular sources, but also to the fact that the majority of the burials are primary inhumations in pit graves with no observable interventions in their stratigraphy. Thus, direct evidence for collective burials in Estonian material is absent, as indicated by the Valma II and III burial. Only single cases can be pointed out from inhumations where consecutive interments may be assumed. These are the cases where single bones of another individual have been found at the grave of an otherwise complete inhumation. Still, one has to state that a complete archaeothanatolocical analysis could not be undertaken here, as in most cases the position of the single bones is not known (*Chapter 6.2.*). Moreover, one also has to take into account the possibility that these were not collective burials, but an outcome of a reduction process that was triggered by practical necessities, not ritual aspects. However, these aspects also highlight the attitudes of hunter-gatherers toward their deceased ones.

One such case can be found at Kivisaare. On the 25th of July in 1909, Martin Bolz found and excavated a burial (IXa/b; 'grave/feature III' in Bolz 1914 or 'Grab 4' in Ebert 1913) containing the bones of an adult and a three-year-old child (Figure 68; Ebert 1913, 506; Bolz 1914, 20). Both skeletons were heavily fragmented; however, it can be concluded that the deposition of the child was a primary burial. The nature of the burial of the adult remains unclear. Bolz describes the burial as an intact one; at least the first 117 cm from its NW part was undisturbed. An intervention of the grave pit occurred around the 122 cm from the NW end of the grave (Bolz 1914, 20). This was also the area where the bones of the adult became visible. The sources, however, do not allow a detailed analysis of this burial; it is likely that the child burial was dug into an older grave. The majority of the adult skeleton must have been removed then. Whether this could be treated as a collective burial or a disturbance of an older grave (also seen in Zvejnieki: e.g. Nilsson Stutz 2010, 38; Nilsson Stutz 2013, 1022) cannot be established due to the inadequacy of the sources.

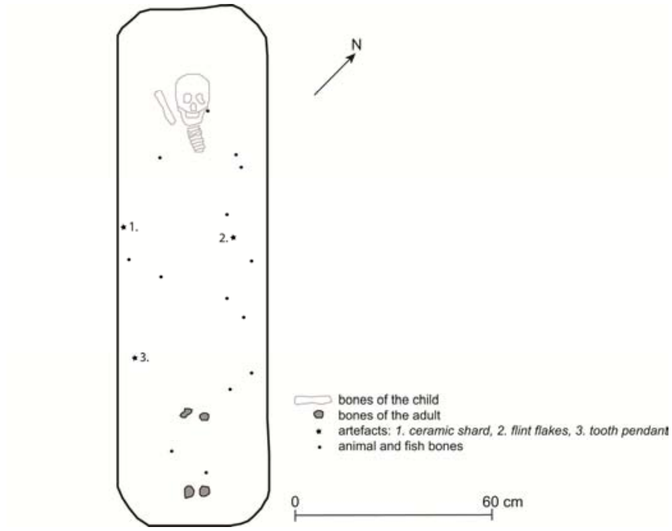

Figure 68. Kivisaare IXa / Kivisaare IXb containing the remains of two individuals.
Due to the insufficient background information one cannot conclude whether this represents a collective burial or is an outcome of reduction processes. (Drawing reproduced after Bolz 1914, Abb. 2)

6.2. Loose human bones in settlement sites and graves

It is by no means novel to state that the majority of the hunter-gatherers did not receive primary inhumations in pit graves (e.g. Jaanits 1961a; Gray Jones 2011). Taking into account the possibility of the cemeteries being partly destroyed and other taphonomic factors, inhumations do not represent the whole Mesolithic populations. The comparison of the quantity of the known Stone Age graves and settlement sites clearly illustrates the absence of the deceased. Despite the increase in the number of Late Mesolithic and Neolithic find places (Kriiska 2006, 70) the ratio of known settlement sites and burials has not changed since the mid-20th century in the territory of Estonia. Even if we include the sites with loose human bones, less than 10% of the sites known to us contain human remains. Moreover, new radiocarbon dates show that not all the graves once considered to originate from Stone Age actually do (Tõrv & Meadows 2015).

Despite the fact that Larsson et al. (1981) suggested already in the 1980s that loose human bone finds could represent a different kind of mortuary practices, this possibility has only recently been elaborated in more detail in Mesolithic and Neolithic hunter-gatherer archaeology (e.g. Guminski 2003; Knüsel & Outram 2006; Louwes Kooijmans 2007; Gray Jones 2011 and the references therein). This has not been different in the case of Estonia where loose human bones have not been considered and/or proven to be part of a funerary repertoire of hunter-gatherers. However, it has been suggested that not all the loose human bones from settlement layers must derive from destroyed inhumations (Lõhmus 2005; Jonuks

2009), and other explanations for their presence should be sought. The following section is the first attempt to find patterns in the occurrence of loose human bones in the settlement layers to explain possible practices behind them.

Until now, 14 settlement sites and burial places with features of loose human bones are known in Estonia. Only in Võru and Sindi-Lodja have no settlement layer been recorded. A clear regional difference came about in the distribution of loose human bones in the occupation layers. There is more variability in southern Estonia (incl. the island of Saareamaa) where loose human bones tend to appear primarily at the sites where also inhumations are found (Kivisaare, Kõnnu, Tamula, and Valma). They also occur without any inhumations (Akali, Kääpa, Pikasilla, and Tooma) or, as stated earlier, without any concurrent occupation layer (Võru and Sindi-Lodja). In north-eastern Estonia, loose human bones appear at sites where no inhumations are recorded (Kunda Lammasmägi, Kudruküla, and Narva Joaorg). Whether these differences are driven by taphonomical aspects of single sites or could contribute to the understanding of hunter-gatherer mortuary practices will be discussed subsequently.

6.2.1. Description of features with loose human bones

Hereinafter a more thorough description of the sites that play key role in understanding the different practices behind the loose human bone phenomenon in hunter-gatherer mortuary repertoire will be given. As discussed in *Chapter 5.1.1.*, due to the poor representativeness of the sources and/or accessibility of the skeletal assemblages, Kunda Lammasmägi (MNE/MNI = 3/3) and Kudruküla (MNE/MNI = 6/2) from north-eastern Estonia, Kääpa (MNE/MNI = 2) from southern Estonia, and Sindi-Lodja (MNE/MNI = ?) from the south-eastern coast of Estonia will only serve as background information.

6.2.1.1. Loose human bones from north-eastern Estonia: Narva Joaorg

Altogether four features with Stone Age human remains were recovered at Narva Joaorg. Individuals V and VI are not included in the present study due to their later date. The features with human bones were located in the densely occupied areas of the settlement (Figure 69). No remarkable structures (constructions or soil colourations) were recorded as being found close to the bones, except in the case of burial III. Similarly to the adult cranial remains of individual II, the child of burial III was placed directly on the limestone bedrock. It was possible to distinguish a slight difference in the colouration of the pit compared to the II Mesolithic/D layer; moreover, Jaanits connected the four limestone slabs discovered c. 20 cm above the bones to the grave structure, suggesting that these were covering the grave (Jaanits 1963, 8–9; Jaanits et al. 1982). A single tooth pendant was found close to individual III (AI 4264: 2207), and close to individual IV also several dozen of tooth pendants were found (AI 4264: 2268, 2272). However, in both of these cases the exact spatial relation between the loose human bones and tooth pendants cannot be established.

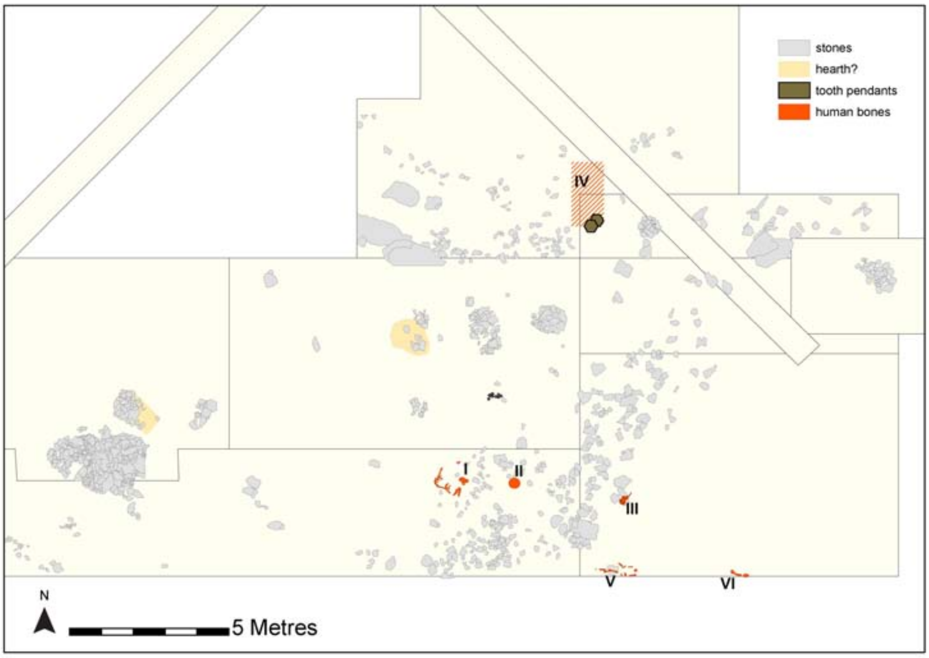

Figure 69. An excerpt of the excavation plan at Narva Joaorg.
The loose human bones are marked with red; skeletons V and VI are not included in the present analysis, as these derive from a later period.
(Drawing after TLU AI, 1-4-21-1; K.Göbel, N. Binkowski & M. Tõrv)

A total of 77 bone fragments, including 28 of those that could not be determined entirely, were recorded in Narva Joaorg, representing five individuals (Table 28). The identifiable fragments show that the most frequent were from heads (crania together with teeth 49%). Contexts II and IV contained only the remains of crania. In the case of feature I, fragments of crania together with teeth were most frequent (55%), followed by the fragments of vertebra (36%) and ribs (13%); all the other post-cranial bones were represented by very few fragments (1–3). The upper limbs were absent, as were the pelvis and the small bones of the feet. However, based on the excavation report, the bones of the feet were present in burial I (Jaanits 1962, 6), and the bones of individual III derived mostly from the cranium, but single long bones (probably a humerus) were found close to these (Jaanits 1963, 8). The reanalysis of the sources about burial III allowed me to distinguish both of the clavicles, too.

Due to the poor preservation of the skeletal assemblage and the somewhat poor field documentation, an archaeothanatological analysis could only be conducted with restrictions. There is not enough information about features II and IV, thus the space of decomposition and nature of the burial remains unknown (Table 24 and 25). Burial III also allows limited observations (Figure 72); the drawing and photographs do not permit direct conclusions about the side of appearance of single bone elements to be drawn. It is only possible to determine that the cranium, both clavicles, and the right humerus were present in the feature. However, based on the position of the left clavicle (probably displaying its superior side) and the right humerus, it can be assumed that the whole upper body exhibits its anterior side. The close spatial relation, the anatomically correct positioning of the bones, and the information about the undisturbed grave pit together suggest that an articulated body was placed into the grave. The maintenance of the position of the clavicles indirectly suggests decomposition in a filled environment. So, even if the four limestone slabs were part of the grave structure, there must have been sediment directly in front of the body to prevent any movements of the clavicles. A more thorough discussion about burial I is presented in *Chapter 6.2.2.2.*

Table 28. The number of identified and unidentified fragments recorded in Narva Joaorg divided by find contexts.
"X" denotes documented in the field, but the exact number of fragments is not known as the feet bones of individuals I and the skeleton of individual III were not available for osteological analysis.

Fragment ID	*I*	*Ia*	*II*	*III*	*IV*	*Total*
Cranium	**17**	0	**10**	**X**	**3**	**30**
Mandible	0	0	0	0	0	**0**
Teeth	**8**	0	0	0	0	**8**
Hyoid	0	0	0	0	0	**0**
Clavicle	0	0	0	**X**	0	**0**
Manubrium	0	0	0	0	0	**0**
Sternum	0	0	0	0	0	**0**
Scapula	**2**	**1**	0	0	0	**3**
Humerus	0	0	0	**X**	0	**0**
Radius	0	0	0	0	0	**0**
Ulna	0	0	0	0	0	**0**
Carpals	0	0	0	0	0	**0**
Metacarpals	0	0	0	0	0	**0**
Hand phalanges	0	0	0	0	0	**0**
Ribs	**8**	0	0	0	0	**8**
Vertebrae	**23**	0	0	0	0	**23**
Sacrum	0	0	0	0	0	**0**
Os coxa	0	0	0	0	0	**0**
Femur	2	0	0	0	0	**2**
Patella	0	0	0	0	0	**0**
Tibia	**1**	0	0	0	0	**1**
Fibula	**1**	0	0	0	0	**1**
Tarsals		0	0	0	0	**0**
Metatarsals	**X**	0	0	0	0	**0**
Foot phalanges		0	0	0	0	**0**
NISP	**36**	**1**	**9**	**0**	**3**	**49**
Unidentified fragments	27	0	1	0	0	**28**
Total fragments	**63**	**1**	**10**	**0**	**3**	**77**

6.2.1.2. Loose human bones from southern Estonia

6.2.1.2.1. Fragments of crania from Akali, Kääpa, Pikasilla, Valma and Võru

From Akali, Kääpa, Pikasilla, Valma, and Võru mostly cranial bones, mandibles, and teeth have been found (Table 29). From Pikasilla, one part of the post-cranial body has been found: a metacarpal. Pikasilla I is represented by both deciduous and permanent teeth of a young child. All the permanent teeth are in a stage of formation, indicating that not only teeth but the maxilla and mandible must have been present in the initial deposit. The second individual from Pikasilla (II) is represented only by a permanent M^1.

From Akali altogether it was possible to determine three individuals in the osteological collection; bones from feature 2 (AI 4013: 6975) were not available in the collection. From the middle part of the cultural layer, 21 skull fragments of an adolescent/young adult of an area of c. 10 cm were found (Table 10: 1 and 29) and cranial bones of another adult were recorded from an area of c. 20 cm (Table 10: 3 and 29).

Table 29. The number of identified bone elements from Akali, Kääpa, Pikasilla, and Võru.

Fragment ID	***Akali I***	***Akali III***	***Kääpa AI 4245***	***Kääpa (VM 3000: 765)***	***Pikasilla I***	***Pikasilla II***	***Valma***	***Võru***
Cranium	**21**	**11**	**1**	**X**	0	0	0	**X**
Mandible	0	0	0	0	0	0	**1**	0
Teeth	0	0	**5**	0	**17**	**1**	**1**	0
Hyoid	0	0	0	0	0	0	0	0
Clavicle	0	0	0	0	0	0	0	0
Manubrium	0	0	0	0	0	0	0	0
Sternum	0	0	0	0	0	0	0	0
Scapula	0	0	0	0	0	0	0	0
Humerus	0	0	0	0	0	0	0	0
Radius	0	0	0	0	0	0	0	0
Ulna	0	0	0	0	0	0	0	0
Carpals	0	0	0	0	0	0	0	0
Metacarpals	0	0	0	0	**1**	0	0	0
Hand phalanges	0	0	0	0	0	0	0	0
Ribs	0	0	0	0	0	0	0	0
Cervical vert	0	0	0	0	0	0	0	0
Thoracic vert	0	0	0	0	0	0	0	0
Lumbar vert	0	0	0	0	0	0	0	0
Sacrum	0	0	0	0	0	0	0	0
Os coxa	0	0	0	0	0	0	0	0
Femur	0	0	0	0	0	0	**1**	0
Patella	0	0	0	0	0	0	0	0
Tibia	0	0	0	0	0	0	0	0
Fibula	0	0	0	0	0	0	0	0
Tarsals	0	0	0	0	0	0	0	0
Metatarsals	0	0	0	0	0	0	0	0
Foot phalanges	0	0	0	0	0	0	0	0
NISP	**21**	**11**	**6**	**?**	**18**	**1**	**3**	**?**
Unidentified fragments	0	0	0	0	0	0	0	0
Total fragments	**21**	**11**	**6**	**?**	**18**	**1**	**3**	**?**

Fragments of skulls were reported in Kääpa. These represent a cranium of an adult together with some maxillary teeth (AI 4245) and a single cranial fragment of another individual (VM 3000: 765).

Jaanits (1955a) has stated in his field report of Valma that several loose human bones were found in addition to the three burials. However, going through the human bone and artefact collections in TLU AI, only a handful of loose human bones were found. However, it might be that some of the loose human bones ended up in the faunal collection, but these were not accessible. Thus, only single bones, the head of a femur, a fragment of mandible, and a left I^1 were determined. Features associated with these bones have not been observed. The skull of the adult from Võru was not possible to find in the collection, thus no osteological analysis was undertaken. In addition to the mentioned sites, single teeth have been found at Pedassaare (TÜ 1685; pers. comm. A. Vindi); as it was found during the field survey, no exact context is recorded.

6.2.1.2.2. Kivisaare

In the analysis of loose human bones from Kivisaare, only the results of the excavations of 1931, 1956 (Table 30 and 31), and 2003/2004 (Table 34) are taken into account since the location of these excavation plots are clearly separable from one another and thus should entail different individuals. Although I undertook the osteological re-assessment of all loose human bones from the Kivisaare 2002 field seasons (results of previous analysis Kriiska et al. 2004), I will not include them in my thesis due to the complex research history of the site. Firstly, several researchers conducted their excavations on the same spot at the south-eastern part of the drumlin, without being able to determine the limits of previous excavations (Bolz 1914; Jaanits 1965a; Kriiska & Johanson 2002; Ottow 1911; Tallgren 1921). This makes it impossible to reconstruct the initial situation and constrains the subsequent analysis. Moreover, as two of the inhumations from Kivisaare have been recently dated to the Early Bronze Age (Tõrv & Meadows 2015), the chronology of the site becomes more complex, making it impossible to date single bones to either of the time periods without any direct dates. Thus, in order to understand what is going on with the loose human bones found during the field season 2002, a different approach should be chosen and a separate study undertaken. Due to the insufficient field documentation, the contextualisation of loose human bones gathered during the season 1931 and 1965 is not unambiguous. Loose human bones are found from the eastern, south-eastern, and south-western part of the drumlin. The recorded contexts (Table 30) vary in size and shape, from clearly defined dark depressions of cultural layer to areas of more than 80 m^2. Indreko (1931, 4) mentions in his field report that small fragments of human bones were found from the whole excavation area. The only more solid description of a context is given about y_1–a/16–17, where Jaanits has distinguished an oval 1.2 × 0.85 m depression with abundant finds of charcoal and also single human bones (Jaanits 1965, 8). This further makes the estimation of the minimum number of individuals and their interpretation in the context of mortuary practices complicated.

Table 30. Contextual information about the loose human bones at Kivisaare from field seasons 1931 and 1965.
(Indreko 1931; Jaanits 1965a)

No.	*Context*	*Year of excavation*	*Size of the area (m^2)*	*Location on the drumlin*	*Characteristics of the area*
1.	Square AEBF	1931	4	SE	only few stones at the vicinity of the human bones
2.	1931	1931	?	SE	no contextual data available
3.	22.9.1931	1931	?	SE	stone backing beneath the bones
4.	loose soil	1931	?	SE	no contextual data available
5.	y_1–b/12–13	1965	6	SW	no clear description of the context is given; from the area a 1.7 × 1.4 m was located; animal bones were found
6.	y_1-a/16–17	1965	1.02	SW	clear depression of cultural layer; charcoal and human bones
7.	y_1–h/12–17	1965	82	SW	no clear description of the context is given, from that area of the excavation plot several pits with dark layer were found; among these also burial XXI
8.	f–h/18–20	1965	9	SW	no changes in the colouration of the sediment were described
9.	f–k/6–11	1965	36	SW	no clear contextual information available; from that area also grave XX was found
10.	ä–ö/42–44	1965	6	SE	no contextual information available; no finds were gathered; the Early Bronze Age burials were located at the same area
11.	"close to the III burial"	1965	?	SW	no contextual information available

Altogether 173 bone elements, heavily fragmented, including seven that could be identified only by their broad bone type, were counted from these two field seasons. Similarly to other sites, fragments of crania are the most abundant (25.4%) followed by hand bones (16.2%), vertebrae (9.2%), and scapulae and ribs (both 8.7%). Absent from the sample are the mandible, hyoid, manubrium, and sternum from the upper body, and the sacrum, patellae, tarsals and foot phalanges from the lower body and limbs.

The volumes of the context where more than 10 bone fragments were found range between 1–9 m^2. The majority of the fragments have been found from the context y_1–a/16–17 that could refer to a destroyed inhumation. Due to the abundant excavations on the drumlin, the interpretation of the loose human bones at Kivisaare remains open since no surface modifications have been observed to indicate secondary practice.

Table 31. The number of identified bone fragments from Kivisaare, field seasons 1931 and 1965.

Fragment ID	***1931***	***AEBF***	***22.9.1931 (adult)***	***22.9.1931 (sub-adult)***	***Loose soil (1931)***	***y_1–b/12–13***	***y_1–h/12–17***	***f–k/6–11 (adult)***	***f–k/6–11 (sub-adult)***	***ä–ö/42–44 (adult)***	***ä–ö/42–44 (sub-adult)***	***f–h/18–20 (adult)***	***f–h/18–20 (sub-adult)***	***"Close to burial III" (1965)***	***y1–a/16–17 (black soil depression)***	***Total***
Cranium	0	2	0	3	0	14	0	7	0	5	2	2	0	0	9	44
Mandible	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Teeth	0	0	0	0	3	0	0	1	0	0	6	0	0	0	1	11
Hyoid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clavicle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Manubrium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sternum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scapula	0	0	0	4	0	2	0	0	0	2	0	2	0	1	4	15
Humerus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Radius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4
Ulna	0	0	0	1	0	0	0	0	0	0	0	1	0	1	3	6
Carpals	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
Metacarpals	0	0	0	1	0	0	0	0	0	2	1	2	0	0	4	10
Hand phalanges	1	0	1	0	0	0	0	2	0	4	0	6	0	1	1	16
Ribs	0	4	0	0	0	0	0	0	0	0	0	6	0	0	5	15
Cervical vert	0	0	0	0	0	0	0	0	0	1	0	0	0	0	6	7
Thoracic vert	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	8
Lumbar vert	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Sacrum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Os coxa	0	0	0	0	0	0	0	0	1	0	0	0	2	1	1	5
Femur	0	2	0	0	0	1	1	0	1	0	0	1	0	0	5	11
Patella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tibia	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	3
Fibula	0	4	0	0	0	0	0	0	0	0	0	1	0	0	0	5
Tarsals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metatarsals	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Foot phalanges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NISP	2	14	1	9	3	17	1	10	2	14	9	25	3	5	51	166
Unidentified fragments	0	6	0	1	0	0	0	0	0	0	0	0	0	0	0	7
Total fragments	2	20	1	10	3	17	1	10	2	14	9	25	3	5	51	173

6.2.1.2.3. Tamula

At Tamula, loose human bones occur together with intact inhumations and separately in occupation layers (Table 32). Moreover, some of the graves labelled already during the excavations were represented by less than half of the skeleton (IV, V, XIII, XXIII, and XXV) and are included in the discussion here. Jaanits immediately connected these bones to destroyed inhumations: "*Die in der Siedlung gefundenen Bestattungen, auf untersuchten Fläche wurde ihrer ingesamt 25 entdeckt, werden wohl auch mit Wohngebäude in Zusammenhang gestanden haben. Sie waren teils zerstört, die Mehrzahl aber insofern erhalten,* *dass man imstande war, über die Lage und Beigaben der Skelette Kalrheit zu bekommen"* (Jaanits 1984, 184; my emphasis). Due to that assumption, no detailed documentation of these features was undertaken. Furthermore, as the additional individuals from graves XIII, XIX, XXI, and XXIV were only determined during the osteological analysis, the contextual information about these is obviously absent. Moreover, one cannot entirely exclude the possibility of these bones being mixed-up at the repository; however, due to the heavy fragmentation of the bones it is impossible to ascertain this retrospectively.

Table 32. Loose human bones from inhumations and non-grave contexts at Tamula.

Fragment ID	***IV***	***V***	***XIII***	***XIIIa***	***XV***	***XVI***	***XIXa***	***XXIa***	***XXIII***	***XXIV***	***XXIVa***	***XXV***	***1956***	***1961***	***2007***	***Total***
Cranium	**14**	0	**88**	**1**	**58**	0	0	0	0	**79**	0	**14**	**5**	0	**1**	**260**
Mandible	0	**1**	**2**	0	0	0	0	0	0	0	0	0	0	0	0	**3**
Teeth	0	**2**	**5**	0	**1**	**1**	0	0	0	**9**	**1**	0	0	**1**	0	**20**
Hyoid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Clavicle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Manubrium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Sternum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Scapula	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	**1**
Humerus	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**2**
Radius	0	0	**1**	**1**	0	0	0	0	0	0	0	0	0	0	0	**2**
Ulna	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Carpals	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Metacarpals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Hand phalanges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Ribs	0	0	**19**	0	0	0	0	0	0	**1**	0	0	0	0	0	**20**
Cervical vert	0	0		0	0	0	0	**1**	0	**1**	0	0	0	0	0	
Thoracic vert	0	0	**36**	0	0	0	0	0	0	0	0	0	0	0	0	**38**
Lumbar vert	0	0		0	0	0	0	0	0	0	0	0	0	0	0	
Sacrum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Os coxa	0	0	**2**	0	0	0	0	0	0	0	0	0	0	0	0	**2**
Femur	0	0	**1**	0	**2**	0	0	0	0	0	0	0	0	0	0	**3**
Patella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Tibia	0	0	**1**	0	**2**	0	0	0	**1**	0	0	0	0	0	0	**4**
Fibula	0	0	**1**	0	0	0	1	0	**2**	0	0	0	0	0	0	**4**
Tarsals	0	0	**1**	0	0	0	0	0	**2**	0	0	0	0	**1**	0	**4**
Metatarsals	0	0	**3**	0	0	0	1	0	**8**	0	0	0	0	**2**	0	**14**
Foot phalanges	0	0	**1**	0	0	0	0	0	**5**	0	0	0	0	0	0	**6**
NISP	15	3	55	2	63	1	2	1	18	87	0	14	5	4	2	**258**
Unidentified fragments	0	0	19	5	5	0	0	0	0	4	1	0	0	1	0	**35**
Total fragments	**15**	**3**	**74**	**7**	**68**	**1**	**2**	**1**	**18**	**91**	**1**	**14**	**5**	**5**	**2**	**306**

At Tamula IV, cranial bones and a right humerus were found, as well as several animal bones. Animal bones were also present in the vicinity of burial XXIII, which itself consisted of human leg and feet bones, and in burial XXIV. In case of burial V, only a fragment of the mandible and two dental crowns were present. The exact number of bone elements at Tamula XIII is difficult to establish because some of the bones are mixed with the bones of skeleton XII; however, its fragmentation was noted already in the field.

The majority of the loose bones from occupation layers are stray finds from the shallow waters of Lake Tamula. These are primarily hand and feet bones; in 2007 also a right humerus was found. In 1956, five fragments of parietal bones were collected from the squares e–g/21–23, which is the area where burials XVII–XIX were located. As the parietal bones of these three inhumations are available in the collections (fragmented in the case of XVIII), it is highly likely that these fragments belong to another individual. The additional bones from the grave cuts of inhumations represent four individuals.

6.2.1.3. Loose human bones from Saaremaa: Kõnnu

From seven more specified contexts altogether the remains of 7 individuals were found (Figure 70); additionally loose human bones with no contextual references were gathered during the field campaigns in 1979, 1981, and 1984 at Kõnnu.

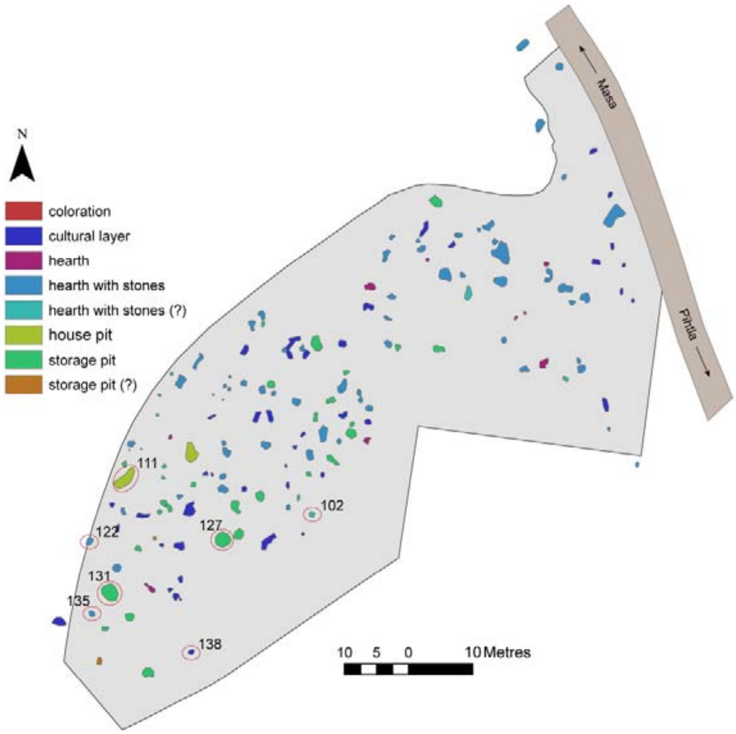

Figure 70. The destroyed area of Kõnnu settlement with documented depressions of the cultural layer.

The function of the depressions is determined after Jaanits (TLU AI, f12). The features with loose human bones are marked with red circles and the numbers indicate the labels assigned by Jaanits during the field seasons of 1977–1978. (Drawing after: TLU AI, 4-1-57-1)

A total number of 96 human bone fragments, including four that could only be identified by their broad bone type (Table 33), were recorded from the faunal collection. The identifiable fragments suggest that skulls were most frequent (crania, mandible, teeth together 69%) in the sample. From features 102 and 135 no other bone elements were found. This was followed by upper (15%) and lower limbs (11%); however, no carpals, metacarpals, or hand/foot phalanges were present. From feature 127, only the fragments of ribs were found. The torso (clavicle, manubrium, sternum, scapula, vertebrae, sacrum), patellae, and tibia were absent in all of the contexts at Kõnnu.

Table 33. The number of identified and unidentified fragments recorded in Kõnnu divided by find context.

Fragment ID	***102***	***111***	***122***	***127***	***131***	***135***	***138***	***Year 1979***	***Year 1981***	***Year 1984***	***Without context***	***Total***
Cranium	**17**	0	0	0	0	**10**	0	**5**	**1**	**17**	0	**50**
Mandible	0	0	0	0	0	0	**1**	**1**	**1**	**1**	0	**4**
Teeth	0	0	0	0	0	0	0	**3**	**5**	0	**1**	**9**
Hyoid	0	0	0	0	0	0	0	0	0	0	0	**0**
Clavicle	0	0	0	0	0	0	0	0	0	0	0	**0**
Manubrium	0	0	0	0	0	0	0	0	0	0	0	**0**
Sternum	0	0	0	0	0	0	0	0	0	0	0	**0**
Scapula	0	0	0	0	0	0	0	0	0	0	0	**0**
Humerus	0	0	**1**	**1**	0	0	0	**2**	0	0	0	**4**
Radius	0	**1**	0	0	0	0	0	**1**	**1**	**1**	0	**4**
Ulna	0	0	0	0	**1**	0	0	0	**5**	0	0	**6**
Carpals	0	0	0	0	0	0	0	0	0	0	0	**0**
Metacarpals	0	0	0	0	0	0	0	0	0	0	0	**0**
Hand phalanges	0	0	0	0	0	0	0	0	0	0	0	**0**
Ribs	0	0	0	**2**	0	0	0	0	0	0	0	**2**
Cervical v.	0	0	0	0	0	0	0	0	0	0	0	**0**
Thoracic v.	0	0	0	0	0	0	0	0	0	0	0	**0**
Lumbar v.	0	0	0	0	0	0	0	0	0	0	0	**0**
Sacrum	0	0	0	0	0	0	0	0	0	0	0	**0**
Os coxa	0	0	0	**1**	0	0	0	**1**	0	0	0	**2**
Femur	0	**1**	0	0	0	0	0	**2**	**1**	**1**	0	**5**
Patella	0	0	0	0	0	0	0	0	0	0	0	**0**
Tibia	0	0	0	0	0	0	0	0	0	0	0	**0**
Fibula	0	0	0	0	0	0	0	**1**	0	0	0	**1**
Tarsals	0	0	0	0	0	0	0	**1**	**1**	0	0	**2**
Metatarsals	0	0	0	0	0	0	0	**1**	**2**	0	0	**3**
Foot phalanges	0	0	0	0	0	0	0	0	0	0	0	**0**
NISP	**17**	**2**	**1**	**4**	**1**	**10**	**1**	**18**	**17**	**20**	**1**	**92**
Unidentified fragments	0	3	0	0	0	0	0	1	0	0	0	**4**
Total fragments	**17**	**5**	**1**	**4**	**1**	**10**	**1**	**19**	**17**	**20**	**1**	**96**

Unlike the inhumations, all the loose human bones are located at the SW area of the settlement (Figure 70), deriving from different contexts: a house pit (111), storage pits (127 and 131), hearths with stones (102, 122, and 135), and the lower part of the cultural layer (138). Quartz, flint debris, and animal bones were found at all the features; additionally, all but features 138 and 111 contained charcoal, and all but feature 138 contained stones. Grinding stones were present in all features, as were stone artefacts and sherds of ceramic vessels (except 102). Storage pit 131 – one of the largest depressions beside the house depression (111) – contained the largest amount of grinding stones, quartz and other stone artefacts, bone artefacts, ceramic sherds, and tooth pendants. Tooth pendants were also found at feature 111.

The poor quality of the field documentation does not allow archaeothanatological principles to be applied to analyse these features, yet more solid conclusions about the body treatment can be drawn based on the bone representativeness and context; bones found during the field seasons in 1979, 1981, and 1984 are not included because there are no references to more specific find contexts.

6.2.2. Possible interpretations of the loose human bone phenomenon

6.2.2.1. Destroyed inhumations

As inhumations have been considered the only archaeologically traceable mortuary practice in the hunter-gatherer communities, it is rather logical that the loose human bones were all previously attributed as outcomes of destroyed inhumations. However, it has rarely been possible to prove the existence of destroyed inhumations directly. In Estonia, the case is even more complicated as usually the outlines of graves cannot be distinguished (*Chapter 6.1.2.*), and the stratigraphic relations between the habitation layers and loose human bones have not been observed in detail. In some cases, however, the time and dimension of the disturbances of inhumations has been established and only in single cases later intrusions can be proven by the application of the principles of archaeothanatology.

Examples of known later intrusions include one at Veibri in the 20th century, dated based on the brick at the bottom of the cut (Figure 65; Johanson et al. 2006–2011), one at Kivisaare XXa, which was found in 1964 by gravel miners who partly destroyed it by their activities (Figure 57; Jaanits 1965a), and one at Kõnnu where the inhumations were also destroyed by gravel mining (Jaanits 1979). From Kivisaare another feature indicating a later intrusion of probable inhumations was burial XXIX excavated in 2003–2004. A bundle of bones of three individuals was neatly packed into a 50 × 30 cm pit, at a depth of c. 20 cm (Figure 71; Kriiska & Lõhmus 2004). The majority of the bones belonged to an adult individual; also, three fragments of a sub-adult's left femur (TÜ 1113: L5) and a single fragment of another femur of a second adult (TÜ 1113: L28) were recorded (Table 34). The representativeness of various parts of the skeleton, together with the lack of post-depositional modification of the bone surfaces, suggests that the bones in the deposit derive from a primary inhumation(s). Moreover, it was most likely a reburial of skeletons that the locals came across in 19th century, since amongst the bones a black relief button (TÜ 1113: 3062) was found. Intrusions of this type from historic periods are also known from other places in the Baltic Sea region (e.g. Spiginas 1: Butrimas 2012; Zvejnieki: Zagorskis 1987; Nilsson Stutz et al. 2008).

Table 34. Loose human bones presented by individuals from the feature excavated in 2002–2004 (Kivisaare XXIX).

Fragment ID	**XXIXa**	**XXIXb**	**XXIXc**	**Total**
Cranium	**6**	0	0	**6**
Mandible	0	0	0	**0**
Teeth	0	0	0	**0**
Hyoid	0	0	0	**0**
Clavicle	0	0	0	**0**
Manubrium	0	0	0	**0**
Sternum	0	0	0	**0**
Scapula	**1**	0	0	**1**
Humerus	**5**	0	0	**5**
Radius	**1**	0	0	**1**
Ulna	**3**	0	0	**3**
Carpals	0	0	0	**0**
Metacarpals	**2**	0	0	**2**
Hand phalanges	0	0	0	**0**
Ribs	**4**	0	0	**4**
Cervical vert	0	0	0	**0**
Thoracic vert	0	0	0	**0**
Lumbar vert	**1**	0	0	**1**
Sacrum	0	0	0	**0**
Os coxa	**4**	0	0	**4**
Femur	**8**	**3**	**1**	**12**
Patella	0	0	0	**0**
Tibia	**1**	0	0	**0**
Fibula	**1**	0	0	**1**
NISP	**37**	**3**	**1**	**41**
Unidentified fragments	3	0	0	**3**
Total fragments	**40**	**3**	**1**	**44**

Figure 71. A reburial of bones of three individuals in Kivisaare.
(Photo: Kriiska & Lõhmus 2004)

None of the above-presented intrusions were made by Stone Age people. Yet the deliberate destruction of primary inhumations during the Stone Age in Europe occurs: good examples can be given from Ajvide, Gotland (Burenhult 2002; Andresson 2004), Zvejnieki in Latvia (Zagorskis 1987; Nilsson Stutz et al. 2008), and Olenii Ostrov in north-eastern part of the Russian Federation (Gurina 1956; Jacobs 1995). Despite the abundance of this kind of practice in the region, there are only two examples from Estonia that could be seen as a destroyed inhumation during the occupation of the site: Narva Joaorg III and Tamula XV.

At Narva Joaorg III the close spatial relation and anatomical order of the bones, supported by the information about the undisturbed grave pit, indicate that initially an articulated body was interred (Figure 72). The maintenance of the position of the clavicles indirectly refers to the decomposition in a filled environment. Thus, according to the archaeothanatological analysis, Narva Joaorg III was probably a primary burial in a filled space. However, the majority of its post-cranial skeleton had been dug up after some time. Although one cannot determine the particular acts, stratigraphy allows suggesting that the post-burial intrusion must have taken place before the deposition of the layer containing various types of ceramics (B layer), as no disturbances were observed there (Jaanits 1963, 8–9).

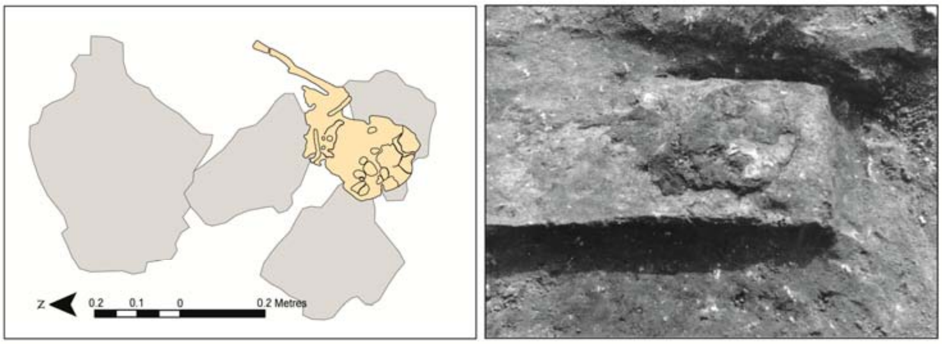

Figure 72. The* in situ *position of the cranium, clavicles, and a humerus of Narva Joaorg III burial.
The close spatial relation and anatomical correctness of these bones suggests that initially it was a primary burial that decomposed in a filled space. This is further supported by the observation of a grave cut without later intrusions. Due to the absence of knowledge about the labile articulations this assumption cannot be verified. Yellow – human bones; grey – unburnt stones. (Drawing after TLU AI; photo: AI-95-40-17)

Due to the above-mentioned difficulties, the archaeothanatological toolset cannot fully be applied to explain the reasons behind the loose human bones at Tamula. While the labile articulations of the child of burial XV cannot be observed in the field documentation, the presence of various bone elements and the overall position of the skeleton suggests that initially it was a primary burial

(Figure 73). Due to the poor preservation and heavy fragmentation of the skeleton, the side of appearance of single elements and maintenance rate of articulations cannot be determined. Thus, the initial body position and space of decomposition are to be reconstructed tentatively. The overall position of the bones indicates that the individual was placed into the grave on its back with extended limbs; the maintenance of the articulations between the vertebral column suggests a filled environment for the decomposition of the corpse. The primary nature of the burial is archaeologically supported by the horizontal wooden branches found immediately beneath the skeleton (Jaanits 1955b; 1957a, 86) and by the grave goods consisting of tooth pendants (AI 4118: 1407, 1412), a bird bone pendant (AI 4118: 1407), and fragments of bone artefacts (AI 4118: 1403, 1406, 1448).

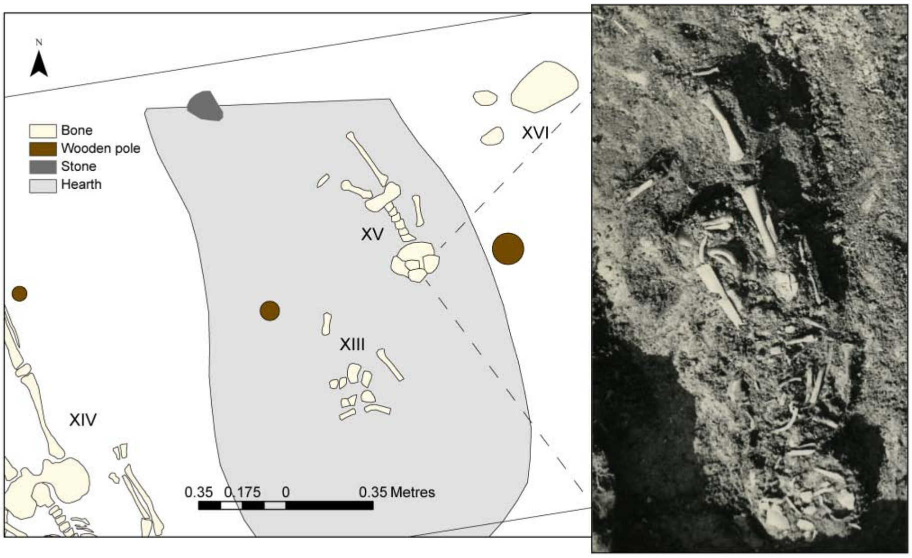

Figure 73. The concentration of loose human bones labelled as Tamula XIII, Tamula XV, and Tamula XVI.
The presence of the majority of the cranial and limb bones, together with the bones of thoracic cage of individual XV and the overall position of the bones, indicate that the deposit was primary. However, during the later activities the burial was partly destroyed. (Drawing and photo: TLU AI, 4-1-29-3 and f12)

The number of destroyed inhumations that could be proven by the application of archaeothanatological principles is low. Moreover, the majority of the cases do not contribute to our understanding about the handling of the deceased by hunter-gatherers but are intrusions made during later periods. The two exceptions of Narva Joaorg III and Tamula XV indicate that Stone Age people did interact with human remains after the burial. However, the poor preservation of the skeletons does not allow clarifying whether and to what extent these acts were part of mortuary practices.

6.2.2.2. Loose human bones as part of mortuary practices

The majority of the features with loose human bones do not allow linking them to mortuary practices directly, be it due to the poor preservation of the bones or the absence of precise contextual data. There is, however, one exceptional case that directly refers to secondary mortuary practices and several that indirectly – through analysis of context and representation of bone elements – allow suggesting that these were part of the mortuary repertoire of hunter-gatherers.

6.2.2.2.1. Deposition of body parts – archaeothanatology and analysis of cut-marks on the bones of individual I at Narva Joaorg

Burial I at Narva Joaorg (Figure 74) is the best-documented deposit with loose human bones that allows further discussion about the nature of burial in that the space of decomposition can be reconstructed tentatively. The bones were found from the I Mesolithic / C layer at the depth of 112–119 cm from the reference point and spread around a square-like area of c. 80 × 60 cm. Beneath the cranium, which reached to the depth of 124 cm, some animal bones together with charcoal were found; c. 50 cm north from the loose human bones three vertebrae of an animal were observed (Jaanits 1962b); no grave goods were found. Despite the fact that animal bones have been found from several Mesolithic burials in Europe (Grünberg 2013), the connectedness of these three vertebrae with the loose human bones remains unclear. The deposit was located at the topmost part of the I Mesolithic / C layer, with the post-cranial bones slightly higher than the cranium. Due to this and the fact that no grave cut was observed, Jaanits suggested that these bones did not represent a burial, but belonged to a whole body that was left above ground (Jaanits 1962b, 6–7).

Altogether 64 bone fragments representing various parts of the body were recorded (Table 28); less fragmented were the limb bones. The vast majority of the fragments belonged to a cranium (together with teeth) and vertebrae. In addition to the bones observed during the osteological analysis, also feet bones were recorded in the field.

The position of the disarticulated bones and cut-marks analysed below leave no doubt that these skeletal parts of an adult were the outcome of a different kind of practice than primary inhumation. In the field, the spatial relation of the bones was described, but the side of appearance of single elements was not documented. Therefore, the following description benefits mostly from the photographs taken from different perspectives and resolution, and the drawing.

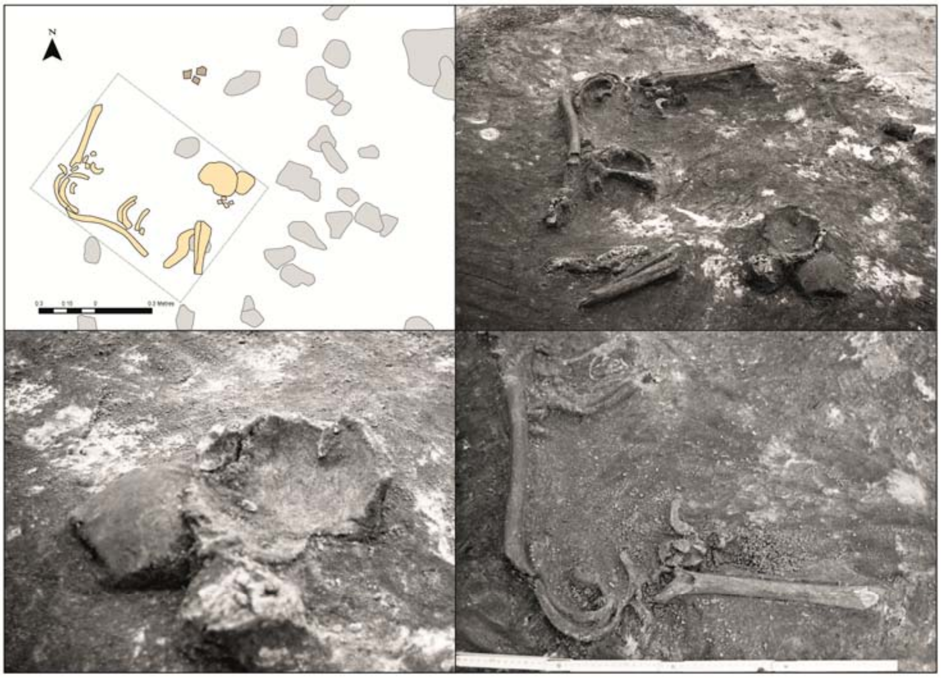

Figure 74. The* in situ *position of the bones of Narva Joaorg I burial at the I Mesolithic / C layer.
The articulation between the left tibia and fibula is maintained, which indicates that the left leg must have been fleshed or the ligaments upheld during the time of deposition. The rest of the skeleton is disarticulated indicating a multi-episodic burial ritual. Yellow – human bones; beige – animal bones; grey – unburnt stones; grey rectangle – indicates the possible area of the grave cut. (Drawing and photos TLU AI, 4-1-21-1 and f12)

The position of the cranium is not entirely clear from the photographs; however, due to the accidental destruction of the cranium in the field (Jaanits 1962b, 5), the endocranial surface of the occipital bone is visible. Next (E) to the occipital bone, being slightly beneath it, one of the parietals is visible exhibiting its lateral side; however, its position cannot be determined. Although Jaanits (1962b, 6) mentions that immediately south of the cranial bones fragments of vertebrae were found, it is impossible to ascertain whether these belonged to cervical vertebrae. Moreover, their side of appearance or exact relation to the cranium cannot be determined as no articulations are observable.

Post-cranial bones lie S and SW of the cranium. The left tibia, located c. 20 cm S of the cranium, exhibits its posterior and lateral sides, and its proximal end points toward the cranium. At the immediate vicinity of the lateral side of the left tibia is the left fibula, which exhibits its posterior side. The articular surfaces of the tibia and fibula are not preserved. The position of vertebrae that are located on the lateral side of the fibula cannot be determined, as only obscure fragments are visible in the photograph.

Farther NW of the distal end of the left leg bones is a right femur exhibiting its lateral and medial side. It is oriented NW–SE, its distal end directed SE. It is perpendicular to the left leg bones. Perpendicular to the distal part of the right femur and NE of it are four fragments of ribs. The poor resolution of the photograph does not show their side of appearance. To the N of the proximal end of the right femur (next to its anterior side), six fragments of further ribs was found. Their side of appearance is impossible to determine, yet one can see that their heads are all directed toward the proximal end of the left femur (N). The length and curvature of the ribs indicate that these derive from ribs 3–8. Moreover, their close relation indirectly suggests that they might have been in articulation during the time of deposition. Next to the proximal ends of these ribs is the left femur, oriented in the direction of NE–SW and perpendicular to the right femur. Its proximal end is directed towards the ribs (SW) and it displays its posterior side, with the femoral head directing towards the W. At the lateral side of the proximal part of the left femur, four additional bone fragments were found. As these are small fragments they are not identifiable to an element; however, according to Jaanits (1962, 6) these were fragments of ribs and foot bones. The latter were not identified during the osteological analysis.

6.2.2.2.1.1. Modifications on the bone surfaces

The majority of the bones bear no modifications or were covered with varnish during conservation, which prevents any significant analysis that could be telling about the mortuary treatment of the corpses.

The bone surfaces of both femurs, however, bear cut-marks (Figure 75). On the right femur, altogether 15 cut-marks on the medial side covering the whole length of the bone shaft were recorded. On the left femur, 18 cut-marks are located on the medial and posterior side of the bone shaft until the medial supracondylar line, being most marked close to the gluteal line. The cut-marks on the right femoral shaft are diagonal to the bone structure, reaching from the proximal posterior part to the distal medial part of the shaft (away from the *linea aspera*). On the left femoral shaft these are also diagonal to the bone structure, running from the proximal medial part to the distal posterior part of the femoral shaft (towards the *linea aspera*). The average range of the cut-marks on the right femur is 6–20 mm and on the left femur 9–38 mm.

Figure 75. Examples of cut-marks made by a stone tool on the medial and posterior shaft of the left femur (a) and the medial side of the right femur (b) of individual I at Narva Joaorg.
The location and direction of the cut-marks are marked with red. (Photos: S. Stolc)

On the left femur the striated bottom of the cut become clearly visible (Figure 76). As a result of an experimental study about injuries caused by lithic projectiles, similar traces were recognised while cutting the bone with an edge of a projectile point (Smith et al. 2007), as well as the markings on the atlas and axis of skeleton 4593 from building 6 at Çatalhöyük (Andrews & Bello 2009[2006], 24, Fig. 2.6). Although not many studies have been undertaken about the cut-marks on Mesolithic human bone assemblages, several known cases indicate that dismembering the bodies was practiced. The osteological analysis by Amy Gray Jones (2011, 104pp) of a bone assemblage from the Mesolithic (5500–4450 cal. BC) site Hardinxveld in the Netherlands revealed that cut-marks were present among traces of burning and 'dry' fractures on bone surfaces. Moreover, the most frequently modified element was the femur, as is the case here in Narva Joaorg.

Figure 76. The striated bottom of a cut-mark from the left femur assures that the incision was made with a stone tool.
(Photo: M. Tõrv)

6.2.2.2.1.2. Description of the initial deposit

The presence of single elements of the skeleton in the feature and their disarticulation refers to a secondary burial. This, however, makes it more difficult to reconstruct the initial body position and space of decomposition. Moreover, a question needs to be answered of whether bare bones or still fleshed parts of a corpse were deposited.

The position of the occipital bone allows suggesting that the cranium initially displayed its anterior side. All the teeth present in the osteological collection derive from the maxilla, and the absence of mandible both in the deposit and collection demonstrates that only the cranium was buried. Although the articular surfaces either at the proximal or distal ends of the left tibia and fibula are not observable in the photograph, their close spatial distribution to one another indirectly refers to the possibility that it was not bare bones that were deposited initially. At least part of the ligaments were present during their deposition to keep these bones together during the decomposition process. This becomes even more plausible if we consider the fact that directly beneath these bones was a wrist-sized stone, which must have destabilised the position of the loose bones. The available information about the loose vertebrae found S of the cranium and next to the left leg bones, and those found at the SE part of the feature close to the proximal ends of both femurs does not allow any conclusions to be drawn about their initial position in the deposit. The initial position of the ribs cannot be established. Whether these were deposited as part of the torso together with some meaty parts of the corpse cannot be said for sure. However, their spatial distribution together with the articulated left leg seems to favour this. Both of the femurs, placed perpendicular to one another with the proximal ends directing toward each other, were placed into the deposit presenting their posterior sides.

The bone elements at Narva Joaorg I indicate a selection of body parts: the head, parts of the torso, and the lower limbs were deposited. This demonstrates that the heads or skulls were regarded as important. The abundance of cranial fragments in the sample is neither accidental nor can we argue that archaeologists were more prone to recognise cranial fragments, as the whole faunal collection has been analysed (Paaver 1965) and no other human bones were found.

The cut-marks on the femurs and the left tibia and fibula still in articulation, which suggests that the cadaver was cut into smaller parts before depositing it into a shallow rectangular pit. Due to the varnish it is not possible to distinguish whether the cut-marks on the bone were done to a fleshed thigh or dry bones. The position of these on the lateral sides of the *linea aspera*, however, indicates dismemberment and the processing of a fleshed body (parts). The *linea aspera* and its superior parts of spiral, pectineal, and gluteal lines are the attachment points of many buttock and thigh muscles. The cut-marks along the medial and posterior shaft of the left femur in particular are consistent with the removal of muscles from the posterior thigh to separate the limb from the trunk and at the knee. The idea of depositing body parts and not bare bones is further supported by the maintained articulation between the left tibia and fibula. Even though the grave cut was not observable, a slight difference in the colouration of the sediment near the human bones was only observed at burial III (Jaanits 1963, 8), which would suggest that the placement of the bones delimits the area of the pit where they were deposited.

As stated above, no visible grave cut was observed, and Jaanits went even further arguing that these bones were not placed into a pit, but the corpse was left to decompose above the ground and was later covered by alluvial sediments (Jaanits et al. 1982). This interpretation cannot be ruled out entirely, being supported by the stratigraphic observations done in the field (Jaanits 1962b, 7). However, the restricted position of the bones and the maintenance of the articulation between the left tibia and fibula suggest that the final decomposition of the corpse took place in a filled environment. Thus, the body parts and bones were most likely placed into a shallow pit that was immediately filled with sediment.

6.2.2.3. Features with loose human bones that raise questions

Unfortunately, the majority of the features with loose human bones do not allow such unequivocal interpretations due to the insufficiency of the sources and the heavy fragmentation of the bones themselves. In addition to archaeothanatological observations, also the Bone Representative Index (BRI, Bello & Andrews 2009[2006]), which represents the percentage of bones recovered compared to that expected for one individual, has been applied to the collections of Akali (MNI=2), Kivisaare (MNI=15), Kudruküla (MNI=2), Kõnnu (MNI=7), Narva Joaorg (MNI=4), Pikasilla I (MNI=1), and Tamula (MNI=15). Gray Jones (2011, 161) has shown with her comprehensive study about loose human bones in the context of Mesolithic north-western Europe that the profiles of the relative representativeness of bone elements also reflects various practices. In the present context, it also allows a tentative differentiation between destroyed inhumations and probable practices connected to single bones and not entire bodies.

It becomes clear from the analysis (Figure 77) that the overall representativeness of the bones at all sites is less than 10%, ranging from 0.6% at Kõnnu to 9% at Pikasilla I. In the majority of the analysed assemblages, only 2.4–5.8% of the whole skeleton is present, resembling the values observed at the Mesolithic site Hardinxveld in the Netherlands (Gray Jones 2011, 161). The low representativeness of the bones in general at Kõnnu is partly brought about by the destruction done at the site during the 1970s; at Kudruküla (0.9%) this could be explained by the erosion of the cultural layer (Tšugai et al. 2014). The abundant utilisation of the Kivisaare drumlin is clearly responsible for the probable bone loss in the sample too, but in other cases such clear taphonomic factors cannot be considered. Taking these sites together, entirely absent are the hyoid, manubrium, and sternum from the upper body, and the sacrum together with the patellae from the lower body. These are either small and/or fragile bones that could have decayed or have gone missing during the excavations. For instance, the analysis of primary inhumations shows that at Tamula and Kivisaare sacrum was rarely present in otherwise complete skeletons.

The most abundant are fragments of crania (28.6% in Kõnnu to 100% in Akali and Kudruküla). One cannot observe the presence of crania in Pikasilla I; however, this might be due to the taphonomy of the site that does not retain bone tissue. The presence of both deciduous and permanent teeth belonging to a single individual suggest that initially a skull (both mandibular and maxillary teeth are present) was placed into the ground. Kudruküla, Kõnnu 102, Narva Joaorg IV, and Tamula XXV are features that entailed only cranial bones or their fragments. Similar cases have also been observed at Kääpa and Võru (Jaanits 1973). Kudruküla stands out as an odd case with both mandibles and crania present. In other sites a clear under-representation of mandibles, e.g. in Kõnnu (crania= 28.6%, mandibles=7.1%) and Tamula (crania=53.3% and mandible=13.3%) can be observed; the rest of the sites lack mandibles entirely. However, there are features where no cranial fragments were observed (in Kivisaare, Kõnnu, and Tamula). The idea of depositing loose crania/skulls/ heads is supported by similar finds from other sites in Mesolithic and Neolithic Europe (*Chapter 6.1.4.2.*), which further implies that the high representativeness of cranial fragments in the sample cannot be merely random or due to the research bias.

Pikasilla I is primarily represented by teeth, all belonging to a sub-adult. This is an interesting pattern, and one could argue that this was not part of funerary practices but rather represent other rites of passage (i.e. initiation). However, we could allege that Pikasilla I was a burial – it might even represent a primary inhumation – in which initially a head must have been deposited (see above); the single metacarpal found in the vicinity provides additional support.

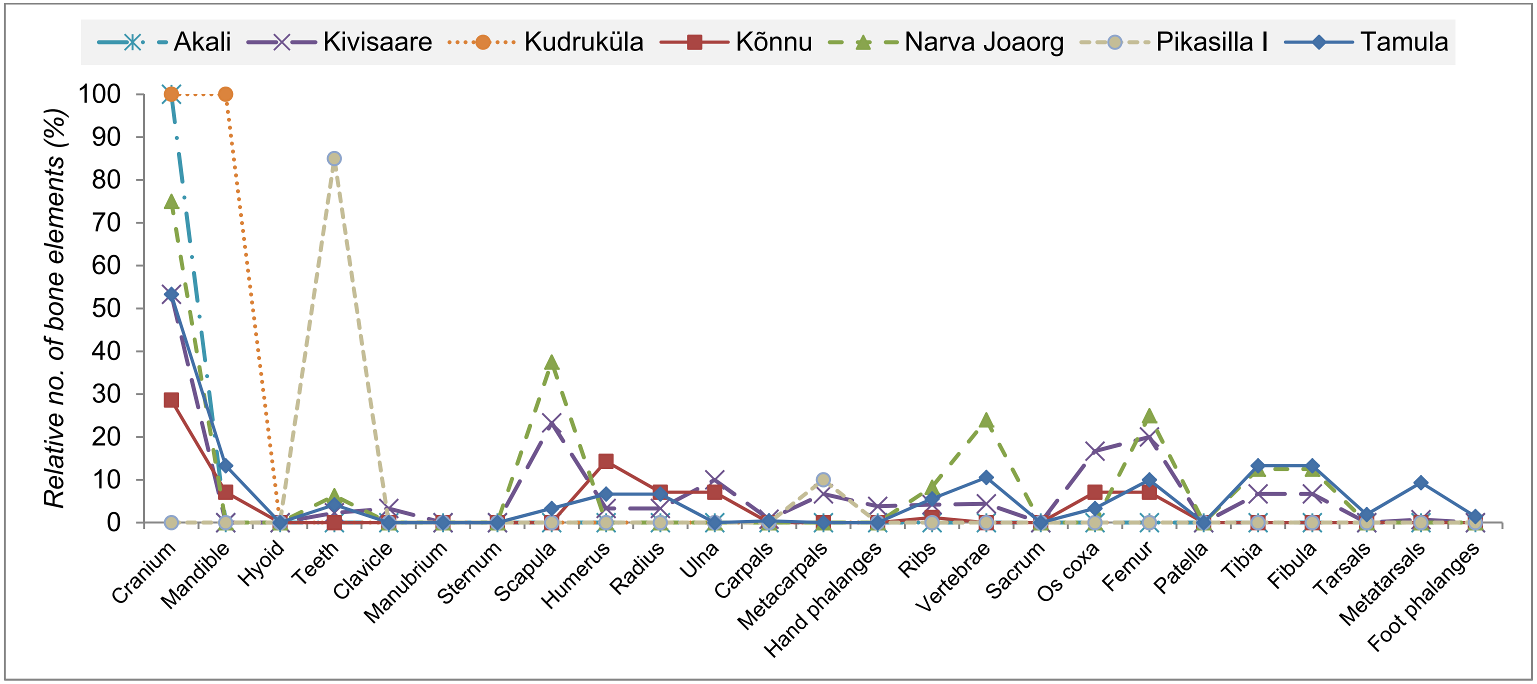

Figure 77. Comparison of BRI at Akali, Kivisaare, Kudruküla, Kõnnu, Narva Joaorg, Pikasilla I, and Tamula.

The representativeness of the post-cranial skeleton varies greatly in sites and also inside single assemblages. Looking at all the sites, we observe that manubriums, sternums, carpal bones, sacrums, and patellae are not represented at all. At Tamula, for instance the sternum, ulna, metacarpals, sacrums, and patellae are absent. At Kõnnu, the upper limb bones, together with os coxae and femora are most frequent; the same can be said about Kivisaare. Tamula and Kivisaare demonstrate the widest range of bone elements within their loose bone assemblages.

The results of the osteological analysis, which includes the representativeness and fragmentation of bone elements, and the stratigraphic relations allow some indirect conclusions about the character of loose human bones in Tamula to be made. At this point, it is difficult to find strong arguments against Jaanits' (1948, 19; 1957c) assumption that the loose human bones from settlement layer (IV, V, XIII, XV, XVI, XXIII, XXIV, and XXV) most likely belong to destroyed primary inhumations. If we observe the BRI profile of burial XV at Tamula, which we were able to determine as a destroyed inhumation by an archaeothanatological analysis (*Chapter 6.2.2.1.*), we see that the cranial bones and teeth, together with the less resistant bones of the thoracic cage (vertebrae), and the lower limb bones (femur and tibia) could be observed in the osteological collection (Figure 78). As indicated in the archaeothanatological analysis, even more bones were present in the initial deposit, just not all of them were gathered. A rather similar pattern can be observed in the case of Tamula XIII. The field description (Jaanits 1955b) and the results of the osteological analysis indicate that both cranial and post-cranial bones were initially present[36], among these even hand and feet bones. This pattern seems to support the hypothesis of a destroyed primary inhumation. The destruction of the initial deposit, however, could not have been caused by the establishment of the hearth, as the bones were found 3–16 cm above it. The idea of a primary inhumation is also supported by the grave inventory consisting mainly of dress adornments such as tooth and amber pendants (AI 4118: 1022–1026) together with a flint scraper and a flake (AI 4118: 1027, 1028). The presence of small post-cranial elements together with the fragments of cranium and teeth could also suggest that Tamula XXIV was once a primary burial of a child that was destroyed during later Stone Age activities. The interpretation of loose human bones as destroyed inhumations is also supported by their spatial relation in the cultural layer; these were found in the middle (IV, V, XIII, XX, and XXV) or upper part (V and XXIII) of the cultural layer, whereas the intact inhumations are placed significantly lower.

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[36] With this burial the exact number of single skeletal elements in Table 14 is tentative, as there are some references to the idea that the bones of skeletons XII and XIII have been mixed up at the collection. However, the bone elements found during the osteological analysis correspond to those mentioned by Jaanits (1956b).

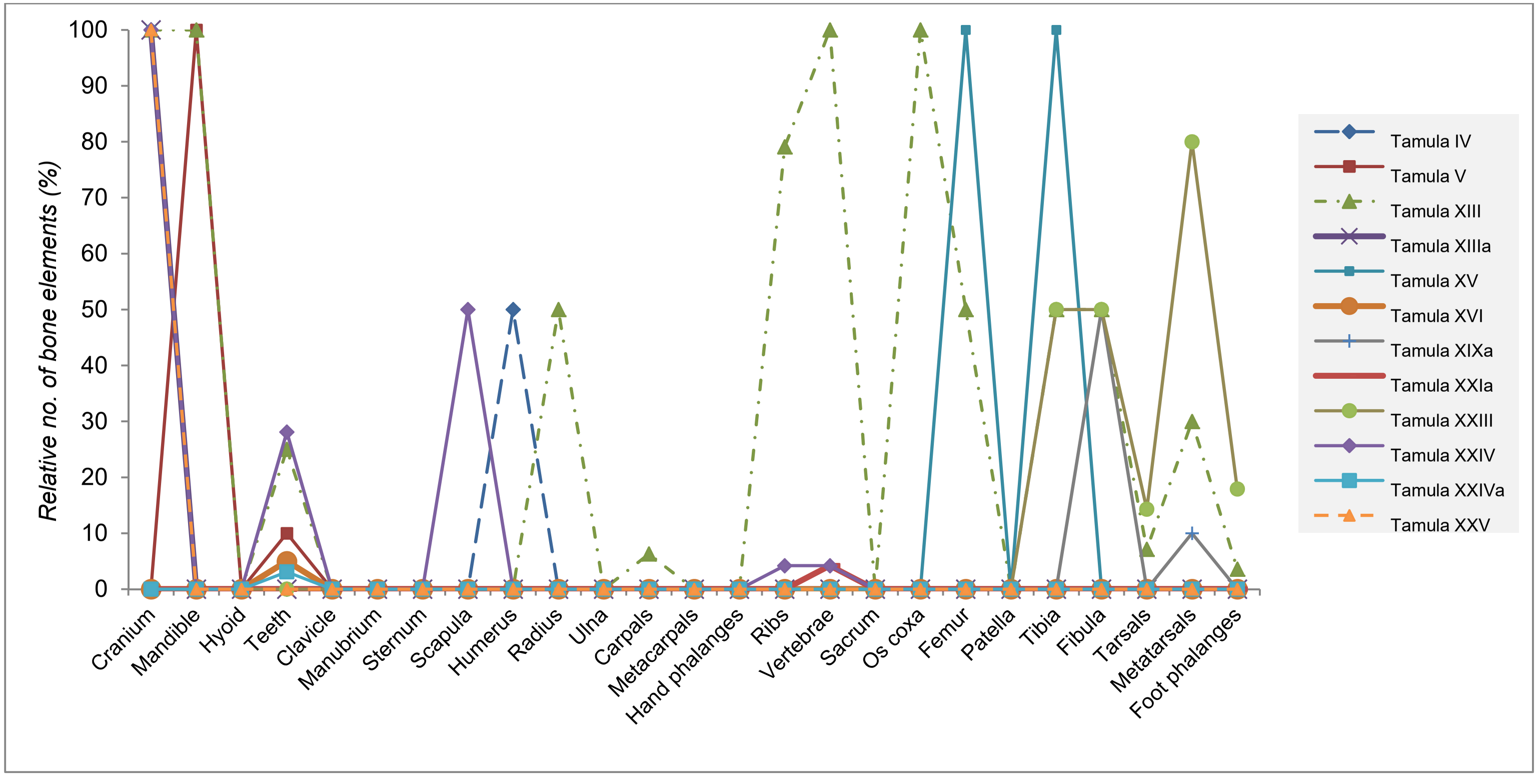

Figure 78. Comparative BRI of Tamula loose human bones assemblages.

A rather distinctive pattern is seen in the case of Tamula XXIII where only the bones of the left leg and the tarsals, metatarsals, and phalanges of both feet were found (Table 32). The restricted number and selection of bone elements here seems to suggest that only distal part of the lower limb or the bones of limb were deposited initially. However the absence of any modification on the bone surface does not support the idea of defleshing; whether the bones were left to decompose above the ground could not be established in the present study.

In the case of Kivisaare, it is difficult to argue in favour of the loose bone phenomenon being part of a funerary repertoire of hunter-gatherers. These difficulties are mostly related to the research history of the site and the utilisation of the drumlin as a gravel mine during the 19th and 20th centuries. Mining activities and ploughing have destroyed the upper part of the cultural layer, together with the burials. Also, excavations have been carried out in the same spot by several researchers, which makes it more complicated to assess the minimal number of individuals buried there. The complicated chronology of the site prohibits a conclusion to be drawn about the exact number of interments and treatment of the corpses during the Stone Age, as not all the skeletons were dated (not to mention the loose human bones). Moreover, there are several cases where the exact position of the loose human bones is not recorded or no specific features connected to them are documented (Table 30).

However, there is one more-or-less clear cut case that allows suggesting that the loose human bones found in the cultural layer were the outcome of a destroyed inhumation. That is the c. 1 m^2 area filled with black humus-rich soil (y_1–a/16–17) excavated in 1965. Unlike other areas with loose human bones in Kivisaare, here the cranial and post-cranial bones of an adult were observed. The 51 bone fragments were from a variety of elements, including cranial bones, shoulder girdle bones of the thoracic cage, and hands and feet bones. The presence of fragile bones and the location of the excavation plot suggest that Jaanits re-excavated one of the graves unearthed already at the beginning of 20th century. This allegation is indirectly supported by the activities of gravel miners and the archaeologist on the drumlin at the beginning of 20th century. As Jaanits states, the south-eastern area of the drumlin was heavily demolished and he was only able to excavate the seemingly undisturbed part (Jaanits 1965, 11). Another case of a destroyed inhumation could be the burial Kivisaare XVIIa/b, where a metal stud next to the cranial bones was found (Indreko 1931). These examples indicate that it is impossible to establish whether the scattered bones recorded in 2002 at the excavation plot that overlapped with several earlier excavation areas belong to an initial deposit or to a destroyed (i.e. already excavated) inhumation. To resolve this puzzle, one should apply different methods.

In addition to the above-described features with loose human bones there are several cases that cannot directly be connected to destroyed inhumations nor to secondary mortuary rituals. Due to the complicated environmental and taphonomic history of the lower reaches of the river Pärnu (Kriiska & Lõugas 2009; Rostentau et al. 2011), and the early discovery of loose human bones from the river bed, one cannot exclude the possibility that these bones derive from destroyed inhumations. Their absence in the collection and the lack of more solid contextual information, however, does not allow further conclusions to be drawn. The same goes for the loose human bones found at Kudruküla. Due to the eroded cultural layer (Tšugai et al. 2014), one cannot reach a conclusion of their initial context and thus further discussion about their relatedness to possible practises is impossible.

The above analysis indicates that rarely any intrusions to the inhumations were conducted during the Stone Age (excl. some instances in Tamula); the majority of the destruction has been caused by later human activities (e.g. ploughing, gravel mining, and other earthworks). These later intrusions tend to maintain the general outline of the skeleton. Moreover, the represented bone elements range from cranium to various post-cranial parts of the body and the fragments are fairly large.

Due to the insufficient sources and the heavy fragmentation of the bones, the interpretation of these bone assemblages has to remain open. However, Stodder (2008, 78 Table 3.4) has noted, in comparing secondary burials with victims of a conflict, that partial representations of skeletons together with cut-marks and defleshing marks are characteristic of secondary burials. Although here only Narva Joaorg I presented cut-marks on both femora, the high fragmentation of skeletons could speak in favour of secondary mortuary practices at other sites, too. What one can conclude is that probably some of the bones were circulated in the community as part of secondary mortuary practices as we have seen in Narva Joaorg I. The importance of heads/skulls and/or crania in the mortuary rituals also becomes clear. So even if the majority of the bone assemblages do represent destroyed inhumations, secondary practices could tentatively be argued for at Akali, Kõnnu, Võru, and Tamula, where the representation of bones seems to refer to the selection of specific body elements by hunter-gatherers and their utilisation in mortuary rituals.

6.3. Conclusions about mortuary practices

Applying archaeothanatological principles to the analysis of old excavation data means constant cross-referencing between various sources. Moreover, one must be aware that final conclusions are out of the reach; instead several loose ends remain. Despite these shortcomings, this approach allows the re-analysis of roughly one-third of the sample, allowing a more dynamic picture of Stone Age hunter-gatherer mortuary practices in Estonia.

The dominant mortuary practice in hunter-gatherer communities known archaeologically was primary burial beneath the ground, meaning that the funeral was undertaken shortly after death. The vast majority of the deceased were placed singly into a shallow grave dug into the occupation layer or virgin soil in an area for the deceased. The spatial distribution of the bones indicates that the graves were immediately backfilled by the sediment taken from the pit and the decomposition of cadavers took place in the ground. While placing the bodies into graves, various positions were staged. The deceased was placed into the grave on its back with either both upper and lower limbs in extension or flexed. Bodies on their lateral sides with flexed limbs were exceptional. However, several graves and features contained the remains of more than one individual. The majority of these were multiple burials, i.e. graves where the deceased were interred simultaneously, referring further to a catastrophic event (e.g. illness) in a community. The Veibri quadruple grave, with its arrangement of the bodies, exhibits the effort and care rendered toward the deceased. Largely due to the insufficient source material and the heavy fragmentation of loose human bones, one is unable to demonstrate the presence of collective graves in the material at the moment.

One could argue that the character of the grave pits, which are shallow and mostly without any additional structure, demonstrates the simple and careless way of depositing deceased hunter-gatherers. On the contrary, from several graves (esp. at Tamula) additional wooden "beddings" were found beneath the bodies and covering the corpses. One could also argue for tight wrappings made of organic materials such as hide or soft containers made of bark. The presence of latter was also supported by archaeological evidence. All these additions in the simple grave pit indicate a more complex way of handling the dead in hunter-gatherer communities. The latter is also supported by the gift giving to the deceased: some people were accompanied with different kinds of tools. However, most of the grave inventory could have been part of the clothing (dress ornaments) and thus cannot directly be connected to practices performed during the mortuary rituals.

While primary inhumation clearly dominates in the practices of Stone Age hunter-gatherers, alternatives existed and these should be taken as part of their mortuary repertoire, too. Usually, the integrity of the body was important to maintain, which is also shown by rare instances of disturbances or reduction of primary inhumations by the hunter-gatherers themselves. Most often the loose human bones deriving from destroyed inhumations were the outcome of actions in later times, i.e. historic periods, such as by ploughing, gravel mining, or other earthworks. However, several cases from Tamula and Narva Joaorg indicate that the primary deposition was not the final ritual. Three cases from Tamula prove that there are reasons to speak about the post-burial manipulation of corpses when these are skeletonised to manipulate the bones, either removing them from the initial deposit or altering their original position. The composition of the skeletal elements in features with loose human bones further suggests that certain parts of body were treated differently. Most often we find fragments of skulls or crania being deposited separately. Narva Joaorg I is the only occasion where we have evidence of a secondary burial ritual with dismembered body parts, being still (partly) fleshed during their deposition.

In summary, the following mortuary practices were observed archaeologically in hunter-gatherer communities in Estonia:

(1) The deceased were probably kept in the vicinity of the living community; this could be indicated by the finds of burials and loose human bones in the occupation layers of settlement sites;
(2) Primary inhumations were considered the norm, meaning that funerals were mostly simple ceremonies where the recently dead person was manipulated;
(3) Primary burials were mostly designated for a single person; however, several multiple burials have been documented, while the presence of collective burials could not be proven;
(4) Although the integrity of the body was maintained during the primary inhumations, there were cases that indicate that primary burial was just one phase in the sequence of practices; the reopening of graves and removal of single body parts together with secondary rites in terms of defleshing could be considered in the range of mortuary practices, too;
(5) Shallow grave pits with no additional structures were used; these were backfilled immediately after the deposition of the corpse;
(6) Additional structures made of organic materials, such as wooden branches, bark, and probably also fur and hides were used occasionally to pad the grave cuts and wrap the bodies;
(7) A variety of body positions in the graves, the most common being on the back with extended limbs could be observed;
(8) In some instances the deceased were accompanied with grave goods; the vast majority of the grave inventory, however, represents dress ornaments.

These practices allow a more theoretical and comprehensive discussion about the core of hunter-gatherer mortuary repertoire in Estonia. Thus, in the final chapter, the mortuary practices are looked at on a temporal scale provided by radiocarbon dates. Bringing together the results of the osteological, biochemical, and archaeothanatological analyses, the change and invariability of the mortuary rituals of hunter-gatherers over the period of c. 6500–2600 cal. BC is provided.

CHAPTER 7. SYNTHESIS: FROM SINGLE PRACTICES TO THE LONG TERM PERSPECTIVE IN MORTUARY RITUALS

In the final chapter, I will return to the questions of who, how, where, and by whom were buried. By answering these questions I will try to provide a plausible description of a norm of hunter-gatherer death ways during the time period of 6500–2600 cal. BC. Thus far the discussion over the norm of mortuary practices of Mesolithic and Early Neolithic hunter-gatherers has been dominated by the idea of cemeteries with intact inhumations. However, I agree with Nilsson Stutz (2003), Gray Jones (2011), and Conneller (2011) that other aspects of hunter-gatherer rituals, among these different kinds of mortuary practices, need to be investigated to get a fuller understanding about their societies in general and their mortuary practices specifically. I argue that primary inhumation in a cemetery context was just one aspect of the norm and the actual picture was more diverse and dynamic.

Departing from single practices described in *Chapter 6* and incorporating the information about the people interred either as intact or disarticulated bodies (*Chapter 5.1.*) and the temporal frame of single burials (*Chapter 5.3.*), I will discuss five aspects of the practices to pinpoint to the commonalities and variation in hunter-gatherer mortuary rituals. These features encompass: (1) the location of the dead, (2) the nature of the burial, (3) the number of individuals interred and their temporal relation to one another, (4) any additional grave features, and (5) possible archaeologically invisible practices (Figure 79).

The material aspects of the mortuary practices will guide us first to discuss the function and objectives of mortuary rituals. The mechanisms behind the maintenance, transmission, and change of cultural practices will be discussed through the lens of participants, i.e. the bereaved. Moreover, the constant tension between the archaeologically observable practices and archaeologically invisible ones will be taken into account to put the here-observed material into a more plausible context. These considerations lead us to the identification of the core of mortuary rituals that remained invariable throughout the period under discussion. But not only the most deeply rooted structures behind the practices will be discussed, but also the variability is highlighted as being one part of the core of mortuary rituals of hunter-gatherers.

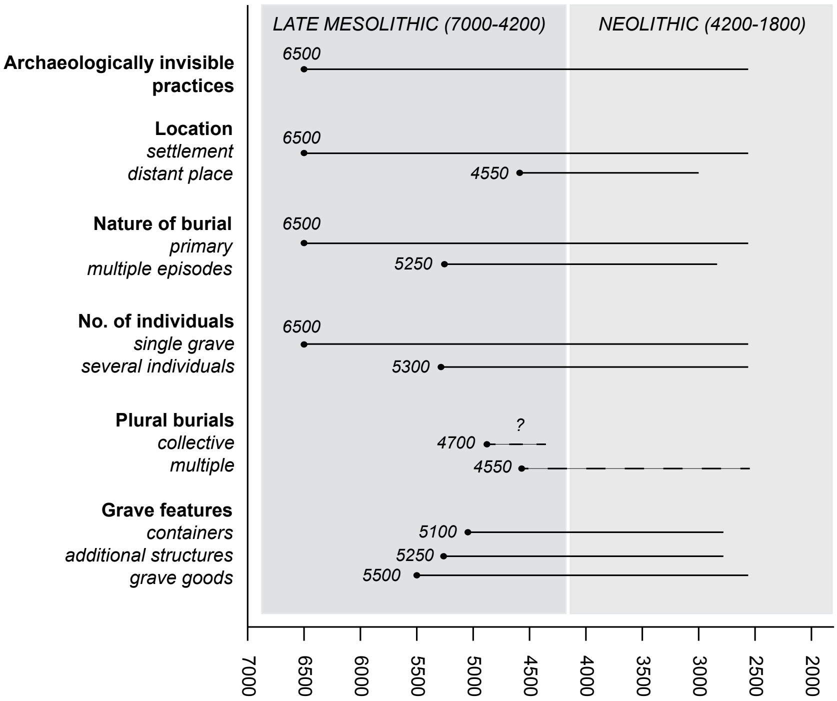

Figure 79. The continuity and change of various aspects of hunter-gatherer mortuary practices.
These are reflected in 38 radiocarbon dates; dashed lines indicate practices that have not been dated directly. Dates are given in calendar years (cal. BC).

7.1. Repeated use of designated places for mortuary rituals

We can see from the archaeological evidence that some places emerged to be repeatedly used for burials since the Middle Palaeolithic (Pettitt 2011, 121pp; Nilsson Stutz 2014, 713; but see Mithen 1994, 120–121). A range of cemeteries, i.e., large formal disposal areas, are known throughout Europe from the Late Mesolithic and the Neolithic periods (e.g. Gurina 1956; Zagorskis 1987; Larsson 1989[1985]; Oshibkina 2006; Kostelyva & Utkin 2010; Boroneanţ & Bonsall 2012; Piezonka et al. 2013; Borić et al. 2014). One can debate over the use of the term 'cemetery' or even reject its use in the context of hunter-gatherer societies, as the number of interred individuals, the degree of their spatial organisation, and the time of usage varies considerably (see Chapman 1981; Meiklejohn et al. 1998, 205; Nilsson Stutz 2003, 187pp; Blankholm 2010 [2008], 122; Meiklejohn et al. 2009, 639). This, however, does not change the fact that during the Late Mesolithic and Early Neolithic the number of places where more than one individual has been interred, mostly as primary inhumations, increased in Europe.

New radiocarbon dates (*Chapter 5.3.*) indicate that settlements were repeatedly used for burying people in Estonia from 6500 to 2600 cal. BC (Figure 79). The earliest burials were interred at Narva Joaorg and Kõnnu; the youngest are found at Naakamäe and Tamula. Moreover, the archaeological data show that the vast majority of the people – either articulated or disarticulated bodies – were interred into the soil at settlements with thicker or thinner occupation layers containing a variety of structures, everyday items, debris from tool production, and faunal remains (Akali, Kivisaare, Kudruküla, Kunda, Kõnnu, Naakamäe, Narva Joaorg, Pikasilla, Tamula, Tooma, and Valma; see also *Chapter 4.1.*).

7.1.1. Markers of territory, liminal and/or exceptional places

What does the clustering of the dead toward the end of Mesolithic in Europe in general, and in Estonia in particular, signify? The reasons behind the emergence of formal disposal areas have been debated about over decades in hunter-gatherer archaeology without arriving at a consensus. These have been believed to serve different functions and the motivations behind their occurrence have not only been linked to ritual practices. Three main lines of interpretation could be distinguished here.

Firstly, the most prevailing explanations follows the Saxe 8th hypothesis: *"To the degree that corporate group rights to use and/or control crucial but restricted resources are attained and/or legitimized by means of lineal descent from the dead (i.e. lineal ties to ancestors), such groups will maintain formal disposal areas for the exclusive disposal of their dead, and conversely"* (Saxe 1970, 119pp), connecting the spatial clustering of dead with ancestral claims of one's territory (Chapman 1981; Clark & Neeley 1987; Zvelebil & Dolukhanov 1991, 263; Larsson 1993; Rowley-Conwy 1998; 1999; Halinen 1999, 176–177; Kriiska 2003, 12–14; Zvelebil 2003; 2010[2008], 38). The latter is further associated with the more complex and sedentary lifeways of hunter-gatherers, together with population pressure, making this phenomenon an "innovation" of Late Mesolithic hunter-gatherers (e.g. Zvelebil 2003; 2010[2008]; for a critique see Rowley-Conwy 2001, 51p; Nilsson Stutz 2014). Looking at the cultural and economic background of the Late Mesolithic and Neolithic populations in the eastern Baltic area, the settlement pattern indicates a decrease of hunting areas and sedentary camps, making a clear division between the inland and coastal habitats (Kriiska 2009; Nordqvist & Kriiska 2015). Moreover, with the emergence of Combed Ware pottery, an increase in contact between groups in a large area can be seen (Nordqvist & Herva 2013; Nordqvist & Kriiska 2015 and references therein). Also a diversification of material culture could be observed; people started to make pottery during the 6th millennium, used amber as a means of personal ornaments, and polished their stone tools from the end of 5th and 4th

millennium (e.g. Jaanits et al. 1982; Kriiska 2009; Nordqvist & Herva 2013; Nordqvist & Kriiska 2015 and references therein). All the observed characteristics together with the first archaeologically visible burials in settlement layers seem to suggest that the Estonian material in general fits with the above hypothesis. However, the presence of solitary graves in non-settlement contexts from around 4550–2600 cal. BC (Figure 79: Veibri, Kõljala, Külasema Metsikumäe), and the single probable cemetery at Jalukse (see *Chapter 4.1.3.1.*), indicate that mortuary rituals were not primarily used to communicate territorial claims. It definitely was not the main structuring aspect of these practices. Thus, whether the sedentary way of life and repeated use of some sites as burial places is directly connected to the claims of a territory of a hunter-gatherer group remains an open question.

The second approach stresses the particularity of places in the cultural landscape (e.g. water, caves and shell middens; Larsson 1990, 154; Sundström 2003, 121pp; Nilsson Stutz 2005; Zvelebil 2010[2008], 45; Jonuks 2009; Conneller 2013, 354–355). Within this framework, burial sites are seen as persistent and liminal places between different worlds (e.g. Three-Tier hunter-gatherer world structure: Zvelebil 2003; 2010[2008], 43). This interpretation departs from the ethnographic Khanty belief system, where cemeteries – *"the settlements of the dead"* – are principally avoided by the living population, being visited only at times to undertake mortuary rituals and commemorate the dead (Jordan 2001, 97–98). Large burial sites like Olenii Ostrov and Zvejnieki in NE Europe have been regarded as such liminal places, where being part of the place (in whatever form) itself constituted the core of mortuary practices (Zvelebil & Jordan 1999; Zvelebil 2004b, 196; Nilsson Stutz 2010, 38).

Following the lead of Zvelebil (2004), Jonuks has argued that the settlement and burial site at Tamula might not have been a quotidian occupation camp, but rather a place that was visited or periodically inhabited to conduct mortuary rituals (Jonuks 2009, 128–129). He bases his interpretation mostly on the characteristics and abundance of tooth and figurine pendants at Tamula. To strengthen his argument he brings in the examples of the tightly flexed burials Tamula XXI and XXII. He considers their restricted body position, together with the birch and pine bark found at grave XXII that might have been remnants of wrappings (a basket or another kind of transport vessel) suitable for transportation (Jonuks 2009, 131), to point further at the centrality of the Tamula burial place. The archaeothanatological findings support the idea of burial XXI being bound (*Chapter 6.1.3.1.2.*). The initial body position of the burial XXII, however, seems to indicate that the body was arranged into the tightly flexed position at the level of knees during the funeral (*Chapter 6.1.3.1.4.*), not earlier as one could expect if the body would have been transported within a bark vessel. Moreover, the bark container most probably was not used for transportation but rather to pad the grave pit and cover the corpse on site.

It is hard to find evidence against the idea of burial sites being somehow special in the hunter-gatherer landscapes. Moreover, one could see this being in accordance with the accepted tripartite model of mortuary rituals proposed by van Gennep (1960). In some societies, the liminal phase requires the physical separation of the mourners and the dead, and this separation could be accomplished by such a "mortuary settlement". Additionally, one finds anthropological examples of mobile or semi-mobile tribes that have carried their dead and/or bones of the deceased to these specially designated places to be buried properly (e.g. Saar 1998; Chénier 2009, 32 and reference therein). These practices are not only limited to the mobile hunter-gatherer tribes. For instance, a delayed burial was practiced in Finland during 1751–1850 where the dead bodies were kept over the winter and transported to the parish church in a remote area to be buried in consecrated soil when the ground was melted (Núñez 2015; see also Micozzi 2006[1997], 177). Despite the domination of primary burials in the here-observed archaeological record, we cannot distinguish the length of the liminal period. Thus, conducting mortuary rituals in a special place, i.e. "mortuary settlement", repeatedly during an extended period of time might have produced similar cultural layers as we see in regular residential sites. However, if we observe the mortuary rituals of the northern Khanty we see that in addition to being used in the actual mortuary ceremonies, cemeteries were visited during commemoration rituals that involved making fire and feasting (Saar 1998), but no other activities that could leave material culture traceable in the archaeological record. Whether this would have been enough to produce as extensive of a cultural layer as we see in Tamula over a millennia is hard to answer. To my mind, we do not have enough proof at the moment to make conclusions about the exceptionality of the site (except the presence of burials). The available archaeological record does not prove the interpretation proposed by Jonuks (2009); neither allows eliminating this idea entirely.

The two above-given explanations treat repeatedly used burial sites as being part of the cultural norm of the mortuary repertoire. The third interpretation, however, sets these outside the common practices. Jimmy Strassburg (2000, 156–162) argues that instead of representatives of the norm 'cemeteries' should be seen as exceptions because the people interred there represent only a small fraction of the whole population of hunter-gatherers (see also Orme 1981, 244; Knutsson 1995; Lõhmus 2005). He further suggests that only the rejected and outcasts of the community, i.e. the *"remnants of individuals stigmatised, in one way or another, as particularly stubborn varieties of queer and dangerous undead"*, were buried this way (Strassburg 2000, 158). Jaanits (1961a) and Jonuks (2009) also suggest that the inhumations belong to somehow special people, but not deviants as suggested by Strassburg. Jaanits stated that it is obvious that not all the members of the community got the same post-mortem treatment; only a few of them – prominent members of the group – were interred to the grounds of residential sites (Jaanits 1961a, 69). Where the others are remains to be answered. Jonuks alludes in his thesis that the burials at Tamula and Valma with abundant grave goods (excl. those with no grave goods or few tooth pendants such as at Veibri and Kivisaare) were those of shaman-like individuals (Jonuks 2009, 122; see also Zagorska 2000, 81, 92; Zvelebil 2010[2008], 50pp). The interpretation by Jaanits is more general including all the burials from residential sites, the explanation to richly adorned burials by Jonuks, however, leaves the question of inhumations without grave goods unanswered. Neither of these takes into account the mortuary practices executed outside residential sites.

Recently the osteological studies of loose human bones have started to contest the primacy of 'cemeteries' with primary burials as being the only norm of disposing of the deceased by hunter-gatherers (Gray Jones 2011; Schulting 2015; Bugajska 2015; Wallduck & Bello 2015). One could perceive this as an additional line of evidence supporting the interpretation proposed by Strassburg (2000). However, this does not mean that the inhumations in residential sites stand outside the normative handling of deceased hunter-gatherers. The picture becomes even more complex when solitary burials are included in the discussion.

7.1.2. Life and death side by side

Sites repeatedly used for mortuary rituals were central places within the hunter-gatherer landscape and were part of a more dynamic web of paths and places. These were inhabited by small groups over a long time period, in some instances extending over several millennia. Although not all the inhabitants were buried into the grounds of a settlement the mortuary profile, a cross-section of all age groups, and the presence of both females and males, together with stable isotope studies (*Chapter 5.2.*), indicate that rather closed groups were using single burial areas. The latter becomes especially clear when looking at homogenous intra-site isotope signatures of Tamula (*Chapter 5.2.2.* and *5.4.*). Their centrality, however, does not necessarily mean a physical separation from everyday life and spaces, i.e. residential sites. Quite the contrary, similarly to the inseparability of sacred and profane in the lives of hunter-gatherers, life and death must not have been separated, but rather tightly connected to one another in hunter-gatherer societies (see Brück 1999; Nilsson Stutz 2003, 189, 363–365; Nilsson Stutz 2014, 721 and the references therein).

The inseparability of life and death becomes especially obvious when we observe the spatial distribution of mortuary remains in the landscape. These are situated on the river banks and estuaries, on the islands on lakes or Baltic Sea, always in connection to the life-ensuring freshwater reservoirs. As shown in *Chapter 4.1.* the majority of the sites with human remains in Estonia are associated with (contemporaneous?) occupation layers. Primary inhumations have been found from Kivisaare, Kõnnu, Naakamäe, Narva Joaorg, Tamula, Valma settlements; loose human bones of which at least some represent secondary mortuary rituals from Akali, Kivisaare, Kudruküla, Kunda Lammasmägi, Kõnnu, Kääpa, Narva Joaorg, Pikasilla, Sindi-Lodja, Tamula, Tooma, and Valma. Only a single case of a probable cemetery at Jalukse is known, marking the physical partition between the domains of the living and the dead. Singular burials outside the settlement context (Külasema Metsikumäe, and Veibri) representing single events as indicated by the archaeothanatological analysis and radiocarbon dates could also be connected to the realms of living.

This dominant pattern fits with the trends observed elsewhere on the European continent (e.g. Larsson 1993; 2000; Butrimas 2012; Piezonka et al. 2013), differing clearly from the cave sites with Mesolithic human remains on the British Isles (Conneller 2013, 354). However, this does not mean that proper cemeteries were not part of the hunter-gatherer landscape. The pattern indicated by the stable isotope analysis (Tõrv & Eriksson in prep.), the spatial relation between the settlement layer and burials (Zagorskis 1987; Nilsson Stutz et al. 2013), and the longevity of the site (Zagorska 2006), Zvejnieki most likely represents a proper hunter-gatherer cemetery in the E Baltic region. Jalukse could have fitted into this pattern; however, the poor representativeness of the sources does not allow a final decision on that.

Although the specific function of Estonian Stone Age settlements has not been analysed thoroughly, one could argue based on the characteristics of cultural layers, i.e. the abundance of material culture, structures, and faunal remains (*Chapter 4.1.*), that sites with human remains could be considered as places where human presence might have been year-round ("major (semi) permanent villages" Zvelebil 2010[2008], 32–33; Kriiska 2009; Table 12). Even if these sites were not inhabited throughout the year, these were key points in the landscape where one resided for an extended period of time, took off for longer hunting trips, and returned repeatedly. This also meant that death must have occurred more often there than in provisionally inhabited camps. Death must have been omnipresent. It was visible and required immediate response. As shown by the archaeothanatological analysis, hunter-gatherers responded to the death of their kin with primary inhumation in the context of residential sites. However, this was not the only option, as discussed below.

Although the stratigraphy of all the here-observed sites is not clear-cut, the repeated use of them for mortuary rituals (not a single site with only one burial!) allows arguing that differently from many ethnographically known examples (e.g. Woodburn 1999[1982]), these sites were not permanently abandoned after the executed mortuary rituals. Moreover, the repeated use is further supported by the fact that no overlapping or intersecting graves are known, which indicates that the locations of earlier burials were known to the bereaved (see also Jaanits 1961a; Jonuks 2009; for comparison see Zvejnieki: Nilsson Stutz 2010). While the lack of visual sources from Kivisaare does not allow any substantial conclusions to be drawn about the spatial distribution of single graves to one another, at Tamula the observable alignment and clustering of graves further supports the idea of structuring and planning of the realms of the dead within the settlement. However, whether there were taboos for relinquishing the settlement temporarily after someone's death cannot be ascertained archaeologically, thus this idea cannot be excluded entirely either.

It is justified to inquire why we do not have burials from all the residential sites. One way of explaining this is to argue for a research bias. We have either theoretically ignored the fact of finding inhumations and loose human bones from settlements by assuming that there should be formal cemeteries and neglecting loose human bones as being part of mortuary practices at all, and/or the excavations have not been thorough enough to trace all the human remains. Thus, there is a lot more to discover in the future. On the other hand, one could argue that even the few known burial places within the quotidian occupation layers are misleading. We have the know-how for searching Stone Age occupation sites, but not cemeteries. Instead, we should seek real cemeteries from other locales, but we just do not know where or how to look for them. However, the contrast becomes most obvious when comparing the abundance of primary burials at Tamula with the single features with loose human bone at Akali, Kääpa and the absence of human remains at Villa and Kullamägi (Jaanits 1953; 1955a). These sites are situated within the same environment, i.e. overgrown by peat, which should have permitted similar preservation conditions. Moreover, one could eliminate research bias as all of these sites were excavated by Jaanits applying similar field techniques and opening rather large areas. To my mind, this contrast only becomes relevant if we consider primary inhumation as the proper means of disposing of hunter-gatherers. But as I intend to show below, this was not the case and thus Akali, Kääpa, Villa and Kullamägi must not deviate from the norm at all, but represent different kinds of mortuary rituals undertaken in different places and remaining invisible in archaeological record.

7.1.3. Conclusions

Places, where death was repeatedly materialised, should be considered as navel points within hunter-gatherer landscapes. However, one cannot prove that these were in place to manifest territorial claims; neither should these be considered outside the norm of hunter-gatherer mortuary repertoire. Quite the opposite, these were part of the norm.

Currently, the Estonian material demonstrates that proper cemeteries, i.e. the settlements for the dead, were not part of the hunter-gatherer mortuary repertoire. Instead, life and death were intertwined, clearly inseparable as the realms of sacral and profane in hunter-gatherer world. The places where people resided were also the places where they died, and were buried. Death was materialised within residential sites, but also in remote locations that the whole tribe or a smaller group stopped over or passed by while moving in the landscape from camp to camp, to hunt or to visit other groups. The number of primary inhumations found may reflect the temporal density of the usage of these sites, meaning that fewer burials are to be found from seasonal camps and more from the repeatedly inhabited settlements. However, as long as our sample remains as scanty as it is today, this could only be regarded as a plausible hypothesis, not a proven fact. Thus, the place itself was not the primary structuring force behind the mortuary rituals, instead the occurrence of the dead body and an immediate reaction to it through mortuary practices structured these places by providing them with a different meaning.

7.2. Primary burial as the norm?

The sites repeatedly used for burial discussed above are most often connected to the primary inhumations. Thus, this has been considered the second aspect of the norm in handling the dead. Regardless of the more rapid changes in other aspects of mortuary practises such as the initial body position, additional grave structures, the abundance and composition of grave goods, or even the place of the interment (Figure 79), most of the archaeologically observable bodies in Estonia have been placed into shallow graves in a fresh state (*Chapter 6.1.*; Table 24). Primary inhumation as a disposal method has been existent throughout the whole study period, being present in almost all of the sites under discussion. However, at Akali, Kudruküla, Kunda Lammasmägi, Kääpa, Sindi-Lodja, Pikasilla, Tooma, and Võru, their presence remains unsubstantiated due to the poor representativeness of the source material.

The primary nature of a burial indicates that hunter-gatherers must have handled death without a considerable delay. However, the limitations of the archaeothanatological approach do not allow clarifying whether the bodies were interred within the time frame of a day or a week. Taking the climatic particularities – cold winters – into account one could argue that the time window between the death and burial could have been even larger: the bodies might have been kept over winter to wait for the ground to be thawed in order to ease the digging of graves. Whether this was the case here cannot be proved; however, it is likely that when someone died during a cold winter in a residential site there might have occurred a significant delay in interring the corpse. Nilsson Stutz (2003, 345; 2010, 37p) has argued based on the example of southern Scandinavian mortuary rituals that the rapid handling of the death was due to the aspiration of obtaining the integrity of the body and thus remembering the deceased as "life-like" (Figure 80). The same tendency could be observed in the Estonian material as illustrated by the "sleeping" or embracing position of several bodies at Kõnnu (III), Tamula (II, XI/XII and XXI), and Veibri (especially I and IV). Differently from Nilsson Stutz (2010, 38), I do not think that wrapping the bodies more common in Zvejnieki (comp. to southern Scandinavian material) and also observed at Kivisaare, Tamula, and Kõnnu is a form of radical pre-burial transformation making the "life-like" image of the deceased less obvious. Hides and bark used for this purpose were used in everyday bodily practices (e.g. dressing, sleeping, camping, etc.), and should not be considered as something exceptional to hunter-gatherers. This practice could instead be viewed as extra care for the deceased ones.

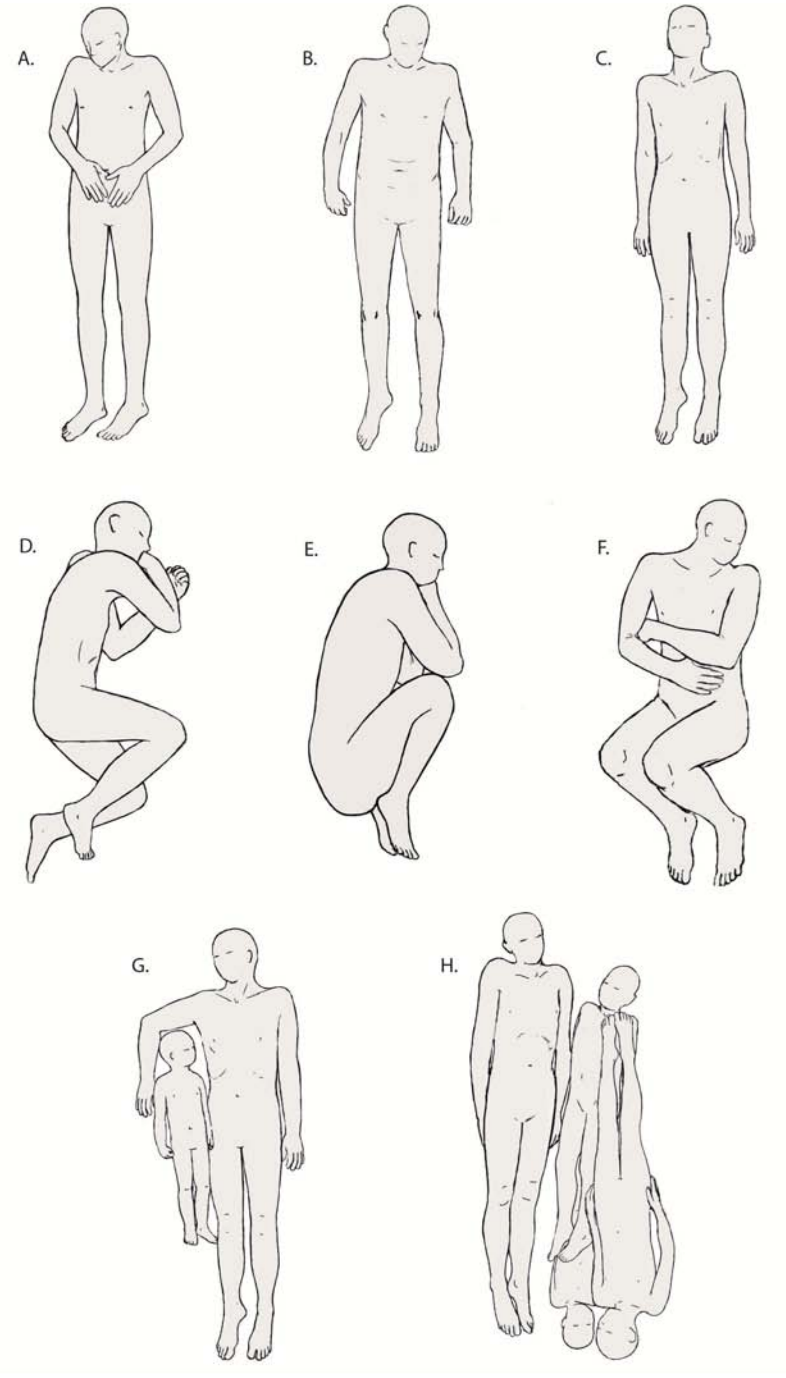

Figure 80. Reconstructions of initial body positions of primary burials.
The drawing illustrates the variety in the initial body positions within the primary inhumations.
A – Naakamäe, B – Tamula XIV, C – Tamula IX, D – Tamula II, E – Tamula XXI, F – Tamula III,
G – Tamula XI/XII and H – Veibri quadruple burial. (Drawing J. Ratas)

The prompt response toward the emergence of a corpse within residential sites may, on the one hand, be explained by practical necessities. It was important to put the body away to avoid direct contact with the processes of decomposition that might have been regarded impure. However, this was not the only trigger for primary inhumation. The quadruple grave at Veibri (also Külasema Metsikumäe), situated farther from its contemporaneous residential site, allows assuming that even if death occurred in a remote area, but all the other circumstances of death (e.g. right way of dying, gender/age/status, season of death, etc.) were appropriate, the dead bodies were handled immediately in the form of primary inhumation. It was not necessary to transport the corpse to a formal disposal area. Thus, as stated above, irrespective of the location of the group (for example being on the road, e.g. moving between seasonal camps or being on a hunting trip), one could have received a primary inhumation that kept the last image of the deceased as "life-like". The absence of reopening episodes in solitary graves (compare Tamula: *Chapter 6.1.*) indicates that this image remained into the memories of these people. The emergence of the corpse structured the place that after the execution of mortuary rituals was perceived and remembered differently by the group.

Moreover, the idea of normative burial as a moral value may not necessarily correspond to the statistical reality (Moore 1986, referred in Robb 2013, 451). Thus, regardless of the fact that the majority of the burials analysed here are primary or probably primary inhumations, other forms of disposal of corpses were present. Within the present material, I have been able to prove that secondary burials in the form of disarticulating and defleshing bodies were part of the accepted norm of disposing the dead. Not only the fact that archaeologists have been unable to recognise other kinds of practices than primary inhumation, but other aspects may also mislead our interpretations. Firstly, taphonomic factors might not allow observing the wide range of practices present in hunter-gatherer societies. For instance, in southern Scandinavia only the presence of shells in the occupation layers provides the favourable conditions for the preservation of bones over millennia (Thorpe 1999, 79). Recently in north-eastern Estonia, a Corded Ware complex (Narva-Jõesuu IIb) was discovered with burials but without any skeletal remains except teeth (Kriiska et al. 2014, 25; Kriiska et al. 2015, 44). This demonstrates that the soils at least in north-eastern Estonia are as acidic as in Finland to preserve unburnt bone. Moreover, as discussed below, the absence of the vast majority of the population in the archaeological record hints to mortuary practices that leave no traces, further suggesting that primary inhumation may not have been the dominant practice at all.

This said, however, I do not argue that primary inhumation was not a proper burial for a hunter-gatherer. Quite the contrary, ethnographic examples indicate that it is not uncommon to have several disposal methods – e.g. exposure above ground, inhumation and cremation, displaying bodies on platforms or trees, water-burial etc. – co-existing within a single society (the closest example would be our own society where cremation and inhumation are both regarded as acceptable options of disposal; e.g. Kroeber 1927; Ucko 1969 and references therein). Thus, it is time to abandon the culture-historical paradigm that equals the occurrence of different practices – here variation in initial body position – with different ethnic groups. Moreover, the variety in practices does not necessarily have to manifest rapid change in the underlying structures of the norm. The latter becomes especially evident at Narva Joaorg, where both primary and multiple episode burials appear more-or-less simultaneously, and/or at Tamula and Kõnnu, where we can observe a variety of initial body positions and wrapped and unwrapped bodies.

Thus, instead of being the only normative way of handling the dead, primary inhumation was only one accepted way of disposing of the body. It is the one that is most easily accessible in archaeological record. What constituted the other normative ways of disposing of the bodies?

7.2.1. Missing burials and people

It is by no means a novel statement that not all the members of the society devolved the same kind of mortuary treatment after death (see e.g. Ucko 1969, 269 and the reference therein; Knutsson 1995; Strassburg 2000; Nilsson Stutz 2014). Even if in some known sites one could argue that the human remains constitute a more-or-less representative sample of the living population (Louwes Kooijmans 2007; Weiss-Krejci 2011, 68), the majority of the deceased have passed into oblivion and only a handful of people are accessible in the archaeological material. To understand the loss that we are facing in the here-observed material, let us estimate the total population size for the Late Mesolithic and Neolithic Estonia by using a population density of 0.1 individuals per km^2 (Milner et al. 2004), and a total of the area of 45 227.63 km^2 as a thought experiment. The result would be 4522.7 individuals per generation. Assuming that the generational turnover is 25 years and the time depth of the present study being roughly 4000 years (160 generations!) the total estimate of the people living in Estonia during the time period under discussion would be 723.632. This figure should be taken as an illustrative guide as the density of 0.1 individuals per km^2 is the low end range for ethnographically known hunter-gatherers (Kelly 2013, Table 7–3.). Moreover, the group size of nomadic hunter-gatherers usually varies considerably, remaining between 6 and 60; for sedentary hunter-gatherers between 33 and 1500 (Kelly 2013, 171). Hence, the given estimate is highly conservative. It, however, gives some idea of the order of magnitude.

We observe that the archaeologically known burials – primary inhumations and multiple episode burials containing the remains of c. 122–174 individuals (*Chapter 5.1.2.*) – in Estonia do not even cover one generation. Not even all the known Mesolithic burials (9600–5500/4300 cal. BC) in Europe get close to this estimate (232 burial sites with more than 2000 individuals; Grünberg 2000; 2013, 232). Thus, where are all these people?

7.2.1.1. Extended mortuary processes: burials in multiple episodes

Despite the immediate reaction of the mourners, mortuary practices may have been executed over a longer period of time and with bodies being in various stages of decomposition. Such burials in multiple episodes are known from the Upper Palaeolithic until modern times all over the world (e.g. Jacobi 2003, 102; Pettitt 2011, 338). Among these cultures are also Mesolithic hunter-gatherers in Europe (see e.g. Nilsson Stutz 2003; Louwes Kooijmans 2007; Gray Jones 2011; Conneller 2011; Bugajska 2015). Burials in multiple episodes may result fully articulated or only partially articulated/preserved bodies; moreover, it is not rare to have a complete loss of bodies.

In the present work it was demonstrated for the first time that in several instances loose human bones in the occupation layers of Estonian Stone Age settlements were the outcome of mortuary practices (*Chapter 6.2.2.2.*), referring to burials in multiple episodes. However, not only these, but also some primary inhumations with reopening episodes (*Chapter 6.1.4.*) signalled the continuous interest in the deceased and practices related to them after the primary interment. Thus, there was no single proper way of handling the dead during an extended period of time; instead, burials with multiple episodes may have taken various forms. These ranged from the active defleshing of corpses (Narva Joaorg I) to the dismemberment of primary inhumations (Tamula III) and other forms of secondary manipulation of bodies (e.g. Tamula XXII). This also implies that it was not always important to maintain the integrity of the body and mourners must have been acquainted to the less "life-like" images of their ancestors (see also Nilsson Stutz 2003). However, differently from other regions in Europe (e.g. Brinch Petersen & Meiklejohn 2003; Collins & Coyne 2003; Nilsson Stutz 2003; Borić et al. 2009), cremations are not known at the territory of Estonia.

Although burials in multiple episodes are underrepresented in the archaeological record, this most probably does not reflect the past reality. Due to the scarcity of evidence, it is hard to estimate the importance of burials in multiple episodes in Stone Age hunter-gatherer societies. However, the ratio between primary inhumations and burials in multiple episodes will not change before the loose bone phenomenon receives wider recognition in hunter-gatherer archaeology. Another aspect to consider is the one pointed out by Weiss-Krejci (2013, 293), who has interestingly argued that in societies where burials in multiple episodes are executed, the intact burials found by an archaeologist could instead of being primary inhumations be evidence of incomplete burials (see also Bugajska 2015). Following this line of argumentation, the only archaeologically visible complete burial in Estonia would be Narva Joaorg I and probably the reopened graves at Tamula (III and XXII). Although this argument needs to be taken into consideration, I do not think that we have to reduce all our interpretations to that. Instead, drawing from ethnographic examples, we should acknowledge the possibility of various mortuary practices within a single society.

7.2.1.2. Probable cenotaphs?

Another possible explanation for the missing people would be cenotaphs, which are mortuary features without any physical remains of the deceased. On the one hand, the absence of a body means that one of the core functions of the mortuary rituals – disposing of the physical body – remain excluded. On the other hand, the 'absent presence' of the body still marks the body's central place in mortuary rituals (Nilsson Stutz & Tarlow 2013, 6), and depending on cultural norms, various groups perform mortuary rituals without the actual presence of body (e.g. Fahlander 2003, 108–109; McKinley 2013, 153; Renshaw 2013, 765–766; but see Parker Pearson 2012[1999], 56). Whether the death of people whose bodies were out of the reach of the mourners for whatever reasons – e.g. an abandonment of the elderly women of the tribe due to the winter famine and their consequent death – was marked physically in hunter-gatherer communities is a complicated issue. What kind of material means other than the deceased body were used to mark someone's death? This is a question that is difficult to address in archaeology, especially as the nature of the cenotaph and the characteristics of old excavation data set their own limits on discussing the possibility of cenotaphs in the hunter-gatherer mortuary repertoire.

The Baltic German scholars, however, have proposed in several instances that dark colourations visible on the drumlin at Kivisaare marked empty graves (Ottow 1911; Ebert 1913). One cannot take this assumption as a fact since during the early excavations at Kivisaare researchers presupposed that they are excavating a cemetery without any other cultural features such as hearths, storage pits, or house depressions. Thus, what determined the interpretation was the cemetery context – all the features found should somehow be related to the mortuary rituals of Stone Age people. However, already Bolz considered three possible interpretations for the 150 × 120 cm dark feature (Grube XIII; Bolz 1914, 25, 28): (1) a hearth, (2) a waste pit (Germ. die Abfallgrube), or (3) a sacrificial pit (Germ. die Opferstätte), which indicate alternative options in understanding the features without human remains. As the character of the site has become more complicated, not only Stone Age graves should be associated with it, but also a Stone Age habitation layer (Kriiska & Johanson 2003; Kriiska et al. 2004) and Early Bronze Age burials (Tõrv & Meadows 2015), the assumption about Stone Age cenotaphs becomes even more questionable, and their presence is difficult to prove retrospectively.

Similarly to Kivisaare, one cannot conclude with certainty that one or another feature without any human remains on the remaining sites was initially part of the mortuary repertoire and signified an empty grave. However, at Tamula, Ots tentatively suggested that the deposit of seven amber pendants, an ornamented bone dagger, a polished bone point, and a dozen of pendants made of elk and marten teeth (Jaanits et al. 1982, 82, Joon. 59; Tamla & Kiudsoo 2006, 6–7; Ots 2006, Joon. 13, 14) – artefacts often found from primary inhumations on the E shore of Baltic Sea (e.g. Jaanits 1957a; Zagorskis 1987; Kostyleva & Utkin 2010) – could be understood as a cenotaph (Ots 2006, 83) instead of its primary interpretation as a wealth deposit (Moora 1946; Jaanits et al. 1982, 82). These artefacts were found in a limited area at the depth of c. 60 cm in the cultural layer, and Moora, who excavated the site in 1946, expected to find a grave based on the artefact types (Moora 1946). Despite the careful excavations, no human remains were recovered. A similar assumption was made by Jaanits (Jaanits et al. 1982, 82) who suggested, based on the location of the deposit between burials VI and VII, that these artefacts might have been devoted to a deceased person. It is not novel to connect the items frequently found at graves deposited separately without any accompanying body or within human-sized pits being interpreted as cenotaphs. There are other hunter-gatherers sites in Europe – e.g. Skateholm II (dog burials representing people, Larsson 1989), Ajvide (Fahlander 2003, 98, 108–109), and Vedbæk Bøgebakken (Orme 1981, 244), – where among primary inhumations also cenotaphs have been observed both based on the character of the structure (observable pit) and the composition of the deposited artefacts.

However, none of the above examples proves the practice of cenotaphs being part of the mortuary repertoire of Stone Age hunter-gatherers in Estonia. These cases also do not prove the opposite – the absence of mortuary rituals related to individuals whose bodies were not available. Thus, at the moment the question of cenotaphs remains open. The wider cultural background and the variability of the ways of handling the dead allow suggesting that a cenotaph might have been an option for granting a proper journey for a remotely located deceased person and regain order in the community. Graves found farther from residential sites, however, might be in disagreement with this assumption, but do not have to if we consider variation being part of the norm.

7.2.1.3. Invisible practices – different forms of primary burials

Based on ethnographic examples, Ucko (1969, 264) has argued that despite the existence of specially designated burial areas it is not uncommon to have *"an attitude to burial simply as a means of disposal".* These "means of disposal" must have still had a ritualising character, and could have varied considerably. Most of these probably left no archaeological evidence. The abundant ethnographical accounts have allowed us to observe mortuary practices such as disposing articulated/disarticulated bodies into water, leaving bodies above the ground, or on top of platforms, hanging bodies from trees, or sending them away to the sea on a boat, etc.

Of course, without any archaeological evidence it is impossible to prove the existence of any of these here. However, Jonuks has proposed within the context of abundant tooth pendants found at Tamula that these might have been associated with former above-ground burials (Jonuks 2009, 130–131). Thus, the deceased bodies faded, but the tooth pendants sank into the cultural layer and were conserved. His hypothesis is hard to verify, but it is a likely option if we consider Tamula as a place just for dead. Moreover, if we return to the story told by Wallis (2013[1993]) we could easily assume that the elderly left behind by the tribe might have died in solitude without any significant mortuary rituals carried out.

Besides, the overall climate at the forest zone Europe and local environmental conditions (e.g. high groundwater level as an explanation for adding wooden beddings to the graves at Tamula) must have dictated the possibilities of disposing the bodies. As exemplified above by the case of 18th–19th century Finnish burials (Núñez 2015), we cannot underestimate the role of the frozen ground and snow cover in delaying burial. As argued earlier, a rather rapid response was required when a corpse emerged. Thus, a plausible scenario in the case of a sudden death of a group member during a wintertime hunting trip would be an above-ground disposal. Even then the "life-like" image of the deceased could have remained, as the group must have moved about in the landscape after the necessary mortuary rituals were conducted.

Although we have no archaeological evidence, just a tentative demographic estimation to prove the absence of the vast majority of hunter-gatherers in the archaeological record, we have to consider that other mortuary rituals were frequently practiced (see also Jaanits 1961a, 69). Yes, their form remains unknown to us. But similarly to the "lithicless ghost settlements" within settlement archaeology (Grøn 2015), considering the invisible practices of the hunter-gatherer mortuary repertoire permits a more realistic picture of the world of Stone Age hunter-gatherers.

7.2.1.4. Research bias

In addition to the differentiated practices such as invisible primary burials or burials in multiple episodes and cenotaphs, one should also account for research biases. Not all the burial places are known to us, or we have not opened the right parts of the studied settlements. A good example of a burial place still to be discovered from Estonia is the settlement and burial site found at Tooma during the field survey in 2011 (Vindi 2015). From the 4th shovel-width test pit, skull and teeth fragments were found. As soon as the excavators realised that these belonged to a human, digging was stopped (Tõrv & Ots 2012, 270, 276; Vindi 2015). Based on the finds (flint flakes and ceramics), it was assumed that the site belongs to the Stone Age. To verify this assumption, a cranial fragment was dated in the framework of the present study, indicating that the burial belongs to the 4th millennium cal. BC (Table 20). Looking at the pattern visible here – co-existence of settlement finds and human remains – it is likely that more burials were interred there. However, the specific character of the site remains to be investigated in the future.

Considering the history of research, in general, no drastic shifts in the practice of archaeology has occurred. However, as shown in Table 12, the capacity of excavations has changed considerably. The excavation plots opened during 1930 until the end of Soviet Era exceeded the size of the ones exposed today from 10 up to 100 times. This probably explains why most of the known inhumations were recovered back then. Thus, we cannot be entirely sure that the settlement sites excavated from the 1990s do not have any mortuary features in them. We just may have poorly placed our excavation plots regarding burials.

What is more, we do not know where to look for solitary burials or proper cemeteries. As the present study clearly shows, most of the known burials come from simultaneous settlement sites. However, some of the burials have been executed in remote places such as Jalukse, Kõljala, Külasema Metsikumäe, Sindi-Lodja, Veibri and Võru. These all have been incidental finds and not a result of a strategic search. We certainly have the know-how to locate new occupation sites, but we are far from locating solitary burials or separately standing cemeteries in the present landscape. The patterns just are not as clear, and thus, these sites are without any doubt underrepresented in our sample.

7.2.1.5. Conclusions

In summary, to understand the core of mortuary practices one needs to acknowledge the fact that both the primary inhumations and burials in multiple episodes represent a fraction of the once available and acceptable mortuary rituals. Leaving aside the question of research bias, one could argue that the idea of leaving a corpse somewhere in the hunter-gatherer landscape did not imply a lack of concern for the dead. First, it is not supported by ethnographically known practices (Ucko 1969, 270) and it could have easily been that the body was the departure point regarding mortuary rituals and thus the meaning of the place was created through these practices. Therefore, we could argue that the practices that we do not have any archaeological evidence for were just as much as part of the mortuary norm as the ones studied archaeologically. The tension between archaeologically visible and invisible practices, however, should be kept in mind while making conclusions about the core of hunter-gatherer mortuary rituals.

7.3. Core of mortuary practices – from function to the underlying structures

Drawing from the change and invariability of mortuary practices depicted in *Chapter 6* I argue that the core of the hunter-gatherer mortuary practices in Estonia was upheld until the mid of 3rd millennium cal. BC, similarly to the life ways (i.e. consistency in world view, no change in subsistence strategies, e.g., the continuous importance of freshwater fishes and marine mammals/fishes and no clear evidence arguing for agriculture) of hunter-gatherers. What constitutes this core?

7.3.1. Function of hunter-gatherer mortuary rituals

Differently from the power of archaeothanatological analysis to identify ways of handling the body one can only assume the overall function of hunter-gatherer mortuary rituals. The ethnographic examples and social theories, however, allow suggesting that these in general represent the idea that the deceased remained human to the bereaved: *"To be excluded from this final treatment might mean being excluded from humanity"* (Nilsson Stutz 2014, 270). Moreover, mortuary rituals were and are about excluding a person from the living and incorporating her/him to the realms of dead, the ancestors. This must not have been different within hunter-gatherer societies. However, some examples of fully articulated dog burials for example from Skateholm (Larsson 1993) and Dudka (Guminski 2015) raise the question of what it meant to be human and whom was perceived as an ancestors in those times, as discussed by Chris Fowler (2004).

The overall function usually remains unchanged (Raud 2013), and the proper handling of the body is directed by the norms of a particular culture. Moreover, mortuary rituals conform to and (re)create the cosmology of the group (e.g. Nilsson Stutz 2003). Probably this has not been significantly different in Stone Age hunter-gatherer societies in Estonia where death was omnipresent, and thus a more practical matter than we are used to think in our own 21st century Western societies.

Apart from the primary aim of the mortuary rituals, these may have served other purposes. These might have been arenas for creating socio-economic and political alliances (e.g. Hayden 2009), been places for information exchange (e.g. Hayden 2009), act as claims for land ownership (see above), and/or presenting the wealth of the mourners/deceased (e.g. Hayden 1990; 2009; Parker Pearson 2012[1999]). Whether any of the mortuary rituals presented in this thesis served any of these purposes cannot be said with certainty. The possibility of mortuary rituals being a larger social event or signify territories of specific hunter-gatherer groups will be discussed below to some extent. Despite the fact that the objectives of single mortuary rituals may differ from one another, their main aim or function was to grant a proper farewell for the deceased and to maintain or regain order in the community. However, the ways of achieving this, i.e. the proper handling of the death, were variable within and among hunter-gatherer communities.

7.3.2. Gradual changes instead of outbreaks – who partake mortuary rituals

People and their structured actions underlie the maintenance and change of practices. The underlying structures of practices were known to all the participants allowing repetition, i.e. maintenance, and brought about changes (see *Chapter 2.2.1.2.*). Who were performing mortuary rituals? Raud (2013) has pointed out that even in the most loosely structured societies, not all the members could have executed all cultural practices. Their roles are prescribed by the norms. This means that some individuals are more active (conductors) than others (audience). Whether the hunter-gatherer mortuary practices were open to the whole community or restricted to a group of specialists is rather difficult to detect in the archaeological record. An additional issue is whether the changes brought about during mortuary rituals were rapid or gradual. The frameworks of ritual theory and ethnographic examples together with the here-observed material allow some tentative appraisals.

It has been argued that death is less disruptive in the sense of demography in modern societies, yet its consequences are more disturbing for the bereaved individuals (Palgi & Abramovich 1985, 405 and the references therein). Following this line of thought, one could argue that Stone Age hunter-gatherers were most probably affected by the death of a group member as a whole, whereas their individual acts and grief must not have been clearly materialised. This, of course does not mean that they did not feel sorrow, or did not express their devastating feelings. The words of a !Kung woman Nisa who had just lost her husband demonstrate this vividly: *"I picked up my infant son, and that was when my crying began. I sat there and cried and cried and cried"* (Shostak 2002[1981], 189). Taking this into account, as well as the fact that archaeologically observable mortuary practices were conducted on hunter-gatherers of both biological sexes and a range of age groups as was shown in *Chapter 5.1.*, it is plausible to assume that mortuary rituals in general were executed by the whole group, thus being rather open practices in these societies. The openness of mortuary practices – all the members of the community from toddlers to elders were allowed to participate – becomes more evident if we take a look at the unchanging or gradually changing structures underlying these rituals. Both in sites repeatedly used for burials and in solitary graves, death required rather rapid response, whereas the emergence of the body must have been considered as a departure point for the resulting practices. However, the treatment of the dead might have varied considerably, as did body ornamentation and any additional grave features. This was the changing nature of the unchanging mortuary practices of Stone Age hunter-gatherers in Estonia.

However, the locales were mortuary rituals were conducted might have had an effect on the range of participants. For example while analysing the LKB burials in Bavaria, Germany of both cemeteries and settlement sites, a clear patterning was observed in cemeteries, in contrast to more variability in burials found in settlements. Archaeologists interpreted these discrepancies with differences in the audience, arguing that larger groups attended the rituals undertaken in cemeteries, but those executed in settlements were accompanied only by close kin (Pechtl & Hofmann 2013, 133). Similarly to the Bavarian case, it is highly probable that different people engaged in mortuary rituals at residential sites at Tamula, Kivisaare, Kõnnu, Naakamäe and Narva Joaorg compared to sites with solitary burials at Veibri, Kõljala, and Külasema Mestikumäe. It is plausible to assume that at settlements a larger group could have gathered, perhaps not only the residents of a particular site, but also people from the nearby settlements, to conduct more elaborated mortuary rituals. Moreover, it could be assumed that not all the participants had an active role. They rather formed an audience who participated in these rituals through their presence. To exaggerate one might even picture something similar to the *"excessively lavish funeral feasts"* held in many agricultural and trans-egalitarian societies at Thailand, Indonesia, New Guinea, Polynesia, and South Asia (Hayden 2009).

Mortuary rituals conducted farther from the residential sites could have had fewer participants. As argued above, these sites could be regarded as places where death occurred while being on the road and thus not the whole community must have been present. This further suggests that all the participants had an active role. However, as the mortuary practices undertaken in remote areas were similar to those observable in settlements, one could argue that the bereaved who buried the dead in these locales must have taken part of mortuary rituals held in their residential sites to obtain their habitus in mortuary rituals.

Moreover, one could assume that different kinds of mortuary practices required various kinds of participants. As we observed in *Chapter 2*, in the context of the 20th century mortuary rituals in Estonian villages, not all the practices were undertaken by the same people; a range of taboos existed. For example, washing the corpse was conducted by the neighbours, not by the close kin, guarding the body was undertaken in turns, and not all the members of the family participated in the most populous part of the mortuary ritual, which is the funeral procession to the church and cemetery. Although it is difficult to reveal such practices in the context of hunter-gatherer mortuary rituals, a number of single practices that might have been performed by different group members could be assumed. For instance digging the grave and wrapping the body into hides or bark might have happened simultaneously. Also padding the grave pit with bark, constructing additional structures, and backfilling the grave might have been undertaken by various group members. Probable taboos connected to the body might have restricted the circle of people directly handling the corpse (e.g. wrapping and covering the body with hides/bark, arranging it in the grave, re-opening graves, and post-depositional manipulation of bodies). These restrictions, however, do not have to mean that the rest of the group was omitted from these practices. Instead, they might have obtained their habitual behaviour through observation, not through active participation.

Despite the general openness of mortuary rituals, it could be assumed that some of the practices were undertaken by a ritual specialist. Based on exceptional characteristics of burials it has been argued in the case of Olenii Ostrov (Gurina 1956; O'Shea & Zvelebil 1984), Zvejnieki (Zagorska 2000; 2001; Zagorska & Lõugas 2000), Skateholm (Schmidt 2000; Strassburg 2000), Vædbak Bøgebakken (Meiklejohn et al. 2000; Zvelebil 2010[2008], 50), Janislawice and Donkalnis (Zvelebil 2010[2008], 50), and Bad Dürrenberg (Porr & Alt 2006) that some graves entailed shamans. This interpretation has been proposed in the context of richly adorned graves at Tamula and Valma, too (Jonuks 2009, 122). The idea of Late Mesolithic and Neolithic shaman graves conforms with the idea of an animistic worldview that has been advocated by Peter Jordan and Zvelebil, departing from the Khanty worldview where shamans were considered the agents of change (Jordan 2001; Zvelebil 2010[2008], 52). We could argue that those practices that rarely occur in archaeological material – such as the active defleshing of corpses at Narva Joaorg and/or the controlled reopenings of primary burials and post-depositional manipulation of bodies at Tamula – could have required the active participation of shaman-like individuals.

7.3.3. Conclusions

Stone Age hunter-gatherers were familiar with death. The commonality of the structuring principles of mortuary rituals and their relatively long-lived character suggests that mortuary practices, in general, must have been open practices in hunter-gatherer societies. To gain cultural knowledge about the proper way of handling the dead, even small children must have taken part of these rituals, first probably as more passive audience members, and with the growth of cultural competency about mortuary rituals, their role in them grew, too. However, it seems plausible that the quantity of participants in mortuary rituals executed on residential sites varied from those at remote locales. Moreover, it is highly likely that some of the practices – such as active defleshing corpses and/or controlled reopenings of graves and post-depositional manipulation of bodies – were reserved to be undertaken by a ritual specialist such as a shaman.

7.4. Conclusions: the omnipresent death and the variety of responses to it

The long-term perspective in analysing single mortuary practises has revealed that the norm of mortuary rituals of hunter-gatherers might not be straightforward. However, this does not indicate that a ‘common thread’ did not exist or that the structuring principles cannot be revealed. Departing from the archaeothanatological and biochemical analysis of the skeletal samples from Estonia, I have proposed that the core of mortuary rituals of Stone Age hunter-gatherer was upheld during the period of c. 6500 to 2600 cal. BC and consisted of five structuring principles. These are (1) the familiarity with death in hunter-gatherer societies, (2) a death resulting in an immediate response, (3) the body as a departure point in mortuary practices, and (4) variety as the norm in the direct handling of the deceased. Finally, (5) mortuary rituals could be described as open practices, which allow gradual changes over the long term.

Death was omnipresent, which is rather different from our experiences today that tend to hide it through institutionalising the practices. The death of a group member must have affected the whole community, not only the closest kin. Being part of the everyday life of hunter-gatherers also meant that no strict (physical) separation from the world of the living was made. We observed that the majority of the primary inhumations and also loose human bones had been found in the occupation layers. Moreover, the remote places with evidence of mortuary rituals further indicate that the occurrence of death while moving about in the landscape was not unknown. These places form a part of the dynamic landscapes of hunter-gatherers and signal the semi-mobile life of these people. Moreover, in addition to the solitary graves and cemeteries, these landscapes must have entailed a range of mortuary rituals that remain invisible to our eye.

The dominance of primary inhumations in the archaeological record not only demonstrates research bias, but also indicates that death must have been handled without a significant delay in these societies. The immediate response to the emergence of the dead body should be seen as one of the structuring principles in hunter-gatherer mortuary rituals. It may not have been as instantaneous as Nisa the !Kung woman describes: *"I slept a long time. Just before dawn was about to break, I got up and left the village; /.../ I sat in the bush and started to miscarry. /.../ I sat there and soon it came down. I didn't see the baby, just blood. I broke off a branch, dug a big hole, and buried it – the blood with the little thing inside."* (Shostak 2002[1981], 187), but prompt enough to maintain the "life-like" image of the deceased.

This being said, we can move on to the next structuring principle of mortuary rituals. As the bodies were interred where the death occurred, irrespective to the initial significance of the place, we may argue that the emergence of the dead body itself was the departure point for the succeeding rituals. Probably the identities of the deceased, the circumstance of the death, the cosmologies of the group, and/or other aspects of culture unknown to us framed the appropriate line of practices undertaken. These appropriate ways varied: in some instances it was important to wrap the bodies, and in other cases the bodies were supported by additional structures in grave pits; some of the dead also received grave goods attached to their bodies. To my mind, the spatial distribution of sites with mortuary remains indicates that these locales were structured and meanings given to them through the execution of mortuary rituals, not the other way around.

The immediate and direct handling of corpses during the mortuary rituals, however, may or may not have left any archaeologically observable evidence. We observed that not all the loose human bones were the outcome of repeated use of burial sites and thus results of destroyed primary inhumations. Instead, I was able to prove that a continuous interest toward some of the dead was upheld, and the active defleshing and post-depositional manipulations were part of the mortuary repertoire. Moreover, taking also the plausible cenotaphs and archaeologically invisible practices together with the variety of additional grave structures, wrappings, and grave goods into account, I argued that variation in these practices was considered as being part of the norm in hunter-gatherer mortuary rituals. Or as shown ethnographically *"/.../ in the vast majority of cases known ethnographically, a culture or society is not characterized by one type of burial only, but that, on the contrary, one society will undertake several different forms of burial /.../"* (Goody 1959 referred in Ucko 1969, 270). In the present context, the variability as a norm is further illustrated by the fact that we were not only able to observe temporal and spatial differences in mortuary rituals (e.g. abundance and composition of grave goods), but these were present within single burial sites, becoming most obvious at Tamula. Moreover, one cannot entirely exclude the possibility that leaving members of a community behind to die due to a winter famine or other dire reasons as described by Wallis (2013[1993]) was part of the normative handling of death among hunter-gatherers in Estonia.

Mortuary rituals were open practices, accessible to toddlers and newcomers, not to mention the senior members of the group. We have observed that archaeologically visible mortuary rituals were available to both sexes and to a range of biological age groups. Why should we then assume that there were any restrictions on who partake these rituals? We have also seen that the core principles of mortuary rituals have remained the same throughout the period under discussion. Even if we assume that some of the practices were conducted by specialists (e.g. reopening of graves and disarticulating bodies), the openness of these rituals allowed children and newcomers to acquire their cultural competency on how to properly handle death within hunter-gatherer societies through observation and active participation. This knowledge was passed on to the next generation, thereby allowing gradual changes. Compared to other cultural phenomena in hunter-gatherer societies (e.g. technological choices, preferences of raw materials, first attempts to cultivate the land?), the tempo of changes in mortuary rituals was not as quick. The changes that might have been perceived by the people participating in these rituals are thus not clearly visible for us in the material culture. Thus, as we observed, the core of mortuary rituals described within this thesis persisted from the mid of 7th millennium until the mid of 3rd millennium cal. BC. The gradual changes within these rituals remain almost invisible in archaeological record.

SUMMARY

This thesis was about hunter-gatherer mortuary practices in Estonia during the time period of c. 6500–2600 cal. BC. In *Chapter 1*, as a starting point for the current research, a brief overview of the research history was given and the questions of the present thesis posed. It was asked how was death handled in hunter-gatherer communities during the Late Mesolithic and Neolithic in Estonia. What was the norm throughout the c. four millennia time span? Did it change, and if so, how? A secondary focus of the thesis was set on the buried themselves, namely their primary identities: age, sex, and dietary biography.

In *Chapter 2*, the theoretical grounds were set. As a departure point for understanding mortuary practices and people behind the burials, the ‘body’ representing material culture was chosen. It was regarded as being a historical and cultural construct, but also a biological and physical reality. Its intertwined duality allowed seeing the body as a medium by which one perceives, experiences, and changes the surrounding world. Through the application of practice theories, we observed that the maintenance and change of the world came about through practices within specific contexts. Thus, mortuary rituals were both enacted by the bodies, but also formed and (re)shaped the bodies.

Chapter 3 gave an overview of the toolkit applied to answer the above-posed questions. A multi-disciplinary approach to detect Stone Age mortuary rituals and the people themselves was chosen to demonstrate the potential of the human remains that have been excavated and documented decades ago. The application of post-excavational archaeothanatology, together with the application of a range of biochemical methods and fundamental osteological research, allowed the hunter-gatherer mortuary practices to be explored from different perspectives.

In *Chapter 4*, all the sites under study were presented. From the source critical point of view, it was stressed that every single site must be viewed separately and the representativeness of its material evaluated case-by-case. It was shown that the quality and quantity of finds depend on a variety of factors, including the discovery of the site, the excavation of the site, and the post-excavation treatment of the finds. The old excavation data raises questions, and not all the features with human remains could be re-analysed by the application of archaeothanatology. However, these old finds are valuable in answering the posed questions, and the restrictions given by the source material should not be seen as limitations, but as a challenge that could be faced with proper discussion about the source criticism of every single site and burial.

Chapter 5 summarised the results of osteological research, stable isotope research, and human bone radiocarbon dating analysis. It was demonstrated that both sexes and all age groups were chosen to be inhumed or their bones scattered around settlement sites. It became clear, however, that these people do not represent the entire population, but make up only a small part. This becomes especially clear with the new radiometric dates from human collagen that indicate that the mortuary remains included in the present study come from a wide period: 6500–2600 cal. BC. The low number of inhumations and loose human bones suggests that those who received mortuary treatments that leave archaeological evidence were carefully selected. However, this selection was not based on their biological attributes such as sex and/or age. The relative homogeneity of the stable isotope data within populations also implies that dietary differences were not correlated with this selection. Stable isotope analyses suggest that two major groups with distinct dietary preferences co-existed: (1) predominantly sedentary fishers and (2) sedentary hunters of marine fishes and mammals, and only maybe and then occasionally 'incipient tillers'.

Chapter 6 demonstrated the potential of archaeothanatology to use old excavation data to reveal single practices. Despite some limitations that are mostly due to the insufficiency of excavation data, this approach allowed the re-analysis of roughly one-third of the sample. This analysis revealed that the following mortuary practices are visible in the archaeological record: (1) the burials and loose human bones were found in the occupation layers of settlement sites; (2) primary inhumations were most dominant and considered as norm; (3) these were mostly designated for a single person but several multiple burials were present; (4) the integrity of the body was maintained during the primary inhumation but single cases allow concluding that primary burial was just one phase in the row of practices (e.g. reopening of graves, removal of body parts, defleshing); (5) in the case of primary inhumations, shallow graves with no additional structures were used; these were backfilled immediately after the deposition of the corpse; (6) only occasionally were additional structures made of organic materials used to pad the grave cuts and wrap the bodies; (7) we observed a variety of body positions within and among hunter-gatherer groups; and (8) sometimes the deceased were accompanied by grave goods.

In the final chapter – *Chapter 7* – mortuary rituals were examined from a long-time perspective that revealed that the norm of mortuary rituals of hunter-gatherers might not have been straightforward. However, departing from the archaeothanatological and biochemical analysis of the skeletal samples from Estonia, I have proposed that the core of mortuary rituals of Stone Age hunter-gatherers was upheld during the period of c. 6500 to 2600 cal. BC and consisted of five structuring principles. These are (1) the familiarity with death in hunter-gatherer societies, (2) death resulted in an immediate response, (3) the body as a departure point in mortuary practices, and (4) variety as the norm in the direct handling of the deceased. Finally, (5) mortuary rituals could be described as open practices, which allow gradual changes over the long term.

ABBREVIATIONS

Institutions

AI = TLU AI – Archaeological Research Collection of Tallinn University.
CAMS –Center for Accelerator Mass Spectrometry, USA.
Hela – Laboratory of Chronology, Department of Physics, University of Helsinki, Finland.
KIA – Leibniz-Laboratory for Radiometric Dating and Isotope Research, Christian-Albrechts University at Kiel, Germany.
MAE RAS – Museum of Anthropology and Ethnography, Russian Academy of Sciences, Russian Federation.
NLM – Archaeological collections of the Narva Museum, Estonia.
LuS – Lund University, Sweden
Poz – Poznan Radiocarbon Laboratory, Poland.
SM – Archaeological collections of the Saaremaa Museum, Estonia.
TA – Geobiochemical Laboratory of the Institute of Zoology and Botany, Academy of Sciences Estonian S.S.R., Estonia.
TÜ – Archaeological collections of the Chair of Archaeology at the University of Tartu, Estonia.
TÜ AK – Archaeological archives of the Chair of Archaeology at the University of Tartu, Estonia.
TÜR – Library of University of Tartu, Estonia.
U – Uppsala, Sweden
Ua – Department of Physics and Astronomy, Uppsala University, Sweden.
UBA – CHRONO Centre for Climate, the Environment, and Chronology, Queen's University Belfast, United Kingdom.
VM – Archaeological collections of the Võrumaa Museum.

Publications

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OPIA – Occasional Papers in Archaeology. Uppsala: Uppsala University, 1989–.
SMYA – Suomen Muinaismuistoyhdistyksen Aikakauskirja, I –. Helsinki, 1874 –.

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SUMMARY IN ESTONIAN

Praktikate püsivus. Multidistsiplinaarne uurimus küttide ja korilaste matustest Eestis, ajavahemikul 6500–2600 aastat eKr

Käesoleva töö keskmes on küttide ja korilaste matmispraktikad. Erinevalt varasematest töödest, mis seadsid fookuse üksikutele arheoloogilistele kultuuridele ning nende matmispraktikate erisuste väljatoomisele, vaatab käesolev töö matuseid pikas ajalises perspektiivis, kaasates analüüsi esimesed inimsäilmed ajast u. 6500 eKr, kuni küttide ja korilaste matmisviiside hääbumiseni u. 2600 aastat eKr. Ühtlasi ei keskendu siinne töö palju-uuritud hauapanustele ega nende tähendustele, vaid toob esiplaanile surnukeha ning sellega ümberkäimise matusetalituse käigus, eesmärgiga tuvastada kultuuriüleseid praktikaid ning sõnastada küttide ja korilaste matmisrituaali norm.

Esimene peatükk annab põgusa sissevaate varasemasse uurimistöösse, seades lähtealuse käesolevale. Oluline on mõista, et siinne töö põhineb varasema kaevamismaterjali taaslugemisel, mis seab teatud piirangud küsimuseasetusele ning analüüsi täielikkusele. Samas annab väljakaevamiste järgselt unustusehõlma vajunud luustike fookusesse tõstmine uusi teadmisi kiviaja küttide ja korilaste matmispraktikate kohta. Lähtudes maetutest ja nende füüsilistest säilmetest, on töö kõige laiemaks küsimuseks, kuidas käitusid kütid ja korilased kaaslase surma korral. Selleks, et antud küsimusse selgust tuua, käsitlen seda väiksemate osade kaupa:

(1) Millised matmispraktikaid küttide ja korilaste kogukondades esines?
(2) Kuidas surnukeha matmisrituaalide jooksul koheldi?
(3) Millised olid maetute esmased identiteedid (bioloogiline sugu ja vanus, elatusallikad), kas ja kuivõrd on need mõjutanud matmispraktikaid?
(4) Kas ja mil määral matmispraktikad ligi nelja aastatuhande jooksul muutusid?

Vastavalt püstitatud küsimustele on töö jaotatud temaatiliselt kaheks. Esimene osa tegeleb osteoloogiliste meetodite ja isotoopanalüüside rakendamise kaudu surnute identiteetide (taas)loomisega, teine aga keskendub matmispraktikate detailsele rekonstrueerimisele. Nende kahe süntees võimaldab arutelu praktikate normi üle ning koos radiosüsiniku dateeringutega käsitleda nende muutust ja muutumatust pikas ajalises perspektiivis.

Teises peatükis arutletakse töö teoreetiliste lähtekohtade üle, mille aluseks on Bourdieust lähtuvad praktikate teooriad, mis võimaldavad käsitleda üksiksündmusi osana suuremast süsteemist. Matuseid vaadatakse kui üht kultuurilise praktika vormi, mis alluvad kindlatele reeglitele ning mille käigus luuakse, levitatakse ning säilitatakse kultuurilisi tähendusi. Tähelepanu keskmes ei ole erakordne, nagu arheoloogias sageli tavaks on, vaid korduv ja püsiv, ehk see, mis on habituaalne küttide ja korilaste matmispraktikates. Matmisrituaalide tuuma avamiseks keskendutakse eelkõige viiele praktikate materiaalsele aspektile, milleks on matuste paiknemine kultuurmaastikul (ptk. 4), üksikute matuste olemus (ptk. 6), surnute arv ja nende ajalise seose määratlemine ühes kontekstis (ptk. 5 ja 6), lisastruktuurid hauas (ptk. 6) ning arheoloogiliselt nähtamatute ja nähtavate praktikate proportsioon (ptk. 7). Praktikate materiaalsed aspektid, mis saavad nähtavaks eelkõige surnukehas (siin: luustik), mida käsitletakse materiaalse kultuuri osana, juhivad meid arutlusele matuserituaalide funktsiooni ja eesmärkide üle, samuti mehhanismide üle, mis säilitavad, levitavad ja kutsuvad praktikates esile muutusi. Viimaste üle diskuteeritakse matuserituaalides osaleda võinud kogukonna liikmete vahendusel. Nende küsimuste kaudu jõutakse matmisrituaalide põhisisu tuvastamise ja sõnastamiseni.

Kolmas peatükk tutvustab arheotanatoloogiat, mis on tafonoomial, anatoomial/osteoloogial ning arheoloogial rajanev käsitlusviis matuste uurimise kohta, mis seab fookusesse inimkeha. Arheotanatoloogiline lähenemine on kaheetapiline analüüs, mis hoiab kirjelduse ja tõlgenduse teineteisest lahus. Esmalt esitatakse luustiku detailne anatoomiline kirjeldus, mis omakorda on aluseks hilisemale algse matusesituatsiooni 'tihedale kirjeldusele'. Üksikud matused on omakorda aluseks küttide ja korilaste matuserituaalide normi selgitamisel. Et ideaalis rakendatakse arheotanatoloogiat välitöödel, siis arutletakse selles peatükis ka meetodi sobilikkuse üle vana kaevamisdokumentatsiooni taasanalüüsil. Samuti antakse kriitiline ülevaade kasutatud osteoloogilistest (kollektsioonide kirjeldus, bioloogiline sugu ja vanus) ja biokeemilistest meetoditest (stabiilsete isotoopide analüüsid ja luukollageeni dateerimine radiosüsiniku meetodil). Need on aluseks küttide ja korilaste esmaste identiteetide rekonstrueerimisel ning üksikute matuste dateerimisel.

Neljas peatükk käsitleb kõiki Eestis teadaolevaid küttide ja korilaste matmispaiku. Viimaste all on silmas peetud nii selliseid, kust on leitud terviklikke luustikke kui ka üksikuid inimluid. Muistiseliikide põhjal võib need paigad jagada kolmeks. Terviklikke luustike on leitud asulakohtadest, samuti eraldiseisvatelt muististelt (kalmistud või üksikmatused); üksikuid inimluude katkeid, millest vähemalt mõned kontekstid moodustavad osa küttide ja korilaste matuserepertuaarist, on samuti leitud asulakohtade kultuurkihist. Et käesolev töö põhineb varasemalt kaevatud ja uuritud matmispaikadel, ei ole kõik matused allikatega – tekstiliste ja visuaalsete välitööde materjalidega – ühtlaselt kaetud. Kaevamisjärgse arheotanatoloogia nõuded allikatele tingivad selle, et kõiki neljandas peatükis välja toodud paiku edasises töös süvitsi ei analüüsita. Umbes kolmandik töösse hõlmatud materjalist võimaldab arheotanatoloogilist süvaanalüüsi; ülejäänud teated matustest moodustavad aga taustafooni, võimaldades realistlikumat pilti toonastest matuserituaalidest.

Viies peatükk esitleb osteoloogiliste, stabiilsete isotoopide ja radiosüsiniku analüüside tulemusi, luues tausta arheoloogiliselt tuvastatavatele maetutele. Luukollektsioonide terviklikkuse ja fragmentaarsuse analüüs näitas, et suuremast osast luustikest on hoidlates alles üksnes kuni kolm neljandikku. Üksikute inimluude kogumid võivad aga sisaldada vaid ühte luukildu. Selline olukord raskendab nii soo kui ka vanusemääranguid; enamgi veel, vaagnate sage puudumine haudades (väljakaevamistel kasutatud metoodikaga seonduv) muudab problemaatiliseks arheotanatoloogilise analüüsi terviklikkuse. Osteoloogilised analüüsid näitavad, et esineb nii laste kui ka naiste ja meeste terviklikke luustikke, aga ka kõigi nende üksikuid luid. Stabiilse süsiniku ja lämmastiku isotoopide uuringud näitavad selgelt, et sisemaa ja Saaremaa inimeste toidubaas oli püügimajandusliku tagapõhjaga, kusjuures sisemaal domineerivad mageveekalad ning Saaremaal merekalad ning -imetajad. Samuti selgub, et sisemaa matmispaikadesse maetud inimeste toitumus on teineteisest statistiliselt erinev, viidates paigatruudusele. Enamgi veel, Tamula matmispaiga kogukonnasisesed isotoopnäitajad on niivõrd homogeensed, et võivad viidata tõsiasjale, et sellesse asulasse on matnud vaid ühe kogukonna liikmed. 26 uut adiosüsiniku dateeringut inimluu kollageenist näitavad, et küttidele ja korilastele omased matmisviisid saavad Eesti alal arheoloogiliselt nähtavaks juba umbes 6500 eKr (Narva Joaorg) ning püsivad umbes kuni 2600 eKr (Tamula ja Naakamäe).

Kuues peatükk esitleb kaevamisjärgse arheotanatoloogia tulemusi. Arheoloogiliselt nähtavate matmispraktikate seas domineerib selgelt maahaudadesse asetatud esmane laibamatus. Seda nii samaaegsete asulate territooriumil kui ka eraldi matmispaikades. Esmane laibamatus tähendab, et surnuga on tegeletud võrdlemisi kohe pärast surma konstateerimist ning ühe tseremoonia vältel. Samuti on maahauad, kuhu surnukehad asetati, pinnasega täidetud kohe pärast surnu sängitamist. Valdavalt peegeldab luustike asend ka surnu algset asendit hauas, seda eriti juhtudel, kus haua täitepinnas on laiba lagunemise käigus tekkivad tühimikud täitnud järk-järgult. Vaadeldud perioodil on surnute algse kehaasendi osas esindatud mitmed variandid. Domineerib selili-siruli asend, kus nii üla- kui ka alajäsemed on välja sirutatud, mõnel juhul on aga jalad puusast ja/või põlvedest kõverdatud ning asetatud paremale või vasakule küljele. Surnute asetamist vasakule või paremale küljele tuli ette harva, ent sellise tava esinemine näitab, et kägarmatuseid ei saa seostada üksnes nöörkeraamika kultuuridega. Vaatamata sellele, et valdavalt on hauda asetatud vaid üks indiviid korraga, tuleb ette haudu, kuhu on üheaegselt asetatud kaks või enam surnut (Kivisaare, Kõnnu, Tamula ja Veibri). Kollektiivmatustest, mis viitaksid surnukehade eriaegsele asetamisele ühte struktuuri, hetkel kindlad andmed puuduvad. Selliste pratkikate olemasolu võib aga üksikjuhtudel oletada Kivisaares ja Valmas. Harva esines olukordi, kus esmaste laibamatustega haudu on lõhkunud needsamad kütid ja korilased. See omakorda näitab, et varasemad matused on leinajatele teada ning haudade puutumatust on oluliseks peetud. Hauad ise olid madalad ja valdavalt ilma igasuguste sisemiste lisastruktuurideta. Samas näitab nii arheoloogiline materjal kui ka arheotanatoloogiline analüüs, et mitmeski hauas on algselt olnud kas puidust ja/või tohust või mõnest muust orgaanilisest materjalist kosntruktsioon. Eelkõige on need asetsenud surnukehade taga. Samuti näitab arheotanatoloogiline analüüs, et mitmedki surnud on enne hauda asetamist olnud tugevalt mähitud kas loomanahkadesse või tohtu. Lisaks esmasele laibamatusele võib üksikute inimluude taustal arutleda mitme-episoodiliste matmispraktikate olemasolust küttide ja korilaste kogukondades. Nagu näeme, siis valdavalt on üksikute inimluudena leitud koljude katkeid, mis viitab surnu pea erilisele rollile ning sellega seotud praktikatele toonastes ühiskondades. Koljude või inimpeadega seonduvaid matmispraktikaid on täheldatud mujalgi Euroopas. Mitme-episoodilised praktikad on varieerunud, hõlmates aktiivset liha eemaldamist luudelt (Narva Joaorg) ning esmaste laibahaudade avamist ja sekundaarset surnukehadega manipuleerimist (Tamula). Kirjeldatud praktikad ning asjaolu, et mitmetesse haudadesse on asetatud panuseid, demonstreerivad küttide ja korilaste matmiskombestiku keerukust.

Seitsmendas peatükis on kokku võetud teave surnute esmastest identiteetidest ning üksikutest matmispraktikatest ja nende ajalistest raamidest, et pöörduda sissejuhatuses püstitatud matmisrituaalide kvintessentsi küsimuse juurde. Lähtuvalt matuserituaalide materiaalsetest väljendustest küsitakse, kas kalmistud on ainsad matmispaigad küttide ja korilaste ühiskondades ning kas esmane laibamatus oli nende matmispraktikate tegelik dominant. Nagu juba eelpool öeldud, esinesid matused Eesti alal nii samaaegsete asulate kultuurkihtides kui ka elupaikadest eemalseisvatel matmispaikadel (kalmistud ja üksikmatused). Et suur osa matuseid on leitud toonaste elupaikade kultuurkihtidest ning ka üksikud matused võiksid markeerida paiku, mis jäävad küttide ja korilaste (sesoonsetele) rändeteedele, on välja pakutud, et küttide ja korilaste kogukondades olid elu ja surmaga seonduvad praktikad teineteisega tihedalt seotud. Vaatamata sellele, et arheoloogilises materjalis on ülekaalus esmased laibamatused, millele on ka varasemas uurimistöös enim tähelepanu pööratud, näitavad kokku alla 200 inimese säilmed ligi nelja aastatuhande pikkusest ajavahemikust, et vaid vähestele küttidele ja korilastele sai osaks seesugune surmajärgne kohtlemine. Selleks, et küttide ja korilaste matmisrituaale paremini mõista, tuleb tingimata arvestada nendegi praktikatega, mis arheoloogilisi jälgi ei ole jätnud. Käesolevas töös on näidatud, et lisaks esmastele laibamatustele olid paralleelselt kasutusel mitme-episoodilised matused, samuti on juba varem tähelepanu juhitud kenotaafide ja nn nähtamatute praktikate olemasolule toonastes rituaalides. Praktikate paljusust kui normi ühe kogukonna sees tõendavad ka paljud antropoloogilised uuringud. Samuti ei saa mööda vaadata arheoloogilise uurimistöö tendentslikkusest üldiselt, mis olemasolevat pilti kindlasti moonutab.

Sarnaselt antropoloogiast teadaolevale võib siingi eeldada, et matuserituaalide funktsiooniks oli eemaldada surnu elavate ühiskonnast vastavalt ettenähtud normile ning tagada kogukonna toimimine. Praktikate lähtepunktiks oli surnukeha ilmnemine. Erinevalt tänapäevast, kus lähedase surm on väga isiklik ning harva kogu ühiskonda raputav sündmus, oli ühe grupi liikme surm küttide ja korilaste ühiskonnas tervet rühma puudutav seik, mis omakorda vallandas rea toiminguid. Sellele reageeriti ühiselt. Surm ei seisnud lahus toonaste inimeste eludest, mida näitavad matused asulate kultuurkihis ning küttide ja korilaste rändeteedel. Oluline oli surmale reageerida koheselt, ent selleks läbiviidavad praktikad varieerusid. Mõned neist jätsid materiaalseid jälgi (esmased laibamatused, mitme-episoodilised praktikad ja kenotaafid), teised mitte (maapinnale jätmine, vette asetamine jne). Valdavalt oli oluline säilitada ettekujutus surnust kui veel elusast inimesest (esmased laibamatused), ent üksikutel juhtudel pöörduti maetute juurde tagasi, et nende säilmeid ühel või teisel moel manipuleerida.

Matuserituaalid olid avatud kultuurpraktikad. Nii nagu ei olnud arheoloogiliselt nähtavad praktikad kättesaadavad vaid ühe bioloogilise soo või vanuserühma esindajatele, nii on tõenäoline, et matuserituaalides osalesid kõik rühma liikmed alates imikust kuni raugani. Samas ei tähenda see, et neil kõigil oli aktiivne osa surnu kohtlemisel, ilmselt esines teatav rollijaotus (aktiivsed osalejad ja pealtvaatajad) ja pole ka välistatud, et üksikuid praktikaid, nagu nt matuste taasavamine ja surnukeha sekundaarne manipuleerimine, viisid läbi selleks ettenähtud spetsialistid (nt šamaanid). Samuti on tõenäoline, et asula territooriumil või kalmistul toimunud matuserituaalides oli osalejaid rohkem kui üksikute asulatest eemalseisvate matuste puhul, kus surnukeha ümber toimetasid vaid retkel viibinud inimesed. Selliselt olid matuserituaalid kohtadeks, kus lapsed ja kogukonna uued liikmed omandasid matmispraktikate normi, millest sai nende *habituse* osa. Millise tähenduse üks või teine kogukonnaliige kogetule andis, sõltus igast üksikust indiviidist ning tema taustast, samuti võis see iga konkreetse matusega muutuda; ühtlasi on seda tähendusloomet minu hinnangul pea võimatu arheoloogiliselt tabada.

Vaadates matuseid pikas perspektiivis, tõdeme, et drastilisi muutusi nende materiaalsetes väljendustes pole toimunud. Stabiilsus matustega seotud materiaalses kultuuris omakorda ei tähenda, et vaadeldud ligi nelja aastatuhande jooksul surnutega seotud praktikad ei muutunud. Olen näidanud, et ajas ja ruumis esines variatsioone (nt kehaasendid; variatsioone esines ka ühe matmisala piires). Samuti näeme, et 5. at lõpul eKr ja 4. at eKr sagenevad arheoloogiliselt jälgitavad matuserituaalid ning seesugune tendents kestab kuni 3. at eKr keskpaigani. Nende muudatuste taga ei olnud ilmselt aga kultuurivälised mõjurid, vaid kultuurisisesed metanormid, mis võimaldasid järk-järgulisi muutusi, mitte „kultuuri plahvatust“. Seetõttu jäävad need muutused arheoloogiliselt peaaegu nähtamatuks. Kokkuvõtvalt leian, et küttide ja korilaste matmispraktikad säilitasid oma põhisisu – surnukeha kui praktikate lähtekoht, kohene reageering surmale, elu ja surma range lahutamatus, matmisrituaalide avatud olemus ja normikohaste praktikate paljusus – siin vaadeldud nelja aastatuhande jooksul, st ajavahemikus 6500–2600 eKr.

CURRICULUM VITAE

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Education:

2001 Türi Secondary School
2005 history (archaeology), University of Tartu

Professional employment:

2012–2015 Centre for Baltic and Scandinavian Archaeology (ZBSA; Germany) – PhD candidate;
2010–2012 Centre of Excellence in Cultural Theory, University of Tartu – assistant of the archaeology research group;
2007–2011 National Heritage Board – senior inspector of Pärnu County;
2007–2011 University of Tartu – technician;
2006–2007 Ltd. Muinaslabor – board member;
2002 University of Tartu – technician.

ELULOOKIRJELDUS

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2001	Türi Gümnaasium
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Teenistuskäik:

2012–2015	Balti ja Skandinaavia Arheoloogia Keskus (ZBSA; Saksamaa) – doktorant;
2010–2012	Kultuuriteooria Tippkeskus (CECT), Tartu Ülikool – assistent arheoloogia uurimisrühmas;
2007–2011	Muinsuskaitseamet – Pärnumaa vaneminspektor;
2007–2011	Tartu Ülikool – tehnik;
2006–2007	OÜ Muinaslabor – juhatuse liige;
2002	Arheoloogia kabinet, Tartu Ülikool – tehnik.

APPENDICES

Appendix 1. OxCal code for dates from Tamula represented in Figure 30.

```
Plot()
 {
  Phase("Wood beneath XI")
  {
   Curve("Terrestrial", "IntCal13.14C");
   R_Date("Tamula XI; UBA 28202", 4377, 29);
  };
  Phase("Human collagen")
  {
   Label("assumes local reservoir effect of 1000, 350 14C years");
   Label("% aquatic C based on FRUITS estimate of fish constibution to delta13C value");
   Curve("Terrestrial", "IntCal13.14C");
   Curve("Aquatic", "IntCal13.14C")
   {
    Reservoir(1000, 350);
   };
   Mix_Curves("Tamula mean", "Terrestrial", "Aquatic", 50.7, 10);
   R_Date("Tamula I; Poz-15645", 4680, 40);
   Mix_Curves("Tamula III", "Terrestrial", "Aquatic", 51.7, 7.5);
   R_Date("Tamula III; Poz-10826", 4940, 40);
   Mix_Curves("Tamula VI", "Terrestrial", "Aquatic", 43.9, 10);
   R_Date("Tamula VI; KIA 48956", 4417, 20);
   Mix_Curves("Tamula VII", "Terrestrial", "Aquatic", 50, 7.9);
   R_Date("Tamula VII; Hela-1335", 5760, 45);
   Mix_Curves("Tamula VIII", "Terrestrial", "Aquatic", 44.4, 9.8);
   R_Date("Tamula VIII; Hela-1336", 5370, 45);
   Mix_Curves("Tamula X", "Terrestrial", "Aquatic", 52.0, 7.8);
   R_Date("Tamula X; UBA 27362", 4902, 52);
   Mix_Curves("Tamula XIV", "Terrestrial", "Aquatic", 56.0, 6.3);
   R_Date("Tamula XIV; UBA 27361", 5331, 44);
   Mix_Curves("Tamula XVIII", "Terrestrial", "Aquatic", 51.6, 7.7);
   R_Date("Tamula XVIII; UBA 27359", 4696, 39);
   Mix_Curves("Tamula I", "Terrestrial", "Aquatic", 50.7, 10);
   R_Date("Tamula XIX; Hela-1337", 4925, 40);
   Mix_Curves("Tamula XXI", "Terrestrial", "Aquatic", 54.0, 7.0);
   R_Date("Tamula XXI; UBA 25994", 5132, 35);
   Mix_Curves("Tamula XXIII", "Terrestrial", "Aquatic", 55.0, 6.8);
   R_Date("Tamula XXIII; UBA 25995", 5189, 34);
   Mix_Curves("Tamula XXII diet", "Terrestrial", "Aquatic", 51.7, 7.9);
   R_Date("Tamula XXII; Ua-43123", 4830, 39);
   Mix_Curves("Tamula IX diet", "Terrestrial", "Aquatic", 50.8, 7.7);
   R_Date("Tamula IX; KIA 48838", 4995, 22);
  };
  Sequence()
  {
   Boundary("Start 1");
   Phase("1")
   {
    Combine("Tamula IX")
    {
     R_Date("Tamula IX; UBA 28201", 4593, 36);
     Date("=Tamula IX; KIA 48838");
    };
    Combine("Tamula XXII")
    {
     Date("=Tamula XXII; Ua-43123");
     R_Date("Tamula XXII; Ta-219", 4080, 100);
    };
    Phase("Human collagen")
    {
     Date("=Tamula I; Poz-15645");
     Date("=Tamula III; Poz-10826");
     Date("=Tamula VI; KIA 48956");
     Date("=Tamula VII; Hela-1335");
     Date("=Tamula VIII; Hela-1336");
     Date("=Tamula X; UBA 27362");
     Date("=Tamula XI; UBA 28202");
     Date("=Tamula XIV; UBA 27361");
     Date("=Tamula XVIII; UBA 27359");
     Date("=Tamula XIX; Hela-1337");
     Date("=Tamula XXI; UBA 25994");
     Date("=Tamula XXIII; UBA 25995");
    };
   Span("Tamula_boundary diff");
   };
   Boundary("End 1");
  };
```

Appendix 2. FRUITS output for Tamula individuals.

GROUP RESULTS

Consumer	Food	Mean	sd	2.5pc	median	97.5pc
TamulaIIIyc	animal	0.07369	0.06457	0.002092	0.05665	0.2411
TamulaIIIyc	plant	0.5998	0.06668	0.4794	0.5925	0.7478
TamulaIIIyc	fish	0.3266	0.05818	0.2019	0.3327	0.4211
TamulaIIIoc	animal	0.0756	0.06372	0.002631	0.05976	0.24
TamulaIIIoc	plant	0.6018	0.068	0.4815	0.5943	0.7519
TamulaIIIoc	fish	0.3225	0.05819	0.1981	0.3278	0.4185
TamulaIIIad	animal	0.06881	0.06245	0.001912	0.05135	0.2241
TamulaIIIad	plant	0.5961	0.06502	0.481	0.5897	0.7381
TamulaIIIad	fish	0.335	0.05527	0.2141	0.3406	0.4254
TamulaVIIyc	animal	0.07589	0.06603	0.00227	0.05836	0.252
TamulaVIIyc	plant	0.6038	0.06769	0.4806	0.5971	0.7538
TamulaVIIyc	fish	0.3203	0.05856	0.1936	0.3252	0.4178
TamulaVIIIyc	animal	0.1132	0.09212	0.00382	0.09056	0.345
TamulaVIIIyc	plant	0.611	0.09063	0.4417	0.6057	0.8011
TamulaVIIIyc	fish	0.2758	0.06849	0.1395	0.2776	0.3998
TamulaVIIIoc	animal	0.09886	0.0794	0.003163	0.08086	0.2946
TamulaVIIIoc	plant	0.6054	0.08183	0.4561	0.5978	0.782
TamulaVIIIoc	fish	0.2958	0.06478	0.1596	0.3002	0.4067
TamulaVIIIta	animal	0.1092	0.08729	0.00384	0.08997	0.3231
TamulaVIIIta	plant	0.6087	0.09076	0.4499	0.5983	0.8025
TamulaVIIIta	fish	0.2821	0.06912	0.1405	0.2854	0.4039
TamulaXad	animal	0.06488	0.05693	0.002048	0.04869	0.2088
TamulaXad	plant	0.5978	0.05979	0.493	0.591	0.7322
TamulaXad	fish	0.3373	0.05295	0.2193	0.3424	0.423
TamulaXIVoc	animal	0.04473	0.04011	0.001427	0.03368	0.1505
TamulaXIVoc	plant	0.5881	0.04686	0.509	0.582	0.6971
TamulaXIVoc	fish	0.3672	0.04427	0.2663	0.3728	0.4384
TamulaXVIIoc	animal	0.08764	0.07381	0.003028	0.0681	0.2782
TamulaXVIIoc	plant	0.6032	0.07504	0.467	0.5959	0.768
TamulaXVIIoc	fish	0.3092	0.06177	0.1796	0.3145	0.4116
TamulaXVIIIad	animal	0.06672	0.059	0.002176	0.0513	0.2225
TamulaXVIIIad	plant	0.6002	0.06259	0.4874	0.593	0.7388
TamulaXVIIIad	fish	0.3331	0.05602	0.2108	0.3399	0.4228
TamulaXXIaad	animal	0.05333	0.04748	0.001472	0.0406	0.175

TamulaXXIaad plant 0.5934 0.0543
0.5021 0.5861 0.7171
TamulaXXIaad fish 0.3533 0.04892
0.2427 0.3595 0.434
TamulaXXIIyc animal 0.07682 0.06626
0.002612 0.05838 0.2463
TamulaXXIIyc plant 0.6008 0.06772
0.4814 0.5933 0.7522
TamulaXXIIyc fish 0.3223 0.05779
0.196 0.3278 0.4166
TamulaXXIIoc animal 0.07029 0.06165
0.001991 0.05367 0.2258
TamulaXXIIoc plant 0.5956 0.06379
0.4837 0.5887 0.7396
TamulaXXIIoc fish 0.3341 0.05628
0.2058 0.34 0.4247
TamulaXXIIoc1 animal 0.07039 0.06243
0.002083 0.05303 0.2312
TamulaXXIIoc1 plant 0.5996 0.06589
0.4852 0.5922 0.7502
TamulaXXIIoc1 fish 0.33 0.05741
0.2068 0.336 0.4253
TamulaXXIItaanimal 0.09963 0.08107 0.003201
0.08064 0.2953
TamulaXXIItaplant 0.6098 0.08392 0.4568
0.6022 0.7898
TamulaXXIItafish 0.2906 0.06688 0.1523
0.2952 0.4067
TamulaXXIIad animal 0.06606 0.05612
0.00188 0.05205 0.2108
TamulaXXIIad plant 0.5972 0.06187
0.4922 0.589 0.7406
TamulaXXIIad fish 0.3368 0.05524
0.2154 0.3439 0.4261
TamulaXXIIIad animal 0.05221 0.04842
0.001405 0.03882 0.175
TamulaXXIIIad plant 0.5901 0.05157
0.5013 0.5841 0.7081
TamulaXXIIIad fish 0.3577 0.04818
0.2485 0.3637 0.4341

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaIIIyc
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=13.98(0.50) [13C]=-24.17(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake
Food Mean sd 2.5pc median
97.5pc
animal 0.07369 0.06457 0.002092 0.05665
0.2411
plant 0.5998 0.06668 0.4794 0.5925
0.7478
fish 0.3266 0.05818 0.2019 0.3327
0.4211
Estimates on fraction contribution
Fraction Mean sd 2.5pc median
97.5pc
protein 0.3538 0.03793 0.2603 0.3632
0.3984
energy 0.6462 0.03793 0.6016 0.6368
0.7397
Estimates on signal contribution from food
Proxy Food Mean sd 2.5pc
median 97.5pc
15N animal 0.1003 0.08357 0.003065
0.07931 0.307
15N plant 0.1632 0.04797 0.08784
0.157 0.276
15N fish 0.7365 0.08403 0.5469
0.7477 0.8659
13C animal 0.08427 0.07155 0.00248
0.06616 0.2648
13C plant 0.4148 0.07399 0.2888
0.4067 0.5842
13C fish 0.5009 0.07948 0.3332
0.5073 0.6404

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaIIIoc
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=13.61(0.50) [13C]=-24.19(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake
Food Mean sd 2.5pc median
97.5pc
animal 0.0756 0.06372 0.002631 0.05976
0.24
plant 0.6018 0.068 0.4815 0.5943
0.7519
fish 0.3225 0.05819 0.1981 0.3278
0.4185
Estimates on fraction contribution
Fraction Mean sd 2.5pc median
97.5pc
protein 0.3527 0.03874 0.2579 0.3626
0.3984
energy 0.6473 0.03874 0.6016 0.6375
0.7424
Estimates on signal contribution from food
Proxy Food Mean sd 2.5pc
median 97.5pc
15N animal 0.1051 0.08558 0.003782
0.08394 0.3218
15N plant 0.1655 0.04969 0.0862
0.1581 0.2821
15N fish 0.7294 0.08522 0.532
0.7416 0.8612
13C animal 0.08821 0.07299 0.003175
0.06998 0.2761
13C plant 0.4161 0.07557 0.2892
0.4074 0.5873
13C fish 0.4957 0.07972 0.3243
0.5016 0.6367

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaIIIad
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=13.47(0.50) [13C]=-24.65(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.06881	0.06245	0.001912	0.05135	0.2241
plant	0.5961	0.06502	0.481	0.5897	0.7381
fish	0.335	0.05527	0.2141	0.3406	0.4254

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3568	0.03605	0.2657	0.366	0.3986
energy	0.6432	0.03605	0.6014	0.634	0.7343

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.09319	0.08004	0.002821	0.07157	0.2869
15N	plant	0.1631	0.04965	0.08077	0.1574	0.2779
15N	fish	0.7437	0.08102	0.5584	0.7557	0.8698
13C	animal	0.0793	0.06977	0.002329	0.0603	0.2483
13C	plant	0.411	0.07285	0.2867	0.404	0.5741
13C	fish	0.5097	0.077	0.3462	0.5147	0.6469

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaVIIyc
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=14.01(0.50) [13C]=-23.97(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.07589	0.06603	0.00227	0.05836	0.252
plant	0.6038	0.06769	0.4806	0.5971	0.7538
fish	0.3203	0.05856	0.1936	0.3252	0.4178

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3518	0.03844	0.2558	0.3605	0.3984
energy	0.6482	0.03844	0.6016	0.6395	0.7443

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1054	0.08805	0.003304	0.0837	0.3363
15N	plant	0.1676	0.04988	0.09093	0.1605	0.2871
15N	fish	0.727	0.08772	0.5239	0.7398	0.8636
13C	animal	0.08787	0.07473	0.002611	0.06893	0.2834
13C	plant	0.4195	0.0753	0.2926	0.4104	0.5905
13C	fish	0.4927	0.08091	0.3192	0.4988	0.6356

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaVIIIyc
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=13.47(0.50) [13C]=-23.09(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.1132	0.09212	0.00382	0.09056	0.345
plant	0.611	0.09063	0.4417	0.6057	0.8011
fish	0.2758	0.06849	0.1395	0.2776	0.3998

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3359	0.04871	0.2208	0.3456	0.3978
energy	0.6641	0.04871	0.6023	0.6545	0.7792

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.164	0.1237	0.006014	0.1398	0.4622
15N	plant	0.183	0.0638	0.08874	0.1729	0.3434
15N	fish	0.653	0.1149	0.3896	0.6668	0.836
13C	animal	0.1339	0.1049	0.004827	0.1111	0.3907
13C	plant	0.4384	0.0965	0.2786	0.4271	0.657
13C	fish	0.4277	0.09544	0.2323	0.4319	0.601

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaVIIIoc
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=12.71(0.50) [13C]=-23.89(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.09886	0.0794	0.003163	0.08086	0.2946
plant	0.6054	0.08183	0.4561	0.5978	0.782
fish	0.2958	0.06478	0.1596	0.3002	0.4067

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3442	0.04446	0.2357	0.3549	0.3981
energy	0.6558	0.04446	0.6019	0.6451	0.7643

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1399	0.1073	0.004638	0.1178	0.3948
15N	plant	0.178	0.06032	0.08971	0.1678	0.3274
15N	fish	0.6821	0.1019	0.456	0.6948	0.8426
13C	animal	0.1159	0.09092	0.003784	0.09612	0.3342
13C	plant	0.4281	0.08932	0.2831	0.4167	0.6333
13C	fish	0.4559	0.08959	0.2687	0.4614	0.6132

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaVIIIta
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=12.19(0.50) [13C]=-23.80(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.1092	0.08729	0.00384	0.08997	0.3231
plant	0.6087	0.09076	0.4499	0.5983	0.8025
fish	0.2821	0.06912	0.1405	0.2854	0.4039

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3384	0.04886	0.2216	0.3499	0.3979
energy	0.6616	0.04886	0.6021	0.6501	0.7785

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1573	0.1182	0.006258	0.1351	0.4374
15N	plant	0.1838	0.06833	0.08753	0.1709	0.3531
15N	fish	0.6589	0.1121	0.408	0.6706	0.8376
13C	animal	0.129	0.09992	0.004839	0.1077	0.3695
13C	plant	0.4352	0.09792	0.2815	0.4197	0.6628
13C	fish	0.4358	0.09562	0.2398	0.44	0.6072

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaXad
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=12.7(0.50) [13C]=-25.1(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food Mean sd 2.5pc median
97.5pc
animal 0.06488 0.05693 0.002048 0.04869
0.2088
plant 0.5978 0.05979 0.493 0.591
0.7322
fish 0.3373 0.05295 0.2193 0.3424
0.423
Estimates on fraction contribution
Fraction Mean sd 2.5pc median
97.5pc
protein 0.36 0.03382 0.2737 0.3687
0.3988
energy 0.64 0.03382 0.6012 0.6313
0.7263
Estimates on signal contribution from food
Proxy Food Mean sd 2.5pc
median 97.5pc
15N animal 0.08649 0.07361 0.002862
0.06647 0.2683
15N plant 0.1641 0.04563 0.0907
0.159 0.268
15N fish 0.7494 0.07633 0.5763
0.7609 0.8683
13C animal 0.07388 0.06367 0.002397
0.05662 0.2322
13C plant 0.4068 0.06813 0.2885
0.4006 0.5576
13C fish 0.5193 0.07402 0.3623
0.5237 0.6496

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaXIVoc
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=14.5(0.50) [13C]=-25.5(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake
Food Mean sd 2.5pc median
97.5pc
animal 0.04473 0.04011 0.001427 0.03368
0.1505
plant 0.5881 0.04686 0.509 0.582
0.6971
fish 0.3672 0.04427 0.2663 0.3728
0.4384
Estimates on fraction contribution
Fraction Mean sd 2.5pc median
97.5pc
protein 0.3687 0.0276 0.2978 0.3764
0.3991
energy 0.6313 0.0276 0.6009 0.6236
0.7023
Estimates on signal contribution from food
Proxy Food Mean sd 2.5pc
median 97.5pc
15N animal 0.05917 0.05256 0.001949
0.04434 0.196
15N plant 0.1468 0.03898 0.07798
0.144 0.2323
15N fish 0.7941 0.05875 0.6596
0.8006 0.889
13C animal 0.05098 0.04542 0.001641
0.0382 0.1704
13C plant 0.3885 0.05882 0.2846
0.3842 0.5208
13C fish 0.5605 0.06327 0.4244
0.5645 0.6757

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaXVIIoc
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=14.12(0.50) [13C]=-23.47(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake
Food Mean sd 2.5pc median
97.5pc
animal 0.08764 0.07381 0.003028 0.0681
0.2782
plant 0.6032 0.07504 0.467 0.5959
0.768
fish 0.3092 0.06177 0.1796 0.3145
0.4116
Estimates on fraction contribution
Fraction Mean sd 2.5pc median
97.5pc
protein 0.3477 0.04165 0.2442 0.3572
0.3983
energy 0.6523 0.04165 0.6017 0.6428
0.7558
Estimates on signal contribution from food
Proxy Food Mean sd 2.5pc
median 97.5pc
15N animal 0.121 0.09804 0.004467
0.09602 0.3642
15N plant 0.1699 0.05273 0.08663
0.1618 0.2963
15N fish 0.7091 0.09497 0.4921
0.7221 0.8528
13C animal 0.1006 0.08301 0.003541
0.07858 0.3117
13C plant 0.4234 0.08062 0.2873
0.4144 0.6082
13C fish 0.4761 0.08493 0.299
0.4801 0.6231

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaXVIIIad
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=14.1(0.50) [13C]=-24.3(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values

[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.06672	0.059	0.002176	0.0513	0.2225
plant	0.6002	0.06259	0.4874	0.593	0.7388
fish	0.3331	0.05602	0.2108	0.3399	0.4228

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3554	0.0366	0.2652	0.3646	0.3984
energy	0.6446	0.0366	0.6016	0.6354	0.7348

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.09283	0.07968	0.003124	0.07244	0.3058
15N	plant	0.1607	0.04701	0.08384	0.1553	0.2705
15N	fish	0.7465	0.08076	0.5525	0.7585	0.8707
13C	animal	0.07805	0.06773	0.002648	0.06028	0.2619
13C	plant	0.4115	0.07093	0.2888	0.4041	0.5678
13C	fish	0.5105	0.07685	0.3466	0.5163	0.6449

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaXXIaad
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=13.4(0.50) [13C]=-25.3(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.05333	0.04748	0.001472	0.0406	0.175
plant	0.5934	0.0543	0.5021	0.5861	0.7171
fish	0.3533	0.04892	0.2427	0.3595	0.434

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3632	0.03173	0.2829	0.3716	0.399
energy	0.6368	0.03173	0.601	0.6285	0.7172

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.07174	0.06224	0.002025	0.05541	0.2292
15N	plant	0.1532	0.04168	0.08222	0.1493	0.2481
15N	fish	0.7751	0.06687	0.6217	0.784	0.8806
13C	animal	0.06136	0.05372	0.001706	0.04706	0.1961
13C	plant	0.3975	0.06399	0.2822	0.3925	0.5376
13C	fish	0.5412	0.06884	0.3962	0.5456	0.6663

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaXXIIyc
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=12.89(0.50) [13C]=-24.48(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.07682	0.06626	0.002612	0.05838	0.2463
plant	0.6008	0.06772	0.4814	0.5933	0.7522
fish	0.3223	0.05779	0.196	0.3278	0.4166

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3543	0.03792	0.2595	0.3639	0.3984
energy	0.6457	0.03792	0.6016	0.6361	0.7408

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1068	0.08933	0.00372	0.08374	0.3299
15N	plant	0.1704	0.05058	0.09247	0.1633	0.2905
15N	fish	0.7228	0.08685	0.5195	0.7355	0.8552
13C	animal	0.08948	0.07587	0.003033	0.06888	0.2786
13C	plant	0.417	0.07615	0.2873	0.4092	0.5895

13C fish 0.4935 0.08031 0.3208
0.4999 0.634

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaXXIIoc
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=13.05(0.50) [13C]=-24.83(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake
Food Mean sd 2.5pc median
97.5pc
animal 0.07029 0.06165 0.001991 0.05367
0.2258
plant 0.5956 0.06379 0.4837 0.5887
0.7396
fish 0.3341 0.05628 0.2058 0.34
0.4247
Estimates on fraction contribution
Fraction Mean sd 2.5pc median
97.5pc
protein 0.3579 0.03601 0.2655 0.3675
0.3988
energy 0.6421 0.03601 0.6012 0.6325
0.7345
Estimates on signal contribution from food
Proxy Food Mean sd 2.5pc
median 97.5pc
15N animal 0.09667 0.08256 0.002802
0.07529 0.3005
15N plant 0.1615 0.04876 0.08217
0.1563 0.2732
15N fish 0.7419 0.08349 0.5528
0.7542 0.8713
13C animal 0.0818 0.07055 0.002334
0.06299 0.2575
13C plant 0.407 0.0727 0.2808
0.4006 0.5703
13C fish 0.5112 0.07877 0.3403
0.518 0.649

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaXXIIoc1
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=12.98(0.50) [13C]=-24.67(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake
Food Mean sd 2.5pc median
97.5pc
animal 0.07039 0.06243 0.002083 0.05303
0.2312
plant 0.5996 0.06589 0.4852 0.5922
0.7502
fish 0.33 0.05741 0.2068 0.336
0.4253
Estimates on fraction contribution
Fraction Mean sd 2.5pc median
97.5pc
protein 0.3545 0.0375 0.2622 0.3643
0.3986
energy 0.6455 0.0375 0.6014 0.6357
0.7378
Estimates on signal contribution from food
Proxy Food Mean sd 2.5pc
median 97.5pc
15N animal 0.0972 0.08396 0.002961
0.07589 0.3128
15N plant 0.1626 0.04931 0.08421
0.1566 0.2797
15N fish 0.7402 0.08407 0.544
0.7531 0.8692
13C animal 0.08184 0.07168 0.002477
0.06288 0.2671
13C plant 0.4112 0.0748 0.2856
0.4027 0.5824
13C fish 0.5069 0.0797 0.3376
0.5131 0.6462

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaXXIIta
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=12.44(0.50) [13C]=-23.87(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake
Food Mean sd 2.5pc median
97.5pc
animal 0.09963 0.08107 0.003201 0.08064
0.2953
plant 0.6098 0.08392 0.4568 0.6022
0.7898
fish 0.2906 0.06688 0.1523 0.2952
0.4067
Estimates on fraction contribution
Fraction Mean sd 2.5pc median
97.5pc

protein	0.3401	0.04598	0.2315	0.35	0.398
energy	0.6599	0.04598	0.602	0.65	0.7685

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1428	0.1103	0.005063	0.1202	0.4
15N	plant	0.1819	0.06289	0.08883	0.17	0.3381
15N	fish	0.6753	0.1055	0.4413	0.6887	0.8407
13C	animal	0.117	0.09253	0.003976	0.09627	0.3359
13C	plant	0.4349	0.09206	0.2833	0.4232	0.6432
13C	fish	0.4481	0.09245	0.2548	0.4538	0.6094

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaXXIIad
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=12.97(0.50) [13C]=-24.86(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.06606	0.05612	0.00188	0.05205	0.2108
plant	0.5972	0.06187	0.4922	0.589	0.7406
fish	0.3368	0.05524	0.2154	0.3439	0.4261

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3575	0.03603	0.2667	0.3669	0.3987
energy	0.6425	0.03603	0.6013	0.6331	0.7333

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.09003	0.07435	0.002689	0.07272	0.2748
15N	plant	0.1613	0.04643	0.08666	0.1548	0.2723
15N	fish	0.7487	0.07557	0.5741	0.7591	0.8667
13C	animal	0.0761	0.06347	0.002206	0.06067	0.2358
13C	plant	0.4078	0.07154	0.2874	0.4004	0.5738
13C	fish	0.5161	0.07552	0.3541	0.5209	0.6487

INDIVIDUAL CONSUMER RESULTS REPORT: TamulaXXIIIad
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=14.1(0.50) [13C]=-25.2(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(1)
[fish][energy][13C]=-36(1)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.05221	0.04842	0.001405	0.03882	0.175
plant	0.5901	0.05157	0.5013	0.5841	0.7081
fish	0.3577	0.04818	0.2485	0.3637	0.4341

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3651	0.02995	0.2882	0.3732	0.399
energy	0.6349	0.02995	0.601	0.6268	0.7118

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.06957	0.06297	0.001906	0.05303	0.23
15N	plant	0.1509	0.0399	0.08522	0.1467	0.2407
15N	fish	0.7795	0.0668	0.6231	0.7894	0.8816
13C	animal	0.05957	0.05435	0.001625	0.04517	0.199
13C	plant	0.3949	0.06129	0.2865	0.3903	0.5302
13C	fish	0.5455	0.06758	0.4	0.5503	0.6668

Appendix 3. OxCal code for dates from Kivisaare represented in Figure 32.

```
Plot()
 {
 Curve("Terrestrial", "IntCal13.14C");


  {
  Sequence( )
  {
   Boundary("Start of burial activity");
   Phase("Burial activity")
   {
    R_Date("Kivisaare III (1965); UBA- 25993 ", 5796, 37);
    R_Date("Kivisaare IV (1965); Poz-10840", 5450, 40);
    R_Date("Kivisaare IV (1965); KIA-50905", 5705, 35);
    R_Date("Kivisaare LHB (1965); UBA-27670", 6233, 48);
    R_Combine("Kivisaare IV (1965)")
    {
     R_Date("Kivisaare IV (1965)", 5450, 40);
     R_Date("Kivisaare IV (1965)", 5705, 35);
    };
    Span("Kivisaare_boundary diff");
   };
```

```
  Boundary("End of burial activity");
 };
```

Appendix 4. OxCal code for dates from Veibri represented in Figure 33.

```
Plot()
 {
  Phase("Veibri uncorrected, calibrated with IntCal13 only")
  {
   R_Date("Veibri I:I (Ua-43124)", 5580, 39);
   R_Date("Veibri I:I (UBA-27355)", 5790, 43);
   R_Date("Veibri I:II (Hela-1331)", 6090, 45);
   R_Date("Veibri I:III (KIA-48842)", 5841, 29);
   R_Date("Veibri I:IV (KIA-48843)", 5940, 22);
  };
  Phase("Estimated dates - FRE corretcion")
  {
   Curve("Terrestrial", "IntCal13.14c");
   Curve("Freshwater","IntCal13.14c")
   {
    Reservoir(500,100);
   };
   Label("assumes effective freshwater reservoir effect of 500,100 14C years in fish consumed");
   Label("% aquatic C based on FRUITS estimate of fish contribution to delta-13C  value");
   Combine("Veibri quadruple grave")
   {
    Mix_Curves("Veibri I:I diet", "Terrestrial", "Freshwater", 50, 5.9);
    R_Date("Veibri I:I (UBA-27355)", 5790, 43);
    Mix_Curves("Veibri I:III diet", "Terrestrial", "Freshwater", 52.3, 7.2);
    R_Date("Veibri I:III (KIA-48842)", 5841, 29);
    Mix_Curves("Veibri I:IV diet", "Terrestrial", "Freshwater", 51.3, 7.5);
    R_Date("Veibri I:IV (KIA-48843)", 5940, 22);
   };
  };
 };
```

Appendix 5. FRUITS output for Veibri individuals.

GROUP RESULTS

Consumer	Food	Mean	sd	2.5pc	median	97.5pc
VeibriIyc	animal	0.07274	0.06329	0.002078	0.05581	0.2308
VeibriIyc	plant	0.6064	0.06874	0.4887	0.598	0.7591
VeibriIyc	fish	0.3209	0.05955	0.1911	0.327	0.4184
VeibriIoc	animal	0.1053	0.08882	0.003553	0.08276	0.331
VeibriIoc	plant	0.6002	0.08432	0.4398	0.595	0.7778
VeibriIoc	fish	0.2945	0.06462	0.1648	0.2969	0.4082
VeibriIoc1	animal	0.09499	0.07895	0.003454	0.07537	0.2921
VeibriIoc1	plant	0.6049	0.07997	0.4614	0.5982	0.7739
VeibriIoc1	fish	0.3001	0.06339	0.1685	0.3049	0.4077
VeibriIta	animal	0.07168	0.06419	0.002291	0.05318	0.2366
VeibriIta	plant	0.6	0.06551	0.483	0.5933	0.7456
VeibriIta	fish	0.3284	0.0575	0.2002	0.3349	0.4202
VeibriIta1	animal	0.0783	0.06563	0.002412	0.06174	0.2443
VeibriIta1	plant	0.598	0.06682	0.478	0.5905	0.7468
VeibriIta1	fish	0.3237	0.05683	0.2009	0.3291	0.4198
VeibriIIoc	animal	0.08016	0.06963	0.00279	0.06076	0.2608
VeibriIIoc	plant	0.6051	0.07192	0.4746	0.5974	0.7603
VeibriIIoc	fish	0.3148	0.06153	0.183	0.3201	0.4167
VeibriIIta	animal	0.09059	0.07771	0.003203	0.06981	0.2877
VeibriIIta	plant	0.6008	0.07672	0.4543	0.5943	0.7634
VeibriIIta	fish	0.3086	0.06258	0.1764	0.3129	0.4147
VeibriIIad	animal	0.08343	0.07059	0.002901	0.06574	0.2648
VeibriIIad	plant	0.5989	0.07179	0.4687	0.5919	0.7544
VeibriIIad	fish	0.3176	0.06006	0.1875	0.3236	0.416
VeibriIIIyc	animal	0.08267	0.07144	0.002904	0.06384	0.2629
VeibriIIIyc	plant	0.6044	0.07224	0.4674	0.5994	0.759
VeibriIIIyc	fish	0.3129	0.06	0.1843	0.3179	0.4122
VeibriIIIoc1	animal	0.0605	0.05464	0.001702	0.04483	0.2049
VeibriIIIoc1	plant	0.5957	0.05889	0.4922	0.5893	0.7287
VeibriIIIoc1	fish	0.3437	0.05246	0.2273	0.3498	0.4292
VeibriIV	animal	0.06616	0.05836	0.002286	0.05039	0.2187
VeibriIV	plant	0.5983	0.06219	0.4906	0.59	0.7361
VeibriIV	fish	0.3355	0.05515	0.2166	0.3414	0.4249

INDIVIDUAL CONSUMER RESULTS REPORT: VeibriIyc
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=15.35(0.50) [13C]=-23.17(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(0.5)
[fish][energy][13C]=-36(0.5)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.07274	0.06329	0.002078	0.05581	0.2308
plant	0.6064	0.06874	0.4887	0.598	0.7591
fish	0.3209	0.05955	0.1911	0.327	0.4184

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3496	0.04041	0.2509	0.3593	0.3983
energy	0.6504	0.04041	0.6017	0.6407	0.7491

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1029	0.08569	0.003199	0.08178	0.315
15N	plant	0.166	0.04924	0.09078	0.1585	0.2847

15N	fish	0.7311	0.08589	0.5319
0.7444	0.862
13C	animal	0.0854	0.07249	0.002513
0.06646	0.2637
13C	plant	0.4225	0.07757	0.2949
0.4131	0.6022
13C	fish	0.4921	0.08145	0.3153
0.499	0.6345

INDIVIDUAL CONSUMER RESULTS REPORT: VeibriIoc
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=14.58(0.50)	[13C]=-22.73(0.50)
Isotopic offset
[15N]=5(1)	[13C]=4.8(0.5)
Weights
[15N][protein]=100(0)	[15N][energy]=0(0)
[13C][protein]=75(5)	[13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1)	[fish][protein][13C]=-29(0.5)
[fish][energy][13C]=-36(0.5)
Concentrations
[animal][protein]=50(5)	[animal][energy]=50(5)
[plant][protein]=10(2)	[plant][energy]=90(2)
[fish][protein]=80(3)	[fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake
Food	Mean	sd	2.5pc	median
97.5pc
animal	0.1053	0.08882	0.003553	0.08276
0.331
plant	0.6002	0.08432	0.4398	0.595
0.7778
fish	0.2945	0.06462	0.1648	0.2969
0.4082
Estimates on fraction contribution
Fraction	Mean	sd	2.5pc	median
97.5pc
protein	0.3435	0.04386	0.2384	0.3525
0.3982
energy	0.6565	0.04386	0.6018	0.6475
0.7616
Estimates on signal contribution from food
Proxy	Food	Mean	sd	2.5pc
median	97.5pc
15N	animal	0.1457	0.1156	0.005555
0.1189	0.4288
15N	plant	0.1703	0.05691	0.08398
0.1615	0.3099
15N	fish	0.684	0.1075	0.437
0.6983	0.85
13C	animal	0.1213	0.09941	0.004423
0.09732	0.3726
13C	plant	0.4242	0.08768	0.2769
0.413	0.6237
13C	fish	0.4544	0.08985	0.2691
0.4579	0.6144

INDIVIDUAL CONSUMER RESULTS REPORT: VeibriIoc1
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=14.99(0.50)	[13C]=-22.61(0.50)
Isotopic offset
[15N]=5(1)	[13C]=4.8(0.5)
Weights
[15N][protein]=100(0)	[15N][energy]=0(0)
[13C][protein]=75(5)	[13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1)	[fish][protein][13C]=-29(0.5)
[fish][energy][13C]=-36(0.5)
Concentrations
[animal][protein]=50(5)	[animal][energy]=50(5)
[plant][protein]=10(2)	[plant][energy]=90(2)
[fish][protein]=80(3)	[fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake
Food	Mean	sd	2.5pc	median
97.5pc
animal	0.09499	0.07895	0.003454	0.07537
0.2921
plant	0.6049	0.07997	0.4614	0.5982
0.7739
fish	0.3001	0.06339	0.1685	0.3049
0.4077
Estimates on fraction contribution
Fraction	Mean	sd	2.5pc	median
97.5pc
protein	0.3431	0.04438	0.2381	0.3527
0.3979
energy	0.6569	0.04438	0.6021	0.6473
0.7621
Estimates on signal contribution from food
Proxy	Food	Mean	sd	2.5pc
median	97.5pc
15N	animal	0.1347	0.1062	0.005251
0.1108	0.4007
15N	plant	0.1686	0.05383	0.08776
0.1603	0.2992
15N	fish	0.6967	0.1001	0.4628
0.7107	0.8492
13C	animal	0.1114	0.0902	0.004196
0.08964	0.3361
13C	plant	0.4272	0.08636	0.2834
0.4167	0.6228
13C	fish	0.4614	0.08727	0.2831
0.4673	0.6137
INDIVIDUAL CONSUMER RESULTS REPORT: VeibriIta
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=15.12(0.50)	[13C]=-23.52(0.50)
Isotopic offset
[15N]=5(1)	[13C]=4.8(0.5)
Weights
[15N][protein]=100(0)	[15N][energy]=0(0)
[13C][protein]=75(5)	[13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1)	[fish][protein][13C]=-29(0.5)
[fish][energy][13C]=-36(0.5)
Concentrations
[animal][protein]=50(5)	[animal][energy]=50(5)
[plant][protein]=10(2)	[plant][energy]=90(2)
[fish][protein]=80(3)	[fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake
Food	Mean	sd	2.5pc	median
97.5pc
animal	0.07168	0.06419	0.002291	0.05318
0.2366
plant	0.6	0.06551	0.483	0.5933
0.7456

fish	0.3284	0.0575	0.2002	0.3349	0.4202

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.354	0.03773	0.2597	0.3633	0.3983
energy	0.646	0.03773	0.6017	0.6367	0.7403

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.09907	0.08461	0.003357	0.07641	0.3125
15N	plant	0.1588	0.04643	0.08614	0.1523	0.2674
15N	fish	0.7422	0.08477	0.5474	0.756	0.8683
13C	animal	0.08307	0.0722	0.002706	0.06329	0.2694
13C	plant	0.4151	0.07303	0.2915	0.408	0.5802
13C	fish	0.5019	0.07888	0.3351	0.5083	0.6419

INDIVIDUAL CONSUMER RESULTS REPORT: VeibriIta1
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=15(0.50) [13C]=-23.3(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(0.5)
[fish][energy][13C]=-36(0.5)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.0783	0.06563	0.002412	0.06174	0.2443
plant	0.598	0.06682	0.478	0.5905	0.7468
fish	0.3237	0.05683	0.2009	0.3291	0.4198

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3536	0.03785	0.2592	0.3634	0.3983
energy	0.6464	0.03785	0.6017	0.6366	0.7408

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1082	0.08766	0.003541	0.08764	0.3271
15N	plant	0.1645	0.04857	0.08585	0.1588	0.2799
15N	fish	0.7273	0.0843	0.5323	0.7385	0.8586
13C	animal	0.09042	0.0744	0.00296	0.07263	0.2781
13C	plant	0.4164	0.07442	0.2931	0.4075	0.5876
13C	fish	0.4932	0.07769	0.3301	0.4983	0.6309

INDIVIDUAL CONSUMER RESULTS REPORT: VeibriIIoc
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=15.02(0.50) [13C]=-23.09(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(0.5)
[fish][energy][13C]=-36(0.5)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.08016	0.06963	0.00279	0.06076	0.2608
plant	0.6051	0.07192	0.4746	0.5974	0.7603
fish	0.3148	0.06153	0.183	0.3201	0.4167

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3482	0.04127	0.2492	0.3578	0.3982
energy	0.6518	0.04127	0.6018	0.6422	0.7508

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1124	0.0942	0.003925	0.08785	0.3574
15N	plant	0.1658	0.05077	0.08595	0.1588	0.2847
15N	fish	0.7217	0.09262	0.5035	0.7368	0.8592
13C	animal	0.09307	0.0795	0.003264	0.07172	0.3012
13C	plant	0.4237	0.07939	0.2904	0.4156	0.6035
13C	fish	0.4832	0.0837	0.3086	0.49	0.6282

INDIVIDUAL CONSUMER RESULTS REPORT: VeibriIIta
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=14.41(0.50) [13C]=-23.23(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(0.5)
[fish][energy][13C]=-36(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake
Food Mean sd 2.5pc median
97.5pc
animal 0.09059 0.07771 0.003203 0.06981
0.2877
plant 0.6008 0.07672 0.4543 0.5943
0.7634
fish 0.3086 0.06258 0.1764 0.3129
0.4147
Estimates on fraction contribution
Fraction Mean sd 2.5pc median
97.5pc
protein 0.3472 0.04173 0.2463 0.3566
0.3982
energy 0.6528 0.04173 0.6018 0.6434
0.7542
Estimates on signal contribution from food
Proxy Food Mean sd 2.5pc
median 97.5pc
15N animal 0.1258 0.102 0.00478
0.1006 0.3758
15N plant 0.1674 0.05313 0.08421
0.1593 0.2959
15N fish 0.7068 0.09818 0.4763
0.7217 0.8569
13C animal 0.105 0.08743 0.003834
0.08238 0.3241
13C plant 0.4213 0.08282 0.2804
0.4121 0.606
13C fish 0.4737 0.08668 0.2911
0.4806 0.6258

INDIVIDUAL CONSUMER RESULTS REPORT: VeibriIIad
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=14.40(0.50) [13C]=-23.46(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(0.5)
[fish][energy][13C]=-36(0.5)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake
Food Mean sd 2.5pc median
97.5pc
animal 0.08343 0.07059 0.002901 0.06574
0.2648
plant 0.5989 0.07179 0.4687 0.5919
0.7544
fish 0.3176 0.06006 0.1875 0.3236
0.416
Estimates on fraction contribution
Fraction Mean sd 2.5pc median
97.5pc
protein 0.3504 0.04024 0.2539 0.3604
0.3984
energy 0.6496 0.04024 0.6016 0.6396
0.7461
Estimates on signal contribution from food
Proxy Food Mean sd 2.5pc
median 97.5pc
15N animal 0.1147 0.09368 0.004269
0.0928 0.3518
15N plant 0.1653 0.05087 0.08331
0.1577 0.2841
15N fish 0.72 0.09056 0.5081
0.732 0.8583
13C animal 0.09617 0.07998 0.003487
0.07729 0.3009
13C plant 0.4178 0.07894 0.2834
0.4089 0.5994
13C fish 0.486 0.08281 0.3091
0.4928 0.6295

INDIVIDUAL CONSUMER RESULTS REPORT: VeibriIIIyc
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=15.16(0.50) [13C]=-23.00(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(0.5)
[fish][energy][13C]=-36(0.5)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake
Food Mean sd 2.5pc median
97.5pc
animal 0.08267 0.07144 0.002904 0.06384
0.2629
plant 0.6044 0.07224 0.4674 0.5994
0.759
fish 0.3129 0.06 0.1843 0.3179
0.4122
Estimates on fraction contribution
Fraction Mean sd 2.5pc median
97.5pc
protein 0.3487 0.04092 0.2478 0.3577
0.3981
energy 0.6513 0.04092 0.6019 0.6423
0.7524
Estimates on signal contribution from food
Proxy Food Mean sd 2.5pc
median 97.5pc
15N animal 0.1146 0.09499 0.004341
0.09068 0.3535
15N plant 0.167 0.05115 0.08428
0.1606 0.2856
15N fish 0.7184 0.09152 0.5039
0.7328 0.8579
13C animal 0.09555 0.08084 0.003576
0.07514 0.2989
13C plant 0.4241 0.07913 0.2896
0.416 0.6011
13C fish 0.4803 0.08224 0.3084
0.4864 0.6237

INDIVIDUAL CONSUMER RESULTS REPORT: VeibriIIIoc1
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=16.06(0.50) [13C]=-23.54(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(0.5)
[fish][energy][13C]=-36(0.5)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.0605	0.05464	0.001702	0.04483	0.2049
plant	0.5957	0.05889	0.4922	0.5893	0.7287
fish	0.3437	0.05246	0.2273	0.3498	0.4292

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3591	0.03464	0.2714	0.368	0.3987
energy	0.6409	0.03464	0.6013	0.632	0.7288

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.08182	0.0721	0.002377	0.06146	0.2662
15N	plant	0.1525	0.04183	0.08103	0.149	0.249
15N	fish	0.7657	0.07315	0.5953	0.7768	0.8799
13C	animal	0.06935	0.06186	0.001985	0.05159	0.2296
13C	plant	0.4073	0.06732	0.293	0.4015	0.5577
13C	fish	0.5233	0.07164	0.3704	0.5279	0.654

INDIVIDUAL CONSUMER RESULTS REPORT: VeibriIV
10000 updates took 6 s
INPUT DATA (Routed model: Yes; Model with offsets: Yes;
Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=15.86(0.50) [13C]=-23.27(0.50)
Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)
Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(0.5)
[fish][energy][13C]=-36(0.5)
Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4
ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.06616	0.05836	0.002286	0.05039	0.2187
plant	0.5983	0.06219	0.4906	0.59	0.7361
fish	0.3355	0.05515	0.2166	0.3414	0.4249

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3554	0.03666	0.2665	0.3647	0.3986
energy	0.6446	0.03666	0.6014	0.6353	0.7336

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.09077	0.07792	0.003348	0.07075	0.2931
15N	plant	0.155	0.04483	0.07995	0.1496	0.2587
15N	fish	0.7543	0.07841	0.5655	0.7653	0.8728
13C	animal	0.07657	0.06662	0.002713	0.05856	0.2509
13C	plant	0.4105	0.07009	0.2897	0.4038	0.5686
13C	fish	0.513	0.07489	0.3536	0.5186	0.6455

Appendix 6. OxCal model for dates from Veibri represented in Figure 34.

```
Plot()
 {
  Phase("Estimated dates")
  {
   Curve("Terrestrial", "IntCal13.14c");
   Curve("Freshwater","IntCal13.14c")
   {
    Reservoir(1500,100);
   };
   Label("assumes effective freshwater reservoir effect of 1500,100 14C years in fish consumed");
   Label("% aquatic C based on FRUITS estimate of fish contribution to delta-13C value");
   Combine("Veibri quadruple grave")
   {
    Combine()
    {
     Mix_Curves("Veibri I:I diet", "Terrestrial", "Freshwater", 50, 5.9);
     R_Date("Veibri I:I (Ua-43124)", 5580, 39);
     Mix_Curves("Veibri I:I diet", "Terrestrial", "Freshwater", 50, 5.9);
     R_Date("Veibri I:I (UBA-27355)", 5790, 43);
    };
    Mix_Curves("Veibri I:II diet", "Terrestrial", "Freshwater", 48.6, 8.2);
    R_Date("Veibri I:II (Hela-1331)", 6090, 45);
    Mix_Curves("Veibri I:III diet", "Terrestrial", "Freshwater", 52.3, 7.2);
    R_Date("Veibri I:III (KIA-48842)", 5841, 29);
    Mix_Curves("Veibri I:IV diet", "Terrestrial", "Freshwater", 51.3, 7.5);
    R_Date("Veibri I:IV (KIA-48843)", 5940, 22);
   };
  };
 };
```

Appendix 7. OxCal code for dates from Narva Joaorg represented in Figure 35.

```
Plot()
 {
  Phase("Narva Joaorg I Mesolithic layer, calibrated with IntCal13 only")
  {
   R_Date("TA-33", 5820, 200);
   R_Date("TA-7", 5300, 250);
```

```
  };
  Phase("Narva Joaorg II Mesolithic layer, calibrated with IntCal13
only")
  {
   R_Date("TA-52", 7375, 190);
   R_Date("TA-40", 6740, 250);
   R_Date("TA-17", 6020, 210);
  };
 };
 Phase("Narva Joaorg III Mesolithic layer, calibrated with IntCal13
only")
 {
  R_Date("TA-53", 7640, 180);
  R_Date("TA-25", 7580, 300);
  R_Date("TA-41", 7090, 230);
  R_Date("Narva Joaorg IV", 7681, 45)
  {
  };
 };
 Phase("Single event")
 {
  Combine("Narva J_II and IV")
  {
   R_Date("Narva Joaorg II", 7531, 48);
   R_Date("Narva Joaorg IV", 7681, 45);
  };
  Phase("Estimated dates, FRE 300,50")
  {
   Curve("Terrestrial", "IntCal13.14c");
   Curve("Freshwater","IntCal13.14c")
   {
    Reservoir(300,50);
   };
   Combine("Narva J_II and IV")
   {
    Mix_Curves("Narva Joaorg II diet", "Terrestrial", "Freshwater",
45.8,8.9);
    R_Date("Narva Joaorg II", 7531, 48);
    Mix_Curves("Narva Joaorg IV diet", "Terrestrial", "Freshwater",
51.7,7.4);
    R_Date("Narva Joaorg IV", 7681, 45);
   };
  };
 };
 Phase("Separate events")
 {
  Phase("Estimated dates, FRE 300,50")
  {
   Curve("Terrestrial", "IntCal13.14c");
   Curve("Freshwater","IntCal13.14c")
   {
    Reservoir(300,50);
   };
   Mix_Curves("Narva Joaorg II diet", "Terrestrial", "Freshwater",
45.8,8.9);
   R_Date("Narva Joaorg II", 7531, 48);
   Mix_Curves("Narva Joaorg IV diet", "Terrestrial", "Freshwater",
51.7,7.4);
   R_Date("Narva Joaorg IV", 7681, 45);
  };
 };
```

Appendix 8. FRUITS output for Narva Joaorg individuals.

GROUP RESULTS

Consumer	Food	Mean	sd	2.5pc	median	97.5pc
NarvaJoaorgII	animal	0.1023	0.08667	0.003692	0.08039	0.3278
NarvaJoaorgII	plant	0.6011	0.08053	0.4484	0.5945	0.7683
NarvaJoaorgII	fish	0.2966	0.06398	0.1637	0.2996	0.4078
NarvaJoaorgIV	animal	0.06228	0.05578	0.001746	0.04682	0.2076
NarvaJoaorgIV	plant	0.5994	0.06156	0.4936	0.5908	0.7402
NarvaJoaorgIV	fish	0.3383	0.05457	0.2156	0.3452	0.4249

INDIVIDUAL CONSUMER RESULTS REPORT: NarvaJoaorgII
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=15.9(0.5) [13C]=-22.1(0.5)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(0.5)
[fish][energy][13C]=-36(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.1023	0.08667	0.003692	0.08039	0.3278
plant	0.6011	0.08053	0.4484	0.5945	0.7683
fish	0.2966	0.06398	0.1637	0.2996	0.4078

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3442	0.04323	0.24	0.3536	0.3981
energy	0.6558	0.04323	0.6019	0.6464	0.76

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1442	0.1154	0.005766	0.1172	0.4283
15N	plant	0.1643	0.05206	0.08387	0.1564	0.2874
15N	fish	0.6915	0.1075	0.4405	0.7076	0.8537
13C	animal	0.1195	0.09849	0.00447	0.09524	0.365
13C	plant	0.4222	0.08554	0.2779	0.4131	0.6132
13C	fish	0.4583	0.08908	0.2744	0.4643	0.6178

INDIVIDUAL CONSUMER RESULTS REPORT: NarvaJoaorgIV
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=16.2(0.5) [13C]=-23.3(0.5)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[fish][protein][15N]=10(1) [fish][protein][13C]=-29(0.5)
[fish][energy][13C]=-36(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[fish][protein]=80(3) [fish][energy]=20(3)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.06228	0.05578	0.001746	0.04682	0.2076
plant	0.5994	0.06156	0.4936	0.5908	0.7402
fish	0.3383	0.05457	0.2156	0.3452	0.4249

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3565	0.0368	0.2629	0.3656	0.3987
energy	0.6435	0.0368	0.6013	0.6344	0.7372

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.0846	0.07374	0.002541	0.06529	0.2753
15N	plant	0.1537	0.04426	0.08163	0.1479	0.2583
15N	fish	0.7617	0.07583	0.5842	0.7728	0.8781
13C	animal	0.07139	0.06297	0.002101	0.05415	0.2349
13C	plant	0.4112	0.07062	0.2899	0.4041	0.573
13C	fish	0.5174	0.07425	0.358	0.5237	0.6478

Appendix 9. OxCal code for dates from Saaremaa represented in Figure 36.

```
Plot()
 {
  Phase(uncorrected calibrated dates)
  {
   Curve("Terrestrial", "IntCal13.14C");
   R_Date("Kõljala I; UBA 27363", 5180, 44);
   R_Date("Kõljala III; UBA 25996", 4914, 32);
   R_Date("Kõnnu I; KIA 49481", 6297, 29);
   R_Date("Kõnnu II; UBA 25997", 6222, 33);
   R_Date("Kõnnu III; KIA 49480", 6896, 27);
   R_Date("Kõnnu 111 (1); UBA 26077", 6277, 45);
   R_Date("Naakamäe; Ua-4822", 4152, 85);

   {
   };
   Phase("RE corrected dates")
   {
    Label("assumes marine reservoir effect of 279, 100  14C years");
    Label("% aquatic C based on FRUITS estimate of marine protein constibution to delta-13C value");
    Curve("Terrestrial", "IntCal13.14C");
    Curve("Aquatic", "Marine13")
    {
     Reservoir(279, 100);
    };
    Mix_Curves("Koljala I", "Terrestrial", "Aquatic", 80, 10.5);
    R_Date("Kõljala I; UBA 27363", 5180, 44);
    Mix_Curves("Koljala III", "Terrestrial", "Aquatic", 84.6, 6.7);
    R_Date("Kõljala III; UBA 25996", 4914, 32);
    Mix_Curves("Konnu I", "Terrestrial", "Aquatic", 58.9, 15.6);
    R_Date("Kõnnu I; KIA 49481", 6297, 29);
    Mix_Curves("Konnu II", "Terrestrial", "Aquatic", 73, 11.5);
    R_Date("Kõnnu II; UBA 25997", 6222, 33);
    Mix_Curves("Konnu III", "Terrestrial", "Aquatic", 79.2, 9.5);
    R_Date("Kõnnu III; KIA 49480", 6896, 27);
    Mix_Curves("Konnu 111 (1)", "Terrestrial", "Aquatic", 68.9, 12.8);
    R_Date("Kõnnu 111 (1); UBA 26077", 6277, 45);
    Mix_Curves("Naakamäe", "Terrestrial", "Aquatic", 74.3, 10.5);
    R_Date("Naakamäe; Ua-4822", 4152, 85);
   };
  };
 };
```

Appendix 10. FRUITS output for Saaremaa individuals.
GROUP RESULTS

Consumer	Food	Mean	sd	2.5pc	median	97.5pc
KOLIyc	animal	0.08929	0.07181	0.003144	0.07146	0.2632
KOLIyc	plant	0.2269	0.1066	0.03368	0.221	0.4557
KOLIyc	marine	0.6838	0.1221	0.4396	0.6852	0.9168
KOLIad	animal	0.06341	0.05586	0.001743	0.04806	0.205
KOLIad	plant	0.1985	0.09908	0.02232	0.1945	0.4036
KOLIad	marine	0.738	0.1089	0.5138	0.7407	0.9396
KOLIIIyc	animal	0.04347	0.0404	0.001327	0.03138	0.1491
KOLIIIyc	plant	0.1613	0.09092	0.01278	0.158	0.3487
KOLIIIyc	marine	0.7952	0.09868	0.5895	0.7986	0.9601
KOLIIIoc	animal	0.04215	0.03739	0.001332	0.03178	0.1391
KOLIIIoc	plant	0.1692	0.08904	0.01309	0.1678	0.3489
KOLIIIoc	marine	0.7886	0.09518	0.6023	0.7898	0.9627
KOLIIIad	animal	0.04764	0.04266	0.001495	0.0356	0.1569
KOLIIIad	plant	0.1692	0.09238	0.01403	0.1651	0.3628
KOLIIIad	marine	0.7831	0.1014	0.5752	0.7862	0.9608
KOLIIIad1	animal	0.04136	0.03812	0.001216	0.03033	0.1441
KOLIIIad1	plant	0.1595	0.09158	0.01254	0.153	0.356
KOLIIIad1	marine	0.7991	0.09862	0.5932	0.8068	0.9632
KONIyc	animal	0.1247	0.09858	0.004419	0.1029	0.3572
KONIyc	plant	0.2413	0.1148	0.04027	0.2319	0.4927
KONIyc	marine	0.634	0.1434	0.3585	0.6394	0.9006
KONIoc	animal	0.1853	0.1259	0.008809	0.1672	0.4657
KONIoc	plant	0.2842	0.1303	0.06413	0.2683	0.5844
KONIoc	marine	0.5306	0.1593	0.2354	0.5263	0.8487
KONIIaoc	animal	0.1057	0.08324	0.003735	0.08708	0.3121
KONIIaoc	plant	0.2304	0.1091	0.03762	0.223	0.4652
KONIIaoc	marine	0.6639	0.1295	0.3998	0.6676	0.9023
KONIIbyc	animal	0.1236	0.0946	0.004889	0.1033	0.3488
KONIIbyc	plant	0.249	0.1196	0.04853	0.2355	0.5196
KONIIbyc	marine	0.6274	0.1404	0.348	0.6307	0.8936
KONIIIad1	animal	0.2661	0.1459	0.02077	0.2621	0.5556

KONIIIad1	plant	0.3768	0.1584	0.1265	0.3523	0.7244
KONIIIad1	marine	0.357	0.149	0.1131	0.343	0.6897
KONIIIad2	animal	0.07239	0.06337	0.002204	0.05449	0.2384
KONIIIad2	plant	0.2019	0.1038	0.02493	0.1947	0.4292
KONIIIad2	marine	0.7257	0.1184	0.4748	0.7327	0.9353
KON1111	animal	0.1196	0.09163	0.004497	0.1009	0.3347
KON1111	plant	0.258	0.118	0.0527	0.2486	0.5206
KON1111	marine	0.6224	0.1388	0.3473	0.6252	0.8814
NAAKyc	animal	0.0982	0.0751	0.003599	0.0829	0.2826
NAAKyc	plant	0.2182	0.1073	0.0359	0.2105	0.4532
NAAKyc	marine	0.6836	0.1216	0.4432	0.6881	0.9107

INDIVIDUAL CONSUMER RESULTS REPORT: KOLIyc
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=14.60(0.50) [13C]=-15.23(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.08929	0.07181	0.003144	0.07146	0.2632
plant	0.2269	0.1066	0.03368	0.221	0.4557
marine	0.6838	0.1221	0.4396	0.6852	0.9168

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3646	0.02997	0.2885	0.3722	0.3989
energy	0.6354	0.02997	0.6012	0.6278	0.7116

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1205	0.0941	0.004426	0.09905	0.3457

15N	plant	0.06447	0.03802	0.00815	0.05844	0.1608
15N	marine	0.815	0.09913	0.5859	0.8326	0.959
13C	animal	0.1053	0.08348	0.003704	0.08506	0.3046
13C	plant	0.1449	0.07339	0.02102	0.1376	0.3144
13C	marine	0.7498	0.1048	0.5264	0.7562	0.9306

INDIVIDUAL CONSUMER RESULTS REPORT: KOLIad
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=15.50(0.50) [13C]=-14.30(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.06341	0.05586	0.001743	0.04806	0.205
plant	0.1985	0.09908	0.02232	0.1945	0.4036
marine	0.738	0.1089	0.5138	0.7407	0.9396

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3703	0.02557	0.3053	0.3768	0.3991
energy	0.6297	0.02557	0.6009	0.6232	0.6947

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.08264	0.07172	0.00222	0.06296	0.2621
15N	plant	0.05462	0.03216	0.005346	0.04969	0.1311
15N	marine	0.8627	0.07567	0.6814	0.8775	0.9699
13C	animal	0.07363	0.06459	0.001961	0.05552	0.2369
13C	plant	0.1219	0.06357	0.01359	0.1164	0.2587
13C	marine	0.8044	0.0848	0.6215	0.8119	0.9515

INDIVIDUAL CONSUMER RESULTS REPORT: KOLIIIyc
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=15.78(0.50) [13C]=-12.73(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.04347	0.0404	0.001327	0.03138	0.1491
plant	0.1613	0.09092	0.01278	0.158	0.3487
marine	0.7952	0.09868	0.5895	0.7986	0.9601

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3758	0.02245	0.32	0.3821	0.3992
energy	0.6242	0.02245	0.6008	0.6179	0.68

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.05615	0.05106	0.001696	0.04131	0.1877
15N	plant	0.04241	0.02723	0.003183	0.03859	0.1064
15N	marine	0.9014	0.05739	0.7621	0.9127	0.9796
13C	animal	0.05119	0.04712	0.001525	0.03741	0.1725
13C	plant	0.08952	0.05076	0.007352	0.08605	0.199
13C	marine	0.8593	0.06731	0.7115	0.8651	0.9691

INDIVIDUAL CONSUMER RESULTS REPORT: KOLIIIoc
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=15.30(0.50) [13C]=-12.61(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.04215	0.03739	0.001332	0.03178	0.1391
plant	0.1692	0.08904	0.01309	0.1678	0.3489
marine	0.7886	0.09518	0.6023	0.7898	0.9627

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.377	0.02009	0.3258	0.3824	0.3993
energy	0.623	0.02009	0.6007	0.6176	0.6742

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.05421	0.04675	0.001759	0.04177	0.1741
15N	plant	0.04419	0.0259	0.003156	0.04181	0.1023
15N	marine	0.9016	0.05317	0.7757	0.9102	0.9805
13C	animal	0.04929	0.04296	0.001594	0.03777	0.1597
13C	plant	0.09441	0.05082	0.007392	0.0922	0.2
13C	marine	0.8563	0.06449	0.719	0.8598	0.9702

INDIVIDUAL CONSUMER RESULTS REPORT: KOLIIIad
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=15.86(0.50) [13C]=-13.16(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)

[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.04764	0.04266	0.001495	0.0356	0.1569
plant	0.1692	0.09238	0.01403	0.1651	0.3628
marine	0.7831	0.1014	0.5752	0.7862	0.9608

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3745	0.02262	0.3142	0.381	0.3992
energy	0.6255	0.02262	0.6009	0.619	0.6859

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.06276	0.05485	0.002023	0.04748	0.2028
15N	plant	0.04476	0.02764	0.003312	0.04115	0.1116
15N	marine	0.8925	0.06142	0.7423	0.9041	0.9797
13C	animal	0.05644	0.04986	0.001799	0.04247	0.1838
13C	plant	0.09733	0.05476	0.007986	0.09284	0.2168
13C	marine	0.8462	0.07278	0.6898	0.8518	0.9683

INDIVIDUAL CONSUMER RESULTS REPORT: KOLIIIad1
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=15.9(0.50) [13C]=-12.7(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.04136	0.03812	0.001216	0.03033	0.1441
plant	0.1595	0.09158	0.01254	0.153	0.356
marine	0.7991	0.09862	0.5932	0.8068	0.9632

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.377	0.02121	0.3213	0.383	0.3994
energy	0.623	0.02121	0.6006	0.617	0.6788

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.05449	0.04926	0.001656	0.04043	0.1832
15N	plant	0.04176	0.02747	0.003254	0.03729	0.1068
15N	marine	0.9038	0.05624	0.7671	0.9149	0.9823
13C	animal	0.04931	0.04504	0.001492	0.03633	0.1677
13C	plant	0.08872	0.05201	0.007367	0.08353	0.2046
13C	marine	0.862	0.0674	0.714	0.869	0.972

INDIVIDUAL CONSUMER RESULTS REPORT: KONIyc
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=13.05(0.50) [13C]=-15.67(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.1247	0.09858	0.004419	0.1029	0.3572
plant	0.2413	0.1148	0.04027	0.2319	0.4927
marine	0.634	0.1434	0.3585	0.6394	0.9006

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3596	0.03353	0.2748	0.3682	0.3986
energy	0.6404	0.03353	0.6014	0.6318	0.7253

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1669	0.1269	0.006172	0.1408	0.4581
15N	plant	0.07027	0.04423	0.01022	0.06162	0.1829
15N	marine	0.7628	0.1323	0.4628	0.7838	0.9527
13C	animal	0.1454	0.1129	0.005254	0.1212	0.4052
13C	plant	0.1567	0.0819	0.02586	0.1454	0.3497
13C	marine	0.6979	0.1323	0.4241	0.7105	0.9212

INDIVIDUAL CONSUMER RESULTS REPORT: KONIoc
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=12.13(0.50) [13C]=-16.51(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.1853	0.1259	0.008809	0.1672	0.4657
plant	0.2842	0.1303	0.06413	0.2683	0.5844
marine	0.5306	0.1593	0.2354	0.5263	0.8487

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3495	0.0412	0.2463	0.3596	0.3984
energy	0.6505	0.0412	0.6016	0.6404	0.7537

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.2572	0.1636	0.01362	0.2391	0.6078
15N	plant	0.08692	0.05783	0.01537	0.07293	0.2421
15N	marine	0.6559	0.1641	0.3092	0.6669	0.9255
13C	animal	0.2196	0.1447	0.01073	0.2014	0.534
13C	plant	0.1919	0.1002	0.04117	0.1738	0.4396
13C	marine	0.5886	0.1564	0.2783	0.5907	0.8784

INDIVIDUAL CONSUMER RESULTS REPORT: KONIIaoc
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=13.1(0.50) [13C]=-15.3(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.1057	0.08324	0.003735	0.08708	0.3121
plant	0.2304	0.1091	0.03762	0.223	0.4652
marine	0.6639	0.1295	0.3998	0.6676	0.9023

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3627	0.03056	0.2852	0.3699	0.3987
energy	0.6373	0.03056	0.6013	0.6301	0.7148

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1397	0.106	0.005166	0.1185	0.3995
15N	plant	0.06677	0.04139	0.008983	0.05891	0.1696
15N	marine	0.7935	0.1113	0.5317	0.8116	0.9564
13C	animal	0.1224	0.09445	0.004473	0.1024	0.3543
13C	plant	0.1479	0.07646	0.02338	0.1378	0.3285
13C	marine	0.7296	0.1146	0.479	0.7409	0.9249

INDIVIDUAL CONSUMER RESULTS REPORT: KONIIbyc
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=13.39(0.50) [13C]=-15.84(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.1236	0.0946	0.004889	0.1033	0.3488
plant	0.249	0.1196	0.04853	0.2355	0.5196
marine	0.6274	0.1404	0.348	0.6307	0.8936

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3571	0.0357	0.2683	0.3661	0.3988
energy	0.6429	0.0357	0.6012	0.6339	0.7318

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1698	0.1233	0.0074	0.146	0.4532
15N	plant	0.07371	0.04786	0.01221	0.06291	0.1977
15N	marine	0.7565	0.1273	0.4689	0.7743	0.9483
13C	animal	0.1467	0.1092	0.006112	0.1239	0.3995
13C	plant	0.1642	0.08703	0.03076	0.1493	0.3743
13C	marine	0.6891	0.1279	0.4233	0.6965	0.9114

INDIVIDUAL CONSUMER RESULTS REPORT: KONIIIad1
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=12.30(0.50) [13C]=-17.90(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.2661	0.1459	0.02077	0.2621	0.5556
plant	0.3768	0.1584	0.1265	0.3523	0.7244
marine	0.357	0.149	0.1131	0.343	0.6897

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3252	0.05582	0.2013	0.3358	0.3976
energy	0.6748	0.05582	0.6024	0.6642	0.7987

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.3932	0.1865	0.04013	0.4024	0.7304
15N	plant	0.1324	0.09194	0.03095	0.104	0.3826
15N	marine	0.4743	0.1706	0.1669	0.4632	0.8213
13C	animal	0.3207	0.1654	0.02786	0.3214	0.6395
13C	plant	0.2754	0.1399	0.08329	0.2433	0.6093
13C	marine	0.4039	0.1536	0.1421	0.3918	0.7404

INDIVIDUAL CONSUMER RESULTS REPORT: KONIIIad2
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=12.90(0.50) [13C]=-14.28(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.07239	0.06337	0.002204	0.05449	0.2384
plant	0.2019	0.1038	0.02493	0.1947	0.4292
marine	0.7257	0.1184	0.4748	0.7327	0.9353

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3694	0.02687	0.2997	0.3767	0.3992
energy	0.6306	0.02687	0.6008	0.6233	0.7003

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.09486	0.08066	0.003026	0.07316	0.2964
15N	plant	0.05631	0.03612	0.006328	0.05005	0.1437
15N	marine	0.8488	0.08712	0.6375	0.8674	0.9683
13C	animal	0.08425	0.07268	0.002598	0.06463	0.2674
13C	plant	0.1235	0.06714	0.01571	0.1163	0.277
13C	marine	0.7923	0.09497	0.5782	0.8028	0.9477

INDIVIDUAL CONSUMER RESULTS REPORT: KON1111
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=12.30(0.50) [13C]=-15.70(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.1196	0.09163	0.004497	0.1009	0.3347
plant	0.258	0.118	0.0527	0.2486	0.5206
marine	0.6224	0.1388	0.3473	0.6252	0.8814

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3564	0.03558	0.2691	0.3653	0.3987
energy	0.6436	0.03558	0.6013	0.6347	0.731

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1643	0.1218	0.006213	0.1404	0.4452
15N	plant	0.07635	0.04763	0.01368	0.06557	0.2018
15N	marine	0.7594	0.1274	0.4745	0.7782	0.9462
13C	animal	0.1419	0.1073	0.005238	0.1201	0.3916
13C	plant	0.1691	0.08548	0.03297	0.1566	0.3728
13C	marine	0.6891	0.1276	0.4195	0.6973	0.9066

INDIVIDUAL CONSUMER RESULTS REPORT: NAAKyc
10000 updates took 6 s

INPUT DATA (Routed model: Yes; Model with offsets: Yes; Concentration-dependent model: Yes; Minimum uncertainty: 0.001)
Individual data
[15N]=15.62(0.50) [13C]=-15.67(0.50)

Isotopic offset
[15N]=5(1) [13C]=4.8(0.5)

Weights
[15N][protein]=100(0) [15N][energy]=0(0)
[13C][protein]=75(5) [13C][energy]=25(5)

Food values
[animal][protein][15N]=5(1) [animal][protein][13C]=-24(0.5)
[animal][energy][13C]=-28(0.5)
[plant][protein][15N]=2(0.5) [plant][protein][13C]=-25(0.5)
[plant][energy][13C]=-26(0.5)
[marine][protein][15N]=15(2.5) [marine][protein][13C]=-21(1.5) [marine][energy][13C]=-26(0.5)

Concentrations
[animal][protein]=50(5) [animal][energy]=50(5)
[plant][protein]=10(2) [plant][energy]=90(2)
[marine][protein]=44(5) [marine][energy]=56(5)

Prior info
[protein]/([protein]+[energy])>0.1
[protein]/([protein]+[energy])<0.4

ESTIMATES
Estimates on food intake

Food	Mean	sd	2.5pc	median	97.5pc
animal	0.0982	0.0751	0.003599	0.0829	0.2826
plant	0.2182	0.1073	0.0359	0.2105	0.4532
marine	0.6836	0.1216	0.4432	0.6881	0.9107

Estimates on fraction contribution

Fraction	Mean	sd	2.5pc	median	97.5pc
protein	0.3629	0.03037	0.2866	0.3705	0.3987
energy	0.6371	0.03037	0.6013	0.6295	0.7135

Estimates on signal contribution from food

Proxy	Food	Mean	sd	2.5pc	median	97.5pc
15N	animal	0.1312	0.09689	0.005041	0.1131	0.3605
15N	plant	0.06222	0.0392	0.008365	0.05446	0.1607

15N	marine	0.8066	0.1004	0.5798	13C	plant	0.1426	0.07521	0.0229
	0.8203	0.9582				0.1334	0.3167		
13C	animal	0.1145	0.08616	0.004308	13C	marine	0.7429	0.1052	0.5222
	0.09745	0.3219				0.7494	0.9274		

DISSERTATIONES ARCHAEOLOGIAE UNIVERSITATIS TARTUENSIS

1. **Heidi Luik.** Luu- ja sarvesemed Eesti arheoloogilises leiumaterjalis viikingiajast keskajani. Bone and antler artefacts among Estonian archaeological finds from the viking age until the middle ages. Tartu, 2005.
2. **Tõnno Jonuks.** Eesti muinasusund. Tartu, 2009.
3. **Gurly Vedru.** Põhja-Eesti arheoloogilised maastikud. Archaeological landscapes of North-Estonia. Tartu, 2011.
4. **Riina Rammo.** Tekstiilileiud Tartu keskaegsetest jäätmekastidest: tehnoloogia, kaubandus ja tarbimine. Textile finds from medieval cesspits in Tartu: technology, trade and consumption. Tartu, 2015, 336 p.