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A Middle Pleistocene steppe bison find within the Dürnstein Castle (Wachau, Lower Austria)

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Abstract
In the course of foundation works in the Dürnstein Castle cervical and front leg bones of a large *Bison priscus* bull were discovered in fluvial sediments. The small city of Dürnstein with its medieval centre is part of the UNESCO Wachau Cultural Landscape and is built mainly on Palaeozoic basement rocks. The find location is completely overbuilt, but remnants of fluvial sediments on the bones together with the altitude of the site approximately 17 m above the Danube point to a Middle Pleistocene fluvial aggradation level not younger than ca. 240,000 years, and the maximum age is 400,000 years. The fossil bearing location is interpreted as a small sandy bay of the Pleistocene Danube, protected from later degradation and erosion. Morphometric comparisons and taphonomic analyses of the bones allow the reconstruction of a scenario in which the bison probably had drowned in a flood and its carcass was buried quickly before destruction by scavengers or erosion. The study includes a comparison with bison specimens of an unpublished small megafaunal assemblage from adjacent Krems-Kreuzbergstraße. Processing marks on parts of these bones point to an anthropogenic Middle Palaeolithic influence and translocation. In addition, a tentative chronological sketch of the regional Bison species succession (*B. menneri, B. schoetensacki, B. priscus*) from the Early to the Late Pleistocene is presented.

1. Introduction

Finds of steppe bisons in Austria with a well documented topographic context are extremely rare (see Döppes and Rabeder, 1997). Furthermore no Palaeolithic site excavated so far in Austria documents a significant role of this species as a main target by ancient regional foragers. Contrarily there are not few well-known sites, "non-cultural" and "cultural", with numerous bison bones in Western, north-west Central Europe and Eastern Europe (e.g. Gaudzinski, 1995; Sher, 1997; Kahlke et al., 2011; Maniakas and Kostopoulos, 2017). Döppes and Rabeder (1997) list the most important Early to Late Pleistocene terrestrial assemblages from Austria, but single finds and species-poor sites were not considered in this compilation. The scientific archives of Lower Austria obviously keep further bones from Pleistocene large bovids, but find locations of these specimens are mostly unknown, and even fewer are indications of their stratigraphic or taphonomic context. This state-of-the-art demands basic research on recent findings with documented context.

Skeletal parts of a bison were discovered in the course of foundation works around the year 1995 inside the Dürnstein Castle hotel area (Schloss Dürnstein). Later, the owner of the hotel communicated the discovery to the local archaeological authority and afterwards donated the bones to the Palaeontological Department of the University of Vienna (IPUW). The authors became involved only several years after the recovery. The find spot could be localized in a strongly overbuilt area. In this paper a description of the vertebrate find is presented and, in combination with the geological setting, the age of the bison is discussed and its taphonomy is reconstructed. Further finds in Lower Austria allow to sketch the regional succession of *Bison* species during the Pleistocene.

2. Site description and geological setting

2.1 The Dürnstein site

Dürnstein lies at the orographic left side of the Danube (Fig. 1A). In this area of the Wachau cross valley, which is registered as a UNESCO Cultural Landscape, the river is flowing in a S- to SSE-direction and has a mean water level of 195 m a.s.l. The bones were found within the Dürnstein Castle area, a palace, which is located on a rock ledge in the northern part of the town and is nowadays used as a hotel (Fig. 1B). Dürnstein Castle ("Schloss Dürnstein") should not to be confused with the medieval fortress ("Burg Dürnstein", "Ruine Dürnstein"), a ruin about 150 m above the city. According to the owner of the Dürnstein Castle, Johann Christian Thiery, the bones were discovered mid-1990s in the course of the construction of a second entrance into the restaurant's

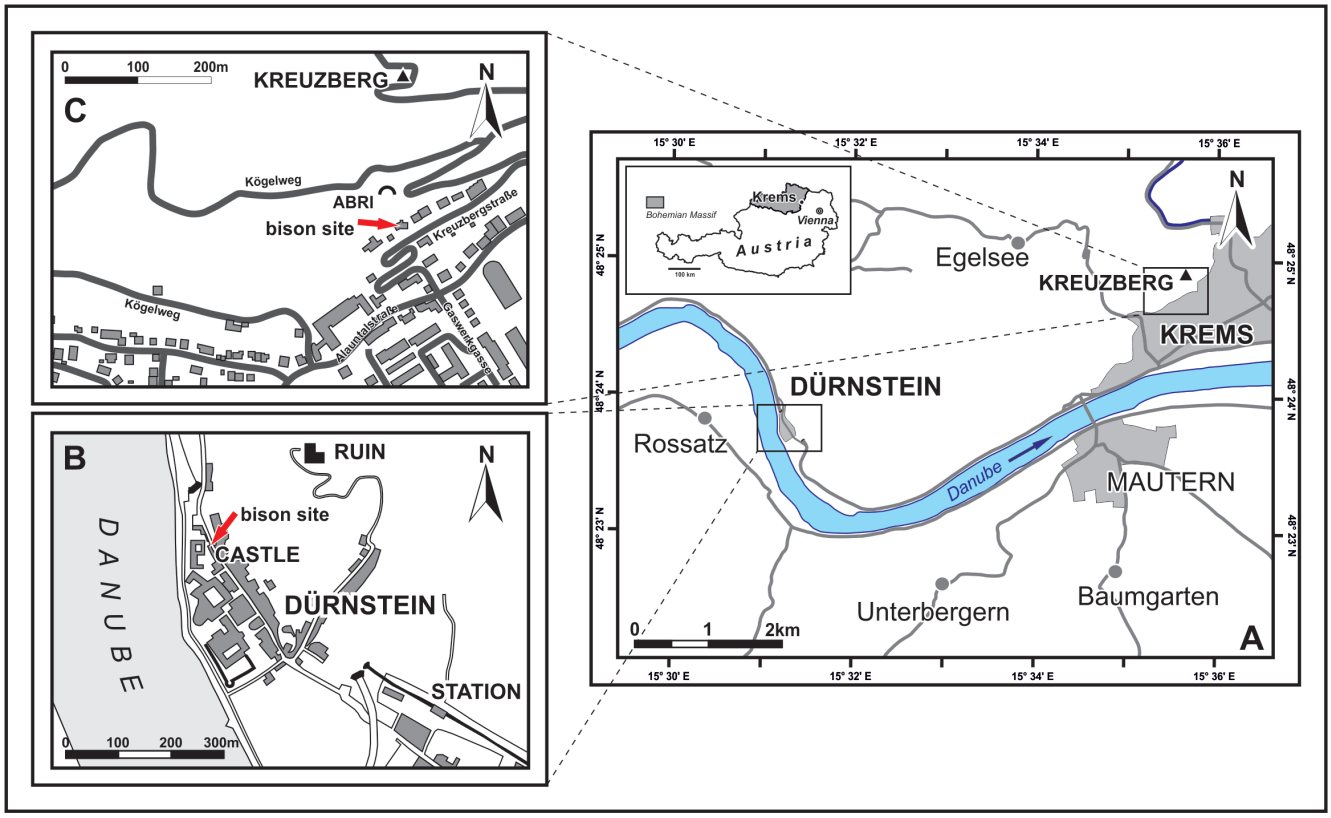


Figure 1: A: Simplified map of the area between Dürnstein and Krems with the investigated locations in Dürnstein and Kreuzberg northwest of Krems. B: Detailed map of the position of the bison site in Dürnstein Castle. Arrow indicates the find position. C: Detailed map of the position of the bison site (arrow) and the abri above at the Kreuzbergstraße in the northwestern part of Krems.

kitchen (WGS 84: 48° 23′ 46,5″ N; 15° 31′ 09,2″ E) (Fig. 4) and were the only fossil finds. They were embedded in sand, 3.5–4 m below the pavement level, which lies at 216 m a.s.l., 21 m above the river. Therefore, the finding spot is at approximately 212 m a.s.l., about 17 m above the river. Today it is overbuilt and there are no outcrops in the closer surroundings. The town of Dürnstein is built on the Gföhl gneiss, an orthogneiss, which is part of the Gföhl Unit of the Bohemian Massif (Fig. 2) (Matura et al., 1983). The castle (palace) and the collegiate church in the south are located on rock elevations at about 216 m and 209 m a.s.l., respectively. However, the monastery between the two buildings is situated in a small, up to 10 m deep bay-like depression, which probably was formerly filled by fluvial sands (Fig. 3).

2.2 Krems-Kreuzbergstraße site

The location of this unpublished assemblage about 7 km downstream from Dürnstein lies at the Kreuzberg slope in the northwestern part of the city of Krems (Fig. 1C). The bones were discovered in 2002 by the local collector Peter Minor in the outcrop and the excavated material during a house construction at Kreuzbergstraße 9. The location is situated approximately 200 m south of the Kreuzberg (WGS 84: 48° 24′ 40,4″ N; 15° 35′ 24,0″ E; cadastral commune Krems, parcel 351/3), at about 225 m a.s.l. This site lies about 31 m above the river altitude, which is approximately 13 m above the altitude of the Dürnstein find. According to the collector and photos from the site, the bones were found in loess with layers of boulders and smaller pieces of syenite gneiss and were scattered over a vertical range of about 3 m. These aeolian-fluvial sediments follow above a strong dark brown palaeosol, showing the onset of a cold phase after a warm humid period. The loess site lies close to a NE-striking syenite gneiss ridge, which crops out in abandoned vineyards above (Fig. 2; Fuchs et al., 1984). An abri is located in the gneiss ridge at an altitude of about 251 m (WGS 84: 48° 24' 41,5" N; 15° 35' 22,4" E) (Fig. 1C).

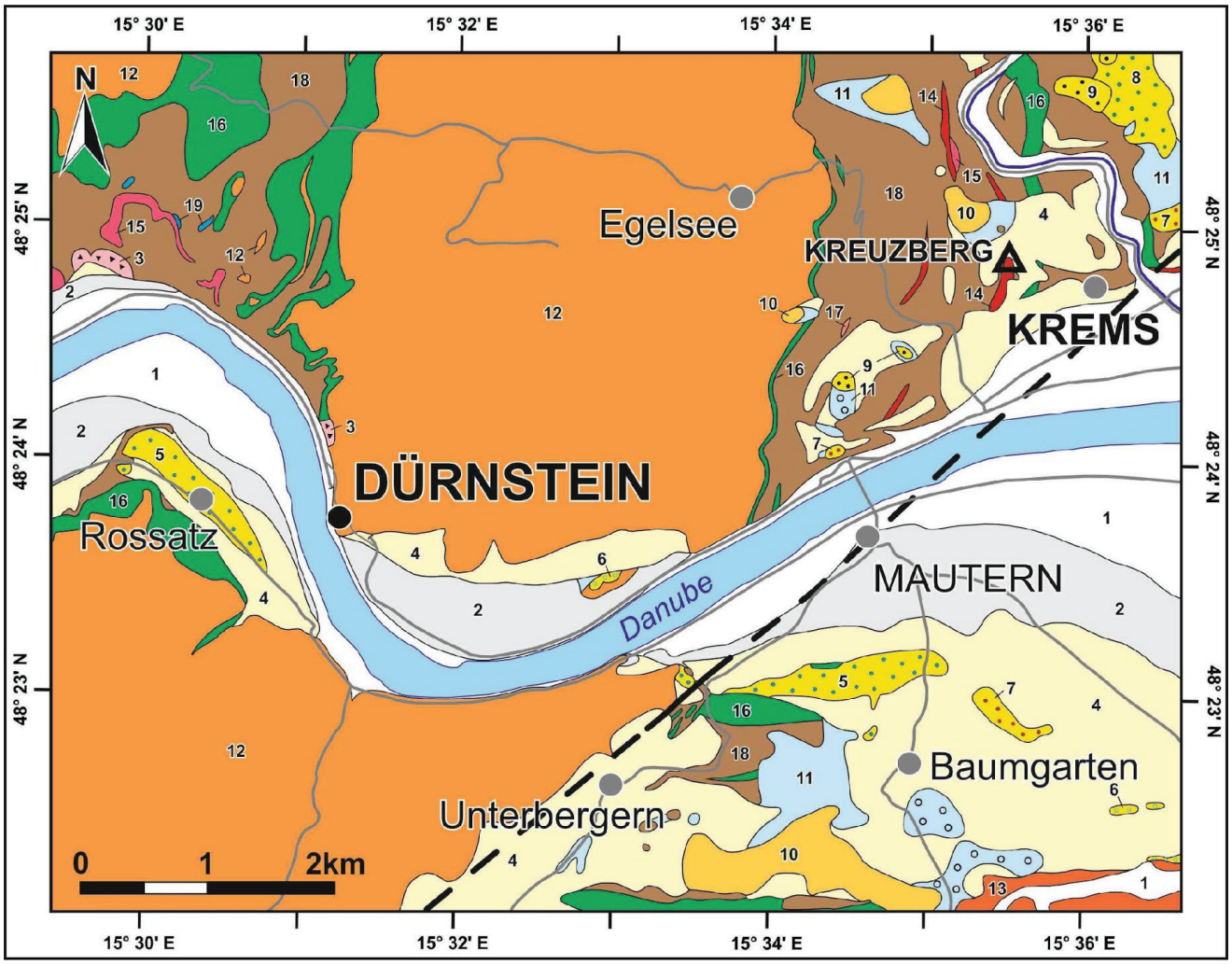
3. Material and methods

3.1 Bones and archives

The bison bones from Dürnstein described in this paper are stored in the Department of Palaeontology at the University of Vienna, label IPUW 5100/1-7 (Tab. 1). The specimens

IPUW label	Bone specimen
5100/3	Epistropheus (axis), fragmented
5100/4	3rd cervical vertebra
5100/5	4th cervical vertebra, fragmented
5100/1	Humerus dext., shaft and distal part
5100/2	Radius/Ulna dext., olecranon is missing
5100/6	Os ulnare dext. (Os pyramidale)
5100/7	Os intermedium dext. (Os semilunare)

Table 1: *Bison priscus* bones from Dürnstein.



Quaternary Sediments

- 1 Fluvial sediments; Holocene
- 2 Higher levels of fluvial sediments; Holocene
- 3 Debris; Holocene - Pleistocene
- 4 Loess, loam; Pleistocene
- 5 Terrace sediments (gravel, sand) 17 m above Danube; Middle Pleistocene
- 6 Terrace sediments (gravel, sand) 25-30 m above Danube; Middle Pleistocene
- 7 Terrace sediments (gravel, sand) 45 m above Danube; Middle Pleistocene
- 8 Terrace sediments (gravel, sand) 105 m above Danube; Early Pleistocene
- 9 Terrace sediments (gravel, sand) 130 m above Danube; Early Pleistocene

Diendorf Fault

Alpine-Carpathian Foredeep

- 10 Hollabrunn-Mistelbach Fm. (gravel, sand, clay, fluvial to lacustrine); Late Miocene (Pannonian)
- 11 Hollenburg-Karlstetten Fm. (conglomerate, gravel) and marine marl; Middle Miocene (Badenian)

Moldanubian Superunit

- 12 Gföhl gneiss (orthogneiss)
- 13 Granulite
- 14 Syenite gneiss. Granite gneiss
- 15 Diorite gneiss
- 16 Amphibolite
- 17 Migmatitic gneiss, leucocratic
- 18 Paragneiss, mica schist
- 19 Marble

Figure 2: Geological map of the area between Dürnstein and Krems (redrawn from Matura et al., 1983; Fuchs et al., 1984).

Figure 3: The Dürnstein Castle (left) on a rock terrace of Gföhl gneiss, 21 m above the Danube and the collegiate church (right). The monastery is located between these two buildings in a small bay-like depression, some meters deeper. The bones of the bison were found behind the castle (Photo: R. Roetzel).

were cleaned and preserved in the laboratory of the Department (Figs. 5, 7, 11, 12). The specimens from Krems-Kreuzbergstraße (KrKr) and from Mysy in Russia are stored in the Department of Geology and Palaeontology at the Natural History Museum in Vienna (NHM). The Krems-Kreuzbergstraße assemblage was collected in the year 2002, the Mysy assemblage came into the NHM collection very probably in the course of the 19th century.

Figure 4: The new entrance into the restaurant's kitchen east of the Dürnstein Castle where the bones of the bison were found (Photo: R. Roetzel).

Figure 5: *Bison priscus* from Dürnstein: humerus (IPUW 5100/1), cranial, lateral, caudal, medial views (from left). Scale bar in cm.

Both the Dürnstein and the Krems-Kreuzbergstraße samples have the same light ivory coloured and brittle appearance and show a higher density than abundant regional Late Pleistocene loess fossils. The latter are generally brownish to grey, and their density is lower. The Krems-Kreuzbergstraße bone assemblage comprises some tens of mostly fragmented specimens and consists only of bones that either can be attributed to bison or to red deer. Two humerus fragments from *Cervus elaphus* show modifications that happened to the fresh ("green") bone, and include longitudinal, spiral and edged breaks. These destruction patterns of the compact bone are interpreted as signs produced by humans in order to access the bone marrow. Thus, at least one part of the assemblage was very probably accumulated in the course of provisioning by hunter-gatherers, and there are no signs that scavenging animals affected the material. Long fluvial transport can be excluded.

3.2 Comparative material

Studies were performed in order to discriminate *Bison* and *Bos* (Martin, 1987, 1990; Prat et al., 2003) and specimens at the University of Vienna, the Natural History Museum in Vienna and the Staatliches Naturkundemuseum in Stuttgart were included. The measurements are in correspondence with well-known measuring sections (Van den Driesch, 1976; Martin, 1987, 1990; Prat et al., 2003). At the Natural History Museum of Vienna only an undated bison sample from Mysy on the Kama River in the Perm region of the eastern East European Plain was available. Finds of Pleistocene large mammals from Mysy are repeatedly referred to as late Middle Pleistocene (e.g. Sickenberg, 1962; Foronova, 2014). The Late Pleistocene and Upper Palaeolithic bison "mass sites" Amvrosievka and Anetovka in the southern Ukraine (Starkin, 1999) provided a valuable data pool. Bones of the more eastern site Amvrosievka were dated to 23,012–21,962 cal BP (Soubrier et al., 2016) and the Anetovka site in the more western part is approximately 21,300 BP old (uncalibrated age in Dolukhanov et al., 2001).

Concerning the species attribution of the Amvrosievka bison – and this is very probably also valid for Anetovka – recent results point to a mitochondrial genome

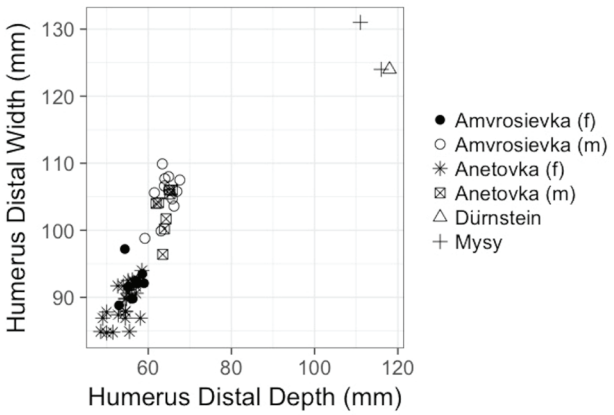


Figure 6: Distal humerus measurements of the Dürnstein specimen of *Bison priscus* compared to Pleistocene specimens from Mysy (Russia) and published data from the Ukrainian Amvrosievka and Anetovka Late Pleistocene assemblages (Starkin, 1999). (f): female, (m): male.

Figure 7: *Bison priscus* from Dürnstein: antebrachium (IPUW 5100/2), cranial, lateral, caudal, medial views (top from left), radius and fragmented ulna, proximal and distal views, and with two carpals from dorsal (bottom). Scale bar in cm.

difference if compared to the late Middle Pleistocene steppe bison (Soubrier et al., 2016). These authors assign the Amvrosievka bison to the mitochondrial cladeX and suggest that it descended from an ancient hybridization of steppe bison and an ancestral aurochs within a time-span of 152,000–92,000 yr BP (compare Massilani et al., 2016, supplementary and critical notes by Spassov, 2016). A more recent study based on morphometrics and genome analysis rejects this hybridization hypothesis (Grange et al., 2018). The data from the large Ukrainian samples are used in this paper mainly for the size comparison with the Dürnstein bison.

Specimen	Side	Smallest diaphyseal width	Distal width	Distal depth*	Width of trochlea **	Inner diameter of the trochlea
IPUW 5100/1	dext	68	124	118	approx.120	58
NHM 2019/0129/0003	dext	63	131	111	114	56
NHM 2019/0129/0004	sin	59	124	116	112	54

Table 2: Measurements of the humerus in mm of *Bison priscus* from Dürnstein (IPUW 5100) and Mysy, Russia (NHM 2019/0129). * perpendicular to distal width, ** from distal.

Specimen	Side	Greatest length	Proximal width	Proximal depth	Width of the proximal articulation facet	Smallest diaphyseal width	Distal width incl. Ulna	Distal depth
IPUW 5100/2	dext	428	129	68	113	68	113	78
KrKr 02	dext	-	127	68	114	-	105	70
NHM 2019/0129/0005	sin	416	113	59	104	65	107	71
NHM 2019/0129/0006	sin	399	130	67	115	69	114	69
NHM 2019/0129/0007	dext	400	116	62	108	65	106	82
NHM 2019/0129/0008	dext	373	125	64	112	62	112	82

Table 3: Measurements of the radius in mm of *Bison priscus* from Dürnstein (IPUW 5100), Krems-Kreuzbergstraße (KrKr) and Mysy, Russia (NHM 2019/0129).

4. Results

4.1 Palaeontological description

The Dürnstein assemblage contains eight bones, or seven, if the antebrachium is counted as one (Tab. 1). From the axial skeleton the anatomical unit of the cervical spine, vertebrae C2 to C4, is preserved.

4.1.1 Morphology

According to results from discriminative studies of the distinctive potential of postcranial bones of *Bos* and *Bison* a simple and explicit determination of a bone is rather tentative due to the adaptive flexibility of bovid species (Martin, 1987, 1990; Prat et al., 2003). The distal trochlea of the Dürnstein humerus in lateral view has an oval shape (Fig. 5), compared to the more equally rounded form in *Bos primigenius* (Prat et al., 2003: Fig. 14). The trochlear crest is definitely not sharp and the fossa olecrani is rather narrow, compared to the broader form in *Bos* (see Martin, 1990: 12). The proximal extremity of the Dürnstein radius (Fig. 7) shows the same undulated dorsal margin of the humeral facet as figured in Figure 15 of Prat et al. (2003). This line in *Bos* is simply convex. In the Dürnstein radius the lateral facet to the ulna is smoothly concave. In the *Bos* radius Martin (1990) observed a deep notch ("Einkerbung"). In the Dürnstein radius the notch of the collateral ligament is clearly oriented laterally, which is coherent with *Bison* (Prat et al., 2003). The distal extremity is only slightly bent if viewed from distal (Fig. 7). This supports the Bison determination compared to the more strongly bent outline observed on the *Bos* radius (Martin, 1990).

4.1.2 Comparative results of the measurements

Measurements are provided (Tab. 2-6) and some are plotted in the diagrams together with the Amvrosievka and Anetovka samples from the southern Ukraine (Starkin, 1999)

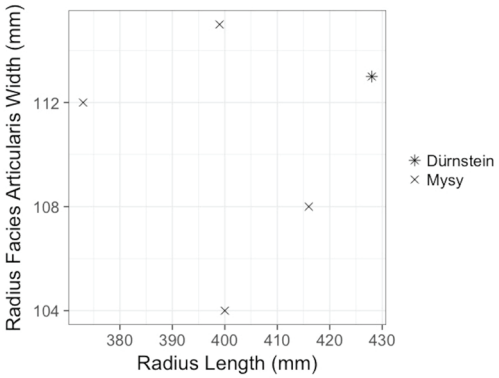


Figure 8: Radius measurements (proximal width to total length) of the Dürnstein specimen of *Bison priscus* compared to Pleistocene specimens from Mysy (Russia).

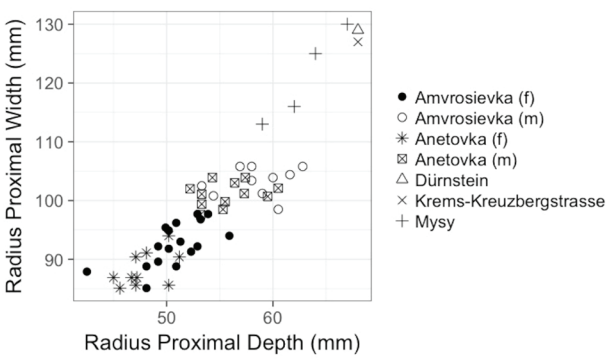


Figure 9: Proximal radius measurements of the Dürnstein and Krems-Kreuzbergstraße specimens of *Bison priscus* compared to Pleistocene specimens from Mysy (Russia) and published data from the Ukrainian Amvrosievka and Anetovka Late Pleistocene assemblages (Starkin, 1999). (f): female, (m): male.

Specimen	Side	Width of the radial incisure
IPUW 5100/2	dext	68
NHM 2019/0129/0006	sin	68
NHM 2019/0129/0008	dext	68

Table 4: Measurements of the ulna in mm of *Bison priscus* from Dürnstein (IPUW 5100) and Mysy, Russia (NHM 2019/0129).

(Figs. 6, 9, 10). There may be small differences in the orientation of measuring tracks but the results allow precise conclusions. The measurements of the humeri of the Dürnstein and the Mysy specimens show their big size and the massive distal ends (Tab. 2, Figs. 5, 6). Besides the humerus, the Dürnstein radius (428 mm, Tab. 3, Figs. 8, 9) suits best in a wider geographic comparison. The range of data from Belgium is 380-432 mm (N=5) (Germonpré, 1993). Specimens from western France range between 328-420 mm (N=45) (Vercoutère and Guérin, 2010), and the radii from a skeleton in the Ariége measures 375 and 395 mm (Crouzel et al., 1982). Martin (1987) observed a radius length range of 334-425 mm (N=28) from Rhine terraces, again below the Dürnstein specimen. Observations on Western Siberian Pleistocene populations report 343-431 mm for male individuals (N=49), and the range of 102 further specimens is 333-414 mm (Shpansky et al., 2016). The dimensions of the proximal and the distal ends of the radius of the Dürnstein bison underline its large size and sturdiness (Figs. 8, 10). We conclude that the Dürnstein bison is close to the upper size range limit of the species, and it is therefore identified as a male individual.

From Krems-Kreuzbergstraße two further bones allow a sketch of the size dimension for comparison within a broader view on the two Danube individuals (Tab. 3). It is a fragmented right scapula with the humeral facet, and a distal metacarpal. The smallest width of the scapula collum (KLC according Van den Driesch (1976)) is 89.7 mm,

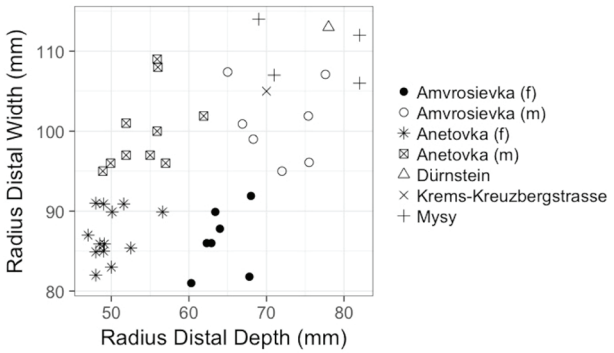


Figure 10: Distal radius measurements of the Dürnstein and Krems-Kreuzbergstraße specimens of *Bison priscus* compared to Pleistocene specimens from Mysy (Russia) and published data from the Ukrainian Amvrosievka and Anetovka Late Pleistocene assemblages (Starkin, 1999). insert: (f): female, (m): male.

and the width of the articulation facet (BG) is 74.1 mm. The distal fragment of a (right?) metacarpale II/III from Krems-Kreuzbergstraße measures 84.0 mm (width Bd according Van den Driesch (1976)) and 43.8 mm (dorso-plantar diameter Td). The distal width Bd is consistent with the mean of 83.9 mm (N=19) of *Bison priscus* from Germany (Schertz, 1936). The Western Siberian range is 74-90 mm for 75 cows, and 80-108 mm for 143 bulls. Means are around 79 mm for females and 93 for males (Shpansky et al., 2016). As a result the Krems-Kreuzbergstraße specimen (84.0 mm Bd) is close to the mean.

Concerning the comparison of the cervical vertebrae (Tab. 6, Fig. 12), only few data from Western Europe are available. The neural channel or foramen vertebrale of the epistropheus in *B. priscus "gigas"* from the Ariége measures 32 mm height to 44 mm width and in the C3 and the C4 it is 29 to 29 mm (Crouzel et al., 1982), all roughly the same as the Dürnstein individual.

The measurements give a clear image of the rather large size of the Dürnstein bison and the slightly smaller Krems-Kreuzbergstraße individuals. The size of the Danube specimens is similar to Middle Pleistocene data from Western Europe and from Russia. Finally, the Late Pleistocene bisons from Eastern Europe are smaller (Starkin, 1999), and the same is true for Wallertheim in Germany (Gaudzinski, 1995). Observations on Austrian material suggest the survival of large bisons until the Late Pleistocene, at least to approximately 25,000 yr BP. Thenius (1959) mentioned a distal humerus fragment from Willendorf V and reported a width (Bd) of 131 mm and a thickness (Td) of 121 mm, roughly the same as for the Middle Pleistocene Dürnstein specimen.

4.2 Sedimentary analysis and palaeoenvironmental reconstruction

Sediments from the Dürnstein site were only available from sandy relicts inside the bones and on some of their surfaces. Grain-size analysis classifies them as silty-gravelly fine to medium sand (Tab. 7) (Füchtbauer, 1959; Müller, 1961). In the prevailing sand portion (64.1 weight %) fine and medium sand dominate, whereas the gravel fraction (15.9 weight %) contains a remarkably high amount of medium gravel. In the silt fraction (18.0 weight %) coarse silt is predominant, while the clay portion (2.0 weight %) is extremely low. The mean grain size (Mz) lies around 2 phi (250 µm) and sorting according to standard deviation (σ_i) (Folk and Ward, 1957) is very poor.

The predominant fine sandy sediment with small portions of medium to fine gravel points to the deposition in a calm, protected environment, outside the main fluvial channel. This is supported by the relatively high silt fraction in the sand, which was probably derived from the metamorphic basement rocks.

4.3 Taphonomy

The Dürnstein bone assemblage consists of two anatomical units. These are (1) the cranial portion of the neck from the second to the forth cervical vertebra, and (2)

Figure 11: *Bison priscus* from Dürnstein: os ulnare (IPUW 5100/6), lateral view left and medial view right, and os intermedium (IPUW 5100/7) in the middle, proximal view. Scale bar in cm.

the proximal part of the right forelimb from the upper arm bone to the proximal wrist bone row. The consistent measurement results and the singularity of the elements undoubtedly show that the two units belong to the same individual. The anatomical unit of three cervical vertebrae represents the cranial neck portion, but without the atlas. This often remains attached to the skull in natural non-human as in human-generated assemblages due to its strong joint tissues.

The bones are partly slightly abraded, and the proximal humerus and the ulna olecranon are broken. Sandy and silty sediment remained on the surface as well as on breakage surfaces, which speak in favour of only a short transport on the surface or within the sediment. Some fractures are apparently modern artefacts, which occurred during the recovery or between sampling and this study.

The process of how body parts are separated postmortem is mainly controlled by biological intrinsic factors, primarily by the strength of connecting tissues, such as ligaments, sinews, muscles, cartilages and the skin. The main extrinsic factors are large carnivores, birds of prey, and man. Patterns of destruction of a corpse include the morphology of the destruction and the sequence of dismemberment. They can in turn be used for the identification of the destruction agents. The connection between the cervical vertebra is very tight, and a strong connection also exists between the forearm and the wrist. The articulation between the shoulder blade and the ribcage is different. There is no joint and because of this, the two parts separate after decay of the connecting muscles unless they are held together by the embedding sediment. This implies that the frontal carcass parts of the Dürnstein specimens were quickly embedded.

The discovery of the bones in the palace area has not been documented and thus it is not known if further bones were found in the near surroundings of the trench. The two carcass parts neck and forelimb, which are close together in a living animal, discovered within a small area allow two different hypotheses: (1) Neck and forelimb were embedded together in the sand, and held together also by the skin. This happened rather quickly and the carcass was not further destroyed by scavengers. (2) The bison was targeted or scavenged by Palaeolithic foragers. Neck and fore limb were discarded together after dismemberment of the carcass. This second hypothesis is rather speculative, because neck parts and limbs contain high nutritious tissues. In hunter-gatherer societies these precious body parts are transported to the camps for more sophisticated exploitation and use (e.g. Morin et al., 2016).

No apparent gnaw-marks are visible on the protruding parts of the bone, so that the loss of the proximal part of the humerus and the destruction of the olecranon ulnae can hardly be attributed to large carnivores such as lions or hyenas. The most probable natural cause is inundations that sweep away animals, often from their temporary shelter on stream islands or shores. Their corpses

Label	Specimen	Greatest height (proximo-distal length)	Greatest width (dorsal)	Greatest diameter (dorso-palmar)
IPUW 5100/6	Os ulnare dext. (scaphoid)	55.0	35.5	53.0
IPUW 5100/7	Os intermedium dext. (semilunatum)	43.5	38.0	58.5

Table 5: Measurements of the os ulnare and the os intermedium in mm of *Bison priscus* from Dürnstein (IPUW 5100).

Figure 12: *Bison priscus* from Dürnstein: cervical vertebrae C2 to C4 in anatomical connection (IPUW 5100/3-5), dorsal, left side, C2 cranial and C4 caudal views. Scale bar in cm.

finally land on a beach or flood plain, and sediments may protect the carcass from scavengers like vultures, hyenas, or men (e.g. Behrensmeyer, 1988).

The reconstructed palaeoenvironmental situation of the Dürnstein case is a bay-like depression between the castle (palace) rock and the church rock (Fig. 13). In this sheltered area the current velocity was considerably lower than in the main channel area of the braided river in the west. It is assumed that in this rather stagnant zone the carcass of the bison was washed up and rather quickly covered by sands during rising water levels. Furthermore, the finding position of the bones was in the rearmost part of the bay, where the current velocity was likely low.

4.4 Chronology

The find spot of the Dürnstein bison bones is located at approximately 212 m a.s.l., about 17 m above today's river (mean 195 m a.s.l.). The terrace surface level of the last glaciation (Würmian) in the Wachau is located slightly above 200 m a.s.l., approximately 5-7 m above the river. Remnants of pre-Würmian terrace sediments on the opposite side of the Danube at the Rossatz and Mauternbach villages (Fig. 2, Matura et al., 1983) lie at a comparable level of approximately 210 to 215 m a.s.l., 15-20 m above the river and their altitude suggests a late Mindel age (Matura and Heinz, 1989). Given the lack of precise terrace dates between Upper Austria and Vienna (cf. Pfleiderer, 2008; Preusser and Fiebig, 2009; van Husen and Reitner, 2011a, 2011b) we cannot exclude a pre-Riss glacial age (corresponding the Marine isotope stages (MIS) 8-10) (Kukla, 2005) and thus an age of 240 ka or older is indicated. An attribution to the Mindel glaciation (MIS 12) would indicate an age of about 400 ka as maximum age.

5. Discussion

The oldest finds in Austria of large bovids of the genus *Bison* are reported from Deutsch-Altenburg, assemblages DA2C, DA4B and DA4A (Frank and Rabeder, 1997a). Single, mainly fragmented finds from Early Pleistocene karst fissure fillings (ca. 1.6-1.2 Ma, L. Maul personal communication) are referred by G. Rabeder to *Bison schoetensacki* (Frank and Rabeder, 1997a). If this determination is correct, this locality would pre-date the current first appearance date of the species. According Palacio et al. (2017) *B.schoetensacki* appears first in the early Middle Pleistocene. Based on other studies (Sher, 1997; Kahlke et al., 2011; Van Asperen and Kahlke, 2017; Maniakas and Kostopoulos, 2017) we would expect the presence of *B. menneri* in the Early Pleistocene of the middle Danube region.

Somewhat younger is the older part of the Laaerberg assemblage in the southern elevated part of Vienna, which was collected at the beginning of the 20th century. Two partly fragmented metatarsals do not allow a species determination, but also the stratigraphic level of the specimens within the Laaerberg sequence is unknown (Döppes and Rabeder, 1997).

The early Middle Pleistocene (0.8-0.7 Ma) (cf. Markova and Puzachenko, 2018) megafauna assemblage from Hundsheim includes well preserved bison finds (Freudenberg, 1908, 1914), which were later attributed to *B. schoetensacki*

Label	Specimen	Width under the transverse processes	Total length	Max. height of neural channel	Max. width of neural channel
IPUW 5100/3	C2 (axis)	62.5	-	37	36.5
IPUW 5100/4	C3	approx.78	approx.88	-	-
IPUW 5100/5	C4	approx.88	-	25	29

Table 6: Measurements of the cervical vertebrae in mm of *Bison priscus* from Dürnstein (IPUW 5100).

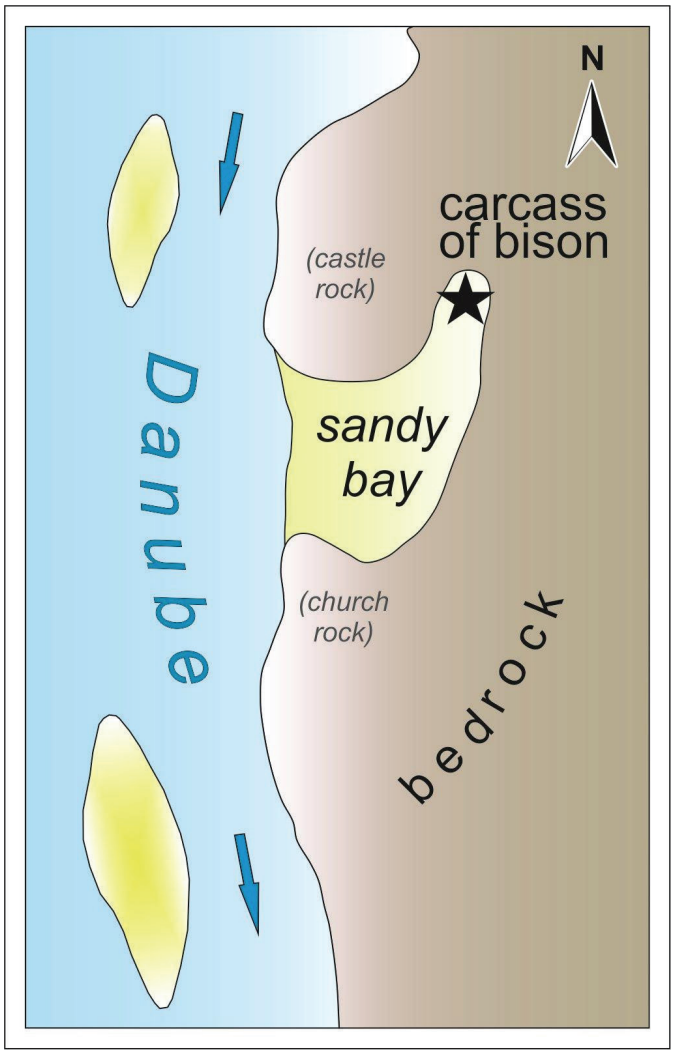


Figure 13: Reconstruction of the Middle Pleistocene depositional scenario of the bison carcass in a sheltered bay back from the Danube main stream.

(Rabeder and Frank, 1997b). A thorough but unfortunately unfinished reassessment from the late 1990s (Ch. Römer, personal communication 2010) referred the Hundsheim bison closer to *B. menneri*. On the basis of the measurements in Bauer (1999) the first author suggests that the Hundsheim specimens represent a rather tall form with long and slender metapodials which are rather precisely within the dimensions of *B. menneri* as published in Brugal and Lacombat (2004) and Maniakas and Kostopoulos (2017).

In 1912 (Freudenberg, 1914) the Middle Pleistocene "Deutsch-Altenburg" site was discovered. It was the first assemblage of the Plio-Pleistocene Deutsch-Altenburg site complex and later labelled as Deutsch-Altenburg 1 (DA1). Together with *Ursus deningeri*, *Canis mosbachensis*, and *Equus mosbachensis* remains of *Bison* cf. *schoetensacki* (Frank and Rabeder, 1997b; Nagel and Rabeder, 1997) were found.

Single finds from Middle Pleistocene loess and river bank sediments are stored in archives of the Natural History Museum of Vienna and the Museum Krems, but their find locations and stratigraphic context remain unknown. A small assemblage of large animal bones was collected from a sand pit in the Kamp valley close to the Rosenburg village (290 m a.s.l., approximately 25 km NNE of the two Wachau sites) in the late 20th century. It contained *Bison* sp. besides *Equus* sp. (the size speaks in favour of *E. mosbachensis*), a large cervid (*Alces* size), a pro*bos*cidean (probably *Elephas antiquus*), and *Ursus* sp. (cf. *etruscus* in Geyer, 1998). Regional terraces at this altitude within the Bohemian Massif are hypothesized as being formed by tributaries of the Middle Pleistocene Danube (Nagl and Verginis, 1989). A hypothetical attribution to a more humid (interglacial?) period before 0.5 Ma is suggested here.

A well preserved *B. priscus* bull skull with both horn cores was discovered in a wine cellar at Langenlois-Buriweg (Fladerer et al., 2005). Palaeopedological analysis of palaeosols in this outcrop dates the find to the late Middle Pleistocene (Rissian) to early Late Pleistocene (Early Würmian), ca.150-70 ka. The Krems-Kreuzbergstraße assemblage (see chapters 2.2 and 3.1) may represent the same time span as the Dürnstein bison. But as it is not determined by a terrace age, a Rissian or early Late Pleistocene age is not excluded. The deer bones in this assemblage display breakage, which is characteristic for human processing. Up until now only the Gudenushöhle and the Teufelsrast-Felsdach are sites with evidence of Neanderthal presence in the region (Neugebauer-Maresch, 1999). In the middle Danube region no Palaeolithic sites with dominant bison bones are known, and hence the role of bison hunting is interpreted as rather small.

Besides unstratified single finds in fluvial deposits and loess, excavations at Upper Palaeolithic sites in Austria only rarely yielded bison bones. The steppe bison in the middle Danube region was never a main game species of Upper Palaeolithic groups, as were woolly mammoth, horse and reindeer. But bisons as large as the Dürnstein individual, are documented at least until about 25 ka BP (see chapter 3.3, Willendorf V, Thenius, 1959). Large steppe bisons around the Last Glacial Maximum are also reported from Western Europe (cf. Grange et al., 2018).

sample	medium gravel %	fine gravel %	coarse sand %	medium sand %	fine sand %	coarse silt %	medium silt %	fine silt %	clay %	Mean Mz	Stdev σ_I
Dürnstein-1	11.0	4.9	4.9	14.6	44.6	10.5	4.9	2.6	2.0	2.8	2.95

Table 7: Grain size analysis of sandy remains preserved within the bones of the Dürnstein bison (grain size in weight percent, mean in phi-unit, Mz (Φ16+Φ50+Φ84)/3) and standard deviation σ_I after Folk and Ward, 1957).

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