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The extent of cereal cultivation among the Bronze Age to Turkic period societies of Kazakhstan determined using stable isotope analysis of bone collagen

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ABSTRACT

This paper explores the contribution of plant foods to the diet of presumed pastoral societies in Kazakhstan. Carbon and nitrogen stable isotope analysis, together with radiocarbon dating, was carried out on human and animal bones from 25 Chalcolithic, Bronze Age, Early Iron Age, Hunic and Turkic sites across Kazakhstan. We use these data to examine dietary differences across time and space within and between populations.

Our results show that at the Bronze Age sites of mountainous southern Kazakhstan people consumed C_4 plants, likely domesticated millets (*Panicum miliaceum* and *Setaria italica*) as supported by previously published archaeobotanical direct evidence. By dating individuals with high $\delta^{13}C$ values we find the earliest evidence to date of the consumption of large quantities of millet in Central Asia. By contrast, there is little input of C_4 plants to diets of individuals dating to the Bronze Age from northern Kazakhstan. Stable isotope data from later periods show that from the Early Iron Age and continuing through to the Turkic period, C_4 plants were a major component of the human food web across the region. The wide variety of stable isotope results, both within and between contemporary sites from the southern regions of Kazakhstan, indicates a diversity of food choice.

1. Introduction

The Bronze Age in Kazakhstan has been associated with a significant transformation in the societies of the region, notably a transition from fishing and hunting to pastoralism (Kalieva and Logvin, 2011; Outram et al., 2012; Frachetti and Benecke, 2009). Pastoral nomadism as a food-producing economy based on specialized animal husbandry was considered the only form of human subsistence strategy in the grassland during the Bronze Age (Khazanov, 1994) until recent research on past steppe societies has shown the use of a much wider range of food sources than just animal products (e.g. Leonard and Crawford, 2002; Spengler et al., 2013a; Lightfoot et al., 2014). The presence of crop species in archaeobotanical records from southern Kazakhstan show that this territory constitutes a crossroads for the movement of crops that were traded and shared by mobile pastoral societies (Frachetti, 2012; Frachetti et al., 2010; Spengler et al., 2014a). Southwest Asian crops, such as wheat and barley (*Triticum turgidum/aestivum* and *Hordeum vulgare/nudum*), were spreading eastwards to China, while the Chinese crops, such as broomcorn and foxtail millets (*Panicum miliaceum* and *Setaria italic*), arrived in Europe by the Bronze Age period (Jones et al., 2011; Motuzaite Matuzeviciute et al., 2013). While great contributions have been made to the

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study of the timing and pathways of the spread of millet from China to Europe, it is still a topic of continuing research (eg. Motuzaite Matuzeviciute et al., 2013; Spengler et al., 2014a; Hunt et al., 2008).

Over the past few years, archaeobotanical studies have repeatedly provided evidence for the availability, and probable consumption, of domestic cereals among pastoralists living along the piedmont of southern Central Asia (e.g. Spengler et al., 2014a,b,c; Rouse and Cerasetti, 2014). However, despite the suggestion that during the Final Bronze Age agriculture in the region of Kazakhstan and Turkmenistan was well-established with a wide range of cereals being grown (Spengler et al., 2014a,b,c), archaeobotanical data alone cannot provide information on the extent of cereal consumption by a population or by an individual. While no stable isotope studies have been carried out in southern Kazakhstan, previous stable isotope studies from central and northern regions of Bronze Age Kazakhstan have found that only small amounts of C_4 foods were consumed by Bronze Age populations (Ventresca Miller et al., 2014; Lightfoot et al., 2014).

Stable isotope analysis is a direct method to investigate past human diets at the level of an individual. Using this technique it is possible to identify C_4 plant consumption by an individual through an analysis of their skeletal chemistry (see below). Through consideration of the existing macrobotanical evidence we can then identify which C_4 plants were available for consumption.

This paper explores the changing role of cereals in Central Asia through isotopic analysis of individuals from across Kazakhstan from the Chalcolithic to the Turkic period. Stable isotope analysis allows us to assess the proportion of C_4 plants entering the human food chain, and the analysis of animal bones allows us to consider whether those C_4 plants were eaten directly by humans or if any human C_4 signal was acquired through the consumption of C_4-eating animals. Our primary objective here is to investigate the beginning of the consumption of C_4 plants in the human diet in the present territory of Kazakhstan, by looking at isotopic evidence for changing dietary patterns though time and space. In particular, we aim to ascertain whether C_4 plants (most likely Chinese millets) were consumed on a significant scale by Bronze Age populations as a staple food. Finally, we aim to establish whether there are regional trends, by considering the human and animal data by geographic location – north and south Kazakhstan, chosen on account of their clear topographical differences. Previous research has suggested that the topography played a major role in the spread of the agricultural products (cattle and cereals) in southern Kazakhstan (Frachetti, 2012).

2. Background

2.1. Archaeobotanical evidence of broomcorn millet in Central Asia

While the dominant narrative in the literature is that the Bronze Age inhabitants of Kazakhstan were pastoralists consuming mainly animal products (Khazanov 1994; Cribb, 1991; Kuzmina, 2008), in recent years the evidence for plant cultivation and consumption has grown (e.g. Chang et al., 2003; Spengler et al., 2013a, 2014a,b,c). Sickles and grinding stones have been discovered at prehistoric sites all across Central Asia (Dakhshleiger, 1980; Volkov and Dryabina, 2001; Okladnikov, 1959), indicating human involvement in harvesting and processing plants. Ethnographic studies suggest that cereal cultivation, in particular millet (*P. miliaceum*) (Bezhkovich, 1973; Dakhshleiger, 1980), has played a very important role among the populations of Central Asia (Di Cosmo, 1994; Vainshtein, 1980; Dakhshleiger, 1980; Bezhkovich, 1973). This crop was, and still is, highly suitable for cultivation by semi-nomadic societies in Central Asia, as it completes its life cycle in a very short period (40–90 days) (Nesbitt and Summers, 1988) and has the lowest water requirements among the major crops (Baltensperger, 2002; Rachie, 1975). Gaiduchenko (2000, 2002) reports the remains of "millet porridge (Panicoideae gen. sp.)" on the walls of Chalcolithic pottery from the Tersek Culture in Northern Kazakhstan, although the methodology of identification is unclear. These reports of millet residues were disputed by Frachetti et al., 2010 as they lack species identification, as well as chronological and morphological information. The earliest directly dated macroremains of a few broomcorn millet (*P. miliaceum*) grains are from the Early Bronze Age human burial at Begash (*ca.* 2200 cal BC) in southeastern Kazakhstan, from a sample that also included wheat grains (*T. turgidum/aestivum*) (Frachetti et al., 2010). Archaeobotanical research by Spengler and colleagues (2014a,b) report the presence of wheat, barley, broomcorn and probably foxtail millets at Tasbas in south-eastern Kazakhstan, dated to 1450–1250 cal BC (Spengler et al., 2014a) and in the Murghab delta (Turkmenistan) at site 1211/1219 which is attributed to the Late/Final Bronze Age period (*ca.* 1950–1300 BC) (Spengler et al. 2014c). Further to the southwest of Central Asia, broomcorn millet was found at Late Bronze Age Shortughai, Afghanistan (Spengler and Willcox, 2013) and Ojakly in eastern Turkmenistan; the grain from Ojakly was directly dated (1740–1614 cal BC) (Rouse and Cerasetti, 2014).

In neighbouring Xinjiang, China, broomcorn millet grains have been found together with wheat and barley grains at second millennium BC sites (e.g. Chen and Hiebert, 1995). For example, in the Lop Nor Desert in Xiaohe, a small vessel plaited out of willow branches, roots and grass stems and containing wheat and millet grains was placed in the burial of two wooden dolls dated to *ca.* 1650–1450 BC (Baumer, 2012, p. 123). Further east, broomcorn millet has been found at Majiayao culture sites in western Gansu province, China, dated to 2700–2300 BC (Dani and Masson, 1992).

From the Early Iron Age, archaeobotanical data from Kazakhstan is supported by both macrobotanical remains and phytoliths. Recent studies of phytoliths from south-eastern Kazakhstan indicated millet (Panicoid and *Setaria* sp.) and wheat (*Triticum* sp.) (Chang et al., 2003; Rosen, 2001; Rosen et al., 2000), while macrobotanical investigations of carbonised plant remains have revealed the presence of a range of domesticated cereals, including free-threshing wheat, hulled and naked barley, foxtail and broomcorn millet, and grapes (Spengler et al., 2013a).

2.2. Stable isotope research in Central Asia

The few published stable isotope studies in Kazakhstan have focused on Chalcolithic or Bronze Age sites in the northern and central territories. In combination with published zooarchaeological data (eg. Kalieva and Logvin, 2011; Frachetti and Benecke, 2009; Outram et al., 2012), they indicate a Bronze Age diet based on cattle and ovicaprid meat and milk as well as freshwater fish (Privat et al., 2006; Ventresca Miller et al., 2014; O'Connell et al., 2003; Privat, 2004). Some dietary contribution of C_4 plants is detectable, with a few human outliers from the Lisakovsk and Bestamak sites in the northern regions with higher $\delta^{13}C$ values near −18‰ (Ventresca Miller et al., 2014). The stable isotope analysis recently conducted from the central regions of Kazakhstan report the possible consumption of C_4 plants among a small part of population during the Final Bronze Age period (from *ca.* end of the 2nd to the beginning of the 1st millennium BC) (Lightfoot et al., 2014). From a slightly later period, stable isotope research in the Minusinsk basin of Russia, north of the Altai Mountains, has shown that C_4 plants were consumed by the local inhabitants from *ca.* 1400 BC onwards (Svyatko et al., 2013). Stable isotope studies of Early Iron Age Scythian populations in the Tuva region of southern Siberia (1st century BC) have shown that C_4 plants formed a