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Birds in Estonian zooarchaeological material: diversity, importance and the earliest appearance of domesticated species

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TABLE OF CONTENTS

LIST OF PAPERS

I Ehrlich, F., Rannamäe, E. & Valk, H. 2020. Bird exploitation in Viljandi (Estonia) from the Late Iron Age to the early modern period (c. 950–1700). – *Quaternary International*. DOI: 10.1016/j.quaint.2020.07.018
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II Ehrlich, F., Piličiauskienė, G., Urbonaitė-Ubė, M. & Rannamäe, E. 2020. The Meaning of Eagles in the Baltic Region. A Case Study from the Castle of the Teutonic Order in Klaipėda, Lithuania (13th–14th Century). – *Archaeologia Lituana*, 21, 59−78. DOI: 10.15388/ArchLit.2019.21.4
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III Ehrlich, F., Rannamäe, E., Laneman, M., Tõrv, M., Lang, V., Oras, E. & Lõugas, L. 2021. In search of Estonia's earliest chicken. – *Estonian Journal of Archaeology*, 25 (2), 160−181. DOI: 10.3176/arch.2021.2.04
Author contribution: conceptualization, collecting and analysing the data (expect collecting some of the bones and analysing the results of radiocarbon dates), writing the first full draft, visualization. The manuscript was edited as collaboration by all authors.

IV Ehrlich, F., Aguraiuja-Lätti, Ü., Lõugas, L. & Rannamäe, E. 2022. Application of morphometric and stable isotope analyses for distinguishing domestic and wild geese. – *International Journal of Osteoarchaeology,* 32 (2), 457–466. DOI: 10.1002/oa.3080
Author contribution: conceptualization, methodology, collecting and analysing the morphometric data, writing and editing the draft (except the parts regarding stable isotopes), visualization of the morphometric results. The manuscript was edited as collaboration by all authors.

1. INTRODUCTION

In 2022, there are 398 wild bird species listed to live in Estonia, including migratory birds and some vagrants (Estonian Ornithological Society). These birds inhabit very different environments, such as waterbodies, woods, and bogs, but also towns and villages. How the bird fauna in Estonia has changed through time, is difficult to evaluate, but zooarchaeology – the study of animal remains from archaeological sites – can shed some light to this question. The three main classes of animals we encounter in the studied archaeological material are mammals (*Mammalia*), birds (*Aves*), and fish (*Pisces*). Mammals are usually the most abundant, thus studied most extensively. Also, fish remains are often numerous (yet, much affected by excavation methods) and have gained some more interest. Birds, however, have received less attention. Although papers on archaeological bird remains from Estonia have been published before (e.g. Lõugas 1981; Mannermaa & Lõugas 2005; Jounuks *et al.* 2018; Maldre *et al.* 2018), there is usually only a brief overview of their presence among the rest of the osteological material (e.g. Saks & Valk 2002; Lõugas *et al.* 2012; Valk & Rannamäe 2015). The situation in the other two eastern Baltic countries – Latvia and Lithuania – is very similar (e.g. Bilskienė & Daugnora 2001; Daugnora *et al.* 2002; Blaževičius *et al.* 2012; Mannermaa 2013; Rumbutis *et al.* 2018). Current state of research has its roots in the overall development and history of zooarchaeology in the region. Namely, while mammals and fish have received more interest, there have been no specialists on bird remains; and in turn, no comprehensive reference collections. All of this started to change in 2014 (Lõugas & Rannamäe 2020, 138). The Institute of Systematics and Evolution of Animals at the Polish Academy of Sciences (Kraków, Poland) has had a very important role in the development of avian zooarchaeology in Estonia. There, under the guidance of Dr. Teresa Tomek, I was able to learn the identification of bird bones and use their reference collection. The work conducted in Kraków is also included in this thesis.

Bird remains can fill several gaps in our knowledge about history, because birds have been important in several aspects of human lives. These include people's diet, usage of raw material, burial practices, rituals, trade, social status, hunting strategies, pets and companions, history of domestication, etc. Archaeological bones can provide information not only about human culture, but also about environment, climate, and faunal history, including extinct species. Because of the wide variety of topics this information can shed light to, birds are a valuable source of knowledge about the past.

1.1. Outline and aims of the dissertation

The current thesis is a continuation of previous bachelor and master theses (Ehrlich 2016; 2018). Work with bird bones from the town of Viljandi, Estonia, started for the bachelor thesis and concentrated on Late Iron Age material. For the master thesis, birds from medieval and early modern Viljandi were studied, whereas consumption between different social strata and different time periods were compared. Those two theses later formed the basis for Paper I and gave the impulse for the following doctoral research. The topic and aims of the thesis were further framed by participation in the project *Foreign vs local in Medieval and Modern Age foodways in the eastern Baltic: tracing the changing food consumption through provenance analyses* (funded by the Estonian Research Council grant no PRG29, 1.01.2018−31.12.2022, PI: Lembi Lõugas).

In the four papers included in this thesis, the main research questions are the following:

- Which bird species were present in Estonia from the Late Iron Age to the Early Modern Period (800–1700)? (Paper I)
- How did people use different bird species? Why were they important? (Papers I and II)
- When did the most common domesticated birds – chicken (*Gallus gallus domesticus*) and goose (*Anser anser domesticus*) – arrive to present-day Estonia? (Papers III and IV)
- Which methods should be used for finding the earliest domestic birds (especially the domestic goose)? (Paper IV)

The first part of the study is mainly based on the material from two castles of the Teutonic Order – Viljandi, Estonia (Paper I), and Klaipėda, Lithuania (Paper II). The first article, ***Bird exploitation in Viljandi (Estonia) from the Late Iron Age to the early modern period (c. 950–1700)*** in *Quaternary International*, concentrates mainly on birds as food, raw material, and marker of social status, and compares their usage during different time periods and social strata (open data for this paper are visible in ARHEST database and in DataDOI (Ehrlich *et al*. 2020)). The second article, ***The meaning of eagles in the Baltic region. A case study from the castle of the Teutonic Order in Klaipėda, Lithuania (13th–14th century)*** in *Archaeologia Lituana*, studies the importance and possible ways to use eagles in the Baltic region, concentrating mainly on Lithuania and Estonia (open data for this paper are visible in DataDOI (Ehrlich 2020)).

The second part of the thesis investigates the arrival of domesticated birds until present-day Estonia. This part of the study concentrates mainly on two domestic bird species – chicken and goose – whose remains are found more frequently in archaeological sites. Compared to other species, these two are more thoroughly studied in the world (e.g. Albarella 2005; Peters *et al*. 2016; Fothergill *et al*. 2017; Honka *et al*. 2018; Poland 2018; Walker & Meijer 2020). In the third paper, ***In search of the earliest chicken in Estonia*** in *Estonian Journal of Archaeology*, the main question is when the chicken appeared in the area of present-day Estonia (open data for this paper are visible in ARHEST database). Regarding the risk that the earliest chicken bones may turn out to be younger than expected by their archaeological context, radiocarbon dating was a valuable tool. For the domestic goose, the question of the earliest evidence is complex, and before finding the earliest domestic goose in present-day Estonia, the question of how to distinguish wild goose from domesticated goose needed to be solved. This topic is discussed in the fourth paper, ***Application of morphometric and stable isotope analyses for distinguishing domestic and wild geese*** in *International Journal of Osteoarchaeology* (open data for this paper are visible in appendix of the paper and in ARHEST database). Although the domestic goose is usually larger than its wild relatives and they can be distinguished morphometrically (e.g. Poland 2018), the method can be problematic in case of early domestic individuals. Therefore, the analysis of stable isotopes as a supportive method was applied.

The introductory part of the thesis integrates the four above-mentioned papers into a discussion on why bird bones should be studied and what information has been gathered during this study. The paper starts with an introduction to the research history on bird bones in Estonia and neighbouring regions (all sites in the eastern Baltic region mentioned in the introductory part of the thesis are marked in Fig. 1). This is followed by theories about different areas of avian archaeology, that is, the human-bird relationship, exploiting birds for food, status, and companionship, but also questions about domestication. Next follows an introduction to the archaeological and modern material, and principles for their selection. The paper will then continue to describe the used methods, which are based on the skeletal anatomy (Fig. 2), biology, ageing, sexing, pathologies, taphonomies, and quantification. The problems of preservation, collection, and interpretation of the osteological material are also considered. The results are discussed with a focus on the use and domestication of birds that are found in Estonia, specifically the chicken, goose, duck, turkey, peafowl, and pigeon. Attention is also given to the diversity and meaning of birds from the Stone Age to the Early Modern Period in Estonia. In the appendix, all bird species mentioned in the introductory part of the thesis are listed with their English, Latin, and Estonian names.

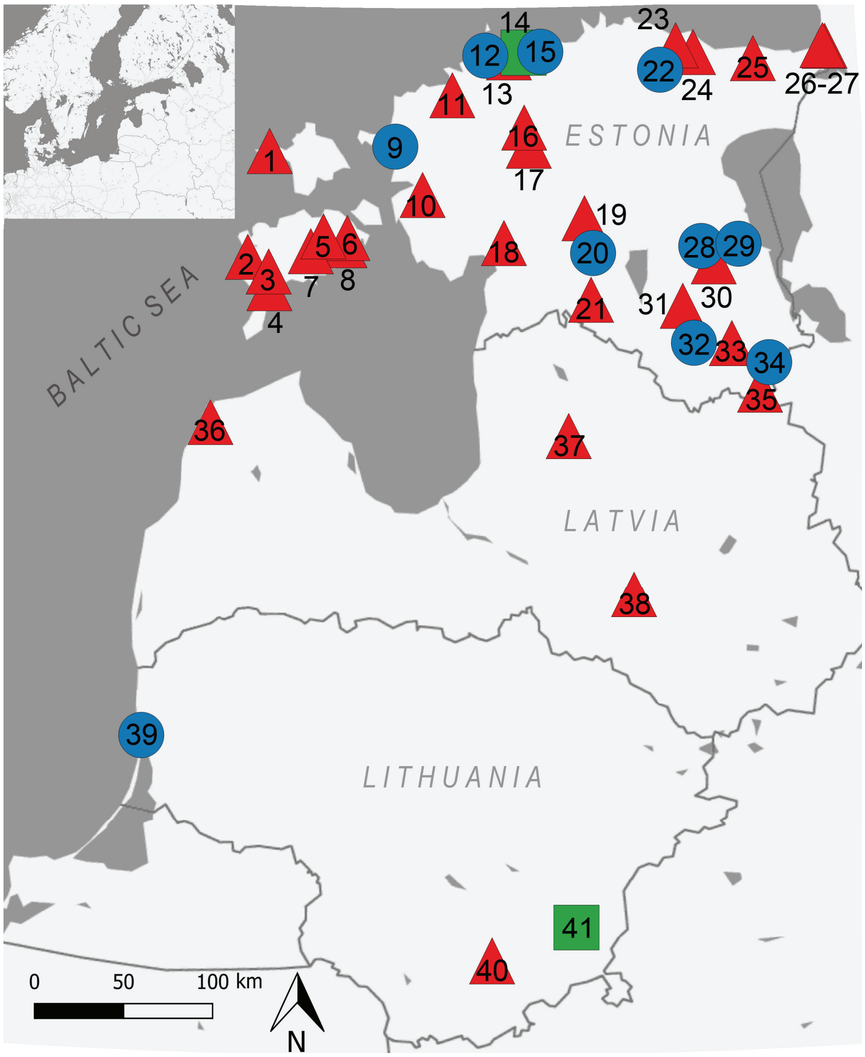

Figure 1. Archaeological sites in the eastern Baltic region mentioned in the introductory part of the thesis. For sites marked with blue circles, I identified the bird bones myself; for red triangles, the identifications are based on published data by other researchers; and for green squares, I identified the material partially, whereas the remaining part was identified by other researchers. Sites in Estonia: 1 – Kõpu; 2 – Loona; 3 – Naakamäe; 4 – Salme; 5 – Kõnnu; 6 – Ridala; 7 – Kaali; 8 – Asva; 9 – Haapsalu; 10 – Lihula; 11 – Padise; 12 – Ilmandu; 13 – Tallinn; 14 – Iru; 15 – Rebala; 16 – Maidla; 17 – Linnaaluste; 18 – Pulli; 19 – Lõhavere; 20 – Viljandi; 21 – Karksi; 22 – Rakvere; 23 – Kunda; 24 – Pada; 25 – Kukruse; 26 – Kudruküla; 27 – Riigiküla; 28 – Tartu; 29 – Kastre; 30 – Kõivuküla; 31 – Otepää; 32 – Vaabina; 33 – Tamula; 34 – Vastseliina; 35 – Siksälä; sites in Latvia: 36 – Ventspils; 37 – Āraiši; 38 – Asote; sites in Lithuania: 39 – Klaipėda; 40 – Jurgionys; 41 – Vilnius. More detailed information can be found in Papers I–IV. Map data: Snazzy Maps and QGIS, made by Freydis Ehrlich.

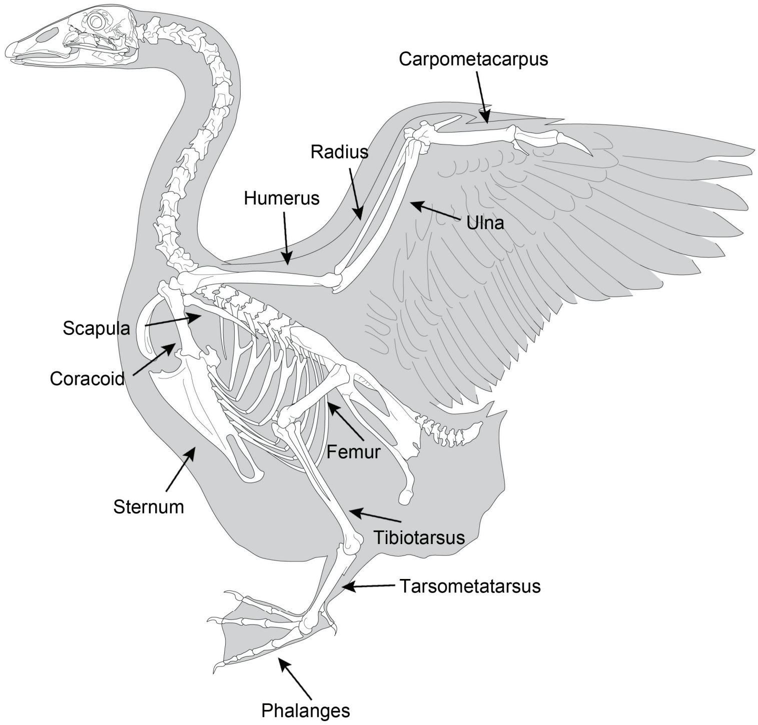

Figure 2. Bird's skeletal elements mentioned in the text. Element names after Ernits & Nahkur (2013), Ernits (2015). Figure data: ArcheoZoo.org (2018), made by Freydis Ehrlich.

To conclude, I thank my two supervisors, Eve Rannamäe for supervising and teaching me how to be a researcher since 2014, and Valter Lang for all the useful advice during doctoral studies. The help I received from Teresa Tomek (Institute of Systematics and Evolution of Animals at the Polish Academy of Sciences) was also remarkable as over the visits to Kraków she taught me how to identify bird bones. Eha Järv (Estonian University of Life Sciences) was great help in improving the reference collection by providing a place to prepare the skeletons, and by occasionally helping to find new specimens for the collection, whereas Ülo Väli (Estonian University of Life Sciences) helped me in identifying birds before preparation; I also thank him for allowing me to use his personal reference collection. I would also like to thank Lembi Lõugas (Tallinn University) and Liina Maldre (Tallinn University) for their kind help in choosing the bones to study, finding literature, and discussing zooarchaeology with me. Giedrė Piličiauskienė (Vilnius University) and Eduards Plankājs (University of Latvia) always gave quick and thorough answers regarding both local bones and literature in their local language, respectively Lithuanian and Latvian. I also thank Arvi Haak (Tartu City Museum) for helping with the contexts of Viljandi, Ragnar Saage (University of Tartu) for teaching me how to visualise my data, Andres Vindi (University of Tartu) for making X-rays, Martin Malve (University of Tartu) for the help in identifying pathologies and clarifying the context of Tartu bones, Andres Tvauri (University of Tartu) for additional information about some contexts of Viljandi, and Heiki Valk (University of Tartu) for all the support over the years. Katarina Damčević (University of Tartu) and the Communicating Science group were also inspiring and supportive with several writing retreats over the years. I am also thankful to all the co-authors and reviewers who taught me a lot during the process, and all the collection managers at museums and research institutions for providing access to the used material. Finally, I must thank my family, especially Märt Keevend, for being my main support throughout the process. The reasearch was supported by the Estonian Research Council grant no. PRG29 and no. TT14 for the core facility NATARC, and the European Regional Development Fund (Graduate School of Culture Studies and Arts, funded by University of Tartu ASTRA Project PER ASPERA).

2. RESEARCH HISTORY

To understand Estonian research history on bird bones, the overview of the research in the world and in the neighbouring regions of Estonia is presented. This chapter is divided into four parts: 1) the world, 2) the eastern Baltic region, 3) Fennoscandia, and 4) north-western Russia. History of research differs between those four areas considerably.

2.1. The World

Avian anatomy has been studied by naturalists from the 18th century onwards, but scientists turned to the whole skeleton only from the mid-19th century, as before mainly beaks, claws, and skins were studied (Serjeantson 2009, 5). At that time, archaeological and natural fossil bird bones were researched by avian palaeontologists whose primary interests were the evolution, distribution, and extinction of birds (*ibid*.). Only from the 20th century onwards bird bones were used to answer archaeological questions (*ibid*.). One important study was conducted by Hildegarde Howard (1929) who created illustrations for identifying bird skeletal elements (Reitz & Wing 2008, 18). Graham Clark (1948) summarised the information about prehistoric human-bird relationships in Europe based on many classic 19th century ethnographic and historic accounts (Mannermaa 2008, 17; Serjeantson 2009, 5–6). Another important work is by Elliot W. Dawson (1963) who summarised knowledge of birds in archaeology, providing an extensive geographical summary (Mannermaa 2008, 17).

By 1969, only about 200 publications on bird remains from archaeological sites had been published; by now, this number has increased tremendously (Serjeantson 2009, 6). Since then, one of the most important developments was the creation of skeletal reference collections in institutions other than natural history museums, leading to the study of bird remains by Joachim Boessneck and Angela von den Driesch in Munich, Germany (*ibid*.). Many dissertations written in the Palaeoanatomical Institute of Ludwig-Maximilians-Universität Münich are still relevant (Bacher 1967; Woelfle 1967; Erbersdobler 1968; Kraft 1972; Fick 1974; Langer 1980; Otto 1981; Schmidt-Burger 1982; Kellner 1986). Most of these handbooks were used when identifying bones for this thesis.

Research on bird bones has become an important part of (zoo)archaeology. The Bird Working Group (BWG) of International Council for Archaeozoology (ICAZ) was founded in Madrid in 1991, and since then it has had a strong influence in this study field (Serjeantson 2009, 6–7). Particularly all conference proceedings are a very important outcome of the BWG meetings (Morales 1993; Serjeantson 1997; Bocheński 2002; Grupe & Peters 2005; Prummel *et al*. 2010; Bejenaru & Serjeantson 2014; Albarella *et al*. 2020; Dirrigl Jr. & Brush 2020). Most of these were used while writing this doctoral thesis. It is important to note that the 9th BWG meeting in 2018 was dedicated to Dale Serjeantson who has contributed greatly towards the development of avian archaeology, co-authored an identification key (Cohen & Serjeantsion 1996), and published several articles on bird remains. The most important and influential publication by Serjeantson is her book *Birds* (2009).

2.2. The eastern Baltic region

Despite birds having found their place in general (zoo)archaeology, it has not been the case in the eastern Baltic region. In Estonian zooarchaeology, bird bones have been identified as part of animal bone assemblages from the second half of the 20th century. One of the first researchers who identified and wrote about birds among other material was palaeozoologist Johannes Lepiksaar (e.g. Lepiksaar 1942). Due to the second world war, he was forced to emigrate to Sweden in the 1940s (Kriiska & Lõugas 2006, 275), where he started working with local faunal remains, including bird bones (e.g. Lepiksaar 1955; 1967; 1977; 1983). In the 1950s, bird and mammal bones and pendants made of these that were found from the settlement site of Tamula, Estonia, were studied by Loreida Põder (Kriiska & Lõugas 2006, 275). For a long time afterwards, bird bones in Estonia were practically left unexamined or were identified only superficially. In his monography, Kalju Paaver (1965) mentions the number of bird bones found from Estonian, Latvian and Lithuanian Stone and Metal Age sites, but has not given the list of species. However, for Asote hill fort in Latvia, species of birds were published (Paaver 1961). Paaver also published a summary of the development of avian fauna in eastern Baltics (Paaver 1959). In both Latvia and Lithuania, Valentina Danilchenko[1] worked with bird bones from 1965 to the 1990s, but similarly to Paaver, only the number of birds was given (e.g. Danilchenko 1990). In Latvia, during the second half of the 20th century mammal and bird bones found from archaeological excavations of various periods were studied by Arnis Mugurēvičs and Ilze Renga (Vasks & Zariņa 2021, 78). Antra Strazdiņa has discussed birds from the Stone Age (Strazdiņa 1986). An exception for this period of research, when a bird species – chicken – was more discussed, was an article by Vello Lõugas (1981), where he discussed problems about chicken and eggs in the ritual context, and the relation of these to burials in Estonia and neighbouring countries.

From the 1990s, bird bones have been identified by several Estonian researchers: Paul Saks and Eha Järv (Estonian University of Life Sciences) (e.g. Saks & Järv 2001; Saks & Valk 2002; Järv 2005), Lembi Lõugas (Tallinn University) (e.g. Lõugas 1996a; 1996b; 2017), Liina Maldre (Tallinn University) (e.g. Maldre 2000), and since 2010s by Eve Rannamäe (Univesity of Tartu) (e.g. Rannamäe 2010). Bird bones have been more thoroughly discussed only in

[1] For Latvia, the information is based on a personal communication with Eduards Plankājs 16.08.2021, because identifications by Danilchenko are unpublished.

recent decades, getting more attention since 2014 (Lõugas & Rannamäe 2020, 138). Until then, bird bones were often identified by a local zooarchaeologist only as 'chicken' or 'birds' and only mentioned or briefly discussed in publications. In Lithuania, Rasa Bilskienė started to work with bird bones in 1990s, and although she left the field after a short period, she still published a few papers (e.g. Bilskienė & Daugnora 2001). Lately, ornithologist Saulius Rumbutis has identified and discussed bird bones from Lithuania (e.g. Blaževičius *et al*. 2012; Rumbutis *et al*. 2018).

In general, the most thorough studies on bird bones in the Baltic region have been conducted by external researchers. For example, Kristiina Mannermaa has worked with Estonian and Latvian material that is mostly prehistoric (e.g. Mannermaa & Lõugas 2005; Mannermaa 2013); material from both countries has also been discussed by Maltby *et al*. (2019). Teresa Tomek has worked with Estonian material from different time periods (e.g. Lõugas *et al*. 2012; Lõugas & Tomek 2013; Maldre *et al*. 2018) and Anne Karin Hufthammer has examined Lithuanian material (e.g. Daugnora *et al*. 2002; Stančikaite *et al*. 2009). It is important to recognise that compared to a non-specialist, a specialist on bird bones can provide more information about the bird species, but also provide wider interpretations about the environment, human-bird relationship, utilisation, etc. and come to relevant conclusions. The profound works in the eastern Baltic region conducted by external researchers only confirm this.

Other resources besides bones also provide valuable information. Of such studies, one is about archaeological eggshells from Kukruse cemetery, Estonia (Jonuks *et al*. 2018). Information can be found from the works of historians: for example, Jüri Kivimäe (1996) has written about the, possibly, first turkey in Estonia, whereas Inna Põltsam-Jürjo and Anu Mänd have written about food, including birds, in medieval Livonia (e.g. Mänd 2004; Põltsam-Jürjo 2013).

2.3. Fennoscandia

Compared to the eastern Baltic region, the history of studying bird bones in Fennoscandia is longer – the first works of bird osteology go back to the 1980s and 1990s (Mannermaa 2008, 18, and references therein). In Finland, Kristiina Mannermaa has worked with bird bones. Her dissertation considers birds and people in the Baltic Sea region, including area of present-day Estonia, during the Stone Age (Mannermaa 2008). Goose bones from Finland have been studied by Johanna Honka using ancient DNA (aDNA) (e.g. Honka *et al*. 2017). For Sweden, works by Per Ericson and Tommy Tyrberg are important (e.g. Tyrberg 2002; Ericson & Tyrberg 2004). In Norway, Anne Karin Hufthammer should be mentioned (e.g. Montevecchi & Hufthammer 1990). Additionally, recent papers by Samuel Walker on reconstructing past avian communities in Norway are also worth mentioning (e.g. Walker *et al*. 2019; Walker & Meijer 2020). Important papers on Danish bird bones have been written by Anne Birgitte Gotfredsen (e.g. Gotfredsen 2013; 2014).

2.4. North-western Russia

In north-western Russia, birds have been studied by both foreign and local scholars. Important studies have been conducted by Sheila Hamilton-Dyer, Ellen Hambleton, and Mark Maltby (e.g. Hamilton-Dyer 2002; Maltby 2012; Hamilton-Dyer *et al*. 2017; 2020). In recent years, few papers on the aDNA of goose and chicken remains from Russia have been published, including sites from the north-western part (e.g. Honka *et al*. 2018; Lebrasseur *et al*. 2021). Lately, bird bones from Russia have been thoroughly studied by Dilyara Shaymuratova (Galimova) (e.g. Galimova *et al*. 2014; Shaymuratova *et al*. 2019).

3. THEORY

Zooarchaeological material can provide firm evidence of bird usage in the past, indicated by the identified species, age, sex, taphonomies, and pathologies, and give information about how the birds have been used or raised. However, these marks are not always present or identifiable and therefore interpreting the human-bird relationship and the variety of roles that birds have had might be more challenging. Comparing the data obtained during identifications with the information from written sources, and sometimes even with modern practises, can help. In this chapter, the human-bird relationship and different meanings of birds are addressed, while in the methods section, the more direct information that bones themselves can provide is described.

In many Western societies, animals are primarily treated as objects – like sources of food and raw materials – and resources to be regulated, managed, and marketed (Hill 2013, 117). Literature on animal studies reveals how diverse human-animal interactions actually have been, making it apparent that animals played subjective, agential roles in many ancient societies (*ibid*.). During prehistoric times, birds were a part of people's everyday life and might have affected their daily activities (Mannermaa 2008, 10). In Estonia too, people in the past were much more interested in birds, and not only for material reasons. This is shown by many cases in folklore, where a wide variety of birds are seen as messengers, bringing information about the weather, fire, birth, death, and so on (Hiiemäe 2016). Not to mention the myth known on several continents that the universe originated from a bird's egg (Lõugas 1981, 96; Jonuks *et al*. 2018, 10). Moreover, birds have been kept for their beauty, voice, and companionship (Serjeantson 2009, 316), and they played a part in entertainment, status, environment, and religion, even though zooarchaeological evidence for these roles might be hard to find. Although the biggest role birds have had, is for food, and most of the archaeological material studied is food waste, I have not elaborated this topic thoroughly in this chapter. Instead, I have found necessary to shed light on other possible uses of birds in history to draw more complex picture of people's habits in the past. The topics are chosen based on the papers making up this thesis.

3.1. Human-bird relationship

The human-bird relationship has several layers, but sometimes it is hard to interpret or even notice these in archaeological material. Some birds, like chicken, might have had several different meanings through their lifetime. For example, people can develop a close relationship with a chicken, but still eat the bird afterwards (Sykes 2012, 159; Doherty 2013, 84). Even when the animals are raised only for a short period, the majority of their meaningful associations with humans are played out while alive; the act of being killed, processed, and eaten represents only a small fraction of the relationship (Sykes 2012, 159).

However, in zooarchaeological material, it is sometimes impossible to tell if before its death the bird had an objective, subjective, or both values to people. In most cases, we can only interpret the value after its death.

In the context of Estonian archaeological material, we can associate human-animal relationship with total control over animals from at least the Late Bronze Age (850–500 BCE) onwards. At that time, people did not rely on hunting anymore, because animal domestication and husbandry gave them more freedom, but also more control. This meant more and longer contact with the animals, which developed a human-animal relationship (Armstrong Oma 2010, 177). Based on zooarchaeological material, the interpretation of human-bird relations is often difficult to make. For example, in medieval (1225–1560 CE) and early modern (1560–1700 CE) Estonia, people in towns relied on hinterlands and suburbs around the town, but also raised their own animals (Põltsam-Jürjo 2013, 41 ff.). Therefore, it is hard to say, which birds were raised in towns and which were brought in. This complicates the understanding of the human-animal relationship within one specific site. Moreover, it is sometimes even impossible to say if the bird was hunted or kept in captivity (in case of geese and ducks, for example).

3.2. Birds as markers of social status

The exploitation of birds does not show only the relationship between humans and birds. It can also give information on relationships between people, for example, because eating is not only a basic need, but also a social act, this may display someone's wealth and prestige (Mannermaa 2008, 10). Eating or not eating certain animals might also have been regulated by ideological beliefs in the society (*ibid*.). The concept of what is edible differs between societies (*ibid*., 10–11). Therefore, studying bird bones does not only show what people ate, but also helps to understand the mentality of the people in that time. Most of the material analysed in this study is from the Middle Ages and the Early Modern Period, whereas some comparison can also be drawn with the works of historians (e.g. Mänd 2004; Põltsam-Jürjo 2013). This helps to interpret and understand how wild birds were used in showing social status or wealth (also discussed in Paper I). During the Middle Ages, wild animals were a tool for showing status and position, because hunting was a privilege for the people with higher status (Põltsam-Jürjo 2013, 53, 55). However, by the Late Medieval Period, richer merchants and councillors were allowed to consume game as well (Mänd 2004, 344, 349). By the mid-16th century, the eating of wild birds and smaller game animals was more a comment on wealth rather than status, and therefore it was common in guilds, fraternities, and other events of wealthier artisans (*ibid*.). For example, in 16th century historical documents, the Eurasian crane (*Grus grus*), swan (*Cygnus* sp.), and western capercaillie (*Tetrao urogallus*) are mentioned as food served at guild feasts (*ibid*., 298, 345). At feasts organized for guests of a higher status, partridge (*Perdix perdix*) and even peafowl were served (*ibid.*). Besides the symbolic meaning, size might be another factor making the bird desirable for food, as it is suggested to be the case for swan (Sykes 2004, 91). Additionally, merely the fact that a wider range of birds are represented in the archaeological material can be a sign of higher status consumption (*ibid.*, 97).

One marker which indicates social status is the presence of hawk and falcon bones, since these birds were used for hawking or falconry. While *hawking* and *falconry* are used as synonyms, the former is sometimes used to refer specifically for the use of hawks and the latter for falcons (Serjeantson 2009, 316). In this thesis, *hawking* is used because even though falcons have been found from Estonia as well (e.g. Maldre *et al.* 2018, 1235), it is the hawks who are more in focus. Hawking refers to the capturing of wild birds and smaller wild mammals by using birds of prey (Serjeantson 2009, 316). Hawking is also practiced today, being most common in the East, especially in the Arab countries (*ibid.*). It seems that hawking has always been primarily a sport or symbol of status, because there are more effective ways to catch birds and mammals for food (*ibid.*). As hawking was a privilege of the upper ranks of society, most finds of raptors come from high status locations like castles, palaces, and hunting lodges (*ibid.*, 325, and references therein). In the past, it was an enormously popular activity in Europe and Asia among the high ranks (*ibid.*). Not much is known about hawking in Estonia. More information can be found in Lithuania. For example, bones of hawks, leather hoods and belts for falcons have been found from Vilnius Castle (Blaževičius *et al.* 2012; Rumbutis *et al.* 2018, 119; Makowiecki *et al.* 2019, 357). In addition, written sources describe capturing falcons that are more suitable for hunting in open terrain (Bezzenberger 1889, 30). Some medieval written evidence about hunting hawks is also related to Latvia (Maltby *et al.* 2019, 163). Archaeological evidence has also been found from north-western Russia, where besides the bones of hawks and falcons, leather belts and possible falconers' bells have been present (Hamilton-Dyer 2002, 104). According to archaeological material, it seems that northern goshawk (*Accipiter gentilis*) was used for hawking in medieval Belarus and Ukraine as well (Gorobets & Kovalchuk 2017, 154). Hawking is discussed in Papers I and II.

3.3. Birds in symbolic meaning and rituals

In archaeological records, symbolism is more difficult to detect than the material aspects of human behaviour. One possibility to see the symbolism is the presence of birds in graves. Animals, including birds, have accompanied inhumations and cremations in many cultures, both as funeral feast or as being part of other activities unrelated to food (Serjeantson 2009, 340). Additionally, birds might have been intended as food for the deceased on their journey to the afterlife, or these were offerings to the gods to ensure safe arrival in the afterlife (*ibid.*, 343). It is also possible that the birds were deposited mainly because they were luxury food (*ibid*., 343–344). In Kukruse cemetery, Estonia (dated to the end of the 12th – beginning of the 13th century CE), an egg painted red had been placed in a grave probably for ritual purposes related to Christianity, while another egg found in a grave might have been related to food consumption in afterlife or as a symbol thereof (Jonuks *et al*. 2018, 10–11). Whether the chicken bones could be similar symbols or refer to other funeral activities remains debatable. In Estonian sites, chicken bones are sometimes present in graves as well. In sites of mainly Bronze and Early Iron Age, like Rebala and Ilmandu III stone graves, chicken bones were present, but the relation with burials is often questionable because of the disturbance of the layers (Paper III). Additionally, birds have been buried with people as companions. For example, in Late Iron Age Scandinavia, individuals of high status were buried with their companion animals, including falcons kept for hawking (Serjeantson 2009, 345). Similarly in the Pre-Viking Age ship burial found in Salme, Estonia, bones of hawks and falcons were present (Maldre *et al*. 2018).

Symbolic meaning can also be expressed in pendants. For example, from Late Iron Age (9th–13th century CE) Estonia, four pendants made of chicken bones have been found. Three of these come from Lõhavere hill fort and are chicken carpometacarpals hung on a bronze chain (Jonuks & Rannamäe 2018, 174). The fourth find from Otepää hill fort is a pendant made of chicken tarsometatarsus with a spur (*ibid*.). Additionally, pendants made of claws of the white-tailed sea-eagle (*Haliaeetus albicilla*) have been found from Linnaaluste III settlement site and Pada cemetery; whereas a pendant made of a claw of the white-tailed sea-eagle or the golden eagle (*Aquila chrysaetos*) comes from Rakvere settlement site (Konsa *et al*. 2003, fig. 4; Luik & Maldre 2005, 269; Malve *et al*. 2020, 192–193). One pendant made of a bone of some bird of prey has also been found from a burial in Kukruse (Jonuks & Rannamäe 2018, table 12.1). Pendants of the white-tailed sea-eagle and the meaning thereof are discussed in more depth in Paper II.

3.4. Domestication

Domestication of animals has been thought to be so important that it has been compared to the discovery of fire and tools (Davis 2002, 126). Namely, it gave remarkably more control over food resources, which allowed protection from climate and environmental uncertainty affecting human population size and human evolution (Davis 2002, 126; Brown *et al*. 2009; Larson & Fuller 2014, 116). Domestication has been stated to be an evolutionary process that involves long-term and continuous change that has a beginning but no end (Larson & Burger 2013). It could have taken centuries or even millennia before an animal could have been labelled as ‘domestic’ and it is still unclear, at what point the animal becomes ‘domestic’ after all (Zeder 2006, 107; Larson & Burger 2013).

Questions like when, where, and why different species were domesticated has been considered one of the exciting challenges in zooarchaeology (Davis

2002, 126), that with modern possibilities, like aDNA, is being addressed more and more. Of domestic birds, chicken is the most researched in this regard (e.g. Girdland Flink *et al*. 2014; Wang *et al*. 2020; Eda 2021), but also studies of turkey (e.g. Speller & Yang 2016; Manin *et al*. 2018) and goose are conducted (e.g. Barnes *et al*. 2000; Heikkinen 2017; Honka 2020). Domestic species are those whose breeding is largely controlled by humans, creating an artificial selection more suitable for humans rather than a natural one (Davis 2002, 126). For example, birds used for hawking are often collected from nests and raised by people (Prummel 1997, 333), but they are never domestic. There are several reasons why some species were preferred to be domesticated whereas others were not. One of these reasons is the domestication pathway. Several of these pathways have been defined. For chicken, goose, duck, and pigeon, it was the commensal pathway that was used (Larson & Burger 2013; Larson & Fuller 2014, 123, fig. 1). The commensal pathway means that the animal itself played a bigger role in its domestication; for example, less aggressive individuals being attracted to human food waste (Larson & Burger 2013; Larson & Fuller 2014, 117).

It is easier to domesticate species with well-defined dominance hierarchies (especially among the males), who are more like herd animals and therefore more social, because humans can imprint the role of the leader or, in case of young individuals, the mother (Davis 2002, 127). For example, chicken was easily domesticated, because similarly to free-ranging domestic chicken, social groups of the jungle fowl (*Gallus gallus*) usually consist of one dominant male and one dominant female to whom others subordinate (Marino 2017). The dominance hierarchy is set up from the first meeting by the dominant hen, who pecks, claws or jumps on the subordinates (*ibid*.). By behaviour and cognitively, most of the animals domesticated for food, like chickens, are very similar to their ancestors, because they are mainly selected on physical characteristics like the growth rate, fecundity, percentage of body fat, etc. (*ibid*.).

For several bird species, it seems that they were domesticated because the bird or its feathers had an importance in religious or ritual activities (Serjeantson 2009, 2). For example, chicken has had many roles in the past. At first, its symbolic meaning was more important than its role in the menu and chickens were kept for sacrifices and cockfighting, but also for their sound, and perhaps also for eggs and feathers (Serjeantson 2009, 268; Sykes 2012, 160). Only later did people start to eat chicken meat and eggs regularly (Serjeantson 2009, 399). In general, domestication tends to make animals less aggressive toward potential predators, but some breeds of domestic chickens are more aggressive than their ancestor (Marino 2017). This can be related to the fact that one of the reasons for keeping chickens was cockfighting. Regarding turkeys, there have been two possible hypotheses on why they were domesticated. One of these is that turkeys were attracted by cultivated gardens and crops, which purported their domestication; the other hypothesis suggests that the birds were captured because of their feathers and feathered skins (Serjeantson 2009, 288).

There are several ways to distinguish domestic birds from their wild ancestor, but the differentiation is not always easy. One sure sign of domestication is the sudden arrival of a new species (Davis 2002, 133), like the chicken and turkey in Estonia, whose ancestors are not present in the area. For geese and ducks, the differentiation is more difficult, because the ancestors for both species are native to the area as well. Changes in morphology have been used as markers in the differentiation of the domestic from the wild (Poland 2018). Other factors can also influence those criteria and one must remain cautious with interpretations (Davis 2002, 133). At first, domestic populations were small and therefore hybridisation with wild animals was needed (Larson & Burger 2013). This makes the finding of the earliest domestic specimens even more difficult. Nevertheless, through time this led to the domestic population becoming genetically more divergent than the original domesticated population (*ibid*.).

4. MATERIAL

Archaeological bird remains can be bones, feathers, and eggshells. All three categories need a certain set of skills and preparation to study. In Estonia, mostly bones, which is also the most abundant find category, have been studied. Eggshells have received less attention. A study of chicken eggs has been published by Jonuks *et al*. (2018) while Rannamäe & Lõugas (2019, 69) mention possible chicken eggs; additionally, eggshells with no species identification are mentiond by Haak *et al*. (2022, 44). Some data of eggshells from Latvia have also been published (Jonuks *et al*. 2018, 8, and references therein). The feathers found from Estonia have not been given attention so far. In the current study, only bones were involved, while eggshells and feathers will hopefully be studied in the future.

Bird bones analysed for this study are stored in the archaeological collections of the Archaeological Research Collection at Tallinn University (Papers III and IV), the Department of Archaeology at the University of Tartu (Papers I, III, and IV), and in the zooarchaeological collections of Vilnius University (Paper II). Few assemblages reassessed for Paper III are stored in the Estonian History Museum. For Paper IV, additional comparative data of modern geese were studied in the Natural History Museum at the University of Tartu, zoomedicum at the Estonian University of Life Sciences, and zoological collection of the Estonian Museum of Natural History.

Only a fraction of the zooarchaeological material in Estonia has been identified over decades of research. While available identification reports and publications are much valued, these can be problematic (more on this topic in Paper I, III, and chapter 5.2.). Therefore, for the reliability of the raw data that formed the basis of this study, all bones that had previously been identified by other scholars were re-assessed.

The material was selected according to the aims and topic of each of the four papers. The thesis covers a long time period from the Prehistory to the Early Modern Period. Papers I and IV cover this time span completely. The aim of Paper I is to give an overview of bird species and their exploitation in Viljandi from the later part of the Viking Age to the Early Modern Period (10th–18th century CE). Material from Viljandi was chosen for two reasons: firstly, it was easily accessible as it was stored by the Department of Archaeology at the University of Tartu; and secondly, mammal bones from the same sites had been thoroughly studied before (more about this in Paper I). Paper IV discusses whether it is possible to separate wild and domestic goose bones by morphometrics and stable isotope analysis. To that aim, goose bones from various time periods from the Prehistoric (for some of the sites the more specific time period was unknown) to the Modern Period (19th century) and different sites in Estonia were included. Papers II and III concentrate on a shorter time span. In Paper II, bone remains from the early medieval (13th–14th century CE) castle of the Teutonic Order in Klaipėda, Lithuania, are presented. The study was conducted in collaboration with colleagues from Lithuania, who initiated the study and co-authored the paper. Moreover, the Klaipėda Castle made a useful comparison to the material from Viljandi Castle, published in Paper I, giving new insight into the usage of birds. Paper III is mainly concentrated on prehistoric time, covering chicken bones from several sites in Estonia that had layers already from the Mesolithic (9000–3900 BCE) or Neolithic Period (3900–1750 BCE). Nevertheless, results were mostly discussed in the context of the Bronze (1750–500 BCE), Pre-Roman (500 BCE – 50 CE), and Roman Iron Age (50–450 CE) (more data in Paper III). For this reason, bird bones from Stone Age sites are shortly discussed in chapter 6.1.

5. METHODS

5.1. Factors influencing the presence of bird bones in zooarchaeological material

In northern Europe, absence or scarcity of birds in archaeological material is often related to the minor role of birds in the economy and religion, or connected to taphonomical features (Mannermaa 2008, 9). The absence and scarcity of some bird species can be caused by the recovery method used at excavations, for example whether the material was sieved or hand-collected, because smaller species can be easily missed if a sieve is not used (Lõugas 2018, 17). Sieving trials have shown that when sieving, bird bones constitute around 40% of the total mammal and bird bones, while for hand collected material, bird bones form rarely more than 10% (Hamilton-Dyer 2002, 101). Excavation by hand will recover the larger bones of chickens and bones of birds larger than chicken, giving emphasis to larger species (Serjeantson 2009, 103). Immature bones of larger species can also be lost or underrepresented when the sieve is not used (*ibid*.). But the presence of immature bones also depends of the soil, as juvenile bones do not preserve that well (Reitz & Wing 2008, 265). Still, without sieving, small elements like wing digits and phalanges will be lost and not added to the list of present species, although those would be important for information about butchery, consumption, feather use, and so on (Serjeantson 2009, 103). Additionally, it could be that small birds are absent in the material because of economic reasons, for example when hunters preferred large birds (*ibid*., 393). The disposal is another important factor – bones can be carried away or added by different agents like dogs, cats, pigs, rodents, humans or such (*ibid*., 397). Adult dogs, cats, and pigs might also eat small and fragile bones completely, leaving no trace of the eaten birds (Gál 2007, 79). All abovementioned factors need to be considered when analysing and interpreting a bone assemblage.

5.2. Taxonomical identification

Anatomical elements, completeness, side, taxonomic group of bone and bone fragments were recorded. Open access data are available online in the ARHEST database (following the guidelines by Lõugas (2018)) or DataDOI repository. Whether the data were uploaded to ARHEST or DataDOI or both, was chosen based on the nature of the data. Data of Paper I are represented in both databases (DataDOI: Ehrlich *et al*. 2020). Data of Paper II are visible only in DataDOI (Ehrlich 2020). Data of Papers III and IV are visible in ARHEST database. Additionally, all data of Paper IV are added as supplementary information to Paper IV. The bones and bone fragments were identified to the smallest possible taxon by morphological features using the modern reference collections available at the Department of Archaeology (Papers I, II, III, IV) and the Natural History Museum at the University of Tartu (Estonia; Papers I, II), Archaeological Research Collection at Tallinn University (Estonia; Papers I, III), the personal reference collection of Ülo Väli (Paper II), and the Institute of Systematics and Evolution of Animals at the Polish Academy of Sciences (Kraków, Poland; Papers I, III). The latter collection is very extensive and useful for identifying bird bones. The collections in Estonia contain the most common bird species found in Estonian zooarchaeological material, but many species are still missing. The collection at the Department of Archaeology at the University of Tartu was started in 2011 and has been actively added to and improved since 2014 by the holder of the zooarchaeological collections, Eve Rannamäe (Lõugas & Rannamäe 2020, 138), with some of my own assistance. Eha Järv (Zoomedicum at the Estonian University of Life Sciences) has had an important part in developing the collection by providing facilities for the preparation of skeletons and helping to find new specimens for the collection. Since the reference collection is relatively young, it is still small, containing 305 individuals from 85 species. Of these, some individuals are represented only by one bone, while others by complete skeletons. Several bone atlases were used for the identification as well (Bacher 1967; Woelfle 1967; Erbersdobler 1968; Kraft 1972; Otto 1981; Schmidt-Burger 1982; Tomek & Bocheński 2000; 2009; Bocheński & Tomek 2009).

Often it is impossible to identify a bone find's exact species, because bird bones present very slight differences among the members of the same family, and also morphological characteristics between individuals of the same species may vary extensively (Mannermaa 2008, 41; Serjeantson 2009, 63). Therefore, specific identifications should be taken with some reserve as even the best scholars cannot identify every fragment of bone to species due to similarities (Ericson & Tyrberg 2004, 18). It is important to consider when an accurate identification is possible, as the most common problem is over-interpretation and identifying bones to species level even when it is actually impossible (*ibid.*). Correct identifications depend on several factors, like which kind of bones and taxa are present, how much research has been done on the osteology of the taxonomic group in question, comparative collection (*ibid.*), but also, the experience of the scholar. Considering these factors, it is important to note that errors might sometimes be present among published identifications.

Some taxonomic groups of birds are more difficult to study than others. For example, in the current study, more attention was given to anseriforms. Identifying their exact species is very hard. For ducks sometimes a size category of large (mallard-sized), small (teal-sized), and medium (including wigeon) are used (Hamilton-Dyer *et al*. 2020, 255). While identifying the exact taxa can be hard, separating between the domestic and wild forms of some birds based on their morphology can be even harder. In many cases, the criterion is bone size, but this is often relative and the comparision is difficult in case of fragmented material, but also in case of whole specimens, since the measurements of different species and forms might overlap. This is a problem addressed in Paper IV, where possible ways to separate wild and domestic goose are tested by morphometry. Measurements of archaeological *Anser* sp. and *Branta* sp. sized anseriforms were compared with the measurements of modern individuals using RStudio. Results of morphometrics were compared with those of stable isotope analysis. Even with the combination of methods, the earliest domestic goose bones form Estonia might be difficult to separate. Namely, domestic goose became larger and more robust only later (Honka 2020, 40).

5.3. Identifying sex and age

Similarly to mammals and fish, recognising signs in the skeleton which characterise age and differences between the sexes are among the basic data for interpreting bird bones (Serjeantson 2009, 35). For galliforms, one method to separate the male and female is the presence of spurs. The problem, however, is that not all cocks have spurs, and therefore, they might be identified in the zooarchaeological material as females (Doherty 2013, 83–85). In case of a chicken ancestor, the red junglefowl, it has been noted that the spurs occur quite late; even two-year-old birds might have only small spurs attached (*ibid*., 87). This means that spurs should be expected only in older individuals of domestic chicken, and cockerels (c. 4–6 months) slaughtered primarily for meat would show no hint of spurs or even spur scars (*ibid*.). On the other hand, some female turkeys and modern chicken breeds have spurs (Sadler 1991, 43; Serjeantson 2009, 48). Presence of spurs or spur scars is presented in Papers I and II.

Another way to identify sex is medullary bone, which is located in the medullar cavity of the bone. It is an endosteal layer of bone that appears only in females and serves as a calcium reservoir for one or two weeks before and after the egg laying period (Eda *et al*. 2010, 255). However, the absence of medullary bone does not mean that the specimen is male, because hens did not lay eggs continuously. Nowadays one of the aims for raising domestic fowls is egg production, meaning that chickens are almost continuously laying eggs and with that the medullary bone is also continuously present (Gál 2006, 53). The medullary bone is visible in the fragmented bones, but hard to see in whole bones, meaning that proportions of female birds might actually be different. In case of whole bones, sometimes a hole is drilled to the bone to see the medullary lesion (e.g. de Groene *et al*. 2020, 83). Histological analysis has been used on archaeological bones as well, but this is also a destructive method; it is used to contrast medullary bones to compact and spongy bone (Eda *et al*. 2010). Candeling by passing the bones directly above a vertically seated flashlight can be used as well, but this method has not yet been tested on archaeological bones (Werning 2018). X-ray is another method that can be used, but with this method the medullary bone is visible when the cavity is filled and hard to distinguish when only lining in the bone wall is present (Serjeantson 2009, 53; Fothergill *et al*. 2017). The medullary bone has been used for identifying sex in Papers I and II, for both papers, medullary lesion was registred only for fragmented bones. X-ray method was tested for the introductory part of this thesis (chapter 6.2.1.).

Third method for identifying sex is the size of the bird, but this can be used only for some species. For example, for the western capercaillie and black grouse (*Lyrurus tetrix*), males are larger than females, while for accipitriforms, females are larger than males. The method was used in Paper I.

Identification of bird age at death is based on bone growth, porosity, fusion, and for galliforms by size of the spur (Latimer 1927; Habermehl 1975; Sadler 1991; Serjeantson 2009, 36; Doherty *et al*. 2021). Not much is known about the timing of skeletal development of wild birds as studies have mainly been based on domestic birds (Serjeantson 2009, 36). The avian skeleton reaches maturity earlier than mammalian, as the skeleton of birds mature before the bird develops breeding plumage and reaches sexual maturity (*ibid*., 35). Such early maturing and absence of teeth means that it is more difficult to study immature bird bones than immature mammal ones; however, it provides important information about poultry husbandry and hunting (e.g. Serjeantson 2002; 2009, 35). Bones of immature as well as mature domestic chickens are often found at archaeological sites, but it is rare to find large quantities of wild birds' immature bones (Serjeantson 2009, 35). For example, the partial skeleton of juvenile Eurasian sparrowhawk (*Accipiter nisus*) from Viljandi was interpreted as an evidence for the use of hawking (Paper I). Some pathologies, like enthesophytes and degenerative joint disorder, might indicate the old age of the bird, but such pathologies might be caused by other factors, like nutrition, dysplasia, or pathogens as well (Serjeantson & Morris 2011; Fothergill *et al*. 2017; Doherty *et al*. 2021). For Papers I and IV, bones with joint disorders were recorded, but not included in the discussion about the age of the bird. In Papers I and II, bones were divided as juvenile, subadult, or adult without any further ageing. In Papers III and IV only bones of adults were included.

5.4. Taphonomical features

The term taphonomy is used by zooarchaeologists to mark all changes which take place between the death of an organism and its appearance in a laboratory (Lyman 2001, 4; Serjeantson 2009, 99). Taphonomical features like cut, gnaw, and burn marks were recorded for Papers I and II to see if the researched birds had been used for food or raw material (e.g. for extracting certain bones and feathers). However, cut marks are rarely found on bird bones because the bones are fragile and can easily break (Mannermaa 2008, 40). Besides, only the largest birds have to be butchered before cooking them in a pot, while the smaller ones fit whole (Serjeantson 2009, 138). Therefore, absence of such marks does not mean that birds were not used for food. Of cut marks, those from dismembering and filleting for meat or from tool-making are the most common, while skinning marks are rarely seen, because birds are not skinned as often as mammals (*ibid*., 132, 138).

Cut marks can also indicate that bones were made into tools or other objects. In Paper II, cut marks on eagle bones were attributed to pendant making.

Similar assumptions were made with an accipitrid bone discussed in Paper I. Cut marks can also be a sign of entertainment, because chicken tarsometatarsi with cut off spurs can be associated with cockfighting (Paper I; chapter 6.3.2.).

Similarily to cut marks, burn marks are rarely found on bird bones. These are associated with cooking and eating, but also with waste disposal and rituals (Mannermaa 2008, 41). Usually, bones are not affected by fire when cooked and might rather show how bones were disposed after consuming (Mannermaa 2003, 6; Serjeantson 2009, 153). Bones might have ended up near a fireplace or got burning marks during a house fire (Gál 2007, 78).

Gnaw marks were recorded, but the percentage of gnawed bones in the material is problematic. Adult dogs, cats and pigs can chew up small and fragile bird bones completely, while kittens are able to consume long bones of juvenile chicken (*ibid*., 79). Identifying taxonomic groups who left gnawing marks on bird bones is usually a more complicated than in case of mammal bones (*ibid*., 79), and was not done for this study.

5.5. Pathologies

Pathologically modified bird bones are usually rare in archaeological assemblages (Gál 2013, 217). This might be influenced both by sample size and taphonomy, but also by the age of birds, because younger individuals are less affected by pathological conditions, like those related to longevity (Bartosiewicz 2021, 16). While birds are susceptible to fractures and other injuries because their bones are light, their bones do tend to heal more rapidly than those of mammals (Gál 2013, 236; Bartosiewicz 2021, 16). Pathological changes in the bone are more often seen on domestic birds kept for egg production or as breeding stock (Serjeantson 2009, 55). Husbandry of domestic birds has allowed injured and diseased birds to survive in the past; whereas the presence of healed fractures or other changes is potential evidence of human care (*ibid*., 36). On the other hand, domestic birds kept in large flocks suffer more often from traumas and diseases, such as fractures, rickets, and viral illnesses (Gál 2007, 91–92). On wild birds, pathologies are rarer (*ibid*., 92) since it is difficult for a seriously injured or diseased bird to survive in the wild (Serjeantson 2009, 36). In this study, pathologies were mostly related to chicken and goose (Papers I, IV), but eagles with pathologies were also found (e.g. Paper II). Among these cases were some diseases that had not been found in the eastern Baltic region before. It is difficult to evaluate, if the occurrence of found diseases are common or rare as compared to, for example, human paleopathology that is more advanced (Bartosiewicz 2021, 14). One reason why animal paleopathology is less advanced compared to human paleopathology, lies in taxonomic diversity: as each animal possesses a specific skeletal anatomy, they are prone to species-specific diseases (*ibid*.). Also, animal bones are often food-waste, meaning that the bones are commingled, and it is impossible to analyse pathological lesions of the whole skeleton based on isolated bone fragments (*ibid*.).

5.6. Quantifying the data

In Papers I and II, the number of identified specimens (NISP) was shown including both whole and fragmented bones. Fragments that were obviously from a single bone were counted as one. NISP is relative as some taxa have more identifiable bones per individual than others (O'Connor, 2000, 56). Sometimes NISP counts include vertebrae and ribs, sometimes not; sometimes all fragments are counted, sometimes only a selection (Maltby *et al*. 2018, 1004). For this thesis, all skeletal elements and fragments of skeletal elements were counted. Each fragment does not represent a separate individual, because several fragments might belong to the same bird (O'Connor 2000, 56) and therefore the minimum number of individuals (MNI) was used where possible. Using the MNI for assemblages with complex sedimentary units might be complicated (*ibid*., 60–61), but since bones from one context were incorporated to Paper II, MNI was added to that paper. MNI is counted by the most abundant skeletal element, for long bones only those of left or right side are considered, depending on which is represented more. As an exception, left and right side bones might be counted together if, for example, bones from the left side belong to an adult and from the right side to a juvenile as those cannot belong to the same individual. It is important to note, that MNI is only an estimate, as the real number of individuals in the assemblage cannot be recovered and the MNI might be in correlation with sample size (*ibid*., 60). Moreover, rare taxa are over-represented as one bone of a rare taxon will have the MNI of one, while ten bones of a more abundant taxon could also have the MNI of one if all the bones represent different skeletal elements (*ibid*.). Another problem regarding NISP, MNI, and bird bones is that even though these values are calculated in a similar way as for mammals and fish, it should be noted that it is complicated to estimate the relative contribution of different animals in the human diet (Serjeantson 2009, 92). There are several reasons for that, for example: 1) mammals are bigger and contribute more to the diet; 2) mammals also have more elements in the skeleton (especially with teeth counted); 3) bird bones do not fragment into as many identifiable fragments as mammal bones (*ibid*., 92, 95). Therefore NISP would show relatively low value of birds compared to mammals (*ibid*., 92, 97).

Standardised measures were taken after von den Driesch (1976) for Papers I, II, and III. Measures were essential for Paper III and IV, as the destructive method (see chapter 5.7.) was used. For Paper I, the measurements are visible in DataDOI repository (Ehrlich *et al*. 2020); for Paper II, these are included in the article and in DataDOI (Ehrlich 2020); and for Paper III, the measurements are visible in sampling protocols referred to therein. For the morphometric study in Paper IV, standard after Poland (2018) was used. Due to large amount of data in Paper IV, the morphometric data were quantified and visualised with R programming language in RStudio. All measurements and R code is included as supplementary information in Paper IV. For all papers, the measurements were recorded to the nearest 0.1 millimetre.

5.7. Destructive methods and sampling ethics

For Papers III and IV, destructive methods were used. For Paper III, chicken bones were radiocarbon dated by AMS (accelerator mass spectrometer), whereas for Paper IV, goose bones were sampled for stable isotope analysis. In addition, three bones were radiocarbon dated for the introductory part of this thesis. The methods of radiocarbon dating and stable isotope analysis are elaborated on in more depth in Papers III and IV, respectively. The problems regarding the extensive use of destructive methods in (zoo)archaeology have been discussed before (Pálsdóttir *et al*. 2019; Evin *et al*. 2020). In summary, zooarchaeological material might seem as an endless resource because of the seemingly large number of animal bones found from excavations, but animal bones are actually a limited resource that is unevenly divided between time periods, regions, etc. (Pálsdóttir *et al*. 2019). For example, finding the desired species might often be difficult and these finds might be rare (e.g. the earliest chicken specimen for Paper III). Additionally, taking a sample from the bone might have an impact to future studies, as some measurements can no longer be taken or some taphonomical features, like cut marks, are no longer preserved, not to mention that for smaller bones, like those of birds, sampling might use up all of the bone (*ibid*.). On the other hand, bird bones are prone to stratigraphic movement (due to bioturbation, building, agricultural activities, etc.) (Best *et al*. in press), and therefore, radiocarbon dating was necessary when searching for the earliest evidence of the species.

All specimens sampled for destructive analyses were chosen and documented with great care. The selected specimens were measured before, whereas photos were taken before and after the sampling. In some laboratories, the sampled bones are documented with 3D scanning (Sykes *et al*. 2019, 509), and hopefully similar, more precise methods for documenting the bones will be available (in both equipment and needed skills) in the future in the eastern Baltic area as well. Especially for the bird bone material, where identifying the species might be difficult, it could give an opportunity to re-evaluate the identifications with new criteria in the future.

All samples were taken with the permissions given by the holding institutions. The sampling protocols were handed in to the Department of Archaeology at the University of Tartu (TÜ PP Nos. 100, 102, 104) and Archaeological Research Collection at Tallinn University (AI PP Nos. 436, 438, 488, 489, 506, 541). The remains of the sampled bones were returned to the collections. In addition to the samples published in Paper III, three more bird bones were dated for this introductory part of the thesis[2]: around 1 g of sample was removed from the bones and submitted to AMS radiocarbon dating at the Poznań Radiocarbon Laboratory and the CHRONO Centre at Queen's University Belfast. The results

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[2] The sampling for three additional samples was funded by the Estonian Research Council grant No PRG29.

were calibrated with the OxCal v4.4.4 (Bronk Ramsey 2009), using the IntCal20 atmospheric calibration curve (Reimer *et al*. 2020), and were rounded by five.

6. RESULTS AND DISCUSSION

6.1. Diversity of birds in Estonia form the Stone Age to the Early Modern Period

Of the rich bird fauna in Estonia, only some species have found their way to human settlements. Nevertheless, osteological material from the settlement sites can be diverse. Water birds, especially different ducks, dominate the Mesolithic. This was expected, as in other contemporary sites in Finland, Sweden, and Latvia, ducks are the most common birds (Mannermaa 2008, 51). In Estonia, birds from Kunda Lammasmägi have been well studied, among them the mallard, tufted duck (*Aythya fuligula*), common eider (*Somateria mollissima*), velvet scoter (*Melanitta fusca*), long-tailed duck (*Clangula hyemalis*), goosander (*Mergus merganser*), greylag goose (*Anser anser*), whooper swan (*Cygnus cygnus*), arctic loon (*Gavia arctica*), red-throated loon (*Gavia stellata*), great crested grebe (*Podiceps cristatus*), great cormorant (*Phalacrocorax carbo*), and white-tailed sea-eagle (Lõugas 1996a, table 1, and references therein). Riigiküla IV settlement has revealed the presence of common teal (*Anas crecca*) or garganey (*Spatula querquedula*), whereas material from Pulli settlement site included black grouse (Lõugas 1997, appendix V; 2008, table 1). Similar species are represented on the island of Hiiumaa, where the faunal remains from Kõpu I settlement site have included common eider, goosander, great cormorant, and white-tailed sea-eagle; and also on the island of Saaremaa, where in Kõnnu settlement site additionally to aforementioned species, also long-tailed duck and red-breasted merganser (*Mergus serrator*) are represented (Moora & Lõugas 1995, 478; Lõugas 1997, appendix II.A). While most of the species are evidence of hunting waterfowl for its meat or eggs, white-tailed sea-eagle might have also been used for some ritual ceremony (Moora & Lõugas 1995, 478). However, it is possible that those eagles were used for meat as well, as assumed based on the bones found from Neolithic Loona settlement site (Mannermaa 2008, 58).

From the Neolithic, most of the bird bones are from sites with Combed-Marked Pottery (Kriiska *et al*. 2020, 119). In the settlement site in Tallinn Vabaduse Square (3200–2900 calBCE), at least nineteen different species were found (Lõugas & Tomek 2013). Similarly to Mesolithic, ducks were the most common species here: common teal, mallard (*Anas platyrhyncos*), cf. common eider, tufted duck, greater scaup (*Aythya marila*), long-tailed duck, goosander, velvet scoter, black scoter (*Melanitta nigra*), common goldeneye (*Bucephala clangula*), and smew (*Mergus albellus*) (Lõugas & Tomek 2013, 471, table 2). Additionally, other water birds were present, including greylag goose or bean goose (*Anser fabalis*), black guillemot (*Cepphus grille*), gull (*Larus* sp.), arctic loon, and great crested grebe (*ibid*.). Of other species cf. white-tailed sea-eagle, black grouse, and western capercaillie were found (*ibid*.). Birds have also been identified from Kudruküla, where the grey heron (*Ardea cinerea*) was found

(Lõugas 1996b); from Naakamäe, where the great cormorant and northern goshawk were found; and from Loona, where swan, red-breasted merganser, Eurasian woodcock (*Scolopax rusticola*), razorbill (*Alca torda*), pigeons, carrion crow (*Corvus corone*) or rook (*Corvus frugilegus*), Eurasian skylark (*Alauda arvensis*), and thrush (*Turdus* sp.) were found (Mannermaa & Lõugas 2005, appendix 1a). The list of identified species complies well with Stone Age sites in Finland, Sweden, and Latvia (Mannermaa 2008, 51–55). Even though the list is long, bird meat was probably not a very important part of human diet at that time (Lõugas & Tomek 2013, 477). In some extent, bird bones and feathers were used for making tools (Mannermaa 2008, 59–61). People hunted mostly near the seashore and many of the species hunted were in the region only seasonally, indicating that the birds were hunted during migration in March or April to October or November (Lõugas & Tomek 2013, 477–478). This claim is supported by the fact that there is a small number of immature birds, and the absence of the medullary bone (*ibid.*, 479). From sites with Corded Ware, not much is known about bird hunting, but some burnt bird bones have been reported (Kriiska *et al*. 2020, 119).

Not much is known of animal husbandry during the Early and Middle Bronze Age. By the Late Bronze Age, domestic animal husbandry was established in the area of present-day Estonia (e.g. Maldre 2008), but domestic birds were not represented yet. For the Late Bronze Age, bird bones from Asva, Ridala, and Kaali in Saaremaa have been studied. Similarly to Stone Age sites, long list of anserifroms, mainly different ducks, were present (Tomek *et al*. 2010). Additionally, a number of species not recorded for previous periods emerged: rough-legged buzzard (*Buteo lagopus*), northern goshawk, golden eagle, western water rail (*Rallus aquaticus*), common coot (*Fulica atra*), Eurasian crane, grey plover (*Pluvialis squatarola*), Eurasian woodcock, common snipe (*Gallinago media*), great snipe (*Gallinago gallinago*), rock dove (*Columba livia*), common cuckoo (*Cuculus canorus*), tawny owl (*Strix aluco*), ural owl (*Strix uralensis*), European nightjar (*Caprimulgus europaeus*), black redstart (*Phoenicurus ocherous*), and corvids like Eurasian jackdaw (*Coloeus monedula*), carrion crow or hooded crow (*Corvus cornix*), and common raven (*Corvus corax*) (*ibid*.). In Asva, chicken bones were present among the recovered faunal remains, but those turned out to be from the Middle Iron Age (Paper III).

In the Pre-Roman Iron Age and the Roman Iron Age, zooarchaeological material comes mainly from graves (Lang 2007, 111), whereas in terms of quantities it is not directly comparable with the earlier period of Late Bronze Age. From this time period, Ilmandu III *tarand* grave has revealed the bones of black grouse, other unidentified galliforms, ducks, small corvids, and other unidentified passeriforms (Ehrlich 2021a).

The zooarchaeological material of the following periods of the Migration Period (450–550 CE), the Pre-Viking (550–800 CE), and the Viking Age (800–1050 CE) has been less identified (Tvauri 2012, 105). From this time period, bird bones have been noted in Lihula stone grave (5^{th}–7^{th} century) and on Maidla II stone grave-field (10^{th}–13^{th} century) (Maldre 2003, 271, table 1). In

Lihula, two possible chicken bones have previously been reported (*ibid*., 266), but these were not reassessed for this thesis.

From the later part of the Viking Age onwards, again, more bird bones have been identified. Compared to other species, usually domestic chicken, goose, and duck dominate (e.g. Lõugas *et al*. 2012, table 1; 2019, table 1; Paper I, II). These species are discussed in more depth in chapter 6.2. Only a few new species are present from this period onwards. Among these are the common quail (*Coturnix coturnix*), hazel grouse (*Tetrastes bonasia*), grey partridge, gadwall (*Mareca strepera*), Eurasian wigeon (*Mareca penelope*), northern shoveler (*Spatula clypeata*), boreal owl (*Aegolius funereus*), barnacle goose (*Branta leucopsis*), Eurasian sparrowhawk, common buzzard (*Buteo buteo vulpinus*), black kite (*Milvus migrans*), black woodpecker (*Dryocopus martius*), common starling (*Sturnus vulgaris*), Eurasian magpie (*Pica pica*), and house sparrow (*Passer domesticus*) (e.g. Lõugas *et al*. 2012; 2019; Paper I). However, since not many sites from the Stone and the Bronze Age have been studied, it is possible, that these species were present before as well.

As most of the species found can be related to the human diet, some species could have lived close to towns, taking advantage of the food available among urban refuse (Maltby 2020, 338), and have been incorporated to the deposit incidentally, not as a food waste. Those species are for example gulls, kites, buzzards, ravens, smaller corvids, owls, pigeons, and smaller passerines (Hamilton-Dyer 2002, 104; Maltby 2020, 338), all of which are represented by a few bones also in Viljandi from different time periods and sites (Paper I). Besides being scavengers, some of these birds were a threat to young poultry (Hamilton-Dyer 2002, 104). It is possible that some of the species were caught during hawking (Maltby 2020, 338). For example, in Nerevsky site in Novgorod, north-western Russia, a tarsometatarsus of buzzard associated with leather belts could indicate that the bird might have been captive and possibly used as a decoy (Hamilton-Dyer 2002, 104). Also a tarsometatarsus of an immature Eurasian crane with leather belts was found that might also be related to hawking training (Hamilton-Dyer *et al*. 2020, 277). Namely, Eurasian crane has been suggested to be a valuable hawking prey (Sykes 2004, 99). Gulls and cormorants might have also been an occasional addition to the diet (Hamilton-Dyer *et al*. 2020, 277). Cormorant has been found, for example, in medieval Klaipėda Castle (Paper II). It is also possible that corvids were eaten (Gál 2007, 87; Gorobets & Kovalchuk 2017, 157; Wiejacka *et al*. 2020).

6.2. Domestic birds in Estonia

6.2.1. Chicken

Chicken was domesticated from the red junglefowl subspecies *Gallus gallus spadiceus* that has later interbred with other local jungle fowl species (Girdland Flink *et al*. 2014; Wang *et al*. 2020). The bird is currently indigenous to south-eastern China, Thailand, and Myanmar (Wang *et al*. 2020). Red junglefowl was attracted to kitchen scraps, animal dung, and crop-processing waste leading to domestication (Larson & Fuller 2014, 123). The bird was domesticated at least by 4000 BCE as suggested by archaeological finds in the Indus Valley, India (*ibid*.). The bird first arrived to Europe by 11^{th}–9^{th} century BCE as evidence of chicken has been found from that period from different areas in Europe, including Italy, Ukraine, and the Czech Republic (Kyselý 2010, 17, 20; Trentacoste 2020; Corbino *et al*. 2021). Even though chicken was already introduced in Europe, the Roman expansion encouraged the more intensive spread of chicken to western and central Europe (Maltby *et al*. 2018). More about the domestication time and place of the red junglefowl and dispersal of chicken to northern part of Europe can be found in Paper III.

One of the main questions in this thesis – when did chicken first appeare to the area of present-day Estonia? – is discussed in Paper III. To answer this question, nine chicken bones were radiocarbon dated by AMS. Only four of these roughly coincided with the time period suggested by their archaeological context. This is not exceptional, as in an example by Best *et al*. (in press) only five of the 23 dated chicken bones coincided with the context, and similarly to Paper III, the rest were younger than their archaeological context. Even though not all bones coincide with the archaeological context by radiocarbon dates, these filled some gaps in the knowledge of early evidence of chicken. As researched in Paper III, the earliest chicken find as of today is from the Pre-Roman Iron Age (200 calBCE – 5 calCE) and is found from Rebala stone-cist grave. This is followed by a longer hiatus, as the next bones are from the Pre-Viking and the Viking Age, according to the radiocarbon dating results: 600–775 calCE for Asva hilltop site, 665–775 calCE for Ilmandu III *tarand* grave, and of 675–950 calCE for Iru hilltop site (more information in Paper III). This timeline will possibly be supplemented in the future. For example, information about two possible chicken bones from Lihula stone grave (5^{th}–7^{th} century CE) (Maldre 2003, 266) were found later, and therefore the bones were not verified and radiocarbon dated for the thesis. Another possible chicken find with an early date is from Kõivuküla hill fort supposedly from the Migration Period (Valk *et al*. 2012, 31), but the specimen seems to be missing from the collection, and therefore it was not possible to verify the previous identification. Additionally, as new material is identified, new evidence of early chicken might be revealed. However, current knowledge of Estonian material is coherent with the hypothesis for the European part of Russia to where chicken expanded at the beginning of the first millennium CE, but stayed rare until the 9^{th}–12^{th} century CE (Lebrasseur *et al*. 2021, 228). Similar frequencies of chicken remains are also seen in other countries around the Baltic Sea. For example, in Sweden, during the Migration Period (ca 400–550 CE), chicken was fairly uncommon, but became more widespread from the Late Iron Age onwards (Tyrberg 2002, 219).

By the later Viking Age, chicken became the most common bird species in the Estonian zooarchaeological material (Papers I, III). At least from the Middle

Ages onwards chicken also dominates among bird bones in Latvia, Lithuania, and several sites in north-western Russia (e.g. Blaževičius *et al*. 2012, 316; Rumbutis *et al*. 2018, 115, table 7; Maltby *et al*. 2019, table 6.17; Lebrasseur *et al*. 2021, 223; Paper II). Few exceptions have occurred in north-western Russia. One of the exceptions is medieval (9^{th}–10^{th} century CE) Staraya Ladoga, where the number of domestic birds was 3.5 times smaller than the number of wild species, whereas in medieval Gorodishche and Novgorod settlement sites duck bones formed over 60% of all bird ones (Maltby 2019, 220; Shaymuratova *et al*. 2019, 110). However, for other sites in north-western Russia, chicken becomes the dominant bird species at least by the 10^{th}–12^{th} century CE, depending on the site (Hamilton-Dyer *et al*. 2020, 283; Lebrasseur *et al*. 2021, 223). In Belarus, duck dominates in a small Struga-2 settlement site from the 10^{th}–13^{th} century CE (Gorobets & Kovalchuk 2017, table 5). In Polish towns, goose became more important than chicken from the 16^{th}–18^{th} century CE onwards (Makowiecki & Gotfredsen 2002, 74). Since goose bones are considerably bigger than the ones of chicken, the excavation method might have some effect on the proportions of the recovered bird species. In medieval Lithuania and Poland it seems that chicken is frequent and abundant in different assemblages and chicken were available for different social groups (Rumbutis *et al*. 2018, 115; Makowiecki *et al*. 2019, 347, 350).

One important aspect in discussing the importance of chicken is the sex and age of identified specimens. For Paper I and II it was possible to identify the sex of chicken bones, where the medullary bone was identified only visually from fragmented bones. For Viljandi (Paper I), the proportion of bones that could be associated with hens by medullary bone or cocks by spurs were low in every area (prehistoric settlement site, castle, town, suburb), not exceeding 2%. For Klaipėda (Paper II), the proportion was 21%, but since the sample size was only 75 specimens in total, the percentage might be biased. The fact that the proportion of bones with medullary bone was low is not exceptional. This could show that people did not slaughter laying hens but rather old and not laying hens or roosters (Eda *et al*. 2010, 255). However, for the introductory part of the thesis, a small portion of bones from Vastseliina Castle were chosen for X-ray testing to see if the percentage would raise significantly when whole bones are included (Fig. 3). Forty whole skeletal elements were chosen, and for a comparison, ten fragmented bones were added, where the presence or absence of medullary bone was noted during visual identification – six medullary and four without medullary leisure. Of forty elements, only three, all of those femurs, seemed to have medullary leisure (TÜ-1435/AZ-2:27, TÜ-1435/AZ-3:22, TÜ-1435/AZ-10:05; Ehrlich 2019). There are a few additional possible medullary bones present, but it would be difficult to identify these only by thin layer. The low number of medullary bone was expected, as for Estonian sites usually only a small percent of the fragmented bones yield medullary bone (e.g. Paper I).

Figure 3. Examples of archaeological chicken bones X-rayed for the presence of medullary bone. Whole specimens with medullary bone (A1 – TÜ-1435/AZ-2:27; A2 – TÜ-1435/AZ-3:22; A3 – TÜ-1435/AZ-10:05), fragmented specimens with medullary bone that was visible before X-ray (B1 – TÜ-1435/AZ-2:30; B2 – TÜ-1435/AZ-11:11), and bone not medullary (C – TÜ-1435/AZ-1:44). X-ray pictures were made in the Department of Archaeology at the University of Tartu by Andres Vindi.

Often a considerable number of juvenile bones of galliforms have been found from Estonian sites; these probably belong to chicken as the percentage of this species is usually larger than that of the others, and therefore, juvenile birds are often related to consumption of meat (e.g. Papers I, II). By the presence of the juveniles, chicken have also been suggested to be bred in castles, for example in Karksi (Maltby *et al*. 2019, 156). Also in other regions, like Britain, it has been suggested that many chickens were raised in towns (Maltby *et al*. 2018). This often suggests that young chickens were consumed for meat, but since it is almost impossible to identify the exact age of the bird as age is usually given only as 'juvenile' or 'adult' (Thomas *et al*. 2016), the details of meat consumption can not be confirmed on the individual level. Not many bird bones, including juveniles, yield cut or gnaw marks that would be direct evidence of butchering, and therefore, natural fatalities caused by inadequate management and diseases cannot be ruled out either (Gál 2007, 79; Mannermaa 2008, 40; Thomas *et al*. 2016).

Pathologies give information about the management of birds. Healed bone fractures and joint disorders were the most common finds for chicken, as showed in Paper I. In medieval Viljandi, one case of avian osteopetrosis (sometimes referred to as osteopetrosis gallinarum) was also present (Paper I). The disease is caused by avian leucosis viruses (ALV) and influences the skeletal system, affecting diaphysis of long bones, but leaving epiphyses unaffected (Gál 2006, 57; Fothergill 2017, 854). The ALVs are transmitted from hen to offspring by egg albumen (Pruková *et al*. 2007). Birds with avian osteopetrosis become anaemic and start limping (Gál 2006, 57). So far, not many cases of this disease have been found from the eastern Baltic region. The case presented in Paper I is the only known case in Estonia, but two others have recently been found from Vilnius, Lithuania (Ehrlich *et al*. in prep.). Other geographically closest cases are from Hungary, Austria, and Germany (Gál 2008; Gál & Kunst 2014; Fothergill 2017). Therefore, it is probable that the more zooarchaeological material is identified, the more cases will emerge in the Baltic area as well. Avian osteopetrosis is not only a disease from the past, it has been observed also in modern broilers and egg-laying chicken (Gao *et al*. 2010).

6.2.2. Goose

There are two lineages of domestic goose: the Chinese and the European domestic goose. The Chinese domestic goose was domesticated from swan goose (*Anser cygnoid*) (Ren *et al*. 2016), while the ancestor of the European domestic goose is greylag goose (Sun *et al*. 2014), which is seasonally found from the wide area of most of Eurasia and north Africa (MacDonald & Blench 2000, 529). Because of its pink beak and paler plumage, the European domestic goose is thought to have been derived from the eastern (*Anser anser rubitostris*) subspecies which breeds in south-eastern Europe and Asia (Albarella 2005, 252; Honka 2020, 39). It is not known when and where the European goose was first domesticated. It might have happened in Old Dynastic Egypt, because from the

5th dynasty (2723–2300 BCE) there are bas-relief and illustrations that suggest the presence of domestic goose (Albarella 2005, 252). However, the more reliable evidence is from the 18th dynasty (1450–1341 BCE) and by that time goose is thought to have been fully domesticated (MacDonald & Blench 2000, 530). The earliest evidence of domestic goose in Europe is thought to be from the 8th century BCE according to written sources (MacDonald & Blench 2000, 530; Albarella 2005, 252–253). It seems that the domestication of the European goose is most likely to have happened in the vicinity of the eastern Mediterranean (Heikkinen 2017, 25). Since geese are easily domesticated, this process occurred probably numerous times (MacDonald & Blench 2000, 529).

The earliest evidence of the domestic goose in northern Europe comes from high status graves in Denmark, where it was probably present during the Roman Iron Age (around 200–250 CE) (Gotfredsen 2013, 366). There, it became abundant probably during the 5th–12th centuries CE as the bird occurs in numerous sites and becomes the second most common species after chicken (Gotfredsen 2014, table 2). In Sweden, the earliest evidence of the bird occurs at approximately the same time, during the 6th–11th centuries CE, when large and clearly domesticated goose bones are frequently present in graves (Tyrberg 2002, 216–219). The massively increased number of goose bones from this period onwards also supports this hypothesis (*ibid.*, 216). In Norway, it is most likely that domestic geese were present by 1100 CE, and became more abundant 1300 CE onwards (Walker *et al.* 2019, 26; Walker 2021, 28, 40).

In the eastern Baltic region, the earliest evidence of domestic goose is from a much later period. It was most probably present in medieval Latvia (Maltby *et al.* 2019, 157). In Estonia, domestic goose is thought to be present during the Iron Age or the Middle Ages, based on the presence of pathological bones (Papers I, IV), while in written sources more evidence is from the 16th century (Põltsam-Jürjo 2013, 24). In Lithuania, domestic goose is suggested to be present in archaeological material since the 16th century (Blaževičius *et al.* 2012, 316). More reliable information from the eastern Baltic area is from 1645 CE, when in Riga, Latvia, Salomon Gubert published a handbook of duck and goose breeding, containing information also regarding Estonian birds (Piirsalu 1997, 12–13). The earliest evidence from Russia is from the Middle Volga Region indicated by the presence of immature or subadult birds found from 5th–10th centuries CE (Galimova *et al.* 2014, 350, table 1; Honka *et al.* 2018), while by aDNA analyses domestic goose is present at least from the 11th century CE onward (Honka *et al.* 2018).

One of the aims for this thesis was to discuss when domestic goose arrived in the area of present-day Estonia. This, however, turned out to be a task beyond the scope of this thesis, as domestic and wild individuals are very difficult to distinguish between in zooarchaeological material. Namely, there are nine goose species in Estonia – five in genus *Anser* and four in genus *Branta* (Estonian Ornithological Society) – and all of these have very similar bone morphology. The main difference seems to be in size. Morphometrics has been used successfully before (Poland 2018), but modern domestic goose might not be entirely comparable to, for example, medieval domestic individuals, who presumably were smaller in size. Therefore, in Paper IV, additionally to morphometric analysis, stable isotope analysis was used. As a result, morphometrics did help to separate wild and domestic birds to some extent, and in some cases also gave an opportunity to separate the wild species. However, exact species for many specimens remained unclear. In Paper IV, wild specimens seemingly dominated among archaeological material. This could support information in written sources, whereby domestic geese have been mentioned at least from the 16th century (Põltsam-Jürjo 2013, 24). On the other hand, based on morphology, all time periods from the Iron Age to the Early Modern Period yielded both groups, presumably domestic and presumably wild specimens. Although none of the bone finds have been radiocarbon dated, it shows a possibility that domestic goose was present in the area even earlier than suggested by written sources. As seen from the results with dating chicken (Paper III), same would be needed for geese to appoint a clear timeline.

The results of Paper I show that in different parts of Viljandi, goose was the second most common bird after chicken from the Late Iron Age onwards. For medieval Klaipėda Castle, Lithuania (Paper II), bones of chicken and eagle were more abundant, but small sample size might have influenced the results. In medieval and early modern Vilnius Castle, goose was the second most abundant species after chicken (Rumbutis *et al*. 2018, 112). Also in medieval and post-medieval Norway, domestic goose never dominated in the assemblages the same way as chicken, but was nevertheless abundant (Walker *et al*. 2019, 26; Walker 2021, 28, 40). Polish towns from the 16th–18th century onwards, where goose was more important than chicken, seem to be exception in the wider region (Makowiecki & Gotfredsen 2002, 74). In medieval north-western Russia, goose was consistently present in Troitsky site, but formed only 5% of all bird bones (Maltby 2019, 220). Even though there are some differences, goose still seems to be one of the most common bird species found in the material, and the abundance of this species might suggest the presence of domestic specimens to some extent. Similar conclusions have been drawn about Poland's zooarchaeological material, as goose was the second most common bird during the rule of the Teutonic Order (Makowiecki *et al*. 2019, 354).

Geese have been exploited for meat, liver, fat, feathers, and eggs in various regions in Europe, including Estonia, Fennoscandia, and Russia (Albarella 2005, 253; Tikk *et al*. 2008, 105; Bardone *et al*. 2016, 56; Poland 2018, 4–6; Honka 2020, 39). This species was kept more for secondary products and probably slaughtered only on special occasions or at settlements where wealthy people lived, resulting in a small number of excavated juvenile bones (Gál 2006, 54). Juvenile goose bones are present in Estonian material relatively rarely; for example, in Viljandi (Paper I), where out of the 155 goose bones from different sites none belonged to juveniles. Goslings were also absent in Klaipėda Castle (Paper II) and in medieval Gorodishche and Troitsky IX–XI settlements (Hamilton-Dyer *et al*. 2020, 260–261, 275). In Latvia, only few juvenile goose bones have been found in two medieval sites of Āraiši Castle and

Ventspils town (Maltby *et al*. 2019, 157). In medieval and post-medieval assemblages in Norway, also only little evidence of juvenile goose bones have been found (Walker 2021, 40). Because of the small number of juvenile bones in the area, a femur of immature goose from the Late Bronze Age Kaali settlement (AI-4915/1977/AZ-149; Tomek 2019) was radiocarbon dated by AMS[3] during the writing of this thesis. The result of radiocarbon date of 761–418 calBCE (Fig. 4) coincides with previous dates from the site (Lang 2007, 77). In Late Bronze Age Saaremaa, domesticated duck has been suggested to be present (Tomek *et al*. 2010). The presence of a young goose in Kaali might suggest that additionally to ducks, domesticated goose was also present, but it is difficult to draw any conclusions on only one specimen.

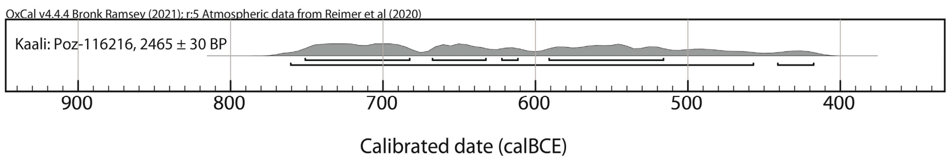

Figure 4. Calibrated radiocarbon date of a goose femur found from Kaali settlement.

Several goose bones included in this study had pathologies. For example, in the medieval town of Viljandi, a humerus with a healed fracture and a carpometacarpus with a joint disorder were found (Paper I). Another two carpometacarpi with joint disorders were found from Iron Age Otepää hilltop site and early modern Viljandi Castle (Paper IV). Even though the percent of bones with pathologies is smaller for geese, those pathologies are similar to the ones that are found on chicken bones from different sites of Viljandi (Paper I). These comparisons suggest that the pathologigal goose bones might belong to domestic birds, because domestic birds are thought to be more prone to trauma than wild specimens (Serjeantson 2009, 55). As the earliest such find is from the Iron Age, it could be one of the earliest evidences of domestic goose in Estonia (Paper IV). However, more analyses are needed to clarify if it is wild or domestic, and if it is truly from the Iron Age as suggested by the archaeological context.

6.2.3. Duck

The wild ancestor of the European domestic duck (*Anas domestica*) is a mallard, who is common throughout the northern hemisphere (Albarella 2005,

[3] Sampling protocol (AI PP 489) was handed to the Archaeological Research Collection at Tallinn University. Results of radiocarbon date: cal BCE/CE date (68.3%) – 752–517 calBCE, cal BCE/CE date (95.4%) – 761–418 calBCE, %C – 11.2%, %N – 3.3%, Coll. yield (%) – 8.7%.

254). Its wide habitat makes detecting the domestication time and place difficult. The earliest records in northern Europe come from the 12th century CE, but it is possible that domestic duck was present in Sweden already in the Late Iron Age (550–1060 CE) (Tyrberg 2002, 219). Fairly firm archaeological evidence of domestic ducks are found from Eketorp on Öland in Sweden, as an increased number of juvenile birds and size variation between the first (ca 400–700 CE) and second phase (ca 1000–1300 CE) of occupation has been noted (Albarella 2005, 255).

Domestic duck does not seem to be as important in medieval assemblages as chicken and goose. In medieval north-western Russia and in the lake Ilmen region, it is unlikely that domestic ducks were commonly kept, because the wildfowl was abundantly available in that region (Hamilton-Dyer *et al*. 2020, 274). Moreover, duck hunt remains a common sport there (Maltby 2019, 220). Similarly, it is possible that duck bones from the castles of the Teutonic Order in Poland derive from mallards hunted at nearby lakes (Wiejacka *et al*. 2020). Lack of ducks characterises also the assemblages in Norway, and according to written sources, woodland birds were preferred to waterfowl because of their taste (Walker *et al*. 2019, 27). Regarding Estonia, not much is known about domestic ducks so far. Some evidence of possibly domestic individuals is present already in the Late Bronze Age Asva, Ridala, and Kaali, as suggested by body size and pathologies (Tomek *et al*. 2010). In written sources, domestic duck is mentioned only in the 17th century (Põltsam-Jürjo 2013, 26). In other regions, for example Poland, information of breeding domestic ducks in royal farms comes from 15th century written sources (Makowiecki & Gotfredsen 2002, 75). In Sweden, the word for domesticated duck "anka" is first mentioned in 1587 (Tyrberg 2002, 219).

Similarly to the goose, it is very difficult to attribute duck bones found in archaeological sites to their domestic or wild forms only by morphology (Albarella 2005, 249), or differentiate wild species from each other. This is possible with the help of rich comparative collection, but the collections held in Estonia currently hold only few specimens of ducks, and many of those are from mallard. Therefore, in many cases, exact species cannot be identified and it has been suggested it is best to classify them by size category (Hamilton-Dyer *et al*. 2020, 255). Duck bones can also be studied by morphometrics (Poland 2018), but so far this has not been used for Estonian material.

Ducks have been valued for their meat, as at least the wild forms were considered as important source of protein and fat in the past (Poland 2018, 2). Nevertheless, there have been some regional differences in consuming this species. For example, in medieval England, duck meat was considered as poor food because of the birds' unhealthy eating habits (Albarella 2005, 255). In medieval Novgorod and Gorodishche in north-western Russia, duck bones formed over 60% of all bird bones (Maltby 2019, 220). In medieval Troitsky XI site, north-western Russia, the importance of ducks in people's diet decreased from the middle of the 12th century CE onwards as chicken became more important (Hamilton-Dyer *et al*. 2020, 268). For different sites in Viljandi, on the other hand, it seems that the percentage of ducks has not decreased notably, being in most cases smaller than for chicken and goose (Paper I). Usually, the high percentage of juvenile birds suggests that the birds are being bred in captivity (Hamilton-Dyer *et al*. 2020, 270) and consumed mainly for meat (e.g. Paper I and II). However, the percentage of juvenile duck bones from all sites in Viljandi combined is only 2.8%, most of those from the medieval castle (Paper I). For north-western Russia, the percentage of juvenile ducks was only 0.8–1.6% (Hamilton-Dyer *et al*. 2020, 270, 272). Additionally to consuming for meat, ducks have been valued for eggs, as they naturally produce more eggs per day than chicken (Poland 2018, 4). Similarly to goose, the liver and feathers of ducks could also have been important (*ibid*., 5–6).

6.2.4. Turkey

There were at least two separate domestications of turkey subspecies *Meleagris gallopavo gallopavo*: one event was in northern or central Mexico and second in south-western United States; however, the latter does not contribute to the genetical stock of modern domestic turkey (Speller *et al*. 2010). It is difficult to say when turkey was domesticated, because as evidenced by archaeological finds, wild birds were also hunted; however, it is thought that the domestication occurred around 2000 years ago (Thornton *et al*. 2012). Turkey had an importance as a source of food, but turkey feathers and bones were also used to produce variety of things, like musical instruments, medicine, and tools (*ibid*.). In the early period turkey also had a mainly sacrificial meaning in ritual offerings (Thornton & Emery 2017).

Turkey was known to the Spanish, French, and English colonists from the beginning of the 16th century (Reitz *et al*. 2016, and references therein). The earliest evidence in Europe so far are from 1511 and 1512, when the bird was imported to Spain (Crawford 1992, 310–311). Turkey spread quickly after its first introduction through the Hapsburg Empire and distributed throughout Europe remarkably soon after being brought to Spain (Reitz *et al*. 2016). Turkey is first mentioned in Italy in 1520, in Germany in 1530, in France in 1534, in England in 1541, and in Norway in 1550 (Crawford 1992, 311; Serjeantson 2009, 290). In Sweden and Denmark, the bird was first mentioned in 1550, and later again in 1611 (Tyrberg 2002, 227). The earliest archaeological evidence in Sweden is from the 16th or early 17th century from Ny Varberg, Nörrköping (*ibid*.). The earliest evidence in Norway is somewhat younger and comes from 1708–1783 from Erkebispegården site (Walker *et al*. 2019, 28). In Lithuania, turkey bones have been found from the Vilnius Castle, where the earliest specimen is radiocarbon dated to 15th–17th century (Rumbutis *et al*. 2018, 118). Turkey bones are present in several Polish sites from 16th–17th century onwards (Makowiecki & Gotfredsen 2002, 69; Makowiecki *et al*. 2019, 359, table 12.6). Turkey breeding became more widespread in Poland from the second half of the 18th century (Wiejacka *et al*. 2020). The earliest firm evidence from the Czech Republic is from 1578 (Kyselý & Meduna 2019, 6432).

Similarly, as to the rest of the Europe, turkey appears very quickly to the area of present-day Estonia. According to written sources, the Bishop of Tartu, Johannes V Bey, received a camel as a gift from Russian Duke Mikhail Glinski in March 1534, and in return, among other things, the Bishop sent him a turkey with a Moor who took care of the bird (Kivimäe 1996; Mänd 2016, 10–11). As he sent the bird to the Russian Duke within a week, Johannes V Bey must have had the bird already in his possession, and as the Bishop had received the bird from Germany, it was possibly brought to Tartu already in summer 1533 (Kivimäe 1996; Mänd 2016, 11). Soon after, turkeys were raised by Jesuits, as known from written sources from the 16th century (Põltsam-Jürjo 2013, 26). Turkeys have been related to Jesuits also elsewhere (Kyselý & Meduna 2019, 6435, and references therein). For the eastern Baltic region, guidance for raising turkeys was included in the Salomon Gubert handbook from 1645; and in the same period of 17th–18th century, turkeys were sometimes bred in manors (Kahk *et al*. 1992, 45; Piirsalu 1997, 12–13).

In Estonia, only nine turkey bones from four archaeological sites have been found so far: Haapsalu Castle (coracoid, scapula, humerus), Tartu (coracoid, two humeri, tarsometatarsus), Vaabina manor (coracoid), and Tallinn (sternum) (Lõugas *et al*. 2020; Maldre 2020; Rannamäe & Ehrlich 2020; Ehrlich 2021b; Haak *et al*. 2022). Most of these come from the sites excavated during recent years. Therefore, it is possible that more will be found as new sites are excavated or as previously excavated zooarcheological material is studied further. Archaeological contexts suggest a wide timeframe for the bone finds, as some are from the 16th–17th century and some from the 19th century (Lõugas *et al.* 2020; Maldre 2020; Rannamäe & Ehrlich 2020)[4]. Those from older contexts coincide well with the information found in written sources. Even though none of the turkey bones come from the material identified and published for this thesis, dating the arrival of turkey to the area of present-day Estonia was important for this research as one of the aims was to discuss the arrival of domesticated birds. To this purpose, two turkey bones were radiocarbon dated by AMS to clarify the dating of possibly oldest specimens from Estonia. One turkey humerus selected for radiocarbon dating is from Haapsalu[5] (AI-HM-9206/AZ-134), dated to a short time period of 1580–1650 CE by archaeological context (Lõugas *et al*. 2020). The second radiocarbon dated bone is a humerus

[4] Information about archaeological context of bones from Tartu is based on a personal communication with Martin Malve 15.02.2022

[5] Sampling protocol (AI PP 541) was handed to the Archaeological Research Collection at Tallinn University. Results of radiocarbon date: cal BCE/CE date (68.3%) – 1661–1800 calCE, cal BCE/CE date (95.4%) – 1667– … calCE, $\delta^{13}C$ – -21.2, $\delta^{15}N$ – 7.5, C:N – 3.14, Coll. yield (%) – 10.

from the mid-16th century to 1704 Tartu[6] (TM-A-283/AZ-2:1). Both samples had the potential to be one of the earliest evidences from Estonia. However, both bones turned out to be over a hundred years younger than suggested by written sources (Fig. 5). The bone from Haapsalu Castle is younger than expected by the archaeological context as the results fell between 1667 and the 20th century. The bone from Tartu seems to originate from within the wide time frame suggested by archaeological context as the result was between 1655 and the 20th century. Considering the results of radiocarbon dates, the possibility that the bones are of modern origin instead cannot be excluded.

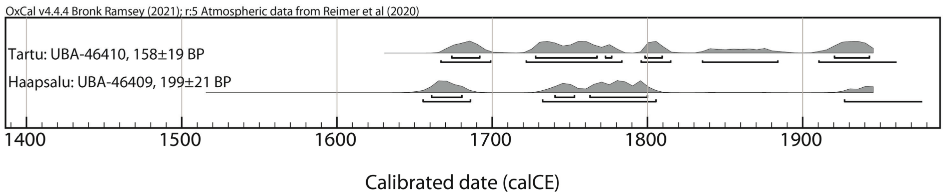

Figure 5. Calibrated radiocarbon dates of turkey bones found from Tartu and Haapsalu.

Turkey was a luxury in Europe during the Early Modern Period. It was related to power and status, and was probably traded for a significant price (Walker 2021, 41). This is also indicated by the fact that turkeys are often found from sites related to higher class; whereas compared to goose and chicken, they usually make up a marginal part of assemblages (Kyselý & Meduna 2019, 6432, 6444). However, an example of an exception is Vilnius Castle, where 16 turkey bones were present in a 16th–18th century layer, making it the third most common bird after chicken and goose in this layer (Rumbutis *et al*. 2018, table 7). Since in Estonia only few turkey bones have been found and most of those come from high status sites like a castle or a manor, we can indeed regard it as a luxury bird in the region during the Early Modern Period.

6.2.5. Peafowl

Two wild peafowl species have been domesticated: the Indian peafowl (*Pavo cristatus*) and the green peafowl (*Pavo muticus*); the former is usually preferred, because it is easier to keep in captivity (Serjeantson 2009, 310). Peafowl was domesticated in south-eastern Asia (*ibid*., table 12.1). Compared to turkey, peafowl arrived to Europe considerably earlier – they were known in Europe

[6] The information about archaeological context of the bone is based on a personal communication with Martin Malve 15.02.2022. Sampling protocol (TÜ PP 104) was handed to the Department of Archaeology at the University of Tartu. Results of radiocarbon date: cal BCE/CE date (68.3%) – 1674–1943 calCE, cal BCE/CE date (95.4%) – 1655– … calCE, $\delta^{13}C$ – -21.4, $\delta^{15}N$ – 8.9, C:N – 3.16, Coll. yield (%) – 4.

already in the 6th century CE (Kyselý & Meduna 2019, 6435 and refrerences therein). The earliest bones of peafowl in Poland originate from the 11th century CE, but according to zooarchaeological material, the bird remained a rare species in the following centuries (Makowiecki & Gotfredsen 2002, 76; Makowiecki *et al*. 2019, 359; Wiejacka *et al*. 2020). In the Czech Republic, the earliest evidence is from the written sources of the 12th century (Kyselý & Meduna 2019, 6435). In Norway, the earliest appearance of peafowl is from the Viking Age (895–905 CE) burial ship at Gokstad (Walker 2021, table 2). In Sweden, peafowl were regularly kept in manors during the 16th century (Ericson & Tyrberg 2004, 44). For the eastern Baltic region, peafowl is represented in Lithuania, Vilnius Castle, were five specimens have been found from the 14th–16th century layers (Rumbutis *et al*. 2018, table 7). So far, there are no peafowl bones found from Estonia, but since the bird is mentioned in written sources (Mänd 2016, 12; Põltsam-Jürjo 2013, 106), it could be a matter of time until it is identified in zooarchaeological material.

Similarly to turkey, peafowl never became widespread in this area, and it was a luxury food or pet kept for its beautiful appearance, either way it relates to status and higher class (Serjeantson 2009, 332). In Poland, the species was kept by rich nobility in the 18th century and was rarely eaten in cities (Makowiecki & Gotfredsen 2002, 76). The feathers of peafowl were sometimes used to surround the meal when the bird was served (*ibid*.). It could have been used in a similar manner with a surprise dish for Master Wolter von Plettenberg when he visited Tallinn in 1513 (Mänd 2016, 12; Põltsam-Jürjo 2013, 106). Peafowl were also important, for example, on festive tables in the Czech Republic (Kyselý & Meduna 2019, 6435).

6.2.6. Pigeon

The ancestor of domestic pigeon is rock dove that was possibly domesticated in the Near East; however, because of the wide distribution of wild rock dove, other regions cannot be ruled out entirely (Serjeantson 2009, 304–305). It is unclear when pigeon was domesticated, but it is possible that it had happened by the 1st millennium BCE and, based on finds from Greece, was present in Europe by the mid-1st millennium BCE (*ibid*., 306). More evidence from central Europe and Scandinavia seems to be from the first century CE onwards (*ibid*., table 12.4).

Even though some pigeon bones have been identified in Estonian material (Paper I), in most cases it is difficult to say if those are domestic or not. Namely, rock dove and domestic pigeon are morphologically identical, and the size of the domestic ones can vary widely: some might be smaller than rock dove, while others might be larger than common woodpigeon (*Columba palumbus*), which is the largest of columbiforms in Europe (Fick 1974; Tomek & Bocheński 2009, 86). Domestic pigeons were kept throughout Europe during the Middle Ages, but wild pigeons were also present in towns, since these are commensal species (Hamilton-Dyer *et al*. 2020, 290).

In Norway, rock dove is present from the Bronze and the Early Iron Age onwards, even though prior to the Post-Medieval Period (from 1500 CE onwards) there is little evidence of this bird (Walker 2021, 36, table 2). It is, however, unclear if those specimens belong to feral or natural populations (*ibid*., 36). According to written sources, in Sweden domestic pigeons were rather rare during the Middle Ages, but presumably became more common from the mid-19th century onwards (Tyrberg 2002, 227). In some Polish sites like medieval Kałdus settlement site and Starogród Castle of the Teutonic Order, domestic pigeon has been identified (Makowiecki *et al*. 2019, 343; Wiejacka *et al*. 2020). In Estonia, eating domestic pigeon is mentioned in written sources from the 18th century (Bardone *et al*. 2016, 56).

Domestic pigeons have been kept for variety of reasons like sacrifices, meat, dung, and even for carrying messages (Serjeantson 2009, 308). There are also a few juvenile pigeons represented in medieval and early modern Viljandi Castle, where a tibiotarsus and carpometacarpus with cut marks suggest that at least some of the pigeons found from Estonian material were eaten (Ehrlich 2018, appendix 3; Paper I). From Estonia, there is so far no evidence that pigeons were used for other purposes. It is unclear, if all pigeon bones ended up in the archaeological context by human activity, because it is possible that some of those specimens got there incidentally (Maltby 2020, 338).

6.3. Changing meaning of birds through time

6.3.1. From grave to table

It has been suggested that chicken was brought to western Asia and Europe for ritual purposes (Serjeantson 2009, 362). Chicken was considered to be a sacred bird in the regions where the earliest finds are from burial sites, for example in Slovakia and Germany, where the earliest evidence is from the 1st century BCE (*ibid*.). The earliest finds from Thailand, China, and Italy are also from burial sites (Best *et al.* in press, and references therein). As in many areas in Europe, chicken are also buried individually, showing the importance of that bird (Doherty *et al*. 2021; Best *et al.* in press). Birds buried in this way do not have any evidence of human consumption and are often older individuals (Doherty *et al*. 2021; Best *et al.* in press). Early chicken, whose population size was limited, were probably not considered to be food, but rather exotic birds or rare pets; therefore related to social status (Sykes 2012; Trentacoste 2020; Best *et al*. in press). When chicken became more abundant and grew in importance as a food source, it did not lose its ritual value, as chicken were buried with humans as a food offering or might have had important symbolic meaning of leading human souls to the afterlife (Trentacoste 2020; Best *et al*. in press).

Earliest evidence in the northern part of Europe show similar patterns in the role of chicken. In Sweden and Denmark, chicken was seen as a high-status commodity before it became dominant (Walker *et al*. 2019, 25). For example, in

Denmark, three inhumation graves with chicken bones are known in Vråby, Munkehøjgård, and Kærup Nord, all from the Roman Iron Age (c. 1–375 CE), while usually domestic mammals have been preferred (Gotfredsen 2013, 357–358). The birds were offered as food for the deceased as evidenced by the arrangements of the birds in pottery vessels or their location in relation to other food offers (*ibid*., 367). Chicken was not an everyday commodity for Roman Iron Age people in Scandinavia and the presence of an entire chicken in a grave further added luxury (*ibid*., 368). The main purpose of placing animal parts in Roman Iron Age inhumation graves in Scandinavia was to provide the deceased with provisions, but it had additional symbolic or status-related connotations (*ibid*., 368).

Interpretations whreby chicken has both economic and symbolic value have also been attributed to Iron Age finds in Estonia, which originate from different contexts, like settlements and burials (Jonuks *et al*. 2018, 7–8). In Estonia, the earliest chicken is also from a grave, even though only one bone has been found and the connection with human burials remains unclear (Paper III). This is not something exceptional for Estonia, as the earliest evidence of cattle and sheep are also from graves, whereas those are also represented only by a single bone or bone tool (Lõugas *et al*. 2007, 25–26). Even when chicken becomes more abundant in the area of present-day Estonia from the 10th century CE onwards (Paper I), chicken eggs have been found from Kukruse burial (end of the 12th – beginning of the 13th century CE) and chicken bones from Siksälä cemetery (13th–15th century CE) (Valk & Laul 2014, 90; Jonuks *et al*. 2018). Also, in Jurgionys cemetery, Lithuania, chicken bones have been found in a 14th–16th century CE grave (Vitkūnas 2015, 186, 191). By that time, chicken was already a common bird species also in Lithuania (e.g. Rumbutis *et al*. 2018, table 7).

In Late Iron Age (c. 950–1225 CE) Viljandi, bird bones form 2–8% of all zooarchaeological material (Rammo & Veldi 2005, 102; Valk & Rannamäe 2015, 128). Among the bird remains, chicken dominates, indicating that it provided meat and possibly eggs (Paper I). This might seem a small percentage, and in some of the previous studies it has been thought that the number of chickens in the Late Iron Age was small and that their number increased only in the Middle Ages (Jonuks *et al*. 2018, 7). But it is rather usual that bird remains form less than 10% of the whole zooarchaeological material even in the Middle Ages (e.g. Benecke 1993, 28; Hamilton-Dyer 2002, 101; Maldre *et al.* 2018, 1229; Walker 2021, 38). By the Middle Ages, chicken became important meat supply as seen in the number of bones and also in the percentage of juvenile birds (Paper I).

Goose have had a sacred meaning in Roman Egypt and Roman Italy, and in Greece (Albarella 2005, 253). Whereas it is possible that goose had an important role also in northern Europe, as the earliest evidence of domestic goose in Denmark has also been found from high status graves during the Roman Iron Age (around 200–250 CE) (Gotfredsen 2013, 366). Similarly, during the Late Iron Age (550–1060 CE), domesticated goose bones are frequently present in graves in Sweden (Tyrberg 2002, 216–219). Not much is known about goose or other domestic birds besides chicken in the graves in Estonia.

6.3.2. Cockfighting

It has been suggested that cockfighting is one of the main reasons for domesticating chicken (Serjeantson 2009, 268; Sykes 2012, 160). Supposedly, cockfighting could have been the reason for the spread of chicken also in central Europe, because in some of the early sites, the ratio of cockerels to hens was 3:1; on the other hand, this proportion might also indicate predominant use in meat production (Benecke 1993, 24; Sykes 2012). Nevertheless, particularly for the early evidence, cockfighting or ritual meaning seems more plausible (Sykes 2012). Traces of cockfighting can be indicated by cut off spurs. One reason for cutting off the spurs might be aggression control, because the birds can be very violent while defending their territory or fighting with other males during the mating period (Gál 2008, 43). Such fights might end even with death (Barber *et al*. 2012, 108). Another reason is the use of artificial spurs made of metal or bone (Serjeantson 2009, 327). From Estonia, no artificial spurs are known, but five tarsometatarsi with cut off spurs have been found: one from Late Iron Age Viljandi settlement site, one from 14th–16th century Padise monastery, one from the end of the 16th–17th century Vastseliina Castle (TÜ-1435/AZ-06:04, Fig. 6), one from early modern Viljandi Castle, and from medieval or early modern Vabaduse Square settlement site in Tallinn (AI-6917/558:213, Fig. 6) (Valk 2006, 2; Tomek 2010; Lõugas *et al*. 2012, 89; Ehrlich 2019; Paper I). Similar cases have been found from several sites around Europe, for example, two chicken spurs with cut marks from medieval Portugal (Moreno-García & Pimenta 2010, 270, fig. 4). Chicken bones interpreted as evidence of cockfighting have also been found from medieval and early modern Norway (Bergen, Oslo, Trondheim) (Walker & Meijer 2020). There is another example of cut off spur from 16th century Brussels, Belgium (Thys & Van Neer 2010, 81). In case of aggression control, it is more common to remove only half of the natural spur (Walker & Meijer 2020, 130), which is not the case for most of the Estonian examples. The examples, where the spur is removed closer to the shaft can be related to cockfighting instead, because it is necessary to remove the spur in order to attach an artificial spur (*ibid*., 132). Therefore, a spur with cut marks from Tallinn Vabaduse Square might be related to aggression control, even though cockfighting cannot be excluded.

Figure 6. Two chicken tarsometatarsi: A – tarsometatarsus with its spur cut off from Vastseliina (TÜ-1435/AZ-06:04), B1 – tarsometatrsus with cut marks on its spur from Tallinn Vabaduse Square (AI-6917/558:213) from plantar view and B2 – from dorsal view. Cut marks are shown with arrows. Photo: Eve Rannamäe, Freydis Ehrlich.

6.3.3. Feathers and bone items

Several species of birds, like sparrowhawks, Eurasian crane, swan, ravens, and possibly Eurasian jackdaws might have been valued for their plumage (Serjeantson & Morris 2011, 88; Hamilton-Dyer *et al*. 2020, 262 ff.), even though none of the specimens found had any cut marks. However, eagle bones have sometimes cut marks. The meaning of eagles can be difficult to understand, because these can be birds living and dying in the area, or killed as pests (Hamilton-Dyer 2002, 104), and therefore the usage of the bird is not always clear (discussed in more depth in Paper II). However, as only parts of the skeleton are usually found, it is more likely that those birds were killed elsewhere and parts of the carcasses were brought to the settlement for some reason (Hamilton-Dyer *et al*. 2020, 262). Cut marks on eagle wing bones suggest that at least in some cases, the reason was the use of feathers (*ibid*.). This is also possible for medieval Viljandi Castle, as carpometacarpus and radius of white-tailed sea-eagle with cut marks were present (Fig. 7) (Ehrlich 2018). Similar finds come also, for example, from north-western Russia, as a white-tailed sea-eagle humerus and carpometacarpus with cut marks were present at the 12th century CE Novgorod Troitsky site (Hamilton-Dyer 2002, 104). Furthermore, in Viljandi Castle, out of twenty medieval white-tailed sea-eagle bones, fifteen were wing bones and the rest leg bones (Fig. 8) (Ehrlich 2018; Paper I). In Klaipėda Castle, on the other hand, out of eighteen eagle bones only five were from wings (Paper II). Additionally, among the remaining thirteen eagle bones, four had cut marks suggesting that in the case of Klaipėda, extracting claws for pendants was the main purpose, not feathers (Paper II). Using eagles for feathers or pendants has been discussed in more detail in Paper II.

Figure 7. Carpometacarpus (VM-10922/AZ-94:6) of the white-tailed sea-eagle from medieval Viljandi Castle. Cut mark is shown with an arrow. Photo: Eve Rannamäe, Freydis Ehrlich.

Figure 8. Tarsometatarsus and phalanges (VM-11041/AZ-276:1-5) of white-tailed sea-eagle from medieval Viljandi Castle. All specimens probably belong to the same individual. Photo: Eve Rannamäe, Freydis Ehrlich.

Worked bird bones are usually rare in archaeological assemblages, because bird bones are smaller and thinner than those of mammals and their shape and structure sets limits for their use (Gál 2005, 325). Some evidence is from medieval Viljandi Castle, where a whistle made of chicken-sized galliform ulna has been found (Paper I). Whistles made of bird bones have also been found from much earlier sites of Neolithic settlement site in Tallinn Vabaduse Square and from Tamula Neolithic settlement site (Lõugas & Tomek 2013, 477–478). Even present day hunters sometimes use whistles made of avian bones to lure different animals like foxes, martens, polecats, and hazel grouse (*ibid.*, 478). While the whistle from medieval Viljandi is made of an ulna of chicken-sized galliform, it seems that at least during the Middle Ages flutes were usually made of the long bones, preferably ulna, of larger birds like goose, swan, heron, or eagle (Küchelmann 2010, 172). It makes a good raw material because of its length and resistance (Gál 2015, 363). The bones of mammals have also been used for making flutes, but bird bones were possibly preferred for the thin walls and hollow ducts (Gál 2005, 334). For example, two flutes made of golden eagle ulnae come from a 16th century high status site of Visegrád-Alsóvár, Hungary (Gál 2005, 328; Gál 2015, 363). A bone flute made of a domestic goose humerus was present in 2nd–3rd century CE Carnuntum–Mühläcker, Austria (Gál & Kunst 2014, 341).

7. CONCLUSION

Bird bones are an important source of information about the past, helping to fill the gaps about what people ate, what tools they used, how they displayed their social status, practised rituals, etc. However, until lately, bird bones in the eastern Baltic region have received only little attention compared to the bones of mammals and fish. The main aim of this thesis was to fill this gap by providing a more detailed overview of the bird species present in zooarchaeological material, and to determine what roles birds had in the past. These questions were tightly linked to another aim – to discuss when domestic species reached the area of present-day Estonia.

The diversity and meaning of birds in the past were mainly based on material from the Late Iron Age to the Early Modern Period Viljandi area, Estonia, and Klaipėda Castle, Lithuania (Papers I and II). Bird bones from the Stone Age and the Bronze Age are partially previously studied by other scholars, and in this introductory part of the thesis only a brief overview has been provided. During the Stone Age, water birds, especially ducks, were the most important. As most of the birds were used for food, there were some species like eagles that might have had a ritual value instead. From the later part of the Viking Age, chicken becomes the dominant bird species in zooarcheological material, followed by goose and duck. However, variety of other species is usually also present. The diversity of species used can give information about relationships between people. Based both on written sources and archaeological evidence, consuming certain species such as Eurasian crane, swan, or western capercaillie as food can be related to status. Similarly, hawking was something related to higher class. Birds did also have a symbolic or ritual meaning. For example, chicken skeletons and eggs have been found in graves, and bones of different species have been used for pendants. Additionally, feathers of some species, like eagles, were used, whereas artefacts, like whistles, were made of bird bones. In case of some species, like corvids and pigeons, it is difficult to say if their presence in deposits is caused by human activity or by natural processes.

Domestication is an important topic that is studied with the help of archaeological bones. It was possible to find the most probable earliest evidence of chicken as a bone was radiocarbon dated to Pre-Roman Iron Age, while other examples were dated not earlier than the Pre-Viking Age (Paper III). It was difficult to find the earliest evidence of domestic goose, as methods for differentiating between wild and domestic forms were needed. Other species like ducks, turkeys, peafowl and pigeons were discussed as well. Of those, the early evidence of turkey was found, while other species are needed to be studied in the future.

There are still many questions about birds in the past that remain unanswered and deserve further studying. For example, from where and by whom were domestic chicken and goose brought to present-day Estonia, and was chicken introduced to the area more than once. Also for goose and duck, making a difference between wild and domestic specimens needs further attention in order to determine the earliest domestic forms in the area. aDNA analysis would be one of the methods with a potential to solve several questions regarding chicken and goose. As research develops and more faunal remains are studied, there is also hope that new species can be added to the list of occurring material – for example, peafowl. And, of course, as more material from different sites and time periods is being studied, deeper discussion on the value and meaning of different species becomes possible. Only then we can start drawing comparisons in the diversity, importance, and arrival of birds in the whole eastern Baltic region.

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SUMMARY IN ESTONIAN

Linnud Eesti zooarheoloogilises materjalis: mitmekesisus, tähtsus ja varaseimad tõendid kodustatud liikidest

Sissejuhatus

Eestis on Eesti Ornitoloogia Ühingu andmetel 2022. aasta seisuga 398 metsikut linnuliiki, kellele lisanduvad kodulinnud. Mitmed neist liikidest on läbi aegade olnud inimeste elus väga tähtsal kohal nii toidulaual, esemete valmistamisel, kui ka näiteks sotsiaalse staatuse ja uskumuste väljendamisel. Selleks, et uurida lindude tähtsust minevikus, lähtusin zooarheoloogiast, täpsemalt arheoloogiliste linnuluude uurimisest. Selline lähenemine oli vajalik, kuna seni on linnuluud imetaja- ja kalaluude kõrval Baltikumis vähe tähelepanu saanud. Väitekirjas uurisin linde mitmest aspektist: 1) milliseid linnuliike võib leida Eesti zooarheoloogilisest materjalist, eelkõige viikingiajast varauusajani (950–1700 m.a.j.; I artikkel); 2) kuidas inimesed erinevaid liike kasutasid ja kuidas need liigid olulised olid (I ja II artikkel); 3) millal jõudsid kõige levinumad kodulinnud – kodukana ja koduhani – tänapäeva Eesti alale (III ja IV artikkel); 4) milliseid meetodeid tuleks kasutada kodustatud lindude eristamisel metsikutest, keskendudes eelkõige hanedele (IV artikkel).

Uurimislugu

Eestis on linnuluid varasemalt määranud enne Teist maailmasõda näiteks Johannes Lepiksaar ja 1950ndatel Loreida Põder. Alates 1990ndatest on arheoloogiliste loomaluude uurimisega tegelenud mitmed uurijad nagu Paul Saks, Eha Järv, Lembi Lõugas, Liina Maldre ja alates 2010ndatest Eve Rannamäe, kes on kõik rohkemal või vähemal määral linnuluid määranud ja nende kohta tulemusi avaldanud. Lisaks on Eesti materjali määranud ka välismaised linnuluude uurijad Kristiina Mannermaa ja Teresa Tomek. Kui Läti ja Leedu uurimisseis on sarnane Eestiga, siis näiteks Fennoskandias on linnuluid märksa rohkem uuritud.

Teooria

Tihti on linde peetud pelgalt toiduallikaks, kuid minevikus oli neil kindlasti suurem tähendus. Näiteks on folklooriski linde nähtud sõnumitoojatena, kes toovad teavet ilma, tulekahju, sünni, surma jne kohta. Lisaks on nad olnud osa meelelahtusest, staatuse näitamisest, keskkonnast ja religioonist. Nende tähenduste uurimine linnuluude põhjal on aga keeruline ülesanne, mille uurimisele määramise käigus saadud tulemuste, kirjalike allikate ja ka tänapäevaste praktikate võrdlemine võib kaasa aidata.

Inimeste ja lindude vahelist suhet on zooarheoloogilise materjali põhjal keeruline tõlgendada, kuna enamasti jääb suurem osa tähenduslikust suhtest just linnu eluaega. Uurimise teeb keerulisemaks seegi, et näiteks kanal võib olla mitu erinevat tähendust – eluajal võis lind olla omanikule lemmikloom, kuid võis sellest hoolimata hiljem toidulauale jõuda. Lindude ja inimeste vaheline suhe on luuleidudele tuginedes raskesti jälgitav, sest vähemalt keskaja ja varauusaja materjali põhjal on raske hinnata, milliseid linde kasvatati linnas ja millised toodi sinna eeslinnast või tagamaalt. Zooarheoloogias ongi seega tihti jälgitav vaid linnu surma järgne tähendus.

Linnud sotsiaalse staatuse näitajana. Linnuluud on lisaks lindude ja inimeste vahelise suhte uurimisele ka oluliseks allikmaterjaliks inimeste omavahelise suhte uurimisele. Osa toitude söömine on ühiskonnas olnud rangelt reguleeritud – mis oli lubatud osale ühiskonna kihtidest, polnud lubatud teisele. Selle teema uurimisel on oluline roll ka linnuluude määramisel saadud tulemuste võrdlemisel ajaloolaste leitud infoga. Näiteks võib kirjalike allikate põhjal teatud liike nagu sookurge, luike, metsist ja nurmkana seostada vähemalt kuni 16. sajandini kõrgema staatusega linnaelanike pidusöökidega. Kuid linde kasutati staatuse näitamisel ka muudmoodi kui pidusöökidel. Näiteks oli kullide kasutamine jahil just kõrgklassi eelis ning kullide esinemine määratud materjali hulgas vihjab, et sellega tegeleti ka Eestis.

Sümboolset tähendust ja rituaale saab uurida näiteks kalmetest leitud linnuluude abil. Nimelt on loomi kalmetesse pandud mitmetes kultuurides. Linnud võisid olla mõeldud toiduks teel teispoolsusesse või ohverdusena jumalatele. Linde ja nende mune võib leida ka Eesti kalmetest, kuid enamikel juhtudel on säilinud vaid üksikud luud ja nende puhul pole võimalik öelda, kas need sattusid leiukohta juhuslikult pinnase liikumise tõttu või olid need tõepoolest mõeldud hauapanustena. Teine oluline viide lindude sümboolsele tähendusele on linnuluust ripatsid. Kui enamik Eestist leitud ripatsitest on kotkaste küünistest, siis mõned pärinevad ka erinevatest kanaluudest.

Kodustamine on samuti oluline teema, mida zooarheoloogia meetodite abil uuritakse. Kodulindudest on põhjalikumalt uuritud kanu, hanesid ja kalkuneid. Kodustatud liigid on näiteks need, kelle aretust mõjutab paljuski inimese valik. Näiteks on jahipidamiseks kasutatud kulle korjatud juba pesast ja neid on kasvatanud inimesed, kuid kodulinde neist pelgalt seetõttu ei saa. Põhjuseid, miks just teatud liigid kodustati, on mitmeid. Näiteks on lihtsam kodustada neid liike, keda inimeste jäätmed ligi meelitavad või kelle karjas on selge hierarhia. Kodustamise põhjuseks pole alati olnud toidulaua täiendamine, näiteks võisid mitme linnuliigi kodustamisel rolli mängida hoopis suled või koht rituaalides.

Materjal

Kuigi zooarheoloogilise materjali hulgas leidub ka munakoori ja sulgi, keskendusin siiski vaid linnuluude uurimisele (jn 2). Väitekirja materjal on seotud artiklite teemaga ja seetõttu keskendub linnuluudele peamiselt nooremast rauaajast varauusajani, samas kui varaseimate kanaluude otsimine (II artikkel) viis ka kivi- ja pronksiaja materjaliga tutvumiseni. Väitekirja sissejuhatavas peatükis on tutvustatud põgusalt ka kivi- ja pronksiaja materjalis esinevaid linnuluid. Kui I ja II artikkel keskendusid vaid ühele muistisele või piirkonnale (vastavalt tänapäevane Viljandi linn ja Klaipėda ordulinnus, Leedu), siis III ja IV artikkel hõlmasid erinevaid muistiseid, kuid kaasatud on nendest vastavalt vaid kana- või haneluud (jn 1 on märgitud kõik sissejuhatavas peatükis mainitud Baltikumi muistised). Varem teiste uurijate poolt määratud materjali määrasin selle väitekirja tarbeks üle.

Meetodid

Seda, kui suure osakaalu linnuluud zooarheoloogilisest materjalist moodustavad, mõjutavad mitmed asjaolud. Tihti on linnuluude osakaalu seostatud sellega, kas kaevamistel pinnast sõeluti või mitte, sest väiksemad skeletielemendid, väiksemate lindude ja noorlindude luud võivad ilma sõelumata tähelepanuta jääda. Samuti on võimalik, et linnuluid oligi materjalis erinevatel põhjustel vähem. Nii näiteks võivad koerad ja sead lindude luud tervikuna ära süüa, mistõttu ei jää nende lindude tarbimisest arheoloogilises materjalis ühtegi jälge.

Teine oluline aspekt linnuluude uurimisel on nende **taksonoomiline määramine**. Tihti on keeruline luid mõnele konkreetsele liigile omistada, kuna samasse sugukonda kuuluvad liigid võivad omavahel väga sarnased olla. Seega tuleb määrangutesse suhtuda ettevaatlikkusega, sest määramise õigsus sõltub mitmest asjaolust, sh võrdluskogu suurusest ja uurija kogemusest.

Võimalusel dokumenteerisin isendi **soo ja vanuse**. Soo määramiseks kasutasin kanaliste puhul kannuse olemasolu (isaste eristamiseks) ja metsikute kanaliste ja haugaslaste puhul luu suurust. Samuti vaatasin üdiluu olemasolu, mis esineb emastel lindudel munemisperioodil ning mõned nädalad enne ja pärast seda. Seda sai dokumenteerida enamikel juhtudel vaid fragmenteeritud luude puhul, kuid väitekirja sissejuhatava peatüki tarbeks katsetasin Vastseliina linnusest leitud tervete kanaluude puhul ka röntgenit (jn 3). Vanuse määramisel lähtusin luu poorsusest ja diafüüside ehk luu otste kinnitumisest.

Lisaks soole ja vanusele dokumenteerisin ka **tafonoomilised näitajad**. Eelkõige registreerisin lõike-, närimis- ja põlemisjälgede olemasolu. Kuigi neid esineb harvemini kui näiteks imetajate luudel, annavad need lindude kasutamise kohta palju teavet. Näiteks võib lõikejälgede abil tõlgendada, kas leitud luud olid toidu- või töötlemisjäägid. Närimis- ja põlemisjälgede põhjal on tõlgendusi juba keeruline teha. Nimelt on linnuluude puhul tihti keeruline välja selgitada, kas närimisjäljed jättis inimene või mõni muu imetaja. Samuti on võimalik, et põlemisjäljed tekkisid luudele näiteks lõkkesse viskamise, aga mitte toidutegemise käigus.

Luudel esines ka **patoloogiaid** ehk haigustest ja traumadest põhjustatud muutusi. Linnud on oma habraste luude tõttu altid näiteks luumurdudele. Samuti esineb kodulindudel rohkem haigusi seoses halbade pidamistingimutega. Patoloogiaid on loomaluude puhul keeruline uurida, sest enamasti ei jõua uurijani mitte terve skelett, vaid üksik luu. Seetõttu on raske hinnata ka patoloogia levikut teistele sama isendi luudele. Paljud haigused aga ei mõjuta üldse luustikku, vaid levivad ainult pehmetes kudedes.

Linnud zooarheoloogilises materjalis kiviajast varauusajani

Arheoloogilises materjalis leiduvate lindude nimekiri võib olla väga mitmekesine. Kiviaegses (9000–1750 e.m.a) leiuaineses võib eelkõige kohata erinevaid veelinde, peamiselt parte. Samas leidub vähesel määral ka näiteks hanesid, tetri, metsiseid ja kotkaid. Enamik nendest on seotud toidujäätmetega, kuid näiteks kotkaluud võivad osutada ka rituaalidele. Kui hilisel pronksiajal (850–500 e.m.a) oli koduloomakasvatus Eestis juba levinud, siis lindude puhul olid endiselt olulisel kohal samad liigid nagu kiviajalgi. Eelrooma (500 e.m.a – 50 m.a.j) ja rooma rauaaja (50–450) zooarheoloogiline leiuaines on pärit peamiselt kalmetest ja pole nii mahukas kui eelneval perioodil. Seega on ka lindude kohta sellest perioodist vähem teada. Rahvasterännuajast (450–550) ning eelviikingiajast (550–800) on loomaluid samuti vähe määratud. Rohkem on teada alates viikingiaja teisest poolest varauusajani, kus peamise osa leitud linnuliikidest moodustavad kodukanad, haned ja pardid. Mitmed lindude rühmad nagu vareslased, kajakad ja tuvid ei pruugi sel perioodil olla seotud inimtegevusega ja võivad olla sattunud zooarheoloogilisse materjali juhuslikult looduslike protsesside tulemusena, kuid siiski ei saa nende toiduks või muul eesmärgil tarbmist välistada.

Kodulinnud zooarheoloogilises materjalis

Üheks väitekirja eesmärgiks oli välja selgitada, millal esimesed kodulinnud Eesti alale jõudsid. Luid radiosüsinikumeetodi abil dateerides selgus, et seni varaseim **kodukana** pärineb Rebala Lastekangrute I kalmest eelrooma rauaajast. Viikingiaja teisest poolest alates leidub kanaluid juba rohkem ja vähemalt keskajast alates on Baltikumis enim leiduvaks linnuliigiks just kodukana, olles kättesaadav erinevatele ühiskonna kihtidele. Kana tähtsuse kohta toidulaual saab teavet ka vanuselise ja soolise osakaalu abil. Näiteks Viljandis on väga vähe munevate kanade luid, viidates sellele, et munakanu vähemalt munemisperioodil lihaks ei tarvitatud. Suur noorlindude osakaal viitab muuhulgas ka linnustes kasvatatud kanadele. Kodukana kehvadele pidamistingimustele viitavad ka patoloogiad. Nimelt leidus nii liigesevigastuse kui ka luumurdudega kanade luid. Haruldasem oli üks osteopetroosise juhtum Viljandist. Eestist on see ainus taoline leid, samas kui Vilniuse linnusest on teada kaks sarnast leidu.

Haned on enamasti arvukuselt teine linnuliik zooarheoloogilises materjalis. Nende puhul on siiski keerulisem välja selgitada, kas luude näol on tegemist metsiku või kodustatud vormiga, sest kodustatud ja metsikud vormid on üksteisega morfoloogiliselt väga sarnased. Kui kodukana puhul nende eellast – puna-džunglikana – Eesti alal ei kohta, siis koduhanede eellane hallhani on Eesti alal üsna levinud liik, kelle luid leidub juba kiviaegsetel asulakohtadel.

Üksikud patoloogiatega luud alates rauaajast vihjavad samuti, et hanesid võidi juba sel ajal kodudes kasvatada. Noorte hanede luid leidub harva ja see näitab, et hanesid peeti enamasti ilmselt muul eesmärgil ja kasutati liha saamiseks pigem vaid erilistel juhtudel. Üks varaseimaid noorlinde on leitud aga näiteks hilispronksiaegsest Kaali asulakohast (jn 4).

Parte esineb kõigil perioodidel ja pardid on tihti kana ning hane järjel arvukuselt kolmandaks linnuks. Siiski pole sarnaselt hanedega selge, millal kodupart Eesti alale toodi. Võimalik, et metsikuid parte püüti veel ka keskajal. Vähem on zooarheoloogilises materjalis teisi kodulinde. Näiteks on **kalkuni** luid seni leitud vaid neljalt muistiselt. Euroopasse jõudis see lind alles 16. sajandi alguses ja levis seejärel kiirelt üle terve Euroopa. Kirjalike allikate põhjal võib järeldada, et kalkun toodi sel ajal ka Eesti alale, samas kui arheoloogilised leiud on mõnevõrra hilisemad (jn 5). Kuigi kirjalikes allikates on mainitud ka **paabulindu**, siis selle linnu luid Eestist veel seni leitud pole. Nende avastamine on tulevikus siiski tõenäoline, kuna paabulinnu luid on teada näiteks Leedust. Kodulindudest viimane, keda ka Eestis kohata võib, on **kodutuvi**. Sarnaselt hanede ja partidega on arheoloogilises materjalis kodutuvisid aga keeruline teistest tuvilistest eristada ja seetõttu jääb ka nende puhul selgusetuks, millal kodutuvi Eesti alale jõudis. Noorte tuvide luud keskaegsest ja varauusaegsest Viljandi ordulinnusest viitavad, et kodutuvi võis juba siis olla esindatud.

Lindude muutuv tähendus

Lindude tähenduse muutumine on jälgitav näiteks kodukanade ja hanede puhul. Nimelt on mujal Euroopas täheldatud, et tihti on esimesed leiud **haudadest ja alles hiljem jõuavad need liigid toidulauale**. Seega võib nende esialgne levik olla samuti seotud rituaalse tähendusega, kuid nad võisid olla ka lemmikloomad oma eksootilisuse tõttu. Ka pärast seda, kui viikingiaja teisel poolel muutusid kodukanad toidulaual oluliseks, pandi neid endiselt hauapanustena kaasa näiteks Eestis ja Leedus.

Kanade kodustamise juures on oluline koht olnud **kukevõitlusel**, mida peetakse üheks kodukana laiema leviku põhjuseks. Arheoloogiliste leidude põhjal on keeruline kukevõitlust tuvastada, kuid sellele võivad viidata lõikejäljed kukekannustel. Kannuseid lõigatakse ära ka agressiivsuse vähendamiseks, kuid selle tarbeks eemaldatakse tavaliselt vaid pool kannust. Mitmel Eestist leitud näitel on aga eemaldatud enamik kannusest (jn 6). Võitluskukkedel asendati loomulik kannus metallist või luust kannusega, kuid Eestist pole ühtegi sellist veel seni leitud.

Läbi aegade on kasutatud erinevate lindude **sulgi**. Mujalt Euroopast on teada näiteks raudkullide, sookurgede, luikede ja ronkade sulgede kasutus. Kuigi need liigid esinevad ka Eesti leiumaterjalis, pole seni sulgede kasutamisest zooarheoloogiliste leidude hulgas kindlaid tõendeid. Küll aga on kasutatud kotkaste sulgi, mida tõendavad lõikejälgedega kotka tiivaluud, mis omakorda viitab sulgede eemaldamisele (jn 7). Samuti on suurem osa Viljandi linnusest leitud kotkaluudest just tiivast, samas kui erinevaid jalaluid oli vaid viis ja need kõik kuuluvad tõenäoliselt samale isendile (jn 8).

Linnuluid kasutati ka **esemete valmistamiseks**. Kuna linnuluud on imetajate omadega võrreldes kerged, haprad ja väiksed, siis on neist valmistatavate esemete valik üsna piiratud. Keskaegsest Viljandi ordulinnusest on leitud näiteks üks kanalise küünarluust valmistatud vile. Vilesid on ka neoliitilistest asulakohtadest. Vähemalt keskajast alates aga eelistati vilede valmistamiseks suuremate lindude, nagu haned, luiged ja kotkad, luid.

Kokkuvõte

Linnud olid mineviku inimese elus olulisel kohal, nii toidulaual kui ka uskumustes ja inimeste omavaheliste suhete näitamisel. Siiski on mitmeid teemasid, mis sellest väitekirjast välja jäid. Näiteks pole teada, millisest piirkonnast kodukana Eesti alale toodi. Samuti pole selge, millal koduhaned ja -pardid Eesti alale jõudsid. Lisaks on selliseid liike, sh paabulind, kelle luid Eesti zooarheoloogilisest materjalist veel leitud ei ole, kuid kes kirjalike allikate põhjal võiksid leiumaterjalis olla. Erinevate liikide tähenduse mõistmiseks tuleb uurida linde erinevatelt muistisetüüpidelt ja ajaperioodidest nii Eestist kui ka naaberaladelt.

APPENDIX

The English, Latin, and Estonian names for the bird species mentioned in this study. Wild species are after the Estonian Ornithological Society and domestic ones after Ernits (2015) and Serjeantson (2009).

English	Latin	Estonian
Anseriforms	***Anseriformes***	**Hanelised**
Domestic goose	*Anser anser domesticus*	Koduhani
Domestic duck	*Anas domestica*	Kodupart
Barnacle goose	*Branta leucopsis*	Valgepõsk-lagle
Greylag goose	*Anser anser*	Hallhani (roohani)
Swan goose	*Anser cygnoid*	Stepihani
Bean goose	*Anser fabalis*	Rabahani
Whooper swan	*Cygnus cygnus*	Laululuik
Garganey	*Spatula querquedula*	Rägapart
Northern shoveler	*Spatula clypeata*	Luitsnokk-part
Gadwall	*Mareca strepera*	Rääkspart
Eurasian wigeon	*Mareca penelope*	Viupart
Mallard	*Anas platyrhynchos*	Sinikael-part
Common teal	*Anas crecca*	Piilpart
Tufted duck	*Aythya fuligula*	Tuttvart
Greater scaup	*Aythya marila*	Merivart
Common eider	*Somateria molissima*	Hahk
Velvet scoter	*Melanitta fusca*	Tõmmuvaeras
Black scoter	*Melanitta nigra*	Mustvaeras
Long-tailed duck	*Clangula hyemalis*	Aul
Common goldeneye	*Bucephala clangula*	Sõtkas
Smew	*Mergus albellus*	Väikekoskel (pudukoskel)
Goosander	*Mergus merganser*	Jääkoskel
Red-breasted merganser	*Mergus serrator*	Rohukoskel
Galliforms	***Galliformes***	**Kanalised**
Domestic chicken	*Gallus gallus domesticus*	Kodukana
Red junglefowl	*Gallus gallus*	Puna-džunglikana
Wild turkey	*Meleagris gallopavo*	Metskalkun
Indian peafowl	*Pavo cristatus*	Sini-paabulind
Green peafowl	*Pavo muticus*	Rohe-paabulind
Hazel grouse	*Tetrastes bonasia*	Laanepüü
Western capercaillie	*Tetrao urogallus*	Metsis
Black grouse	*Lyrurus tetrix*	Teder
Grey partridge	*Perdix perdix*	Nurmkana (põldpüü)
Common quail	*Coturnix coturnix*	Põldvutt
Caprimulgiforms	***Caprimulgiformes***	**Öösorrilised**
European nightjar	*Caprimulgus europaeus*	Öösorr
Cuculiforms	***Cuculiformes***	**Käolised**
Common cuckoo	*Cuculus canorus*	Kägu
Columbiforms	***Columbiformes***	**Tuvilised**
Rock dove	*Columba livia*	Kodutuvi
Common woodpigeon	*Columba palumbus*	Kaelustuvi (meigas)

English	Latin	Estonian
Gruiforms	***Gruiformes***	**Kurelised**
Western water rail	*Rallus aquaticus*	Rooruik
Common coor	*Fulica atra*	Lauk
Eurasian crane	*Grus grus*	Sookurg
Podicipediforms	***Podicipediformes***	**Pütilised**
Great crested grebe	*Podiceps cristatus*	Tuttpütt
Charadriiforms	***Charadriiformes***	**Kurvitsalised**
Grey plover	*Pluvialis squatarola*	Plüü
Eurasian woodcock	*Scolopax rusticola*	Metskurvits
Great snipe	*Gallinago media*	Rohunepp
Common snipe	*Gallinago gallinago*	Tikutaja (taevasikk)
Razorbill	*Alca torda*	Alk
Black guillemot	*Cepphus grille*	Krüüsel
Gaviiforms	***Gaviiformes***	**Kaurilised**
Red-throated loon	*Gavia stellata*	Punakurk-kaur
Arctic loon	*Gavia arctica*	Järvekaur
Suliforms	***Suliformes***	**Suulalised**
Great cormorant	*Phalacrocorax carbo*	Kormoran (karbas)
Pelecaniforms	***Pelecaniformes***	**Pelikanilised**
Grey heron	*Ardea cinerea*	Hallhaigur
Accipitriforms	***Accipitriformes***	**Haukalised**
Osprey	*Pandion haliaetus*	Kalakotkas
Golden eagle	*Aquila chrysaetos*	Kaljukotkas (maakotkas)
Eurasian sparrowhawk	*Accipiter nisus*	Raudkull
Northern goshawk	*Accipiter gentilis*	Kanakull
Black kite	*Milvus migrans*	Must-harksaba
White-tailed sea-eagle	*Haliaeetus albicilla*	Merikotkas
Rough-legged buzzard	*Buteo lagopus*	Karvasjalg-viu (taliviu)
Common buzzard	*Buteo buteo vulpinus*	Hiireviu
Strigiforms	***Strigiformes***	**Kakulised**
Boreal owl	*Aegolius funereus*	Karvasjalg-kakk (laanekakk)
Tawny owl	*Strix aluco*	Kodukakk
Ural owl	*Strix uralensis*	Händkakk
Piciforms	***Piciformes***	**Rähnilised**
Black woodpecker	*Dryocopus martius*	Musträhn
Passeriforms	***Passeriformes***	**Värvulised**
Eurasian magpie	*Pica pica*	Harakas
Eurasian jackdaw	*Coloeus monedula*	Hakk
Rook	*Corvus frugilegus*	Künnivares
Carrion crow	*Corvus corone*	Mustvares
Hooded crow	*Corvus cornix*	Hallvares
Common raven	*Corvus corax*	Ronk (kaaren)
Eurasian skylark	*Alauda arvensis*	Põldlõoke
Common starling	*Sturnus vulgaris*	Kuldnokk
Black redstart	*Phoenicurus ochruros*	Must-lepalind
House sparrow	*Passer domesticus*	Koduvarblane

PUBLICATIONS

CURRICULUM VITAE

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Other scientific publications:

Haak, A., Rannamäe, E. & Ehrlich, F. 2022. Körn, kooska ja kulu. Tartu kesk-aegsetest linnaloomadest – Tallinna Linnamuuseumi Toimetised, 2, 23–53.

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