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From intra-site variation to inter-site comparison in medieval faunal material from Katedraalikoulu, Turku, Finland

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ABSTRACT

Faunal material from urban sites is important for understanding the socio-economic specialisation and spatial development of towns and cities. Variation caused by specialised activities, such as slaughter, crafts or consumption, may affect anatomical and species distribution, which could influence inter- and intra-site comparability. To study the variation within urban faunal assemblages, bone material from seven medieval contexts in the Katedraalikoulu area of Turku, Finland was examined. In this material, the deposition of kitchen waste seems to have had the greatest effect on species and anatomical distribution, with deposits that are rich in fish and bird bones but not in cattle bones. On the other hand, the general waste deposits exhibit only minor variations in the proportions of major domesticates, indicating possibilities for valid inter-site comparisons. Faunal material contributes greatly to understanding the complexity of the archaeological deposition processes and to the more precise identification of primary and secondary layers.

1. Introduction

Zooarchaeological material from urban sites is significant source material for understanding the diet and provisioning of a town's inhabitants, in addition to the town's socio-economic development and spatial organisation. Comparing urban and rural material can exhibit evidence of the relationship between towns and their surrounding areas (Dobney et al., 1996; O'Connor, 2003; Grau-Sologestoa et al., 2016). Evidence of crafts, industry and commerce provides information about specialisation and the process of urbanisation (Serjeantson, 1989; Dobney et al., 1996). The networks for acquiring and processing animal products can indicate characteristics of the economic system. In Finnish towns such as Turku, small-scale agriculture persisted in the form of subsistence until the early 20th century (Jutikkala, 1957; Nikula, 1971). Thus, some of the meat that was consumed was acquired from animals raised by the inhabitants themselves, and some was acquired from live animals that were brought from the surrounding rural areas. Animals were slaughtered in the household's own yard in the autumn, with the meat being preserved for consumption (cf. Talve, 1997).

Zooarchaeological research from urban sites could help to reconstruct patterns of animal use in the past and study variations in animal husbandry practices, production and consumption in different locations and periods. This requires a comparison of quantitative data from different contexts, phases or sites; thus, inter-site studies using 'big data' are becoming more common (Lau and Kansa, 2018). However, inter-site comparison is meaningful only if the assemblages in question are similar enough. Zooarchaeological material can be formed as a result of a range of activities, such as slaughter, carcass preparation, meat consumption, crafts, rituals, the disposal of dead animals and general waste management, all of which affect the species and anatomical distribution of a bone assemblage (e.g. Bläuer et al., 2019; Heinrich, 2017; O'Connor, 1989; Serjeantson, 1989). Ideally, inter-site comparisons should include contextual data and be limited to comparing assemblages that were created through similar activities, e.g. food disposal. Additional factors affecting the comparability of the samples include variations in the preservation, recovery and analysis of the bone deposits affecting the species and anatomical distribution, which are major components of comparative studies (e.g. Clason and Prummel, 1977; Lyman, 1994; O'Connor, 2003).

In urban sites, assemblages resulting from the selective acts of slaughter, food-processing, consumption and crafts are sometimes present and can be identified by the species and anatomical distribution. Thus, waste pits for specialised craft activities may consist of selective elements of one species only (Bläuer et al., 2019; Bläuer et al., 2020). Animal heads and lower limbs tend to be concentrated in the place of slaughter or where crafts such as tanning, bone-working or horn-

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working took place (Bläuer et al., 2019; Heinrich, 2017; Levitan, 1989; O'Connor, 1989; Serjeantson, 1989). In general, ribs and vertebrae are more commonly found in the place of consumption (O'Connor, 1989; Tourunen, 2011b). The proportion of cattle to smaller animals is likely to be lower in kitchen waste, as larger cattle bones were more often defleshed and discarded before food was prepared. Cattle bones that do appear in kitchen waste consist largely of rib and vertebrate fragments, while for the smaller animals that are present there is a more equal distribution of anatomical elements, as they would have been brought into the kitchen in a less processed state, or even as virtually complete carcasses (Tourunen, 2011b). Pre-burial taphonomic processes, such as trampling, attrition and burning, can also affect the composition and identifiability of the material (e.g. Lyman, 1994; Tourunen, 2011a). The recovery methods applied during the excavations affect the species abundance and anatomical distribution (Clason and Prummel, 1977; O'Connor, 2003). There are also challenges in combining samples that have been identified by different people (inter-analyst variation) and recorded using different methods (Lau and Kansa, 2018; Morin et al., 2019). In addition, comparisons between different taxonomic groups are especially challenging. The data is affected by different numbers of skeletal elements per individual, different preservation and recovery rates, and cultural differences in processing practices (Lyman, 2008; Lyman, 2015).

Understanding the context of the faunal remains is crucial for interpreting the data: for example, studying a tanner's waste pit or ritual deposits contributes little to knowledge about diet but provides information about craft processes and belief systems. However, this is not always possible in practice, as deposits are often mixed, comprising faunal material from several different activities. Mixing can happen after primary deposition, due to the redeposition of layers in the dynamic urban space (c.f. Rainsford & O'Connor, 2016). However, mixed deposits can also occur because of the proximity of the activities: the same waste pit or layer might simply have been used for all types of waste created within the yard. This seems to be common in medieval and post-medieval Turku. Historical sources and zooarchaeological material indicate that slaughtering, butchering, consumption and crafts often took place in household yards, resulting in mixed deposits (Nikula, 1971; Tourunen, 2008). In Turku, some contexts included larger amounts of cattle, sheep and goat horn cores or metapodials, probably connected with craft activities. These bones were found mixed with household waste, and the effect of the metapodials and horn cores on the context's species distribution was estimated to be slight (Tourunen, 2008). It also seems that only a limited amount of meat consumed in households was purchased as ready-cut pieces between the 14th and 18th centuries (Tourunen, 2008).

In this paper, I investigate the variability of species composition and anatomical distribution in urban faunal material from the excavations of Katedraalikoulu (2014–2015) in Turku, and I study the effect of possible intra-site variability on inter-site comparisons. The basic mechanism behind this variation is examined. Do the differences in contexts reflect differences in the general patterns of animal exploitation, the activities that created them, or depositional factors? First, different methods of describing the variation in the samples are applied. Second, patterns in the faunal samples are examined, considering the origin of the variations observed. To observe the patterns in the faunal material more clearly, data from Katedraalikoulu is also compared with four deposits created through specialised activities, with little evidence of mixing. These include kitchen, slaughter, and craft waste and the ritual deposit of butchered but complete skeletons, which serves as an example of a non-selective deposit. These analyses add to the knowledge of the spatial organisation of the town, in addition to the level of specialisation and urbanisation in Turku. Further, the results aid in understanding the factors affecting inter-site comparison.

2. Material

2.1. Turku Katedraalikoulu

The Katedraalikoulu site is located in the centre of the medieval town of Turku, near the Old Great Market and medieval town hall (Saloranta, 2018). The excavations on the site were conducted by the Museum Centre of Turku in 2014 and 2015, and they revealed medieval layers with well-preserved organic material such as seed, pollen, moss, invertebrates, and animal bones. In this paper, animal bones recovered from seven contexts are presented, dating from the 13th to the 16th centuries. Thus, the contexts do not belong to a single period of use. During the excavations, soil was transported to tables, where it was trowelled carefully, and all observed finds were hand-picked. In addition, soil samples of ca. 30 L were taken and wet sieved with a 1 mm mesh. Fish bone material from the Katedraalikoulu site has been previously published in Lõugas and Bläuer (2020).

The archaeological interpretations about the contexts are variable (Table 1). Contexts M040 and M259 were layers with various burnt material, interpreted as debris created by fires that destroyed a building or buildings. Context M051 was found inside of a wooden frame, interpreted as a latrine. A close investigation of the material revealed two phases in the filling: at the bottom, there was a waste layer connected with the use of the latrine and most of the shaft was filled with a secondary deposit. Contexts M059 and M536 were interpreted as animal dung and bedding layers created by animal husbandry on the premises, deposited in the yard. M093 is the bottom layer of the site, representing layers pre-dating the town. Context M129 was layer of clayey soil with soot, interpreted as a waste dump.

2.2. Comparative material

Four deposits from Naantali, Rauma, Uusikaupunki, and Raisio were selected for comparison and to assist in detecting patterns in the faunal material. These are materials, which represent waste from one activity (food preparation and consumption, craft, slaughter or ritual), and they exhibit little evidence of mixing. These include the medieval kitchen waste layer from the Bridgettine Abbey of Naantali (Tourunen, 2008) and post-medieval slaughter waste pits from the town of Uusikaupunki, containing skulls, mandibles, and the lower leg bones of cattle (Bläuer et al., 2020). In the town of Rauma, shallow depressions with post-medieval cattle metapodial raw material production waste were recovered (Bläuer et al., 2019). Raisio Mulli is a Late Iron Age settlement site with a ritual deposit, including butchered but complete sheep and goat skeletons, and complete pig and chicken skeletons (nineteen sheep, four goats, two pigs, and two chickens; Hukantaival and Bläuer, 2017). After butchery and assumed consumption, the sheep and goat bones were carefully collected and deposited in a pit in the ritual area, at the same time disturbing the previous deposits. In addition to the mixed ritual area, two separate sheep skeletons were found in single pits. These deposits serve as comparative material, with little selection regarding bone elements. However, they have undergone butchery and taphonomic processes such as fragmentation during burial.

3. Methods

Meaningful comparisons between assemblages requires reproducible quantification of the species and anatomical profiles. These exhibit valuable information concerning the utilisation of the animals and the activities practised at the archaeological site. For the quantification of the Katedraalikoulu faunal material, the Number of Identified Specimens (NISP) was used. With well-documented pros and cons, NISP is still the most common quantification method used in the research literature and therefore the one commonly available for inter-site comparisons (e.g. Lyman, 2018; Morin et al., 2019; O'Connor, 2003). Long bone shafts, ribs, and vertebrae too fragmented for species identification were

Table 1
Sites and contexts mentioned in the text. Faunal material from Naantali, Rauma, Raisio and Uusikaupunki are used as comparative material for Turku samples.

Site	Dating of the context (s)	Museum code	Context	Description
Katedraalikoulu, Turku	1450–1520 CE	TMM23146	M040	Layer of clay or sandy clay with soot and debris, probably demolition layer after fire.
Katedraalikoulu, Turku	1450–1520 CE	TMM23146	M051	Fill of latrine, mix of primary material in the bottom and secondary fill on the top.
Katedraalikoulu, Turku	1350–1400 CE	TMM23146	M059	Wood chip, manure, clay. Deposited on (cattle?) yard area.
Katedraalikoulu, Turku	1250–1300 CE	TMM23146	M093	Bottom layer of colored clay, probably meadow before urbanization phase.
Katedraalikoulu, Turku	1350–1400 CE	TMM23146	M129	Clay, soot and soil. Presence of small bones observed during the excavations.
Katedraalikoulu, Turku	1400–1550 CE	TMM23146	M259	Layer of burnt debris and soot, probably demolition layer after fire.
Katedraalikoulu, Turku	1350–1400 CE	TMM23146	M536	Clay, wood chip, manure. Deposited on (cattle?) yard.
Bridgettine Abbey of Naantali	1400–1500 CE	KM2005034	M978	Kitchen waste layer deposited under or within a building.
Itäkatu, Rauma	1700–1800 CE	KM 41,320	18 contexts	Waste from metapodial shaft processing and collecting.
Mulli, Raisio	900–1100 CE	TYA 619, 631, 642	24 contexts	Ritual pits including butchered but complete animal carcasses.
Liljalaaksonkatu, Uusikaupunki	1700–1800 CE	TMK23522	7 contexts	Pit fills and layers of slaughter waste from cattle.

recorded as either a large or small ungulate. Specimens identified to the large ungulate level are most likely cattle (*Bos taurus*), because only cattle have been identified of the potential species, including horse (*Equus caballus*), elk (*Alces alces*), and wild forest reindeer (*Rangifer tarandus fennicus*). Small ungulate bones are derived from sheep (*Ovis aries*), goats (*Capra hircus*), and pigs (*Sus scrofa*). Most cattle vertebrae and ribs are found in the large ungulates category, as is the proportion of sheep, goat, and pig vertebrae and ribs in the small ungulate category. Therefore comparison of the large and small ungulates produces potentially different proportion of abundances than comparison on the species level.

The proportion of different animal classes (mammal, bird, fish) was calculated as variation on the composition of the faunal material could reveal different deposition activities, such as presence of kitchen waste.

Presenting anatomical distribution element by element may be the most accurate recording method, but it is impractical when comparing several contexts or sites, because figures with such detailed data would be difficult to read and interpret. Bones of cattle (including large ungulates), sheep, and goats (sheep and goat, and sheep or goat), and pigs were divided into categories, representing different utilisations of carcass parts. It is realised that the utilisation pattern and butchering practices varied in time, place, and for different species, but for comparison purposes, some categorisation is required. Horn cores have often been utilised for horn working (e.g. Yeomans, 2008). Metacarpals might be attributed to several activities such as slaughter, tannery, or crafts (Bläuer et al., 2019; Bläuer et al., 2020; Serjeantson, 1989). Cattle muzzles, including the premaxilla and the anterior part of the mandible, and phalanges were a source of gelatine and were utilised in traditional cooking (Bläuer et al., 2020; Räsänen and Ollikainen, 1978). Cattle carpal bones may have been left attached to the radius-ulna or metacarpals during butchering (cf. Bläuer et al., 2019), and distal tibia to calcaneus, talus, and other tarsals. Thus, these bones are considered here as a non-specific group. The anatomical distribution was also examined by calculating the proportion of bone elements belonging to the trunk of animals considered part of the diet (thus excluding dog, cat, mouse, and rat bones).

To further examine the composition of the faunal remains in different contexts, Simpson's Diversity Index (1-D, unbiased: a measure of evenness) and Richness (the number of species present in the sample) were calculated by using PAST V.4.01 software (Hammer 2020. For their use for zooarchaeological material, see Faith and Du, 2018). Evenness refers to the relative dominance of different species. In an even assemblage, all species are equally abundant while an uneven assemblage has one or a few dominant species. (Faith and Du, 2018). Evenness and Richness are useful tools for reproducible quantifying of the taxonomic diversity and in detecting variation and change in the utilization patterns of animals (e.g. Faith, 2007; Blois et al., 2010). To calculate richness, certain species were counted together due to challenges in species-level identification. These include sheep and goat, wild galliformes, fish from the perch family, and cyprinids. When using the proportion of the three most abundant mammal species in the comparisons, sheep, goat and sheep, or goat bones were counted together and regarded as a single species unit.

To be able to identify the primary refuse deposition evidence open epiphysis-metaphysis pairs were recorded (one element of minimal bone movement, EMM in Yeshurun et al., 2014). These are unlikely to remain paired if soil layers are disturbed and therefore they indicate primary deposition.

4. Results

4.1. Species distribution

A total of 23,105 bones, teeth, or bone fragments was recovered from seven investigated contexts from the Katedraalikoulu excavations (Table 2). Sheep and goat, cattle, mountain hare *(Lepus timidus*), and pig bones are the most abundant mammal bones counted with %NISP. As expected, the recovery method affects the species distribution of hand-picked and sieved samples. Thus, 96% of the fish, 18% of hare, and 1% of cattle remains are derived from the water-sieved samples. There is notable variation in the presence of different animal classes (mammal, bird, fish) in different contexts and in hand-picked and water-sieved material (Fig. 1). Fish bones are most abundant in M129 and in M051. In addition, M129 includes a high number of unidentified fish bones, mainly pins, which are not included in Fig. 1 (see Table 2). The proportion of the main domesticates, cattle, sheep, goats, and pigs, also varies (Fig. 2). The proportion of cattle is lowest in M129 (15%), and highest in M040 (48%). For sheep or goats, and pigs the lowest proportions are found in M040 and M093 (33% and 7%), and the highest in M129 (60% and 26% respectively).

Table 2
Species distribution in each context and sample (NISP). L = hand-picked sample, PL = water-sieved sample.

Context	M040		M051			M059		M093		M129		M259			M536	
Species/Sample	L6	PL3	L10	PL4	PL11	L1	PL63	L14	PL49	L3	PL81	L16	L16 (under post)	PL192	L27	Total
Domestic mammals																
Sheep (*Ovis aries*)	8		34			29		6		15		39	1		19	151
Goat (*Capra hircus*)			13			7		3		2		13			10	48
Sheep/goat	14	3	65	3		160		24	1	124	15	93	1	5	95	603
Cattle (*Bos taurus*)	36		119	2		108		18	2	35	3	108	2		83	516
Pig (*Sus scrofa*)	13	1	39	2		54	2	3	1	50	17	31			41	254
Dog (*Canis familiaris*)												1			1	2
Cat (*Felis catus*)			12	8		1									13	34
Wild mammals																
Mountain hare (*Lepus timidus*)	2		10	3	1	85	1	2	3	114	41	16		4	13	295
Red squirrel (*Sciurus vulgaris*)					1							1			1	3
Seal (Phocidae)						1										1
Rat (*Rattus* sp.)		3	1	6						1	1	4				16
Mouse (Muridae)											1			1		2
Domestic birds																
Chicken (*Gallus domesticus*)	1		9		39	33		2		42	6	2			9	143
Domestic/wild birds																
Galliformes	1		5			22		1		46	17	1			5	98
Goose (*Anser* sp.)						4				11						15
Mallard/domestic duck (*Anas platyrhynchos*)						1						1				2
Duck (Anatidae)			2							8	1	1			2	14
Wild birds																
Black grouse (*Lyrurus tetrix*)			1							7		4				12
Western capercaillie (*Tetrao urogallus*)												1				1
Western capercaillie/Black grouse						1				1		5				7
Common raven (*Corvus corax*)			3			1									1	5
Swan (*Cygnus* sp.)						3						1				4
Scoters (*Melanitta* sp.)										2						2
Typical mergansers (*Mergus* sp.)			1							1						2
Marine Fish																
Clupeidae cf. Herring (*Clupea harengus*)				3	145		2		1	1	163			9		324
Gadidae cf. Cod (*Gadus morhua*)			1		6										1	8
Freshwater fish																
European perch (*Perca fluviatilis*)		3		7	30	1				21	209	2				273
Zander (*Sander lucioperca*)										6	3					9
Percidae		16		19	108	5	12		3	14	489			20	2	688
Pike (*Esox lucius*)		10	7	12	7	30	4		1	45	226	46		7	21	416
Cyprinids (Cyprinidae)		3		3	8	5	2			19	138	1		7	1	187
Burbot (*Lota lota*)					1						19					20
European whitefish (*Coregonus lavaretus*)		4		2	1						14			1		22
Migratory fish																
Eel (*Anguilla anguilla*)											4			2		6
Small ungulate	21	3	60	3	3	496	4	28	1	608	63	97	1	5	152	1545
Large ungulate	51	2	137	1	1	227	2	51		99	6	142	4	4	139	866
Small animal		5	6	3	7	41	2	5	2	5	125	7		8	40	256
Carnivora											1					1
Bird		4	11	7	2	71	1	4		128	69	17		1	12	327
Fish	1	219	2	164	1818	26	96		16	277	9540	24	1	194	27	12,405
Not identified	42	244	57	165	105	207	93	23	47	230	1572	196	10	349	182	3522
Total	190	520	595	413	2283	1619	221	170	78	1912	12,743	854	20	617	870	23,105

Comparing the proportions of large and small ungulates (counting cattle and large ungulates together and sheep, goat, pig, and small ungulates) reveals a similar pattern to a comparison of cattle, sheep, or goats and pigs. However, the proportion of large ungulates is 10% higher than just cattle bones in M040, M051, M093, and M259, meaning that proportionally more bones have been identified as large ungulates than small ungulates.

4.2. *Anatomical distribution*

There is some variation in the anatomical distribution of the samples (Fig. 3). Anatomical elements has been divided into groups in order to estimate the activities they have resulted from. The groups are mostly anatomical but for cattle hooves and muzzle bones have been combined to form a group of bones used for gelatine extraction. For cattle, the counts of specimens assumed to relate to food preparation and consumption (elements from the trunk, upper limbs, hooves, and muzzle)

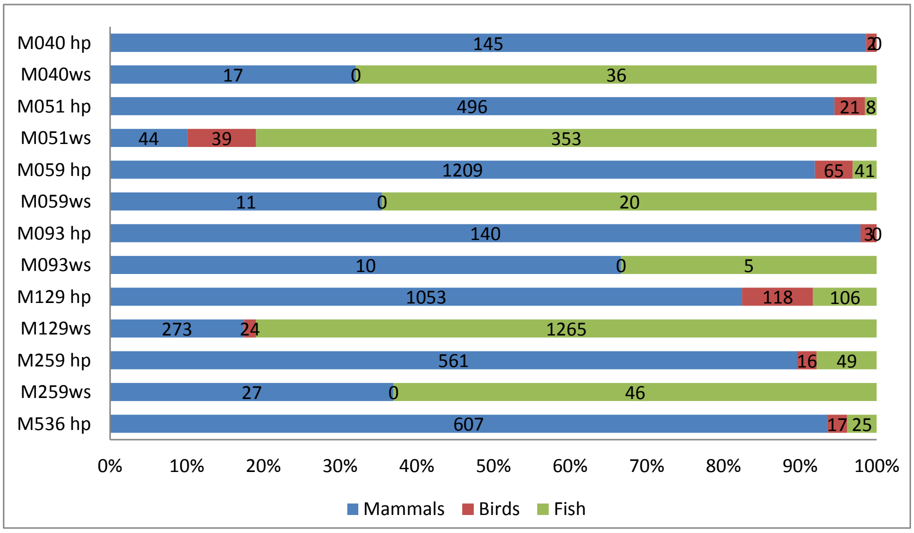

Fig. 1. Percentages of mammal, bird, and fish bones in the Katedraalikoulu samples (NISP). Hp, hand-picked material, ws = water-sieved sample.

are highest for M059, M093, and M129. None of the samples exhibits a special abundance of metapodials or horn cores. For sheep and goats, the proportion of metapodials is high in M259, and low in M129 and Naantali, and the proportion of trunk bones is low in M051 and M536 (Fig. 4). It should be noted that many rib and vertebrae fragments belonging to sheep, goats, and pigs have been categorised as small ungulates. For pigs, the number of identified fragments is smaller in every context, which hampers detailed comparison (Fig. 5). However, it should be noted that bones from the head are absent in the Naantali sample, while material from Katedraalikoulu exhibits a more equal distribution of elements, though trunk bones are absent in M059.

4.3. Patterns in species dominance, anatomical distribution, diversity, and richness

To further examine the species and anatomical variation within the samples, the proportion of trunk elements (vertebrae, ribs, and sternum) in the samples was counted and compared with the proportion of the three most abundant mammal species in the sample (Fig. 6). It is assumed that in deposits related to food processing and consumption, the proportion of trunk elements is high and the species distribution more equal, because the small species are better represented, suggesting the proportion of the three most common species should be low. These are compared to the samples consisting of slaughter, craft, and kitchen waste, as well as ritual deposits consisting of butchered but complete animal carcasses. As expected, single activity deposits are located in the margins of the chart area. Slaughter and craft waste from Uusikaupunki and Rauma exhibit the dominance of one species and a small number of trunk bones. Naantali kitchen waste includes high species variability and abundant trunk bones. Mulli ritual deposits exhibit low species diversity but a higher number of trunk elements. The Katedraalikoulu contexts fall within this variation but are closer to the kitchen waste deposit type.

The similarity of the proportion of trunk elements in the Naantali kitchen waste and Mulli ritual deposits merits a closer examination (cf. Stiner, 1991). If Naantali includes selected body parts from meat-rich areas, should it not include more trunk elements than an intentional deposit of skeletons? Examining the anatomical distribution of Mulli and Naantali more closely, it can be seen that while the number of trunk elements is higher in Naantali than in Mulli, the higher number of long bone fragments in the former make up for the difference in percentages. Thus, the anatomical distribution is not similar, but the abundance of long bone fragments in Naantali diminishes the proportion of trunk elements. When divided into head, trunk, and upper and lower leg bones, the difference in the anatomical representation becomes apparent (Table 3).

Simpson's diversity index (1-D, unbiased) was compared with species richness in the sample (Fig. 7) for the water-sieved samples. M093 exhibits the least diversity and richness. M051 is the most diverse sample, and Naantali the richest.

4.4. Preservation and deposition factors

Some data was also collected for the preservation and deposition of faunal material to estimate their effect on the species and anatomical distribution and interpretation of the primary and secondary character of the context. Based on the presence of anatomical articulations (complete but unfused epiphysis-metaphysis pairs) and conversely, abrasion on the surface of the bones (recorded as present or absent), it was concluded that while M040 and M259 are both derived from layers of burnt debris, there was a difference in their deposition history (Table 4). M040 includes abraded bones and no epiphysis-metaphysis pairs; M259 includes bone material with very good preservation in 17 epiphysis-metaphysis pairs. The shaft of latrine M051 is likely to be filled with secondary material, as the bones are abraded and show evidence of dog or pig gnawing, which would have been impossible after the material was inside the structure. The lowest fill of the latrine, however, is likely to be primary human excrement deposition including primary fish bones that have passed through digestive systems mixed with bones from upper fill. M093 included both abraded bones, but also one epiphysis-metaphysis pair, indicating the possibly mixed origin of the sample. M059 and M536 were both interpreted as yard deposits with signs of animal husbandry. However, while material from M059 was well preserved, with seven epiphysis-metaphysis pairs, M536 with worn bones may instead be yard deposits in secondary deposition. In contrast with other contexts, bone fragments more than 10 cm long are rare in M129. However, the fragment size was not systematically recorded in this analysis.

5. Discussion

Observations and interpretations of the archaeological context do not always accord with the bone material. For example, the matrix of M259 is burnt debris and demolition material from a fire (e.g. soot, burnt clay, brick fragments and mortar, burnt wood), but the bone material is mostly unburned and in primary deposition, with accumulations of especially sheep and goat metapodials. Thus, it is likely that the bone material is not directly connected to the fire event but relates

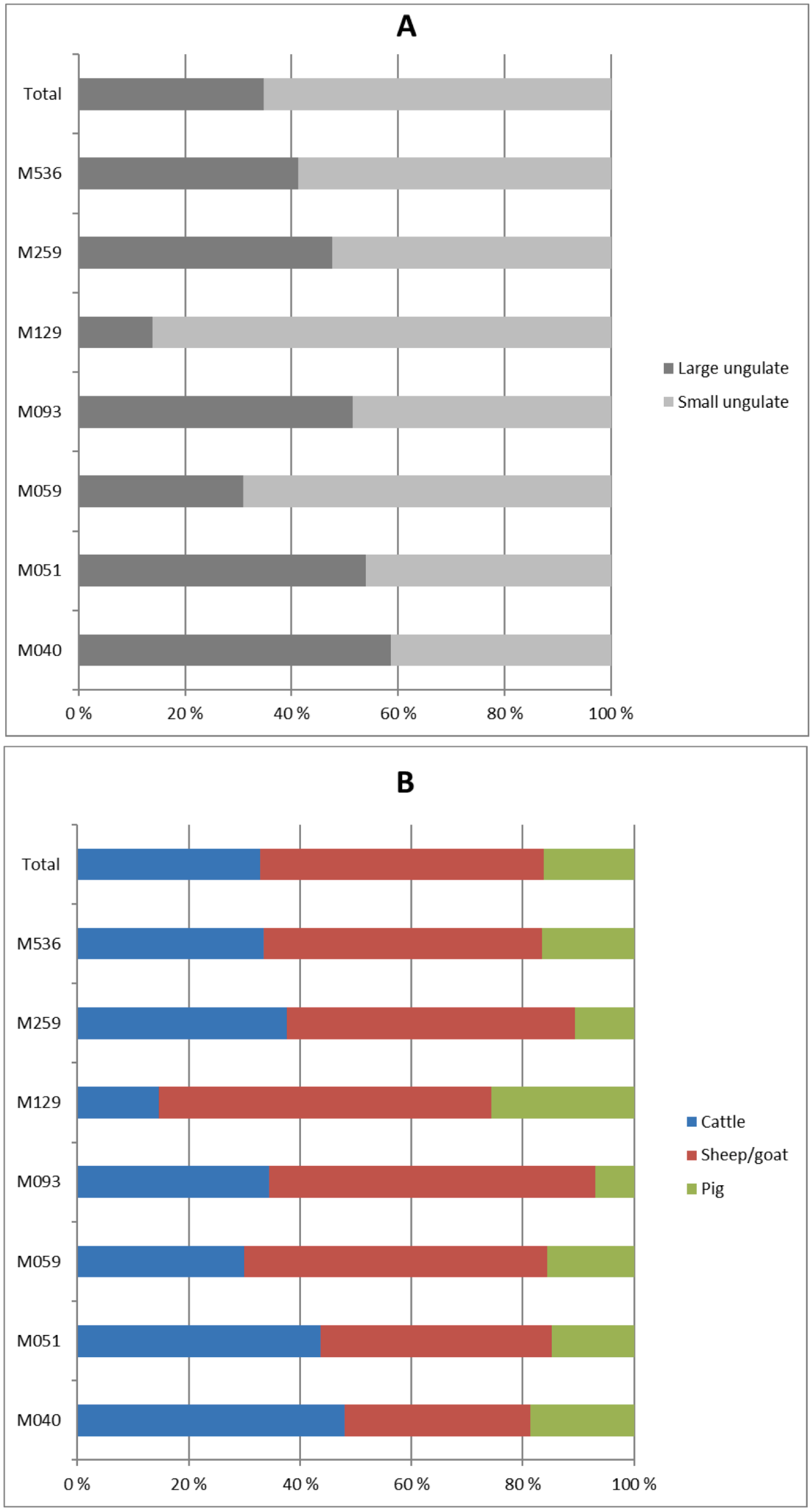

Fig. 2. a %NISP of large ungulate remains (combined cattle and small ungulates) and small ungulate remains (combined small ungulate, sheep, goat, and pig). Fig. 2b. %NISP comparisons of specimens that were identifiable to the genera level (cattle, sheep or goat and pig).

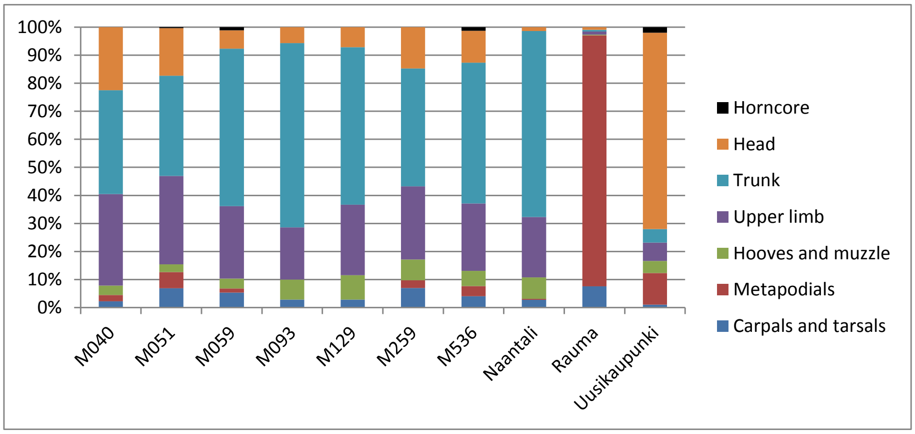

Fig. 3. Anatomical distribution of cattle bones from Katedraalikoulu, Naantali, Uusikaupunki, and Rauma. NISP for M040 89, M051 260, M059 337, M093 70, M129 139, M259 257, M536 221, Naantali 585, Rauma 2048, and Uusikaupunki 397. Head = skull bones (excluding horn cores and premaxillae), mandibles (excluding the anterior part), os hyoideum, and teeth; trunk = ribs, vertebrae, and sternum; upper limb bones = scapula, humerus, radius, ulna, pelvis, femur, patella, and proximal tibia; hooves and muzzle = premaxilla, anterior mandibula, phalanges 1–3, carpals, and tarsals, including distal tibia.

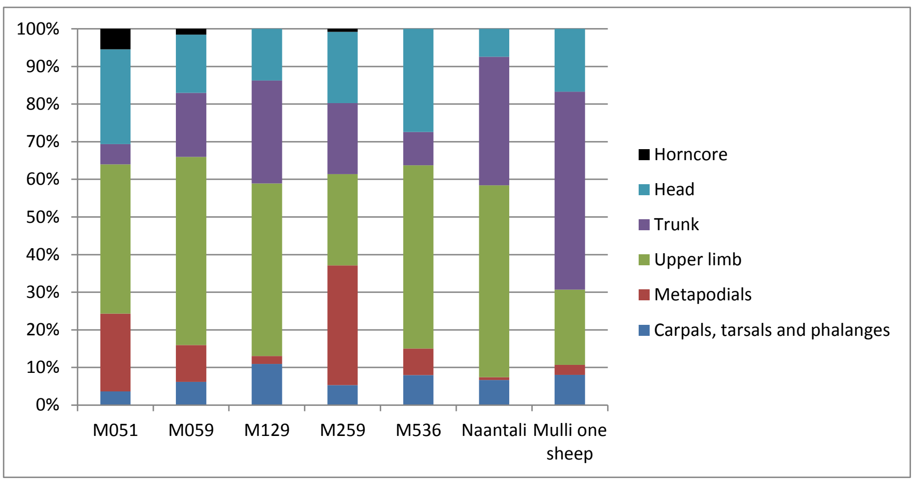

Fig. 4. Anatomical distribution of sheep and goat bones from Katedraalikoulu, Naantali, and Mulli (one sheep). NISP for M040 25 (not shown), M051 111, M059 194, M093 34 (not shown), M129 146, M259 132, M536 113, Naantali 284 and Mulli 150. Head = skull bones excluding horn cores, mandible, os hyoideum, and teeth; trunk = ribs, vertebrae, and sternum; upper limb bones = scapula, humerus, radius, ulna, pelvis, femur, patella, and tibia.

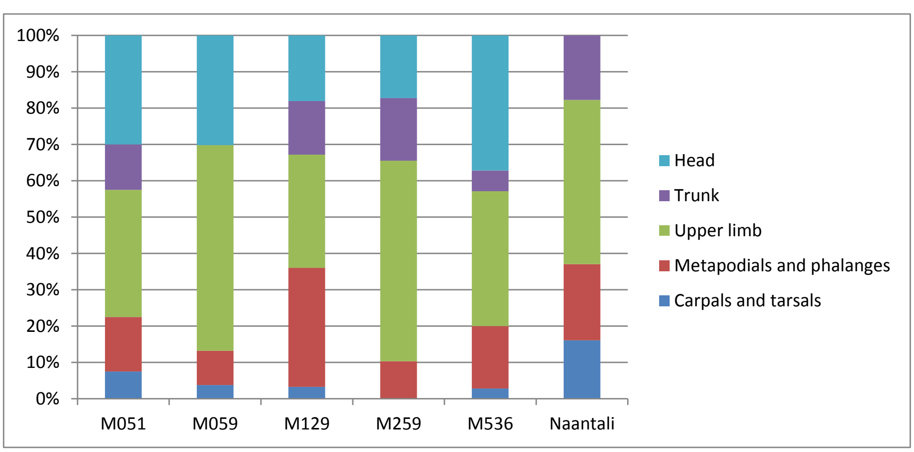

Fig. 5. Anatomical distribution of pig bones from Katedraalikoulu and Naantali. NISP for M040 14 (not shown), M051 40, M059 53, M093 4 (not shown), M129 61, M259 29, M536 35, Naantali 62. Head = skull, mandible, os hyoideum, and teeth; trunk = ribs, vertebrae, and sternum; upper limb bones = scapula, humerus, radius, ulna, pelvis, femur, patella, tibia, and fibula.

perhaps to utilization of vacant space for small-scale craft activities after the fire. Context M093 was initially archaeologically interpreted as a meadow pre-dating the urban phase. However, both bone and plant material are more likely to represent a phase of urban occupation and the first evidence of waste accumulation, rather than the utilisation of agricultural land (pers. comm. Mia Lempiäinen-Avci). For cattle yard deposits in M059 and M536, different deposition events are proposed. Bone material from M059 is largely in the primary context, perhaps

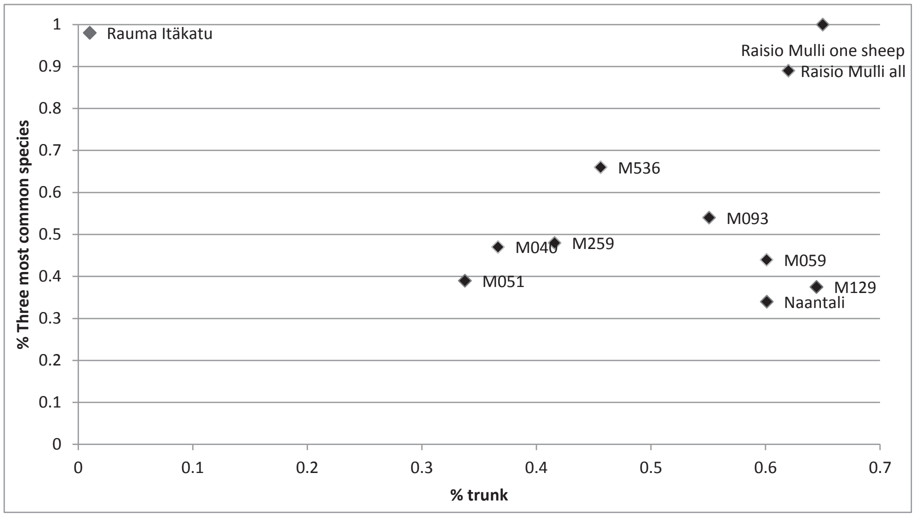

Fig. 6. Percentage comparison of the three most common mammal species (cattle, sheep/goat, pig or hare), and the percentage of trunk bones of consumed animals in the contexts (NISP).

Table 3
Anatomical distribution in Mulli and Naantali samples (% NISP).

	Mulli	Naantali
Head	19,4	4,5
Trunk	58,1	70,1
Limbs, upper	14,1	20,4
Limbs, lower	8,4	4,9

kitchen waste accumulated in the older yard matrix, with M536 probably being a secondary fill. Similar discrepancy with ecofacts and other archaeological data has been noted in previous urban studies (Dobney et al., 1996; Tourunen, 2008). Combining different types of data could help to study the complexity of the archaeological deposition processes, and in more precise identification of primary and secondary layers. This in turn could help to understand the use and development of the urban space.

The intra-site context variation in Katedraalikoulu may affect inter-site comparisons. For example, the proportion of fish, even in the standard-sized sieved samples, varied significantly. The proportion of cattle in the main domesticates in M129 was only 15%, but it was 48% in M040 and 33% in the material as a whole. Thus, the selection of the contexts for analysis and comparative material may affect the results.

Food preparation and consumption could be one of the factors affecting anatomical and species distribution. The large number of fish and bird bones, the small bone fragment size, and the high proportion of trunk elements indicate that the sample from M129 includes waste from food processing and consumption (Figs. 1 and 6). The same also seems to apply to material from M059, with the exception of the low proportion of fish bones and the presence of large bone fragments. These contexts exhibit also the lowest proportions of cattle bones. This may indicate that the selection towards discarding large bone elements before food preparation may affect species distribution. Similar results have been obtained from the Naantali kitchen waste deposits (Tourunen, 2011b). However, in M129 and M059, cattle bone elements from limbs are well represented, as they are from the trunk, unlike in Naantali. While divergent in other ways, these two deposits do not differ from other contexts when Simpson's diversity index and sample richness are compared. Thus, it seems possible that the observed variation in the species proportion is affected by food preparation and consumption patterns.

The highest proportion of cattle bones is derived from contexts that

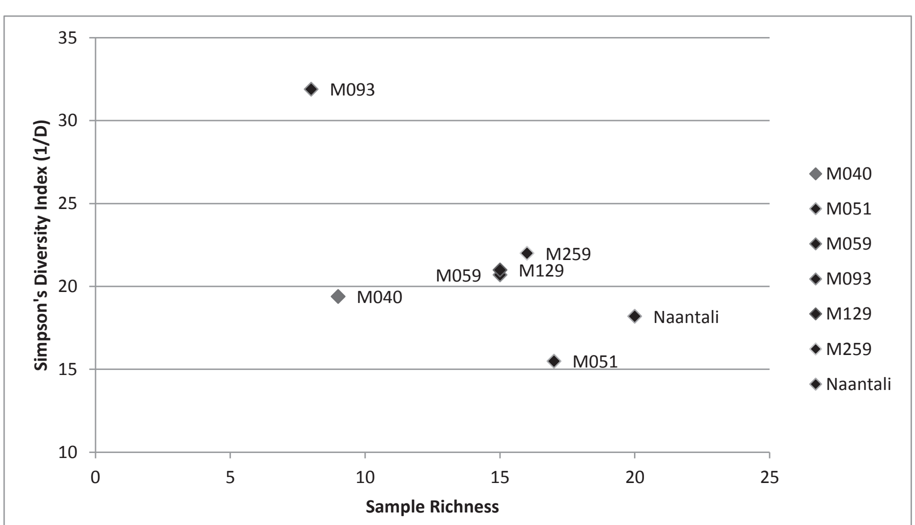

Fig. 7. Comparison of Simpson's Diversity Index and Species Richness (NISP).

Table 4
Number of anatomical articulations (epiphysis-metaphysis pairs) and proportions of abraded bones, rodent and dog or pig gnawing in the Katedraalikoulu material (%NISP, fish bones excluded).

Site	Context	Articulations	Abrasion	Rodent gnawing	Dog/pig gnawing
Katedraalikoulu, Turku	M040	–	2,6	1,5	2,6
Katedraalikoulu, Turku	M051	–	2,7	1,9	4,5
Katedraalikoulu, Turku	M059	7	0,1	2,1	8,3
Katedraalikoulu, Turku	M093	1	1,8	2,2	5,7
Katedraalikoulu, Turku	M129	2	0,3	1,6	1,8
Katedraalikoulu, Turku	M259	17	0,6	0,5	2,0
Katedraalikoulu, Turku	M536	1	1,3	0,5	8,1

have been interpreted as mainly secondary deposits (M040, M051). This may indicate some destruction of smaller or more fragile elements, such as bones with low structural density, e.g. ribs and vertebrae (Lyman, 1994). Thus, the preservation may have influence on the anatomical distribution. However, the high proportion of fish bones for M040 indicates that this is unlikely. For M051, most of the fish bones are derived from the bottom primary fill (Table 2). Post-discard taphonomic factors – gnawing, trampling, and relocating bones may have accelerated the demise of the bones of smaller species. Thus, more cattle bones would originally have been deposited in the yard area far from the kitchen, and additional attrition could have enhanced the difference further.

Waste from small-scale tannery activity, sheep and goat metapodials, was observed in context M259 (Fig. 4). The total number of metapodials was 42 (NISP), which consisted of 28% of all the sheep and goat bones. Without these bones, the number of cattle, and sheep and goat bones in the sample would be equal, and the proportion of the cattle higher, 44% instead of 38%. Thus, waste from craft activities mixed with domestic waste may have a small effect on the proportions of the animals in the sample, even if it does not make a great difference in the overall pattern in this case. A similar conclusion has previously been reached in the analysis of medieval and post-medieval material from Turku (Tourunen, 2008).

The Katedraalikoulu faunal remains exhibit context-dependent intra-site variation. However, compared with all the variation presented in Fig. 6, all the samples from Katedraalikoulu represent a minor variation on the same common theme. An examination of species composition and anatomical distribution demonstrates that most of the material from Katedraalikoulu seems to be derived from general domestic waste, including all anatomical elements, the exceptions being M 129 and M059, which include material from food preparation and consumption. For the presence of the main domesticates, the major pattern seems to remain constant with minor fluctuation: cattle and sheep (and goats) are the most common domesticates in the urban diet in Medieval Turku, with pigs utilised less. A similar pattern has been observed in previous studies (Tourunen, 2008). This could implicate that also inter-site comparisons could present valid results, as long as waste type is controlled.

Thus, intra-site context variation is a factor that should be considered before attempting inter-site or inter-phase comparisons. The identification of various activity areas within an urban area provides information about the organisation of the slaughter and animal utilisation, meaning the livestock trade and crafts, and everyday environment and realities of the inhabitants. In this study, using species abundance and the proportion of fish and bird bones and trunk elements incorporated with examining bone-surface modifications, bone fragmentation, and articulation patterns per context, proved efficient tools for identifying the deposit type, while Simpson's diversity index and species richness were less efficient.

6. Conclusions

The analysis of the faunal material reveals that in medieval Katedraalikoulu in Turku, the specialisation of acquiring and processing animal products was still limited. Yard deposits typically include anatomical elements relating to slaughter, butchery, consumption and even small-scale craft activities. This is likely to represent a system where live animals, raised or purchased, were slaughtered in the yard for a household's own consumption. Small-scale crafts could also be practised in the same area. However, the deposits are not uniform. In this material, the most significant factor affecting the proportions of the main domestic species and mammal, bird and fish bones is the process of meat preparation, which leads to an accumulation of specialised kitchen waste that is rich in fish and bird bones, with fewer cattle bones. In the more generalised waste deposits, the pattern of cattle, pig, and sheep or goat proportions is relatively uniform. While craft activities may affect proportions of certain species, this was not a major factor in the Katedraalikoulu material.

To understand the frequently complex histories of urban depositions, archaeological and environmental data should be combined. In large urban faunal materials indicators such as gnawing marks, epiphysis-metaphysis pairs, burning and abrasion are useful tools to gather information about the taphonomic processes that have shaped the assemblage. Also, this data contributes to the study of activity areas in the urban space. For future studies, these results stress the importance of having an awareness of past activities and processes, and the potential of faunal studies for the study of urban sites. Animal bones from urban deposits are an important source for the comparative analyses of the urbanisation processes, economic networking, spatial development and local characteristics of towns. However, the potential variations in the deposition history of the contexts may reduce the meaningfulness of these studies. Thus, classifying context types by their anatomical and species distribution is recommended prior to a comparative analysis.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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