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Zooarchaeology of livestock and game in medieval and early modern Estonia

Eve Rannamäe
eve.rannamae@ut.ee

Department of Archaeology, Institute of History and Archaeology, University of Tartu, Ülikooli 18, 50090 Tartu, Estonia

Ülle Aguraiuja-Lätti
uagura@tlu.ee

Archaeological Research Collection, Tallinn University, Rüütli 10, 10130 Tallinn, Estonia

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ABSTRACT

In this article, zooarchaeological evidence from 37 medieval and early modern sites in Estonia were assembled and examined. The analysis of over 69 000 mammal remains gave a comprehensive overview of the production and consumption of animal resources in the 13th to 18th century castles, towns, rural settlements, and one monastery. The focus was on domestic livestock: cattle, sheep, goats, pigs and horses. Cattle remains were most abundant, confirming it as the primary animal resource in the study period. Morphometrical analysis and tooth wear study supported the historical knowledge of a stronger tradition of draught oxen in the north and a possible focus on dairy husbandry in the south. Sheep and goat husbandry also had several purposes: kill-off times indicated lamb consumption and keeping the herd for wool and reproduction. Pigs, on the other hand, were raised only as a food resource. Stable carbon and nitrogen isotope analyses revealed differences in grazing areas and feed types between species and geographical regions. Compared to the main livestock, horses and also wild mammals had insignificant roles in providing primary resources but immense importance in manifesting status (horses and hunting) or in use for work and military purposes (horses). Overall, the animal husbandry of the Middle Ages and Early Modern Period developed towards the innovations and improvements of modern times, with native breeds being one example of the heritage of the past.

KEYWORDS

animal husbandry, draught cattle, milk production, stable isotopes, Middle Ages, Early Modern Period.

Introduction

In western Europe, the Middle Ages (approximately from the late 5th to the late 15th century) were a time of vast developments in animal husbandry. For example, there was the build-up of the Spanish Merino sheep monopoly between the 12th and 16th centuries, and its supremacy together with the British wool lasted until the end of the 17th century (e.g. Porter et al. 2016, 860). Other examples are the improved ploughing methods and increased manure production (e.g. Holmes & Thomas 2022). Changes also occurred in horse husbandry, which continuously developed to fit the demands of military service, while also draught oxen started to be substituted with horse power (e.g. Ameen et al. 2021; Holmes & Thomas 2022).

Compared to the western part of Europe, the Middle Ages in the historical territories of Livonia and Prussia started later, with the Baltic Crusades in the 13th century that brought new power structures, the emergence of towns, and widening trade networks. Animal husbandry – one of the bases for the medieval economy – has been shown to have been differently affected in Livonia and Prussia. While in Prussia, the local livestock husbandry was affected (improved) by rural immigrants, in Livonia, the indigenous husbandry regimes prevailed (Pluskowski et al. 2019a, 38–39). In the Estonian Research Council project PRG29, we focused on the region of historical Livonia, more closely on the area of present-day Estonia. The first attempts of livestock improvement took place in the 17th century, which accelerated here (as elsewhere in Europe) during the 'agricultural revolution' in the 18th and 19th centuries (see overview in Rannamäe 2016, 25–26). However, compared to the transition from the pre-crusades period to the Middle Ages, there is no comprehensive overview of the development of animal husbandry during the transition from the Middle Ages to the Early Modern Period. Although one could hypothesise that some of the origins of early modern innovations could have been set already in the Middle Ages, the roots of modern animal husbandry have gained less interest in zooarchaeological research.

The history of livestock husbandry over six hundred years, from the Middle Ages to the Early Modern Period, is an extensive topic. The current article does not attempt to provide complete results on the matter; it reviews current knowledge, adds new data, and generates new ideas for future research. In this article, we only study the mammal species of livestock and game, as the remaining animal resources – avian and aquatic – are discussed elsewhere in this issue (Ehrlich et al., this issue; Lõugas & Aguraiuja-Lätti, this issue). Our main aims are to: 1) analyse the production and consumption of animal resources within the 600 years from 1220 (beginning of the Middle Ages) to 1800 (end of the Early Modern Period); 2) investigate the origins of modern animal husbandry, i.e. whether any of the early modern trends could have had their beginnings somewhere in the Middle Ages; 3) review whether livestock resources were only local or whether there was also foreign input, i.e. animal trade.

To these aims, we analysed over 69 000 mammal specimens (sp.) – bones, teeth and fragments thereof. Although disarticulated, fragmented, and re-deposited bone refuse is only a fraction of what once were living animals or their products, the high number of specimens analysed in this paper is considered sufficient to discuss the main trends in the consumption of livestock products. The focus will be on the main domestic livestock – cattle, sheep, goats and pigs – and the use of their primary (meat, hide, bone) and secondary products (milk, wool, traction). Principal methodologies include intra- and inter-site counts of specimens, anatomical representation, age structures, and morphometrics. The horse as a domestic animal with a slightly different position, and wild mammals, represented in the material with only small numbers, will be discussed briefly. In addition to the zooarchaeological methods based on morphology, previously published results from biomolecular methods – ancient DNA, ZooMS, and especially stable isotopes – are used in data interpretation.

Material and methods

The zooarchaeological material comes from 37 archaeological excavations in Estonia conducted between 1986 and 2021, dated to the Middle Ages and Early Modern Period (Fig. 1; Table 1). For the analysis, we created so-called analytical units based on regions, periods, and types of archaeological sites.

Regions. Historically, Estonia has been divided into two: northern (together with the western islands) and southern Estonia, with interim areas in the centre of the country (e.g. Pajusalu et al. 2020, 71–75). This division has strong historical, cultural, linguistic, and geographical reasoning, and thus, we as well rely on it in our studies of livestock husbandry. However, the analytical units based on regions were not rigidly assigned in all analyses. When studying a particular question, we considered the relevant historical background and grouped the sites accordingly. For example, when studying the oxen culture, we dwelled from the early modern division of Estonia vs Livonia. However, when studying the stable isotopes from sheep and goat samples, we took the different grazing lands in coastal vs inland regions as our starting point.

Periods. In general, we compared the Middle Ages (1220–1558) to the Early Modern Period (1558–1800). Where necessary and possible, assemblages were divided into subperiods: 1) Middle Ages I (MA I) from 1220 to 1400; 2) Middle Ages II (MA II) from 1400 to 1558, i.e. until the beginning of the Livonian War (1558–1583); 3) Early Modern Period I (EMP I) from 1558 to 1710, i.e. the time of the Russian, Polish, and Swedish rule; 4) Early Modern Period II (EMP II) from 1710 to 1800, i.e. the time of the Russian rule (EMP II could also include some specimens from 1800 onwards). As is common in archaeological material, especially in zooarchaeological material that cannot be dated purely visually, a large part could not be assigned to the four subperiods. For many assemblages, specimens could not even be divided between the medieval or early modern deposits. Therefore, assemblages were included in temporal analyses depending on the research question.

Site types. According to the social stratigraphy and the economic background, the study sites were divided into five types: castle (n = 8; including those of the Livonian branch of the Teutonic Order and the bishops), urban (n = 13; sites within the town walls, including cesspits and churchyard deposits), suburban (n = 10; sites outside the town walls), rural (n = 5; farm settlements), and monastic sites (n = 1). The sizes of these assemblages are highly diverse, with rural sites being especially underrepresented (Table 1). There must have been a diachronic increase in urbanisation, but the composition of the material also strongly reflects present-day considerations, i.e. rescue excavations in towns that result in plentiful amounts of material.

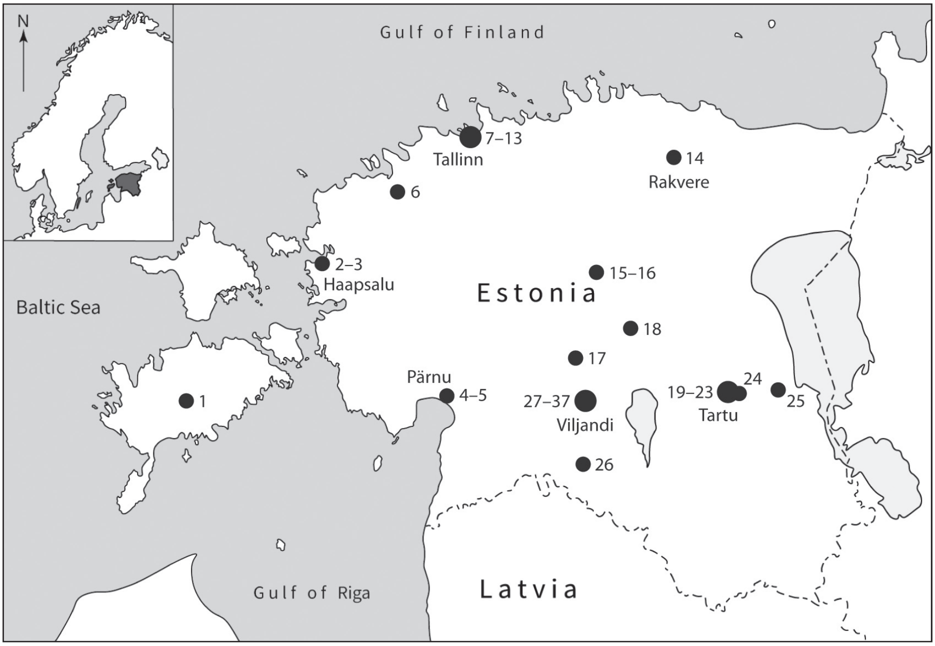

FIG. 1. Archaeological sites in Estonia with mammal remains analysed in this study. The numbers correspond to the site numbers in Table 1.

Data for a total of 69 419 mammal specimens were assembled in the project PRG29. These include both newly identified materials and those from previous publications and identification reports (Table 1). The long timeframe of the conducted identifications, the various skill sets of different analysts, and the use of different methods applied to the study material mean that a complete comparison between the raw data of all studied sites is impossible. The only overarching tool we use is the Number of Identified Specimens (NISP). Other features, such as kill-off patterns, metrical data, and butchering, are reviewed based on a selection of sites where relevant information is available. Specific methods for each analysis are given below in each respective section.

The osteological data regularly recorded for each specimen were taxon, skeletal element, side, and fragmentation; irregularly, also age, sex, and features of taphonomy and pathology. Some specimens have been previously studied by biomolecular methods, the results of which are referenced here. These include the use of Zooarchaeology by Mass Spectrometry (ZooMS) for separating sheep and goats (Aguraiuja-Lätti et al. 2022) and clarifying one anomalous cat bone (Lõugas et al. 2019), analyses of genetic markers for sheep (Rannamäe et al. 2016a; 2016b; 2020), cattle (Niemi et al. 2015; Rannamäe et al. 2022), and goats (Rannamäe et al. 2023b), and the studies of stable carbon and nitrogen isotopes of various mammal species (Lightfoot et al. 2016; Aguraiuja-Lätti et al. 2022; Malve et al. 2023; isotopic values summarised in Rannamäe et al. 2023a, table 4). Graphs in this article were created in MS Excel, and statistical significance was measured in the PAST software v. 4.09 (Hammer et al. 2001) and SPSS v. 28.

TABLE 1. Overview of archaeological sites with mammal specimens studied in the project PRG29. N total – total number of specimens from the site, including unidentified mammals. NISP – number of identified specimens, excluding unidentified mammals.
For details, see Rannamäe et al. (2023a, table 1)

Location	No. on Fig. 1	Archaeological site and excavation year(s)	Collection ID	Site type	N total	NISP
Käku	1	Käku smithy, 2006–2008, 2012–2014	AI 6845	Rural	1446	470
Haapsalu	2	Jaani 4, 2002	HM 8914	Urban	283	271
	3	Haapsalu Castle, 2017	AI-HM 9206	Castle	1350	990
Pärnu	4	Malmö 15, 1992	AI-PäMu A 2509	Urban	2225	1733
	5	Põhja St, 2002	PäMu A 2570	Urban	635	525
Padise	6	Padise Monastery, 2010–2011	AI 0003	Monastic	1832	993
Tallinn	7	Roosikrantsi 9/11, 1996	AI 6109	Suburban	2932	2914
	8	Vabaduse väljak 1, 2008–2009	AI 6917	Suburban	444	273
	9	Tartu mnt 1, 2011	AI 7032	Suburban	3352	3352
	10	Tatari 13, 2017–2018	AI 7863	Suburban	1363	921
	11	Tatari 1, 2020–2021	AI 8352	Suburban	873	591
	12	Estonia pst 7, 2018, 2020	AI 8013	Suburban	446	367
	13	Estonia pst 7, 2019	AI 8013	Suburban	1826	1224
Rakvere	14	Pikk St and St Michael's churchyard, 2019	AI 8183	Urban (including churchyard)	7557	4223
Sargvere	15	Sargvere settlement, 2019	TÜ 2821	Rural	226	172
	16	Sargvere settlement, 2020	TÜ 2881	Rural	167	120
Kärevere	17	Kärevere settlement, 1986	AI 5390	Rural	281	2354
Põltsamaa	18	Põltsamaa Castle, 1998	TÜ 714	Castle	1294	879
Tartu	19	University of Tartu Botanical Gardens (Lai 38/40), 1989	TM A-43	Urban	683	561
	20	Ülikooli 15, 2005, 2007	TM A-141	Urban (cesspit)	878	607
	21	Küütri 1, 2006	TM A-162	Urban (cesspit)	406	266
	22	Lutsu 12, 2016	TM A-244	Urban (including cesspit)	902	806
	23	Oa St, 2021	TM A-283	Suburban	5511	3698

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TABLE 1. *Continued*

Lohkva	24	Lohkva settlement, 2012	TÜ 2004	Rural	331	122
Kastre	25	Kastre Castle, 2001	TÜ 1014	Castle	3349	2435
Karksi	26	Karksi Castle, 2011–2012	TÜ 1929	Castle	11 213	6436
Viljandi	27	Pikk 4, 1991	TÜ 3007	Urban	491	488
	28	Laidoneri väljak 10, 1991	VM 10326	Urban	48	48
	29	Lossi 14a, 1993	VM 10536	Urban	278	267
	30	Viljandi Castle, 2002	VM 10875	Castle	300	70
	31	Viljandi Castle, 2003	VM 10922	Castle	2843	2059
	32	Laidoneri väljak 10, 1994–1995	VM 10942	Urban (including cesspit)	1874	1813
	33	Viljandi Castle, 2004	VM 11041	Castle	4986	2137
	34	Vaksali 4, 1999	VM 11090	Suburban	5386	4930
	35	Tartu St, 1996	VM 11117	Suburban	450	426
	36	Viljandi Castle, 2006	VM 11167	Castle	674	321
	37	Laidoneri väljak 10, 1993–1995	VM 11457	Urban	284	225
				Castle	26 009	15 327
				Urban (including cesspits/church-yard)	16 544 (1942/115)	11 833 (1484/58)
			Subtotal	Suburban	22 583	18 696
				Rural	2451	1119
				Monastic	1832	993
				Total	69 419	47 968

Of the 69 419 specimens (Table 1; Rannamäe et al. 2023a, table 2), 31% (N = 21 451) were possible to determine only as unidentified mammals (Mammalia) and are not considered further in this article. The remaining 69% (NISP = 47 968) included species of livestock, companion animals, terrestrial game, micromammals, and sea mammals (seals) (Table 2).

TABLE 2. Identified taxa analysed in the project PRG29, total NISP (number of identified specimens) = 47 968. Divided by period and site type: MA – Middle Ages, EMP – Early Modern Period, Ur – urban, Uc – urban cesspit, Su – suburban, Ru – rural, Ca – castle, Mo – monastic. Unidentified suids, artiodactyls, ungulates, canids, and carnivores are listed with domestic livestock and companions (see main text)

Taxon	MA						EMP					MA/EMP			Total
	Ur	Uc	Su	Ru	Ca	Mo	Ur	Su	Ru	Ca	Mo	Ur	Su	Ru	
Cattle (*Bos taurus*)	2543	337	6733	50	5124	335	3082	3058	93	804	180	555	683	219	**23 796**
Sheep (*Ovis aries*)	125	146	432	5	141	51	105	113	25	137	10	50	72	6	**1418**
Goat (*Capra hircus*)	117	6	326		67		93	179	3	6		27	60		**884**
Sheep/goat (*Ovis aries*/*Capra hircus*)	823	134	1876	28	2673	147	710	486	140	550	67	179	166	77	**8056**
Pig (*Sus domesticus*)	589	462	1553	20	1735	132	487	432	78	302	50	119	258	88	**6305**
Swine (*Sus* sp.)			17				3								**20**
Horse (*Equus caballus*)	12		357	7	9		27	63	28	1	2	2	49	45	**602**
Artiodactyls (Artiodactyla)	167	190	253	1	2405		394	583	9	494		7		6	**4509**
Ungulates (Ungulata)	14	2	182	4			6	51	4	189			1	9	**462**
Total livestock	**4390**	**1277**	**11 729**	**115**	**12 154**	**665**	**4907**	**4965**	**380**	**2483**	**309**	**939**	**1289**	**450**	**46 052**
Elk (*Alces alces*)	2		3		29	2	1	1				1			**39**
Roe deer (*Capreolus capreolus*)			1							2					**3**
Cervids (Cervidae)			1		25										**26**
Mountain hare (*Lepus timidus*)										3	1				**4**
Hare (*Lepus* sp.)	7	71	52		132	3	9	23	2	130	4	1	7		**441**

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TABLE 2. *Continued*

Taxon	MA						EMP					MA/EMP			Total
	Ur	Uc	Su	Ru	Ca	Mo	Ur	Su	Ru	Ca	Mo	Ur	Su	Ru	
Beaver (*Castor fiber*)					1					1					**2**
Brown bear (*Ursus arctos*)	1	2	1		9					1		2			**16**
Fox (*Vulpes vulpes*)			4		17				1	31		1			**54**
Pine marten (*Martes martes*)												1			**1**
Weasel (*Mustela nivalis*)									1						**1**
Mustelids (Mustelidae)			1												**1**
Total game	**10**	**73**	**63**	**0**	**213**	**5**	**10**	**24**	**4**	**168**	**5**	**6**	**7**	**0**	**588**
Dog (*Canis familiaris*)	15	20	128	114	55		14	3	1	60		6	8	1	**425**
Dog/wolf (*Canis* sp.)			1	1	7			1	1	45			2		**58**
Canids (Canidae)			2					1							**3**
Cat (*Felis catus*)	18	95	30		4	4	13	18	1	45		3	3	46	**280**
Carnivores (Carnivora)		1								6					**7**
Total companions	**33**	**116**	**161**	**115**	**66**	**4**	**27**	**23**	**3**	**156**	**0**	**9**	**13**	**47**	**773**
Ringed seal (*Pusa hispida*)	1						1								**2**
Seals (Phocidae)			10				1					1			**12**
Total sea mammals	**1**	**0**	**10**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**14**

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TABLE 2. *Continued*

Taxon	MA						EMP					MA/EMP			Total
	Ur	Uc	Su	Ru	Ca	Mo	Ur	Su	Ru	Ca	Mo	Ur	Su	Ru	
Field mouse (*Apodemus* sp.)			14												**14**
Water vole (*Arvicola amphibius*)			60						1				16		**77**
Cricetids (Cricetidae)									1						**1**
Hedgehog (*Erinaceus europaeus*)			1	1			1			43					**46**
Vole (*Microtus* sp.)			4												**4**
Murids (Muridae)			245												**245**
Brown rat (*Rattus norvegicus*)			1		3										**4**
Black rat (*Rattus rattus*)					5										**5**
Rat (*Rattus* sp.)	7	9	6		19		5			4	1				**51**
Rodents (Rodentia)	1	6	30		5					3			27		**72**
Red squirrel (*Sciurus vulgaris*)		3									4				**7**
Shrew (*Sorex* sp.)			7												**7**
Mole (*Talpa europaea*)				1									1		**2**
Micromammals (Micromammalia)					5				1						**6**
Total micromammals	**8**	**18**	**368**	**2**	**37**	**0**	**6**	**0**	**3**	**50**	**5**	**0**	**44**	**0**	**541**
														TOTAL MAMMALS	**47 968**

Livestock stood in the core of medieval and early modern animal resources, and also forms the central material for the current article. Here, the livestock (NISP = 46 052) includes cattle, sheep, goats, pigs and horses, and artiodactyls, bovids and ungulates that were impossible to identify to a specific species, but that most probably originate from the main livestock (mostly rib and vertebra fragments). A large part of artiodactyl specimens is those from sheep, goats or pigs based on size – but not identified to species. Fragments of unidentified ungulates and artiodactyls could also come from wild cervids. However, as the total number of wild mammals is proportionally very small in the analysed material (NISP = 588), it is considered unlikely. Despite the game having been an insignificant resource for food by volume, it is often associated with the upper classes of society and, therefore, relevant in exploring the foodways of medieval and early modern Estonia. It will be discussed below.

Dogs and cats and their roles in medieval and early modern societies are discussed separately by Nuut et al. (this issue), as are sea mammals by Lõugas & Aguraiuja-Lätti (this issue). Rodents and other micromammals are an important proxy for studying past societies and trade, especially in urban environments. However, as the main research topic of this issue considers foodways and livestock, the analysed micromammals (NISP = 541) will not be discussed further here.

Cattle

EVIDENCE OF MEAT CONSUMPTION

The most apparent evidence of beef consumption is the presence of cattle remains in butchering and food waste. In the analysed assemblage (NISP = 47 968), cattle formed half of the specimens (50%, NISP = 23 796). Among the main livestock only (cattle, sheep, goats, pigs and horses, total NISP = 41 061), its proportion was 58%. As noted in previous studies (e.g. Maldre 2008a; Maltby et al. 2019, 143–145), the slaughtered cattle in bone assemblages from the Middle Ages and Early Modern Period had usually reached their adulthood. This was the case also in the current study material. Among all cattle remains, 92.5% were recorded as adults, and 7.5% were those of juveniles or subadults, including foetuses and newborns (NISP = 1792). The highest proportion of juveniles/subadults per site type was evident in urban cesspits – 33.8% (114 out of 337 cattle sp.). This was an expected result because cesspits were often used for discarding full or partial animal carcasses, especially those of juveniles (e.g. Maldre 1997; Haak et al. 2022). In suburban, castle, and urban sites, the proportion of juveniles/subadults among the cattle remains was 7.9% (827 sp. out of 10 474), 7.2% (428 sp. out of 5928), and 6.4% (396 sp. out of 6180), respectively. The smallest number of juveniles and subadults was evident in rural (5%, 18 out of 362 sp.) and monastic sites (1.7%, 9 out of 515 sp.). Therefore, in general, it seems that cattle were kept after they had reached adulthood, whether to increase the meat yield, produce milk, and/or exploit them for work (see below).

DRAUGHT CATTLE

The use of draught oxen (castrated male cattle) and horses in the past had a very strong cultural background around the Baltic Sea. Ants Viires (1973) has given an overview of the phenomenon. While oxen were historically preferred in northern and western Estonia, horses were more used in southern Estonia. This regional division is far from clear-cut and has fluctuated in time for multiple reasons. Preference for horses or oxen has been related to and driven by the nature of the soil, contacts with other cultures, used equipment (ploughs), and periodical changes (e.g. in wartime, horses might not have been available). Some evidence indicates that regional patterns might go as far back as the prehistoric times (Viires 1973, 429–430).

Zooarchaeological studies on cattle remains in Estonia and Finland have confirmed close cultural links of the oxen culture in the Baltic Sea region. The castration time of bulls in Estonia and Finland as one of the cultural features has been studied by analysing morphometric changes in metacarpal bones (Rannamäe et al. 2022). The research showed that in the Middle Ages and Early Modern Period, late castration was practised in Estonia and early castration in Sweden. However, there appears to have been a shift from one cultural influence to the other in Finland. Namely, in the Middle Ages, cattle in Finland were castrated as adults, and in the Early Modern Period, at a young age. Zooarchaeological data also supported the idea that in Estonia, the early modern tradition of castrating cattle as adults (as known from historical sources) could have reached into the Middle Ages.

In the article by Rannamäe et al. (2022), metacarpals only from the oxen region, i.e. northern Estonia, were studied. Here, we wanted to test further whether the cultural distinction of preferring oxen in the north and horses in the south could also be seen in osteological material. To this aim, we conducted a simple test on the distal breadth of metacarpal bones, which has shown to be a good marker for distinguishing sex (males, females, oxen) and use for labour (widening of the distal epiphysis due to workload; e.g. Albarella 1997; Bartosiewicz et al. 1997; Davis et al. 2018). Our hypothesis was to see wider distal breadths of metacarpals in the north (indicating cattle use for labour) and smaller distal breadths in the south (where cattle were less used for work).

Our dataset included measurements of the distal breadth (Bd; after von den Driesch 1976) for 387 metacarpals of adult individuals from the Middle Ages and Early Modern Period (Rannamäe et al. 2023a, table 3). In addition to the materials studied in the project PRG29, 47 metacarpals were added from other archaeological sites, such as Sauna Street (n = 32) and Ravi Street (n = 8) in Tallinn, Jakobi Street in Tartu (n = 12), and Vastseliina Castle (n = 3). Bd measurements were grouped (Fig. 2) following the proportion of oxen in different parts of Estonia in 1744 (Viires 1973, map 1). According to Viires (1973, 433–434), the revision of that year reflects a more or less normal state of animal husbandry compared to some of the earlier times of wars, requisitions, and epidemics.

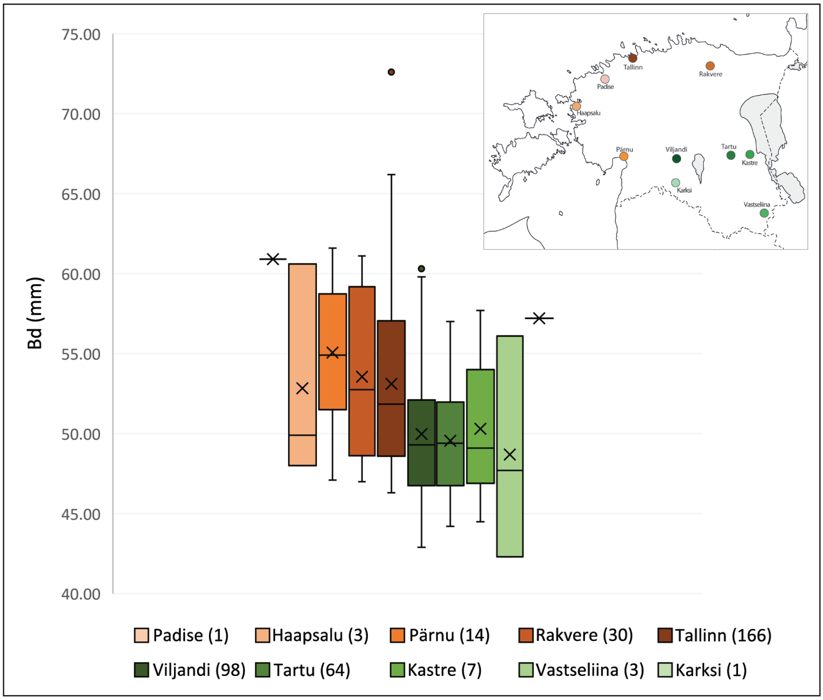

FIG. 2. Cattle metacarpal distal breadth (Bd) in the historical so-called oxen region (orange colours) and horse region (green colours). The number of analysed specimens is given in the legend. The sites are assigned into regions after Viires (1973, map 1), oxen percentage 25–45% being the threshold. Each boxplot represents 50% of a group's data (box) with an average (x), median (line), and extended whiskers for upper and lower quartiles. Tallinn and Viljandi groups each include an outlier.

The results showed that, indeed, metacarpals from the northern and western parts of Estonia have wider Bd compared to those from the southern regions (Mann-Whitney U test, $U = 11\,190$, $p < 0.001$), indicating a higher presence of work animals in the north. Separate tests with only medieval or only early modern individuals were conducted, and the outcome was the same. This preliminary result seemingly supports the original hypothesis by Viires (1973) that the cultural tradition of preferring oxen to horses in the northern and western parts of present-day Estonia might have had its roots already in the Middle Ages, but should, of course, be further studied in detail.

MILK PRODUCTION

In southern Estonia, where ploughing was mainly done with horses, cattle husbandry was orientated to milk production: in the first half of the 18th century, oxen in southeastern Estonia formed only around 18–26%, in some places 4–6% of the total cattle (Kahk et al. 1992, 343). Proceeding from the results for oxen in the northern part of the country and the possible roots for oxen vs horses tradition (at least) in the Middle Ages (see the previous subchapter and Rannamäe et al. 2022), we wanted to conduct yet another test and see whether osteological evidence would coincide with the historical knowledge of the focus being on milk production in the south.

To assess the extent of dairy husbandry in the past economy, several zooarchaeological methods exist, such as the study of kill-off patterns or the analysis of stable isotopes. Here, we relied on the former, i.e. the slaughter age of cattle. Zooarchaeological studies have shown that in prehistory, the lactation of cows was usually manipulated by killing surplus calves to use the milk for human purposes (e.g. Helmer & Vigne 2007). Moreover, old animals in the material have been interpreted as dairy cows (e.g. Gillis et al. 2013, 463–464; Kamjan et al. 2021, 10). To assess the kill-off patterns in our material, data from both mandibular tooth wear (Grant 1982) and long bone epiphyseal fusion (fused vs unfused) were considered. Because of the different recording methods by different analysts over the years, only a small number of mandibles (n = 54) was possible to assess for the mandible wear stage (M.W.S., after Grant 1982). In regional comparison, we relied on the exact geographical division as for draught animals (i.e. Viires 1973, map 1).

Overall, the number of juvenile cattle in our material is small. In the total number of recorded juveniles (considering both tooth and epiphyseal data), we can see a slight increase in juveniles from the Middle Ages (5.5%) to the Early Modern Period (7%). In both periods, there are fewer juveniles in northern Estonia (2.9% in MA, 5% in EMP) compared to southern Estonia (6.6% in MA, 9.1% in EMP). Because of the small number of juveniles, also the M.W.S. data showed minimal differences between the groupings, although confirming the pattern of slightly more juveniles in the Early Modern Period compared to the Middle Ages (Fig. 3). Generally, the data analysed here confirm the results of some previous studies that intensive dairy farming was not practised in medieval Livonia (e.g. Maltby et al. 2019, 144–145),

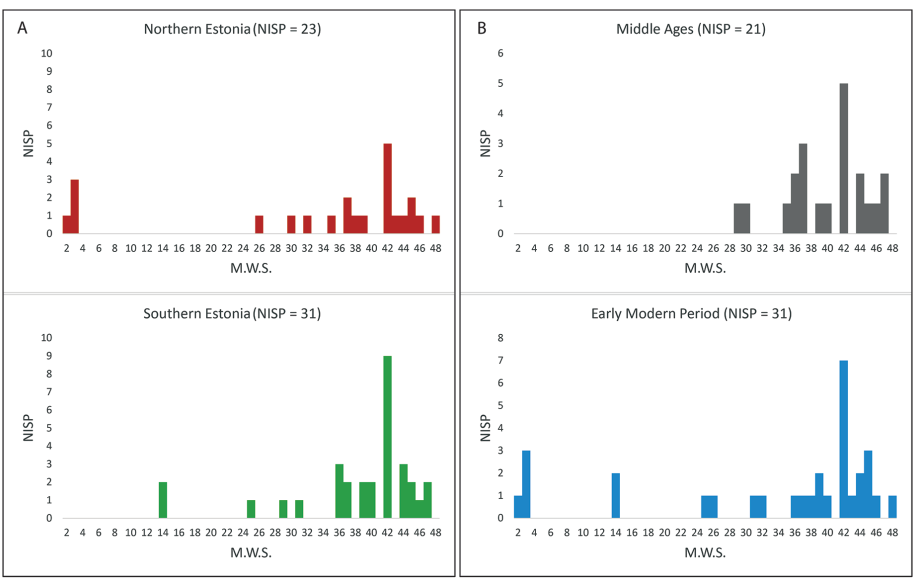

FIG. 3. Mandible wear stages (M.W.S., after Grant 1982) of cattle in A – northern vs southern Estonia; B – Middle Ages vs Early Modern Period. NISP – number of identified specimens.

and seemingly correlates with historical records of a bigger focus on milk production in the southern part of Estonia (Kahk et al. 1992, 343) and the increasing focus on dairy husbandry in the Early Modern Period. This topic should be investigated further to better understand the herd structure and breeding strategies of the past.

CATTLE HERDING AND BREEDING

Based on stable isotope data, cattle were herded in a variety of locations, from forested environments to more open habitats, as evidenced by the variation in their δ^{13}C values (Lightfoot et al. 2016; Aguraiuja-Lätti et al. 2022; Malve et al. 2023). However, no clear trends are apparent between the animal's isotopic value and its sampling context (e.g. urban or rural, northern or southern Estonia, medieval or early modern), suggesting that herding strategies may have varied based on local (environmental) conditions. The nitrogen isotopic values of cattle also demonstrate a significant range (from 4‰ to 8‰), almost covering a whole trophic level (Fig. 4). This indicates variation in the isotopic composition of cattle feed, with higher δ^{15}N values likely reflecting the consumption of cultivated and/or manured plants, which have more positive nitrogen isotopic values compared to wild plants. Based on sulphur isotopic evidence, some cows from coastal sites, such as Tallinn and Pärnu, were probably herded on coastal meadows (Aguraiuja-Lätti et al. 2022).

Feeding and nutrition are tightly linked to the animal's physique, productivity, and breeding. The first documented attempts of cattle improvement come from the first half of the 17th century when cattle of Dutch, German, Swedish, and Finnish origin were imported to Estonia by local landlords (Liiv 1935, 146; Soom 1954, 129). From the time before the 17th century, however, there is no documented

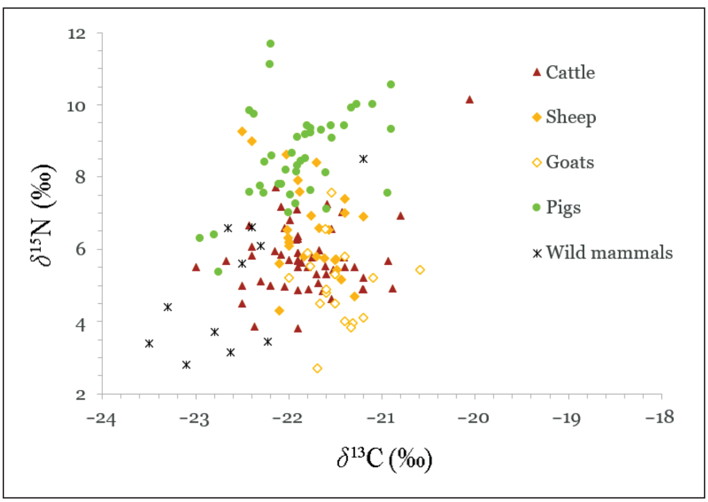

FIG. 4. Stable carbon and nitrogen isotope values for medieval and early modern cattle (n = 57), sheep (n = 27), goats (n = 18), and pigs (n = 41) from the study region, demonstrating both inter- and intraspecies variation. Wild mammals are added for reference to display differences between habitats and feeds. Data from Lightfoot et al. (2016), Aguraiuja-Lätti et al. (2022), Malve et al. (2023).

information on selective cattle breeding. Previous studies on ancient DNA have suggested southern and western European influence (e.g. from Germany and Sweden) on local cattle stock in the Middle Ages and eastern influence (e.g. from Russia) in the Early Modern Period (Niemi et al. 2015) but additional genetic studies would be needed to validate those suggestions further.

In zooarchaeological material, it is possible to look into population changes via morphology. The size of cattle has shown to be one of the markers in studying the possible introduction of new animals or improvement of local stock (Pluskowski et al. 2019a). For the withers height calculations, the method by Matolcsi (1970) and the greatest length (GL, after von den Driesch 1976) for 236 metacarpals (Rannamäe et al. 2023a, table 3) were used. For the individuals from the Middle Ages, the range of withers height is 89.6–128.5 cm, and for those from the Early Modern Period, the range is 91.1–122.0 cm. Comparison between the two periods does not show significant differences (Mann-Whitney U test, $U = 4145.5$, $p = 0.5092$) (Fig. 5: A). For the specimens that could be assigned to subperiods, the Kruskal-Wallis H test revealed statistically significant differences ($H = 9.665$, d.f. $= 3$, $p = 0.022$), with pairwise comparisons using Dunn-Bonferroni post hoc tests demonstrating the difference to lie between MA I and EMP I ($p = 0.037$) but not between other periods (Fig. 5: B). However, do note the small sample sizes of these groups.

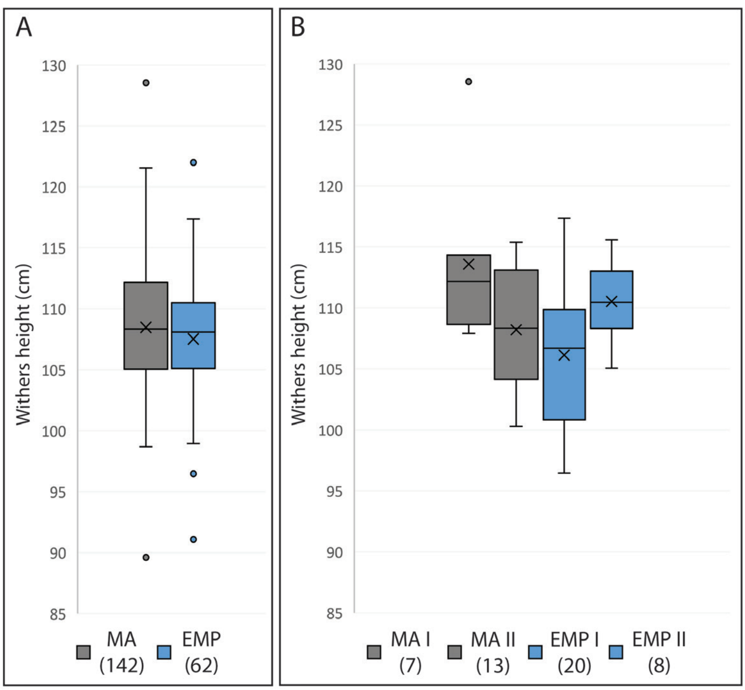

FIG. 5. Withers height of cattle from the Middle Ages (MA) and Early Modern Period (EMP). A – comparison between MA and EMP; B – comparison between the subperiods of MA and EMP. Each boxplot represents 50% of a group's data (box) with an average (x), median (line), and extended whiskers for upper and lower quartiles. Groups MA, EMP and MA I include outliers.

Kahk et al. (1992) have given some insights into the keeping and well-being of local cattle in the Early Modern Period. In general, the conditions were demanding, and the productivity of local cattle was low. In the 17th century, a single cow produced around 400–500 kg of milk in a year (Kahk et al. 1992, 343) (for comparison, modern Holsteins in Estonia produce on average 10 000 kg of milk in a year; EPKK 2022). Low productivity has been explained by the 'breed' characteristics of local cattle, poor keeping conditions and feeding (straw and chaff as winter feed, with no additional fodder), keeping infertile and old cows, and periodical animal epidemics (Kahk et al. 1992, 343, 347, 478). Although regular improvement and breeding started in the 19th century (Kahk et al. 1992, 376), the conditions for animal keeping were still poor, cattle were small (weighing around 120–210 kg) and badly fed (Kahk et al. 1992, 369). The authors refer to descriptions of how animals screamed of hunger and how weak they were in the first days of spring while drawing themselves to the pastures. Whether these poor characteristics of early modern cattle husbandry could also reflect the conditions of previous centuries remains open in the current state of research.

The sheep and the goat

THE IMPORTANCE OF SHEEP AND GOAT HUSBANDRY

The sheep and the goat are two different species with different biologies, herding, and products. Therefore, it is essential to distinguish them also in archaeological material. In our study material of sheep and goat specimens (NISP = 10 358), the proportion of definite sheep, as listed in the identification tables, was 13.7% against 8.5% of goats (Table 2). The difficulties of distinguishing the two species by bone morphology and the skills of each analyst are important factors here, but the overall proportion is probably accurate. Additionally, a ZooMS analysis for species identification was conducted for a selection of stable isotope samples (Aguraiuja-Lätti et al. 2022).

The sheep and the goat are usually the second most abundant species in medieval and early modern materials. As with cattle, sheep and goat husbandry in Estonia have strong historical connections to the rest of the Baltic Sea region and northern Europe in general. The present-day native sheep breed in Estonia – the Kihnu native sheep – has proven to have genetic affinities with both the (pre)historic local sheep and the group of northern European short-tailed sheep (Rannamäe 2016; Rannamäe et al. 2016a; 2016b; 2020). Affinities between this group of sheep are also reflected in similar characteristics of the wool known from northern Europe (Rammo 2015, 133–134). In Estonia, Finland, and Sweden, goat populations have shown historical connections also based on maternal genetic lineages (Rannamäe et al. 2023b). Moreover, zooarchaeological and historical studies in Finland have suggested continuity in goat husbandry from at least the Late Iron Age to modern times (Bläuer et al. 2022). In Estonia, this continuity has not been studied yet, and the history of the local goat is little known.

Sheep and goats are usually described as having been raised to produce meat, milk, and wool. In addition, hair, pelts, horn sheaths, and bones were valuable materials (e.g. Haak et al. 2012). In archaeological material, the juvenile remains usually hint at the consumption of delicate lamb and the meat of young goats (e.g. in Karksi Order Castle, Rannamäe & Lõugas 2019). The overall proportion of juveniles among caprine remains is 15.8% (NISP = 1634). M.W.S. for the study material revealed a rather homogeneous distribution of individuals of different relative ages (Fig. 6). However, the medieval assemblage with more specimens seems to give us three broad age groups: M.W.S. of 2–12 represent lambs up to six months of age, M.W.S. of 18–27 are juveniles from ca nine months to two years, and M.W.S. of 30–42 represent animals of ca two and a half to seven years of age (converted to absolute ages after Greenfield & Arnold 2008, table 6). Notable are the three individuals with M.W.S. of 45, i.e. individuals of nine years or older. This agrees with the utilisation of caprines in various ages: juveniles were slaughtered for delicate meat and maybe for a general kill-off to avoid keeping too many animals over winter; older animals were kept for reproducing the herd and producing wool and possibly milk. To our knowledge, there is no direct archaeological evidence of

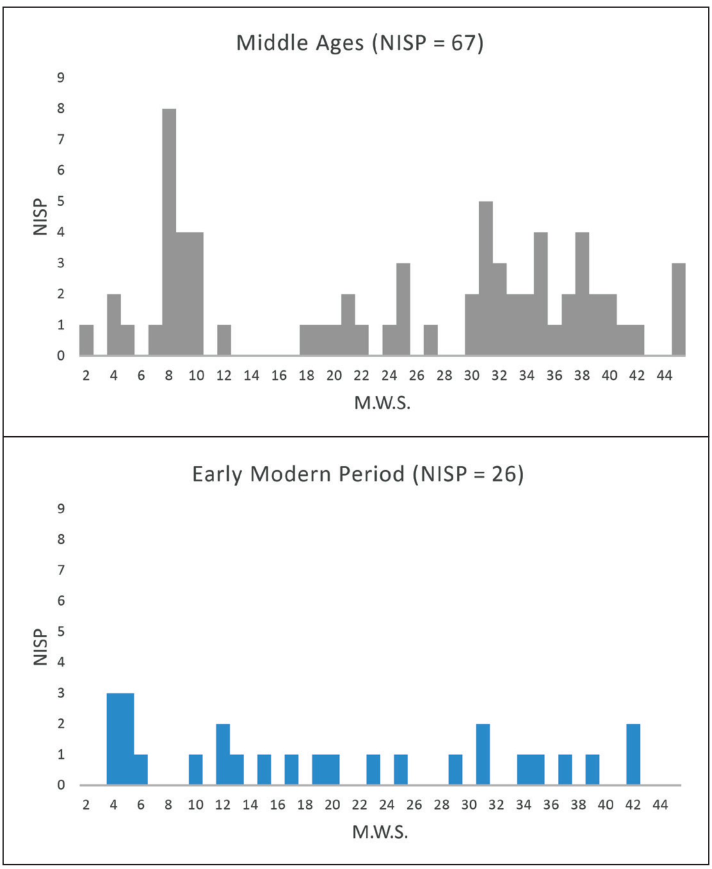

FIG. 6. Mandible wear stages (M.W.S., after Grant 1982) of sheep and goats in the Middle Ages and Early Modern Period. NISP – number of identified specimens.

the use of sheep or goat milk in the area of present-day Estonia. The oldest animals also indicate that mature animals were worth keeping, and their living conditions and health were optimal for survival. In modern times, goats and sheep live to around 12 years old. In future studies, these older individuals would be interesting to identify to species, and also investigate with palaeopathology methods.

SHEEP AND GOAT HERDING

The different feeding practices of sheep and goats are revealed in stable isotope data. Although partially overlapping, goats and sheep occupy slightly different dietary niches, and the same can be said about their comparison with cattle (see Fig. 4). All three have statistically significantly different nitrogen isotopic values as assessed by the Kruskal-Wallis H test ($p \leq 0.036$ for pairwise post hoc comparisons), with goats also having significantly different carbon isotopic values ($p \leq 0.044$ for pairwise post hoc comparisons between goats and cattle/sheep), suggesting differences in feeding or herding conditions.

Of all the domestic herbivores, goats display, on average, the highest (more positive) δ^{13}C and the lowest δ^{15}N values, which can be taken to indicate that they were generally herded in relatively open and natural landscapes (or were fed resources from these types of habitats). Goat nitrogen isotopic values demonstrate a similar degree of variation as cattle, with a few of the higher δ^{15}N values being likely influenced by the consumption of manured plants. No trends are visible between the isotopic data and sample context (e.g. location or period).

Although the majority of sheep samples show an overlap in their isotopic ratios compared to goats, several individuals stand out, characterised by their relatively low δ^{13}C and high δ^{15}N values. Values in this range are not commonly seen for domestic herbivores and are similar to those of some pigs (see Fig. 4) but also geese (Ehrlich et al. 2022; Ehrlich et al., this issue) sampled from similar contexts. These sheep, with such outstanding results, are overwhelmingly from coastal sites, such as Tallinn and Pärnu (Fig. 7). In fact, sheep from northern Estonia have statistically significantly different δ^{15}N values than those from southern sites (Mann-Whitney U test, $U = 30.5$, $p = 0.005$) but similar δ^{13}C values ($U = 97.5$, $p = 0.537$). This suggests that there were differences between herding practices and/or the types of feeds between the two regions.

Sheep may have been herded on coastal meadows – a practice also known from recent history (e.g. Sammul et al. 2000, 21; Köster et al. 2004, 46) –, although in that case, we would expect higher (not lower) carbon isotopic values more similar to those of marine organisms. Considering their similarity with some cattle and wild mammals (see Fig. 4), their carbon isotopic signal rather seems to reflect feeding in an uncultivated, terrestrial environment. This is supported by their associated sulphur isotopic data, which indicate that coastal sheep were not feeding on soils affected by sea-spray (i.e. marine sulphates) (Aguraiuja-Lätti et al. 2022). For example, a previous study from the Orkney Islands (Scotland) demonstrated that the sheep left to graze on coastal seaweed had very high δ^{13}C, δ^{15}N, and δ^{34}S values,

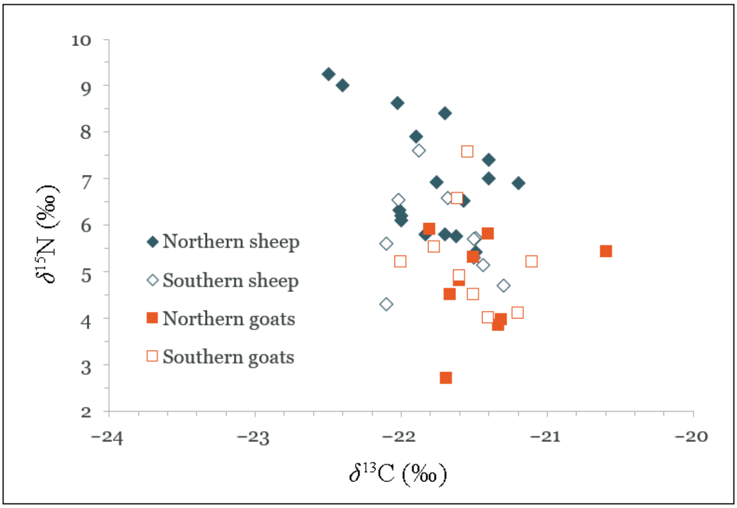

FIG. 7. Stable carbon and nitrogen isotope values for medieval and early modern sheep and goats from northern and southern Estonia. Data from Lightfoot et al. (2016), Aguraiuja-Lätti et al. (2022), Malve et al. (2023).

similar to those of marine fauna (Guiry & Szpak 2020). The authors also suggested the influence of seabird guano (which is enriched in ^{15}N) as a plausible natural explanation for high nitrogen isotopic values in terrestrial animals from coastal regions. The sheep from coastal sites in our study may have thus been herded on natural, uncultivated landscapes but not directly at the seashore.

The pig

Pigs are not multipurpose animals like cattle, sheep, or goats – they were only exploited for their primary products, i.e. mostly for meat as well as for hide and bones. In our dataset, pigs were in third place after cattle and caprines (NISP = 6305), a typical pattern in Estonian and European medieval/post-medieval assemblages. There were another 20 specimens of *Sus* sp. in the material that could also represent wild boars. Here, we give an overview of the stable isotope analyses.

PIG KEEPING

In the Middle Ages, pigs were kept both in urban and rural conditions, often left to forage independently or fed with kitchen leftovers (Põltsam-Jürjo 2017, 10–12). This is also reflected in their stable isotope signals, which demonstrate that pigs from historic period sites occupy a unique dietary niche, as their average carbon and nitrogen isotopic values are statistically significantly different compared to other domesticates (including dogs and chickens) (Aguraiuja-Lätti et al. 2022). Pig isotope data from the study area indicate a broad range of isotope values but no statistical trends when compared by location or period. This suggests that the conditions for keeping pigs differed on a household basis, although we cannot rule out that there existed more specific trends between, for example, rural and urban pigs that are not reflected in the current (spatiotemporally diverse) dataset.

There is a moderate yet statistically significant positive correlation between $\delta^{13}C$ and $\delta^{15}N$ values (Pearson's R, $r = 0.441$, $p = 0.004$; but $r = 0.599$, $p < 0.001$ when excluding two outliers with the highest $\delta^{15}N$ values), with the lowest values being associated with a predominantly herbivorous diet and the highest with the consumption of animal protein. The former is similar to some sampled cattle (see Fig. 4) as well as to wild mammals (Aguraiuja-Lätti et al. 2022), suggesting that they may have been left to forage in the surrounding woodlands. Pigs with higher carbon and nitrogen isotopic values are similar to some dogs (Nuut et al., this issue), which can be taken to indicate that they were kept closer to dwellings and fed food scraps. The presence of a few outliers with low $\delta^{13}C$ and high $\delta^{15}N$ values may be indicative of freshwater fish consumption.

A point to consider when interpreting pig stable isotope data is that pigs were typically slaughtered when young. Almost a third (29.2%) of the pig specimens in our dataset were from juveniles/subadults (NISP = 1842). Very young animals who were still suckling can display the so-called nursing effect, which increases both carbon and nitrogen isotopic values by up to one trophic level, ca 3‰ for $\delta^{15}N$ and 1‰ for $\delta^{13}C$ (Jenkins et al. 2001; Cherney et al. 2021). It is thus feasible that some pigs with the highest $\delta^{15}N$ values may have still been suckling before butchering. Unfortunately, it is not always possible to determine the animal's age based on a single bone, nor can we be sure of the exact age pigs were slaughtered in the past.

The horse

The horse has had great importance and many roles in its history (e.g. Maldre 1998; Maltby et al. 2019; Kreem 2022). One of these roles, relevant to the project's aims, has been a resource for meat (e.g. Maldre 2008b; Maldre & Luik 2009). With the beginning of the Middle Ages in the 13th century, the consumption of horse flesh in Livonia and Prussia decreased, and the military importance of horses increased (Pluskowski et al. 2019a, 33–34). Due to the diverse roles of horses and the small number of their remains, studying them is a complicated matter. Although the number of horses in the past was in thousands, only a fraction of their remains have ended up in the faunal assemblages, which usually represent food waste. Here, horse specimens form 1.3% (NISP = 602) out of all analysed mammal remains and 1.5% out of the identified livestock (cattle, sheep, goats, pigs and horses, total NISP = 41 061).

All horse remains were disarticulated at the time of the excavations, although there are examples of certain parts of skeletons that have belonged to a single individual (Peets et al. 2013; Rannamäe et al. 2019; Malve et al. 2022, 255; Nuut & Ehrlich 2022; Rannamäe & Ehrlich 2023). Pluskowski et al. (2019b, 68) have written about disarticulation as the most effective way of disposing horse carcasses, which is probably how most horse remains have ended up in waste deposits. However, for some of those remains, occasional horse meat consumption could also be discussed.

In the current dataset, only five horse specimens have been recorded with cut marks[1] (including a chop mark on a humerus, surface cut marks on a femur, and split first phalanges), but these hardly say anything about the processing of horse carcasses or the reasons for it. Gnaw marks have been recorded only on 28 specimens, thus allowing us to agree with Pluskowski et al. (2019b, 68), who have stated that 'the absence of gnawing marks or meat removal cuts suggests horses were not typically knackered for feeding to dogs'. The details of fragmentation and processing marks on horse remains will be focused on in future research.

The game

There is little evidence of game and wild taxa in the zooarchaeological material. Wild mammals form 1.2% (NISP = 588) of the total analysed mammals. In the medieval assemblage, game forms 1.2% (NISP = 364) of the total medieval specimens; in the early modern assemblage, the respective proportion is a little higher, 1.6% (NISP = 211). The majority of the skeletal remains of the hunted animals have been found from castles, followed by (sub)urban sites (Table 3). Most of the wild mammal specimens come predominantly from the hare (75.7%), which coincides with historical information (Põltsam-Jürjo 2013, 55). The hare is followed by the red fox, elk, brown bear, roe deer, beaver, and unidentified cervids – all of them most probably hunted for both food and hides or fur. However, almost half of the cervid specimens are actually fragments and leftovers of antler processing (see Haak et al. 2012). The red fox and mustelids (including the pine marten and weasel), on the other hand, must have been hunted only for their fur, often indicated by skinning marks on their skeletal remains (e.g. Lõugas et al. 2019, fig. 9).

A small proportion of wild mammal remains reflects several aspects. Firstly, hunting was a privilege for the upper classes (see Mänd 2012, 344–345; Põltsam-Jürjo 2013, 53, 55; 2022, 112; this issue). Secondly, game meat clearly did not constitute a necessary food resource. Thirdly, the remains of the hunted animals might have been left in the forest to some extent. Lastly, wild animals could have represented something out of the ordinary in a society entirely dependent on domestic livestock and plants. An interesting hint for a hare possibly kept in captivity (maybe as a pet?) comes from a 14th century Tartu cesspit, as revealed in stable isotope studies by Aguraiuja-Lätti et al. (2022).

1 According to the Master's thesis by Rannamäe (2010, table 1), altogether 41.1% (NISP = 129) of the horse bones excavated in Viljandi, Vaksali 4, in 1999 (VM 11090) carried cut marks. Some of these specimens were reinvestigated for the current study but no cut marks were observed. Therefore, the authors of this work would like to point out the probable analyst bias and the need to revise the horse bones of the mentioned assemblage in future studies.

TABLE 3. Overview of game animals (NISP – number of identified specimens) by site type. The proportion of the game in each site type is shown. Note that small samples in rural sites are less likely to contain specimens of wild animals

Taxon	Castle, 2.4%	Monastic, 1.0%	Urban (including cesspit), 0.8%	Suburban, 0.5%	Rural, 0.4%	Total
Hare	265	8	88 (71)	82	2	445
Fox	48		1	4	1	54
Elk	29	2	4	4		39
Cervids	25			1		26
Brown bear	10		5 (2)	1		16
Roe deer	2			1		3
Beaver	2					2
Pine marten			1			1
Weasel					1	1
Mustelids				1		1
Total	381	10	99 (73)	94	4	588

Discussion: the development of livestock husbandry

Zooarchaeological material is the primary evidence for studying the production and consumption of animal resources in the past. Although high in the number of identified specimens, the study material represents only a small fraction of the animals that once lived in this 600-year period. To really know about the keeping of these animals at a certain point in time in the past, detailed studies of their biographies, herd structures, and relationship to humans should be investigated. Here, instead, we have provided a broader view of animal husbandry, with an aim to review the existing scientific framework of medieval and early modern animal husbandry in Estonia as well as to provide new insights into the topic.

Overall, our analysis confirmed much of the understanding we already had. Animal resources relied on the main domestic livestock: cattle, sheep, goats and pigs. Faunal remains have mostly been found in towns and castles, while the evidence from rural sites is unfortunately underrepresented. Castles and towns can be mostly regarded as sites of consumption, since animals and products were typically brought there for slaughtering and processing from rural hinterlands. Nevertheless, animals were also kept inside and outside the town walls and within the castle borders (e.g. Põltsam-Jürjo 2017, 10–11; Haak et al. 2022; Kreem 2022). This aspect should be considered when placing the animals we study in their historical context, i.e. whether the bones and teeth in high-status sites and towns reflect the keeping conditions there or in rural farms instead. The presence and abundance of different livestock in various contexts shows us the resources available to the population at a certain period as well as their preferences. However, the archaeological context and the depositional history should also be kept in mind. In zooarchaeological studies, we often compare different site types, such as castles, towns, and rural settlements, because they represent different social strata and ethnic populations – especially from the 13th century onwards when urban populations started to be formed mainly by people of German origins, while the countryside remained for the native people (e.g. Pluskowski et al. 2019a, 29).

Our study material shows roughly three groups forming based on the NISP in different site types (Fig. 8). Firstly, the castle and monastic sites are similar, with cattle making up 51–53%, sheep/goats 28–31%, pigs 18–19% (chi-squared test for cattle, sheep/goats and pigs: $\chi^2 = 3.5652$, d.f. = 2, p = 0.1682), and horses less than 0.2%. The similarity here is expected because both site types are associated with a higher class. Secondly, the towns and suburbs appear quite similar: cattle 62–65%, sheep/goats 22% and pigs 13% (although a chi-squared test for cattle, sheep/goats and pigs shows a statistically significant difference: $\chi^2 = 6.9084$, d.f. = 2, p = 0.0316). The proportion of horses, however, indicates a slight difference here: in the town, horse remains form 0.4%, but in the suburb, 2.5%. Thirdly, we have the rural settlements, which differ the most from the other site types, with 40% of cattle, 32% of sheep/goats, 21% of pigs, and as much as 8% of horses.

One reason for such a difference between rural and other types of sites could be the smaller sample size of rural assemblages. However, note that the monastic group also has a small number of specimens and yet fits well to the expected proportions. The other reason for having more horses in rural sites is the overall characteristics of rural settlements compared to urban areas. As the site of final consumption (and less production), towns contrast with rural settlements, which mainly were production sites; thus, the waste associated with consumption vs production would be expected to differ. Whether horses could have been exploited for meat more in rural sites cannot be answered here but will be investigated in the future. Furthermore, disposing of horses in rural or even suburban vs urban/castle sites could have been different: in towns and castles, there would have been an urgent need to get rid of a large animal carcass and take it somewhere out of the town walls, while in rural/suburban sites, the dead animal might have been buried on the farm or near the household. Moreover, all of the above-mentioned partial skeletons of horses come from rural or suburban sites (excluding the partial hind limb in the waste pit of urban Viljandi (Rannamäe et al. 2019)). Finally, the consumption pattern of rural sites is similar to that of the Final Iron Age sites (11th–13th centuries) – i.e. reflecting proportionally more pigs (e.g. Maldre 2012) and horses (e.g. Maldre 2007; 2012) –, which would be expected because of the continuity of native population in the countryside after the 13th century.

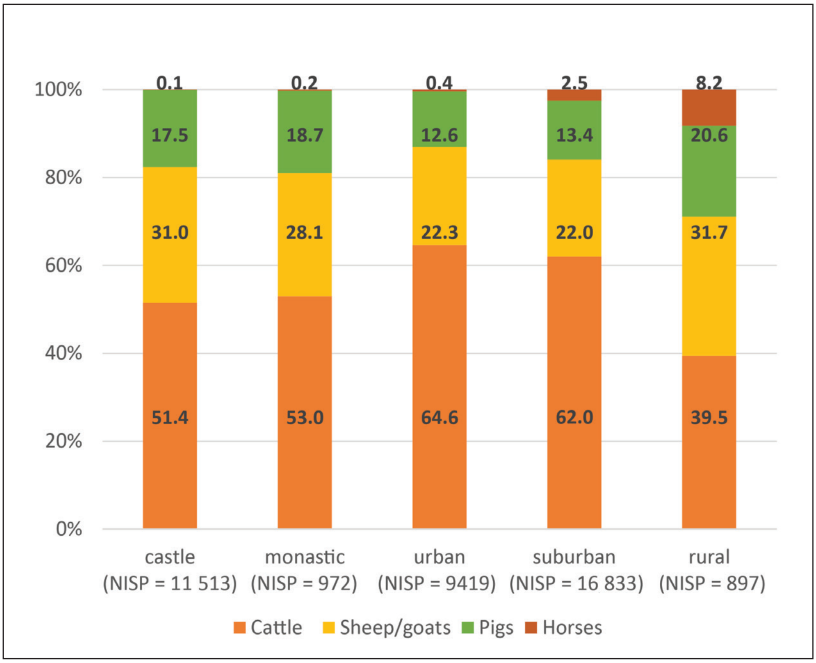

FIG. 8. Proportion of the main livestock species by site type. NISP – number of identified specimens; corrected by removing partial skeletons.

The keeping of animals is reflected in their variable isotopic signals, which indicate the use of different grazing habitats and/or feeds, from forests and uncultivated coastal meadows to fields and pastures, which were likely enriched by manure (either through deliberate practices or by leaving livestock to graze on the fields after harvest). Animals could have also been fed manured plants directly, for example, over the winter. The results also suggest that despite local conditions being probably the main determinant of grazing behaviour (e.g. the importance of coastal meadows in northern and western Estonia), there were some fundamental differences between cattle, sheep, and goat herding, reflected in their statistically distinct stable isotope values. In the future, a targeted study of specific species or animals from a particular region should help us shed more light on the diversity of animal-keeping practices in the past.

Six hundred years is a long time, and it would be reasonable to think that deliberate selection in animal breeding was taking place already in the Middle Ages (and also before that). In dogs, for example, new types and shapes become visible in medieval assemblages (see Nuut et al., this issue). For livestock, the morphological or morphometric evidence is not as clear. Cattle size differences show quite a homogenous cross-section in the Middle Ages and Early Modern Period, although hinting at a size decrease in the Early Modern Period (see Fig. 5). Could these hints overlap with the early modern knowledge of very poor cattle keeping, as described above? Or could it indicate selection towards dairy animals, i.e. less need for large oxen? Based on NISP data, there are clear temporal trends between northern and

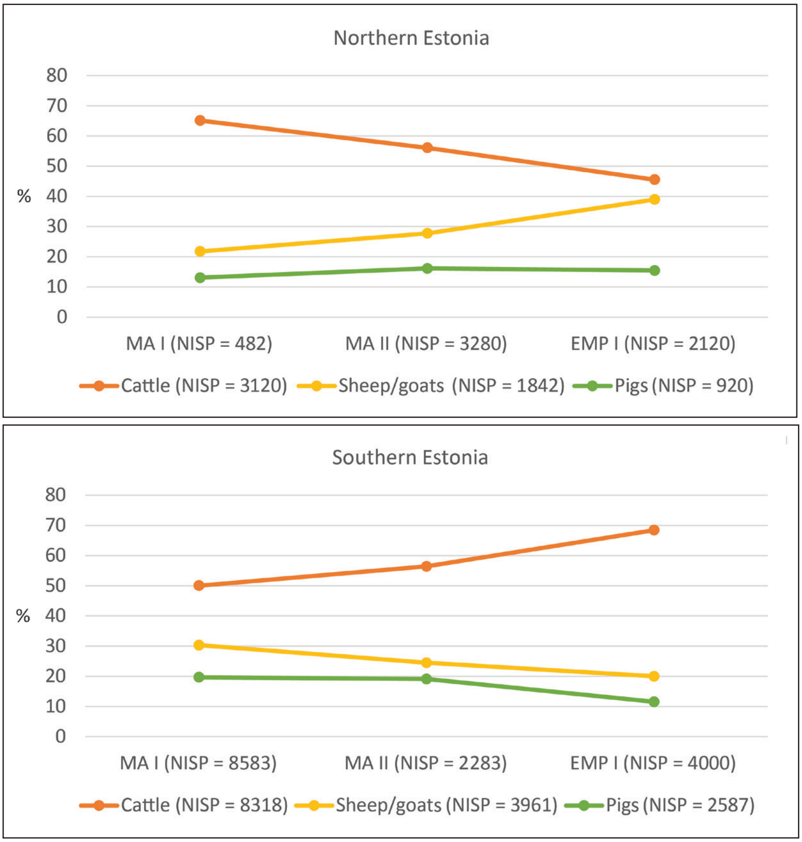

FIG. 9. Proportion of cattle, sheep/goats and pigs by period in northern and southern Estonia. MA I – Middle Ages I, MA II – Middle Ages II, EMP I – Early Modern Period I. NISP – number of identified specimens.

southern Estonia (Fig. 9). Interestingly, in northern Estonia, the proportion of cattle decreases and that of the sheep/goat increases, while in southern Estonia, it is the opposite: the proportion of cattle increases and that of the sheep/goat (and the pig) decreases. Therefore, could the putative increase in cattle husbandry in southern Estonia refer to a greater focus on (dairy) cattle?

In addition to (hypothetical) selection, could there have been improvement with imported individuals? The Middle Ages was a time of extensive trade, but in Estonian material, we currently have no evidence of trading with livestock except with horses. The movement of horses in the Middle Ages is visible in the historical records (Kreem 2022, 43–46). Regarding the osteometric and morphological data, however, imported horses have not been distinguished. The size of medieval horses in Estonia has been estimated to be around 128–144 cm (Maldre 1998, 215; Rannamäe 2010, 46), but whether this includes different types needs a detailed study in future projects. The first written evidence of the first attempts of imports and improvement of pigs, cattle (both dairy and beef), and sheep are from the 17th and 18th centuries; large-scale breeding started only in the 19th century (see Rannamäe 2016, 25–26). Therefore, we can conclude that even if there were occasional imports of cattle, sheep, or pigs before the 18th and 19th century, it was on a very small scale and with no visible effect on the population development (see Soom 1954, 130 for similar argumentation).

The large-scale breeding that started in the 19th century, together with the establishment of breed books, systematic improvement, and specific aims towards better milk, meat, or wool yield, is directly connected to the livestock husbandry of today. The breeding was primarily based on local animals – aboriginal cattle, sheep and horses – that played an essential role in being the basic component for the developed breeds, and that were also preserved as native breeds. Today, their descendants are the Estonian native cattle, the Estonian native horse, and the Kihnu native sheep. Therefore, through historical continuity, we can confidently say that modern animal husbandry had its beginning in the past, at least in the Middle Ages.

Conclusions

The current study proved a necessary milestone in the research of medieval and early modern zooarchaeology in Estonia. We showed that historical and ethnographic traditions could be compared with osteological material – such as the past tradition of using oxen in different parts of Estonia. We have also shown that the livestock herded here for hundreds of years have their descendants still prevailing in the form of present-day native breeds, such as the Kihnu native sheep. Although our study period covered the time from the 13th to 18th century, it was followed by one of the more critical centuries in our history, namely the agricultural revolution and large-scale changes that, in the end, brought us to the modern economy. Early modern centuries are covered with more written evidence than the Middle Ages, but it is still fragmentary, and therefore, we would like to stress the immense importance of zooarchaeological material also from recent centuries.

On the one hand, the dataset collected during the project PRG29 is extensive and includes plenty of information, of which only part was presented and analysed here. On the other hand, the available data need to be refined in future studies by specifying the recordings for specimens, especially for the taphonomical features of butchering and food preparation, and for the slaughtering ages and herd management. Furthermore, a specialised investigation of the pathologies must be conducted to get more hints on the keeping and herding of animals. Only then would there be an opportunity to bring the analyses to a more detailed level, and improve our understanding of past livestock husbandry and the use of animal resources.

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Karjakasvatus ja metsloomad kesk- ning varauusaegses Eestis – zooarheoloogiline uurimus

Eve Rannamäe ja Ülle Aguraiuja-Lätti

RESÜMEE

Artikkel koondab endas andmeid 69 419 loomaluu kohta 37st Eesti kesk- ja varauusaegsest (13.−18. sajand) leiukohast (joonis 1; tabel 1 ja 2), et anda ülevaade loomakasvatusest ja loomsete produktide tarvitamisest. Eesmärk ei ole anda teemast täielikku detailset ülevaadet, vaid võtta kokku seniste uuringute tulemused, lisada uusi andmeid ning määrata kindlaks edasised uurimissuunad. Andmestik on jaotatud regioonide (valdavalt Põhja- ja Lõuna-Eesti), perioodide (keskaeg ja varauusaeg) ning leiukohtade (linnused, linnad, eeslinnad, kloostrid, külad) põhjal.

Peamine fookus on kariloomadel: veis, lammas, kits, siga ja hobune. Kõige arvukamad on veiseluud, moodustades 50% kõigist määratavatest luudest ning 58% peamistest kariloomadest. Veiseid on ajalooliselt kasutatud Põhja- ja Lääne-Eestis veoloomadena, sellal kui Lõuna-Eestis eelistati künnitöödel hobuseid. Morfomeetrilised uuringud veiste kämblaluude põhjal näivad viivat selle kultuuritraditsiooni juured tagasi keskaega: Põhja-Eestis on veiste kämblaluude distaalsed laiused suuremad, viidates loomade kasutamisele tööloomadena, samas kui lõunas on vastavad mõõtmed väiksemad (joonis 2). Veiste tapavanuse uurimine paljastas, et loomad olid tapmise hetkel valdavalt täiskasvanueas (joonis 3). Noorloomade vähesuse tõttu võib oletada, et vähemalt keskajal ei olnud Liivimaal intensiivset piimakarjakasvatust, kuigi piimakarja osakaal näis olevat suurem Lõuna-Eestis ja näis suurenevat ka varauusaja perioodil. Stabiilsete isotoopide analüüsid valitud loomaluudest annavad tunnistust sellest, et veiseid karjatati erinevates tingimustes, nii metsastel aladel kui ka avamaastikel, sealhulgas rannaniitudel ja ka söötis põllumaadel (joonis 4). Veiste turjakõrguse analüüs aga näitas, et loomad aja jooksul märkimisväärselt ei suurenenud (joonis 5).

Lambad-kitsed on tavaliselt olnud veiste järel populaarsuselt järgmine karilooma liik. Kuigi kummalgi on omamoodi iseloomuomadused ja pidamistingimused, on neid morfoloogiliselt tihti raske eristada. Selles uuringus oli võimalik lammaste-kitsede hulgast tuvastada 13,7% lambaid ja 8,5% kitsi. Lambapidamisel on Eestis pikad traditsioonid ja näiteks Kihnu maalamba geneetilised juured lähevad tagasi juba esiaega. Lammaste-kitsede hulgas on noorloomi 15,8%, mis osutab nende tähtsusele lihaloomana. Samas on paljud isendid ka kõrge vanuseni elanud – neid peeti tõenäoliselt villa, aga võimalik et ka piima saamiseks (joonis 6). Kitsed ja lambad erinevad nii üksteisest kui ka veistest karjatamistingimuste poolest, mida kinnitavad ka luu kollageenist tehtud stabiilsete isotoopide analüüsi tulemused. Kitsede puhul näidi eelistavat pigem avatud, looduslikke maastikke, sellal kui lammaste puhul ilmnes selge erinevus Põhja- ja Lõuna Eestist pärit loomade puhul, mis võib olla tingitud lammaste karjatamisest rannikualadel (joonis 7).

Sead on lammaste-kitsede järel uuringus kasutatud luude arvukuse poolest kolmandal kohal. Erinevalt teistest kariloomadest ei olnud sead mitmeotstarbelised, vaid neid kasvatati peamiselt liha saamiseks (kuid ära kasutati ka nahad ja luud). Isotoopanalüüsid on näidanud, et neidki karjatati väga erinevates tingimustes, mis ilmselt sõltusid kohalikest (loodus)oludest. Vabapidamisel sead otsisid ise endale toitu, mis oli valdavalt taimset päritolu, sellal kui teisi peeti majapidamiste lähedal ning toideti inimeste toidujääkidega, milles leidus palju loomseid valke.

Kuigi hobune on ajalooliselt olnud väga tähtis loom, moodustavad tema luud ainult 1,3% valimist. Alates 13. sajandist väheneS Liivimaal hobuseliha söömine, sellal kui hobuse sõjaline tähtsus suurenes. Sellest annab tunnistust ka asjaolu, et hobuste luudel praktiliselt puuduvad lõikejäljed. Hobustele sarnases mahus on tuvastatud ka metsloomade luid (1,2% valimist; tabel 3). Nendest kõige arvukamad on jänes, rebane, põder, karu ja metskits, keda kütiti nii liha kui ka naha pärast. Palju esineb ka sarveleide. Metslooma liha oli toidus väga väikese tähtsusega, kuid sel oli oluline sotsiaalne aspekt, sest metsloomade küttimine ja nende liha söömine oli kõrgklassi privileeg.

Võrreldes kariloomade arvukust erinevates leiukohtades eristub kolm rühma: linnused ja kloostrid, linnad ja eeslinnad ning külad (joonis 8). Kõige rohkem torkab silma külade materjal, kus on proportsionaalselt rohkem hobuste ja lammaste-kitsede-sigade ning vähem veiste luid. See võib olla tingitud linna ja maa fundamentaalsetest erinevustest, sest küla oli valdavalt tootmise ja linn tarbimise koht. Samuti võib tähele panna, et külade materjal sarnaneb hilisrauaaegsete leiukohtade materjaliga, mis näib kinnitavat kohaliku rahva loomakasvatustraditsioonide püsivust peale 13. sajandi vallutust. Analüüs näitab ka erinevusi Põhja- ja Lõuna-Eesti vahel: keskajast varauusajani väheneb põhjas veiste osakaal ja suureneb kitsede-lammaste oma, sellal kui lõunas on näha vastupidine trend (joonis 9). Ka see nähtus võib olla seotud piimakarja suurema osatähtsusega Lõuna-Eestis.

Kuigi uurimistöö tulemused ei näidanud jälgi kohalikust tõuaretusest või uute tõugude sissetoomisest enne uusaega, võime siiski väita, et kaasaegsete loomakasvatustavade alged on jälgitavad juba keskajal, peegeldades traditsioonide püsivust.

Edasistes uuringutes peaks olemasolevat andmestikku täpsustama, uurides lähemalt lihakehade töötlusjälgi, tapavanuseid, karja pidamistingimusi ning luudel esinevaid patoloogiaid, et nii saada veelgi rohkem infot loomade kasutamise kohta minevikus.