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Horsemeat consumption in Late Bronze Age Estonia: a case study from the Iru fortified settlement

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ABSTRACT

Horsemeat consumption has been one of the most intriguing questions about ancient dietary practices. Zooarchaeological materials from the Late Bronze Age in Estonia (850–500 BCE) contain high proportions of the domestic horse (*Equus caballus*) compared to subsequent periods, leading to debates about the cultural-economic features of eating horsemeat during this period. One of the assemblages rich in horse remains is from the Iru fortified settlement in northern Estonia, first studied by Kalju Paaver in the 1960s. This article revisits the Iru zooarchaeological material with the aim of clarifying the significance of horsemeat consumption among Iru people and expanding the discussion about the Bronze Age horse culture in prehistoric Estonia. Several findings confirmed the consumption of horsemeat. First, the taxonomic analysis showed a high proportion of horse specimens among livestock remains, contextually interpreted as kitchen and food refuse. Second, despite the horse specimens coming mainly from the cranium (teeth) and body parts with low meat yield (distal elements of the limbs), the evidence of butchering, especially for elements representing meaty body parts, attests to various food procurement activities. Third, the presence of juvenile specimens in the material refers to the culling of young animals, even though there is no direct evidence of utilising juvenile meat. The study results are discussed in the frame of contemporaneous material from Estonia and elsewhere, touching upon the extent of horsemeat consumption, the tools used for butchering, and the possible origins of the Bronze Age horse culture in Estonia.

KEYWORDS
Equus caballus, zooarchaeology, ancient diet, taphonomy, butchering, stone tools.

Introduction

The 'equid timeline' in Estonia starts in the Mesolithic with the wild horse (*Equus ferus*), who was one of the game animals (Paaver 1965, 181). Remains of the wild horse are known from the settlement sites of Lammasmägi at Kunda and Kääpa, where they form a small part of the faunal remains (Paaver 1965, 180–182; Maldre & Luik 2009, 37; Kriiska et al. 2020, 66). A specimen from Kunda has been dated to around 6300 cal BC, and a specimen from Kääpa to around 4500 cal BC (Sommer et al. 2011, table 1). A few specimens of the wild horse have also been recovered from the Neolithic settlements of Akali, Villa, and Tamula, but in general, the wild horse in this region was extinct by Late Neolithic (Paaver 1965, 182; Maldre & Luik 2009, 37; Kriiska et al. 2020, 41). In the Late Neolithic, between 2730 and 2490 cal BC (Oras et al. 2023 and references therein), early farming was introduced to the region, including cattle (*Bos taurus*), sheep and/or goat (*Ovis aries* / *Capra hircus*), and most probably the domestic pig (*Sus domesticus*) (see discussion on domestic pig vs wild boar in Oras et al. 2023, 4). Although Late Neolithic horse finds have raised the question of whether these belong to domestic horses (*Equus caballus*), the contextual evidence does not support this hypothesis (see discussion in Maldre & Luik 2009, 37–38). Moreover, recent research suggests that the ancestors of the current domestic horse were not domesticated until around 2200 BC in the northern Caucasus and were then dispersed across Eurasia, replacing all local populations by around 1500 to 1000 BC (Librado et al. 2021; 2024). The earliest radiocarbon-dated evidence of the domestic horse in Scandinavia is from the beginning of the Bronze Age ca 1600 cal BC (Kveiborg 2019, table 3; Kveiborg et al. 2020), in Latvia from the Bronze Age ca 1100 cal BC (Vasks et al. 2021), and in Finland from the Late Bronze Age ca 830–540 cal BC (Bläuer & Kantanen 2013).

The archaeological evidence for most of the 2nd millennium BC, i.e. the Early Bronze Age, is scarce in Estonia (Lang 2007, 19–48). It has been suggested that the human population was small and settlements were sparse and relatively mobile (Lang 2018, 22), leaving no or very few material traces. Rich material of settlement sites provided by fortified settlements does not appear until the Late Bronze Age (850–500 BC). These sites have provided comprehensive zooarchaeological evidence, where strong reliance on livestock is undoubtedly exhibited. This is also the time of the earliest evidence of domestic horses in Estonia, dating from the 8th to 6th/5th centuries cal BC (Librado et al. 2021, table S1; Tõrv et al. in prep.). The richest faunal materials of that period have been recovered from the fortified settlements of Asva and Ridala in Saaremaa (western Estonia) and Iru in northern Estonia.

The domestic horse is an animal that has had a significant impact on human history. Horses have played a crucial role in the movement of people, their economy and culture. The cultural and economic background of the first domestic horses in Estonia has been discussed before focusing on the general exploitation of horses (Paaver 1965, 393; Maldre 1998; Maldre & Luik 2009) and riding equipment (Lang 2007; 2009). Here, we concentrate on a very important cultural feature – food – and namely, the consumption of horsemeat. In the faunal remains of the Late Bronze Age sites of Asva and Ridala, up to 11% of all livestock are horse specimens (Paaver 1965, 364–365, table 101; Lõugas 1994, 75; Maldre 2008; Maldre & Luik 2009; Lõugas et al. 2021). Since most of those specimens are from young horses and the slaughter ages and the proportion of body parts are similar to those of cattle, it has been suggested that horses were bred for meat (among other purposes) (Maldre & Luik 2009). However, since the overall proportion of horse specimens is relatively low (only one tenth of the livestock remains), horsemeat is not considered to have played a dominant role in the diet of Asva and Ridala people, i.e. in the western islands. In northern Estonia, however, in the Iru fortified settlement, the percentage of horse specimens is reported to be much higher, over 30% of the domestic animals. This was pointed out by Maldre (1998), who in turn referred to an earlier study by Kalju Paaver (1965, 365–366). Paaver, unfortunately, only mentioned the high proportion of horses but did not analyse the material further. In his preliminary identification report (Paaver 1966), he summarises the identified specimens (taxon and quantity) but provides no raw data for each specimen.

To investigate horsemeat consumption in Late Bronze Age Estonia, the Iru zooarchaeological material, outstanding for its proportion of horse specimens, was revisited to address the question of horsemeat consumption as part of Late Bronze Age dietary practices. In this article, our main interest is to reveal firm evidence for horsemeat consumption and address the unusually high proportion of horses in the Iru material through in-depth zooarchaeological analysis. We hope to open a broader discussion on Late Bronze Age horse culture in Estonia and the different roles horses played.

Material and methods

The Iru fortified settlement in northern Estonia (Fig. 1) was repeatedly excavated between 1936 and 1986 (Lang 1996; Tõnisson 2008, 187 and references therein). The material includes evidence from the 3rd millennium BC until the 11th century AD. Mixed contexts have made it difficult to assign animal remains to

FIG. 1. Above – the Late Bronze Age fortified settlements mentioned in the text (map modified from Wikimedia Commons, by Flappiefh, CC BY-SA 4.0). Below – the Iru archaeological site (photo by Maili Roio, Estonian National Heritage Board, 17.04.2023).

specific periods. Direct dating of single specimens is of help here (see below), but would still not date the whole osteological assemblage. Animal remains have hardly any morphological characteristics that can be dated to any specific period, and previous studies of different archaeological sites have proved that the specimens often originate from much later periods (e.g. Rannamäe et al. 2016, table S1). To find those contexts in Iru that most probably contain Late Bronze Age material, excavation reports were examined. Finally, material from the excavations in 1953–1956 (AI 4051, Archaeological Research Collection, Tallinn University) and 1986 (AI 5302) was selected for the analysis, as it most likely originates from the Late Bronze Age.

ZOOARCHAEOLOGICAL MATERIAL FROM 1953–1956

From 1952 to 1956, the area of the central rampart and the southern plateau of the Iru archaeological site was excavated (Tõnisson 2008, fig. 91). From the excavations in 1952, there are no animal remains in the collections, and Paaver's preliminary identification report (1966) does not include any material from that year either (but note that animal remains are mentioned in the excavation report; Vassar 1952, 11–12). The excavations continued in 1957 and 1958 in other parts of the southern plateau, and although the material from 1957 is included in Paaver's report, it was not studied for the current project. The report on faunal remains includes a scheme for distinguishing the layers of the Late Bronze Age fortified settlement and the Late Iron Age hillfort (Paaver 1966, table 1). The scheme lists the squares and technical layers of the excavation plot from which the fortified settlement material originates, and was thus taken as the primary source of information in selecting the material for this study. It is important to note that Paaver himself mentioned that the material was commingled and that the temporal distinction between the two settlement phases was unclear (Paaver 1966, 2). Since the excavations, the zooarchaeological collection from Iru has been moved several times and not all the storage conditions were good or suitable by present-day standards. Characteristic of the archiving methods of the 1950s and 1960s, faunal specimens were often divided into small open boxes and assembled into larger so-called standard storage boxes (Lembi Lõugas, pers. comm., March 2024). In several cases, the smaller boxes and their contents had flipped and commingled over decades. Handwritten identification labels with taxon names are partially preserved (although often commingled and not associable with the respective specimens), and some of the original context labels have perished or are only partially legible.

For these reasons, the material was washed and organised for this study; before that photos were taken of the content of each box. It cannot be guaranteed that all labels and contexts follow their original documentation or that the scheme described in the initial report was fully understood. However, we have good reasons to presume that most of the material does indeed come from the settlement contexts as initially proposed by Paaver (1966, 2), and the potential biases would not affect the overall interpretation of the material. In organising the faunal material, each context was given a new archaeozoology collection (AZ) number. A total of 664 contexts were recorded (AZ-1–AZ-664) in 79 boxes from the excavation years of 1953–1956. Of these, 168 contexts were selected for identification using the criteria by Paaver described above. Within a context, each specimen was given a sequence number starting with 1.

ZOOARCHAEOLOGICAL MATERIAL FROM 1986

From 1984 to 1986, the central rampart of the Iru archaeological site was again excavated (Lang 1996, fig. 5). Among the faunal remains recovered, there is a box from 1986 from 'layer V' that was reported to originate from the Late Bronze Age (Lang 1988). The material had not been studied before. During the current work, each specimen in the box was given an AZ number. Two specimens from this context – sheep/goat and wild boar – were radiocarbon-dated to the Late Bronze Age (8th to 5th century cal BC), and one specimen – cattle – to the Migration Period (5th to 6th century cal AD) (Tõrv et al. in prep.; for details, see Rannamäe 2024b, table 2). Clearly, the younger specimen among the assemblage shows that the material is not entirely contemporaneous as expected, and any firm results should be made with caution. However, most of the material seems to represent the fortified settlement, as recorded by context.

METHODS

After organising the material, the specimens were identified and described using the anatomical reference collection at the Department of Archaeology (University of Tartu) and osteology handbooks (Ernits & Saks 2004; Ernits & Nahkur 2013). For mammals, age at death was described based on tooth eruption and wear (Silver 1969; Grant 1982; Ernits 2000), as well as on epiphyseal fusion (Silver 1969; Chaix & Méniel 2001). A particular focus was placed on recording cut marks as direct evidence of carcass processing (Seetah 2019). Cut marks were mainly inspected with the naked eye and hand lens or, where necessary, under a Dino Lite portable digital microscope (DinoCapture 2.0, AnMo Electronics Corporation).

Results

The results are presented as a line of evidence for horsemeat consumption, including the proportion of horse specimens among the rest of the livestock, the distribution of skeletal elements in the food refuse that would indicate carcass processing and utilisation, processing marks on the bones, and rough age estimates of the studied individuals. The analyses revealed qualitative differences between the 1950s and 1980s assemblages, which are therefore presented separately.

TAXONOMIC PROPORTIONS OF THE UTILISED MAMMALS

The material from the excavations in 1953–1956 comprises 1672 recorded specimens. Of these, 1455 mammal specimens (88% of all mammal specimens) are presented in this study (Table 1; Fig. 2). The remaining finds are unidentified artiodactyls and ungulates (n = 26), mammals (n = 156), micromammals (n = 13), fish (n = 13), birds (n = 7), and vertebrates (n = 2) and are not discussed further here (for raw data, see Rannamäe 2024b, table 1).

The material from the excavations in 1986 comprises 1385 specimens. Of these, 211 mammal specimens (16% of all mammal specimens) are presented in

TABLE 1. List of taxa and the number of identified specimens (NISP) in the analysed material from the Iru fortified settlement. The material presented here includes only the identified mammals. For other faunal groups and raw data, see Rannamäe 2024b, tables 1 and 2

Group	Taxon	NISP 1953–1956	NISP 1986
Livestock	Cattle (*Bos taurus*)	493	24
	Horse (*Equus caballus*)	487	7
	Sheep/goat (*Ovis aries* / *Capra hircus*)	241	129
	(incl. sheep)	(9)	(4)
	(incl. goat)	(4)	(1)
	Pig (*Sus domesticus*)	106	23
Companion animals	Dog (*Canis familiaris*)	75	0
Wild land mammals	Elk (*Alces alces*)	7	1
	Roe deer (*Capreolus capreolus*)	0	1
	Cervids (Cervidae)	1	1
	Beaver (*Castor fiber*)	6	3
	Wild boar (*Sus scrofa*)	0	5
	European polecat (*Mustela putorius*)	1	1
Wild marine mammals	Seals (Phocidae)	38	16
	(incl. ringed seal, *Pusa hispida*)	(1)	(0)
	Total	1455	211

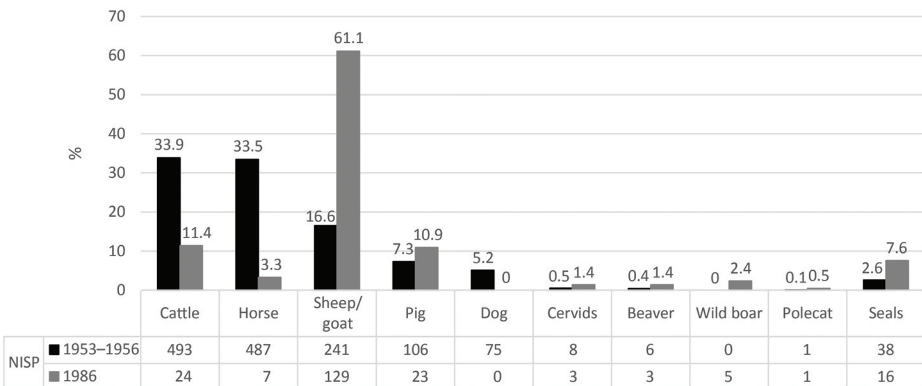

FIG. 2. Proportion of identified mammal specimens from the two assemblages from the Iru fortified settlement.

this study (Table 1; Fig. 2). The remaining finds are unidentified artiodactyls and ungulates (n = 33), mammals (n = 1086), micromammals (n = 28), fish (n = 13), birds (n = 10), gastropods (n = 2), and vertebrates (n = 2) and are not discussed further here (for raw data, see Rannamäe 2024b, table 2).

Although the total number of specimens is roughly similar (1672 vs 1385), the two assemblages have very different fragmentation levels and identification rates. Most of the specimens in the 1950s material could be identified to species, because the material consists primarily of large fragments, selectively collected and not sieved during the excavations and/or selectively preserved after the initial analysis in the 1960s (Lembi Lõugas, pers. comm., March 2024). To our knowledge, the rest of the material has not preserved. The material from the 1980s, on the other hand, had not been analysed before and was more or less in its post-excavation state. It consists mostly of small fragments and thus has a visual appearance characteristic of what would be expected from prehistoric assemblages, leading to a low identification rate. Therefore, it could be concluded that the single box from 1986 may represent the Late Bronze Age material better than the 79 boxes from 1953–1956. However, the identified material from 1986 is too small to make meaningful interpretations about the utilised taxa in Late Bronze Age Iru. Therefore, both assemblages should be considered in parallel but also interpreted with caution.

Most of the material in the analysed Iru assemblages (87–91%) belongs to domestic livestock. Among the wild mammals, there is little evidence of cervids, beaver, wild boar and polecat. Seals seem to have provided most of the game meat. The dog, usually regarded as a companion animal, was only found in the 1950s assemblage. Cut marks on dogs' crania (including mandibles) and a humerus may indicate both skinning and defleshing.

A closer look at the livestock – cattle, horses, sheep, goats, and pigs – reveals that the proportions between the two assemblages are quite different. In the 1950s material, horses and cattle have very similar proportions, each accounting for roughly a third of the livestock; while sheep, goats, and pigs constitute less than a fifth of the material. In the 1980s material, on the other hand, horses have the smallest share with only less than 5%; cattle are not very numerous either, constituting a little more than a tenth of the livestock, and similar to the number of pigs. Sheep and goats, however, form the majority, with roughly two-thirds of all livestock specimens.

Although the proportions of different species are considered biased because of the preservation and size of the assemblages, we can be confident that both assemblages contain horses. Moreover, by mere number, horse remains are quite abundant (total number of identified specimens from two excavations is 496).

REPRESENTATION OF THE SKELETAL ELEMENTS OF LIVESTOCK

The proportions of different skeletal elements in archaeological assemblage often indicate the nature of the refuse. Elements from the upper limbs, ribcage, spine, and pelvis come from meatier body parts (i.e. food remains), while crania and distal parts of the limbs are usually associated with primary butchering (i.e. dressing). This division, however, is not always clear-cut, as, for example, distal limb bones (including phalanges) can be extracted for marrow and crania for brains, tongues and other culinary parts. Moreover, any disturbances in archae-

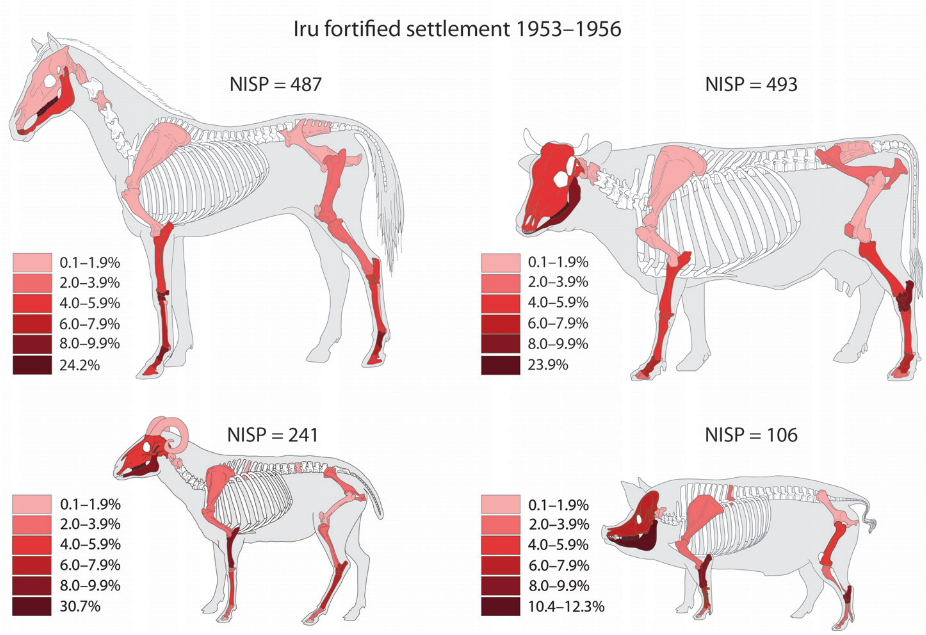

FIG. 3. Schematic view of the proportion of skeletal elements for each livestock species in the material from the Iru fortified settlement from the excavations in 1953–1956. The darker the colour, the higher the frequency of the element. In the calculations, some specimens were added together (e.g. carpal bones, tarsal bones) and some were divided (e.g. unspecified metapodial bones were divided between the fore and hind limbs). Skeleton templates after Michel Coutureau (Inrap), Vianney Forest (Inrap) – ©1996 ArchéoZoo.org.

ological sites over time contribute to the vagueness of clear-cut waste assemblages.

In the 1950s material, the proportion of the skeletal elements is very similar between the cattle and the horse, but also between all livestock (Fig. 3). It is evident that only certain skeletal elements have been stored in the collections. The most abundant are teeth, mandibles and foot bones. Notably, horse teeth were also abundant at the Asva and Ridala sites (Maldre 2008, 270; Maldre & Luik 2009, 39). This could be for various reasons, such as better preservation in the soil, or because teeth are easier to notice during excavations and later to identify than some other bone fragments, or because the number of teeth per individual is high compared to other skeletal elements. Vertebrae and ribs, on the other hand, are almost missing from the material, and the reasons for this could be multiple. In zooarchaeological assemblages, ribs and vertebrae are often fragmented (already cut and broken during butchering and cooking processes) and difficult to identify to species – therefore, they are often not recorded at all. Moreover, due to their fragmentation and abundance in a skeleton, they are of little value – for example, ribs and vertebrae cannot be used in the calculation of the minimum number of individuals in the assemblage. The same could apply to proximal parts

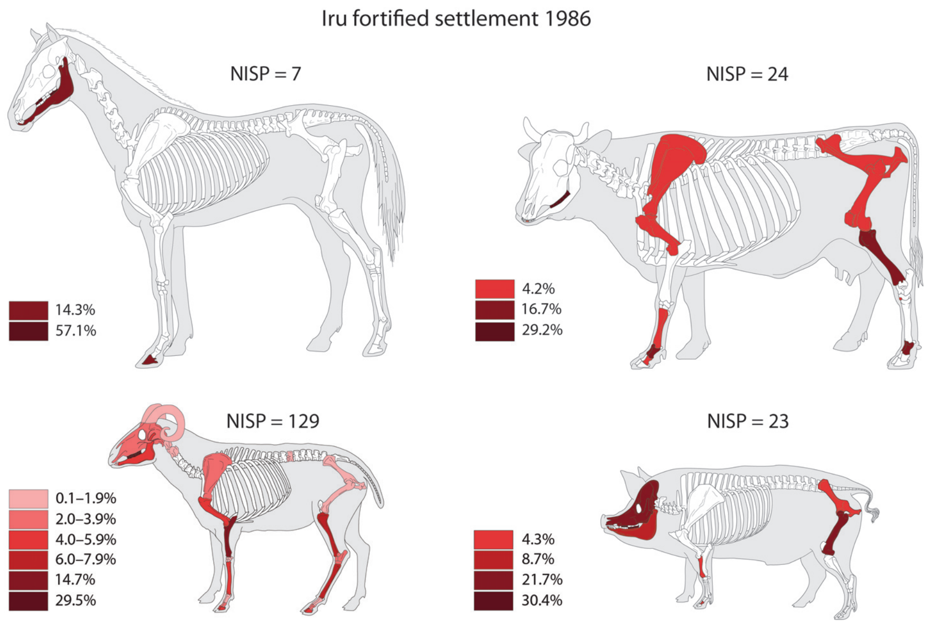

FIG. 4. Schematic view of the proportion of skeletal elements for each livestock species in the material from the Iru fortified settlement from the excavations in 1986. The darker the colour, the higher the frequency of the element. In the calculations, some specimens were added together (e.g. carpal bones, tarsal bones) and some were divided (e.g. unspecified metapodial bones were divided between the fore and hind limbs). Note that the proportions here are not representative as the number of identified specimens is small. Skeleton templates after Michel Coutureau (Inrap), Vianney Forest (Inrap) – ©1996 ArchéoZoo.org.

of the limbs, together with shoulder blades and hip bones that are clearly under-represented in the Iru material. During butchering, these elements are broken into smaller pieces and have therefore lost their analytical characteristics.

The 1980s material is too small to highlight the differences in skeletal representation. The only species with a slightly higher number of identified specimens and thus more trustworthy percentages is the sheep/goat (Fig. 4). The horse is represented only by a mandible, five teeth, and a coffin bone.

PROCESSING MARKS ON HORSE BONES

The clearest evidence of butchering on archaeological animal bones is usually cut marks. Although fragmentation (i.e. bone breakage) could also be the result of butchering, the distinction between intentional bone breakage and fragmentation due to various taphonomic processes is limited (Seetah 2019, 109–110). In this study, we focused on recording only cut marks, but some of the more obvious impact marks were noted as well. During the initial screening of the bones with the naked eye, many cut marks were missed, especially the very sharp and shallow filleting marks. It was only with a magnifier or a digital microscope that these cut marks became visible. A microscope was not always necessary here, but a 7–14x hand lens was sufficient. Cut marks were visible on the remains of all livestock species (according to initial screening for cut marks, they were detected on at least 17% of the bones, i.e. excluding teeth). To study the consumption of horsemeat, we focused on studying cut marks on horse specimens, as well as cattle, because those two species are similar in size and could thus have been processed using the same technique, leaving comparable evidence.

Processing marks fall into four main categories: skinning, disarticulation, meat removal, and marrow and grease extraction (see Lyman 2008, 279 and references therein). Cut marks on carpals and tarsals, metapodials, phalanges, sesamoid bones and around the head could be associated with the removal of skin, tendons, or hoof walls (Fig. 5). Cut and impact marks on or near the joints indicate disarticulation, i.e. dismemberment. Meat removal or filleting is characterised by slicing marks, mostly on the surface of the bones from meaty parts of the body. Bone breaking could indicate marrow extraction.

To test the hypothesis of horsemeat consumption, we narrowed our search for cut marks on the specimens from meatier body parts. Filleting marks, associated with the removal of meat from bone, would be expected on upper limb bones and vertebrae, where there is more muscle. Thus, the skeletal elements studied in detail for both the horse and cattle were cervical vertebrae, scapula, humerus, upper part of the antebrachial bones, sacrum, hip bones, femur, patella, and upper part of the tibia. In recording and naming the cut marks, we followed the example of Seetah (2019, 150–152), but modified these according to our material. The types recorded were fine slices (fine cuts on the very surface of the bone), slices (slightly wider cuts than fine slices, slightly deeper into the bone), impact marks (clear blows on the bone, indicated by a fractured edge of the bone), point insertions (puncture marks), scoop marks (wider cut surfaces), and cut-throughs (the latter is not functionally a cut mark, but rather a chop mark; see Greenfield 1999, 798). All the named types are likely related to meat processing activities such as filleting (slices and fine slices) and dismemberment (impact marks, scoop marks, point insertions, cut-through bones). Of the 42 horse specimens studied in detail for cut marks on meat-rich elements (1950s material only), 21 specimens had cut or impact marks. Of the 84 cattle specimens studied in detail for cut marks on meat-rich elements (both 1950s and 1980s material), 35 specimens had cut or impact marks. Overall, horse and cattle bones had similar proportions and types of cut marks in similar locations (Fig. 6).

Cut marks related to meat processing were also found on juvenile individuals, which are only present in the 1950s material. Of the 487 horse specimens, based on the stages of epiphyseal fusion or tooth eruption, 51 belong to juveniles and four to subadults (a total of 11% of all horses). The absolute age of individuals is impossible to determine from loose bone and teeth, but at least 21 specimens belong to individuals <24 months old, including at least ten <15 months, and at least one <12 months old (after Silver 1969; Ernits 2000; Chaix & Méniel 2001). For the rest of the juvenile specimens, it can only be said that they belong to

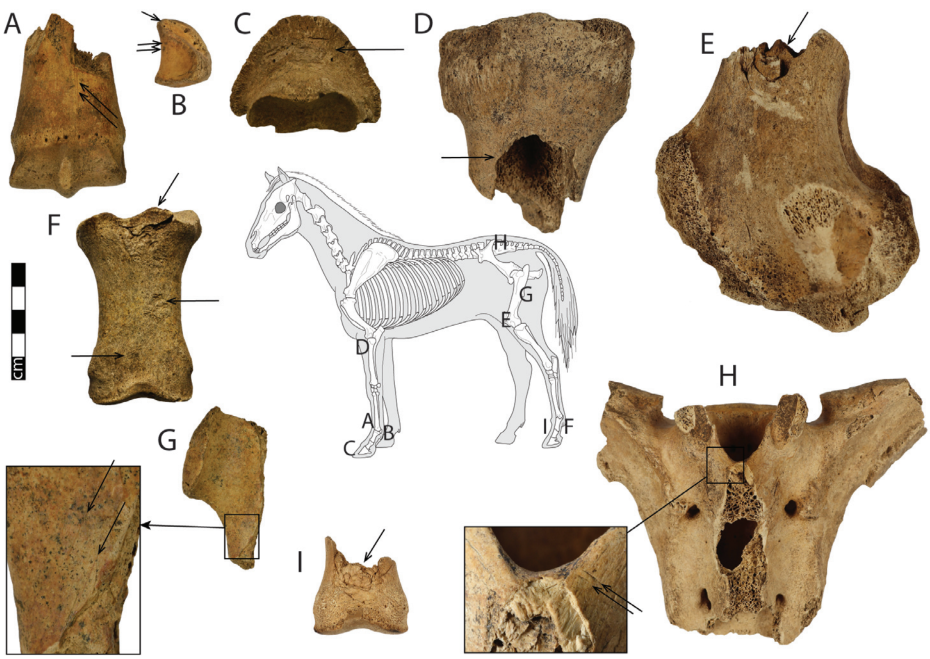

FIG. 5. Examples of butchering marks on horse bones, indicated by arrows. A – parallel vertical slices on a metapodial bone, most likely related to skinning (AI-4051/1954/AZ-230:03); B – point insertions and a slice on a proximal sesamoid bone, possibly related to the removal of tendons (AI-4051/1954/AZ-45:30); C – scoop marks on a third phalanx, possibly from the removal of the hoof wall (AI-4051/1954/AZ-157:21); D – impact mark on the proximal part of a radius that could be associated with either dismembering or marrow extraction (AI-4051/1954/AZ-236:04); E – impact mark on the distal part of a femur that could be associated with either dismembering or marrow extraction; the same specimen also has slices on it (not shown on the figure) (AI-4051/1955/AZ-467:31); F – impact mark and slices on a first phalanx, possibly related to dismembering and skinning, respectively (AI-4051/1956/AZ-662:07); G – parallel fine slices on a femur, most likely from filleting (AI-4051/1954/AZ-157:18); H – slices on a sacrum, associated with meat removal (AI-4051/1954/AZ-256:33); I – impact mark on a juvenile first phalanx, possibly for marrow extraction (AI-4051/1954/AZ-255:15). A, B, C, F and I are elements from either the fore or hind limb, their position on the skeleton is arbitrary. Skeleton template after Michel Coutureau (Inrap), Vianney Forest (Inrap) – ©1996 ArchéoZoo.org.

individuals under three to five years old. Interestingly, there are only four juvenile specimens (out of 51) among the elements associated with meatier body parts. Only one of these, a diaphysis of a single tibia, has fine slice marks on it. However, it is possible that those are not related to the removal of flesh but to skinning instead. Cut marks on a juvenile distal radius, metacarpus, calcaneus, and possibly talus also indicate skinning. Impact mark on a first phalanx, however, could be related to marrow extraction (Fig. 5: I). Of the 493 cattle specimens, five belong to neonates (or slightly older calves), 144 belong to juveniles,

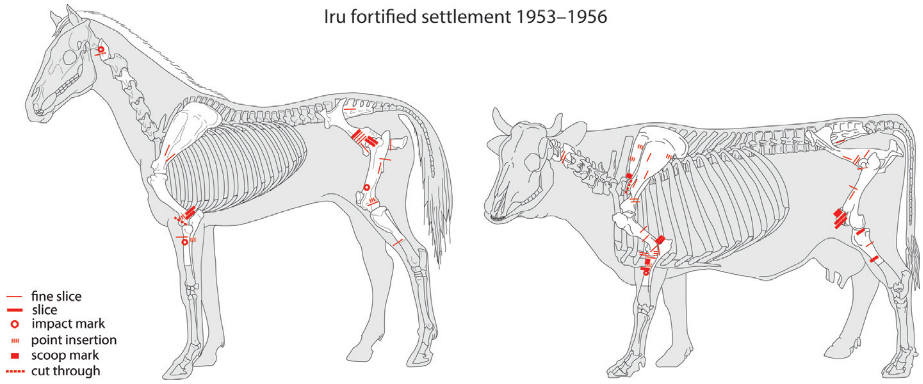

FIG. 6. Schematic view of the location and type of cut and impact marks on horse and cattle specimens of the 1950s material from the Iru fortified settlement. On the few fragments from the 1980s, there were slice marks on cattle scapula, hip bone, femur, and patella (not shown in the figure). For raw data and detailed descriptions, see Rannamäe 2024b, tables 1 and 2. Skeleton templates after Michel Coutureau (Inrap), Vianney Forest (Inrap) – ©1996 ArchéoZoo.org.

and four to subadults (a total of 31% of all cattle). Of the newborns, one tibia has a slice mark; and of the juveniles, fine slices and slices occur on eight bones, including a scapula, radius, femur, and tibia. Indications of skinning are on one mandible, two tali, a centroquartal bone, calcaneus, and first phalanx. One juvenile cattle metapodium is split longitudinally. The material from juvenile horses and cattle clearly indicates that young cattle were utilised for meat (more elements from meatier body parts compared to the horse, and cut marks on them), while the evidence for young horses is less clear (very few meatier elements and no cut marks on them).

Discussion

The zooarchaeological material from the Iru fortified settlement site is challenging. First, long-term habitation of the site over millennia makes it difficult to assign the material to a given period and habitation layer. Second, as a result of the analysis presented in this study, it is clear that the material has been selectively preserved, which makes any interpretation about the faunal assemblages ambiguous. However, several conclusions can be made about the Late Bronze Age diet, including the inclusion of horsemeat.

UTILISATION OF MAMMAL RESOURCES

The Late Bronze Age society in prehistoric Estonia relied on livestock. This is evident from the fortified settlements in Iru but also in contemporaneous Asva and Ridala (Paaver 1965, 364–365, table 101; Lõugas 1994, 75; Maldre 2008; Lõugas et al. 2021). The same pattern is known from contemporaneous sites in the eastern Baltic, i.e. Latvia (e.g. Vasks et al. 2011; 2019), Lithuania (e.g. Bliujienė et al. 2020; Minkevičius et al. 2023), and Poland (e.g. Sobociński & Makowiecki 1994; Makowiecki & Makowiecka 2004). An insignificant number of wild animals shows that wild resources did not provide essential subsistence. Their rarity more likely indicates the uniqueness of hunting and maybe its association with a distinct social status. As for game animals, the faunal assemblage gives a higher prominence to aquatic resources due to the high proportion of seal bones, whereas terrestrial wild species remain in a clear minority.

The primary livestock were cattle, sheep, goats, pigs, and horses. It is possible that animal production mainly relied on sheep and goat farming because these two bovids form almost half of the livestock in Asva (Lõugas 1994, 78; Lõugas et al. 2021) and Ridala (Maldre 2008), and more than half in the 1980s material from Iru. The latter probably gives a more adequate picture of the livestock proportions in Iru, as only larger bone elements were collected in the 1950s excavations, artificially diminishing the proportion of sheep and goats. Pigs and cattle could have had similar extent of utilisation. Their proportions in the Iru, Asva, and Ridala assemblages vary from around a tenth of the livestock to a third (Fig. 2; Lõugas 1994; Maldre 2008; Lõugas et al. 2021). It seems that in Iru and Asva, cattle keeping could have occupied a larger share of animal husbandry than pigs, while in Ridala pig husbandry could have been more important.

Regarding horse husbandry, we are quite confident that the previously reported high proportion of horses in Iru – more than 30% of domestic mammals – reflects the preservation and research bias rather than the actual utilisation of horses by Late Bronze Age people. Although cautiously, we would suggest that the inhabitants of Iru utilised horses to a similar extent as the contemporaneous Asva and Ridala people, as attested to by the analysed material from Iru from the 1980s with a more complete zooarchaeological assemblage, where horses comprise only around 5% of the livestock. Elsewhere in the eastern Baltic, the proportion of horses in faunal assemblages fluctuates as well, from less than 10% to around 30%, but in some cases this figure is affected by sample size and preservation, as in Iru (Sobociński & Makowiecki 1994; Makowiecki & Makowiecka 2004; Vasks et al. 2011; Daugnora et al. 2013; Vasks et al. 2019; Bliujienė et al. 2020; Minkevičius et al. 2023). Nevertheless, the horse was clearly one of the livestock species and could have been utilised for various products such as skin, meat, and tendons (based on faunal remains), bones (based on bone items, mostly metapodials; see Maldre & Luik 2009, 43–44), and horsehair (no direct evidence, but highly possible). Although the high proportion of horses in the Iru material from the 1950s is clearly derived from selected preservation (the 10% in Asva and Ridala is probably more reliable), we can state that horses were consumed for meat. Cut marks were present on half of the specimens from the meatier body parts, which is convincing evidence that flesh was removed for consumption. This is supported by the extent of horse remains from Late Bronze Age assemblages in general. Since these assemblages comprise primarily food waste and include horse remains along with other livestock remains, we could hypothesise that whatever roles horses had in their lifetime (working, riding), part of them were utilised for meat and other secondary products at the end of their lives. To study the exploitation of horses both during their lifetime and after death, their age at death and slaughter patterns should be examined in detail in future research. For now, we can see that a tenth of the horse specimens belonged to juveniles, but it is impossible to say whether they were intentionally butchered at a young age or utilised after natural death. Nevertheless, culling of foals for meat would seem impractical because their potential value as adults would have been higher.

BUTCHERING IN THE LATE BRONZE AGE

Regarding the butchering of horses (or any other livestock), cut marks are our primary evidence. This raises the question of how the animals were butchered and which activities and tools left those marks. Moreover, since the Iru zooarchaeological assemblage includes material from both the Late Bronze Age settlement and the Iron Age hillfort, the question arises whether the cut marks could be assigned to specific tools intrinsic to one period or the other.

Some of the studied bones were broken with heavy blows (e.g. Fig. 5: D–F, I), which could have been made with stones or larger stone tools, most likely stone axes. No stone axes have been found from Iru, but there are five fragments from the Asva fortified settlement and a single fragment from Ridala. The large number of stone axes from Latvian and Lithuanian sites, e.g. Ķivutkalns, Brikuļi, Narkūnai, Nevieriškė, and others (e.g. Grigalavičienė 1986, 62; Volkaitė-Kulikauskienė 1986, 18; Graudonis 1989, 21; Vasks 1994, 34), shows their wide use during the Late Bronze Age.

However, skinning, disarticulation, and meat removal had to be done with some kind of blade. There are some bronze knives in Estonian archaeological material, but they are not very common. They only come from burial contexts, and they seem to have been prestigious items rather than daily utilities (Lang 2007, 142). Bronze finds from the Iru fortified settlement are quite rare: some bronze awls, fragments of bronze rings, a single bronze spearhead, and indications of bronze rings casting on the site (Lang 1996, 46ff.). Thus, bronze was used in Iru at that time, but we do not have any evidence that it was used as a tool in the butchering process.

Usage of stone tools for different tasks would therefore be expected before the broader use of iron, including at the Iru Late Bronze Age fortified settlement. Bronze and Iron Age flint use has not been explicitly studied in Estonia, but stone tools have been found at different sites dating to these periods. In other parts of Europe, Bronze and Iron Age flint working is characterised by *ad hoc* knapping, an increase in the expedient or situational production of artefacts, and an increased use of functional, only slightly retouched or unretouched flakes rather than prepared tools for different cutting and scraping tasks (Young & Humphrey

1999, 239; Högberg 2004, 234f.; Butler 2005, 179). Thus, there are few recognisable tool types, but mostly tools were multifunctional, i.e. the same tools were used for expedient tasks. For example, it has been proposed that the flint and quartz tools from the Asva fortified settlement in Saaremaa might have served as multifunctional tools for different tasks, including leather and fur working, but also bone and antler working (Sperling 2014, 322). Bone artefacts from Asva exhibit various transverse and longitudinal lines that were likely created during cutting, shaving, and smoothing of the bone (see more in Luik 2013, 409).

The flint flakes in Iru are good examples of the characteristic features of multifunctionality, as many of them are heavily used from all sides and show varying degrees of damage to the edges. Thus, they may date from the Bronze Age habitation and be linked to activities of the fortified settlement. By default, all flint and quartz finds have previously been connected to the habitation of the Late Neolithic Corded Ware Culture (Lang 1996, 37). However, the few pure Corded Ware Culture contexts studied in Estonia have yielded hardly any stone tools (Kriiska 2000), contradicting the Neolithic date of the stone tools in Iru. On the other hand, flint and quartz finds are available from the Iron Age contexts of the second half of the 1st millennium AD, e.g. from Kuusalu, Aakre, and Tilleoru hillforts, to name but a few. Therefore, without closed contexts, the dating of the flint and quartz finds from Iru would remain ambiguous, and at this point, we cannot say for sure that they come from the Late Bronze Age (or earlier or later periods).

According to Greenfield (1999, 798), cut marks made by stone can be distinguished from those made by metal tools. Moreover, he has shown that cut marks on bones make a useful proxy for studying the spread and extent of metal tools (in the absence of metal artefacts themselves), and allow to assess the importance of stone versus metal tools in the subsistence technology of the time. In Iru, if we expect (mostly) the use of stone tools for butchering activities, we would expect to see cut marks characteristic of these tools, that is, wide and irregular grooves (see Greenfield 1999, 804). With the naked eye, we were able to recognise wide and irregular cut marks among the Iru material (e.g. Fig. 5: B–C, F), but any meaningful information on processing and butchering could only be gathered by future in-depth analysis using a scanning electron microscope. Additionally, use-wear traces and microremains on stone tools, possible microdebris inside the cut marks on animal bones, and experimental archaeology (see, e.g. Daugnora et al. 2013) could be promising sources for studying prehistoric butchering technologies.

ORIGINS OF THE LATE BRONZE AGE HORSE CULTURE

The development of the horse phenomenon has been similar in the eastern Baltic region. Horse remains from archaeological sites in Latvia, Lithuania, and Poland unambiguously indicate the consumption of horsemeat among the Bronze Age people of that region (Sobociński & Makowiecki 1994; Makowiecki & Makowiecka

2004; Vasks et al. 2011; Daugnora et al. 2013; Vasks et al. 2019; Bliujienė et al. 2020; Minkevičius et al. 2023). However, livestock rearing, including butchering and food preferences, is culturally driven. Therefore, we might ask, where would the horse phenomenon in Estonia and elsewhere in the eastern Baltic have originated?

Due to the demographic and cultural setback in the Early Bronze Age Estonia, northern Latvia, and Finland, local development and continuity into the Late Bronze Age, when the entire material culture was renewed, has been disputed. The arrival of new people over time is more plausible (Lang 2018). This would allow us to speculate that the horse culture we witness here for the first time was also brought to these areas by the incoming migrants. But from which region could the earliest domesticated horses in Estonia and the Baltics have come, and when did they arrive here? There are at least three possible scenarios.

(1) **From Scandinavia or Central Europe.** In Scandinavia, the earliest evidence of the domestic horse precedes the earliest specimens in Estonia by up to a whole millennium; in Latvia, by around five to three hundred years; and in Finland, the first evidence of the horse is from a very similar timeframe as in Estonia. The horse tooth found at Reznes Barrow in Latvia is the oldest Latvian find so far (1225–1028 cal BC; Vasks et al. 2021), showing that domesticated horses were already spread in this area before the establishment of fortified settlements. Contacts and probable migrations from Scandinavia and northern Central Europe during the Middle Bronze Age are known (Lang 2018; Saag et al. 2019). The Reznes and Kalnieši type barrows in the lower reaches of the Daugava River point culturally to the region of the south-eastern Baltic Sea coast as well as to southern Scandinavia (Graudonis 1967). Thus, the first horses could have been brought from either Scandinavia or Central Europe.

(2) **From the North Caucasus.** At around the same time, i.e. at the end of the 2nd millennium BC, a certain immigration from the direction of the Dnieper River had reached northern Estonia, which is indicated by a group of specific temple ornaments from the lower reaches of the Dnieper and a bronze battle axe from the Koban culture area in the Caucasus (Lang 2007, fig. 89; 2015). Five Late Bronze Age horses from Asva and Ridala (among them the three earliest radiocarbon-dated specimens, see above) have been genetically analysed, showing that these individuals belonged to the same genetic group as the ancestors of the current domestic horse from the lower Volga-Don region (Librado et al. 2021). Therefore, the oldest horses may have reached us directly from the North Caucasus.

(3) **From the Eastern European forest belt.** In the same time window, the first western Uralic groups from the Volga-Oka areas also began to reach the Baltic Sea region (Lang 2018). The horse was already known in that region at that time either through contacts with the peoples of the Dnieper River basin or the North Caucasus. Antler cheekpieces of horse harness found in fortified

TABLE 2. Radiocarbon dates for analysed horse specimens from the stone-cist cemeteries. Samples were radiocarbon-dated by AMS in Poznań Radiocarbon Laboratory. The obtained AMS dates were calibrated with OxCal v4.4.4 (Bronk Ramsey 2021), using the IntCal20 atmospheric calibration curve (Reimer et al. 2020) and rounded by ten. Sampling permissions were given by the Archaeological Research Collection, Tallinn University (sampling protocols AI PP Nos 725–727)

Archaeological site and excavation year	Collection/specimen ID	Skeletal element	Lab No.	^{14}C age	Cal date (95.4%)	%C	%N	C:N	Collagen yield (%)
Kangru at Väo 1959	AI 4303	Ulna	Poz-179988	335 ± 30 BP	1470–1640 cal AD	13.9	5.1	3.2	3.4
Kangru at Väo 1980	AI 5080	Incisor (deciduous?)	Poz-179986	415 ± 30 BP	1420–1630 cal AD	11.9	3.9	3.6	2.9
Jaani at Väo 1982	AI-5220/AZ-4:1	Premolar (mandibular P1)	Poz-179987	620 ± 30 BP	1290–1400 cal AD	7.0	2.1	3.9	4.1

settlements and some graves point to the east and south-east, and they copy bone and metal cheekpieces known from steppe and forest-steppe zones, including the Koban culture area in the North Caucasus (Zbruyeva 1952, pl. XII: 11–13; Patrushev & Khalikov 1982, pl. 82: 2a, 85: 3a, 127: 1e, 138: 2; Kozenkova 1989, fig. 103: A26–28). Moreover, osteological material shows a much greater importance of the horse in the eastern part of the Eastern European forest belt than in our fortified settlements in the Late Bronze Age (cf. Apals et al. 2001, 122). In this scenario, horses would have arrived via waterways from the Volga to Daugava rivers and then diverged to the north and south. Note, however, the potential bias in the proportions of previously excavated and identified material, as learnt in the case of Iru.

All three scenarios are equally possible at the current state of research, and further research is needed to exclude some of them. However, archaeological material in Estonia is scarce from the Early Bronze Age. There are horse remains from the stone-cist cemeteries of the Middle and Late Bronze Ages, such as Muuksi, Jaani at Väo, Kangru at Väo, Pärna at Väo, Jõelähtme, Kuristiku, Proosa, and Iru (Vassar 1937; Rannamäe et al. 2014; Varul & Rannamäe 2014; Laneman et al. 2015; Rannamäe 2024a; Rannamäe et al. 2024; see also Tõrv et al. in prep.), and also from an early *tarand* grave – Ilmandu III (material analysed by Maldre 1997). From the latter, a horse bone has been dated to the Late Bronze Age (8th to 5th century cal BC; Tõrv et al. in prep.). As part of this study, we also dated three horse specimens from two stone-cist cemeteries – Kangru at Väo and Jaani at Väo – but these proved to be from the Middle Ages or Early Modern Period (Table 2). Therefore, those horse remains are not associated with burials. The same applies to some of the other radiocarbon-dated animal specimens from stone-cist graves that have been shown to come from later periods (see, e.g. Rannamäe et al. 2016, table S1; Tõrv et al. in prep.). Nevertheless, it cannot be excluded that at least some of the horse remains found at these or some other cemeteries are earlier than the Late Bronze Age, and thus the question of the symbolic or ritual role of horses in the Bronze Age remains open, together with their arrival.

Conclusions

Horses in Late Bronze Age Estonia were used for multiple purposes, including meat. The latter has been directly proved in the case of the material from the Iru fortified settlement, where cut marks on horse bones show different butchering activities, including meat removal. However, contrary to the earlier notion of Iru people being especially focused on horsemeat consumption, it is likely that they consumed horses to a lesser extent, similar to other contemporaneous communities (i.e. those in Asva and Ridala). Nevertheless, the quantity of horse remains in Late Bronze Age zooarchaeological material shows the importance of this animal as a food source, both in everyday life and probably also in funeral customs, not to mention its role as a working and riding animal. Further cultural and socio-economic contextualisation and ancestry reconstructions would be needed for Estonian Bronze Age horse remains in the future. As part of this, perhaps most urgently, the horse remains from the Early and Middle Bronze Ages and the Late Neolithic should be radiocarbon-dated, because we cannot be certain that the Asva, Ridala, and Iru horses were indeed the first imported domestic horses. Specimens that would be from the early part of the Bronze Age would open new discussions on the burial customs and cultural contacts with neighbouring areas. Potential specimens from the Neolithic, on the other hand, should be genetically studied to confirm their belonging to *Equus ferus* or *E. caballus*, in order to study the disappearance of the wild horse and the arrival of the domestic horse in the area.

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Hobuseliha hilispronksiaegses toidus Iru kindlustatud asulakoha näitel

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RESÜMEE

Hobuse ajalugu Eestis algab metshobusega, kelle luujäänuseid on leitud mesoliitilistest Kunda Lammasmäe ja Kääpa asulakohtadest. Üksikuid leide on ka neoliitilistest asulakohtadest, kuid üldiselt olid metshobused selleks ajaks siinsetel aladel juba välja surnud. Esimesed kariloomad jõudsid Eesti aladele hilis-

neoliitikumis, koduhobune aga teadaolevalt alles hilispronksiajal, u 8.–6./5. sajandil eKr. Tolleaegsetest kindlustatud asulakohtadest leitud koduloomade luud näitavad selgelt, et loomsete ressursside põhiallikas oli karjakasvatus. Loomsete ehk toidujäänuste hulgas on valdavalt veise-, lamba-, kitse- ja sealuid, aga ka hobuseluid. Kui Asva ja Ridala kindlustatud asulakohtade materjalis on hobuseluid u 10% koduloomade luudest, siis Iru asulakoht paistab silma 30% osakaaluga. 1960ndatel Kalju Paaveri poolt määratud, Iru kindlustatud asulakoha zooarheoloogiline materjal võeti käesolevas artiklis uuesti uurimisele eesmärgiga mõista, miks just Irus on hobuseluid nii palju, ja sellega avada laiem diskussioon hobuse osatähtsuse üle pronksiaegses Eestis, eriti hobuseliha olulisuse üle toidus.

Artiklis uuriti Põhja-Eestis asuva Iru kindlustatud asula loomaluid, mis pärinevad 1953.–1956. aasta (AI 4051) ja 1986. aasta kaevamistelt (AI 5302). Kuna Iru on pika ajalooga muistis, kus kihistused on raskesti eristatavad või segunenud, on luumaterjal segu hilispronksiaegsest asulakohast ja viikingiaegselt linnamäelt pärit materjalist. Uurimistööks vajaliku materjali valikul aitas Kalju Paaveri esialgne määranguaruanne, kus ta on 1950ndate kaevamiste materjalis eristanud ruudud ja korrised, mille materjal peaks kuuluma kindlustatud asulakohale. 1986. aasta materjali puhul on pronksiaegne päritolu kindlam. Luud korrastati ja kirjeldati: määrati taksonoomiline kuuluvus ja kirjeldati vanust ning erilise tähelepanu all oli lõikejälgede analüüs.

1950ndate materjalist esitati artiklis 1672 ja 1980ndate materjalist 1385 luuleidu. Selgus, et 1950ndate materjal on vaid osaliselt kaevamistel üles võetud ja/või säilitatud – selles on vaid suuremad luuleiud, kusjuures puuduvad roided ja selgroolülid. 1980ndate materjal on esinduslikum. Enamik luuleide kuulub kariloomadele – veisele, hobusele, lambale, kitsele ja seale –, kusjuures suurim rõhk paistab olevat olnud lamba-/kitsekasvatusel. Koduloomadest on veel esindatud koer. Metsloomi on materjalis vähem, nendest suurema osa moodustavad hülged.

Kuigi 1950ndate materjalis on hobuseluid üle kolmandiku (nii nagu Paavergi omal ajal kirjutas), sai käesoleva analüüsi käigus selgeks, et nende suurt osakaalu on mõjutanud materjali valikuline säilitamine. 1980ndate materjalis, mis on säilinud oma praegusel kujul tõenäoliselt alates kaevamistest, on tõendeid hobustest palju vähem. Seega on tõenäolisem, et hobuse osakaal Irus võis sarnaneda samaaegsete näitajatega Asva ja Ridala materjalis, kus hobuseluid on kümnendiku jagu. Hobuseluude hulgas on skeletielemente nii liharikastest kui ka -vaestest kereosadest. Kõige rohkem on koljufragmente ja hambaid, samuti jäsemete kaugmisi osi, mida saab seostada eelkõige nahanülgimise ja tapajäätmetega. Oluline on aga see, et materjali hulgas esineb ka lihaselistest kereosadest abaluid, reieluid, selgroolülisid, puusaluid ja ristluid ning et nendel luudel ilmneb lõikejälgi. Fileerimis- ja löögijäljed viitavad üheselt liha eemaldamisele ja on seega otsene tõestus hobuseliha tarvitamisest.

Lõikejäljed näitavad, milliste tööriistadega loomade lihakehasid töödeldi. Pronksist tööriistadega seda tõenäoliselt ei tehtud. Löögijäljed on tehtud nähtavasti kivide või kivikirvestega, lõikejäljed aga mitmeotstarbeliste kivitööriistadega. Kuna viimaseid on keeruline dateerida, ei saa Irust leitud tulekivist või kvartsist tööriistu siduda hilispronksiajajaga, veelgi enam loomade lihakehade töötlemisega. Edasistes uurimustes võiks analüüsida kiviriistade teradel ja ka luude lõikejälgedes säilinud mikroosakesi, et muu hulgas mõista tolleaegset tehnoloogiat ning hinnata metalli levikut.

Toitumine on kultuuriline nähtus ja kindlasti on seda ka hobuseliha tarvitamine. Et mõista, millise kultuuritaustaga olid Eesti alal elanud hilispronksiaegsed inimesed ja kust võis pärineda nende hobuseliha söömise tava ning hobusekultuur laiemalt, peab küsima, kust võidi hobused meie aladele tuua. Hilispronksiaegse hobusekultuuri päritoluks on kolm stsenaariumi.

(1) Lätist Reznesi kääpast leitud hobusehammas on siinsetel aladel seni vanim, näidates, et kodustatud hobused levisid siin juba enne kindlustatud asulate rajamist. Reznesi ja Kalnieši tüüpi kääpad Daugava alamjooksul osutavad kultuuriliselt nii Läänemere kaguranniku piirkonnale kui ka Lõuna-Skandinaaviale, seega võidi esimesed hobused tuua kas Skandinaaviast või Kesk-Euroopast.

(2) Ligikaudu samal ajal, s.o II aastatuhande lõpus eKr, on Põhja-Eestisse jõudnud mõningane migratsioon Dnepri suunalt, millele osutab rühm spetsiifilisi oimuehteid Dnepri alamjooksult ja pronksist sõjakirves Kaukaasiast Kobani kultuuri alalt. Kuna ka Asva ja Ridala hobuste DNA osutab põlvnemisele Põhja-Kaukaasias kodustatud loomast, võivad vanimad hobused olla jõudnud meile otse sealt.

(3) Samas ajaaknas hakkasid Läänemere äärde jõudma ka esimesed lääneuurali rühmad Volga-Oka aladelt, kus hobune oli sel ajal tänu kontaktidele Dnepri jõgikonna rahvastega juba tuntud. Ida suunale osutavad kindlustatud asulatest ja mõnest kalmest leitud luust suitsekangid. Osteoloogiline materjal näitab hobuse märksa suuremat osatähtsust Ida-Euroopa metsavöötme idapoolsemas osas kui meie kindlustatud asulates hilispronksiajal.

Kõik kolm stsenaariumit on tänase uurimisseisu juures ühtviisi võimalikud ning neist mõne välistamiseks on tarvilikud edasised uurimistööd, sh kindlustatud asulate eelse tõendusmaterjaliga. Keskmise ja hilise pronksiaja kivikalmetest on hobuseluid küll leitud, kuid seni on vaid üks neist dateeritud hilispronksiaega (Ilmandu III tarandkalmest), samas kui kolm hobuseluud on dateeritud kesk- või varauusaega (Väo Kangru ja Väo Jaani kivikirstkalmetest). Lisaks radiosüsinikumeetodil dateerimisele oleksid vajalikud detailsemad zooarheoloogilised (sh biomolekulaarsed) analüüsid.