Earliest direct evidence for broomcorn millet and wheat in the central Eurasian steppe region

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Before 3000 BC, societies of western Asia were cultivating wheat and societies of China were cultivating broomcorn millet; these are early nodes of the world's agriculture. The authors are searching for early cereals in the vast lands that separate the two, and report a breakthrough at Begash in south-east Kazakhstan. Here, high precision recovery and dating have revealed the presence of both wheat and millet in the later third millennium BC. Moreover the context, a cremation burial, raises the suggestion that these grains might signal a ritual rather than a subsistence commodity.

Keywords: Kazakhstan, Bronze Age, pastoralism, cereals, wheat, millet, agriculture, cremation

Introduction

From the earliest archaeological preoccupation with the 'agricultural revolution', a major arena of scientific inquiry has revolved around the regional identities of people who spread domesticates and agricultural practices, those who acquired them, and the dynamics of interaction along the frontiers of different forms of food production. At its most essential, this line of study has been defined by two key requisites: finding direct evidence for domesticated plants and animals; and securely dating that evidence in comparison with neighbouring datasets. This has often led to arguments about the direct and indirect pathways toward food production that connect or differentiate the economic strategies of societies around the world. In some cases, however, vast gaps in evidence have left us with few data to work

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Received: 12 March 2010; Accepted: 16 May 2010; Revised: 28 May 2010

with, so determinations about the direction of diffusion, chronology, or even independent domestication of crops (and animals) in particular regions, cannot be made with confidence. For example, throughout the history of archaeological study in the central Eurasian steppe zone, a lack of reliable evidence for use of domesticated grains before the first millennium BC has constrained our understanding of the economies and realms of interaction that characterise Eurasian steppe communities and their neighbours before and during the Bronze Age (*c.* 3000–1000 BC).

Within the vast territory of the central Eurasian steppe (Figure 1), direct archaeological evidence of agricultural production, consumption, and regional diffusion of domesticated grains during the Neolithic and Bronze Age is concentrated only in the westernmost regions – essentially the territories north of the Black Sea and further west to central Europe. Yet for decades, archaeologists have argued for the use of domesticated grains in the subsistence economies of pastoralists living throughout the wider steppe region in the late third and second millennia BC (Kuz'mina 2007: 141). This argument has remained largely speculative due to the vast lacuna in directly dated evidence for crops before the first millennium BC outside the westernmost territories of the Eurasian steppe (Lebedeva 2005). To date, a chronological gap of more than 7000 years exists between the first regional domestications of wheat (*Triticum* spp.) in south-west Asia, broomcorn millet (*Panicum miliaceum*) in China, and the earliest directly dated evidence of those grains in central Eurasian archaeological contexts. Both geographically and chronologically, the near void in archaeobotanical evidence across the steppe zone, from the Gansu (Hexi) Corridor to the Caucasus, has clouded archaeological models of diffusion of domesticated crops over an enormous territory of the world. However, recent archaeological research suggests that Eurasian mobile pastoralists were key agents for the transmission of numerous technologies and products across the steppe zone, promoting networks of interaction between economies and societies from eastern Asia to south-west Asia and Europe in the third and second millennia BC (Anthony 2007; Frachetti 2008).

The earliest cultivation and use of domesticated cereals in Neolithic economies are well documented from at least 8000 BC in south-west Asia (Willcox 2005; Weiss *et al.* 2006). By the sixth millennium BC, domestic varieties of wheat and barley (*Hordeum vulgare*) (among other crops) comprise staple foods for Neolithic agriculturalists from south-west Asia to Europe and south Asia (Colledge *et al.* 2004; Bellwood 2005). Recent studies in eastern Asia at the site of Cishan in north-eastern China document the cultivation of broomcorn millet as early as 8000 cal BC between the Loess Plateau and the North China Plain (Crawford 2009; Lu *et al.* 2009). Evidence for millets – broomcorn and foxtail (*Setaria italica*) – is more abundant in later Neolithic sites throughout the Yellow River valley and in more upland regions (i.e. elevated terraces) of central and eastern China by 6000 BC (Zhao 2005; Crawford *et al.* 2006; Liu *et al.* 2009). Interestingly, domesticated millet is also found before 5000 BC in western and central Europe, sparking debates about possible pathways across central Eurasia *versus* scenarios of independent domestication (Lisitsina 1984; Zohary & Hopf 2000). This issue will not be resolved until more is known about genetic relationships between domesticated broomcorn millet and the phytogeography of its wild ancestors.

Li *et al.* (2007) provide the earliest evidence of wheat in China around 2600 BC, at the site of Xishanping (Figure 1). Crawford *et al.* (2005) present evidence for wheat at the sites

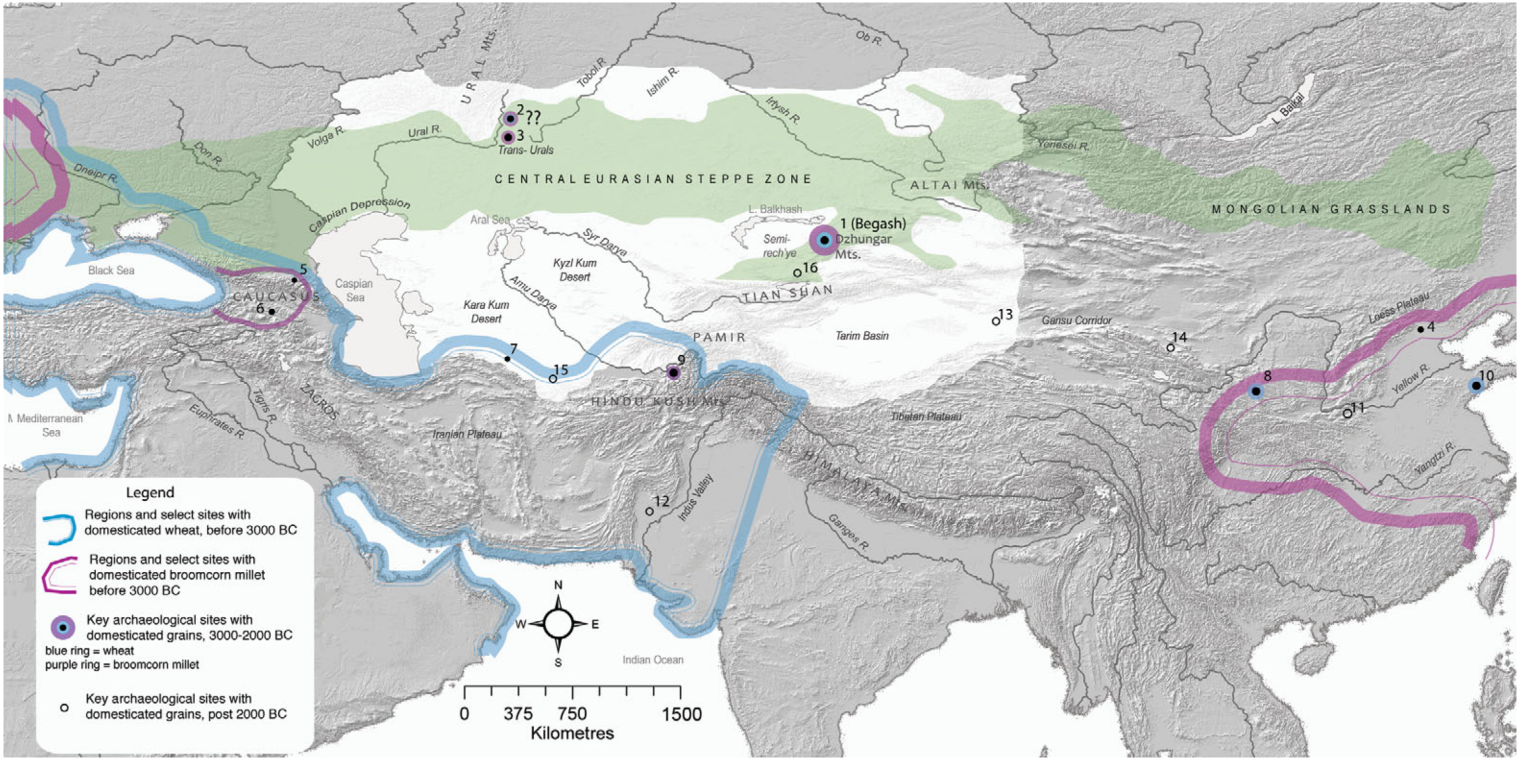

Figure 1. Key regions and selected sites with archaeological evidence of wheat and broomcorn millet in prehistory: 1. Begash (Frachetti & Mar'yashev 2007); 2. Arkaim (Gadyuchenko 2002); 3. Alandskoe (Gadyuchenko 2002); 4. Cishan (Lu et al. *2009); 5. Chokh (Lisitsina 1984); 6. Kyul-tepe (Lisitsina 1984); 7. Jeitun (Harris & Gosden 1996); 8. Xishanping (wheat at* c. *2500 BC) (Li* et al. *2007); 9. Shortugai (Willcox 1991); 10. Liangchengzhen (wheat* c. *26–1900 BC) (Crawford* et al. *2005); 11. Zaojiaozhu (wheat* c. *19–1500 BC) (Crawford* et al. *2005); 12. Pirak (Costantini 1981); 13. Lop Nor (Xiaohe & Gumugou sites, wheat* c. *2000–1500 BC) (Crawford* et al. *2005; Flad* et al. *2010); 14. Donghuishan (wheat* c. *1700 cal BC) (Flad* et al. *2010); 15. Tahirbai-tepe (wheat & millet* c. *1500 BC) (Hunt* et al. *2008); 16. Tuzusai (wheat & millet* c. *700 BC) (Chang* et al. *2003; Rosen* et al. *2000).*

of Liangchengzhen and Zaojiaoshu in eastern China around 2000 BC. Flad *et al.* (2010) directly dated wheat remains from Donghuishan in the Hexi Corridor (western Gansu) to *c*. 1700 cal BC, demonstrating that by the second millennium BC wheat was widely distributed outside its concentrated region(s) of domestication. Yet, the long chronological hiatus between the earliest evidence of domesticated wheat and millet in regional Neolithic agricultural centres and corresponding archaeological evidence of these domesticates in the Late Bronze Age has left the trail cold beyond the borders of south-west and eastern Asia. Thus, new studies documenting domesticated crops from the third millennium BC in the vast intervening territory – the central Eurasian steppe – represent an essential focus for more complete comprehension of the vectors of transmission of domesticated grains between earlier agricultural centres in China, south-west Asia and Europe.

This article presents archaeobotanical evidence from the pastoralist campsite Begash (phase 1a, *c*. 2500–1950 cal BC), located in the piedmont steppes of the Dzhungar Mountains in south-eastern Kazakhstan (Figure 1). At Begash, carbonised seeds of broomcorn millet and wheat were recovered through systematic flotation of soils from a cremation burial cist and from an associated funerary fire-pit. A direct AMS date from the millet and wheat seeds yielded a 2-sigma range of 2460 to 2150 cal BC, while additional AMS dates of associated charcoal samples from the burial cist and related fire-pit fall between 2290 and 2020 cal BC (Table 1). Nearly all the domesticated seeds were recovered from the burial context; flotation samples from the domestic hearths of the same chronological period at Begash contained only two broomcorn millet grains. Currently, the remains from Begash predate by roughly 1500 years any other absolutely dated evidence of millet or wheat in the steppe zone and are the earliest reported anywhere in central Eurasia from the Don River to the Hexi Corridor (China) (cf. Kuz'mina 2007: 141). The documentation of domesticated grains at Begash establishes a key point of reference for the transmission of both wheat and millet along distinct routes – and possibly in different directions – through the mountains of central Asia and into the steppe territory by the late third millennium BC.

Archaeological context and methods

The prehistoric settlement of Begash, located in the Semirech'ye region of eastern Kazakhstan, was excavated in 2002, 2005 and 2006 as part of the joint Kazakh-American Dzhungar Mountains Archaeology Project (DMAP) (Frachetti & Mar'yashev 2007). From at least 2500 BC, Begash was occupied by small groups of mobile pastoralists, whose economy was based on vertically transhumant sheep/goat herding in the Dzhungar Mountains (Frachetti & Benecke 2009).

The broad chronology of occupation at Begash is derived from 34 AMS samples taken throughout the site's stratigraphic levels, which date the earliest occupation (phase 1a) to the Early/Middle Bronze Age (*c*. 2500 BC), with later construction phases in the Middle Iron Age (phase 3, *c*. 400 cal BC), medieval and historic periods (phase 5/6) (Frachetti & Mar'yashev 2007). The chronology of phase 1a, in particular, is derived from four AMS samples with overlapping 1-sigma ranges from 3100 to 1950 cal BC. However, given the wide error margin for the earliest AMS sample (4220$\pm$220 yrs BP, uncalibrated), a more conservative calibrated range of 2460–1950 cal BC is preferred by the authors.

Table 1. Calibrated AMS chronology of seeds and organic samples from phase 1a burial context at Begash.

Lab sample #	Sample # & archaeological context	Material	Calendar age uncalibrated yrs BP	Calibration intercept(s) cal BC	2-sigma calibrated results: (95% prob.) cal BC
Beta-266458	FS47a Burial cist	Carbonised millet and wheat grains	3840±40	2290	2460–2190 2170–2150
Beta-266459	FS47b Burial cist	Wood charcoal	3760±40	2190 2170 2150	2290–2110 2100–2040
Beta-266460	FS50 Ritual fire-pit (lower level)	Wood charcoal	3740±40	2140	2280–2240 2240–2030
Beta-266457	FS44 Ritual fire pit (upper level)	Wood charcoal	3720±40	2130	2260–2260 2210–2020

Excavations of the phase 1a occupation at Begash revealed a single domestic structure and an associated cremation burial *c.* 8m away (Figure 2). Excavators encountered the outer stone border of the burial cist along the north-west edge of the excavation balk wall and, thus, dug a 1m trench extension so as to stratigraphically approach the cist from above without disturbing or contaminating the burial. Located directly adjacent to the cist itself, the burial context also includes a circular ash and charcoal deposit, which is interpreted as a funerary pyre due to its proximity and stratigraphic relationship to the burial. In addition to their functional parity and proximity, the nearly identical AMS ranges of these two features further support this conclusion.

Two types of soil samples – bulk samples and feature samples – were collected during excavations at Begash for the purpose of flotation. Bulk samples were collected from all cultural layers throughout the site to assess baseline botanical data. Feature samples were taken from every distinct anthropogenic context, such as occupation floors, burials, hearths and middens. Sample sizes varied with feature size, but 10 litres was the target volume.

Eight flotation samples were taken from phase 1a contexts, and five of these contained domesticated grains, resulting in a total of five classified as wheat or Cerealia (see below) and 28 classified as broomcorn millet grains (Tables 2 & 3). Ninety-four percent (93.9%) of the domestic seeds came from three samples all associated with the burial context (cist and funerary fire-pit). The cremation cist was devoid of ceramics or metals and contained only funerary ashes and small bone fragments. Half the volume of the ash in the cist, as well as soil samples from the funerary fire-pit alongside the cist were floated and sieved for macrobotanical remains. In the case of the phase 1a fire-pit, 9.5 litres of soil were taken from the upper level and 2 litres were taken from the lower level, while 30 litres of the soil and ash remains from inside the burial cist were collected and processed for flotation. Approximately 2–3 litres of soil were sampled from each of the domestic hearths in phase 1a (Figure 2). The samples were floated using a simple bucket method as described in Pearsall (2000). A

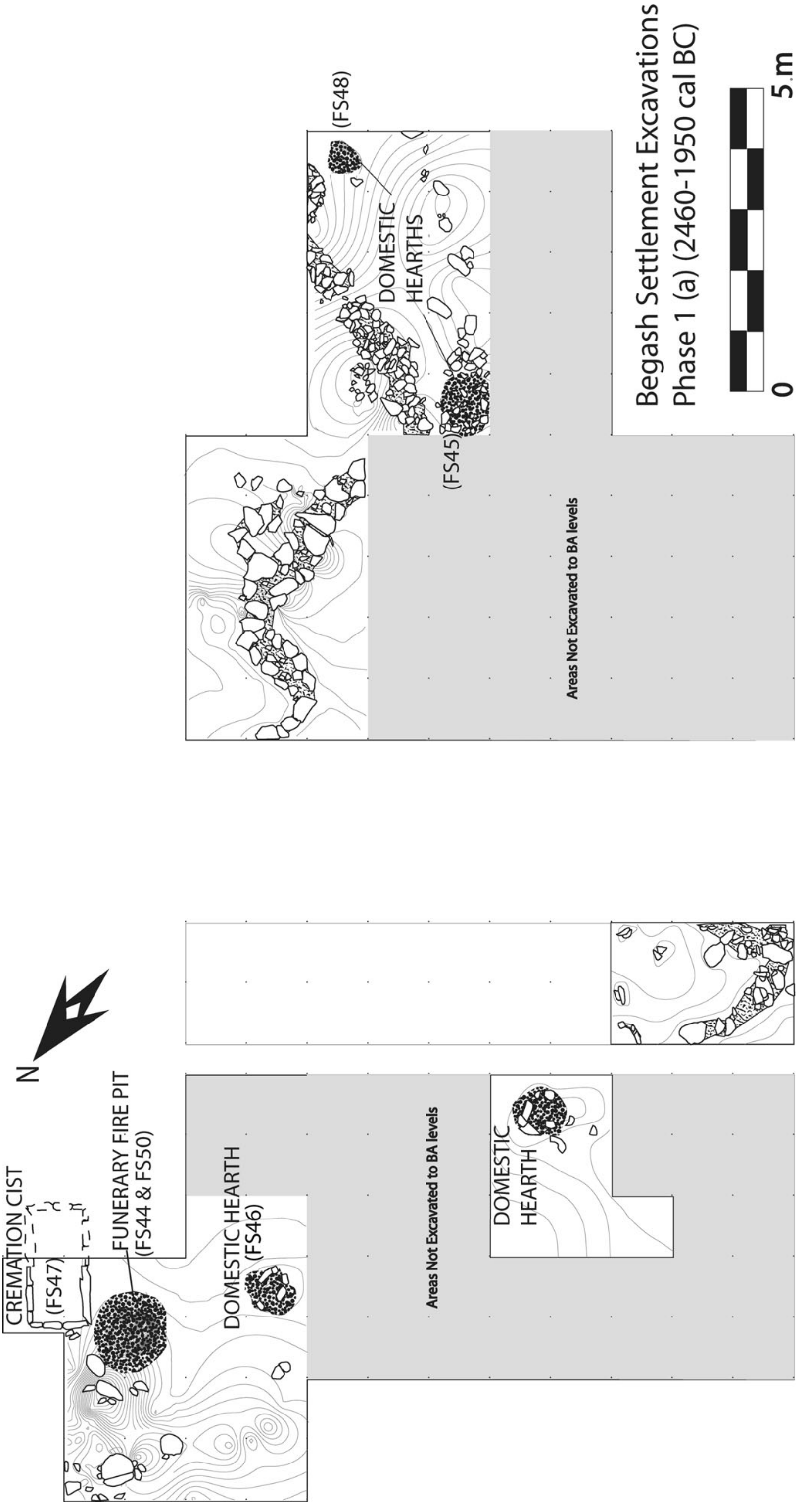

Figure 2. Plan of excavations of Begash, phase 1a (after Frachetti & Mar'yashev 2007).

Table 2. Flotation samples from Begash with *Panicum miliaceum.*

Sample # & age	Archaeological context (litres floated L)	Total	# of whole	# of frag. or puffed	Measurements of whole seeds			
					Length (mm)	Width (mm)	Scutellum height (mm)	Scutellum/seed length ratio
FS2 AD 1220–1420	Domestic hearth (6L)	45	8	37	(See *Table 4* for measurements of later samples)			
FS6 390–50 cal BC	Domestic hearth (9.5L)	24	11	13				
FS19 1950–1700 cal BC	Domestic hearth (5L)	1		1				
FS47 2460–2040 cal BC	Burial cist, ash from human cremation (30.8L)	12	2	10	1.6 1.5	1.4 1.5	0.6 0.6	0.40 0.60
FS44 2260–2020 cal BC	Funerary fire-pit (upper level) (9.5L)	10	4	6	1.6 1.9 2.2 1.8	1.5 1.6 2.1 1.5	0.5 0.9 1.1 1.0	0.31 0.47 0.50 0.56
FS50 2280–2030 cal BC	Funerary fire-pit (lower level) (2.0L)	4	1	3	1.6	1.5	1.0	0.63
FS48 2460–1950 cal BC	Domestic hearth (3.0L)	1	1		1.5	1.4	0.9	0.60
FS45 2460–1950 cal BC	Domestic hearth (3.1L)	1	1		1.7	1.6	0.5	0.38

total of 32 samples were floated from the Begash site representing all phases of occupation. A minimum sieve size of 0.355mm was used for light fraction samples and 1.00mm was used for heavy fraction. The high concentration of inorganic material, specifically clay clots, made it impractical to use a smaller sieve size for the heavy fraction.

The archaeobotanical evidence

Four large cereal fragments and one complete wheat grain were identified in the late third millennium BC samples from the burial cist. The Begash wheat is from a free-threshing variety (either *Triticum aestivum* or *T. turgidum*), measuring 5.2mm in length and 4.3mm in width; therefore, the length to width ratio (1.21) indicates a compact wheat form. The cereal grains from Begash have easily recognised ventral furrows, which tend to be deep, while the dorsal side is round and protruding with a sunken embryo notch (Figure 3).

Table 3. Prevalent taxa recovered at Begash in Brone Age contexts (2460–1000 cal BC).

Flotation sample #	Date range cal BC	Vol. litres	Wood (>2.oomm) Ct.	Wood (>2.oomm) Wt.	*Triticum aestivum/turigidum*	Cerealia	*Panicum miliaceum*	*Stipa* type	Panicoid type	*Chenopodium* spp.	*Cheno-ams*	*Galium* sp.	*Hyoscyamus niger*	*Malva* sp. (c.f. *sylvestris*)	Polygonaceae	*Polygonum* sp.	Brassicaceae	*Tribulus* type	*Mentha/Nepata* type	*Hypericum* sp.	*Lithospermum arvense*	Asteraceae type	Unidentified seed	Unidentifiable seed frags.	Awn	Worked fibres (unidentifed)
12	1625–1000	9.5	67	0.48				10	1	40	32	28	11	39	2	12	2	4	2			4	9	85	1	
10	1950–1700	9	144	1.2					2	65	72	4	2	1		2				1				58		
19	1950–1700	5	11	0.03			1	11		48	122	125				1						34	6	116		5
36	1950–1700	0.4	4	0.03				1			1	5												1		
37	1950–1700	1	6	1.03						1			1										1	1		
38	1950–1700	9	15	1.06				9		112	116	4	55									1		16		
39	1950–1700	0.7	59	0.23					1	3	7													3		
40	1950–1700	3.1	NC	13.55				30		9	4					5					1		1	17		
41	1950–1700	0.85	4	0.02							4	6	2													
43	1950–1700	1.8	19	0.08				1		9	7	8	3			1						2		11		
42	2460–1950	6.2	688	7.13						5	15	78												8		
44	2260–2020	9.5	NC	14.77			10	2	1	21	21	121	1			6					1	1		41		
45	2460–1950	3.1	50	0.43			1	1	1	7	13	18	4			1							2	14		
46	2450–1950	1.25	425	2.61				8		2		15												6		
47	2460–2040	30.8	NC	16.59	1	4	12	11	3	57	50	79	9			1					1	1	1	49		
48	2460–1950	3	256	2.02			1	2		4	24	13	2			2						6		34		
49	2450–1950	9	NC	6.13				2		138	24	32				1								2	1	
50	2280–2030	2	NC	9.23			4	4		8	2	24	1									2	11	3		
	Totals	105.2	NC	76.62	1	4	29	92	9	529	514	560	91	40	2	32	2	4	2	1	3	51	31	465	2	5

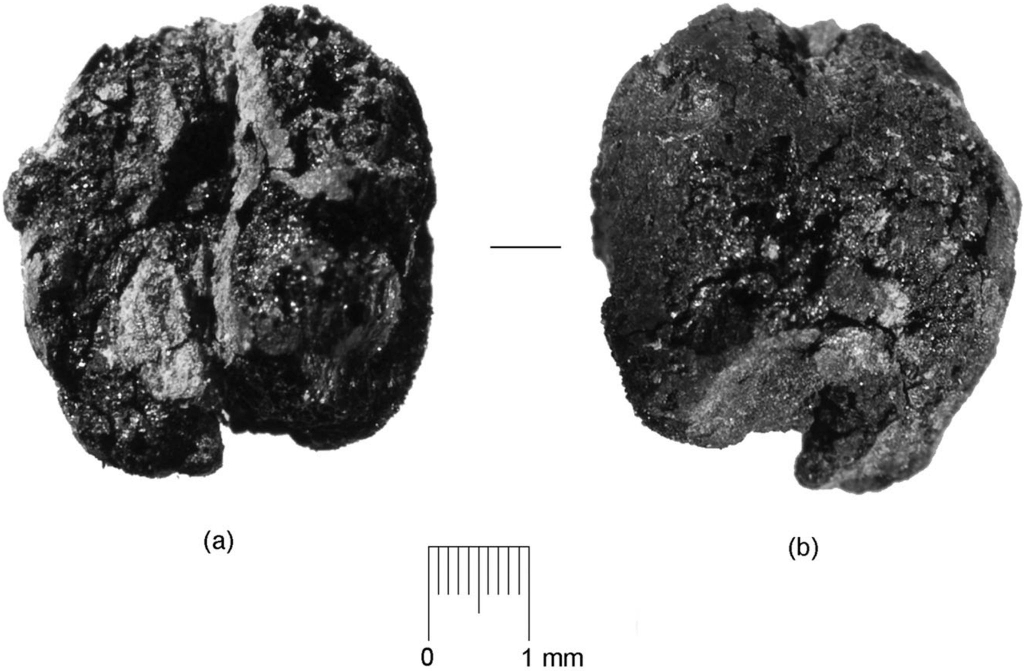

Figure 3. Carbonised wheat seed from Begash (FS47) 2460–2150 BC (calibrated): a) ventral view; b) dorsal view.

The dorsal side does not appear to be humped – a feature more common in barley grains. The ventral side on the whole grain is rather flat and only slightly rounded, a trait also common in the fragmented grains. Thus, we think all the cereal grains represent a similar form of wheat. The plump round seed shape of the Begash wheat generally conforms to hexaploid (2n=42) wheat species, *T. aestivum*, but short round forms of wheat have sometimes been placed into different taxa, including *T. sphaerococcum* and *T. compactum*. In fact, due to overlaps in size and morphological characteristics, most researchers no longer practice differentiation between varieties of free-threshing wheats when associated spikelet parts are not present. Given the limited sample size of the Begash assemblage, the authors acknowledge the possibility that the Begash wheats are from a free-threshing tetraploid (2n=28), *T. turgidum*. Therefore, we conservatively lump them under the category *T. aestivum/turgidum.*

The identification of the Bronze Age wheat from Begash is important because compact wheat forms are known in the Indus Valley region at Mehrgarh by at least the mid fifth millennium BC (Costantini 1984; Zohary & Hopf 2000) and at later Harappan sites, *c*. 2500–2000 cal BC (Weber 1991). Compact *T. aestivum* is also identified at sites such as Anau South and Gonur Tepe, documenting that round, free-threshing wheat was already in use in southern central Asia by 3000–2000 BC, and likely earlier (Moore *et al.* 1994; Miller 1999, 2003). Further north along the western fringe of the Pamir Mountains, additional

Table 4. Measurements of whole seeds of *P. miliaceum* from Begash, post-1000 BC.

Sample # & age	Length (mm)	Width (mm)	Scutellum (mm)	Scutellum/length ratio
FS2 AD 1220–1420	2.2	2.1	1.2	0.55
	2.3	2.2	1.3	0.57
	2.1	2.0	0.9	0.43
	2.0	1.8	0.9	0.45
	2.3	2.2	1.0	0.43
	2.2	2.1	1.0	0.45
	2.0	1.8	0.9	0.45
	2.3	2.3	1.1	0.48
FS6 390–50 cal BC	2.4	2.4	0.9	0.38
	2.3	2.3	0.7	0.30
	2.3	2.3	0.8	0.35
	2.4	2.3	1.0	0.42
	2.5	2.3	0.6	0.24
	2.0	1.9	0.7	0.35
	2.0	2.0	0.7	0.35
	1.9	2.0	1.0	0.53
	2.1	2.1	0.7	0.33
	2.2	2.0	0.6	0.27
	2.3	2.2	1.0	0.43

evidence of free-threshing wheat is documented in phase III levels (*c.* 2600–2000 BC) at the site of Sarazm in western Tajikistan (Willcox n.d.; Razzokov 2008).

Crawford (1992) notes that in eastern Asia, wheat forms are predominantly hexaploid and he suggests this is the case for the earliest wheat in China (*c.* 2600 cal BC) and for later archaeobotanical wheat from Korea (*c.* 1000 cal BC) and Japan (beginning of the first millennium AD) (see also Crawford & Lee 2003). Recently published wheat from Donghuishan (*c.* 1700–1500 cal BC) in the Hexi Corridor (Gansu) conforms to a compact morphotype similar to the wheat recovered from Begash (cf. Flad *et al.* 2010). Of course, more archaeobotanical evidence and more detailed comparisons are necessary before confident statements can be made about the possible spread of wheat from southern central Asia or the northern Indus Valley through Semirech'ye into China. Nonetheless, chronologically and geographically, the Begash wheat lends support to the hypothesis that a likely trajectory for wheat into China was north through the mountains from southern central Asia and east along the foothills of the Tian Shan and Dzhungar Mountains, spread by mountain pastoralists in the mid to late third millennium BC.

Carbonised remains of broomcorn millet exist throughout the 4000 year chronology of habitation at Begash (Table 2), whereas foxtail millet is recovered only in samples dating to the first millennium BC and later. Although the morphology of the third millennium BC broomcorn millet is consistent with that of later periods, the later millets are larger (Table 4). Nevertheless, the measurements of the earliest broomcorn millets (see Table 2) are well within the range of published sizes for domesticated *Panicum miliaceum* across Eurasia (Renfrew 1973; Fuller 2006). All of the caryopses are round to oval in broad view (Figure 4) and scutellum length is less than two-thirds total caryopsis length with broad width.

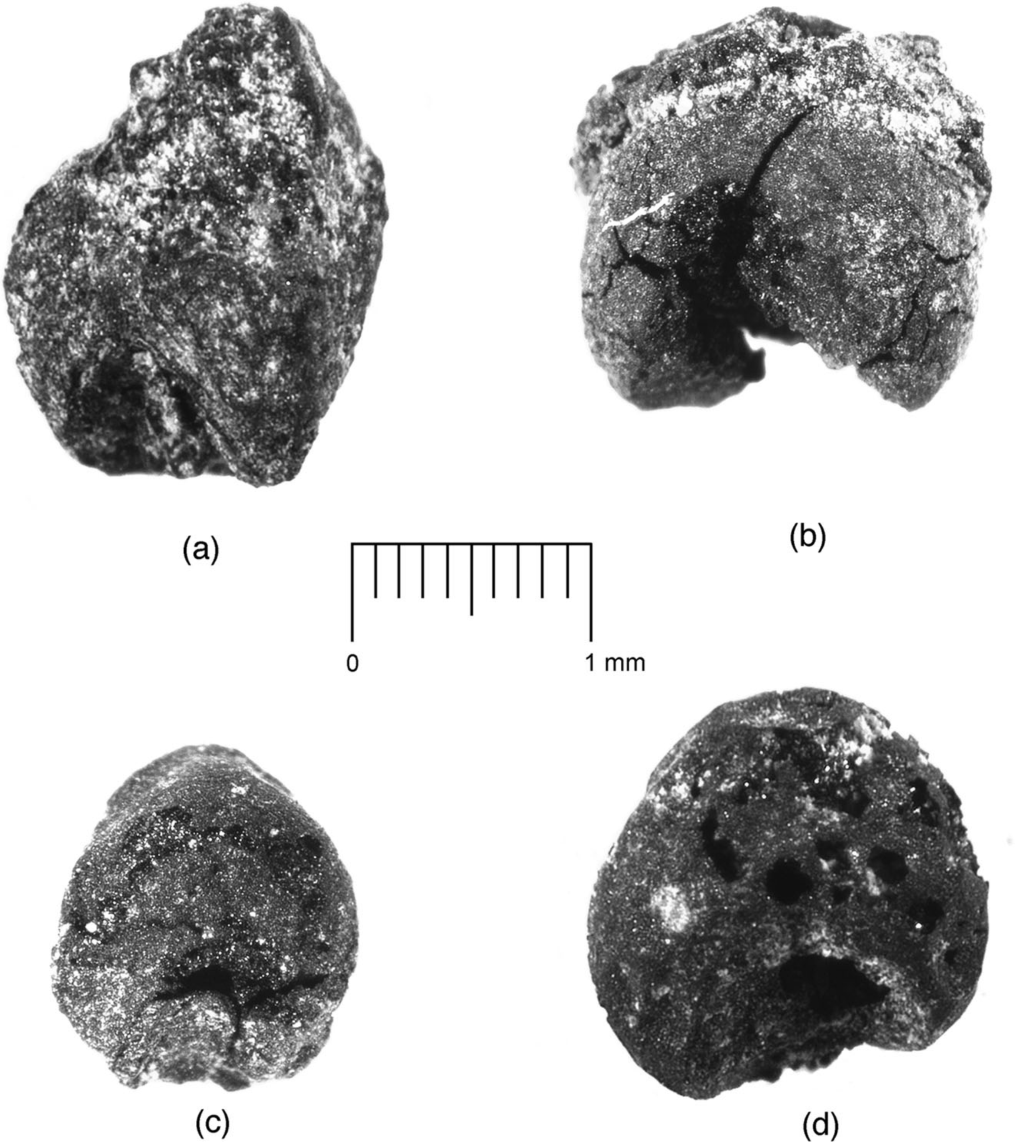

Figure 4. Carbonised millet (P. miliaceum*) seeds from Begash, phase 1a: a) FS47; b & c) FS44; d) FS50.*

Since the earliest occupation phase at Begash predates any other pastoralist settlement in the region and archaeologically spans nearly 500 years, direct AMS dates were obtained for the domesticated seed remains and for their corresponding contexts. Three samples of wood charcoal – one from the burial cist and two from the associated fire-pit – were AMS dated at Beta Analytic, establishing that all came from undisturbed contexts of the late third millennium BC (Figure 5). Subsequently, seven fragmentary broomcorn millet seeds from the burial cist were submitted for direct AMS dating to more precisely date the plant evidence at Begash. Because these fragments yielded only 0.6mg of carbon (post-treatment)

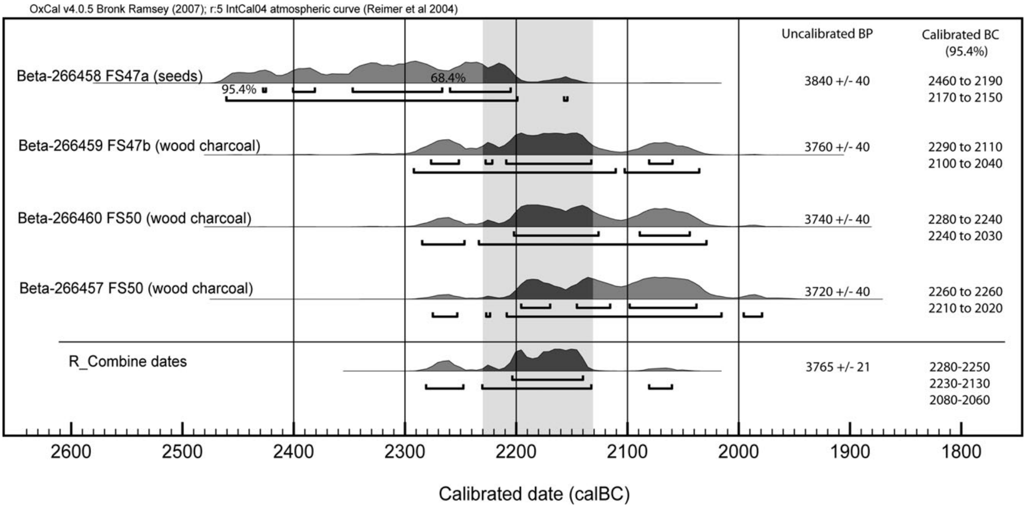

Figure 5. Calibrated ranges (BC) of AMS dates from flotation samples containing domesticated seeds at Begash.

and after consultation with the AMS technicians at Beta Analytic, a fragmentary wheat grain from the same burial-cist flotation sample was added to the sample of millet seeds to produce the Beta-266458 AMS date. The grains are absolutely dated between 2460 and 2150 cal BC (95.4% confidence), with the most probable calibration intercept of 2290 cal BC (Table 1). Given the archaeological context, a weighted average of all the samples was used to yield a 2-sigma range between 2280 and 2060 cal BC with the highest probability density (79%) falling between 2230 and 2130 cal BC (see Figure 5).

Wild herbaceous seeds were the predominant plant remains recovered in the phase 1a assemblage and were prevalent throughout the assemblages from all phases at Begash (Table 3). The presence of wild herbaceous seeds at Begash could result from a number of taphonomic processes, including seed rain as well as human and animal foraging. Wild herbaceous seeds could also have been introduced in domestic contexts through the burning of dung laden with seeds, a practice prevalent among ethnographically documented pastoralist communities of the Eurasian steppe.

A variety of wild taxa were identified at Begash, with *Chenopodium album*, *Hyoscyamus* sp., *Galium* sp., and *Stipa*-type being most abundant from phase 1a. *Chenopodium* is the most common seed type documented throughout all occupation phases at Begash. The smooth testa and relatively large size of these seeds conforms to *C. album*, a species commonly found in archaeobotanical assemblages across Eurasia. *Hyoscyamus* seeds are also identified in many of the Begash samples. Only two species from this genus grow in this part of Eurasia, *H. niger* and *H. pusillus* (Wu *et al.* 2006: 306), with *H. niger* being the more common species found in the area today. The *Galium* seeds from Begash are large and were likely setose (bristly). A number of caryopsis fragments from a long-seeded species of grass were also identified; these caryopses are similar in morphology to those of *Stipa*. In addition, they are often associated with twisted awns in the assemblage. While a definitive identification as *Stipa* is not possible, this is one of the more prevalent grasses in the region today.

Discussion

Across the steppe territory of central Eurasia and its periphery, archaeobotanical evidence for the use or production of domesticated grains before the second millennium BC has only been documented in two regions. In the western regions, north of the Black Sea, farming communities cultivated einkorn (*T. monococcum* ssp. *monococcum*) and emmer (*T. turgidum* ssp. *dicoccum*) wheat, barley and broomcorn millet as components of their sedentary village economies from at least the sixth millennium BC (Pashkevich 2003). In southern central Asia, Neolithic villages such as Jeitun, along the northern piedmont of the Kopet Dag range in present day Turkmenistan, also provide evidence for the cultivation of einkorn and emmer wheat and barley around 6000 BC (Harris & Gosden 1996: 377; Moore *et al.* 1994; Miller 1999; Hiebert 2003). In both regions, the presence of wheat and barley is commonly associated with distinct trajectories of slow diffusion of south-west Asian domesticates starting before the sixth millennium BC – west and north into Europe (Price 2000) and east across the Iranian Plateau to central Asia (Miller 1999). The occurrence of domesticated millet in central Europe is also documented before 5000 BC (Lisitsina 1984; Austin 2006), although the pathways of its diffusion have been far more difficult to explain. As noted by Hunt *et al.* (2008) and discussed above, the earliest evidence for broomcorn millet comes from north-eastern China, making the lacuna in the central Eurasian steppe a major impediment for understanding possible vectors of transmission, east to west or otherwise.

The only previous reports of archaeobotanical evidence for wheat and millet of the third millennium BC in the central Eurasian steppe comes from the Middle Bronze Age sites of Arkaim and Alandskoe (*c.* 2200–1800 BC), located in the trans-Ural region (Gadyuchenko 2002). However, the reported grains are not directly dated and the archaeobotanical details of the samples are not published in full: Gadyuchenko (2002) reports *Panicum* sp. and *Triticum* sp. from Arkaim and Alandskoe without species identification, direct chronology, or morphological information. Thus, we await the results of future research, such as that currently underway at nearby sites such as Stepnoe, to confirm the existence of a wider distribution of domesticated grains in the trans-Ural region (B. Hanks *pers. comm.*). Currently, well-dated evidence for domesticated plant use in the Eurasian steppe comes from only a few steppe settlements of the first millennium BC, such as Tuzusai, also located in the Semirech'ye region of south-eastern Kazakhstan (Chang *et al.* 2003). Sampling and soil analysis there yielded phytoliths of millet, wheat and barley, from Iron Age contexts AMS dated to around 700 cal BC (Rosen *et al.* 2000).

The near absence of domesticated plant evidence from anywhere in the central Eurasian steppe is partly an artefact of archaeological methodology. Only recently have flotation and archaeobotanical analysis become standard methods among archaeological projects in the steppe zone (Anthony *et al.* 2005). Yet, recent research using comprehensive flotation of soils from Bronze Age burials and settlements, such as Krasnosamarskoe in Russia's Samara Valley, illustrate that communities of the third to second millennia BC in the western forest-steppe region relied primarily on wild plants, rather than cultigens, to augment their pastoralist economies (Anthony *et al.* 2005). Likewise, only wild plants have been recorded from archaeobotanical studies of early third-millennium BC burial kurgans in the north

Caspian steppe region (Shishlina *et al.* 2008). Although similar wild plant taxa were also prevalent in the phase 1a assemblages at Begash, the site provides a unique archaeological case for the use of domesticates among central Eurasian steppe pastoralists during the middle to late third millennium BC, especially in the eastern region.

The presence of both wheat and broomcorn millet at Begash highlights the challenges faced by researchers who seek to understand the role of pastoralists in the spread of crops across central Eurasia and the significance, if any, of crops in pastoralist economies at various places and times. At Begash, only two millet seeds were recovered from domestic hearths in phase 1a, while 26 millet seeds and five wheat/cereal specimens were recovered from the burial and associated funerary fire-pit. Given their overall low abundance across the site and increased concentration in ritual features, broomcorn millet and wheat do not appear to have been an everyday food source among pastoralists at this time. To the extent that Begash is representative of the earliest use of domesticated grains in the steppe region, broomcorn millet and wheat may have initially been sought by Eurasian pastoralists in this region as important ritual commodities for use in burial ceremonies during the late third millennium BC. Interment of wheat grains with the dead is further documented in later cemetery sites of the second millennium BC in Lop Nor (Xinjiang) (Flad *et al.* 2010). Meanwhile, the consumption or offering of other economically restricted resources, such as horses, has recently been documented through lipid analysis of ceramics from Late Bronze Age burials in the central steppe region (Outram *et al.* in press). These new data suggest that a complex array of ritual practices involving ideologically important commodities, such as domesticated grains and possibly horses, could have helped fuel the transmission of these innovations across Eurasia.

Given the isolation of Begash in relation to other known data, it is premature to specify the pathways or motivations that brought wheat and millet to these steppe pastoralists in the late third millennium BC. Several species of wheat – especially emmer and bread wheats – were widely grown in southern central Asia and along the piedmont of central Asian mountains by the third millennium BC (discussed above, also Moore *et al.* 1994). Begash's strategic location along a pass through the Dzhungar Mountains may have situated it along what Lu (quoted in Lawler 2009: 941) calls a 'wheat road'; part of a mountain corridor along which wheat (and other innovations) may have diffused into China in the third millennium BC. The small, roundish wheat grains from Begash conform to a morphotype some researchers have called 'Indian dwarf wheat' (*T. aestivum* ssp. *sphaerococcum*; Zohary & Hopf 2000: 52), which is believed to have been common in the northern Indus Valley at the time in question (Weber 1991). Later wheat remains of the second millennium BC from western China share the plump, round morphology of the Begash wheats (Flad *et al.* 2010), suggesting that the central Asian mountains may have provided a key passage for wheat diffusion into western China in the Middle Bronze Age. Although this explanation provides a tantalising vector for regional interaction, complications in sub-specific identification and the need for more comparisons make direct regional associations premature at this time (cf. Fuller 2001).

How broomcorn millet spread into Kazakhstan is an even more difficult question given its earlier presence in both China and south-east Europe. Hunt *et al.* (2008) summarise the evidence for Old World millets predating 5000 BC, stressing the lack of unified identification criteria, wide regional gaps in archaeobotanical data, and the fact that the wild ancestor of *P. miliaceum* is not clearly identified. Due to broomcorn millet's short growing season (30–45 days), minimal sowing investment and low moisture requirements, it could have been produced on a small scale by dry-farmers and agro-pastoralists outside major agricultural areas, including rich ecological microenvironments of the Eurasian steppe. Recent reports from sites such as Yuezhuang and Xinglonggou (*c.* 6000 BC) show that broomcorn millet in China was grown effectively in elevated contexts as well as in river valleys, suggesting that – at least environmentally – upland valley/foothill settings like that around Begash could have supported limited millet cultivation (Zhao 2005; Crawford *et al.* 2006). However, there is little evidence to support this claim at present.

Conclusion

The archaeobotanical remains from Begash document a key node on the map of prehistoric economic transformation and significantly reorient our questions concerning the innovation of agricultural production and/or the diffusion of regional products along protracted networks of exchange, especially among pastoralists living throughout the steppes and mountains of central Eurasia. The current evidence is not indicative of an established productive agricultural economy at Begash in the mid to late third millennium BC, though more sites must be excavated and analysed. Instead, we propose that domesticated wheat and millet represent rare commodities in this region around 2200 BC, and that domesticated grains were a minor provision in what was predominantly a pastoralist economy at Begash (and regionally) well into the second millennium BC. The recovery of millet and wheat in burial and ritual contexts, rather than from domestic features (e.g. cooking hearths), suggest that domesticated plants held importance beyond subsistence in their earliest use by steppe pastoralists at Begash. A provocative synthesis of emerging facts about Bronze Age burial rituals among steppe communities suggests the possibility of broad ideological motivations behind the acquisition of grains for ritual consumption or veneration, perhaps to augment other consumptive offerings like horses. The nature of ritual exploitation of exotic, high-status, or scarce crops and animal resources is an exciting new direction for study in Eurasian archaeology, for which methods like archaeobotany and residue analysis are essential (cf. Outram *et al.* in press). By the middle of the first millennium BC, both wheat and millet production increasingly augmented the base economy for the region's pastoralists and fuelled clear changes in their social and political landscape (Chang *et al.* 2002).

In sum, Begash represents one of the earliest dated archaeological sites at the crossroads of western China, south-west Asia, and the Eurasian steppe and illustrates an early confluence of trajectories for diffusion of grain crops, such as wheat and broomcorn millet, during the late third millennium BC. The seed remains from Begash do not resolve questions concerning the earliest spread or regional domestications of wheat and broomcorn millet during the Neolithic. However, by extending the absolute chronology of domesticated plant use in central Eurasia more than 1500 years into the past, the archaeobotanical data from Begash significantly expand our geographic and chronological understanding of the diverse vectors of interaction, ritual exploitation, and diffusion among societies of eastern Asia, south and south-west Asia, and regions further west across the Eurasian landmass.

Acknowledgements

Funding for this research was provided by the National Science Foundation, grant # 0535341, the Mary Morris-Stein Foundation, and by Washington University in St Louis. We are grateful to Dr Olga Pontes (Washington University in St Louis) for her help with seed imaging. Professors Gary Crawford and Philip Kohl contributed helpful comments and improvements to the final manuscript. Finally, we thank Professor Karl Baipakov, director of the Institute of Archaeology, Almaty Kazakhstan, for his support of continued international collaboration.

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