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The Paleolithic open-air site of Tolbor-17 (Mongolia): A preliminary faunal report

Abstract: The open-air site of Tolbor-17 (T17), located in northern Mongolia, contains one of few faunal assemblages in the region from early Marine Isotope Stage 3 (MIS 3, ~57-29 ka cal BP). During this period, humans migrated into northern Asia as part of the Initial and Early Upper Paleolithic (IUP and EUP). Much is still unknown about these populations, including the adaptive strategies that facilitated their success at the geographic margins of hominin dispersal. This paper presents the preliminary analysis of the T17 faunal assemblage, a valuable source of data on early human subsistence and paleoecology. Although small (n = 836) and fragmentary, the assemblage illuminates several aspects of early human behavior, namely the butchery of large and extra-large ungulates as well as the use of osseous tools and personal ornaments. In addition to ungulates, humans also exploited marmot, ostrich (eggshell) and at least one large carnivore, attesting to the wide range of human-animal interactions at the site. In addition to humans, carnivores also modified the assemblage, likely as scavengers of human butchery waste. These results provide a basis for future analyses at the site, focusing on the agents of accumulation, taphonomic processes, and implications for early human adaptations in Central Asia.

Keywords: *Marine Isotope Stage 3 (MIS 3), Initial Upper Paleolithic, Northern Asia, Mongolia, Zooarchaeology*

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1. Introduction

Under study since the late 19th century, Mongolia hosts numerous Late Pleistocene archaeological sites from Marine Isotope Stage 3 (MIS 3, ~57-29 ka cal BP) (Voelker et al. 1998; van Kreveld et al. 2000; Zwyns et al. 2014a; Gunchinsuren 2017a, 2017b). This period is characterized by the dispersal of modern humans (*Homo sapiens*) into Eurasia, starting with the Initial Upper Paleolithic (IUP) ~50-40 ka cal BP and the Early Upper Paleolithic (EUP) ~40 ka cal BP (Kuhn and Zwyns 2014; Li et al. 2020; Zwyns 2021). The IUP is broadly defined by the appearance of transitional lithic industries with both Middle and Upper Paleolithic features, namely Levallois-like reduction and blade technology, respectively (Zwyns 2012; Kuhn and Zwyns, 2014; Zwyns et al. 2019). This period is also associated with early personal ornaments made from animal teeth and ostrich eggshell (OES) as well as new forms of osseous technology (Derevianko and Rybin 2003; Lbova 2011; Zwyns et al. 2019). Starting ~40 ka cal BP, EUP industries appeared, characterized by increased bladelet production (Gladyshev et al. 2010).

Except for a faint signal detected among current Asian populations, early IUP settlers did not contribute to the current gene pool (Hajdinjak et al. 2021). Yet, populations may have survived somewhere in Asia, and it is unclear if this transition was more of a "rupture" or a "logical continuation" of cultural traditions (Derevianko et al. 2013; Rybin et al. 2020, p. 135). As far as we know, two main human lineages are identified in East Asia between ~40-30 ka cal BP, coeval with the EUP. Identified in the Arctic Circle, the Yana ancestry (Sikora et al. 2019) likely corresponds to populations that extended southward, into the steppe of Central and East Asia. Further south, the Tianyuan ancestry is known from the eponymous cave in Zhoukoudian, China (Fu et al. 2013). The context in which EUP occurs is therefore key to understanding the definite instalment of our species in the Eurasian landscape. From an adaptive standpoint, it is a critical moment during which behavioral innovations are generalized against the backdrop of complex population dynamics, at the beginning of the climatic deterioration leading to the Last Glacial Maximum (Goebel et al. 1999).

In northern Mongolia, evidence for MIS 3 subsistence and paleoenvironment is limited; however, other parts of northern Asia, such as the Cis- and Transbaikal, shed light on the larger region (Izuho et al. 2019; Shichi et al. 2023). During the Late Pleistocene, northern Asia was composed of cold, humid, tundra-forest-meadow-steppes inhabited by cold-adapted species such as woolly mammoth (*Mammuthus primigenius*), woolly rhinoceros (*Coelodonta antiquitatis*), and reindeer (*Rangifer tarandus*) (Vasil'ev 2003; Ma et al. 2013; Khenzykhenova et al. 2016, Izuho et al. 2019). Prior to the IUP, Middle Paleolithic hominins hunted megafauna, medium-large ungulates, and occasionally fish and birds. Upper Paleolithic humans hunted similar species, aside from a decreasing reliance on megafauna (Vasil'ev 2003). Less is known about the period between the Middle and Upper Paleolithic,

Figure 1. Map of Mongolia depicting the position of Tolbor-17 in relationship to the capitol, Ulaanbaatar. Color gradient corresponds to elevation. Figure produced by Gallo et al. (2021).

given the dearth of IUP and EUP sites with adequate faunal preservation. Additionally, of these sites, few faunal assemblages have been systematically studied.

This study presents the preliminary faunal analysis of Tolbor-17 (T17), an MIS 3 site located in northern Mongolia within the Selenga drainage system (Figure 1).

Although small and fragmentary, the assemblage is relatively well-preserved and provides a new opportunity to explore hominin subsistence and paleoenvironment in the region. This investigation focuses on two main questions: (1) what characterizes IUP/EUP subsistence at the site? (2) how does T17 compare to other sites in the region? Answers to these questions will illuminate larger aspects of hominin subsistence, namely how IUP/EUP groups adapted to new environments as they dispersed and how that differed from earlier and later hominins on the landscape.

2. Background

Located in northern Mongolia, the Selenga drainage system hosts numerous MIS 3 archaeological sites. IUP and EUP occupations are especially well-documented, representing the far reaches of this chrono-cultural complex and early human dispersals into northern Asia (Kuhn and Zwyns 2014). Parts of the Selenga drainage system are particularly rich, namely the Dorolj, Orkhon, and Tolbor valleys. The latter contains over eighty open-air archaeological sites across an area of ~25 square kilometers (Zwyns et al. 2014a).

Tolbor-17 (T17) is an open-air site situated on a south-facing slope of the Tolbor Valley, which was formed by the Ikh Tolborin-Gol (Great Tolbor River), a tributary that joins the Selenga River ~15 km to the north (Zwyns et al. 2014a, 2014b). The site was initially discovered and excavated by A. Tabarev and S. Gladyshev in 2010 (Gladyshev et al. 2012; Tabarev et al. 2013). In 2017, excavations were renewed by a joint Mongol-Japanese-American team led by B. Gunchinsuren, N. Zwyns, and M. Izuho. These excavations took place in three seasons between 2017 and 2019, resulting in three excavation pits (Pits 1-3), followed by a sampling season in 2024 with plans to expand the site horizontally in 2025. During excavations, all finds > 2 cm were piece plotted, and the remaining material was sieved through 4 and 2 mm screens (Gallo et al. 2021; Johnson et al. 2024; Zwyns pers. comm. 2024).

The T17 stratigraphy is divided into three lithostratigraphic units (LU or Layer): LU1 represents a Holocene soil formation, LU2 includes loess and loess-like deposits, and LU3 is a laminar silt filled with gravels and cobbles (Gallo et al. 2021; Johnson et al. 2024; Zwyns pers. comm. 2024). The depositional history is complex, evidencing various post-depositional alterations (e.g., solifluction, deflation). Identified in neighboring sites, LU2 corresponds to early MIS 2 (< 29 ka cal BP), while at T17, dates from the upper part of LU3 correspond to late MIS 3 (33-34 ka cal BP) (Gladyshev et al. 2013; Zwyns et al. 2014b). Additional dates from the lower part of LU3 are in progress but likely extend the chronology beyond 40 ka cal BP (Zwyns pers. comm. 2024). This chronology is consistent with other MIS 3-2 assemblages in the Tolbor valley, which span from ~45-30 ka cal BP (Zwyns et al. 2019; Rybin et al. 2020). The focus of this paper is the faunal material from LU3 (also denoted as Layer 3).

Prior studies of T17 focused on a portion of the lithic assemblage and evidence of burning. Johnson et al. (2024) studied the microblade assemblage from LU2 and Gallo et al. (2021) studied the thermal alteration of faunal remains from LU3. Investigations of the larger lithic assemblage, site formation processes, paleoenvironment, and various biomolecules (e.g., aDNA, amelogenin, isotopes) are ongoing. This paper constitutes the first formal zooarchaeological analysis of the site.

3. Materials and methods

A total of 836 faunal remains were analyzed from T17, which includes all piece-plotted finds (n = 541) as well as all bucket finds > 2 cm or identifiable (n = 296). This report focuses on material from LU3, considered here as a single assemblage (n = 759). Overlying layers were excluded, as the spatial distribution shows their differentiation in Pits 1 and 2 but mixing in Pit 3 (Figure 2). This also limits the analysis to material dated to MIS 3.

Primary data collection followed current zooarchaeological standards (Grayson 1984; Lyman 1994; Stiner 2005; Reitz and Wing 2008) utilizing various atlases (Schmid 1972; Cohen and Serjeantson 1996; Hillson 2005), 3D imagery (e.g., from Sketchfab.com), and two comparative collections at the University of California, Davis: the Zooarchaeology Comparative Collection (Anthropology Department) and the Mammal Collection at the Museum of Wildlife and Fish Biology (Department of Wildlife, Fish, and Conservation Biology). Standard measurements and scan sites were collected when present (von den Driesch, 1976; Lyman, 1984). Ageable specimens were assigned an age at death based on epiphysial fusion (unfused, partly fused, nearly fused, or fully fused), tooth eruption, and tooth wear (Severinghaus 1949; Stiner 1990).

All specimens were identified to the lowest possible taxonomic level and size class. Size class categories follow Stiner (2005) with modifications for Eurasian Pleistocene taxa (e.g., Saarinen et al.

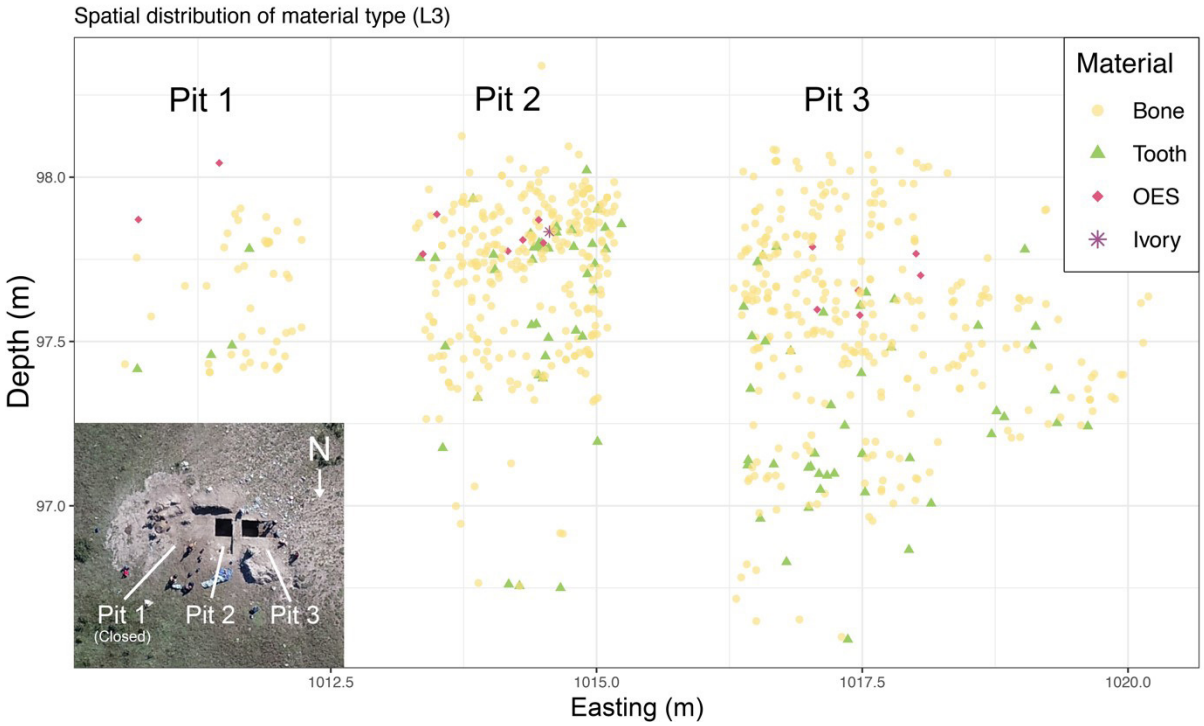

Figure 2. Tolbor-17 (Layer 3). Vertical spatial distribution of faunal materials by NISP (number of identified specimens) across the three excavation areas (Pits 1-3). Additional plots of spatial data are presented in the supplementary.

2016) and include small ungulate (10-50 kg; e.g., roe deer, gazelle, Saiga antelope), medium ungulate (50-100 kg; e.g., Ovicaprids), large ungulate (100-350 kg; e.g., reindeer, red deer), extra-large ungulate (> 350 kg; e.g., Equids, *Bos/Bison* sp.), megafauna (> 1000 kg; e.g., wooly rhinoceros, wooly mammoth), small carnivore (< 30 kg; e.g., marten, fox), large carnivore (> 30 kg; e.g., wolf, bear), small mammal (< 10 kg), medium-large mammal (> 10 kg). For the identified assemblage, both NISP (number of identified specimens) and MNI (minimum number of individuals) were calculated (Grayson 1984; Lyman 2008).

To investigate the assemblage's taphonomic history, fractures were recorded following current standards (Morlan 1980; Johnson 1985; Villa and Mahieu 1991), and cortical surfaces, when preserved, were observed under directional light and magnification (Eschenbach illuminated lens, 10x). Observations included anthropogenic and carnivore bone surface modifications (Fisher 1995; Domínguez-Rodrigo and Piqueras 2003; Domínguez-Rodrigo et al. 2009; Starkovich and Conard 2015; Fernandez-Jalvo and Andrews 2016; Soulier and Costamagno 2017; Costamagno et al. 2019), trampling damage, root etching, burning stage (Stiner et al. 1995), weathering stage (Behrensmeyer 1978), and staining area and intensity (López-González et al. 2006). All specimens were also examined for other anthropogenic modifications (e.g., ornament production, tool use) with reference to relevant literature (Delporte et al. 1988; Barge-Mahieu et al. 1990; Villa and d'Errico 2001; Auguste et al. 2002; Backwell and d'Errico 2014; Venditti et al. 2023).

Data were collected in E5 (McPherron 2024) and further analyzed in Excel version 16.94 (Microsoft Corporation 2025), R version 4.4.2 (R Core Team 2025), and R Studio version 2024.12.0+467 (Posit Team 2024).

4. Results

Approximately 9% of remains (n = 71) were identified to genus or avian family (Table 1).

A total of 12 species are represented: wooly mammoth (*Mammuthus primigenius*), large bovid (*Bos*/*Bison* sp.), equid (*Equus* sp.), reindeer (*Rangifer tarandus*), ovicaprid (*Ovis*/*Capra* sp.), bear (*Ursus* sp.), lion (*Panthera* sp.), wolf (*Canis* cf. *lupus*), ostrich (*Struthio* sp.), raptor (Accipitridae or *Falco* sp.), marmot (*Marmota marmota*), and vole (*Microtus*/*Chionomys* sp.) (Figure 3-4). Other than vole, each taxon is represented by an MNI of 1. The low MNI relative to the high NISP indicates a highly fragmented assemblage.

Table 1. Tolbor-17. Taxonomic representation of layer 3 (L3) by NISP and MNI. NISP = number of identified specimens, MNI = minimum number of individuals. Data from layer 1, layer 2, and indeterminate layers (NISP = 77) is presented in the supplementary material.

Group	Taxon	L3 NISP	L3 MNI	% Group	% Total
Carnivores	Wolf (*Canis* cf. *lupus*)	1	1	6%	<1%
	Lion (*Panthera* sp.)	6	1	38%	1%
	Bear (*Ursus* sp.)	2	1	13%	<1%
	Large felid or hyenid	1		6%	<1%
	Large carnivore	4		25%	<1%
	Small felid	1		6%	<1%
	Indet. carnivore	1		6%	<1%
	Total carnivore	16		100%	2%
Ungulates	Small or medium bovid	5		2%	1%
	Ovicaprid (*Ovis*/*Capra* sp.)	2	1	1%	<1%
	Medium bovid	2		1%	<1%
	Large bovid (*Bos*/*Bison* sp.)	9	1	4%	1%
	Reindeer (*Rangifer tarandus*)	1	1	<1%	<1%
	Large cervid	3		1%	<1%
	Equid (*Equus* sp.)	16	1	7%	2%
	Woolly Mammoth (*Mammuthus primigenius*)	1	1	<1%	<1%
	Small or medium ungulate	5		2%	1%
	Medium ungulate	1		<1%	<1%
	Medium or large ungulate	45		17%	6%
	Large ungulate	33		14%	4%
	Large or extra-large ungulate	65		26%	8%
	Extra-large ungulate	61		25%	8%
	Extra-large ungulate or megafauna	8		4%	1%
	Indet. ungulate	31		12%	4%
	Total ungulate	288		100%	37%
Rodents	Vole (*Microtus/Chionomys* sp.)	12	3	60%	1%
	Marmot (*Marmota* sp.)	6	1	30%	1%
	Indet. microfauna	2		10%	<1%
	Total rodent	20		100%	2%
Birds	Ostrich (*Struthio* sp.)	13	1	89%	2%
	Large bird (Accipitridae or *Falco* sp.)	2	1	11%	<1%
	Total bird	15		100%	2%
General	Hare or fox-sized mammal	6		1%	1%
	Small mammal	4		1%	<1%
	Medium or large mammal	393		94%	53%
	Indet. mammal	12		3%	1%
	Small mammal or bird	4		1%	<1%
	Indeterminate	1		<1%	<1%
	Total general	420		100%	57%
Total		759			

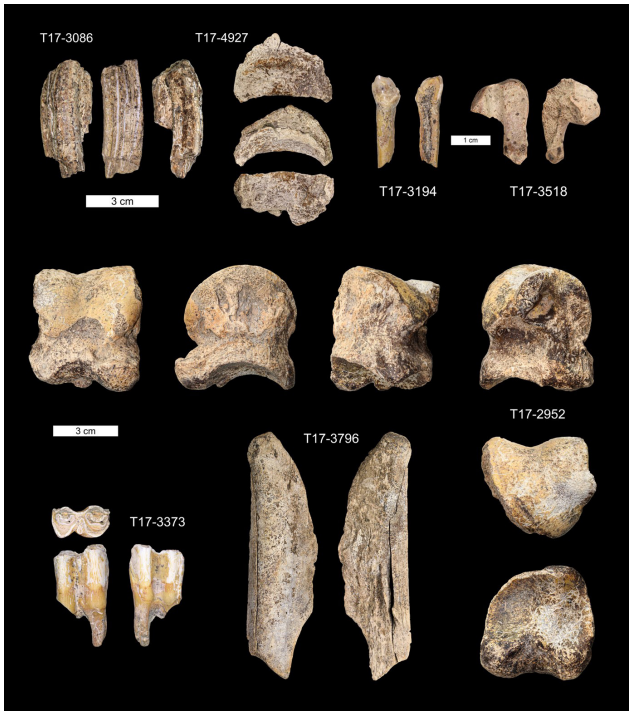

Figure 3. Tolbor-17. Ungulate remains: reindeer (Rangifer tarandus) lower second incisor (3194); Ovicaprid (Ovis sp. or Capra sp.) first phalanx (3518); equid (Equus sp.) lower second premolar (3086) and third phalanx (4927); large bovid (Bos/Bison sp.) second phalanx (2952), lower left first molar (3373), and metatarsal (3796).

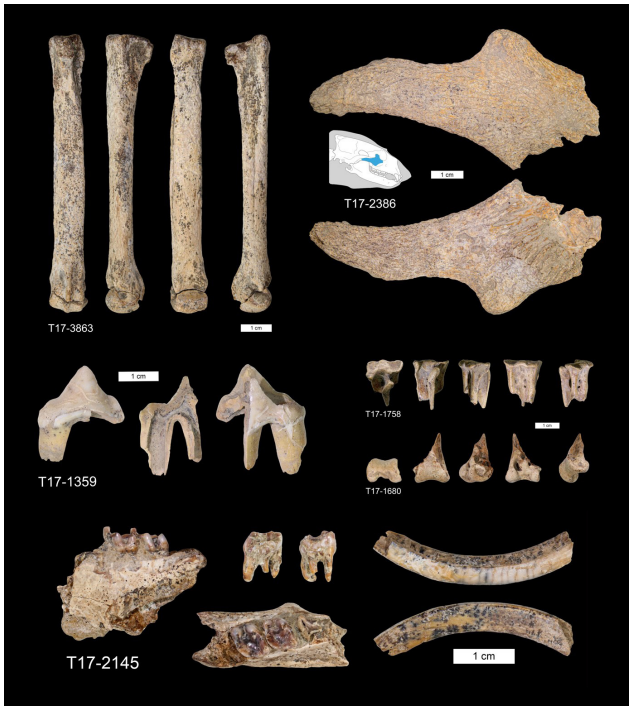

Figure 4. Tolbor-17. Other animal remains: wolf (Canis cf. lupus) right third metatarsal (3863), bear (Ursus sp.) right zygomatic (2386), lion (Panthera sp.) premolar (1359), avian (likely Accipitridae or Falco sp.) left proximal tarsometatarsus (1758) and left distal tibiotarsus (1680), and marmot (Marmota sp.) left mandible and left maxillary incisor, fourth premolar, first molar, second molar, and third molar (2145).

When broken down by size class (n = 297), most remains correspond to ungulates (87%), especially extra-large ungulates (33%), large or extra-large ungulates (26%), medium or large ungulates (17%), and large ungulates (14%) (Figure 5).

Carnivores (5%), birds (5% including ostrich eggshell fragments), and large rodents (3%) are infrequent. Concerning the spatial distribution of the larger taxonomic groups, ungulates are evenly distributed throughout the sequence, while carnivores, rodents, and especially birds (namely OES beads) are concentrated in the upper half of the sequence.

The assemblage is highly fractured, with approximately 41% of remains exhibiting green fractures (Figure 6).

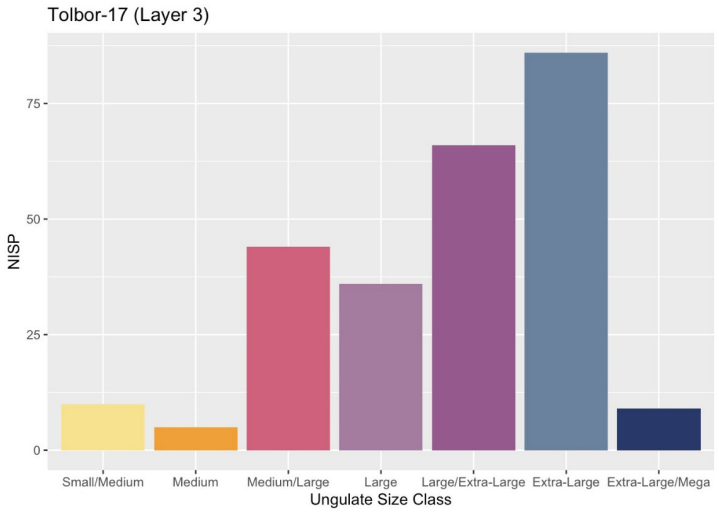

Figure 5. Tolbor-17 (Layer 3). Ungulate NISP by size class. NISP = number of identified specimens, Mega = megafauna.

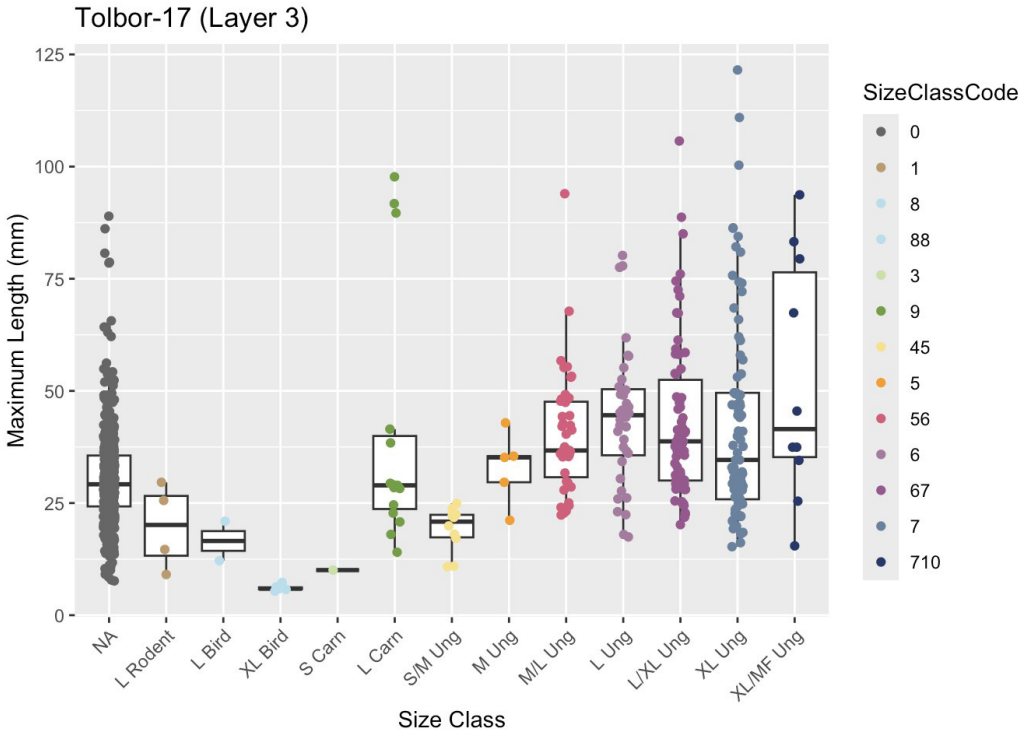

Figure 6. Tolbor-17 (Layer 3). Distribution of maximum length (mm) by size class. NA = not applicable, Carn = carnivore, Ung = ungulate, S = small, M = medium, L = large, XL = extra-large, MF = megafauna.

This includes cone fractures (n = 22), transverse fractures (n = 193), split fractures (n = 346), spiral fractures (n = 38), and peeling (n = 5). Most of the assemblage (91%) also exhibits some form of dry fracture, indicating considerable post-depositional fragmentation.

Bone surface modifications are difficult to observe, as surface preservation was poor. Anthropogenic modifications are recorded on 10% of specimens (n = 74) and include impacts (n = 18) and cut marks (n = 42) (Table 2).

Table 2. Tolbor-17 (Layer 3). Anthropogenic bone surface modifications. NISP = total NISP from each category. NA = indeterminate size class (e.g., medium to large mammal). Note: some specimens were omitted due to incomplete information.

Size Class	*NISP*	*Cuts*	*%*	*Impacts*	*%*	*Worked*	*%*
Small Carnivore (< 30 kg)	1	0	0%	0	0%	0	0%
Large Carnivore (> 30 kg)	15	1	7%	0	0%	2	13%
Small ungulate (10-50 kg)	0	0	0%	0	0%	0	0%
Small or medium ungulate	10	0	0%	1	10%	0	0%
Medium ungulate (50-100 kg)	5	0	0%	0	0%	0	0%
Medium or large ungulate	44	5	11%	2	5%	0	0%
Large ungulate (100-350 kg)	36	3	8%	1	3%	1	2%
Large or extra-large ungulate	66	4	6%	5	8%	4	5%
Extra-large ungulate (> 350 kg)	86	3	3%	3	3%	1	10%
Extra-large ungulate or megafauna	10	2	20%	0	0%	0	0%
Large rodent (1-15 kg)	9	1	11%	0	0%	0	0%
Large bird (1-15 kg)	2	0	0%	0	0%	8	62%
Extra-large bird (> 15 kg)	13	0	0%	0	0%	4	1%
NA	458	21	5%	6	1%	0	0%
Total	**755**	**40**	**5%**	**18**	**2%**	**2**	**13%**

Cut marks could be associated with specific butchery activities on three occasions: cut marks on two large ungulate metapodials are consistent with tendon extraction and cut marks on an extra-large ungulate humerus indicate defleshing (Soulier and Costamagno, 2017; Costamagno et al., 2019).

Carnivore modifications are recorded on 5% of remains and include drags (n = 12), bites (n = 18), punctures (n = 5), crenulation (n = 2), and digestion (n = 6) (Table 3).

Table 3. Tolbor-17 (Layer 3). Carnivore bone surface modifications. NISP = total NISP from each category. NA = indeterminate size class (e.g., medium to large mammal), All = any anthropogenic modification. Note: some specimens were omitted due to incomplete information.

Size Class	*NISP*	*Bites*	*%*	*Punctures*	*%*	*Drags*	*%*	*Crenulation*	*%*	*Digestion*	*%*	*Gnawing*	*%*
Small Carnivore (< 30 kg)	1	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Large Carnivore (> 30 kg)	15	0	0%	1	7%	0	0%	0	0%	1	7%	0	0%
Small ungulate (10-50 kg)	0	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Small or medium ungulate	10	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Medium ungulate (50-100 kg)	5	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Medium or large ungulate	44	0	0%	1	2%	1	2%	1	2%	0	0%	0	0%
Large ungulate (100-350 kg)	36	1	3%	0	0%	0	0%	0	0%	0	0%	0	0%
Large or extra-large ungulate	66	5	8%	0	0%	3	5%	0	0%	0	0%	1	2%
Extra-large ungulate (> 350 kg)	86	3	3%	0	0%	1	1%	0	0%	0	0%	1	1%
Extra-large ungulate or megafauna	10	0	0%	0	0%	0	0%	0	0%	1	10%	0	0%
Large rodent (1-15 kg)	9	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Large bird (1-15 kg)	2	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Extra-large bird (> 15 kg)	13	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
NA	458	9	2%	3	1%	7	2%	1	0%	4	1%	3	1%
Total	**755**	**18**	**2%**	**5**	**1%**	**12**	**2%**	**2**	**0%**	**6**	**1%**	**5**	**1%**

Gnawing was primarily observed on large and extra-large ungulate remains, although one *Panthera* sp. specimen also exhibits bite marks. Measurements of mark length and width indicate both large and small carnivores modified the assemblage (Fig. 7).

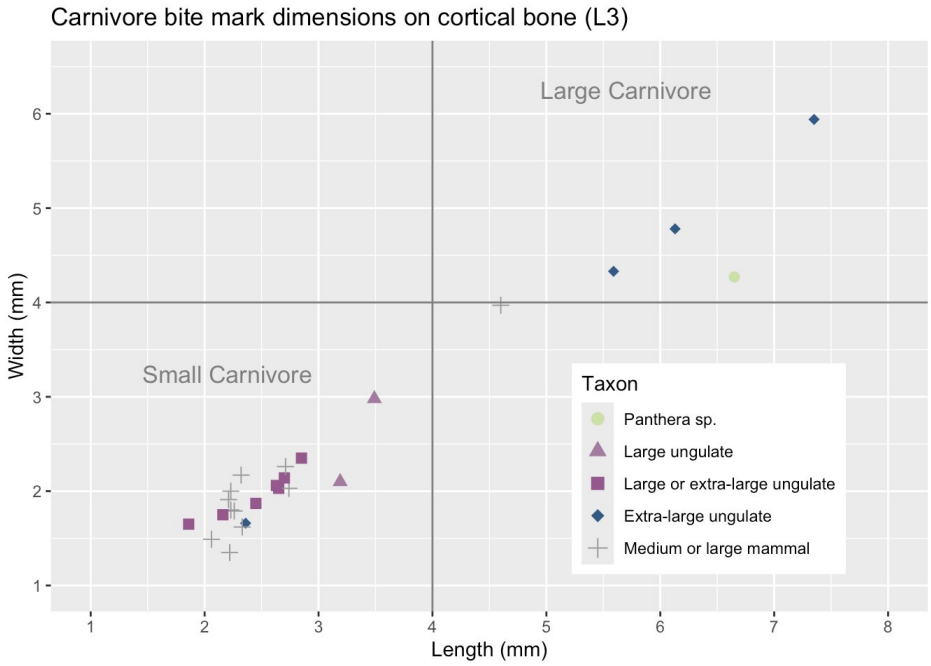

Figure 7. Tolbor-17 (Layer 3). Carnivore bite mark dimensions on cortical bone. Size cutoffs were adapted from Dominguez-Rodrigo and Piqueras (2003) and Starkovich and Conard (2015).

Other taphonomic modifications (Table 4) include polish or rounding (n = 85), burning (n = 15) (for screened material, see also Gallo et al., 2021), weathering (n = 163), black staining (n = 617), and red staining (n = 34). Over half (n = 381) of the assemblage is also affected by root etching, which destroyed most cortical surfaces and impeded more detailed observations.

Table 4. *Tolbor-17 (Layer 3). Other taphonomic observations. Green = green fractures, Root = root etching, Burn = burning stages 1-6, Weather = weathering stages 1-5, Black = black staining, Red = red staining, NA = indeterminate size class (e.g., medium to large mammal).*

Size class	*NISP*	*Green %*	*Root %*	*Polish %*	*Burn %*	*Weather %*	*Black %*	*Red %*
Small carnivore (< 30 kg)	1	0 0%	0 0%	0 0%	0 0%	0 0%	1 100%	0 0%
Large carnivore (> 30 kg)	15	1 7%	11 73%	1 7%	0 0%	4 27%	11 73%	0 0%
Small ungulate (10-50 kg)	0	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%
Small or medium ungulate	10	2 20%	3 30%	0 0%	0 0%	3 30%	8 80%	0 0%
Medium ungulate (50-100 kg)	5	0 0%	0 0%	0 0%	0 0%	1 20%	3 60%	0 0%
Medium or large ungulate	44	33 75%	24 55%	7 16%	0 0%	11 25%	44 100%	4 9%
Large ungulate (100-350 kg)	36	31 86%	27 75%	1 3%	0 0%	16 44%	35 97%	3 8%
Large or extra-large ungulate	66	56 85%	42 64%	13 20%	1 2%	15 23%	63 95%	1 2%
Extra-large ungulate (>350 kg)	86	29 34%	30 35%	7 8%	1 1%	11 13%	70 81%	2 2%
Extra-large ungulate or megafauna	10	8 80%	2 20%	3 30%	1 10%	2 20%	10 100%	0 0%
Large rodent (1-15 kg)	9	1 11%	1 11%	0 0%	0 0%	0 0%	3 33%	0 0%
Large bird (1-15 kg)	2	1 50%	0 0%	1 50%	0 0%	0 0%	1 50%	0 0%
Extra-large bird (> 15 kg)	13	0 0	0 0%	0 0%	1 8%	0 0	0 0%	3 23%
NA	458	148 32%	241 53%	52 11%	11 2%	100 22%	368 80%	21 5%
Total	**755**	**310 41%**	**381 50%**	**85 11%**	**15 2%**	**163 22%**	**617 82%**	**34 5%**

It was possible to age a small number of specimens. Juvenile remains include a deciduous extra-large ungulate tooth fragment and two vertebral centrums with unfused epiphyses from a medium or large mammal. All other elements with preserved metaphyseal regions are fully fused (n = 12) and most adult dentition exhibits some degree of wear (n = 6), indicating most ageable individuals are adults.

Lastly, some specimens exhibit more significant anthropogenic modifications. This includes ostrich eggshell beads (n = 13), a possible retoucher made from the humerus of an extra-large ungulate, a possible bone point, two possible bone needles, a notched bone fragment, and two possible ornament preforms. Concerning the latter, one was made from a large carnivore incisor (probably lion), and the other from a large bovid incisor. Both exhibit bilateral scraping on the root, likely in preparation for perforation. The notched piece exhibits five parallel and transverse incisions, deeper than cut marks observed elsewhere in the assemblage. The bone point is broken longitudinally and presents deep, longitudinal scraping and polish across the entire preserved surface. Both the point and the notched piece are reminiscent of findings at other IUP/EUP sites across Eurasia (Shunkov et al. 2020; Martisius et al. 2022). Finally, there is a possible worked ivory fragment, but additional observations are required to confirm this.

5. Discussion

5.1. Assemblage summary

The T17 faunal assemblage is taxonomically diverse but represented by few individuals. Ungulates are the most abundant, especially large and extra-large ungulates, which correspond to large bovids (e.g., aurochs or steppe bison), equids (e.g., horse), and large cervids (e.g., reindeer). Ovicaprids and woolly mammoth are also present. Carnivores are less frequent but include at least three taxonomic groups: canid (e.g., wolf), felid (e.g., cave lion), and ursid (e.g., cave bear). Other taxa include ostrich (only beads made from eggshell), raptor (e.g., falcon, hawk, eagle), marmot, and vole.

Traces of both carnivore and anthropogenic activity were observed on some remains. Carnivore damage is located on ungulates and a single *Panthera* sp. specimen. Tooth mark measurements indicate both large and small carnivore agents, although no small carnivores, other than a small felid, were observed. Cut marks and impacts were likewise recorded on ungulates as well as a single marmot. Most cut marks were undiagnostic, but some could be associated with specific butchery practices: defleshing and tendon removal.

Although largely well-preserved, the remains are heavily modified by post-depositional processes. Root etching, weathering, and staining all affect the assemblage and limit cortical surface preservation, likely obscuring many surface modifications. Other processes, such as solifluction and deflation, also altered the vertical and horizontal location of faunal remains, inhibiting more detailed spatial analyses.

5.2. Human and carnivore subsistence

Ungulates: Both humans and carnivores accessed ungulates at T17. Human agency is attested by cut and impact marks, osseous artifacts, and the larger lithic assemblage, while carnivore agency is represented by bite marks and other surface modifications. Humans were likely the primary agents, as anthropogenic traces are more numerous and carnivore damage appears on the same species exploited by humans (namely large and extra-large ungulates), suggesting they scavenged human butchery waste. However, it is certainly possible that some remains were accumulated by carnivores. Concerning human behavior, ungulates are the most abundant by NISP and MNI, attesting to their role in diet and subsistence. Although extra-large ungulates exhibit a higher NISP, the MNI of each ungulate taxon is only 1, suggesting an opportunistic, rather than selective, hunting strategy. Varying transportation, butchery, and/or taphonomic processes may explain the higher frequency of larger remains; however, additional investigation is required to test these hypotheses.

Carnivores: Carnivore remains are minimally modified. A single bite mark on a *Panthera* sp. specimen may indicate some within-order predation or scavenging. The modified carnivore incisor, likely an ornament preform, evidences some human involvement. However, ornaments, even unfinished preforms, can be transported between sites and may not represent the predation or scavenging of carnivores at T17. This tooth does evidence interaction in the larger region, although it is unclear if the tooth was scavenged from a carcass or if carnivores were explicitly hunted. Another possibility is the accumulation of carnivores via natural deaths. However, this is less likely, given that T17 is an open-air site and multiple individuals from at least three species are represented.

Small mammals: Traces of anthropogenic and carnivore activity are largely absent from the small mammal assemblage. One cut mark is recorded on a small mammal, which may correspond to a marmot or a similarly sized mammal (e.g., hare, fox). The vole remains likely correspond to natural deaths or avian predation. Due to limited reference material, these remains could not be identified beyond genus (*Microtus*/*Chionomys* sp.). This, along with the small sample size, inhibits further interpretation of the paleoenvironment and micromammal predators that may have deposited the remains at the site.

Ostrich: Other than OES beads, there is no evidence of either carnivore or human involvement in the accumulation of ostrich remains. All OES beads are 'finished' – i.e., fully formed, some with use wear inside the perforation – and there are no examples of earlier production stages (Rigaud pers. comm. 2024). Given that ostrich skeletal material is absent, it is possible that the OES beads were not produced locally but rather brought to the site attached to clothing or other goods. There are unmodified shell fragments associated with most of the UP archaeological deposits in the Tolbor Valley, and at T17, there are some unmodified shell fragments eroding out of Late Pleistocene deposits around the site (McCartin pers. obs., 2024). This suggests that ostriches were present in the area and/or that humans collected shells and brought them to T17 for food or as raw materials. The Late Pleistocene presence of ostrich in the region is also supported by radiocarbon dates from unmodified OES in northern Asia, which place ostrich eggs as far north as Lake Baikal during MIS 3-2 (Janz et al. 2009; Kurochkin et al. 2010).

Raptor: Avian remains also include the distal tibiotarsus and the proximal tarsometatarsus of a raptor (Accipitridae or *Falco* sp.). Both remains show affinities to small eagles and hawks (e.g., *Aquila nipalensis*), but also fit well with falcons, such as the peregrine falcon (*Falco peregrinus*). The side, size, proximity, and preservation suggest the two specimens originate from the same individual, representing the left "ankle" joint. Neither element evidences a particular agent of accumulation. Although the potential interaction between hominins and birds of prey at T17 is intriguing, it is currently not possible to rule out accumulation via carnivore predation or natural deaths.

5.3. Regional insights

Fauna from T17 is typical of MIS 3 sites in northern Asia, although many species are absent, despite being recorded in the larger region. These include wooly rhino (*Coelodonta antiquitatis*), camel (*Camelus* sp.), extra-large cervids (e.g., *Megaloceros giganticus*, *Alces alces*), antelope (e.g.,

Saiga tatarica, *Spirocerus kiakhtensis*), Mongolian gazelle (*Procapra gutturosa*), hare (*Lepus* sp.), pika (*Ochotona* sp.), hyena (*Crocuta Crocuta*), lynx (*Lynx lynx*), and various small carnivores (e.g., *Vulpes* sp., *Martes* sp.) (Khenzykhenova et al., 2011, 2016). It is difficult to assess whether their absence is due to the small sample size, the distribution of animals on the landscape, human hunting decisions, animal behavior, or other factors. It is also unclear if these animals are truly absent or if poor preservation limits identification. Future ZooMS (Zooarchaeology by Mass Spectrometry) analyses will thus clarify the true diversity of taxa at T17.

Two sites in the Tolbor Valley also preserve faunal material: Tolbor-16 (T16) and Tolbor-21 (T21). The former is located a few hundred meters north of T17 and includes 262 faunal remains. The material is briefly summarized by Zwyns et al. (2014b, 2019), who note the presence of equid and large bovid remains, OES beads, and a similar degree of weathering and fragmentation as T17. Located a few kilometers north of T17, T21 presents a small, but well-studied, assemblage of 210 faunal remains (Rybin et al. 2020). Although the assemblage contains no carnivores, the overall diversity is high and, like T17, each taxon is represented by a single individual. Remains are highly fragmented, weathered, and root etched. Cortical surfaces exhibit some cut marks and impacts, but no traces of carnivore damage. Rybin et al. (2020) conclude that humans occupied the site multiple times during MIS 3 and 2, forming a palimpsest of habitations focused on the exploitation of medium-large ungulates. Humans at T21 also produced symbolic material culture in the form of personal ornaments made from OES and stone as well as a possible phallus ornament (Rigaud et al., 2023).

Considering the Tolbor assemblages together, similarities in subsistence practices, site use, and preservation are apparent. All three sites are consistent with multiple small, short-term habitations by IUP/EUP humans who primarily exploited large and extra-large ungulates. T17 may be a slight outlier, as the assemblage is much larger, despite similar areas of excavation, and includes multiple carnivores. Future work should investigate whether this disparity is the result of occupation duration, site use, seasonality, or other factors. This information will also facilitate larger comparisons between the inhabitants of the Tolbor Valley and other regions in northern Asia.

6. Conclusion

T17 is one of few MIS 3 sites in northern Mongolia with preserved fauna, facilitating new analyses of hominin subsistence and paleoenvironment during the first dispersal of humans into northern Asia. The faunal assemblage, although small and fragmentary, provides clear evidence of human subsistence practices, namely the butchery of large and extra-large ungulates and the use of osseous tools and personal ornaments. Humans also exploited marmot, ostrich (eggshell), and at least one carnivore, attesting to the wide range of human-animal interactions at or near the site. Carnivores also accessed the assemblage, but likely as scavengers, rather than primary agents. T17 is comparable to other sites in the region, which exhibit a similar diversity of species, number of individuals, and degree of post-depositional modification. Where T17 differs is in the larger sample size and the abundance of carnivores. However, larger sites are better recorded outside of the Tolbor Valley.

Moving forward, future analyses should address the following questions: (1) Who were the primary vs. secondary agents of accumulation? (2) What produced the observed differences between the upper and lower parts of the sequence (e.g., taphonomic processes, occupation events)? (3) How can T17 illuminate larger aspects of hominin subsistence, namely how IUP and EUP groups adapted to new environments as they dispersed across Eurasia and how those adaptations differed from earlier and later hominins on the landscape. Some of these questions may be answered by ZooMS and stable isotope analyses, which are in progress, as well as the addition of new faunal material as the excavation expands in the coming years.

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