



Patterns of pastoralism in later Bronze Age Kazakhstan: new evidence from faunal and lipid residue analyses

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ABSTRACT

Current research themes relating to prehistoric Central Asian pastoralism are discussed, and the Neolithic to Bronze archaeological sequence in Kazakhstan is briefly outlined. The results of new faunal analyses of six later Bronze Age sites in Central and Northern Kazakhstan are presented. These studies are based upon the analysis of 63,529 bone fragments, of which 27,023 were identifiable to species and element. These assemblages are compared with 16 other sites in Central and Northern Kazakhstan, and the Trans-Ural region. The herd structures at the final Bronze Age site of Kent are discussed in detail. Analyses of absorbed lipid residues from four sites are also presented. In total, 140 pottery sherds were analysed, of which 73 provided sufficient residues for stable isotope ratio determinations. It is concluded that species proportions are highly variable regionally. Cattle are most prevalent in the forest steppe zone, whilst caprines become more common in semi-arid steppe regions. Proportions of horse are particularly variable, even within environmentally similar areas. Lipid residue results indicate the high prevalence of ruminant dairy products in pottery vessels, whilst faunal data from Kent suggests that cattle husbandry might have been particularly focussed on milk, in comparison with sheep and goats. The significance of horses within prehistoric pastoralism is discussed.

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1. Introduction

1.1. Current research and Eurasian steppe pastoralism

Research into prehistoric steppe pastoralism is currently 'one of the most dynamic fields' (Renfrew, 2009, xvi) within prehistoric archaeology. Over the last 20 years or so, a vast area has opened up to scholars and fieldworkers from around the world (Hanks and Lindruff, 2009), and, as well as much new collaborative fieldwork, existing collections are becoming the subject of some large scale absolute dating programmes (e.g. Hanks et al., 2007; Panyushkina et al., 2008) and other forms of previously unavailable scientific

analysis (e.g. Outram et al., 2009, 2011; Stear, 2008). Recent scholarship in the field (e.g. Frachetti, 2009; Hanks and Lindruff, 2009) has warned against assumptions of homogeneity that may, at times, have characterized past work on steppe pastoralists, which sometimes lacked sufficient local resolution to see differences in social complexity, economy and mobility.

At the same time as needing to understand variations and developments within the steppe zone, the role of Central Asia in wider prehistoric world has come under increasing focus. Sherratt (2006) drew attention to the "Trans-Eurasian Exchange" that saw, in the Bronze Age, the emergence of significant trading between two great centres of early agricultural development, the Near East and China. Such exchange involved metals, precious stones, horses and crops. Jones et al. (2011) add much more detail regarding the agricultural aspect of this exchange, which must have occurred by the start of the Bronze Age; millet came from China to Europe and wheat went in the other direction. Due to a general lack of flotation sieving and archaeobotany in much of Central Asia, the routes of such crop movement are only now being investigated. This Trans-Eurasian Exchange is compared in importance to the "Columbian Exchange" between Europe and the Americas (Jones et al., 2011),

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The Botai Culture, and its sister culture to the west, the Tersek (Kalieva and Logvin, 1997), end at the start of the 3rd millennium BC. After this there is very limited settlement evidence in the region until the Bronze Age establishes itself firmly in the very late 3rd millennium BC. The sites of Sergeevka and Balandino, dating to the mid 3rd millennium BC, represent possible transitions from the horse-dominated Eneolithic to a Bronze Age economy more heavily based upon ruminants (Anthony, 2007; Frachetti, 2008).

The Bronze Age Sintashta Culture dates from about 2100–1800 BC (Anthony, 2007, 2009) and is located in the steppe territory between the Ural Mountains and the River Tobol (see Fig. 1) (Koryakova and Epimakhov, 2007), with key settlements being Sintashta, Arkaim, Alandskoye and Andreyevskoye. Settlements of this culture consisted of sub-circular fortresses, perhaps best represented by the Arkaim settlement with its concentric walls, and spoke-like sub-divisions (Anthony, 2007, 2009; Kohl, 2007; Koryakova and Epimakhov, 2007; Kristiansen and Larsson, 2005). In the settlement middens of Sintashta and Arkaim the refuse consisted of 60% cattle, 26% sheep/goat and 13% horse, showing a significant economic shift at this time towards domestic ruminants (Anthony, 2007, 2009). However, horse sacrifice was a key component of high status burials at this time (Anthony, 2007, 2009; Kristiansen and Larsson, 2005) and the richest Sintashta graves contain the remains of chariots (Anthony, 2007, 2009; Kohl, 2007; Koryakova and Epimakhov, 2007; Kristiansen and Larsson, 2005). In northern Kazakhstan the Sintashta culture devolved into the Petrovka Culture, dating to the first part of the 2nd millennium BC (Anthony, 2007; Yevdokimov and Varfolomeev, 2002). Petrovka burials also contain horse sacrifices, horse tack and chariots (Koryakova and Epimakhov, 2007), but the number of such burials declines through the period (Anthony, 2007).

The later part of the Bronze Age in central and northern Kazakhstan is dominated by the Andronovo Culture, and its Alakul and Fyodorovo sub-cultures (Koryakova and Epimakhov, 2007; Yevdokimov and Varfolomeev, 2002). During this period, in the mid 2nd millennium BC, the economic focus upon the pastoral exploitation of domestic ruminants continues, but Andronovo graves are simpler and are typified by both inhumations and cremations accompanied by ceramics with geometric designs. Animal sacrifices continue, but include a number of different species, particularly dogs, with animals frequently represented by their heads and feet (Koryakova and Epimakhov, 2007). The final phase of the Bronze Age (c. 1300–900 BC) in Kazakhstan consists of the Sargary and Begazy–Dandybaevsky Cultures (Frachetti, 2008; Koryakova and Epimakhov, 2007; Yevdokimov and Varfolomeev, 2002). Once again, mixed domestic ruminants dominate in the faunal assemblages, whilst funerary rites now involve inhumations with relatively modest grave goods comprising ceramics and occasional ornaments (Koryakova and Epimakhov, 2007). It is the later Bronze Age, from the Andronovo through to final Bronze Age, which is the focus of this study. This is a period of mature steppe pastoralism, in a period when “Trans-Eurasian Exchange” (Sherratt, 2006) would have been well-established.

2. Materials and methods

2.1. The faunal and ceramic assemblages studied

New data presented in this study are analyses of six later Bronze Age settlement faunal assemblages comprising 63,529 bone fragments, of which 27,023 were identifiable to species and element (NISP), and 140 absorbed lipid residue analyses of pottery sherds from four settlements, of which 73 provided sufficient residue for stable isotope ratio determinations. All the samples come from

domestic contexts, rather than funerary ones, but should be treated as palimpsest deposits for those sites. In the vast majority of cases dating comes from ceramic sequences rather than direct absolute methods. The locations of all the sites discussed can be seen in Fig. 1.

The final Bronze Age, Begazy–Dandybaevsky Culture (12th–9th centuries BC), settlement of Kent (Yevdokimov and Varfolomeev, 2002; Omarbekova et al., 2007), is located in a valley with a stream, between granite hills, in an area central Kazakhstan that is otherwise semi-arid steppe. Kent is a very substantial settlement, and most likely a centre of regional focus during this period. It provided the largest assemblages for our study (21,625 NISP, and 31 lipid residue determinations). The site of Alat is of the same period and immediately adjacent to Kent, across the stream, and provided a further 1876 NISP from its faunal assemblage, but it was not selected for detailed lipid residue analysis. Dongal is another final Bronze Age site in the same region (Yevdokimov and Varfolomeev, 2002) which yielded a small faunal assemblage of 305 NISP and 7 lipid residue results. Bugully is also final Bronze Age, but is from the semi-arid steppe to the south of Karaganda and yielded a small faunal assemblage (334 NISP), but no residue results. The last of the final Bronze Age sites studied is Konezavod III (14th–9th centuries BC), which produced a good sample of 28 lipid residue determinations. The faunal assemblage was not studied by the authors of this paper, but a published analysis was already available (Akhinzhanov et al., 1992). By contrast, this site is located in the forest steppe of northwestern Kazakhstan.

The sites studied from the earlier Andronovo period (Yevdokimov and Varfolomeev, 2002) were Lisakovsk and Temirkash. Temirkash is located in semi-arid steppe to the immediate northwest of Karaganda and produced a bone NISP of 650, but no residue results. Lisakovsk is located in the forest steppe zone in northwest Kazakhstan on the banks of the Tobol River. This site yielded a NISP of 2233 and seven lipid residue results were obtained.

Below, the results from these newly analysed sites are compared with faunal assemblages from 16 previously published sites from the same regions of Kazakhstan, plus the Trans-Ural region to the immediate northwest. The sites of Kambulat, Shatrovo, Verkniia Sanarka and Kipel (16th–13th centuries BC) are all Andronovo sites from the Chelyabinsk region studied by Tsalkin (1972). These sites all have small assemblages and the data have been combined to a total of 1751 NISP. Zamarayevskoe, Kipelskoe and Novoburinskoe (16th–13th centuries BC) are also Andronovo, and in the same region. These sites, studied by Kosintsev (1989), have also been combined to produce a total of 1028 NISP. Druzhnyi (14th–9th centuries BC) (Germanov and Kosintsev, 1995), with an NISP of 2452, and Novonikolskoe 1 (15th–9th centuries BC) (Makarova, 1980), NISP 3440, both date from the later Andronovo through into the final Bronze Age, and are located in the same Trans-Ural region. Petrovka 2 (17th–9th centuries BC) (Makarova, 1980), NISP 2764, is located near Petropavlovsk and covers the Andronovo and final Bronze Age periods, as do Konezavod 3 (16th–9th centuries BC) (Akhinzhanov et al., 1992) near Kustanai, Myrzhiik (14th–9th centuries BC) (Akhinzhanov et al., 1992), in the semi-arid steppe to the south of Karaganda, and Chaglinka (Akhinzhanov et al., 1992), near Kokshetau, with NISPs of 3106, 5503 and 1389 respectively. Final Bronze Age sites include Sargary (9th–8th centuries BC) (Makarova, 1976; Akhinzhanov et al., 1992) to the southwest of Kokshetau, Karkaralinskoe (Makarova, 1977) to the southeast of Karaganda and Atasu (13th–9th centuries BC) (Akhinzhanov et al., 1992) to the south of Karaganda, with NISPs of 5246, 1287 and 10614 respectively. The majority of these site locations are shown in Fig. 1.

2.2. Zooarchaeological methods

The selected faunal assemblages were assessed in advance of analysis in relation to bone recovery practices during excavation, and subsequent retention and storage decisions. In Kazakhstan, in the past, good recovery of animal bones, and retention of complete assemblages, was not always a priority. The difficulties in dealing with such data are very well discussed in Morales and Antipina (2003) in their critical assessment of Srubnaya faunas from a neighbouring region. The assemblages reported here received good hand-picked recovery and comprehensive retention. Whilst a lack of sieving biases strongly against fish, birds and small mammal remains, and may skew some specific taphonomic patterns for larger mammals, it is less likely that key aspects of quantification within large mammal classes would be seriously affected under such a recovery regime (see Payne, 1972; Lyman, 2008 for discussion). As such, this paper concentrates on issues related to the relative abundance and husbandry of domestic large mammals. The site of Temirkash (excavated by Outram in collaboration with Varfolomeev), however, was fully sieved using a screen size of less than 5 mm, and thus provides a degree of control in relation to missing proportions of smaller species.

The quantification unit used is a simple NISP count (Klein and Cruz-Urbe, 1984), referring to numbers of specimens identifiable to species and element. This simple quantification method was chosen to allow comparisons with other published assemblages using a common basis. Sheep and goat can be very difficult to distinguish, so a combined caprine class is used in overall summaries. Where distinction between the species was possible it followed criteria outlined by Boessneck (1969) and Payne (1969, 1985), though recently published research questioning of the reliability of some dental-based criteria is noted (Zeder and Pilaar, 2010). Fusion stages were based upon data given by Silver (1969) and sheep/goat mandible ageing and interpretation follows Payne (1973). Given the variations noted between different sheep and goat populations, in terms of fusion and dental developments (Zeder, 2006), these data are used to understand general slaughter patterns rather than establish precise ages at death. Metrical separation of cattle metacarpals into groups by sex follows principles outlined by Higham and Message (1969) and Legge (1981).

2.3. Lipid residue methods

2.3.1. Lipid extraction

Lipids were extracted using an established protocol (Evershed et al., 1990; Charters et al., 1993). Approximately 2 g of each potsherd was sampled and the surface cleaned using a modelling drill (Como Mini Drill, MFA Como Drills) to remove any exogenous lipids, such as those originating from soil or fingers due to handling by excavators and/or curators. The sherds were ground in a pestle and mortar to a fine powder, accurately weighed and 20 µg of internal standard (*n*-tetratriacontane, Sigma–Aldrich Company Ltd, Gillingham, UK) added. Lipids were extracted using chloroform:methanol (10 ml, 2:1 v/v) and sonication (2 × 15 min), then centrifuged (2500 rpm, 20 min; MSE Mistral 1000) and filtered through a silica column (1 g) to remove any particulate matter. A portion of the TLE was treated using *N,O*-bis(trimethylsilyl)trifluoroacetamide (BSTFA; Sigma–Aldrich Company Ltd., Gillingham, UK) containing 1% trimethylchlorosilane (30 µl, 70 °C, 45 min). Excess BSTFA was removed under nitrogen and the derivatised TLE was dissolved in hexane and analysed by high temperature gas chromatography (HTGC). Visible, or surface, residues (denoted as SR) adhering to potsherds were removed using a scalpel and extracted and analysed using the same protocol as for the potsherds.

2.3.2. Lipid hydrolysis and preparation of fatty acid methyl esters

Methanolic sodium hydroxide (5% v/v) was added to an aliquot of the TLE and heated (70 °C, 1 h) with regular mixing. After cooling, the neutral fraction was extracted with hexane (3 × 3 ml). The remaining solution was acidified to pH 3 (HCl 1M) and the free fatty acids extracted with chloroform (3 × 3 ml) and the solvent removed under nitrogen. The FAME derivatives were extracted with chloroform and the solvent removed under nitrogen. FAMES were re-dissolved into hexane prior to analysis by GC, GC–MS and GC–C–IRMS.

2.3.3. Modern Kazakh reference animal fats

Samples of modern animal fats were collected from northern Kazakhstan between 2002 and 2005. In total, 11 pork, 6 beef and 10 horse meat samples were collected from local markets, and 5 cow's milk and 6 horse milk samples were collected directly from farmers. Although the diets of these animals are unknown, farmers in the region almost exclusively rear their animals on the steppe. Pollen data from numerous lakes and swamps in northern Kazakhstan has indicated that the steppe vegetation in northern Kazakhstan has changed very little since 10,100 yr B.P (Tarasov et al., 1997; Kremenetski, 2003). Therefore it can be reasonably assumed that the diet of the modern steppe reared reference animals is adequately representative of the type of diet prehistoric steppe reared animals would have consumed. In addition 16 freshwater fish samples were also obtained. A number of these were freshly caught from rivers in Lisakovsk and Kokshetau and others were bought at markets in Kustenai, Kokshetau and Karaganda, in total the sample set comprises samples of roach (3), perch (2), pike (4), carp (6) and catfish (1). Animal tissues were sampled with a scalpel, and freeze dried in a glass vial. The freeze-dried samples were weighed and 70 µg of internal standard (*n*-tetratriacontane) was added. The lipids were extracted using the method described above. The supernatant was centrifuged (2500 rpm, 10 min) and filtered through a silica column (1 g). An aliquot of the TLE was derivatised with BSTFA, as described above, and analysed by HTGC. A further aliquot was saponified and the acid fraction was derivatised to FAMES, and analysed by GC, GC/C/IRMS and GC/TC/IRMS.

2.3.4. HTGC analysis

HTGC analyses were performed on a Hewlett Packard 5890 series II gas chromatograph coupled to an Opus V PC with HP Chemstation software. The samples were injected into a fused silica capillary column (15 m × 0.32 mm i.d.) coated with a dimethyl polysiloxane stationary phase (J&W Scientific; DB1-HT, 0.1 µm film thickness). The temperature programme comprised a 2 min isothermal period at 50 °C followed by an increase to 350 °C at 10 °C min⁻¹; the temperature was held at 350 °C for 10 min. A flame ionisation detector was used to monitor the column effluent. The carrier gas used was hydrogen with a column head pressure of 10 psi.

2.3.5. GC/MS analysis

FAMES were analysed by GC/MS using a ThermoFinnigan Trace MS. Samples were introduced using a PTV injector set to splitless mode onto a polydimethylsiloxane column (Phenomenex, ZB-1, 60 m × 0.32 mm i.d., 0.1 µm film thickness). The initial injection port temperature was 50 °C with an evaporation phase of 1 min followed by a transfer phase from 50 °C to 300 °C at 14.5 °C s⁻¹ with an isothermal period of 37 min. The GC program consisted of an isothermal period of 2 min at 50 °C followed by an increase to 300 °C at a rate of 10 °C min⁻¹. Following this the temperature was held at 300 °C for 10 min. The MS was operated in electron ionisation (EI) mode with a GC interface temperature of 300 °C and a source temperature of 200 °C. The emission current was 150 µA and the MS acquired in the range of *m/z* 50–650 at 1.3 scans per

second. The data acquisition and processing were carried out using XCalibur software.

2.3.6. GC/combustion/isotope ratio MS (GC/C/IRMS)

Two different GC/C/IRMS instruments were used in this work: (i) Varian 3400 GC coupled to a Finnigan MAT Delta S IRMS via an extensively modified Finnigan MAT type I combustion interface, Cu and Pt wires (0.1 mm o.d) in an alumina reactor (0.5 mm i.d). The reactor temperature was maintained at 860 °C and the mass spectrometer source pressure was 6×10^{-6} mbar. Faraday cups were used for the detection of ions of m/z 44 ($^{12}\text{C}^{16}\text{O}_2$), 45 ($^{13}\text{C}^{16}\text{O}_2$ and $^{12}\text{C}^{17}\text{O}^{16}\text{O}$) and 46 ($^{12}\text{C}^{18}\text{O}^{16}\text{O}$). The GC was fitted with a fused silica capillary column (60 m \times 0.32 mm i.d) coated with a high cyano-propyl modified methyl polysiloxane stationary phase (Varian Inc., USA; VF23 ms; 0.15 μm film thickness). The temperature program consisted of an isothermal period of 1 min at 50 °C followed by an increase to 240 °C at a rate of 10 °C min^{-1} followed by an isothermal period of 10 min at 240 °C, and (ii) a ThermoElectron Delta^{plus} XP isotope ratio mass spectrometer coupled to a ThermoElectron Trace GC with a Thermo-Electron GCCIII combustion interface, using the same GC column as above. Samples were injected via a PTV injector in splitless mode. The combustion reactor temperature was maintained at a temperature of 940 °C and the reduction reactor at a temperature of 600 °C. The source pressure was maintained at 6×10^{-6} mbar and faraday cups were used to detect ions of mass 44 ($^{12}\text{C}^{16}\text{O}_2$), 45 ($^{13}\text{C}^{16}\text{O}_2$ and $^{12}\text{C}^{17}\text{O}^{16}\text{O}$) and 46 ($^{12}\text{C}^{18}\text{O}^{16}\text{O}$). The temperature program consisted of an isothermal period of 1 min at 40 °C followed by an increase to 240 °C at a rate of 10 °C min^{-1} followed by an isothermal period of 1 min at 240 °C.

2.3.7. Data processing

The $^{13}\text{C}/^{12}\text{C}$ ratios are expressed relative to the VPDB (*Belemnitella americana*) standard.

$$\delta^{13}\text{C} = \frac{R_{\text{SAMPLE}} - R_{\text{STANDARD}}}{R_{\text{STANDARD}}} \times 1000$$

Where:

$\delta^{13}\text{C}$ is measured in ‰ and

$R_{\text{SAMPLE}} = ^{13}\text{C}/^{12}\text{C}$ in the sample

$R_{\text{STANDARD}} = ^{13}\text{C}/^{12}\text{C}$ in the standard

Each sample was run in duplicate and any questionable runs were repeated. An external standard consisting of a mixture of FAMES ($\text{C}_{11:0}$, $\text{C}_{13:0}$, $\text{C}_{16:0}$, $\text{C}_{21:0}$ and $\text{C}_{23:0}$) of known isotopic composition, was run regularly between sample runs to ensure the integrity of the data. Results were calibrated against a reference CO_2 standard, which was injected directly into the ion source three times at the beginning and three times at the end of each run. Instrumental precision was typically $\pm 0.3\text{‰}$ or better. $\delta^{13}\text{C}$ values for the individual fatty acids were determined by correcting the values obtained for the corresponding FAMES using a simple mass balance calculation to account for the extra carbon added during derivatisation (Rieley, 1994)

$$\delta^{13}\text{C}_{\text{FA}} = \frac{(\text{no. C}_{\text{FAME}} \times \delta^{13}\text{C}_{\text{FAME}}) - \delta^{13}\text{C}_{\text{MeOH}}}{\text{no. C}_{\text{FAME}}}$$

Where:

$\delta^{13}\text{C}_{\text{FA}}$ = $\delta^{13}\text{C}$ value of the fatty acid

$\delta^{13}\text{C}_{\text{FAME}}$ = $\delta^{13}\text{C}$ value of the FAME

$\delta^{13}\text{C}_{\text{MeOH}}$ = $\delta^{13}\text{C}$ value of the derivatising methanol

$\text{no. C}_{\text{FAME}}$ = total number of carbon atoms in the FAME

no. C_{FA} = total number of carbon atoms in the original fatty acid

In order to make them directly comparable with the ancient fats, the $\delta^{13}\text{C}$ values for the modern reference fats were corrected for post-industrial CO_2 by adding 1.2‰ (Friedli et al., 1986).

Archaeological animal fats are classified to the major commodity classes using a scatter plot which groups $\delta^{13}\text{C}$ values of modern reference animal fats (reared on isotopically comparable diets to animals in antiquity; into confidence ellipses (1.s.d., Systat, SPSS Inc.; Outram et al., 2009; Stear, 2008)).

3. Results

3.1. Species representation in faunal assemblages

Table 1 presents the NISP and %NISP for each of the faunal assemblages by major species groupings. Sheep and goats have been combined in this table. The 'wild large mammal' includes deer species, gazelle, saiga, bear, aurochs, wild ass, wild goats, camel and pig. The wild or domestic status of pigs and camels in this region at this time is not totally clear, but they form an exceptionally small proportion of the assemblages. The small mammal class includes foxes and anything smaller, including rodents, lagomorphs and mustelids. Dogs have been listed separately, whilst birds and fish form two combined groups.

It is clear that all assemblages are dominated by cattle, caprines and horses. The relative proportions of these main species groupings are displayed in Fig. 2 for each site. It is immediately apparent that the proportion of horses varies wildly from site to site. At Lisakovsk horses represent only 3.7% of the total assemblage, whilst at Dongal they represent 46.2%. Cattle and caprines are clearly very significant at all sites, but Lisakovsk is particularly cattle dominated (a cattle:caprine ratio of 2.42) whilst Temirkash (ratio of 0.36) and Kent (0.57) are strongly caprine dominated. The differentiation of sheep and goat is difficult, so proportions derived from the limited number of specimens that could be separated should be treated with some caution. At most sites, however, clearly identified sheep very strongly outnumber goats. The only exception is Temirkash where there were only 22 specimens positively identified as sheep, whilst 35 were goats.

Dogs are present in low numbers at all sites, apart from at Bugully, where none were found. Temirkash has the highest representation at 1.1% NISP. Large wild species are present at all sites but are in relatively small proportions ranging from 2.3% to 4.5%. Small mammals, birds and fish are very poorly represented, if not totally absent, at all sites. Much of this pattern is likely to be due to a lack of sieving at all but Temirkash, where there is better representation of all these groups (and dogs). Temirkash yielded 14.2% small mammals, including hare and marmot, but 10.4% was accounted for by small rodents, some of which could have been

Table 1

Number of identifiable specimens (NISP) and %NISP by species grouping and site.

Species	NISP/%NISP					
	Kent	Lisakovsk	Temirkash	Alat	Bugully	Dongal
Horse (<i>Equus</i>)	4154/19.2	82/3.7	59/9.1	289/15.4	125/37.4	141/46.2
Cattle (<i>Bos</i>)	6072/28.1	1482/66.4	118/18.2	696/37.1	125/37.4	73/23.9
Sheep/Goat (<i>Ovis/Capra</i>)	10655/49.3	613/27.5	328/50.5	806/43.1	76/22.8	76/24.9
Dog (<i>Canis</i>)	155/0.7	2/0.1	7/1.1	11/0.6	0/0	2/0.7
Wild large mammals	571/2.6	51/2.3	29/4.5	70/3.7	8/2.4	13/4.3
Small mammals	8/0	0/0	92/14.2	3/0.2	0/0	0/0
Birds (<i>Aves</i>)	10/0	3/0.1	7/1.1	1/0.1	0/0	0/0
Fish (<i>Pisces</i>)	0/0	0/0	10/1.5	0/0	0/0	0/0
Total	21,625	2233	650	1876	334	305

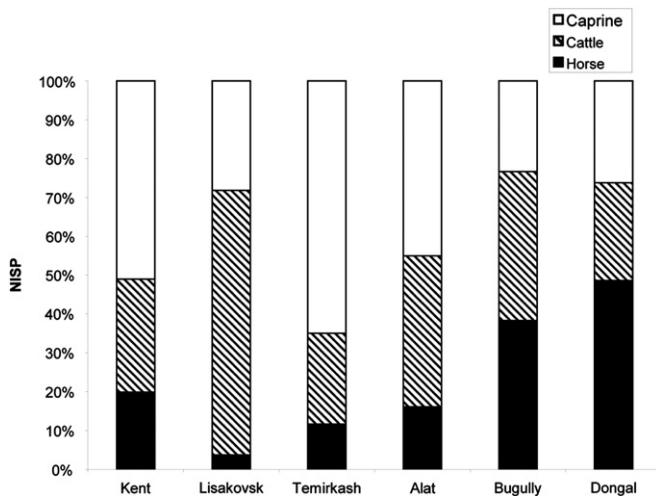


Fig. 2. The relative proportions of caprines, cattle and horses only, based upon NISP, for the six sites newly analysed by the authors.

intrusive. Even with sieving, bird and fish remains were still very rare at 1.1% and 1.5% respectively. Temirkash is the only site where any fish at all were recovered, and these included the remains of pike, roach and bream. Whilst Temirkash clearly demonstrates what can be lost if sieving is not undertaken, it also suggests that small mammals, birds and fish were not a mainstay of diet, though their exploitation should be noted.

3.2. Regional comparisons of species representation

The relative proportions of horse, cattle and caprines for the 16 comparator faunal assemblages are displayed in Fig. 3. Once again, it is clear that proportions of horse vary considerably, with the strongest representation being at Druznyi at 35% of the total assemblage, whilst at Myrzhik horses make up only 2.3% of total NISP. Whilst cattle and caprines are clearly significant at all sites, the majority of the sites are cattle dominated, particularly the sites in the Chelyabinsk region, where the cattle:caprine ratios are between 3 and 3.6. The two sites where caprines significantly outnumber cattle, Atasu with a ratio of 0.6 and Myrzhik at 0.4, are both to the far south of central Kazakhstan. Like the newly studied

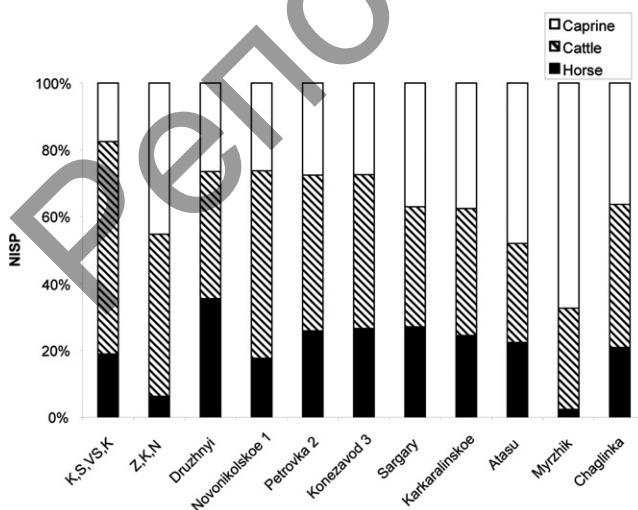


Fig. 3. The relative proportions of caprines, cattle and horses only, based upon NISP, for previously published sites.

assemblages, these data highlight considerable regional variation in the numbers of the main domestic species.

At all of the sites both pigs and dogs are commonly present but in small numbers (usually less than 1% NISP). Other species are most common at Atasu and Myrzhik, at 2.2% and 3.3% NISP respectively, but are usually less than 1% at other sites. It is clear that large wild mammals were not a major component of diet at any of the sites, though proportions of fish, birds and small mammals will have been adversely affected by a general lack of sieving.

3.3. Lipid residue analyses

Figs. 4 and 5 display the results of absorbed lipid residue analyses on potsherds from Dongal, Kent, Konezavod and Lisakovsk. Fig. 4 shows $\delta^{13}\text{C}$ values of fatty acid methyl esters of $\text{C}_{16:0}$ and $\text{C}_{18:0}$ as points, whilst the ellipses ($p = 0.683$ confidence ellipses, SYSTAT 7.0) represent the $\delta^{13}\text{C}$ values of modern reference animal fats collected in Kazakhstan (Outram et al., 2009). Fig. 5 is an additional method of classifying lipid extracts where $\Delta^{13}\text{C}$ ($= \delta^{13}\text{C}_{18:0} - \delta^{13}\text{C}_{16:0}$) values are plotted against their $\delta^{13}\text{C}_{16:0}$ values, with reference materials represented by their $\Delta^{13}\text{C}$ ranges. This display method has the advantage of removing the effects of regional isotopic variations, such that only relative differences caused by varying metabolic fractionation in different species/fat types are displayed (the fundamental basis of determinations), allowing more direct comparison between different residue studies. Furthermore, extracts will plot further to the right the higher the percentage of C_4 plants there is in the animals' diets.

It is immediately clear that ruminant animal fat dominates at all four settlements. A relatively small proportion of pots appear to have been utilized for horse products alone, despite the fairly strong representation of horse bones at some sites. This raises several possibilities. Horses may not have been utilized to a high degree at these settlements for food, but it is also possible that when horses were slaughtered they were not cooked in pots, or that the majority of pots in which horses were cooked were also used for other purposes, producing an integrated signal that falls within the ruminant range. Despite the relatively low proportions of pots used exclusively for horse products, they exist at all sites, including those with very small sample sizes.

By far the most common products to be identified in the ceramics are ruminant dairy products, which clearly outnumber those containing ruminant adipose fats. This is a clear indication of the importance of dairy products, but, at the same time, might also reflect the need to use pottery vessels in the processing and storage of dairy products, whilst meat products might be consumed after roasting, without the need for ceramic cooking vessels.

Not surprisingly, given their extremely low representation in faunal assemblages, no porcine fats were identified. It is also interesting to note that no fish lipids were identified in any of the pots.

3.4. Herd structures at Kent

The assemblage from final Bronze Age Kent, provided sufficient sample sizes to study aspects of the age and sex structure of herds. The material recovered from the 2006 season of excavations formed the basis of this more detailed study. It was possible to create slaughter patterns based upon fusion data for caprines, cattle and horses. Additionally, there were sufficient caprine mandibles to allow age profiling, and metrical analysis of cattle metacarpals allowed insight into sex ratios within the herd.

Fig. 6 displays percentage survival at different fusion stages for caprines. There is a high degree of survival up until the final fusion

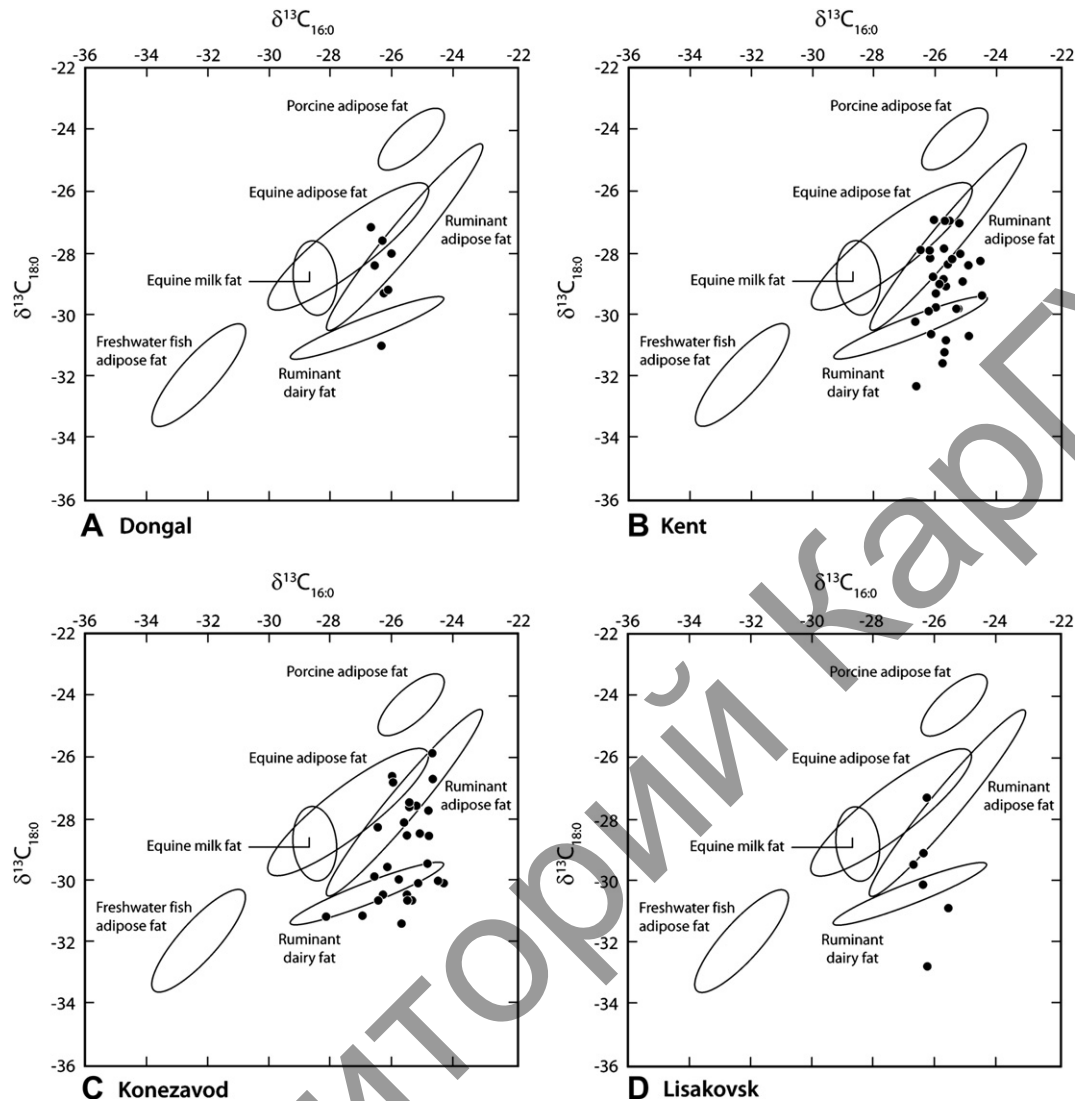


Fig. 4. Results of lipid residue analyses. Points indicate $\delta^{13}\text{C}$ values of fatty acid methyl esters of $\text{C}_{16:0}$ and $\text{C}_{18:0}$, whilst ellipses ($p = 0.683$ confidence ellipses, SYSTAT 7.0) represent the $\delta^{13}\text{C}$ values of modern reference animal fats collected in Kazakhstan.

stage at about three years old, then there is a significant drop from 71.5% to 44.2% survival. This drop is highly likely to indicate the slaughter of a number of males (most likely) for their meat, at the point that the animals reach full size. This pattern is backed up by data from mandible age stages as displayed in Fig. 7, alongside classic models for meat, milk and wool exploitation (after Payne, 1973). This graph also shows a steep drop between year 3 and 4, with the overall pattern tracing between the wool and meat lines. However, this graph also displays a distinct under-representation of neonatal deaths one would expect to see naturally. This is a common feature of archaeological results using this method, as noted by Halstead (1989), and it most likely relates to taphonomic factors such as the poor survivorship of neonatal bones, and the possibility that young lambs that died in the field were never transported back to the site. Since the method works on cumulative percentages, the lack of neonatal jaws will leave the line too high along its length. Fig. 8 shows a modification to the data to assume neonatal deaths up the 6 months at the same rates as that seen in the wool curve (representing only natural attrition rather than the deliberate culling seen in the milk model). This results in a pattern much closer to the meat model. What is clear, however, is a period of culling, most

likely for meat, at the point animals reach full size. This does not mean that caprines were not also exploited for secondary products, but the pattern suggests that the flock was not optimized for wool or milk, and some prime age meat was harvested.

Fig. 9 displays percentage survival by fusion stage for cattle. This graph indicates a high level of survival in all juvenile stages of development with 70.8% surviving to full maturity. There is no evidence of culling animals at prime meat age, when the animals approach full size. Fig. 10 displays metrical data for metacarpals, which are sexually dimorphic (Higham and Message, 1969; Legge, 1981), and useful for distinguishing wild aurochs (Kyselý, 2008). The graph displays breadth distal (Bd) for metacarpals in terms of numbers of specimens in each millimetre class. A sample of Danish aurochs (Degerbøl and Fredskild, 1970) has been added to the graph for reference purposes. It is immediately apparent that the Kent specimens partly overlap with the aurochs distribution. Using a large sample of cattle and aurochs data, Kyselý (2008) has established that there should only be an overlap between cattle and aurochs between 66 mm and 73 mm, where large male domesticates overlap with small female aurochs. Whilst acknowledging that there may be some regional variation between Kyselý's

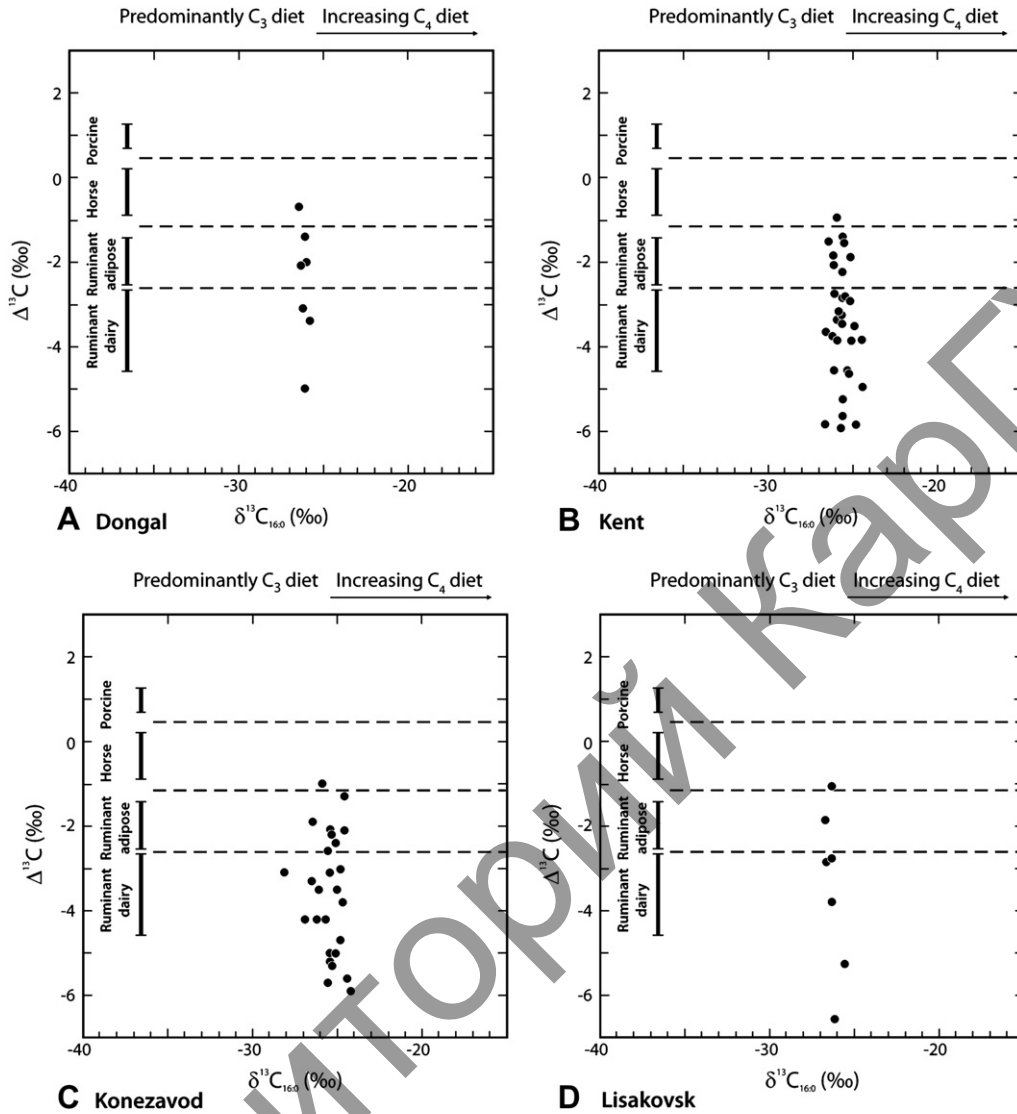


Fig. 5. Results of lipid residue analyses. An additional method of classifying lipid extracts where $\Delta^{13}\text{C}$ ($= \delta^{13}\text{C}_{18:0} - \delta^{13}\text{C}_{16:0}$) values are plotted against their $\delta^{13}\text{C}_{16:0}$ values, with reference materials represented by their $\Delta^{13}\text{C}$ ranges.

European data and Central Asia, three Kent specimens (76 mm, 78 mm, 87 mm) are clearly aurochs. A further three specimens (70 mm and 72 mm) could be either male domestic cattle or female aurochs. The rest are almost certainly all domestic, with 17 specimens (ranging between 53 mm and 59 mm) being female and at

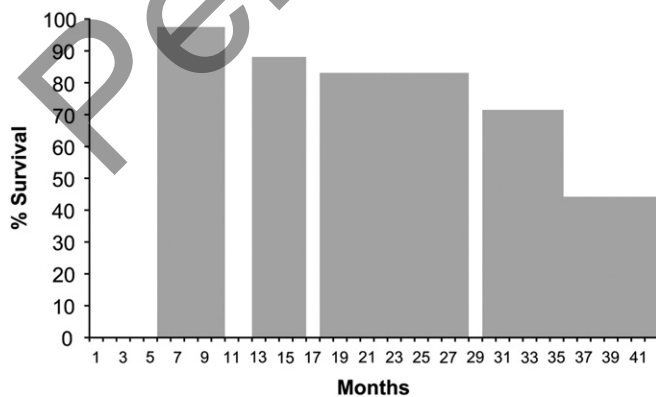


Fig. 6. Percentage survival of caprines at different fusion stages at Kent.

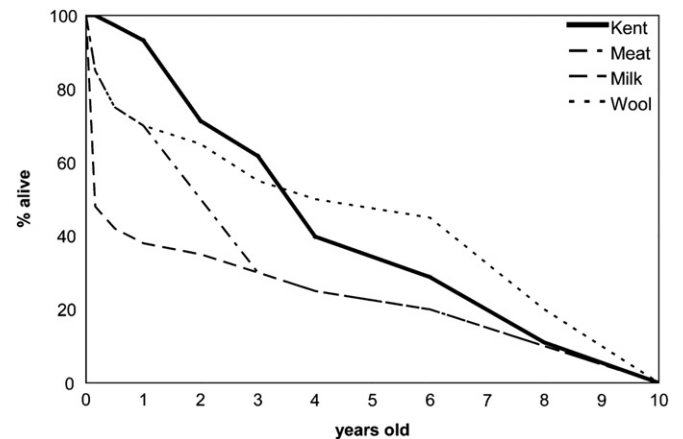


Fig. 7. Kill-off pattern for caprines at Kent based upon mandible age stages alongside models for meat, milk and wool exploitation (after Payne, 1973).

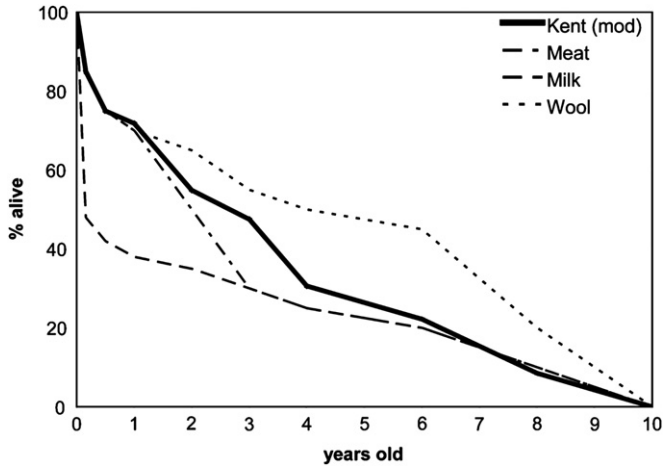


Fig. 8. Modified kill-off pattern for caprines at Kent based upon mandible age stages alongside models for meat, milk and wool exploitation (after Payne, 1973). The first six months of the Kent curve have been adjusted to conform to normal expectations for neonatal deaths, in order to model the removal of a possible taphonomic bias.

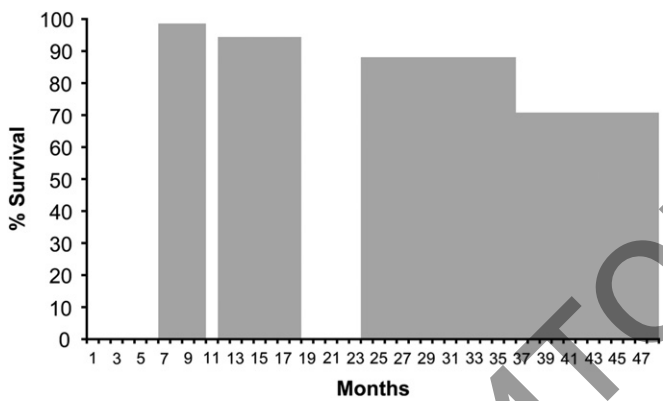


Fig. 9. Percentage survival of cattle at different fusion stages at Kent.

least 6 (between 62 mm and 65 mm) being male. To summarize, both male and female aurochs are likely to be present and, of the domestic cattle, the female:male ratio is between 2.8 and 1.9. The former seems more likely given the significant gap between the main domestic male group and those that are possibly female aurochs. This is, therefore, a strongly female biased cattle herd, though possibly not to the extent expected in a purely dairy herd. If significant numbers of males do not appear to be being slaughtered at prime meat age, and the adult population is largely female, that must lead one to conclude that a significant number of males must have been slaughtered very early in their life, and are not well represented, for taphonomic reasons discussed above, within the assemblage. The herd appears to be being managed principally for secondary products.

Fusion data for horses (Fig. 11) appears to indicate that most horses were kept until they were adult, with 90.9% surviving to maturity. Clearly, some neonatal deaths are likely to have been masked by taphonomy, but there is clearly not a major cull for meat at prime age, nor is there evidence for the extensive presence of horse milk in ceramics in Fig. 4 (see Outram et al., 2009; for discussion of the identification of horse milk residues). Horses may well have been primarily kept for riding/traction with occasional slaughter of excess numbers for meat, and the low scale milking of mares cannot be excluded.

In summary, it is likely that all species saw mixed use, but there is evidence for slightly different emphases in their exploitation, with caprines more often slaughtered for prime age meat, cattle exploited more heavily for dairy products and horses for traction and/or riding.

4. Discussion

4.1. Species selection and environment

Bendrey (2011), in surveying patterns of animal exploitation across the Eurasian plains and steppe in later prehistory, concluded that there were strong regional biases to species selection, and these could, particularly in relation to ratios of cattle and caprines, be strongly correlated to environment. This present study backs up this thesis. Those sites with higher proportions of sheep/goats than cattle, such as Temirkash, Alat, Kent, Atasu and Myrzhik, are all to

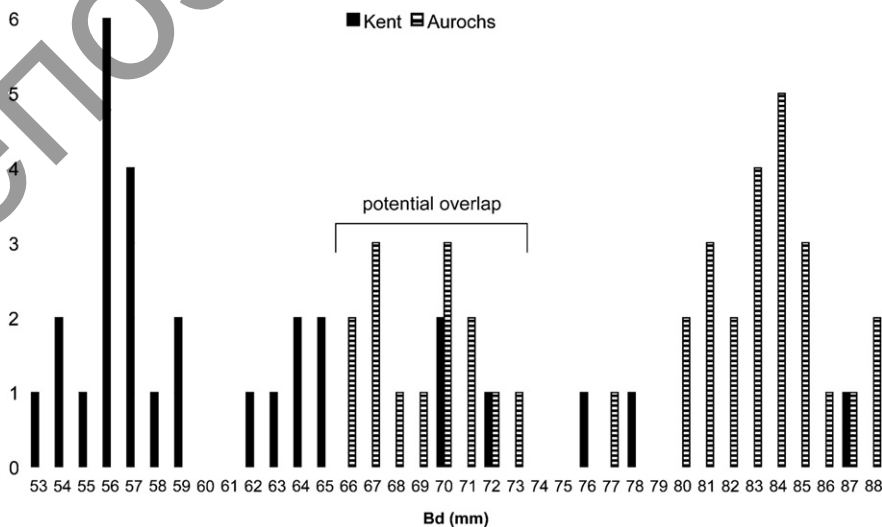


Fig. 10. The breadth distal (Bd) in millimetres of cattle metapodia from Kent, compared with a sample of wild aurochs. The size range where there is potential for overlap between aurochs and domestic cattle is marked.

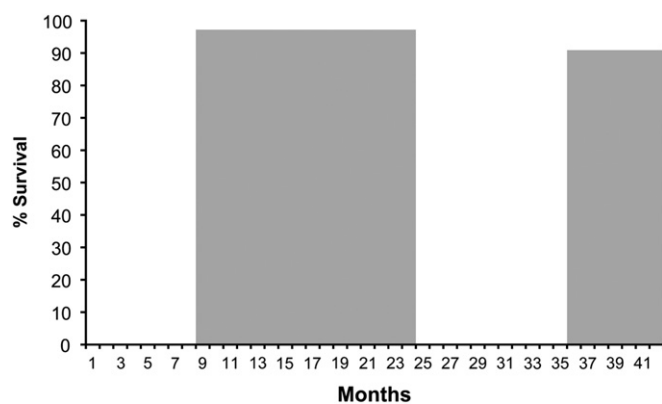


Fig. 11. Percentage survival of horses at different fusion stages at Kent.

be found in semi-arid regions of Central Kazakhstan. Those sites with very high proportions of cattle include all of the Trans-Ural sites in the Chelyabinsk region and other forest steppe sites in northwest Kazakhstan such as Lisakovsk, Konezavod 3 and Petrovka 2. These areas have higher rainfall and provide much more lush grassland vegetation.

The variation in the proportion of horses is much less readily explained by correlation with climate and vegetation types, with both low and high representation being evidenced in both ecozones (see discussion of horse below). There is also not a particularly good correlation between the date of sites and the variation in species emphasis.

4.2. The role and significance of horses

Frachetti and Benecke (2009) presented the results of faunal analyses from the multi-period site of Begash in the southeastern Kazakhstan. The site has occupation from the early Bronze Age to post-medieval times. They conclude that the horse did not form a very significant part of early prehistoric pastoralism at the site, and only increased in number a little, along with an expansion in hunting of wild animals in the 1st millennium BC. Horses are indeed a small part of assemblages at Begash, but the authors go on to extrapolate further: “the small Bronze Age presence and limited expansion of horses in the faunal record before historic periods demands that we reconsider the degree to which domestic horses played a dominant role in emerging pastoral lifeways...” (Frachetti and Benecke, 2009, 1036). Given the high level of variation seen in the assemblages discussed above, it seems very difficult to accept such a generalisation based upon one site, in one region of Central Asia. Begash is situated in the more arid south of Kazakhstan, though Begash itself is located in much less arid foothills, and faunal patterns in this region clearly should not be used to characterize semi-arid steppe or forest steppe zones much further north. Furthermore, the data in this paper show the high degree to which horse frequencies vary within a single region and environment, suggesting that a single site might not be representative of patterning, even on a relatively local basis.

Focussing particularly on the later Bronze Age (Andronovo plus final Bronze Age), Begash has a NISP of 612, and the proportion of horse is 3.9%. In the 24 sites discussed above, the range in proportions of horse bones is from 2.4% (Myrzhik) to 46.2% (Dongal), and horses represent 18.9% of 65,603 NISP of all sites added together, whilst the mean average is 21.1%. Hence, the characterization from Begash is very much towards the bottom of the range. There are also problems in making straightforward assumptions about economic significance from percentages in palimpsest

assemblages. Percentages of livestock in actual prehistoric herds cannot be directly represented by the palimpsest of ‘deadstock’, because of animal’s varying life cycles. For instance, a horse used for riding may live 20 or 30 years, whilst a sheep might be killed for meat at age 2 or 3. Therefore, as many as 10 slaughtered sheep could enter the palimpsest whilst that single riding horse was alive. Unless the mathematics of this are considered properly, this would seriously under-represent the proportion of horses, or other animals present in live herds. Sheep and horses, of course, also yield very different amounts of meat, when they are slaughtered. However, whilst horses and cattle yield much more flesh, slaughter of caprines specifically for meat is often more common as it results in less of a sacrifice to overall herd productivity and results in packages of meat that are more easily handled; it is a lower risk strategy.

It is most likely the case, as indicated by the Kent husbandry strategies and the lipid residues, that ruminants formed the food staple at most sites, but even at low archaeological proportions, like 3.9%, horses used principally for riding could have formed quite significant proportions of livestock and fulfilled an essential role in herding and mobility. As well as facilitating transport, faster communications and herd control, horses also are better adapted to surviving steppe winters, because of their ability to continue grazing under snow and live outside without being foddered, year round. Both horses and sheep use their hooves successfully to clear snow to get at grass, whilst cattle ineffectively attempt to use their noses, and usually need to be foddered and sheltered in harsh winters (Koryakova and Hanks, 2006). In mixed herds, horses and sheep can be useful in clearing snow, thus allowing cattle to undertake some grazing in their wake.

Hence, even in fairly low archaeological proportions, horses can be an extremely significant component of mixed pastoralism. However, at some of the sites discussed above, the proportion of horses is actually quite large. Once meat weights are taken into account, horses must have provided much food at these particular sites. In ethnographic accounts, a high proportion of horses is often taken to symbolize higher wealth and status (Koryakova and Hanks, 2006), and this may have been true in the past too. A comparison of faunal data and lipid residue analyses from settlement and cemetery sites in the later Bronze Age of Kazakhstan (Outram et al., 2011), has shown that both horse bones and lipid residues are much more frequent at funerary monuments than in settlements. This suggests that horse might have been a common component in funerary feasts. Perhaps horse meat was, as it is in Kazakhstan today, often reserved for special events, particularly by those of higher status and wealth. It is also worth noting that if a particular meat type is more commonly roasted and directly consumed it will become under-represented in lipid residues from ceramics, in comparison more run-of-the-mill stews and dairy processing activities.

5. Conclusions

This study has demonstrated that recent calls for more nuanced studies of regional variation with prehistoric steppe pastoralism are justified. In the later Bronze Age, it is clear that there is considerable variation in species representations from site to site, even within one region. Extreme caution must be exercised when making wide zooarchaeological generalisations based upon small sample sizes and single sites. The proportion of horses in assemblages is particularly variable. This may be due to very localized environmental conditions or to varying levels of wealth and status. High proportions of cattle are more generally found in the wetter forest steppe zone, whilst sheep and goats are more common in semi-arid regions, in line with wider patterns noted by Bendrey (2011). Lipid residue studies show a high proportion of ruminant dairy fats

at all sites studied, whilst examination of herd structures at the site of Kent indicate that, at least at that site, cattle may have been the main focus of milk production, whilst caprines were targeted more for prime meat slaughter. Horses would have been valued for riding and mobility, as well as their excellent adaptation to steppe winters. Their meat must have been a significant part of the diet at some sites, given the proportions in faunal assemblages, and it is possible that horse meat was particularly consumed at feasts.

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