

# Animal Remains from the Early Copper Age (Epilengyel) Settlement Pits in Rannersdorf, Lower Austria

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## Abstract

In contrast to the Middle Neolithic, when the importance of subsistence hunting reached its peak, the settlements of subsequent periods suggest a greater dependence on domestic animals and cattle. So far, however, scarce Early Copper Age faunal collections show that the development was not uniform and that the relative importance of species depended on the natural environment and the socio-economic status of the sites. This paper provides new insight into the dietary habits and animal husbandry practices of the Bisamberg-Oberpullendorf Group settled in eastern Austria at the end of the 5<sup>th</sup> millennium BC. The analysed food debris discovered during the 2001–2002 rescue excavation in Rannersdorf (Lower Austria) hints at the pastoral character of the economy, with a reliance on grazing herbivores. A significant proportion of cattle and caprines were slaughtered at an older adult age, showing that these were animals serving multiple functions. Pigs and wild animals were of minor importance, and dogs may have been consumed. The inhabitants hunted red deer, aurochs and beavers, occasionally also birds, small carnivores and wild horses. The presence of the latter speaks against dense forests in the region.

## Keywords

Epilengyel, Bisamberg-Oberpullendorf Group, Lower Austria, subsistence, animal husbandry, hunting

## Zusammenfassung – Tierreste aus den frühkupfer-/epilengyelzeitlichen Siedlungsgruben in Rannersdorf, Niederösterreich

Im Gegensatz zum Mittelneolithikum, als die Bedeutung der Subsistenzjagd ihren Höhepunkt erreichte, deuten die Siedlungen der folgenden Perioden auf eine größere Abhängigkeit von Haustieren und Rindern hin. Die bislang spärlichen frühkupferzeitlichen Faunensammlungen zeigen jedoch, dass die Entwicklung nicht einheitlich war und dass die relative Bedeutung der Arten von der natürlichen Umgebung und dem sozioökonomischen Status der Fundorte abhing. Die vorliegende Arbeit gibt neue Einblicke in die Ernährungsgewohnheiten und Tierhaltungspraktiken der Ende des 5. Jahrtausends v. Chr. in Ostösterreich besiedelten Bisamberg-Oberpullendorf-Gruppe. Die analysierten Nahrungsreste, die bei der Rettungsgrabung 2001–2002 in Rannersdorf gefunden wurden, deuten auf einen pastoralen Charakter der Wirtschaft hin, mit einer Abhängigkeit von weidenden Pflanzenfressern. Ein erheblicher

Teil der Rinder und Ziegen wurde im höheren Erwachsenenalter geschlachtet, was zeigt, dass es sich um Tiere handelte, die mehrere Funktionen erfüllten. Schweine und Wildtiere spielten eine untergeordnete Rolle, und möglicherweise wurden auch Hunde verzehrt. Die Bewohnerinnen und Bewohner jagten Rothirsche, Aurochs und Biber, gelegentlich auch Vögel, kleine Fleischfresser und Wildpferde. Das Vorhandensein der letzteren spricht gegen dichte Wälder in der Region.

## Schlüsselbegriffe

Epilengyel, Bisamberg-Oberpullendorf-Gruppe, Niederösterreich, Subsistenz, Tierhaltung, Jagd

## 1. Introduction

The Bisamberg-Oberpullendorf cultural group (BOG) which occupied the territory of eastern Austria during the Early Copper Age represents the last stage of the indigenous Lengyel (MOG, Mährisch-Ostösterreichische Gruppe) phase.<sup>1</sup> Together with the Münchshöfen Culture in the northeastern Alps, the Jordanów Culture in Bohemia and Moravia, the Ludanice Group in southwestern Slovakia, the Kanzianiberg-Lasinja Group in Styria and Carinthia and the Lasinja Group in western Hungary, Slovenia and Croatia, they form the Epilengyel cultural complex, established by absolute dates at around 4000 BC.<sup>2</sup> This time horizon is connected to the beginning of metallurgy in the Middle Danube area and is characterized by gradual changes in the settlement pattern. The post-Neolithic populations expanded to all parts of the country, abandoned the large

<sup>1</sup> The Moravian-East Austrian Group (MOG) is the western branch of the Painted Pottery Culture of the Middle Neolithic in the Middle Danube region: RUTTKAY 1995.

<sup>2</sup> BÁNFFY 1995. – TASIĆ 1995, 19–42. – PAVÚK 2000, 21–22. – RUTTKAY, TESCHLER-NICOLA, STADLER 2015, 160. – TRAMPOTA, KVĚTINA 2020. – GABULOVÁ 2022.

central settlements and moved to more dispersed (smaller) ones. Their material culture is typified by elements combining innovations (e.g. earliest use of copper, new pottery design), with some of the regional Lengyel traditions (e.g. architecture, mortuary practices). An increasing number of excavated settlements in recent decades have revealed a great deal of information about their architecture and pottery style, but little about their way of life. One of the least explored areas relates to their economic background, subsistence farming and animal husbandry.<sup>3</sup>

This article presents new archaeozoological analyses of a mid-sized collection of well-dated (c. 4300–4050 calBC) faunal remains unearthed during a large-scale rescue excavation in the Rannersdorf village area (Bruck an der Leitha District, Lower Austria). The archaeological research carried out by the Austrian Federal Monuments Office (BDA) from 2001–2002 explored thousands of prehistoric features including burials, dwellings and settlement pits filled with the material culture of several prehistoric periods.<sup>4</sup> Part of the Early Copper Age settlement, which was strategically located between the foothills of the Carpathians and the Alps, consisted of longhouses and pits of the Epilengyel (Bisamberg-Oberpullendorf Group) material culture.<sup>5</sup> This study investigates the hand-retrieved bone material from two of the clay extraction pits, which were scrutinized in a detailed and up-to-date fashion in order to explore the meat dietary pattern and animal husbandry practices as well as shedding more light on animals and the economy at the end of the 5<sup>th</sup> millennium BC.

## 2. Material and Methods

The animal remains originate from the complex of settlement pits S2–5, which ranged in size from 675 to 1100 cm in length and 22 to 100 cm in depth. The pits were located between the longhouses and served as clay extraction pits. Later, they were used for waste disposal. The most distinct was the large and shallow Pit S5 (maximal depth 35 cm), flanked to the south by two smaller pits, the eastern one of which cut through a gravel layer.<sup>6</sup> This locus contained a number of well-preserved bones scattered or embedded between large pebbles, implying a special deposit.<sup>7</sup> The

animal bone material deposited here (Sample 145) and in the Pit S5 was the primary reason for the archaeozoological analysis. The record also included material from the Pit S3 (Feature 1467), which was included in the detailed taphonomic, taxonomic, and morphological analysis. Altogether, 14 samples were selected for detailed analysis (Tab 1). Remaining bone samples, representing the settlement pits S2 and S4 (features 1196, 1197, and 2007) were not recorded in full detail but screened for possible representation of further species or measurable bones to obtain a complete taxonomic and osteometric profile of the assemblage. In total, more than five hundred bone specimens were analysed for this article, a sample sufficient to obtain representative and comparable results for the site and the period.<sup>8</sup>

During the fieldwork, the animal remains were retrieved from the sediments by hand. Judgemental sampling without a finer extraction method of collecting the microfauna (e.g. sieving, flotation), was employed.<sup>9</sup> The bones available for the study were therefore almost exclusively bones of large vertebrates. Apart from the bones of a single bird and a few small rodents, no microfaunal remains were recovered. Before the analysis, four bone specimens (of unidentified large mammals) from samples 145 and 1553 were randomly selected for radiocarbon dating, carried out in the BETA analytic testing laboratory in Miami (Lab. No. Beta 549481-84). Except for a single specimen, which showed a c. eight-centuries-younger date, the selected bone fragments show calibrated dates typical for the Epilengyel horizon (4338–4046 calBC).<sup>10</sup> This study considers the assemblage as a single chronological unit, although, concerning the multi-period character of the site's occupation and the absolute dating results, the possibility of intrusions/residuals from other prehistoric periods cannot be ruled out.

In the laboratory, the identification and determination of osteological material was based on a visual-comparative method and was carried out with the help of a modern reference collection and literature.<sup>11</sup> The majority of finds were anatomically (66 %) and taxonomically (64 %) identified. The unidentified specimens were assigned to the auxiliary

<sup>3</sup> RUTTKAY 1995, 110–128.

<sup>4</sup> SAUER et al. 2002. – SAUER 2006. – See the contribution by V. Reiter in this journal's current issue, REITER 2024, pp. 11–38 [editor's note].

<sup>5</sup> REITER 2024.

<sup>6</sup> REITER 2024, Abb. 9–10.

<sup>7</sup> The working hypothesis which considered this place to be 'an animal carcass processing spot' was later rejected: REITER, personal communication.

<sup>8</sup> Large archaeozoological syntheses suggest that a minimum of 200–300 specimens from at least two features need to be identified to provide reliable results on taxa representation on-site. A sample of this size is considered suitable for comparable purposes from a regional and chronological perspective. – See, e.g., KYSELÝ 2012, 12. – HOLMES 2014, 36.

<sup>9</sup> REITER, personal communication.

<sup>10</sup> For details, see REITER 2024.

<sup>11</sup> KOLDA 1936. – OLSEN 1960. – SCHMID 1972. – SOKOLOV 1979. – COHEN, SERJEANTSON 1996.

size categories, indicating affinity to the large (e.g. cattle, aurochs, red deer, horse), medium/large (e.g. wild boar, roe deer), or medium-sized animals (e.g. sheep, goat, dog). The taxonomic nomenclature followed the recommendation of the International Commission on Zoological Nomenclature.<sup>12</sup> Alongside taxonomy and anatomy, the recording protocol included information on anatomy and an assessment of the sex and age at death of the individual.<sup>13</sup> The skeletal element representation was evaluated based on the NISP quantification and the relative weight difference (WISP-diff.) methods.<sup>14</sup> The mortality profiles of cattle, pigs and caprines are based on the stage of epiphyseal fusion in long bones and the eruption and wear of teeth.<sup>15</sup> Description of bone modifications included surface weathering (erosion), cutting, chopping, gnawing, burning, or bone-working. Different sources of taphonomic evidence were quantified to identify and compare the taphonomic processes affecting the accumulation of animal remains in each context (pit, feature and sample).<sup>16</sup> Percentages of skeletal completeness and limb bones with epiphyses (i.e. portions with the most diagnostic traits), as well as mean specimen weights and the index of fragmentation (if = N/weight)<sup>17</sup> were used as indicators of taphonomic loss. Only charred and calcined specimens were considered burnt. Bone-working assessed the work waste, ad-hoc tools, and used splinters. Modifications by commensal animals included rodent gnawing and carnivore gnawing, biting and puncture marks, as well as ragged proximal ends, while modifications made by unidentified animals include, besides other types, digested bones.<sup>18</sup> The definition of butchery patterns includes the evaluation of cut and chop marks indicating killing, skinning, and disarticulation or filleting. The type of fractures and possible impact marks were recorded to evaluate food processing (e.g. marrow and grease extraction, deliberate breaking of bones).

The quantitative data are analysed and presented based on three methods – the number of identified specimens (NISP), the weight of identified specimens (WISP), and the minimum number of individuals (MNI).<sup>19</sup> The latter was estimated for the whole assemblage based on the left/right side bone affiliation, age, sex, and pathological changes.

Each specimen was weighed to the nearest 0.1 gram. Bone or a loose tooth that fit anatomically to a fragment from the same sample was counted as one.

The measurements were taken with a tape measure or a slide calliper, with an accuracy of 0.1 mm.<sup>20</sup> The withers height and total body weight in dogs were estimated based on the length of the cranial cavity and the shaft circumference of preserved long bones.<sup>21</sup> The size of domestic animals was evaluated on the basis of the statistical evaluation of the osteometric data (descriptive statistics) and logarithmic size indices (LSI) method.<sup>22</sup> The metrical data were collected according to criteria established by Angela von den Driesch<sup>23</sup> and converted into log size index (LSI) values to enable size comparability between different anatomical elements. Standards used for LSI calculations are female aurochs from the Mesolithic site of Ullerslev in Denmark<sup>24</sup> and the modern female wild boar from Elazi in Turkey.<sup>25</sup> The distributions of logarithmic size indices are expressed in histograms drawn for comparable populations from the Neolithic and Eneolithic sites, in which '0' on the horizontal axis represents the standard animal and the number of observations in each interval (0.1) is provided above each column. In the LSI analysis, breadth and depth measurements of the humerus, radius, ulna, femur, tibia, talus, metapodials, and phalanges 1 and 2 were used and the median values compared. The osteometric data were compared with available records from Neolithic and Copper Age sites from eastern Austria and the adjacent regions.<sup>26</sup> The most representative data from the region – the collection from the Middle Neolithic site of Friebritz-Süd<sup>27</sup> – was used as a major reference in the biometric analysis.

### 3. Results and Interpretations

#### 3.1. Taphonomic Analysis

The major factors behind the accumulation and deposition of animal bones within the settlement pits were of anthropogenic origin and included the processes connected

<sup>12</sup> GENTRY, CLUTTON-BROCK, GROVES 2004.

<sup>13</sup> SILVER 1969. – HABERMEHL 1975. – LEVINE 1982. – KOMÁREK 1993. – HORARD-HERBIN 2000, 117–119. – FANDÉN 2005. – BRASSARD, CALLOU 2020.

<sup>14</sup> KUNST 2002, Tab. 268a–b.

<sup>15</sup> SCHMITZBERGER 2009a, 70–71. – PUCHER 2020, 41 and Tab. 12.

<sup>16</sup> ÇAKIRLAR 2012, 5–6 and Tab. 2.

<sup>17</sup> TÓTH et al. 2020, 249.

<sup>18</sup> LYMAN 1994.

<sup>19</sup> REITZ, WING 2008, 191–231.

<sup>20</sup> VON DEN DRIESCH 1976.

<sup>21</sup> WYROST, KUCHARCZYK 1967. – CHRÓSZCZ et al. 2007. – ONAR et al. 2015.

<sup>22</sup> MEADOW 1999.

<sup>23</sup> VON DEN DRIESCH 1976.

<sup>24</sup> DEGERBØL, FREDSKILD 1970, 10.

<sup>25</sup> HONGO, MEADOW 2000, 140 and Tab. 8.

<sup>26</sup> AMBROS 1961. – AMBROS 1968. – FABIŠ 1995. – PUCHER 1996. – PUCHER, ENGL 1997. – PUCHER 2003. – PUCHER 2004a. – PUCHER 2004b. – DRESLEROVÁ 2006. – PUCHER 2006a. – PUCHER 2006b. – KYSELÝ 2008b. – SCHMITZBERGER 2008. – SCHMITZBERGER 2009a. – SCHMITZBERGER 2009b. – SCHEBECZEK 2019.

<sup>27</sup> PUCHER 2020.

Analysis	Pit	Feature	Area	Layer	Sample	N	Weight (g)	Weathering	<sup>14</sup> C	Taxa represented
Full record	S3	1467	NW quarter	1 to bottom	171	26	531.8	mod	–	BT, OC, SD, HS
		1467	NE quarter	1 to bottom	173	58	1544.0	mod	–	BOS, BT, OC, SD
		1467	SW quarter	1 to bottom	174	25	198.1	mod	–	BT, OC, SD
		1467	SW quarter	1 to bottom	175	1	9.0	h	–	MM
		1467	SE quarter	1 to bottom	179	54	2083.4	mod+w	–	BOS, BT, OC
	S5	230	–	1	33	21	498.5	mod	–	BOS, BT, CH, SX
		230	N profile	1 to bottom	39	10	202.2	h	–	BOS, OC, SD
		230	E profile	1 to bottom	41	8	252.3	mod	–	BOS, BT, CE
		230	–	1–2	73	196	3920.8	mod	–	BP, BOS, BT, OC, OA, CH, SX, CA, CE, CF
		230	–	2	145	40	3010.7	l	x	BP, BT, BOS, OC, SX, CA
		230	E half	2	1549	38	1151.2	mod	–	BP, BOS, BT, OC, CH, SD
		230	W half	2	1553	82	3370.6	mod	x	BOS, BT, OC, CH, SD, CE
		231	SW half	1 to bottom	36	11	226.4	mod	–	BOS, BT, CE
	231	NE half	1 to bottom	71	7	106.6	mod	–	BOS, SD	
Screening	S2	1196	–	1 to bottom	160	214	4495.0	h	–	BOS, OC, CE, CF, EQ, RO
		1196	–	1 to bottom	161	12		h	–	SX
		1196	–	1 to bottom	165	53		mod	–	BP, BT, BOS, OC, SX, AN
		1197	–	1 to bottom	162	455	10025.0	h	–	BT, OC, SX, CA, CE, CF, MU, RO
		1197	–	1 to bottom	163	7		mod	–	BT, BOS
		1197	–	1 to bottom	177	197		mod	–	BT, BOS, OC, SX, CF
		1197	–	1 to bottom	218	112		mod	–	BT, OC, SX, CE
	S4	2007	NE quarter	1 to bottom	182	76	2372.0	h+w	–	BT, BOS, CA
		2007	SE quarter	1 to bottom	183	10		mod	–	BT
		2007	SW quarter	1 to bottom	184	62		h+w	–	BT, OC
		2007	NW quarter	1 to bottom	188	36		mod	–	BOS, BT, OC, SX

Tab. 1. Rannersdorf, the sample list with the contextual and taphonomic information. – Erosion: l = light, mod = moderate, h = heavy; w = bone surface smoothed by water activity; N = number of remains; x = sampled for radiocarbon dating. – Taxa are as follows: AN = *Anas* sp., BOS = *Bos* sp., BP = *Bos primigenius*, BT = *Bos taurus*, CA = *Castor fiber*, CE = *Cervus elaphus*, CF = *Canis familiaris*, CH = *Capra hircus*, EQ = *Equus* sp., HS = *Homo sapiens*, MM = medium mammal, MU = mustelid, OA = *Ovis aries*, OC = *Ovis/ Capra*, RO = small rodent, SD = *Sus domesticus*, SR = small rodent, SX = *Sus* sp.

to the feeding of humans. Further natural forces, including the climate and post-burial compression, shaped the preservation of the analysed material. The surface of the bone specimens was mostly moderately eroded (Tab. 1), suggesting a relatively short period of exposure for the bone remains (up to three years since the death of the animal) to agents such as temperature, moisture or sunlight.<sup>28</sup> There were a few samples that contained bone fragments eroded by water activity, thereby indicating the redepositing of part of the material. The surviving bone completeness varied between particular contexts (samples), indicating different taphonomic agents or pathways. The index of fragmentation (IF) ranged from 0.013 to 0.126, with an

average of 0.051 (Fig. 1), and may be viewed as low to moderate. In particular features it varied from 0.032 to 0.078, reflecting relatively good preservation of the natural morphology and completeness of the studied bone remains. The least fragmented material accumulated was found in Sample 145, pointing to the distinct character of the mixed deposit of well-preserved bones and the layer of big pebbles ('gravel layer'). Compared to other material from the settlement (Tab. 2), Sample 145 includes a higher proportion of completely preserved elements (15 %) and limb bones with preserved epiphyses (37.5 %). The specimens deposited there also display no or just light erosion of the bone surfaces. As far as indicators of food processing are concerned, however, they seem to be butchered to a similar or even slightly higher extent (Tab. 2). The most significant difference between bones from this deposit and the analysed

<sup>28</sup> Weathering stage 1. – LYMAN 1994, 355 and Tab. 9/1.

settlement pits can be seen in gnawing. Sample 145 had the highest proportion of specimens gnawed by canids (47.5 %). It means that domestic dogs had similar access to the deposited food remains, although their overall impact on the bone preservation was, according to the above, low. Carnivore gnawing was recorded on various elements of commonly consumed bovines (21.9 % of the total), caprines (31.4 %) and suids (25 %). Gnawing occurred sporadically on bones of wild taxa (e.g. beaver femur, deer humerus).

Altogether 146 specimens display clear (3.4 %) or presumed traces (89.7 %) of butchery. Marks of animal slaughter or skinning, the activities involved in primary butchery,<sup>29</sup> were not recorded. The extraction of brain tissue can, however, be presumed on the basis of old breakages and impact marks recorded on cattle, goat and dog skull elements (n = 5). Chop marks related to the initial dismembering of the carcass into the major cuts or portions (secondary butchery) were clearly recorded on the proximal tibia of sheep/goats and the distal humerus (both Sample 1553) or thoracic vertebra of cattle (Sample 145). A substantial portion of bones (19 % of NISP) exhibit modifications caused by a heavy blunt tool causing splitting and breakages in order to extract the bone fat (tertiary butchery). The exploitation of bone marrow is supported by small to very small splinters, occurring with a frequency of 10.7 % to 27.3 % per sample (15.2 % on average). Regarding the predominance of spiral or helical type fractures and durable bones of large mammals, it can be hypothesised that most of them were freshly broken, either during food processing or later on, through the feeding of carnivores. Apart from a single case of short cut marks located transversally to the distal diaphysis of a long bone, no traces of the use of a sharp metal or stone tool (blade or point insertion) were noted in the Rannersdorf material.

Burning and bone-working did not contribute significantly to the taphonomic history of the material. Two burned specimens from the settlement Pit S5 (Sample 73) were a brown-coloured cattle metatarsal fragment and the blackened fragment of the mandible symphysis of a pig. Both suggest the moderate heating (from 250 to 550°C) of a bone.<sup>30</sup> As for bone-working, a large diaphysis (tibia?) fragment of cattle and the distal tibia of a caprine (both Sample 39) exhibit deliberately rounded areas at one of the shaft ends (Fig. 2/1–3). Their total length did not exceed 10 cm (97.9 and 62.3 mm). The macroscopic investigation of the modified areas (old breakage edges) did not reveal a use-wear pattern, except for polishing. Antler-working

was documented based on a flattened and polished antler tip (Fig. 2/4) and the big fragment of the shed antler (Sample 1553) with transversely and longitudinally oriented chop marks above the pedicle.

The comparison of the skeletal element distribution within the selected subsets of analysed material revealed a greater representation of the cranial and hind limb elements including the most distal parts such as metapodials and basipodial bones in the ‘gravel layer’ deposit. On the other hand, teeth were absent there (Fig. 3). Regarding other elements, no significant selection of a particular body part was observed. In all of the subsets, the meat-bearing elements predominated, while the face, tail and feet bones (‘the butcher’s refuse’) made up no more than 25 % of the total weight. Sample 145 shows the most balanced representation of the elements bearing the best meat (39.9 %), medium-quality meat (36.0 %) and the meatless elements (23.8 %).

### 3.2. The Representation of the Taxa

In total 581 bone specimens have been analysed and fully recorded for this study (Tab. 3). The human remains, comprising nine specimens, all originated from Pit S3 and Feature 1467 (Sample 171). They all represent the elements of the upper limb of a single adult individual and, following the field documentation, may be related to the human skull also discovered in Feature 1467.<sup>31</sup>

The remaining material (n = 572) comprises only animal remains, of which more than half (63.5 %) have been taxonomically identified. The remaining portion was assigned to the auxiliary categories (n = 209), among which remains representing the large-sized animals slightly predominated (ratio 1:0.8). Only one-quarter of the identified remains were assigned to the wider taxonomic groups such as genus, family or class level. The majority of specimens were identified on a species level (83.7 %), although a substantial portion remained questionable due to the fragmentary state of bones and problems related to the differentiation of domestic and wild forms in bovines or suids (n = 93).

Generally speaking, considering all questionable identifications, the analysed settlement debris was dominated by domestic species (Fig. 4). The plausibly identified species were cattle (*Bos taurus*), pig (*Sus domesticus*), sheep (*Ovis aries*), goat (*Capra hircus*) and dog (*Canis familiaris*). A single sheep bone was identified, and more specimens of this species may have been represented within the mixed category of caprines (*Ovis/Capra*). The wild animals identified

<sup>29</sup> RIXSON 1989, 49.

<sup>30</sup> After LYMAN 1994, 385–386 and Fig. 9/9.

<sup>31</sup> The human bone remains were separated from the animal bone material and anthropologically analysed: REITER 2024.

Indicators	Subset			
	Sample 145	Pit S3	Pit S5	All
<i>Taxonomic composition</i>				
Total N (n of identified animal taxa)	40(5)	154(4)	413/8	572/12
% of domestic taxa	67.5	51.9	41.2	43.9
% of wild taxa	2.5	–	4.6	3.5
% of cattle	40.0	33.8	27.6	29.0
% of caprines/pig	17.5/2.0	12.9/5.2	9.9/2.4	10.7/3.0
<i>Fragmentation</i>				
Index of fragmentation (IF)	0.013	0.036	0.032	0.033
% of complete/almost complete skeletal elements	15.0	3.9/7.8	0.5/6.8	1.4/7.1
% of limb bones with epiphyses and/or metaphyses	37.5	4.5	4.1	4.2
% of small to very small specimens	15.0	27.3	10.7	15.2
Mean weight of specimens representing medium-sized mammals	32.6	10.6	14.7	13.8
Mean weight of specimens representing large-sized mammals	98.3	42.5	39.3	39.9
<i>Burning</i>				
% of burned (charred and calcined) specimens	–	–	0.5	0.4
<i>Food processing and tool manufacturing</i>				
% of specimens modified during marrow and grease extraction	25.0	12.3	22.8	18.7
% of specimens with cut and chop marks	10.0	–	2.1	1.1
% of specimens with traces of working	–	–	1.0	0.7
<i>Modification by commensal animals</i>				
% of specimens with traces of carnivore activity	47.5	9.7	17.0	15
% of specimens with traces of rodent activity	–	–	–	–
<i>Surface abrasion</i>				
% of specimens of heavily eroded surface	–	4.3	4.5	4.4
% of specimens with slightly eroded surface	42.5	51.6	95.2	85.2
% of specimens with water-smoothened surface	–	37.6	–	8.6

Tab. 2. Rannersdorf, the taphonomic indicators in selected subsets and overall assemblage. The taxonomic composition includes antler specimens.

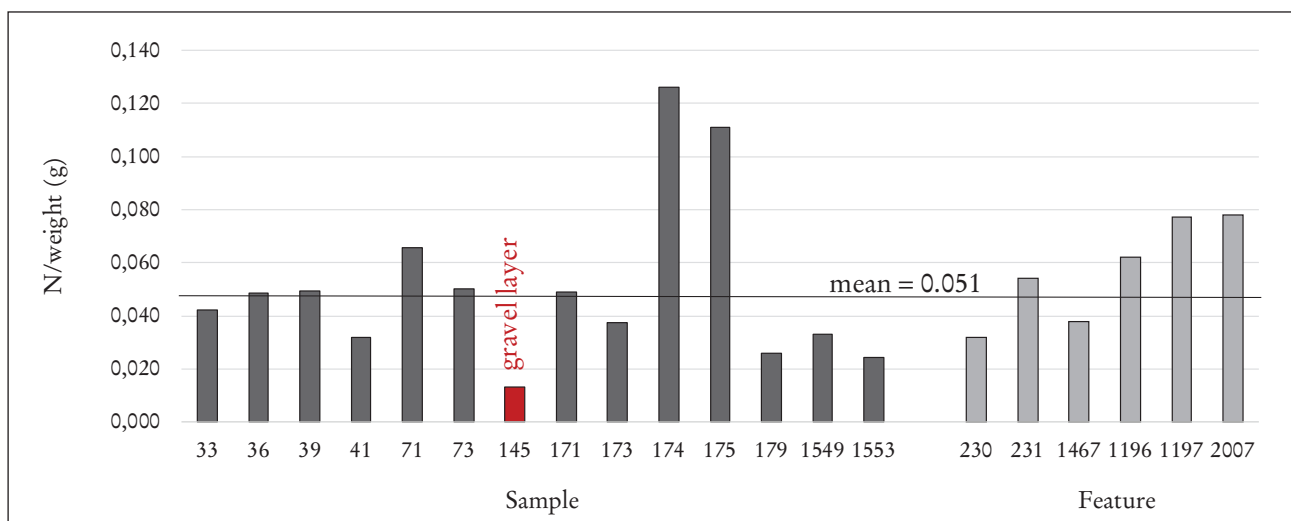


Fig. 1. Rannersdorf, the general extent of bone fragmentation in analysed samples and features.

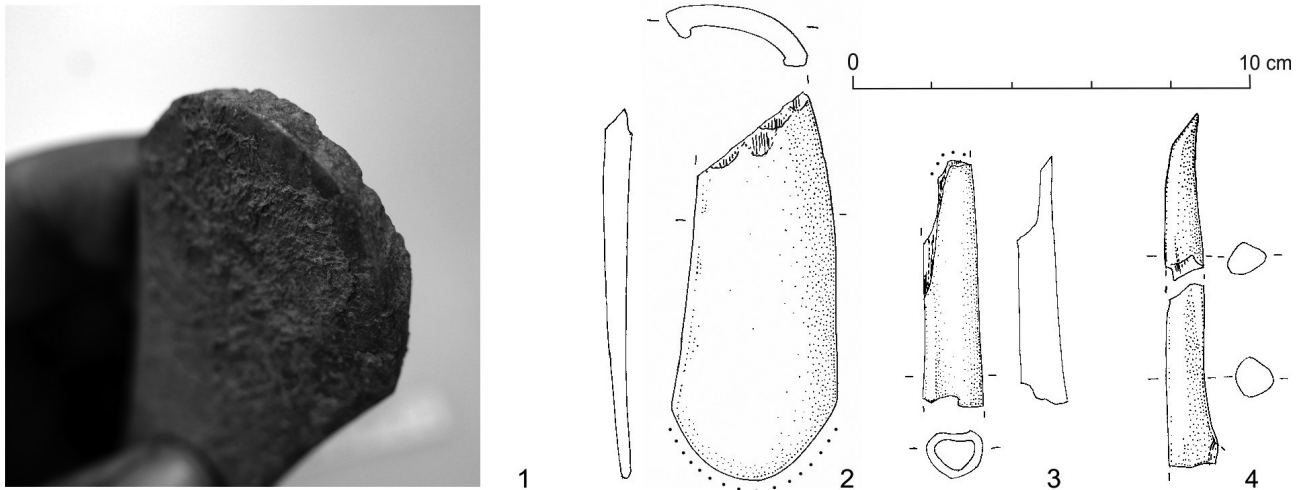


Fig. 2. Rannersdorf, the worked bone and antler specimens. – 1–2. A spatula-like implement made of a large mammal (cattle) diaphysis (tibia?) fragment (Sample 39). – 3. Distal diaphysis of caprine tibia with polished apex (Sample 39). – 4. Highly polished and flattened tip of a red deer antler preserved in two pieces (Sample 36).

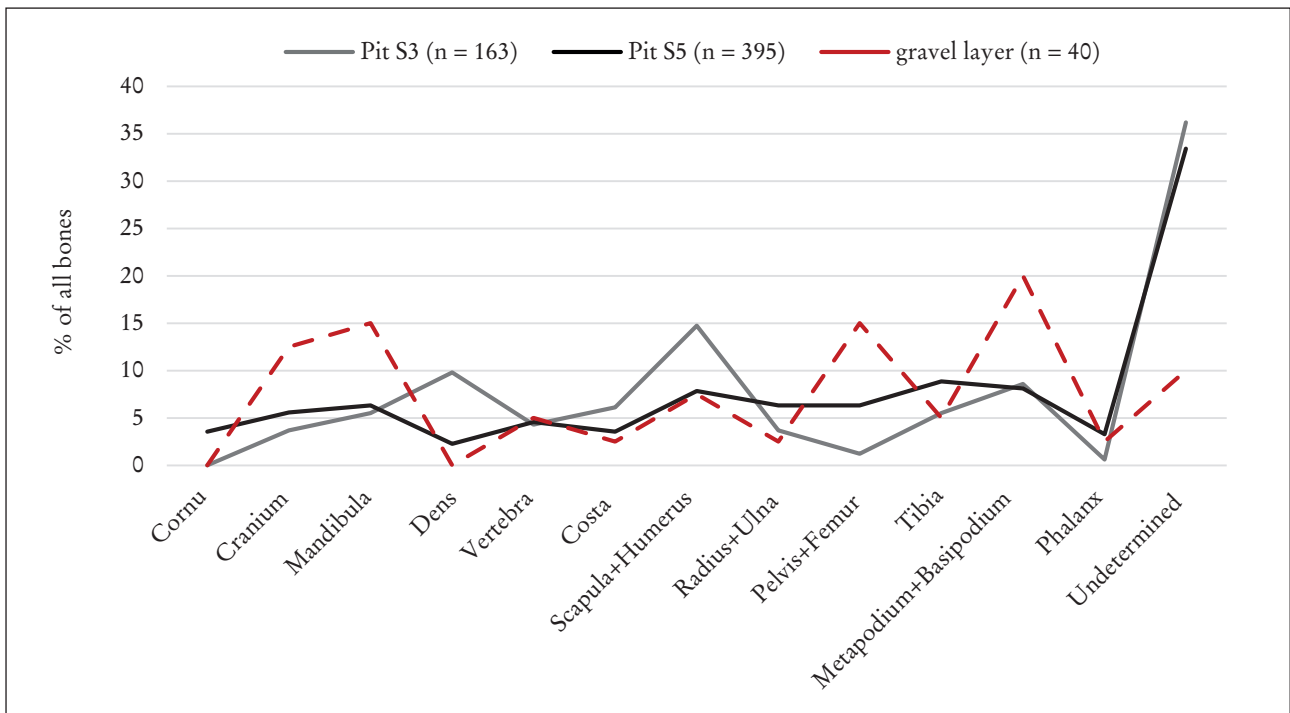


Fig. 3. Rannersdorf, the skeletal element representation (% NISP) in analysed pits S3 and S5 and the bone-gravel deposit (Sample 145).

include aurochs (*Bos primigenius*), red deer (*Cervus elaphus*) and beaver (*Castor fiber*). In addition to that, the screening of remaining material (from features 1196, 1197 and 2007) revealed the tooth of a horse (*Equus* sp.), bones from a small mustelid (*Mustelidae*), hamster (*Cricetus cricetus*) and an unidentified bird, most probably belonging to the duck genus (cf. *Anas*).

The primary quantification methods attest the predominance of domestic taxa, by number (43.9 %) and by weight (61.8 %). The wild taxa constituted 3.7 % by number and 7.2 % by weight. Quantification within the group of identified specimens (NISP = 363) shows a clear predominance of large bovids (Fig. 5). The overall share of cattle (BT + BT?), aurochs (BP + BP?) and unidentified

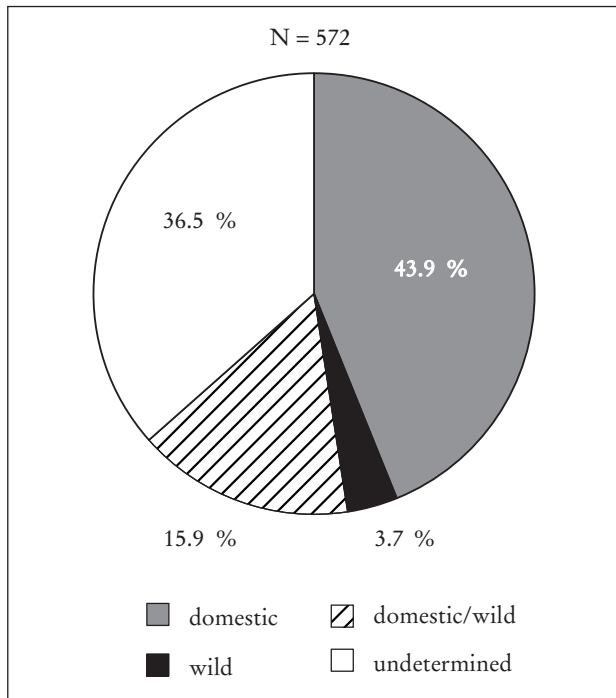


Fig. 4. Rannersdorf, the representation (% N) of domestic and wild taxa.

bovines (*Bos* sp. – BOS + BOS?) was 69.1 % by number and 84.2 % by weight. The bones of other taxa make up either a small (less than 10 %) or negligible (less than 2 %) number of finds. After the large bovines, only caprines occurred in bigger numbers. However, their portion was significant only in terms of the number of finds; by weight their share was small, similar to suids (5.9 % versus 4.3 %). Within the group of wild taxa, the red deer and aurochs (33.3 %) were the most represented species, above all on counting the antler specimens (47.6 % with antlers; 28.6 % without antlers). The beaver was the third most common wild animal (9.5 %).

A clear predominance of cattle (BT + BT?) was recorded in the analysed sample (Fig. 6). By NISP, cattle make up 66.4 %, caprines 24.4 %, pigs 6.8 %, and dogs 2.2 % of the total. By WISP, the share of cattle was 86.1 %, of caprines 8.9 %, of pigs 3.5 %, and of dogs 1.5 %.

Following the MNI quantification, the remains of at least 11 cows/bulls/oxen, six pigs, two goats, two dogs and one sheep were identified. This makes a total of at least 27 individuals.

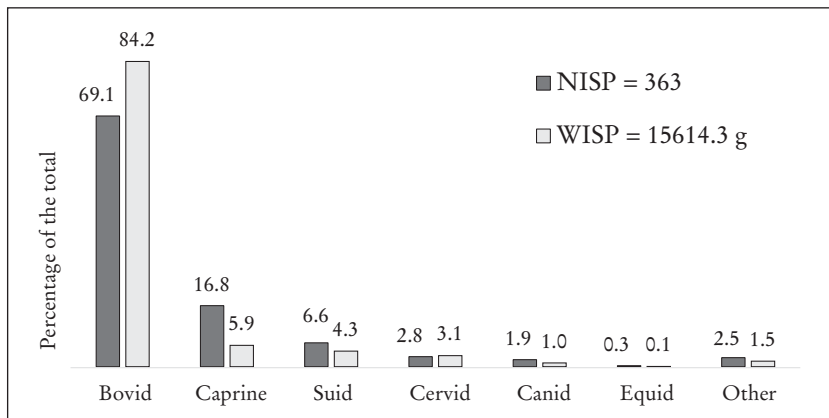


Fig. 5. Rannersdorf, the representation (% NISP and % WISP) of wider taxonomic groups. Red deer antler specimens are included in the quantification. “Other” includes remains of beaver, mustelid, bird and undistinguished bovines/cervids.

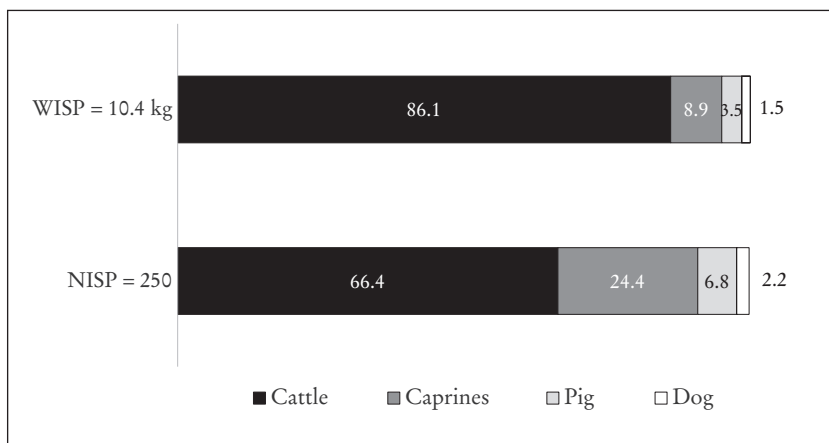


Fig. 6. Rannersdorf, the representation of domestic species on the basis of primary quantification methods.



Element	Domestic mammal						Domestic/wild mammal				Wild mammal					Bird	Undetermined animal				Human	Total								
	BT?	OA	CH	CH?	OC	OC?	SD	CF	EQ	BOS	BOS?	BOS/CE	SX	BP	BP?		CE	CE?	CA	MU			AN?	LM	MLM	MM	MX	BX	HS	HS?
Cornu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-	-	-	-	-	-	-	-	4	
Processus cornualis	9	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11		
Neurocranium	-	1	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	6		
Occipital	2	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5		
Parietal	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	3		
Frontal	4	3	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	10		
Maxilla	-	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4		
Maxilla + dens	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2		
Mandibula	5	3	-	-	4	-	1	1	6	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25		
Mandibula + dens	2	-	-	-	5	-	4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14		
Dens	3	11	-	-	3	-	1	1	6	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26		
Vertebra	6	10	-	-	-	-	-	-	2	-	3	-	-	-	-	-	-	-	-	-	2	-	3	-	-	-	-	26		
Costa	-	4	-	-	-	-	-	-	13	2	-	-	-	-	-	-	-	-	-	-	2	-	3	-	-	-	-	24		
Scapula	3	1	-	-	2	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	4	-	1	-	-	-	-	15		
Humerus	10	6	-	-	3	-	2	1	11	-	-	-	-	1	-	1	-	1	-	-	2	-	3	-	-	-	-	42		
Radius	4	1	-	-	8	-	1	-	2	1	-	2	-	1	-	1	-	-	-	-	-	1	-	1	-	-	-	21		
Ulna	3	1	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12		
Carpometacarpus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1		
Metacarpus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2		
Metacarpus 3/4	5	4	-	-	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15		
Phalanx I ant.	2	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	6		
Pelvis	1	-	-	-	2	-	1	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	7		
Femur	6	2	-	-	3	-	2	1	2	-	1	-	-	-	-	-	-	1	-	-	1	-	2	-	-	-	-	21		
Tibia	6	4	-	2	1	14	1	1	4	1	-	1	-	1	-	1	-	-	-	-	-	7	-	-	-	-	-	44		
Talus	4	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5		
Calcaneus	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2		
Centrotarsale	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2		
Metatarsus 3/4	9	2	-	-	3	-	-	-	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	17		
Phalanx I post.	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1		
Metapodium	1	-	-	-	-	-	2	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6		
Phalanx I	3	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	5		
Phalanx II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1		
Phalanx III	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1		
Undetermined	-	16	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	92	16	28	36	1	-	-	195		
N	92	74	1	7	2	50	1	17	7	1	68	10	5	7	4	3	7	3	2	1	1	106	16	50	36	1	6	581		
NISP %	45.7	0.3	2.5	14.1	4.7	1.9	0.3	21.5	1.4	1.9	0.3	2.8	0.6	0.3	1.9	2.8	0.3	0.3	0.3	0.3	-	-	-	-	-	-	-	-		
Domestic & wild total %	251 = 69.2 (69.9 %)										91 = 25.1 (25.4 %)										20 (16) = 5.5 (4.5 %)					1 = 0.3 %				
Identifiability %	363 = 63.5 %										363 = 63.5 %										209 = 36.5 %					-				

Tab. 3. Rannersdorf, taxonomic and anatomic determination of finds. Quantified by NISP. The values in parentheses show proportions without antler specimens. For taxa coding, see Table 1. - LM = large mammal, MLM = medium to large mammal, MX = mammal, BX = bone.

pigs and dogs and, at the same time, reduced the predominance of large-sized cattle. The higher frequency of pig and caprine remains is also supported by their frequency in the analysed samples. The cattle show up in 80 %, the caprines in 68 % and pigs in 64 % of all samples ( $n = 25$ ). The repeated occurrence of red deer (28 %), dog (20 %), goat (16 %), beaver (16 %), and perhaps also aurochs (16 %) was recorded. Sheep, horse, bird, and mustelid belong to the rare taxa (together 4 % of the total number of retrieved samples).

### 3.3. Domestic Species

#### 3.3.1. Cattle (*Bos taurus*) and the Large Bovines (*Bos* sp.)

The fragmentary condition of remains from prehistoric sites causes serious problems for the clear differentiation of domestic and wild forms of bovines.<sup>32</sup> The pronounced sexual dimorphism leads to an overlap between the size variation of cattle and aurochs and, at the same time, diagnostic features of the *Bos* and *Bison* genera are often not recognizable. During the Late Neolithic, the Middle Danube area including eastern Austria was inhabited by the European bison (*Bison bonasus*) and the aurochs (*Bos primigenius*).<sup>33</sup> In addition, domestic cattle (*Bos taurus*), introduced by the early farmers from the Near East, spread in the region.<sup>34</sup> Although the exact ecological requirements of the large Neolithic bovines remain questionable, the location of the studied site in the warmest corner of the country – the Vienna Basin and the Danube floodplain – might have favoured the aurochs.<sup>35</sup> The archaeozoological evidence from Austria has pointed out that the numerous records of aurochs coincide with the distribution area of the Neolithic and Copper Age settlements, while finds of bison are sporadic and mainly come from the sites in the alpine and subalpine zones.<sup>36</sup>

The relative indicators used in the differentiation between the wild and domestic forms of bovines such as the thickness of the compact bone, the specimen's weight and the development of the muscle attachment surfaces suggest that a minority of the finds studied may represent wild bovines. Moreover, as the few well-preserved specimens exceeding the size of domestic cattle do not exhibit features

typical for a bison, all of them were assigned to aurochs.<sup>37</sup> Beside clearly or presumably determined cattle (BT or BT?) and aurochs (BP or BP?), however, a relatively large portion of the material remains undifferentiated (21.5 % of NISP) and represents the category cattle/aurochs (BOS and BOS?). These specimens may represent the bulls or oxen of domestic cattle (1), the cows of aurochs (2) or their hybrids (3). The hybridization or local domestication of aurochs is sometimes presumed on the basis of the osteometric analyses and genetics. However, most of the current research considers the 'transitional forms' as a proof of metric overlap between them rather than as local domestication.<sup>38</sup> According to some scholars, their frequent occurrence may also reflect an increase in the average body size of domestic cattle.<sup>39</sup> In Rannersdorf, the LSI analysis revealed that the majority of measurable bovine elements are smaller than the standard female aurochs individuals from Denmark (Fig. 7). The local population differs significantly from the Middle Neolithic bovines from Friebritz, where c. 35 % was represented by aurochs or bison. This supports the presumption about the prevalence of domestic cattle within the bovine collection from Rannersdorf. The only three specimens exceeding the standard may either represent female aurochs or very large cattle, perhaps castrated male individuals (more in section 3.5). Moreover, the distribution of LSI values for Rannersdorf cattle produces two peaks, thus indicating the representation of both sexes in the material.

As for domestic cattle, cranial as well as postcranial elements were represented (Tab. 3). Based on anatomy, bone symmetry and the ageing and size of the elements, the assemblage consisted of at least 11 individuals. Apart from short bones such as calcanei, tali or phalanges, no cattle bone has been preserved in its entirety. Nearly half of the complete elements ( $n = 39$ ) comprise loose teeth. As for the anatomical representation of finds, among the most overrepresented was the (distal) humerus, while mandibles, metapodials, and tibiae were also frequent. On the other hand, vertebrae and ribs were significantly underrepresented, mainly due to their fragmentary character and the problems associated with their taxonomic identification.<sup>40</sup> The WISP difference method also revealed a slight underrepresentation of the pelvis and femur in the collection (Fig. 8).

32 DEGERBØL, FREDSKILD 1970. – KOBRYŃ, LASOTA-MOSKALEWSKA 1989. – KYSELÝ 2008a.

33 BAUER 2001, 730–743. – SCHMITZBERGER 2009a.

34 SCHEU et al. 2015. – PUCHER 2017a.

35 KYSELÝ, MEDUNA 2009, 247–248. – LIEB, EMBLETON-HAMANN 2022, 37–38.

36 SCHMITZBERGER 2009a, 70–72 and Fig. 30. – SCHAER et al. 2022.

37 The fragmentary character of some specimens prevents plausible conclusions being drawn.

38 BENECKE 1994, 48–55. – BARTOSIEWICZ 2005, 57. – KYSELÝ 2008a. – SCHMITZBERGER 2009a, 73–74. – SCHIBLER, ELSNER, SCHLUMBAUM 2014. – PUCHER 2020.

39 BENECKE 1994, Fig. 24.

40 No vertebrae and ribs were available in the reference collection.

The morphology and sex of culled bovines can be inferred from the four horn-core specimens. The samples 1553 and 1549 were of small dimensions and had a thin-walled construction and a circular cross-section, perhaps suggesting the female sex. A case with a porous structure to the horn-core indicated a subadult age of the individual. The largest preserved right horn-core specimen (Sample 160; Fig. 9/1) had a destroyed distal part and apex, but displayed a distinctive basal circumference (206 mm). Its oval cross-section and slight curvature, pointing downwards, suggest it is related to the wild bovines, most probably female aurochs. This specimen is comparable to auroch females and domestic oxen at Friebritz (Fig. 10). A large fragment of a horn-core (Sample 1553) was not measurable, but its thin walls, length and slight curvature point to the domestic form of cattle, most likely a castrated male (Fig. 9/2). The predominance of females (cows) in the culled cattle is also indicated by the size and shape of the metapodials (Tab. 4), although the absence of a complete metapodium did not allow sex to be assessed with confidence, so the presented results should be treated with caution. A pelvic fragment with acetabulum (Sample 145) represents either a female aurochs or a large ox (see Appendix 1/9<sup>41</sup>).

The dental ageing of available mandibles ( $n = 6$ ) and loose teeth ( $n = 5$ ) showed that the earliest slaughter of those cattle took place between the first and the second year of life, i.e. not earlier than the subadult age (Fig. 11). Although some of the loose teeth (e.g. a strongly abraded milk premolar and the third molar without abrasion) may represent younger animals, the predominance of animals that died at adult and mature age is visible. Within this group, the culling of adults (2–5 years of age) and mature cattle (more than 5 years old) seems to be balanced. The results based on the epiphyseal and apophyseal fusion in the postcranial skeleton ( $n = 39$ ) yielded similar results (Fig. 12). It suggests the absence of calves (0–3 months) and juvenile individuals (up to 6–10 months). The earliest death was evidenced through two distal humeri with unfused epiphyses (samples 145 and 179), suggesting that both died before the 15<sup>th</sup>–20<sup>th</sup> months. This method shows a focus on the culling of cattle between 2 and 4 years of age, with mortality at c. 60%. Approximately half of those surviving had been culled in their third year of life, while only a few animals seem to survive maturity, suggesting an emphasis on primary (meat) production.<sup>42</sup> Thus,

Sex (BT + BOS)	Female (Cow)	Castrated male (Ox)	Male (Bull)
Horn-cores	2	1?	–
Metacarpus	7	–	2?
Pelvis	–	1?	–
Metatarsus	5	–	–
Total	14	2?	2?

Tab. 4. Rannersdorf, the sex assessment in domestic cattle. For taxa coding, see Table 1.

the combination of dental and epiphyseal fusion points to a mixed meat and milk exploitation pattern with the absence of calves and two peaks of the slaughter – one in young adult age (in 2–4 years of age) and the second in maturity (from the 5<sup>th</sup> year onwards). The first one coincides with the first-quality meat and the best yield and the second, with a focus on secondary production – milk or draught power.<sup>43</sup>

The limited metric data and the absence of completely preserved long bones in Rannersdorf do not allow the retrieval of significant information on the size including the withers height of local cattle. However, some indicators were gained with the help of individual measurements or their combination through the LSI-method. The comparison of the well-preserved tali, for instance, has indicated that three of four specimens are rather small, having dimensions from the lower end of the size range recorded at the Middle Neolithic Friebritz. All may represent females, while the remaining fairly large and robust (compared to the Friebritz aurochs) specimen, perhaps comes from a (castrated?) male (Fig. 13). A comparison of humeri revealed similar results, suggesting a significantly smaller size of the Early Copper Age cattle from Rannersdorf. The local cattle had smaller (and more gracile?) proximal limb dimensions. While the median of the trochlear breadth in the humerus is 77 mm, in Friebritz it is 81.5 mm. A single cattle individual from Rannersdorf with a value of 95.4 mm therefore seems to represent a female aurochs or very large ox (Fig. 14). The comparison of the BT median value suggests slightly bigger cattle than reported from the pile-dwelling sites (e.g., Mondsee; BT = 71.5 mm) but fits well with the size from the following Copper (Potzneusiedl; BT = 78 mm) and Bronze Age sites (Schleinbach; BT = 78.5 mm). This is in line with the trend towards a reduction in body size among cattle beginning in the Late Neolithic. This hypothesis includes the

<sup>41</sup> The raw osteometric data (full list of bone measurements) from Rannersdorf is available as an online Appendix: doi: 10.1553/archaeologia108s39-A.

<sup>42</sup> PUCHER 2020, 45 and Fig. 32.

<sup>43</sup> UERPMANN 1973, 316.

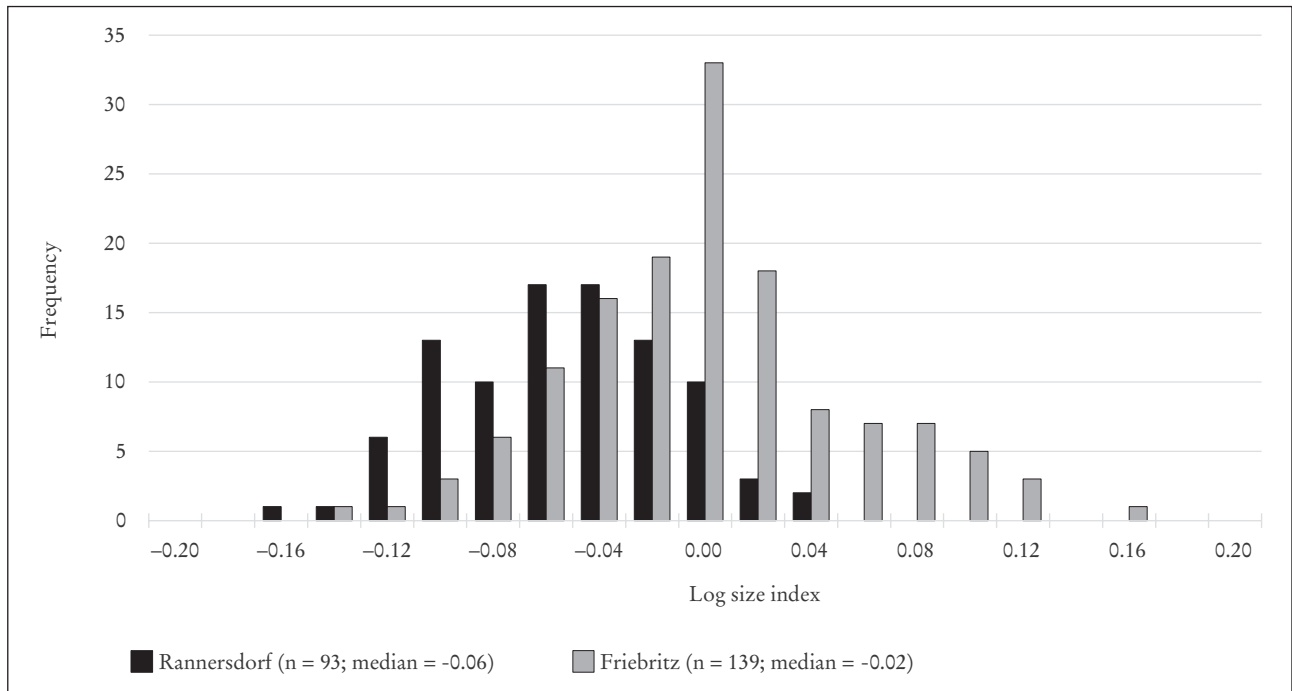


Fig. 7. The size comparison of the large bovines (BT + BP + BOS) from the studied site and Friebritz (PUCHER 2020) based on the LSI method. The standard refers to the female aurochs individual from Mesolithic Denmark (see section 2, Material and Methods).

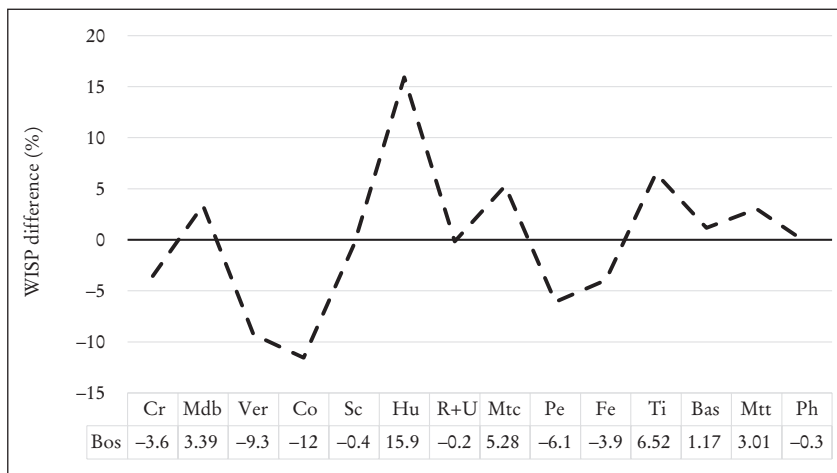


Fig. 8. Rannersdorf, the skeletal element representation (% WISP-difference) in cattle (BT + BOS).

possibility of the replacement of the large Middle Neolithic cattle by smaller (different?) populations.<sup>44</sup>

**3.3.2. Caprines (*Ovis/Capra*)**

The caprines were the second most abundant taxonomic group in the assemblage studied (Tab. 3). Due to the

similar anatomy of sheep (*Ovis aries*) and goats (*Capra hircus*), both imported to the region by the first Neolithic farmers, there is a persistent problem in archaeozoology of distinguishing between them based on fragmentary material.<sup>45</sup> In Rannersdorf, only ten specimens (c. 20 % of

44 SCHMITZBERGER 2009a, 77.

45 E.g. ZEDER 2008. – For the criteria used in distinguishing caprine species, see section 2, Material and Methods.



Fig. 9. Rannersdorf. – 1. Partly preserved horn-core of a female aurochs (Sample 160). – 2. Fragment of a horn-core of domestic (perhaps castrated) cattle (Sample 1553). – 3. The size variation in bovine first phalanges (Sample 160). – 4. The size variation in bovine second phalanges (samples 173 and 177). – 5–6. (Female?) goat calvaria with partly preserved horn-cores (samples 1553 and 145).

the total caprines) have been identified to a species level. Interestingly, most of these finds represented goats, while sheep were identified only based on a single neurocranial fragment (Sample 73). The partially fused cranial sutures and the shape of the small horn-core suggested that the latter most probably originated from the skull of a subadult female sheep (Appendix 1/19). Similarly, two fragmentary goat neurocrania (samples 145 and 1553), both with partially

preserved horn-cores, belonged to females of subadult and adult age, respectively (Fig. 9/5–6). The remaining goat remains were represented by skull and tibia fragments. In addition, the complete talus of a goat was found during the screening of available material in Sample 188.

The bulk of caprines were represented by elements of the postcranial skeleton (Tab. 3). No vertebrae, costae, basipodium or phalanges were recorded. The cranial and

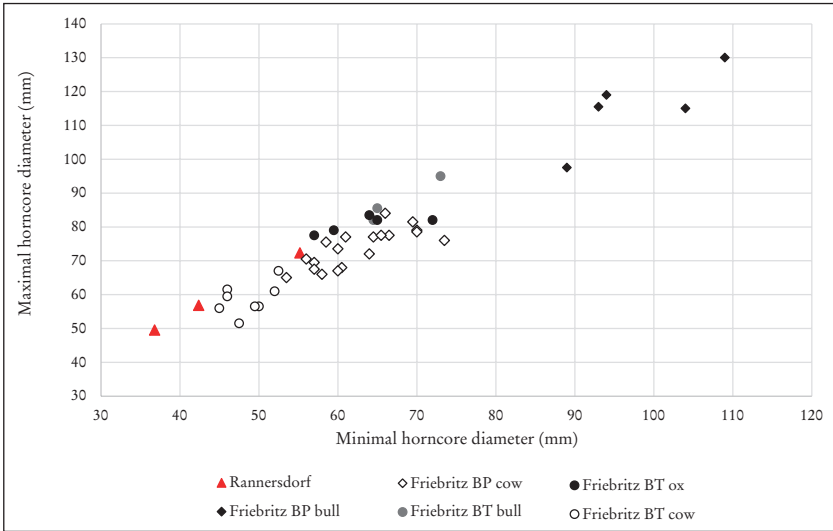


Fig. 10. Sexing the cattle and aurochs horn-cores from the studied site with the help of the dimensions at the base and comparison with the horn-core finds from the Middle Neolithic Friebritz (PUCHER 2020).

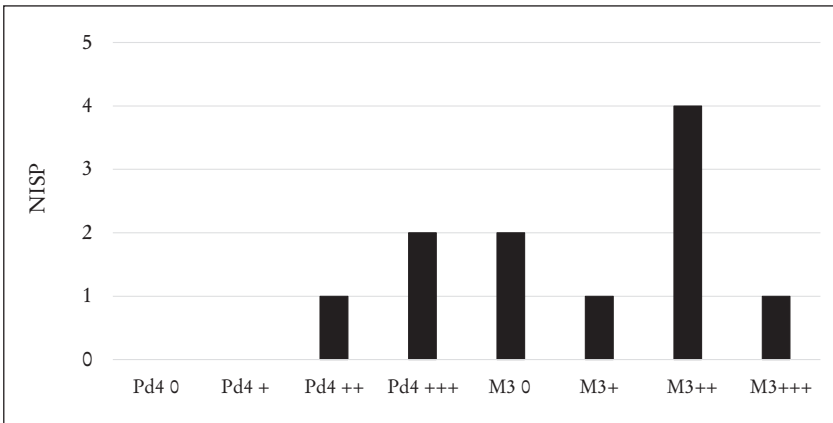


Fig. 11. Rannersdorf, dental ageing in cattle (BT + BOS; n = 11). – Legend: 0 = unworn; + light wear, ++ medium wear, +++ = strong wear of the teeth; Pd4 = lower milk premolar; M3 = lower third permanent molar.

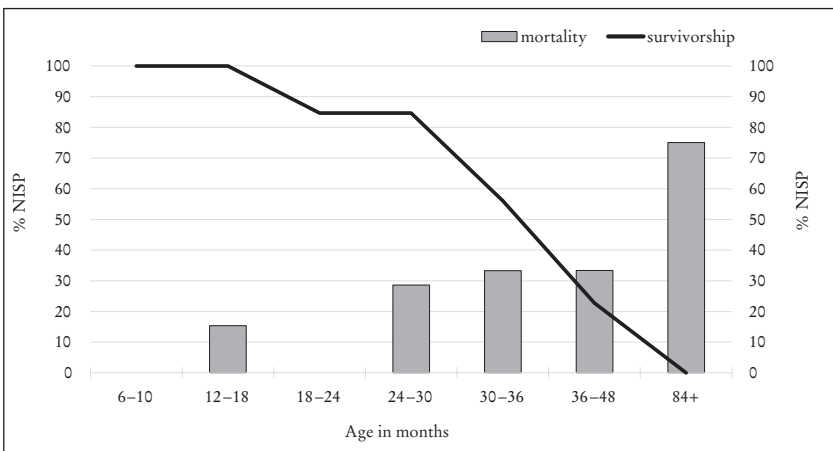


Fig. 12. Rannersdorf, the survivorship and mortality of cattle (BT + BOS) based on the epiphyseal fusion (n = 39).

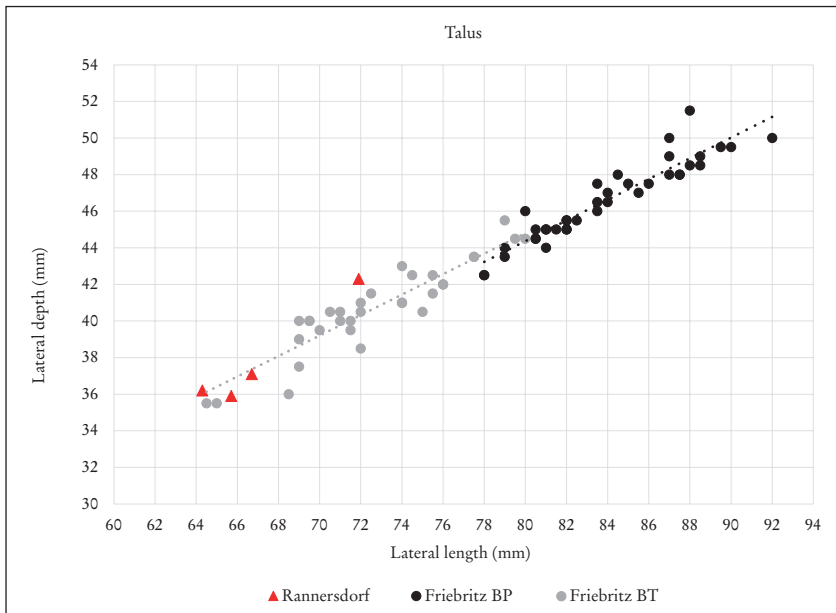


Fig. 13. The scatter diagram comparing the size of bovine tali from the studied site and the Middle Neolithic Friebritz (Pucher 2020).

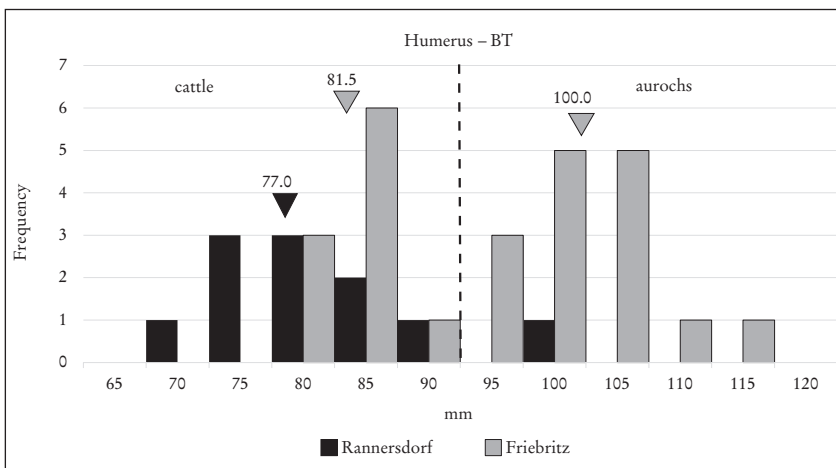


Fig. 14. Comparison of the size of bovine humerus trochlear breadth (BT) from the studied site and the Middle Neolithic Friebritz (Pucher 2020). The triangle indicates the median value.

mandible fragments made up 31.2 % of the total NISP. In contrast to the raw counts, the WISP difference method showed an overrepresentation of the cranial elements and tibiae (Fig. 15). In terms of the contribution of meat to the diet, the skeletal elements bearing medium-quality meat predominated (80 % by WISP). The parts with the best meat and the butchers’ refuse were poorly represented (13.4 % and 6.6 % by WISP).

With the exception of the females identified on the basis of the horn-cores, information on the sex of culled caprines is unavailable. The shape of a caprine’s pelvic bone (Sample 179/28) points more to a goat, with the acetabulum length

(LA) falling within the range of females.<sup>46</sup> The age has been assessed in 42 specimens and suggests the predominance of adult (and subadult/adult) animals. The earliest slaughter based on epiphyseal fusion data was evidenced by a femur and tibia (both Sample 145) and represented an individual or individuals slaughtered before reaching the first year and a half or the second year of life. The size of a partially preserved radius (Sample 73) suggests that the animal died very young, probably unborn or shortly after birth (newborn). In addition,

<sup>46</sup> Cf. Pucher 2020, 102.

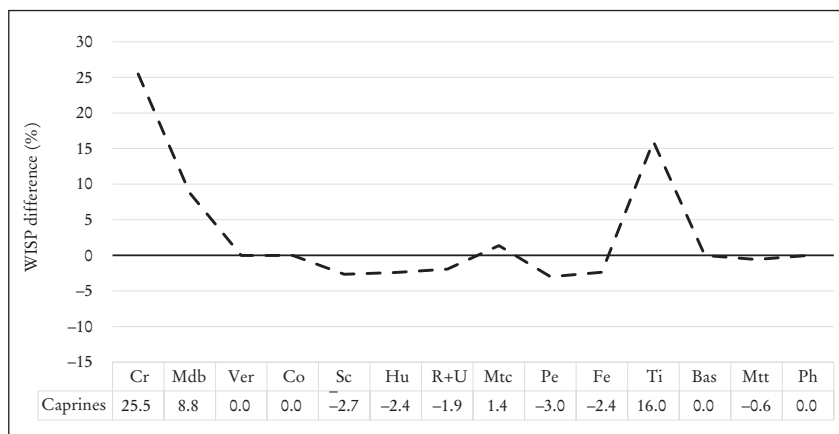


Fig. 15. Rannersdorf, the skeletal element representation (% WISP-difference) in caprines (OA + CH + OC).

another apparently foetal humerus with open epiphyses was identified during the screening procedure (Sample 166). Its total length was 56 mm (without epiphyses), suggesting the caprine died shortly before birth, on at least the 136<sup>th</sup> day (i.e. four and a half months) of pregnancy. If we consider the early spring to be the usual time of birth for young caprines, we may presume that it happened at some point in February or in March. As for the dental ageing data, the abrasion of teeth in four mandibles has been assessed. The medium or advanced abrasions of the occlusal surface in permanent molars (M3) suggest that all died at an older age (Appendix 1/22). To sum up, the assemblage comprised bones of at least one foetus, one young adult (under 1.5–2 years) and four mature (older than 7 years) animals. Unfortunately, the information is valid only for taxonomically undifferentiated caprines.

The remains from Rannersdorf show that the goats had horns of scimitar shape and of almond to oval cross-section. Both likely females had horns that were medially flattened and curved outwards. Their size was similar to that of female goats from the Keutschacher See<sup>47</sup> or Friebritz.<sup>48</sup> Compared to the Copper Age goats from Olgersdorf, both Rannersdorf individuals had a larger basal circumference.<sup>49</sup> The information available for sheep is even more scarce. The only identified individual had horns curving outwards, but their overall morphology remains unclear due to its small size and the fragmentary (rudimentary?) character (Appendix 1/19). Regarding the postcranial skeleton, the material yielded a limited number of measurable fragments (Appendix 1/21,

23–28). Due to the absence of completely preserved long bones, assessment of the withers height of local sheep or goats is impossible. The comparison of available measurements, however, suggests that their size was probably similar to the range reported from other Late Neolithic sites. The comparison of the tali from Unterparschenbrunn<sup>50</sup> and Mondsee<sup>51</sup> to that from Rannersdorf has indicated that the local goat individual (Appendix 1/21) was big in size or was a male. Thus, it is possible that both female and male goats are present in the studied assemblage.

### 3.3.3. Pig (*Sus domesticus*) and Unidentifiable Suids (*Sus* sp.)

The Late Neolithic assemblages show a great size overlap between the wild boar (*Sus scrofa*) and domestic pig (*Sus domesticus*) size variation range, which makes their identification difficult.<sup>52</sup> According to Manfred Schmitzberger, the large or large-toothed domestic pigs became visible in Austrian materials from the end of the Lengyel Culture, when hybridization between the species took place on a larger scale.<sup>53</sup> A similar increase in the size of domestic pigs, related to the intensified cross-breeding with wild boars at the beginning of the Copper Age, has been reported from the adjacent regions (e.g. the Czech Republic).<sup>54</sup> Suid

<sup>47</sup> PUCHER 2003, 279.

<sup>48</sup> PUCHER 2003, 279.

<sup>49</sup> The basal circumference in goat horn-cores from Olgersdorf was 85–86 mm. – BAUER 1971, 147.

<sup>50</sup> PUCHER 1990, 60.

<sup>51</sup> Cf. PUCHER, ENGL 1997, 130 and Tab. 41.

<sup>52</sup> LASOTA-MOSKALEWSKA, KOBRYŃ, SWIEZYNSKI 1987. – SCHMITZBERGER 2009a, 56–57.

<sup>53</sup> It is presumed that domestic pigs of the eastern Alpine region acquired the European haplotype as early as the first half of the 4<sup>th</sup> millennium BC, by a process that probably began in 4300/4100 BC. – SCHMITZBERGER 2009a, 60.

<sup>54</sup> KYSELÝ 2016, 68–69.



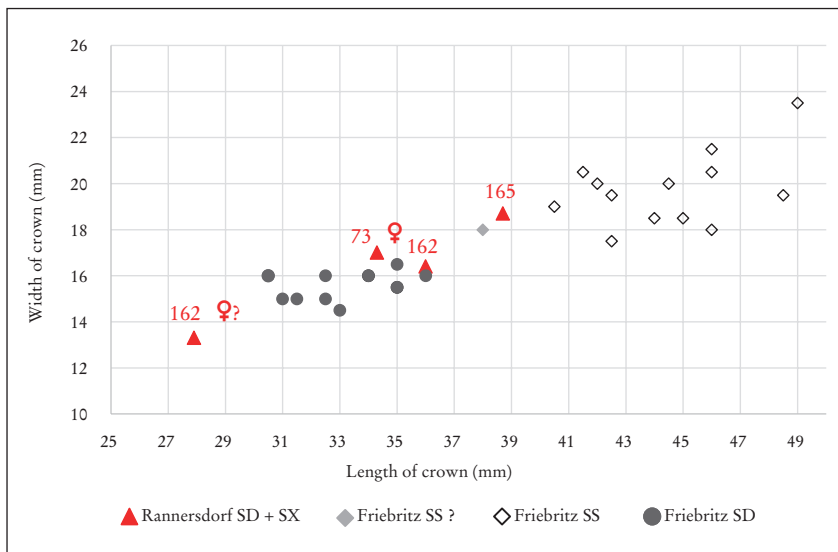


Fig. 16. Comparison of the size of suid third lower molars (M3 inferior) from the studied site and the Middle Neolithic Friebritz (PUCHER 2020).

cranial and postcranial elements in which the affiliation to the domestic form could not be plausibly attested also occurred in the Rannersdorf assemblage (Tab. 3).

The limited measurable elements have been compared to the Middle Neolithic Friebritz and other Late Neolithic collections. The predominance of pigs with large-sized teeth was suggested by the M3 crown dimensions (Fig. 16).<sup>55</sup> Interestingly, one of the large molars represents a female (Sample 73/47). On the other hand, there were another two individuals within the minimal and maximal size range for the third molar, suggesting great size variability in pigs – some with small teeth (Sample 1549), some reaching the large wild boar-like teeth (Sample 165). The robust stature of domestic pigs in Rannersdorf has also been indicated by the sturdily built mandible (Sample 73/47) and the maxilla (Sample 33/17) of adult females. Both have the teeth of the large or transitional size (Appendix 1/29).

With the exception of the teeth, the material did not offer additional information on the cranial morphotype of the local pigs. As suggested by the mandible fragments, however, their skulls were probably robustly built, similar to those of wild boars. The Neolithic material from Austria, however, points to pigs of small to medium size with high and slender limbs.<sup>56</sup> In Rannersdorf, no individual larger than the standard (female) wild boar from Turkey has been recorded.

However, a few elements (tibia, talus) represented a bigger individual or individuals than the standard reference from Late Neolithic England.<sup>57</sup> Compared to the variation ranges reported for the wild and domestic pigs in Friebritz, the individual values show that a single specimen (Sample 182) fitted in the spectrum of ‘wild/domestic’ pigs or the small (female) wild boar.<sup>58</sup>

The pigs were usually slaughtered at subadult age, between their first and second year of life. The ageable mandibles with teeth (and loose lower teeth) represented one animal at the age of 6–12 months, five at 12–24 months, two at 24–36 months and one at an age older than 36 months (Specimen 73/47). The mandible ageing includes data from fully recorded as well as screened samples. The single well-preserved maxilla (Specimen 33/17) belongs to a female older than two years. The epiphyseal fusion recorded in long bones provided similar results, suggesting a focus on optimal meat production. Just fusing distal epiphysis in the humerus and tibia shows that the individuals were circa 1–2 years old. Another two specimens originate from animals between 1 and 3.5 years. A single small metapodial with unfused distal epiphysis suggests the presence of a juvenile pig.

Based on NISP, a balanced representation of the cranial and postcranial pig bones can be assumed. With WISP, an overrepresentation of the cranial elements, mainly mandible

<sup>55</sup> Cf. PAYNE, BULL 1988, 40. – HONGO, MEADOW 2000, 140 and Tab. 8. – PUCHER 2020, 51–54, 105 and Tab. 45.

<sup>56</sup> SCHMITZBERGER 2009a, 61.

<sup>57</sup> ALBARELLA, PAYNE 2005, 598 and Tab. 7.

<sup>58</sup> Cf. PUCHER 2020, 52–54, 106 and Tab. 48.

fragments, was observed. Elements of the axial skeleton such as vertebrae, costae or ribs were absent, but may have remained undetermined in the ‘medium mammal’ category (Tab. 3). As for diet, the skeletal elements with ‘medium-quality’ meat predominated in the bone debris (83.7 % by WISP), while those with the best meat were poorly represented. The meatless bones, i.e. butchers’ refuse, occurred rarely (0.8 %).

#### 3.3.4. Dog (*Canis familiaris*)

Although dogs occurred relatively frequently in the studied samples, their overall numbers were low (Tab. 3). A partly preserved skull with the related left mandible (*mandibula sinister*), right humerus, femur and another mandible fragment were found in samples 73 and 145. The screening procedure yielded two more mandible fragments and an incomplete femur in samples 162, 182 and 218. Despite the only partial preservation of the mandibles, all provided the measurements important in deciphering the morphotype of at least four dog individuals.<sup>59</sup>

The skull CA-1 consisted of the neurocranium, loose maxillary and zygomatic bones and the nearly complete left mandible (Fig. 17/1, 5). The facial part of the skull was severely damaged but restored in the laboratory. No upper teeth were preserved, although some of the broken-off root tips of upper permanent dentition (C–M3) remain inside the alveoli. Both palatal processes of the maxilla were damaged and the nasal and incisive bones were completely missing in the material. The basal part of the neurocranium was severely damaged and deformed. The cranial sutures are not obliterated and the basioccipital-basisphenoid connection is still visible, indicating a subadult age of approximately 8–12 months for this individual. A similar age is suggested by the adjacent left mandible, in which a permanent canine exhibits no wear, while the carnassial protoconid shows very light wear, with the exposed dentine indicating a dog of young age (less than 24 months). At the same time, the developed alveolus for missing permanent M3 proves the animal was at least 6–7 months old. The mandible also exhibits light crowding of the molars (M1–M2), a condition considered to be one of the symptoms of domestication.<sup>60</sup> If the young dog died at some point between 6 months and 2 years, the sex identification remains questionable. In general, the skull and the mandible show more female signs. The skull is gracile, with vaulted parietal bones and without the

sagittal crest. The temporal lines meet far behind the bregma and the orbital process is strongly hooked.

The right mandible from Sample 73 was preserved as an alveolar part between C and M1, while symphysis and the ramus were completely missing (Fig. 17/2). The body basis was opened by the postmortal longitudinal breakage, with no clear impact marks of butchery observed. This specimen definitely represents another dog individual CA-2, because it is slightly larger than the CA-1 mandible. Moreover, this mandible is missing the alveolus of the first permanent premolar (P1). Apart from P2, all cheek teeth were post-mortally missing, so it is not possible to assess the dental wear stage. However, the moderately worn P2, with clearly observable island dentine exposure, indicates a higher adult age for the dog CA-2 (probably over 1 year). Without X-ray examination, it is hard to choose between possible causes of recorded oligodontia. In adult dogs, the missing alveolus can either suggest an *intra vitam* loss of P1 (and subsequent enclosure of the alveolus during life), or the presence of the inherited dental anomaly, related to domestication processes in dogs (shortening of the face and muzzle).<sup>61</sup>

The other two mandibles represent another two dogs, CA-3 and CA-4. The mandible CA-3 (Fig. 17/4) shows severe surface erosion and empty alveoli from the post-mortally missing permanent dentition. The enamel wear in the only preserved molar tooth (M2) shows no dentine abrasion, suggesting a young adult age of the individual. In mandible CA-4, the alveolar part and molar part were separated into pieces and the ramus is absent (Fig. 17/3). The preserved premolars P2–P4 and molar M2 show no dentition or enamel wear, which indicates that this young individual must have died shortly after permanent dentition eruption, at the age of at least 6–7 months. The sex of the CA-2, CA-3 and CA-4 individuals cannot be stated; however, the mandibles are similarly small and slightly more robust when compared to the CA-1 dog. Artificial modifications were not recorded.

The postcranial dog elements included the distal part of a humerus and two proximal femora. The humerus exhibits recently fused distal epiphysis, with the suture line visible, indicating an individual at approximately 5–8 months of age. A similar age is indicated by the femur (Sample 218), in which the recently fused caput and trochanter major with the line preserved suggest that the animal died at the age of c. 6–9 months. The second femur (Sample 73), showing completely fused caput and trochanters, suggest a somewhat

<sup>59</sup> Appendix 1/36–39.

<sup>60</sup> BARTOSIEWICZ 2013, 193.

<sup>61</sup> BARTOSIEWICZ 2013, 193–198. – HORARD-HERBIN, TRESSET, VIGNÉ 2014, 25.

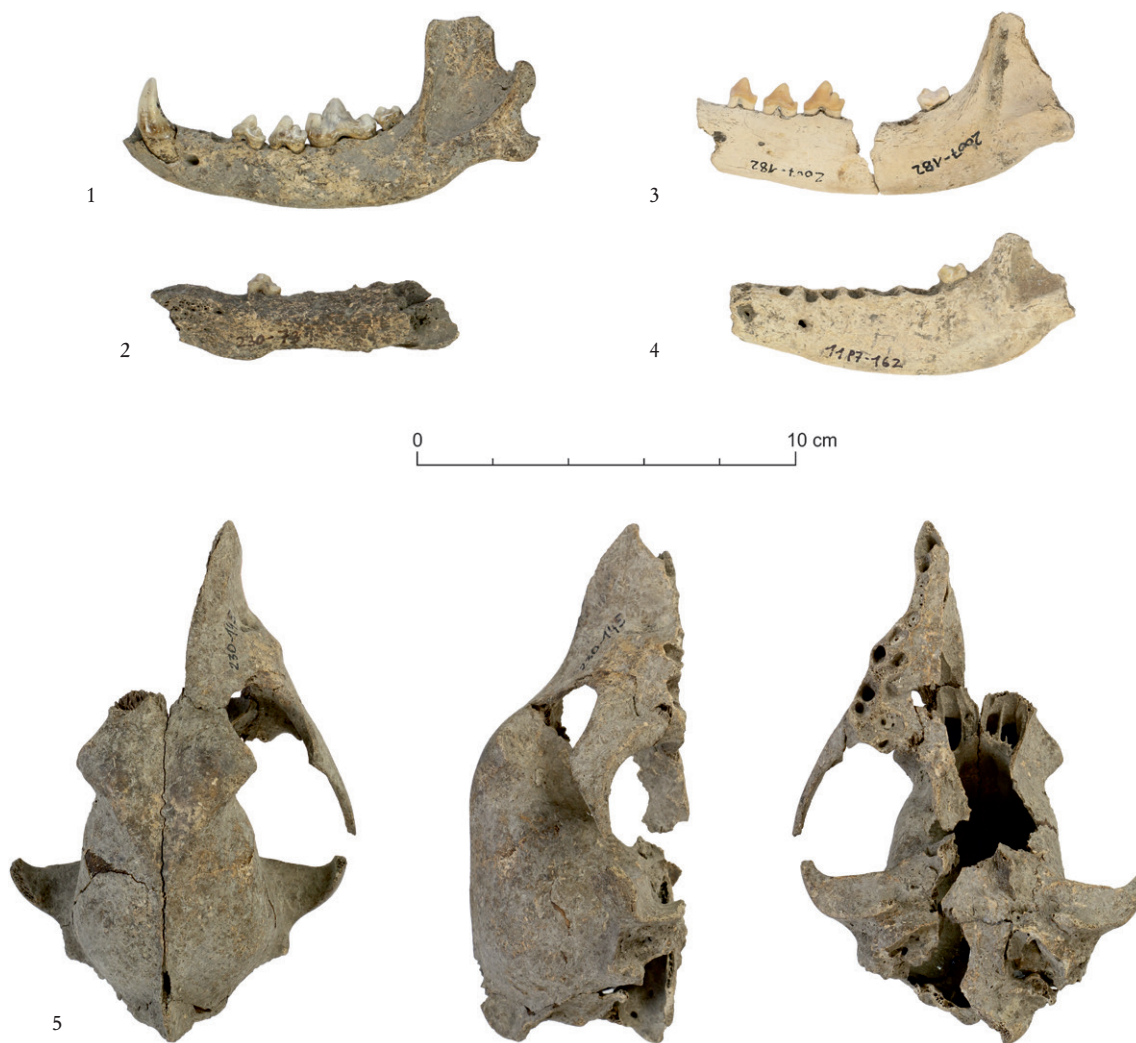


Fig. 17. Rannersdorf, the cranial bone elements of domestic dogs. – 1. Well-preserved left mandible related to the skull depicted in this figure (Sample 73). – 2. Alveolar fragment of the right mandible (Sample 73). – 3. Fragment of the left mandible (Sample 182). – 4. Fragment of the left mandible (Sample 162). – 5. Dorsal, lateral and basal view of a partly damaged dog's cranium (Sample 145).

older individual, of at least 9–10 months in age. Although the bad preservation of long bone surfaces complicated the observation of modifications, a detailed examination under the magnifying glass revealed short transversal cut marks, located on the shaft, just below the proximal epiphysis of a femur (Sample 218) and just above the distal epiphysis of a humerus (Sample 73). These hardly visible cut marks and the old spiral fractures of the midshaft in two of three specimens suggest human manipulation (butchery?) of the dog remains. Similar signs of butchery, indicating the dogs' contribution to the Neolithic diet or dog sacrifice have been reported from Austria and beyond.<sup>62</sup>

The cranial morphology and the small and gracile post-cranial elements of the Rannersdorf dogs strongly resemble the dogs of *palustris* type (*Canis familiaris* t. *palustris*) or *Torfspitz*, described from the Swiss Neolithic pile-dwellings.<sup>63</sup> Spitz-like animals had vaulted braincases and pointed noses, straight legs and measured between 35 and 54 cm at the withers (mostly 41 to 47 cm).<sup>64</sup> They represent the majority of the Neolithic and Eneolithic sites of the Middle Danube area.<sup>65</sup> In Rannersdorf, the reconstructed profile reveals very similar features to *palustris*-type (turbar) dogs, including

<sup>62</sup> WAGNER 1930, 77.

<sup>64</sup> BÖKÖNYI 1974, 317–318. – BENECKE 1994, 109–112.

<sup>65</sup> PUCHER, ENGL 1997, 37–38. – BARTOSIEWICZ 2002. – SCHMITZBERGER 2009a, 49 and Tab. 2. – MOSER 2011, 78–81. – KYSELÝ 2021. – SALIARI, PUCHER, MOSSER 2023.

<sup>62</sup> BÖKÖNYI 1974, 320. – MOSER 2011, 18, 84–85. – HORARD-HERBIN, TRESSET, VIGNE 2014. – SALIARI, PUCHER, MOSSER 2023.

a medium-steep forehead, moderate stop, wider face and short muzzle. The basal length calculated from the CA-1 mandible was 134.3 mm, which, together with the approximately zygomatic breadth of 95 mm, indicates a small and relatively wide head.<sup>66</sup> A smaller cranium may point to the female sex, suggested by the above-mentioned diagnostic traits. The small-sized dog is also confirmed by the mandible teeth metrics.<sup>67</sup> With the exception of the find of a miniature mandible from the Keutschacher See, they are of similar size as turbarry dogs known from the Neolithic and Eneolithic sites of Austria.<sup>68</sup> The length and breadth of the CA-1 carnassial (18.5/7.6 mm) is at the lower limits of range recorded in the Slovenian pile-dwellings.<sup>69</sup> The comparison of the size of extracted lower canine of the same mandible (GL = 32.9, GB = 6.0, GD = 8.9) with teeth of the Eneolithic dogs in the Czech Republic also reveals the smaller size of CA-1 individual.<sup>70</sup> The length of the lower premolar row (P2–P4) in Rannersdorf dogs ranges between 30.6 and 34.6, with an average 31.8 mm, suggesting a quite uniform population.

The internal length of the cranial cavity (71.4 mm) allowed the estimation of a withers height of the CA-1 individual of approximately 41 cm, which corroborates well with the lower limit found in the Neolithic turbarry dogs and the modern Spitz-type breeds (e.g. German Medium Spitz).<sup>71</sup> The gracility and small size of the Rannersdorf dogs are suggested by the revealed humeri and femora. The body weight is calculated on the basis of the midshaft circumference of a single humerus (37 mm) and two femora (32 and 34 mm). According to the epiphyseal fusion, the fully adult dog weighed 14.2 kg and two younger (5–10 months) individuals 8.6 and 10.2 kg. This confirms small to medium-sized dogs in Rannersdorf, comparable to a modern Basenji or Mudi.<sup>72</sup> The slender body used to be considered as a skeletal adaptation to the dietary habits of Neolithic dogs (scavenging on human food remains) and their semi-feral way of life.<sup>73</sup>

### 3.4. Wild Species

#### 3.4.1. Aurochs (*Bos primigenius*)

The anatomic and metric analysis of bovine remains from Rannersdorf reveals negligible representation (or possibly

even the absence) of wild aurochs in studied samples. With the exception of a measurable humerus fragment (Fig. 14), the radius, tibia, pelvis and a couple of phalanges exhibit very large dimensions and the sturdy build typical for Neolithic aurochs. According to the state of epiphyseal fusion, the majority of postcranial specimens belonged to adult individuals. In addition to the fully recorded samples, more skeletal elements of transitional size have been registered, indicating a low but regular occurrence of aurochs or very large domestic cattle (castrated bulls?) in the consumption waste. Some of the finds retrieved by screening (e.g. a horn-core fragment from Sample 160, first phalanx from Sample 177; Fig. 9/1, 3–4) showed dimensions reaching or exceeding the values reported for the female aurochs from the Middle Neolithic sites. In conclusion, the overall representation of aurochs was 1.2 %, with a presumed occurrence in 16 % of all bone samples.

The aurochs occurs regularly in the Neolithic assemblages of Austria, but its representation varies between sites, regions and periods. The species had been quite frequent in the Middle Neolithic (average 10 % of the total number), but from the Late Neolithic its share of the bones decreased (0.9 %).<sup>74</sup> The distinct drop in its frequency during this period is typical for the whole Middle Danube region and used to be explained by large-scale extermination of aurochs and the reduced importance of subsistence hunting at the beginning of the Early Copper Age.<sup>75</sup> A similar decrease has been reported for red deer. While in the Middle Neolithic settlement its average frequency was 7.2 %, in the Late Neolithic it drops to 1.3 % of the total finds. As for the Epilengyel settlements, scarce aurochs remains have been reported from Schleinbacher Ziegelei and Weiden am See.<sup>76</sup>

#### 3.4.2. Red Deer (*Cervus elaphus*)

The antlers and bones of red deer are among the most frequent objects in the Rannersdorf assemblage. They occurred in 28 % of bone samples, with a frequency of 1.7 %. After the exclusion of possible shed antlers (n = 4) from the quantification, the representation of red deer became similar to that of the aurochs. Altogether 10 specimens from at least one individual have been recorded within the fully recorded samples (Tab. 3). The identified elements include postcranial – humerus, ulna, tibia, metatarsal bone and first phalanx – as well as cranial elements – antler. Their morphology, size and

<sup>66</sup> BARTOSIEWICZ 2002, 83 and Tab. 7.

<sup>67</sup> Appendix 1/36.

<sup>68</sup> PUCHER 1996, 51 and Tab. 42. – PUCHER, ENGL 1997, 137 and Tab. 63. – PUCHER 2003, 280. – PUCHER 2004a, 398 and Tab. 40.

<sup>69</sup> Cf. BARTOSIEWICZ 2002, 79–80 and Fig. 1, Tab. 3.

<sup>70</sup> Cf. KYSELÝ 2021, 495 and Tab. 3.

<sup>71</sup> ČISAŘOVSKÝ 2008.

<sup>72</sup> <https://en.wikipedia.org/wiki/Basenji> (last access 18.10.2024). – <https://en.wikipedia.org/wiki/Mudi> (last access 18.10.2024).

<sup>73</sup> BENECKE 1994, 111 and Fig. 69. – BARTOSIEWICZ 2002, 85–88.

<sup>74</sup> SCHMITZBERGER 2009b, 130 and Tab. 6/2.

<sup>75</sup> BÖKÖNYI 1974, 117–118. – KYSELÝ 2012, 21.

<sup>76</sup> PUCHER 1996, 24 and Tab. 1. – SALLIARI, PUCHER 2017.

the state of epiphyseal fusion show that at least one adult individual died at a minimum age of four years.

The bad preservation and fragmented state of the specimens precluded assessment of the original number of antlers or more detailed study of modifications related to manufacture or the use of antlers as a raw material. However, the collecting of shed antlers was clearly evidenced through the large antler fragment with part of the main beam and a burr found in Feature 230 (Sample 1553).<sup>77</sup> It belonged to a mature male. Despite the highly eroded surface of this specimen, it was possible to recognise the traces of transversal and longitudinal chopping through the burr and the beam. Another worked fragment was retrieved in Feature 231 (Sample 36); it represents the bilaterally flattened and polished distal part of an antler tine.<sup>78</sup>

With the exception of the male antlers, the scarcity of other diagnostic elements such as a pelvis or skull means that the sex of hunted individual(s) cannot be stated. The measurements of the well-preserved scapulae, talus and second phalanx supplemented the dataset<sup>79</sup> and show that the size of Rannersdorf individuals fits well within the range of the Neolithic populations of the Middle Danube area.<sup>80</sup> Obviously larger individuals, however, were reported from the Lengyel and Baden Culture settlement in Svodín (south-west Slovakia).<sup>81</sup>

The minimal and maximal values might be indicators of the sex of the individuals. Thus, a single humerus with the distal breadth of 55.9 mm, if compared to the red deer from Neolithic Austria,<sup>82</sup> points to a smaller animal, perhaps a female. Similarly, the length of 53.5 mm of an acetabulum fragment speaks for a female too.<sup>83</sup> By comparison, in males from the Keutschacher See this measurement (LA) ranged from 55 to 62 mm (n = 3).<sup>84</sup> At Melk-Winden, the red deer acetabulum length ranged from 58.5 to 69.5 mm (n = 9), with an average of 61.8 mm in males and from 54.5 to 57.0 mm (n = 9), with an average of 55.1 mm in females.<sup>85</sup> This

suggests the presence of at least one female in the assemblage. Accordingly, one or more males can be suspected not only on the basis of antlers but also because of postcranial elements. The comparison of the glenoid breadth of two scapulae from the Sample 160 indicate large-sized deer or stags, since its values (BG = 48.1 and 50.8 mm) are at the upper limit of the range reported for the red deer in the Middle Neolithic Melk-Winden (from 37.0 to 48.5 mm; with an average of 43.1 mm).<sup>86</sup> These differences may indicate that both sexes were present in Rannersdorf.

### 3.4.3. European Beaver (*Castor fiber*)

Beavers are the third most common wild species in Rannersdorf. They formed 16 % of retrieved bone samples, with a frequency of 0.3 %. A distal shaft of the left humerus and nearly complete left femur have been identified in Feature 230 (Sample 73). The screening of remaining samples helped to reveal another four specimens in features 1196 and 1197 (samples 160, 162, and 177). These finds include two right femora, one left femur and a single alveolar fragment of the right mandible. In total, six specimens of at least two individuals have been documented (Fig. 18).

The bone surfaces in all specimens were moderately or strongly weathered and partly covered with a thin inorganic (soil) layer which complicated the study of their artificial modifications. No butchery marks were observed, except a possibly modified humerus with an old spiral fracture on its proximal end. On the other side of the same bone, fresh breakage (excavation damage?) was registered.

Beavers reach full body size as middle-aged adults, i.e. at 6–9 years of age. They are sexually mature in their 3<sup>rd</sup> or 4<sup>th</sup> year and may live to an age of 15–20 years.<sup>87</sup> The unfused epiphyses in one of the femora (Sample 73) suggest a young adult aged between their third and sixth year. In the remaining femora, the proximal and distal parts of the bones were damaged by canid gnawing, but comparable dimensions speak for a similar (adult) age of the individuals. As for the humerus and mandible fragment, a comparison with the reference adult individuals indicated the subadult/adult age.

So far, sparse osteometric data from the Austrian sites revealed no significant size changes in beavers during the Holocene, but it seems that the ones at the Late Neolithic pile-dwellings were somewhat smaller than those inhabiting

77 The greatest preserved length of antler beam with partly preserved burr was 222 mm.

78 The greatest preserved length of antler tine with preserved apex was 84 mm.

79 Appendix 1/40–46.

80 Cf. PUCHER 2004a, 382. – DRESLEROVÁ 2006, 32. – SCHMITZBERGER 2009b, 305–308. – PUCHER 2020, 110–114.

81 Cf. MOSER 2011, 107–109.

82 Cf. PUCHER, ENGL 1997, 140 and Tab. 75. – PUCHER 2004a, 382 and Diagram 4, Tab. 4. – SCHMITZBERGER 2009b, 306.

83 PUCHER 2004a, 381 and Diagram 2. – MOSER 2011, 106 and Tab. 20/2/2. – PUCHER 2020, 111 and Tab. 80.

84 PUCHER 2003, 281.

85 After PUCHER 2004a, 399 and Tab. 49.

86 After PUCHER 2004a, 399 and Tab. 44.

87 In the wild, they usually live to an age of 7–8 years. – FANDÉN 2005, 200.



Fig. 18. Rannersdorf, bone elements of the beaver. – The first specimen from the left is a humerus with the spiral fracture of the diaphysis (Sample 73). Remaining specimens represent four femora and a single mandible fragment with the teeth (samples 73, 160, 162, 177).

Lower Austria.<sup>88</sup> The Rannersdorf measurements of the femur and humerus fit this picture. The smallest breadth of the femur diaphysis ranges from 19.7 to 23.6 mm ( $n = 4$ ), suggesting similarities with the Middle Neolithic Friebritz, but they are of larger stature than the beavers found at the pile-dwellings at the Keutschacher See.<sup>89</sup>

#### 3.4.4. Horse (*Equus* sp.)

During the screening procedure, an equine tooth, most probably the second lower incisor, was identified in Feature 1196 (Fig. 19). The dental crown with the occlusal plane remained undisturbed, but the root had been partly disturbed by fresh longitudinal fractures.<sup>90</sup> A probably permanent incisor was worn flat, which means it belonged to an adult horse. If only the loose incisors are available, the assessment of the age of an individual is very difficult, since the eruption and the classification of wear depend upon the interpretation of the relationships between the various teeth within the jaw.<sup>91</sup> Nevertheless, if the identification of the position of the incisor is correct, then the oval shape of the occlusal plane as well as of the infundibulum filled with

cementum suggest that at the time of death, the horse was a young adult, roughly between its 5<sup>th</sup> and 7<sup>th</sup> year.

In equids, the species determination based on a single tooth is just as difficult as ageing. During the Neolithic and the Copper Age, two wild equids may have been present in the region – the first is a smaller European wild ass (*Equus hydruntinus*) and the second is the larger wild horse (*Equus ferus*). Both were steppe animals adapted to life in open grassland with a preference for temperate climates.<sup>92</sup> In the Late Pleistocene, *E. hydruntinus* was widespread, but the climatic changes of the Holocene prompted a contraction of the steppe and the fragmentation of its distribution area. Consequently, surviving sub-populations of this small equid became highly vulnerable to the humans, which meant that in Europe it became extinct by the Copper or Bronze Age.<sup>93</sup> So far, the latest records in Austria come from the Early or Middle Neolithic sites (the latter with a question mark), but a possibility of later, the Middle Neolithic occurrence, remains open.<sup>94</sup> So, the local evidence does not support its hypothetical presence in Copper Age Rannersdorf. Moreover, comparison of the incisor size with the reference material

<sup>88</sup> SCHMITZBERGER, PUCHER 2003, 17 and Figs. 4–5.

<sup>89</sup> Cf. PUCHER 2003, 282. – PUCHER 2020, 63.

<sup>90</sup> The maximal preserved length of incisor was 63 mm, the maximal breadth of the occlusal area was 18.9 mm.

<sup>91</sup> LEVINE 1982, 229.

<sup>92</sup> E.g. KRATOCHVÍL 1973. – UERPMANN 1973. – VÖRÖS 1981. – KYSELÝ, PEŠKE 2016.

<sup>93</sup> BURKE, EISENMANN, AMBLER 2003. – ORLANDO et al. 2006. – GEIGL, GRANGE 2012. – CREES, TURVEY 2014. – NÉMETH et al. 2017.

<sup>94</sup> PUCHER 1991. – SCHMITZBERGER 2009b, 226–227. – PUCHER 2017a, 185. – PUCHER 2017b, 377.



Fig. 19. Rannersdorf, the wild horse incisor (Sample 160), lateral, labial and occlusal view.

(an individual from the early medieval grave) suggested its affiliation to the true (cabaloid) horses.

Compared to asses, wild horse remains are more common at the Neolithic and Copper Age sites, although the frequency is low.<sup>95</sup> From Lower Austria, the largest collection (NISP = 37) has been reported from the Middle Neolithic Friebritz.<sup>96</sup> There most of them represented loose teeth and a few poorly preserved bone fragments which were interpreted as a sign of the shrinking of local populations.<sup>97</sup> The European wild horse became extinct around the Copper Age – Bronze Age transition or during the Bronze Age, when large herds of domesticated horses first appeared in the region.<sup>98</sup> The presumably domestic horse started to be abundant in Austria during the Early Bronze Age, but restricted to the eastern lowlands.<sup>99</sup> This is in line with the genetic studies, which recently attested that domestic horses spread in central Europe with humans from the area north of the Caucasus not earlier than 2200 BC.<sup>100</sup> Therefore, assuming the dating of the incisor is contemporary to

the rest of the material, the size and available knowledge on horse domestication leads us to conclude that the incisor from Rannersdorf represents a hunted individual from the remaining wild horse populations, although local domestication or taming cannot be ruled out.<sup>101</sup>

#### 3.4.5. Other Wild Taxa

The screening procedure revealed a single bone fragment of an unidentified mid-sized carnivore in Feature 1197 (Sample 162). The left radius with the preserved proximal part of the bone had fused epiphysis indicating an adult age of the individual. Its morphology points to the family *Mustelidae*, of which marten, badger, otter or polecat are native to the region studied.<sup>102</sup> A comparison with the reference material, however, excludes the first three taxa. The size of the specimen is similar to the wild cat, which suggests that the radius most likely represents the European polecat (*Mustela putorius*) or the steppe polecat (*Mustela eversmannii*).<sup>103</sup> The first-mentioned is known as a habitat generalist with a preference for humid areas such as freshwater lakes, rivers, wetlands and more forested areas, while the second is mainly associated with the open steppe and grassland habitats as well as agricultural land with a mosaic of pastures, fields, and shrubland vegetation.<sup>104</sup> The distribution of the steppe polecat often coincides with its prey, formerly abundant populations of ground squirrels and hamsters, whose burrows they also inhabit.<sup>105</sup> Interestingly, the mid-sized carnivore radius and the hamster (*Cricetus cricetus*) bones from Rannersdorf originate from the same sample and settlement pit (Tab. 1). The steppe polecat is regularly present at Neolithic sites in Austria, suggesting that its fur and possibly also the meat of this carnivore were of interest.<sup>106</sup> The radius from Rannersdorf bears no marks of human manipulation, but it does exhibit the same weathering and coloration (dark brown) as other bone specimens in the studied collection, leaving the question of the hunting of polecats open.

Besides the mammals, a single bird bone was recorded through screening in Feature 1196 (Sample 165). A left

<sup>95</sup> VÖRÖS 1981. – AMBROS 1986, 16. – BENECKE 1994, 65–75. – DRESLEROVÁ 2006. – MOSER 2011, 114.

<sup>96</sup> PUCHER 2020, 61–62.

<sup>97</sup> SCHMITZBERGER 2009a, 89–93 and Fig. 36.

<sup>98</sup> NÉMETH et al. 2017.

<sup>99</sup> PUCHER 1992. – PUCHER 2012, 3.

<sup>100</sup> LIBRADO et al. 2021.

<sup>101</sup> E.g. PEŠKE 1986. – KYSELÝ, PEŠKE 2016. – KYSELÝ, PEŠKE 2022. – This assumption is valid if the dating of the find to the Late Neolithic is correct. However, in a multi-period site such as Rannersdorf, the possibility of later (? Bronze Age) intrusion must also be admitted, which leaves the final determination of the horse open.

<sup>102</sup> SPITZENBERGER 2001, 603–647.

<sup>103</sup> The proximal breadth of the radius was 8.6 mm. See also Appendix 1/50.

<sup>104</sup> ŠÁLEK et al. 2013. – CROOSE et al. 2018.

<sup>105</sup> ŠÁLEK et al. 2013, 233–234.

<sup>106</sup> SCHMITZBERGER 2009a, 52–54.

carpometacarpal was preserved in the form of the second metacarpal bone. It was similarly coloured and weathered to the mustelid or horse remains, suggesting its contemporary origin. Apart from the old breakages, it showed no other modifications in its natural shape. Nevertheless, due to a lack of reference material, taxonomic identification has not yet been possible, although its dimensions point to one of the species of waterfowl. The bone was preliminarily assigned to the wild duck (*Anas sp.*).<sup>107</sup>

### 3.5. Concluding Remarks

#### 3.5.1. The Origin of Samples

The animal remains discovered in Rannersdorf were shaped through variable biotic and thanatic processes.<sup>108</sup> The recorded modifications mostly resulted from the processing of carcasses and included extraction of the meat, bone, marrow, or inner tissues that might have been consumed (e.g. the brain). Other human activities documented by the modifications include the preparation and consumption of food, and the use of bone or antler as raw materials in the making of working tools. The latter was represented by the sporadic occurrence of discarded manufacture waste (e.g. chopped deer antler) and simple ad-hoc implements made from the skeletal elements of available species (e.g. diaphysis splinters).

The taphonomic analysis showed no significant spatial differences in the character of the analysed settlement debris, although the extent of fragmentation and gnawing varied from context to context. The bone and pebble deposit, creating a distinct layer within one of the pits (Sample 145) shows the best-preserved material (in terms of anatomical completeness), perhaps as a result of the highest frequency of sturdy cattle bones in this particular deposit. These bones, however, displayed the highest proportion of canid gnawing, indicating their similarity (taphonomic history) to the rest of the food debris. The cranial and postcranial elements were similarly distributed across the space.

The assemblage is a time-averaged sample of the activities carried out within a particular settlement area.<sup>109</sup> Even today, people remove food remains from the interiors of dwellings to either the area immediately adjacent to the living space or to central dumps. Both are usually located near the primary food consumption area.<sup>110</sup> Considering the location of the analysed pits, it is likely that the food remains

come from the nearby longhouses, the floors of which were without such finds. The results of the absolute dating of randomly selected specimens attest the relation of the bone debris to the Epilengyel horizon, although contamination from other periods cannot be completely excluded. Particularly questionable are the solitary finds of the horse, bird, or mustelid as well as small rodents. In the case of the latter, their burrowing behaviour throws doubt on their origin and possible interpretations.

#### 3.5.2. The Meat-Based Diet

The meat was part of the staple food at the studied site. The presence of the cranial and postcranial elements in most of the determined domestic species allows us to assume that the livestock was slaughtered and processed locally. This presumption applies to the most common cattle and caprines, but also to the pig, in which the meatless elements occurred to a lesser extent. The local exploitation of bone marrow is also likely based on the modification observed and the extent of fragmentation. The animal bones were deliberately split and broken shortly after the animal's death. The impact marks and old fractures recorded on the skull or mandible fragments also indicated that the internal consumable tissues (e.g. brain, tongue) might have been consumed in Rannersdorf.

The quantification results suggested that the bulk of consumed meat originated from domestic species (69 % of NISP), with cattle being the major supplier (45.7 %). The ageing of cattle remains showed that, at least in this part of the settlement, veal was not on the menu. Instead, beef from young adults (2–4 years of age) and mature individuals (over 5 years) was used to prepare food. The carcass parts bearing the 'best-quality beef portions' were slightly overrepresented compared to those of the mid-quality and meatless elements. The results further show that additional demand for meat was covered by caprines (16.9 %). The preference for goats was indicated by ten specimens of this species. Like in cattle, the mortality profile of the culled herd showed the predominance of adult or mature individuals. The low frequency of pig remains (4.7 %) suggests that pork was consumed less frequently at the site. Pigs were slaughtered in the optimal yield age, between the 1<sup>st</sup> and 2<sup>nd</sup> year of life.

Cynophagia remains questionable, although the regular presence of dog bones in about one-quarter of the samples and the cut marks located on the humerus and femur support the idea of its occasional practice. A sporadic enrichment of the diet was venison (5.5 % of NISP). The red deer, aurochs, and beaver were most plausibly also hunted for dietary reasons. This presumption is based on skeletal element representation and the butchery marks identified.

<sup>107</sup> It is comparable to a mallard (*Anas platyrhynchos*). For measurements, see Appendix 1/50.

<sup>108</sup> O'CONNOR 2012, 20–21.

<sup>109</sup> MAROM, ZUCKERMAN 2011, 43.

<sup>110</sup> MAROM, ZUCKERMAN 2011, 43.



Site	Region	Culture/Group	NISP*	BT	OC	SD	CF	EQ	Wild	Literature
Ansfelden	UA	Münchshöfen	33	9	6	12	0	0	6	SCHMITZBERGER 2008.
Leonding	UA	Münchshöfen	43	3	2	1	0	0	25	KUNST 2001.
Rannersdorf	LA	Bisamberg-Oberpullendorf Group	363	166	61	17	6	–	17	This study.
Wangheim	LA	Epilengyel	2	1	–	–	–	1	–	SCHMITZBERGER 2009a.
Olgersdorf	LA	Epilengyel/ Furchenstichkeramik	23	5	14	2	–	–	2	BAUER 1971.
Schleinbacher Ziegelei	LA	Epilengyel	46	37	2	2	–	1	4	PUCHER 1996.
Unterparschenbrunn	LA	Baalberg/ Furchenstichkeramik	(161)	(62)	(39)	(17)	(3)	–	(40)	PUCHER 1990.
Puch-Scheibelfeld	LA	Baalberg/Gemischte Gruppe mit Furchenstichkeramik	124	7	59	57	–	0	1	PUCHER 2006.
Poysdorf-Winzerstraße	LA	Baalberg/Gemischte Gruppe mit Furchenstichkeramik	?	(10)	(2)	(3)	(1)	–	–	NEUGEBAUER, RUTTKAY, PUCHER 1999.
Weiden am See	BU	Epilengyel?	?	70 %	20.9 %	4.2 %	x	x	x	SALIARI, PUCHER 2017.
Purbach	BU	Gemischte Gruppe mit Furchenstichkeramik	35	18	4	3	–	0	2	PUCHER 2004.
Keutschacher See	CA	Kazianiberg-Lasinja	844	108	80	44	7	0	430	PUCHER 2003.

Tab. 5. The Early Copper Age settlements with the analysed faunal remains from Upper (UA) and Lower Austria (LA), Burgenland (BU) and Carinthia (CA). Quantified by NISP. The values in brackets were retrieved from the raw counts of specimens listed in literature. x = species present, \* = NISP values including antler fragments. For taxa coding, see Table 1.

The remains of all three species were regularly present in the samples. On the other hand, solitary finds of the wild horse, a carnivore (polecat?), and a bird (duck?) do not provide a solid basis for a dietary interpretation. These wild taxa may have been hunted for some other reason (e.g. social, economic) or may have been intrusive/residual in origin.

Although based on an insignificant number of finds, so far the Epilengyel settlements of eastern Austria show data similar to Rannersdorf (Tab. 5). Their subsistence seems to be based on beef and supplemented by sheep or goats. They relied on the products of domestic livestock, with minor input from hunted animals.<sup>111</sup> The most recent archaeozoological analysis at Weiden am See, located just a few kilometres from the studied site, shows the same dietary pattern with the predominance of beef and caprines and a small contribution from pork and venison.<sup>112</sup> A clear predominance of beef, although resulting from a limited number of finds (n = 48), was reported from the contemporary settlement in Schleinbach. All other determined species,

including caprines, pigs, aurochs, red deer, wild horse and wild ass were perhaps eaten sporadically.<sup>113</sup> The contemporary Münchshöfen settlements (e.g., Ansfelden, Leonding) hint at a regional difference with a higher intake of venison in the territory of the northeastern Alps.<sup>114</sup> Similarly, subsistence hunting was of great importance at the pile-dwellings in the mountainous Carinthia (e.g. the Keutschacher See). The more or less uniform image seems to diversify in the following centuries (e.g. Baalberg, *Furchenstichkeramik*), where archaeozoological data also documents an increase in hunting activities (Unterparschenbrunn)<sup>115</sup> or the greater importance (consumption) of pig and caprines compared to cattle (Puch-Scheibelfeld).<sup>116</sup>

When looking at adjacent regions, the results from Rannersdorf are comparable to the Epilengyel settlements of the Ludanice and Balaton-Lasinja cultural groups, occupying the lowlands of southwest Slovakia and western Hungary.<sup>117</sup> Both indicate that cattle were of major importance, but the ratio of pork to caprine meat was more balanced,

<sup>111</sup> BAUER 1971. – PUCHER 1990. – PUCHER 1996. – NEUGEBAUER, RUTTKAY, PUCHER 1999. – PUCHER 2004b. – PUCHER 2006a. – SCHMITZBERGER 2009a, 182. – SALIARI, PUCHER 2017.

<sup>112</sup> SALIARI, PUCHER 2017.

<sup>113</sup> PUCHER 1996, 24.

<sup>114</sup> KUNST 2001. – SCHMITZBERGER 2008.

<sup>115</sup> PUCHER 1990.

<sup>116</sup> PUCHER 2006a.

<sup>117</sup> BARTOSIEWICZ 1995. – FABIŠ 1995. – HOLUB 2022.

especially at the Ludanice Group settlements. A similar predominance of the bones of domestic animals and cattle has been reported for most of the Early Copper Age sites in Bohemia, Moravia and Croatia.<sup>118</sup> Hunted fauna rarely exceeded 15 % of the total, although exceptions occurred, for instance at the Jordanów Culture settlements in Bohemia. There, the wild taxa made up c. 35 % of NISP.<sup>119</sup>

### 3.5.3. Animal Husbandry

The faunal collections from the turn of the Late Neolithic and Copper Age show a general increase of domestic animals and cattle.<sup>120</sup> At the same time, the continuing decline of hunting is observed. In Austria, the species assortment of the Late Neolithic (*Mittelneolithikum*) and Copper Age (*Jungneolithikum*) settlements show similar trends, implying an increased reliance on animal farming at the expense of hunting. The fall in the representation of wild species ranged from c. 56 % in the Late Neolithic to 21 % in the Copper Age.<sup>121</sup> A distinct increase of cattle (from c. 27 % to 48 %) and caprines (c. 5 % to 20 %) was recorded. An increase in caprines is related to the successful recovery of sheep husbandry after its collapse in the Middle Neolithic (around 4900/4800 BC).<sup>122</sup> However, despite its complete recovery during the Copper Age, there were still some sites without sheep or where goats predominated (e.g. Furth bei Göttweig, Jevišovice Culture).<sup>123</sup> The scarcity of sheep in Rannersdorf, although caprines were relatively abundant, might represent another proof of goats as an important part of the Early Copper Age husbandry.

The analysed Epilengyel material from eastern Austria shows a reliance on farming, with a small role for hunting.<sup>124</sup> People kept cattle, sheep, goats, pigs and dogs and hunted for similar wild species including aurochs, red deer, roe deer, wild boar, hare or sparsely distributed wild equids. The overall predominance of cattle and caprines at Epilengyel sites points to the pastoral character of the animal husbandry. In Weiden am See, the cattle age-at-slaughter and sex determination suggest mixed utility, with possible secondary production. The

younger cows and oxen could provide good-quality meat and older ones were used as breeding females, possibly providing milk and the (working?) oxen. The caprines were usually killed between the 3<sup>rd</sup> and 7<sup>th</sup> years of life, with meat and milk as the major output.<sup>125</sup> Unfortunately, the mortality profiles from other Epilengyel settlements are insignificant due to the limited number of remains. The most recently evaluated assemblage from the Ludanice Group settlement in Nitra revealed the predominance of subadult cattle, primarily reared for their meat.<sup>126</sup> No cattle survived their fourth year here. A similar pattern was seen in pigs, while in caprines, meat and milk seemed to be the major breeding purpose. Cattle husbandry focused on meat production has also been reported from the Ludanice Group in Jelšovce.<sup>127</sup>

Sporadic finds of castrated males (oxen) have been reported from the Early Copper Age sites, but their presence cannot be directly linked to secondary use.<sup>128</sup> Knowledge of castration was present from the earliest times, but its main purpose was to mitigate intraspecies aggression and to deal with the temper of the males.<sup>129</sup> It should be noted that modifications of the horn-cores and the pathologies of joints, linked to the use of cattle for traction,<sup>130</sup> have not been systematically studied at Epilengyel sites. In Austria, the earliest evidence connected to the use of cattle for traction comes from the Bronze Age.<sup>131</sup> In Rannersdorf, except for a single phalanx showing a slight enlargement of the proximal articular surface (lipping), no changes potentially related to the use of the cattle for pulling or carrying a load were recorded.

The ageing and sexing data provided by the analysis in Rannersdorf suggest almost the same exploitation pattern as in Weiden am See. The pigs as single-purpose animals produced meat (and lard). The majority were slaughtered at the optimal age, between the 1<sup>st</sup> and 2<sup>nd</sup> years of the animal's life. The large and small herbivores revealed a more puzzling mortality pattern, complicated by the small number of finds and the fact that caprines included two species of possibly different use. Cattle ageing revealed the predominance of young adult (2–5 years) and mature individuals (over 5 years), showing two peaks of slaughter. The first one, covering the life span between the 2<sup>nd</sup> and 4<sup>th</sup> years represents the younger animals killed for the meat. This age coincides

<sup>118</sup> KYSELÝ 2012, 25, 30 and Graphs 18, 26. – REED 2017, 1748.

<sup>119</sup> KYSELÝ 2007. – KYSELÝ 2012, 25.

<sup>120</sup> BARTOSIEWICZ 2005.

<sup>121</sup> The values referred to here correspond to the mean representation of a species in the total number of finds (% of n). After SCHMITZBERGER 2009a, 129 and Tab. 6/1.

<sup>122</sup> PUCHER 2017a. – PUCHER 2017b. – GRÖMER, SALIARI 2018. – SCHMÖLCKE, GROSS, NIKULINA 2018.

<sup>123</sup> KUNST 2006.

<sup>124</sup> BAUER 1971. – PUCHER 1990. – PUCHER 1996. – NEUGEBAUER, RUTTKAY, PUCHER 1999. – PUCHER 2004b. – PUCHER 2006a. – SCHMITZBERGER 2009a, 182. – SALIARI, PUCHER 2017.

<sup>125</sup> SALIARI, PUCHER 2017, 49.

<sup>126</sup> HOLUB 2022, 177.

<sup>127</sup> FABIŠ 1995, 180.

<sup>128</sup> E.g. BAUER 1971, 146–147.

<sup>129</sup> SCHMITZBERGER 2009a, 97.

<sup>130</sup> PEŠKE 1985. – BARTOSIEWICZ, VAN NEER, LENTACKER 1997. – KYSELÝ 2012, 50–51.

<sup>131</sup> SCHMITZBERGER 2009a, 97.

with the first-quality meat and the best yield.<sup>132</sup> The individuals surviving into maturity were probably used in breeding and secondary production. The predominance of females allows us to presume that milk was of importance, although the lack of the calves that would represent the ‘post-lactation’ slaughter<sup>133</sup> speaks against intensive milk production. The manure might have been of interest.<sup>134</sup> In Rannersdorf, milk was possibly produced more frequently by the caprines. The prevalence of adults and mature animals suggests that besides meat, milk or wool might have been of interest. In caprines, the young ones may have been killed without stopping the milk production in females, so it is possible to presume that the most common milk suppliers were the goats. Concerning wool, despite providing a significant proportion of caprines, the study set revealed a single individual sheep, so its production at Epilengyel sites remains unlikely.

#### 3.5.4. The Palaeoenvironment

Among the faunal remains, the insects, molluscs, small rodents and birds belong to the most useful indicators of the natural setting of archaeological sites.<sup>135</sup> Unfortunately, when dealing with hand-retrieved bones, these taxa rarely show up in representative numbers. The studied assemblage is no exception. It included solitary bird and small rodent remains and although the latter belong to taxa widely used in palaeoenvironmental reconstructions, if not stratified, the interpretations remain disputable.

The European hamster found in the settlement Pit S2 is a solitary forest-steppe species. In its core area it is restricted to open habitats, colonizing alluvial and other types of forests. The site lies within its present-day distribution area, where it has been continuously present since the Neolithic.<sup>136</sup> The species spread far west into the young steppes or cultivated steppes of Europe during the Holocene. They are attracted by anthropogenic habitats such as crop fields, meadows or gardens, which might have been the case with the analysed settlement and its vicinity.

Based on the assumption that the ecological requirements of species have not changed throughout time and that people concentrated their hunting activities near the settlements, some of the large mammals present in Rannersdorf may also provide some clues for the local environment.<sup>137</sup> Among the most specific is the wild horse, which is considered a typical

species of the warm forest-steppe zone. Similar to the brown hare, the horse prefers open forest (edge) communities or forests opened by clearing, fire, and animal grazing. Their high frequency used to be connected to advance clearing activities.<sup>138</sup> The predominance of cattle and caprines in the material also speaks against closed forests around Rannersdorf.

On the other hand, the red deer is often cited as an indicator of closed forests, although some scholars argue that its morphology and behavioural patterns characterise it as a native inhabitant of more open landscapes that only humans have pushed back into densely forested areas.<sup>139</sup> Similarly disputable are the preferences for the past habitats of aurochs, which might include both open and forested areas. The archaeozoological and written records speak for its wide ecological valence depending upon the region, climate, or human activities. For aurochs, a special relationship with sedge marshes and marshy forests has been repeatedly recorded.<sup>140</sup>

The proximity of water biotopes including the flowing and stagnant waters, alluvial forests, and swamps, was evidenced by the beaver and unidentified duck remains. The site lies directly on the bank of the smaller Schwechat River and within a short distance from the Danube River. During prehistory, beavers were common in all larger central European river ecosystems. The highly social and territorial animal constructs dams in the shallow waters and may transform a small creek into a series of ponds. Its building activities elevate the water column and may cause floods.<sup>141</sup>

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#### Appendix 1

The raw osteometric data from Rannersdorf can be found at: doi: 10.1553/archaeologia108s39-A.

<sup>132</sup> Cf. UERPMANN 1973, 316.

<sup>133</sup> PEŠKE 1994a. – BALASSE 2003.

<sup>134</sup> HOEKMAN-SITES, GIBLIN 2012, 515.

<sup>135</sup> E.g. PEŠKE 1981. – PEŠKE 1994b.

<sup>136</sup> SPITZENBERGER 2001, 406–414.

<sup>137</sup> REITZ, WING 2008, 307.

<sup>138</sup> SCHMITZBERGER 2009a, 100.

<sup>139</sup> SCHMITZBERGER 2009a, 100.

<sup>140</sup> KYSELÝ 2008a, 9–10.

<sup>141</sup> FANDÉN 2005. – VALACHOVIČ 2012, 84.

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