Zooarchaeological analysis of the Ulaan bulag Xiongnu burial site

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Ⅰ. Introduction

The Ulaan Bulag burial site, which is located in Yöröö district, Selenge province, contains 86 tombs associated with the Xiongnu period. In 2022, three tombs were excavated at this site (Ishtseren *et al.*, 2022). Of these, only Burial 3 yielded animal remains, consisting exclusively of cattle bones. In this report, we present the preliminary results of the zooarchaeological analysis of these cattle remains.

Ⅱ. Bone specimens

Most of the cattle bones recovered from Burial 3 were assembled as a collection, with many showing signs of breakage and fracturing. The assemblage included fragments of cattle skulls with mandibles, lower extremities (Ph1, Ph2, and Ph3), and caudal vertebrae (tail bones). Despite the fragmented condition of many bones, the number of individuals could be determined by examining relatively intact mandibles. A total of 5 pairs of mandibles (10 mandibles) were nearly complete, with visible teeth in their rows. Additionally, we identified loose deciduous premolars (dP4) and some erupting teeth belonging to one juvenile cattle. Based on the analysis, it can be determined that six cattle heads, along with small phalanges and tail bones, were sacrificed in the grave **(Figure 1)**. Among the phalanges, 46 were identified as first phalanges (Ph1). Of these, 34 were fused, indicating adult cattle, whereas 32 were unfused, suggesting they belonged to younger individuals. This distinction highlights differences in the age of the cattle. We identified 36 second phalanges (Ph2), of which 35 were fused, and only a single phalange was unfused. Additionally, 27 third phalanges (Ph3) were present. Moreover, the assemblage also included 42 sesamoids, with 20 distal and 22 proximal sesamoids. In total, 40 caudal vertebrae were recovered, ranging from the larger vertebrae near the base of the tail to the smaller vertebrae at the tip **(Table 1)**. Pathologies such as exostoses, lipping, *i.e.*, extension of articular surfaces, and osteoarthritis were nearly absent in the phalanges of cattle.

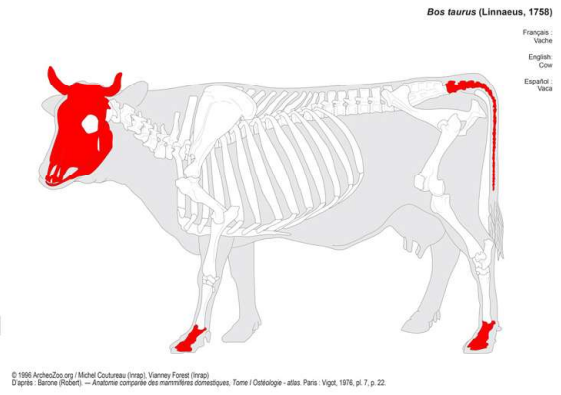

Fig.1 Cattle specimens

■ Cattle Age

The mandibles of the cattle indicate the presence of six individuals (minimum number of individuals = 6). The age of the cattle was determined based on the tooth wear stage, following the system outlined by Grant (1982), with age classes assigned following Legge (1992).

Table 1 Recorded specimens

Taxon	Element/Specimens	Count	Fused	Unfused
Cattle	Cranial part	At least 4 individuals		
	Mandibles	6 individuals		
	First phalanges	46	34	32
	Second phalanges	36	35	1
	Third phalanges	27		
	Proximal sesamoid	22		
	Distal sesamoid	20		
	Caudal vertebrae (tail bone)	40		

Fig.2 Lateral and occlusal surface of the cattle mandibles

Table 2 Tooth wear stages and attributed age

	dP4	M1	M2	M3	Stage	Age
Cattle 1	C	K	G	F	6	3-4 years
Cattle 2	-	K-L	K	J	8	6-8 years
Cattle 3	-	M	K-L	K	8	6-8 years
Cattle 4	-	K	G	B	6	26-36 months
Cattle 5	K-L	F			4	6-15 months
Cattle 6	B	-	-	-	3	1-3 months

■ Cattle 1

Cattle skull, horns, and mandible parts. The upper and lower premolars (P2, P3, and P4) and molars (M1, M2, and M3) are complete and preserved, whereas most incisors are missing. Based on the wear stage of the lower molars, this individual is estimated to be 3–4 years old **(see Table 2 and Figure 2)**.

■ Cattle 2

A complete pair of mandibles (right and left sides). The premolars and molars (P2, P3, P4, M1, M2, and M3) are complete and preserved. Based on the wear stage of the molars (M3), this individual is estimated to be 6–8 years old **(see Table 2 and Figure 2)**.

■ Cattle 3

A complete pair of mandibles (right and left sides) with all premolars (P2, P3, and P4) and molars (M1, M2, and M3) fully preserved. Based on the wear stage of the M3 molar, this individual is estimated to be between 6

and 8 years old. However, the wear stage of the M1 molar, which has reached level "m," typically corresponds to an age range of 8–10 years **(see Table 2 and Figure 2)**. Therefore, although the individual is estimated to be 6–8 years old based on the M3 wear stage, the condition of M1 suggests it may align with stage 9 (8–10 years), implying that Cattle 3 could be at least a year older than Cattle 2.

■ Cattle 4

A pair of mandibles (right and left sides) with a few premolars (P3) and molars (M1, M2, and M3) are preserved. The deciduous premolars (dP2 and dP4) have fallen, and the permanent P2 and P4 premolars are only beginning to erupt. There is slight wear on the anterior cusp of molar M3. This evidence suggests that the individual is estimated to be 3–4 years old **(see Table 2 and Figure 2)**.

■ Cattle 5

A pair of mandibles (right and left) containing a few deciduous premolars (dP2, dP3, and dP4) and the first molar (M1) are preserved, whereas the second molar (M2) is only beginning to erupt. The deciduous premolar 4 (dP4) exhibits significant wear, reaching the "k, l" level, and the first molar (M1) also shows noticeable wear **(see Table 2 and Figure 2)**, which indicates that the individual was likely between 6 and 15 months of age.

■ Cattle 6

The specimen consists of loose teeth, including deciduous premolars (dP4) and a few erupting molars. The deciduous premolar 4 (dP4) shows slight wear, classified as "level b." According to Legge's age assignment based on wear stages, a 1-month-old calf (Stage 1) has no wear on its deciduous teeth, whereas a calf aged 1–3 months (Stage 2) typically exhibits wear levels ranging from "a" to "f" on the dP4. Therefore, the age of this individual is estimated to be between 1 and 3 months **(see Table 2 and Figure 2)**.

Ⅲ. Measurements

Measurements were obtained for the mandible height, length of the tooth row, and the relatively intact first (Ph1), second (Ph2), and third (Ph3) phalanges. These measurements followed the methodology established by Angela von den Driesch. The measured specimens included 2 mature bovine jaws, 21 first phalanges (Ph1), 22 second phalanges (Ph2), and 9 third phalanges (Ph3). Comprehensive measurement data for each bone specimen are provided in Tables 3–6.

We compared the results of the Ulaan Bulag cattle measurement study with previous data collected from

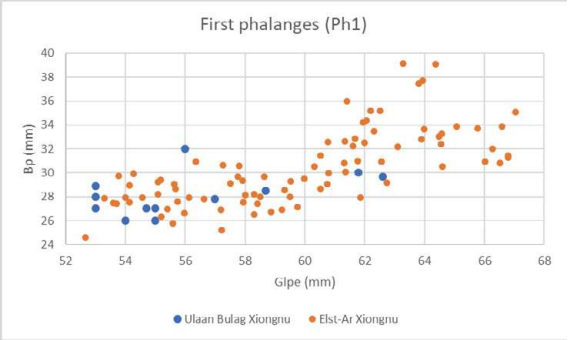

Fig.3 Measurements of the cattle first phalanges
(Bp=Breadth proximal; Glpe=Greatest length of the peripheral half)

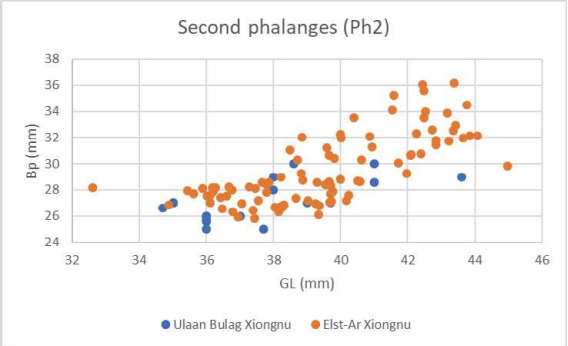

Fig.4 Measurements of the cattle second phalanges
(Bp=Breadth proximal; Gl=Greatest length)

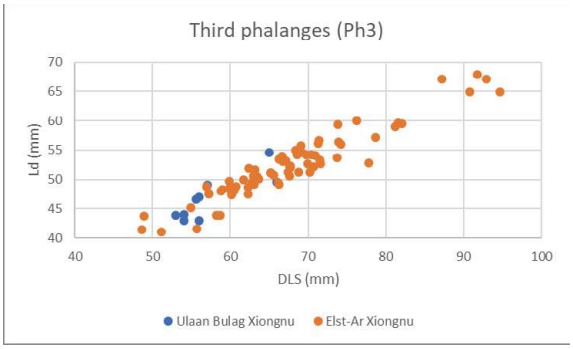

Fig.5 Measurements of the cattle third phalanges
(Ld=length of dorsal surface; DLS=Diagonal length of the sole)

Table 3 Measurements of the mandibles (Only adult cattle) from Ulaan Bulag

Individual number	Asymmetry	Length (7)	Length (8)	Height (15a)	Height (15b)	Height (15c)
Cattle 2	Right	14	87	83	55	41
Cattle 2	Left	142	87	82	54	41
Cattle 3	Right	131	84	64	48	35
Cattle 3	Left	131	86	64	47	32

Table 4 Measurements of first phalanges (Ph1) from tomb 3

Specimens	Epiphyseal fusion	Glpe	Bp	Bd
Ph1	fused	62.6	29.7	28.5
Ph1	fused	58.7	28.5	29
Ph1	fused	61.8	3	29.4
Ph1	fused	56	32	30
Ph1	fused	57	27.8	28
Ph1	fused	57.9	-	-
Ph1	fused	53	28.9	26
Ph1	fused	54.7	27	25
Ph1	fused	53	27	26
Ph1	epifused	-	26.8	-
Ph1	fused	56	-	24
Ph1	fused	58	-	26
Ph1	fused	53	-	25
Ph1	fused	56	-	29
Ph1	fused	6	-	-
Ph1	fused	53	-	-
Ph1	fused	54	-	26
Ph1	fused	53	28	26
Ph1	fused	55	26	25
Ph1	fused	55	27	24
Ph1	fused	54	26	24

Table 5 Measurements of second phalanges (Ph2) from tomb 3

Specimens	Epiphyseal fusion	GL	Bp	Bd
Ph2	fused	43.6	29	24
Ph2	fused	41	28.6	24
Ph2	fused	41	30	26
Ph2	fused	38.6	30	26
Ph2	fused	38	29	26
Ph2	fused	38	28	27
Ph2	fused	39	27	24
Ph2	fused	39.7	27	24
Ph2	fused	39.7	-	25
Ph2	epifus	40	-	-
Ph2	fused	41	-	24.7
Ph2	fused	36	26	22
Ph2	fused	35	27	22
Ph2	fused	37	26	23.6
Ph2	fused	37.7	25	21.6
Ph2	fused	36	25	20
Ph2	fused	36	25.7	21
Ph2	fused	36	25.6	20
Ph2	fused	35	27	22
Ph2	fused	34.7	26.6	21
Ph2	fused	36	26	21
Ph2	fused	35	27	22

Table 6 Measurements of third phalanges (Ph3) from tomb 3

Specimens	DLS	Ld	MBS
Ph3	43.6	29	24
Ph3	41	28.6	24
Ph3	41	30	26
Ph3	38.6	30	26
h3	38	29	26
Ph3	38	28	27
Ph3	39	27	24
Ph3	39.7	27	24
Ph3	39.7	-	25
Ph3	40	-	-
Ph3	41	-	24.7
Ph3	36	26	22
Ph3	35	27	22
Ph3	37	26	23.6
Ph3	37.7	25	21.6
Ph3	36	25	20
Ph3	36	25.7	21
Ph3	36	25.6	20
Ph3	35	27	22
Ph3	34.7	26.6	21
Ph3	36	26	21
Ph3	35	27	22

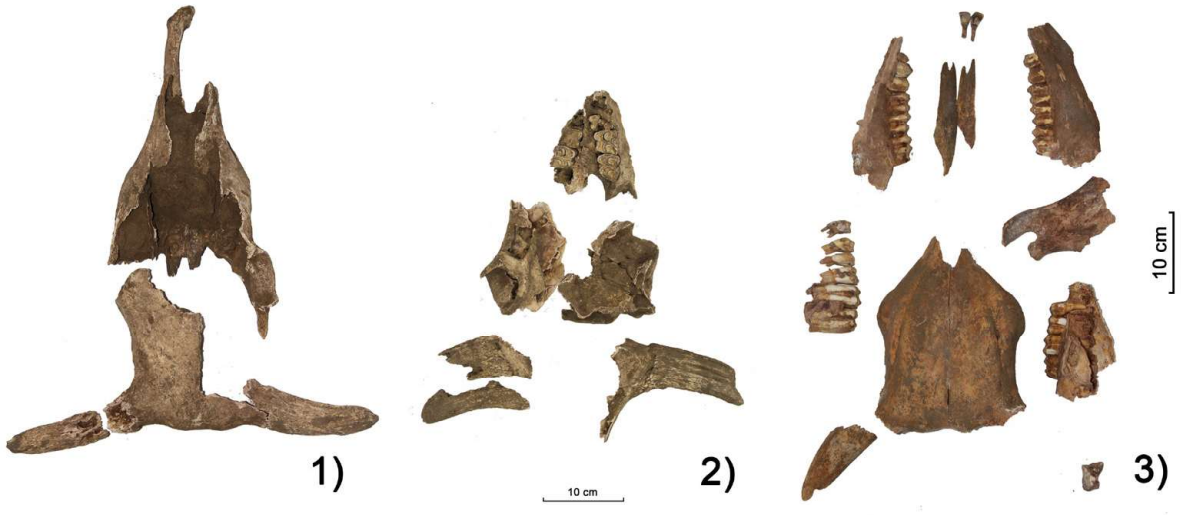

Fig.6 Cattle Skull Parts from the Ulaan Bulag Site

the Elst-Ar Xiongnu period site in Dashinchilen soum, Bulgan aimag **(Figures 3–5)**. The measurements of the Ulaan Bulag cattle bones closely align with those of the Elst-Ar cattle. As shown in the figures, several specimens collected from the Ulaan Bulag burial site suggest that they likely belong to relatively large individuals. It can be inferred that one of the two mature cattle (aged 6–8 years) found in the Ulaan Bulag burial was likely a relatively large-bodied male.

Based on the skull and phalanges morphology, the Ulaan Bulag cattle can be identified as Bos taurus. However, a few cattle, such as "Bull 3," exhibit more rounded mandibles than those in the other cattle. It remains unclear whether this is a simple morphological variation or if it is species-related. At the current stage of this research, the cause of this variation has not been determined. Additionally, three cattle in this group displayed distinct horn features **(Figure 6)**.

The sacrificial use of head, foot phalanges, and tail

bones is a common feature of the rituals of Xiongnu burials, often referred to as “Zuld” in Mongolian. This type of ritual, associated with animal sacrifice, was prevalent during the Xiongnu period and dates back to the Bronze Age among Inner Asian pastoral nomads, continuing throughout history to the recent centuries, as evidenced by various archaeological, historical, and ethnographic sources. “Zuld” represents a ritual form, symbolizing the entire animal (Ankhbayar 2004: 77). Some small local variations were observed in the faunal assemblages at the Ulaan Bulag burial site. First, it was a tradition in ancient “Zuld” sacrifices for the atlas (first cervical vertebra) to be articulated with the skull. However, no atlas bone was found in the Ulaan Bulag faunal assemblages. Second, it was common for Zuld rituals to include the heads of sheep and goats alongside cattle or horses. The unique characteristic of this Ulaan Bulag burial site is that the sacrifice consisted entirely of cattle bones, with several cattle involved, which may be related to their subsistence strategy and the composition of livestock species in their pastoral practices.

The cattle remains discovered in Burial 3 revealed a considerable variation in age. The sacrificial animals included two mature cattle, two pre-adult cattle, one heifer, and one juvenile aged 6–8 years, 3–4 years, 6–15 months, and 1–3 months, respectively. If these animals were deliberately slaughtered for burial, the presence of the 1–3-month-old calf suggests that the grave was most likely prepared during the summer months. Among ancient pastoral nomadic communities in Mongolia, it was a tradition to sacrifice animals of various species and ages, such as horses, cattle, sheep, and goats, including young animals, occasionally alongside their mothers (Tuvshinjargal 2022). This practice reflects the ideological and cultural beliefs of these ancient societies. Based on these results, we propose the following hypothesis: it was believed that the deceased raised these animals in the afterlife; therefore, the sacrificial animals were chosen with a diverse mix of ages and genders.

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