Animal bones from the medieval settlement Otok (Gutenwerth) near Dobrava pri Škocjanu, Slovenia

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Izvleček

Predstavljena študija je analiza 452 živalskih kosti iz dveh predelov srednjeveškega naselja Otok (Gutenwerth), časovno umeščenih v 12.-14. stoletje. Gradivo je bilo zbrano pred več kot 30 leti, ko so pobirali predvsem cele, izredne primerke. Kljub sicer skromnemu številu najdb pa razpoložljiv vzorec vendarle vsebuje zelo kvalitetno arheozoološko in kulturno-zgodovinsko informacijo. Čeprav kvantitativnega razmerja med različnimi vrstami domačih živali ni bilo mogoče podrobneje analizirati, so posamezne najdbe ponudile veliko podatkov o uživanju mesa, srednjeveški govedoreji, obrtni dejavnosti (predvsem strojenju) in deformacijah na kosteh, ki so verjetno povezane z izkoriščanjem vlečne moči živali. V povezavi s slednjim so od arheoloških izkopanin pomembne najdbe konjskih in volovskih podkev. Kljub skromni velikosti vzorca ta ponuja zgoščeno zoološko informacijo, ki je nepogrešljiva pri interpretaciji sočasnih zgodovinskih virov.

Ključne besede: Otok (Gutenwerth), Dobrava pri Škocjanu, Slovenija, srednji vek, uživanje mesa, velikost/masa goveda, vlečna moč, strojenje, podkovanje

Abstract

This study is an analysis of 452 animal bones from two sites of the medieval settlement at Otok (Gutenwerth), representing the 12-14th century. The material was collected over 30 years ago. Therefore, mostly complete, spectacular animal bones were saved at the time. Consequently, in spite of its small size, the assemblage carried high quality archaeozoological and culture historical information. While it was not sufficiently large for the detailed quantitative study of proportions between domesticates in animal keeping, individual remains revealed high quality information on meat consumption, medieval cattle breeding, craft activities (especially tanning) and skeletal deformations possibly related to draught exploitation. Among the archaeological finds, horse and ox shoes are relevant to this latter topic. In spite of its small size, this assemblage offers concentrated zoological information that is indispensable in interpreting the contemporaneous historical record.

Keywords: Otok (Gutenwerth), Dobrava pri Škocjanu, Slovenia, Middle Ages, meat consumption, cattle stature/live weight, draught exploitation, tanning, shoeing

Animal bones discussed in this study were brought to light from the medieval settlement Otok (Gutenwerth) near Dobrava pri Škocjanu in southern Slovenia. Excavations were carried out at two sites between 1971 and 1975. Each of the excavated surfaces, opened along the ancient bed of the Krka River, measured approximately 1000 square meters.

With no archaeozoological analysis in sight over three decades ago, animal bones at Otok (Gutenwerth) were collected concentrating on the pieces that were considered most interesting by the excavators. Therefore, they bear more archaeological than zoological information. While the bone assemblage can by no means be considered representative, it powerfully illustrates some important aspects of animal use at this medieval market town.

The significance of the settlement also justified the normative evaluation of this selected set of animal bones in light of zoologically relevant coeval and modern materials. The "best" bone finds that found their way to the Collections of the National Museum in Ljubljana shed light to the external appearance and function of some of the animals slaughtered. They provide, therefore, uniquely important information on medieval animal exploitation in the southern part of Slovenia.

MATERIAL

Site 1 represents an area of workshops and a Romanesque church in the southern section of the medieval market town. Site 2, located northwest of Site 1, lay in the center of the same settlement. It represents, therefore a habitation area with houses, shops and a major street surface.

The numbers and chronological distributions of bones gathered at the two sites are relatively uneven (*Table 1*).

While the industrial periphery represented by Site 1 was dominated by animal remains from the 12th-13th centuries, most bones from Site 2 originate from undated proveniences. From this second area, on the other hand, almost twice as many bone fragments were collected as from Site 1. Most of the chronologically identifiable remains at Site 2 originate from the 12th century. Consequently, the 12th century is better represented by the material in the center, while information on 13th century animals is available only from Site 1 (*Fig. 1*). This chronological distinction, however, may not be of overwhelming importance in terms of the animals used during this short part of the Middle Ages: differences between the two sub-assemblages are more likely to reflect the function of the two areas (center vs. periphery) than diachronic developments.

Table 1: The chronological and spatial distribution of bones (NISP).
Tab. 1: Kronološka in prostorska porazdelitev kosti (NISP).

Site / izkopno polje	Century / stoletje				Total / skupaj
	12	**13**	**14**	**no date / nepoznano obdobje**	
1	69	93	1	7	170
2	55	3	8	216	282
Total / skupaj	**124**	**96**	**9**	**223**	**452**

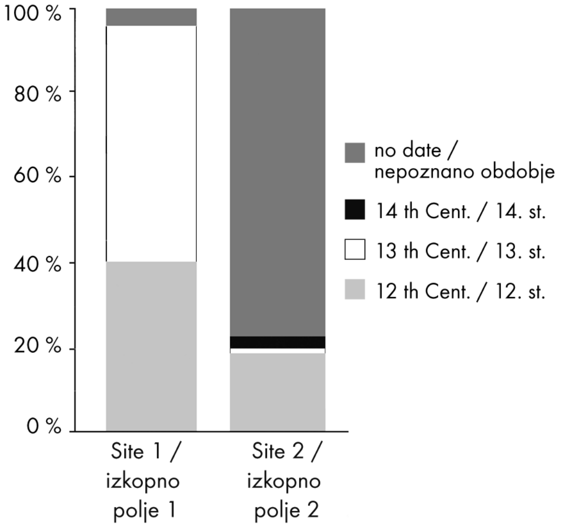

Fig. 1: The composition of the animal bone assemblage.
Sl. 1: Sestava gradiva živalskih kosti.

Although the gathering of animal remains was strongly selective, it cannot be considered random, since it concentrated on the ”best” pieces as judged by excavators with no zoological training. This is, as usual, shown by the fact that the relatively small assemblage contains a typically high proportion of well preserved, measurable bone specimens. The overwhelming majority are robust cattle metapodia, resistant to a host of taphonomic factors, including butchery, natural fragmentation and destruction by dogs.[1] Horn cores form the next largest group of major zoological interest. These bones bear substantial information concerning medieval bovids, including cattle, sheep and goat.

The disadvantage of this faunal material is that it cannot be reliably used in the standard, quantitative reconstruction of meat consumption, since species proportions and body part representation in the faunal list cannot be taken at face value. Due to hand-collection, small bones from animals such as caprines (sheep or goat) and pig are probably underrepresented in the final, inventorised assemblage. Selective archaeological recovery may consequently distort the appraisal of the extent to which animals played a major role in medieval meat consumption at this site.

Forms of ”secondary” exploitation (especially, the use of draught or pack animals) and hide processing), on the other hand, are illustrated by valuable individual finds included in the material collected at the site.

In addition to the effects of selective recovery, a number of ”real” pre-depositional taphonomic factors possibly influenced the composition of this assemblage:

1. Differences between Sites 1 and 2 must have been caused by the aforementioned medieval func-

[1] L. Bartosiewicz, Archaeozoology or zooarchaeology?: A problem from the last century, *Archaeologia Polona* 39, 2001, 75-86.

tional difference between the two areas. Industrial deposits at Site 1 seem to have been accumulated in more clearly defined features, while household garbage and refuse of all sorts were probably more thoroughly mixed in the habitation area of Site 2, especially the intensively used road surface (trampling and leveling). The negligible number of small, taxonomically non-identifiable bone fragments is probably the result of the aforementioned modern-day bias caused by selective recovery.

2. Primary, medieval bone loss must be reckoned with if the animals died off site (e. g. in the fields) or their slaughter and primary butchering took place at special places outside the excavated surfaces. This would be a typical manifestation of differential disposal especially in complex urban settlement, characteristic of specialised, non-subsistence economies.

3. Gnawing marks by dogs (9 of 170 bones at Site 1 and 3 of 282 bones at Site 2) are indicative of bone loss due to scavenging by these animals as well as pigs which probably co-habited with humans at this medieval settlement. Even in the Altstadt of Frankfurt am Main pigs, consumers of kitchen refuse,[2] were banned as late as 1481 because they were "unworthy of a great city".[3] It is possible, therefore, that in the probably less urbanised environment of 12th-13th century Otok, as in many towns until the recent past,[4] pigs were literally part of the landscape.

METHODS

All animal species in this paper are described in terms of the number of identifiable bone specimens (NISP). Estimating the numbers of individuals is a procedure riddled by subjective bias even in more completely retrieved animal bone samples.[5] Sporadically occurring articulated bones, naturally, were recorded by individuals.

Identifiable remains of the most important meat producing animals were classified into Hans-Peter Uerpmann's[6] categories ranging between A to C, representing decreasing meat content, associated with quality in modern economic terms.[7] In the case of the Otok material, however, these tentative values would reflect the aforementioned taphonomic loss as much as patterns of medieval meat consumption.

Considering the relatively great number of well preserved bones in this assemblage, the standardised measurement of bones was of particular importance. The system and nomenclature of measurements developed by Angela von den Driesch[8] was applied. An additional measurement was, however, introduced on long bones. While BD conventionally stands for the mediolateral breadth of the distal epiphysis, DD was used to measure the greatest dorsoventral depth in the same region.

MEAT CONSUMPTION

Typically for most medieval urban settlements, meat from domestic animals was the main source of animal protein (the consumption of dairy products is difficult to reconstruct using only animal bones). The only wild animal species identified in the Otok assemblage, red deer was represented only by antler fragments, that is, manufacturing debitage. This observation is of particular importance, since antler could also be acquired by gathering shed antler during the spring, i. e. without killing the animal. A complete animal bone assemblage, including antler remains found attached to the skull, would be required to decide, whether hunting played any role in the diet at this site.

A tentative classification of bone fragments into the previously mentioned categories of meat quality is shown by sites in *Table 2*. It is remarkable that (regardless of chronological sub-division) the percentual distribution of bones assigned to various meat value categories is almost identical at the two sites. Similarities between cattle and sheep/goat are especially striking. Pig, a single purpose meat animal, stands apart with half of its bones representing good quality (category A) cuts at both sites. On the other hand, dry limb bones (tarsalia, metapodia and phalanges) are very small in

[2] H. J. Greenfield, Bone consumption by pigs in a contemporary Serbian village: implications for the interpretation of prehistoric faunal assemblages, *Journal of Field Archaeology* 15, 1988, 473-479.

[3] N. J. G. Pounds, *An economic history of medieval Europe* (London 1974) 278.

[4] L. Bartosiewicz, "There is something rotten in the state..." Bad smells in Antiquity, *Journal of European Archaeology* 6/2, 2003, 171-191.

[5] D. K. Grayson, *Quantitative Zooarchaeology*. Studies in Archaeological Science (New York 1984).

[6] H.-P. Uerpmann, Animal bone finds and economic archaeology, *World Archaeology* 4/3,1973, 308-309.

[7] L. Bartosiewicz, This little piggy went to market ... An archaeozoological study of modern meat values, *Journal of European Archaeology* 5/1, 1997, 170-182.

[8] A. von den Driesch, *A guide to the measurement of animal bones from archaeological sites,* Peabody Museum Bulletin 1 (1976).

Table 2: Meat quality NISP values by sites.
Tab. 2: Število ostankov posamezne kvalitetne kategorije po izkopnih poljih.

Species / vrsta	**Site 1 / izkopno polje 1**			**Total / skupaj**
Meat Quality / kakovost mesa	**A**	**B**	**C**	
cattle / govedo	23	35	61	119
sheep/goat / ovca/koza	1	8	9	18
pig / domači prašič	9	8	2	19
Total / skupaj	**33**	**51**	**72**	**156**
	Site 2 / izkopno polje 2			
cattle / govedo	26	80	121	227
sheep/goat / ovca/koza	1	8	13	22
pig / domači prašič	10	8	5	23
Total / skupaj	**37**	**96**	**139**	**272**

pigs and horns are entirely missing. Thus, in contrast to caprines, both selective recovery and anatomical differences tend to reduce the percentage of poor quality, category C bones in pig.

Bone distributions by meat quality categories do not reflect the known functional differences between Sites 1 and 2. In this selected assemblage, general characteristics of animal species tend to interfere with possible spatial distinctions by meat exploitation.

Cattle (*Bos taurus* L. 1758)

Cattle is by far the animal species best represented in the faunal list from the settlement of Otok (*Table 3*). It seems to be unambiguously the most important animal species in this assemblage. At Site 1, its bones are more than five times as common as those of either pig or sheep/goat. Half of the identifiable specimens belonged to the poorest meat quality category (C), that is mostly represent the distal extremity segment.

At Site 2, cattle bones number consistently twice as many as the remains from smaller domesticates. The proportion of category C bones is, however, similarly high. This category includes hefty, compact bones (such as astragali, metapodia etc.) as well as "spectacular" horn cores. The consistently high proportion of these bones associated with poor meat quality therefore probably results from a combination between the differential preservation and preferential collection of such specimens by archaeologists.

In spite of distortions caused by selective archaeological recovery, cattle is known to have been the most important supplier of meat at many medieval urban sites due to its large individual size and frequently documented central merchandising system. For example, an association of butchers was mentioned in London in a document from 1179,[9] while in Hungary, a butchers' guild was organised in Buda by the late 13th century. The butchers of Buda were engaged in trading both live cattle and beef.[10]

It is for this reason that the overwhelming dominance of cattle bones in this assemblage seems realistic in spite of all the biasing factors carefully considered.

Pig (*Sus domesticus* Erxl. 1777)

Pig bones consistently numbered one 1/8 of those from cattle in both the 12th (13:88) and 13th (8:64) century assemblages, as well as among the bones with no dated provenances (21:185; *Table 3*). This proportion is comparable to data from other medieval urban sites. Pig, however, is more comparable to sheep and goat in terms of live weight, reproduction and resulting meat output. The increasing proportion of pork consumption relative to that of mutton between the 11th-13th centuries in Basel has been interpreted as a sign of improving living standards.[11] The high incidence of category A pig bones is certainly indicative of the importance of pork in meat consumption at both sites of this settlement (*Table 2*).

[9] P. Jones, *The butchers of London* (London 1976).

[10] B. Bevilaqua Borsody, *A budai és pesti mészároscéhek ládáinak okiratai 1270-1872* 1 (Documents from the chest of the Buda and Pest butchers' guilds 1270-1872) (Budapest 1931).

[11] J. Schibler, B. Stopp, Osteoarchäologische Auswertung der hochmittelalterlichen (11.-13. Jh.) Tierknochen aus der Barfüsserkirche in Basel (CH), in: D. Rippmann, B. Kaufmann, J. Schibler, B. Stopp (eds.), *Basel Barfüsserkirche: Grabungen 1975-1977* (Olten, Freiburg im Breisgau 1987) 307-335, Abb. 1.

Table 3: The chronological distribution of animal bones (NISP).
Tab. 3: Kronološka porazdelitev živalskih kosti (NISP).

Species / vrsta	Century / stoletje				Total / skupaj
	12	13	14	no date / nepoznano obdobje	
cattle / govedo	88	64	9	185	346
sheep / ovca	3	2		5	10
goat / koza	5	5		3	13
sheep/goat / ovca/koza	8	8		4	20
pig / domači prašič	13	8		21	42
horse / konj	1	1		4	6
hen / petelin	2				2
red deer / jelen	2	1			3
large ungulate / veliki kopitarji	1	8		1	10
Total / skupaj	123	97	9	223	452

Unfortunately, the number of bones from these medium size domestic ungulates was small at the site of Otok, therefore diachronically changing proportions between the remains of pig and sheep/goat are impossible to interpret. A purely cultural interpretation of archaeozoological data may be erroneous even if bones are gathered systematically.

Sheep (*Ovis aries* L. 1758) and goat (*Capra hircus* L. 1758)

As was mentioned previously, the small number of bones from medium size ungulates makes the appraisal of their role as suppliers of meat unreliable. While mutton was undoubtedly consumed by the inhabitants of this town, the meat from sheep and goat seems to have been less important than pork. In addition to the selective retrieval of bones, the great number of category C bones (horn cores and metapodia; *Table 2*) may be related to tanning activities as will be discussed later.

Other animal species

Of the remaining species in the faunal list (*Table 3*) only domestic hen (*Gallus domesticus* L. 1758) may be considered unambiguously a meat animal. Its presence is not a surprise in the 12th century urban deposit. Chicken may have been easily kept in the town itself. Remains of horse (*Equus caballus* L. 1758) and red deer (*Cervus elaphus* L. 1758) did not occur within the context of meat consumption at this site. Aside from a more-or-less complete front limb found at Site 1, horse was represented only by a maxilla fragment that came to light at Site 2. Red deer antler fragments were recovered from a workshop area.

OSTEOMETRICAL RECONSTRUCTION

Small cattle are depicted in medieval sources relatively frequently (*Fig. 2*).[12] In the absence of

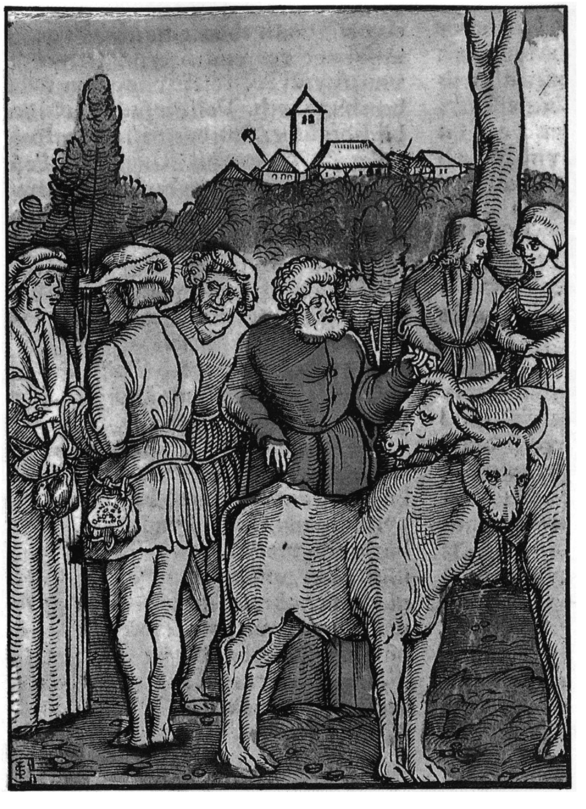

Fig. 2: Representation of small medieval cattle in Hans Leonhard Schäufelein's *Evangelienbuch* (1515).
Sl. 2: Ponazoritev majhnih srednjeveških goved v delu *Evangelienbuch* Hansa Leonharda Schäufeleina (1515).

[12] D. Dercsényi and P. Granasztói, *Vác* (Budapest 1960); J. Thuróczy, *A magyarok krónikája* (The Chronicle of Hungarians) (Budapest 1980).

scientific data, however, iconographic evidence could not be verified. Thanks to the fact that well preserved bones were collected, the size of animals represented at this site may be estimated both in absolute (cattle, horse) and relative terms.

Cattle withers height estimations

Withers height estimations are based on the greatest lengths of the few completely preserved metapodia in cattle.[13]

The cessation of longitudinal growth in long bones, appears at the time of epiphyseal fusion. According to most authors[14] the distal end of metacarpalia reach this state by the age of 2-2.5 years. A somewhat older age of 3 years is suggested for the fusion of metatarsals, but an even longer time of 3-3.5 years was given by Silver.[15] These relatively young ages mean that complete metapodials originate from animals which are not necessarily fully grown, but already reflect the inherited potential stature rather than the actual withers height of the individual.[16]

As is shown in *Appendix 2,* six complete metapodia were recovered from undated deposits at Site 2. The yielded a mean withers height of 1082.5 mm (standard deviation = 26.4 mm). Four 12th century withers height estimates averaged a similar 1064.6 mm (standard deviation = 42.5 mm). The withers height of the smallest cattle was less than 1 m (959.8 mm; 13th century), while the tallest individual had an estimated withers height of 1169.3 mm (14th century). Even the extremes of withers height, however, fit within the overall picture of small medieval cattle.[17]

Cattle live weight estimations

In contrast to more proximally located long bones,[18] early fusing metapodial bones adapt to the weight increase of animals, to a great extent, by the external widening of bone and an increase of cortical bone ensured by bone remodeling. In 1637, Galileo Galilei observed that as a result of the cubic increase in live weight relative to linear measurements, bones must be scaled out of proportion to support the animal's body mass. While longitudinal bone measurements are proportional to body mass in a more degressive manner than would be expected on the basis of this cubic increase (allometric coefficient = 0.26), bone diameters display a somewhat less degressive growth trend (allometric coefficient = 0.36).[19]

This principle was used in the estimation of live weight, using reference collections in the Hungarian Agricultural Museum, Budapest and in the Koninklijk Museum voor Midden-Afrika in Tervuren, Belgium (collections described in *Appendix 3*[20]). Relationships between the decimal logarithms of live weight (LW, kg) and the mean diameter of metapodia (smallest breadth and smallest depth of diaphysis were averaged = d, mm) were studied. In this calculation no sub-divisions by age, sex or phaenotype were used: all data were pooled on a functional basis.

The allometric equations obtained for 130 metacarpals were as follows:

$$\log d = 0.308 * \log LW + 0.681 \quad (r = 0.741)$$

This trend, supported by a high and significant linear correlation clearly shows the aforementioned

[13] J. Boessneck, Ein Beitrag zur Errechnung der Widerristhöhe nach Metapodienmasse bei Rindern, *Zeitschrift für Tierzüchtung und Züchtungsbiologie* 68/1, 1956, 75-90; V. I. Calkin, Izmenchivost metapodii i eo znachenie dla izuchenia krupnogo rogatogo skota (Metapodialia variation and its significance for the study of ancient horned cattle), *Biulleten Moskovskovo Obshchestva Ispitatelei Prirodi. Otdel biologicheski* 55, 1960, 109-126; J. Matolcsi, A budavári ásatások állatcsontjai (Animal bones from the excavations of Buda Castle), *Élet és Tudomány* 6, 1977, 163-166; L. Bartosiewicz, Biometrics at an Early Medieval butchering site in Hungary, in: E. A. Slater J. O. Tate (eds.), *Science and Archaeology Glasgow 1987,* BAR British Series 196 (1988) 361-367.

[14] M. F. X. Lesbre, Contribution a l'étude de l'ossification du squellette de Mammiféres Domestiques, *Annales de la Societé d'Agriculture Science et Industrie de Lyon* 5, 1897, 1-106; A. Z. Bruni, U. Zimmerl, *Anatomia degli animali domestici 1* (Milano 1951); K.-H. Habermehl, *Altersbestimmung bei Haustieren, Pelztieren und beim jagdbaren Wildtieren* (Berlin, Hamburg 1961); I. A. Silver, The ageing of domestic animals, in: D. R. Brothwell, E. Higgs (eds.), *Science in archaeology, a survey of progress and research* (Bristol 1965) 250-268; E. Schmid, *Tierknochenatlas* (Amsterdam, London, New York 1972).

[15] Silver (n. 14) 252.

[16] W. Prummel, Withers height for cattle: metapodials give higher values than other long bones, *Communications of the IVth International Conference of ICAZ* (London 1982).

[17] S. Bökönyi, *History of domestic mammals in Central and Eastern Europe* (Budapest 1974) 136.

[18] P. L. Bergström, L. H. Van Wijngaarden-Bakker, De metapodia als voorspellers van formaat en gewicht bij runderen, *IVO-Rapport* B 206, 1983, 3-46.

[19] R. Mc N. Alexander, Body support, scaling and allometry, in: M. Hildebrand, D. M. Bramble, K. F. Liem, D. B. Wake, (eds.), *Functional vertebrate morphology* (Cambridge Mass., London 1985) 27-37.

[20] L. Bartosiewicz, W. Van Neer, A. Lentacker, Metapodial asymmetry in cattle, *International Journal of Osteoarchaeology* 3/2, 1993, 69-76.

Fig. 3: Differences in the robusticity of metatarsus in cows (a and b) and bull/ox (c).
Sl. 3: Razlike v robustnosti stopalnic pri kravah (a in b) ter bikih/volih (c).

cubic increase of live weight relative to bone diameters in the front limb that carries most of the animals body mass in cattle. This tendency is somewhat less apparent in 124 metatarsal bones:

$$\log d = 0.269 * \log LW + 0.773 \ (r = 0.640)$$

When the equations are reversed, the live weight of medieval cattle from Otok can be estimated. These values (listed in *Appendix 3*) averaged 205 kg. Never the less, differences in the robusticity of cattle metapodial bones reflect a great variability in this regard, attributable, to some extent, to sexual dimorphism (*Fig. 3*).

Cattle typology

Morphologically, the form identified at Otok is characterised by short and gracile horns representing the traditional "brachyceros" cranial type.[21]

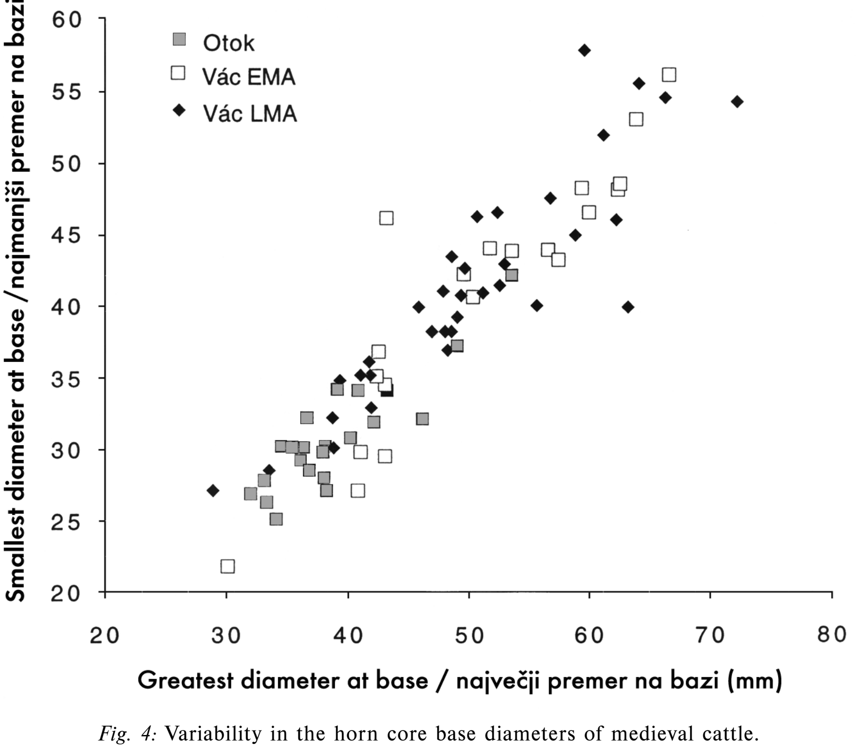

Fig. 4: Variability in the horn core base diameters of medieval cattle.
Sl. 4: Variabilnost v premeru rožnic na njihovi bazi pri srednjeveških govedih.

[21] J. Matolcsi, *A háziállatok eredete* (The origin of domestic animals) (Budapest 1975) 30.

Fig. 5: Draught cattle of Buša type (Bökönyi, n. 17).
Sl. 5: Vprežno govedo tipa buša (Bökönyi, op. 17).

The average length of 12 non-dated specimens was 82.6 mm (standard deviation = 17.2 mm) and only a 13th century specimen reached the length of 135 mm. Diameters measured at the bases of horn cores are also indicative of small, brachyceros type animals even by medieval standards (*Fig. 4*). In this graph, horn core diameters of the Otok cattle were plotted together with early (EMA: 11-13th centuries) and late (LMA: 14-15th centuries) medieval specimens from Vác, a market town north of Budapest in Hungary. Two major size groups in this scatter diagram correspond to cows (smaller horns) and bulls/oxen (larger horns). While no size difference is apparent between early and late medieval cattle from Vác, cattle from Otok had remarkably small horns. This also results from the fact that, with the exception of two specimens, all horn cores from Otok seem to originate from cows.

In terms of body conformation, the small, traditional Buša cattle (*Fig. 5*) may be considered analogous (even if not directly related) to the medieval animals identified at Otok. These latter, however, look extremely gracile even in light of recent cow metacarpal measurements gathered by Mennerich in Bosnia.[22] Metacarpal bones from draught oxen of Buša lineage were most robust in that modern reference collection. While these measurements more-or-less form a continuum, 12th-13th century bones from Otok fall within the lower third of the size range (*Fig. 6*).

Withers height estimations of a horse

An almost complete front limb, including a fragmented scapula, a humerus, radius and a metacarpus were found at Site 2. The greatest lengths of these bones yielded an estimated withers height of 1336.5 mm.[23] This stature may be considered average for the Middle Ages, although coeval horses in Germany were usually taller sometimes reaching a withers height of 1500 mm.[24]

This adult horse, possibly a mare, was definitely slender legged: the smallest diaphyseal breadth

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22 G. Mennerich, *Römerzeitliche Tierknochen aus drei Fundorten des Niederrheingebietes* (München 1968) Dissertation, Institut für Paleoanatomie, Domestikationsforschung und Geschichte der Tiermedizin der Universität München.

23 L. Bartosiewicz, Avarkori lovak végtagarányai (Extremity proportions of Avar Period horses), *Móra Ferenc Múzeum Évkönyve* 1991, 301-310.

24 W. Herre, Die Haustierreste mittelalterlicher Siedlungen der Hamburger Altstadt. Untersuchungen über die Tierknochenfunde in der Kleinen Bäckerstrasse, *Hammaburg: Zoologischer Garten N. F.* 17, 1950, 103-121; H. Requate, *Zur Geschichte der Haustiere Schleswig-Holsteins,* Zeitschrift für Agrargeschichte 4, 1956; H.-H. Müller, *Die Tierreste von Alt-Hannover. Hannover,* Hannoversche Geschichtsblätter 12 (1959).

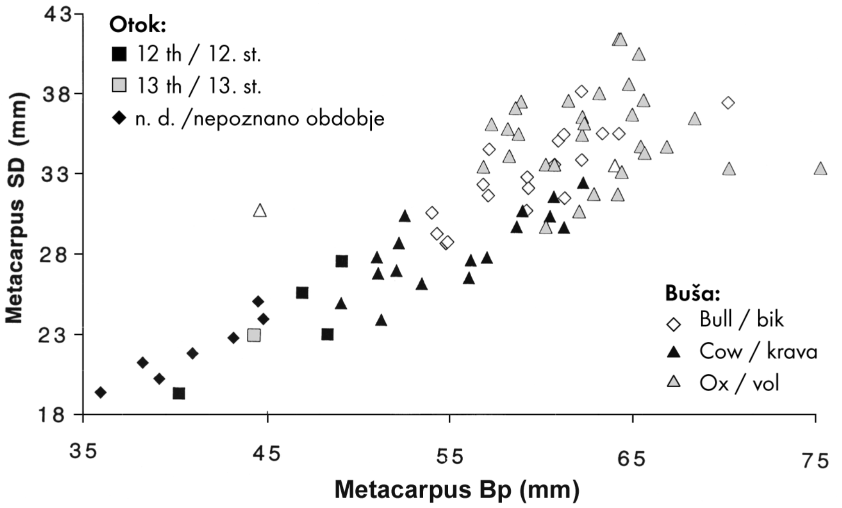

Fig. 6: Comparison between the slenderness of medieval cattle from Otok and modern Buša cattle.
Sl. 6: Primerjava vitkosti srednjeveških goved z Otoka s sodobnim govedom tipa buša.

of the metacarpus measured only 13.8% of greatest length. Brauner's[25] criterion for the "slender legged" category is a value ranging between 13.6-14.5%. Unfortunately, these articulated bones originate from a road deposit so that their chronological position cannot be precisely identified. It is noteworthy, however, that a very small horse shoe, found in Square 551 of the same site, could be dated to the 14th century (Vida Stare, personal communication).

Red deer antler

Red deer antler fragments saved from this site should under no circumstances be regarded as kitchen refuse. This raw material may have originated equally from hunting or gathering shed antler during the winter.

Two measurable burr fragments displayed marks of sawing. Their circumferences measured 307.4 and 311.2 mm which is more than the 247.3 mm mean value (standard deviation = 2.66 mm) calculated for 18,272 modern antlers from Hungary.[26] Using the modern analogy, antler roses of this size may have belonged to single (one side) antlers weighing over 9 kg in mature animals.

CRAFTS, PROCESSING ANIMAL PRODUCTS

In major medieval cities, specialised butchers slaughtered animals and marketed animal products. As was mentioned previously, the accurate reconstruction of meat consumption patterns is not possible at Otok. However, medieval butchers were frequently involved with primary hide processing as well. The overwhelming dominance of bones from adult and mature cattle in tanning areas may also be interpreted as evidence of hide exploitation,[27] although selective recovery at the sites of Otok may have somewhat overemphasised the importance of the tanning industry.

Both sites were littered with horn cores and well preserved metapodium fragments also commonly occurred at the settlement. As mentioned, Site 1 had been identified as a tanning area on the basis of specialised metal artifacts and large pits characteristic of this activity. It is noteworthy, however, that there is no marked difference between the relative frequencies of horn cores and metapodial bones at the two sites. Numerous complete goat horn cores were discovered as well (*Appendix 2*). Goat horn core deposits occur relatively frequently in urban deposits and are usually associated with

[25] A. Brauner, *Materiali k poznaniyu domashnikh zhivothnikh Rossii* I. *Loshad kurgannikh pogrebenij Tiraspolskogo uyezda, Gershonskoy gubernii, Equus goschkewitschi, Mihi* (Materials to the knowledge of domestic animals in Russia I. Horse in the kurgan burials of Tirapolski district), Zapiski Imperialnovo Obshchestva Sel'skogo Hoziaystva Yuzhnoi Rossii 86/1, Odessa (1916).

[26] I. Bán, Gy. Fatalin, A gímszarvastrófea-értékmérők és az életkor (Trophy traits and age of red deer), in: I. Bán et al. (eds.), *Élőhely és trófeavizsgálat számítógéppel* (Computerized habitat and trophy evaluation) (Budapest 1986) 122-158.

[27] Schibler, Stopp (n. 11) 321.

Fig. 7: Sixteenth century tannery in Jost Amman's *Das Städebuch* (1568).
Sl. 7: Strojarna v 16. stoletju, kot jo prikazuje delo *Das Städebuch* Josta Ammana (1568).

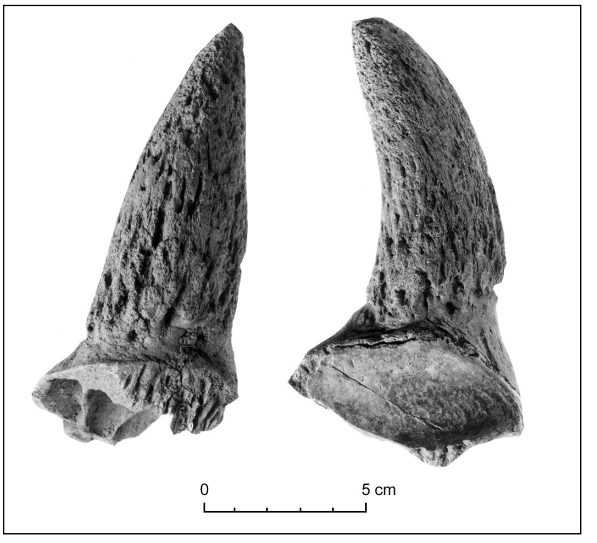

Fig. 8: Short horn cores of cut off of the skull of cattle.
Sl. 8: Kratke goveje rožnice, ki so bile odsekane od lobanj.

tanning activities.[28] A typical, triangular sheep horn core base fragment with cutmarks was found in the 12th century deposit of Square 67 at Site 1, southwest of Tanning Pit 1 (Vida Stare, personal communication). In general, however, the great proportion of metatarsals is most characteristic of Site 1 (especially during the 12th-13th centuries) that includes the tannery.

Raw hides were often taken to the tannery with the horns and feet still attached to them (*Fig. 7*). Large ungulates were skinned after by separating the feet between the phalanges and the distal end of metapodia. According to Noddle[29] the relative absence of bovine phalanges in kitchen deposits may suggest the existence of a tannery even if unlocated by archaeological data, such as relevant features pinpointed during the excavation. *Figure 8* also shows how horns, carefully cut at the base, may have been carried to the tannery together with raw hides. Horn cores showing such cut marks were also found at Site 1 (*Fig. 8*).

Alternatively, metapodial bones were left in the hide together with the phalanges. This latter possibility is shown by a skinned stag depicted by Albrecht Dürer (*Fig. 9*). Robust metapodia may have served as weights when the skins were hanged to dry. An ethnographic example of drying goat skins this way during the winter was described by Schmid from Obersaxen during the mid 1960's. Traditionally the feet and horns attached to the skin also helped the verification of the animal's age and condition when the skin was sold.[30] The lack of phalanges, especially from small artiodactyls, within the tannery refuse from Otok, however, may be due to recovery bias.

The hides of freshly flayed modern cows of an unimproved breed comparable to the Otok individuals (live weight: 216-377 kg) weigh 15.5-30.7 kg.[31] Skin processing was not only, as Schmid described it, a tedious, "*langwieriges Geschäft*".[32]

[28] For example E. Schmid, Ziegenhörner als Gerberei-Abfall, *Korrespondenzblatt der Schweizerischen Gesellschaft für Volkskunde* 5/6, 1973, 65-66; D. Serjeantson, Animal remains and the tanning trade, in: D. Serjeantson, T. Waldron (eds.), *Diet and crafts in towns,* BAR British Series 199 (1989) 129-146.

[29] B. Noddle, Animal and plant remains I. Mammal bone, in: H. Clarke, A. Carter (eds.), *Excavations in King's Lynn 1963-1970* 1, The Society for Medieval Archaeology Monograph Series 7 (1977) 368-399.

[30] E. Schmid, Als das Gerben noch ein langwieriges Geschäft war ..., *Ciba-Geigy-Zeitschrift* 4/1, 1974, 8-11.

[31] N. N. Kolesnik, *Evoluciya krupnovo rogatovo skota* (Stalinabad 1949).

[32] Schmid (n. 30) 8.

Fig. 9: Red deer skin with intact head and feet as depicted in Albrecht Dürer's design of Emperor Maximilian's triumphal arch (1515).
Sl. 9: Jelenja koža z nepoškodovanimi glavo in spodnjimi deli obeh parov okončin, kot jo je na zmagoslavnem slavoloku cesarja Maximiliana upodobil Albrecht Dürer.

Large scale, industrial tanning also became one of the most polluting activities in medieval towns. In addition to masses of refuse from defleshing, skin processing included the use of lime or ash and often urine for the purposes of dehairing. Soaking in an alkaline solution containing trypsin is also common. Additional substances used in soaking included dog excrement and pigeon dung. Drenching was often made using stale beer or urine. Only after these procedures were vegetable and mineral tanning agents applied. As may be seen in the background of *Fig. 7,* these procedures were carried out preferentially along shallow river banks. The site's proximity to the ancient bed of the Krka River may be of relevance here. Tanning within the urban settlement of Otok gives us yet another glimpse of medieval standards of hygiene.

DRAUGHT EXPLOITATION

Medieval livestock prices from England (1290-1315[33]; 1348-1349[34]) consistently suggest that draught oxen were the most valuable domestic animals. The 20% smaller price of common cart horses probably is due to the fact that they had no meat value: hippophagy became a taboo after the onset of Christianity in many European countries.[35] The Vienna Illustrated Chronicle mentions that during the 1046 pagan uprising in Hungary, people "ate horse flesh and committed all sorts of other horrible sins".[36]

It is difficult to tell whether cattle slaughtered at medieval Otok had been used as working animals previously or beef was obtained from animals raised predominantly for meat. Bones from beasts of burden were not necessarily incorporated in kitchen refuse unless the meat of these animals was consumed.[37] In medieval Italy the tough meat of working oxen indeed served as food only in the lower social strata, people with very strong stomachs or very vigorous persons.[38]

As far as the morphological signs of draught exploitation are concerned, the animal's age, live weight and function all stimulate ectopic bone growth. Combining deformations of different causes, however, mirrors reality when a variety of conditions define an animal's working capacity. A culminating effect of distorting factors (old age, pathologies and overworking) usually leads to culling. Sporadic osteological evidence of what may have been draught exploitation, however, is available even in this small assemblage. Osteological symptoms of heavy working fall in three groups at this site.

Robusticity of metapodial bones

Mennerich[39] identified gain in live weight as the single cause leading to the robusticity of metapodials. Heavy draught exploitation, however, stimulates additional growth in skeletal mass in order to restore optimal strain balance in the bones.[40] As was discussed within the context of live weight reconstructions, even bones of comparable length may belong to animals of different live weights. In addition to the manifestation of sexual dimorphism in body mass, extensive draught

[33] M. Murphy, J. A. Galloway, Marketing animals and animal products in London's hinterland circa 1300, *Anthropozoologica* 16, 1992, 93-100.

[34] J. Langdon, *Horses, oxen and technological innovation* (Cambridge 1986) 200.

[35] Ib. 261.

[36] J. Matolcsi, *Állattartás őseink korában* (Animal keeping in the time of our ancestors) (Budapest 1982) 252.

[37] E. S. Wing, Evidences for the impact of traditional Spanish animal uses in parts of the New World, in: J. Clutton-Brock (ed.), *The walking larder. Patterns of domestication, pastoralism, and predation* (London 1989) 72-79.

[38] P. de Crescenzi, *Trattato della agricultura (Liber ruralium commodorum)* (Milano 1805).

[39] Mennerich (n. 22) 21.

[40] L. E. Lanyon, C. T. Rubin, Functional adaptation in skeletal structures, in: M. Hildebrand, D. M. Bramble, K. F. Liem, D. B. Wake (eds.), *Functional vertebrate morphology* (Cambridge Mass., London 1985) 1-25, Figs. 1-12.

exploitation inevitably results in the increase of transversal diaphysis measurements. In addition to some non-measurable fragments, a short but unusually robust 14th century metatarsal was found at Site 2. The breadth of its diaphysis is almost 50% greater than that of any other metatarsals in this assemblage. Even if this bone represents an animal different from the 12th century cattle used at Otok, it is so stout that it may well originate from a draught animal.

Bone resorption in metacarpals

In draught cattle sometimes depressions occur more-or-less symmetrically especially above the distal epiphysis on the metacarpals' palmar surface. This phenomenon is also known from archaeological contexts.[41] Its anatomical location typically corresponds to the overlap between the *bursae articulares* of the metapodia and proximal phalanges. Sub-pathological bone resorption is likely to occur in this area which is less affected by mechanical strain than the bone's dorsal surface.[42]

This deformation was observed on the distal end of a metacarpus and near the proximal epiphysis of another fragment (*Fig. 10*). In the latter case, bone remodeling is accompanied by the formation of smaller exostoses. It seems to be related to the resorption and remodeling that takes place as part of a sometimes arthrotic process caused by consistent loading. Draught exploitation contributes significantly to the formation of such depressions. Both specimens originate from undated contexts at Site 2.

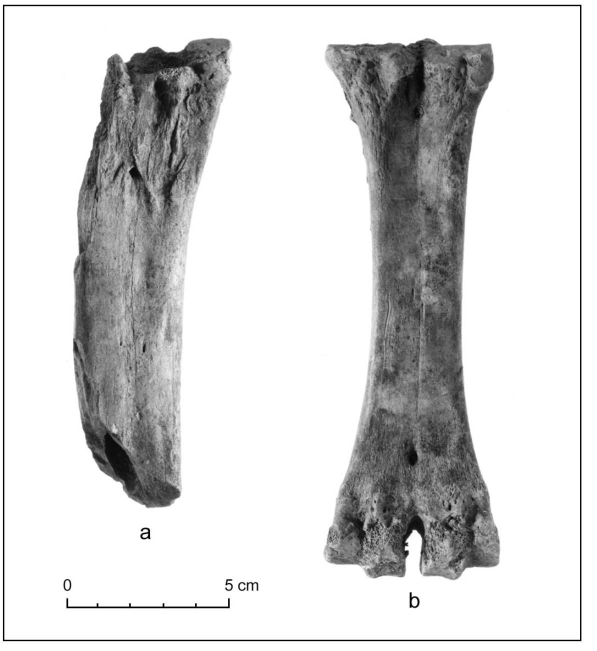

Fig. 10: Non-pathological, adaptive bone remodeling (resorption and broadening) on cattle metacarpal bones, possibly related to draught exploitation.
Sl. 10: Nepatološko, prilagoditveno preoblikovanje (resorpcija in odebelitev) goveje dlančnice, ki je verjetno povezana z izkoriščanjem vlečne moči živali.

Spavin

Spavin is the ankylosis of bones in the tarsal articulation of ungulates. It results in the fusion and thickening between the bones of the hock joint.[43] It has been described as the result of periostitis caused by fatigue and culminating minor trauma which ultimately leads to this condition[44] which is widely interpreted as a functional hypertrophy caused by work in modern draught cattle.[45]

A proximal metatarsus fragment from cattle displayed an early stage of spavin which preceded fusion. The edge of the articular surface show signs of inflammation which eventually leads to a fusion with the distal row of tarsal bones (*Fig. 11*).

Eighty-eight cases of Medieval cattle spavin from Schleswig-Schild show various stages of this condition.[46] Initial exostoses on the tarsalia and metatarsal occurred in one third of the spavin-affected bones. On ten bones, the deformation of articular surfaces was evident. A fusion of tarsalia was observed in 53% of the 88 specimens. Complete fusions

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[41] For example W. Van Neer, B. De Cupere, First archaeozoological results from the Hellenistic-Roman site of Sagalassos, in: M. Waelkens (ed.), *Sagalassos* 1. *First General Report on the Survey (1986-1989) and excavations (1990-1991),* Acta Archaeologica Lovaniensia Monographiae 5 (1993) 225-238, Fig. 146.

[42] J. G. M. Ramaekers, The dynamic shear modulus and damping of compact bovine metacarpal bone in dependence on the topography along the bone shaft, *Netherlands Journal of Zoology* 29/2, 1979, 151-165.

[43] L. Bartosiewicz, R. Demeure, I. Mottet, W. Van Neer, W., A. Lentacker, Magnetic resonance imaging in the study of spavin in recent and subfossil cattle, *Anthropozoologica* 25-26, 1997, 57-60.

[44] B. Tormay, *A szarvasmarha és tenyésztése II* (The cattle and its breeding) (Budapest 1906) 117.

[45] H. Blumenfeld, *Über den Spat der Rinder* (Leipzig 1909) Dissertation; M. Stillfried, A szarvasmarhák idült tarsitise (Chronical tarsitis in cattle), *Közlemények az Összehasonlító Élet- és Kórtan Köréből* 19, 1926, 147-154; K. Wamberg, E. A. McPhearson, *Veterinary encyclopedia* 4 (1968); C. Wells, Ancient arthritis, *May and Baker Pharmaceutical Bulletin* 21, 1972, 67-70.

[46] H. Hüster, *Untersuchungen an Skelettresten von Rindern, Schafen, Ziegen und Schweinen aus dem mittelalterlichen Schleswig. Ausgrabung Schild 1971-1975,* Ausgrabungen in Schleswig. Berichte und Studien 8 (Neumünster 1990).

Fig. 11: Exostoses on the proximal end of a cattle metatarsus (proximal and medial aspects), indicative of an early stage of spavin possibly caused by draught exploitation.
Sl. 11: Eksostoza na proksimalnem koncu goveje stopalnice (proksimalni in medialni pogled), ki nakazuje zgodnje faze bramorja, domnevno nastalega zaradi izkoriščanja vlečne moči živali.

between the tarsalia and the proximal metatarsal, however, were reported only in two cases. Consequently, Hüster[47] concluded that spavin usually begins in the centrotarsale from where the ankylosis spreads to other parts of the tarsal joint. The specimen from Otok, therefore, may be indicative of a stage that is more advanced than it looks. A series showing the advancement of spavin in 14-16th century cattle from Holland was published by Davis.[48]

While Rosenberger[49] identifies cattle spavin as a disease characteristic of draught cattle, he also mentions the close, medially turned position of hocks (known as "cow hocks") and other inherited abnormalities of foot conformation as an important predisposition. Regardless of spavin, "narrow hocks" are listed by Tormay[50] as a strongly negative trait in draught cattle since it leads to weak, desoriented gait in oxen. Concurrently, Alur[51] described gagged hocks and turned-out toes in domestic animals as general consequences of "social evolution".

REMARKS ON HORSE AND OX SHOEING

In addition to the numerous horse shoes recovered from this medieval settlement, especially at Site 2, a flat piece of iron may be interpreted as an ox shoe. It was recovered from a 14th century deposit from Site 2.

The mounting of iron shoes on draught animals is aimed at reducing extreme wear thus alleviating strain, lameness and pain especially when the animals are walking on hard substrate. The first written reference to the shoeing of horses appears in "*Strategicon*" written around 900 AD by the Emperor Leo the Wise.[52] Some shoeing of oxen was introduced during the Middle Ages in England, but it was always less frequent than in the case of horses.[53] While horse shoes may be considered common, ox shoes occur but rarely in late Medieval archaeological assemblages in Hungary.

Since, according to an ancient Hungarian proverb, "oxen are milked on their feet",[54] proper claw care is of fundamental importance. The apparently higher strain on the front feet is expressed by the practical consideration that at least the front claws (especially the lateral toe) of cattle were fitted with iron shoes in the Eifel region at the beginning of the 20th century. The degree to which other claws were shoed depended on the extent to which the animals served in tillage or road transport.[55]

As opposed to horse hooves, the toes of cattle are connected by the flexible system of bands (*ligamentum interdigitale decussatum*) which allows the foot to stretch as loading increases.[56] Oxen,

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[47] Ib., 44.

[48] S. J. M. Davis, *A rapid method for recording information about mammal bones from archaeological sites,* Ancient Monuments Laboratory Report 19/92 (1992) Fig. 7: 9.

[49] G. Rosenberger, *Rinderkrankheiten* (Berlin, Hamburg 1970) 491.

[50] B. Tormay, *Kalauz a lópatkolásban kovácsok számára* (Guide to horse shoeing for blacksmiths) (Budapest 1884) 122.

[51] K. R. Alur, Faunal studies and their connotation, in: A. T. Clason (ed.), *Archaeozoological studies,* (Amsterdam 1975) 407-412.

[52] R. Lefebvre des Noëttes, *L'Attelage le Cheval de selle á travers les ages. Contribution á l'historie de l'esclavage* (Paris 1931).

[53] Langdon (n. 34) 222.

[54] G. O. Nagy, *Magyar szólások és közmondások* (Hungarian idioms and proverbs), 2nd edition (Budapest 1976) 527.

[55] F. J. Ferber, Zu schwach um aufzustehen, in: *Dünnbeinig mit krummem Horn. Die Geschichte der eifeler Kuh* (Meckenheim 1986) 85-114.

[56] H. Ruthe, *Der Huf* (Jena 1969), zweite überarbeitete Auflage.

therefore, may be fitted with single, horse-shoe like irons only for a short time when used on smooth road surfaces.[57] Fastening their two claws on the same device for too long a time decreases flexibility does more damage to the animal's foot than the actual lack of shoeing. It is for this reason that traditionally two separate shoes are mounted on the claws of the lateral and medial toe in draught oxen. These so-called "broad shoes" are similar to the half of a simple horse shoe.

Under natural circumstances the caudally located "heel" area of claws is most prone to wear. According to the Compton Survey underrun heel was a source of lameness in 8.7% of the cases in (unshod) dairy cows.[58] Shoes must fit to the cranial outline of claws, but have to reach 3-5 mm beyond the claws' caudal end.[59] Fitting too short shoes on the claw can seriously damage the animals' foot.[60] The piece of iron possibly originating from an ox shoe represents the broad, central portion with the caudal ends eroded. The aforementioned small horse shoe, on the other hand, is significantly less worn. Its elongated ends must have served a protective purpose.

CONCLUSIONS

While the small, selectively recovered 1971-1975 animal bone assemblage from Otok (Gutenwerth) offered no reliable information on the 12-13th century medieval meat diet in this market town (aside from the probably dominant importance of beef, as in most other urban centers at the time), the excavators did collect bones of zoological interest. These are indicative of a small, brachyceros type medieval cattle, widely spread during that period. The animal remains originating from two functionally different areas of this settlement may also be brought into association with tanning at Site 1, as indicated by a concentration of cattle metapodia. Osteometric data, as well as some pathological deformations on these bones show that draught cattle, whose hides ended up in the tannery, must have been exposed to hard work. Although the assemblage is too small to further explore this problem on a broad, statistical basis, selective collection that evidently concentrated on well-preserved metapodia provided sufficient evidence to substantiate this hypothesis.

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Cattle / govedo						Site / predel	Century / stoletje
astragalus	dex.	53.2	48.2	33.5	29.6	2	n. d.
astragalus	sin.	55.8	5	33.8	30.9	2	n. d.
astragalus	dex.	63	57.9	38.8	33.6	2	12

Appendix 1: Astragalus measurements (mm, after von den Driesch, n. 8).
Pril. 1: Dimenzije skočnic (mm; povzeto po von den Driesch, op. 8).

[57] Tormay (n. 50) 197.

[58] A. M. Russell, G. J. Rowlands, S. R. Shaw, A. D. Weaver, Survey of lameness in British dairy cattle, *Veterinary Record* 111/8, 1982, 155-160.

[59] Ruthe (n. 56) 190.

[60] F. Habacher, *Der Huf- und Klauenbeschlag* (Wien 1948).

Species / bone vrsta / kost	Side / stran	GL	Bp	Dp	SD	Sd	Bd	Dd	Withers height / višina ob vihru	Site / predel	Century / stoletje
Cattle / domače govedo											
proc. cornualis	dex.		46.1	32.1						1	n. d.
proc. cornualis	dex.	65.8	33.3	26.3						1	n. d.
proc. cornualis	dex.		42.1	31.9						2	n. d.
proc. cornualis	dex.		49	37.2						2	n. d.
proc. cornualis	sin.	55.5	39.1	34.2						2	n. d.
proc. cornualis	dex.	74	34.1	25.1						2	n. d.
proc. cornualis	sin.	75.9	38.1	30.2						2	n. d.
proc. cornualis	dex.	76.5	34.5	30.2						2	n. d.
proc. cornualis	dex.	78.2	38	28.0						2	n. d.
proc. cornualis	dex.	80.5	40.2	30.8						2	n. d.
proc. cornualis	dex.	81	36.3	30.1						2	n. d.
proc. cornualis	dex.	88.5	33.1	27.8						2	n. d.
proc. cornualis	sin.	93.8	37.9	29.8						2	n. d.
proc. cornualis	sin.	97.8	36.8	28.5						2	n. d.
proc. cornualis	dex.	123.6	40.8	34.1						2	n. d.
proc. cornualis	sin.		36.1	29.2						1	12
proc. cornualis	sin.		36.6	32.2						1	12
proc. cornualis	dex.	73.1	38.2	27.1						2	12
proc. cornualis	dex.		53.5	42.1						1	13
proc. cornualis	sin.	135	35.4	30.1						1	13
proc. cornualis	dex.	86.1	43.2	34.1						2	12
proc. cornualis	sin.	63.4	32	26.9						1	n. d.
scapula	dex.					40.8	34.7	57.2		1	n. d.
scapula	dex.					32.9	35.1	51.2		1	n. d.
humerus	sin.				32.2	36.1	64.7	66.1		2	n. d.
radius	dex.		65.2	33.8						1	n. d.
radius	sin.		56.1	30.1						2	n. d.
radius	dex.				30.9	19.2	56.2	38.2		1	n. d.
metacarpus	sin.		44.4	25.9	25.2	17.1				1	n. d.
metacarpus	dex.		46.7	27.1						1	n. d.
metacarpus	dex.				21.5	16.1				2	n. d.
metacarpus	sin.				32.1	21	59.9	31.8		2	n. d.
metacarpus	dex.		35.9	20.5	19.4	15	36.9	20.9		2	n. d.
metacarpus	sin.		38.2	22.5	21.3	15.5	37.9	20.9		2	n. d.
metacarpus	sin.		39.1	25.1	20.3	16				2	n. d.
metacarpus	dex.		40.2	23.8						2	n. d.
metacarpus	sin.		40.9	26	21.9	16.9				2	n. d.
metacarpus	sin.		43.1	25.5	22.9	16.4				2	n. d.
metacarpus	sin.		45.2	27.2			46.1	23.9		2	n. d.
metacarpus	dex.		48.9	27.5						2	n. d.
metacarpus	sin.		55.9	37.1						2	n. d.
metacarpus	sin.		62.5	35.5						2	n. d.
metacarpus	sin.		63	37.8						2	n. d.
metacarpus	dex.	169.8	44.7	25.5	24.1	16.5	46	21.5	1018.8	2	n. d.
metacarpus	dex.	170.2	46.8	26.9	25.8	18.1	48.2	25.3	1021.2	2	12

metacarpus	sin.	174.2							1045.2	2	n. d.
metacarpus	sin.		48.2	29.1	23.2	18				1	12
metacarpus	sin.		54.9	28.8						1	12
metacarpus	sin.		40.2	22.9	19.4	14.8	34.9	21.1		2	12
metacarpus	dex.		48.9	30.2	27.8	18.2				2	12
metacarpus	sin.		51.9	31.9						2	12
metacarpus	sin.		44.2	26.1	23.1	15.3				1	13
metatarsus	dex.				18.8	18.1	40.1	23.5		2	n. d.
metatarsus	?				19.4	19.1				2	n. d.
metatarsus	dex.				19.5	20.3				2	n. d.
metatarsus	sin.				19.6	18.1				2	n. d.
metatarsus	dex.				19.9	17.5	43	24.1		2	n. d.
metatarsus	sin.				20.1	19.8	41.9	21.1		2	n. d.
metatarsus	dex.				20.9	19.4				2	n. d.
metatarsus	sin.				20.9	18.2	42.2	23.6		2	n. d.
metatarsus	dex.				21.1	20.8				2	n. d.
metatarsus	dex.				22.9	19.4	44.2	27.1		2	n. d.
metatarsus	dex.				23	22.1				2	n. d.
metatarsus	sin.				25.1	21.5	47.2			2	n. d.
metatarsus	sin.				25.9	23.2	52.9	27.1		2	n. d.
metatarsus	dex.		31.6	26.5						2	n. d.
metatarsus	sin.		32.1	32.4	19.9	18.6				2	n. d.
metatarsus	sin.		32.2	31.5	21.1	20.2				2	n. d.
metatarsus	sin.		34.1	31.5						2	n. d.
metatarsus	dex.		36.5	35.1	20.3	20.1	42	24.2		2	n. d.
metatarsus	dex.		37.2	37.8						2	n. d.
metatarsus	sin.		38.2	37.6						2	n. d.
metatarsus	sin.		38.7	35.3	20.9	19.1				2	n. d.
metatarsus	dex.		39	35.4	22.8	20.2				2	n. d.
metatarsus	sin.		39.4	38.2	21.9	21.5	46.6	28.2		2	n. d.
metatarsus	sin.		39.7	37						2	n. d.
metatarsus	dex.		42.1	39.8						2	n. d.
metatarsus	sin.		43.1	40.5						2	n. d.
metatarsus	sin.		45.3	37.8	26.1	23.2				2	n. d.
metatarsus	sin.		51.9	52						2	n. d.
metatarsus	sin.	193.1	38.5	34.9	22.4	20.5	43.2	24	1062	2	n. d.
metatarsus	sin.	196.8	47.3	38.2	28.2	23.1	48.2	27.1	1082.4	2	n. d.
metatarsus	dex.	197.3	38.7	37.1	20.2	18.2	45	24.9	1085.2	2	n. d.
metatarsus	sin.	200.3	37.9	38.7	19.9	18.7	42.9	25.2	1101.7	2	n. d.
metatarsus	dex.	203.4	40.9	37.9	23.8	20.1	5	27.1	1118.7	2	n. d.
metatarsus	dex.				18.4	19				1	12
metatarsus	sin.		32.6	32.2	20.2	18.1				1	12
metatarsus	dex.		34.8	35.6						1	12
metatarsus	dex.		34.9	35.2	19.6	18.1				1	12
metatarsus	dex.		35.8	34.2						1	12
metatarsus	dex.		37.1	33.2						1	12
metatarsus	dex.		40.8	40.2						1	12
metatarsus	dex.		44.4	39.2						1	12
metatarsus	sin.	192.1	41.9	37.2	23.3	20.6	45.2	23.6	1056.5	1	12
metatarsus	dex.	204.2	40.2	36.5	19.4	17.9		26.1	1123.1	1	12

metatarsus	sin.				24.1	21.2	49	27.3		2	12
metatarsus	sin.	192.3	36.9	34.9	19.1	19.5	43.1	25.2	1057.7	2	12
metatarsus	sin.				18.5	17.2				1	13
metatarsus	dex.		31.8	33.1	21.1	19.2				1	13
metatarsus	dex.		33.2	34.1	16.5	17				1	13
metatarsus	dex.		37.2	38.3	2	19.6				1	13
metatarsus	sin.		38.6	36.3	22	20.3				1	13
metatarsus	sin.		39	35.1	22.4	21.2				1	13
metatarsus	dex.		39.4	35.1	20.3	19.9				1	13
metatarsus	sin.		41.9	39.8	23	23				1	13
metatarsus	dex.	174.5	36.5	32.9	21.1	18.2	43.3	24.9	959.8	1	13
metatarsus	sin.	186.2	40.2	39.1	21.1	20.2	44.1	26	1024.1	1	13
metatarsus	dex.				20.1	19.1	42	25.8		2	14
metatarsus	dex.	212.6	51.1	43	29.8	23.8	56.5	29.3	1169.3	2	14
Sheep / ovca											
proc. cornualis	dex.		39.5	29						2	n. d.
proc. cornualis	sin.		51.8	34.9						2	n. d.
proc. cornualis	dex.		51.1	38.1						1	13
os sacrum	dex.		31	15.3						2	12
tibia	sin.				13.2	10.9	24.1	18.2		1	n. d.
metatarsus	dex.		20.4	19.1	12.1	10.2				2	n. d.
Goat / koza											
proc. cornualis	dex.	91.3	28.1	18.9						2	n. d.
proc. cornualis	dex.	117.2	27.8	19.1						2	n. d.
proc. cornualis	sin.	116.9	27.7	16.9						2	12
proc. cornualis	sin.	119.9	32.1	20.6						2	12
proc. cornualis	dex.	149.2	34.3	2						2	12
proc. cornualis	dex.	118.2	29.9	19.5						1	13
proc. cornualis	sin.	153.1	32	19.9						1	13
proc. cornualis	sin.	153.8	31.1	21.5						1	13
proc. cornualis	sin.	115	34.1	28.8						2	13
Pig / domači prašič											
scapula	dex.					23.8	24.8	36.1		2	n. d.
humerus	sin.				16.2	21.9	37.1	38.5		1	n. d.
humerus	dex.				15	21.3	36.5	38.1		2	n. d.
radius	dex.		27.9	19.8	17.3	11.3				2	13
tibia	sin.				18.5	13.2	28.1	22		1	13
Horse / konj											
humerus	dex.	274.2	76.9	96.1	33.2	39.1	81.1	73.9	1336.5	2	n. d.
radius	dex.	328.2		5					1336.5	2	n. d.
metacarpus	dex.	222.4	46.1	32.4	30.8	21.1	46.8	32.3	1336.5	2	n. d.
Red deer / jelen											
cornus cervi	dex.		54	43.9						2	12
cornus cervi	dex.		55.2	43.9						2	12

Appendix 2: Horn core and long bone measurements (mm, after von den Driesch, n. 8).
Pril. 2: Dimenzije rožnic in dolgih kosti (mm; povzeto po von den Driesch, op. 8).

Modern bulls / sodobni biki	Live weight (kg) / masa žive živali (kg)	Smallest breadth / najmajša širina	Smallest depth / najmanjša globina	Mean diameter / povprečen premer
a	37	37	37	37
b	555.8	40.7	27.4	34.1
c	13.8	0.4	0.2	0.3
d	568.0	40.4	27.1	33.7
e	83.6	2.2	1.5	1.6
f	424.0	9.4	6.7	6.3
g	405.0	36.6	24.2	31.7
h	829.0	46.0	30.9	38.0
i	2.1	-0.1	0.4	0.4
j	0.5	0.5	0.7	0.9
Modern cows / sodobne krave				
a	67	67	67	67
b	416.1	35.2	24.6	29.9
c	8.4	0.2	0.2	0.2
d	420.0	35.1	25.1	30.0
e	68.9	1.9	1.6	1.7
f	372.0	8.2	7.7	7.4
g	278.0	32.0	21.2	27.1
h	650.0	40.2	28.9	34.5
i	1.0	-0.4	-0.4	-0.3
j	0.4	0.4	-0.1	0.3
Modern oxen / sodobni voli				
a	26	26	26	26
b	569.3	44.7	27.3	36.0
c	26.5	0.6	0.3	0.4
d	501.0	45.0	27.1	35.9
e	135.0	2.8	1.6	2.0
f	401.0	9.8	6.0	7.6
g	449.0	40.1	25.1	32.6
h	850.0	49.9	31.1	40.2
i	-0.5	-0.6	0.1	-0.1
j	0.9	0.3	0.7	0.4
Otok (Gutenwerth) / Otok (Gutenwerth)				
a	14	14	14	14
b	242.7	23.4	16.8	20.1
c	1 2.8	0.9	0.4	0.7
d	230.4	23.0	16.5	19.5
e	47.8	3.5	1.6	2.5
f	180.6	12.7	6.2	9.5
g	188.7	19.4	14.8	17.1
h	369.3	32.1	21.0	26.6
i	2.9	1.8	2.1	2.3
j	1.5	1.2	1.3	1.3

a - Count / velikost vzorca
b - Mean / povprečje
c - Standard error / standardna napaka
d - Median / mediana
e - Standard deviation / standardna deviacija
f - Range / razpon
g - Minimum / najmanjša vrednost
h - Maximum / največja vrednost
i - Kurtosis
j - Skewness / odklon

Appendix 3: Parameters of live weight and metacarpus measurements (mm) used in estimations.
Pril. 3: Podatki o masi živih živali in dimenzije (mm) dlančnic, ki so bile uporabljene pri izračunu.

Modern bulls / sodobni biki	Live weight (kg) / masa žive živali (kg)	Smallest breadth / najmajša širina	Smallest depth / najmanjša globina	Mean diameter / povprečen premer
a	34	34	34	34
b	562.8	34.7	30.4	32.5
c	13.8	0.4	0.3	0.3
d	572.0	34.3	30.4	32.3
e	80.3	2.3	1.9	1.9
f	424.0	9.3	11.7	8.5
g	405.0	31.9	23.2	28.7
h	829.0	41.2	34.9	37.2
i	2.8	1.2	5.4	0.5
j	0.7	1.2	-1.1	0.6
Modern cows / sodobne krave				
a	67	67	67	67
b	416.1	30.2	28.4	29.3
c	8.4	0.2	0.2	0.2
d	420.0	30.0	28.3	29.1
e	68.9	1.8	1.5	1.4
f	372.0	8.1	7.3	6.8
g	278.0	26.2	24.9	26.4
h	650.0	34.3	32.2	33.2
i	1.0	-0.1	0.2	0.1
j	0.4	0.3	0.2	0.5
Modern oxen / sodobni voli				
a	23	23	23	23
b	564.0	37.8	33.2	35.5
c	26.8	0.8	0.5	0.6
d	501.0	37.8	33.0	35.4
e	128.5	4.0	2.5	3.0
f	401.0	13.4	10.1	10.6
g	449.0	30.9	29.8	30.4
h	850.0	44.3	39.9	41.0
i	-0.6	-1.1	2.1	-0.2
j	0.8	-0.3	1.4	0.2
Otok (Gutenwerth) / Otok (Gutenwerth)				
a	44	44	44	44
b	252.5	21.5	19.9	20.7
c	5.9	0.4	0.3	0.3
d	241.1	20.9	19.7	20.1
e	39.2	2.6	1.7	2.1
f	189.7	13.3	6.8	10.0
g	183.5	16.5	17.0	16.8
h	373.2	29.8	23.8	26.8
i	1.4	2.0	-0.2	1.1
j	1.2	1.2	0.6	1.0

a - Count / velikost vzorca
b - Mean / povprečje
c - Standard error / standardna napaka
d - Median / mediana
e - Standard deviation / standardna deviacija
f - Range / razpon
g - Minimum / najmanjša vrednost
h - Maximum / največja vrednost
i - Kurtosis
j - Skewness / odklon

Appendix 4: Parameters of live weight and metatarsus measurements (mm) used in estimations.
Pril. 4: Podatki o masi živih živali in dimenzije (mm) stopalnic, ki so bile uporabljene pri izračunu.

Species / vrsta	Side / stran	Length of toothrow / dolžina zobnega niza		Lower M3 tooth / spodnji M3 zob		Site / predel	Century / stoletje
				length / dolžina	width / širina		
Cattle / govedo		toal / vsi kočniki	molar / meljaki				
mandibula	sin.		72.1	28.9	13.1	2	n. d.
mandibula	dex.		76.8	33.2	13.2	2	n. d.
mandibula	dex.		77.7	34.9	15.3	2	n. d.
mandibula	dex.	71.5		30.0	13.4	2	n. d.
mandibula	dex.	113.6	74.6	30.0	11.6	2	n. d.
mandibula	dex.	118.5	72.9	32.1	12.7	2	n. d.
Sheep / ovca							
mandibula	dex.		42.1	19.9	7.9	1	12
mandibula	sin.	66.4	45.8	20.3	7.2	2	n. d.

Appendix 5: Mandibular measurements (mm, after von den Driesch, n. 8).
Pril. 5: Dimenzije spodnjih čeljustnic (mm; povzeto po von den Driesch, op. 8).

Živalski ostanki iz srednjeveškega naselja Otok (Gutenwerth) blizu Dobrave pri Škocjanu, Slovenija

Povzetek

Tukaj obravnavane živalske kosti so bile izkopane na najdišču Otok (Gutenwerth) pri Dobravi pri Škocjanu med leti 1971-75. Večinoma so bili pobrani le najzanimivejši primerki. Razpoložljivo gradivo tako sicer ni reprezentativno, vseeno pa omogoča proučevanje srednjeveškega izkoriščanja živali. Izkopana sta bila dva predela, vsak po približno 1000 m^2 površine.

Izkopno polje 1 zaobjema delavnice in cerkev na južnem delu mesta. Izkopno polje 2, locirano SZ od izkopnega polja 1, leži v središču istega naselja. Zaobjema hiše, trgovine in ulico ter tako očitno predstavlja stanovanjsko območje. Število in kronološka porazdelitev kosti med obema predeloma sta dokaj nesorazmerna (*tab. 1*). Med gradivom iz izkopnega polja 1 prevladujejo ostanki iz 12.-13. stoletja, medtem ko številne kosti iz izkopnega polja 2 ni mogoče umestiti v natančnejši časovni okvir. Je pa število živalskih ostankov iz izkopnega polja 2 skoraj dvakrat tolikšno, kot to velja za izkopno polje 1. Večina časovno opredeljivih kosti iz izkopnega polja 2 sodi v 12. stoletje. Ostanki iz 13. stoletja so zastopani le v vzorcu iz izkopnega polja 1 (*sl. 1*).

Razmeroma majhen vzorec vsebuje značilno visok delež dobro ohranjenih, merljivih kosti. Ogromno večino predstavljajo robustni goveji metapodiji, ki uspešno kljubujejo spektru različnih tafonomskih dejavnikov. Rožnice predstavljajo drugo najštevilčnejšo skupino, ki tudi vsebuje pomembno zoološko informacijo. Te kosti ponujajo temeljne podatke o srednjeveških bovidih, vključujoč govedo, ovce in koze.

Omenjeno gradivo je preskromno, da bi omogočalo zanesljivo kvantitativno rekonstrukcijo vzorcev uživanja mesa. Zato pa nekatere najdbe lepo ponazarjajo izkoriščanje sekundarnih produktov živinoreje (predvsem vlečne moči) in obdelavo kož.

Kvantitativni opis obravnavanih vrst temelji na številu določljivih primerkov (NISP). Ocenjevanje števila osebkov je namreč podvrženo subjektivni pristranosti celo pri bolj reprezentativnih vzorcih.

Določljivi ostanki vrst, ki so pomembne kot vir mesa, so bili razvrščeni v Uerpmannove kategorije A do C. Kategorija A vključuje skeletne elemente iz najbolj mesnatih in (v skladu s sodobnimi standardi) najbolj kvalitetnih delov trupa, kategorija C pa tiste iz najmanj mesnatih/kvalitetnih.

Razmeroma veliko število dobro ohranjenih kosti med obravnavanim gradivom je narekovalo uporabo standardiziranega sistema zajemanja metričnih podatkov in nomenklature, ki ju je razvila von den Drieschova.

Kot je to značilno za srednjeveška urbana naselja, so bile domače živali poglavitni vir živalskih beljakovin tudi na srednjeveškem Otoku (uživanje mleka in mlečnih izdelkov je le s proučevanjem živalskih kosti težko rekonstruirati). Jelen, sicer edina lovna žival v obravnavanem gradivu, je bil zastopan le s fragmenti rogovja, tj. s surovino za specifične obrtne dejavnosti. Gre za pomemben podatek, saj je mogoče rogovje pridobiti tudi s pobiranjem spomladi naravno odpadlih primerkov, tj. brez ubijanja živali. Bolj verodostojne podatke o morebitnem lovu na jelene zaradi uživanja njihovega mesa bi bilo mogoče pridobiti z analizo popolnejšega vzorca živalskih ostankov, ki bi vključeval tudi na lobanjo še prirasle primerke rogovij.

Domače govedo (*Bos taurus* L. 1758) je daleč najbolje zastopana živalska vrsta v obravnavanem gradivu (*tab. 3*) in je brez dvoma tudi najpomembnejša. V vzorcu iz izkopnega polja 1 število govejih kosti za več kot petkrat presega število prašičjih oz. ovčjih/kozjih. Polovica določljivih kosti sodi v najmanj kvalitetno kategorijo C, ki večinoma vključuje skeletne elemente distalnega dela obeh parov okončin.

V gradivu iz izkopnega polja 2 število govejih kosti le za dvakrat presega število ostankov manjših domestikatov, je pa delež kosti iz kategorije C podobno visok. Omenjena kategorija vključuje trdne, kompaktne kosti (npr. skočnice, dlančnice, stopalnice) ter "spektakularne" rožnice. Izrazito visok delež ostankov iz manj mesnatih delov trupa gre torej najverjetneje pripisati kombinaciji različno intenzivnega razpadanja kosti v sedimentu in pa selektivnega zbiranja najdb s strani arheologov.

Število kosti domačega prašiča (*Sus domesticus* Erxl. 1777) predstavlja približno osmino tistih domačega goveda tako med gradivom iz 12. (13 : 88) in 13. stoletja (8 : 64) kot tudi med tistimi brez natančne časovne opredelitve (21:185; *tab. 3*). Takšno

razmerje je primerljivo s podatki iz ostalih srednjeveških urbanih najdišč. Prašič je sicer po svoji masi in sposobnosti razmnoževanja ter s tem po iztržku mesa bolj primerljiv z drobnico. Pogostnost kosti iz kategorije A nedvomno kaže na pomen svinjine v prehrani na obeh predelih obravnavanega najdišča (*tab. 2*). Ovca (*Ovis aries* L. 1758) in koza (*Capra hircus* L. 1758) sta sicer zastopani s preskromnim številom najdb, da bi bilo njuno vlogo kot vir mesa mogoče verodostojno oceniti, vendar domnevno nista dosegali pomena svinjine. Od preostalih vrst, ki so zastopane v vzorcu, je mogoče le domačo kokoš (*Gallus domesticus* L. 1758) zanesljivo povezovati z izkoriščanjem mesa. Najdb konja (*Equus caballus* L. 1758) in jelena (*Cervus elaphus* L. 1758) namreč na obravnavanem najdišču ni mogoče razumeti kot ostanek prehrane.

Osteometrične rekonstrukcije domačega goveda se je mogoče lotiti tudi pri sicer skromnem vzorcu z Otoka. V srednjeveških virih so razmeroma pogosto prikazana majhna goveda (*sl. 2*). Višina ob vihru je bila ocenjena na osnovi največje dolžine manjšega števila v celoti ohranjenih govejih metapodijev.

Kot je to mogoče razbrati iz priloge 1, vključuje časovno neopredeljivo gradivo iz izkopnega polja 2 šest primerkov nepoškodovanih metapodijev. Izhajajoča povprečna višina ob vihru znaša 1082,5 mm (standardna deviacija = 26,4 mm). Na osnovi štirih primerkov iz 12. stoletja je bila povprečna višine ob vihru ocenjena na 1064,6 mm (standardna deviacija = 42,5 mm). Najnižja ocenjena višina ob vihru je znašala manj kot 1 m (959,8 mm; 13. stoletje), najvišja pa 1169,3 mm (14. stoletje). Se pa tudi obe navedeni skrajnosti umeščata znotraj variacijske širine za majhna srednjeveška goveda.

Masa žive živali je bila ocenjena s pomočjo primerjalnih zbirk Madžarskega kmetijskega inštituta iz Budimpešte in institucije Koninklijk Museum voor Midden-Afrika iz Tervurena (Belgija). Alometrična enačba, pridobljena z analizo 130 dlančnic sodobnih goved, je sledeča:

$$\log d = 0,308 * \log LW + 0,681 \quad (r = 0,741)$$

Ta trend, ki ga podpira visoka in statistično značilna linearna korelacija, nedvoumno dokazuje kubični porast mase živih živali glede na premer kosti pri skeletnih elementih prednjih okončin, ki pri govedu podpirajo pretežni del telesne mase. Pri 124 stopalnicah je navedeni trend manj očiten:

$$\log d = 0,269 * \log LW + 0,773 \quad (r = 0,640)$$

S preoblikovanjem enačb je mogoče oceniti maso živih goved s srednjeveškega Otoka. Ta v povprečju znaša 205 kg (seznam je podan v prilogi 4), je pa variabilnost pridobljenih ocen velika. Gre za posledico razlik v robustnosti govejih metapodijev, ki jo je do neke mere mogoče pripisati spolnemu dimorfizmu (*sl. 3*).

Z morfološkega zornega kota so za goveda z Otoka značilne kratke in gracilne rožnice, kakršne povezujemo s tradicionalnim "bachyceros" tipom lobanje. Povprečna dolžina 12 časovno neopredeljivih primerkov je znašala 82,6 mm (standardna deviacija = 17,2 mm) in le en primerek iz 13. stoletja je dosegel dolžino 135 mm. Tudi premeri rožnic na njihovi bazi pričajo o živalih tipa brachyceros, ki so majhne celo za srednjeveške standarde (*sl. 4*).

Z vidika strukture telesa je mogoče srednjeveške živali z Otoka obravnavati kot analogne (čeprav ne tudi neposredno sorodne) z majhnim, tradicionalnim govedom tipa buša (*sl. 5*). So pa primerki z Otoka gracilnejši celo v primerjavi s predstavniki recentnih goved iz Bosne, katerih metapodije je metrično obdelal Mennerich. Dlančnice vprežnih volov tipa buša iz omenjene zbirke so robustnejše. Primerki z Otoka, ki so datirani v 12. in 13. stoletje, se namreč umeščajo v spodnjo tretjino variacijske širine recentnih majhnih goved tipa buša (*sl. 6*).

Na izkopnem polju 2 je bila najdena skoraj popolna prednja okončina konja, vključno s poškodovano lopatico, nadlahtnico, koželjnico in dlančnico. Na osnovi največje dolžine navedenih kosti je bila višina konja ob vihru ocenjena na 1336,5 mm, kar se ujema s povprečnimi vrednostmi srednjeveških konj. Omeniti velja, da je bila na istem izkopnem polju najdena tudi podkev zelo majhnega konja, ki je bila datirana v 14. stoletje.

Fragmentov rogovja z Otoka nikakor ne gre razumeti kot ostanke prehrane. To surovino so namreč lahko pridobivali tako z lovom kot tudi s pobiranjem naravno odpadlih primerkov pozimi.

Izkopno polje 1 je zajelo območje, kjer se je izvajalo strojenje. V to smer kažejo najdbe specifičnih kovinskih orodij in večje jame, ki so značilne za takšno aktivnost. Pri tem je zanimivo, da med obema izkopnima poljema ni bistvenih razlik med relativnima frekvencama rožnic in metapodijev. Izkopane so bile tudi številne nepoškodovane kozje rožnice (*pril. 1*). Ko so kože prinašali v strojarno, so se teh pogosto še vedno držale rožnice in parklji (*sl. 7*). Velike kopitarje so odirali tako, da so na skrajnem spodnjem delu okončin zarezali med prstnicami in distalnim koncem metapodijev. Rožnice so od surovih kož, ki so jih prinesli v strojarno, odstranili s pazljivim rezom na njihovi bazi (*sl. 8*).

V nekaterih primerih dlančnic/stopalnic niso ločili od prstnic, tako da so se lahko tudi te še vedno držale kož, ki so jih prinesli v strojarno (*sl. 9*).

Strojarstvo v velikem obsegu, tako rekoč na industrijski ravni, je postalo ena bolj onesnažujočih dejavnosti v srednjeveških mestih. Poleg velike količine odpadkov, ki so nastali pri samem odiranju, so pri strojenju uporabljali tudi apno ali pepel in pogosto urin za odstranjevanje dlake. Običajno je bilo tudi namakanje v alkalnih raztopinah, ki so vsebovale tripsin.

Izkoriščanje vlečne moči domestikatov je bilo v srednjem veku zelo pomembno. V tem pogledu je bil vol najpomembnejša domača žival. Je pa težko oceniti, ali so srednjeveški prebivalci Otoka govedo še pred zakolom uporabljali tudi kot vprežno živino ali pa je bila njihova reja usmerjena predvsem v produkcijo mesa. Kosti vprežne živine namreč niso nujno zastopane med kuhinjskimi odpadki, sploh če njihovega mesa niso uživali.

Izkoriščanje vlečne moči živali se pri kosteh na morfološki ravni odraža kot stimulacija ektopične rasti kostnega tkiva. Posamezni primerki takšnih kosti so zastopani tudi v gradivu z Otoka. Osteološki simptomi težkega dela se na tem najdišču uvrščajo v tri skupine:

1. Poudarjeno izkoriščanje vlečne moči stimulira dodatno rast kostne mase, kar naj bi povrnilo optimalno ravnotežje ob obremenitvi kosti. Poleg nekaj majhnih in torej neizmerljivih kostnih fragmentov je bila na izkopnem polju 2 najdena tudi nenavadno robustna stopalnica iz 14. stoletja. Širina njene diafize za skoraj 50 odstotkov presega širino diafize vsake od preostalih stopalnic v vzorcu. Morda gre za ostanek živali, ki je odstopala od tipa goved, kakršna so bila v 12. stoletju karakteristična za Otok. Zaradi njene robustnosti pa bi bilo obravnavano stopalnico kljub temu smiselno pripisati vprežni živali.

2. Pri vprežnem govedu se včasih pojavijo bolj ali manj simetrične depresije, predvsem nad distalno epifizo dlančnic na njihovi palmarni strani. Navedeni fenomen je poznan tudi iz arheološkega konteksta. Takšna deformacija je bila prisotna tako na distalnem koncu dlančnice kot tudi blizu proksimalne epifize nekega drugega fragmenta (*sl. 10*). Zdi se, da gre za posledico resorpcije in preoblikovanja kot sestavnega dela včasih artritičnega procesa, ki ga sproži konstantno obremenjevanje. Oba primerka izvirata iz časovno neopredeljivega vzorca iz izkopnega polja 2.

3. Bramor je vnetje kosti skočnega zgiba pri kopitarjih, ki se izraža v zraščanju in odebelitvi omenjenih kosti. Pripisuje se periostitisu, ki nastane zaradi napornega dela oz. zaradi iz tega izhajajočih manjših travm. Končno stanje interpretiramo kot funkcionalno hipertrofijo zaradi izkoriščanja vlečne sile živali.

Proksimalni fragment goveje stopalnice kaže sledi zgodnjih faz bramorja še pred pričetkom zraščanja. Rob sklepne površine kaže znake vnetja, kar bi sčasoma privedlo do zraščanja z nartnimi kostmi (*sl. 11*).

Med izkopavanji na Otoku (predvsem na izkopnem polju 2) so bile pridobljene številne konjske podkve. Najden je bil tudi ploščat kos železa, ki bi ga bilo mogoče interpretirati kot volovsko podkev. Izvira iz skupka v okviru izkopnega polja 2, ki je datiran v 14. stoletje. Uporaba železnih podkev pri vprežni živini je motivirana z željo po omejevanju obrabe kopit (s tem pa tudi šepavosti in bolečine). Priporočljiva je predvsem pri živalih, ki hodijo po trdi podlagi. Za najstarejšo omembo konjskih podkev v pisnih virih velja *Strategicon*, ki ga je okrog leta 900 AD napisal cesar Leon Modri. Volovske podkve so poznali v srednjeveški Angliji, vendar so bile manj razširjene od konjskih. Podobno velja za Madžarsko, kjer je uporaba volovskih podkev v srednjem veku vedno zelo zaostajala za uporabo podkev pri konjih.

Pri govedu je vsak par prstov med seboj povezan s prožnim sistemom vezi (*ligamentum interdigitale decussatum*), zaradi česar se lahko stopalo ob naraščajočem obremenjevanju nekoliko raztegne. Pri konju temu ni tako, zato je mogoče pri volih uporabiti konjskim podobna kopita le za kratka obdobja hoje po gladki, ravni površini. Predolga/prepogosta pričvrstitev obeh prstov na isto podkev namreč zmanjša prožnost, kar živali dejansko bolj škoduje kot koristi. Zaradi navedenega sestavljata volovsko podkev običajno dva ločena kovinska nastavka, po eden za lateralni in medialni prst. Te t. i. "široke podkve" so podobne polovici običajne konjske podkve.

Ob koncu lahko zaključimo, da med leti 1971-1975 selektivno zbrano kostno gradivo z Otoka (Gutenwerth) pri Dobravi pri Škocjanu sicer ni ponudilo zanesljivih podatkov o uživanju mesa v 12. in 13. stoletju v tem trgu, da pa vsebujejo zbrane kosti vseeno obilico zooloških informacij. Pokazale so na obstoj majhnih srednjeveških goved tipa brchyceros, ki so bila v tem obdobju splošno razširjena. Gradivo iz dveh ločenih predelov znotraj obravnavanega najdišča je pokazalo na verjetno strojenje kož na območju izkopnega polja 1, o čemer priča velika koncentracija govejih metapodijev. Osteometrični podatki in nekatere patološke deformacije kažejo na to, da je bilo vprežno govedo, katerega kože so končale v strojarni, izpostavljeno težkemu delu. Čeprav skromnost vzorca onemogoča nadaljnje proučevanje omenjene problematike na višji, statistični ravni pa selektivno zbrano gradivo z obilo dobro ohranjenih metapodijev vendarle ponuja dovolj dokazov za utemeljeno podkrepitev te hipoteze.

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