ANTÆUS

37

ANTÆUS

Communicationes ex Instituto Archaeologico

37/2021

Sigel: Antaeus

ANTÆUS

37

Communicationes ex Instituto Archaeologico

Communicationes ex Instituto Archaeologico

Distribution of exchange copies by
the Library of the Institute of Archaeology, Research Centre for the Humanities
H-1097 Budapest, Tóth Kálmán u. 4.

The publication of this volume was supported by special grants of the Hungarian Academy of Sciences
and the Secretariat of Eötvös Loránd Research Network

HU ISSN 0238-0218

Desktop editing and layout by Archaeolingua
Printed in Hungary by the Prime Rate Kft.
Cover by H&H Design

INHALT – CONTENTS

LIST OF AUTHORS

BARTOSIEWICZ, LÁSZLÓ
Stockholm University
Department of Archaeology and Classical Studies
SE–106 91 Stockholm,
Institutionen för arkeologi och antikens kultur
laszlo.bartosiewicz@ofl.su.se

BENKŐ, ELEK
Institute of Archaeology,
Research Centre for the Humanities
H–1097 Budapest, Tóth Kálmán utca 4.
benko.elek@abtk.hu

BOLLÓK, ÁDÁM
Institute of Archaeology,
Research Centre for the Humanities
H–1097 Budapest, Tóth Kálmán utca 4.
bollak.adam@abtk.hu

GÁL, ERIKA
Institute of Archaeology,
Research Centre for the Humanities
H–1097 Budapest, Tóth Kálmán utca 4.
gal.erika@abtk.hu

KOLLÁTH, ÁGNES
Institute of Archaeology,
Research Centre for the Humanities
H–1097 Budapest, Tóth Kálmán utca 4.
kollath.agnes@abtk.hu

KONCZ, ISTVÁN
Eötvös Loránd University
Institute of Archaeological Sciences
H–1088 Budapest, Múzeum krt. 4/b
fredgar22@gmail.com

KOVÁCS, BIANKA GINA
Institute of Archaeology,
Research Centre for the Humanities
H–1097 Budapest, Tóth Kálmán utca 4.
kovacs.bianka@abtk.hu

KOVÁCS, GYÖNGYI
Institute of Archaeology,
Research Centre for the Humanities
H–1097 Budapest, Tóth Kálmán utca 4.
kovacs.gyongyi@abtk.hu

KOVÁCS, LÁSZLÓ
Institute of Archaeology,
Research Centre for the Humanities
H–1097 Budapest, Tóth Kálmán utca 4.
kovacs.laszlo@abtk.hu

LANGÓ, PÉTER
Institute of Archaeology,
Research Centre for the Humanities
H–1097 Budapest, Tóth Kálmán utca 4.
lango.peter@abtk.hu

RÉVÉSZ, LÁSZLÓ
University of Szeged
Department of Archaeology
H–6722 Szeged, Egyetem u. 2.
reveszlaszlo1986@gmail.com

SZENDE, KATALIN
Central European University
Department of Medieval Studies
H–1051 Budapest, Nádor u. 9.
A–1100 Quellenstraße 51, Wien
szendek@ceu.edu

SZŐKE, BÉLA MIKLÓS
Institute of Archaeology,
Research Centre for the Humanities
H–1097 Budapest, Tóth Kálmán utca 4.
szoke.bela@abtk.hu

TAKÁCS, MIKLÓS
Institute of Archaeology,
Research Centre for the Humanities
H–1097 Budapest, Tóth Kálmán utca 4.
takacs.miklos@abtk.hu

TEREI, GYÖRGY
Budapest History Museum,
Castle Museum, Medieval Department
H–1014 Budapest, Szent György tér 2.
Buda Castle Building E
tereigy@btm.hu

ABBREVIATIONS

ActaArchHung	Acta Archaeologica Academiae Scientiarum Hungaricae (Budapest)
ActaEthnHung	Acta Ethnographica Academiae Scientiarum Hungaricae (Budapest)
ActaOrHung	Acta Orientalia Academiae Scientiarum Hungaricae (Budapest)
ActaMusPapensis	Acta Musei Papensis. A Pápai Múzeum Értesítője (Pápa)
Agria	Agria. Az Egri Múzeum Évkönyve (Eger)
AH	Archaeologia Historica (Brno)
AHN	Acta Historica Neolosiensia (Banská Bystrica)
AJMK	Arany János Múzeum Közleményei (Nagykőrös)
AKorr	Archäologisches Korrespondenzblatt (Mainz)
Alba Regia	Alba Regia. Annales Musei Stephani Regis (Székesfehérvár)
AnalCis	Analecta Cisterciensia (Roma)
AnnHN	Annales Historico-Naturales Musei Nationalis Hungarici (Budapest)
Antaeus	Antaeus. Communicationes ex Instituto Archaeologico (Budapest)
Antiquity	Antiquity. A Review of World Archaeology (Durham)
AR	Archeologické Rozhledy (Praha)
ArchA	Archaeologia Austriaca (Wien)
ArchÉrt	Archaeologiai Értesítő (Budapest)
ArchHung	Archaeologia Hungarica (Budapest)
ArchLit	Archaeologia Lituana (Vilnius)
ArhSof	Археология. Орган на Националния археологически институт с музей – БАН (Sofia)
ARR	Arheološki Radovi i Rasprave (Zagreb)
Arrabona	Arrabona. A Győri Xantus János Múzeum Évkönyve (Győr)
AV	Arheološki Vestnik (Ljubljana)
Balcanoslavica	Balcanoslavica (Prilep)
BÁMÉ	A Béri Balogh Ádám Múzeum Évkönyve (Szekszárd)
BAR	British Archaeological Reports (Oxford)
BMÖ	Beiträge zur Mittelalterarchäologie in Österreich (Wien)
BudRég	Budapest Régiségei (Budapest)
Castrum	Castrum. A Castrum Bene Egyesület folyóirata (Budapest)
CommArchHung	Communicationes Archaeologicae Hungariae (Budapest)
Cumania	Cumania. A Bács-Kiskun Megyei Múzeumok Közleményei (Kecskemét)
DBW	Denkmalpflege Baden-Württemberg (Stuttgart)
EMÉ	Az Egri Múzeum Évkönyve (Eger)
EurAnt	Eurasia Antiqua. Zeitschrift für Archäologie Eurasiens (Bonn)
FolArch	Folia Archaeologica (Budapest)
FontArchHung	Fontes Archaeologici Hungariae (Budapest)
GMSB	Годишник на музеите от Северна България (Варна)
GZM	Glasnik Zemaljskog muzeja Bosne i Hercegovine u Sarajevu (Sarajevo)
GZMS	Glasnik Hrvatskih Zemaljskih Muzeja u Sarajevu (Sarajevo)
HAH	Hereditas Archaeologica Hungariae (Budapest)

Hesperia	Hesperia. Journal of the American School of Classical Studies at Athens (Princeton)
História	História. A Magyar Történelmi Társulat, majd a História Alapítvány folyóirata (Budapest)
HOMÉ	A Herman Ottó Múzeum Évkönyve (Miskolc)
INMVarna	Известия на Народния музей – Варна (Varna)
IstMitt	Istanbuler Mitteilungen (Tübingen)
JAMÉ	A nyíregyházi Jósa András Múzeum Évkönyve (Nyíregyháza)
Jászkunság	Jászkunság. Az MTA Jász-Nagykun-Szolnok Megyei Tudományos Egyesület folyóirata (Szolnok)
JbAC	Jahrbuch für Antike und Christentum (Bonn)
JPMÉ	A Janus Pannonius Múzeum Évkönyve (Pécs)
KMMK	Komárom-Esztergom Megyei Múzeumok Közleményei (Tata)
LK	Levéltári Közlemények (Budapest)
MAA	Monumenta Avarorum Archaeologica (Budapest)
MacAA	Macedoniae Acta Archaeologica (Skopje)
MAG	Mitteilungen der Anthropologischen Gesellschaft (Wien)
MBV	Münchner Beiträge zur Vor- und Frühgeschichte (München)
MHKÁS	Magyarország honfoglalás és kora Árpád-kori sírleletei (Budapest)
MittArchInst	Mitteilungen des Archäologischen Instituts der Ungarischen Akademie der Wissenschaften (Budapest)
MFMÉ	A Móra Ferenc Múzeum Évkönyve (Szeged)
MFMÉ StudArch	A Móra Ferenc Múzeum Évkönyve – Studia Archaeologica (Szeged)
MMMK	A Magyar Mezőgazdasági Múzeum Közleményei (Budapest)
MŰÉ	Művészettörténeti Értesítő (Budapest)
MŰT	Művészettörténeti Tanulmányok. Művészettörténeti Dokumentációs Központ Évkönyve (Budapest)
NÉrt	Néprajzi Értesítő (Budapest)
NMMÉ	Nógrád Megyei Múzeumok Évkönyve (Salgótarján)
OA	Opvscvla Archaeologica (Zagreb)
Offa	Offa. Berichte und Mitteilungen des Museums Vorgeschichtliche Altertümer in Kiel (Neumünster)
PA	Památky Archeologické (Praha)
Prilozi	Prilozi Instituta za povijesne znanosti Sveučilišta u Zagrebu (Zagreb)
PrzA	Przegląd Archeologiczny (Wrocław)
PtujZb	Ptujski Zbornik (Ptuj)
PV	Přehled výzkumů (Brno)
PZ	Prähistorische Zeitschrift (Berlin)
RégFüz	Régészeti Füzetek (Budapest)
RGA	Reallexikon der Germanischen Altertumskunde (Berlin)
RT	Transylvanian Review / Revue de Transylvanie (Cluj)
RVM	Rad Vojvoðanskih muzeja (Novi Sad)
SbNMP	Sborník Národního Muzea v Praze (Praha)
Scripta Mercaturae	Scripta Mercaturae. Zeitschrift für Wirtschafts- und Sozialgeschichte Gutenberg)
SHP	Starohrvatska Prosvjeta (Zagreb)
SlA	Slovenská Archeológia (Bratislava)
SlAnt	Slavia Antiqua (Poznan)

SlSt	Slovanské štúdie (Bratislava)
SMK	Somogyi Múzeumok Közleményei (Kaposvár)
StComit	Studia Comitatensia. A Ferenczy Múzeum Évkönyve (Szentendre)
StH	Studia Historica Academiae Scientiarum Hungaricae (Budapest)
StSl	Studia Slavica Academiae Scientiarum Hungaricae (Budapest)
StudArch	Studia Archaeologica (Budapest)
Századok	Századok. A Magyar Történelmi Társulat folyóirata (Budapest)
TBM	Tanulmányok Budapest Múltjából (Budapest)
Tisicum	Tisicum. A Jász-Nagykun-Szolnok Megyei Múzeumok Évkönyve (Szolnok)
USML	Utrecht Studies in Medieval Literacy (Turnhout)
VAH	Varia Archeologica Hungarica (Budapest)
VAMZ	Vjesnik Arheološkog muzeja u Zagrebu (Zagreb)
VMMK	A Veszprém Megyei Múzeumok Közleményei (Veszprém)
WiA	Wiadomości Archeologiczne (Warszawa)
WMMÉ	A Wosinsky Mór Múzeum Évkönyve (Szekszárd)
ZalaiMúz	Zalai Múzeum (Zalaegerszeg)
Zborník FFUK, Musaica	Zborník Filozofickej Fakulty Univerzity Komenskóho. Musaica (Bratislava)
ZbSNM	Zborník Slovenského Národného Múzea. História (Bratislava)
ZfAM	Zeitschrift für Archäologie des Mittelalters (Köln)
ZHVSt	Zeitschrift des Historischen Vereins für Steiermark (Graz)
Ziegelei-Museum	Ziegelei-Museum. Bericht der Stiftung Ziegelei-Museum (Cham)
ZRNM	Zbornik Radova Narodnog Muzeja (Beograd)

ANTAEUS 37 (2021) 421–472

ERIKA GÁL

ARCHAEOZOOLOGICAL ASSESSMENT OF THE REFUSE DEPOSIT OF THE ARCHIEPISCOPAL RESIDENCE IN ESZTERGOM

Zusammenfassung: Die zwischen 2014 und 2016 am Fundort Esztergom, Várhegy-Kőbánya durchgeführten Ausgrabungsarbeiten förderten eine beträchtliche Anzahl an Tierknochen zutage. Neben der manuellen Einsammlung war es dem Sieben zu verdanken, dass außer Säugetierfunden beispiellos viele Fisch- und Vogelknochen vorkamen, die uns seltene Einblicke in die Lebensmittelbeschaffungs- und Zubereitungsgewohnheiten des klerikalen Zentrums im 14.–15. Jahrhundert ermöglichen. Auch die Überreste gejagter Säugetiere ergaben ungewohnte Ergebnisse. An der Verteilung der Gebeine kann abgelesen werden, dass von den vier identifizierten Arten in der Küche des Erzbischofs lediglich Feldhasen verzehrt wurden, während Rehe, Hirsche und Bären nur in Form terminaler Skelettüberreste im Fundmaterial vertreten waren. Den Großteil der zur Gruppe des Rotwilds gehörenden Fundkomplexe machten Geweihstücke aus, bearbeitet, als Rohstoff oder in Form von Werkstattausschuss. Über die Erörterung der Fleischbeschaffungs- und Zubereitungsmethoden hinaus beinhaltet das Manuskript die typologische Kategorisierung und Beschreibung von Knochen- und Geweihgegenständen.

Keywords: bone and antler tools, animal husbandry, hunting, eating habits, medieval period, clerical centre

The archaeozoological literature on the settlements of the late medieval period (14th to 16th centuries), particularly on high-status sites such as noble and ecclesiastic centres, is for the greater part restricted to the finds from Buda within Hungary. The study of the goods arriving to the royal centre, including livestock and other meat provisions, as well as the human-animal interactions pointing beyond simply what was eaten, have always enjoyed a prominent position on the period's research agendas.[1] The overall picture of regional elite centres is highly varied and detailed assessments are available for animal bone samples from the queenly centre in Segesd, the *castellum* of Őcsény-Oltovány and the manor house of Baj, Öreg-Kovács-hegy.[2] In contrast, no more than species lists are available for the high-status sites of Visegrád, all assemblages featuring representative and remarkable elements, from which little more information can be gleaned than the frequencies of various species and their possible exploitation, while providing virtually no information about meat distribution and food preparation practices. The single exception is the recent study on the bone and antler implements from Visegrád Castle, offering an insight into the period's bone and antler working as well as into the range of mass-produced items for daily use and various unique decorative objects.[3]

One shared trait of the above bone assemblages, irrespective of the depth of their archaeozoological assessment, is that the finds were collected manually (only the assemblage from the lower layers of Well 8 of the Teleki Palace were sieved),[4] as a result of which the smaller finds such as fish, bird and rodent bones are poorly represented and, as a consequence, little is known

1 *Bökönyi 1958; Bökönyi 1963; Bökönyi 1964; Matolcsi 1977; Matolcsi 1981; Csippán 2004; Daróczi-Szabó 2004.*

2 *Bartosiewicz 1996; Bartosiewicz 2010; Bartosiewicz 2016.*

3 *Bökönyi 1974* 26–28; *Kováts 2005.*

4 *Daróczi-Szabó 2004* 254, fig. 2.

10.62149/Antaeus.37.2021_15

about them. In the light of the above, the recent excavation at the Esztergom, Várhegy-Kőbánya site (Site no. 2246) between 2014 and 2016 does not merely increase the number of the few animal bone assemblages from medieval ecclesiastic centres, but the bone material recovered using advanced field techniques also holds out the promise of new insights.[5]

The layers on the southern slope of the castle hill accumulated underneath the kitchen of the medieval archiepiscopal residence. However, the bone material also contained remains that were not strictly associated with the kitchen premises and with meat processing and the various dishes prepared for the table, and in this sense, the assemblage can be characterised as household refuse. Knowing that the site had been disturbed by modern earth-moving operations and that the earth removed during previous excavations was also deposited on the site, the analysis focused on the material from closed layers. The stratigraphic units could be assigned to two groups (SU 4–8 and SU 18–23, and SU 3 and SU 17, respectively), which on the testimony of the radiocarbon dates were deposited between the late 13th and the 15th centuries. The three measurements (1270–1390 cal AD, 1285–1400 cal AD and 1330–1445 cal AD)[6] fall into the 1330–1390 range *(fig. 1)*, implying that the bones could have accumulated during a shorter period of time. Nevertheless, in the lack of more reliable data, the above dates are regarded as broad indications and it seems more likely that the material is made up of an assemblage that had accumulated earlier, during the 14th century, and one that was deposited later, during the 15th century.

The swift and efficient treatment of animal waste in the immediate vicinity of the archiepiscopal palace was no doubt an important task since the remains that were not adequately covered emitted foul odours and also led to the appearance of scavengers and rodents. At the same time, the buried animal bones were preserved in good condition in the pits of the stone quarry.

As a result of sieving, which complemented the hand-collection of bones, there is an unparalleled abundance of fish and bird bones in addition to mammalian bones in the assemblage,[7] providing a rare insight into the food acquisition and preparation practices of a late medieval ecclesiastic household. The present study focuses on the domestic and wild mammals as well as the fowls, while the fish remains will be discussed by László Bartosiewicz in a separate study. Given that no major differences could be noted either in the species distribution, or in the slaughtering age, or in the utilisation of various species between the 14th- and the 15th-century assemblage, the material will be analysed and discussed together.

Results

Of the 7294 animal bones, 6126 belonged to mammals and birds (cf. *Table 1*). The majority, 69.7%, came from domestic species, while wild mammals and fowl represent less than 6%. Although the bones of domestic mammals outnumber fowl in the overall number of bones, the highest number of finds originates from domestic hen. One possible explanation, aside from the fact that poultry keeping has modest space requirements compared to its many advantages (meat, eggs, feather, guano), is the employed recovery method, as a result of which small-sized bones are also amply represented *(fig. 2)*.

---

5 I am grateful to Dr. Balázs Major, department head and leader of the excavation, for the opportunity to assess the animal bone finds.

6 The measurements were made of two domestic hen tibiotarsus fragments (Sample D-AMS 020206 from Layer SU and Sample D-AMS 020204 from Layer SU 3) and a sheep or goat tibia fragment (Sample D-AMS 023745 from Layer 10).

7 Sieving was performed with 5 mm and a 2 mm mesh sieves. Kind personal information from Róbert Lóki and Eszter L. Kis Szabó.

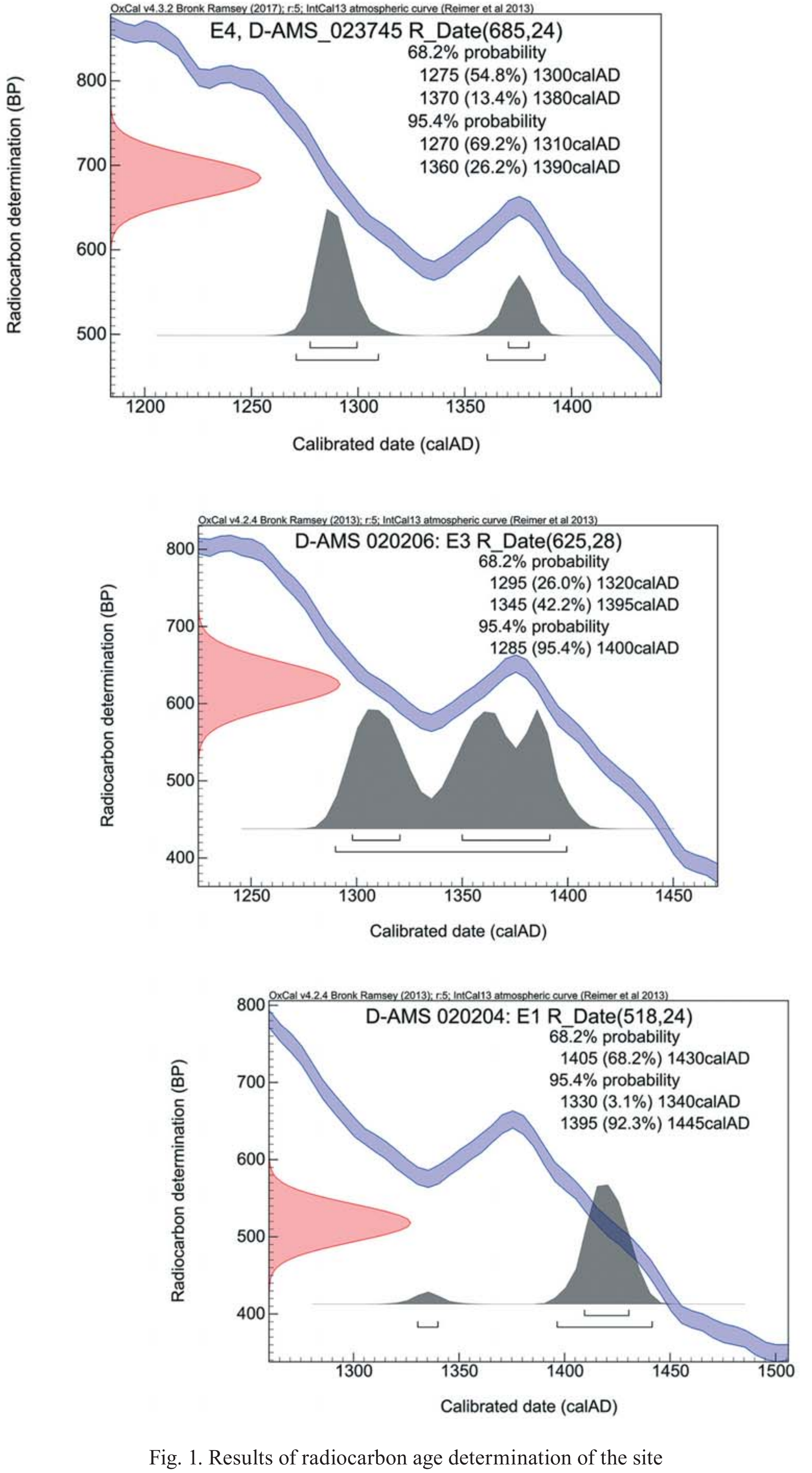

Fig. 1. Results of radiocarbon age determination of the site

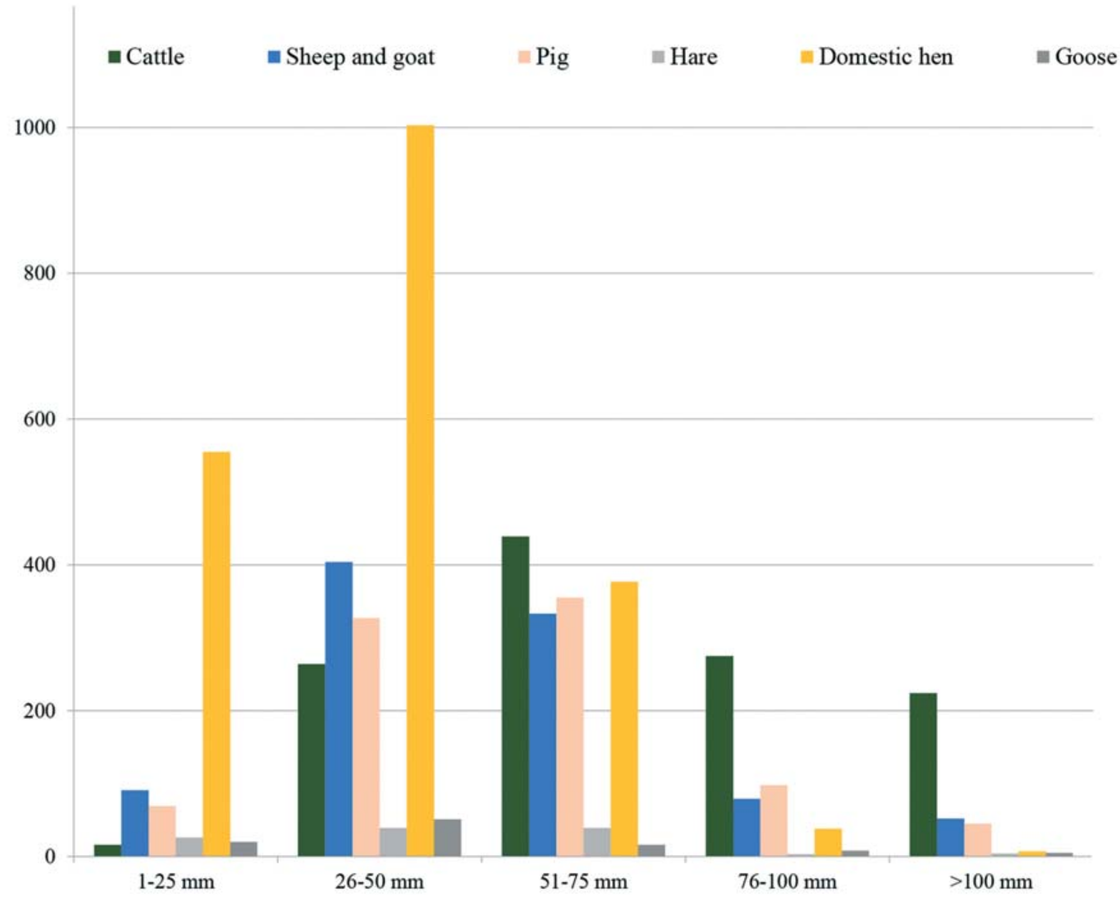

Fig. 2. The distribution of bone remains by main size groups

Horse, kept for transportation and traction, is entirely lacking from the material, while the few dog and cat bones most likely represent fallen creatures in the kitchen waste of the archiepiscopal palace. The rodent remains, apparently from mice and rats, were found in anatomical order and had more-or-less complete skeletons. Their presence in a refuse heap is quite natural since it was an abundant source of food for these animals. These two species are the two most frequent small mammals on human settlements because the artificial environment created by humans provides excellent habitats for them.[8]

1. Domestic animals

1.1. Cattle

Cattle bones (1218 pieces) were the most frequent mammalian remains in the assemblage by 16.7% of all determinable vertebrates *(Table 1).* It must be noted that the high number of bones can be explained by the chopped-up ribs and their fragments, which made up over one-half of the cattle bones (716 pieces, 50%). These were cut into 5–15 cm long "pot-size" chunks for preparing rib chops *(fig. 3. 1).* The number of vertebrae (116 pieces) and the bones of the meaty limbs (197 pieces) is considerably lower. At the same time, skull fragments and limb ends were also represented in the assemblage, indicating that the kitchen also received these body parts *(fig. 2).*

[8] *Kovács 2014* 50–51.

Fg. 3. Cut and chop marks, 1. cattle ribs; 2. cattle radius and ulna forming the elbow; 3. lumbar vertebra from sheep

Cattle is the by far the largest-bodied species in the assemblage, exceeding by far the body mass of smaller ungulates, and the meat distribution of this animal called for the most extensive primary (slaughterhouse) and secondary (kitchen) dismemberment, indicated not only by the number of fragments, but also by the chop and cut marks on the bones *(figs 4–5).* Aside from the ribs, the spine and the joints of the limbs (such as the elbow joint) and the skeletal parts bearing large muscles (such as the mandible, the scapula, the pelvis, the femur and the radius) called for chopping with sharp metal implements *(fig. 3. 2).*

Despite the high number of bones, there were hardly any suitable for determining the mortality profiles of cattle, owing to the dominance of ribs and the extensive chopping and cutting. The epiphyseal fusion of a few scapulae, ulnae and tibiae are an indication of the consumption of calves younger than two or even one year.[9] The 14th century assemblage contained the metacarpals of a cca. 255-day-old foetus,[10] indicating the spring slaughter of the mother, or an abortion.

[9] *Chaix – Méniel 2001.*
[10] *Prummel 1987* 29, fig. 9.

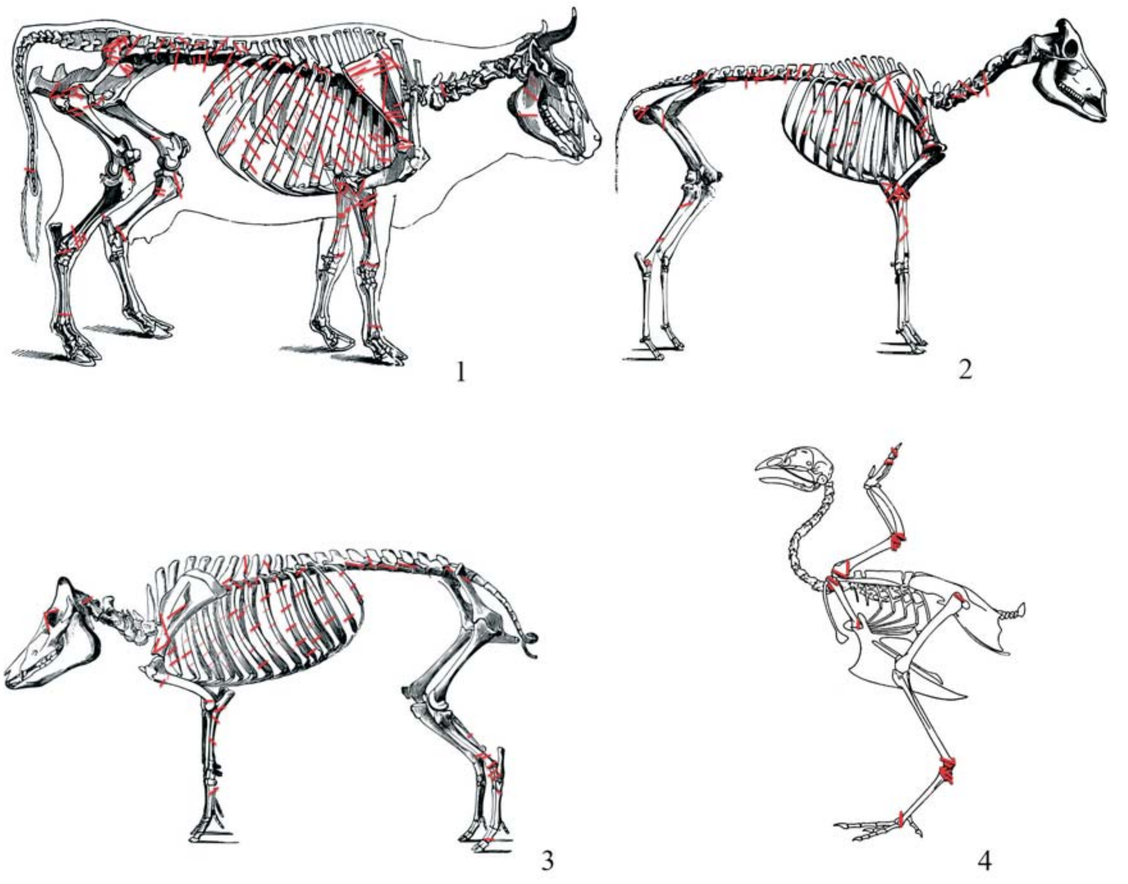

Fig. 4. Summary of cut and chop marks on skeletons of the most frequent meat-providing species.
1. cattle; 2. sheep and goat; 3. pig; 4. domestic chicken

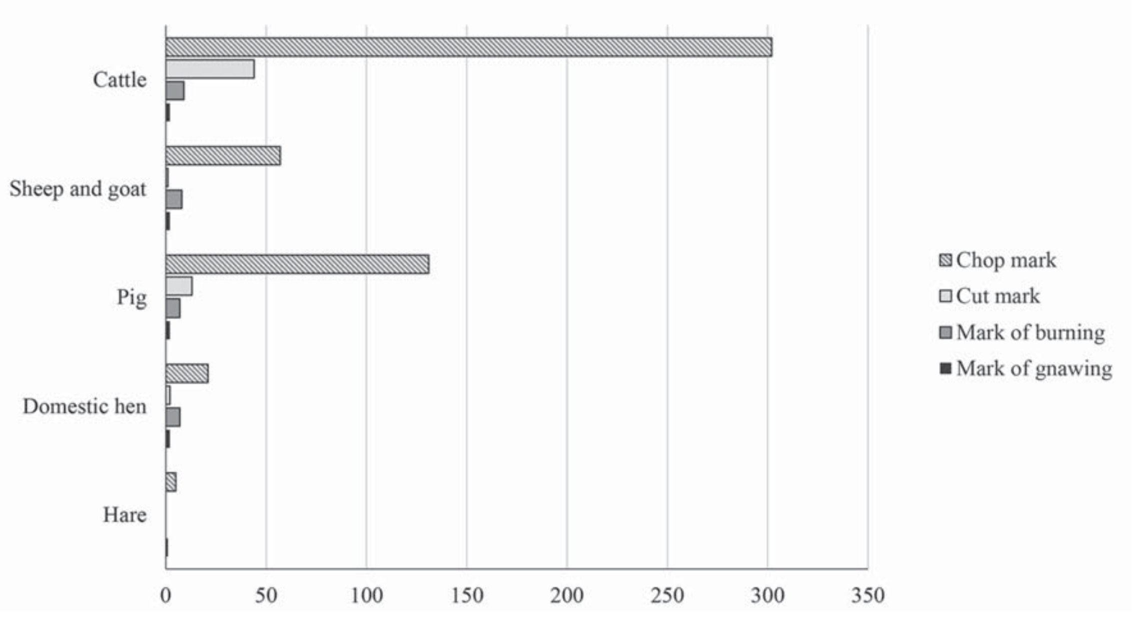

Fig. 5. The distribution of various taphonomic marks on remains of the most frequent species

1.2. Sheep and goat

The second most frequent mammals in the Esztergom assemblage are sheep and goat (13.1%). Only a few skeletal elements (skulls, horn-cores, metacarpals and metatarsals) enable a distinction to be drawn between these two species and therefore the presence of goat in the assemblage cannot be excluded, even though there was no conclusive evidence for its presence. Similarly, as in the case of cattle, there were no skull or horn-core fragments, and thus nothing is known about the breed of ruminants raised in the broader Esztergom area during the 14th–15th centuries. The withers height of a female sheep from the 14th-century assemblage was estimated to 53.7 cm *(Table 4)*.[11]

The distribution of skeletal parts is more even than in the case of cattle: in addition to the bones of the trunk *(fig. 2c)*, the meaty limb parts were the most frequent, and the dry limbs and the bones of the limb ends are present in higher numbers than of cattle, whose body size was considerably larger *(Table 2)*, suggesting the consumption of pork feet stew-like dishes, which is confirmed by the presence of a sheep hock found in anatomical order *(fig. 6)*.

The epiphyseal fusion of the skeletal elements and the extent of tooth abrasion indicate that most of the bones come from a few-month-old lambs and 1- or 2-year-old sheep, although a few wholly fused vertebrae reflect the slaughter of 5-6-year-old sheep.[12] The latter had probably been kept for their milk and wool as well as for maintaining the animal stock in the nearby villages provisioning Esztergom with meat.

Fig. 6. Articulated sheep bones forming the ankle: the distal part of tibia, the calcaneus and astragalus, and the os centrotarsale

1.3. Pig

The proportion of pig bones (12.3%) is roughly identical to that of small ruminants in the assemblage and even slightly exceeds it in the 14th century material *(Table 1).* Regarding the distribution of body parts, the high number of skull fragments (117 pieces) is particularly striking, being higher than of all the other species together. One possible explanation is that pig skulls and mandibles are more robust and therefore likely to be better preserved and that the number of their teeth (22) is higher than of ruminants (16). It must also be borne in mind that pig heads were used for a wide variety of dishes in Hungarian culinary culture. The frequency of ribs is identical to that of cattle, while the bones of the dry limbs and limb ends resembles that of small ruminants *(Table 2).*

[11] *Teichert 1975.*

[12] *Chaix – Méniel 2001; von den Driesch 1976* 77, Table X.

Fig. 7. Medullary bone tissue in domestic hen femora

It would appear that the dismemberment of pig carcasses required more effort than in the case of small ruminants: we found chop and cut marks made by cleavers and knife on twice as many bones than on sheep (and perhaps goat) bones. The cleaving of the skull and of the leg joints as well as the chopping of the ribs probably meant more work for the kitchen staff engaged in food preparation *(fig. 3)*.

Similarly to sheep, most of the remains reflect the butchery of pigs ranging from few-month-old piglets to two-year-old pigs, although the occasional older, 4–5-year-old animal is also attested. We identified a few remains of a cca. 107-day-old foetus in the 14th-century assemblage.[13] In this case, it is impossible to determine the season when it was killed because under favourable conditions pigs may have two litters per year.[14]

1.4. Hen

The assemblage from Esztergom is dominated by hen, accounting for more than one-quarter of the bones (27.1%). In contrast to the mammals described in the foregoing, this high proportion can be explained by the absolute number of skeletal remains, rather than by the cutting up of certain body parts or the fragmentation of the finds. Compared to mammals, far fewer chop and cut marks can be seen on hen, and generally on fowl bones. These can usually be found on the larger joints (shoulder, elbow, pelvic and ankle joints) and when the wing ends were removed *(fig. 3)*. Besides the obvious primacy of the meaty limbs and the bones of the trunk, the frequency of the dry limbs and the bones of the rear is quite striking.

The estimated minimal number of individuals based on epiphyseal fusion, the preservation and the right and left positions is 52 individuals, of which 19 were young and 33 were adult animals. Among the latter, we could identify 12 hens and 17 roosters based on the medullary bone tissue associated with eggshell formation *(fig. 7)* and the presence or lack of a spur on the tarsometatarsus. Given that medullary bone tissue is only present during the laying period in the post-cranial bones, its lack more likely indicates a lull in egg laying during the late autumn and early winter period rather than the smaller proportion of hens.[15]

A comparison of the size proportions of intact tarsometatarsals after sexing can offer clues as to whether a particular assemblage contained the remains of more than one domestic hen breeds. This is also apparent in the Esztergom assemblage: the proportions of one tarsometatarsal are visibly different than the ones in the cluster of the majority of roosters on the scattergram, indicating the presence of a hen-sized, but squatter breed *(fig. 8)*. The sizes of the majority correspond to the bone sizes of the domestic hens found in Buda Castle and the Baj manor house, while the larger ones compare well with the specimens from the 15th-century layers of the Dominican monastery in Buda *(Table 4)*.[16]

[13] *Chaix – Méniel 2001; von den Driesch 1976* 77, Table X; *Prummel 1987* 21–41, figs 1–21.

[14] *Bartosiewicz 2006* 108.

[15] *Gál 2008* 45–46.

[16] *Matolcsi 1977* 185; *Matolcsi 1981* 235, Table 17; *Bartosiewicz 2010* 356.

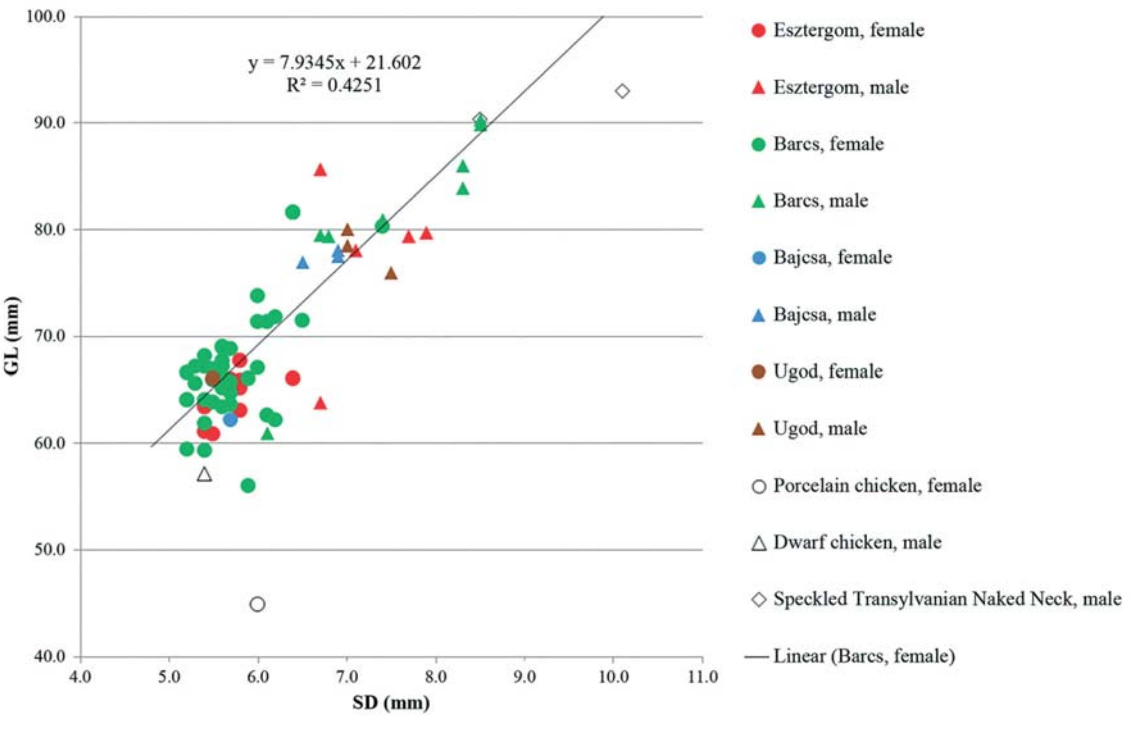

Fig. 8. Scatterplot of the maximum length (GL) to the smallest width of the corpus (SD) of the tarsometatarsus in medieval, early modern and recent domestic hen

1.5. Domestic pigeon

Although widespread in medieval Europe, this fowl is rarely attested in the Hungarian bone assemblages.[17] At Esztergom, pigeon accounts for a minimal proportion (0.3%) of the material. The 22 post-cranial elements representing the entire body aside from the head come from two young and three fully-developed specimens.

1.6. Other domesticates

Besides the species kept for their meat, the assemblage contained the occasional dog, cat and rodent bones. The five dog bones from the 15th-century layer probably come from the same individual, which, judging from the fusion of the vertebrae, was around one year old.[18] The six cat bones, all recovered from the 14th-century layer, represent one or two grown individuals.

As a result of sieving, the material contains an unusually high number of rodent bones, which according to the preliminary assessment come from mouse and rat *(Table 1)*. Similar finds are rarely attested in the bone samples from previous medieval excavations. A rat skull was identified in the 16th century layer of the Dominican monastery of Buda, and the post-cranial bones of several rats and other murids were recovered from a 14th–15th-century cistern and pit at the Vác-Piac utca site. Evidence for the 14th–15th-century presence of black rat has been reported from the Remetehegy rock shelter in the Buda Mountains and from the Teleki Palace in Buda Castle.[19]

[17] *Bökönyi 1974* 426; *Bökönyi 1982* 150.
[18] *Chaix – Méniel 2001.*
[19] *Matolcsi 1981* 239, fig. 21; *Kovács 2014*.

Fig. 9. Proximal phalanx from brown bear next to a recent counterpart

2. Wild animals

The remains of wild species yielded surprising results, both regarding mammals and fowl. At Esztergom, there is nothing to indicate the consumption of cervids and boar, the popular and frequent hunting booty in castles and other royal residences during the medieval period.[20] Boar is entirely lacking, while red deer and roe deer are only represented by their antlers and terminal bones *(Tables 2–3)*. The third large-bodied mammal, brown bear, was identified from a phalanx in the 15th-century material *(fig. 9)*,[21] making brown hare the most frequent wild mammal in the Esztergom bone assemblage *(Table 1)*. The distribution of the skeletal elements likewise reveals that hare was a popular dish in the archiepiscopal palace since all body regions are represented in the assemblage and, similarly to the domestic mammals, the finds were dominated by the bones of the trunk and the meaty limbs *(Table 2)*. The age distribution indicates that mainly fully-grown individuals were eaten, alongside a few juveniles.

In contrast to the hunted mammals, there is a striking variety of wild birds, among which at least twenty species could be identified, alongside the possible presence of greylag goose and mallard.[22] Most bird species are represented by a few bones only, suggesting opportunistic hunting *(Table 1)*. In contrast, grey partridge yielded a remarkably high number of finds: the 239 bones account for 3.3% of the entire assemblage and come from eleven adult and nine young specimens.

Northern goshawk and sparrowhawk represent the birds of prey, whose remains are attested in the 15th-century assemblage. The goshawk phalanx is a rare find and in the lack of comparative bone sizes, the bird could not be sexed. In contrast, it could be clearly established that the sparrowhawk carpometacarpus came from a female *(Table 4)*.

3. Goose and duck

The duck bones falling into the size range of geese and mallard constitute a separate group both in terms of their amount (117 pieces, 1.6%) and in terms of their interpretation. Although their frequency eclipses that of the other wild birds identified in the assemblage (the only exception being grey partridge), they fit into the variety of hunted species in the broader Esztergom area. In fact, besides Turdidae, Anatidae have the greatest variety with four different species *(Table 1)*.

At the same time, the bone assemblage clearly indicates that poultry occupied a prominent place in the provisioning of the archiepiscopal palace: in addition to the two domestic hens with different body size, pigeons were kept, and we cannot exclude the breeding of partridge. Aside from the secondary products such as eggs and feathers, the breeding of domestic goose and domestic duck is also suggested by the presence of the post-cranial bones of young individuals of both fowl species. The incidence of chicks needs no explanation in the case of bred animals, while it does not make economically sense to kill them during hunting.

[20] *Bökönyi 1963* 397; *Matolcsi 1977* 185–86; *Daróczi-Szabó 2009.*

[21] I am grateful to department head Dr. Tamás Görföl for his permission to study the comparative bone material in the Mammal Collection of the Hungarian Natural History Museum. The recent phalanx shown in the photo (Inv. no. 95.14.1) comes from a roughly four-year-old Russian male specimen.

[22] I am grateful to curator Dr. Mihály Gasparik for providing access to the comparative bird bone collection in the Department of Palaeontology and Geology of the Hungarian Natural History Museum.

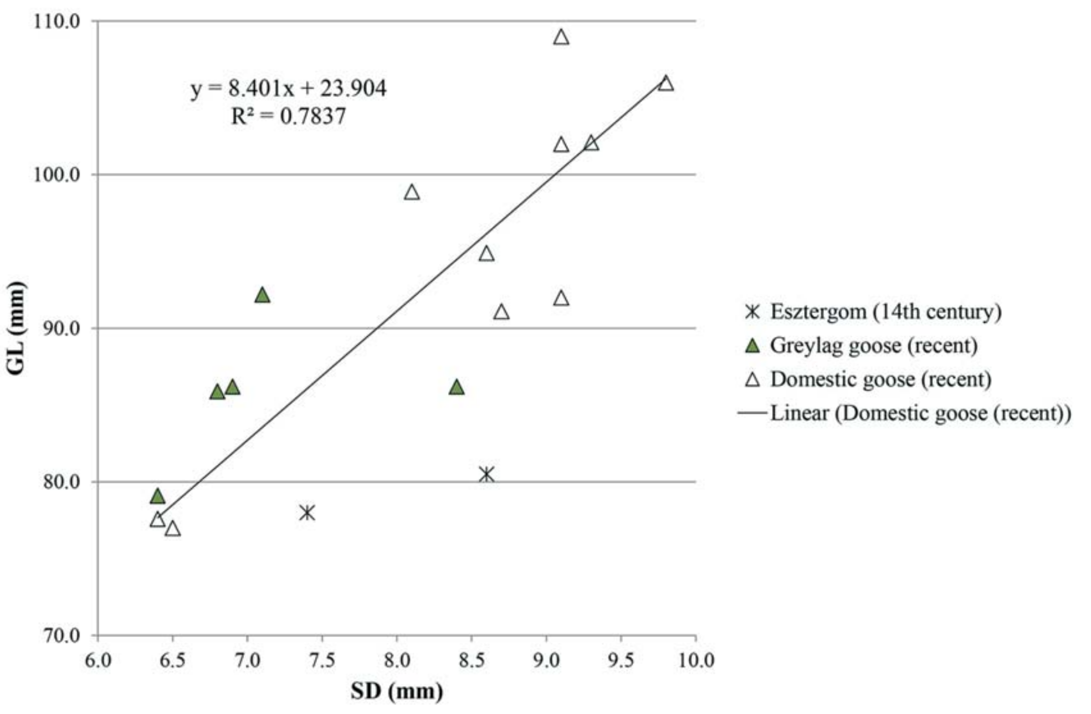

Fig. 10. Scatterplot of the maximum length (GL) to the smallest width of the corpus (SD) of the tarsometatarsus in greylag goose and domestic goose

It is impossible to determine using traditional archaeozoological methods whether the goose and duck remains originate from wild or domestic animals. There are no differences in bone morphology, while in the case of size differences, the differences from the sexual dimorphism of the species in question must also be taken into consideration: in other words, the size ranges of the wild males are roughly identical with those of domestic females. However, conclusive results cannot even be expected from genetic analyses since cross-breeding between domestic and wild individuals cannot be ruled in the Carpathian Basin. At the same time, there can be sites on which the outstandingly high number of remains can be confidently assigned to one or another type in view of the find context and the frequencies of domestic species. For example, the refuse accumulated in Well 8 of the Teleki Palace contained an even higher number of goose than hen bones and their frequency roughly matched that of cattle and small ruminants, therefore these were assigned to domestic goose.[23]

The articulated skeletal elements in the Esztergom material enable the comparison of size proportions as well as a discussion of the above issue despite the methodological reservations. Compact tarsometatarsals survived in highest numbers and thus I compared the smallest breadth/greatest length distribution with the corresponding sizes of recent wild and domestic geese in Hungarian and foreign collections.[24] The diagram reveals that the two size types are strongly correlated ($R^2 = 0.783$), while the divergences are rather large compared to the linear trend line ($y = 8.401x + 23.904$). The size proportions of the strikingly squat finds from Esztergom fall closest to the smaller wild and domestic geese, which obviously does not solve the wild/domestic issue

[23] *Daróczi-Szabó 2004* 257, fig. 6.

[24] I am grateful to Dr. Mihály Gasparik (Department of Palaeontology and Geology of the Hungarian Natural History Museum), Dr. Andrea Kőrösi (Museum of Hungarian Agriculture) and Dr. Günther Karl Kunst (VIAS Universität Wien) for providing access to the collections and enabling comparative bone measurements.

Fig. 11. Bones displaying pathological conditions. 1. exostosis on the cotyla medialis of tarsometatarsus in domestic hen; 2. traces of fracture on cattle rib; 3. gingivitis in sheep mandible

(as anticipated), but does make for reliable sexing because conforming to the sexual dimorphism of the Anseriformes, females are considerably smaller than males *(fig. 10)*.

The sizes of the mallard and greylag goose remains from Buda Castle fit in nicely with the size of the finds from Esztergom *(Table 4)*.[25] At the same time, Sándor Bökönyi described the goose bones brought to light on earlier excavations in Buda as coming from a "small, at the most medium-sized, primitive breed".[26] The humerus identified as originating from domestic goose in the Segesd assemblage is more robust than the two goose humeri from Esztergom.[27]

4. Pathological alterations

A few post-cranial bones bore traces of pathologies. Their low number (13 pieces, 0.2%) can be attributed to the fact that most of the animals earmarked for consumption were slaughtered at a young age. Similarly to the number of finds, domestic hen dominated the pathological remains: mechanical trauma, healed fractures, exostosis and inflammation could be noted on six limb bones *(fig. 11. 1)*.

[25] *Matolcsi 1977* 186; *Matolcsi 1981* 240.
[26] *Bökönyi 1963* 411.
[27] *Bartosiewicz 1996* 210.

The next most frequent pathology affected the ribs (four pieces). More-or-less healed rib injuries could be equally found among cattle, sheep and pig bones. The callus formation on the cattle rib shown in *fig. 11. 2* indicates that either the bone had healed to some extent, but did not completely fuse (i.e. only a loose pseudo-joint was formed) or that it had been broken shortly after the ossification owing to its loose structure. The chop marks and injuries on cattle ribs can be regarded as being representative in the assemblage because these are large and well-preserved skeletal elements that are nevertheless increasingly prone to injuries when these animals are herded or driven.[28]

Finally, we identified three dental pathologies in the 15th-century material: the tip of a dog canine broke off during the animal's life, an upper cattle molar is unevenly worn and traces of the inflammation of the gum (gingivitis) could be seen on a sheep mandible *(fig. 11. 3)*. Large samples from both prehistoric and historic times have shown that in the case of sheep, this pathology is most frequent in the region of the fourth premolar (LP4) and the first molar (LM1).[29]

5. Worked bone

Although the overwhelming majority of the bone assemblage from Esztergom is made up of food remains and kitchen waste from the preparation of various dishes, a few bone and antler fragments bearing manufacture and use-wear traces also came to light among the refuse. The following section contains a list of these bone and antler finds according to their type, together with their find context and date as well as their dimensions.[30]

5.1. Bone needles

Trench I, SU 5 (14th century): needle, made from a sheep or goat long bone *(fig. 12. 1)*. GL. 3.7 mm; GW. 9.0 mm; GD. 3.5 mm; diam. of eye 3.5 mm.

Trench I, SU 5 (14th century): needle fragment lacking the head, made from sheep or goat long bone. GL. 66.6 mm; GW. 7.4 mm; GD. 3.7 mm.

Trench I, SU 18 (14th century): needle fragment lacking the head, made from sheep or goat long bone. GL. 60.3 mm; GW. 4.9 mm; GD. 3.4 mm.

5.2. Bone knife handles

Trench I, SU 18 (14th century): handle fragment, carved from a cattle long bone diaphysis with rounded surface, very shiny. GL. 101.2 mm; GW. 19.6 mm; GD. 6.8 mm. There are two perforations on the fragment: diam. 4.0 mm and 1.5 mm.

Trench I, SU 3 (15th century): handle fragment, carved from a cattle long bone diaphysis with rounded surface. GL. 83.0 mm; GW. 15.8 mm; GD. 7.8 mm. There is a broken perforation on the fragment: diam. 3.3 mm.

5.3. Belt mount

Trench I, SU 17 (15th century): fragment of a belt mount, carved from an ungulate (probably cattle) long bone diaphysis with greenish bronze patina. Rivet holes were drilled in the centre of the raised disc and the two antithetic leaf motifs *(fig. 12. 2)*. GL. 19.0 mm; GW. 10.1 mm; GD. 4.3 mm.

---

[28] *Gál – Kunst 2018* fig. 4. 7.

[29] *Bartosiewicz – Gál 2013* 178–179, fig. 147.

[30] The abbreviations used in the descriptions are as follows: SU: stratigraphic unit, GL: greatest length, GW: greatest width, GD: greatest depth (thickness).

5. 4. Crossbow fittings
Trench I, SU 4/A (14th century): fragments of nut and arrow base plate, both carved from red deer antler *(fig. 12. 3)*. Dimension of the nut: GL. 32.0 mm; GW. 12.5 mm; GD. 12.1 mm; diam. of perforation 5.1 mm.
Trench I, SU 18 (14th century): fragment of an arrow base plate, carved from cattle metatarsal. GL. 22.7 mm; GW. 13.1 mm; GD. 7.0 mm; diam. of perforations 3.9 mm.
Trench I, SU 22 (14th century): fragments of arrow base plates, carved from red deer antler. Dimension of the larger fragment: GL. 29.9 mm; GW. 15.6 mm; GD. 5.0 mm. Dimensions of the smaller fragment: GL. 23.0 mm; GW. 13.6 mm; GD. 3.8 mm; diam. of perforation 4.6 mm.
Trench I, SU 23 (14th century): fragments of arrow base plates, carved from red deer antler *(fig. 12. 4)*. Two specimens survived intact: GL. 44.7 mm; GW. 24.2 mm; GD. 6.1 mm; diam. of perforation 5.0 mm; GL. 51.0 mm; GW. 22.8 mm; GD. 5.4 mm; diam. of perforation 5.5 mm. Only fragments survived of four other exemplars: diam. of perforations 4.0 mm, 4.1 mm, 5.0 mm.
Trench I, SU 3A (15th century): fragments of two arrow base plates, carved from red deer antler. Larger fragment: GL. 33.3 mm; GW. 18.2 mm; GD. 6.3 mm; smaller fragment: GL. 8.1 mm; GW. 23.3 mm; GD. 5.6 mm; diam. of perforations 3.9 mm.

5.5. Other bone plaques and stiffeners
Trench I, SU 4/A (14th century): fragment of a slender stiffening plate with several perforations and traces of rivets and corrosion *(fig. 12. 5)*. GL. 86.3 mm; GW. 5.8 mm; GD. 4.0 mm.
Trench I, SU 23 (14th century): plaque carved from red deer antler with three perforations (diam. 4.0 mm, 4.2 mm, 5.5 mm). The perforation closest to the pointed end retains a *ca.* 12 mm long rivet *(fig. 12. 6)*. GL. 59.6 mm; GW. 15.8 mm; GD. 7.1 mm.

5.6. Bone pipe
Trench I, SU 3 (15th century): small tube cut from a bird (probably goose) ulna diaphysis *(fig. 12. 7)*, without any other visible traces of working. GL. 50.4 mm; GW. 9.5 mm; GD. 7.4 mm.

5.7. Bone carving
Trench I, SU 3 (15th century): leaf-shaped ornament, probably carved from an ungulate long bone diaphysis *(fig. 12. 8)*. GL. 54.1 mm; GW. 10.5 mm; GD. 3.2 mm.

5.8. Toy
Trench I, SU 3 (15th century): toy made from a pig proximal phalanx by grinding the edges on the proximal and distal epiphyses and perforating the bone in a dorso-ventral and medio-lateral direction *(fig. 12. 9)*. GL. 34.7 mm; GW. 15.2 mm; GD. 14.8 mm. The perforations are slightly irregular, diam. 4.0 mm.

5.9. Other antler implements
Trench I, SU 6 (14th century): plaque carved from red deer antler beam. The spongy tissue was removed from the beam split lengthwise, two oblique openings were made on the cortical surface and the section between them was carved flat, perhaps for guiding a strap or some similar fabric *(fig. 12. 10)*. GL. 70.2 mm; GW. 29.0 mm; GD. 3.6 mm.

The 11 bone and 15 antler implements account for a very small portion (0.4%) of the find material. Most of the bone items were made from cattle long bones, from the metacarpals and metatarsals that were useless in terms of meat and were removed during the primary processing, indicated also by the sawed ends of the bones *(fig. 13. 1–2)*. The long, regular form and thick walls of these bones made them an ideal raw material for carving larger items such as knife handles,

Fig. 12. Bone and antler artefacts, 1. needle; 2. belt mount; 3. fragment of crossbow nut; 4. arrow base plate in crossbow; 5. bone stiffener; 6. antler cover with nail; 7. bone tube; 8. bone decoration; 9. toy made from pig phalanx; 10. antler belt driver (?)

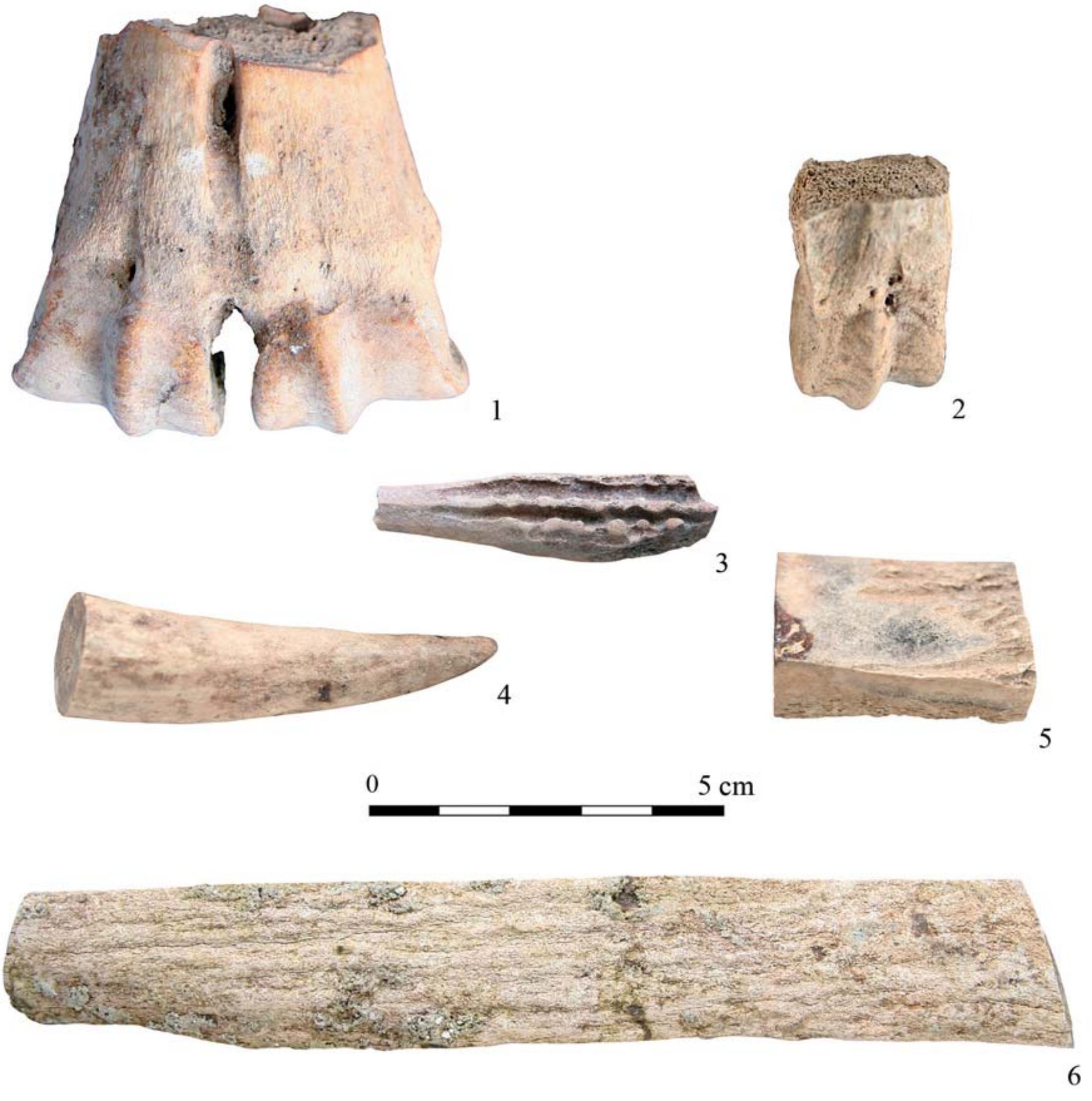

Fig. 13. Workshop debris, 1–2. distal ends of cattle metatarsals; 3. half-made or failed object made from red deer antler; 4. end of crown tine in red deer antler; 5. piece of red deer antler with trace of rust; 6. red deer antler slat cut to size

arrow bases and larger plaques.[31] In contrast, sheep and goat bones with their thinner walls were excellent raw material for slender needles. The even lighter and more fragile bird bones were generally fashioned into flutes and other musical instruments.[32]

Aside from the implements, the find included several dozen semi-finished artefacts and workshop waste such as sawn bone and antler terminals as well as filed antler plaques cut to the appropriate size, indicating that the archiepiscopal palace received not only finished utilitarian and decorative objects, but that there was a bone and antler workshop in its immediate proximity *(fig. 13. 3–6)*.[33]

[31] *Bartosiewicz 2006* 197–198, fig. 169; *Kováts 2008* 113.

[32] *Gál 2005* 326–330, figs 2–3 and 5–8; *Kovács 2005* 314, fig. 4. 2–4.

[33] *Csippán 2010* 32.

Meat distribution and processing

The quantitative and qualitative indices of the animal bone assemblage both suggest that the refuse deposited from various activities in the archiepiscopal palace's kitchen was predominantly made up of the waste from the preparation and consumption of various dishes, while a smaller portion represented household refuse and the remains of animals scavenging refuse heaps.

The species and bone distribution clearly reveal that there were certain preferences regarding the meat arriving to the kitchen: in addition to the general traits of animals – for example, large-bodied wild animals were apparently shunned, while so-called white meat (fish and poultry) were preferred – some body parts were obviously more preferred than others. Accordingly, only those part of the domestic mammals was used after the primary (slaughterhouse) dismemberment and distribution that were needed for particular dishes, while poultry arrived with only the head removed at most. However, it is also feasible that since poultry keeping required neither too much space, nor too much labour, they were raised within the castle, similarly as in the Őcsény-Oltovány castellum.[34] In this case, their blood was also used for cooking. Called "black juice" in medieval times, it appears in many of the period's cook-books among the recipes not only for poultry, but also for other meats.[35]

The dietary value of animals depends on the useful (meat and fat) and the less useful (tendons and bones) parts typical for the body regions and their proportion relative to each other. Hans-Peter Uerpmann classified skeletal parts into three grades: the best-quality meat ("A") is represented by the vertebral column (excluding the tail), the upper leg bones, the bones of the shoulder and the pelvic girdle, medium-value meat ("B") by the lower leg bones and the skull (with brain and jaw musculature) and mandible (jaw musculature and tongue), and the ribs and sternum, while lowest-value meat ("C") by the face bones, the tail and the feet (including ankle joints).[36] This classification reflects the meat value of the bones since what constitutes delicacies differs from one culture to the next and also depends on personal taste as well as on culinary fashion.

It seems instructive to examine the four most frequent mammalian species at Esztergom from this aspect since the distribution of body regions reveals that only the head was cut off in the case of poultry before they were processed. The same holds true for hare, the only difference being that the limb extremities did not always reach the kitchen, but were often chopped off after the hunt *(Table 2)*.

The dominance of ribs reflects the frequent consumption of medium-value ("B") meat, followed by best-quality ("A") meat of ruminants and hare, while in the case of pig, there was a preference for the head and the feet, the lowest-value meat ("C") *(Table 3)*. It must nevertheless be borne in mind that genuine meat consumption was in all likelihood more diverse than suggested by the quantitative indices of the surviving animal bones since no osteological evidence has remained of the consumption of fillet cuts.

The high fragmentation characterising the Esztergom material was also noted in the assemblages from other high-status sites. The sharp chop marks on the vertebrae of the 14th–15th century finds from Buda Castle are a reflection of the butchering practice of the Buda butchers to cleave the animal carcass in half.[37] Heavy chop marks were identified on the medieval cattle bones from Segesd and the cutting of the elbow joints on the forelegs of ruminants.[38] In addition to the customary dismemberment of cattle in the Baj manor house, the frequent chop

---

[34] *Bartosiewicz 2016* 170.

[35] *Lakó 1983; Benda 2009* 57.

[36] *Uerpmann 1973*.

[37] *Matolcsi 1977* 180–181.

[38] *Bartosiewicz 1996* 186, 194, Table 4.

marks on the limb extremities indicate the presence of active tanneries, confirmed also by other archaeological evidence in the find material and on the settlement itself.[39]

Unlike the alternating frequencies of chop and cut marks, the taphonomic traits indicate that heat effects and gnawing affected the bones of domesticates to a similar extent *(fig. 4)*. The low proportion of the latter would suggest that kitchen waste and left-over food were dumped in a location that was inaccessible to cats and dogs relatively quickly after the preparation of the dishes and their consumption. Moreover, despite the documented presence of rodents, the bones do not bear their gnaw marks. One possible explanation is that the bones thrown into the refuse were still covered with soft tissues (cartilages, meat, tendons).

Distribution of species

Three peculiarities can be noted in the Esztergom assemblage in terms of the identified species, namely the frequency of fish and of domestic and wild fowl. The poultry supply of the archiepiscopal palace was quite clearly based on hen keeping, which could be practiced in a relatively small space even within a castle's walls. Domestic hen represents the earliest domesticated fowl species, attested since the Late Bronze Age in Europe.[40] Hen is an undemanding, highly fertile species and its eggs, available for the greater part of the year, are an important source of protein. Its meat and eggs could be consumed even on fast days during the medieval period.[41]

The number of wild birds is outstanding; previously, the number of species known from one or another sit was under ten. This is the first medieval assemblage containing the remains of gadwall, little bustard and various songbirds such as common blackbird, redwing, song thrush and spotted nutcracker.[42] The natural habitats of the twenty different bird species reflect the diversity of the natural environment in the broader Esztergom area. Mallard and glossy ibis reflect the hunting of waterfowl and wading birds on the Danubian floodplain. Grey partridge, common quail and little bustard prefer arable land and grassy plains. Pheasants and rooks thrive in shrubland and parkland, although pheasants were kept as tamed birds, too.[43] The earliest medieval osteological evidence for this species, repeatedly introduced to the Carpathian Basin, comes from the 13th-century layers of Buda Castle,[44] while later it is attested both in urban (Visegrád-Kálvária, 14th century), elite (Visegrád-Palota, 14th–15th centuries) and rural environments (Sümeg-Sarvaly, 15th–16th centuries).[45]

Although rooks are birds of cultivated fields, they regularly appear on human settlements for foraging.[46] These birds, moving in large flocks, are generally viewed with mistrust owing to the damage they cause and their clamour; at the same time, several corvid species were kept as pets, either in a cage or raised from a young age for personal enjoyment.[47]

Jay, starling and blackbirds live in forests and shrubland. Spotted nutcrackers do not nest in Hungary, but are winter guests, and fieldfare is similarly mostly to be found in winter. According to the account book of archbishop Hyppolite d'Este, seven fieldfares were among the delicacies served at a banquet he gave in Buda on February 19, 1520.[48] Common teal passes

---

[39] *Bartosiewicz 2010* 328–338; *Petényi – Bartosiewicz 2010.*
[40] *Kyselý 2010.*
[41] *Lakó 1983; Serjeantson 2001* 263.
[42] *Bökönyi 1974; Matolcsi 1977* 191, Table 1; *Gál 2015.*
[43] *Kordos 2006* 171.
[44] *Matolcsi 1981* 241.
[45] *Bökönyi 1974* 424, 426; *Matolcsi 1982* 233, Table 1.
[46] *Hume 2003* 369.
[47] *Bartosiewicz 1995* 69; *Gál 2003* 130; *Serjeantson 2009* 332.
[48] *Zolnay 1977* 311.

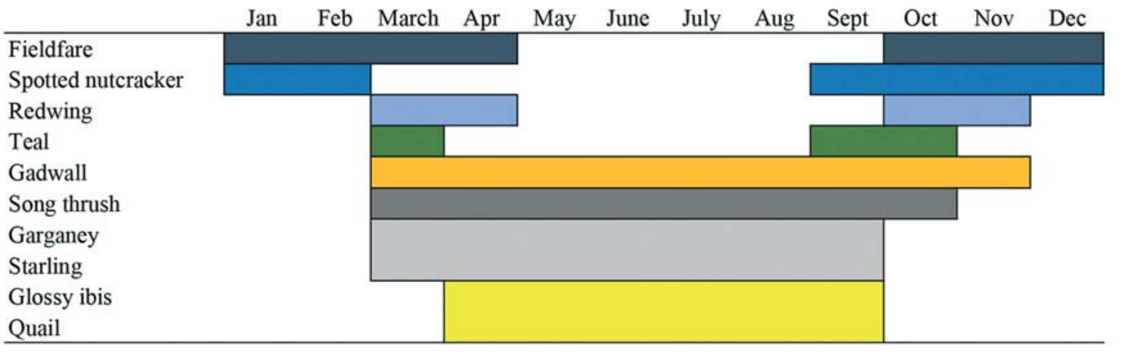

fig. 14. The seasonal presence of wild birds identified in the assemblage in Hungary

through Hungary in larger flocks in spring and autumn, similarly to redwing, which sometimes winters here.[49] The evidence on the seasonal presence of non-resident species indicates that the persons provisioning the archiepiscopal palace could hunt birds in every season *(fig. 14)*. Birds of prey are in fine condition during their autumn-winter passage and migration and can be hunted more easily because they fly in large flocks.[50] In Anna Bornemisza's 16th-century cook-book (essentially a translation and slightly revised version of the cuisine of the 16th-century royal sovereigns of Central Europe), mistle thrush appears as a royal dish that could be consumed during fasts, too.[51]

Goshawk and sparrowhawk nest in trees on forest margins near open meadows and cultivated land, and also make an appearance near humans, particularly in winter, when both are unwanted guests owing to the damage they cause. At the same time, these two diurnal predators were popular in hawking. The females, larger than the males, were trained for short-distance, i.e. hawking on foot.[52]

Given that most of these birds fall into the small game category, they were hunted with guns, crossbows or nets and boughs smeared with honey.[53] Neither can the use of trained birds of prey be wholly excluded, especially since goshawk and sparrowhawk are both represented in the bone assemblage and since there is evidence for hawking from the Árpádian Age onward in Hungary, both in charters and in place-names.[54] Both species have a predilection for low-flying smaller birds and goshawk can also be trained to hunt medium-sized prey such as pheasants and hares *(Table 4)*.[55]

Published in England in 1486, the chapter on hawking in *The Boke of Saint Albans* describes the different birds of prey associated with social status: yeomans had goshawsk, priests had sparrowhawks, holy water clerks had muskets and knaves had kestrels. Although medieval English social values can hardly be projected onto medieval Hungary, it does nevertheless indicate that despite being church dignitaries, the social class nearer to the common folk did not possess rare and valuable, possibly imported species (such as peregrine falcon and gyrfalcon), but hunted with easily acquirable Accipitriformes that could be trained for hunting birds and smaller fur creatures.[56]

[49] *Peterson et al. 1977; Hume 2003.*
[50] *Woolgar 1999* 114–115.
[51] *Lakó 1983* 57–59.
[52] *Zolnay 1977* 95; *Mulkeen – O'Connor 1997; Prummel 1997* 336; *Duhay 2000* 88.
[53] *Csőre 2000.*
[54] *Somlyói Tóth 1985* 12.
[55] *Duhay 2000* 88.
[56] *Bartosiewicz 2018* 115–118.

Goshawk and sparrowhawk are mentioned in 14th-century Hungarian written sources.[57] Although there is no direct, conclusive archaeozoological evidence for hawking in Hungary, the osteological record nevertheless suggests that these two bird species can be associated with this hunting activities.[58] Both species are attested in several medieval European assemblages;[59] in Hungary, the earliest occurrence of both species is the 12th–13th-century assemblage from Budapest-Kánafalu, where the most frequent hunted wild bird was grey partridge.[60] The finds from Esztergom represent the first instance of their presence in a late medieval assemblage; goshawk and sparrowhawk have also been reported from the Ottoman Turkish-period material from Bajcsa-Vár and the 16th–18th-century bone assemblage from Pilisszentkereszt Monastery,[61] while sparrowhawk has been identified among the Ottoman Turkish-period finds from the Carmelite monastery in Buda Castle (Színház utca 1–11).[62]

Goshawks preyed on grey partridge and brown hare, and thus hunting with these two predatory birds would explain the frequency of these two species, both living in open areas and nesting on the ground, among the wild animals. At the same time, the numerous grey partridge remains – representing different age groups – in the animal bone sample also raises the possibility that similarly to poultry, this species was kept and bred in a human environment, a practice attested in medieval England.[63] Whichever the case, grey partridge is the most frequent wild bird species on medieval settlements.[64] If the specimens in the Esztergom assemblage reached the palace as hunting prey, the presence of young birds reflects early summer hunts.[65]

It is quite certain that pigeons were bred at Esztergom (or nearby), despite the low number of finds (22 pieces in all, representing 0.4% of the assemblage). Regarded as a delicacy, domestic pigeon increased the dishes made from small birds that were regarded as luxury dishes and could be served at any time of the year.[66] In addition to its meat, pigeon also provided feathers, while pigeon guano was utilised as manure and was also used in tanning in medieval times. Pigeon droppings were a source of saltpetre needed for gunpowder production once the use of fire-arms became widespread and thus its value increased manifold across Europe. Pigeons were possibly also kept as ornamental birds in Esztergom Castle. It would appear that the training and use of carrier pigeons became general during the Ottoman Turkish rule in Hungary.[67]

Until recently, pigeon remains dating from the medieval period were only known from the 14th–15th-century bone assemblage of Visegrád-Palota that contained one lone specimen.[68] In the wake of more recent excavations and the assessment of their finds, we now have a much clearer picture of the distribution of this species *(fig. 15)*. Osteological evidence for pigeon from late medieval contexts is known from the villages of Hódmezővásárhely-Gorzsa and Tiszagyenda-Morotva part (two and twenty bones, resp.)[69] as well as from Solt-Tételhegy, where a juvenile specimen was found.[70] Mention must also be made of the finds of the bones of a juvenile and fully-grown individual from the Ottoman Turkish (16th-century) levels of the "amulet pit" uncovered on

[57] *Rácz 2012.*
[58] *Prummel 1997; Gál 2012a.*
[59] *Mulkeen – O'Connor 1997* 444, Table 2.
[60] *Daróczi-Szabó 2013* 12–13, fig. 3.
[61] *Gál 2002; Gál 2012a; Gál 2015.*
[62] Kind personal communication from Dr. Márta Daróczi-Szabó.
[63] *Woolgar 1999* 114.
[64] *Bökönyi 1963* 416; *Bartosiewicz et al. 2018* 69.
[65] *Hume 2003* 151.
[66] *Gál 2020a.*
[67] *Marton 2007; Marton 2014.*
[68] *Bökönyi 1974* 426.
[69] *Lyublyanovics 2018* 142, 154.
[70] *Biller 2014* 205.

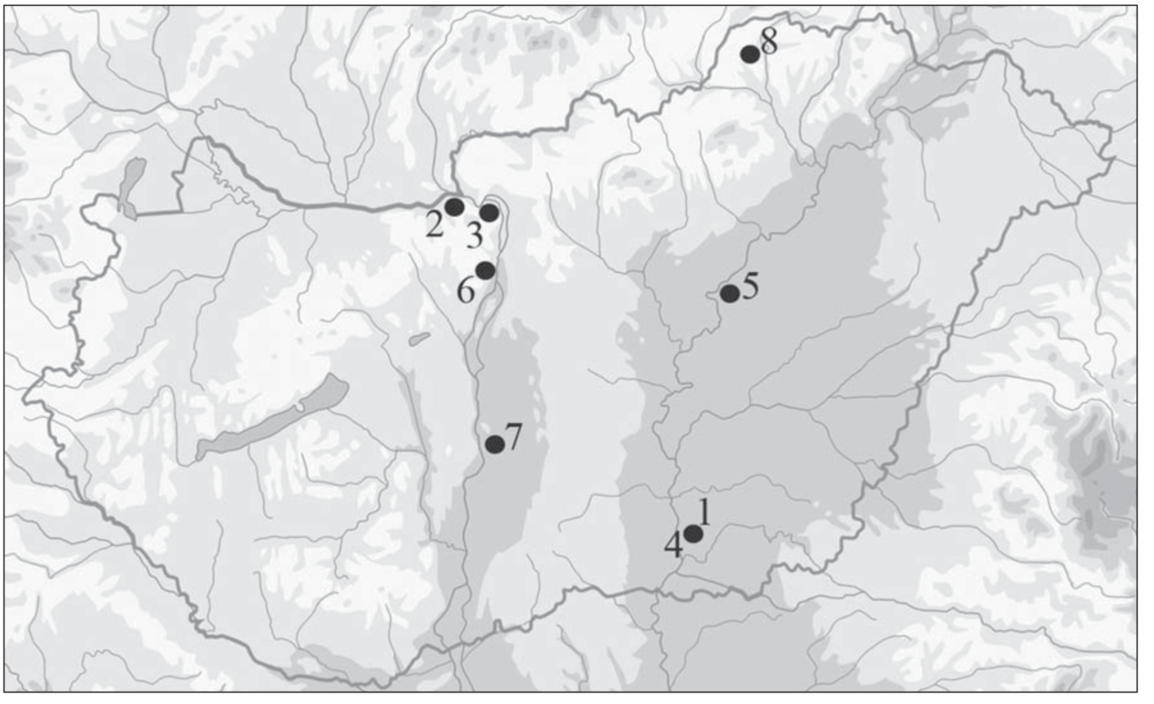

Fig. 15. The chronological distribution of domestic pigeon in medieval Hungary,
1. Hódmezővásárhely-Gorzsa (10th–13th century); 2. Esztergom, Várhegy-Kőbánya (14th–15th century);
3. Visegrád-Palota (14th–15th century); 4. Hódmezővásárhely-Gorzsa (14th–16th century);
5. Tiszagyenda-Morotva (14th–16th century); 6. Buda, Szent György tér (16th century);
7. Solt-Tételhegy (10th–16th century); 8. Szendrő-Kastély (17th century)

Szent György tér in Buda Castle[71] and of the four bones, probably from the same individual, from Szendrő-Felsővár, dating from the 17th century.[72] An earlier report describing the material culture of the settlements on the Hungarian Plain ravaged by the Ottoman Turks in all likelihood also refers to remains from this period. According to the description, a pigeon skeleton was discovered in a cooking pot in a pit of a house at (Lajos)Mizse.[73] Knowing that the house in question was a simple building in a rural milieu, it seems more likely that the bird was a domestic pigeon rather than a dish made from a wild pigeon species. However, since this piece of information does not come from an osteologist, I have not included the site on the distribution map of domestic pigeons.

Similarly to grey partridge, the frequency of hare bones raised the possibility that some actually represent the domestic rabbit and that they had perhaps been bred. Brown hare and domestic rabbit (the domesticated variety of coney) can only be distinguished from each other based on a few skeletal elements and smaller bone dimensions are also an indication of domestic rabbit. These bones are in a poor state of preservation in the Esztergom material; however, the exemplars on which the morphological traits enabling a distinction between the two species could be observed rather suggested brown hare, which was also underpinned by the bone dimensions *(Table 4)*.[74]

Although the Romans kept (fattened) wild rabbits in pens enclosed with stone walls or in parks *(leporarium)* from where the animals were unable to burrow their way out, the domestication and breeding of this species only began during early medieval times in south-western France.[75]

[71] I am grateful to Dr. Péter Csippán for allowing the publication of this still unpublished data.
[72] *Daróczi-Szabó 2009.*
[73] *Szabó 1938* 86.
[74] *Callou 1997* 14, fig. 2.
[75] *Irving-Pease et al. 2018.*

At first, domestic rabbits were solely to be found in religious institutions because they could be more easily kept in stone buildings. Following their spread in German religious and noble milieus, they also reached Central Europe. The first osteological evidence in Hungary comes from the 16th–17th-century layers of Visegrád-Salamon torony. In this assemblage, the roughly one hundred rabbit bones account for 1.19% of the entire assemblage.[76] Anna Bornemisza's cook-book has twenty recipes for hare/rabbit, although without specifying whether wild or domestic. The last recipe mentions the capture of a pregnant hare, suggesting that this species was acquired by hunting, which also seems to be confirmed by that the recipes for hare are found among the ones for the preparation of deer and wild boar dishes.[77]

As already mentioned in the above, one of the most striking traits of the Esztergom assemblage is the lack of bones from large-bodied game indicating their exploitation for meat. There were no wild boar remains, while the terminal bones of cervids and bear could have been part of cured hides taken to the palace. The dominance of limb extremities among the deer bones from the manor house investigated at Baj, Öreg-Kovács-hegy is also an indication that they reached the settlement together with the hides. Very little of the skeletal elements of the meaty regions of the deer killed during the hunt were brought back; the filleted meat was wrapped in the hide and then transported to the manor house.[78]

According to medieval sources, bear meat was not consumed; instead, this species was valued for its hide from which royal carpets, carriage blankets and the like were made. The 15th-century painting on the ceiling of the Szmrecsány church in Slovakia, lying some 200 km north of Esztergom, depicts a hunter killing a bear and we know that archbishop Hyppolite d'Este organised a bear hunt in the Mátra Mountains in 1518, on the occasion of his birthday.[79] Thus, we cannot exclude the possibility that bear meat was served in the archiepiscopal palace. Bear paw and bear foot are known to have been delicacies, even though there are few sources specifically mentioning this from the Carpathian Basin, despite the many indirect references.[80] The 16th-century cook-book already cited in the foregoing has a recipe for the preparation of bear foot (and bear head).[81] In medieval Poland, bear paw as well as bear ham and smoked bear tongue were popular delicacies. Aside from these body parts and the bear's skinned hide, the remainder of the carcass was left in the forest.[82]

Osteological evidence for bear is rare in Hungary. Of the 45 sites yielding bear bones mentioned in a recent overview, 35 are prehistoric.[83] A bear radius fragment is known from one of the houses of the 11th–12th-century settlement of Esztergom-Szentgyörgymező, which, being part of a meaty limb, can be regarded as food remain.[84] Less is known about the three late medieval bear finds from urban and high-status sites.[85] The 14th-century layer of Visegrád-Kálvária and the 14th–15th-century layers of Visegrád-Palota yielded one and five skeletal elements, respectively,[86] but nothing else is known about these finds, similarly to the single bear

76 *Bökönyi 1963* 416; *Bökönyi 1974* 334–336, 429.
77 *Lakó 1983* 123–125; *Bartosiewicz et al. 2010* 87–91, Table 2, fig. 3.
78 *Bartosiewicz 2010* 341.
79 *Zolnay 1977* 84–88.
80 *Zolnay 1977* 90.
81 *Lakó 1983* 128.
82 *Dembińska 1999* 95.
83 *Bárány 2011–2013* 26.
84 *Vörös 1989.*
85 It has since been demonstrated that the intermaxillary bone from the 14th-century layer of Segesd, listed as the fourth late medieval site in Annamária Bárány's study (*Bartosiewicz 1996* 185) does not come from brown bear, but from leopard *(Bartosiewicz 2001; Bartosiewicz 2015).*
86 *Bökönyi 1974* 424, 426.

find from the 14th–15th-century layer of Buda Castle, mentioned in an earlier publication.[87] The closest anatomical analogy to the bear find from Esztergom is the first phalanx recovered from Pit 3 of the Bronze Age settlement investigated at Füzesabony-Öregdomb. The exostosis on the proximal part suggests that it came from an older individual.[88]

Bone and antler working

None of the antler pieces in the Esztergom assemblage had any skull fragments attached to them and thus their presence does not in itself indicate deer hunting. Representing either worked pieces or raw material and workshop waste, the antlers could equally well have been gathered in forests after the stags had shed them.

The bone and antler implements listed in the above were quotidian utilitarian artefacts, some of which represent late medieval mass-produced items made using the same techniques.[89] These include the simple knife handles, needles, the crossbow nut, the belt mount, the pipe made from bird bone and the possibly unfinished antler implement,[90] whose counterparts are known from the 14th–16th-century assemblages brought to light at Visegrád, Buda and Baj.[91] Disc-shaped and rectangular mounts have been found at Nagylak (which reached the collection of the Hungarian National Museum through an antiquities dealer) and in the churchyards of the southern Balaton region (Balatonszabadi-Pusztatorony and Kötcse-Pócapuszta).[92]

One good analogy to the toy made from a perforated phalanx comes from the 14th–16th-century layers of the Szent György tér-Királyi istálló site in Buda Castle, another one from the Baj manor house.[93] They best resemble the so-called bone foals in the ethnographic material: children used pairs of ungulate phalanxes and "harnessed" them.[94]

As regards finished products, most represent the fittings of crossbows (13 pieces), a weapon that became widely used in Hungary during the 14th century, while no more than one to three pieces came to light of other implement types. The number of finished antler products, 14 in all, is eclipsed far by the antler fragments that can be interpreted as raw material or workshop waste. The lack of pieces or of waste indicating the production of bone beads, mainly used for stringing into rosaries,[95] is striking, since one would reasonably expect their production in an ecclesiastic centre.

In the light of the above, it seems likely that the small workshop was not designed for producing a large variety of articles or for mass-producing certain items, but rather for manufacturing certain types and for repairs, for example specialising in making replacements for easily damaged crossbow fittings.[96] A similar workshop can be cited from Viljandi in Estonia, where workshop waste was found not in the bone material of the medieval town, but in the 13th–16th-century layers of the castle overlooking the settlement, where the waste was five times as much compared to the finished products. The latter represented two major groups: crossbow fittings and articles for leisurely pastimes such as dice, chess pieces and flutes. The assemblage included an antler plaque

---

[87] *Bökönyi 1964* 369.
[88] *Bárány 2011–2013* 32, 37, fig. 5. 2.
[89] *Kováts 2008* 113.
[90] *G. Sándor 1963* 110–111, fig. 3. 3.
[91] *Gál 2005* 328–330, fig. 8; *Kovács 2005* 312–313, figs 2–4; *Kováts 2005* 296–299, figs 3 and 10; *Bartosiewicz 2010* 338.
[92] *G. Sándor 1959; Magyar 2010* 146–150, figs 1 and 5–7.
[93] *Csippán 2007* fig. 3; *Bartosiewicz 2010* 339.
[94] *Magyar Néprajz VI* 545, fig. 6.
[95] *Kováts 2008* 113–115, fig. 2.
[96] *Gál 2020b.*

with a row of perforations resembling the slender bone plate shown in *fig. 12. 6,* which on the strength of the ethnographic record was probably a bag fitting.[97]

Evidence for the activity of an itinerant bone-worker came to light in Guetrat Castle near Salzburg, occupied during the 12th–13th centuries. It would appear that the artisan only travelled to the castle periodically with the necessary raw material and made bone needles, handles, crossbow nuts and gaming counters for his customers.[98] The clientele of the 14th–15th-century crossbow workshop in Vilnius came from the ranks of the aristocracy.[99] Another remarkable assemblage from Vilnius containing over 1700 bone and antler artefacts came to light from the 13th–18th-century layers of the castle: the finds include several utilitarian and decorative objects (such as knife handles, needles, toys, crossbow fittings and carved bone plaques) which are also attested in Esztergom.[100]

Medieval elite sites

Even though the sediment was not sieved when collecting the 14th–15th-century animal bones at Visegrád Castle, and the full assessment of the bone assemblage has not been completed, the material from this site shares the most similarities with the Esztergom assemblage in terms of species frequencies *(fig. 16)*. Hen was the most frequent among domestic species, while brown hare among wild species; the number of fish and grey partridge remains was noteworthy and pigeon, thrush and brown bear, all delicacies during the period, were also represented. Cattle, small ruminants and pig, the three most frequent meat species, each accounted for 15–25% of the entire assemblage.[101]

Most of the archaeozoological assemblages from high-status sites were brought to light in Buda Castle. The number of poultry exceeds that of mammals and brown hare is the most frequent wild species. The number of domestic poultry rose dynamically in the 14th century compared to the 13th century and continued to retain its high proportions. The proportion of hunted species also rose, as did that of imported species such as oyster, the latter generally explained by the royal court's Italian connections.[102]

In contrast, sheep dominated the 14th–16th-century assemblage from the Dominican monastery in Buda.[103] A similarly high frequency of sheep has only been reported from the queenly centre in Segesd among the elite sites.[104] In contrast, small ruminants are less frequent in the material from the 14th–16th-century monastery of Visegrád, Rév utca-Beneda, dominated by cattle, similarly to the Baj, Öreg-Kovács-hegy manor house.[105]

Although a geographically distant parallel, it must nevertheless be mentioned that pig, the third meat species, was the most frequent in the 14th-century assemblage from the Franciscan monastery of Marosvásárhely. However, none of the species eclipsed the other ones. Domestic hen was amply represented and the presence of domestic pigeon and fish – both fitting neatly into a clerical milieu – is noteworthy.[106]

---

[97] *Haak et al. 2012* 310–330, figs 14–31.
[98] *Lang 2010.*
[99] *Rackevičius 1999.*
[100] *Luik et al. 2019.*
[101] *Bökönyi 1974* 426.
[102] *Bökönyi 1958* 457; *Bökönyi 1963* 396, 416, fig. 14. is based on the aggregate of the animal bone finds recovered during three successive excavation seasons.
[103] *Matolcsi 1981* 210.
[104] *Bartosiewicz 1996* 197, Table 1.
[105] *Bökönyi 1974* 428.
[106] *Gál 2012b* 698–699, Table 1.

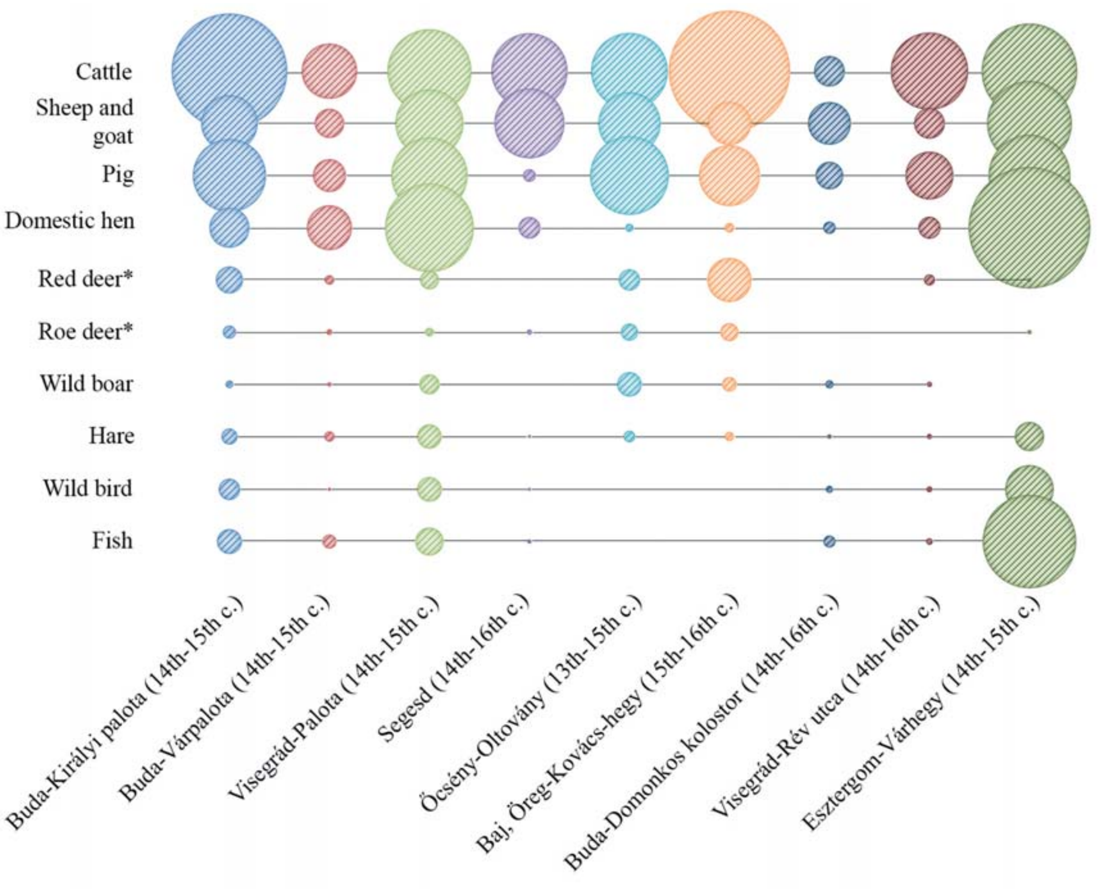

Fig. 16. Share of remains from the main meat-providing species in high status settlements from late medieval Hungary (* data regarding the bone and antler remains from cervids were not separated in early publications, therefore their proportions may show distortion)

The medieval elite sites excavated in England are characterised by the joint frequency of fish and birds, particularly on sites where sieving was employed to recover the animal bones. St. George's Priory in Canterbury yielded almost 5000 fish and 672 bird bones. Fowl are predominantly represented by medium- and small-sized birds, while thrush and lark were identified among songbirds, alongside even smaller species. These were probably caught with nets and traps; however, the partial skeleton of a common kestrel was also found in the monastery, and knowing that this species can be trained to hunt smaller birds,[107] it is possible that the monks or even the abbot engaged in hawking.[108]

Conclusion

In consequence of the sieving employed during the investigation of the Esztergom, Várhegy-Kőbánya site, a fauna assemblage rich in fish, bird and rodent bones was recovered, which is outstanding among the other contemporaneous assemblages and again proves the importance of sieving and flotation on excavations. The remains of gadwall, little bustard, common blackbird, redwing, song thrush and spotted nutcracker have been identified for the first time in a Hungarian medieval bone assemblage.

[107] *Duhay 2000* 20–21.
[108] *Serjeantson 2001.*

The composition of the 14th–15th-century kitchen waste from the archiepiscopal palace clearly reflects an elite cuisine: in addition to an abundance of fish, the primacy of fowl (reflecting a distinct preference for white meat), the slaughter of young animals and a preference for certain body regions (ribs, spinal columns, head, limb extremities and the variety of dishes that could be prepared from them (rib chops, pork feet stew, aspic, brawn and the like). It seems likely that in addition to pigeon and various small birds, bear paw was also served as a delicacy.

At the same time, there is no osteological evidence for the consumption of large-bodied game, although this does not exclude the possibility that filleted meat was occasionally brought to the palace kitchen. The skeletal elements of the wild mammals nevertheless suggest that the hides and shed antlers were utilised. In addition to these, the bones of domestic mammals also served as raw material for the manufacture and repair of household and hunting implements, decorative objects and toys. The amount of raw material and workshop waste, exceeding by far the number of finished products, as well as the finished products themselves, rather suggests a small workshop specialising in certain artefact types.

Before being consumed, domestic and wild fowl were exploited in many different ways: eggs, feathers and guano, and some individuals of wild species were no doubt tamed for amusement, and were kept as pets or trained for hunting.

These traits of the assemblage fit in nicely with our current image of animal exploitation and meat consumption of late medieval elite and monastic households, adding a host of new details to our knowledge. Excavations employing refined collection strategies and various analytical procedures as well as the publication of the finds will no doubt add new insights into the environment, lifeways and activities of ecclesiastic centres.

REFERENCES

Bárány 2011–2013 A. Bárány: Szubfosszilis barnamedve *(Ursus arctos L.)* leletek Magyarországról (Sub-fossil brown bear *(Ursus arctos L.)* finds from Hungary). FolArch 55 (2011–2013) 25–44.

Bartosiewicz 1995 L. Bartosiewicz: Animals in the urban landscape in the wake of the Middle Ages. British Archaeological Reports International Series 609. Oxford, 1995.

Bartosiewicz 1996 L. Bartosiewicz: Közép- és török kori állatmaradványok Segesdről (Medieval and Turkish Period animal bones from Segesd, Southwestern Hungary). SMK 12 (1996) 183–222.

Bartosiewicz 2001 L. Bartosiewicz: A leopard (*Panthera pardus L.* 1758) find from the late Middle Ages in Hungary, in: *Buitenhuis – Prummel 2001* 151–160.

Bartosiewicz 2006 L. Bartosiewicz: Régen volt háziállatok. Bevezetés a régészeti állattanba [Domestic animals in the past. An introduction to archaeozoology]. Budapest 2006.

Bartosiewicz 2010 L. Bartosiewicz: Állatmaradványok Baj-Öreg-Kovács-hegy késő középkori udvarházának ásatásából ásatásából [Animal remains from the excavation of the late medieval manor house in Baj-Öreg-Kovács-hegy], in: S. Petényi (ed.): A baji nemesi udvarház gazdasági tevékenységéről, különös tekintettel a tímárkodásra. Adatok a középkori magyar bőripar történetéhez. Tata 2010, 305–359.

Bartosiewicz 2015 L. Bartosiewicz: „Every skin teeth aint a laugh": Medieval leopard find from Hungary. Hungarian Archaeology E-Journal 2015 autumn (http://files.archaeolingua.hu/2015O/Bartosiewicz_H15O.pdf).

Bartosiewicz 2016 L. Bartosiewicz: Animal remains from the late medieval castellum of Őcsény-Oltovány, Southern Hungary, in: Gy. Kovács – Cs. Zatykó (eds): "per sylvam et per lacus nimios" The Medieval and Ottoman Period in Southern Transdanubia, Southwest Hungary: The Contribution of the Natural Sciences. Budapest 2016, 155–176.

Bartosiewicz 2018 L. Bartosiewicz: „Midőn, mint jó rárók, mezőn széllyel járók…". Társadalmi identitás és solymászat az újkor hajnalán ('Like valiant hawks they fly across the embattled sky…': social identity and falconry in Early Modern Age Hungary), in: E. Benkő – Gy. Kovács – K. Orosz (eds): Mesterségek és műhelyek a középkori és kora újkori Magyarországon. Tanulmányok Holl Imre emlékére. Crafts and Workshops in Hungary during the Middle Ages and the Early Modern Period. Budapest 2018, 113–124.

Bartosiewicz – Gál 2013 L. Bartosiewicz – E. Gál: Shuffling Nags, Lame Ducks: The Archaeology of Animal Disease. Oxford – Oakville 2013. https://doi.org/10.2307/j.ctvh1djdq

Bartosiewicz et al. 2010 L. Bartosiewicz – A. Gyetvai – H-C. Küchelmann: The Beast in the Feast, in: A. G. Pluskowski – G. K. Kunst – M. Kucera – B. Manfred – H. Irmgard (eds): Bestial mirrors: Using Animals to Construct Human Identities in Medieval Europe. Animals as Material Culture in the Middle Ages 3. Wien 2010, 85–99.

Bartosiewicz et al. 2018 L. Bartosiewicz – A. Zs. Biller – P. Csippán – L. Daróczi-Szabó – M. Daróczi-Szabó – E. Gál – I. Kováts – K. Lyublyanovics – É. Á. Nyerges: Animal exploitation in Medieval Hungary, in: J. Laszlovszky – B. Nagy – P. Szabó – A. Vadas (eds): The Economy of Medieval Hungary. Leiden – Boston 2018, 113–165.

Benda 2009 B. Benda: Lakoma a költészetben, avagy két vers táplálkozástörténeti elemzése [Feast in poetry, or nutritional analysis of two poems], in: T. Császtvay (ed.): Szolgálatomat ajánlom a 60 éves Jankovics Józsefnek. Budapest 2009, 48–62.

Biller 2014 A. Zs. Biller: Solt-Tételhegy feltárásának állatcsont leletei (The animal bones from the excavation at Solt-Tételhegy), in: Á. Somogyvári – J. Szenpéteri – Gy. V. Székely (eds): Településtörténeti kutatások. Solt-Tételhegy, Kiskunfélegyháza, Amler-bánya Archaeologia Cumanica 3. Kecskemét 2014, 205–224.

Bökönyi 1958 S. Bökönyi: A budai Várpalota ásatásának csontanyaga (Die Tierknochenfunde der Ausgrabungen im Burgpalast von Buda). BudRég 18 (1958) 455–486.

Bökönyi 1963 S. Bökönyi: A budai Várpalota ásatásának csontanyaga II (Die Tierknochenfunde der Ausgrabungen im Burgpalast von Buda II). BudRég 20 (1963) 395–425.

Bökönyi 1964 S. Bökönyi: A budai Várpalota ásatásának csontanyaga III (Die Tierknochenfunde der Ausgrabungen im Burgpalast von Buda III). BudRég 21 (1964) 369–373.

Bökönyi 1974 S. Bökönyi: History of Domestic Mammals in Central and Eastern Europe. Budapest 1974.

Bökönyi 1982 S. Bökönyi: Fowl, domestic, in: J. R. Strayer (ed.): Dictionary of the Middle Ages. New York 1982, 150–151.

Buitenhuis – Prummel 2001 H. Buitenhuis – W. Prummel (eds): Animals and Man in the Past: Essays in Honour of Dr. A. T. Clason, Emeritus Professor of Archaeozoology Rijksuniversiteit Groningen, the Netherlands. Archaeological Research and Consultancy Publication 41. Groningen 2001, 151–160.

Callou 1997 C. Callou: Diagnose différentielle des principaux éléments squelettiques du lapin (genre *Oryctolagus*) et du lièvre (genre *Lepus*) en Europe occidentale. Fiches d'Ostéologie Animale pour L'Archéologie, Série B: Mammifères 8. Valbonne 1997, 3–23.

Chaix – Méniel 2001 L. Chaix – P. Méniel: Archéozoologie. Les animaux et l'archéologie. Paris 2001.

Csippán 2004 P. Csippán: 13–14. századi állatcsontleletek a budai Szt. György tér délnyugati részéről (Tierknochenfunde des 13-14. Jahrhunderts aus dem Südwestlichen Teil des Szent György-Platzes in Buda). BudRég 38 (2004) 201–206.

Csippán 2007 P. Csippán: Az állatcsontok eltérő kulturális szokásokat jelző szerepe (Animal bones as markers of cultural diversity). BudRég 41 (2007) 299–316.

Csippán 2010 P. Csippán: Az állati nyersanyagokat feldolgozó műhelyek azonosítási lehetőségei (Identification markers of workshops producing goods made from animal-derived raw materials), in: *Gömöri – Kőrösi 2010* 31–37.

Csőre 2000 P. Csőre: Vadászat a feudális kori Magyarországon [Hunting in feudal Hungary]. História 2000/1 (2000) 28–33.

Daróczi-Szabó 2004 L. Daróczi-Szabó: Animal bones as indicators of kosher food refuse from 14th century AD Buda, Hungary, in: S. J. O'Day – W. van Neer – A. Ervynck (eds): Behaviour Behind Bones: The Zooarchaeology of Ritual, Religion, Status and Identity. Proceedings of the 9th ICAZ Conference. Oxford 2004, 252–261.

Daróczi-Szabó 2009 M. Daróczi-Szabó: Szendrő-Felsővár kora újkori állatcsontjainak vizsgálata (Early Modern Age animal remains from Szendrő-Felsővár, Hungary), in: L. Bartosiewicz – E. Gál – I. Kováts (eds): Csontvázak a szekrényből. Budapest 2009, 151–171.

Daróczi-Szabó 2013 M. Daróczi-Szabó: Az Árpád-kori Kána falu állatcsontjainak vizsgálata (The study of animal remains from Kána village, Period of the Árpád Dynasty). PhD Dissertation at the Eötvös Loránd University, Budapest. Budapest 2013.

Dembińska 1999 M. Dembińska: Food and Drink in Medieval Poland: Rediscovering a Cuisine of the Past. Philadelphia 1999.

von den Driesch 1976 A. von den Driesch: A Guide to the Measurements of Animal Bones from Archaeological Sites. Peabody Museum Bulletins 1. Cambridge, MA 1976.

Duhay 2000 G. Duhay: Ragadozómadár-tartás és a solymászat természetvédelmi vonatkozásai [The nature conservation aspects of predatory bird farming and falconry], in: Zs. Kalotás (ed.): Természetvédelmi ismeretek a madár- és denevérgyűrűzési, valamint a solymászvizsgához. Budapest 2000, 83–113.

G. Sándor 1959 M. G. Sándor: Középkori csontosövek a Magyar Nemzeti Múzeumból (Mittelalterliche Knöcherne Gürtel im Ungarischen Nationalmuseum). FolArch 11 (1959) 115–123.

G. Sándor 1963 M. G. Sándor: Középkori csontmegmunkáló műhely a budai várpalotában (Srednevekovaja masterskaja dlja obrabotki kostej v krepostnom dvorce Budy). BudRég 20 (1963) 107–124.

Gál – Kunst 2018 E. Gál – G. K. Kunst: Pathological observations on mammalian remains from the Roman sanctuary at Carnuntum-Mühläcker (Austria), in: L. Bartosiewicz – E. Gál (eds): Care or Neglect? Evidence of Animal Disease in Archaeology. Oxford – Philadelphia 2018, 45–60.

Gál 2002 E. Gál: Madárleletek a bajcsai várból [Bird remains from the fortification of Bajcsa], in: Gy. Kovács (ed.): Weitschawar – Bajcsa-vár. Zalaegerszeg 2002, 101–105.

Gál 2003 E. Gál: Adaptation of different bird species to human environments, in: J. Laszlovszky – P. Szabó (eds): People and Nature in Historical Perspective. Budapest 2003, 120–138.

Gál 2005 E. Gál: New data on bird bone artefacts from Hungary and Romania, in: *Luik et al. 2005* 325–338.

Gál 2008 E. Gál: A régészeti madártan szerepének, módszereinek és alkalmazásának rövid összefoglalása [Brief summary of the role, methods and practice of archaeo-ornithology], in: E. Jerem – Zs. Mester – F. Cseh (eds): Oktatónapok Százhalombattán. Budapest 2008, 41–53.

Gál 2012a E. Gál: Possible evidence for hawking from a 16th century Styrian Castle (Bajcsa, Hungary), in: D. C. M. Raemaekers – K. Esser – R. C. G. M. Lauwerier – J. T. Zeiler (eds): A Bouqet of Archaeozoological Studies: Essays in Honour of Wietske Prummel. Groningen Archaeological Studies 21. Groningen 2012, 170–177.

Gál 2012b E. Gál: Állatcsontleletek a középkori Székelyföldről (Animal bones from the Szekler land in the Middle Ages), in: E. Benkő (ed.): A középkori Székelyföld II. Budapest 2012, 663–750.

Gál 2015 E. Gál: "Fine feathers make fine birds": the exploitation of wild birds in medieval Hungary. Antaeus 33 (2015) 345–368.

Gál 2020a E. Gál: Remains of small domestic and game birds from medieval sites in Hungary. Quaternary International 543 (2020) 99–107. https://doi.org/10.1016/j.quaint.2020.03.039

Gál 2020b E. Gál: Late medieval bone and antler working at the residence of the archbishop of Esztergom (Northern Hungary). ArchLit 21 (2020) 79–96. https://doi.org/10.15388/ArchLit.2019.21.5

Gömöri – Kőrösi 2010 J. Gömöri – A. Kőrösi (eds): Csont és bőr. Az állati eredetű nyersanyagok kézműipari feldolgozásának története, régészete és néprajza (Bone and Leather. History, Archaeology and Ethnography of Crafts Utilizing Raw Materials from Animals). Budapest 2010.

Haak et al. 2012 A. Haak – E. Rannamäe – H. Luik – L. Maldre: Worked and unworked bone from the Viljandi castle of the Livonian Order (13th–16th centuries). Lietuvos archeologija 38 (2012) 295‒338.

Hume 2003 R. Hume: Madárvilág Európában [Birds of Europe]. Budapest, 2003.

Irving-Pease et al. 2018 E. K. Irving-Pease – L. A. F. Frantz – N. Sykes – C. Callou – G. Larson: Rabbits and the Specious Origins of Domestication. Trends in Ecology & Evolution 33/3 (2018) 149–152. https://doi.org/10.1016/j.tree.2017.12.009

Kordos 2006 L. Kordos: Évezredek bizonyítékai – A fácánok kalandos históriája [Testimonies of millennia – Adventurous history of pheasants]. Magyar Vadászlap (2006/3) 170–171.

Kovács 2005 E. Kovács: Remains of the bone working in medieval Buda, in: *Luik et al. 2005* 309–316.

Kovács 2014 Zs. E. Kovács: A kisemlősfauna holocén kori változásai Magyarországon – a házi patkány (Rattus rattus) megjelenése és terjedése [Changes of the small mammal fauna in Hungary during the Holocene – The dispersal history of black rat (Rattus rattus)]. PhD Dissertation at the University of Debrecen, Debrecen 2014.

Kováts 2005 I. Kováts: Finds of worked bone and antler from the Royal Palace of Visegrád, in: *Luik et al. 2005* 293–304.

Kováts 2008 I. Kováts: A középkori csontmegmunkálás [Medieval bone carvings], in: A. Kubinyi – J. Laszlovszky – P. Szabó (eds): Gazdaság és gazdálkodás a középkori Magyarországon: gazdaságtörténet, anyagi kultúra, régészet. Budapest 2008, 113–116.

Kyselý 2010 R. Kyselý: Review of the oldest evidence of domestic fowl Gallus gallus f. domestica from the Czech Republic in its European context. Acta Zoologica Cracoviensia – Series A 53 (2010) 9–34. https://doi.org/10.3409/azc.53a_1-2.09-34

Lakó 1983 E. Lakó: Bornemisza Anna szakácskönyve 1680-ból [Anna Bornemisza's cookbook from 1680]. Bukarest 1983.

Lang 2010 F. Lang: Bone working and production in the medieval castle of Guetrat (Salzburg), in: A. Legrand-Pineau – I. Sidéra – N. Buc – E. David – V. Scheinsohn (eds): Ancient and Modern Bone Artefacts from America to Russia. Cultural, technological and functional signature. BAR International Series 2136. Oxford 2010, 87–95.

Luik et al. 2005 H. Luik – A. M. Choyke – C. E. Batey – L. Lõugas (eds): From Hooves to Horns, from Mollusc to Mammoth. Manufacture and Use of Bone Artefacts from Prehistoric Times to the Present. Proceedings of the 4th Meeting of the ICAZ Worked Bone Research Group at Tallinn, 26th–31st of August 2003. Muinasaja teadus 15. Tallinn 2005.

Luik et al. 2019 H. Luik – G. Piličiauskienė – P. Blaževičius: Late Medieval and Early Modern bone and antler working in the Vilnius Castle complex. Cuadernos de Prehistoria y Arqueología de la Universidad de Granada 29. (2019) 187–201.

Lyublyanovics 2018 K. Lyublyanovics: New Home, New Herds: Cuman Integration and Animal Husbandry in Medieval Hungary from an Archaeozoological Perspective. Archaeolingua Central European Archaeological Heritage Series 10. Oxford 2018.

Magyar 2010 K. Magyar: A Dél-Balaton középkori templom körüli temetőiben feltárt állati eredetű csont- és bőrmellékletek rövid értékelése (A short study of leather and bone grave goods from some South Balaton medieval cemeteries), in: *Gömöri – Kőrösi 2010* 143–153.

Magyar Néprajz VI T. Dömötör – M. Hoppál – P. Niedermüller – Zs. Tátrai (eds): Magyar Néprajz VI. Népzene, néptánc, népi játék [Hungarian ethnography VI. Folk music, folk dance, folk play]. Budapest 1990.

Marton 2007 Sz. Marton: Középkori galambposta Magyarországon (Were there carrier pigeons in Medieval Hungary?). Acta Universitatis Szegediensis: Acta Historica 125 (2007) 93–105.

Marton 2014 Sz. Marton: Középkori galambposta (Szentföld, Európa, Magyarország) (Medieval carrier pigeons [Holy Land, Europe, Hungary]). JEL-KÉP 1 (2014/3). https://doi.org/10.20520/Jel-Kep.2014.3.2

Matolcsi 1977 J. Matolcsi: A budai királyi palota északi előudvarában feltárt XIV–XV. századi állatcsontok (Os d'animaux des XIVe et XVe siècles mis au jour dans l'avantcour nord du château royal de Buda). BudRég 24 (1977) 179–198.

Matolcsi 1981 J. Matolcsi: Mittelalterliche Tierknochen aus dem Dominikanerkloster von Buda, in: K. H. Gyürky – J. Matolcsi: Das mittelalterliche Dominikaner-kloster in Buda. Mittelalterliche Tierknochenfunde aus dem Dominikaner-kloster Buda. FontArchHung. Budapest 1981, 203–254.

Matolcsi 1982 J. Matolcsi: Tierknochenfunde von Sarvaly aus dem 15.–16. Jahrhundert, in: I. Holl – N. Parádi (eds): Das mittelalterliche Dorf Sarvaly. FontArchHung. Budapest 1982, 230–253.

Mulkeen – O'Connor 1997 S. Mulkeen – T. P. O'Connor: Raptors in towns: towards an ecological model. International Journal of Osteoarchaeology 7 (1997) 440–449. https://doi.org/10.1002/(SICI)1099-1212(199707/08)7:4<440::AID-OA375>3.0.CO;2-3

Petényi – Bartosiewicz 2010 S. Petényi – L. Bartosiewicz: Tímárkodással kapcsolatos adatok a Baj – Öregkovács-hegyi koraújkori nemesi udvarház területén (Data on tanning at the Early Modern Age manorial house at Baj – Öregkovács-hegy, Hungary), in: *Gömöri – Kőrösi 2010* 229–242.

Peterson et al. 1977 R. T. Peterson – G. Mountfort – P. A. D. Hollom: Európa madarai [Birds of Europe]. Budapest 1977.

Prummel 1987 W. Prummel: Atlas for identification of foetal skeletal elements of Cattle, Horse, Sheep and Pig. Part 2, in: Papers from the 5th International Archaeozoological Conference, Bordeaux, August 1986. ArchaeoZoologia 12 (1987) 11–42.

Prummel 1997 W. Prummel: Evidence of hawking (falconry) from bird and mammal bones. International Journal of Osteoarchaeology 7/4 (1997) 333–338. https://doi.org/10.1002/(SICI)1099-1212(199707/08)7:4<333::AID-OA374>3.0.CO;2-7

Rackevičius 1999 G. Rackevičius: Arbaletų dirbtuvės Vilniuje (XIV a. II pusė – XV a. I pusė) (Crossbow workshops in Vilnius). Lietuvos Arheologija 18 (1999) 175–183.

Rácz 2012 J. Rácz: Állatnevek enciklopédiája [Encyclopedia of Animal Names]. Budapest 2012.

Serjeantson 2001 D. Serjeantson: A dainty dish: consumption of small birds in Late Medieval England, in: *Buitenhuis – Prummel 2001* 263–274.

Somlyói Tóth 1985 T. Somlyói Tóth: A solymászat történetéből [From the history of falconry]. Nimród 1985/4 (1985) 11–13.

Szabó 1938 K. Szabó: Az alföldi magyar nép művelődéstörténeti emlékei (Kulturgesichtliche Denkmäler der Ungarischen Tiefebene). Budapest 1938.

Teichert 1975 M. Teichert: Osteologische Unterschungen zur Berechnung der Widerristhöhe bei Schafen, in: A. T. Clason (ed.): Archaeozoological Studies. Papers of the Archaeozoological Conference, Groningen 1974. Amsterdam – New York 1975, 51–69.

Uerpmann 1973 H.-P. Uerpmann: Animal Bone Finds and Economic Archaeology: A Critical Study of 'Osteo-Archaeological' Method. World Archaeology 4/3 (1973) 307–322.

Vörös 1989 I. Vörös: Esztergom-Szentgyörgy mező Árpád-kori település állatcsontmaradványai (Előzetes közlemény) (Tierknochenreste aus der árpádenzeitlichen Siedlung von Esztergom-Szentgyörgymező [Vorbericht]). Dunai Régészeti Közlemények 3 (1989) 51–56.

Woolgar 1999 C. M. Woolgar: The Great Household in Late Medieval England. New Haven – London 1999.

Zolnay 1977 L. Zolnay: Kincses Magyarország. Középkori művelődésünk történetéből [Treasures of Hungary. On the history of culture in Hungary in the Middle Ages]. Budapest 1977.

APPENDIX

Species	14th century		15th century		14th and 15th century	
	NISP	%	NISP	%	NISP	%
Cattle *(Bos taurus)*	775	15.82	443	18.50	1218	16.69
Sheep *(Ovis aries)*	43	0.89	15	0.63	58	13.15
Sheep and goat (Caprinae)	591	12.06	310	12.94	901	
Pig *(Sus domesticus)*	612	12.49	282	11.77	894	12.26
Dog *(Canis familiaris)*	3	0.06	5	0.21	8	0.11
Cat *(Felis catus)*	6	0.12	0	0	6	0.08
Domestic mammal total	**2030**	**41.44**	**1055**	**44.05**	**3085**	**42.29**
Domestic hen *(Gallus domesticus)*	1368	27.92	612	25.55	1980	27.14
Domestic pigeon *(Columba domestica)*	17	0.35	5	0.21	22	0.30
Domestic fowl total	**1385**	**28.27**	**617**	**25.76**	**2002**	**27.44**
Red deer *(Cervus elaphus)*	0	0	2	0.08	2	0.03
Roe deer *(Capreolus capreolus)*	2	0.04	0	0	2	0.03
Brown bear *(Ursus arctos)*	0	0	1	0.04	1	0.01
Hare *(Lepus europaeus)*	70	1.43	41	1.71	111	1.52
Wild mammal total	**72**	**1.47**	**44**	**1.83**	**116**	**1.59**
Glossy ibis *(Plegadis falcinellus)*	0	0	1	0.04	1	0.01
Eurasian teal *(Anas crecca)*	0	0	1	0.04	1	0.01
Gadwall *(A. strepera)*	0	0	2	0.08	2	0.03
Garganey *(A. querquedula)*	0	0	1	0.04	1	0.01
Tufted duck *(Aythya fuligula)*	1	0.02	0	0	1	0.01
Goshowk *(Accipiter gentilis)*	0	0	1	0.04	1	0.01
Sparrow hawk *(A. nisus)*	0	0	1	0.04	1	0.01
Partridge *(Perdix perdix)*	170	3.47	69	2.87	239	3.28
Quail *(Coturnix coturnix)*	1	0.02	3	0.13	4	0.05
Pheasant *(Phasianus colchicus)*	6	0.12	3	0.13	9	0.15
Little bustard *(Tetrax tetrax)*	1	0.02	0	0	1	0.01
Fieldfare *(Turdus pilaris)*	6	0.12	3	0.13	9	0.12
Blackbird *(T. merula)*	3	0.06	0	0	3	0.04
Redwing *(T. iliacus)*	2	0.04	0	0	2	0.03
Song thrush *(T. philomelos)*	4	0.08	4	0.17	8	0.11
Mistle thrush *(T. viscivorus)*	8	0.17	2	0.08	10	0.14
Starling *(Sturnus vulgaris)*	1	0.02	0	0	1	0.01
Jay *(Garrulus glandarius)*	1	0.02	0	0	1	0.01
Spotted nutcracker *(Nucifraga caryocatactes)*	1	0.02	0	0	1	0.01
Rook *(Corvus frugilegus)*	0	0	3	0.13	3	0.04
Perching bird (Passeriformes sp. indet.)	7	0.15	4	0.17	11	0.16
Wild fowl total	**212**	**4.33**	**98**	**4.09**	**310**	**4.25**
Domestic goose/Greyleg goose *(Anser domesticus/A. anser)*	67	1.38	33	1.38	100	1.38
Domestic duck/Mallard *(Anas domestica/A. platyrrhynchos)*	10	0.20	7	0.29	17	0.23
Galliform (Galliformes sp. indet.)	29	0.60	17	0.71	46	0.63

Species	14th century		15th century		14th and 15th century	
	NISP	%	NISP	%	NISP	%
Rodent (cf. *Mus musculus/Rattus rattus)*	60	1.21	24	1.00	84	1.15
Red deer antler	70	1.41	32	1.34	102	1.40
Roe deer antler	1	0.02	1	0.04	2	0.03
Large ruminant	14	0.28	2	0.08	16	0.22
Small ruminant	81	1.67	18	0.76	99	1.36
Small mammal	5	0.10	5	0.21	10	0.14
Mammal	10	0.20	2	0.08	12	0.16
Bird	85	1.74	40	1.68	125	1.72
Fish*	**768**	**15.68**	**400**	**16.70**	**1168**	**16.01**
Total identifiable	**4899**	**100.00**	**2395**	**100.00**	**7294**	**100.00**

*The fish remains will be discussed by László Bartosiewicz in a separate study within this volume.

Table 1. Mammalian and bird species identified in the settlement and their distribution within the bone assemblage (NISP: number of identified specimens)

Bone type	Cattle	Sheep and goat	Pig	Hare	Domestic hen	Partridge
cornus		1				
neurocranium	10	5	26		6	
viscerocranium	5	4	24		7	
mandibula	16	12	28	12	9	
linguale	1	4				
dentes	15	13	31	7		
atlas			7			
axis		2	1			
Head	**47**	**41**	**117**	**19**	**22**	**0**
vert. cervicalis	33	16	14	3	69	2
vert. thoracalis	21	78	40	4	1	
vert. lumbaris	61	41	22	2	6	
os sacrum	1	3	1		3	
clavicula					53	17
coracoid					158	27
sternum	7				90	6
costa	716	299	448	22	140	3
Trunk	**839**	**437**	**525**	**31**	**520**	**55**
scapula	58	59	16	5	130	36
humerus	14	55	16	6	143	25
radius	23	57	11	4	188	24
ulna	33	29	14	11	143	23
pelvis	31	23	22	6	92	4
femur	17	28	17	7	105	15
patella		1	2			
tibia	21	75	12	10	190	26
fibula			18		27	

Bone type	Cattle	Sheep and goat	Pig	Hare	Domestic hen	Partridge
Meaty limb	**197**	**327**	**128**	**49**	**1018**	**153**
carpalia	10	2	7			
metacarpalia	11	19	23	1	41	10
calcaneus	6	8	8			
astragalus	3	11	4	1		
centrotarsale		4				
metatarsalia	13	10	26	6	138	14
Dry limb	**43**	**54**	**68**	**8**	**179**	**24**
vert. caudalis	4	4	4	1		
ph. proximalis	8	17	16	2	125	4
ph. media	12	19	19		115	3
ph. distalis	12	5	13		1	
Terminal bones	**36**	**45**	**52**	**3**	**241**	**9**
Long bone	45	54	3	1		
Flat bone	11	1	1			
Total	**1218**	**959**	**894**	**111**	**1980**	**239**

Table 2. The distribution of skeletal parts in the main species

Skeletal element	Cattle	Sheep and goat	Pig	Hare
atlas			7	
axis		2	1	
vert. cervicalis	33	16	14	3
vert. thoracalis	21	78	40	4
vert. lumbalis	61	41	22	2
os sacrum	1	3	1	
vert. caudalis	4	4	4	1
sternum	7			
scapula	58	59	16	5
humerus	14	55	16	6
pelvis	31	23	22	6
femur	17	28	17	7
A (High-value meat)	**247**	**309**	**160**	**34**
frontale	8	3	1	
neurocranium	2	2	25	
mandibula	16	12	28	12
linguale	1	4		
costa	716	299	448	22
radius	23	57	11	4
ulna	33	29	14	11
patella		1	2	
tibia	21	75	12	10
fibula			18	
B (Medium-value meat)	**820**	**482**	**559**	**59**
cornus		1		

Skeletal element	Cattle	Sheep and goat	Pig	Hare
viscerocranium	3	1	19	
maxilla	2	3	5	
dentes	15	13	31	7
carpalia	10	2	7	
metacarpalia	11	19	23	1
ph. proximalis	8	17	16	2
ph. media	12	19	19	
ph. distalis	12	5	13	
calcaneus	6	8	8	
astragalus	3	11	4	1
centrotarsale		4		
metatarsalia	13	10	26	6
C (Low-value meat)	**95**	**113**	**171**	**17**
Long bone fragment	45	54	3	1
Flat bone fragment	11	1	1	
Total (A+B+C)	**1218**	**959**	**894**	**111**

Table 3. The distribution of skeletal parts according to the meat value categories *(Uerpmann 1973)* introduced by Hans-Peter Uerpmann

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
***Bos taurus* Linnaeus, 1758**											
scapula	sin				52.2	46.6	37.1			I	4/A
radius	sin				69.4	35.6				II	3
radius	sin				69.5	37.5				I	19
metacarpus	dex				57.7	35.3	32.6			II	3
metacarpus	sin							61.0	29.5	II	4
phalanx 1 anterior			51.9		25.2		23.0	23.6		I	23
phalanx 1 anterior			53.0		25.4		20.7	22.3		I	4/A
phalanx 1 anterior			56.9		27.3		22.4	26.1		II	3
phalanx 1 anterior			61.2		22.7		18.7	21.1		II	4
calcaneus	sin		123.4		39.0					I	19
calcaneus	dex		125.3		41.4					II	3
metatarsus	dex							61.6	31.1	II	3
phalanx 1			47.0		25.3		21.7	23.1		II	3
phalanx 1 posterior			51.6		22.7		19.4	20.5		II	19
phalanx 1 posterior					30.0		26.0	29.7		II	3/A
phalanx 2			32.1		23.8		18.9	20.0		I	6
phalanx 2			33.6		26.1		19.3	22.1		I	5
phalanx 2			34.2		25.3		19.9	22.9		II	3
phalanx 2			34.5		25.9		19.6	20.9		I	3
phalanx 2			36.8		27.3		20.7	21.9		II	4
phalanx 2			37.5		29.2		20.8	21.9		II	3
phalanx 2			37.6		29.0		22.2	23.3		I	5
phalanx 2			40.3		31.0		22.4	25.1		II	3/A

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
phalanx 3			53.9		42.9		18.7			I	22
phalanx 3			57.7		44.0		19.6			I	20
phalanx 3			61.7		41.6		19.4			I	23
phalanx 3			70.0		54.8		23.6			II	3
***Ovis aries* Linnaeus, 1758**											
scapula	sin				29.9	18.3				I	22
scapula	dex				31.2	18.7	19.8			I	23
scapula	sin				31.7	19.2	17.0			I	22
radius	dex				30.2	15.4	15.1			I	20
radius	sin				31.9	16.2	16.9			I	23
radius	dex				34.6	17.2				I	4/A
pelvis	dex	female			26.4					I	4/A
pelvis	dex				30.4					I	4/A
tibia	dex						14.5	26.1	21.1	I	23
tibia	dex						15.0	26.4	21.5	I	22
tibia	sin						15.3	25.1	20.4	I	19
astragalus	sin		27.8		15.8	15.5		17.5		II	4
astragalus	dex		31.4		17.5	18.3		20.0		I	6
calcaneus	dex		52.6		17.6					II	3
calcaneus	dex		57.0				19.7			I	22
calcaneus	sin		58.9		18.9					II	3
calcaneus	dex		60.7				20.6			II	4
metatarsus	dex	female; WH=53.71 cm	119.1		19.7	19.4	11.2	23.1	15.2	II	4
Caprinae Gray, 1821											
radius	dex				27.5	16.4				II	3
pelvis	dex				26.4					I	20
centrotarsale	dex		21.2							I	23
centrotarsale	dex		24.7							II	4
centrotarsale	dex		25.1							I	4/A
astragalus	sin		28.1		15.0	15.6		17.6		II	4
astragalus	dex		30.0		17.5	17.2		19.3		II	3
phalanx 1			34.2		11.7		9.6	10.8		I	23
phalanx 1			35.1		12.2		9.5	10.5		I	23
phalanx 1			36.7		11.2		9.0	10.1		I	22
phalanx 2			21.5		11.4		8.2	9.7		I	23
phalanx 2			25.5		10.9		7.5	8.3		II	3
***Sus domesticus* Erxleben, 1777**											
dens (UM3)	sin		32.5		14.1					I	22
dens (LM3)	dex	male	40.3		16.8					II	4
humerus	dex							39.4		I	20
radius	dex				26.6	17.9				I	4/A
radius	dex				27.0		17.0			II	4
metacarpus IV	sin		77.6		15.0	14.7	11.2	14.7	15.5	I	19
metacarpus IV	dex				15.6	15.3				I	17

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
pelvis	dex				30.0					II	19
tibia	sin							31.4	24.9	II	3
astragalus	sin		41.3							II	3/A
phalanx 1			33.6		16.5		13.0	15.3		I	4/A
phalanx 1		worked bone	34.3		14.5	14.8	12.9	14.1		I	3
phalanx 1			34.3		15.5		12.5	14.6		II	3
phalanx 1			36.4		17.2		13.4	16.4		II	3
phalanx 1			37.1		15.4		12.2	14.2		I	3
phalanx 2			20.4		13.9		10.9	12.4		I	6
phalanx 2			22.7		16.3		13.3	14.8		I	23
phalanx 3			31.5		28.9		12.5			I	23
***Canis familiaris* Linnaeus, 1758**											
atlas			41.9		82.7	20.5				II	3
patella	sin		21.4		11.3					II	3
astragalus	dex		16.6							II	3/A
phalanx 1	sin		23.0		9.6	9.8	6.5	6.9		I	23
***Felis catus* Linnaeus, 1758**											
atlas			23.5		53.1	8.2				II	4
canine			23.3							I	5
***Gallus domesticus* Linnaeus, 1758**											
coracoideum	sin		46.6		44.3		4.7	12.3	10.4	I	23
coracoideum	dex		49.4				4.4	12.7	10.3	I	4/A
coracoideum	sin		43.7	42.7			3.9	11.9		II	6
coracoideum	dex		45.4		43.4		4.1			I	23
coracoideum	dex		45.9		44.0		4.6	11.5		I	3
coracoideum	dex		46.8	44.6			4.4			I	5
coracoideum	sin		47.6	45.7			3.7			I	5
coracoideum	sin		48.0	45.6			4.2		10.3	II	4
coracoideum	dex		48.3				4.6	13.6	11.1	II	3
coracoideum	sin		48.6	46.7			4.3			II	3/A
coracoideum	dex		48.7	47.0			4.2	13.0	10.0	II	3/A
coracoideum	dex		48.8	46.9			5.2			I	5
coracoideum	sin		49.0	46.7			4.2			I	6
coracoideum	sin		49.2				4.9	12.6		II	4
coracoideum	dex		49.5	47.0			4.4			I	3
coracoideum	dex		49.8	47.2				13.4	10.3	II	3
coracoideum	dex		49.9	46.4			5.1			I	5
coracoideum	sin		50.3	48.3			4.6			I	3
coracoideum	dex		51.2				4.8			I	6
coracoideum	dex		51.3		49.3		4.5	13.8		I	18
coracoideum	sin		53.4	50.8			5.1			II	3/A
coracoideum	dex		53.6	50.7			4.7			I	5
coracoideum	sin		55.7	53.6			5.3	14.8	11.3	II	4
coracoideum	dex			47.6			4.1			II	4
coracoideum	dex			45.6			4.1			I	23

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
coracoideum	dex						4.8	12.7	10.6	II	3
coracoideum	sin						4.8	14.3	11.8	II	19
coracoideum	dex			51.2			4.8			I	5
coracoideum	dex			52.4			5.1			II	4
coracoideum	sin							15.9			17
scapula	sin		55.2		8.9			3.3		II	4
scapula	sin		58.9		10.4			4.4			17
scapula	sin		61.0		10.4			4.4		I	20
scapula	dex		61.7		11.1			4.6		I	23
scapula	sin		64.4		10.6			4.5		I	3
scapula	sin		66.3		11.5			4.5		II	4
scapula	sin		69.9		12.4			5.5		I	3
scapula	dex		70.7		12.1			5.2		I	5
scapula	dex		72.3		12.3			5.3		I	5
scapula	dex		75.6		13.4			5.7		I	6
scapula	sin				10.4			4.0		II	19
scapula	sin				10.4			4.8		I	6
scapula	sin				10.5			4.2		I	22
scapula	sin				10.5			4.5		II	3
scapula	dex				10.6			3.9		II	3/A
scapula	dex				10.6			4.2		II	19
scapula	dex				10.6			4.2		II	3
scapula	sin				10.7			4.3		II	4
scapula	dex				10.9					I	6
scapula	sin				11.0			4.1		II	4
scapula	sin				11.1			4.5		I	5
scapula	dex				11.2			4.5		I	3
scapula	dex				11.2			4.6		II	4
scapula	sin				11.3			4.3		I	23
scapula	sin				11.3			4.6		II	4
scapula	sin				11.4			4.7		II	3
scapula	dex				11.4			4.9		I	3
scapula	sin				11.5			4.7		I	18
scapula	sin				11.7			5.0		I	6
scapula	dex				11.8			5.0		II	3
scapula	dex				11.9			5.1		I	18
scapula	dex				11.9			5.3		I	18
scapula	sin				11.9			5.4		I	5
scapula	dex				12.1			5.0		I	3
scapula	sin				12.2			5.2		II	3
scapula	dex				12.3			5.2		II	3
scapula	dex				12.3			5.3		I	3
scapula	sin				12.4			4.9		II	4
scapula	dex				12.4			5.1		I	3
scapula	dex				12.6			5.4			17
scapula	dex				12.6			5.5		I	5

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
scapula	dex				12.7			5.0		I	6
scapula	sin				12.7			5.3		I	23
scapula	sin				12.8			4.6		I	5
scapula					12.8			6.0		I	6
scapula	sin				12.9			4.8		II	4
scapula	sin				13.0			5.5		II	4
scapula	sin				13.3			5.4		I	3
scapula	dex				13.8			5.3		I	5
scapula	sin				14.2			4.9			23
humerus	dex		59.4		17.2		6.1	13.6		II	3/A
humerus	dex		61.7		17.6		6.7	13.4		II	4
humerus	dex		62.4		18.4		6.2	14.0	7.7	I	20
humerus	sin		62.5		18.1		6.3	13.9		I	18
humerus	dex		63.5		17.6		6.3	13.5		I	3
humerus	dex		63.7		17.3		6.2	13.4			17
humerus	dex		67.0		18.4		6.7	13.6		II	3A
humerus	sin		68.2		19.5		7.3	14.6		II	3
humerus	sin		73.7		20.2		7.0	15.7		I	5
humerus	dex		76.8		23.0		8.2	17.2		II	3
humerus	dex				17.7		6.6			I	5
humerus	dex				17.7					I	3
humerus	sin				17.8					I	20
humerus	sin				17.9					I	3
humerus	dex				18.0						17
humerus	dex				18.3		6.5			I	4
humerus	dex				18.5		6.7			I	5
humerus	dex				19.1		7.7			II	19
humerus	dex				20.6					I	18
humerus	sin				20.6					II	3
humerus	sin				21.4		7.3			I	19
humerus	dex				21.8					II	3
humerus	sin						6.0	13.2		II	3A
humerus	sin						6.1	13.3		I	3
humerus	sin						6.1	13.8		I	5
humerus	dex						6.2	13.5	7.2	I	6
humerus	sin						6.4	15.0	7.4	I	5
humerus	sin						6.8	14.1		I	3
humerus	sin						6.9	14.2		II	4
humerus	sin						6.9	15.4	8.5	II	3
humerus	dex						7.3	15.6	9.0	I	3
humerus	dex							13.2		I	20
humerus	dex							13.4	7.4	II	3
humerus	dex							13.6	7.2	I	4/A
humerus	sin							13.6	7.2	I	17
humerus	sin							16.3	8.8	I	4/A
humerus	sin							16.4	9.1	I	4/A

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
radius	sin		51.8		4.5		2.7	6.0		I	3
radius	sin		52.5		4.6		2.4	5.9		I	6
radius	sin		53.0		4.8	5.1	3.0	6.3		I	4/A
radius	sin		54.1				2.2	5.6		II	3/A
radius	sin		54.5		4.6	5.4	2.5	5.6		I	4/A
radius	dex		54.5		4.7		2.6	6.0		II	4
radius	dex		54.7		4.6		2.8	6.0		II	3/A
radius	dex		54.7				2.6	6.5		II	3
radius	dex		55.0		4.3		2.8	5.7		I	5
radius	sin		55.3		4.6		2.5	6.0		II	4
radius	dex		55.3		4.6		2.6	6.1		I	3
radius	dex		55.3		4.8		2.7	6.3		I	4
radius	sin		55.5		4.8		2.6	5.8		I	3
radius	sin		55.7		4.5		2.9	5.9		II	3
radius	sin		56.0		5.0		2.6	5.9		II	4
radius	sin		56.3		4.4		2.7	6.0		I	6
radius	sin		56.3				2.7	6.0		I	3
radius	dex		56.4				2.8	6.3		I	4
radius	dex		56.7				2.7	5.9		I	20
radius	sin		56.9		4.5		2.7	5.9		II	4
radius	dex		56.9		4.5		2.8	6.1		II	4
radius	dex		57.0		4.6		2.8	5.8		II	3
radius	sin		57.0		4.8		2.4	6.3		II	4
radius	sin		57.0				2.6	6.0		I	17
radius	sin		57.6		4.6	5.0	3.1	6.2		I	23
radius	dex		59.5		4.5		2.7	6.3		I	3
radius	dex		60.0		4.9		3.0	6.6		I	6
radius	sin		60.3				2.7	6.5		II	3
radius	sin		60.8		5.0		2.6	6.5		I	22
radius	dex		61.3		5.0		3.2	6.3		I	5
radius	sin		61.7		5.3		3.0	6.6		I	5
radius	sin		61.9				2.8	6.3		II	3
radius	dex		62.2		5.4		2.7	6.7		II	3/A
radius	sin		62.4		4.9	5.2	2.8	6.8		I	4/A
radius	dex		62.6				3.1	6.9		II	3/A
radius	sin		63.7		5.4		2.7	6.8		I	3
radius	dex		64.5		5.1		3.4	7.3		II	4
radius	dex		65.4		5.4		3.4	6.9		I	5
radius	dex		65.6		5.5		3.0	7.5		II	3
radius	sin		66.2		5.2		2.7	6.7		II	3
radius	dex		67.3				3.2	7.6		I	4
radius	sin		67.5		5.8		3.3	7.4		II	4
radius	sin		70.2				2.7	6.2		I	3
radius	dex				4.7		2.6			II	4
radius	sin				5.3		3.3			I	5
radius					5.4		3.3			I	4

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
radius	dex						2.0	5.9		I	6
radius	dex						2.5	5.4	3.0	II	3
radius	dex						2.7	5.9		I	4
radius	dex						2.7	5.9		I	20
radius	dex						2.7	6.2		I	17
radius	dex						2.7	6.8	3.7	I	3
radius	dex						2.8	5.7		II	3
radius	sin						2.8	5.7		I	5
radius	sin						2.8	5.9		II	4
radius	sin						2.9	6.1		I	23
radius	sin						2.9	6.3	3.4	II	3
radius	sin						2.9	6.5	4.1	II	3/A
radius	dex						3.0	6.3		II	3
radius	sin						3.0	7.0		II	3
radius	sin						3.1	6.6		I	6
radius	sin						3.1	6.7	4.0	II	3/A
radius	dex						3.1	7.0		I	5
radius	sin						3.1	7.1	3.8	II	4
radius	sin						3.1	7.2		I	5
radius	dex						3.1	10.0		I	18
radius	dex						3.2	6.2		I	6
radius	sin						3.2	6.3		I	5
radius	sin						3.3	6.2	3.6	I	6
radius	sin						3.3	6.4		I	6
radius	sin						3.4	6.9		I	5
radius	sin							6.6	3.8	I	6
radius	dex							7.1		II	3
ulna	sin		59.1		8.8	11.9	3.8	8.6		II	3/A
ulna	dex		59.3		8.0	11.0	3.5	8.6		I	18
ulna	sin		59.9		8.1	11.4	4.0	8.4		II	3/A
ulna	dex		60.0		8.4		4.0	8.7		I	6
ulna	dex		60.3		8.1	11.7	3.4	8.6		II	4
ulna	dex		61.4		8.5	11.7	3.8	8.7		I	4/A
ulna	sin		61.5				3.7	8.4		I	3
ulna	dex		62.3		8.0		3.6	8.6		II	6
ulna	sin		62.3		8.9	12.3	3.6	8.7		I	5
ulna	dex		62.4		8.0	11.3	4.0	8.8		I	3
ulna	dex		64.6		9.0	12.3	3.9	8.8	6.6	II	4
ulna	sin		65.4		9.0	12.3	3.9	9.0		I	22
ulna	sin		70.1		14.0		5.4	9.9		I	3
ulna	sin		70.4		9.3	13.7	4.4	10.0		I	17
ulna	sin		70.8		10.0	13.7	4.2	9.8		I	23
ulna	dex				7.8	11.6	3.9			II	4
ulna	dex				8.3	11.6	3.6			II	3/A
ulna	dex				8.3	11.7	3.5			II	3/A
ulna	sin				8.3		3.6			I	3

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
ulna	dex				9.3	14.1	4.6			I	4/A
ulna	dex				9.4	13.4	4.2			II	3
ulna	sin				9.4	13.9				I	3
ulna	dex						3.3	8.3		I	3
ulna	sin						3.4	8.6		I	3
ulna	sin						3.5	8.4			17
ulna	sin						3.6	8.6		I	4/A
ulna	sin						3.7	8.5		I	6
ulna	sin						3.7	8.6	6.5	II	3
ulna	sin						3.8	8.7		I	22
ulna	sin						3.8	8.8		I	3
ulna	dex						3.8	8.9		II	3
ulna	sin						3.8	8.9			17
ulna	dex						3.8	9.2		I	6
ulna	sin						3.9	8.7		I	5
ulna	dex						3.9	9.0		I	22
ulna	sin						4.0	8.7		I	5
ulna	sin						4.1	10.0		I	18
ulna	dex						4.2	9.9	6.2	I	4
ulna	sin						4.3	10.5	7.8	I	5
ulna	sin						4.4	10.6	7.3	II	4
ulna	dex						4.6	10.2	7.6	II	3
ulna	sin						4.6	10.3		I	6
ulna	dex						4.7	10.4			17
ulna	sin						5.2	8.8		I	4
ulna	sin						5.3	9.9	7.4	I	5
ulna	sin							8.5	6.8	I	20
ulna	sin							8.5	6.2	I	3
ulna	dex							8.6		I	18
ulna	sin							8.9	6.7	II	4
ulna	dex							9.0			17
ulna	dex							9.1	6.4	I	3
ulna	sin							10.0		I	18
ulna	dex							10.6	8.2	II	19
carpometacarpus	sin		31.4		10.8			7.7		II	4
carpometacarpus	dex		32.1		10.3			7.4		I	4/A
carpometacarpus	dex		32.3		9.7			7.0		I	3
carpometacarpus	dex		32.5	30.4	10.4			6.0		II	3
carpometacarpus	sin		33.0	30.9	10.8			6.2		II	3
carpometacarpus	sin		33.1		10.6			6.7		II	3
carpometacarpus	sin		33.1		10.8		3.5	7.2		I	4/A
carpometacarpus	dex		33.2		10.5			7.0		I	5
carpometacarpus	dex		33.2		10.9			6.7		I	23
carpometacarpus	sin		33.4		10.5			7.0		II	4
carpometacarpus	dex		33.4		10.5			7.6		I	5
carpometacarpus	sin		33.4					6.7		II	3/A

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
carpometacarpus	dex		34.1		11.4			7.4		II	3/A
carpometacarpus	dex		34.2		11.3			7.3		I	23
carpometacarpus	dex		34.4	32.0				11.1	6.5	II	3
carpometacarpus	dex		34.7					6.9		II	4
carpometacarpus	sin		35.1		11.4			7.2		II	3
carpometacarpus	dex		35.3		10.9			7.7		I	4/A
carpometacarpus	sin		35.3	32.6	11.0			6.4		II	19
carpometacarpus	dex		35.5	33.3	10.9			6.3		II	3
carpometacarpus	sin		35.6	32.8	10.9			7.0		II	4
carpometacarpus	sin		36.7	33.9	12.2			6.7		II	4
carpometacarpus	dex		39.4		12.4			7.8		I	4
carpometacarpus	sin		40.5		12.2			7.8		I	22
carpometacarpus	sin				10.2					II	3/A
carpometacarpus	dex				10.9					I	4
carpometacarpus	dex				11.1			8.5		I	4
carpometacarpus	sin				12.4					II	3
carpometacarpus	sin				13.5					I	4
carpometacarpus	sin							7.5		I	4/A
phalanx 1 digiti 2			14.4							I	6
femur	dex		66.7	62.9	13.9	9.4	5.8	12.8	10.8	I	4
femur	sin		66.8	62.1	14.9		6.1	12.9	10.8	II	3
femur	sin		67.1		13.2		5.9	13.0		II	3
femur	dex		68.0		62.6	9.9	6.1	13.6		II	4
femur	dex		68.8	63.7	14.4	10.6	6.3	13.6	10.9	II	3
femur	sin		70.0	65.0	14.0	9.2	6.0	13.7	11.4	II	4
femur	sin		70.9	65.8	14.1	10.1	6.0	14.0	11.7	II	3/A
femur	sin		71.7	67.0	14.5	10.0	5.9	14.3	11.4	I	3
femur	dex		73.5	68.1	15.3	11.1	6.5	14.2	11.7	I	6
femur	dex		74.4	68.6	15.2	10.7	6.6	14.0	11.8	I	23
femur	dex		79.0	73.0	17.0	12.0	6.7	16.2	12.9	II	4
femur	sin		81.9	76.1	16.7	11.5	7.3	15.7		I	6
femur	sin		83.1	77.1	16.7		7.6	16.4	13.4	I	4/A
femur	dex				13.8					I	18
femur	dex				13.9	10.1	5.9			I	3
femur	sin	female			14.1	9.3	6.5			I	3
femur	dex				14.3	8.4				I	20
femur	sin				16.2		7.2			I	23
femur	dex				16.5					I	3
femur	dex				16.6	10.7				I	23
femur	sin				16.6	10.9				II	4
femur	sin				16.8	10.2				I	6
femur	dex				18.0	11.9				I	3
femur	sin	female					5.6	13.1	10.6	II	3
femur	dex						6.0	13.5	11.2	II	4
femur	sin	female					6.0	14.0	11.0	I	17
femur	sin	female					6.1	13.4	10.5	I	5

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
femur	sin	female					6.2	14.4	11.9	II	4
femur	dex	female					6.4	13.4	11.0	II	3
femur	dex						6.5	14.2	10.9	II	3
femur	sin						7.1	15.7	12.5	II	4
femur	sin						8.2	19.6		II	3
femur	sin							13.0	10.1	I	4/A
femur	dex							13.4	10.9	I	22
femur	sin							13.6	11.0	I	5
femur	sin							14.1	10.2	I	3
femur	sin							15.4	12.2	II	3/A
femur	dex							17.1	11.8	II	4
tibiotarsus	sin		89.8		17.2		5.4	9.9	9.4	II	3/A
tibiotarsus	dex		93.2		17.4		5.2	9.2		II	4
tibiotarsus	dex		94.2		18.1		5.6	9.7		I	23
tibiotarsus	sin		95.1		18.3		5.3	10.2	10.7	II	3A
tibiotarsus	dex		115.1		21.8		7.2	12.3	12.7	I	17
tibiotarsus	sin				17.1		5.2			II	3
tibiotarsus	dex				17.2					I	3
tibiotarsus	sin				17.5					I	18
tibiotarsus	sin				17.7					I	5
tibiotarsus	sin				18.0					II	3
tibiotarsus	dex				18.4		5.0			II	4
tibiotarsus	dex				18.7	5.9				I	3
tibiotarsus	sin				18.7		5.3			II	3
tibiotarsus	dex				18.9		5.6			I	18
tibiotarsus	sin				21.2		7.1			II	4
tibiotarsus	dex				21.6		6.5			II	3
tibiotarsus	dex				22.4		6.9			II	3
tibiotarsus	sin				22.5					II	3
tibiotarsus	sin				22.8		7.6			I	22
tibiotarsus	dex				22.9		7.8			I	3
tibiotarsus	sin				24.2						17
tibiotarsus	dex						5	9.3	9.1	II	3
tibiotarsus	dex						5.0	9.9		I	3
tibiotarsus	sin						5.0	10.0	10.1	II	4
tibiotarsus	sin						5.0	10.3	10.0	I	3
tibiotarsus	dex						5.1	10.6	10.3	II	3
tibiotarsus	dex	female					5.2	10.0	10.3	II	4
tibiotarsus	sin						5.4	10.5	11.0	II	4
tibiotarsus	dex						5.4	10.9	11.3	I	3
tibiotarsus	dex						5.6	10.4	9.9	II	3
tibiotarsus	dex	female					5.7	10.7	10.9	II	3/A
tibiotarsus	sin						5.8	10.8	11.1	II	3A
tibiotarsus	sin						5.9	10.8	11.1	I	3
tibiotarsus	dex						5.9	11.0	12.0	II	19
tibiotarsus	sin						5.9	11.1	12.1	I	5

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
tibiotarsus	dex						6.0	10.1	10.2	II	4
tibiotarsus	sin						6.4	11.1	11.9	I	23
tibiotarsus	sin						6.7	11.1	12.0	II	19
tibiotarsus	sin						6.7	11.5	12.8	II	3
tibiotarsus	dex						7.4	12.2	12.3	I	4
tibiotarsus	sin						7.4	13.0	14.1	II	3
tibiotarsus	sin						7.9	12.7	13.6	I	4/A
tibiotarsus	dex							9.6	9.7	I	19
tibiotarsus	sin							9.7	10.3	I	5
tibiotarsus	dex							9.7	10.5	I	4
tibiotarsus	dex							9.8		I	3
tibiotarsus	dex							9.9	11.1	I	18
tibiotarsus	dex							10.0	10.2	II	4
tibiotarsus	sin							10.0	10.3		17
tibiotarsus	sin							10.1	10.5	I	4
tibiotarsus	dex							10.2	10.5	II	3
tibiotarsus	dex							10.2		II	3/A
tibiotarsus	dex							10.6	10.8	II	3
tibiotarsus	dex							10.7	10.8	II	3
tibiotarsus	dex							11.1	11.3	I	20
tibiotarsus	sin							12.0	11.5	II	3
tarsometatarsus	sin	female	60.8		12.3		5.5	12.0		I	6
tarsometatarsus	sin	female	61.1		11.1		5.4	11.3		I	6
tarsometatarsus	sin	female	63.0		12.3		5.8	11.6		II	4
tarsometatarsus	sin	female	63.4		11.3	10.7	5.4	11.2		I	6
tarsometatarsus	sin	male	63.8		12.3		6.7	12.3		II	4
tarsometatarsus	sin		65.1		11.9	10.7	5.8	11.9		I	3
tarsometatarsus	sin	female	65.8		11.9		5.8	12.2		II	3
tarsometatarsus	sin	female	65.9		11.3		5.7	12.0		II	6
tarsometatarsus	dex	female	66.0		12.0		6.4				17
tarsometatarsus	dex	female	67.7				5.8			I	23
tarsometatarsus	sin	male	78.0		14.2		7.1	14.8		I	5
tarsometatarsus	sin	male	79.4				7.7	15.1		II	4
tarsometatarsus	sin	male	79.7		14.4		7.9	13.7			17
tarsometatarsus	dex	male	85.7		14.6		6.7	15.0	11.3	II	3
tarsometatarsus	sin				11.0	9.7				II	3
tarsometatarsus	sin				11.3		6.0				17
tarsometatarsus	sin				11.4	11.5	5.7			II	3
tarsometatarsus	dex				11.4		5.7			II	3
tarsometatarsus	sin				11.6					II	3
tarsometatarsus	sin				12.1					I	4
tarsometatarsus	dex				12.6					II	3
tarsometatarsus	dex				13.3					I	23
tarsometatarsus	sin	male			13.9		7.4	14.7		I	5
tarsometatarsus	sin	male			14.8	14.9	8.1			II	3/A
tarsometatarsus	sin				16.8	14.0				I	4/A

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
tarsometatarsus	dex						5.5	12.1		I	22
tarsometatarsus	dex	female					5.7	12.8		I	23
tarsometatarsus	dex						5.8	13.5		I	5
tarsometatarsus	dex						5.9	12.7	9.5	I	3
tarsometatarsus	sin						6.2	13.0	7.8	II	3
tarsometatarsus	dex	male					6.3	12.7	9.4	II	3
tarsometatarsus	sin	female					7.0	13.7	10.4	II	3
tarsometatarsus	sin							11.5		II	3/A
tarsometatarsus	sin							12.0	8.9	II	3
tarsometatarsus	dex							12.0		I	6
tarsometatarsus	dex							13.4	10.5	I	4/A
tarsometatarsus	dex							13.8		II	4
tarsometatarsus	dex							14.0	8.9	I	3
tarsometatarsus	dex							15.0	11.2	I	4
tarsometatarsus	dex							15.9	11.6	I	4/A
***Columba domestica* Gmelin, 1789**											
coracoideum	dex		27.4	25.7			2.7		6.8	II	3
coracoideum	dex		27.5	25.8			3.0		7.5	I	6
coracoideum	sin		35.0	33.3			3.8	13.6	9.7	II	4
coracoideum	sin			26.7			2.7			I	3
coracoideum	sin							14.9	9.9	II	3
humerus	sin		40.8		13.1		4.8	9.6	6.3	II	4
humerus	sin		45.2		18.5		5.4	11.1		I	22
ulna	sin						3.2	5.2	4.0	II	4
femur	dex		36.6	34.0	6.9	4.2	2.5	7.2	5.2	II	4
femur	sin						3.7	7.5	6.2	I	6
tarsometatarsus	sin		30.7		7.3	6.9	3.2	7.9	5.3	I	5
***Cervus elaphus* Linnaeus, 1758**											
phalanx 1			57.1		22.3		17.3	20.7		II	3
phalanx 2			44.6		20.1		15.1	15.9		II	3
***Capreolus capreolus* Linnaeus, 1758**											
phalanx 1 posterior			34.1		10.3		8.2	10.4		I	23
phalanx 3			29.6		23.5		5.9			I	23
***Ursus arctos* Linnaeus, 1758**											
phalanx 1			40.7		16.0	14.7	12.5	12.7	9.6	II	3
***Lepus europaeus* Pallas, 1778**											
scapula	sin				15.7	11.9	8.2			II	19
humerus	sin						6.6	12.7	10.4	II	3
humerus	dex							13.0	9.7	II	3/A
radius	dex				9.6	5.9				I	18
ulna	dex					12.4	11.4			I	5
metacarpus 2	dex		20.6		5.4		3.5	4.8		II	3
pelvis	sin		76.0				10.2	20.0		II	4
pelvis	sin		100.0				11.8	24.5		II	4
femur	dex		94.4		22.0	11.5	7.9	20.3		II	4

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
tibia	dex				21.8	23.0	9.5			I	18
astragalus	sin		17.7							I	6
metatarsus 2	sin		57.9				4.6	6.5		II	3/A
metatarsus 3	sin		59.5		6.1	9.4	4.6	6.6		II	3/A
metatarsus 4	sin		56.6				4.4	6.0		II	3/A
metatarsus 4	dex		60.8				4.1	6.2		II	4
metatarsus 5			48.9		9.1		3.9			II	3
***Plegadis falcinellus* Kaup, 1829**											
humerus	sin							15.1	8.5	II	3
***Anas querquedula* Linnaeus, 1758**											
coracoideum	sin		40.5	38.1			3.8	13.6		I	3
***Anas strepera* Linnaeus, 1758**											
coracoideum	dex		48.0	43.5			4.9		19.4	II	3
tibiotarsus	sin						3.7	7.4	7.5	I	3
***Aythya fuligula* Linnaeus, 1758**											
tibiotarsus	dex						4.0	7.8	8.2	II	4
***Accipiter gentilis* Linnaeus, 1758**											
phalanx pedis 2 digiti 2			23.9		7.6	5.8	5.1	5.7	5.5	II	3
***Accipiter nisus* Linnaeus, 1758**											
carpometacarpus	sin	female			10.0					I	3
***Perdix perdix* Linnaeus, 1758**											
coracoideum	sin		35.4				3.2			I	4
coracoideum	dex		36.7	34.5			3.6			II	4
coracoideum	sin		37.2	34.9			3.6		9.8	I	6
coracoideum	sin		39.7	36.9			3.3	13.3	9.4	II	4
coracoideum	dex			34.2			2.8			II	3
coracoideum	sin						3.5		9.0	I	5
scapula	sin		49.1		8.2			3.2		II	3A
scapula	sin		53.9		8.5			3.3		I	18
scapula	dex		54.1		8.6			3.2		II	4
scapula	sin				8.3			3.4			17
scapula	sin				8.7			3.2		II	4
scapula	sin				8.7			3.9		I	23
scapula	dex				9.9			3.9		I	23
scapula	sin				10.1			4.1		I	18
scapula	sin				10.1			4.2		I	4/A
humerus	dex		50.3		13.4		4.6	9.5	5.1	I	18
humerus	dex				11.5					I	4/A
humerus	dex				13.1					I	3
humerus	dex						4.2	9.6	5.2	II	3
humerus	sin						4.4	10.0	5.7	II	3/A
humerus	sin						4.8	9.8			17
humerus	dex							9.5	5.0	II	3A
humerus	dex							9.6	5.2	II	4

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
humerus	sin							9.7	5.5	I	3
humerus	sin							10.9		I	6
radius	sin		38.5				1.8	4.7		I	5
radius	sin		39.3		3.3		1.8	4.5		I	22
radius	dex		40.7		3.3	3.9	1.9	4.7		I	4/A
radius	dex		42.4				2.0	4.9		I	4/A
radius					3.6	3.2	1.8			II	4
radius	dex				3.9	3.3	1.8			II	3
radius	sin						1.8	4.5	2.3	I	6
radius	sin						2.0	4.6		I	3
radius	sin							4.6	3.2	II	4
ulna	sin		44.8		6.1	8.0	2.6	6.0	4.2	II	4
ulna	dex		45.9		5.7	8.5	2.6	6.5	4.6	II	4
ulna	dex		46.6		5.8	8.3	2.7	6.5	4.5	II	3
ulna	dex				5.9	8.1	2.6			II	4
ulna	sin				6.3	8.6	2.6			II	19
ulna	sin						2.6	6.5	4.3	I	22
ulna	sin						2.6	6.5		I	17
ulna	sin						2.9	6.6		II	4
ulna	sin							5.1		II	4
carpometacarpus	sin		25.9	23.8	7.5			5.0		I	4
carpometacarpus	dex		26.1	24.5	7.6			5.3		II	4
carpometacarpus	sin		27.0	24.9	7.6			5.3		I	20
carpometacarpus	sin		27.2	25.5	7.7			5.1		I	6
carpometacarpus	sin		27.5	25.7	7.6			5.6		I	3
carpometacarpus	sin		27.5	25.6	7.7			5.6		I	3
carpometacarpus	dex		27.6	25.9	7.8			5.7		I	4
carpometacarpus	sin		27.7	25.7	8.0			5.0		I	3
carpometacarpus	sin				7.9					II	4
phalanx 1 digiti 2			12.8								17
femur	sin		54.9	52.8	10.1	6.1	4.0	9.5	7.6	II	3/A
femur	sin		55.1	52.4	9.9	6.4	3.7	9.5	7.7	II	3
femur	dex		55.1	52.1	10.7		4.1	9.1	7.4	II	3
femur	sin		56.5	53.0	10.4		4.1	9.3		I	17
femur	dex				9.5	6.3				I	23
femur	dex				9.8	6.6				I	6
femur	dex				10.4	7.0	3.9			II	4
femur	dex						4.3	9.2	7.4	II	3/A
tibiotarsus	sin		67.0				3.4			I	4/A
tibiotarsus	sin		67.1		10.0		3.5			I	4/A
tibiotarsus	sin		70.8		10.5		3.6	6.8	7.1	II	4
tibiotarsus	dex				10.8					II	4
tibiotarsus	sin				11.6		3.7			I	23
tibiotarsus	dex						3.4	6.7	6.5	II	3
tibiotarsus	dex						3.5	6.6	6.5	II	4
tibiotarsus	dex						3.6	6.6	6.3	II	3

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
tibiotarsus	dex						3.7	6.6	6.6	II	4
tibiotarsus	dex						3.9	6.9	6.4	II	3/A
tibiotarsus	dex						3.9	7.2	7.2	I	17
tibiotarsus	sin							7.0	6.0	I	5
tarsometatarsus	dex		29.3		6.0	6.1	2.5	5.9	4.3	II	3
tarsometatarsus	dex		41.0		7.6	7.6	3.6	8.1	5.9	II	3/A
tarsometatarsus	sin		42.1		7.6	7.3	3.5	8.3		I	5
tarsometatarsus	dex				7.1					II	3
tarsometatarsus	dex				7.8	7.5	3.7			I	3
tarsometatarsus	sin				8.0	7.7				I	23
tarsometatarsus	dex						3.3	7.7	5.1	I	22
***Coturnix coturnix* Linnaeus, 1758**											
furcula			27.0							II	3
ulna	sin						1.5	3.7	2.7	II	3
carpometacarpus	dex		19.5	19.1	4.9			3.4		II	3/A
tibiotarsus	sin						2.3	4.8	4.7	II	4
***Phasianus colchicus* Linnaeus, 1758**											
coracoideum	sin		44.6	43.2			4.0		8.3	I	23
coracoideum	dex		44.7				4.1		10.2	II	4
coracoideum	dex	male	51.8	48.8			4.5		10.6	I	20
carpometacarpus	sin		31.3	29.0	9.8			5.2		I	23
carpometacarpus	sin		33.4	30.6	10.5			6.8		II	3
tarsometatarsus	dex	female	64.1		10.5	9.9	4.7			II	3A
***Tetrax tetrax* Linnaeus, 1758**											
scapula	dex	male			11.4			4.4		I	4
***Turdus pilaris* Linnaeus, 1758**											
humerus	sin		31.0		10.0		3.0	7.5	4.2	II	3/A
humerus	sin							6.8	3.7	II	3
ulna	dex						2.4	4.7	3.4	II	3
femur	sin		31.2		5.7	3.4	2.6	5.6	4.2	I	23
tibiotarsus	sin						2.3	4.3	4.1	II	3
tarsometatarsus	dex		33.0		4.2		1.5	3.4		II	4
tarsometatarsus	dex				4.4	4.6	1.8			I	22
***Turdus merula* Linnaeus, 1758**											
ulna	sin				4.8	5.6	2.2			II	4
tarsometatarsus	sin		32.8		5.0		1.7	3.8		I	4
tarsometatarsus	sin		34.4		4.6		1.8	3.9		I	18
***Turdus philomelos* Brehm, 1831**											
humerus	dex				8.2					II	3/A
tarsometatarsus	dex		32.0		4.4		1.4	3.2		I	3
tarsometatarsus	sin		32.2		4.5		1.6	3.7		I	22
tarsometatarsus	sin		32.6		4.0	4.3	1.7	3.4	1.8	II	3
tarsometatarsus	dex		33.4		4.0		1.6	3.3		I	22
tarsometatarsus	dex		33.7		4.1		1.5	3.3		I	22

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
***Turdus viscivorus* Linnaeus, 1758**											
humerus	dex		32.1				3.2	7.6	4.2	I	5
humerus	sin						3.3	7.7	4.1	I	17
humerus	sin						3.4	7.5	4.1	I	23
carpometacarpus	sin		23.3	20.7	5.9			5.1		I	23
carpometacarpus	sin		24.2	21.9	5.5			4.9		I	5
femur	sin							5.4	4.0	II	4
tibiotarsus	sin						2.4	4.8	4.8	II	4
tarsometatarsus	sin		32.7		5.0	4.5	1.6	4.0	2.0	I	4
***Sturnus vulgaris* Linnaeus, 1758**											
coracoideum	sin			25.1			1.5		4.4	II	4
***Garrulus glandarius* Linnaeus, 1758**											
coracoideum	sin		29.8	28.4			1.7		5.5	I	4
***Nucifraga caryocatactes* Linnaeus, 1758**											
tarsometatarsus	sin		40.5		5.9		2.4	4.5		I	18
Corvus* cf. *frugilegus											
carpometacarpus	dex							11.2		I	3
phalanx 1 digiti 2	dex		23.5		6.5	4.6	6.8	6.5		I	3
Anser anser/A. domesticus											
coracoideum	dex		69.8		61.7		8.8	27.8		I	3
scapula	sin		90.1		19.3			7.3		II	3
scapula	sin				19.5			7.2		II	3
scapula	dex				19.8					I	3
humerus	sin							20.7		I	22
humerus	sin							23.8	13.3	I	23
radius	dex		142.7		7.9		4.8	10.1		II	4
radius	sin						4.8	10.1	5.3	II	3
radius	sin							9.3		I	19
radius	sin							10.0	5.0	II	4
radius	dex							10.2	5.6	II	3
radius	sin							10.8	5.3	I	3
ulna	dex				15.5	19.6	8.2			I	5
ulna	sin					18.8				I	22
ulna	dex							14.0	11.1	II	3
ulna	sin							15.4		I	3
carpometacarpus	sin		77.5		18.9			11.0		I	20
carpometacarpus	sin		85.4		20.1		10.0	10.9		II	4
carpometacarpus	dex		86.4		20.5			11.8		II	3
carpometacarpus	sin		88.8	82.4	21.2			11.6	7.5	I	3
carpometacarpus	sin				20.1					II	4
carpometacarpus	sin							10.1		I	22
phalanx 1 digiti 2			34.3							I	5
phalanx 1 digiti 2			35.6							II	3
phalanx 1 digiti 2			37.0		8.9		4.6	9.9		II	4
phalanx 1 digiti 2			37.6		9.3		4.8	10.1		II	4

Bone type	Side	Note	GL[a]	Lm	BP[b]	DP[c]	SB[d]	BD[e]	DD	Square	SU
phalanx 1 digiti 2			37.8		10.0			9.7		I	3
femur	dex				19.1		8.3			I	3
tibiotarsus	sin						7.5	15.5	14.8	II	3
tarsometatarsus	dex		78.0				7.4			II	4
tarsometatarsus	dex		80.5		18.1		8.6	19.6	13.8	I	23
Anas platyrrhynchos/A. domesticus											
coracoideum	dex		47.0	42.5			5.2		18.5	II	4
scapula	sin				11.2			4.3		II	4
humerus	dex				19.0		6.9			II	3
humerus	dex				22.0		7.6			I	4/A
humerus	sin						6.1	14.4	7.7	II	4
humerus	dex						6.4	13.6	7.8	II	3
humerus	dex						6.6	14.4	8.5	II	4
ulna	dex		75.4		9.4	11.8	4.6	9.4	6.5	I	3
carpometacarpus	dex		50.8		11.6			7.3		I	3
phalanx 1 digiti 2			20.7							II	3
tibiotarsus	sin		88.3		13.6		4.5	9.4	9.6	II	4

Table 4. Bone measurements (mm) following the standard given in Driesch 1976 *(von den Driesch 1976)* (a L in teeth and DLS in the distal phalanx; b GB in the atlas, patella, calcaneus and centrotarsale; B in teeth,, GLP in the scapula, BPC in the ulna, LA in the pelvis, Dl in the astragalus, and LD in the distal phalanx; c BFcr in the atlas, LG in the scapula, DPA in the ulna, Lfo in the pelvis, and Dm in the astragalus; d BG in the scapula, SDO in the ulna, SB in the pelvis, and MBS in the distal phalanx; e SLC in the scapula and SH in the pelvis). Acronyms: SU=stratigrafic unit; UM3=upper 3rd molar; LM3=lower 3rd molar

ANTÆUS