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Botanical Resource Use in the Bronze and Iron Age of the Central Eurasian Mountain/Steppe Interface: Decision Making in Multiresource Pastoral Economies

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by
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To my parents,

for teaching me to love science and nature

ABSTRACT OF THE DISSERTATION

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Professors Gayle Fritz and Michael Frachetti, Chairs

This dissertation examines botanical resources as components of Central Asian economies in the Bronze (ca. 2500 – 800 B.C.) and Iron Ages (ca. 800 B.C. – A.D. 500) using a paleoethnobotanical data set from four archaeological sites, Begash, Mukri, Tasbas, and Tuzusai. These sites are located in the Semirech'ye region of eastern Kazakhstan, and they occupy distinctive microenvironmental zones along the mountain and steppe boundaries; furthermore, they show a great deal of material cultural similarity and are placed into the same culture groups by researchers. The introduction of macrobotanical studies to Central Asian archaeology allows for a critique of former models of economy. This dissertation is divided into three economic foci, agriculture, pastoralism, and exchange. First, I look at the role of wild plants as herd forage, specifically focusing on how resource patchiness helped shape social systems and networks. Then, I look at the role agriculture played at different sites and how this role

changed over time. Finally, I discuss the role exchange played in the spread of domesticated plants and products such as textiles and grains.

Agriculture: In this dissertation, I demonstrate that domesticated grains (broomcorn millet and compact free-threshing wheat) were present in the economy of the region as far back as the Late Bronze Age (2200 cal B.C.). However, the role of these domesticates and the means of their acquisition are poorly understood. By the Late Bronze Age at the site of Tasbas (1400 cal B.C.), full-scale agriculture was being practiced; specifically cultivating semispherical split-apex naked barley, highly-compact free-threshing wheat, broomcorn millet, possibly foxtail millet, and peas.

The Iron Age transition in this region was marked by major social and demographic shifts, starting around 800 B.C. This dissertation helps to provide a direct causal link between these sociopolitical changes and the intensification of agriculture (following a Boserupian model). The inhabitants of sites such as Tuzusai, on the Talgar alluvial fan, shifted their economy more toward agricultural pursuits and away from mobile pastoralism. The incorporation of new agricultural resources, such as new varieties of wheat, hulled barley, and grapes marks this shift, which was also accompanied by possible intensification through irrigation and crop diversification. The shift toward agriculture was not uniform throughout Semirech'ye; at sites such as Begash and Mukri, economies were much more herd animal-based. Occupants of these sites may have cultivated small-scale, low-investment plots of broomcorn and foxtail millet, crops much more adaptive to a mobile pastoral economy.

Pastoralism: The pastorally-focused economy of these areas relied on forage for herd animals located in orographically determined microenvironments (ecotopes). Herd movement and foraging patterns are also discussed in this dissertation based on the seed composition of burnt dung. The wild seeds in the assemblage indicate that herds were grazed in small forage-rich ecological pockets, rather than on the steppe proper. This system of focused herd grazing is still used today. Focusing economic activities on these pockets means that, while overall population was low, it was localized in specific locations. These pockets became nodes in a network of interaction and exchange across the region, providing locations for winter communal encampment and social meeting spots.

Exchange: By the second millennium B.C. an exchange network had formed, connecting populations in South Asia to people in western China through a system of exchange, linked by mountain valleys. Goods such as metal ore, horses, and textiles were exchanged. This corridor of exchange seems to have brought agricultural technology from China southwest into South Asia and southwest Asian crops into China. By the Late Bronze Age a specific package of agricultural crops had formed across the entire mountain corridor. The increased exchange and interaction that marked the Iron Age transition eventually cumulated into the Silk Road, and it brought new crops and technology into Central Asia, ultimately leading to increased social complexity and stratification.

Chapter 1: Introduction: Bronze and Iron Age Investigations in Central Eurasia

Since the early 1920s, starting with Nicholai Ivanovich Vavilov and V. Gordon Childe, many researchers have studied the origins of agriculture and its spread around the world. Over the past century most of the chronology and map of agricultural spread has been filled in. One of the largest remaining gaps of knowledge on this topic has been the area of Central Asia, Mongolia, and western China. This area has been referred to by some researchers in the field as the "Central Asian void". The void spans a geographic area of almost 4,000 km east/west and covers a temporal span of at least 4,000 yrs. This dissertation provides a piece to this puzzle, a large data point in the middle of this vast area. Central Asia has long been refered to as a "Pastoral Realm' this dissertation shows that the realities of economy during the Bronze and Iron Ages were more complex and that agriculture was part of the economic stratagies.

The geographic area encompassing the mountainous border between modern day China and the countries of Central Asia (Figure 1.1) has been a pivotal location in shaping Eurasian history for millennia. Within this broad region, the river valleys and slopes of the Altai, Dzhungar, Pamir, Kunlun, and Hindu Kush Mountains have played a major role in the spread of people as well as material and intellectual culture across Central Asia. By the second century B.C. the great Silk Road[1] fostered culture flow through these territories, and the development and spread of a number of major political

[1] Christian (2000:2) prefers the term Silk Roads, noting that the term comes from the German phrase *Die Seidenstrassen*, first used by Baron Ferdinand von Richthofen in the late nineteenth century. Similarly, others have followed this plural use, sometimes referring to it/them as Silk Routes. I use the singular here purely for convention and familiarity to many readers.

and imperial entities took place, at least in part, across this geographic area. These include the Achaemenids (Ancient Persian), Arsacids (Parthians), Seleucids, and Han (and later Chinese dynasties, such as the Zhou) to name a few. Also significant, a number of nomadic empires (confederacies) formed across this geographic area, including the Xiongnu, Mongols, Golden Horde, Uighur, and various other Turkic Khanates.

The cultural dynamics and economies that underpin the development of Eurasian societies of the steppe are thought to have undergone significant changes at the start of the Iron Age (ca. 800 B.C.); specifically, a move toward “true nomadism” has been used to define the Iron Age of Central Eurasia (Abetekov and Yusupov 1999; Ishjamts 1999; Khazanov 1984; Kuz'mina 2008). Politically active, nomadic confederacies, such as the Xiongnu Empire, are thought to have unified by the third century B.C., incorporating various regional pastoralist populations from Mongolia, Siberia, and possibly as far west as Lake Balkash (Allard 2006; Barfield 1989; Di Cosmo 1994, 1999; Grousset 2002; Honeychurch and Amartushin 2006, 2007; Sima 1961 [ca. 80 B.C.]; Rogers 2007; Rogers et al. 2005). Beyond these territories imperial conquests on the southern fringes of the eastern steppe led to further interactions between civilizations such as the Achaemenid and steppe pastoralist communities, which the Achaemenids referred to as the Saka. These interactions are depicted in Persian inscriptions, such as on the Behistun Rock, dating to 515 B.C. (Adkins 2003; Koshelenko and Pilipko 1999). Broadly speaking, early historical documentation illustrates the political impact of growing interaction by the end of the first millennium B.C., but there is still only limited archaeological description of the pivotal early developments in economy and social strategy among Eurasian steppe pastoralists that drew regional populations into what Possehl (2004) calls a “Middle Asian Interaction Sphere” during the Late Bronze Age and early Iron Age transition (ca. 800 – 300 B.C.). As Christian (1994:182) puts it, “trade flourished when Inner Asian empires emerged that were capable of protecting large stretches of the Silk Roads. This allowed societies of Inner Eurasia to have profound impact on the history of Outer Eurasia. As a result, the political history of Inner Eurasia shaped the rhythems not just of Inner Eurasia but of the entire Eurasian world-system”. While Christian’s (1994) assessment is correct, he underplays the role of pastoralists in this exchange process. In this dissertation I look at how pastoralists shaped this world-system by spreading technology, specifically agricultural crops, across what McNeill (1963:295) refered to as the “Eurasian Ecumene” by the second millennium B.C.

Over the last decade there has been increasing interest in the Bronze (ca. 2500 – 800 B.C.) and Iron Ages (ca. 800 B.C. – A.D. 500) in Central Asia. Much of this research has focused on developing a better understanding of mobile pastoral lifeways in the past (Anthony 2007; Frachetti 2008a, 2008b; Koryakova and Epimakhov 2007; Rogers 2007; Rogers et al. 2005). Bronze Age populations in eastern Central Asia have traditionally been lumped under the title of the “Andronovo Cultural Complex”, a moniker for an amalgamation of different peoples with unique economies and cultural adaptations.

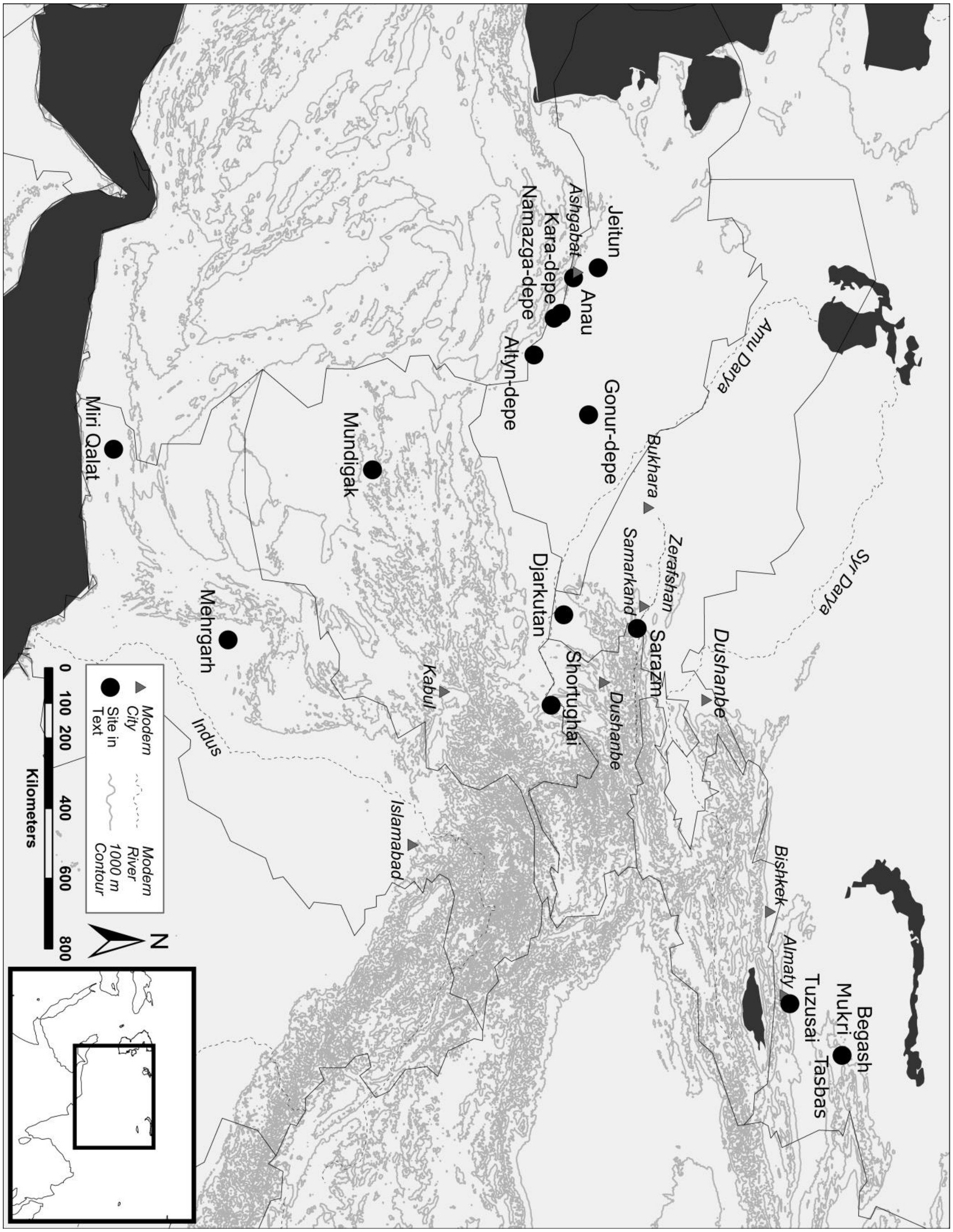

Figure 1.1. Map of Central and South Asia, showing topography and key archaeological sites mentioned in the text

Recent archaeological research in Central Asia and across the steppe shows significant diversity among steppe populations in the Bronze and early Iron Ages, documenting regional variation and considerable differences in mobility patterns, economy, social organization, and resource use (Anthony et al. 2005; Bendrey 2011; Frachetti 2004b, 2008a; Honeychurch and Amartushin 2006, 2007; Honeychurch 2004; Shishlina et al. 2008). Recent studies are showing just how much these mobility patterns varied through time, and that they were not fixed within the cultural practice of a specific population (Frachetti 2004b, 2008a, 2008b; Honeychurch and Amartushin 2006, 2007).

Bronze and Iron Age mobility patterns were dynamic, with factors such as environment and social interactions playing a role in decision making (Frachetti 2004b, 2008a, 2008b; Honeychurch and Amartushin 2007). Decision making is usually driven by multiple factors, possibly relating to issues such as seasonal encampments, use of pasture land and water resources, and herd demographics. Frachetti (2004b, 2006, 2008a, 2008b) uses the term “ordered variability” to describe the mobility strategies used by people in the Bronze Age. By using this term, he suggests that a complex indigenous knowledge system was used to make decisions about seasonal mobility patterns. Such patterns or adaptive processes as defined by Bennett (1969), however, would have varied by season and were not necessarily socially determined on a broader political scale. Groups of people (possibly kinship-based) would have used ecological knowledge to determine which seasonal pastures to use and where to place winter camps. A number of social and environmental factors would have been considered, including pasture quality, availability of water resources, and locations of other mobile groups. The variability in seasonal movements would have brought populations into contact with diverse botanical resources, specifically those distributed orographically. This is especially true for vertical movements between high elevation summer pastures and low elevation winter pastures. Thus, understanding the role of these plants in the economy will lead to a better understanding of the economy as a whole, including mobility, exchange, and diet.

The general reassessment of mobile pastoralism in Eurasia has placed Bronze and Iron Age subsistence and economic strategies in the forefront of recent scholarship. The number of recent publications is growing steadily (Anthony 2007; Anthony et al. 2005; Bendrey 2011; Chang et al. 2002; Frachetti 2004b, 2008a, 2008b; Frachetti et al. 2010a; Frachetti et al. 2010b; Honeychurch and Amartushin 2007; Honeychurch 2004; Jia et al. 2011; Kohl 2007; Koryakova and Epimakhov 2007; Kuz'mina 2008; Shishlina 2008; Shishlina et al. 2008; Spengler et al. 2013; Spengler and Willcox in press; Wagner et al. 2011). Zooarchaeological research has been key to understanding the emergence of Eurasian animal domestication (Benecke and Driesch 2003; Outram et al. 2009) and the herd structure employed by early pastoralists (Bendrey 2011; Benecke and Driesch 2003; Frachetti and Benecke 2009). Previously, domestic animal remains were used to argue for an analytical link between an idealized concept of pure pastoral nomadism and what was present in the fragmented archaeological record (Shilov 1975). Recently, Bendrey (2011:1) critiqued much of this work by stating “the territories of the Eurasian steppe exhibit a broad range of environments, and we would expect to see significant variation in prehistoric animal husbandry according to the characteristics of the environments and the suitability of different animals to these conditions”. Compounding upon these new developments, Frachetti (2012) has argued that this observed diversity in pastoralist strategies was the result of regionally distinct developments in mobile herding economies as early as the fourth to the third millennia B.C.

In eastern Kazakhstan – the focus of this study – a handful of archaeological projects over the past decade have also incorporated paleoethnobotanical techniques to better understand the importance of plants in the pastoralist diet. This trend is evident, both in the Semirech'ye region of southeastern Kazakhstan and across the Eurasian steppe (e.g., Anthony et al. 2005; Chang et al. 2003; Chang et al. 2002; Frachetti et al. 2010b; Jia et al. 2011; Koroluyk and Polosmak 2010; Motuzaite-Matuzeviciute et al. 2012 ; Pashkevich 2003; Popova 2006; Rosen et al. 2000; Shishlina 2008; Spengler et al. 2013; Spengler et al. in press; Wright et al. 2009).

The successful incorporation of archaeobotanical analyses across the Eurasian steppe has led to a better understanding of Bronze and Iron Age subsistence. To depict how distinct the different economic models constructed for the Eurasian steppe are, I draw on five recently published examples in this paragraph, all of which include botanical studies: Krasnosamarskoe; the Egiin Gol Valley; the Talgar fan; Sarazm; and the Murghab Delta.

- Archaeobotanical studies at the site of Krasnosamarskoe, in the Samara River valley near the Russian-Kazakh border, focused on the Late Bronze Age (Anthony et al. 2005; Popova 2006). Popova's (2006) research at this site has shown a complete lack of agricultural goods, but she identified a foraging component in the diet.
- Honeychurch and his colleagues (Honeychurch 2004; Honeychurch and Amartushin 2007; Wright et al. 2009) reconstructed a model for economy in the

Egiin Gol River valley during the period of the Xiongnu (ca. 209 B.C. – A.D. 93) and Orkhon Uighur (A.D. 744 – 840) Empires (polities). The subsistence economy they depict contains components of pastoralism, agriculture, hunting, fishing, and gathering of wild plants (Honeychurch and Amartushin 2007; Wright et al. 2009).

- By the Iron Age a complex agropastoral system had developed in southeastern Kazakhstan at the site of Tuzusai on the Talgar alluvial fan (Spengler et al. 2013). The population living at Tuzusai in the Iron Age relied more on sedentary agriculture than other steppe populations (Chang et al. 2002; Rosen et al. 2000; Spengler et al. 2013).
- By the late fourth millennium B.C., the Sarazm site, an agricultural village outpost had formed in the Zarafshan valley of Tajikistan (Spengler and Willcox in press). This village had an economic system unlike anything north of or near the site, nor would there be a similar agropastorally focused village economy in the northern Central Asian mountains for millennia. Furthermore, the core of the economy at Sarazm was likely mining of rocks, minerals, and metal ore (Isakov 1980; Razzokov 2008).
- Even farther south, in the piedmont of the Kopet Dag Mountains of Turkmenistan, by the second millennium B.C., large agricultural villages formed along river valleys and on the Murghab Delta (Moore et al. 1994). The agropastoral economy at these villages was further supported by mobile pastoral groups living in an interactive sphere around the villages and obtaining agricultural goods from the urban centers (Spengler et al. in review).

Shishlina and Heibert (1998) contrast Bronze Age economies of the desert steppe in southern Central Asia to the steppe of northern Central Asia, suggesting that localized adaptations were vital for economic prosperity. Our ability to assess the extent to which any of these patterns is typical for a given region or time period is limited by the paucity of comparative datasets and the localized geographic distribution of these specific data.

In particular, the view that steppe pastoralists were highly specialized or that there is such a thing as a "pure nomad" is being rejected in favor of dynamic models that show the adaptability of steppe populations (cf. Wendrich and Barnard 2008). Khazanov (1984) argued for the necessity of diversification in the economy of mobile pastoralists in restricted or marginal environments. This, he argues, is largely due to the unpredictability of such socioenvironmental landscapes (Di Cosmo 1994; Honeychurch and Amartushin 2007; Khazanov 1984). Bates and Lees (1977; Lees and Bates 1974), in studying productive economic specialization among contemporary mobile pastoralists in Mesopotamia, have found that the means of accessing agricultural goods and the amount of the diet devoted to these goods is highly variable. Consequently, the level of agricultural intensification and magnitude of social interaction and exchange are variable through time in most mobile economies. As Di Cosmo puts it, "nomads do not have to stay nomadic or die – they can, under certain circumstances, cease to be fully nomadic and shift to a different form of subsistence, which might include limited farming, hunting, gathering, or other activities" (1994:1113).

Archaeologists on the Eurasian steppe tend to use ethnographic accounts as analogues for economic reconstructions of the past (as I do in this dissertation). The economic parallels between the present or recent past (e.g., mobile herding) could lead some to believe that economy on the steppe has remained constant for millennia. In reality, economy, as with culture in general, is always changing. This change is becoming evident in the archaeological record from the Eurasian steppe. The switches between foraging, hunting, fishing, pastoralism, low-investment agriculture, and intensive agriculture may be relatively fluid. While there are many processes that lead to economic change, one that has always been of great interest in Eurasian archaeology is social interaction and exchange. Renfrew and Shennan (1982) see exchange as the key driving force for social change, and Boserup (1990:43) sees increased exchange among her list of responces to population growth, along with her infamous model for technological development. The archaeological study of social interactions in Central Asia is by no means new, nor is the study of inter-regional interactions among Central Asian peoples. However, there have been a number of new studies conducted on broad-scale social interactions in recent years, several specifically focusing on trade between East and Central Asia (e.g., Frachetti 2002, 2004a; Frachetti et al. 2010b; Hemphill and Mallory 2004; Hiebert 2002; Li 2002; Linduff 2006; Mei and Shell 1998, 1999; Thornton and Schurr 2004). These studies are having a broad impact on the understanding of Bronze and Iron Age economy and the roles of social interactions in this system. Exchange of material and intellectual culture has been an important part of archaeological investigation in Central Asia for decades, but the implications of how these interactions shaped daily life and the dynamics of culture through time are only recently becoming understood. This dissertation looks at these exchange networks as a facilitating force in the spread of agriculture and products, such as linen textiles. Furthermore, in a Boserupian sense, I argue that the inflow of novel technology and agricultural innovations supported a growing population during the Iron Age leading to the intensification of agriculture in some regions (Boserup 1983, 1990a, b).

I draw on a Niche Construction Theory framework, defined and discussed in Chapter 2, to critique previous models of archaeological economies in Central Eurasia. Niche Construction Theory provides archaeologists with a framework for studying cultural evolution that rejects environmental determinism and the concept of pastoralists being innately 'Niche Dwellers'. Niche Construction Theory instead promotes the idea that humans construct their environmental setting through cultural and ecological processes[2]. As Bennett (1969:19) states "men *do* manipulate their environment; they are not merely determined by it". For example, mobile pastoralists in marginal or semiarid environments focus on specific locations on the landscape where herd forage and water are available. The ecotone spanning the mountain and steppe boundaries of Central Asia has a characteristic mosaic landscape composed of patches of forage-rich ecotopes. These ecotopes are a vital component in the herding systems used in Central Asia today as well as in the past; they are constructed, shaped, and maintained through daily activities in the *longue durée*.

I explore the concept of pastoralist community from an economic point of view by studying components of decision making linked to mobility and concentrations of human populations on the landscape. In this sense, the view of the steppe as a vast highway of open grassland is replaced by a view of a mosaic landscape spotted with resource pockets, which became central nodes in a vast network of social interactions.

[2] It should be noted that similar ideas are brought up in Human Behavioral Ecology literature.

The movement of goods, genes, technology, and intellectual material through this nodal network is foundational to understanding the spread and eventual acceptance of agriculture in Central Eurasia. By the third millennium B.C. agricultural goods such as broomcorn millet had spread across Central Asia from China. At this same time wheat and barley spread from Central Asia into China. This east-west exchange of agricultural technology increased in the Iron Age with the eventual westward spread of foxtail millet, apricots, walnuts, and rice, in unison with the eastward spread of rye, apples, and grapes.

1.1 The Sociogeographic Landscape

1.1.1 Geographic Setting (Semirech'ye)

Central Eurasia (often referred to as Inner Asia, Middle Asia, or Central Asia), as it will be used in this dissertation, is a vast geographic area extending from the Black Sea to the eastern edge of Xinjiang, China or the Hexi (Gansu) Corridor. It ranges north to southern Siberia and south to the northern edge of the Iranian Plateau. This area is made up of many diverse environmental zones; however, looking at it from a macro-scale there are two distinct geographic features that exemplify Central Eurasia: a series of mountain chains, and the great Eurasian steppe/desert belt. These macro-environments helped influence adaptive processes[3] and shape the cultures of people in the region. However, humans do not experience their landscape on a macro-scale; on a regional scale it is clear

[3] Bennett (1969:14) differentiates between adaptive processes and adaptive stratagies, processes being long term changes and repeated use of stratagies. He sees adaptive stratagies as a conscious action by the actor, while processes are formulated by the observer.

that the landscape is not environmentally homogenous. Stretching southward from the northern forests like fingers of riparian vegetation into the grassy steppe are rivers, including the Don, Volga, Samara, Ural, Tobal, Irtysh, and Yenisey. The Eurasian steppe becomes gradually more arid farther south; southern Central Asia is dominated by deserts, including the Kyzl Kum, Kara Kum, and Taklamakan. Northern Central Asia, however, is predominantly composed of mixed forests. A vast series of mountain chains stretches from Siberia down to the Iranian Plateau, folding in east-west bands. The Iranian Plateau is bordered by the Kopet Dag and Hundu Kush Mountains, which connect to the Pamir range. The Tien Shan, Dzhungar, and Altai Mountains spread north along the modern Chinese, Kazakh, and Russian borders.

Central Eurasia is marked by geophysical, environmental, and climatic variability. In this dissertation, I focus on a more manageable region, Semirech'ye, in southeastern Kazakhstan. By studying the variability within this region, I can project the conclusions back onto a larger macro-scale. Therefore, while I am concerned with macro-scale processes across Central Eurasia, I try first to understand how the same sociocultural processes articulated on a smaller regional scale.

Semirech'ye (Zhetysu) (Figure 1.2) is not an arbitrary study region, it is an historically and culturally-defined area demarcated by distinctive geographic features. The name Semirech'ye means seven rivers; seven major rivers flow through this area from east to west and either empty into Lake Balkhash or disappear into the desert before reaching the lake. The largest river, the Ili, originates in the Tien Shan Mountains near Yining, China, and ends at Lake Balkhash, about 600 km away. The region is demarcated by Lake Balkash to the west, the Tien Shan range and Lake Issyk Kul to the south, and the Dzhungar and Tien Shan Mountains and Lake Alakol to the north and east. The region provided an important pass between oases of Xinjiang (e.g., Lop Nor, Hotan, Lulan, Hami, Turpan, and Urumqi) and the 'West' (Figure 1.1).

1.1.2 Historical Context

Semirech'ye plays and intrical role in Eurasian history and prehistory because of its socioeconomic theater and central position in trade networks connecting east and west. The geoenvironmental characteristics of this region fostered a trade corridor, an artery along a vast network of sociopolitical interactions, ebbing and flowing for thousands of years. The Dzhungarian Gate provided (and still provides today) a navigable pass through the Dzhungarian Mountain chain (Frye 1996:19). Vegetatively rich river valleys and alluvial fans provide water and forage resources for pack animals and, as discussed in this dissertation, agricultural goods. The importance of the passes as part of the Silk Road is historically documented after ca. 200 B.C. (Beckwith 2009; Christian 1994; Frachetti 2004a, 2004b). The Silk Road is made up of a complex network of navigable land-routes through the labyrinth of mountains (Christian 2000; Frye 1996; Middleton 2005). Middleton (2005:3) refers to the Silk Road as a "superhighway" for transporting people, ideas, and goods. The demographics and dynamics of the Silk Road are still little known; even less known is the role these passes may have played during the Bronze and early Iron Ages allowing people to transfer intellectual culture from East to West Asia and eventually to Europe. Bronze and Iron Age culture traits characteristic of the steppe, namely the 'fighting animal motifs', are present in material culture remains across

Xinjiang, China (Abetekov and Yusupov 1999; Hemphill and Mallory 2004; Ishjamts 1999; Li 2002; Linduff 2006; Mei and Shell 1998, 1999). If East Asian domesticates, including broomcorn and foxtail millet, indeed diffused across the mountain passes into northeastern Central Asia, the paleoethnobotanical assemblage for the Koksu River valley should reflect this. Likewise, if southwest Asian crops (wheat and barley) reached China through northeastern Central Asia, sites within the Dzhungar Mountains should be key to helping us understand this process.

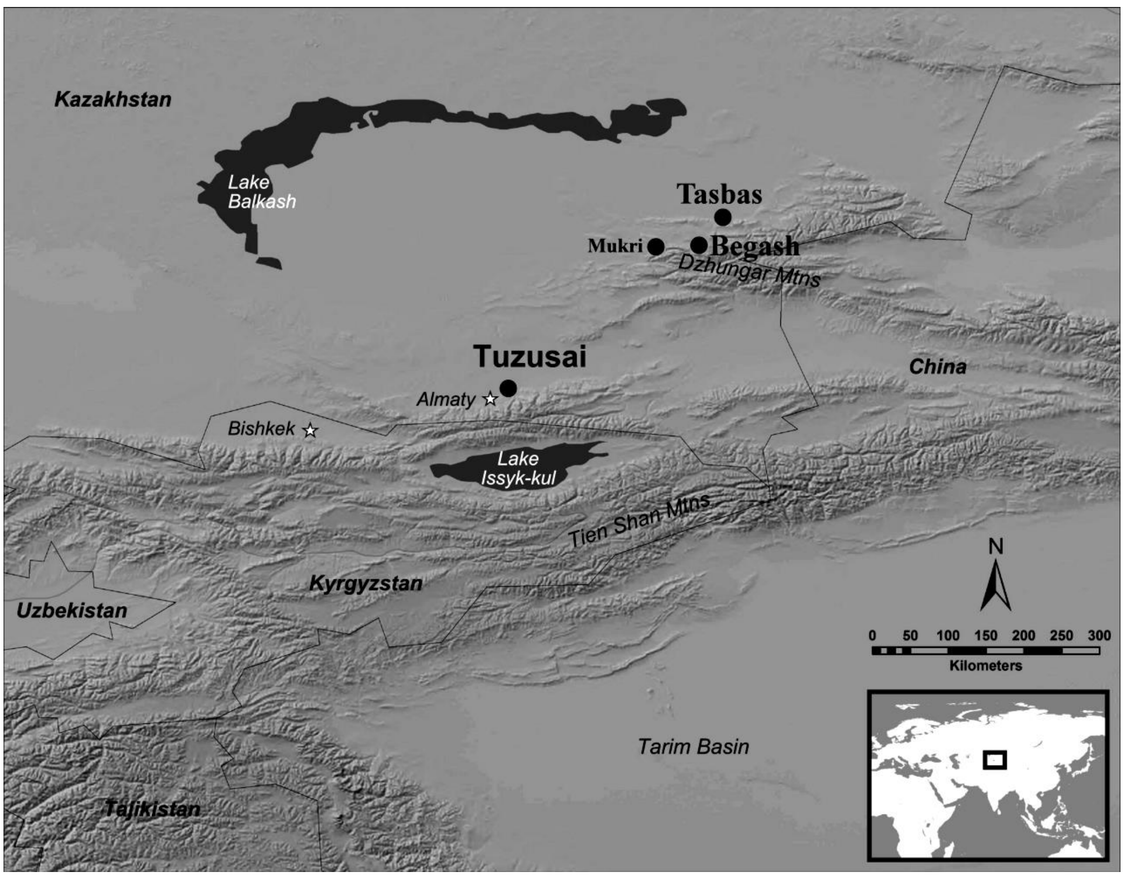

Figure 1.2. Map of Semirech'ye and the four sites analyzed for this dissertation

By early historical times, branches of the legendary Silk Road passed through this region, and by that time trading towns such as Medieval Talgar had formed in Semirech'ye. Genghis Khan brought his armies through the region, and as Baipakov (1998) notes, the Medieval town of Talgar was sacked by Mongols in the thirteenth century. Part of Marco Polo's travels took his expedition through the Ili Valley, as did the plant collection trips of Nicolay Ivanovich Vavilov (Nabhan 2008).

Clearly Semirech'ye has historically been a key area bridging exchange and interaction between major commercial centers from China to southwest Asia. Yet small, tribally organized, populations have, at various times, played the starring role in this historical narrative. Mobile pastoralists have maintained seasonal camps for millennia, using either vertical transhumance or more extensive longitudinal mobility across various regions of the steppe. Merchants and traders, migratory groups, and mobile armies (or raiders) are also figures that appear in historical accounts of the region over time (Golden 2003).

Historical accounts often contextualize peoples of Central Asia only in relation to neighboring, sedentary people. Culturally they were discussed in contrast to the sedentary populations of Persia, China, and Greece. This contrast was most distinctly epitomized in the phrase "the steppe versus the sown" first used by Fleure and Peak (1928), later revisited as the title of a 2005 Eurasian archaeology conference held in Chicago and the following edited volume titled "Beyond the Steppe and the Sown". "The steppe" has connotations of mobility, instability, warfare, raiding, lack of civilization, and wilderness, whereas "the sown" refers to civilization, stability, centralized settlements, and urbanism.

These contrasts are embedded into the historical and archaeological literature, and have long been paradigmatic for economic studies in this part of the world. In this dissertation, I attempt to break down this foundation, arguing that the steppe is an environmentally diverse geographic area occupied by culturally and economically diverse people, who, among other endeavors, cultivated domesticated plants, hence the steppe and the sown are not antithetical poles.

Herodotus of Halicarnassus first constructed this dichotomous foundation with quotes about steppe populations such as: “A people without fortified towns, living, as the Scythians do, in wagons which they take with them wherever they go, accustomed, one and all, to fight on horseback with bow and arrows, and dependent for their food not upon agriculture but upon their cattle” (Herodotus 2003 [ca. 431 - 425 B.C.]: book IV, section 46). Similarly, Chinese historical writings has been shaped by its early depictions of mobile pastoral populations living north of the Han (206 B.C. –A.D. 220), Qin (257 – 206 B.C.), and Zhou Dynastic (1050 – 256 B.C.) borders (Chaliand 2004; Rogers 2007; Yu 2002). Rogers (2007:252) notes that these early texts have shaped Chinese stereotypes of mobile pastoralists for centuries.

The early geographer and explorer Ellis Huntington (1907:9) epitomized this dichotomy when he wrote:

> “Two main types of civilization prevail [in Central Eurasia]: the condition of nomadism with its independent way of life, due to the scattered state of the sparse population, and the condition of intensive agriculture and irrigated oases with its centralized mode of life, due to the crowding together of population in communities whose size is directly proportional to the size of the streams.” [Huntington 1907:9]

Similarly, Rene Grousset (1970 [1939]:xxiii) wrote “The steppe provided with a route of a very different order: a boundless route of numberless tracks, the route of barbarism. Nothing halted the thundering barbarian squadrons”. Sinor (1990:3) claims that “in the endemic conflict between peoples of Inner Asia and the sedentary populations, the former have usually, though not always, taken the role of the aggressor”. Goldschmidt (1979:20-21) took these stereotypes even further, arguing that mobile pastoralism breeds a certain social and physiological type of human that embodies, what he refers to as “masculine” traits. He claims that Eurasian pastoralists have culturally bound preference toward aggression and physical violence, as well as an inability to feel empathy.

Koryakova and Epimakhov (2007:203) introduce the topic of, what they refer to as, the “Nomadic World” with the following stirring and captivating paragraph that they base on their interpretation of the historic literature.

> “The first millennium BC was marked by the appearance in the historical arena of new powerful actors, whose ‘barbarian’ image was associated with constant movement, destruction, and horror. The ancient writers characterized them as extremely militant and victorious. From time to time, their groups emerged on the border of ‘civilizations’ under different names, but always with the same look – armed, mounted warriors symbolizing a new epoch. In a relatively short time, the nomadic people adapted the vast steppe expanse with its extreme climatic conditions and united different areas – either voluntarily or involuntarily – into one economic and cultural zone that greatly enhanced mutual intercommunication. They created the ‘barbarian periphery’ without which the ‘civilized’ states would no longer exist. The birth of this ‘Nomadic World’ in Eurasia was neither

easy nor welcome, but there was no alternative." [Koryakova and Epimakhov 2007:203, all emphases are original]

1.1.3 Archaeological Landscape

Until the dissolution of the Soviet Union (1991) few American or western European archaeologists were able to gain entry into the Soviet states to conduct research (Anthony 1995; Lamberg-Karlovsky 1994). Intensive Soviet archaeological projects focused on two main components of the archaeological record: large medieval agricultural settlements in oasis regions, such as Merv (Nesbitt 1993, 1994); and Bronze and Iron Age burial remains (kurgans) in the steppe zone. Of central concern to this study, little paleoethnobotanical work was conducted during any of these excavations, and the limited work that was conducted focused on ceramic imprints of grains rather than systematic flotation (some exceptions being Lisitsina 1984 and Pashkevich 1984). Pastoralist steppe settlements were often overlooked or not identified; and thus their economic particulars have been assumed or historically hypothesized, without clear archaeological correlates. However, collaborative research over the past 15 years in the Eurasian steppe reflects new focus on pastoralist settlements and domestic economy. These collaborations provide new opportunities to more comprehensively study Eurasian mobile pastoralists in the Bronze and Iron Ages, and to apply scientific methods—such as paleoethnobotany—toward the reconstruction of complex economies and adaptations at play during the critical transition from the Bronze Age to the Iron Age.

Soviet models depicted steppe societies as large, regional cultures – underpinned by a concept of ethnogenesis (Gryaznov 1969; Koryakova and Epimakhov 2007). This literature uses a strict culture-historical approach to describe elements of material culture and to classify that material culture into highly generalized and large-scale culture groups. However, a trend in recent years has been to identify subregional variations in these culture groups and recognize the heterogeneity of these mega-groups or cultural complexes.

Academic research across disciplines has further propagated this notion of highly mobile Central Eurasian populations. The broad distribution of steppe fighting animal style art and artifacts, which stretch from Europe to Mongolia, has long been explained by long-distance migrations of people (Ishjamts 1999; Jettmar 1965; Okladnikov 1959). Furthermore, by creating culture groups that span vast geographic areas (e.g., Andronovo or Srubnaya) archaeologists have generalized and blurred the limited archaeological material. Following strict Soviet period cultural historic approaches, researchers have depicted steppe societies as large regional cultures (Anthony 2007; Gryaznov 1969; Koryakova and Epimakhov 2007; Kuz'mina 1994). These loosely related culture groups have been justified because of the perceived mobility of steppe populations, covering vast areas. Models of lage-scale interaction and exchange have been dominated by a discourse of migration and diffusion; for example Srubnaya exists as a cultural entity because of a combination of concepts dominant in Soviet archaeology, including ethos and migration.

In recent years it has become evident that materially based culture groups such as the "Andronovo" consist of highly diverse assemblages, even within small geographic areas (Frachetti 2008a). Both Soviet and post-Soviet archaeological research has centered on concepts of mobility and pastoralism (Mair 1998; Mallory 1989). Few studies have looked at settlements (a few exceptions include Anthony et al. 2005; Frachetti 2008a) and focus has been on burial contexts. Kohl (2007:15-19) refers to this burial focus in the archaeological literature of the past several decades as “Kurgan Archaeology”. In neglecting settlements and focusing on burials, the mobile warfare model of advancing hordes of steppe ‘nomads’ has been further propagated since material culture of burials often includes weapons and provide glimpses of a limited and not particularly representative portion of the overall population. The model I present deviates from culture historical and typological theories of nomadism to outline both sedentary and semisedentary aspects of Eurasian pastoralism, as well as the mixed agricultural and mobile multiresource pastoralism that defined economic and subsistence strategies of Semirech’ye for millennia.

The Andronovo Cultural Complex

Archaeologists often describe the Bronze Age material culture from the Semirech’ye region as being a mixed regional variant of the Andronovo Cultural Complex. The period of the Middle (2300 – 1900/1700 B.C.) to Late Bronze Age transition is often discussed in terms of increased political and socioeconomic complexity. The number of archaeological sites and their size increase and expand in geographic area. The two main regional variants of the Andronovo Cultural Complex of concern here are the Alakul and the Federovo. Sites containing material culture that is typically ascribed to the Federovo are found across western Siberia and all of Kazakhstan. Korochkova and Stefanov (2004:92) note that Fedorovo style ceramics are found in the Tien Shan Mountains, within the southern edges of Semirech’ye. Most of the excavations conducted on sites from this culture group, and consequently most of the recovered excavation material, has focused on burials.

Material culture representative of these mobile pastoralists who used metallurgy have been found across Semirech'ye. The sites of Talapty and Kuigan (both in the Koksu River valley) provide two examples of this mixed material culture assemblage (Goriachev 2004). Therefore, culture groups from northeast and central Kazakhstan, such as the Atasu, Begazy, and Dongal, are often associated with the regional variants present in the Bronze Age of Semirech'ye. Decorated pottery is a key identifiable trait of this time period.

The Late (1700 – 800 B.C.) or Final Bronze Age (1300 – 800 B.C.) has typically been discussed in terms of the Fedorovo people expanding south and east from the Altai Mountains and the forest-steppe onto the Kazakh steppe (Kuz'mina 1994). Typically Bronze Age peoples in Semirech'ye are seen as extensions of culture groups originating farther west. It has been postulated that Federovo and Alakul Cultures moved into the Semirech'ye region between the fifteenth and the twentieth centuries B.C. from the Altai (Goriachev 2004). However, there are a few earlier sites in the region, such as Begash and Turgen. Decorated coarse wear continues in the archaeological record until the end of the Bronze Age.

Iron Age: Saka and Wusun

This dissertation focuses on the Bronze and Iron Age interface period (800 – 300 B.C.); as Koryakova and Epimakhov (2007:203) pointed out in the quote below, researchers almost universally see this period as a time of increased focus on mobility (except see Chang et al. 2003). During this period there is a sharp increase in the number and size of burial mounds and settlements and the first appearance of large ‘royal’ kurgan graves (Abetekov and Yusupov 1999).

Ishjamts (1999:151) notes that between “700 – 300 B.C. – the territory of Mongolia and other parts of Inner Asia knew a fully developed nomadic way of life, often referred to as Central Asian nomadism”. Chen and Hiebert (1995:285) claim that the switch to the Iron Age was marked by the introduction of horse nomadism. Abetekov and Yusupov (1999) also support this early Iron Age transition model in the following quote:

> “The eighth to sixth centuries B.C. witnessed the development of a class society both among the nomadic tribes and in the settled oases. The development of a specialized nomadic cattle-breeding economy obviously led to major economic and social changes … The transition to a nomadic way of life in the eighth and seventh centuries B.C. occurred at much the same time over the whole of Central Asia and southern Russian steppes”. [Abetekov and Yusupov 1999:25]

The Iron Age on the steppe is marked by numerous settlements and burial mounds. Artifacts in their burial mounds often include bronze and iron swords and weapons as well as undecorated, hard-fired fine ware. Evidence for chariots and horse breeding increases during this time period and the distinctive stylistic forms of the Scythians and Saka are well established and widely dispersed. Increased social complexity is evident in the elaborate nature of many burial mounds, most notably findings associated with the Issyk golden man from the Issyk Kul region of southern Semirech’ye. The increase in social complexity, elaborateness and number of burial mounds, and the increased complexity of material culture are key components of what many researchers refer to as the Iron Age transition.

> “The transition to the Iron Age is marked by the disintegration of these societies and by an increased incidence of their collapse. Against a background of ecological stress, the Eurasian population changed the basic thrust of its economic activity. One can say that this time (1000-800 B.C.) was probably the most dramatic moment in the prehistory of Eurasia. It set in motion a chain of recurrent westward migrations that continually disrupted the cultural sequences of Central Eurasia.” [Koryakova and Epimakhov 2007:338]

1.2 Overview and Contributions of this Dissertation

Aims of this Dissertation

In this dissertation, I synthesize data from four sites in Semirech’ye with Bronze and Iron Age components – Begash, Mukri, Tasbas, and Tuzusai – providing a chorological study. My identification of an agricultural component in pastoralist economies of Semirech’ye makes the Iron Age sites of the Talgar region and nearby Bronze Age sites such as Tasbas key for understanding the adoption of agriculture and domesticated plant use throughout Central Asia. Studies of macrobotanical remains from these sites, located in significantly different environmental settings, form the basis for comparing patterns of plant use and for modeling pastoralist strategies among neighboring populations at the key tempral interface of the Bronze and Iron Ages. This dissertation has three main contributions that counter the current model of economy across Central Asia: 1) I show that agricultural goods played a role in the economy and discuss how they may have fit into the larger system; 2) I discuss the role exchange networks might have played in the early spread of agriculture across Eurasia; and 3) I discuss the role of wild plants as vital resources of herd forage and how the distribution of these wild plants helped shape society.

Using macro-paleoethnobotanical data, I investigate the following questions: 1) what variation in plant use and subsistence strategy existed among Late Bronze Age and early Iron Age pastoralists living in the foothills and plains of Semirech'ye? 2) To what extent did local environmental variables influence reliance on food production, gathering, and herd-forage selection? And 3) what role did agriculture play, what crops were produced or acquired through exchange, and how did domesticated plants fit into the pastoral system? Both Bronze and Iron Age contexts are represented, situating the evident changes in subsistence strategies and plant use within broader sequential and interregional developments. The new data are compared with those from other archaeobotanical assemblages to document the variation in subsistence of Eurasian Bronze and Iron Age mobile pastoralists and the significance of agriculture when it became part of these systems. The results of this dissertation contradict the idea that the Bronze Age represented a mixed agropastoral system on the steppe which 'evolved' into a 'pure' pastoral system during the Iron Age.

Chapter 2

Chapter 2 constructs the theoretical latticework for this dissertation. In this section, I break down and critique key themes in discourse of the prehistoric Eurasian steppe. The chapter is broken down into three sections: exchange and interactions; concepts of mobile pastoralism; and pastoralist economy and social views. The first of these sections starts off by critiquing the long-held model that the Iron Age marked a period of increased pastoral reliance and mobility. This section then progresses into a discussion of the role of exchange in Central Eurasian pastoralist economies, especially in relation to the Silk Road. The second section approaches a number of preconceived and often untested ideas about the economies of archaeological pastoralists. The final section uses Niche Construction Theory to argue that humans interact reciprocally with their biophysical surrounding, consequently constructing an anthropogenic landscape.

Chapter 3

Chapter 3 presents the four archaeological sites which were analyzed for this dissertation, as well as presenting a background of the study region. For each of these sites, I break down the excavations and discuss site occupation, chronology, and previous economic studies at the site. Furthermore, I present key archaeological features and material from each site.

Chapter 4

This chapter discusses the vegetation communities of the study area (i.e., steppe, mountains, and steppe/mountain ecotone). The chapter then synthesizes the paleoclimatic and paleoenvironmental models.

Chapter 5

This chapter synthesizes the body of literature pertaining to plant use in economies of historical and archaeological Central Eurasia. The material discussed in this section comes either from archaeological excavations or early historic accounts, mostly of European or Russian explorer into Central Asia before Russian imperial or Soviet influence. This section deals with plant use, focusing on agricultural products and wild foraged plants.

Chapter 6

In this chapter I present the wild seeds and fruit portion of the archaeobotanical information. The chapter starts with an overview of all the seeds in the assemblages, giving totals and densities. The next subsection, methods, describes the field and laboratory methods used. The section on seeds deals with the wild seeds and fruit parts recovered from the study. The section on other remains deals with all other non-seed or fruit material recovered with the exception of textile fragments which are dealt with in their own section in Chapter 7.

The rest of the chapter deals with interpreting the wild seeds and determining what the component of wild plants tells us about aspects of everyday life. This section argues that dung burning as fuel led to the incorporation of many of the seeds into the assemblage; then uses that conclusion to describe herd pasture systems. The last section looks at resource dispersal on the landscape and how interaction and herd animal demands helped shape community.

Chapter 7

This chapter discusses all of the domesticated seeds in the assemblages, as well as the textile fragments. The rest of the chapter presents the model for economy that I work out of the data set. These sections look at agriculture at the four sites and contrast the Bronze to the Iron Age. In this section, I discuss different possible roles of agriculture in the economy and levels of agricultural intensity. Residents at the sites of Tasbas and Tuzusai seem to have had complex agropastoral systems. People at Begash, on the other hand, may have used low-investment agriculture to complement their pastoral system. I suggest that in more marginal locations like Begash, agricultural pursuits were limited, and people may have practices low-investment cultivation. Low-investment agriculture would have used low-input crops like millets. It is, however, clear that at more arable locations, like the Talgar alluvial fan, agriculture was intensified during the Iron Age.

Chapter 8

In this chapter, I propose that second millennium B.C. exchange networks brought agriculture into Central Asia from both China and South Asia simultaneously. These exchange networks moved various crops and crop varieties across Eurasia along with an array of exchange goods. In this sense, the Bronze Age world was loosely interconnected by an undifferentiated network, and the spread of agriculture was similar to data moving through the internet, jumping from one hotspot to the next.

Chapter 2: Theory: The Economy and Ecology of Mobile Pastoralism

2.1 Introduction

In this dissertation I present a regional study of pastoral economies, specifically looking at three components –pastoralism, agriculture, and exchange. In Chapter 6 (pastoralism), I propose that the distribution of wild plants on the landscape shaped pastoral strategies and consequently social interactions. In Chapter 7 (agriculture), I discuss the varying roles agriculture played at different time periods and in different ecological settings. Finally, in Chapter 8 (exchange), I look at exchange through the remains of agricultural goods, first identifying exchange networks from the second millennium B.C., and then proposing that these networks led to the spread of agriculture across Eurasia.

Here, in Chapter 2, I also grapple with these three components of economy; to start the chapter, I deal with exchange as a concept and in practice across Central Eurasia. In the next section of this chapter, I discuss both pastoralism and agriculture as components of the economy, contrasting them and discussing views of both in previous literature from this part of the world. The arguments made in the background literature pertaining to economy have shaped a theoretical foundation for this dissertation and all previous research. The final section in this chapter frames economy and culture into a niche construction framework, taking on an established theoretical paradigm.

2.2 Exchange and Interactions

Introduction

Exchange will be used throughout this dissertation as a broad concept encompassing all sociocultural interactions among people, whereby material or intellectual culture or genetic material is transferred. Oka and Kusimba (2008:340) simply define exchange as an interaction between humans, whereas they define trade as "the material-economic component of exchange and hence a necessary part of any social exchange". They further state that the "overall picture of the political-economic landscape hence is an emergent property of relations between trade and its larger social milieu" (Oka and Kusimba 2008:341). As Renfrew and Shennan (1982) have argued, exchange is the prime driving force of cultural change. Communication and social interaction are fundamental processes leading to the development of social/political identities, economic and technological innovation, and stylistic diffusion (for Eurasian models see Kohl 2007). Therefore, understanding exchange in Bronze and Iron Age Central Eurasia is vital for understanding economic change during the interface period. As I discuss more in Chapter 8, a mountain corridor of exchange had formed in Central Eurasia by the second millennium B.C. (see Frachetti 2012). The "Inner Asian Mountain Corridor" or Possehl's (2004) "Middle Asian Interaction Sphere" was vital for the spread and adoption of agriculture and specific crop varieties such as bread wheat and millet. By the early Iron Age, exchange had increased, leading to an increase in social and economic complexity. The importance of the role of exchange, especially with sedentary populations on the periphery of the steppe, in developments during the interface period is noted by several sources, including Kohl (2007:82) and Barfield (1989:1):

> "Iron Age nomadic societies and ultimately the first steppe empires (and first appearance of truly 'royal' kurgans) came into being in part because they were caught up in larger systems of interregional interaction and exchange, including regular relations with sedentary states to the south (from China to Rome, including the states south of Central Asia, such as the Parthian and Kushan states)." [Kohl 2007:82]

> "Around 800 B.C., the Eurasian steppe underwent a profound cultural transformation that was to shape world history for the next 2,500 years. For the first time the literate civilizations to the south began encountering nomadic horse riding peoples who migrated with their herds of grazing animals across the grasslands of Inner Asia. What set these people apart from their predecessors was their invention of cavalry: fast-moving men on horseback using compound bows to direct a withering barrage of arrows at their enemies from a distance. In spite of their relatively small numbers, within a few centuries they came to dominate the steppe, establishing great empires which periodically terrorized their sedentary neighbors." [Barfield 1989:1]

Bronze Age Networks

By the terminal Late Bronze Age (ca. 1300 – 800 B.C.), mobile steppe peoples were extensively using equine transport (Anthony 2007; Kuz'mina 2008). As a result of their mobile economic strategy these people had large social networks. It is possible that these social, perhaps kinship-based, networks were maintained as a risk management tactic (Barfield 1993). Systems of exchange and interaction between mobile pastoralists and their sedentary/agricultural neighbors have been emphasized in ethnographic research, and a number of researchers have gone so far as to state that mobile pastoralists are inherently dependent upon sedentary agriculturalists (cf. Di Cosmo 1994; the needy theory, discussed later in this chapter).

Social interactions were in a state of flux during the Bronze Age; mobility patterns would have situated communities in predictable, yet variable contexts built across the landscape (Frachetti 2008). Frachetti (2004:viii) has referred to the routine patterning of seasonal mobility, as well as the inherent variation that exists within this pattern, in terms of "ordered variability". These repetitive and variable routines of interaction structured a dynamic network allowing diverse institutions and materials to pass through local communities (Frachetti 2012). As I discuss in Chapter 6, a key aspect of this process is the distribution and character of important forage-rich ecotopes which provided essential social and environmental contexts for people and their herds. While population size may have been generally low, it was not evenly spread out, creating pockets of high density. Here, I explore in greater detail how multiresource economies and diverse contexts of interaction engendered transformations in the subsistence economy among regional herders during the Late Bronze Age and early Iron Age, while also shaping a broader transition in social and political structure across the region.

Of particular importance to this dissertation is the exchange of goods through the mountains of Central Asia. Researchers have discussed the existence of exchange networks in South Asia and southern Central Asia and their role in the spread of agriculture as far back as the fourth millennium B.C. (for a discussion see Spengler and Willcox in press). These networks appear to lead to the movement of goods north into the mountains by the late third millennium B.C. The importance of this exchange network in the spread of agricultural innovations and goods is discussed in detail in Chapter 8 of this dissertation and will not be discussed further here.

The Silk Road(s)

It is generally accepted that throughout the Iron Age the mobility of steppe people increased, at least among some segments of society (Beckwith 2009; Christian 2000; Kuz'mina 2008). The dynamics of the cultural landscape during the Iron Age are marked by an intensification of contacts with neighboring groups. The emergence of more highly linked trade networks, colloquially referred to as the "Silk Road"[4], was a significant stimulus for the increase of regional interaction from the Han period (206 B.C. – 220 A.D.) onward (Kuz'mina 2008). The Han Dynasty 'officially' marks the opening of the Silk Road in 130 B.C. and the collapsing of the Bactrian Empire (Christian 2000; Rogers 2007). The social landscape was further changed by the development of imperial organizations, starting in the Iron Age, as discussed previously in this dissertation.

One way to study the dynamics of the Silk Road in the Iron Age is through the spread of innovations in domestic economy. This spread likely resulted in the introduction of agricultural goods and practices. Semirech'ye is a key location for the study of interactions and exchange along the Silk Road, which traversed the mountains through navigable passes along river valleys, such as those of the Koksu and Ili Rivers (Bartol'd 1962 – 1963). Begash (introduced in the next chapter) is located in the Koksu River valley and the people who lived here likely played a role in exchange of goods through the Dzhungarian Gate, an historically well documented passage through the

[4] I use the term Silk Road as opposed to Silk Roads or Silk Routes, as some researchers have started doing, simply because it may be more recognizable to my readers. See footnote on page 1 of this dissertation.

Dzhungar Mountains (Frachetti 2008b; discussed in Chapter 1). People moving through these mountain-river valleys were carrying goods, most significantly metal and possibly millet seeds, between modern day Kazakhstan and the Xinjiang Autonomous Region of China (Frachetti 2002; Kuz'mina 2008). Broomcorn millet and wheat at Begash in Late Bronze Age layers do not prove that these crops were grown at the site, but their presence indicates a connection, in some form, to agricultural people. If intensive agriculture was not present in Semirech'ye until the early Iron Age (or Late Bronze Age once we consider Tasbas), then its introduction could be a result of increased social interactions on the steppe.

Archaeologists have argued for exchange between steppe societies across the entire Eurasian steppe region and southern Siberia mainly on the basis of material cultural diffusion (Li 2002; Linduff 2006; Mei and Shell 1998, 1999; Schwarz 1984; Spengler and Willcox in press). Agriculture at numerous sites in the oases and river valleys of Xinjiang has been demonstrated through the identification of tools and random finds of carbonized grain remains dating to the Iron Age at sites such as Lop Nor, Loulan, Urumchi, Xiaohe, and Hami (Di Cosmo 1994; Jia et al. 2011; Thornton and Schurr 2004; Wang 1983; Wang et al. 1985). Agriculture based on millets, wheat, and barley is archaeologically and historically described from Xiongnu groups (Di Cosmo 1994; Honeychurch and Amartushin 2007; Honeychurch 2004; Koroluyk and Polosmak 2010; Kuz'mina 2007, 2008; Wright et al. 2009). In addition, it is likely that steppe pastoralists in Semirech'ye were either incorporated into the Xiongnu Empire or interacted with it (Barfield 1989; Di Cosmo 1994). After the collapse of the southern portion of the Xiongnu Empire in 51 B.C., Chinese military force may have pushed the northern portion of the Xiongnu Empire westward, further into Central Asia (Chaliand 2004; Di Cosmo 1994; Yu 1990, 2002).

Valikhanov's early nineteenth century writing about his expedition into the Dzhungar Mountains discusses the extortionist aspect of interactions along the trade routes between China and Central Asia, providing an important sketch of the politics of exchange and the ways in which pastoralists in the mountain valleys controlled and manipulated their political landscape. Valikhanov (1961 – 1972) discusses a political economy based on tributes that trading caravans paid to mountain pastoralists at various points along the route. He notes an array of items used as barter including wheat, silk, medicine, and Chinese tea cups.

Han records from earlier time periods note similar tributes. In 198 B.C., the Han Dynasty was said to have paid a series of appeasement bribes to the Xiongnu Empire (206 B.C. – A.D. 155) to keep them from invading from the north, regions of modern day Inner Mongolia, China, and Mongolia (the Ho-ch'in peace alliance). These tributes are said to have been of items such as silks, fabrics, handicrafts, rice, gold, and money (Ishjamts 1999). Chaliand (2004:23) notes that this 198 B.C. treaty was broken in 158 B.C. when the Xiongnu invaded northern China, leading to additional tribute payments, notably grain, silk, and alcohol. According to Han texts these tributes were paid 10 more times, until the Han Dynasty pushed back the Xiongnu in 119 B.C. (Chaliand 2004; Di Cosmo 1994; Yu 1990, 2002). This extortionist form of economy has shaped the historical interpretations of the Xiongnu; however, recent research has started to call these views into question (Di Cosmo 1994, 1999; Rogers et al. 2005). Barfield (1989) was the first to consider these issues from the perspective of the pastoralists rather than the sedentary agriculturalists. Nonetheless, he still portrays an economy dependent upon extortion from the agricultural Han for subsistence, in what he calls the "Shadow Empire" (Barfield 2001:10). Di Cosmo (1994), on the other hand, not only critiques the shadow empire notion but argues that the Xiongnu had intensive and extensive agricultural pursuits (discussed in Chapter 5). In later work, Di Cosmo (1999) argues that the extortion may have existed but was only necessary for the Xiongnu to maintain a large standing army. When the army was disbanded an agropastoral system was sufficient to support the low density, mobile (or semimobile) populations; under the rule of Xiongnu leaders such as Modu Chanyu, large unified military forces were assembled and needed to be paid.

Lattimore (1967 [1940]) in his influential work "Inner Asian Frontiers of China" insisted that the mobile pastoralists on the periphery of China could have been self-sufficient, and did not need exchange with the empire for survival; this view is supported by Di Cosmo (1994). Despite their potential ability to be self-sufficient, it is clear, based on archaeological records, some level of cultural exchange was taking place between these groups.

Mobile Cores or Peripheries

The scale of an individual pastoralist's world was constantly changing as dictated by the extent of the social interaction network and geographic range of the nodes in that net. Frachetti (2008) discusses the nature of this Bronze Age political landscape and emphasizes the role of exchange in the economic system.

> "If the extent of the local landscape are defined by the ordered variation in pastoral routines and the construction of contexts for interaction that are activated and deactivated at different times, then the extent of the macro-land-scape or the 'global' scale for Bronze Age pastoralists was reflected in the acquisition and reproduction of exotic objects, imagery, and domestic products." [Frachetti 2008:165]

Christian (2000:1) notes that "less well understood is the trans-ecological role of the Silk Roads-the fact that they also exchange goods and ideas between the pastoral and agricultural worlds. The second of these systems of exchange, though less well known, predated the more familiar 'trans-civilizational' exchanges, and was equally integral to the functioning of the entire [world] system". In this quote Christian notes the complexity of exchange networks in this region and also indicates that simply looking at the flow of goods between major 'cores' in East and South Asia will not allow us to understand the nature of exchange in the Bronze and Iron Ages.

There has been considerable discussion over the possibility of political centers having existed within the Bronze or Iron Age worl system of Central Eurasia. Often pastoralists are discussed in terms of "the periphery" or as a "pastoral periphery", suggesting that the core would be the sedentary civilizations of China, South Asia, and Europe. Stepping away from this pastoral periphery model, some researchers have suggested political organization and social centers within the pastoral world (see Beckwith 2009). "A second approach to explaining steppe polities challenges the core-periphery model and instead attributes the development of steppe polities to actions taken by and among steppe groups themselves" (Honeychurch and Amartushin 2007:261). Evidence for pastoral centers and a core-periphery model may exist across Mongolia in the form of large walled settlements and stone monuments from the Xiongnu period (Chase-Dunn and Hall 1997). For discussions of these mouments in unison with the development of social hierarchy and political authority see: Hanks (2010); Miller (2009); Wright (2006, 2007). While some researchers, such as Miller (2009), are attempting to divert discussions away from a core-periphery framework, most researchers agree that unified nomadic polities or confederacies emerged during the Xiongnu period; however, they often disagree over the nature of these polities (Barfield 2001). These unions may have been initially decentralized organizations, loosely structured. Yet, over time they seem to have developed a hierarchical structure, as evidenced by the archaeological record. One of the best lines of evidence for the existence of elites are the elaborate burial mounds of the famous Noyon Uul (Noin Ula) cemetery, much of which was excavated in the 1920 (Rudenko 1962), they are 80 km northwest of Ulaanbaatar in the three valleys: Sujigt, Khujirt, and Zuramt. There are 212 burial features, the most elaborate of these burials earthen mounds range from 16 – 22.5 meters in diameter and 0.5 to 1.95 meters in height. (Honeychurch and Amartushin 2006; Koroluyk and Polosmak 2010).

While there is evidence for political centers in the Iron Age of Mongolia and possibly in the Sintashta Culture of the Urals, there is little evidence for such a system of organization during the Bronze Age on most of the steppe (except in the forest steppe or the west). Some possible exceptions on the eastern steppe include the Bronze Age urban center of Kent in northeastern Kazakhstan and possibly the Begazy-Dandybai Culture in the Late Bronze Age of Central Kazakhstan. There is evidence in Semirech'ye for political stratification starting in the Iron Age; however, this evidence is not as robust as in Mongolia. It seems likely that if political centers did exist in Semirech'ye, starting in the Iron Age, they were not as elaborate as in other regions.

2.3 Mobile Pastoralism in Archaeology and Ethnography

2.3.1 "Nomadism"

Semantics

In this dissertation, I use the term 'Mobile Pastoralism' over 'Nomadism' or 'Pastoral Nomadism'. However, all of these terms are innately flawed; the discourse pertaining to such nomenclature will only be touched upon here, because the critique has been well articulated elsewhere by ethnographers as far back as the early 1970s (Irons and Dyson-Hudson 1972; Salzman 1972). Labeling the organization of a community with a title based on one aspect of its economy serves only to pigeon-hole a complex spectrum of economic strategies into a monolithic prototype. Furthermore, it feeds into a long history of creating nomadic taxonomies and categorizing mobile pastoralists into economic variants (Khazanov 1984; Cribb 1991). A considerable amount of ink has been used to address the issue of economic typologies and the validity of such terminology by other scholars in recent decades (e.g., Salzman 2004; Wendrich and Barnard 2008). Like many taxonomies (especially with Marxist influences), nomadic classifications tended to be arranged as a linear progression with a pure, exemplary ideal at each end, in this case pure nomadism *versus* sedentary agriculturalism. Rogers (2007:250) notes that many of these taxonomies outline societal evolution through stages starting with a basic form of communism and reaching an ideal form of socialism after the formation of states and in true Marxist form – the collapse of capitalism. Pletneva (1982:145) provides a simplified three-tier example, using levels of mobility to classify pastoralists, pure nomadism, seminomadism, and sedentism. When reconstructing subsistence in the archaeological record, one cannot look for a "pure" economy (Diamond 1999:109). As Barfield is quick to point out, there is no "pure nomad" (Barfield 1993:4). The critiques of "pure nomadic pastoralism" have long been accepted by the general academic community and have taken on a detailed historiography of their own; they can be traced back to Lattimore's (1967 [1940]) famous line "a pure nomad is a poor nomad". These critiques do not need to be readdressed, arguing a currently (unanimously) accepted view is moot (for a discussion see: Dyson-Hudson and Dyson-Hudson 1980:19; Salzman 1971, 2004).

It is much more fruitful to think of mobile pastoralism as an array of various economic pursuits, which are based on a pastoralist component. When discussing mobile pastoralists, Wendrich and Barnard (2008:5) use a broad definition of mobility – "the capacity and need for movement from place to place"; they also discuss the etymology of related terms. Salzman (1972:67) was one of the most influential seminal researcher to directly attack the concept of "pure" pastoralism. In his critique, Salzman claims "these ideal types invariably obscure through oversimplification and rigidity the variables at play because they ignore the many subtle and gross variations along the dimension of any given variable". Salzman was studying pastoralists in Iranian Baluchistan and he observed the many varying subsistence strategies they employed. Salzman coined the term "multi-resource nomadism" later revised to "multiresource pastoralism" (Salzman 1972). Salzman is an ethnographer, and it took decades for his observations to properly permeate the archaeological literature; in fact, he has devoted most of his career thus far to promoting the complexity of subsistence strategies among pastoralists (Salzman 1971, 1972, 1982, 2002, 2004). In the following two quotes Salzman describes the complexities and dynamics of pastoralist economies and tries to pull the reader away from simple definitions.

> "Shifting between strategies of adaptation in response to changes in conditions has been very common throughout the Middle East and North Africa. We must also keep in mind that 'Settled' and 'Nomadic', rather than being two types, are better thought of as opposite ends of a continuum with many gradations of stability and mobility." [Salzman 2002:256]

> "Nomadism[5], the regular displacement of the household, is unlikely to be oriented to one and only one productive activity, such as pastoralism, because few populations limit themselves to one productive activity. Rather, nomadic mobility is likely to be put to work as well in aid of other productive activities, such as cultivation, as among the Baluch, or fishing, as among the Nuer. Nomadic mobility is not infrequently from a location of one productive activity, such as pastoralism, to another, such as arboriculture. Thus, categories and labels (such as 'nomadic pastoralists') tend to oversimplify and distort the multisource economies that most nomads have and the versatile, multipurpose nomadism that they use to the fullest." [Salzman 2004:24]

[5]Salzman chooses to use the term 'nomad', arguing that a direct translation of the Greek word means 'to pasture'; therefore, if taken literally it is a synonym of 'pastoralism'. However, he does recognize that popular convention has related 'nomad' to a mobile lifeway and not necessarily to a mobile pastoral life way. When Salzman (2004) uses the term, he is using it as I use mobile pastoralist in this dissertation.

The Ecology of Pastoral Landscapes

Ecology plays an influential role in how people focus their economic pursuits; cultural ecology as defined by Bennett (1969:11) the study of how people “convert the natural environment into natural *resources*”. Understandably, many ethnographers and archaeologists have pointed out an obvious correlation between pastoralists and marginal environments (Bendrey 2011; Casimir 1992; Cribb 1991; Spooner 1971, 1973). The productiveness of mobile pastoralism in environmentally marginal zones, which would require large labor inputs for agriculture, has been shown in a number of studies (e.g., Bacon 1958; Barth 1964; Dahl and Hjort 1976; Leslie and Little 1999).

Bendrey (2011:13) notes that “the specific regional climatic, topographical, and ecological conditions would have influenced decisions as to which proportions of each animal were herded according to their particular biological and behavioral characteristics”. Pastoral landscapes include high alpine zones of the Andes, Himalaya, Pamir, and Altai, as well as arid and semiarid steppe and deserts across Central Asia, southwest Asia, North Africa, and the tundra. Masanov (1995:22-24) notes that much of Kazakhstan is in an environmental zone where maximum rainfalls rarely exceed 200 – 400 mm per year and droughts, soil erosion, soil salination, lack of access to irrigation water, and open winds make agriculture a risky endeavor. There is no doubt that, like agriculturalists, pastoralists pay very close attention to their environment; keeping a mental tab on seasonality in temperature, rainfall, and vegetation growth. In this sense, environment becomes and important factor in decision making, but it is not a sole driving force. The ecological and economic parallels make it easy to fall into the long held trap of environmental determinism; however, cultural preferences are equally important motivating factors in determining economic pursuits. Herders choose to herd because their fathers and their grandfathers herded, because they love the open air and the freedom, because they feel an obligation to keep the traditional ways of life alive, or due to responces of political actions or as political stratagies. Levshin (1840:314, 316,413) noted that Kazakh pastoralists took pride in their mobile livelihood and shunned sedentary life. Likewise, Humphrey et al. (1994) mention that Tuvan herders have pride for their pastoralist lifestyles. This was also discussed by Fernández-Giménez (1994). While I don't want to go as far as Sahlins (1972) and present pastoralists as "The Original Affluent Society", I also want to step beyond the view of them always on the brink of famine and forced by their environment into their economic situation.

Ethnographers studying pastoral nomadism have long attested to its variability in practice showing that the variation is in response to cultural preferences, ecological resource restraints, sociopolitical contexts, and herd animal ecology (Bacon 1958:54; Barth 1964; Dyson-Hudson 1966; Dyson-Hudson and Dyson-Hudson 1980:18; Frachetti 2004b:48-61; Koster 1977; Spooner 1973). The role of agriculture, possibly in the form of low-investment, small-scale, cultivation, is also highly variable (Bates and Lees 1977). In addition, access to agricultural goods through exchange takes on very different forms among mobile pastoralists. "The Eurasian steppe provides a diversity of ecosystems that condition an equally variable array of pastoralist strategies through time and across territory" (Frachetti 2008:74); the amount of time and labor devoted to other pursuits, such as hunting, fishing, craft production, trading, foraging, or cultural or eco- tourism is variable. There are many examples of pastoralists switching between agriculture and pastoralism (Barth 1964; Beck 1986). Ethnographic examples discussing dynamics of practice can been seen among the Kirghiz of the Wakhan corridor in the Pamir Mountains in Afghanistan in Shahrani's study (1979:171-172) and the Basseri of Shiraz in Iran in Barth's study (1964:109). Kohl notes that:

> "Agriculturalists may become pastoralists, and, … livestock herders may become agriculturalists, adopting certain features of the material culture of their agricultural neighbors. Both agriculturalist and herders may practice metallurgy or an entire range of different crafts. The categories we employ must reflect this basic fluidity or interchangeability." [Kohl 2007:53]

Archaeological discussions of economic variability in Central Eurasian pastoralism have been hindered by a lack of paleoethnobotanical analysis and a preconceived concept of what early mobile pastoralist economies would have looked like. In constructing a model for Central Eurasian mobile pastoralists, Honeychurch and Amartushin (2007) noted a multiresource pastoral system among Iron Age Xiongnu in the Egiin Gol valley of Mongolia.

> "Despite some arguments that late Bronze and early Iron Age groups across the Eurasian steppe rapidly adopted a highly specialized form of horse nomadism, the most recent archaeological research argues for long-term change and geographical diversity in subsistence mixtures of agriculture, pastoralism, and hunting-gathering and fishing. The occurrence of higher stock dependency probably did not result in a "pure" pastoral nomadism; rather, the peoples of the northeastern steppe seemed to have maintained a traditional multi-resource pastoralism which included the flexibility to emphasize or de-emphasize subsistence pursuits relative to local environmental, social, and political conditions." [Honeychurch and Amartushin 2006:260]

A Pastoral Bias

There is a long held bias in steppe archaeology arguing for the existence of only mobile pastoralism during the Bronze and Iron Ages (especially for the Iron Age). Arguments for why Central Eurasian populations could not have been mixed agropastoralists or multiresource pastoralists with low-investment agriculture tend to rest on two main pivots: 1) the climatic conditions during this time period did not favor agriculture (Dolukhanov 1981; Koryakova and Epimakhov 2007; Lisitsina 1981); and 2) the general ecology of the steppe could not have supported agriculture (Koryakova and Epimakhov 2007). The degree to which the paleoclimate has changed over the past few millennia has long been debated. A brief summary of these debates is presented in Chapter 4 of this dissertation. While I tend to favor arguments that suggest limited ecological impact on the steppe in the past (e.g., Kremenetski 2003), all paleoclimatic arguments are macro-scalar, and people experience their landscape on a micro-scale. As I also discuss in Chapter 4, the steppe is actually a complex mosaic of environments, rather than a vast homogenous semiarid grassland. These models oversimplify the Eurasian steppe, which is actually a patchwork of river valleys, varying ecotones between hills/mountains and steppe, littoral zones, springs, rock outcroppings, oases, etc. These ecotopes and ecotones have ethnohistorically supported low-investment agriculture and may have done so further into the past as well, regardless of climatic fluctuations.

Often Soviet literature pertaining the Late Bronze Age economies of the Eurasian steppe divides this ecoregion into “forest-steppe” and “semiarid-steppe”. This dichotomy is propagated in recent literature as well (e.g., Bendrey 2011; Kotova and Makhortykh

2010; Kremenetski 2003). In doing so, they created a geographic divide, neatly drawing a line between sedentary mixed agropastoral economies of the European forest-steppe and mobile pastoral economies of the steppe zone proper (sometimes called the nomadic zone) (Liberov 1960). Popova (2006a:459) discusses this geographic distinction in economies, and she notes "linked to this zonal interpretation of Late Bronze Age economies is the perception that, fundamentally, cultivation (which, it has been argued, requires a sedentary life) and pastoralism (which requires mobility) cannot combine without degradation of the productive potential in either activity". This same argument is further elaborated by Bunyatyan (1999:30) where he discusses the correlation between pastoralism and agriculture in the Northern Pontic steppe during the Bronze Age. This dichotomy rests on two generalizations, first that the semiarid-steppe or steppe zone, proper, is environmentally homogenous and does not contain pockets (ecotopes) of fertile land, and second, that mobility automatically excludes the potential for cultivation or low-investment agriculture.

Popova (2006a:461) provides a critique of the social evolutionary models, which correlate ecology and pastoralism. Researchers, such as Cribb (1991), Spooner (1971, 1973), and Casimir (1992) have argued that a people's ecological setting dictates whether they will be pastoral or mixed agropastoral. While there is some limited validity to this statement, humans are adaptive animals. Humans modify their environment and move their settlement locations to suit their economic preferences, linking ecology and economy (Bennett 1969).

2.3.2 The Needy Nomad

A common theme in both archaeological and ethnographic literature is to view pastoralist economies as a branch of, or a complement to sedentary agricultural economies. Researchers often stated as a given that pastoral economies evolved out of mixed agropastoral economies. For example, Christian (1994:195 [emphasis added]) states "pastoral nomadic stratagies have *never* been completely independent of farming societies. They have *always* had to trade, yet in most exchanges they were at a commercial disadvantage"[6]. This model of pastoral evolution was discredited as a universal by Marshall and Hildebrand (2002),when they showed that pastoralism formed before agriculture in Kenya. In Eurasia researchers often claim that 'true' nomadism emerged only after establishing relations with sedentary people (Khazanov 1984:94-95; Kohl 2007:82). Di Cosmo critiques this view, labeling it the "needy theory" (1994:1092), in which the procurement of agricultural goods from sedentary groups is a necessary part of the specialized pastoral economy (see also Barfield 1993). Much of this literature is accompanied by the "starving pastoralist" fallacy, suggesting that pastoralists are in a continual state of risk; whereas agriculture brings stability and reduces risk.

Many of the reconstruction models of economy on the early Eurasian steppe depict mobile peoples as wholly dependent on sedentary neighbors for procurement of agricultural goods (Khazanov 1984:17), often discussed in terms of 'trade or raid'. Soucek (2000:43) claims there is a "symbiosis" between agriculturalists and pastoralists. Khazanov (1984:84) claims that nomads require social exchange to fulfill subsistence

[6] Irronically Boserup (1990b:48) notes that as people intensify their economy and population grows, pastoral products increase in value.

needs. This perception has perpetuated the views that Bronze and Iron Age pastoralists could not have grown their own crops and that they could not feed their own population without outside support. Recent archaeology on the steppe has challenged this concept (Pashkevich 1984, 2003; Popova 2006b; Rosen et al. 2000; Wright et al. 2009).

A good case study of the Needy Theory in research and literature for Eurasia is the Xiongnu. There is a long history of studies of the Xiongnu; all of these studies have had at their foundation in the ancient Han text, Shiji (Sima 1961 [ca. 80 B.C.]). This text describes how the Xiongnu had an extortionist relationship with the Han Dynasty (Chaliand 2004; Yu 1990, 2002). As was noted earlier in this chapter, Barfield (1989) in his famous book "The Perilous Frontier: Nomadic Empires and China" gave a face to the mobile pastoralists and reified history from their perspective. However, he still depicted them from a core-periphery framework and portrayed them as innately dependent upon the Han Dynasty for subsistence. There is ample evidence now, suggesting that Xiongnu urban centers were cultivating plants of their own and that there were more complex practices at play in their economies (Di Cosmo 1994, 1999; Honeychurch and Amartushin 2007; Koroluyk and Polosmak 2010; Rogers et al. 2005; Wright et al. 2009).

There are many ethnographic examples of symbiotic relationships between pastoralists and agriculturalists. However, given the complexity of steppe economies, no one system should be accepted for the entire steppe. Archaeologically, it is possible, with some certainty, to determine if goods are grown at a site or imported, hence a more detailed look at the paleoethnobotanical assemblage of a site is necessary before one can say anything about dependency. For example, a close look at the sites of Tasbas and 1685 show how archaeobotanical assemblages can be used to differentiate between locally grown or imported grain.

- Example 1) at Tasbas (see Chapter 3) agriculture is argued for at the site based on, 1) high densities and ubiquities of domestic grains, 2) the presence of carbonized barley rachises and culm nodes, and 3) the use of straw as a binder in mud brick, believed to be from domesticated barley based on the presence of grains impressions with the straw.
- Example 2) the Late Bronze Age sites of 1685 and 1211, in Turkmenistan, where Spengler et al. (in review) have argued for a system of interaction between mobile pastoralists living in the Murghab Delta on the periphery of large Bronze Age villages, such as Gonur Depe. At the Murghab sites there are no chaff or rachises present, the grains are fully cleaned and stored in ceramic vessels, and the material culture at the site seems to suggest a mobile economy – lacking architecture, storage pits, or processing tools – while there are material culture evidence for exchange with near-by sedentary agriculturalists, mostly in the form of pottery (see for discussion: Spengler et al. in review).

2.3.3 Identifying Mobility and Sedentism

Identifying Mobility

Mobility is a strategy of risk management, in that it provides the ability to move the entire community away from biophysical stresses, such as overgrazing, while also allowing herders to seek out vital resources of water and forage. Ethnographies have emphasized other aspects of risk management associated with mobility among mobile pastoralists, including exchange and social interaction, especially with sedentary groups (Barfield 1993; Bates and Lees 1977; Bourgeot 1981; Di Cosmo 1994; Lees and Bates 1974). Much of the discourse relating to Central Eurasian mobile pastoralists has focused on their long distance mobility and interregional interactions. The discourse surrounding this topic has dealt with issues such as the spread of the Indo-European language, as well as horse breeding and chariot technology, and the proliferation of bronze metallurgy throughout Eurasia from dynastic China to Western Europe (Anthony 2007; Chernykh et al. 2004; Kuz'mina 1994; Mallory and Mair 2000; Mei and Shell 1998, 1999).

Frachetti (2008:151-170) uses computer generated rationality-based models to map potential routes projecting optimal routes between pastures. Based on his optimizing arguments he envisions seasonal camp movements around 25 km. These biannual movements would have taken herds up into the mountains and higher foothills above 1,400 masl for the months of June, July, and August and brought them back down to lower elevation pastures for much of the rest of the year. He notes that the variability in pasture quality and distribution might have taken herders as far as 50 km in some cases; however, in relation to the long distance horizontal movements of the open steppe these are relatively short seasonal movements. Frachetti (2008:162) sees these variable options of migration routes as a network.

This network not only provides herders with a set of migration routes in which to choose from biannually, it also provides an interaction web for social cohesion and the spread of institutions. Movements along these short distance migration routes would have brought people into contact. To understand these interactions we must envision the landscape as a mosaic of environmental patches constructed primarily of a matrix of semiarid steppe or mountain-rock outcropping, but dotted with 'nodes' of resource-rich patches[7]. These environmental patches dictated pastoral movements across the landscape. While a variety of political, social, and preferential values went into the decision making process, the ultimate product would have resulted in a varying network of movements in a pattern of 'ordered variability', as Frachetti (2008:165) refers to it. The environmental ecotopes become nodes on the pastoral landscape bringing people and herds into contact at varying times of the year. Spooner (1973:4) notes that vertical transhumance often focuses on fixed resource-rich locations (or nodes) on the landscape. Perennial settlements often utilize the same resource patches annually. Vertical mobility brings people into contact with a number of diverse ecozones. Botanical resource availability is geographically, as well as temporally, spread across the landscape as a result of orographic mechanisms. Successful use of these diverse resources would require an understanding, not only of geographic resource distribution, but also seasonal growth cycles at various elevations.

Understanding the way these social interactions may have taken place in the Bronze Age is vital for interpreting the archaeological record. Frachetti's (2008) model envisioning a network of interaction, utilizing stable nodal points, provides a new interpretation for the movement of material culture across the Eurasian steppe and mountain zones. Whereas, previous research has argued that long distance migrations led to the movement of material culture across great distances (notably the steppe fighting animal motifs, Abetekov and Yusupov 1999; Ishjamts 1999), some new the long distance

[7] A more detailed description of this model for social intensification and mobility is provided in Chapter 6 of this dissertation.

models for mobility suggest that material culture moved across great distances by means of diffusion. For an articulate discussion of diffusion versus migration models on the steppe see Anthony's "The Baby and the Bathwater" article (1990) or Frachetti (2011). Due to the comprehensive syntheses presented in the aforementioned articles, I will not deal with these debates in this dissertation. If we look to diffusionist models, exchange of items and ideas at nodal points, most commonly during winter communal encampments, would have allowed a pass-along effect. Material or intellectual culture could have been passed through numerous nodes before being incorporated into the archaeological record. In this model, the "dynamic landscape" of mobility leads to long distance material culture movements but does not necessarily have to do with long distance contact (Frachetti 2004b:VIII). Ultimately, all models of mobility in the past rely on ethnographic analogy to explain the geogrphic dispersal of artifacts. Therefore, two equally plausible models, diffusion and migration, can be formed from the widely dispersed material culture in the Central Eurasian Bronze Age.

Identifying Sedentism

In discussions of early sedentary peoples, researchers have generally accepted as a given that intensive agriculture (in a Boserupian sense), high population density, elaborate material culture, architectural remains, craft specialization, and social complexity are tell-tale archaeological signs of sedentism. However, recent data emerging from archaeological excavations seems to suggest that these traits do not seem to hold up for the Eurasian steppe. Sites with elaborate architecture have revealed limited evidence for agriculture, and Bronze Age sites with limited architecture have domestic grains. Researchers have been hesitant to use the term "nomadic empire" and tend to favor “nomadic confederacies”; nonetheless, the concept is generally the same. The archaeological material seems to suggest social stratification and elites, furthermore, by the Iron Age, some level of regional unification. Traditional archaeological typologies for social complexity and correlatively economic complexity and form, do not hold up for Central Eurasia.

One example of a culture which breaks down the above mentioned stereotypes is the Sintashta Culture. The archaeological assemblage of material culture and architecture from the Sintashta Culture (and Petrovka) would have been labeled as belonging to agricultural or agropastoral peoples in any other part of the world. The Sintashta and Petrovka Cultures are Middle Bronze Age and located around the Ural Mountains of southern Siberia and northern Kazakhstan (Drennan et al. 2011; Hanks 2010; Anthony 2007; Koryakova and Epimakhov 2007). They are concentrated in a distinct ecotone between the mountain and steppe zones and sites tend to be located near rivers or streams. Koryakova and Epimakhov (2007) note that the settlements tend to be on flat open areas, elevated above river beds; they suggest that this would help protect against spring floods. The settlements of this culture group are unique and tend to be composed of circular fortified structures which consist of ramparts and ditches, all of which would have been surrounded by a fence or wall (for a more detailed discussion see Drennan et al. 2011). The fortified areas enclose a circular area of 6,000 to 35,000 m^2 (Koryakova and Epimakhov 2007). These urban centers tend to have a fortress with towers and counterforces with entrances allowing access to water. The internal area of the fortification is composed of edifices organized into sectional blocks these rectangular or trapezoidal areas indicate individual house structures; therefore, the entire area is essentially an apartment complex (morphologically paralleling archaeological sites such as Abu Hureyra or Chaco Canyon). The figure below shows a plan map of the Sintashta Culture site of Arkaim.

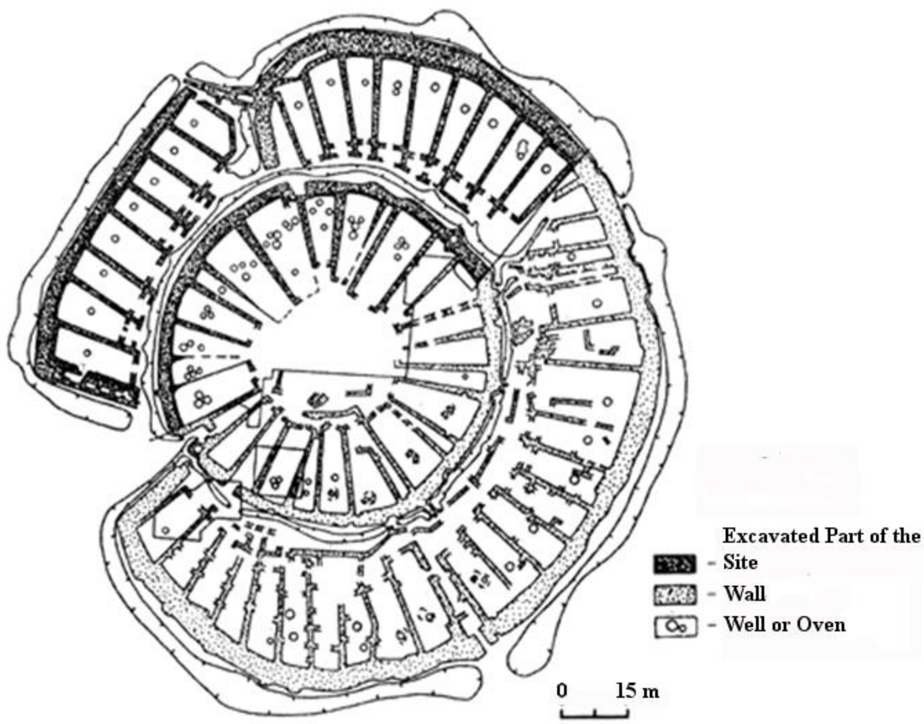

Figure 2.1. Map of the cellular layout of the Arkaim site (Koryakova and Epimakhov 2007:71)

Despite the seemingly sedentary, large-scale settlements of this culture group, most of the research conducted on economy has focused on zooarchaeological material and herd structure (Anthony 2007; Koryakova and Epimakhov 2007; Kosintsev 2000); little attention has been given to the potential for agriculture. However, Kosintsev (2000) does suggest that the herd movements were short distance (based on the dominance of big horned cattle) and seems to suggest a semisedentary pastoral economy.

In fact, domesticated grains were recovered within Sintashta Culture sites, albeit in very low abundance. The reports of archaeobotanical evidence for millet of the third millennium B.C. come from the sites of Arkaim and Alandskoe (ca. 2200 – 1800 B.C.), located in the trans-Ural region (Gadyuchenko 2002). Millet remains are reported to have been found on a house floor at Alandskoe and millet fragments were found in pots from both Arkaim and Alandskoe. However, the reported grains are not directly dated and the archaeobotanical details of the specimens 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.

Based on the new discoveries of domesticated grain fragments, Gadyuchenko (2002) argues that agriculture played an important role in the economy at Arkaim. However, many researchers are still skeptical of cultivation in the Sintashta Culture on the steppe. After addressing the discovery of domestic grains at Arkaim and Alandskoe, Koryakova and Epimakhov (2007:89) note:

> "However, taking into account the severe climatic conditions of the area, one cannot expect to find that this [agricultural] economy would be greatly developed. This thesis is partly supported by the absence of large storage facilities. Until cultivation is proved by a large series of analysis, it will always be under some doubt. We can, however say, at least generally, that the inhabitants of some Sintashta settlements were acquainted with elements of cultivation." [Koryakova and Epimakhov 2007]

Hanks and Johnson (2012 unpublished) presented preliminary research at the Society for American Archaeology Meetings in Memphis, combining stable isotope, survey, and excavation work in the Urals (2100 – 1500 B.C.). What they presented seems to indicate that there were no (or limited) domesticated grains in the region during the Bronze Age. They also suggest that domesticated animals, specifically the dominance of cattle, may actually have led to increased sedentism rather than mobility in the economy. We await the results of future research, such as the paleoethnobotanical work currently underway at the nearby site of Stepnoe, to confirm or dispute the existence and wider distribution of domesticated grains in the trans-Ural region (Bryan Hanks, personal communication 2010).

Similar to Sintashta urban sites, the fortified urban centers of the Xiongnu Empire (descriptions of the large-scale adobe architecture of these centers are presented in Rogers et al. 2005) have been argued to be evidence of mobile pastoral fortifications. These large centers are spread across the Mongolian landscape. Recent research now shows that there was an agricultural component in the economy of the Xiongnu although we do not know how intensive it was (Honeychurch and Amartushin 2007; Wright et al. 2009).

Even key culture sites in the Botai Culture in the Early Bronze Age of southern Russia and northern Kazakhstan have traits of a sedentary lifestyle. The architecture in many of the Botai villages resembles a small sedentary village. At Botai proper, in the last occupation phase, 158 house dwellings have been identified (Kohl 2007:50). These semisubterranean house structures do not resemble typical seasonal hunting camps, yet the Botai Culture is believed to be a specialized horse hunting economy, focusing on migrations of large horse herds on the steppe. Paleoethnobotanical work is currently being conducted on soil samples from Botai (Xinyi Liu personal communication, 2012) as well as the nearby sites of Krasnyi-Yar and Vasilkovka (I am conducting the analysis on the latter sites). The preliminary analyses of these Botai Culture sites have not provided any evidence for agriculture.

The importance of agriculture in Late Bronze Age (and earlier) economies of the forest-steppe (Ukraine, Moldova, Russia, etc.) has been known for a long time (for a discussion of evidence see Pashkevich 2003). However, Anthony et al. (2005) and Popova (2006b) have recently tested this dichotomous boundary for the Samara River valley at the site of Krasnosamarskoe and discovered a semisedentary economy based on pastoralism and foraging of wild grains. The lack of agriculture in this region is further supported by the work of Lebedeva (1996 [discussed in Popova 2006a, 2006b]). She analyzed soil from 38 different archaeological sites and found little evidence for domestic grains (a few domesticates were found in low abundance and ubiquity). These case studies (Sintashta, Xiongnu, Botai, and Eastern Srubnaya) help to show just how complex and variable economies of the steppe can be, they show that seemingly sedentary or semisedentary architectural structures, such as at Krasnosamarskoe do not equate agriculture. Likewise, mobility and lack of architecture do not indicate a lack of agriculture.

2.4 Niche Dwelling vs. Niche Construction

In this section I draw on niche construction theory to build a new model for explaining the diversity and success of archaeological economies in Central Eurasia. Niche construction theory (NCT) provides a critique of archaeology conducted in Central Asia, and it provides archaeologists with a framework for studying cultural complexity that does not rely solely on environmentally deterministic[8] models. The theoretical framework that has developed around NCT can also be used to counter the concept of pastoralists being innately 'niche dwellers'. Pastoralists are often discussed in terms of niche dwelling, implying that they are ephemeral on the landscape and at the mercy of ecological factors. In addition, niche dwelling is a play on the use of the term niche, as I discuss later in this chapter, the term is often used in a vernacular sense to refer to an ecological pocket or specific environmental setting. NCT gives humans agency over their environment through cultural processes. This section of Chapter 2 is twofold; first, I discuss the topic of Central Eurasian economy with a NCT framework, and second, I discuss longterm human impact and landscape modification in Central Asia. I am drawing on NCT to bridge the topics of pastoral economies and ecological pressures, leading to a richer view of the long-term stability of economically related communities in Central Asia.

Niche Construction and Central Eurasian Economy

Ecological models for the origins of pastoralism have been a recurring theme in discourse since the 1970s (Spooner 1971, 1973). Many of these early models are, of course, over simplified; they rely on *Ceteris Paribus*, and take all agency away from the actors in play. Some subsequest research by Irons and Dyson-Hudson (1972) and Dahl and Hjort (1976) has done more to give agency back to the individual pastoral household. The defining characteristic of mobile pastoralism is 'mobility'; therefore, herders have

[8] The introduction of post-processualist theory into the region over the past two decades has already started to pull research away from environmental determinism.

the means to move their entire economy out of unfavorable ecological settings. The ecology of pastoralism is chosen by herders, not *vice versa*. However, the ecology of all humans is not only chosen by those humans it is also effected and modified by them[9].

In archaeological literature (as in most scientific discourse) the term ‘niche’ has become increasingly multivalent. The word is often used in such literature as a colloquialism or in a vernacular sense, referring to an ecological patch or ecotope (e.g., Frachetti 2008:162; Frachetti 2012:18; Kuzmina 1998:80; Shishlina et al. 2008:247; Shishlina and Bulatov 2000:175; Shishlina 2000: 178,180). In this colloquial sense mobile pastoralists can camp in a ‘niche’ to protect themselves and their herds from the harsh winter weather[10]. This is loosely similar in usage to what Wallace (1987:8-9) refers to as a “niche space”. This use of the term parallels its use in economics to refer to a niche market or in architecture to refer to an architectural niche on, for example, the wall of a building. However, in the ecological sciences the term has a different meaning; in this sense it refers to the interrelationship of an organism with other organisms in its ecosystem. It is from a biological scientific framework that the term niche entered anthropological literature and from this perspective it becomes a more explanatory term.

Within the biological sciences, the definition of the term has been heavily debated (for a summary of this debate and summary of the different definitions see Wallace [1987:6-10] or Whittaker et al. [1973:321-324]). Wittaker et al. (1973:321) claim that the term is one of the most confusing (in usage) terms in ecology. Taking a broad approach

[9] Reiterating the phrase by John Bennett, referenced in Chapter 1: “men *do* manipulate their environment; they are not merely determined by it” (Bennett 1969:19).
[10] For example “The location of these site in various ecological areas of the *niche* in question is an important tool which is to be used in the reconstruction of the general economic cycle and the seasonality of the Katakomba groups migrations within the *niche* they exploited (Shishlina 2000:178, italics added)”.

to the term, we can use niche to describe the interrelationship of an organism with all other biotic and abiotic components of its surroundings. Therefore, a niche can only exist as relational to the niches of other organisms in the environment. The presence or absence of a resource, competitors, and environmental stressors will cause that niche to change. An organism's morphology, behavior (in the case of humans some aspects of culture), and ecological requirements are a response to the adaptation to a niche. As Wallace (1987:8) points out a niche is "a more intrinsically behavioral concept, reflecting what organisms actually do, in terms of resource use". When organisms, for example humans, alter their niche in an ecological setting it inversely alters the niches of the other organisms occupying that environment.

NCT has gained popularity among the anthropological community since its introduction less than a decade ago (Day et al. 2003; Laland and Brown 2006; Laland et al. 2001; Odling-Smee et al. 2003). Niche construction was first introduced to evolutionary biology in the early 1980s by Lewtontin (1982, 1983). Two decades later it was picked up by the British anthropological community (Laland et al. 2001), and entered the American anthropological/archaeological literature in 2007 (Smith 2007a, 2007b). NCT is a new model for evolution, which envisions two active processes, natural selection and niche construction. Niche construction is the process of an organism(s) causing long-term physical changes to their environment, which result in a modification of the selective pressures acting on the organism and their descendants (Day et al. 2003; Laland and Brown 2006; Laland et al. 2007; Laland and O'Brien 2010; Laland et al. 2001; Odling-Smee et al. 2003). The effects are also felt by other organisms in the ecosystem. A key component to the definition is the long-term effect on descendants;

long-term effects cause biological change through generations of modified selection pressure, i.e., evolution. Among members of the animal kingdom there are numerous examples of niche construction, e.g., beavers building dams, spiders building webs, mud wasps building a hive, earthworms modifying their soil, and tent caterpillars creating a protective tent. However, humans engage in niche construction on a level far above all other animals, both in magnitude and complexity, cultural niche construction (Laland et al. 2001; Wollstonecroft 2011). Cultural niche construction suggests that reciprocal interactions between human cultural practice ('habitus' [Bourdieu 1977]) and their environment on a long-term basis cause human evolution. Laland et al. (2001) see cultural niche construction as a gene-culture coevolutionary model. NCT situates humans with an active role in their own cultural development through culturally derived, transmitted, and inherited practice.

In the past few years NCT has grown in popularity (Smith 2007a, 2007b; Wollstonecroft 2011), because, as Laland and O'Brien (2010:315) note, "it encourages us to think beyond climate, instability, and an external environment as causes of evolutionary events and to quantify and incorporate human activities as active variables in driving both environmental change and human evolution". From this perspective the archaeological record is key to understanding the trade-offs and decision making processes humans employed when faced with variable environmental constraints (Smith 2007a, 2007b; Wollstonecroft 2011).

NCT provides a needed critique of archaeology conducted in Central Eurasia. It calls for detailed studies of archaeology and ecology that go beyond environmentally deterministic models, and it acknowledges that humans are never 'niche-dwellers'.

Humans are innately niche constructors, shaping and modifying their environment to suit the needs and desires of their community and progeny.

It is easy to see niche construction processes in the archaeological record among sedentary agriculturalists (e.g., architecture, hearths, and storage pits); however, it has been harder for archaeologists and anthropologists to recognize niche construction processes among mobile pastoralists.

The Late Bronze Age is often considered a period of increased pastoral movements (or migrations)[11], traversing great distance, populating areas previously only inhabited by hunter gatherers, such as Semirech'ye (Kuz'mina 2000). The argument for pastoral expansion is typically climatic. Climatic models for the Eurasian steppe usually claim that a period of slightly more humid climatic conditions accounted for expansion and possibly adoption of an agricultural component into the economy (Ivanov 1996; Semenova 2000). This model also claims that the period after this humid climatic optimum there was a marked period of aridity. As a result the early Iron Age (800 – 200 B.C.) has been classified as a period of economic transition where mixed agropastoral systems, dominating in the Late Bronze Age, transitioned into a period of 'pure nomadism' – although, this model has been critiqued fervently over the past decade (Anthony et al. 2005; Chang et al. 2003; Frachetti 2008).

This model also relies on the "Tragedy of the Commons"[12] (Hardin 1968), especially as an explanation for the Iron Age transition. However, since Hardin wrote this

[11]This model, in which pastoralism transplants agropastoralism, was constructed for the forest steppe of Ukraine and southern Russia and does not hold up well on the steppe proper. As Anthony et al. (2005) point out; there has been little good evidence for Late Bronze Age agriculture on the steppe proper.
[12] The "Tragedy" argument posits the case that pastoralists will overgraze commonly held lands because they gain individual profits, in reality pastorlists often have to protect common pasture to retain high output rates on herd products.

pivotal piece in 1968 many economists, historians, and anthropologists have pointed out that (historically) Malthusian catastrophe predictions rarely (if ever) hold up (for critiques of Malthusian economics see Boserup 1983, 1990a, b; Stone 2001). The greater irony is that complex, socially-regulated, land tenure systems and rangeland management strategies give mobile pastoralists greater control over ecological degradation than their sedentary neighbors, who often have to rely on communal water resources and worry about soil salinization, nutrient depletion, concentrated herbivory, and pathologies as responses to agricultural intensification. Browman (1983, 1987a, 1987b) points out that in the Peruvian and Bolivian highlands, Andean pastoralists kept a stable system for over 9,000 years; it was not until the agrarian reform of 1953 in Bolivia and 1969 in Peru that environmental degradation started to lead to a collapse in the pastoralist system. As Browman (1987a:4) notes, "'common' pasture is controlled rationally in areas where modern market incentives have not disrupted indigenous practices". Agrarian reforms have led to soil degradation and legislative restrictions on mobility have led to over grazing. Prior to their incorporation into the global market economy Andean pastoralists had socially ordained practices of rangeland management and conservation (Browman 1987b, 1997, 2008). A good case study against the Tragedy among pastoralists is that of McCabe (1990) where he uses the Turkana of Kenya as a pastoralist example to empirically attack the concept.

Cribb (1991) claims that the primary driving factor for pastoralists is the acquisition of pasture. This simplified view of pastoralism envisions its practitioners as niche dwellers, restricted by the carrying capacity of the land and highly vulnerable to overgrazing, the "niche-dweller" model, suggesting that the environment of a region shapes the economy of the people living in it. This is often how researchers have seen mobile pastoralism on the Eurasian steppe (Bunyatyan 1999; Liberov 1960; Sedova 2000; Shilov 1975). This view demotes the importance of human adaptations to, and modifications of, the landscape. Mobility systems, social land tenure systems, kinship networks, communal herding practices and communal winter encampments, mixed herd compositions, seasonal use of plant resources, and supplementing a meat diet with secondary pastoral products, low-investment agriculture, exchange, hunting, fishing, and foraged wild plants are all socially mitigated strategies that force us to reconsider the limitations of ecological productivity.

Although range ecology, pasture productivity, and pastoral productiveness have been studied ethnographically and applied to archaeological cases (e.g., Frachetti 2008), few have used paleobotanical evidence to examine the topic of overgrazing (but see: Popova 2006b). Using pollen data Popova (2006b) argues that semisedentary pastoralists in the Samara River valley of southern Russia were utilizing range land conservation practices and governing their forage resources. The landscape around the Late Bronze Age site of Krasnosamarskoe is especially appropriate for this study, because Anthony et al. (2005) argued that people were practicing an economic system utilizing short herd movements and not supplementing the diet with any domestic plants. Therefore, conventional thought would suggest that the intensive use of wild plants for herd and human foraging would be more likely to denude the landscape around the site than a mixed agropastoral system. Nonetheless, Popova found no evidence for overgrazing or environmental deterioration. She argues that models implying overgrazing are not good tools for explaining pastoralism in the past, and that all such models need to be scientifically tested.

A critique of the archaeological literature on Central Eurasia using a niche construction approach points out two issues: 1) while climate causes natural selective pressures and is an important variable in human choice, cultural practices leading to niche construction are equally important; and 2) humans are not passively shaped by their environment (i.e., niche-dwellers), they actively engage with it reciprocally, altering the landscape; the effects of their actions are negotiated by future generations of inhabitants.

Pastoralist Ecologies

Most discussions of NCT avoid drawing on actual details and examples; the process of cultural niche construction is so multifaceted and innately part of human culture that to draw on one aspect becomes a challenge. However, Wollstonecroft (2011) argues that pre-consumption food processing is one example of human niche construction. Likewise, Smith (2007a) points out that agriculture and the cultivation of plants is a strong niche constructing force. Other examples of human niche construction processes evident in the early archaeological record include the production of textiles, ceramics, and metallurgical tools, domestication of animals, construction of domestic architecture, channeling of water, and use of dung to fertilize fields and modify soils, just to name a few. These niche constructing processes are clearly part of most early agricultural communities, and are readily identified in the archaeological record of sedentary peoples; however, fewer examples are present or simply not overtly visible in the archaeological record for mobile pastoralists. Mobile pastoralists do construct domestic architecture; however, in many cases it is portable. A yurt or ger is an adaptive response to the environmental setting and reflects economic choices – inevitably modifying the ecological niche. Economic choices, including the choice to be mobile, also play a role in the construction of the herder's ecological niche.

To suggest that mobile pastoralists are niche-dwellers would mean that their cultural practices are a direct response to environmental stimuli. Understandably, many ethnographers and archaeologists have pointed out an obvious correlation between pastoralists and marginal environments (Bendrey 2011; Casimir 1992; Cribb 1991; Spooner 1971, 1973). The productiveness of mobile pastoralism in environmentally marginal zones, which would require large labor inputs for agriculture, has been shown in a number of studies (e.g., Bacon 1958; Barth 1964; Leslie and Little 1999). Bendrey (2011:13) notes that "the specific regional climatic, topographical, and ecological conditions would have influenced decisions as to which proportions of each animal were herded according to their particular biological and behavioral characteristics". Pastoral landscapes include high alpine zones of the Andes, Himalaya, Pamir, and Altai, as well as arid and semiarid steppe and deserts across Central Eurasia, southwest Asia, North Africa, and the tundra. In these environmental zones mobile pastoralism is a more economical approach than sedentary agriculturalism. The ecological and economic parallels make it easy to fall into the long held trap of environmental determinism; however, cultural preferences are equally important motivating factors in determining economic pursuits. There is no doubt that, like agriculturalists, pastoralists pay very close attention to their environment; keeping a mental tab on seasonality in temperature, rainfall, and vegetation growth. In this sense, environment becomes and important factor in decision making, but it is not a sole driving force.

As part of the general reassessment of mobile pastoralism in Eurasia, it is becoming clear that economic diversity during the Bronze and Iron Ages is a key component to adaptive success. Khazanov (1984) argued for the necessity of diversification in the economy of mobile pastoralists in restricted or marginal environments. This is largely related to the unpredictability of socioenvironmental landscapes (Di Cosmo 1994; Honeychurch and Amartushin 2007; Khazanov 1984; Lees and Bates 1974).

Ecological Patchiness and Landscape Modification

As was discussed earlier in this section, the term niche is often used to describe the pocket environments that are central to the economic success of many mobile pastoral systems in Central Eurasia. I was careful to include this semantic revision because the multiple use of the term is drawn upon in this sub-chapter, titled "Niche Construction vs. Niche Dwelling". Mobile pastoralists often focus their economic pursuits on microenvironmental pockets (sometimes referred to as niches); however, this adaptive strategy does not imply that people are innately bound to a defined niche within the ecology of such pockets. NCT does carry the caveat that niche constructing activities must be continued over generations for coevolution to occur. This does not necessarily imply that cultural practice is static, which it never is; however, certain practices, such as herding animals on the same plot of land for generations, modify the ecology of the landscape.

The role of ecological pockets (ecotopes) as patches of resource availability and key points of economic focus on the landscape is discussed in ethnographic studies of mobile pastoralists in Central Asia (Frachetti 2004b:165; Masanov 2000:189; Shishlina 2000; Vainshtein 1980). Herds were/are brought into pockets situated in valleys, leeward slopes, depressions, in bushes, or protected by tall marsh, reed-like stands of *Phragmites australis* and *Typha* spp. (or *Miscanthus* in southern Central Asia). Figure 2.2 shows a modern Kazakh herder's seasonal settlement tucked into a valley and surrounded by low rock outcroppings; the dark green vegetation represents a plant community distinct from the surrounding steppe vegetation. These locations provide rich herd-forage, fodder, and water as well as protection from the weather. A more detailed discussion of this strategy of herd mobility (jumping between distinct ecotopes) is presented in Masanov (1995:88) and Vainshtien (1980). Furthermore, Spengler et al. (in press) trace this system of resource use back to the Bronze and Iron Ages in Central Asia.

These forage-rich patches were/are key nodes in the vast networks of social interaction across this landscape (Frachetti 2008). Herders focused on set loci and returned to the same patches year after year. Pastoralists tend to maintain low population density (Barth 1964); density on the steppe traditionally has been around 1.5 individuals per km^2 (Masanov 1995). The low population densities across the steppe and adjacent regions would not have been an obstacle for social interaction and exchange if people were concentrated at nodal points on the landscape and had predictable movements. Spengler et al. (in press) argue that these ecological nodes fostered a network that spanned vast distances and did not require chance meetings (also Frachetti 2012). If people had been dispersed evenly across these distances, social interaction would have been more happenstance, but population concentrations in ecological patches would have facilitated interactions. In addition, ecological patches were points of congregation for ceremonial events and communal winter encampments (for a more detailed discussion see Spengler et al. in press). Ethnohistorically, these camps varied greatly in number of yurts; they often provided essential locales for vital risk-management practices (such as resource sharing), more intensive community interaction, and also fostered institutions of social cohesion (Barfield 1993; Basilov 1989).

Ecological patches were not 'exploited' by pastoralists, rather they were modified and altered to construct a niche with fewer stressors or competitors. The archaeobotanical seed composition of burnt dung remains from Bronze and Iron Age sites in Central Asia provides us with an idea of the vegetation community around in the patches in the past. At the site of Begash in southeastern Kazakhstan the dominant seeds in burnt dung remains included *Chenopodium* spp., *Polygonum*, and *Malva* (Spengler et al. in press; Chapter 6). These plants are characteristic of disturbed environments, the constant grazing, hoofing, and fertilizing of these loci maintain a vegetation community which favors herding. Through the (likely unintentional) practice of focusing on patches, herders have created an ecological community dominated by nutrient rich herbaceous plants and largely lacking sedges, grasses, and much of the low growing woody vegetation which colonizes areas that are not grazed regularly (personal observations).

Figure 2.2. Modern Kazakh herder's seasonal settlement, located in a distinct ecological pocket, sheep and goat are penned for the night, photo taken in 2009 near Taldy Kurgan, Kazakhstan

The continual influx of nitrogen-rich fertilizer (i.e., herd animal dung) also promotes a vegetation community which is distinct from other areas on the landscape. The role of herd animal dung in maintaining the ecological communities of the nodes is most clearly visible when looking at the locations of animal pens from previous years. Sheep and goat are often penned for the night (Figure 2.2 and 2.3). After a season of penning a thick layer of compacted dung pellets forms on the bottom of the pen. The colonizing vegetation community on the pens is visibly identifiable from hundreds of meters away (Figure 2.3). The most common colonist is often *Chenopodium*, which has a hard testa and can remain viable through digestion. Therefore, herd animal dung is a complete package – nitrogen-rich fertilizer mixed with seeds from nutrient-rich plants. This process of modification of high-impact locations on the landscape through increasing nitrogen, phosphorous, calcium, and other necessary plant minerals by herd grazing has been noted among Maasai pastoralists in Kenya as well (Western and Dunne 1979; Fiona Marshall personal communication, 2012).

Figure 2.3. Modern Kazakh herder's seasonal settlements; *Right*, an active camp/corral structure; *Left*, a vegetation circle marking a remnant pen; both in the Malguzar Mountains of Uzbekistan, photos by Michael Frachetti 2011

In addition to maintaining and modifying a favorable ecological community in these nodes, Bronze and Iron Age peoples across Central Eurasia modified multiple aspects of the ecology. While there is limited data for reconstructing forest cover change in northern Central Asia (although see Tarasov et al. 2007 and Tchebakova et al. 2009) it is clear that there were significant changes in forest cover in southern Central Asia starting in the third millennium B.C. Palynological studies in this region have had mixed results (for discussion see Rosen et al. 2000). Furthermore, as Sugita et al. (1999) point out interpreting landscape openness in the past, especially on a mosaic landscape, is not a simple process and requires extensive palynological research and complementary methodologies. The abundance of wood charcoal in archaeological sites is sometimes used as an indicator of how prevalent wood resources were near the site (see Willcox 2002 or Miller 2004). One of the earliest archaeological settlements thus far identified by archaeologists in Central Asia north of the Kopet Dag Mountains is Sarazm. Wood charcoal at the Sarazm site is both abundant and dense (Spengler and Willcox in press). Several of the flotation samples from the site contained several liters of wood charcoal each. Spengler and Willcox (in press) argue that in the third millennium B.C. in the Zarafshan valley of Tajikastan forest resources (especially slower growing non-riparian species) covered a much larger area than they do today. The deforestation that seems to have taken place in the region sometime after the third millennium B.C. could have been multi-causal, due to land clearing for agriculture (in regions where agriculture was practiced) and use of wood fuel for smelting, pottery firing, and domestic purposes as well as architecture.

Once a region was deforested regeneration would have been suppressed due to herd animal grazing. Young saplings cannot get started in areas that are readily grazed, especially if the dominant animals are sheep and goat. The long-term suppression of woody plant regeneration creates an entirely new vegetation community, one similar to that present across much of the Central Asian mountain foothills today. The grassy foothill vegetation in areas such as the Zarafshan valley is more suiting to a pastoralist economy than forested hills; forage plants would have replaced woody vegetation. This same slow process of modification has been noted for much of the circum-Mediterranean regions, as pastoralists coevolved with the ecology (di Castri 1981).

A similar trend has been argued for by Willcox (2002) as having taken place across much of southwest Asia. Miller (2004) identified a decrease in charcoal abundance and an increase in wild seed abundance during the third millennium B.C. at the site of Malyan in the Zagros Mountains of northwest Iran. She suggests that this is indicative of a shift from using wood to using animal dung as fuel, further supporting the notion of a third millennium B.C. deforestation of the mountains of southern Central Eurasia. Similar findings have been reported from sites in the Khabur Basin of Upper Mesopotamia (Wilkinson 2003), Tell es-Sweyhat and Tell Umm el-Marra in northern Syria, and tell Abu en-Ni'aj in Jordan (Klinge and Fall 2010).

There are palynological data from the western steppe that indicate that deforestation took place during the Bronze Age as well. Kremenetski et al. (1999) suggests that the extinction of Scots pine (*Pinus sylvestris*) in the Dneiper, Don, and Volga River valleys could be linked to early bronze smelting. Kremenetski et al. (1999) note that climate may also have played a role in the deforestation of some valleys, especially along the Volga and Don Rivers where it took place 2,000 years earlier (2500 B.C.) than in the Dnieper. There is limited evidence for agriculture on the western steppe at this time period and economy was likely heavily reliant on pastoralism.

Paleoethnobotanical assemblages for the mountain-foothills of northern Central Asia do not stretch back past the second millennium B.C. The lack of a baseline for wood abundance at these sites does not allow us, as of yet, to determine if a similar deforestation took place in this region. However, Iron Age sites such as Tuzusai (Spengler et al. 2013) and Begash (Spengler et al. in press) have assemblages that almost completely lack wood charcoal and have high abundances of wild seeds. Based on this data, it seems likely that a similar deforestation trend occurred at more northerly sites some time before the first millennium B.C.

Conclusion

Archaeologists have depicted mobile pastoralists as niche-dwellers – occupying specific ecological settings and existing as pastoralists because they were restricted by ecological conditions. Using a NCT framework to critique archaeological discourse helps veer discussions of cultural change away from climatic factors and toward cultural practice and acknowledges a reciprocal interaction between humans and the environment. It is a commonly held belief that because mobile pastoralists hold a less well-defined system of individually regulated land tenure, they inevitably had no concept of resource conservation (cf., Popova 2006b). Fernández-Giménez (1994) studied ecological perceptions of indigenous resource management among mobile pastoralists on the Mongolian forest-steppe. Humphrey et al. (1994) studied indigenous conservation attitudes among Tuvan and Mongolian mobile pastoralists. The reconstruction of human ideologies by means of the archaeological record alone is a difficult endeavor; however, there is little evidence to argue that Central Asian pastoralists before modern times denuded their environment. They did, however, modify the environment to suit their economic practices, as all humans do. In the process of modifying their niche, through the daily activities of herding, they reciprocally altered the niches of all organisms on their landscape.

Chapter 3: Archaeological Sites

This dissertation provides an archaeobotanical analysis of the Semirech'ye region by looking at four archaeological sites. Figure 3.1 contrasts archaeological phases and calibrated AMS dates for these sites, while Figure 3.2 depicts Semirech'ye and pin-points the four onto the geographic landscape (also see Figures 1.1 and 1.2).

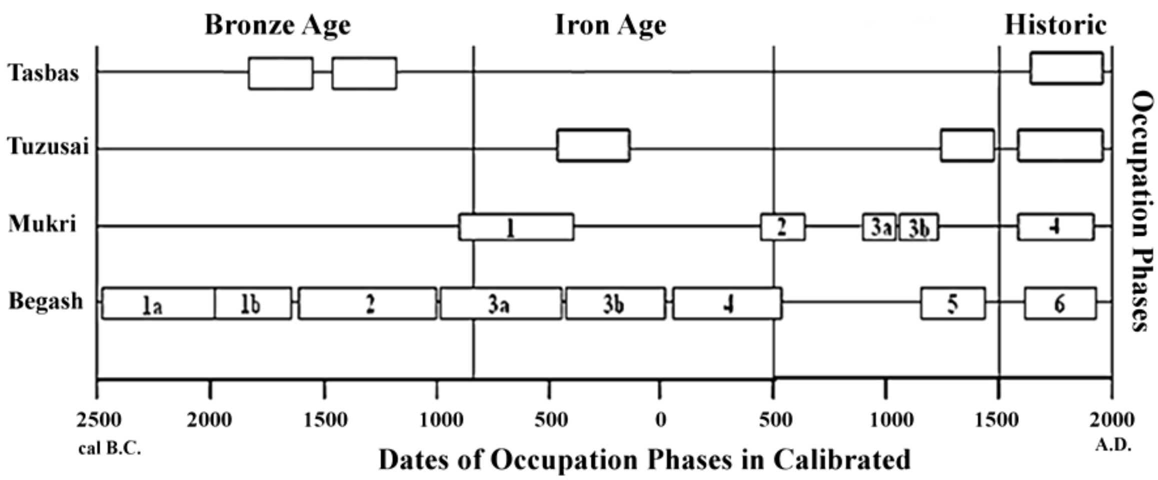

Figure 3.1. Archaeological phases and dates for Tasbas, Tuzusai, Mukri, and Begash

1. The Talgar chronology has been compiled by Chang et al. (2002) and new dating for this dissertation. This dissertation focused on the period of time at Tuzusai between 410 and 150 cal B.C.
2. Data for Mukri and Begash from Frachetti and Mar'yashev (2007:229), Frachetti et al. (2010a)
3. The Tasbas data is all new, unpublished, results

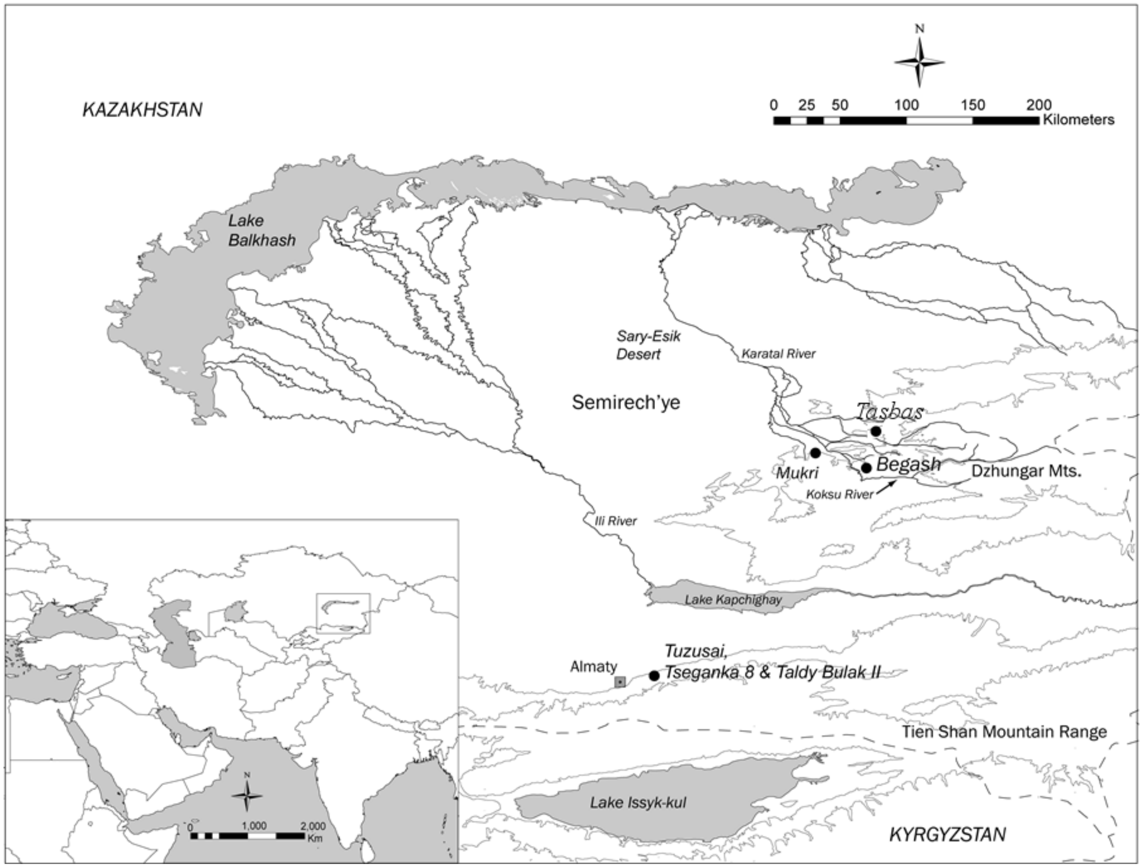

Figure 3.2. Map of Semirech'ye, showing location of Begash, Mukri, Tasbas, and the Talgar sites, contours are 1,000 and 2,000 masl, from Frachetti and Mar'yashev (2007:222)

3.1 Dzhungar Mountains Archaeological Project

3.1.1 Begash

Frachetti and Mar'yashev (2007) excavated the site of Begash, located in the Koksu River valley, as part of the Dzhungar Mountains Archaeology Project (DMAP) (Frachetti 2004b, 2006, 2008a, 2008b). Begash is one of many documented Bronze Age settlement sites in eastern Kazakhstan; however, it is the only site to be well dated radiometrically as well as having incorporated systematic stratigraphy-based excavation methods. These two qualities make Begash a unique settlement study with robust analysis. Excavations were conducted at Begash in an attempt to identify regional variations in the mobile pastoral economy of local populations in the Bronze Age (and later). This series of excavations had three main goals: 1) to reconstruct a model of subsistence economy (especially the role of domesticated plants and animals, mobility patterns, and resource utilization); 2) to understand social interactions and the possibility or extent of inter-regional interactions; and 3) to measure the long-term stability of populations in the region. Begash is only about 20 km from the site of Mukri and only about 200 km north of Tuzusai, both of which are also discussed in this dissertation. Begash is at approximately 950 masl. Occupation at Begash was divided into six chronological phases, as presented in Figure 3.1 and Table 3.1. The earliest botanical material from Begash comes from Phase 1, the end of the Middle Bronze Age. This Phase at Begash provides some of the earliest evidence for a pastoral economy in northern Central Asia. Late Bronze Age occupation (Phase 2) at the site is characterized by decorated vessels and artifacts, which many researchers associate with the materials of Andronovo Cultural Complex. Iron Age occupation at Begash shows material culture similarities to that of the Talgar alluvial fan sites, such as Tuzusai, attributed to people in the Saka and Wusun groups.

Frachetti (2006:129) has applied a landscape approach to archaeology in the Koksu River valley. This has allowed for a holistic view of the anthropogenic environment through time and space. Taking this approach, the dynamic nature of culture on the steppe becomes even more apparent. The variability in economic strategies, especially relating to mobility patterns, is reflected not only spatially but temporally

(Frachetti 2004b, 2008a). Scientific analyses, systematic collection, and standardized recording of both archaeological and paleoenvironmental data allows for a greater understanding of subsistence strategies, mobility patterns, and social interactions, both intra- and inter-regional (Frachetti 2004b, 2006, 2008a, 2008b; Frachetti and Mar'yashev 2007). These archaeological data helps develop an understanding of the cultural and environmental variables that played a role in the lifeways and, specifically, the economy.

The Koksu River valley is a location rich in archaeological material but has received limited attention by researchers. While a number of Soviet survey projects have been conducted in the region, a comprehensive understanding of the archaeological sequence was far from complete (Frachetti 2006). Frachetti and Mar’yashev (2007) have presented an elaborate chronology for this region. In developing an understanding of the anthropogenic impact on the Koksu River valley, a more holistic understanding of archaeology in eastern Kazakhstan will inevitably ensue. The DMAP has focused on the Bronze Age, which is a poorly understood aggregate of varying cultural groups sharing some similarities in material culture often clumped under the title Andronovo Cultural Complex (cf., Frachetti 2008a). By studying the Bronze Age in the Koksu River valley, the DMAP can start to piece together regional variations in the Late Bronze Age (ca. 1950 – 800 B.C.) unique to the mountain and steppe interface of Semirech'ye in eastern Kazakhstan.

A final reason for the importance of the Koksu River valley in a broader archaeological perspective is the location of the valley in relation to the surrounding mountain ranges and the Dzhungarian Gate, which is a network of transversable passes through the mountains. The route connects Gansu to Kazakh Dzhungaria and goes north of the Tien Shan Mountains (Frye 1996:19). The Dzhungarian Gate and nearby passes have played a major role in trade between Asia and Europe.

3.1.2 Occupation Phases

Frachetti and Mar'yashev (2007) have divided occupation at Begash into six archaeological occupation phases. There are no significant hiatuses between phase levels in the stratigraphy, and therefore, it appears that there was a nearly continuous occupation at Begash for approximately 4,000 years. In practice, the site had numerous smaller habitation hiatuses and was a seasonal camp, yet there appears to be steady reuse of the site over the long term. Three of the occupation phases at the site reflect architectural construction, while intermediate phases may represent encampments composed of impermanent structures (Frachetti and Mar'yashev 2007:228-230). Frachetti and Mar'yashev state that:

> "Thirty-four AMS dates provide a chronology of habitation phases at Begash from 2460 cal B.C. to A.D. 1900, without significant evidence for depopulation or substantial social discontinuity in the region or at the site for any long duration in prehistory. This is not to suggest that the population in the Koksu Valley was demographically unchanging" [Frachetti and Mar'yashev 2007:228]

Table 3.1. Archaeological phases and dates from Begash

Phase	Calibrated Date Range		
	Years B.P. (Uncalibrated)	Calibration 1 Sigma	Calibration 2 Sigma
1a	4220 ± 220 – 3650 ± 45 B.P.	2460 – 1950 cal B.C.	3500 – 1890 cal B.C.
1b	3540 ± 140 – 3460 ± 35 B.P.	1950 – 1690 cal B.C.	2300 – 1500 cal B.C.
2	3310 ± 35 – 2880 ± 40 B.P.	1625 – 1000 cal B.C.	1690 – 920 cal B.C.
3a	2657 ± 84 – 2430 ± 45 B.P.	970 – 400 cal B.C.	1010 – 400 cal B.C.
3b	2253 ± 35 – 2050 ±80 B.P.	390 cal B.C. – A.D. 30	400 cal B.C. – A.D. 130
4	1874 ± 37 – 1600 ± 35 B.P.	A.D. 70 – 550	A.D. 60 – 550
5	715 ± 33 – 575 ± 30 B.P.	A.D. 1260 -1410	A.D. 1220 – 1420
6	135 ± 35 – 100 ± 30 B.P.	A.D. 1680 – 1900	A.D. 1660 – 1950

1. Table from Frachetti and Mar’yashev (2007:229)

Occupation Phase 1

Occupation Phase 1 is subdivided into Phases 1a and 1b. Phase 1a is dated to 2460 – 1950 cal B.C. (Frachetti and Mar'yashev 2007:231-232). This occupation phase falls within the Early and Middle Bronze Age in Central Asia. A map of Phases 1a and 1b is presented in Figure 3.3. Phase 1 is essentially a burn horizon; it is well defined in the stratigraphy, with sterile soil below the stratigraphic layer. There is little material culture within the burn layer; however, there were sherds and other material directly above. Phase 1a appeared approximately 2.5 m below the surface. The phase is marked by the construction of at least one occupation structure. Other features associated with this occupation level include hearths and a burial cyst. Granite grinding stones and pestles from this phase attest to grinding activities, possibly of wild grains such as *Chenopodium* or *Polygonum* or domestic grains obtained through trade. Figure 3.4 shows two examples of the grinding stones from Begash (see also Appendix A, Figures 1-4). Grinding stones have been recovered from Iron Age sites across Semirech’ye (Chang et al. 2002). While grain processing is a possibility, grinding stones could also be used for pigment, nut, or root processing.

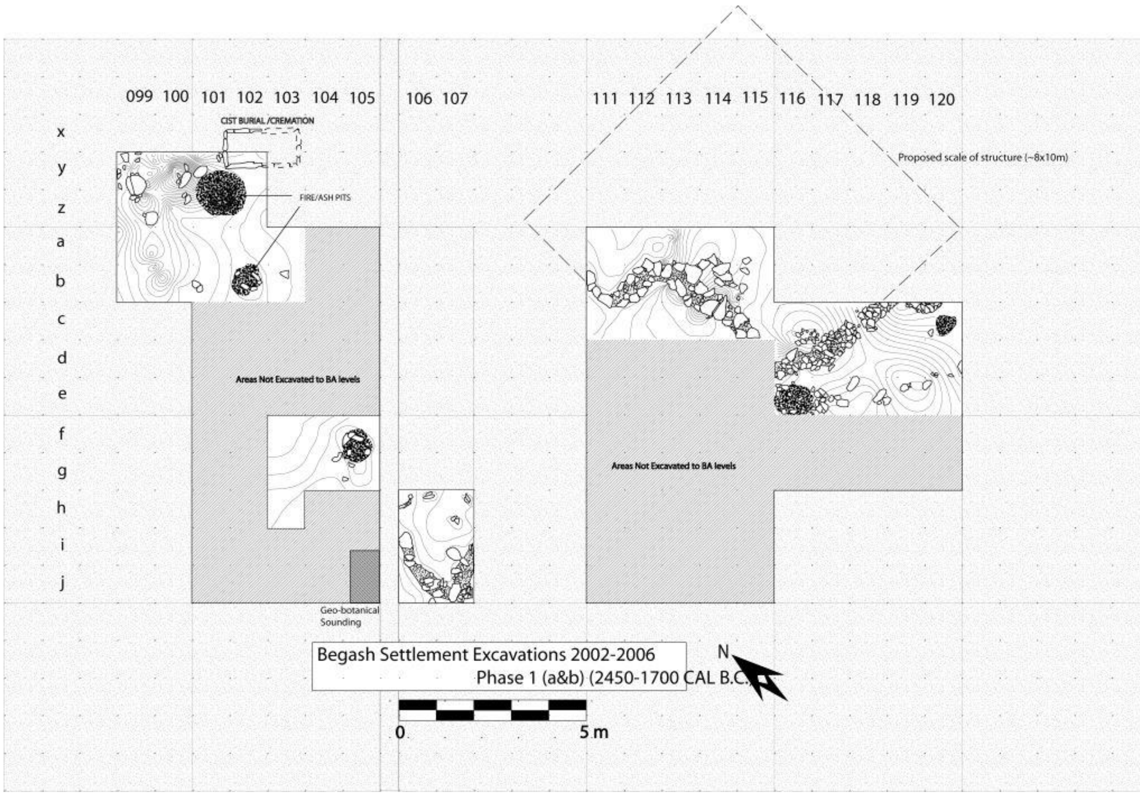

Figure 3.3. Begash phase level 1a and 1b (Frachetti and Mar'yashev 2007)

Phase 1a also contained a large, mostly *in situ*, stone wall foundation (180 cm below datum, sitting on top of the soil level marking Phase 1a); it is likely that these walls once formed quadrilateral shaped, semi-subterranean houses. In addition, a number of hearths, and a flint blades, ground stone granite tools, and herd animal bones were found. Phase 1b (1950 – 1690 cal B.C.) at Begash does not include architectural construction but is marked by a carbon-rich occupation layer (Frachetti and Mar'yashev 2007:232-233). Fewer stone tools were recovered from this layer; however, granite grinding stones were still present. In addition to grinding stones, like in Phase 1a, there were micro-blades, spindle whorls, and ceramics with textile imprints, all of which attest to varying aspects of a diverse craft economy. Phase 1b contained decorated ceramic sherds, in typical styles of the Federovo variant of the Andronovo Cultural Complex and evidence for metallurgy.

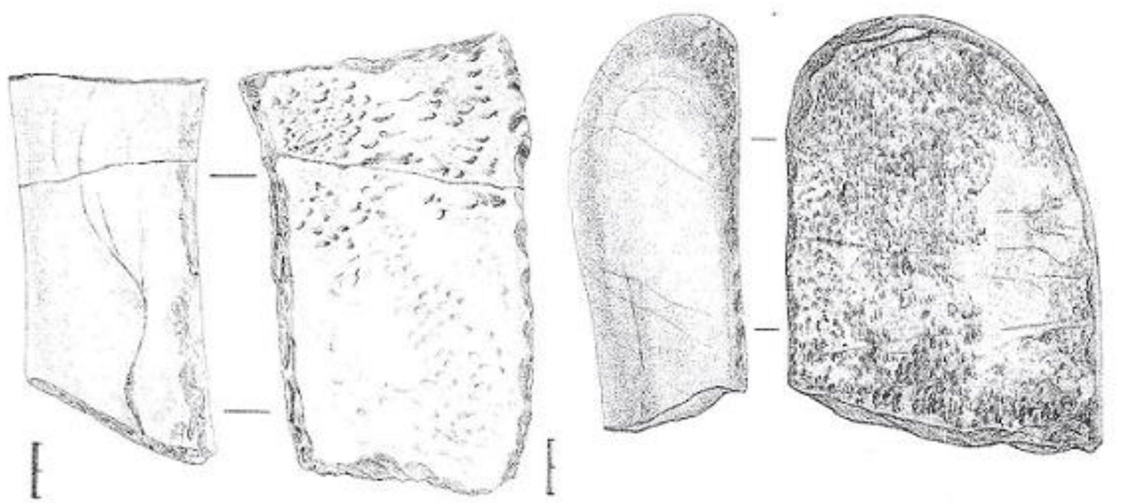

Figure 3.4. Granite grinding stones from Begash (Frachetti 2004b)

Occupation Phase 2

Phase 2 at Begash is dated to 1626 – 1000 cal B.C. (the longest of the occupation phases), the Late Bronze Age (Frachetti and Mar'yashev 2007:233-235). The phase is marked by a thick, culturally rich, fill layer. This phase is also marked by less consistency in occupation; a number of structure foundations, pits and hearths are noted (Frachetti 2004b). The material culture from this stratigraphic layer shows a transition from what existed in Phase 1b. Phase 2 material culture includes decorated pottery and bronze artifacts, as well as granite grinding stones and pestles. There are fewer stone tools in this phase and an increase in decorated ceramics. This phase does not seem to have any distinct architecture of its own but there is a spattering of middens or trash pits, hearths, and artifacts.

It is likely that this thick fill layer represents the filling in of the stone structure form Phase 1, as well as digging and re-leveling of the site's floor. This fill layer seems to represent a mix of material culture from the Late Bronze Age and earlier periods, it is possible that some of this material was turned up during leveling events from earlier contexts.

Occupation Phase 3

Phase 3 is subdivided into occupation Phase 3a (970 – 400 cal B.C.) and Phase 3b (390 – 30 cal B.C.) (Frachetti and Mar'yashev 2007:235-236). This represents the early Iron Age on the steppe. Phase 3a coincides with what is often referred to as Saka Culture and shows similarities to Saka material culture from other sites in Semirech'ye, as noted by Chang et al. (2003). Frachetti and Mar'yashev (2007) note that there is less emphasis on architecture in this occupation phase, and they suggest that this may represent a shift in economy. Models of economic shift at this time period are a key aspect to this dissertation and will be discussed in more detail later. One burial from this stratigraphic layer, which was capped with flagstones, was sampled for flotation. While the burial is the most notable feature in this layer, there were also trash pits and hearths that both attest to a domestic occupation. Phase 3b also reflects Saka material culture, and some of the features at the site include clay floor foundations, postholes, hearths, and pits

(Frachetti and Mar'yashev 2007:235-236). There was also an increase in construction during Phase 3b.

The phase in general is characterized by a hard packed clay (possibly floor) level. Stone walls are divided into small rectangular rooms. The hard packed surface starts at about 60 cm below datum. There was an articulated lamb skeleton across this possible floor-surface, further suggesting that it was an occupation level. Figure 3.5 shows a site map of Phase 3b.

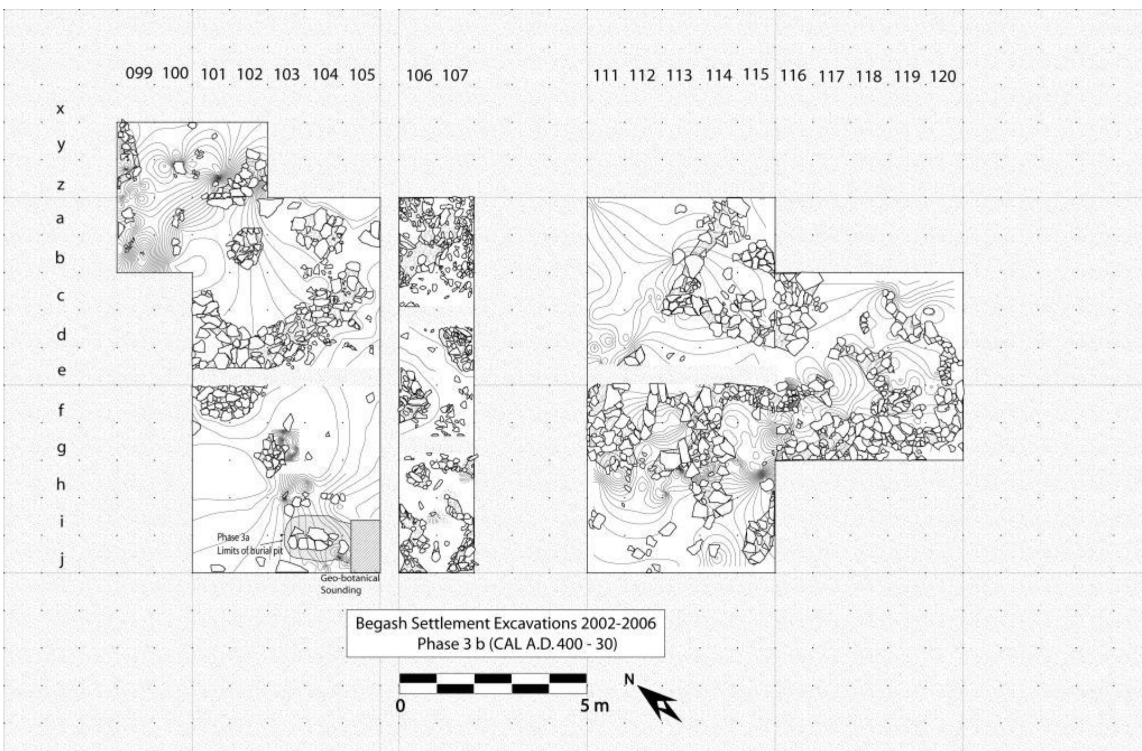

Figure 3.5. Begash phase level 3b with burial unit marked (Frachetti and Mar'yashev 2007:236)

Occupation Phase 4 and 5

Phase 4 (cal A.D. 70 – 550) represents what many archaeologists call Wusun Culture occupation at Begash (Frachetti and Mar'yashev 2007:236-237). This occupation appears to be more sporadic, and structures, such as those built during the earlier Saka construction phase, do not appear to have been used. Trash pits and material culture remains suggest that occupation did occur on the site at this time (Frachetti and Mar'yashev 2007). Material culture remains include iron artifacts and spindle whorls.

Phase 5 (cal A.D. 1260 – 1410) and Phase 6 (cal A.D. 1680 – 1900) represent the final construction phases at the site. These are historic period occupation phases. Architectural construction includes rectangular house structures and corals. These phases represent historic-era occupation at the site. Figure 3.6 shows a map of the site layers 5 and 6.

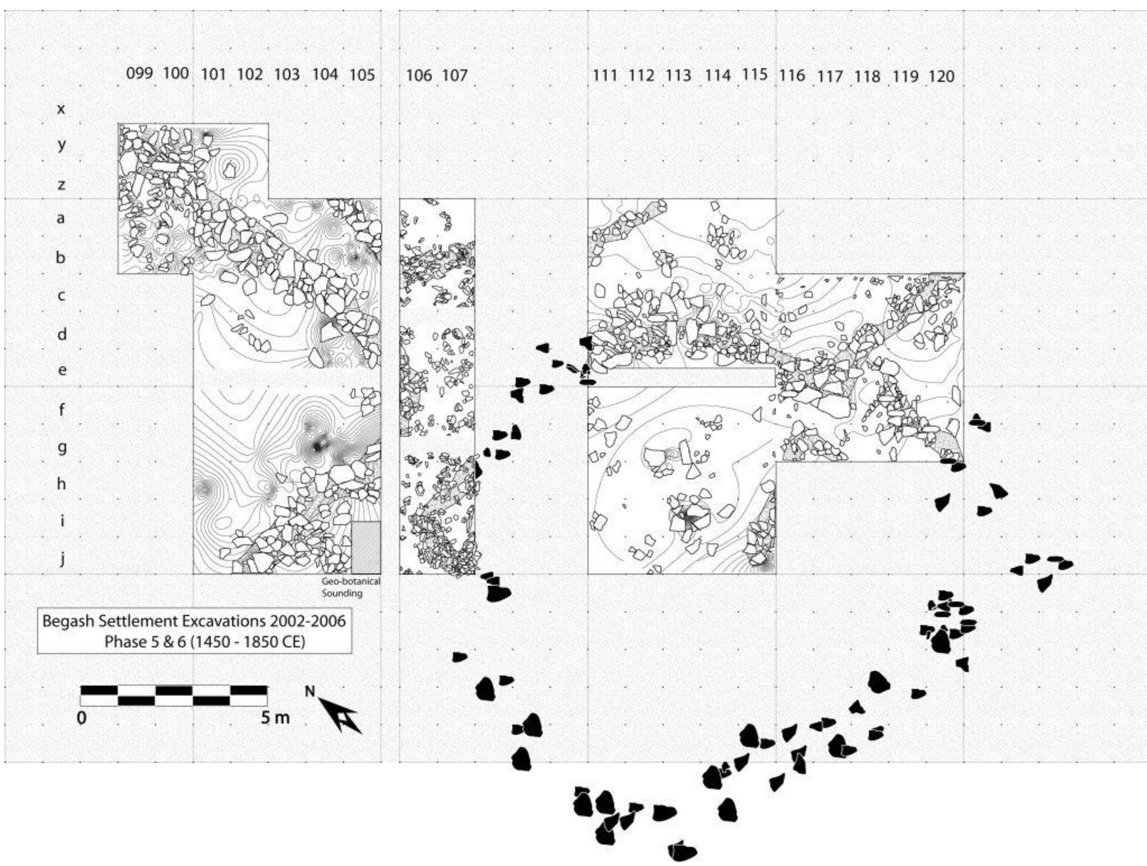

Figure 3.6. Begash phase levels 5 and 6 (Frachetti and Mar'yashev 2007)

3.1.3 Economy

One of the major contributions from the excavations at Begash was a reassessment of the antiquity of pastoralism in northern Central Asia. The AMS dates from the lowest phase at the site show pastoral occupation as far back as 2460 cal B.C. (Frachetti 2008b). It had long been accepted that the Andronovo Cultural Complex formed with the expansion of pastoralists into the southeastern steppe (Fedorovo) around the early second millennium B.C., Begash's phase 1a predates this.

The economy at Begash and Mukri in the Bronze and Iron Ages was based on pastoral products (Frachetti 2008a). Domestic herd animals dominate the faunal assemblage from Begash, specifically sheep, cattle, and horse (Frachetti 2004b:556-561; Frachetti and Benecke 2009). The preliminary Begash zooarchaeological report, conducted by Tleuberdina, at the National Academy of Science in Almaty, is almost exclusively dominated by sheep, cattle (*Bos taurus*), and horse (*Equus caballus*); however, two souslik (*Citellus citellus*) skulls were also found (Frachetti 2004b:556-561). The souslik bones are just as likely intrusive as representative of hunting. A more detailed study conducted by Frachetti and Benecke (2009) (Table 2.2) has shown more evidence for hunting, including red deer (*Cervus elaphus*), goitered gazelle (*Gazella subgutturosa*), Siberian ibex (*Capra sibirica*), and argali (*Ovis ammon*) (Frachetti and Benecke 2009). Frachetti (2004b) further argues that the Bronze Age inhabitants at Begash employed vertical mobile herding patterns. They lived in seasonal settlements and utilized geographically fixed but seasonally variable pasture resources in diverse environmental zones.

	Domestic Mammals							**Wild Mammals**							**Birds**					
Phases	Sheep/Goat	Sheep	Goat	Cattle	Horse	Camel	Dog	Red deer (*Cervuselaphus*)	Goitered gazelle (*Gazellasubgutturosa*)	Argali (*Ovisammon*)	Siberian ibex (*Capra sibirica*)	Wild Pig (*Susscrofa*)	Fox (*Vulpesvulpes*)	Mustelid (*Mustela* sp.)	Eagle owl (*Bubo bubo*)	Chukar partridge (*Alectorischukar*)	Hoopoe (*Upupaepops*)	Starling (*Sturnus vulgaris*)	Unidentified Species	Sum
1a	76	-	(3)	20	-	-	-	4	-	-	1	-	-	-	1	1	-	-	475	578
1b	293	(24)	(5)	108	8	-	4	14	1	-	1	-	3	1	-	-	-	-	1929	2363
2	401	(41)	(3)	158	24	1	6	8	-	1	-	2	10	1	-	-	-	-	2111	2723
3a	61	(3)	(1)	37	3	-	1	6	-	1	2	2	1	-	-	-	-	1	654	771
3b	527	(77)	(3)	132	45	1	1	31	3	2	1	2	8	-	1	-	1	-	4223	4980
4	326	(32)	(1)	160	45	-	5	11	2	4	-	2	2	-	-	-	-	-	2897	3454
5	223	(20)	(2)	109	55	6	2	13	17	-	1	-	1	-	-	-	-	-	3622	4049
6	136	(6)	(5)	94	38	1	1	16	3	4	3	-	-	-	-	-	-	-	2235	2531

Table 3.2. Summary of the zooarchaeological assemblage from Begash, data from Frachetti and Beneke (2009:table 2)

1. Minimum Number Individuals is in parentheses, (MNI)

Other economic endeavors identified at Begash include craft production such as pottery and textile manufacture. Ceramic sherds are found in all occupation layers at the site, with the most elaborate decorated wares recovered from Late Bronze Age layers. Textile manufacture and use is evident at the site in three forms; first, through imprints on ceramic sherds; second, through carbonized fragmentary remains; and third, through the recovery or spindle whorls. Three spindle whorls were found in total, two were made of sandstone and one of ceramic (the latter could be a loom weight). Textile industry at

Begash will be discussed in more detail later in this dissertation; however the noteworthy points are: 1) a course fibered (likely wool) twine was identified in Late Bronze Age layers; 2) a fine woven, double-over single-under textile fragment, of a linen-like fiber was found in an Iron Age hearth feature (ca. 350 B.C.); and 3) ceramic imprinted textiles are utilitarian, while the carbonized Iron Age fragment is a finely woven exchange item, likely brought in along the Silk Road.

3.1.4 Flotation Samples

Table 3.3 lists phase sequences and corresponding flotation samples. Archaeobotanical samples were collected from stratigraphic layers associated with the Late Bronze Age up to historic periods. Consequently, historic samples provide an analogy for socio-economic practices in the Bronze and Iron Ages.

Sample numbers were assigned to all flotation samples. Contexts were defined by distinct characteristics in the soil, such as a particular feature (e.g., a burial or hearth). Not all contexts at Begash were directly dated using radiocarbon. In many cases, dates are based on the sample's association to contexts above and below it. The context number has three digits; the first digit refers to the quadrant number from which the sample came. The archaeological site was divided into four quadrants, each measuring 10 x 10 m. Those quadrants were labeled Operation I, Operation II, Operation III, and Operation IV. Each operation was divided into 5 x 5 m quadrants – A, B, C, and D. In the 2005 excavations, work was done in subquadrants I-D, II-D, III-B, and IV-B. Those subquadrants correlate with the first digit of the three digit context numbers as follows –

I-D, II-D, III-B, and IV-B equate 1xx, 2xx, 3xx, and 4xx, respectively. The other two digits of the context number were filled in as specific features and were designated by number.

A group of contexts that seem to have similarities in material culture and/or date to the same time period were designated an occupation phase number. Contexts were excavated according to cultural horizons and/or features. In this system, each feature (e.g., floor, hearth, wall, or post-hole) was assigned an individual context number. These context numbers were unique to each operation (quadrant) of the site. Phases at Begash were dated by means of the contexts of which they are composed. Therefore, the dating on flotation samples is reliant upon the contexts from which they were removed, not from the phases.

A total of 31[13] soil samples were analyzed from Begash representing all occupations at the site. A total of 18 Bronze Age samples were floated and analyzed. Eight of these samples came from Phase 1a contexts, nine of them came from Phase 1b, and one from Phase 2 (see Table 2.3 for a breakdown of these samples). In addition, 13 Iron Age samples from the Saka period were floated and analyzed, nine from Phase 3b and four from Phase 3a.

[13] Three historic period samples were analyzed in addition to the 31 other samples but not discussed here.

FS #	Context Number	Date Range of Sample	Culture Phase	Total Liters of Soil	Context	Total Seed Density*
FS 5	6	390-50 cal B.C.	3b	4.5	Hearth/Ash Pit	4.7
FS 6	8	390-50 cal B.C.	3b	9.0	Hearth	44.6
FS 7	10	390-50 cal B.C.	3b	1.9	Ash Pit	14.2
FS 8	10	390-50 cal B.C.	3b	1.8	Ash Pit	40.2
FS 9	8	390-50 cal B.C.	3b	2.0	Ash Pocket	1.0
FS 31	4	390-50 cal B.C.	3b	0.85	Orange-Soil Fill	2.4
FS 30	4	390-50 cal B.C.	3b	0.8	Orange-Soil Fill	13.8
FS 34	6	390-50 cal B.C.	3b	1.05	Soil Fill	7.6
FS 35	6	390-50 cal B.C.	3b	1.2	Soil Fill	12.5
FS 11	13	760-400 cal B.C.	3a	2.0	Fill Above Burial	23.5
FS 13	13	760-400 cal B.C.	3a	2.0	Fill Below Burial	32.0
FS 14	13	760-400 cal B.C.	3a	3.5	Burial	23.4
FS 20	13	760-400 cal B.C.	3a	2.0	Soil Fill	55.5
		Sub Totals		32.6		26.5
FS 12	11	1625-1000 cal B.C.	2	9.5	Ash Pit/Hearth	23.5
FS 10	9	1950-1700 cal B.C.	1b	9.0	Ash lens	21.0
FS 19		1950-1700 cal B.C.	1b	5.0	Grid N. Wall	85.8
FS 36	8	1950-1700 cal B.C.	1b	0.4	Soil Fill	35.0
FS 37	11	1950-1700 cal B.C.	1b	1.0	Soil Fill	9.0
FS 38	11	1950-1700 cal B.C.	1b	5.0	Soil Fill	69.8
FS 39	12	1950-1700 cal B.C.	1b	0.7	Soil Fill	30.0
FS 40	13	1950-1700 cal B.C.	1b	3.1	Soil Fill	20.0
FS 41	14	1950-1700 cal B.C.	1b	0.85	Soil Fill	18.8
FS 43	16	1950-1700 cal B.C.	1b	1.8	Soil Fill	54.4
FS 42	16	2450-1950 cal B.C.	1a	6.2	Fire Pit	17.7
FS 44	17	2450-1950 cal B.C.	1a	9.5	Soil Fill	28.1
FS 45	18	2450-1950 cal B.C.	1a	3.1	Soil Fill	29.7
FS 46	18	2450-1950 cal B.C.	1a	1.25	Fire Pit	24
FS 47	20	2450-1950 cal B.C.	1a	30.8	Human Cremation	8.4
FS 48	21	2450-1950 cal B.C.	1a	3	Soil Fill	24
FS 49	23	2450-1950 cal B.C.	1a	5	Soil Fill	42.6
FS 50	17	2450-1950 cal B.C.	1a	2	Soil Fill	33.5
		Sub Totals		91.2		25.9

Table 3.3. Bronze and Iron Age flotation samples from Begash

3.1.5 Mukri

The site of Mukri was excavated by Frachetti et al. (2010a) in 2006. The occupation represents multiple phases of use and abandonment over a 3,000 year period to the present. Occupation at the site was divided into four chronological occupation phases, as seen in Table 3.4. Mukri is a small-scale isolated pastoral seasonal encampment. The site of Mukri is about 50 km west of Begash nestled into low foothills overlooking a tributary of the Koksu River. This site is interpreted as being more environmentally marginal than Begash; however, it is likely that a close connection between populations at these two sites existed (Frachetti et al. 2010a). The chronology of these sites is attested by comprehensive AMS dating and shows occupation during the critical period of transition from the Late Bronze to the Iron Age (ca. 800 – 300 B.C.).

Table 3.4. Archaeological phases and dates from Mukri, data for table from (Frachetti et al. 2010a)

Phase	**Calibrated Date Range**		
	Years B.P. (Uncalibrated)	Calibration 1 Sigma	Calibration 2 Sigma
1a	2610 ± 35 – 2440 ± 40 B.P.	810 – 411cal B.C.	838 – 405cal B.C.
2	1540 ± 45 – 1470 ± 35 B.P.	435 – 633calA.D.	421 – 650 cal A.D.
3a	1120 ± 30 – 1060 ± 35 B.P.	894 – 1020 cal A.D.	784 – 1025 cal A.D.
3b	910 ± 45 – 790 ± 25 B.P.	1042 – 1262calA.D.	1029 – 1276calA.D.
4	195 ± 30 – 155 ± 30 B.P.	1663 - 1945cal A.D.	1648– 1953 cal A.D.

Frachetti et al. (2010a) argue that the site is a strategic node on the pastoral landscape. Therefore, research at Mukri helped investigate issues related to social networks and shifting pastoral ecologies over time. The occupation and abandonment phases of Mukri help us interpret how pastoralists activated and deactivated nodal points in a vast socioenvironmental network of communication and exchange.

Early occupation phases at the site are marked by simple mobile encampments but later, historic, occupations are characterized by a small mudbrick hamlet. One of the key features that makes Mukri important to the present study is its environmental setting. Mukri is located in the Koksu River valley, similar to Begash; however, Mukri is located further downstream in a much more environmentally marginal location. The site is located at 850 masl in a narrow ravine. The Dzhungar Mountains surrounding the site rise to peaks of 4,500 masl and in the west the landscape flattens out to the Sari-Esik desert at 350 – 500 masl. The site is located in an ecological pocket created, today, by a freshwater spring. This spring makes the site stand out on an otherwise harsh landscape. It also turns the site into an important economic node; providing valuable resources of water and forage. The sites lowland setting and protection from the winds may suggest that it was used during winter months.

	Domestic Mammals							**Wild Mammals**					**Birds**		
Phases	Sheep/Goat	Sheep	Goat	Cattle	Horse	Camel	Dog	Red deer (*Cervuselaphus*)	Argali (*Ovisammon*)	Siberian ibex (*Capra sibirica*)	Fox (*Vulpesvulpes*)	Wolf (*Canis lupus*)	Chukar partridge (*Alectorischukar*)	Unidentified Species	Sum
1	7	(1)	(1)	3	1	-	1	-	-	-	-	-	-	16	28
2	90	(3)	(-)	38	14	-	-	1	-	-	-	-	-	251	394
3a	95	(4)	(2)	20	8	-	1	-	-	-	1	-	-	234	359
3b	384	(19)	(5)	94	41	1	4	2	4	-	2	-	3	970	1507
4	165	(17)	(4)	75	35	1	3	1	-	1	5	-	1	408	695

Table 3.5. summary of the zooarchaeological assemblage from Mukri, data from Frachetti et al. (2010a)[14]

Economy at Mukri seems similar to that at Begash with a mixed pastoral system including hunting, pastoralism, and exchange. The zooarchaeological material shows less

[14] Minimum Number Individuals is in parentheses, (MNI)

evidence for hunting than at Begash but has strong evidence for pastoralism (Table 3.5). Seasonal movements would likely have meant herders used the site only during the harsher winter months.

3.1.6 Occupation Phases

Occupation at Mukri is well dated using 14 AMS dates and shows a span of 3,000 years starting around 800 B.C. in the Final or Terminal Late Bronze Age or early Iron Age and continuing through the historic period in the seventeenth and eighteenth centuries. Differentiation between occupation phases was aided by thick layers of abandonment sedimentation and debris fill.

Occupation Phase 1

Occupation Phase 1 (810 – 420 cal B.C.) is the earliest occupation at the site and it starts at the Terminal Late Bronze Age. The base of this level is a hard packed clay layer at about 3 meters below the surface. There was a carbon rich layer with material culture directly above this horizon; however, due to complications during excavation only one sample was taken from this layer for flotation. The site was abandoned by at least 420 B.C., and a thick layer of sterile alluvial fill covered the Phase 1 occupation. There is no map for this phase because such a small area was exposed.

Occupation Phase 2

Occupation Phase 2 (A.D. 440 – 650) represents a return to the site after 700 years of disuse. This period of occupation covers the tail end of what most historians refer to as the Wusun period and the early Turkic period. Construction during this period at Mukri is represented by rectangular stone walled structures. The Phase 2 house is about 8-10 m long. Ceramic material from this phase is mostly similar to other ceramics within Semirech'ye, especially from the Charyn area. However, fragments of a spouted vessel are similar to materials found in central Kazakhstan, and a single painted fragment may be from Xinjiang (Frachetti et al. 2010a).

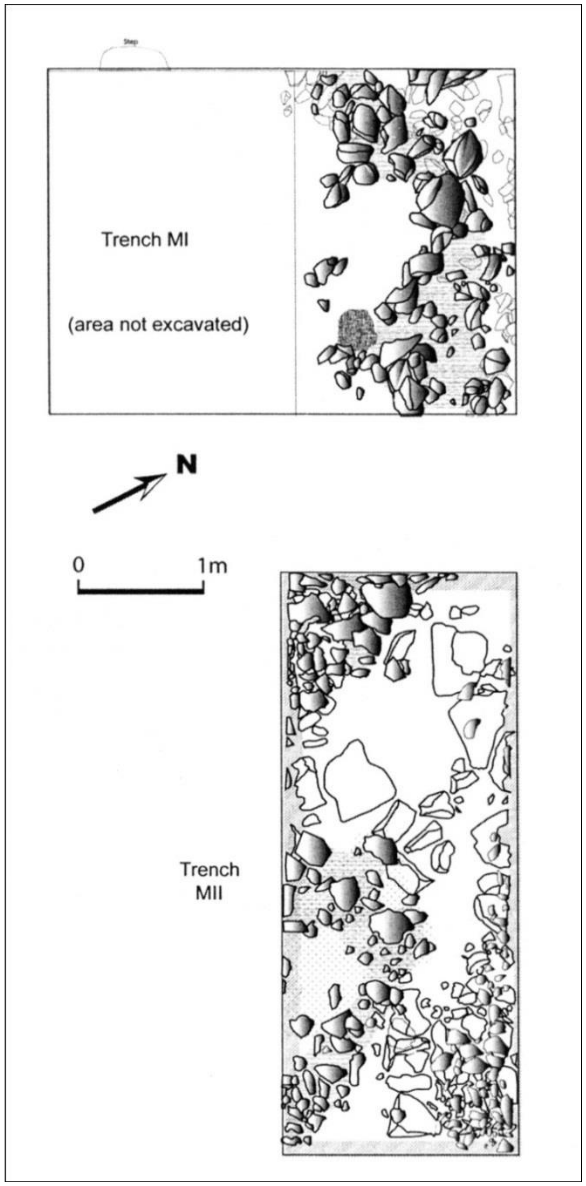

Figure 3.7. Mukri phase 2

Occupation Phase 3a and 3b

Phase 3a (A.D. 890 – 1020) is composed of a mix of fill and new material culture sealing off Phase 2, and Phase 3b (A.D. 1040 – 1260) is represented by an oval architectural structure. The structure is less than 3 m across. The switch from a rectangular walled structure to an oval foundation may symbolize a switch to the use of yurts, still used in the region today.

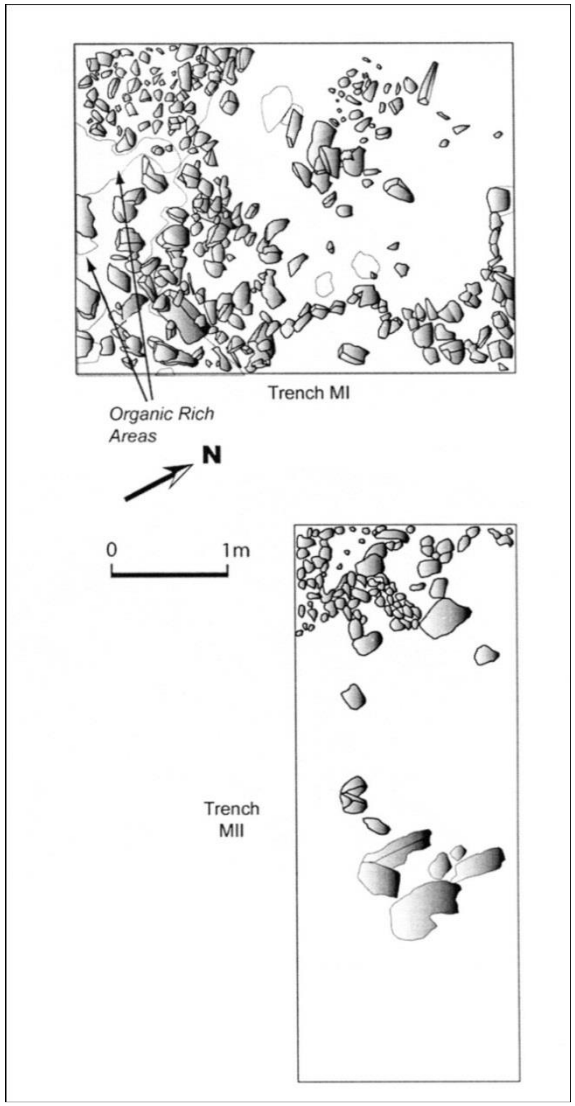

Figure 3.8. Mukri phase 3b

Occupation Phase 4

Phase 4 (A.D. 1650 – 1900) represents another shift in architectural building style. The Phase 4 structure is composed of painted plastered mud brick walls on a base of earthen mortar. The house is approximately 80 m² with two rooms.

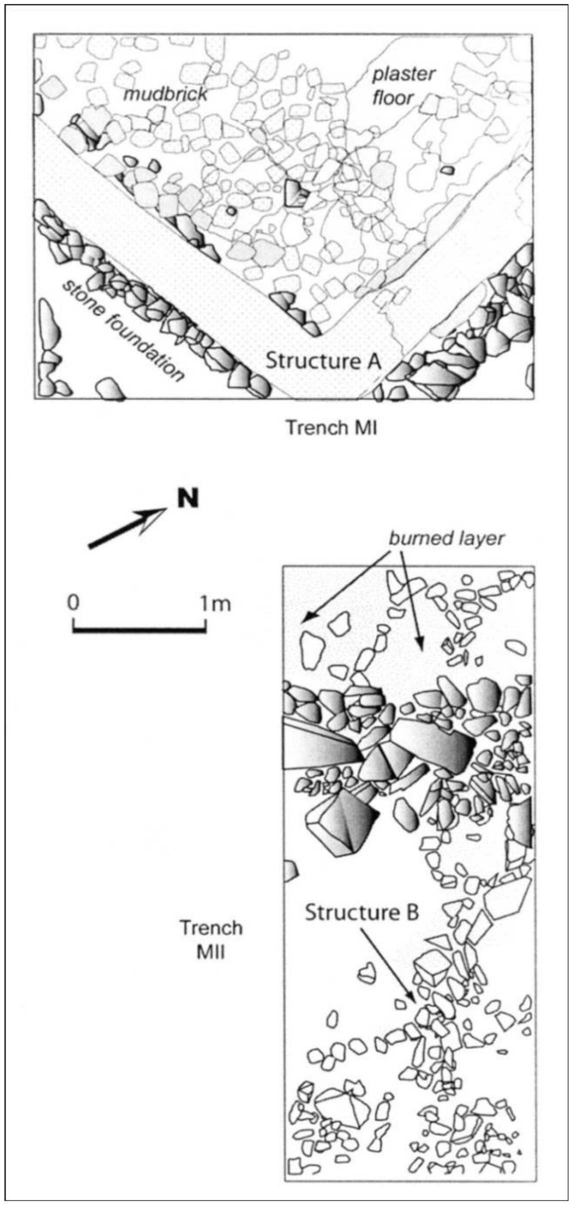

Figure 3.9. Mukri Phase 4

Table 3.6. Flotation sample and phase from Mukri, 2006 field season

FS#	Type of Sample	Unit	Context	Coordinates	Phase	Date
1	Soil	M-I	25	C 206	1	810-420 cal B.C.

3.1.7 Tasbas

The ancient settlement of Tasbas was first excavated in 2001 by Alexei Mar'yashev (2002) and returned to in 2011. The 2011 excavation was conducted as part of the Dzunghar Mountains Archaeological Project, under the directorship of Michael Frachetti and Alexei Mar'yashev. Excavations at Tasbas were led by Paula Doumani as part of her Ph.D. research. The 2011 excavations consisted of a 5x7 m unit, opened directly adjacent to the 2001 excavation. However, due to time restraints the lower stratigraphic layers were only excavated in a trench of 1.5x7 m directly abutting the edge of the 2001 trench. The excavation in 2011 had two primary goals: 1) to better understand the Bronze Age house identified in 2001 and its archaeological context; and 2) to determine if the site contained additional habitation phases.

Tasbas is located in the Byan-Zherek valley, (45.13427 N, 079.36794 E) at an elevation of 1492 masl. It is a multi-phase occupation site, similar to all three other sites discussed above, that is in line with the broad typology of pastoralist campsites found in Semirech'ye. The stratigraphy illustrates periods of occupation and abandonment. This discussion deals with the Late Bronze Age phase at the site, which is characterized by a single house feature and a well preserved domestic oven.

3.1.8 Occupation Phases

Phase 1

Occupation at Tasbas was divided into four phases. The oldest phase at the site is Phase 1. Below the thick layer of abandonment (ctx 128) there is a final occupation layer at the site. Phase 1 occupation starts at about 170 cm below the surface. Phase 1 occupation at the site is only identified by a burial cist. This cist is lined with thin flag-stones similar to the Middle Bronze Age burial at Begash (Frachetti et al. 2010b). The inside of the cist is composed of a thin layer of fine grey ash and another thin layer of finer white hard-packed ash. The excavators believe these layers represent a secondary human cremation internment. The subsoil below the cist was burned, possibly indicating that the remains were cremated inside the cist. If this is the case this would have been a secondary burial. The heat needed to turn a human body to ash would have, at the very least, left cracks in the flag stones and much more pronounced burning marks in the soil. The only other artifacts associated with this layer are small carbonized bone fragments and 3 chipped microliths found just outside the cist. The cist ends at 189 cm below the surface in sterile soil.

Phase 2a

Due to time restraints the excavation unit was reduced to a trench of 1.5x7 m below Phase 2b. Phase 2a represents Late Bronze Age occupation at the site. Radiocarbon dates from grains obtained in this layer place it between 1441 – 1262 B.C. (calibrated 95 percent at 2 sigma). The layer starts at approximately 120 to 125 cm below the surface. This layer is characterized by Bronze Age ceramics, worked grinding stone fragments, disarticulated stone architecture, post holes, occupation floors, a hearth, and a domestic mud brick oven. Several large stones mark the perimeter of an ephemeral architectural structure, possibly having been tent supports. An occupation floor is visible inside this stone wall; the floor is defined by a layer of sherds spread across the surface.

At about 160 cm from the surface another poorly defined ring of stones may have marked a tent or seasonal camp structure. This layer may have been associated with several post holes also at about the same depth. Several ashy deposits were sampled for flotation and carbon dating from this layer (e.g., ctx 106). Ctx 110 (162 – 152 cm of depth) and ctx 109 (111 – 137 cm) both seems to be small hearth features. Several smaller features are dispersed around the site representing ash deposits and soil color changes. Possibly the most well defined feature of the site is a clay cooking oven associated with Phase 2a. This mud-brick oven is roughly rectangular in shape and varies in color depending on how close to the fire the clay was. The oven seems to have an inner chamber and a bowl shaped depression on top; although it is not clear if this has sunken in or was intended to be bowl shaped. Artifacts associated with the oven include carbonized wood and bone as well as ceramic sherds and small round stones. The oven was given several discreet context numbers depending on where the soil was removed from (e.g., ctxs 117, 116, 115). The area directly below the oven consisted of a rich charred deposit, ctx 123, at about 166 cm below the surface. Below ctx 123 was a thick layer (roughly 15 – 20 cm) of dark yellow gravelly soil, ctx 128; this layer had no cultural material and seems to represent a long period of abandonment at the site.

Phase 2b

Directly above the layers of Phase 2a are those of 2b. Phase 2b and 3 layers are divided by the hard-packed terminal layer of context 10. Phase 2b contains multiple thin organic-rich cultural lenses that are interspersed throughout thick fill layers. The fill layers are yellow-brown color and contain ephemeral lenses of carbonized material and darker soils, some of which may be rodent activity. At about 80 cm below the surface the layer terminates with the beginning of Phase 2a – a clear distinction. The ceramic material from this layer is distinctively Late to Final Bronze Age and much of it is decorated.

Phase 3

The Phase 3 layer sits at about 30 – 50 cm below the surface (measured in the north portion of the unit). Much of this layer is made up of yell-brown sandy fill (ctx 10). It is a mix of cultural material (much of which appears to be Final Bronze Age), including disarticulated stone architecture, ashy lenses, and ephemeral soil color changes. This mixture of material seems to suggest periods of abandonments and reworking of the site with no permanent architecture.

The transition from Phase 4 to 3 is interesting because it is rather well defined, Phase 4 being rich in humus. This change in the stratigraphic column seems to represent about 3,000 years of missing stratigraphy. It is possible that erosion on the slope naturally cut off the upper layers; however, it is more likely that human reworking of the surface and leveling of the slope of the hill removed as much as a meter of sediment buildup.

This is further supported by the fact that the feature making up ctx 9 seems to be cut into lower levels

The context 9 midden deposit associated with Phase 4 cuts deeply into Phase 3 and in the south portion of the site continues to a depth of roughly 80 cm. It is possible that this feature represents a filled-in pen or temporary house feature for the twentieth century. As a result of this apparent reworking of Phase 3 layers and likely due to rodent activity there is a mixture of cultural material some of which seems to come from Phase 4 and some from deep in the stratigraphy. This cultural layer extends to about 60 cm below the surface and at the lowest layer is a partially *in situ* ring of stones which would have been about two meters in diameter if compete, likely marking the foundation of a temporary structure. Phase 2b starts directly below this feature.

Phase 4

The most recent phase, phase 4, was excavated directly below the fill of the 2001 excavations. This phase is characterized by a rich, humus filled stratigraphic layer. The soil is dark and expresses a texture similar to a decomposing herd animal pen. The layer is permeated by roots and rodent burrows and feces. This layer is approximately 20 cm in width, starting at the surface. Most of the artifacts recovered from this layer are twentieth century in origin, i.e., iron nails, iron cooking pot fragments, glazed pottery, animal bones, glass, and leather. A stone formation at the base of the level outlines a possible domestic structure. Multiple pits, fills, ash deposits, fire pits, and mottled soil were characteristic of this level. At about 30 cm of depth in the southern side of the unit there appears to be a large midden deposit (ctx 9). Phase 3 starts below this midden in the southern end of the site and below ctxs 4 and 5 across the rest of the site.

3.1.9 Flotation Samples

A total of 28 flotation samples were collected from Tasbas during the field season of 2011. Of these, nine were from Phase 4, and therefore, not included in this study. The nine samples from Phase 4 were not sorted; however, they are floated and were brought to the paleoethnobotany laboratory at Washington University in Saint Louis with the rest of the samples. All of these nine samples were extremely rich in humus. All of the humus floats, and therefore, these samples would require large time investments to sort. It is interesting to note that no domestic grains were visible during flotation and packaging of these nine samples whereas in all of the samples from Phase 2 grains were visible on the surface during flotation.

Of the 19 samples that represent Bronze Age layers from Tasbas, three are from Phase 2b (FS10, 11, and 12). All three of these samples are from fill contexts. Flotation samples 13 through 24 are all from Phase 2a (n = 12). Those samples include a small hearth (FS13), several ashy deposits and fill samples, and five samples associated with the domestic oven (FS16, 17, 21, 22, and 23). Flotation sample 24 is from the abandonment period at the end of Phase 2a and before Phase 1. The final four samples come from Phase 1 and are from inside the cremation cist.

Sample	Ctx #	Sample Type	Date Range	Culture Phase	Vol. (Liters)
FS 10	101	Fill	ca. 1000 cal B.C.	2b	7.2
FS 11	101	Ashy Deposit	ca. 1000 cal B.C.	2b	6.1
FS 12	101	Fill	ca. 1000 cal B.C.	2b	6.5
FS 13	105	Hearth	1400 - 1200 cal B.C.	2a	4.3
FS 14	106	Ashy Fill	1400 - 1200 cal B.C.	2a	6.6
FS 15	108	Ashy Deposit	1400 - 1200 cal B.C.	2a	6.0
FS 16	109	Around the Oven	1400 - 1200 cal B.C.	2a	4.9
FS 17	109	Around the Oven	1400 - 1200 cal B.C.	2a	7.5
FS 18	107	Possible Floor	1400 - 1200 cal B.C.	2a	4.0
FS 19	110	Ashy Deposit	1400 - 1200 cal B.C.	2a	6.8
FS 20	121		1400 - 1200 cal B.C.	2a	7.0
FS 21	109	Clay of the Oven	1400 - 1200 cal B.C.	2a	
FS 22	109B	Inside Oven	1400 - 1200 cal B.C.	2a	4.7
FS 23	123	Ashy area Below Oven	1400 - 1200 cal B.C.	2a	
FS 24	129	Fill	1400 - 1200 cal B.C.	2a	7.4
FS 25	130	Ash, Top of Burial Cist	1800 - 1600 cal B.C.	1	6.2
FS 26	132	Inside Burial Cist	1800 - 1600 cal B.C.	1	7.2
FS 27	126		1800 - 1600 cal B.C.	1	6.4
FS 28	134		1800 - 1600 cal B.C.	1	8.0
Totals					106.8

Table 3.7. Floatation samples and contexts from Tasbas

3.2 Talgar Archaeological Project

3.2.1 Tuzusai

The Tuzusai site is located on the Talgar alluvial fan, in southeastern Kazakhstan, about 15 km east of Almaty, the former capital of Kazakhstan. The site sits 6 km north of the Tien Shan foothill zone at 723 masl (N43º21’50”, E77º06’52”). Tuzusai is located on a rich alluvial fan, which today fosters irrigated agriculture. However, many crops would not be productive in this region without irrigation due to irregularity of rainfall (Utesheva 1959). Excavations at Tuzusai, Taldy Bulak 2, and Tseganka 8, on the Talgar alluvial fan

(Figure 1.2, 3.2, 3.10), were conducted by Chang et al. (2002) as part of the Kazakh-American Talgar Archaeological Project (Chang et al. 2003; Rosen et al. 2000). These settlements were occupied during the Iron Age by people in the Saka (800 – 200 B.C.) and Wusun Culture groups (200 B.C. – A.D. 500). The faunal assemblage is dominated by sheep and goat, which is characteristic of other regional pastoralist assemblages known in the region (Frachetti and Benecke 2009). However, sheep and goats can articulate well with cereal cultivation (Koster 1977). Cattle are also a large component in the assemblage. In addition, horse, ass, camel, and dog were present, indicating a multifaceted pastoral package. Furthermore, a small hunting component seems to have been present in the economy, notably roe and red deer, wild pig, and fox (Chang et al. 2003).

However, despite the obvious importance of pastoralism in the economy, the Talgar sites seem to show a more sedentary form of land use than is present at other nearby sites in the Iron Age (Chang et al. 2002). Phytolith and a preliminary macrobotanical study conducted at Tuzusai, Taldy Bulak 2, and Tseganka 8 suggested a complex agricultural component (Miller 1996 unpublished; Rosen et al. 2000). Chang et al. (2002) describe occupation at Tuzusai as sedentary. Based on ethnographic analogy, they suggest the site was occupied from early spring to late fall, with the majority of time and energy going into agricultural pursuits. A portion of the population might have remained at the site year-round to maintain crops, while another kin-based group moved herds into the Tien Shan foothills (about 20 km from the site) for summer pasturing. Benecke's analysis of herd animal bones at Tuzusai (unpublished report, 2003 [discussed in Chang et al. 2003]) argues for year round occupation, specifically based on herd composition and structure. Kin based groups might have temporarily detached themselves from the year round settlement for summer alpine herding, but it appears that some animals were maintained on the fan proper.

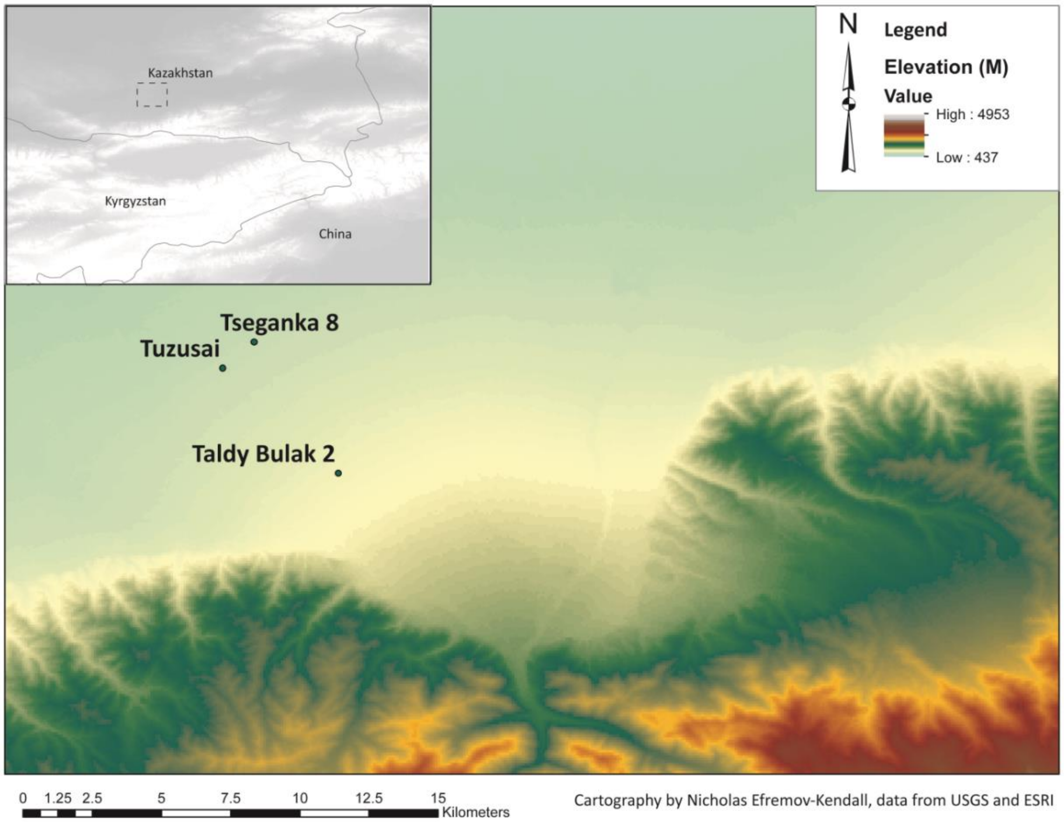

Figure 3.10. Map of the Talgar alluvial fan and key Iron Age sites

Tuzusai is a unique example of a sedentary village in northern Central Asia dating to the Iron Age. Late Bronze and Iron Age villages have been studied further south in Central Asia along the mountain/steppe interface zone. The most northerly of these villages are Sarazm in Kyrgyzstan (Willcox unpublished) and Shortughai in Afghanistan (Willcox 1991). Extensive mud brick architecture and deep cultural layers strengthen the inference that Tuzusai was a sedentary village. Survey work on the alluvial fan also indicates high population densities in the Iron Age (Chang et al. 2002). People in this Iron Age village focused considerable labor and time on agriculture; however, pastoralism was also a major part of the economy.

Tuzusai dates from approximately 400 B.C. to the present with its main occupation between 400 B.C. and A.D. 100 (Saka and Wusun). The features of the site discussed in this paper all date between ca. 410 cal B.C. and 150 cal B.C. The site is located on the west side of an old stream bed about 0.5 km north of the town of Alatau. The site covers an area of 5 – 13 hectares; however, only a small portion of the site has been excavated. In 1992 and 1993 two large blocks were excavated by a Kazakh team; in 1994 – 1996 the Kazakh-American Talgar Project excavated 108 m^2 (Chang et al. 2002). The 2008 – 2010 excavations (a 10 x 5 m area) uncovered eight pit houses and a series of fire pits. There are at least six different cultural levels. The upper two cultural levels are historic or mixed historic and Iron Age. The lower cultural levels are all Iron Age. The site has been excavated to 1.3 m below the surface. The topography of the Talgar alluvial fan and the location of key sites are displayed in Figure 3.10 (Appendix A, Figure 10).

The most notable feature of the site is the immense quantity of mud brick architecture. Numerous overlapping storage pits and larger semi-subterranean pit houses also characterize the site. The area of the site discussed in this paper deals with nearly a meter of sediment accumulation, and AMS dates show it to represent only ca. 200 years of occupation. This rapid sedimentation is due to successive mud brick rebuilding events and year round deposition of cultural fill. This level of rapid cultural sedimentation is similar to Tell sites further south in Central Asia (Rosen 1986). Tuzusai is similar to two other sites excavated on the Talgar fan, Taldy Bulak 2 and Tseganka 8 (Chang et al.

2002). Survey work also suggests that there may have been scatterings of small village or hamlet settlements across the alluvial fan during the Iron Age. These sites are all in stark contrast to other sites in Kazakhstan for this time period, and do not fit into the old model of increased mobility starting in the Iron Age.

In 1996, a macrobotanical analysis conducted by Miller (1996 unpublished) at the University of Pennsylvania Museum-MASCA identified wheat, barley, millets, grapes, and hawthorn. A more comprehensive series of studies was conducted on phytoliths in samples excavated from Tuzusai and Tseganka 8 during the field seasons of 2002 and 2003 (Rosen et al. 2000). Tseganka 8 has layers contemporary with Tuzusai and is only a few kilometers away. These studies found barley, foxtail millet, and possible rice.

3.2.2 Occupation (410 – 150 cal B.C.)

A detailed chronological sequence was pieced together by Chang et al. (2003) for Tuzusai and Tseganka 8. These two sites show continual occupation during the Iron Age periods and successive abandonment periods after the Iron Age. Chang et al. (2003) worked out the chronology for the alluvial fan based on 15 AMS dates from these two sites, nine of which are from Tuzusai. In this chapter I present another 10 AMS dates (Table 3.8). These dates show that the primary Iron Age occupation at the site was relatively short-lived, from 410 – 150 B.C.

A historic occupation on the site in the 1800s or early 1900s is noted by two intrusive fire pits and well dated by a Czar Nicholas II 20 kopek piece (toward the end of the Russian Imperial period). Mongolian period occupation (eleventh to the fourteenth centuries) is marked by a series of burials (Chang et al. 2003; Chang et al. 2002). The burial shafts were dug into Iron Age layers, but are discrete well-defined events in the soil profile. Two dates obtained from material excavated in 1996 fall within what Chang et al. (2003) refer to as stratum 5 or 6 in the stratigraphic sequence. These dates range from around 150 to 10 B.C. They come from the west end of the site in old excavation units. It appears that this phase of occupation is not represented in the excavation units from 2008 – 2010. The rest of the dates from 2002 and all the new dates presented in this article tightly cluster around 410 – 150 B.C., with the possible exception of one older date ranging between 522 – 383 B.C. at two sigma (a direct dated wheat grain). However, the tail end of this date puts it well within the Phase IV/V occupation. This dated grain came from the base of a deep pit house, 7, which is found in the bulk wall.

Laboratory No.	Age B.P. (Uncalibrated)	1 Sigma-68.2% Calibrated Dates B.C./A.D.	2 Sigma-95.4%	Laboratory	Phases from Chang et al. 2003	Culture Phase
OS-86955*	2360±30	487-403B.C.	522-383B.C.	Woods Hole		
B-098385	2320±40	416-264B.C.	516-206B.C.	Groningen		
B-86750	2310±50	413-309B.C.	514-212B.C.	Oxford		
OS-86846	2260±30	380-248B.C.	396-208B.C.	Woods Hole		
OS-87025	2250±25	375-247B.C.	391-209B.C.	Woods Hole		Saka
OS-86845	2240±25	242-368B.C.	389-207B.C.	Woods Hole		(800-
B-098383	2230±30	361-237B.C.	387-204B.C.	Beta Analytic		200B.C.)
OS-86848	2210±35	350-226B.C.	383-196B.C.	Woods Hole		
B-98381	2170±60	336-138B.C.	382-56B.C.	Beta Analytic		Wusun
OS-87023	2200±30	345-221B.C.	376-186B.C.	Woods Hole		(200B.C.-
OS-86847	2200±25	345-223B.C.	368-197B.C.	Woods Hole	Phase V/IV	A.D. 500)
B-098384	2170±30	338-192B.C.	362-116B.C.	Beta Analytic	Phase VI	
OS-86844	2160±25	335-183B.C.	357-112B.C.	Woods Hole	Phase VII	Mongol †
B-86749	2070±40	153-45B.C.	196B.C.-A.D.18	Oxford		
B-86747	2020±40	84-18B.C.	161B.C.-A.D.68	Oxford		
B-142480	650±50	1291-1377A.D.	1275-1404A.D.	Beta Analytic		Historic
OS-86979	120±30	1711-1907A.D.	1679-1940A.D.	Woods Hole		Kazakh
OS-87022	110±25	1711-1903A.D.	1682-1935A.D.	Woods Hole		(1500A.D.-
B-98380	140±70	1697-1917A.D.	1662-1952A.D.	Beta Analytic	Phase VIII	Present)

Table 3.8. AMS dates and phases from Tuzusai
*OS-dates are new to this publication, † (1210 – 1500 A.D.)

All material discussed in this article comes from occupation Phases IV/V and dates between 410 – 150 B.C. Occupation at this time period is characterized by semi-subterranean mudbrick houses with plastered floors. Flotation samples came from hearth features, floors, and pits.

Pit House 4

This pit house is the largest of the pit houses excavated at the site. It is outlined by built up mud brick walls and associated with an inner ring of post holes that run the inside of the house walls. A protruding mound of mud brick in the center of the house is surrounded by post holes (n=15) as well; this is likely a central support for the roof. The house is also characterized by 4 plastered occupation floor layers, plastering over previous occupations. It is hard to tell exactly where the upper most floor was, likely around 270 cm. However, occupation floor 2 is between 280 – 284 cm below datum; then there was between 20 and 30 cm of fill and floor 3 sits between 303 – 310 cm. Floor 4 is below 315 cm. The upper most layers of this pit house were dated between (357 – 112 cal B.C.) and lower (389 – 207 cal B.C.). Therefore it is clear that the house occupation was relatively short, with a possible range of a little over one human generation.

One hammer stone and two grinding stones were found in association with floors 2 and 3. One grinding stone was pink granite and 24x15x8 cm. The other was 8x7x8 cm. Other artifacts include ceramic and bone.

Feature 10

This feature is an ashy deposit, likely the remnants of a hearth inside pit house 4. It may be associated with Features 6 and 9, which are also hearth features. Hearth Feature 6 lies below hearth Feature 9 with several centimeters of fill between, likely collapsed and crumbled mud brick. Feature 10 lies above Feature 9. The three features do not directly overlap. It is likely that the fill between these three hearth features is from the process of reconstructing a new in-door hearth on top of an old one, digging into the mud brick wall to do so. Hearth Feature 10 is significantly smaller that Feature 6, and is only about a third of a meter in diameter, about the same size as Feature 9. All three features are tucked into the northeast corner of pit house 4.

The reconstruction of this layered hearth is not surprising seeing that the entire pit house itself was reworked several times, laying down new plastered floors between each reworking. Hearth Feature 10 is associated with floor 2 and possibly the latest occupation floor of pit house 4. Floor 2 seems to continue under Feature 10 making a clear break between this hearth layer and earlier ones. Floor 2 is roughly located at 280 – 284 cm below datum. Below floor 2 is about 20 – 30 cm of loose fill above the next plaster layer.

Feature 10 appears to be associated with the upper occupation floors of the house; an AMS date was obtained on these upper floors of 357 – 112 cal B.C.

The manner in which the hearth is carved into the house pit wall makes it look like a wall has been built up around the hearth. This surrounding wall is between 240 and 260 cm below datum.

Feature 9

This feature is an ashy deposit and likely the remnants of a hearth inside pit house 4. This feature appears to be associated with Feature 6 and Feature 10 which are also both hearth features. Hearth Feature 6 lies below hearth Feature 9 with several centimeters of fill between, likely collapsed mud brick. Feature 10 lies above Feature 9, with a plaster layer and 20 – 30 cm of fill between. Feature 9 appears to be dug into the east wall of the house pit. Hearth Feature 9 is significantly smaller that Feature 6, and is only about a third of a meter in diameter. It is tucked into the northeast corner of pit house 4.

This hearth feature is likely associated with occupation floor 3 of pit house 4. AMS dates were obtained on the upper (357 – 112 cal B.C.) and lower (389 – 207 cal B.C.) occupation floors of the pit house, likely placing this hearth feature between 357 – 207 cal. B.C. This feature is roughly 110 cm (north and south), 45 cm (east and west), and 10 – 20 cm deep.

Feature 6

Hearth Feature 6 is the oldest and largest of the three layers of hearth features in the northeast corner of pit house 4. Feature 6 was dug down through the lowest floor layer and into the north and east walls. It is about 1.8 m (east and west) and 2.5 m (north and south). It starts at about 300 cm below datum and continues below the fourth and last occupation floor. The feature is thick with burnt ash and has a very dark color.

This hearth would likely have been associated with the oldest occupation floors of the pit house. The earliest occupation layers of the house are dated to 389 – 207 cal B.C.

However, there is also a date on material from this feature, 383 – 196 cal B.C. These dates match closely.

Pit House 5

Pit house 5 shares its north wall with pit house 4. It is significantly smaller than pit house 4. Floor 1 of pit house 5 is higher than the upper floor of much of the rest of the Iron Age features (232 – 246 cm below datum – with a better defined floor at 270 - 280). This upper floor is plastered but not as heavily or well defined as the floors of pit house 4. There are significant amounts of cultural material associated with the upper floor. There was a layer of mud brick below the upper floor with artifacts and an unplastered occupation floor below that.

Feature 12 is a hearth associated with the upper occupation layers of this pit house and it is fixed into the south wall.

Two AMS dates were taken on material from this pit house one from the upper layers of the house (232 – 246 cm) and one from the lower levels (below 280 cm). These came back as 368 – 197 cal B.C. and 396 – 208 cal B.C. respectively. These dates match close with the dates for pit house 4 and suggest a short term and simultaneous occupation for both pithouses.

Pit House 7 (Former Pit 35)

This pit house is only partially exposed running perpendicular to the east excavation wall, more than half the pit house has yet to be excavated. The pit house shares part of its mud brick wall with pit house 4. The exposed area is 1.75 m (east to the site wall) and 2.75 m (north to south); it is also 44 cm deep (from top of the wall) at the southeast end and 42 cm deep at the northeast end. The bottom layers (below 280 cm) of this pit house are rich in cultural material and carbonized organic material, likely a midden dump.

An AMS date was taken on material from the basal area within this pit house, obtaining a date of 522 – 383 cal B.C.

Feature 20

Feature 20 has been dated and appears to be an intrusive fire pit dug into the surface layers of the site. The feature dates between 1682 – 1935 cal A.D. This is significant because in 1994 a similar intrusive fire pit was found at the site and dated to almost the same time period (1662 – 1952 cal A.D.). Therefore there was a later occupation at the site which is likely mixed in with the upper plow layers. Furthermore, this occupation correlates with an intrusive rodent cache in Feature 9 (1679 – 1940 cal A.D.). This rodent cache, which contained uncarbonized domestic millets (broomcorn and foxtail), may have been a commensal rodent in association with the later site occupation during Kazkah or early Russian imperial occupation in the region.

The feature was carefully excavated; however, has not been analyzed. Feature 20A is the northern portion; it is 50 cm (east to west), 58cm (north to south), and 5cm deep. Feature 20B is the southern portion; it is 42 cm (east to west), 46 cm (north to south), and 4 cm deep. The entire feature lies roughly between 175 and 185 cm below datum. Therefore, these features do not pose a risk of contaminating earlier Iron Age layers at the site because soil features in the Iron Age are generally all deeper than 250 cm below datum. Most material higher in the soil column than 250 cm is turbated and very little botanical material is preserved.

Feature 23 is a pit with rich cultural material, likely a midden at the south end of pit house 5. The bottom of this feature is rich in bone and ceramic sherds as well as small fragments of bronze, some of which were recovered in the heavy fraction. An AMS date was taken from material in this pit and provided the date of 376 – 186 cal B.C. While this date has a long error tail (standard deviation) it roughly places the midden as being contemporaneous with the occupation of the pit houses.

Features 24 and 25

These two features make up what appears to be a ‘Tandori’ style bread oven. Feature 24 is a clay fired oven with a wood loading area below and a flat cooking surface above. Similar clay ovens are used across Central Asia and the Turkic world today. Feature 25 is an area of darker soil next to the oven. Both features are built on top of a high mud brick mound, which makes up the north wall of pit house 4. It is constructed on the mud brick wall, placing it much higher in the soil column, which may have contributed to its almost complete lack of carbonized material, either through poor preservation (similar to all material in the upper levels) or by means of prolonged exposure to wind and rain (washing away carbonized material). Dates on the oven-like-feature suggest it is contemporaneous with the pit houses. If indeed the feature is a tandoori bread oven, it would further attest to the importance of domestic grains in the subsistence economy.

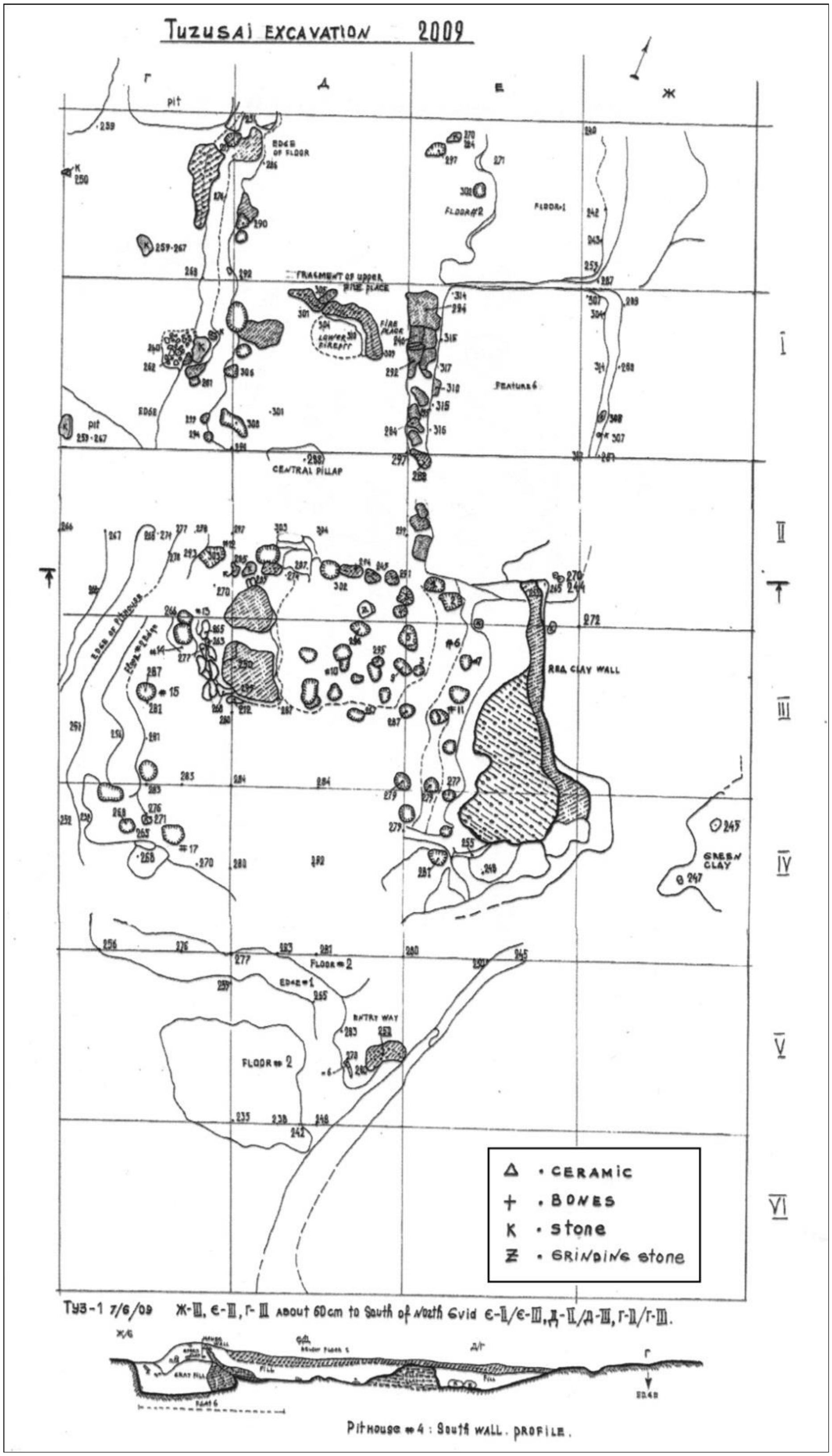

Figure 3.11. Map of the 2008 – 2009 excavations at Tuzusai *Feature 23*

3.2.3 Economy

Zooarchaeological material shows that pastoralism was a major component in the economy. However, the Talgar sites seem to show a more sedentary form of land use than is present at other nearby sites in the Iron Age (Chang et al. 2002). Phytolith analysis, and a preliminary macrobotanical study conducted at Tuzusai, Taldy Bulak 2, and Tseganka 8 suggested a complex agricultural component (Miller 1996 unpublished; Rosen et al. 2000). Chang et al. (2003) describe occupation at Tuzusai as semisedentary. Based on ethnographic analogy, they suggest the site was occupied from early spring to late fall, with the majority of time and energy going into agricultural pursuits. A portion of the population might have remained at the site throughout the summer to maintain crops, while another kin-based group moved herds into the Tien Shan foothills (about 20 km from the site) for summer pasturing.

Pastoralism was a major component of the economy at Tuzusai. Benecke examined the faunal material collected from the 1994 – 1996 field seasons (Benecke 2000 unpublished report discussed inChang et al. 2002), finding that sheep and goat (ovicaprid) were the most abundant category, followed by cattle, and then horse. There were also less prevalent findings of camel (*Camelus* sp.), dog (*Canis lupus* ssp. *familiaris*), and ass (Chang et al. 2002). Hunting may have been part of the economy but it is not well represented in the Tuzusai assemblage, with the exception of pig (*Sus* sp.) and fox (*Vulpes* sp.) remains (Chang et al. 2002).

Domestic Mammals				
Sheep/Goat	Cattle	Horse	Camel	Dog
59 %	33 %	15 %	1.3 %	0.6 %

Table 3.9. Summary of the zooarchaeological assemblage from the 1994 – 1996 excavations at Tuzusai, data from Chang et al. (2002)

1. Only domestic animals are included in this data set.

In 1996, 26 flotation samples were sent to Naomi Miller at the University of Pennsylvania Museum-MASCA for analysis. These samples varied in volume from 2.4 to 5.45 L (pre-flotation), for a total of 89.2 L of analyzed soil. The overall density of wild and domestic seeds in these samples was low. Most of the carbonized seeds were from wild herbaceous plants; and Miller (1996 unpublished) suggests that these were likely from dung burned as fuel.

This study also shows that there was an agricultural component in the economy (Miller 1996 unpublished:2). While the densities of domestic grains in these samples were low, the ubiquities were high. Miller (1996 unpublished) identified: probable "bread wheat (*Triticum aestivum* s.l., a hexaploid)"; barley (*Hordeum vulgare*) ("differentiation between six- or two-row forms was not possible"); millet ("differentiation between broomcorn and foxtail was not possible"); a few grape fragments (*Vitis vinifera*); nut shell ("probably almond [*Prunus* sp.]"); and a possible hawthorn (*Crataegus*) seed.

Another preliminary macrobotanical study was conducted at the site of Taldy Bulak 2, only a few kilometers from Tuzusai. Taldy Bulak 2 is contemporaneous with Tuzusai, and it was excavated in 2006 and 2007 by Chang and her colleagues (unpublished site report). Eight flotation samples from these two seasons were sent to the

Archaeology Research Laboratory at the University of Tennessee, Knoxville, and were analyzed by Kandace Hollenbach. These eight samples were each about 10 L in volume, for a total of about 80 L of analyzed soil (Hollenbach 2008 unpublished). These samples had very poor preservation, densities and ubiquities were low; however, Hollenbach (2008 unpublished) did identify "wheat, c.f. bread (*Triticum*, c.f. *aestivum*)" and a few fragments of unidentified nutshell.

A much more conclusive series of studies was conducted on phytoliths in samples excavated from Taldy Bulak 2 and Tseganka 8 during the field seasons of 2002 and 2003 (Rosen et al. 2000; [2003 unpublished-a; Rosen 2002 unpublished, 2003 unpublished-b]). Tseganka 8 is contemporaneous with Tuzusai and only a few kilometers away. At Tseganka 8, Rosen (2003 unpublished-b) found barley and Panicoid grass phytoliths that she calls "millet (*Setaria* sp.)". At TaldyBulak 2, Rosen (Rosen 2002 unpublished; Rosen et al. 2000) identified phytoliths of millet (*Setaria* sp.) and possible rice (*Oryza sativa*). Based on these microbotanical studies from Tseganka 8 and Taldy Bulak 2, it is evident that there was a more intensive and extensive agricultural system than had been previously discussed. Rosen et al. (2000) and Chang et al. (2003) discuss the role that agriculture may have played in this economy.

3.2.4 Flotation Samples

A total of 63 flotation samples were excavated during the years of 2008 – 2010; however, thus far, only 25 have been fully analyzed. Twenty-three samples were taken during 2010, 37 were taken in 2009, and three during 2008. All flotation samples were given a number based on the year they were taken and the chronological sequence from which they were taken during that year.

FS #	Context	Feature	Depth (cm)	Square	Total Liters	Total Seed Density
08FS1	Ashy Area		240-250	E-II	8.0	28
08FS2	Fill From Pit	Pit 6	265-280	Д-II	8.0	5.6
08FS3	Fill From Pit House	Pit House 4	280-290	Д-II	8.0	3.3
09FS1	Ashy Deposit, Hearth	Feature 10	280-290	Д-II	5.0	21.2
09FS2	Mudbrick from House Floor	Feature 9	~ 265	E-II	4.5	0.4
09FS3	Ashy Deposit, Hearth	Feature 9	260-280	E-II	5.0	3.2
09FS4	Ashy Deposit, Hearth	Feature 9	280-290	E-II	5.0	10.4
09FS5	Pit Fill	Pit House 7	290-300	Ж-II	14.0	9.5
09FS6	Ashy Area in House	Pt House 4	300-310	E-II	14.5	12.8
09FS7	Ashy Area in House	Pit House 4	300-310	E-II	12.0	23.6
09FS8	Fill Above House Floor	Pit House 5	280-285	Ж-VI	8.0	9.4
09FS9	Fill Above House Floor	Pit House 4	300-310	E-II	6.0	28.8
09FS10	Fill Above House Floor	Feature 9	300-310	E-II	16.0	33.9
09FS11	Fill Above House Floor	Pit House 4	265-270	Д-IV	11.0	11.7
09FS12	Mudbrick Near Hearth	Feature 9	290-300	Ж-II	10.0	14.1
09FS13	Fill Above House Floor	Pit House 4	280-290	Д-II	10.0	7.8
09FS14	Fill Above House Floor	Pit House 4	270-280	Г-IV	10.0	11.2
09FS15	Fill Above House Floor	Pit House 4	280-285	Д-IV	10.0	4.0
09FS25	Pit Fill	Pit House 7	320-330	Ж-III	11.0	17.6
09FS31	Fill Above House Floor	Pit House 5	~310	E-V	10.0	6.5
10FS8	Pit Fill	Pit 23	300-310	Ж-IX	6.0	3.8
10FS10	Pit Fill	Pit 23	300-310	Ж-IX	5.0	54.6
10FS11	Pit Fill	Pit 23	300-310	Ж-IX	9.0	23.8
10FS12	Inside Tandori/Hearth	Features 24,25	210-220	Ж-1	2.0	2.0
10FS15	Ashy area next to Tandori	Features 24,25	210-220	Ж-1	4.5	2.4

Table 3.10. List of flotation samples with densities and contexts

During the field season of 2008 a new excavation unit was opened up directly next to old excavation units from 1994 and 1995. The initial 2008 – 2009 excavation unit was 10x6 m. By the end of 2009, another 4x4 m unit was opened at the south end connecting the new units to the 1996 unit. Toward the end of the 2008 field season three flotation samples were taken; they were not floated until the 2009 field season. During 2009 the large excavation area opened during 2008 was brought down to sterile soil, and the majority of the samples were taken. Most of these samples are feature samples;

however, a few point samples were taken from fill layers either above or below features. Follow-up sampling was conducted during the 2010 field season. Several more samples were taken from the previous year's units as well as from new units opened up in 2010. These samples vary in volume from around 2 to 16 L of soil, for a total of 213 L of analyzed soil. Flotation samples and their contexts are displayed in Table 3.10.

Chapter 4: Geography and Environment: Orographically Determined Microenvironments and Pastoralism

4.1 Introduction

It is often argued that the topography and biota of the steppe are the causal factor for the spread of distinct artistic forms (fighting animal motifs) and technologies attributed to mobile peoples, most notably the Scythians. A model has long been propagated where the steppe functioned as a vast highway for horse riding nomads, covering territories from Ukraine to Mongolia (discussed in Anthony 2007). Furthermore, this model is dogmatized in contemporary economic studies, leading to quotes such as: “The steppe belt, an immense swath of landlocked grassland, made possible the appearance of a unique historical phenomenon: the horse-breeding, highly mobile Eurasian nomad” (Soucek 2000:1). For a clear discussion of this Inner Eurasian steppe highway model see Christian’s (1998) article titled “Silk Roads or Steppe Roads? The Silk Roads in World History”. In recent years the scale and practical realities of this vast steppe ‘highway’ has been called into question (Frachetti 2012).

In this dissertation, I favor and alternative model, whereas the steppe could also be looked at, not as a facilitator of movement, but a mosaic landscape with patches of resources, specifically water and herd-forage. Populations were brought into contact at nodal points on the landscape where resources were available. In this sense, pastoralist communities revolved in a reticulated pattern around these nodes, seasonally disbanding and congregating for festivals or winter communal encampment. In this dissertation I also build on this alternative model for mobility and the exchange of goods by applying NCT (discussed in Chapter 2). Using a NCT framework we can argue that, not only did the mosaic landscape of the steppe facilitate exchange and construct communities, it was also an indirect result of millennia of pastoral activities and practices.

Loosely defined, the steppe ecoregion – not including what is often called the forest steppe – includes an area extending from the Black Sea to eastern Mongolia and from southern Siberia to the deserts and coastal regions of Kazakhstan, Uzbekistan, and Turkmenistan. Kuz'mina (2008:10) defines the Eurasian steppe as stretching from the Danube[15] to the Great Wall of China, covering 8,500 km east and west and 400 – 600 km north and south. The Eurasian steppe roughly falls between 58° and 47° north latitude. There is a distinctive vegetation community in this ecoregion, primarily void of woody trees or shrubs and dominated by low – growing herbaceous plants (mostly grasses and *Artemisia*). The ecology of this ecoregion is determined by intercontinentality, which results in low rainfall, <500 mm per annum on average, and a high degree of seasonal variability. This climate is suited for narrow-leaf perennial grasses with deep well-established root systems, often propagating vegetatively through runners as well as sexually. The seasonality and almost completely perennial-dominated vegetation community creates a deep humus layer of dead biomass. Kuz'mina (2008:10) notes that there can be up to 700 tons/hectare of humus, further characterizing the steppe botanical community.

[15] Kuz'mina is including the forests-steppe of Ukraine and Eastern Europe in this definition.

While the Eurasian steppe is often discussed in terms of a uniform environmental zone, in reality the natural conditions of the steppe are diverse (see Kuz'mina 2008:11). The steppe in the south can be up to six times drier than that in the north; precipitation varies between north and south at about 600 mm to 150 mm per annum respectively. Therefore, there are huge phytomass reserves in the north unlike the south. In addition, the reduced perennial biomass turnover in the south leads to greater evaporation and poorer soils. The further south, the more isolated the patches of forage are, and less nutrition can be obtained from the steppe-matrix vegetation, supporting forms of oasis pastoralism as described by Hiebert (2002).

In addition to broad trends in climatic variation, there is a great deal of localized variation (Mordkovich 1982). The steppe is often subdivided into environmental zones (e.g., semiarid steppe, desert-steppe, and forest-steppe). For the sake of this discussion it is more fruitful to think of the steppe in Semirech'ye as a punctuated transition from grass- and forb-dominant areas with higher rainfall, often closer to the foothills, to *Artemisia*-dominant regions, often further from the foothills.

The famous explorer Sir Aurel Stein wrote (1925:378) "On looking at the map it may well seem as if this vast region [Central Eurasia] has been intended by nature to serve as a barrier between the lands which have given to our globe its great civilizations, than to facilitate the exchange of their cultural influences."

Often when archaeologists and historians look at Central Eurasia they focus on an environmentally and biologically diverse group of ecosystems, colloquially referred to as the 'steppe' (or steppe zone). The geographic area of the steppe is often left undefined in such literature, and furthermore, the term has different meanings between researchers. A discussion of what characterizes the steppe is necessary in any discourse relating to how this environmental zone helped shape the people (and their economies) who lived on or *near* it. I emphasize the word ‘near’ in the previous sentence because the actual archaeological distributions of settlements within Central Eurasia shows that populations through the Bronze and Iron Ages tended to focus on intermediary zones. These ecotones are situated at the edge of the steppe zone and other environmental zones, often mountains, forest steppe, or coastal regions. We can see evidence for this from the Bronze Age by looking at the large settlements of the Sintashta Culture, which cluster around the Ural Mountains (Anthony 2007), or the eastern Srubnaya located, primarily, along the forest-steppe/steppe ecotone, often in river valleys, such as the Samara or Don (Anthony et al. 2005). While the aggregate of cultures that researchers refer to as the Andronovo Cultural Complex cannot be pinned down to one region, there are concentrations of occupations in the foothills of the Dzhungar Mountains (Frachetti 2008) as well as along the Caspian and Aral Seas (Kuz'mina 2008). In stating that population focused on ecotones during the Bronze and Iron Ages, I am not implying that the steppe itself was fully depopulated at any point; instead, I suggest that our best understanding of Central Eurasian economy will come from these biologically diverse microenvironmental zones formed at the interface regions of major ecozones. This dissertation is concerned with understanding how humans interacted with these diverse landscapes, shaping their environment and constructing a niche for themselves. The importance of microenvironmental zones will be discussed in more detail from an ethnohistoric and archaeological point of view later in this dissertation.

> "I characterize the Eurasian steppe not as a vast highway of grass but as a mosaic of regionally differentiable eco-social spheres or landscapes. I present the geography of Eurasia as a jigsaw puzzle of discrete regional environmental contexts differentiated by major and minor rivers, mountain ranges, and diverse climatic and ecological micro-niches. I also characterize the cultural geography of the Eurasian steppe as complex and varied, with societies of different scales interacting to generate a dynamic rise and fall of political and economic arenas through time." [Frachetti 2008:7]

Much of the environmental reconstruction for Begash, Mukri, and the sites on the Talgar alluvial fan has been based on the use of modern vegetation studies as an analogy. To a limited extent, these analogies have been tested with paleobotanical studies at Begash (Aubekerov et al. 2003; Frachetti 2004b) and at the Talgar sites (Chang et al. 2002). In 1995, a local team of environmental scientists and researchers prepared an inventory and vegetation profile map of the Talgar area (ENVIRS 1995 unpublished report discussed in Chang et al. 2002). They divided the Talgar alluvial fan into five environmental zones: desert steppe; semiarid bunch grass steppe; herb-bunch grass steppe; deciduous forest with shrub brush; and coniferous forest. Goloskokov (1984) divides the Dzhungar Mountains into six environmental zones: alpine zone; subalpine zone; mountain forest; steppe; riparian zone; and semi-desert steppe. All of these environmental zones are orographically determined, with desert steppe primarily contained outside the geographic boundaries of the alluvial fan.

Studying these environmental zones is vital for understanding the seasonal mobility patterns and economy of Bronze and Iron Age populations living at Begash, Mukri, and in the Talgar area. The utilization of diverse resources, spread across the sociogeographic landscape, would have required a complex traditional ecological knowledge system. Botanical resource availability was not only spatially but also temporally dispersed. Therefore, the use of pasture land, water resources, and foraged or hunted food would have required an intricate knowledge of vegetation lifecycles, environmental processes, geography, and orographic mechanisms.

In this chapter, I start off by discussing the geographic, climatic, and floral diversity of the steppe zone and the Tien Shan and Dzhungar Mountains. Then, I discuss the vegetation composition of the interface region, the mountain/steppe ecotone, and the microenvironmental pockets that are formed in this area. While this discussion is localized to the Semirech'ye region of Kazakhstan, the framework for landscape resource use has a more widespread application for Central Eurasian pastoral economic studies. Human and herd animal ecologies are dependent upon these ecotones; economy is directly tied into the vertical zonality and seasonal variability.

The discussion presented in this chapter is primarily based on the modern environment. I argue that the modern vegetation provides a suitable analogy for the environment of the first and second millennia B.C. While many researchers have argued for climatic shifts in Eurasia for this time period (discussed later in this chapter), there is no reason to believe that the changes were great enough to dramatically alter these vegetation communities. In mountain regions, climatic shifts move vertical zones higher or lower in elevation, but only cause dramatic changes when a vegetation zone is pushed off the mountains. While I present the modern environment as an analogy for the paleoenvironment, I am not suggesting a direct analogy; several studies have identified past environmental changes in Semirech'ye (Khotinskiy 1984; Kremenetski 1997; Rosen et al. 2000).

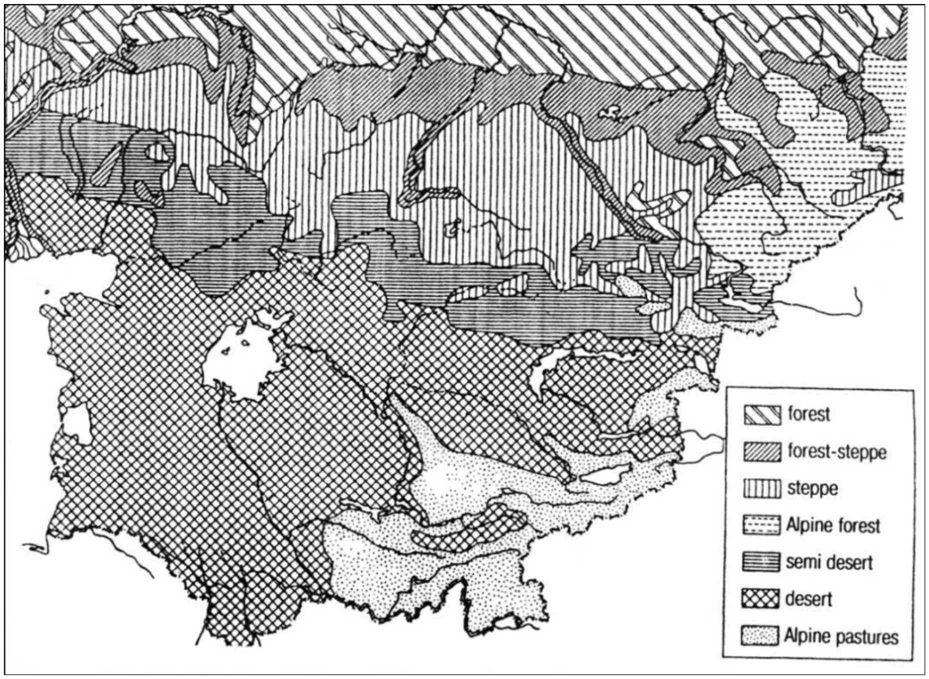

Figure 4.1. Map from Kuz'mina (2008:132), showing locations of categorized environmental zones

The study of ecology in this part of the world is bound in a political framework. Soviet scientists across the sciences were known for constructing elaborate systems of categorization (e.g., Khazanov's [1984] forms of nomads, the archaeological focus on Culture History, classifying stages of social evolution into a Maxists system, and botanical and faunal taxonomy). Soviet ecologists categorized several environmental or microenvironmental zones across Semirech'ye; some examples of taxonomies of environment in Kazakhstan are presented in, Goloskokov (1984), Sokolov (1968) (see Figure 4.2), and Utesheva (1959). This classification system has continued to influence ecological discussions in this region (e.g., Chang et al. 2002; Frachetti 2004b; Kuz'mina 2007 [also see Figure 4.1]; Lavrenko and Karamysheva 1993). Five frequently used categories include: Forest Steppe; Steppe; Semi-arid Steppe; Arid-Desert Steppe; and Mountain Steppe (Frachetti 2004b). There is utilitarian value in categorizing and subcategorizing these zones, especially when maps such as the one presented in Figure 4.1 are produced, providing a good summary of a large geographic area. However, it serves a greater value here to focus on the vegetation composition on an experiential scale. This discussion is intended to be a more detailed look at Semirech'ye. Therefore, broad generalized vegetation maps are not suitable here, nor do they illustrate the small microenvironmental pockets, which are the focus of this discussion. These ecological studies are macroscale; humans do not experience their landscapes on a macroscale.

Semirech'ye borders the political boundaries of Kazakhstan on the south and east and Lake Balkhash on the north and west. Semirech'ye, or *Zhetisu* in Kazakh, means seven rivers, and the region contains seven major river ways, all of which flow from either the Dzhungar or the Tien Shan Mountains to Lake Balkhash. The rivers are fed by mountain rains and glacial melt, and include the Ili, Byan, Irtysh, Ishim, Kapal, Karatal, and the Koksu. This region expresses a high degree of environmental variability as a result of orographic variables. Traveling either east or west, one can pass through mountain meadows, deserts, grasslands, pine forests, and riparian valleys in a path of less than 100 km.

Semirech'ye has a characteristic intercontinental climate. Seasonal variability is extreme with summer highs up to 45°C and winter lows down to -25°C. Furthermore, temperature fluctuations can be drastic, even on a daily basis. Winter storms can appear unexpectedly, and summer rains are unpredictable. All of these variables considered as a whole, Semirech'ye would be an extremely unsuitable place for any productive economy, especially agriculture. However, a closer look shows the high degree of variability across the landscape, providing suitable pockets for agricultural pursuits and herd animal forage.

Detailed Legend **(Translated from Sokolov 1968)**

Main Steppe Zone and Sub-Categories:

I: Forest-steppe zone
II: Steppe zone
1. subzone moderate moisture (rich mixed motley-feather grasses)
2. subzone moderate aridity (poor mixed motley-feather grasses)
3. subzone arid (artemesia-scrub steppe)

III: Desert Steppe zone
IV: Desert Zone
1. Northern scrub-desert
2. Southern typical-desert

Vertical (Mountain) zones and meadows

V: Altai, Saura, and Tarbagataya region
1. high peak fields
2. high peak tundra-meadows
   a. alpine and subalpine low-grass meadow
   b. Stoney and mossey turf tundra
3. mountain forest
   a. fir and park cedar and larch forest
   b. larch forest
4. mountain and foothill forest steppe
   a. aspen, birch, and mixed fir forest
   b. mixed larch, local pine forest, forest grass, grassy steppe and petrophilic steppe
   c. second growth grass steppe
5. mountain and foothill steppe
   a. feathergrass and motley grass steppe
   b. shrub and grass steppe
   c. feathergrass and fescue dry steppe
6. foothill desert-steppe
   a. artemesia-feathergrass-fescue desert steppe

VI: Northern Tian-Shan (including southern foothills and valleys of Tarbagataya)
1. high-peak fields
2. high-peak meadow-steppe
   a. alpine wasteland
   b. sub-alpine meadow and meadow-steppe w/ steep slope
3. mountain forest-meadow steppe
   a. fir forest, forest meadow, and meadow steppe
   b. pine and birch forest
   c. apple forest, shrub meadows, and meadow steppe
4. mountain and foothill savanna-like steppe
   a. feather-motley-grass and motley grass savanna steppe
   b. motley-feathergrass-fescue and feathergrass-motley-grass savanna steppe
5. foothill savanna-like desert steppe
   a. artemesia-feathergrass-fescue ephemeral desert steppe and localized scrub desert
   b. artemesia-feathergrass ephemeral desert steppe and localized typical desert

Figure 4.2. Environmental classifications translated by Frachetti (2004:94) from Sokolov (1968)

The table in Figure 4.3 shows the average rainfall by month for three regions in Semirech'ye. The average rainfall is highly variable between regions, and is dictated by the elevation, slope, rain shadow, and distance from the mountains. In Figure 4.3, I chose to use the data set collected by Utesheva in 1959 to characterize the regions. I also chose three regions within Semirech'ye to present, Almaty, Taldy-Kurgan, and Balkhash. Almaty is 25 km east of the Talgar alluvial fan and the Tuzusai site, and the rainfall levels are comparable. The high rainfall in this region is part of the reason why it is such a productive agricultural location today. The highest rain fall tends to be in spring. It is at this time that most of the perennials bloom and most productive periods of biomass production occur, producing abundant herd forage. It is also this time that agricultural crops require the steadiest and most reliable water sources for germinating and growing seedlings.

The rainfall at Taldy-Kurgan is roughly comparable with levels at Begash and Mukri. Both sites are less than 35 km from Taldy-Kurgan. It is evident that agriculture in this region requires river or spring-fed water sources. There is simultaneously less seasonal variability and less overall rainfall at Taldy-Kurgan than Almaty. The spring peak at Taldy-Kurgan is less than half that of Almaty.

The Balkhash region was added to this table to illustrate the extremes within Semirech'ye. Balkhash provides a good example of a desert steppe environment, little seasonal variability in rainfall, which rarely exceeds 200 mm/month. The average spring rainfall peak is about a ninth that of Almaty.

Average rainfall alone cannot be used as an indicator of available water reserves for vegetation. The further from the mountains, the deeper the water table tends to be. Furthermore, rates of evaporation are reliant upon the organic composition of the soil; more humus means increased water absorption. Humus-poor areas such as the desert steppe tend to have a high degree of rain runoff and even higher evaporation. Kuz'mina (2008) notes that 75 – 85 percent of the rainfall in these regions is lost through evaporation. Most of the vegetation in the steppe zone is adapted for reduced transevaporation, and therefore, the greater the vegetation cover the greater the water retention.

The table in Figure 4.4 illustrates the average monthly temperatures from Almaty and Taldy-Kurgan. Once again, I chose to use Utesheva's 1959 data set. The use of this data set is important for average temperatures seeing that the last century has seen environmental changes across Eurasia. The loss of most of the mountain glacial cover, surface defoliation, reduction of the water table, and global warming have all affected the average temperatures in Semirech'ye. Figure 4.4 shows that the average summer temperatures are fairly similar between the two regions, however, winters at Taldy-Kurgan are much colder and seasonal variability is correlatively greater.

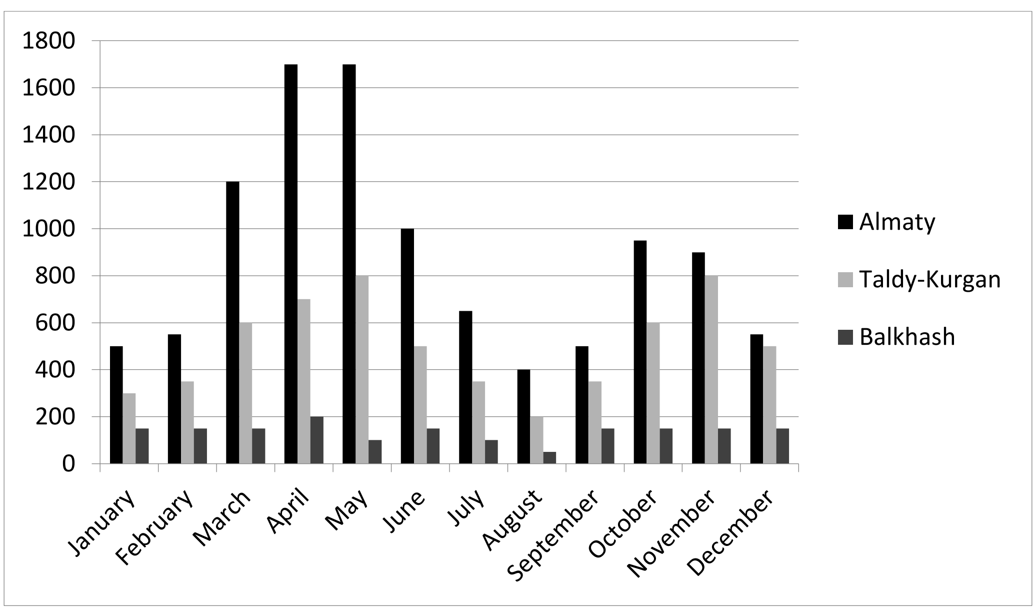

Figure 4.3. Annual regimes of rain fall by month for the Almaty region (representative of the Talgar study area), Taldy-Kurgan (representative of the Begash study area), and the Balkash region (from Frachetti 2004b [originally from Utesheva 1959:271])

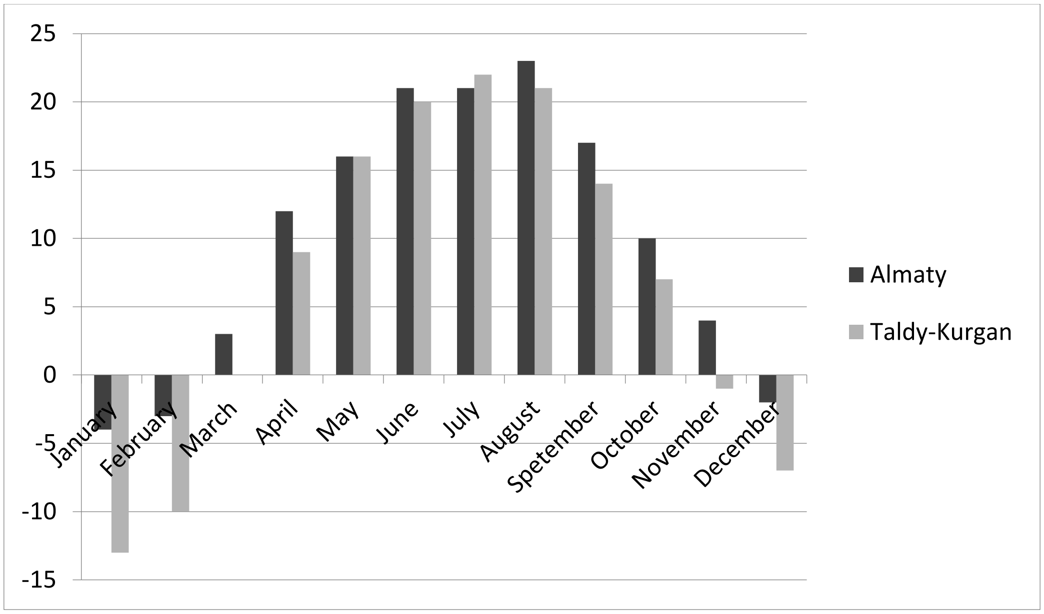

Figure 4.4. Annual temperature by month for the Almaty region (representative of the Talgar study area) and Taldy-Kurgan (representative of the Begash study area) (from Frachetti 2004b [originally from Utesheva 1959:271])

The mountains are the major climatic variable in this region. Average temperatures are most affected by altitude; Goloskokov (1984:11) notes that for every 100 m in elevation increase from the foothills (starting at 600 masl) to the piedmont there is a 0.5° – 1.0° decrease in mean temperature. High elevations over 1,000 masl tend to accumulate a lot of snow in the winter while elevations less than 800 masl rarely build up snow cover. The level of snow cover is extremely influential in herd range ecology for this part of the world; deep snow blocks herd animals' access to forage. In addition, potential agricultural regions are determined by orographic variables. In addition to the temperature changes, changes in elevation result in different soil zones and rainfall. Soil composition and rainfall are both important variables in agriculture and pasture quality. Furthermore, the higher elevations also experience greater fluctuations in daily temperature and are more unpredictable in relation to nocturnal freezes. Goloskokov

(1984:10) suggests that mid-altitude zones have the most moderate climate, around 800 – 1,200 masl. This zone has less seasonal variability, milder winters, and more humid summers, as well as less dramatic spring and fall shifts. This is the zone most suitable for sedentary agriculture.

Elevation is not the only variable determining vegetation composition in these mountains; slope-aspect (windward vs. leeward slopes) is very influential. The rain shadow effect leaves the steppe and arid steppe regions west of the mountains dry. The rain shadow of the Dzhungar Mountains creates a transition from the grass covered foothills to the desert steppe, which starts about 100 km form the mountains and continues to Lake Balkhash. As air masses collide into the mountains they are forced up in elevation. The resulting increase in barometric pressure forces precipitation, often in the form of snow, to fall on the windward sides of the mountains (often the north). This precipitation then feeds the fluvial systems, which create narrow swaths of fodder and irrigable lands spanning across Semirech'ye to Lake Balkhash.

Various waves of glacial advances and retreats throughout the Pleistocene carved deep wide valleys into the Dzhungar and Tien Shan Mountains created mixed-gravel hilly moraines and deposited the loess fields that make up much of the northern steppe soils. Mountain rains and streams support a dense vegetative community in many of these valleys, and their locations provide protection from the weather. The microenvironments created in these valleys are used as summer forage locations by herders.

4.2 The Steppe

Throughout this dissertation, I discuss the steppe, not as a facilitator of movement, but a mosaic landscape with pockets of resources, specifically water and herd-forage. Herders move in search of forage for their herds, indirectly brining populations into contact. In order to depict this economic model, I must first discuss the biological and geophysical characteristics that make up the steppe.

While species composition varies across the Eurasian steppe ecoregion from east to west, the general vegetation trends tend to be similar. Therefore, my discussion of the Semirech'ye steppe is applicable to a larger geographic area. In this section, I present some of the dominant species and geographic features of the Semirech'ye steppe zone.

Laverenko and Karamysheva (1993) characterize the semi-arid steppe with three genera *Stipa*, *Carex*, and *Artemisia*. Looking at this in a more detailed way there is a mosaic of saline surface soils, exposed sandy soils, *Artemisia* and dry-grass patches, rock outcroppings, and springs and riparian areas. A variety of *Artemisia* spp. are mixed throughout the more arid and saline areas, including *A. sublessingiana* and *A. heptapotamica* (Goloskokov 1984). A variety of other saline and drought tolerant species in the Amaranthaceae family are also present including the shrubby *Haloxylon* spp., as well as *Anabasis cretacea* and *Suaeda dendroides*. The steppe in general is most characterized by arid-land Poaceae such as: *Brotrichola ischaemum*; *Festuca valesiaca*; *Kochia prostrate*; *Stipa capillata*; *S. caucasica*; and *S. sareptana*. Some of the forbs also present in the semiarid-steppe of Semirech'ye include *Adonis aestivalis*, *Alcea nudiflora*, *Allium* spp., *Convolvulus* spp., *Echinops nanus*, *Euphorbia rapulum*, *Goniolimon* *callicomum, Hypericum* spp., *Tragopogon ruber*, *Vexibia alopecuroides,* and *Ziziphora clinopodiodes* (Evashenko 2008).

Within this environmental zone there are a variety of vegetation pockets formed by sheltered rock-outcroppings, river valleys, springs and geographic depressions. These pockets have distinct vegetation from the surrounding vast expanses of grass, *Artemisia*, and other dry forbs. If these pockets contain a water source it is likely that the water is surrounded by stands of reeds (*Phragmitis australis*) as well as *Typha angustifolia* and *Epilolobium hirsutum* (Goloskokov 1984). Standing water often contains *Alisma plantago-aquatica*. Only a few tree species are found in these settings, including willow (*S. songarica, S. tenuijlis*, and *S. wilhelmsiana*), *Eleagnus oxycarpa, Populus talassica, Tamarix ramosissima*, and *Ulmus pumila* (Goloskokov 1984). In these river valleys there are also more water demanding grasses, such as *Leymus* and *Aeluropus*. However, these areas tend to be dominated by forbs. A few abundant examples include: *Chenopodium* spp.; *Convulvulus* spp.; *Echium vulgare*; *Galium* spp.; *Hyoscyamus niger*; *Hypericum* spp.; *Lithospermum arvense*; *L. officiale*; *Malva neglecta*; *M. pusilla*; and *Ziziphora clinopodiodes* (Evashenko 2008; Goloskokov 1984).

4.3 The Mountains

This regional study covers two large mountain ranges, the Tien Shan and the Dzhungar. While these ranges are environmentally quite similar they do have distinctive characteristics that set them apart. The vegetational differences between these ranges is due to several variables: the Dzhungar are at a higher latitude; they have a closer proximity to the dry air masses moving west from the Gobi Desert and east from the steppe; and they are not as high and do not have the level of glacial build up that the Tien Shan have. Nonetheless, these two ranges can be combined (and to some extent contrasted) in this discussion because of their high level of biological and geophysical similarity. Like the steppe, the mountain zones in Semirech'ye should not be thought of as a homogenous environmental zone but rather a patchwork of rock-outcroppings, coniferous stands, mountain meadows, and shrubby forests. Furthermore, each of these environmental categories is extremely variable in its vegetative composition.

The Dzhungar Mountain range creates the current political boundary between China and Kazakhstan, also marking the eastern edge of Semirech'ye. The range extends between 43°50'N-46°50'N and 78°50'E-82°50'E. The highest peaks are greater than 4,500 masl and the river valleys are as low as 500 masl. There is approximately 1,000 km^2 of glacial surface cover and according to Goloskokov, in 1984 there were more than 150 individual glaciers[16].

The Tien Shan Mountain range is quite extensive expanding east from Kazakhstan and Kyrgyzstan, well into western China, spanning about 2,800 km east to west. The range expands between 41°50'N-39°00'N and 69°00'E-80°50'E. The range is part of the Himalayan orographic belt. The highest peaks in the range are over 7,000 masl. Much of the surface area above 5,000 masl is covered in ice, and glaciers would have extended down into many of the valleys just a few decades ago.

[16] There has been serious glacial retreating over the past two decades in both the Dzhungar and the Tien Shan Mountains. It is likely that there were even more glaciers or a larger area covered at various times in the past.

These two mountain ranges are sometimes further divided into a number of smaller ranges, each of which has its own vegetative characteristics (Dzhangaliev et al. 2003). In order to simplify this discussion, I will only use the broad range terms of the Dzhungar and the Tien Shan. However, a quick look at some of the ranges in this region can be seen in Figure 4.5.

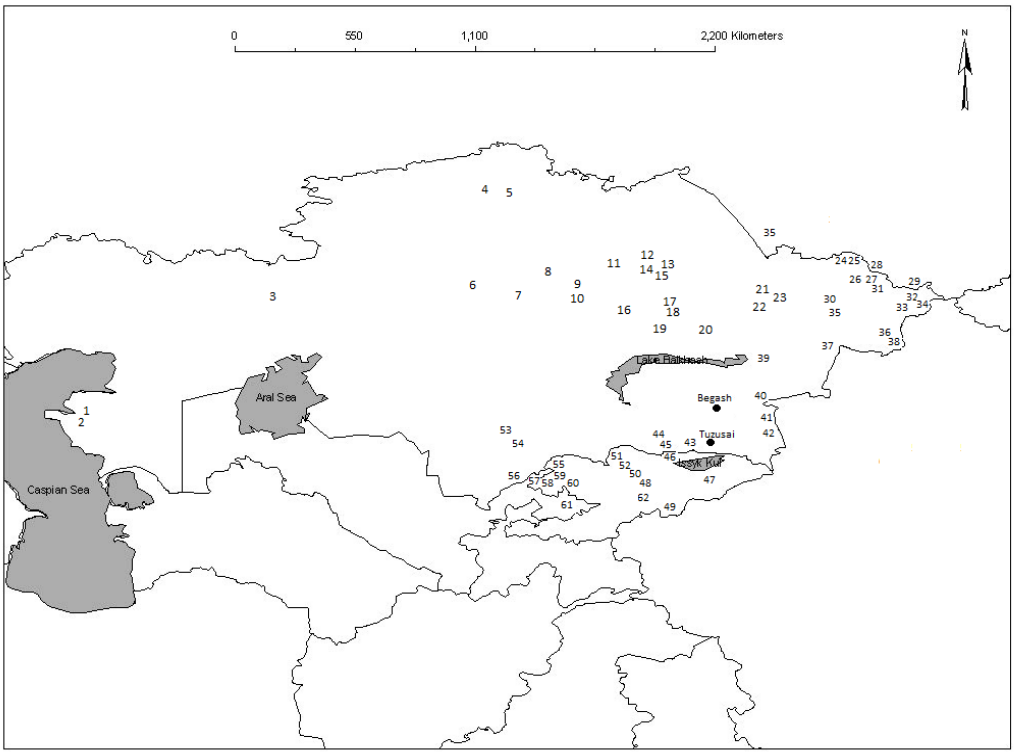

Figure 4.5. Mountain systems of eastern Central Asia: (1) Ak-Tau; (2) Kara-Tau; (3) Mugodzhary; (4) Air-Tau; (5) Kokshe-Tau; (6) Ylu-Tau; (7) Saryzhal; (8) Chadraly; (9) Aimysyk; (10) Eskenel; (11) Niaz; (12) Bayan-Aul; (13) Arkalyk; (14) Kyzyl; (15) Kuu; (16) Bagaly; (17) Kent; (18) Kyzyl-Rai; (19) Arkarly; (20) Ak-Krek; (21) Degelen; (22) Chingiz-Tau; (23) Arkat; (24) Tigiretskei; (25) Ubinskei; (26) Ivanovskei; (27) Uljbinskei; (28) Kholzun; (29) Listvyaga; (30) Kalbinskei; (31) Narymskei; (32) Sarymsakty; (33) Kursumskei; (34) Kadinskie; (35) Arkarly; (36) Monrak; (37) West Tarbagatai; (38) Saur; (39) Arganaty; (40) Dzhungarskie Alatau; (41) Toksanbai; (42) Ketmen; (43) Zailijskei Alatau; (44) Chu-Illjskei; (45) Kendik-Tas; (46) Kungei Alatau; (47) Terskei Alatau; (48) Moldoto; (49) Atbashi; (50) Dzhumgolto; (51) Kirghiz; (52) Susamry; (53) Kara-Tau; (54) Boroldai-Tau; (55) Talasskei; (56) Karzhan-Tau; (57) Ugamskei; (58) Pskemskei; (59) Sandalash; (60) Chatkalskei; (61) Kuraminskei; (62) Ferganskei – Data from Dzhangaliev et al. (2003:309)

In the Tien Shan the vegetation line in approximately 4,000 masl, it is slightly lower in the Dzhungar (Evashenko 2008). While the line may vary slightly in elevation, depending upon solar radiation and snow cover, it tends to be rather abrupt. Above this line only mosses (primarily *Thylacosprmum caespitosum*) and the occasional edelweiss (*Leontopodium ochroleucum*) grow. However, the band of vegetation that falls roughly 3,500 and 4,000 masl is primarily mountain meadows (Evashenko 2008). At this elevation the meadows are primarily dominated by forbs, while the patches of meadows below 3,500 masl are a mixture of high elevation grasses and forbs. Some of these high elevation forbs have underground storage organs (geophytes), such as the *Allium* spp. and *Tulipa* spp. The rest are perennials adapted to this elevation, such as *Aconitum rotundifolium*, *Corydalis gortschakovii*, *Erigeron heterochaeta*, *Geranium saxatile*, *Ligularia narynensis*, *Primula algida*, and *Rhodiola coccinea*.

Between 3,500 and 2,800 masl a patchwork of coniferous high-mountain forests (or tiaga) are mixed with mountain meadows and rock outcrops (Evashenko 2008; Goloskokov 1984). These forests are dominated by Siberian pine (*Pinus sibirica*), Siberian fir (*Abies siberica*), Siberian juniper (*Juniperus sibirica*), and Tien Shan birch (*Betula tianschanica*) (Dzhangaliev et al. 2003). In the Tien Shan the dominant tree species are the Tien Shan spruce (*Picea schrenkiana*) and Tien Shan mountain ash (*Sorbus tianschanica*).

The mountain meadows at this elevation are made up of a combination of high elevation grasses such as the blue grasses (*Poa nemoralis* and *P. pratensis*), *Dactylis glomerata*, *Brachypodium pinnatum*, and *Bromus inermis* (Goloskokov 1984). There is also a high diversity of forbs in this zone, including *Aconitum* spp., *Alchemilla sibirica, Allium* spp., *Delphinium illense*, *Dianthus* spp., *Hypericum hirsutum*, *Solidago viraurea, Thalictrum minus*, *Polygonum* spp., and *Sedum* spp. (Evashenko 2008).

Shrubby forests border the mountain forests at lower elevation zones, these shrubby forests are an intermingling of grasslands and mixed grass/forb fields (Evashenko 2008; Goloskokov 1984). This zone is often further divided into more ecosystems or microenvironmental zones, however, to simplify, it is easier to think of this zone being a gradual fading off into the steppe proper. The shrubby forests cover much of the foothills and alluvium of the Tien Shan and Dzhungar. The Talgar sites, discussed in this dissertation, are all situated in this environmental zone. Once again, it is better to think of this zone as a patchwork of microenvironmental pockets, including riparian areas, grass-dominant fields, mixed-forbs/grass fields, and low-growing shrubby forests.

The riparian areas are dominated by *Populus tremula,* and willows (*Salix* spp.). The shrubby forests have drastically been changed by Soviet agricultural campaigns and dominant shrubby species in the Talgar region today include feral apricots (*Prunus armeniaca*) and cherry (*Prunus avium*) (presumably planted during the Soviet period). Agriculture has turned much of these forests into field systems. However, it is likely that these shrubby forests were dominated by, *Viburnum opulus* (common viburnum) in the Dzhungar Mounatins and *Hippophae rhamnoides* (sea buckthorn) is abundant along alluvial deposits and riverbanks in the Tien Shan. Several wild rose (*Rosa* spp.) species grow across the Semirech'ye region and appear across most of the environmental zones. Two species of *Elaeagnus* (*E. angustifolia* and *E. oxycarpa*) grow throughout Semirech'ye, and like several species of Rosa, are present from the mountain forest regions down to the edge of the arid steppe. *E. angustifolia* is more common in the mountain forests, while *E. oxycarpa* is abundant across the foothills of the Tien Shan (Dzhangaliev et al. 2003) and especially the Talgar region today. Several species of *Rubus* also share the same environmental distribution range as *Rosa* and *Elaeagnus*. These shrubby forests in the foothills and alluvial fans of the Dzhungar and Tian Shan also have several species of wild cherry (*Prunus* spp. and *Cerasus*) (Dzhangaliev et al. 2003). At least seven species of *Crataegus* grow in the foothills of the eastern Kazakhstan mountain ranges, several in the Almaty area specifically (Dzhangaliev et al. 2003). The most discussed of these shrubby-trees are the wild apples, represented by two species in the southern mountains, *Malus sieversii* and *M. niedzwetzkyana*. Historically these species have been reported growing in dense forests in the foothills of the Tien Shan, but little is known about the early ecology of these forests, before Russian imperial and Soviet intervention (Pollan 2006). Historically these shrubby wild-fruit-rich forests have played important economic roles in Kazakhstan in the hilly or low mountain regions from the Altai to the Pamir (Dzhangaliev et al. 2003).

There is a high diversity of forbs in this zone; however, it is not clear how much the species composition has been altered by invasive and agricultural programs. The northern hemisphere invasive agricultural ‘weed’ assemblage is dominant in the Talgar region today, including *Cichorium intybus*, *Rumex crispus*, and *Taraxicum officiale*. However, a number of other forbs are likely native, including *Achillea millefolium*, *Dipsacus dipsacoides*, *Hypericum perforatum*, *Lavartera thuringiaca*, *Nepata pannonica*, *Rumex tianschanicus*, *Salvia deserta*, and *Silene venosa* (Evashenko 2008).

4.4 The Mountain/Steppe Interface

The Talgar alluvial fan is along the mountain/steppe interface ecotone (see Figure 1.1, 1.2, and 3.2) and is composed of ecological pockets or ecotopes of varying vegetation communities. Rosen et al. (2000:611) characterize the region as "a richly diverse mosaic of landscapes within a relatively restricted area". In this ecotone, mountain streams fed from precipitation and glacial melt cut deep fluvial channels into the alluvium. These stream cuts are lined with rich riparian vegetation. In some cases the transition between zonality is abrupt.

Geographic uplift leaves a varying landscape of foothills. These foothills are composed of uplifted bedrock and eroded alluvium deposits. The rock outcroppings and hill valleys all foster specific vegetation communities, distinct from the fluvial systems or the shrubby-forest/steppe vegetation covering much of the remainder of the landscape. This zone is a patchwork of microenvironmental pockets (ecotopes), including riparian areas, grass-dominant fields, mixed-forbs/grass fields, and low-growing shrubby forests. Shrubby forests cover much of the foothills and alluvium of the Tien Shan. This ecotone is important for human economy because it has representative species from all the previously mentioned ecological settings, i.e., the greatest biodiversity.

4.5 Paleoenvironment

Much of the early archaeological and paleoenvironmental research on the steppe focused on paleoclimatic models constructed from northern European pollen cores, applying them to the rest of Eurasia. A more detailed discussion of this large body of literature is presented by Khotinskiy (1984) and Kuz'mina (2008:11-13). General trends in this literature dictate that there was a gradual warming period from the end of the Pleistocene on, disrupted by the Younger Dryas, peaking around the fifth and fourth millennia B.C. This warming trend was followed by a gradual cooling trend, which valleyed around 2000 B.C. A final cooling trend bottomed in the ninth to the seventh centuries B.C. This last cooling trend, during the early Iron Age, is often used to argue for and increased reliance on pastoralism and mobility on the steppe. However, Kuz'mina (2008:11-15) provides two strong critiques of these models: (1) they do not account for local environmental factors such as elevation, rain shadow effect, continentality, proximity to large bodies of water, etc. and (2) it cannot be assumed that models designed for northern Europe apply to the Central Asian steppe. "Unfortunately, we do not have conclusive evidence for the climatic and geographical changes in the Eurasian Steppe and the contiguous territories during the Holocene. There is disagreement not only among various disciplines such as paleobotany, paleozoology, soil science, and limnology–but within each specialty as well." (Kuz'mina 2008:13).

A theme in this literature is that environment on the steppe from the end of the Neolithic optimum in the Mid-Holocene on would have been unsuitable for agricultural pursuits (Yablonsky 1995). This literature rarely takes into account different crop varieties, such as arid-land tolerant millets, low-investment cultivation practices, or irrigation. In addition, many of these studies are conducted in dispirate parts of Eurasia and applied to huge geographic areas.

Kremenetski's (2003) simplified summary of the macroscale view of Holocene climatic variations across the Eurasian steppe zone suggests a period of aridization between 2800 – 2000 B.C. This was followed by a period of increased humidity from 2000 – 900 B.C. The period of climatic amelioration has been noted across much of Europe and Western Asia; it is used in arguments of cultural advance and demographic expansion across this part of the world. Kremenetski (2003) finally suggests that the present environmental conditions reached their current stage around 600 B.C. The mean temperature throughout the Holocene fluctuated between 1 – 2º C and the average annual rainfall may have fluctuated between 50 – 100 mm across the steppe.

However, despite the common use of these paleoenvironmental reconstructions to explain changes in human economy, Kremenetski et al. (2003) argue that climatic fluctuations would have affected broad leaf and conifer forests far more readily than steppe lands. The steppe is significantly more resilient, absorbing such changes rather than experiencing collapse of shifts. These praries have evolved in response to extreme variations characteristic of intercontinental climates.

In addition, there are significant issues with palynological studies in Central Eurasia that need to be addressed before any of their results can be seen as reliable. Sorting out the glitches in the pollen record for this part of the world should eliminate the contradictions that exist in the paleoenvironmental models; however, this will require considerable regional level analysis. For example, R-values are a rather recent introduction to palynology, and much of the research does not include any statistical attempt at calibrating for distance of wind dispersal, quantities of pollen produced per plant, or masting and variability. Furthermore, eastern Central Asia is characterized by a mosaic environment, and forest openness or patchiness is a notoriously difficult issue to confront paleobotanically. For discussions on quantitative approaches to dealing with patchiness see: Jackson and Kearsley (1998); Sugita (1994); or Sugita et al. (1999); addressing this issue will require new approaches and methods. Another significant issue is forest cover, studies from this part of the world have relied heavy on conifer pollen as an indicator of forest cover (e.g., Kremenetski et al. 1999). Saccate pollen can travel for hundreds of miles and irregularities in wind patterns can influence its deposition. It addition, R-values for conifers are hard to calculated due to the extreme abundance of pollen produced per plant and irregularities between years depending on rainfall and temperature in the spring months. Beyond the inherent issues doing anything with conifer pollen, most steppe vegetation is wind-borne and will travel for miles in an open environment like the steppe. The use of a single indicator species is always highly problematic for determining forest cover (see Ford 2008 for a critique). Attempts in other parts of the world have been controversial – for example, the use of elm (*Ulmus*) pollen to identify a deforestation event in the European Neolithic or the use of Ramón (*Brosimum alicastrum*) pollen to identify the Mayan collapse.

Broader issues with pollen studies include the quantification of densities per slide, if a hundred grains are quantified per slide, abundance is *Pinus* or *Picea* pollen will inversely decrease the quantity of herbaceous pollen recorded. The lower abundance of herbaceous pollen is, therefore, a direct variable of the high abundance of conifer pollen and not necessarily reflective of the amount of pollen in the sediments and not directly representative of landscape cover. Mountain forests in eastern Central Asia are dominated by coniferous species; therefore, issues with the use of saccate pollen are unavoidable. In this dissertation, I argue that small ecological patches are key for the mobile pastoral economic system used in the region today. The dominant plant species of these ecological patches are herbaceous and often insect pollinated whereas the surrounding steppe matrix is dominated by grass and *Artemisia* (all wind pollinated). Due to the low pollen production of insect pollinated plants and the small size of many of these ecological pockets, it is likely that they would not be recognized in a paleoenvironmental reconstruction of the landscape.

As I mentioned in the opening of this chapter, paleoclimatic reconstructions are macroscalar, while people experience their landscape on a microscale. Reconstructing ecotopes on a mosaic landscape is problematic because all of these methodological approaches create broad generalied pictures. They rarely, if ever, deal with detailed nuances such as the changes in one river valley or near one spring. Understanding how climatic change affected the details of steppe ecology is more important than a generalist view.

Looking specifically at Semirech'ye, paleoclimatic reconstruction has been done by Rosen et al. (2000) based on phytolith data from the Talgar region. Based on this phytolith data Rosen et al. (2000) argue that there was a climatic amelioration in this region during the Iron Age (starting ca. 800 B.C.). This climatic shift would coincide with the long-argued view that there was a cooling trend during this time period. However, while most researchers have argued that this cooling trend led to unfavorable conditions for agriculture in the steppe, Rosen et al. (2000) argue that it provided better conditions for agricultural pursuits. This argument is further complicated because there are two established paleoenvironmental sequences for eastern Kazakhstan, presented by

Krementski (1997) and Khotinskiy (1984). These two sequences seem to contradict during the time period in question (discussed in Rosen et al. 2000:613).

A detailed understanding of environment from this time period is important because the Bronze and Iron Age interface has long been a period of interest for archaeologists. As is discussed elsewhere in this dissertation, at this time there was an increase in size and number of burial mounds and changes in material culture. Rosen et al. (2000) look at a variety of data sets, including: Tien Shan glacial advances and retreats; Kazakh pollen cores; Siberian pollen cores; and transgression and regressions of Lake Balkhash. Based on this detailed analysis they conclude that there was a climatic amelioration focused around 660 B.C. Chang et al. (2002) later argue that this climatic shift may have led to an intensification of agricultural pursuits, which in turn led to a demographic shift and increased sedentism and archaeological visibility on the landscape.

Rosen et al. (2000:613) are careful to note that "monocausal and environmentally deterministic explanations are seldom satisfactory for the explanation of culture change". They also note the contradictions in the data sets. These contradictions can be used to argue that the effects of any climatic changes were minimal. While there is little doubt that climatic shifts would have been felt by humans in the past, there is no reason to believe that there was a Holocene shift great enough to drastically change vegetation in Semirech'ye. The climate of Semirech'ye is primarily dictated by orographic processes and continentality; these variables have been in place for the past ten million years, since the mid-Miocene. So while there is merit in studying paleoenvironments, until we get a more detailed data set specific for Semirech'ye, which goes back through the Bronze Age (research is underway on this issue at present; Claudia Chang and Pavel Tarasov, personal communication 2011), our best tool for understanding paleoenvironment is modern analogy. Therefore, the modern geophysical environment discussed throughout this chapter can be applied to the Bronze and Iron Age setting in Semirech'ye. That said, we should acknowledge that over the past century there have been changes in vegetation composition and environment in Semirech'ye. The intensification of Soviet and post-Soviet agricultural programs have denuded large portions of the landscape, incorporated invasive species, lowered the water table, and depleted top-soil (Mayhew et al. 2009; Soucek 2000). Furthermore, large scale climatic changes are leading to the loss of glacial cover and reduction of glacial melt water in summer months.

A Palynological Study at Begash

A small palynological study was conducted at the Begash site in 2002 by Siada Nigmatova, of the Institute of Geology, National Academy of Sciences, Almaty, Kazakhstan. This study was conducted as part of the DMAP and consisted of the analysis of 23 soil samples. These samples all contained low pollen abundance.

This study provides limited information for paleoenvironmental purposes; furthermore, only family-level identifications were used (except for *Pinus* and *Artemisia*). The presence of *Pinus* pollen in a few samples is the only arboreal pollen; however, as I just explained saccate pollen, such as that of *Pinus* trees, can travel for hundreds of miles, and therefore, says nothing about the landscape around the site. The two most dominant categories in the assemblage are *Artemisia* and Chenopodiaceae. The dominance of *Artemisia* may indicate that an arid steppe environment was present throughout all time periods at the Begash site. However, it is interesting to note that Poaceae, which is also wind pollinated and produced copious amounts of pollen is poorly represented.

	Samples	*Artemesia*	Chenopodiaceae	Poaceae	Ranunculeae	*Pinus*	Fabaceae	*Ephedra*
Phase 1	1	42	45	NP	9	NP		
Phase 2	2-5	30	70	present	present	NP		
Phase 3	6-10	17	45	25	NP	present		
Phase 4	12-16	30	55	present	12	NP	present	present
Phase 5	18-19	25	75					
Phase 6	21-23	25	75	present	present	NP	NP	present

Artemesia/Chenopodiaceae	%
0.933333333	1.071428571
0.428571429	2.333333333
0.377777778	2.647058824
0.545454545	1.833333333
0.333333333	3
0.333333333	3

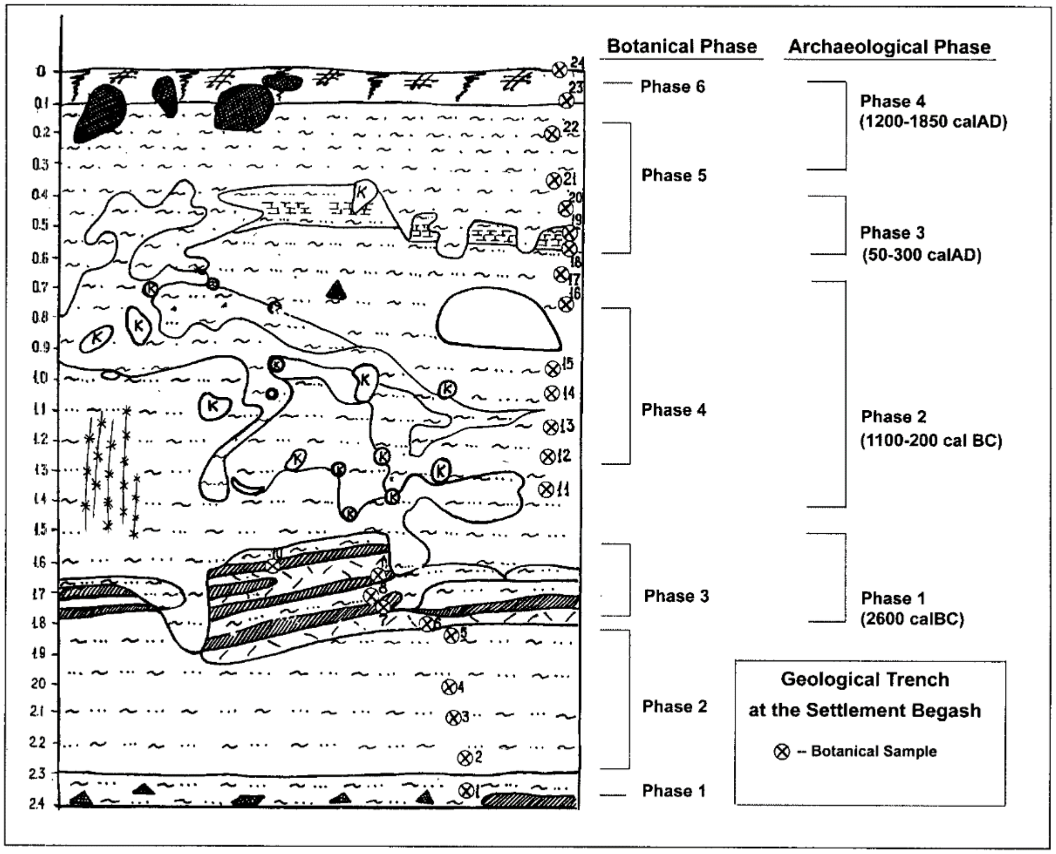

Figure 4.6. Results from a palynological study conducted in 2002 as part of the DMAP at the site of Begash (after Frachetti 2004b)

Chenopodiaceae is useless for interpretations because of the former family's diversity (now re-classified into Amaranthaceae). This family has arid land genera such as shrubby

Haloxylon spp., as well as *Anabasis cretacea* and *Suaeda dendroides*. Some of these genera, notably *Haloxylon*, have species that grow in the most arid desert regions of Central Asia, such as among the sand dunes of the Kara Kum in Turkmenistan. Furthermore, *Chenopodium* and *Amaranthus* plants are characteristic of well-watered areas on the steppe, especially river banks.

Chapter 5: Ethnography and Archaeology: Plants and Eurasian Pastoralists

5.1 Introduction

Before the period of Russian influence there is insufficient information for reconstructing subsistence, and some of our strongest tools for interpreting archaeological subsistence patterns include ethnographies. Nonetheless, ethnographic and ethnohistoric analogies are analytical comparisons and not necessary characteristic of the past. Ethnographic analogies are used here to help interpret archaeologically generated data. Ethnographic accounts clearly attest to the effectiveness of mobile pastoral strategies on the Central Asian steppe (Barfield 1993). These accounts include those of early explorers into Semirech'ye such as Levshin (1840), a Russian historian traveling through the region in the early nineteenth century, and Chokan Valikhanov (1835 – 1865), a Kazakh linguist and historian, commissioned by the Russian Geographic Society to lead an ethnographic and geographic expedition through Semirech'ye (their writings are discussed in Lunin 1973 [in turn discussed in Frachetti 2008]). In addition, eighteenth and early nineteenth century explorers into the Central Eurasian mountain regions wrote about the people they interacted with, such as the early eighteenth century explorer Pesterev (Vainshtein 1980) and the early nineteenth century explorer Priklonskii (1953 [1881]).

The earliest historic records that deal with this part of the world are from neighboring populations talking about the mobile pastoral populations in Central Asia. The oldest of these texts is from the Greek historian Herodotus of Halicarnassus

(Herodotus 2003 [ca. 431 - 425 B.C.]) and to a lesser extent Strabo and Justin[17]. Herodotus mentions the presence of agriculture on the steppe, referring to what he calls the agricultural Scythians; "the Graeco-Scythian tribe called Callipidae, and their neighbors are the Alizones. Both these people resemble the Scythians in their way of life, and also grow grain for food, as well as onions, leeks, lentils, and millet" (Herodotus 2003 [ca. 431 - 425 B.C.]: book 4, section 17). The writings of both Strabo and Justin are secondary references to topics such as the Bactrian revolts which the two authors learned about from the writings of their predecessors, now lost to the sands of time. Strabo referenced much of his accounts on Central Asia to the writings of Apollodoros of Atemita in Parthia (Gardiner-Garden 1987a). Justin's epitone is based on the writings of Trogus Pompeius, who also references Apollodoros as well as Ktesias of Knidos (a Greek physician in Persia) as his sources on Central Asia (Gardiner-Garden 1987a, 1987b).

Three important Chinese texts reference mobile populations on the Chinese dynastic periphery. The most important of these texts is the Shiji (Records of the Great Historian) written somewhere around 80 B.C., by Sima Qian (145 or 135 – 86 B.C.). Eight of the 130 volumes (scrolls) of this text deal with economics, some specifically discuss interactions with the Xiongnu to the north, most importantly discussing the Ho-ch-in Peace Alliance (Sima 1961 [ca. 80 B.C.]). The Hanshu (Book of the Han) was written over a considerable period of time and ultimately finished in A.D. 111; the primary contributor to the volume was Ban Gu (32 – 92 B.C.). There is mention in this series of texts of Han envoys allying with 'Wusun' tribes in the mountains beyond Xinjiang. The Hou Hanshu (Book of the Later Han) was written in the fifth century by

[17] Although these accounts are quite peripheral to the areas discussed in this dissertation.

Fan Yeh (A.D. 398 – 445). This book covers the history of the Eastern Han retrospectively (A.D. 25 – 220). In addition to the Greek and Chinese texts, there are mentions of Scythians in Persian inscriptions. The fifth column of the Behistun Rock inscription (ca. 515 B.C.) depicts Darius the Great's campaigns against Scythians (portrayed with pointed 'Phrygian' style hats) (Dandamayev 1999), after a group of mobile pastoralists attacked the Parthians (Adkins 2003; Koshelenko and Pilipko 1999). However, there is no reason to believe that either the Greek or Persian Empires had any direct contact with populations as far north in Central Eurasia as modern day Kazakhstan.

In the year 130 B.C. Sima Qian wrote a second hand account of the fall of the Bactrian Empire and the opening of the deserts and oases of southern Central Asia. Bartol'd (1956-1962:I:4) notes that this was the first time that an historical event was recorded in the annals of the "East" and "West", or China and Greece, respectively. Officially marking the manisfestation of a globalized world-system on a scale unlike any previously seen (Christian 2000).

It is clear from all these written sources, historic and modern, that mobile pastoralists in Central Asia have relied heavily on dairy products for millennia. While dairy products are important year round, the hot dry summers and cold humid winters limit the potential lambing season to early spring (Barfield 1993:142). Only during this time of the year can sufficient forage be provided to milking mares, ewes, does, cows, and in some cases camel. The spring lambing allows nomads to stock and preserve dairy products (e.g., yogurt, cheese, curds, butter, tar, kumiss, and qurt) for the harsher parts of the year. However, if temperatures drop too low or an unseasonably late snowstorm covers pasture-land, it can be economically devastating. Barfield notes that it only takes a few days under such conditions for livestock to starve or freeze (1993:142). After such an event the economy could take decades to rebound. Frachetti (2006:166) states "in years of extreme cold weather, famine (jute) could strike more than 50 percent of domestic herds. Famines of this scale were recounted to occur on average every 10 years or so".

The Central Asian steppe has a high level of seasonal variability resulting in environmental extremes. Other stressors of herd stability include: predation; epizootics; availability of forage; access to water; and raiding. Subsistence specialization in a non-market based economy, often leads to vulnerability. For mobile pastoralism to be the basis of an economy, tactics of risk management or homeostatic responses must complement that economic strategy (see Barfield 1993; Bourgeot 1981; Galaty 1981; Paine 1970, 1971). Risk-reducing, culture-based practices include: holding herds in common among different generations in the same kinship group; communal winter camps; the inalienability of the herd animals; and social and kinship bonds. Economic diversification also reduces risk and reliance on one food source. Another cultural practice that reduces loss of herd animals during winter months is what Masanov (2000a:189) refers to as the "winter herding cycle".

The winter herding cycle is discussed in a number of studies (e.g., Bulatov 2000:194-195; Frachetti 2004b:164-176; Masanov 2000:188-189; Shishlina 2000:172). The geographic landscape of the steppe, especially in areas like Begash, is highly variable, with hills, valleys, cliffs, rock-outcroppings, and vegetation patches dotting the landscape. As a result, snow cover is not even in all areas. Kazakhs traditionally herd animals in areas with less snow cover, so animals can retrieve forage under the snow. However, if the snow fall is too high, domestic sheep and goats cannot reach the forage underneath the snow. Sheep are capable of hoofing through snow to a depth of 10 – 12 cm (Masanov 2000:188). In contrast, domestic horse can hoof through snow 30 – 40 cm deep (Masanov 2000:188). The winter herding cycle is as follows: first, horses are moved into new snow-covered grazing lands; they then hoof through the snow to reach the steppe grasses below. Next, domestic cattle are brought in to feed on the freshly uncovered patches of grass, while horses are moved to the next pasture. Cattle further uncover snow through trampling before they are moved to the next post-equine-grazed field. Finally, sheep and goats are brought into the field where cattle were recently removed. Sheep and goats are able to digest certain steppe vegetation that horses and cattle leave behind. The breaking of the wind-hardened snow cover by horses allows cattle, sheep, and goats to reach forage (Frachetti 2004b:164-176; Masanov 2000:188).

Like the winter herding cycle, the selection of a winter camp can mean the difference between economic prosperity and poverty. As was just mentioned, much of the steppe has a varying geographic landscape. Camps are situated in valleys, leeward slopes, depressions, in bushes, or protected by tall marsh reed-like stands (e.g., *Phragmites australis*, and *Typha* sp.) (Frachetti 2004b:165; Masanov 2000:189). The use of marsh reed stands as winter shelter is well documented across the steppe. *Phragmites* culms are not bent by the snow, and therefore, remain standing as a wall against the wind. In addition, they provide fodder for animals and architectural material (Anthony et al. 2005:189; Masanov 2000; Shishlina 2000:173). The importance of these ecotope settings is elaborated in Chapter 6.

5.2 Diet

5.2.1 Agriculture

Ethnographic and Ethnohistoric Evidence for Agriculture

In addition to the heavy reliance on meat and dairy products, ethnographic accounts describe ephemeral agricultural practices. Before Russian influence, many mobile peoples on the steppes were growing broomcorn millet and barley in small, low elevation fields (Di Cosmo 1994; Levin and Potapov 1964; Vainshtein 1980). These fields could be situated up to two days ride from winter camps (Vainshtein 1980). Millets (both broomcorn and foxtail millet) and to a lesser extent barley were preferential for the mobile lifestyle due to the minimal investment value and short growing season (Pashkevich 2003).

The manners in which these mobile pastoralists cultivated millet and the intensity of their agricultural techniques were highly variable (Di Cosmo 1994). In addition, most ethnographers who study mobile peoples have noted interactions between these people and sedentary groups (Barfield 1993; Basilov 1989).

Eurasian millets have a short growing season and are hardier than most larger cereal crops. This is likely why broomcorn millet was so readily adopted by the Mediterranean world in the Classical period. The rocky and sandy soil, heavily overgrazed, combined with the dry hot summers of the Mediterranean coasts, would not suit most grain crops without irrigation systems. The same is true for most of Central Asia and areas of Southwest Asia, especially the Levant where millets show up rather late in time (Zohary and Hopf 2000). Ethnohistoric accounts from explorers or early ethnographers on the steppe discuss the use of millet-based agriculture in the economy of Central Asian populations (Priklonskii 1953 [1881]; Seebohm 1882; Vainshtein 1980). The restricted dry environment of the arid-steppe is not suitable for most crops without extensive irrigation. A mobile lifestyle does not allow for energy or time to be put into the development of such irrigation systems. In addition, the need to move between seasonal pastures does not allow the mobile pastoralists to cultivate most crops. However, they are able to plant small plots of broomcorn or foxtail millet in stream beds or near springs during their summer encampments. Pashkevich (2003:292) claims that millets are particularly adapted to the mobile lifestyle on the steppe because of three traits: (1) they have a short growing season; (2) they are drought tolerant; and (3) they have a low seed sowing investment. Pashkevich (2003) describes a mobile agricultural package based on small-scale cultivation of broomcorn millet, foxtail millet, and barley. Pashkevich developed this model of a mobile agro-pastoral system in the Bronze Age based on ethnographic accounts of pastoralists in West Asia and Eastern Europe; however, similar supporting ethnographic accounts exist from Central Asia (Priklonskii 1953 [1881]; Seebohm 1882; Vainshtein 1980).

The short growing season of these grains allows for harvesting before herders need to move to their winter pastures (Vainshtein 1980). The plots used for cultivation were relatively small, rarely larger than 1.5 – 2.0 hectares (Vainshtein 1980:150). These plots were often in river valleys or near a water source. Placing fields (plots) in moist areas reduced the need for irrigation. These plots were usually within 5 km of a fall or spring camp, but they may have been as much as 30 or 40 km from a camp (Vainshtein

1980:148). Because so little care is needed during their growth, the herders only have to ride out to the plots a few times, depending upon weather conditions (Vainshtein 1980). Fields were visited for planting in April and harvesting in October, while little attention and no irrigation were required (Vainshtein 1980).

Rona-Tas's 1959 study of agricultural practices among mobile pastoralists in the Selenga River valley of western Mongolia is probably the best case study for low-investment agriculture among Central Eurasian pastoralists (Rona-Tas 1959 [discussed in Di Cosmo 1994]). In this study Rona-Tas observes small plots near river banks being overturned using wooden plows; soil clots were broken up by hand and then wheat, barley, or rye seeds are planted (also by hand). The herders then take their herds to summer pastures and do not return until autumn. Very importantly, Rona-Tas also notes that harvesting is done by hand without the aid of a sickle. Winnowing was done with large wooded shovels and a horse operated grinding mill was used (Rona-Tas 1959 [discussed in Di Cosmo 1994]).

Similar ethnohistoric accounts of small-scale low-investment farming are found throughout the mountainous and oasis-desert regions of Central Eurasia. Lattimore (1967 [1940]) insisted that steppe populations had the ability to fulfill their own subsistence needs. Argynbaev (1973:155) notes that "at the start of the century dry farming in the Semirech'ye province was introduced only under conditions of small plots, scattered throughout mountain fields". However, despite Argynbaev's statement, it is evident that through much of the Medieval period and likely earlier there was a history of irrigated agriculture along major river ways as evidenced by large towns and settlements (Bartol'd 1962 – 1963). Soucek (2000:3) notes that agriculture, primarily irrigated and oasis type, was practiced near rivers and springs, utilizing mountain rainfall and glacial melt; dry farming was practiced only in higher elevations and foothills

Bartol'd suggests that medieval nomadic invasions may have destroyed sedentary villages and forced agriculturalists off prime grazing land. If this is true then it is possible that from the period of the Mongolian invasions (mid-thirteenth till the fifteenth centuries) until the period of Russian imperialism (1721 – 1917) agriculture may not have been resumed in the region or only took the form of low-investment cultivation. Shifting systems cause issues with ethnographic analogy because agricultural investment may change from year to year and region to region.

Vainshtein (1980:150) points out accounts of Pashkevich's (2003) crop trio – broomcorn millet, foxtail millet, and barley –in mobile pastoralists' agricultural systems in both Tuva and Afghanistan. While Vainshtein (1980:146-150) mentions early accounts of mobile pastoralists conducting millet cultivation across much of Central Asia, Southern Siberia, and Eastern Europe, he specifically discusses practices mentioned in early literature on the Kyrgyz of Afghanistan and Tuvans of the Altai in northern Central Asia.

Vainshtein (1980:146-148) argues that there was early agriculture in Central Asia, specifically in southern Tuva, possibly pre-Iron Age (Scythian) and the Han Dynasty. He is also careful to point out that the mobile pastoralists observed in his ethnohistoric accounts are affected by millennia of imperial conquests. He notes that in the Middle Ages, during Mongolian conquests, many Central Asian mobile pastoralists were forced into a sedentary and more intensified form of agriculture by military force.

When pastoralists fit together these diverse economic pursuits it often causes conflicting labor and time issues (Salzman 2004). In a mixed semimobile agropastoral system, not only are herders called away from their herds during harvest, but prime grazing land is maintained for cultivation. Therefore, economic systems must be constructed, arranging time, space, labor, and capital demands to suit the need of all economic pursuits. Dyson-Hudson (1966) noted that among the Karimojong there was a sexual division of labor, whereas men focused on pastoral pursuits and women focused on agricultural pursuits. In addition to dividing labor, differing economic systems can have complementary components. Salzman (1971, 2002) noted, during his work in Baluchistan, that mobile pastoralists also cultivated dates (*Phoenix dactylifera*). After the processing of the date pits for oil, the mash is used to wean lambs and kids. In addition, the fronds of the palm are used to make ropes for tents and packing for camel transport. Koster (1977) noted, among Greek agropastoralists in northeast Peloponnese, that agriculture and pastoralism can be complementary. In Peloponnese herds are moved among pastures throughout the year but brought into post-harvested agricultural fields to feed on the stubble in the fall.

Archaeological Evidence for Agriculture

It has been accepted, since Raphael Pumpelly's (1908) expedition in 1904, that agriculture in southern Central Asia dated back to the Neolithic and early Aeneolithic. Soviet and post-Soviet research on Bronze Age (and earlier) agriculture in southern Central Asia has shown that there was an intensive agricultural system in the piedmont of the Kopet Dag, Turkmenistan. The earliest phases at the Neolithic villages of Jeitun, Anau, and Namazga I place agricultural origins back into the six millennium B.C. However, as Lisitsina (1981:351) notes “sedentary farming sites of the Neolithic are concentrated exclusively in the northern foothills of the Kopet Dag and thus far have not been found anywhere else, particularly at considerable distance from the mountains”. Dolukhanov (1981) argues that climatic and environmental factors during the second millennium B.C. restricted farmers to these small ecotone zones between the mountain and desert. He further argues that climatic ameliorations during the Bronze and Iron Age interface allowed for more extensive agricultural pursuits.

Soviet research on archaeological agriculture was almost exclusively centered on identifying agricultural tools (reaping tools such as sickles, hoes, or grinding tools) (Korobkova 1981) or grain imprints on ceramics (Pashkevich 1984). There are, of course, a number of issues with these data. First, the utility of a tool is assumed and a sickle knife could just as easily have been used as a skinning knife. Even more problematic is the use of grinding stones as evidence for agriculture. Grinding stones are found across Central Eurasia and date back to the Neolithic in areas where Neolithic sites are found. A grinding stone could be used to grind wild plants (wild grains or nutrient storage plant parts such as geophytes or nuts) or dyes and pigments. Grind stones were used in southwest Asia to process mineral pigments such as ocher. Indeed, ocher pigment is found in some early steppe burials (Field and Prostov 1938). Ethnographic records on the steppe describe the production of flours from the rhizomes of *Typha* and *Phragmites* (Gunda 1949). Pashkevich (1984) notes that querns, grinders, and mill-stones of various sizes and shapes were common among Iron Age steppe sites.

Second, imprints of grains on sherds are extremely rare in many cases and abundant in other cases and there are a number or factors that may or may not lead to an imprint being made on ceramics. Often when ceramics contain imprints it is because grains were spread across a working surface to help keep a pot from sticking during construction or because grains were used as an inclusion (possibly unintentionally mixed in with other inclusion material).

Despite the fact that agricultural tools alone are problematic evidence for identifying agriculture, they are useful supportive evidence, aiding the arguments made in this dissertation. Korobkova (1981) gives a summary of harvesting (reaping) tools found in Central Asia. He also conducted experimental work, reconstructing and using the harvesting implements. He notes that the most common type of harvesting tool is a "harvesting knife" (Korobkova 1981:326). This is a wood or bone tool with two or three prismatic stone flaks affixed into it. Harvesting knifes were found at the site of Ust'Narym in eastern Kazakhstan. "Unmistakable agricultural implements have been found in Jeitun Culture settlements: inset-blade sickles or knives for harvesting… grain hullers, mortars, pestles, grinding stones" (Lisitsina 1981:352). Korobkova (1981) also notes that similar reaping tools are found across Eurasia from Moldova and Ukraine down through the Caucuses and through southern Central Asia including the Zerafshan and Fergana Valleys.

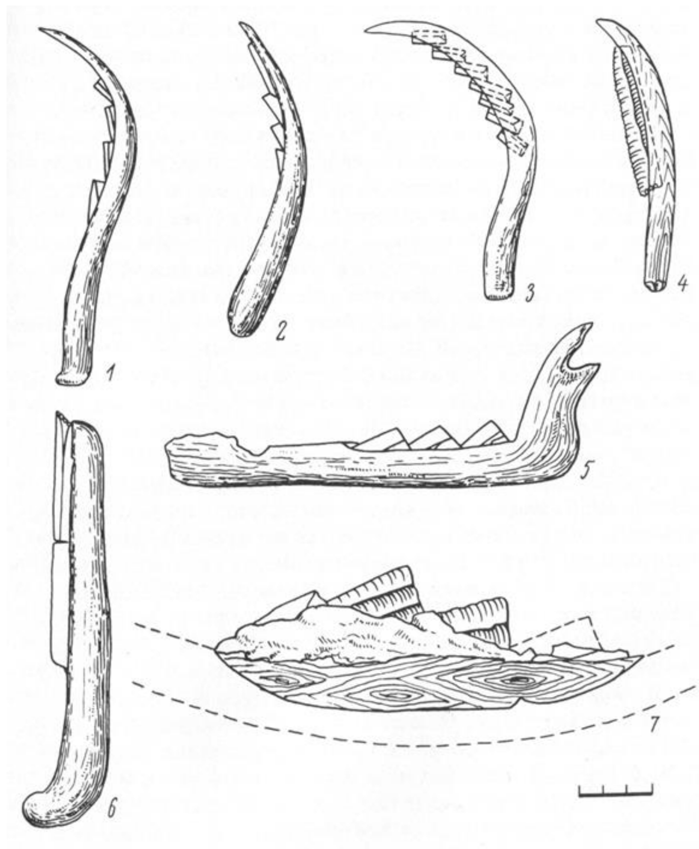

Figure 5.1. An assortment of Neolithic and Bronze Age harvesting tools from Korobkava (1981:327) (1 and 2) sickles from the Karanovo site in Bulgaria; (3) from the Tripolye Culture site of Luka Vrublevetskaia in Ukraine; (4) typical late Tripolye Culture Sickle; (5 and 6) from Shomu-tepe in Azerbaijan; and (6) a harvesting knife from Chopan-depe in Turkmenistan

Lisitsina (1981) notes that stone or metal hoes are not frequently found in Central Asian sites, even in southern Central Asia. She argues that at sites in southern Central Asia, where the existence of agriculture is well established, hoes would not have been necessary because the soft alluvial soil could have been worked by simple wood tools. She suggests that the *Tamarix* wood, which grows in abundance along river ways in the foothills of the Kopet Dag, could have suited as digging tools. Di Cosmo (1994) points out, that stone or metal sickles and plows were not needed, possibly explaining why so few of them are found across much of Central Eurasia before the medieval periods. The only archaeological artifacts to enter the archaeological record would be grinding stones. There are, however, some finds of archaeological artifacts that researchers have claimed to be digging tools from southern Central Asia, such as a pair of stone hoes from the site of Chakmakly-depe (Berdyev 1968).

Despite the fact that low-investment farming in western Mongolia does not require iron tools, iron plowshares and hoes are sporadically found in the region dating back to the Xiongnu period. Several Soviet excavations have noted these iron agricultural tools, including Rudenko's (1962) excavations at the Noin Ula cemetery. Di Cosmo (1994:1102) also notes that millet seeds were found in a Soviet excavation of a 'royal' kurgan in the Noin Ula cemetery only a few kilometers from Ulaanbaatar, Mongolia. A recent study by Koroluyk and Polosmak (2010) found a large cache of un-hulled broomcorn millet grains in the bottom of burials 20 and 31 at the Noin Ula cemetery. Okladnikov (1959:419-420) discusses iron agricultural tools found in the Lake Baikal region of Mongolia. Many of these iron tools come from large fortified urban centers of the Xiongnu period. A description of these large centers is presented in Rogers et al. (2005) or Di Cosmo (1994). One of these centers, Ivolga, dated between the third and first century B.C. has had reported finds of grains of millet, barley, and wheat (Davydova 1968:241); however, proper identification, photography and description was not conducted, nor were the grains direct dated.

Lisitsina (1969, 1981) argues that simple irrigation structures existed in southern Central Asia as far back as the Neolithic or early Aenolithic (Namazga II – IV, mid-fourth millennia B.C.), However, she notes that no solid evidence for these early structures has preserved (possibly due to rapid and heavy sedimentation). A network of irrigation structures has, however, been identified at the site of Geoksyur I from the later Eneolithic (Namazga III, third millennium B.C.). This irrigation system consisted of three parallel canals connecting to a river branch in the delta of the Tedjen River. Lisitsina (1969, 1981) further argues for more complex irrigation systems being implemented in this region starting in the Late Bronze Age and early Iron Age. She notes that this transitional period marks cultural changes across Central Asia; she points out that these changes coincide with increased agricultural pursuits (Dolukhanov 1981; Lisitsina 1981). In the Murghab Delta these cultural changes and agricultural intensification may have also led to a diversification of crops leading to the incorporation of "soft and dwarf wheat, two-row and six-row naked and hulled barley, rye, and chick peas" (Lisitsina 1981:356). Irrigation is argued for at Jeitun based on phytolith evidence (Larkum 2010:149). Hiebert (1994) suggests that irrigated agricultural oases in southern Central Asia appeared 4,000 years ago.

Changes in crop choices may also indicate a switch to an irrigated form of agriculture. Switching to a six-rowed form from a two-rowed form may indicate a switch to irrigation (Harlan 1968; Miller 2003). Replacing glume wheats with free-threshing varieties has been argued to indicate an adoption of irrigation on the Deh Luran Plain, Iran (Helbaek 1969) and Anau North, Turkmenistan (Miller 2003). While, Jack Harlan (1968) pointed out that six-rowed barley is often grown as an irrigated crop, while two-rowed is not, his father, Harry Harlan (1914:29) observed that the plumpness of a cereal grain is more prominently affected by irrigation than the width. Based on this fact, Miller (1999:16) suggests that the highly plump wheat and barley grains of southern Central

Asia may be in part a morphological response to irrigation[18]. Miller (1999) also points out the non-glume varieties of grains are not restricted in their growth, and therefore, the grain is more readily able to become plump. In the Murghab Delta these cultural changes and agricultural intensification may have led to a diversification of crops leading to the incorporation of "soft and dwarf wheat, two-row and six-row naked and hulled barley, rye, and chick peas" (Lisitsina 1981:356).

Vainshtein (1980:145) references irrigation canals in Tuva in the Khemchik valley, which have Kazylgan burials overlaying them. These irrigation canals, according to Vainshtein, predate what most scholars refer to as the Scythian period. If this is an accurate dating, then irrigated agriculture may have existed in the Altai Mountains as far back as the early Iron Age. In the Kazylgan burial grounds archaeobotanical remains of millet grains as well as grinding-stones were reported (Vainshtein 1980:146). Vainshtein (1980:146) also notes that Han period graves in this region not only had remains of millet grains, but also bone hoes. These remains date to the Xiongnu period. Iron and bronze hoes and plows have also been identified in these mountains parts of northern Central Asia (Vainshtein 1980:146; Di Cosmo 1994). Furthermore, Vainshtein (1980) notes findings of millet grains in burials in the Kokel cemetery in southern Tuva in Russia.

There is considerable evidence for agriculture in Xinjiang, China dating as far back as 2000 B.C., and I will not mention all of the discoveries in this synthesis. Part of the reason for such a detailed record supporting agriculture in Xinjiang back into the Bronze Age is the quality of preservation. In many cases food-stuff such as bread or raisins preserve in burials in the desert sands with such high quality they appear to still be

[18] Although she also suggests that they could be a distinct variety of compact wheat and barley.

palatable. Millet and free-threshing wheat cultivation goes back as far as 2000 B.C. at the Lopnor sites of Gumugou and Xiaohe (Di Cosmo 1994: 1106; Lawler 2009; Li et al. 2011; Thornton and Schurr 2004; Wang 1983; [CRAIXAR 2007: discussed in Hunt et al. 2011]). Barley was introduced into the region around 1000 B.C., based upon findings at the site of Alagou (Wang et al. 1985). The Turfan Basin and the regions west of the oasis of Lop Nor along the foothill zones of the Kunlun and Altai Mountains were occupied by small groups of people who had economies of "semi-agricultural and seminomadic ways of life" (Yong and Yutang 1999:227). In these mountains wheat, barley, and both millets, as well as peas and possible oats have been reported to date back to the second millennium B.C. (Fu et al. 2000; Fu 2001). Furthermore, there is now good evidence showing that by the Iron Age in the oases of Xinjiang there were agricultural and horticultural (including viticulture) practices (Jiang et al. 2009; Yong and Yutang 1999). After the establishment of the Han controlled Silk Road (130 B.C.), agricultural military outposts were established in an attempt to connect the oases of Xinjiang (Yong and Yutang 1999). Millet and barley grains were found at the Han period settlement of Edsen Gol (Di Cosmo 1994:1106). This settlement is argued to have been a Chinese colonist settlement in Xinjiang.

Millet grains have been found at the sites of Xintala, Gumugou, and Sidaogou (Debaine-Francfort 1988, 1989). Free-threshing wheats have been found at Xintala, Gumugou, Shirenzi, Kuisu, Lanzhouwanzi, Ranjiagou, and Qunbake (Debaine-Francfort 1988, 1989; Di Cosmo 1994). Di Cosmo (1994) has accumulated all the archaeological evidence for this part of the world and plotted out a map of known agricultural sites in the region. A modified version of this map is presented in Figure 5.2. A discussion of the numerous finds of metal and stone agricultural tools in the Xinjiang region is provided by Di Cosmo (1994:1108). By the Xiongnu period and definitely after the establishment of the Han controlled Silk Road (130 B.C.) sedentary agricultural villages existed throughout the Tarim Basin and Turfan areas and around Lopnor and Lulan. Few of these sites have had systematic flotation or palaeoethnobotanical analyses conducted on them. Recent flotation work currently being conducted in Xinjiang is further illustrating the use of agricultural practices in the oases of Xinjiang (Zhijun Zhao personal communication 2010).

Agricultural tools in western Xinjiang date back to the Bronze Age at the sites of Aksu and Shufu (Di Cosmo 1994:1108). In addition Saka and Wusun agricultural tools have been recovered from the sites of Xintala and Quhui in Xinjiang, south of the Tien Shan. A Wusun tomb at the site of Xifengou also had iron agricultural tools (Di Cosmo 1994; Figure 5.2).

Agricultural production in the Xiongnu Empire has been argued by a number of archaeologists (Barfield 1989; Di Cosmo 1994). The Xiongnu Empire was a unified confederacy, comprised of mostly mobile groups in Mongolia, Siberia, and parts of Central Asia (Barfield 1989; Di Cosmo 1994). Based on Chinese historic accounts it is believed that the Xiongnu Empire unified toward the end of the third century B.C. and the southern portion of the Xiongnu fell to Chinese military attacks in 51 B.C. (Di Cosmo 1994:1095). The northern portion of the Xiongnu may have been pushed westward into Central Asia (Di Cosmo 1994:1095). Di Cosmo (1994) argues that Xiongnu groups cultivated domestic crops and had a high degree of variability among economic strategies. Honeychurch (2004; Honeychurch and Amartushin 2007) has also argued for agriculture and economic variability among Xiongnu peoples.

Chen and Hiebert (1995:283) discuss the nature of second millennium B.C. agriculture in Xinjiang and southern Central Asia, claiming that "most of the various cultures utilized wheat, barley, and millet, with assemblages of stone agricultural tools suggesting its local production in oases". Chen and Hiebert (1995) also propose an 'oasis model' (not Childe's model), they allude to a connection between the economic systems of the deserts of Xinjiang and the deserts along the edges of the Kopet Dag. They suggest that there may have been a flow of economic strategies through the Pamir Mountains connecting Central Asia with western China. They make this claim based on the similarities in irrigated oasis agropastoralism in Xinjiang and south Central Asia.

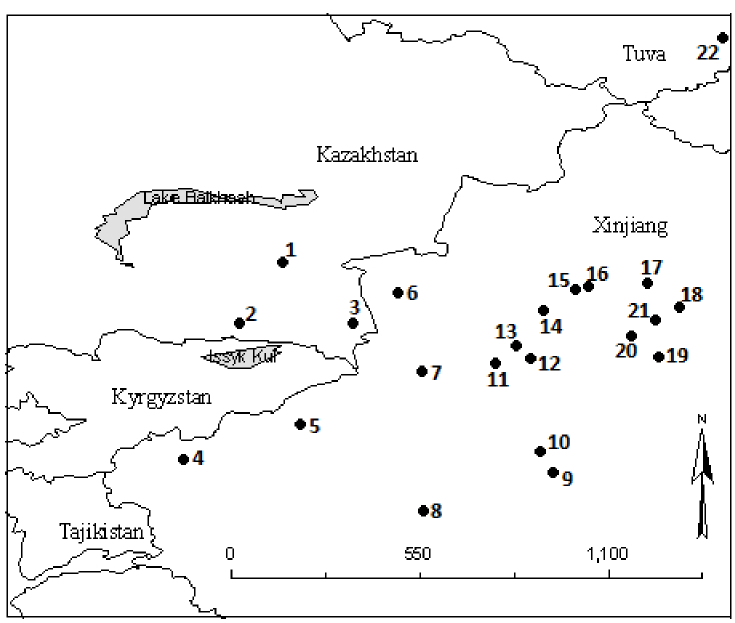

Figure 5.2. Map showing sites in the Late Bronze and early Iron Age with proposed agricultural components (data partially from Di Cosmo 1994:1105): 1) Begash; 2) Tuzusai; 3) Zhaosu; 4) Shufu; 5) Aksu; 6) Nileke; 7) Qunbake; 8) Minfeng (Niyä); 9) Loulan; 10) Gumugou; 11) Yanqi; 12) Alagou; 13) Quhui; 14) Turfan; 15) Sidaogou; 16) Mulei (Mori); 17) Balikun (Barkol); 18) Shirenzi; 19) Hami; 20) Wupu; 21) Kuisu; 22) Pazaryk

Phytolith and macrobotanical analyses conducted at Tuzusai and Tseganka 8, both on the Talgar alluvial fan attest to a complex agricultural component in the economy, including such crops as bread wheat, barley, foxtail millet, and questionable broomcorn millet phytoliths were identified (Chang et al. 2003; Chang et al. 2002; Rosen et al. 2000). There were also remains of grape pips and nutshell (Chang et al. 2002). These settlements were occupied by Saka and Wusun populations during the Iron Age. The rice, in particular, is indicative of a much more intensive form of agriculture than had been shown before to be present on the eastern steppe. Large and heavy grinding stones were found at several sites in Talgar, including Tuzusai, Taldy Bulak 2, and Tseganka 8 (Chang et al. 2002). These sites are discussed in more detail throughout this dissertation.

Other archaeologists have argued for Iron Age agriculture in Semirech'ye. At the site of Aktas 2, Akishev (1969:39-47 [further discussed in Chang et al. 2002:104, 106]) argues that agriculture was practiced in the Wusun period. He argues this based on findings of irrigation canals and farming tools. There were also reports of charred millet and other grains in the bottom of a vessel from the Aktas 2 site (2002). Litvinskii (1989) reports finds of grinding stones in association with, what he interprets as military fortresses in Kazakhstan.

The western steppe, east of the Don River may be a more complicated area for the study or early agriculture. This dissertation does not comprehensively cover this region of the western steppe. Kohl (2007:128) and others (Anthony et al. 2005; Popova 2006) point out that during the Bronze Age there is almost no good empirical evidence for agriculture on the eastern steppe proper. Whereas, on the forest steppe in the Bronze Age, the existence of agriculture is undisputed.

The Srubnaya descended from a pastoral population previously present in the region. Pre-Srubnaya ancestry on the steppe dates back to 5000 B.C. (Anthony et al. 2005:395). The Srubnaya (Timber Grave) sites tend to be associated with permanent timber buildings and thick middens. Due to the sedentary appearance of the settlements, it has been assumed that Srubnaya maintained a complex agro-pastoral system. This view is further supported by two observations: (1) agricultural systems existed in western Srubnaya sites (Pashkevich 2003); and (2) large settlements west of Srubnaya boundaries show indisputable evidence for agriculture from the Late Neolithic on; starting with Bug-Dniestr Culture and becoming intensified with the Tripolye Culture (Anthony et al. 2005; Anthony 2007). In Caucasia and Transcaucasia by the end of the sixth and beginning of the fifth millennium B.C. the Southwest Asian crop assemblage is present. As far back as the fifth millennium B.C., the Bug-Dniestr Culture had domesticated crops on the western steppe and Eastern Europe in Moldavia and Ukraine (Zohary and Hopf 2000). Sacarovca I dates to ca. 4700 B.C.; in addition to a number of possible foraged vegetal foods, several domestic crops were present in the site's archaeobotanical assemblage: i.e., *Triticum monococcum* ssp. *boeoticum; T. turgidum* ssp. *dicoccum; T. aestivum* ssp. *spelta; T. aestivum* ssp. *aestivum; Hordeum vulgare; H. vulgare* var. *coeleste; Panicum miliaceum; Avena* sp.; *Pisum sativum*, and *Lens* sp. (Pashkevich 2003). In the Linearbandkeramik Culture there is evidence for further intensification of agriculture, adding to the western steppe and eastern European repertoire, *Vicia erivilia*, *Lathyrus* sp., *Cannabis sativa*, *Secale* sp., and *Papaver* sp. (Pashkevich 2003). For a more detailed account of these early agricultural sites in Eurasia the reader is referred to Zohary and Hopf (2000).

The agricultural tradition of the western Tripolye Culture (3850 – 3650 B.C.) is well documented in the archaeological record. Tripolye Culture sites have good evidence for extensive agriculture and animal husbandry – emmer, einkorn, bread wheat, naked and hulled barley, peas, vetches, lentils, sheep, goat, cattle, pigs, buckwheat and broomcorn millet, wild and domestic grapes, wild fruits such as plums, hunting and fishing – aurochs, deer, elk, horse. In addition, copper and bone fishing hooks have been recovered (Kohl 2007:44-45). The presence of antler hoes, querns, pestles, grind-stones, and sickles is recorded at sites west of the Black Sea (Pashkevich 2003; Kohl 2007:45). Kohl (2007) envisions an agricultural system using summer wheat and barley interspersed with crops such as peas and lentils and a shifting cultivation relying on burning and incorporation new lands.

The western Tripolye sites show evidence for low-yield, low-investment agriculture. During this time period new land was brought under cultivation with increased yields leading to population growth and increase in settlement size. Many archaeologists have taken the presence of apparently sedentary communities in the archaeological record as evidence enough for agriculture. It is based upon these assumptions that eastern Srubnaya people were thought to have been producing agricultural goods the same as their western counterparts. The presence of agriculture east of the Don has, however, been disputed based upon a lack of evidence. Until the publication of recent work by the Samara Valley Project (Anthony et al. 2005) no extensive palaeoethnobotanical work had been done on Srubnaya sites east of the Don. Fieldwork conducted by the Samara Valley Project from 1995 to 2002 suggests a lack of agricultural goods in subsistence at eastern Srubnaya sites during the LBA. Extensive systematic palaeoethnobotanical analyses at five sites turned up no evidence for domestic plants, but rather seeds of wild vegetal food stuff, pointing to an economy based on foraging and pastoralism (Anthony et al. 2005). Therefore, it has been proposed that the diet of people in the eastern Srubnaya Culture was based on pastoralism and foraging (Popova 2006b, 2007; Anthony et al. 2005).

5.2.2 Foraging of Wild Plants

Food production – pastoralism and agriculture – and hunting-gathering are alternative subsistence strategies; however, they are not mutually exclusive. In fact, Kohl (2007:128) notes that herding and gathering are complementary economic pursuits. Archaeologists often overlook foraging in the fervor to identify productive economies. Too often foraging is associated with the Paleolithic or more generally hunter-gatherers, and therefore, neglected in the rest of the archaeological record. Foraging can be as effective a subsistence strategy, and indeed, often, more effective than agriculture (for discussions see Clarke 1976; Gregg 1988).

There is limited archaeological evidence for foraging in Central Eurasia; however, the dearth of data could be a result of the limited number of paleoethnobotanical studies.

Furthermore, many foraged plant parts, like fruits, greens, and roots, are less likely to be carbonized and preserved. The paleoethnobotanical study conducted by Popova (2006, 2007) and Anthony et al. (2005) at the sites of Kibit 1, Krasnosamarskoe, Peschanyi Dol 1, 2, and 3 are the first archaeological studies to look at the role of foraging on the steppe. Popova's dietary reconstruction suggests a heavy reliance on wild plants, specifically *Allium*, *Amaranthus*, *Chenopodium*, and *Polygonum*. There is better evidence for foraged wild plants in southern Central Asia. Possible foraged wild plants in the piedmont in Turkmenistan include capers (found in the Djietun macrobotanical assemblage [Harris 2010:216]), pistachio (found in the Gonur Depe assemblage [Moore et al. 1994]), as well as almond, wild apple, pear, plum, cherry, fig, pomegranate, grape (Harris 2010; Moore et al. 1994. Foraging is evident at the Early Bronze Age site of Sarazm in the Pamir Mountains of Tajikistan (see Spengler and Willcox in press). Specifically, the seeds and pits of wild fruits, including Russian olive (*Elaeagnus angustifolia*), hackberry (*Celtis* sp.), sea buckthorn berry (*Hippophae* sp.), and rosaceous relatives (*Prunus* and possibly *Rosa*), including almonds. In addition, shell fragments of wild pistachio (*Pistacia vera*) and a single caper (*Capparis* sp.) were recovered (Spengler and Willcox in press).

Nineteenth century explorers into Central Asia noted the importance of wild plants in the diet of local populations (Pesterev [1793, discussed in Vainshtein 1980:194]; Priklonskii 1953 [1881]; Radloff [1861, discussed in Vainshtein 1980:194]; Seebohm 1882). In the late eighteenth century Pesterev wrong about plant foraging among Tuvan mobile pastoralists (Vainshtein 1980:194). In the mid-nineteenth century Prinklonskii (1953 [1881] sec. 31:23) observed the same reliance upon foraging among the Yakuts as well as vertical mobile pastoralists in the Altai Mountains, such as the Altai-Kazakhs.

Vainshtein states “every observer of Tuvan life in the period of the eighteenth to the early twentieth century has commented on the great importance of gathering as an economic activity” (1980:194). Vainshtein (1980:194-197) synthesizes accounts from several early explores and ethnographers in northern Central Asia, all of whom mention the great importance of foraging among local populations. Other ethnographic studies that have emphasized the importance of wild plants in Central Asian mobile populations include Humphrey et al. (1994), Mowat (1970), Popov (1966), and Levin and Potopav (1964).

Geophyte (underground storage organ) is a broad category encompassing all subterranean botanical storage tissues (e.g., roots, bulbs, rhizomes, tubers, etc.). Geophytes were important dietary components for early historic people in the Altai Mountains, i.e., Kazakhs, Tuvans, and people further north such as the Yakuts (Fernández-Giménez 1994; Humphrey et al. 1994; Levin and Potapov 1964; Mowart 1970; Popov 1966; Priklonskii 1953 [1881]; Vainshtein 1980). The following observation was written by a late eighteenth century explorer by the name of Pesterev in Tuva: “right from the middle of August they migrate across the mountains to hunt and gather lily bulbs” (Vainshtein 1980:194). In Pesterev’s interpretation, migration was for collecting wild plant resources for human consumption, rather than to find new pasture land.

Many of the harvested wild roots are spring ephemerals, such as *Erythronium* that had to be harvested in late spring or early summer after the plant has restored its root-nutrients (notably carbohydrates). *Erythronium* bulbs were dried and stored in large sacks (Levin and Potapov 1964). The Yakuts would prepare the fresh bulbs by putting them directly in the ashes or cooking them with their meals. They are still an important food for Tuvans today (Humphrey et al. 1994).

There were also a number of late summer/fall harvested geophytes, including those from *Allium* spp., *Lilium* spp., *Paeonia anomala*, *Polygonum viviparum*, *Sanguisorba alpine*, and *S. officialis* (Levin and Potapov 1964; Mowart 1970; Popov 1966; Vainshtein 1980:194-197). *Lilium* bulb harvesting started in August (Vainshtein 1980). *Sanguisorba alpine* roots were harvested in July and August (Priklonskii 1953 [1881]). Bulbs were stored for the later parts of the winter; scurvy remedies are important among pastoralists, who often have diets lacking in vitamin C (Priklonskii 1953 [1881]; Seebohm 1882). Di Cosmo (1994:1113) claims that for ethnographic Kazakh herding populations wild and cultivated plants are an important supplementary element in the diet, which is particularly important during the winter months. Vitamin C can be obtained through milk but only if it is consumed fresh and unprocessed (not available outside the lambing season). Therefore, it is possible that vitamin C deficiency and associated diseases, such as scurvy, were of major concern in the Bronze and Iron Ages. A food product that can store for extended periods of time and is high in vitamin C would have been advantageous. *Allium* bulbs specifically were an important scurvy preventative (Priklonskii 1953 [1881]).

Several nineteenth century explorers noted that wild *Allium* spp. bulbs (e.g., onions [wild field onions, bear onions], wild garlic, and leeks or ramps) were collected and stored for the later months of the winter (Pesterev [discussed in Vainshtein 1980:194]; Priklonskii 1953 [1881]; Radloff [1861, discussed in Vainshtein 1980:194]; Seebohm 1882). Priklonskii (1953 [1881]) also claims wild onions were sometimes fermented for longer storage. Wild *Allium* species grow in abundance across Semirech'ye today (personal observation 2007 – 2011). Pollen analyses at Krasnosamarskoe support the possibility that *Allium* plants were used in the Bronze Age on the steppe. Popova reports *Allium* pollen in two features, possibly middens, at that site (Popova 2006:235, 2007). *Allium* pollen is transported via faunal vector, and therefore, the grains do not readily become incorporated into the pollen rain.

Other important wild geophytes in the historic diet of Central Asian and southern Siberian populations include: *Armoracia rusticana*; *Astragalus umbellatus*; *Calla palustris*; *Iris* sp.; *Peaonia* sp.; *Phragmites communis*; *Polygonum bistorta*; *P. viviparum*; *Polygonum risturta*; *Sagittaria sagittifola*; and *Typha latifolia* (Gunda 1949; Humphrey et al. 1994; Levin and Potapov 1964; Mowart 1970; Popov 1966; Priklonskii 1953 [1881]; Vainshtein 1980).

There are many fruiting plants that grown in Kazakhstan (for a listing of fruiting trees and shrubs see Dzhangaliev et al. 2003). Berrying as an economic activity is mentioned in many ethnohistoric accounts. Many of these fruit resources are scarce on the steppe; however, vertical mobility would have brought people into direct contact with such resources at higher elevations. Vainshtien notes "that the migratory patterns typical of Tuvans included autumn pastures which were usually in the mountains or foothills (or nearby), which gave access to places where edible plants could be found without too much difficulty" (1980:196). Levin and Potopav (1964) mention the collection of *Crataegus* hips by Kazakh herders; these shrubs grow on the steppe proper (Dzhangaliev et al. 2003)[19].

Some other fruit resources that grow in the foothills and low elevations of the mountains in Kazakhstan include *Vaccinium* spp., *Rubus* spp., *Ribes* spp., and *Prunus*

[19] A few *Crataegus* seeds were found in Miller's (1996 unpublished) macrobotanical study at Tuzusai.

spp. Seebohm (1882) mentions the gathering of cranberries (possibly *V. opulus*) in the boreal forests. Dzhangaliev et al. (2003) claim *V. microcarpus* and *V. palustris* grow in Kazakhstan. Crowberries (lingon berries or fox berries [*V. vitis-ideae*]) were observed being collected in the Altai Mountains and Tuva (Levin and Potapov 1964; Seebohm 1882). *V. myrtillus* (okhata) were collected by mobile pastoralists further north, and eaten raw, boiled, or mixed with *tar*, cream, or milk (Jordan et al. 2001). Four species of *Rubus* have been identified in Kazakhstan (Dzhangaliev et al. 2003). Seebohm (1882) mentions the collecting of cloudberries (*R. chamaemorus*) in the Altai Mountains. Eleven species of *Ribes* grow in Kazakhstan (Dzhangaliev et al. 2003). Ethnographic accounts mention the collecting of red and black currents (*R. vulgare* and *R. nigrum* respectively) (Levin and Potapov 1964; Seebohm 1882). Bird cherries (*Prunus avium*) were collected in Kazakhstan and further north as well (Levin and Potapov 1964; Seebohm 1882). These are just a few of the edible fruits mentioned in Dzhangaliev et al. (2003).

Many of the wild herbaceous seeds found in the paleoethnobotanical assemblage for Begash and Tuzusai have analogous accounts in the ethnobotanical records as being used in subsistence, including *Chenopodium*, *Galium*, *Malva*, and *Polygonum*.

Excavations were conducted at the long-term settlement of Krasnosamarskoe and the herding camps of Peschanyi Dol 1, 2, and 3 by the Samara Valley Project with the purpose of understanding settlement patterns and herding during the Bronze Age (Anthony et al. 2005). Krasnosamarskoe is one of several large scale settlements along rivers on the western steppe, in the middle Volga region. There are similar settlements along the Samara and lower Sok Rivers (Popova 2006:308, 2007). At these sites in the Late Bronze Age, members of the Srubnaya Culture established large settlements with wooden structures (Anthony et al. 2005). Extensive archaeobotanical analysis at these sites produced no evidence of domestic crops. Popova has pieced together an economic model for this community that incorporates movements of herds from various herding camps such as Peschanyi Dol 1, 2, and 3, while large-scale settlements were central meeting locations of ceremonial significance (2006). The most interesting aspect of Popova's model is the role of foraged plant goods. She notes in particular the importance of the wild grain *Chenopodium album* (Popova 2006:307, 2007). High percentages of *C. album* were recovered from Peschanyi Dol 1, 2, and 3 (2 in particular), as well as at Krasnosamarskoe and Kibit 1 and 2 (Popova 2006: 265). A number of *Polygonum* nutlets were found in combination with *C. album* in a waterlogged pit (feature 10) at Krasnosamarskoe (Popova 2006:222-224).

Pertaining to the archaeological record, Hans Helbaek (1952) made the following statement:

> "There can be no doubt that they were gathered as supplementary food in many places. This is proved for the Danish Iron Age by finds in the stomachs of corpses found in bogs and pure deposits of *Chenopodium* and *P*[*olygonum*] l*apathifolium* seeds in burnt houses in Jutland, and disproportionate amounts of *P. convolvulus* in food remains and grain deposits in Central Europe and Denmark demonstrate the utilization of these large fruits" [Helbaek 1952:221].

Luczaj and Szymañski (2007:18) noted in their ethnobotanical work in Poland that *Polygonum* was utilized as food until the early twentieth century. The whole shoots of the plants were harvested, and shoots of *P. lapathifolium* were "scalded and fried with lard, butter, cream, flour or eggs” (Luczaj and Szymański 2007:18). In the same region the leaves and seeds of a number of other *Polygonum* species were harvested for use as potherbs or in soups.

The ethnobotanical record shows how important *Chenopodium* was around the world. *C. album* is noted as a food in Russia, specifically as a famine food by Popova (Popova 2006:264). Both *C. album* and *C. murale* are utilized throughout southwest Asia as a salad-green and potherb (Boulos 1985:151). *C. album* was once cultivated as a bread-grain in southwest Asia. *C. opulifolium* was used as a potherb in the Mediterranean world and east all the way to Iran (Boulos 1985:151). *C. album* was noted in the ethnobotanical accounts in Poland by Luczaj and Szymañski (2007:14). While they particularly mentioned *C. album*, Luczaj and Szymañski (2007:14) suggest that a number of other species were likely utilized.

Chenopodium plants are very common in disturbed soil, and therefore, are prevalent in areas of human activity such as middens, gardens, abandoned livestock pens, and crop fields. Hence, they have been (intentionally or unintentionally) manipulated and cultivated as weedy crop inclusions for millennia. They have long had a close, interconnected relationship with humans.

Ethnohistoric accounts from the first century A.D. attest to both cultivated and wild varieties of *Malva sylvestris* being eaten across the ancient Roman world from Egypt to Rome and east throughout Asia (Dioscorides 1959 [first century A.D.] book 2:144 and book 3:163-164). *M. sylvestris* has been utilized as an important crop for at least two millennia. Dioscorides focusses on domestic crops in book 2; he addresses wild *Malva* later in book 4. There are other accounts that support the widespread cultivation of

M. sylvestris. One account claims that this crop was, at one time, one of the most important vegetable crops in China (Fowler and Mooney 1990). El Hadidi (1984:89) suggests that a wild form of *M. parviflora* may have been eaten in Egypt as far back as the Late Paleolithic. He also suggests that this early wild food may have been the progenitor for the cultivated *M. parviflora* in Egypt today (El Hadidi 1984:89). *M. parviflora* is still cultivated as a potherb in parts of southeast Asia and Egypt; it is sold in markets in Egypt (Boulos 1985:152). Domesticated *M. sylvestris* is hap-hazardously cultivated and eaten in the central plains of China in Sichuan (personal observations 2009 – 2011).

In Poland, until the mid-eighteenth century, both *M. neglecta* and *M. sylvestris* were collected as potherbs (Luczaj and Szymański 2007:17). These species were utilized interchangeably. Luczaj and Szymañski (2007:17) also observed children collecting and eating the raw seeds of both species. Collecting of *Malva* sp. seeds is noted in other ethnobotanical accounts. They were collected until the mid-twentieth century and ground as a flour additive in the making of bread (Luczaj and Szymański 2007:18).

Galium species have had a number of economic uses, but the most notable use in Europe and Asia may have been as rennet in cheese making. A chemical in *Galium* plants causes milk to curdle. Historic and ethnographic accounts of the plant being used for this purpose appear across Europe, from the highland of England, where a rich yellow cheese was produced, to the Mediterranean (1951:927). Aron and the Western Isles were noted in particular for producing cheese in this manner by Lightfoot, in his 1777 ethnobotanical study of Scotland. *Galium* was used as a yellow dye in some parts of the world; it produces a bright yellow-colored cheese (Lightfoot 1777). The generic name, *Galium*, comes from Greek *gala* which means milk. To trace back the oldest account of this practice in the ethnobotanical record we have to look at the writings of Dioscorides. Dioscorides claims that, as a result of its use for coagulating milk, it was also referred to as *Gallion*, *Gallerium*, and *Galatium* in the first century A.D. (1959 [first century A.D.] book 4:96). He notes in particular that shepherds used this plant to curdle milk (Dioscorides 1959 [first century A.D.] book 3:104). At the Srubnaya Culture (Late Bronze Age) site of Krasnosanarskoe, in the Sumara River valley, (Popova 2006:30) notes finding high levels of *Galium* sp. pollen in the corner of an occupation floor. This type of pollen grain was not found anywhere else in the site (Popova 2006:235-236). She also notes that in this corner there was a ceramic artifact, which archaeologists interpret as a cheese strainer (Popova 2006:30). She suggests an evident correlation (Popova 2006b:30,235-236).

Khazanov (1984:39) notes that "all, or almost all, nomads include vegetable foods in their diet, although in different quantities and they procure these foods by different means". It is not possible with the current data set to determine if the herbaceous wild seeds in the Tuzusai, Tasbas, and Begash archaeobotanical assemblage represent food procurement through foraging[20]. Nonetheless, it is important to look for evidence of this economic practice in the archaeological record, especially in light of the importance that this economic practice had for early historic mobile pastoralists.

[20] Issues between identifying remains of human foraged food-stuff and the remains of animal foraged and subsiquently burned dung will be discussed later in this dissertation.

Chapter 6: Archaeobotany: Wild Plants and Pastoralism

6.1 Introduction

As one of the first systematic studies of archaeobotanical remains in Central Asia, this dissertation provides an important foundation for future projects. In Chapter 6, I start off, in the introduction, discussing the botanical assemblage as a whole. The introduction is followed by a methods section. I then present and discuss the wild seeds and plant parts identified in this study. The archaeobotanical assemblage is divided into two chapters based on domesticated verse wild status of the remains. Domesticated seeds/fruits and textile remains are presented in Chapter 7. For each plant category I discuss morphological characteristics and counts. These counts and densities will help provide comparative material for future projects when developing a broader understanding of Central Asian economy and environment in the past.

This dissertation deals with a total of 15,109 seeds and seed fragments (Table 6.1). Of that total, 12,669 are carbonized and 2,440 are uncarbonized. Out of all the carbonized seeds, 3,777 of them are domesticated. In addition, there are 3,664 unidentifiable seed fragments. A total of 433 L of soil was analyzed for this study, from a sum of 74 spanning (including three thirteenth century samples from Begash) samples the Bronze and Iron Ages and representing different ecological settings.

	Domestic Seeds	Wild Seeds	Total (Carbonized)	Uncarbonized Seeds	Liters of Soil	Total Samples
Begash (Iron Age)	57	1,097	865	329	32.6	13
Begash (Bronze)	34	2,485	2,519	43	97.2	18
Mukri	32	149	181	0	0.45	1
Tuzusai	2,314	849	3,163	980	212.5	25
Tasbas	1,287	3,385	4,672	722	106.8	14
Totals	3,777	8,892	12,669	2,440	433	71

Table 6.1. Sums from all four sites

Totals – Begash

Flotation samples from Begash vary in volume from 30 to 0.4 L; the total sum volume is 154 L, from 34 samples. Therefore, there is an average seed density of 26.0 seeds per liter of soil; density in the Iron Age is 26.5 seeds/L and for the Bronze Age 25.9 seeds/L. In addition to the domestic grains, there are 22 other categories of wild seeds, providing a total seed-category richness of 25 (not including unidentified seeds). There is a total of 57 unidentified seeds and 1,049 unidentifiable seed fragments. The total assemblage abundance from Begash is 4,601 carbonized seeds, 5,386 counting the uncarbonized seeds (Mongol Period material is not included in Table 6.1). Of the total seed count, only 134 are domesticated, 57 from the Iron Age, 34 from the Bronze Age, and 43 from Mongol period samples.

Totals – Mukri

Only one sample was taken from Iron Age layers at Mukri. This sample was collected from a hearth feature, and it was only 0.45 L. The sample was collected because of its visible density of ash and carbonized material. A total of 181 seeds were found in this sample, 32 of which were domesticated. Thirty-seven unidentifiable seeds fragments were found.

Totals – Tuzusai

Flotation samples from Tuzusai vary in volume from 2 to 16 L; the total volume of analyzed soil is 212.5 L and 25 samples were processed. There is a total count of 3,163 carbonized, plus an additional 1,309 unidentifiable, seeds and seed fragments. Of the seeds, 2,314 (73.1 percent of the total) were from domesticated plants; 849 of the seeds were from wild plants. Tuzusai has a total density of 14.85 seeds per liter of soil. There is a density of 10.89 domestic grains per liter, and 3.99 wild seeds per liter. Seven taxa of domestic grains were identified and 28 categories of wild seeds were identified; total seed category richness is 35 (not including unidentifiable seed fragments or unidentified seeds).

As a complement to the data from the 25 Tuzusai samples, another 48 samples, that where analyzed by Naomi Miller in 1996, were included. These additional 25 samples are presented in Appendix F. These samples are contrasted to the material from 2008 – 2010. The 25 samples from 1996 were obtained from 8 pit features. Cereal grains were not quantified; rather they were weighed, complicating the comparison. However, ubiquity of domesticated grains was 92 percent. Millets were not differentiated between foxtail and broomcorn. A total of 76 seeds were recovered, including 26 uncarbonized seeds. A total of 89.2 liters of soil were floated providing a seed density (only counting wild) of 0.85 seeds per liter of soil. Hence the assemblage from 1996 has far fewer seeds and far lower density than the samples from 2008 – 2010.

Totals – Tasbas

The total assemblage abundance from Tasbas is 4,672 carbonized seeds, 5,394 counting the uncarbonized seeds. Of the total seed count, 1,287 are domesticated. Flotation samples from Tasbas vary in volume from 4 to 7.5 L; the total volume of all 14 samples is 67 L. The average seed density is 43.7 seeds per liter of soil. In addition to the domestic grains, there are 21 categories of wild seeds, providing a total seed-category richness of 29 (sans unidentified seeds). There are also 19 unidentified seeds and 1,265 unidentifiable seed fragments.

	Begash (Iron Age)			**Begash (Bronze)**			**Mukri**		
				Total	**Density**	**Ubiquity**	**Total**	**Density**	**Ubiquity**
Wheat	1	0.03	7.7	1	0.01	5.6	1	2.22	
Barley									
Broomcorn	24	0.74	7.7	26	0.27	33.3	20	44.44	
Foxtail	20	0.61	15.4						
Peas									
Grapes									
Poaceae	93	2.85	69.2	101	1.04	83.3	61	135.56	
Amaranthaceae	165	5.06	76.9	1,043	10.72	100	88	195.56	
Rubiaceae	79	2.42	84.6	560	5.76	83.3			
Solanaceae	39	1.20	84.6	91	0.94	61.1			
Polygonaceae	303	9.29	30.8	34	0.35	55.6			
Malvaceae	23	0.71	53.8	40	0.41	11.1			
Asteraceae	7	0.21	53.8	51	0.52	44.4			
Boraginaceae				3	0.03	16.7			
Fabaceae	87	2.67	76.9	523	5.38	100			
Lamicaeae				2	0.02	5.6			

Hypericaceae				1	0.01	5.6			
Brassicaceae	1	0.03	7.6	2	0.02	5.6			
Zygophyllaceae				4	0.04	5.6			
Rosaceae	3	0.09	15.4						
Convolvulacaeae									
Caryophyllaceae									
Cyperaceae									

	Tuzusai			**Tasbas**			**Total**		
	Total	**Density**	**Ubiquity**	**Total**	**Density**	**Ubiquity**	**Total**	**Density**	**Ubiquity**
Wheat	448	2.11	92.0	4	0.06	21.4	455	1.11	40.8
Barley	313	1.47	80.0	446	6.66	50.0	759	1.85	38.0
Broomcorn	396	1.86	80.0	41	0.61	50.0	507	1.24	49.3
Foxtail	112	0.53	64.0	11	0.16	21.4	143	0.35	29.6
Peas				59	0.88	28.6	59	0.14	5.6
Grapes	4	0.02	8.0				4	0.01	2.8
Poaceae	206	0.97	92.0	304	4.54	57.1	765	1.87	78.9
Amaranthaceae	187	0.88	84.0	501	7.48	64.3	1,984	4.84	83.1
Rubiaceae	60	0.28	52.0	46	0.69	64.3	745	1.82	67.6
Solanaceae	6	0.03	16.0	7	0.10	28.6	143	0.35	42.3
Polygonaceae	31	0.15	48.0	38	0.57	42.9	406	0.99	45.1
Malvaceae	2	0.01	8.0				67	0.16	15.5
Asteraceae	21	0.10	40.0	4	0.06	14.3	83	0.20	52.1
Boraginaceae	140	0.66	80.0	2	0.03	14.3	145	0.35	35.2
Fabaceae	53	0.25	52.0	186	2.78	64.3	849	2.07	70.4
Lamicaeae							2	0.00	1.4
Hypericaceae							1	0.00	1.4
Brassicaceae							3	0.01	2.8
Zygophyllaceae	1	0.00	4.0				5	0.01	2.8
Rosaceae	6	0.03	16.0	7	0.10	28.6	16	0.04	14.1
Convolvulacaeae	2	0.01	8.0				2	0.00	2.8
Caryophyllaceae	87	0.41	40.0	2,286	34.11	50.0	2,373	5.79	23.9
Cyperaceae	3	0.01	4.0	23	0.34	42.9	26	0.06	9.9

Table 6.2. Totals, ubiquities, and densities for all families in all sites

Interpretations

The wild seeds presented and discussed in this chapter are also significant in that they help us interpret what the landscape looked like around the site, and, as I discuss later in this chapter, they give us a glimpse into herd diet and grazing patterns. The wild seeds in the assemblage may have originated from multiple sources; I, however, argue that they are primarily the result of dung burning as fuel. This being the case, the carbonized wild seeds would have been consumed by herd animals and later burned as fuel. The wild seeds in the assemblages, primarily from Begash, are from plants which grow around the sites today; however, they only grow in restricted ecological pockets like river valleys or near a spring. I argue in this dissertation, based on the wild seed assemblage, that herders in the past moved their herds and flocks into localized pockets of nutrient-rich vegetation. This practice of herding in specific ecological pockets is still practiced in the region today.

6.2 Methods

Sampling Strategy

The archaeobotanical samples discussed in this paper were collected during the 2005 and 2006 field seasons by members of the Dzhungar Mountains Archaeological Project (DMAP)[21], the 2006 field season at Mukri (also by the DMAP), the 2008 – 2010 field seasons at Tuzusai as part of the Talgar Kazakh-American Archaeological Project[22],

[21] Floated under the guidance of Dawn Kaufman.
[22] Tasbas and Tuzusai samples were floated by the author.

and the 2011 field season at Tasbas. Two types of soil samples – column samples and feature samples – were taken for the purpose of flotation. Column samples were taken from all stratigraphic layers at Begash, Tasbas, and Tuzusai. Feature samples were taken from every distinct anthropogenic feature, including occupation floors, burials, and hearths[23]. All of these samples were floated and taken to the paleoethnobotany laboratory at Washington University in St. Louis for analysis[24]. All analysis was conducted by the author under the guidance of Gayle Fritz. A preliminary archaeobotanical study was conducted by Naomi Miller in 1996 at Tuzusai. The data produced from her study is used as comparative material in this dissertation and contrasted to the newly collected and analyzed Tuzusai material presented in this dissertation.

Recovery Methods

At Begash, Tasbas, and Mukri, samples were floated using bucket flotation in the field, as described in Fritz (2005:780-784), Pearsall (2000:29-33), and Watson (1976:79-80), and broken down using water separation by means of manual agitation. Samples were measured by pouring soil in 1-liter increments into a bucket. The volume measurements were recorded to the nearest 0.5 liter. After agitation, suspended organic materials were decanted through a geological sieve with 0.355 mm mesh. Decanting and washing of the soil was continued until no more buoyant material was observed. This light fraction material was then transferred to a muslin pouch for drying. The samples were dried in the open air and bagged. In order to prevent cracking, from either over-

[23] Only one feature sample was taken from Mukri.
[24] Only selective samples from Tuzusai were analyzed due to time restraints.

heating or too-rapid drying, samples were kept in a well shaded location at all times. All equipment was washed and sediments were removed for heavy fraction analysis.

At Tuzusai, samples were floated using a SMAP machine in the field, as described in Fritz (2005:780-784), Pearsall (2000:29-33), and Watson (1976:79-80), and broken down using water separation by means of motorized agitation. The SMAP machine was constructed in the 1990s by the project and uses an overflow spout. Water was supplied from an irrigation canal and brought into the tank by a gas-powered Soviet-period irrigation pump. Samples were measured by pouring soil in 1-liter increments into a heavy fraction sieve in the tank. The volume measurements were recorded to the nearest 0.5 L. Throughout the agitation process, suspended organic material was decanted through a spout and into a geological sieve with 0.355 mm mesh. This light fraction material was then transferred to a muslin pouch for drying. The samples were dried in the open air and bagged. In order to prevent cracking, from either over-heating or too-rapid drying, samples were kept in a well shaded location at all times. All sieves were washed between runs.

Non-buoyant residue remaining with the sample after the removal of light fraction material was then processed for a heavy fraction. Heavy fraction samples were washed through a geological sieve of 1.4 mm. These samples were examined in the field lab for carbonized organic remains, ceramics, bones, beads, metal, or other artifacts, using a 5x hand lens. Very little carbonized material was obtained from the heavy fraction samples; this could be partially a result of the sieve size[25].

[25] Due to large quantities of stone and clay, smaller heavy fraction sieve sizes were not practical.

Laboratory Methods

Once in the lab, light and heavy fractions were weighed and then passed through nested U.S. geological sieves. Generally, mesh sizes larger than 2.00 mm were not needed unless a large amount of charred wood material was present, and in these cases (such as FS 2 from Begash) 3.00 mm or even 4.00 mm sieves were used. Typically, all botanical material larger than 2.00 mm was sorted as one unit, while smaller material was broken down into units using sieves of 1.50 mm, 1.00 mm, 0.71 mm, 0.50 mm, and 0.355 mm. Material smaller than 0.355 mm was left in a unit labeled “pan”. Pan material was scanned extensively but not systematically analyzed. Certain types of carbonized botanical materials were separated only from sieve units larger than 2.00 mm; these include wood, bark, stem, culm, fungal material, thorns, bone, sherds, and beads. Most material larger than 2.00 mm was weighed, counted, and recorded, but charred wood from a few hearth samples was weighed but not counted, due to abundance.

Key categories of carbonized organic remains were also separated from sieve units smaller than 2.00 mm; these include seeds and seed fragments, swollen basal nodes, carbonized insects, fibers, and awns. Both charred and uncarbonized seeds were systematically removed, on the grounds that uncarbonized materials seem not to be intrusive, but come rather from undisturbed contexts. The excavation team on the project found little evidence for bioturbation in areas where flotation samples were taken, Frachetti (personal communication 2007) believes there was stratigraphic integrity for these deposits. Based upon the excavators’ observations, it is possible that uncarbonized seeds in the assemblage are prehistoric in age. Because of the possibility that these seeds are, in fact, ancient, they were collected and quantified separately from the carbonized seeds (shaded columns in Appendix F). Many of the seeds described as uncarbonized show evidence of partial carbonization, which may also suggest that they are non-intrusive. The preservation of fully uncarbonized seeds may be due to the soil aridity. Few uncarbonized seeds were recovered from the Bronze Age samples; this may indicated a drop off in preservation of uncarbonized seeds in the older layers. In addition, there are higher totals and a greater number of categories represented by uncarbonized seeds in the historic samples. It should also be noted that the majority of the uncarbonized seeds were *Chenopodium*. The hard testa of *Chenopodium* preserves well in soils; in addition, the seeds themselves are known to stay viable in the soil seed bank for decades (Thompson et al. 1997). The preservation of *Chenopodium* seeds and other Amaranthaceae seeds with hard testae have been reported in archaeobotanical studies on the Eurasian steppe. Popova reported large numbers of uncarbonized *Chenopodium* and *Amaranthus* seeds at the Late Bronze Age site of Krasosomarskoe, in the Lower Volga Region in Samara, Russia (Anthony et al. 2005; Popova 2006). Shishlina et al. (2008:240-241) also reported preserved *Amaranthus* seeds, specifically *Amaranthus albus*, at the site of Gashun-Sala in the Yergueni Hills, on the steppe northwest of the Caspian Sea, in the Late Bronze and early Iron Age. Reporting carbonized and uncarbonized seeds separately allows for future studies and later identification as to whether the seeds were prehistoric or not.

Once all items were separated into categories based upon taxonomy and type, they were counted and recorded. In the case of domesticated grains (broomcorn millet, wheat, barley, and foxtail millet) another division is made. These taxa are divided into whole caryopses and fragmented caryopses. Whole caryopses were measured. These measurements include length and width of the entire caryopsis and length of the hilum. Hilum lengths are not taken if the grain is still enclosed in its palea and lemma (only applicable with the foxtail millet from Begash). A similar method is used to measure Minimum Number of Individual (MNI) for several seed types in the assemblage, including *Galium* sp. and *Polygonum* sp. However, due to the size of the assemblage MNIs were not attempted for most categories.

Identification of the macrobotanical material was assisted by the use of a number of plant identification keys (i.e., Cappers et al. 2006; Davis 1993; Evashenko 2008; Flood and Gates 1986; Fuller 2002a; Gunn and Gaffney 1974; Katz et al. 1965; Knight 1978; Martin and Barkely 1973; Montgomery 1977; Musil 1963; Renfrew 1973). In addition, a modern comparative collection at Washington University in St. Louis was utilized. A separate comparative collection of material was put together from seeds collected during 2009 to the present. This collection was specifically designed for use in Central Eurasia; a sampling of all seeds was added to the Washington University in St. Louis comparative collection.

6.3 Wild Seeds (and Fruit Parts)

All wild seeds will be discussed here individually and are divided by family. A discussion of what the presence of these seeds mean from a depositional and economic standpoint will be presented in the next section. These wild seeds provide us with a glimpse of the paleoecological setting of the four sites discussed in this dissertation.

Furthermore, they help us build a model of mobility and herd placement on the landscape.

Poaceae

The only wild grass seeds identified below the subfamily level are *Stipa*-Type (Figure 6.1h) and *Setaria* (cf. *viridis*)[26] (Figure 6.1b, e). *Stipa*-Type seeds are long and narrow. These caryopses vary in length, and because almost all of them are fragmentary; measurement ranges are not provided, but they all appear to be longer than 2.5 mm and probably average closer to 4.0 – 5.0 mm. They have micro-striations that run the length of the caryopsis and a faint, protruding micro-ridge that runs the length of the ventral side. In addition, they are acute to acuminate. These caryopses are present in association with awn fragments at Begash, for example FS6 has 12 *Stipa*-Type seed fragments and 149 awn fragments. Many of the local species of *Stipa* have long, hardened awns similar to the fragments found at Begash. *Stipa borysthenica*, a common species on the Kazakh steppe (personal observation, 2011), has an awn that fades into a pampus, together reaching up to 16 cm long; other species have shorter awns. In addition, *Stipa* spp. is one of, if not, the most abundant grass genus on this part of the steppe. There are 203 *Stipa*-Type seeds or seed fragments from the assemblage at Begash, most of these are fragmentary and MNI would be much lower. They are ubiquitous across the Begash assemblage. *Stipa*-Type fragments are common at Tuzusai (n = 35) and Tasbas (n = 184), but not as abundant or ubiquitous as at Begash. *Stipa* caryopses were identified at Godin Tepe in Iran, in Period V layers dating to the fourth millennium B.C. (Miller 1990). *Stipa*

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[26]Catagories of Poaceae, Panicoid (Figure 6.1g), and Pooid, were used for all other wild grasses.

caryopses were also recovered from second millennium B.C. layers at Tell Umm el-Marra on the Jabbul Plain in western Syria (Schwartz and Miller 2007).

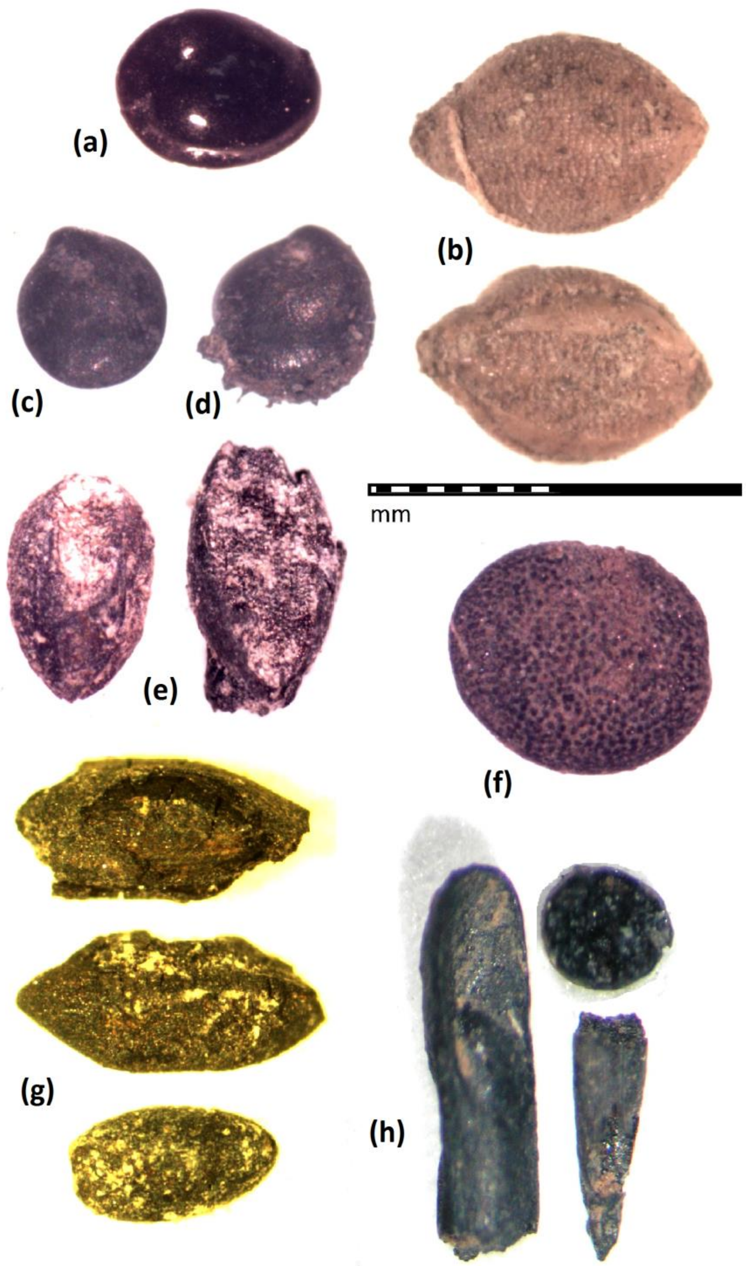

Figure 6.1. Amaranthaceae and Poaceae – a) uncarbonized *Amaranthus* from Tuzusai 2009 FS11; b) uncarbonized wild *Setaria* (cf. *viridis*) from 2009 FS10; c) and d) *Chenopodium album*-Type from Begash 2005 FS6; e) wild *Setaria* (cf. *viridis*) from Tuzusai 2009 FS5; f) *Polycnemum* (cf. *arvense*) from Begash 2005 FS6; g) Panicoid A from Tuzusai 2009 FS7; h) *Stipa*-Type from Begash

The morphology of wild *Setaria* at Begash and Tuzusai are presented in the discussion on wild and domestic foxtail millet, in the next chapter. '*Setaria*' seeds were identified at the southern Iranian sites of Tall-E Jari and Tall-E Malyan, from Bronze Age layers (Miller and Kimiaie 2006). Harrison (1995) found *Setaria* seeds at Anau South (2500 B.C.). Hunt el al. (2008) synthesize the numerous identifications of *Setaria* (wild and domestic) across western Eurasia from Bronze Age and earlier periods.

Amaranthaceae

The most abundant wild seed category in this family is *Chenopodium* spp. These seeds all have a characteristic embryo beak or radicle, and they also have rounded margins unlike the semi-winged or pinched margins of some *Amaranthus* seeds (Figure 6.1a). However, size and minute structural characteristics are so divergent that there is likely more than one species present. Many of the larger specimens have traits that match with *Chenopodium album* (see Martin and Barkely 1973:151; Montgomery 1977:70). They also have faint, striated, semi-longitudinal structuring, from the sulcus scar on the ventral side, and a relatively smooth dorsal side. I placed all of these seeds into a category called *Chenopodium album*-Type (Figure 6.1c, d). Seeds that had a well-defined beak but had a different structuring on the testa were classified as *Chenopodium*-Other. If the testa was completely missing it was put into the category *Chenopodium*-perisperm-only. *Chenopodium album*-Type, *Chenopodium*-Other, and *Chenopodium*-perisperm-only specimens were all placed into the category *Chenopodium* in Appendix F; however, they were all quantified separately. Specimens without a well-defined (or broken off) radicle were clumped into the *Cheno-am* category. The use of *Cheno-am* as a taxonomic category does not imply that amaranth seeds were present in the assemblage. However, following protocol often utilized in the Americas, if the morphological traits needed for differentiation are missing, the taxon *Cheno-am* is used. No carbonized seeds from Tuzusai, Tasbas, or Begash conform closely to the genus *Amaranthus* rather than *Chenopodium*, but at least one species of *Amaranthus* is present in Xinjaing, western China (Wu et al. 2006 vol. 5:417) and may also be native to Kazakhstan. In addition, Popova (Popova 2006) and Anthony et al. (2005) note the presence of amaranth seeds in the carbonized Bronze Age archaeobotanical assemblage from Krasnosamarskoe on the Eurasian steppe in the Samara River valley. Shishlina et al. (2008) identified *Amaranthus album* at Gashun-Sala in the Caspian steppe. A few uncarbonized *Amaranthus* seeds were found at Tuzusai, but may be intrusive. Flad et al. (2009) do not differentiate wild seeds below family level, however, they do break Amaranthaceae and Chenopodiaceae into two separate groups at the site of Donghuishan in Gansu, dated between ca. 1550 and 1450 cal B.C.

Chenopodium seeds are one of the most abundant and ubiquitous seeds in the Begash assemblage (n = 744); *Cheno-ams* are about as abundant (n = 663). They are generally spread evenly across the assemblage. Likewise, at Tuzusai *Chenopodium* is one of the most abundant categories (n = 156), and it is highly ubiquitous. They are dense categories at Tasbas as well, 376 *Chenopodium* seeds and 125 *Cheno-ams*; although their ubiquities are slightly lower at Tasbas. There are 214 seeds in FS19 alone. *Chenopodium* was also the most abundant category at Mukri (n = 84).

Eight grains of Chenopodiaceae were recovered from Bezumennoe 1 settlement, about 2,000 km to the west of Begash in the Volga-Ural Region (Lebedeva 1996 discussed in Popova 2006b). These grains were found in association with 17 domestic grains, six *Panicum miliaceum*, one *Triticum dicoccon*, and 10 *T. aestivo-compactum*. All of these grains are ascribed to a Late Bronze Age Srubnaya context (Lebedeva 1996 discussed in Popova 2006b).

At the Late Shang period site of DGS PI HI, Fuller and Zhang (2007) found morphologically similar *Chenopodium* seeds to those found in the Begash and Tuzusai assemblages, which they call '*Chenopodium* cf. *album*'. *Chenopodium* plants were domesticated in eastern China and are found in some archaeological excavations. Yang et al. (2009) identified a cultivated and possibly domesticated species of *Chenopodium* from the Western Han period site of Han Yangling in eastern China. These grains, *C. giganteum*, were recovered from a burial context and date between 141 – 87 cal B.C. Neolithic caches of wild *Chenopodium* grains have been identified in eastern China (unpublished lecture Zhijun Zhao, 2008) and early domesticated *Chenopodium* have been argued for from the Haimenkou site in Jianchuan County, Yunnan province, China (Xue 2008). Xue (2008) argued that "chenopods" were cultivated in combination with rice, foxtail millet, and wheat at the site as far back as Phase 1 (1600 – 1100 B.C.), with chenopods being the dominant crop from 1600 – 1400 B.C. During Phase 2 (starting at 800 B.C.) wheat became the dominant crop. This site also provides the oldest evidence for wheat in southern China.

Also in the Amaranthaceae family is the genus *Polycnemum*; seeds from plants in this genus were found at Begash (Figure 6.1f). All 14 of the carbonized *Polycnemum* seeds were recovered from later layers at Begash, which is not surprising seeing that it is an arid-steppe plant. There were also 50 uncarbonized *Polycnemum* seeds mostly corresponding to the same samples as the carbonized ones, further supporting the possibility that some of the carbonized seeds may not be intrusive. They have a curled embryo and radicle, like all family members. They are distinctive based on their well-defined surface structuring. According to Wu and Raven (2006 vol. 5:375), there is only one species, with a range from Xinjiang to Central Asia, *P. arvense*. This species is characteristic of sandy, poor soils. Bojnansky and Fragasova (2007:95) report more species that all have morphologically similar seeds in eastern Europe, *P. arvense*, *P. huffelii*, *P. majus*, and *P. verrucosum*, but it is unclear if any of these species make it as far east as Semirech'ye.

Rubiaceae

Carbonized *Galium* sp. or spp. nutlets from Tuzusai and Begash are highly variable in size (see Figure 6.2b, d). All of them are smaller than 2.0 mm in length along the longest axis. Morphologically, the *Galium* seeds tend to be rounder than and slightly smaller than, *G. aparine*, a species abundant across much of Eurasia, eastward to western and southern Siberia (Taylor 1999:714). They are also on the lower end of the longest-axis-length variation scale for *G. spurium*; which like *G. aparine*[27], has longest axis lengths of 2.0 – 3.0 mm (Taylor 1999:713). Among the Tuzusai *Galium* seeds a greater length-to-width dichotomy exists in the larger examples. The majority of the specimens

[27] Many other closely related species exist in the area today; these two species are just used as a comparison for discussion because of their broad ranges and likelihood of being more familiar to the reader.

fall within the size bracket of 0.8 x 0.8 mm for the smaller and 1.8 x 1.5 mm for the largest. The variability in size is a common characteristic of *Galium*; Taylor (1999:713) attributes this variation to a combination of phenotypical plasticity and genecological variation (Taylor 1999:713). Minute surface structuring on the testa wall may indicate that the mericarp was setose (Moore 1975:877-893). It is interesting to note that the vector of dispersal for setose varieties of *Galium* is animal, *via* adherence to fur or wool from herd animals.

While the majority of *Galium* seeds and fragments came from Begash (n = 837), they were also present in the assemblage from Tuzusai (n = 46) and Tasbas (n = 46). They were not recovered from Mukri. Due to the highly fragmentary state of many of the seeds, MNI would be much lower than the totals presented. From Begash FS1, FS19, and FS37 all had high totals of *Galium* seeds.

Galium seeds are found in a surprisingly large percentage of macrobotanical assemblages from around the world. It would be fruitless to try to list even the Eurasian sites with archaeological *Galium* here. However, a few key examples include: Godin Tepe in Iran, where many were found in Period V layers dating to the fourth millennium B.C. (Miller 1990); Tall-E Bakun, in southern Iran from Bronze Age layers (Miller and Kimiaie 2006); Tall-E Malyan, also from the Bronze Age of southern Iran (Miller and Kimiaie 2006); and Anau South, Turkmenistan, dating to around 2500 B.C. (Harrison 1995).

Solanaceae

Hyoscyamus niger seeds range from C-shaped to oblong and are less than 2.0 mm in diameter (Figure 6.2e, f). Using Gunn and Gaffney's (1974:3) identification traits for Solanaceae they are "moderate" sized. They have a sharply curved embryo. In cross-section this embryo appears three times, also known as imbricate (Gunn and Gaffney 1974:5). The most telling characteristic possessed by all the seeds in question is a wavy reticulated surface structuring, with moderately thick reticulation walls. The reticulation wall on a few of these seeds is crowned, and they have a "flush to almost nipple-like" hilum (Gunn and Gaffney 1974:14). Uncarbonized *Hyoscyamus* seeds were recovered from several samples, which aided in the identification of the carbonized seeds; in many cases the uncarbonized seeds matched up with samples that had carbonized *Hyoscyamus* seeds possibly suggesting that they were not intrusive.

While *Hyoscyamus* seeds were present at Tuzusai and Tasbas, the vast majority of the seeds in this category came from Begash. This is not surprising seeing that the plants are common today around rivers and springs on the arid-steppe environments around Begash. The few seeds recovered from Tasbas are generally small and there many be overlap with *Solanum* spp. in the region today.

Goloskokov states that two species of *Hyoscyamus* are present in the Dzunghar and Altai regions, *H. niger* and *H. pusillus* (1984:97). In the Sumara region, across the steppe to the west, Popova notes two species present, *H. depilatum* and *H. niger* (2006: 410). In addition, Gloskokov notes four species of *Solanum* in the Dzunghar and Altai regions, *S. kitagawae*, *S. dulcamara*, *S. nigrum*, and *S. olgae* (1984:97).

Schwartz and Miller (2007) identified 'cf. *Hyoscyamus*' seeds at Tell Umm el-Marra on the Jabbul Plain in Syria (second millennium B.C.). Two '*Hyoscyamus*' seeds were found at the site of Tall-E Bakun, in southern Iran from Bronze Age layers (Miller and Kimiaie 2006); additional *Hysocyamus* seeds were found at Tall-E Malyan, also in southern Iran (Miller and Kimiaie 2006). Further east, a single 'cf. *Hyoscyamus*' seed was recovered from one sample at the Chinese, Late Shang period site of DGS PI HI (Fuller and Zhang 2007). Fuller and Zhang (2007) further differentiate Solanaceae seeds in this assemblage; two samples contain '*Solanum* sp. (cf. *S. nigrum*)'.

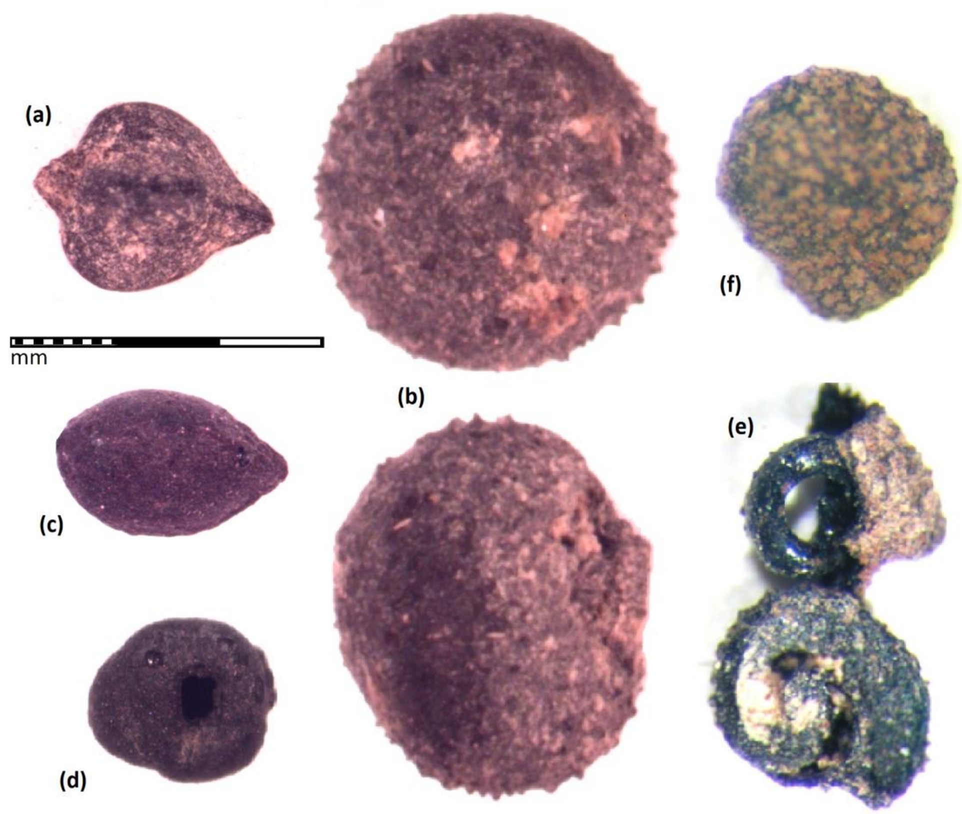

Figure 6.2. Rubiaceae, Solanaceae, and Polygonaceae – a) *Polygonum* from Tuzusai 2009 FS1; b) uncarbonized *Galium* with pericarp adhered, from Tuzusai 2009 FS11; c) *Polygonum* from Begash 2005 FS6; d) *Galium* from Begash 2005 FS6; e) and f) *Hyoscyamus niger* from Begash

Polygonaceae

All of the seeds in the category *Polygonum* spp. have the distinct three-sided shape of many Polygonaceae (Figure 6.2a, c). The embryo on all specimens, where visible, runs the length of one of the three margins. There is a great deal of variation in size and preservation quality of these fruits and kernels. However, there is no obvious morphological variation that would support the identification of distinct species[28]. These seeds and fruits were spread across the assemblages from Begash, Tasbas, and Tuzusai at low ubiquities.

These seeds were divided into two categories, fruits and kernel. This was based, respectively, on the presence or absence of the pericarp or epiderm. If there was a discernible portion of the calcareous pericarp present, the specimen was referred to as a fruit (an achene). The fruits have a psilate surface (fruits from Begash FS6 have micro-structuring), rounded (not at all winged) margins, and an acute apex.

In Begash FS6, 300 well preserved fruits are present in association with *Panicum miliaceum* grains. The *Polygonum* fruits in FS6 are larger than those in any other sample and they have a thicker pericarp. While this sample alone is not enough to argue for wild grain collecting, the mixing of wild *Polygonum* sp. fruits with domestic grains or the harvesting of the wild achenes as pseudo-cereals is well attested for in the ethnographic record for Eurasia (Luczaj and Szymański 2007; Gunda 1949; Chapter 5). *Polygonum* seeds were found in the Volga region to the west of Semirech'ye, on the Central Asian steppe at the sites of Krasnosamarskoe and Peschanyi Dol 1, 2, and 3 (Popova 2006b:222-224). A number of these nutlets were found in combination with

[28]Two seeds in FS12 at Begash were placed in the category Polygonaceae but are too fragmentary to say much about.

Chenopodium album in a waterlogged pit feature (i.e., feature 10) at Krasnosamarskoe (Popova 2006b:222-224). Popova (2006) argues that they were collected as food on the steppe during the Bronze Age.

Malvaceae

All of the charred seeds placed into this category show the distinct shape shared by such Malvaceae as, *Sidalcea* sp., *Malvastrum* sp., and *Malva* sp. (Figure 6.3f). They are all smaller than 1.5 mm and are all more round in lateral view than *Sidalcea* sp. The embryo comes to a rounded tip or radicle, unlike the flattened tip found on *Sidalcea* sp. (Martin and Barkley 1973:181-182). While *Malvastrum* is not a genus represented on the steppe (Popova 2006b:385; Goloskokov 1984:81), these seeds can be further excluded from that genus because they have shallow hylum notches. The two broad faces of the seed are flattened, and in a few cases are minutely concave. The surface is micro-areolate to psilate. Similar structuring is shared by several members of the *Malva* genus (see Montgomery 1977:149).

Malva seeds were not recovered from Mukri or Tasbas, and only two specimens were recovered from Tuzusai. The remaining 185 specimens came from Begash, although 121 of them were from FS1. *Malva sylvestris* grows in well watered ecotopes around Begash today (personal observation 2009). The plant is usually forced to grow very low to the ground due to heavy grazing.

According to Goloskokov, there are only three species of *Malva* present in the Dzhungar and Altai regions, *M. mauritiana*, *M. neglecta*, and *M. pusilla* (1984:81). Popova claims three species live in the Sumara region to the west on the steppe, *M.*

mauritiana, *M. pusilla* and *M. sylverstris* (2006:385). *M. sylverstris,* which is usually spelled *sylvestris*, was originally declared a species by Linnaeus; however, was later recognized to be the same species as *M. mauritiana* by Boissier. Therefore, there are only three possible species which these seeds in question could represent, *M. sylvestris* or its two close relatives *M. neglecta* and *M. pusilla*. Similar *Malva* seeds were found at the site of 1685 in Turkmenistan (Spengler et al. in review). These seeds are still articulated in their carbonized pericarp. They do not appear to be the same species as those from Begash.

Asteraceae

There are four distinct categories within Asteraceae. The first is simply Asteraceae; these four seeds are pappus-form members of the family and are each from a different species. Due to the similarity in morphology among the pappus-form members of the family and the extremely high number of local representatives, no further attempt was made at identification.

Asteraceae A is only found in a carbonized state (Figure 6.3a) and all that is preserved in every example is the pyriform kernel (embryo) of an achene-form member of the family. This category was not found at Tuzusai or Mukri and only four specimens were found at Tasbas. Morphologically it is similar to the kernel of *Iva annua* or *Helianthus annuus*. There are only a few large Asteraceae species in this region that fit the morphology-based category of sunflower seed-like achene, which is not a true monophyletic clade. The most likely possibility is *Oropodon acanthium*.

O. acanthium is present in an uncarbonized state in a number of samples from Begash and Tuzusai but never appears carbonized (Figure 6.3b). These achenes are large ranging from 5 to 7 mm in length and they have highly distinct surface structuring (see Figure 6.3b). It is possible that taphonomic processes, such as possibly carbonization, have left only the embryo in a preserved carbonized state, while only the pericarp preserves in an uncarbonized state. *O. acanthium* grows across Semirech'ye and is one of the early colonizing plants on old excavation units at Tuzusai. The sharp spines that cover the plants reduce herbivory, especially from herd animals; hence, it is prolific in heavily grazed pastures.

The final category within Asteraceae is *Xanthium* sp. Only the spiky fruit coats of *Xanthium* are present (Figure 6.3c). *Xanthium* fruit coats were only recovered from Tuzusai, despite the fact that the plant grows around river ways near Begash today. They also grow in well-watered areas on the Talgar fan. In her preliminary study of the archaeobotany at Tuzusai, Miller (1996 unpublished) found what she calls 'Fruit-case w/Spine'; this pericarp material is likely from *Xanthium*. The fruits of *Xanthium* are 10 – 15 mm long and are covered in 2 mm spine-like protrusions. The carbonized fragments of the fruits are easily identified, even in a highly fragmentary state. However, it is likely that they are overlooked in archaeobotanical analyses in Central Eurasia. They have, however, been identified at the Bronze Age site of 1685 in Turkmenistan (Spengler et al. in review).

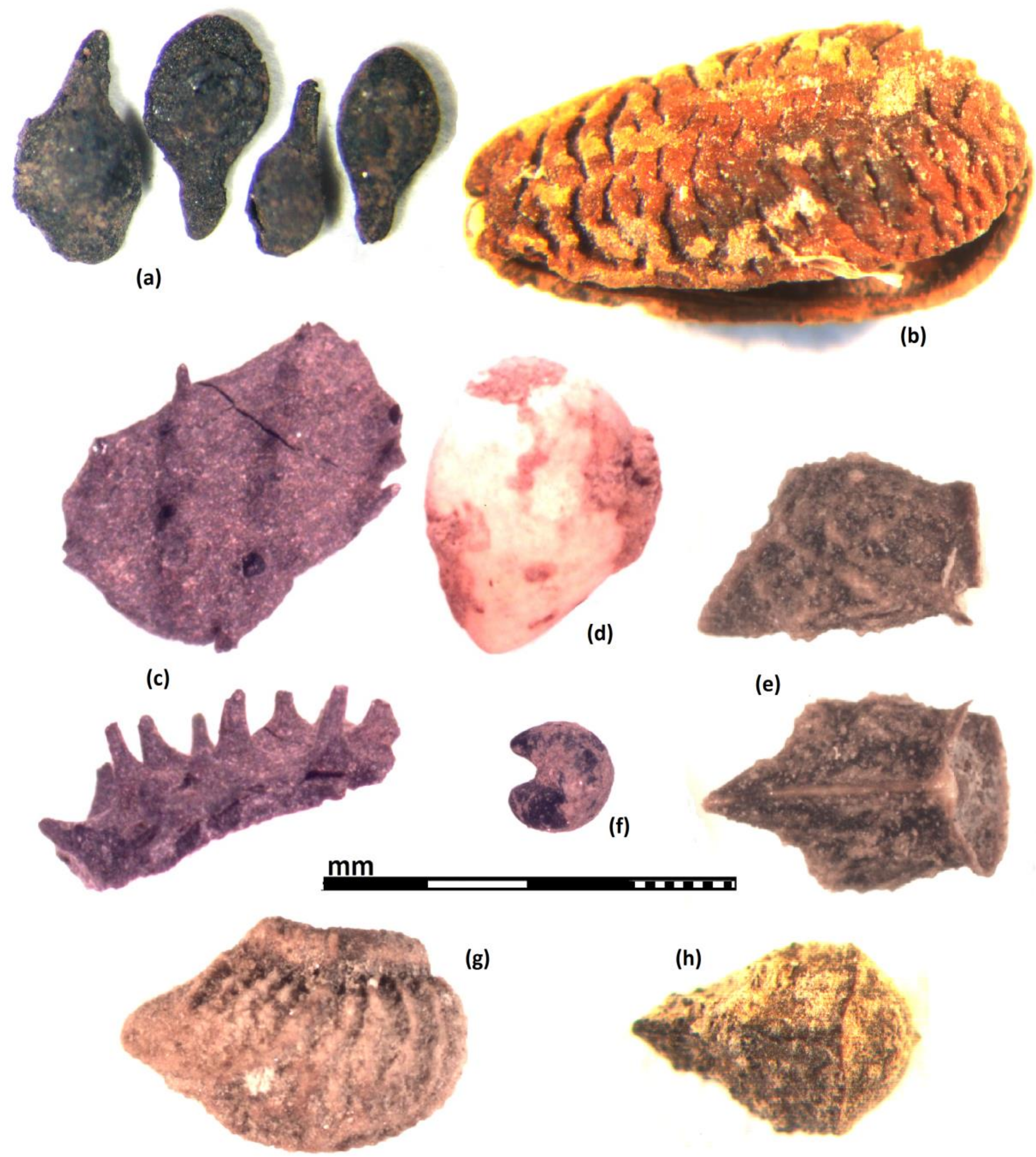

Figure 6.3. Boraginaceae, Asteraceae, and Malvaceae – a) Asteraceae A from Begash 2005 FS19; b) *Onopordon acanthium* from Tuzusai 2009 FS9 (uncarbonized); c) *Xanthium* pericarp from Tuzusai 2008 FS1; d) *Lithospermum officiale* from Tuzusai 2009 FS11 (mineralized); e) *Echium* from Tuzusai 2009 FS10 (uncarbonized); f) *Malva* from Begash 2005 FS6; *Anchusa* from Tuzusai 2009 FS9 (uncarbonized)

Boraginaceae

Lithospermum arvense (Figure 6.3h) and *L. officinale* (Figure 6.3d) fruits are found throughout the cultural levels in all four sites. They are often uncarbonized or only partially carbonized and are recovered from the heavy fraction. Both species were recovered from Tuzusai and *L. arvense* was ubiquitous at the site. At Begash and Tasbas only *L. arvense* was found, and it was present in low densities at ubiquity. Due to their dense fruit coat (mostly the mesocarp) they seem to preserve well. They have the characteristic pinched-teardrop shape. *L. arvense* fruits have a bumpy structured surface and a beaked-apex. *L. officinale* fruits have a smooth polished surface. The uncarbonized fruits are often in a mineralized or semimineralized state. It was impossible to tell if many of them were semimineralized or simply uncarbonized, so many of the seeds placed in the uncarbonized category may actually be mineralized, and therefore, not modern intrusions. *L. officinale* fruits are morphologically very similar to *L. erythrorhizon*, both have two parallel lines of apertures along the margin. However, *L. erythrorhizon* has a distribution limited to east China, Korea, and Japan (Wu et al. 2006).

In the Yanghai cemetery in Turpan, Xinjiang, *L. officinale* fruits were found adhered to wooden vessels (Jiang et al. 2006). These tub-like vessels have the fruits adhered to the top lip portion as ornamental decoration. The vessels are up to 2,500 years old and very well preserved. In Europe archaeological find of *L. officinale* and a close relative, *L. purpureo-caeruleum*, from several sites were used as beads; some of these fruits are found perforated (Jiang et al. 2006). At the site of Hacinebi in Turkey from the Late Chalcolithic (Uruk Phases), Stein et al. (1996) identified uncarbonized fruits of *L. tenuifolium*. *L. tenuifolium* was also found at the second millennium B.C. site of Tell Umm el-Marra in western Syria (Schwartz and Miller 2007). Also at Tell Umm el-Marra, Schwartz and Miller (2007) identified uncarbonized seeds of *L. arvense* and *L.* 'Other'. *Lithospermum* fruits were recovered from the fourth millennium B.C. at Sarazm in

Tajikistan (Spengler and Willcox in press), where they are the most prevalent wild seed in the assemblage.

Echium (Figure 6.3e) and *Anchusa* (Figure 6.3h) are also members of the Boraginaceae family with extremely hard mesocarps. They share some morphological characteristics to the *Lithospermum* fruits but are distinct in shape. These two genera were only identified in flotation sample 2009FS10 from Tuzusai. This sample contains an abundance of large uncarbonized seeds. A direct AMS date on wild *Cannabis* seeds (discussed below) from this sample shows that the uncarbonized seeds in this sample are likely intrusive and probably represent a rodent cache. Carbonized and mineralized *Echium* seeds were recovered from the site of 1685 in Turkmenistan (Spengler et al. in review).

Fabaceae

Several wild species from the Fabaceae family have been identified; there is no reason to believe any of them were cultivated. Some unidentified Fabaceae were left in the category Fabaceae (multiple species) whereas another group of large unidentified Fabaceae seeds were clumped into Fabaceae A (Figure 6.4e). The rest of the Fabaceae fell into the category *Trigonella* (Figure 6.4d) or Fabaceae (cf. *Trifolium/Melilotus*) (Figure 6.4f, g). A single seed from Tuzusai looks like it could be from the genus *Lens* (Figure 6.4h); however, there is no reason to think it is domesticated.

Trigonella seeds are small, semi-cylindrical, and possess a radicle beak, tucked in tightly to the rest of the seed. Fabaceae (cf. *Trifolium/Melilotus*) are larger, round and also have a radicle beak. In her preliminary archaeobotanical study at Tuzusai, Miller

(1996 unpublished) found a few *Trigonella* seeds. These seeds were extremely common at Begash, Tuzusai, and Tasbas. There was a total of 1,055 specimens recovered from Begash, 412 of them were from FS1. There were totals of 31 specimens from Tuzusai and 181 from Tasbas. *Trigonella* seeds are present in most archaeobotanical assemblages from Central and southwest Asia. At the site of Godin Tepe in Iran, these seeds were found in Period V layers dating to the fourth millennium B.C. (Miller 1990). Stein et al. (1996) identified *Trigonella* seeds at the site of Hacinebi in Turkey from the Late Chalcolithic (Uruk Phases). Schwartz and Miller (2007) identified *Trigonella* seeds at the second millennium B.C. site of Tell Umm el-Marra in Syria. In Southern Iran *Trigonella* seeds were found at the sites of Tall-E Bakun, Tall-E Jari, and Tall-E Mushki from Bronze Age layers (Miller and Kimiaie 2006). Harrison (1995) identified *Trigonella* at Anau South in Bronze Age layers (Namazga V and VI) dating to around 2500 B.C. These seeds were found in Early Bronze Age layers at Sarazm, Tajikistan (Spengler and Willcox in press) and Late Bronze Age layers at 1685, Turkmenistan (Spengler et al. in review).

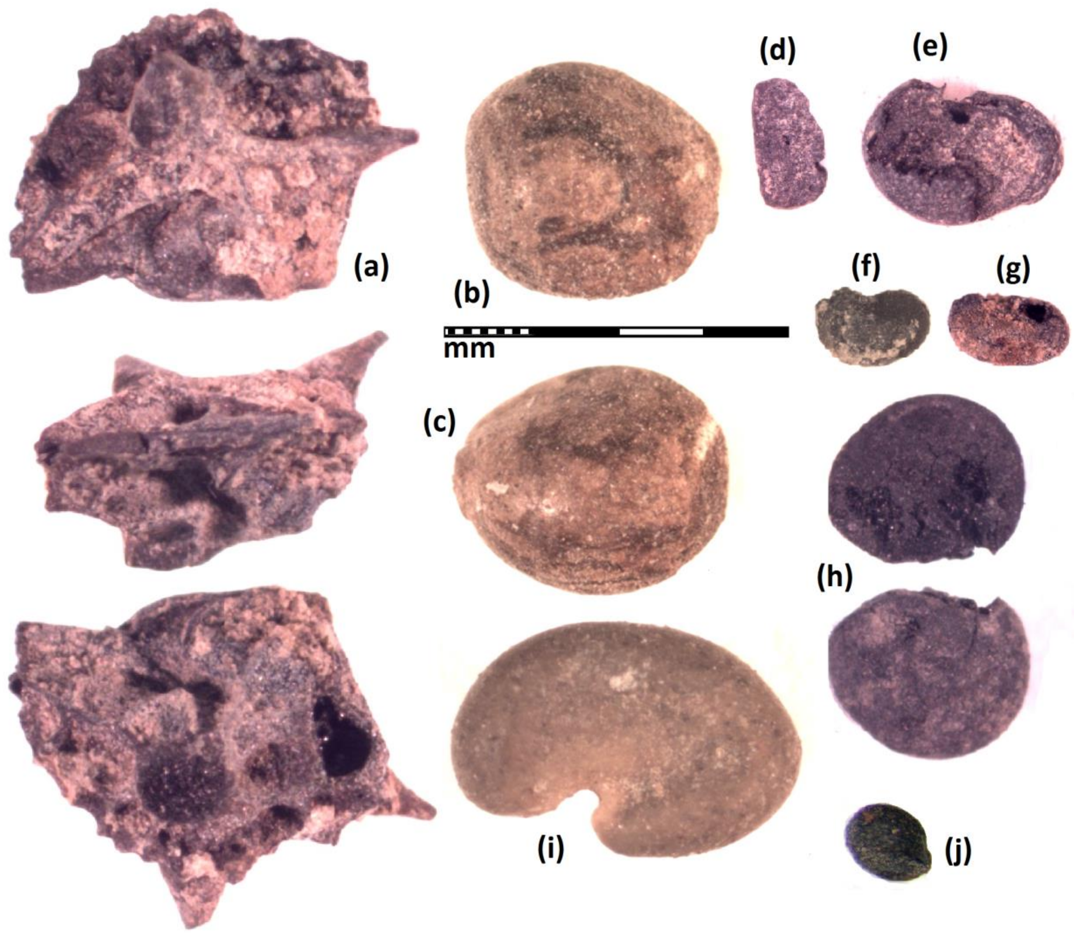

Figure 6.4. Lamiaceae, Fabaceae, Cannabaceae, and Zygophyllaceae – a) *Tribulus terrestris* from Tuzusai 2009 FS14; b) and c) *Cannabis sativa* ssp. *ruderalis* (uncarbonized) from a rodent cache at Tuzusai 2009 FS10 (ca. 200 yrs old); d) *Trigonella* from Tuzusai 2009 FS10 FS4; e) Fabaceae A from Tuzusai 2009 FS14; f) and g) Fabaceae (cf. *Trifolium*/*Melilotus*) from Tuzusai 2009 FS10 and FS14, respectively; h) Fabaceae (cf. *Lens*) from Tuzusai 2010 FS10; i) Fabaceae from Tuzusai 2009 FS10; j) *Mentha*/*Nepata*-Type from Begash 2005 FS12

Lamiaceae

This is a diverse and species-rich family, and identification below the genus level was not attempted for the few small seeds placed in this category. All of the specimen identified are less than 1.0 mm in diameter and most are closer to 0.5 mm. They all have the distinct tri-pinched beak. The two specimens from Begash 2005 FS12 placed in the category *Mentha/Nepata*-Type (Figure 6.4j) have a faint venation on the surface. A number of family relatives grow directly on Tuzusai today, including *Ziziphora clinopodiodes*, which is collected by the excavation project workers to make tea.

Hypericaceae

The genus *Hypericum* is common across much of the northern temperate world; identification below the species level was not attempted for the single small seed placed in this category from Begash FS10. At least one species grows directly on Tuzusai today, *H. scabrum*.

Brassicaceae

This family is abundant and identification below the species level was not attempted for the three small seeds placed in this category from Begash; however, they are morphologically similar to *Capsella* or *Lepidium*. Both genera are present in the region today.

Zygophyllaceae

The seeds of *Tribulus* are distinctive in that they are 'horned', an adaptation for animal dispersal. The seeds are large, >4 mm in length. Wu and Raven (2006 vol.11:49) note only two species in China, *T. cistoides* being localized in semi-tropical regions of Asia and with schizocarps much larger than the few seeds from Tuzusai. However, *T. terrestris* has schizocarps that closely match the Tuzusai seeds in morphology. One fragment of a *T. terrestris* schizocarp was recovered from Tuzusai 2009 FS14, and four schizocarps came from Begash 2005 FS12 (Figure 6.4a).

Cannabaceae

Cannabis sativa ssp. *ruderalis* is a common steppe plant in this part of Central Asia and it currently grows close to all four sites, as well as across Semirech'ye. The uncarbonized seeds from Tuzusai are primarily from one flotation sample, 2009FS10 (Figure 6.4b, c), which appears be a rodent cache. A direct date on several *Cannabis* seeds from this sample shows that they are not old (<200 years). There are 633 large *Cannabis* seeds in this sample which makes up all but two of the recovered specimens. This cache deposit contained other large-seeded, uncarbonized seeds and fruits, further supporting the likelihood that it is a rodent cache. The seeds are not domesticated and it is unlikely that they were cultivated. However, wild cannabis can be used as a fiber source.

Rosaceae

The one large (>3 mm) *Rosa* (Figure 6.5d) seed from Tuzusai 2009 FS5 is from a wild rose hip. Several large wild roses grow in the region today.

In addition, a number of small seeds, around 0.5 mm in length, were placed into the category *Fragaria/Potentilla* (Figure 6.5b). There were totals of three specimens from Begash, eight from Tuzusai, and seven from Tasbas. Woody *Potentilla* plants grow at higher elevations, such as around Tasbas. However, herbaceous *Potentilla* species are extremely common at all elevations. *Fragaria* also grows at all elevations and often acts as ground cover underneath taller vegetation on the steppe or in mountain valleys.

Convolvulaceae

The two Tuzusai *Convolvulus* (Figure 6.5i) seeds were not identified below genus because a comparative collection of all the representative species in the region was not collected. However, they are morphologically close to *C. arvensis*, a species that actually grows on the Tuzusai site today and hangs over the old exposed units. *Convolvulus* seeds were recovered from Godin Tepe in Iran, these seeds were found in layers dating to the fourth millennium B.C. (Miller 1990).

Caryophyllaceae

There are seven carbonized Caryophyllaceae seeds from Begash (n = 1; Figure 6.5c) and Tuzusai (n = 6; Figure 6.5a, e), which were not identified below family level. These seeds represent more than one species. Due to the small number of seeds recovered and the variety of species that grow on the steppe, further identification was not attempted.

The only Caryophyllaceae specimens identified below family level were *Vaccaria/Saponaria* (Figure 6.5f, g, h). These seeds vary in size from 0.7 to 2.0 mm in diameter and are spherical with minute scabrate surface structuring. They all have a fully wrapped embryo. In addition, the seeds puff in a distinct manner when carbonized (Figure 6.5g, h). Large quantities of these seeds were found in a few samples from Tasbas (n = 2,286) and Tuzusai (n = 81). There were 1,108 seeds and seed fragments from Tasbas 2011 FS17 and 1,141 from FS19.

Miller (1996 unpublished) found seeds that she calls ‘cf. *Vaccaria*’ in her study of the Tuzusai botany. *Vaccaria* seeds were recovered from Period V layers dating to the fourth millennium B.C. at the site of Godin Tepe in Iran (Miller 1990). Stein et al. (1996) identified Late Chalcolithic *Vaccaria* seeds in Uruk Phases at the site of Hacinebi in Turkey. Schwartz and Miller (2007) identified *Vaccaria* seeds at the site of Tell Umm el-Marra on the Jabbul Plain in western Syria dating to the second millennium B.C. *Vaccaria* seeds were also identified at the sites of Tall-E Bakun and Tall-E Malyan, from Bronze Age layers Miller and Kimiaie (2006); both sites are in Southern Iran. *Vaccaria/Saponaria* seeds were also identified at 1685 in Turkmenistan (Spengler et al. in review).

Cyperaceae

Seeds from this family are surprisingly rare in the samples from all four sites. Arid-land Cyperaceae are one of the dominant plant categories on the steppe. A few small seeds were found in the samples from Tuzusai (n = 3) and Tasbas (n = 23; Figure 6.5j). Their absence may represent herd dietary preferences, specifically a focus on nutrient-rich vegetation in distinct ecological pockets, or a lower prevalence of these plants in mountain valleys and rich-ecotopes.

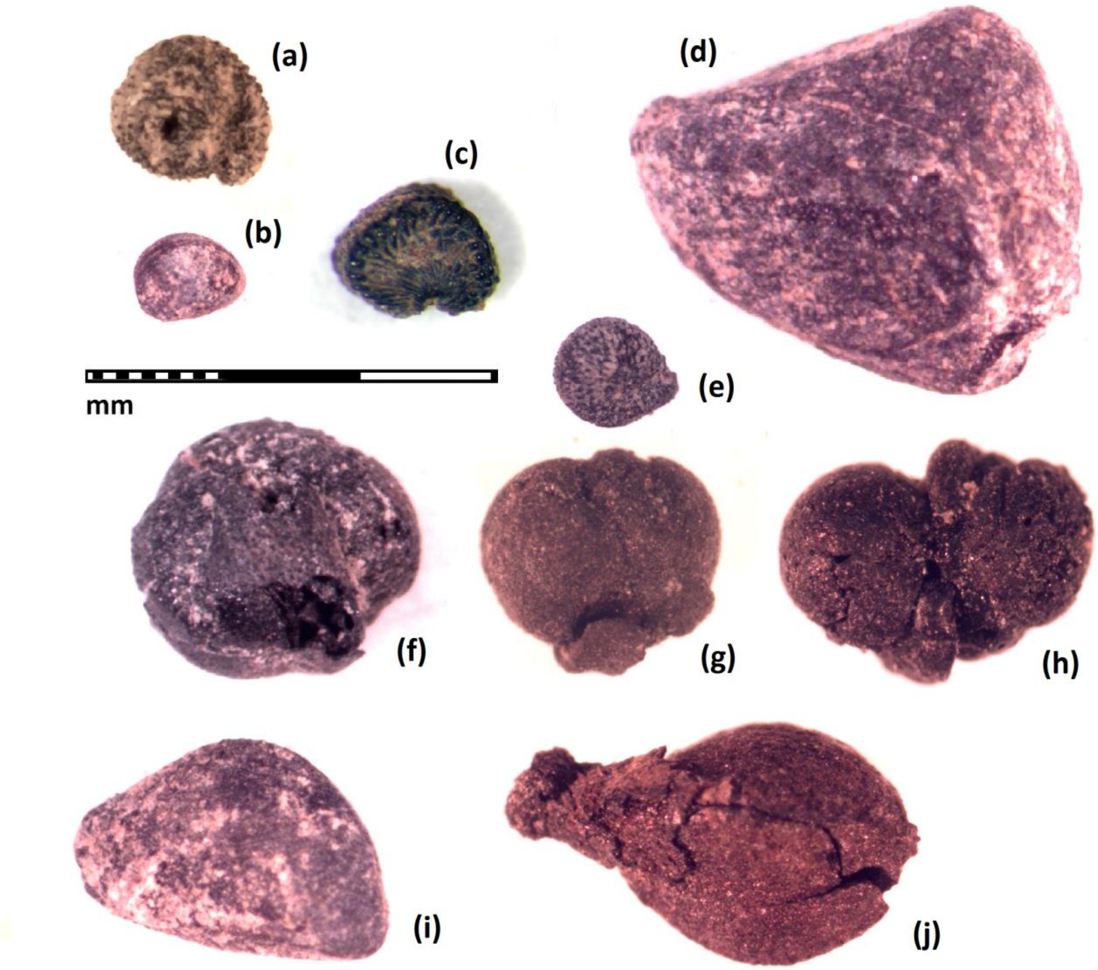

Figure 6.5. Convulvolaceae, Rosaceae, Caryophyllaceae, and Cyperaceae – a) Caryophyllaceae from Tuzusai 2009 FS9; b) *Fragaria*/*Potentilla* from Tuzusai 2009 FS4; c) Caryophyllaceae from Begash 2005 FS1; d) Rosa from Tuzusai 2009 FS6; e) Caryophyllaceae from Tuzusai 2009 FS6; f), g), and h) all *Vaccaria*/*Saponaria* from Tuzusai 2009 FS4 (f) and Tasbas 2011 FS1 (g and h); i) Convolvulaceae from Tuzusai 2009 FS1; j) Cyperaceae from Tasbas 2011 FS17

Seed-Types

Several distinct seed-types were assigned to unidentified seeds that appeared in more than one sample or unidentified seeds which had abundances greater than three. These seed-types will not be discussed here.

6.4 Other

6.4.1 Wood

Wood identification was not attempted for these samples beyond general statements about the categories conifer or angiosperm. Little to none of the wood recovered from Tuzusai and Begash was conifer, at Tasbas, on the other hand, a significant percent of the wood was conifer. The conifer pieces from Tasbas were not quantified. Overall, wood densities and abundances were very low. The only sample with a relatively high density of wood was FS2 from Begash (a historical period sample). The samples from Tuzusai and Tasbas had even lower wood densities than those from Begash. It seems evident that wood was not a major fuel source at any of these sites.

6.4.2 Other (Not Wood)

Other categories that were collected but not all reported here include a single *Setaria* bristle clump, a few rachises, a few thorns (Figure 6.6b), awns (Figure 6.6a), nutshell (Figure 6.6d), ceramic fragments, metal fragments, bone, and carbonized insects. Bone, carbonized insects, and ceramic fragments were all collected and quantified but not discussed in this paper. Although, the human teeth from the Begash cremation are important to this dissertation (Figure 6.6c). The fragments of grass florets, i.e., bristle clump, rachises, and awns, were all quantified and included.

The bristle clump (Begash FS6) is clearly from a *Setaria* grass and does not appear to be domesticated. The awns (Figure 6.18a) are likely from a *Stipa* grass due to their association with *Stipa* seeds in the assemblage and the fact that the most common genera of awned grasses in the region is *Stipa*, which has a twisted awn of the same morphology. There were 13 awn fragments recovered from Tasbas and 154 from Begash, 149 of them were found in FS6. Due to their narrowness it is impressive that any of them were recovered.

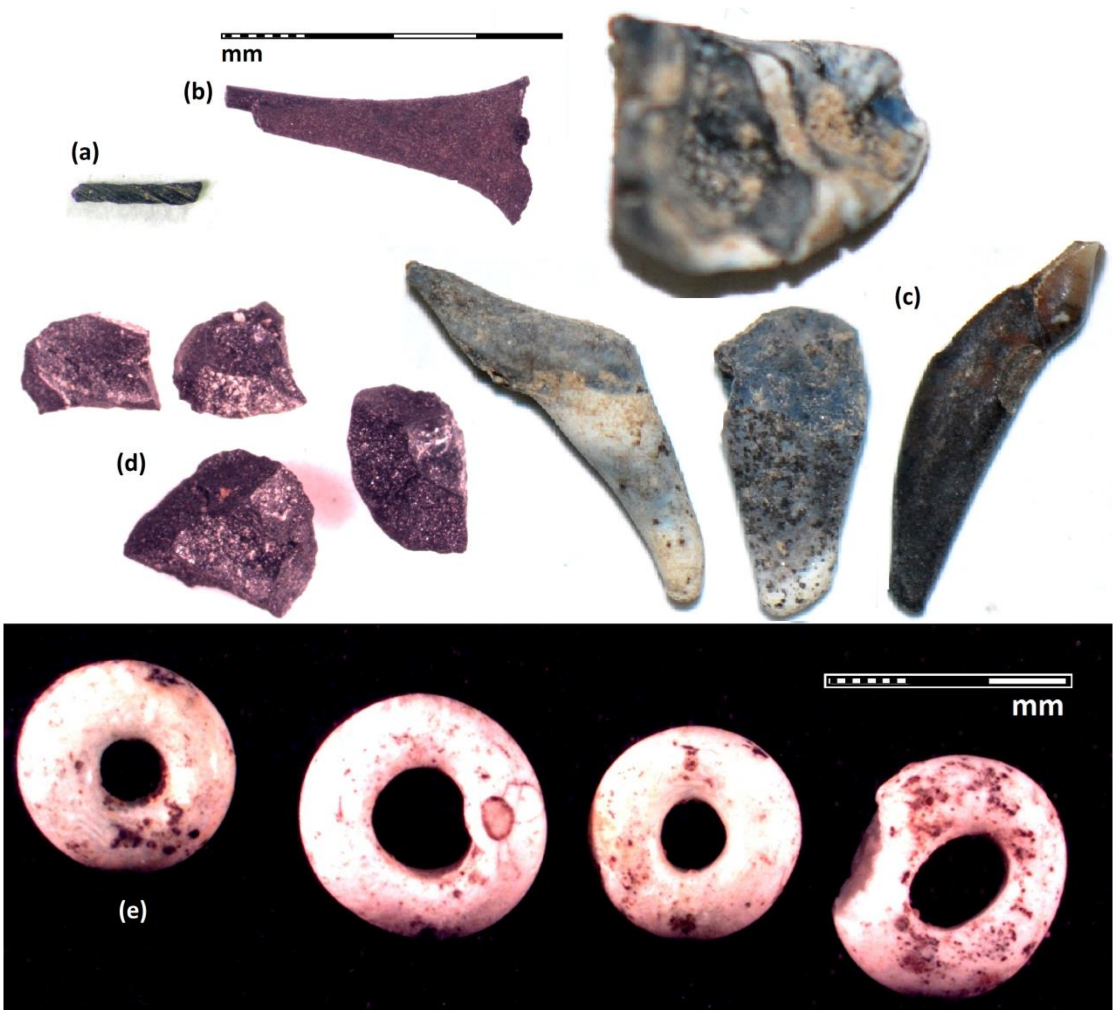

Figure 6.6. Other – awn fragment from Begash FS6; b) thorn from Begash FS6; c) human teeth (burned) from the Begash cremation FS47; d) nutshell fragments from Tuzusai 2009 FS5; e) white glass beads from the Iron Age human burial at Begash FS13 (390 – 50 cal B.C.)

Beads

Begash FS13 is composed of sediments from around the head of the burial. A number of small white glass beads (Figure 6.6e) were removed from the heavy fraction of this flotation sample, as well as from FS14. These beads do not appear in any of the other flotation samples, and therefore, seem to be associated with the burial, likely as grave goods. The beads appear to have been part of an ornamental accessory (possibly sewn into clothing) on or around the head of the buried individual. FS14 comes from the center or stomach area of the burial. FS20 is a bulk sample from the stratigraphic layer that the previously mentioned burial was associated with. Beads along with textiles are often important symbols of identity and lead to social stratification. Beads are symbols of power or group identity (Fuller 2008)

6.5 Pastoralism

6.5.1 Dung Burning

The presence of cultigen millets and wheat at Begash is noteworthy (Frachetti et al. 2010b; Chapter 7), but most of seeds recovered from the site represent wild herbaceous plants. A number of depositional processes might have contributed to the introduction of these seeds into the Begash assemblage, including seed rain, bioturbation, dung burning as fuel, and human foraging. It is difficult if not impossible to sort out which parts of an assemblage were incorporated through the various potential processes. Human foraging and animal foraging can create similar macrobotanical assemblages (Hillman et al. 1997). However, I suggest that a significant portion of the wild seeds in these assemblages was introduced through the burning of dung, based primarily on five lines of evidence: (1) carbonized wood is rare in most of the samples; (2) densities of wild herbaceous seeds are high; (3) large numbers of fragmentary and poorly preserved specimens are present, possibly as a result of mastication and digestion; (4) ethnographic analogies support dung burning as a common practice in such environments, as it is in Semirech'ye today; and (5) experimental dung burning of contemporary material, reported below, produced a similar assemblage.

More than one vector of introduction should always be considered. As was noted earlier in this report, the *Galium* seeds have micropunctate patterning on the dorsal surface; this structuring likely marked the presence of former setae. The natural dispersal mechanism for setae-form *Galium* seeds is through adhering to animal fur, wool, or hair. Herd animals could have brought *Galium* seeds into the site; likewise, wool processing requires cleaning of sheep, goat, and possibly camel wool or hair. It is possible that the same action introduced awned *Stipa* and *Tribulus* seeds, both of which are animal dispersed, into the assemblage.

However, the *Galium* seeds could be the result of dung burning as well. In one sample from Godin Tepe, Iran, (sample 34) Miller reports 144 *Galium* seeds (Miller 1990:9). Miller (1984, 1989, 1990, 1996, 1999; Miller and Gleason 1994; Miller and Smart 1984; Moore et al. 1994) argues that the *Galium* and other wild seeds in macrobotanical assemblages could be the result of dung burning. Seeds are readily incorporated into fires when dung, laden with seeds, is burned for fuel in wood-poor environments. There are environmental and economic parallels between Eurasian steppe sites and sites on the Iranian Plateau with arid-steppe-like environments. Gonur Tepe, in the Kopet Dag Mountains of Turkmenistan, is geographically about 2,000 km from Semirech'ye. At the site of Gonur Tepe, Miller (1999) concludes that dung burning was practiced in the Bronze Age.

Low Abundance of Carbonized Wood

Low abundance of wood charcoal in an assemblage has been used as evidence for dung burning at other sites across Eurasia (Klinge and Fall 2010; Miller and Smart 1984; Miller and Marston in press); likewise, the potential availability of wood resources has been used to argue for or against dung burning. All carbonized wood fragments larger than 2.00 mm were pulled from each Begash sample and counted and weighed; if the wood count was estimated as being over 200 pieces, total counts were not attempted. Fragment number and weight loosely correlate; however, weights provide a rough estimate of wood presence. FS2, from Begash, was the only sample that had high wood charcoal content. FS2 is an historic period sample; Iron and Bronze Age samples varied in wood weight (0 – 28.29 g) but tended to be low (average wood weight is 1.03 g per liter of soil).

Wood weight in relationship to the volume of soil floated increases through time. In the 38 L of soil analyzed from the historic periods at Begash, there were 130.99 g of wood fragments >2.00 mm (mostly from FS2). Of the 32.6 L of soil from the Iron Age analyzed, there was a total of 57.81 g of wood fragments, whereas of the 97.2 L of

Bronze Age soil analyzed, of carbonized wood fragments weighed only 76.62 g. Both riparian wood resources (*Populus* and *Salix*) and dried dung may have been used for fuel.

Popova (2006), however, argues that burning dung for fuel did not contribute to the Samara River valley sites based on the presence of arboreal pollen and wood charcoal in the assemblage. A low percentage of arboreal pollen was recovered from Begash (Frachetti 2004b). If R-values are considered for these pollen sources, the likelihood of abundant forests existing in the areas around Begash is low.

Miller (1996:526) also points out that at sites in steppe environments wood tends to be from riparian forests or shrub plants. She claims these resources are more restricted than other wood sources (Miller 1996, 1997). This is the case at Begash where a dominance of archaeobotanical poplar/willow (*Populus*/*Salix*) pollen and wood was identified (Frachetti 2004b).

Densities and Composition of Wild Herbaceous Seeds

When dung laden with seeds is burned it produces ash and charred matter rich and dense in wild herbaceous seeds. The Begash samples are relatively rich and dense (see Tables 6.1 and 6.2 for densities). The total seed count (sans unidentifiable seed fragments) is 3,383 (a density of 26.02 seeds/liter of soil), plus 720 unidentifiable seed fragments. Of that total, 3,297 (97.5 percent of the total) of are from wild herbaceous plants.

It is also fruitful to look at the seed composition in these assemblages. Certain plants are problematic for herd animals to consume, such as *Hyoscyamus niger, Stipa* spp., and members of the Boraginaceae family. Hillman et al. (1997:651-652) argue that certain plants in the archaeobotanical assemblage at Abu Hureyra, in Syria, such as the florets of *Stipa* and the thick siliceous coats of Boraginaceae would not have been consumed by herd animals (Hillman et al. 1997:651-652). Miller (1997:656) also notes that fully mature *Stipa* florets are avoided by herbivores. Hitchcock (1951:445) notes that the florets of certain species of *Stipa* can injure grazing animals, especially sheep. However, Hitchcock (1951:445) points out that this genus is sometimes used as forage especially in spring and early summer. The mature caryopses of *Stipa* are enclosed in a tough lemma that has a sharp callus, and these grasses have long, hardened awns which can injure the mouths and guts of herd animals. As mentioned above, hard, twisted, carbonized awns found in several samples are likely from mature *Stipa* florets.

Hyoscyamus niger is often noted for being toxic to herd animals (Roberts and Wink 1998). The common English name 'henbane' refers to the fact that chickens often die after eating the plant. The plant produces toxic alkaloids, the most dangerous being hyoscyamine (Roberts and Wink 1998). Stegelmeier et al. (2007) discuss the effects of solanid alkaloids on horses, and Majak et al. (2008:58) note the potential for death in cattle if consumed. However, I have observed local Kazakh herders' goats eating the plant with its fruits during the summer of 2008 near the town of Taldy-Kurgan with no apparent ill effects. While certain solanaceous plants may be avoided by equids and bovids, it is evident that goats and possibly sheep still consume them. Therefore, further research is required before certain plants or plant parts are used as tools to argue against dung burning. It seems possible, that with more research, the dung can be pinpointed more accurately to a specific animal based on the seed composition.

Fragmentary and Poorly Preserved Seeds

As stated above, 720 specimens from Begash were classified as unidentifiable seed fragments. The fragmentary and distorted nature even of many of the identified seeds in these assemblages is a qualitative statement and not easily quantified. In all archaeobotanical assemblages seeds have been subjected to destructive processes for hundreds to thousands of years. In addition, the seeds often go through a series of degrading processes before deposition, including carbonization. Therefore, by their very nature seeds in an archaeobotanical assemblage are damaged and distorted. However, I suspect that there is more distortion here than would exist without the mastication and digestion processes of herd animals like sheep, goat, cattle, and horse acting on the seeds first. This same argument was made by Miller (1984, 1990) for similar sites in southwest Asia and later supported by Klinge and Fall (2010).

This line of reasoning can be taken a step further by looking at the composition of the seeds to further support the argument that they were previously digested. The vast majority of the seeds in the assemblage have hard seed or fruit coats (testa or pericarp); few soft-coated seeds are present, an exception being *Hyoscyamus*. It is possible that hard-coated seeds like *Chenopodium* or *Lithospermum* do not deteriorate as readily during digestion; however, this argument holds limited merit in a semiarid environment like the steppe, where harder seed coats are adaptive for reduced water loss. Taphonomic processes also bias toward hard testae.

Ethnographic Analogies

The use of dung as fuel is still practiced in Semirech'ye by herders today (personal observation 2008 – 2011) and is noted in ethnographic accounts from southern Central Asia and southwest Asia (Miller and Smart 1984, 1996, 1997, 1999). Lattimore (1967 [1940]:253), in his early ethnographic work among Central Asian pastoralists noted the use of dung as fuel. Winterhalder et al. (1974) discuss the importance of camelid dung as fuel among high elevation Peruvian herders. Siller (2000) notes that other Andean herders choose to use dung specifically for pottery firing. In addition, pre-Hispanic archaeological dung burning has been identified in mobile camelid herding populations from Bolivia (Hastorf and Wright 1998; Moore et al. 2010). Hastorf and Wright (1998) discuss a long history of dung use by herders in the Bolivian highlands. Browman (1986:155-156) identified dung use at the site of Chiripa in the Ingavi province of the Bolivian highlands dating back more than 3,000 years. In the same publication, Browman (1986:155) contrasts the relative fuel values for dung and a few highland fuel plants, including grasses, *Azorella* sp., *Baccharis*, and *Lepidophyllum*, concluding that camelid dung was a vital resource on the altiplano. In fact, Browman (1997:30) references accounts that suggest dung production was more important to pastoralists in that region than production of meat, wool, or the trade value of camelids. Rosen et al. (2005) identify archaeological use of dung as fuel in the Negev of Israel, and they discuss its ethnographic use in the region. Katz et al. (2007) show that, archaeologically, dung fuel has been used in the Negev as far back as the Chalcolithic at the site of Grar. Shahack-Gross et al. (2002) and Shahack-Gross (2011) discuss ethnographic dung burning among the Maasai and relate it to archaeological evidence in Kenya. Rhode et al. (2007) mention the modern use of yak dung as fuel in eastern China.

The Dung Burning Experiment

During the field season of 2008, the DMAP was excavating a site near the town of Taldy-Kurgan, about 35 km from Begash. A modern herder's yurt was erected at a summer valley pasture about 15 m from the excavation camp. This herder used a combination of wood collected from a stream edge near the encampment and dung as fuel. The wood was primarily *Populus* and *Salix*. The dung was a combination of cattle patties and bricks of sheep and goat dung from a previous year's pen. The penning of sheep and goats at night leads to a deep and compact lens of dung about 3 m in diameter. The reuse of the same river valley locations, year after year, means that herders can come back and use the dried dung pen from the previous year as fuel (Figure 6.7). Sheep and goat dominated the animal remains in the Begash assemblage; therefore, the dung burned at Begash was likely primarily sheep and goat with a low amount of cattle.

Dung burning experiments have been attempted around the world (Hastorf and Wright 1998; Miller 1984; Milt 1986; Shahack-Gross 2011; Shahack-Gross et al. 2005; Valamoti and Charles 2005). During mid-August of 2008, I collected 20 liters of cattle dung patties. After clearing a surface down to sterile clay in order to reduce contamination from the soil seed bank, I burned the dung, a few patties at a time. The entire process took about three hours and the fire was left smoldering until morning, when it was collected.

Figure 6.7. Image of drying, bricked-up sheep and goat dung in a modern Kazakh winter camp at Bryan-Zherek – image taken during the summer when herds were pasturing in the mountains

The 20 liters burned down to 18.51 grams of fine ash and charred particles, a volume of about half a liter. This was collected and brought to the Paleoethnobotany Lab at Washington University in St. Louis for analysis. The ash was not floated because there was no soil, stone, or artifacts typical of heavy fractions. The material was separated, for ease of analysis, using six geological sieves: 2.80 mm; 2.00 mm; 1.40 mm; 1.00 mm; 0.355 mm, and a catch pan for anything smaller than 0.355 mm. The 2.80 mm sieve only served the purpose of removing large dung fragments that remained articulated. Seeds and fruits were sorted in totality down to 0.355 mm.

None of these seeds was larger than 2.00 mm. Total seed count is 1,291, 60 of which fall in the unidentified category, many obviously belonging to the same species. In addition, there is a total of 271 unidentifiable seed fragments (not included in the total seed count). Density is useless for comparison with other samples because there is no soil matrix. Richness is also useless here, because unidentified seeds were not divided into seed types. *Chenopodium* spp. was, by far, the most abundant category in the sample, with a total count of 641 seeds or seed fragments. The second most abundant category is *Setaria* (n = 187). These caryopses are small and narrow, and therefore, not domesticated. Most of them are still in their paleas and lemmas. Wild *Setaria* grows on the steppe and in river valleys around Semirech'ye today as well as being a common agricultural weed. *Galium* was the next most abundant category (n = 156); however, most of the *Galium* seeds in this sample appear to be from a different species than the *Galium* seeds in the Begash samples. The *Galium* seeds in the experimental dung sample morphologically resemble *G. verum*, whereas, most of the *Galium* seeds in the archaeobotanical samples appear to be more like *G. aparine*; these are two of the many *Galium* species present in the region today. Other abundant categories include Caryophyllaceae (n = 23), Fabaceae (23), *Fragaria*/*Potentilla* (19), *Malva* (14), *Polycnemum* (63), *Polygonum* (20), and *Trigonella* (19). All of these categories are present in the samples from Begash.

A number of characteristics in the experimental sample correlate with the Begash archaeobotanical assemblage: (1) high frequencies of herbaceous seeds; (2) small sizes of these seeds (<2.00 mm); (3) the low abundance of wood; (4) similarities in the actual seed categories present; (5) similarities in which categories are abundant; (6) the presence of partially carbonized and uncarbonized seeds mixed in with carbonized ones; and (7) the fragmentation of seeds and fruits.

The study of burned dung can foster a greater understanding of local range systems in the past, including resource utilization, conservation, and reconstruction of environmental and mobility patterns. Shahack-Gross and Finkelstein (2008) argue that a close analysis of burned dung remains in archaeological sites can help lead to a greater understanding of human economy and subsistence patterns.

It is important to keep in mind that "the source of 'likely dung seeds' cannot be unequivocally assigned to the burning of dung" (Hastorf and Wright 1998:222). I do not suggest that all the wild seeds in the assemblage are the result of dung burning; on the contrary, I think it likely that a variety of depositional processes are at work. While dung burning seems to be a major depositional process, I cannot exclude burned construction material or plants that were burned directly as fuel, or indirectly incorporated as a by-product of winnowing or crop processing, pottery manufacturing, dying of textiles, or through other economic pursuits such as human foraging.

6.5.2 Orographically Determined Microenvironments

When archaeologists and historians discuss the ecology of the Central Eurasian steppe zone they often overlook the extent to which this territory includes environmentally and biologically diverse ecosystems. Both the geographic area and the biological productivity of this vast territory are rarely assessed at specific, locally relevant, scales. Characteristics of the steppe that relate to how the larger ecological zone shaped specific economies of its inhabitants are a focus of today's ongoing research. Actual archaeological distributions of Bronze and Iron Age settlements within Central Eurasia are, in many cases, concentrated in 'ecotones' or transitional environments at the interface of two ecozones, such as between the steppe and mountains or forests and coastal regions. Across Eurasia archaeological remains are often in higher concentrations in ecotones, good examples being large settlements of the "Sintashta Culture", that are clustered along foothills and floodplains of the Ural Mountains (Zdanovich and Zdanovich 2002), and the eastern Srubnaya Culture, located primarily along river valleys within the forest-steppe/steppe ecotone (Anthony et al. 2005; Shishlina and Bulatov 2000). The aggregate of diverse Bronze Age societies of the eastern Eurasian steppe cannot be pinned down solely to ecotone settings. Nevertheless, considerable evidence for the exploitation of such mosaic contexts is typical in the Dzhungar and Tien Shan Mountains of Inner Asia (Chang et al. 2002; Frachetti 2008b) as well as along littoral zones of the Caspian and Aral Seas (Kuz'mina 2007). Concentration on ecotones does not imply that the steppe itself was unused during the Bronze and Iron Ages, yet I suggest that a more specific understanding of Central Eurasian economies and strategies can emerge from analysis of the biologically diverse landscapes formed at the interface of major ecological matrices.

Senft (2009) concluded that even though there are few species endemic to ecotones, these transitional zones contain a species composition combining the array of species on either side of the divide. Therefore, ecotones tend to exhibit relatively greater biodiversity, which engenders a diverse mosaic of ecological 'patches' across often-discontinuous territories (i.e., ecotopes or microenvironments) (Figure 6.8). Ecotonal divides can be either gradual, or – as in the case of the Central Asian mountain/steppe ecotone – a checkerboard of ecological pockets (Figure 6.9). Turner et al. (2011:5) see these alpine ecotones as "cultural edges", whereas the array of biodiversity present in these settings supports a point of "focus of social and economic activities and meeting places where knowledge and goods are produced and exchanged".

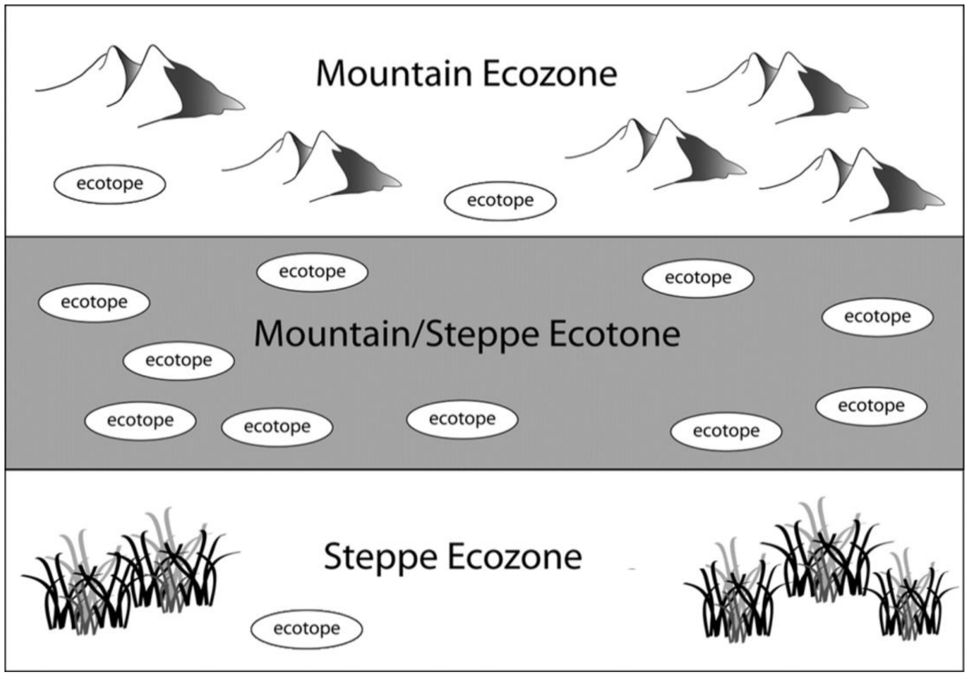

Figure 6.8. Relationship between ecozones, ecotones, and ecotopes

In this dissertation, I define the term ecotope following Troll (1950) as the smallest ecologically relevant unit on a landscape, synonymous with an ecological patch (Foreman and Godron 1986). This use of the term ecotope is in contrast to the definition proposed by Whittaker et al. (1973). The term ecotope can be applied to all distinct ecological pockets on the landscape; however, in this dissertation I use the term as a contrast to the general steppe matrix. Ecotopes are distinct and discrete biotic communities and can be identified based on their biotic components. Across Eurasia, diverse ecotopes played a vital role in herd foraging and grazing practices, both ethnohistorically and archaeologically. Herds were moved across a steppe or semiarid-steppe matrix dominated by nutrient-poor vegetation (e.g., *Artemisia* spp. and arid-land grasses), while herders focused herd pasturing at landscape nodes with rich forage and water resources. These ecotopes are influenced and formed by streams, rock outcrops, valleys, drainages, or springs. Ecotopes also have distinct vegetation communities that differentiate them from surrounding plant communities within the broader ecological matrix. The size, scale, and dimensions of these ecological pockets are highly variable; the specific ecotopes of interest in this dissertation are moist and have denser vegetation than the surrounding matrix. Furthermore, the geographic dispersal and spacing of these ecotopes is variable, but they tend to be in closer concentration in the foothills and more dispersed further into the steppe; in many cases moving between two ecotopes would simply require a jump from one valley to the next.

In this section, I draw from landscape ecology to explain how the dynamics of a mobile production economy played out in the past. I focus on archaeobotanical evidence, specifically from Begash, to reconstruct the significance of ecotopes within the mountain/steppe interface of the Dzhungar Mountains, Kazakhstan (Figure 6.9). The goal of this section is to explain what the archaeobotanical seeds indicate from a depositional and taphonomic point of view; and to discuss what can be inferred about herd pasturing practices from the wild seeds, specifically how they illustrate the use of ecotopes in herding strategies.

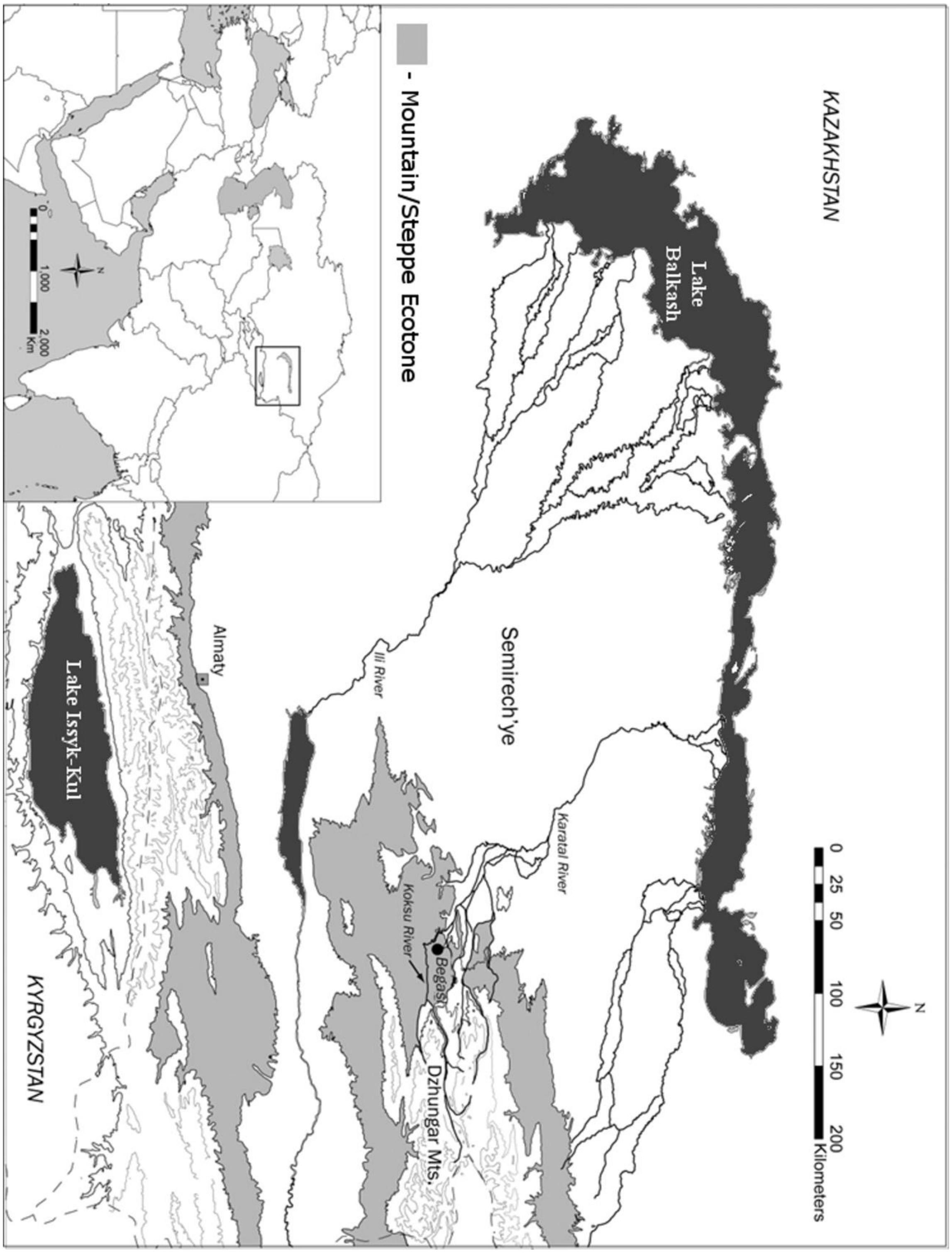

Figure 6.9. Map showing Begash and its geographic setting; mountain/steppe ecotone is darkened in grey

The wild seeds obtained through soil flotation from Bronze and Iron Age layers at Begash were introduced into the archaeobotanical assemblage through many different processes. I propose that the burning of dung as fuel was likely a primary factor. Along with dung burning, I discuss other vectors by which seeds may have entered the Begash assemblage and propose how the plant remains correlate with herd pasture strategies. Given the botanical composition of the area's steppe matrix, I show that herders were targeting rich ecotopes spatially dispersed across a vast mosaic landscape (in some cases densely clustered and in other areas thinly dispersed), rather than exploiting the steppe as grazing generalists. Their detailed knowledge of resource distribution, both spatially and seasonally, was key to their successful pastoral existence for millennia in the mountains of Inner Asia.

Modeling both changing and consistent patterns of resource-oriented mobility is important for understanding how social interactions took place among neighboring groups and ultimately how concepts of community and kinship may have been structured throughout prehistory. Pastoralist landscapes tend to have low population density (Barth 1961). Population density in mobile pastorally focused regions of the steppe traditionally has been around 1.5 individuals per km^2 (Masanov 1995). Accordingly, small groups of humans dispersed evenly and thinly across vast geographic expanses would rarely come into contact by chance. As Bendrey (2011) points out, different herd animals have different ecological demands, and herd species compositions can be diversified and shifted to suit distinct environmental settings. As a result, regionally disproportionate concentrations of both human and herd communities shaped a patchwork of networked nodes that served as central points for more intensive and regular social interaction

(Frachetti 2008a, 2008b). Winter camps were especially important for defining areas of more intensive community interaction and resource sharing. Ethnohistorically documented winter camps across Central Asia provided essential locales for vital risk-management practices (such as resource sharing) and also fostered institutions of social cohesion (Barfield 1993; Basilov 1989). These camps varied greatly in numbers of yurts and human population. Thus, large, forage-rich patches help geographically define the network epicenters of extended kinship and the formation of various relationships between communities of mobile pastoralists at a variety of social scales (Frachetti 2006, 2008a). The social geography of land use at rich, diverse patches is particularly important to successful pastoralist living within mountain/steppe ecotones of Central Eurasia.

The economy in Semirech'ye, at least as far back as the Bronze Age, has had a major pastoralist component (Frachetti 2008b; Frachetti et al. 2010a). However, the details of this productive economy and how it articulated with other economic strategies and social groups across Central Asia are complex. Pastoralists use many different economic strategies (Salzman 1971, 1982, 2004) and incorporate a range of different mobility patterns. Vainshtein (1980) presents a number of ethnohistoric analogies for vertical mobility patterns in Central Asia, discussing examples of both long and short distance seasonal transhumance. While the mobile pastoralists Vainshtein (1980) discusses are primarily in the mountains and valleys of northern Central Asia (Altai Mountains), they still provide a good analogy for archaeological populations in regions closer to the steppe. The Begash macrobotanical assemblage provides direct and indirect data to help reconstruct pastoralist mobility patterns and landuse, more specifically suggesting a parallel between the ethnographic and archaeological record. Archaeobotanical seed remains enable us to reconstruct how herds were periodically moved from one patch to the next or from one river valley to the next stream drainage. Frachetti (2008b) further argues that the Bronze Age inhabitants at Begash employed vertical mobile herding patterns. They lived in seasonal settlements and utilized geographically fixed but seasonally variable pasture resources in diverse environmental zones. Seasonal movements would likely have meant herders used the site only during the harsher winter months.

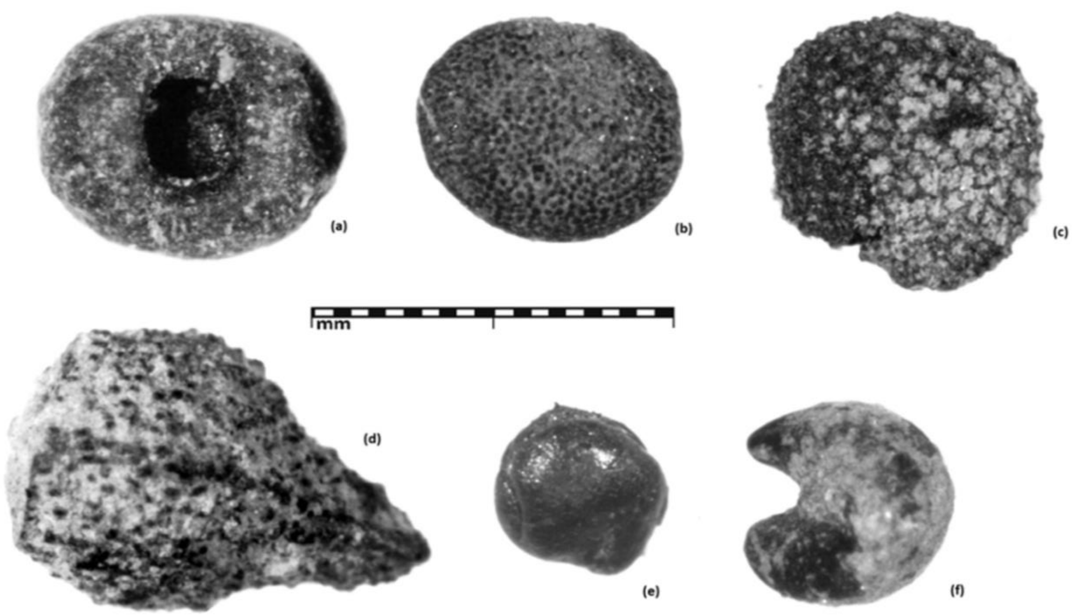

Figure 6.10. Selected wild seeds from Begash: a) *Galium* sp. from FS48; b) *Polycnemum* (cf. *arvense*) from FS6; c) *Hyoscyamus niger* from FS47; d) *Lithospermum arvense* from FS47; e) *Chenopodium* sp. from FS6; f) *Malva* (cf. *sylvestris*) from FS6

The landscape directly around Begash is predominantly semiarid steppe. Interestingly, steppe-land plants are conspicuously absent in the Semirech'ye samples. Instead, there is a variety of plants that are more water demanding such as *Chenopodium*, *Galium, Hyoscyamus, Hypericum,* Lamiaceae, *Lithospermum, Malva, Polygonum,* and *Tribulus*, which together constitute more than 50 percent of the assemblage (Figure 7.5). These plants are found on the landscape around Begash today only in small patches or ecotopes, such as river valleys, rock outcroppings, springs, and stream beds (described above).

In studying ethnohistoric accounts of pastoralists in this region, it becomes evident that these microenvironmental patches were vital for herd and human survival (Vainshtein 1980). Camps were (and still are) situated in valleys, leeward slopes, depressions, in bushes, or protected by tall marsh, reed-like stands of *Phragmites australis* and *Typha* spp. (or *Miscanthus* in southern Central Asia) (Frachetti 2004b:165; Masanov 2000:189; Shishlina 2000; Vainshtein 1980). The use of marsh reed stands as winter shelter is well documented across the steppe. *Phragmites* culms are not bent by the snow and, therefore, remain standing as a wall against the wind. In addition, they provide fodder for animals and architectural material (Anthony et al. 2005; Masanov 2000:189; Shishlina 2000:173). Ethnohistorically and ethnographically, these ecotopes were important focal points, and the locations of archaeological sites, which are typically situated nearby these vegetation patches, indicating that they were also important in antiquity. The image in Figure 6.11 shows a modern Kazakh cattle herd grazing in a stream bed surrounded by *Artemisia*-steppe and Figure 6.12 shows a yurt in a similar valley; the contrast between the rich ecotope and the arid steppe background matrix in the image is abrupt.


Figure 6.11. A modern herd grazing along a stream near Taldy-Kurgan in Semirech'ye

Figure 6.12. Modern Kazakh herder's yurt located in a depression on the landscape with richer vegetation than the surrounding hills, near Taldy Kurgan summer of 2008

Kazakh pastoralists in Semirech'ye have traditionally selected winter camps (*auls*) in specific locations that will protect them and their herds from the harsh continental climate (Valikhanov 1961 – 1972, vol. I:531). Levishin noted this fact when stating:

> "In order to protect themselves from the misfortunes and unpleasantness which winter causes them, the Kazakhs choose for their winter camps the middle of some grove, reeds, hills, or sands in the southern part of the steppe… Their camps, winter as well as summer, cannot be exactly determined and are not always occupied by the same inhabitants. Nevertheless, they are quite constant in their choice of the former, because not all localities present the necessary conditions for a winter camp to the same degree and because the depth of snow does not allow them to move." [Levishin 1840:311-312]

The ethnographer Medvedskii recorded criteria used for selecting a winter camp by Kazakh pastoralists in the late 1800s. Masanov (1995:88) presents Medvedskii's criteria as follows "The winter house (Zimovka) should: a) be well protected from the wind; b) not be covered in deep snow; c) have grassy areas under the snow; d) have a convenient water source; e) have the possibility to gather fuel in large quantities and without excessive work; f) be nearby dry forage, grasses, or fuel."

Frachetti discusses modern mobile herder patterns in Kazakhstan, noting that:

> "Hilly areas of medium elevation and river valleys in the foothills represent typical places for the establishment of winter lodging in the Dzhungar Mountains. The winter camp typically represented a collection of as many as 40-50 households, which, except in the case of those that

> wintered in extremely dry deserts, was stationary from the month of November until mid-April. Those groups did not necessarily settle all in the same location, but rather set up smaller settlement groups in the many ravines and canyons throughout the lowland areas of river valleys." [Frachetti 2004b:165-166]

Masanov (1995) notes that stables were often erected around the camp to help protect animals from the winter weather. These stables were constructed from many different materials, including wood, sod, stone, or even reeds. However, above all Valikhnov (1961 – 1972, vol. I:533) notes that the main criteria for choosing winter encampments is the availability of herd forage. Cattle and sheep cannot reach grass buried below 10 – 15 cm of snow. Keeping horses mixed in with the herd helps, because they break up the snow cover, allowing access for other animals; however, careful selection of locations with low snow cover and abundant vegetation is vital.

I recovered high abundances and ubiquities of wild herbaceous seeds originating from plants that grow in these riparian ecotopes. If the herbaceous seeds in the Semirech'ye archaeobotanical assemblages are the result of dung burning, then we can start to understand herd diet by looking at seed composition. The composition of the assemblage suggests that herders pastured their animals in moist locations, only venturing out into more arid steppe regions to shift between ecotonal patches. In addition, forbs were the dominant forage, and grasses played a small role. On the landscape around Begash there are numerous forage-rich ecological patches separated by rolling hills covered in low steppe vegetation. These microenvironmental zones have botanical communities that closely reflect the paleoethnobotanical assemblage from Begash.

Conclusion

I have argued that the categories of plants present in the archaeobotanical assemblage indicate that herders were grazing and browsing their herds in small ecological patches – or ecotopes – for at least part of the year. I use experimental data among other lines of argument to show that the wild seeds are the result of dung burning and that they represent herd dietary patterns. Mobile pastoralists in the region today still use moist ecological patches near river valleys or rock outcroppings to pasture their animals. These locations, which vary greatly in size, are vital for the economic system, providing winter and summer shelter from the harsh weather for humans and animals, foraged plant material for humans and animals, as well as locations suitable for low-investment millet agriculture. This observation is not only key to understanding herding strategies in Eurasia, but may be important for understanding mobile pastoralism as an adaptive strategy in other regions as well (for example, see Western and Dunne 1979). The evidence from Begash indicates that mobile pastoralists in Semirech'ye shifted between dispersed locales, utilizing geographically and temporally variable plant resources, at least as early as the mid-third millennium B.C.

Herders likely moved from one green patch to another to suit the herd's needs and to mitigate vegetation impact. Mobility is a risk-management strategy in that it provides the ability to buffer the entire economy from biophysical stresses such as overgrazing (Bacon 1958; Barfield 1993; Bates and Lees 1977; Di Cosmo 1994; Lees and Bates 1974; Marston 2011). Vertical mobile pastoralism brings people into contact with a number of diverse environmental settings. Botanical resource availability is geographically and temporally spread across the landscape as a result of orographic processes. Successful use of these diverse resources requires an understanding not only of geographic resource distribution but also seasonal growth cycles at various elevations. It is evident that for millennia herders have had an intimate understanding of the geographic and seasonal distribution of forage resources on the varying landscape of the Semirech'ye steppe and foothills.

Forage-rich ecotopes become even more central to the social interaction process when herders moving from one ecotope to the next come into contact. Conventional views about Bronze and Iron Age pastoralists depict low population densities and small, thinly distributed communities across much of the steppe. If populations were evenly dispersed across these vast expanses, non-planned encounters would be limited. However, when populations are concentrated in small patches across the landscape, local densities become considerably higher, making it more likely for social overlap during major seasonal movements and during smaller moves between ecotopes (Frachetti 2008a).

In this dissertation I focus on the antiquity of extraction of resources within ecotone settings, specifically in patches between mountain and steppe environments. Social and economic ties among pastoralist communities may have been fostered through higher densities of herding groups utilizing forage-rich ecotopes on what otherwise appear to be restricted and unproductive ecological settings. The mosaic nature of ecotone landscapes with diverse patches of biota, resource concentrations, and focal points for human contact and interaction may have had a far greater role in the spread and evolution of mobile pastoralist economies throughout the foothills of Inner Asia from at least the Early Bronze Age. From this perspective, I may reconsider the reality of the

Eurasian steppe not as a vast uniform highway of grass, but view it more accurately as a matrix of locally distributed ecotopes that formed an extensive patchwork of nodal connection points across a network of communication, exchange, and social interaction.

Chapter 7: Agriculture in Bronze and Iron Age Central Asia

7.1 Introduction

The data presented in this chapter are used to build a model of economy for prehistoric peoples in Central Asia. The domesticated grains, grapes, and peas provide us with a direct view into the diet of people in the past. Their presence in these assemblages adds a whole new perspective to the debates over Bronze Age economy. For decades researchers have presented models of economy that focus on the significance of pastoral products. One of the most significant contributions of this dissertation is the revelation that agriculture played a role in the economy at least as far back as the Late Bronze Age. The presence of domesticated grains and peas at Tasbas in association with rachises and grain impressions in fired mud brick suggests that people at the site were growing crops as far back as the mid-second millennium B.C. (ca. 1400 cal B.C.). It is still unclear how intense the agricultural pursuits were at certain sites like Begash and Mukri in the Iron Age and Tasbas in the Late Bronze Age. I theorize that agricultural pursuits were limited at more marginal locations like Begash, and people may have practiced low-investment agriculture, focusing on low-input crops like millets. It is, however, clear that agriculture was intensified during the Iron Age at more arable locations, like the Talgar alluvial fan.

Zooarchaeological analyses of the Begash faunal assemblage show a dominance of domestic animal remains, specifically sheep, cattle, and horse, suggesting that economy was heavily reliant upon herding (Frachetti 2004b:556-561; Frachetti and Benecke 2009). Frachetti (2004:51) argues that the Bronze Age inhabitants of Begash were vertical mobile herders. Perennial settlements were selected to take advantage of the geographically fixed but seasonally variable herd forage resources in mountain environments. Zooarchaeological analyses conducted by Benecke also show evidence for hunting (Frachetti and Benecke 2009). These data indicate the presence of red deer in all phases of the site. Other wild animals that appear with some frequency in the assemblage include goitered gazelle, Siberian ibex, argali, wild pig, fox, and several avian species. Similarly, pastoralism was a core economic pursuit at Tuzusai, with a zooarchaeological assemblage dominated by domestic animals, sheep, goat, horse, donkey, camel, and dog. A small hunting component was identified at Tuzusai as well. Chang et al. (2002) and Rosen et al. (2000) construct a model for economy at Tuzusai based on a semisedentary lifestyle that relied on herd movements as well as intensive agricultural pursuits[29].

7.2 Domesticated Seeds (and Fruit Parts)

7.2.1 Introduction

Domesticated – Begash

The oldest domesticated grains in northern Central Asia come from Begash, phase 1a (2460 – 1950 cal B.C., Middle Bronze Age). These grains consist of four cerealia grains, one free-threshing compact wheat grain (likely hexaploid [*Triticum aestivum/turgidum*]), and 29 broomcorn millet (*Panicum miliaceum*) grains or grain fragments. Two direct dates, one on a cerealia grain and the other on six broomcorn

[29] A more detailed look at the previous economic studies conducted at Tuzusai and Begash is presented in Chapter 3.

millet grains, place the domesticated material around 2200 cal B.C.; a full discussion of the grains and context is presented in Frachetti et al. (2010). Iron Age remains from the site, specifically from a single hearth feature, (FS 6), included more broomcorn millet grains in addition to foxtail millet (*Setaria italica*) grains, the latter was not present in the Bronze Age samples (Table 6.2). These limited remains of domesticated grains do not clearly show us whether or not they were growing crops (by the Iron Age) or if they were obtaining them through exchange. Furthermore, if they were growing crops in the Iron Age, how intense were the agricultural pursuits? I suggest that low-investment millet-based agriculture was likely.

Domesticated – Mukri

The single Iron Age sample from Mukri contained one well-identified wheat grain and one cerealia fragment. In addition, it contained 20 broomcorn millet grains and 10 fragments that were likely broomcorn millet, but were too fragmentary to properly rule out as foxtail millet. The ten fragments were put into the category millet; however, there were no visible traits that resembled foxtail more than broomcorn millet.

Domesticated – Tuzusai

There are seven domestic crop types identified in the macrobotanical assemblage at Tuzusai (Table 6.2): hulled barley (likely all six-rowed [*Hordeum vulgare* var. *vulgare*]); naked barley (*H. vulgare* var. *nudum*); free-threshing compact wheat and free-threshing lax-eared wheat (likely hexaploid); broomcorn millet; foxtail millet; and grapes (*Vitis vinifera* var. *sylvestris*). It is important that we consider the possibility of different landrace varieties of wheat and barley because this would imply they were actively kept segregated by farmers. Maintaining landraces among plants that freely outcross requires active participation by the farmers. Field plots would have been isolated, to prevent hybridization.

The high ubiquities and densities of domesticated grains at Tuzusai support the possibility that agriculture was intensely practiced at the site. This argument is further supported by the elaborate mud brick architecture and complex material culture. The residents at Tuzusai were likely mixed agropastoralists who may have seasonally moved herds but also maintained a sedentary agricultural component in the community.

Domesticated – Tasbas

The domesticated grains recovered from Tasbas include naked barley, highly compact free-threshing wheat, broomcorn millet, and peas (*Pisum sativum*). Morphologically the wheat and barley from Tasbas does *not* resemble the material recovered from Tuzusai. While wide ranges of variation exist within a single landrace variety, it seems likely that these are distinct varieties. The barley is a six-rowed, naked variety with a split apex. Overall, it is relatively compact. The few wheat grains (n = 4) are of a highly-compact free-threshing variety. The peas in particular are of interest, seeing that they are the earliest cultivated legumes in northern Central Asia. This assemblage from Tasbas is the earliest solid evidence for agricultural pursuits in northern Central Asia. It is now clear that people in the mountains of Central Asia were planting crops, possibly in small, low-maintenance plots. They may have focused their attention on herding but also grew barley, millet, and possibly drought-tolerant compact wheat as well as small garden plots of peas.

Domesticated Seeds[30]	Sum	Abundance	Density	Ubiquity	Domesticated/ Total (Ratio)
Begash (Iron Age)	57	5	1.75	38.5	19.2%
Beagsh (Bronze)	34	4	0.35	33.3	73.1%
Mukri	32	4	71.11	100	4.7%
Tuzusai	2,314	7	10.89	100	0.4%
Tasbas	1,279	7	11.98	78.6	2.6%
Totals	3,769	9	7.96	70.1	2.4%

Table 7.1. Ratios of domesticated seeds from all four sites

Cerealia and Millet

The category 'cerealia' was used when a grain was too damaged to differentiate between wheat and barley. There were 880 cerealia fragments in the Tuzusai assemblage and 629 from Tasbas, an additional 5 were recovered from Begash and one from Mukri, 1,515 in total. The category 'millet' was used when a grain was too fragmentary to differentiate between broomcorn or foxtail millet. There were 157 millet fragments in the Tuzusai assemblage. Because foxtail millet was not recovered from Tasbas, all millet fragments were assumed to be from broomcorn millet. Nine millet fragments were recovered from Begash and 10 from Mukri, for a total of 176 fragments.

[30] In an attempt to account for fragmentary material the categories 'cerealia' and 'millet' were not included in this table.

7.2.2 Free-Threshing Wheats

Wheat has received the most archaeobotanical and phytogenetic attention of all Old World crops and the picture of its original domestication and spread is still being sorted out. However, a good discussion of the accepted phylogeny, time frame for domestication, and spread is presented in Zohary et al. (2012:23-51). There are currently five species of wheat recognized, based on cytogenetic criteria. There are two diploid wheats, *Triticum monococcum* (einkorn wheat) and *T. urartu*. These two wheats have wild forms (*T. urartu* is only wild) that closely resemble each other but are genetically isolated. Einkorn was domesticated in southwest Asia by the late ninth millennium B.C. from the wild form *T. monococcum* ssp. *monococcum*. The entire *monococcum* complex of subspecies is closely related and hard to parse out morphologically or genetically. *T. urartu* was never domesticated; however, it is now known that it donated its chromosomes to the polyploid complex that makes up tetraploid and hexaploid wheats. This polyploidy hybridization happened naturally, long before human manipulation of the genus. There are two species of tetraploid wheats, *T. turgidum* and *T. timopheevi*. Molecular and cytogenetic research has shown that the 'A' genome of both of these tetraploids originated in an *urartu*-like ancestral wheat (Dvořák et al. 1993; Dvořák et al. 1998). *T. timopheevi* is an endemic domesticate of a small area of Georgia and is, therefore, not of relevance to this dissertation. *T. turgidum*, on the other hand, spread across much of Eurasia and has been identified at Jeitun on the boarders of Central Asia (Harris 2010). The eastern most spread of this crop in antiquity is not fully known but the lack of any clear evidence for it outside Neolithic Jeitun may suggest that it was replaced by hexaploid wheats in the Eneolithic or Early Bronze Age. *T. turgidum* was domesticated from a wild tetraploid, *T. turgidum* ssp. *dicoccoides* around the same time period that einkorn wheat and hulled barley were domesticated in southwest Asia (late ninth millennium B.C.). Complicating the picture, there are also free-threshing tetraploid wheats; the most prominent of these being durum (macaroni wheat); for a detailed discussion of the origins of free-threshing tetraploids and complications in the archaeobotanical record see Fuller (2002) or Zohary et al. (2012).

There is considerable morphological overlap between free-threshing tetraploid and hexaploid grains; therefore, for the sake of caution, I use the designation *T. aestivum/turgidum* throughout this dissertation. Rachises are diagnostic between the two species; however, wheat rachises are conspicuously absent from almost the entire dissertation assemblage (n = 1). Part of the reason for this caution is the unknown eastern extent of the spread of macaroni wheat. It is feasible that it was cultivated with bread wheats in parts of Central Asia, although the single rachis presented in this dissertation suggests otherwise (Tuzusai-09FS25).

The final wheat species is the hexaploid *T. aestivum* (bread wheat). This species evolved under cultivation form a polyploid cross between a tetraploid *T. turgidum* (already containing the genome 'A' from *urartu*) and a wild grass (*Aegilops tauschii*), providing genome 'D'. Hexaploid wheats have a wide range of types and varieties (landraces); the hexaploid wheat complex can be broken into two groups, hulled (glume) and free-threshing. Hulled hexaploid wheats (glume wheats) include *T. aestivum* ssp. *spelta* and *T. aestivum* ssp. *macha* (the latter is endemic to western Georgia) (Zohary et al. 2012). Free-threshing hexaploid wheats (bread wheats) are easier to process and in many parts of Eurasia replaced emmer or durum wheat as the preferred crop during the Early Bronze Age. While there are many subspecies and varieties of bread wheats, cultivated around the world today, two of particular interest to this dissertation are *T. aestivum* ssp. *compactum* and *T. aestivum* ssp. *sphaerococcum* (see Chapter 8 for a discussion). The grains of hexaploid wheats tend to be plumper than durum (with a large margin of overlap) but have distinct rachises (Jacomet 2006 unpublished), although the grains of *compactum* and *sphaerococcum* are especially plump and in the case of the latter nearly spherical.

The historiography of archaeobotanical remains of free-threshing wheats across Eurasia is complicated and taxonomic classification and criteria for identification have changed significantly over time. In recent years, researchers have veered away from the long-held practice of classifying free-threshing wheats into varieties such as *compactum* or *aestivo-compactum*. For a discussion of the complexities of these former classifications and an argument for why they are no longer used, see Fuller (2002). Zohary et al. (2012:51) note: "A large scale re-examination (by the discriminating rachis morphology) of early remains of '*aestivo-compactum*' naked wheats in west Asia and Europe has not yet been attempted".

While glume wheats were cultivated in the Neolithic at Jeitun (Harris 2010), all other remains of wheats found in Central Asia, as well as China and East Asia, have been free-threshing. In addition, when rachis fragments are recovered, they are of a hexaploid form. Li et al. (2011) have argued that all early wheats in China are bread wheats, based on early herbarium material, modern-historic records, and genetics on early material from Lop Nor in Xinjiang (also see Crawford, G. 1992). It seems probable, based on material from this dissertation and other projects currently underway in southern Central Asia (see Spengler and Willcox in press; Spengler et al. in review), that all wheats in Central Asia from the Bronze Age on were free-threshing hexaploid wheats. However, until more botanical studies have been conducted and we have a larger range of rachises for comparison caution is in order, and I will continue to use the taxon *T. aestivum/turgidum*.

Free-threshing wheat grains are the most abundant domestic grain at Tuzusai (n = 448) and the least abundant grain from Tasbas (n = 8). There is a high degree of morphological variability among these grains; in addition, there is an almost complete absence of rachises or spikelet material. A single fragmentary rachis (the only wheat rachis from any of the sites) from Tuzusai-09FS25 is from a hexaploid variety of wheat (image in Figure 7.5c).

Wheat	Total	Whole[31]	Not Measurable	Average Length (mm)	Average Width	(Ratio) Wheat/ Domesticated
Begash (Iron Age)	1	0	1			57 %
Begash (Bronze)	1	1	0	5.2	4.3	34 %
Mukri	1	0	1			32 %
Tuzusai	448	247	191	3.9	2.7	19.4 %
Tasbas	8	3	5	3.90	2.80	0.6%
Total	459	251	198	4.30	3.30	12.2%

Table 7.2. Totals, measurements, and ratios for wheat from all four sites

[31] Whole is determined by a judgment of whether or not reliable length and width measurements can be taken; therefore a whole puffed or distorted seed would count as 'not measurable'. Most fragmentary seeds smaller than half the total area were thrown into the category cerealia; therefore 'not measurable' seeds are usually larger than half. The ratio in the last column includes cerealia and millet.

Wheat – Morphology and Variability

The wheat from Tuzusai is highly morphologically variable. Most landrace varieties of crops express extreme variability, both between landraces and within a single variety. Similar to Tuzusai, the Shortughai site in Afghanistan (Figure 1.1) has a wide range of wheat morphology. Specifically discussing South Asia, Willcox (Willcox 1991:146) notes, that “given the array of varieties found in the region today the usual distinctions between forms break down because intermediates occur”. However, he also shows that grain morphology at Shortughai is variable between samples. Certain samples have grains that are generally more elongated and other samples are more spherical. He further proposes the possibility that these distinct morphological groups are distinct genetic varieties and not the result of environmental factors such as intensity of irrigation (as Miller 1999 proposed). Willcox (1991:147) notes that “the evidence from samples 20 and 21 suggests that the crops were cultivated separately; perhaps one variety was suitable for dry-farming, the other better adapted to irrigated conditions” (Figure 7.1; 7.2). Using length and width ratios, Willcox (1991) identified two distinct varieties (compact and lax [Figure 7.1]). However, he also shows that there is a much wider range of variation in wheat morphology at Shortughai, not allowing for clear divisions. This wide range of variation is characteristic of most landrace crops. There were likely a number of distinct landrace varieties of wheat grown at or near Shortughai, this scenario is likely representative of Tuzusai as well. Diversification, as I discuss in this dissertation, reduces risk. Incorporating varying landraces of wheat, and maintaining the distinct gene pools, could have helped farmers at Tuzusai cope with unpredictable environmental conditions. Certain landraces could have been favored for traits such as drought tolerance or color.

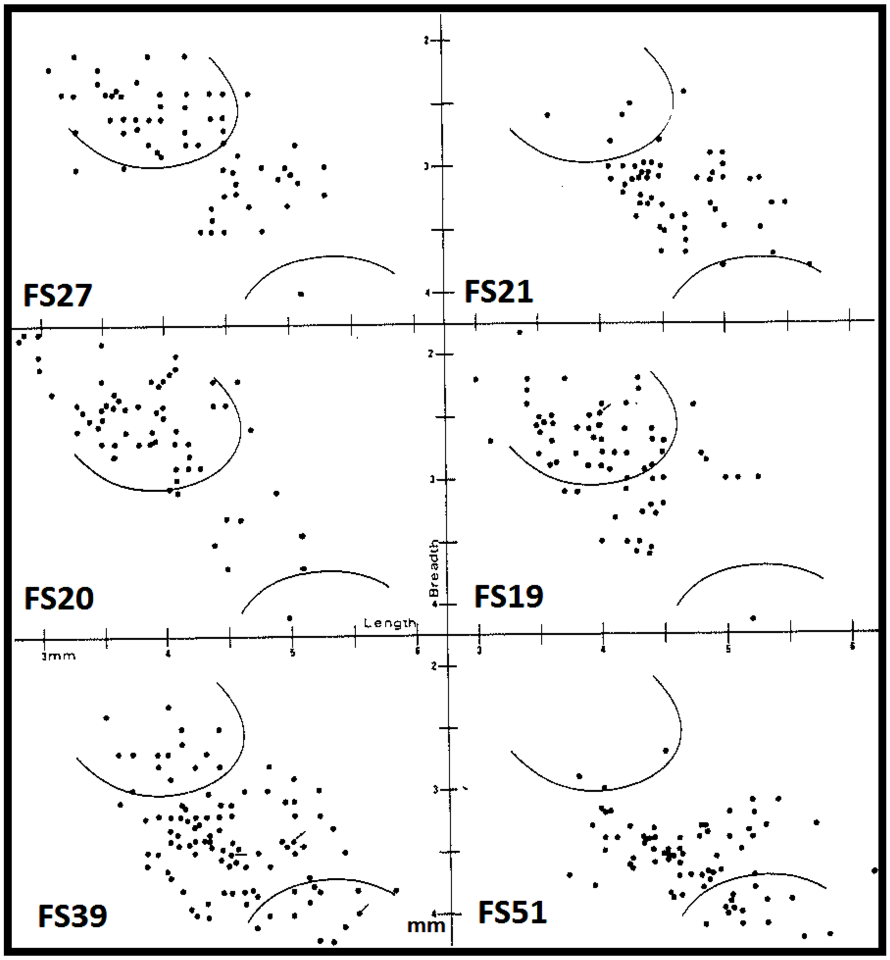

Figure 7.1. Cluster plot of wheat length and width measurements from six samples at the Shortughai site, from Willcox (1991:146, Figure12.2)

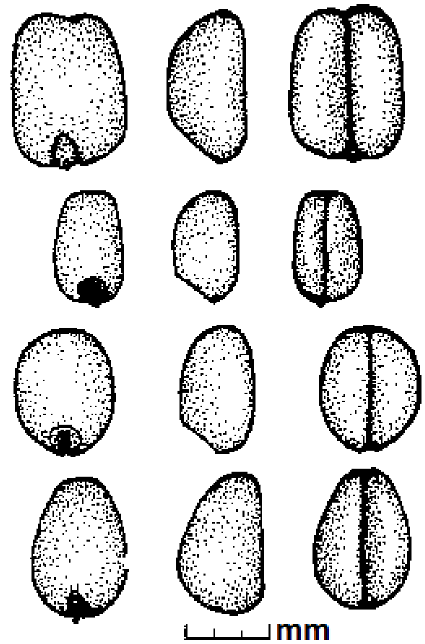

Figure 7.2. Illustration showing some of the variability in wheat morphology at the Shortughai site, from Willcox (1991:147, Figure 12.3)

In discussion here, all wheats are clumped into one category; however, I favor the likelihood that there are at least two varieties of wheat in the assemblage from Tuzusai, a compact-eared form and a lax-eared form. Images of lax and compact-eared wheat from Tuzusai are presented in Figure 7.5a and b. The lax-eared form is elongated and narrower, while the compact form is short and stout. In her work in archaeological sites in Europe, Jacomet (2006 unpublished) uses the cut-off for lax-eared and compact-eared wheats of a 1.5 ratio of length:width. This ratio means that lax-eared grains can be shorter than compact-eared grains as long as they are significantly narrower, for example, see Figure 7.5a verse b. The graph displayed in Figure 7.3 shows a weighted cluster plot of measurements for 199 individual wheat grains from Tuzusai. The line through the cluster plot is not the mean regression line; it is Jacomet's division between the two forms. Therefore, wheats falling above the line would be viewed as compact-eared, whereas those below would be lax-eared. However, there is a complete linear range of variation among the Tuzusai wheats, so no attempt was made to quantify the two forms, and a clear division does not exist. A single wheat grain was also found in Begash FS34 from the Iron Age, dated by context to 390 – 50 cal B.C.

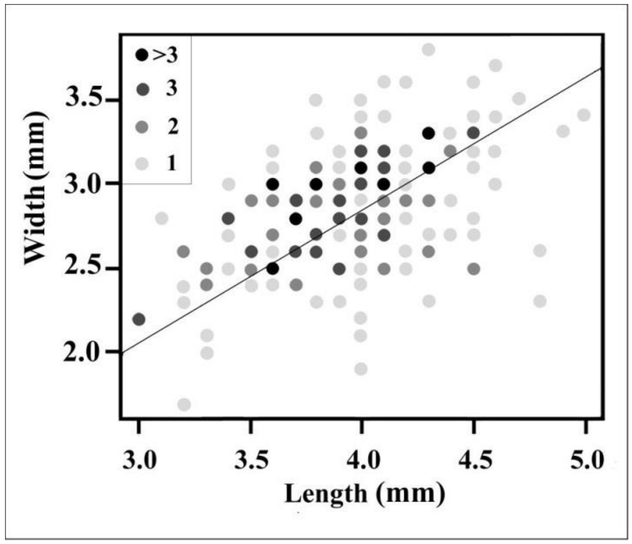

Figure 7.3. Weighted cluster plot of length to width measurements from Tuzusai wheat grains (n = 199)

Another example from Central Asia that illustrates the complexity of Late Bronze and Iron Age wheat morphology is the cache deposit from site 1211, Turkmenistan (ca. 1400 B.C.). A single ceramic vessel filled with over 16,000 carbonized wheat grains was recovered from a storage pit (Spengler et al. in review). Spengler et al. (in review) present a wide range of morphological variability among grains from the closed cache context, ranging from highly-compact (term discussed below) to lax-eared. Figure 7.4 depicts the extremes of this variability. Hence the validity of any classification in Central Asia based on morphology requires further research.

Figure 7.4. Four free-threshing wheat grains, all from FS 7 a site 1211, representing the range of variation present in one context, from Spengler et al. (in review, Figure 2)

A third possible variety of wheat, distinct from what was found at Tuzusai, is the highly-compact form from Tasbas and Begash. All wheat grains from Tasbas and the Late Bronze Age grains from Begash (albeit in low abundance) express this highly-compact morphology. These grains are hemispherical and range from 2.5 to 5.0 mm in diameter. They all have a shallow ventral furrow. The significance of these grains and comparative morphotypes from other archaeological sites are presented in Chapter 8.

Wheat – Begash

Four cerealia grain fragments and one wheat grain were identified in the Middle Bronze Age samples from the human cremation (FS47; see Frachetti et al. 2010). The one measurable wheat grain is free-threshing (either *Triticum aestivum* or *T. turgidum*), measuring 5.2 mm in length and 4.3 mm in width; therefore, the length to width ratio

(1.21) indicates a compact wheat form. At least one of the other cerealia fragments is from a much smaller grain.

Wheat – Mukri

The single well-identified wheat grain from Mukri falls along the scale of variation for the Iron Age grains from Tuzusai. The fragments of cerealia grains look like they would also fall within his range if they were whole.

Wheat – Tuzusai

There is a total of 448 wheat grains and fragments from Tuzusai (Table 7.2). Wheat MNIs were not calculated because the category of cerealia was liberally used, and in most cases at least 50 percent of the grain was needed to determine if it was wheat or barley. Therefore, the MNI is roughly the same as the total count. At Tuzusai, there is a density of 2.10 wheat grains per liter. Wheat ubiquity (percentage of the sample containing a category) is 88 percent, the same ubiquity as barley and the highest density of any grain at the site. Individual sample abundance ranged from 0 to 126 grains. Of the 'whole', fully measurable wheats from Tuzusai (n = 199) the average length was 3.94 mm and the average width was 2.85 mm. Figure 7.5a and b illustrate the range of variation present among wheat grains at Tuzusai.

Wheat – Tasbas

There is a total of 8 wheat grains from Tasbas; all of these grains are from a highly-compact, free-threshing variety (Table 7.2). At Tasbas, as with Tuzusai, MNIs were not calculated. There is a density of 0.07 wheat grains per liter of soil, and ubiquity was 57.1 percent. Individual sample abundance ranged from 0 to 4 grains. The average length was 3.9 mm and the average width was 2.8 mm.

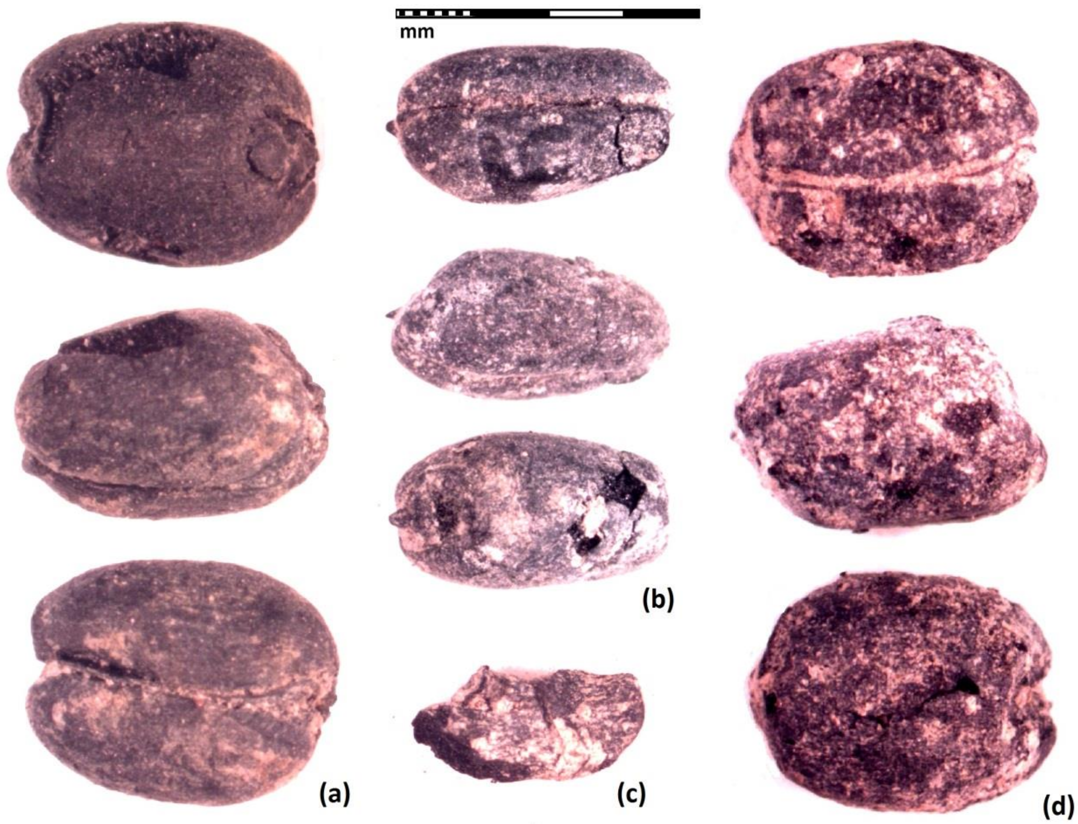

Figure 7.5. Free-threshing wheat grains (a, b, and d) and rachis (c) – a) and c) are from Tuzusai 2009 FS1; and b) and d) are from Tuzusai 2009 FS 5

Wheat – Growing Conditions

Of the different grain crops identified, wheat is the most labor demanding, time consuming, and risky (in terms of crop-failure). Free-threshing wheats were likely fall sown, planted between September and December and harvested between May and July. However, it is possible that they were a spring sown variety. A small portion of the wheat historically grown in northern China were spring sown (2 percent of the total wheat sown [Leonard and Martin 1963:348]). This Chinese spring sown wheat was planted between April and May, as soon as the soils thaw, and harvested between August and September. However, the vast majority of the wheat grown in northern China is fall sown, planted between September and October and harvested between May 20 and June 10. In dryer areas of Eurasia such as southwest Asia where almost all of the rainfall occurs during the winter months, wheats are all fall sown and are planted as soon as the fall rains come. In contrast, Ethiopia has rainy summers, and spring planted wheats are effective (Leonard and Martin 1963:357).

The optimal annual rain fall for wheat is between 635 and 890 mm[32] with at least 100 to 150 mm falling in the two months before harvest. In general wheat plants will not be productive if there is less than 510 mm of rain fall and 50 – 80 mm of rainfall directly pre-harvest (Leonard and Martin 1963:285). Water requirements for wheats vary, especially between landraces; some varieties are noted for being drought tolerant while others are highly water demanding. Nonetheless, wheat requires significantly more water than either millet or even barley. According to Peterson (1965:52) the following crops require said amounts of water for productive growth: broomcorn millet requires 267 mm; maize requires 350 mm; barley, 518 mm; common wheat, 557 mm; rice, 682 mm; and southwest Asian legumes[33], 884 mm. "In general terms the millets, sorghums and corns

[32] Peterson (1965:52) suggests modern wheat tend to require 557 mm of rainfall.
[33] Many varieties of legumes are rather drought-resistant, such as New World beans. Shantz and Piemeisel (1927) are specifically talking about peas, lentils, chick peas, and grass peas.

(maize) are most efficient. The small grain – barley, wheat, oats and rye – required almost twice as much water, while legumes required almost three times as much as the millets, sorghums, and corns" (Shantz and Piemeisel 1927).

> "A plant's efficiency in the use of water is dependent on many factors, and is usually highest when all conditions are optimum for growth. Examples of climatic conditions that tend to increase the transpiration coefficient (i.e. to decrease the transpiration efficiency) of a plant are high temperature, low atmospheric humidity, unfavorable light conditions, and strong winds. Soil conditions tending to increase the transpiration coefficient are complex, and include excessively high or low water content of the soil, lack of available essential nutrients, and an unbalanced supply of nutrients." [Peterson 1965:53]

7.2.3 Hulled and Naked Barley

Barley was domesticated as early as 8000 B.C. in southwest Asia in the Fertile Crescent from a wild, brittle-rachised, two-rowed, hulled form (*H. vulgare* ssp. *spontaneum*) (Harlan and Zohary 1966). However, genetic data has stirred up considerable debate during the past decade over the monophyly of domesticated barley; with each new genetic-based model published, a corresponding paper is published refuting it. In this debate, a number of separate origins for domesticated barley were posed, including Morocco (Molina-Cano et al. 1999), Ethiopia, the western Mediterranean (Molina-Cano et al. 2005), and Tibet (Xu 1982). However, a number of subsequent genetic studies seem to be supporting a monophyletic origin (i.e., Blattner and Mendez 2001; Leon 2010; Li et al. 2004). Tibet, for example has been suggested as a separate center of domestication for barley by Xu (1982) and Ma et al. (1987); it is further suggested that a Tibetan domestication may have taken place as early as 5,000 years ago (Aldenderfer 2007). However, recent genetic work by Yang et al. (2008) has disputed this possibility. Consequently, while there is still a debate over a possible second domestication of barley, likely east of the Fertile Crescent, as Merrell and Clegg (2007) suggest, there is no solid evidence to support an origin in Tibet (Leon 2010; Yang et al. 2008). A further study, by Dai et al. (2012) suggests that domestic barley was introduced the Plateau from elsewhere but genes of local wild varieties crossed with the domesticated lines.

The domestication process of barley is marked by several key events (or series of events): (1) at approximately 8000 B.C., nonbrittle rachis barley was cultivated in southwest Asia; (2) by 6500 B.C. six-rowed forms are cultivated, the mutation of the *Vrs 1* allele may have originated repeatedly in different geographic areas at different times (Komatsuda et al. 2007; Leon 2010); (3) by 6000 B.C. naked barley (mostly six-rowed) was cultivated in southwest Asia and western India (Zohary and Hopf 2000). Taketa et al. (2008) suggest, based on genetic evidence, that a single, unique mutation of the *nud* locus caused the naked phenotype of barley. Much earlier Helbeak (1959) suggested that naked barley spread quickly as the preferable form of food in suitable environments, such as high elevations where wheat is not suited. However, Taketa et al. (2008) point out that the adhered glumes are actually adaptations to protect the grains from environmental stressors, such as drought or cold. In addition to being hardier, hulled barley tends to also be preferable for fermentation and fodder.

Both hulled and naked forms of barley were recovered from the site of Godin Tepe in Iran. These grains were in Period V layers dating to the fourth millennium B.C.

(Miller 1990). At Anau South in Bronze Age layers (Namazga V and VI) (ca. 2500 B.C.) Harrison (1995) notes the presence of both hulled and naked barley. Naked barley is present in flotation samples from sites 1685 and 1681 in Turkmenistan, ca. 1600 B.C. (Spengler et al. in review). This opens the questions of when and through what route these two forms of barley spread north into the mountains of Central Asia (discussed in Chapter 8).

Barley – Tuzusai and Tasbas

The second most abundant grain identified in the assemblage for Tuzusai was barley (total = 313). The total density of barley is 1.47 grains/liter, and the ubiquity is 88 percent. Individual sample abundance ranged from 0 to 75 grains. No barley was found at either Begash or Mukri, and no cerealia fragments from either site had traits that would suggest barley over wheat. Barley was abundant at Tasbas, representing the main grain recovered. Almost all of the barley appears to be hulled (Figure 7.6a, c); however, a few grains are of a naked form (*H. vulgare* var. *nudum*). The possible naked barley grains are not always clearly differentiatable from the hulled form. Good examples of naked barley grains from Tuzusai are presented in Figure 7.6b, e, and 7.7; the grain in Figure 7.6e comes from the floor of pit house 4. Very few naked barley grains were present at Tuzusai, and if quantified, the ubiquity would be very low (roughly 10 percent).

Barley	Total	Whole[34]	Not Measurable	Average Length (mm)	Average Width	(Ratio) Barley/ Domesticated
Begash (Iron Age)	0					
Begash (Bronze)	0					
Mukri	0					
Tuzusai	319	104	214	5.08	2.89	13.79 %
Tasbas	446	206	234	4.54	3.02	34.87 %
Total	765	310	448	4.81	2.96	20.30 %

Table 7.3. Totals, measurements, and ratios for barley from all four sites

In contrast to Tuzusai the barley recovered from Tasbas is all of a naked morphotype (Figure 7.6d; 7.8). In addition to it being naked, it has an overall short and stout morphology, suggesting a compact variety. The average length of grains from Tasbas (4.54 mm) is significantly shorter than that from Tuzusai (5.08 mm); however, the average width from Tasbas (3.02 mm) is slightly greater than from Tuzusai (2.89 mm). All 446 of these grains are plump and have a split apex (also unlike almost all of the Tuzusai grains), and range in length from 3.0 to 5.5 mm. The shorter rounder grains from Tasbas are well illustrated in Figure 7.8a and b. The overall density is 4.17 grains per liter. The ubiquity was 50 percent; abundance ranged from 0 to 215 grains per sample (Table 7.3).

[34] Whole is determined by a judgment of whether or not reliable length and width measurements can be taken; therefore a whole puffed or distorted seed would count as 'not measurable'. Most fragmentary seeds smaller than half the total area were thrown into the category cerealia; therefore 'not measurable' seeds are usually larger than half. The ratio in the last column includes millet and cerealia.

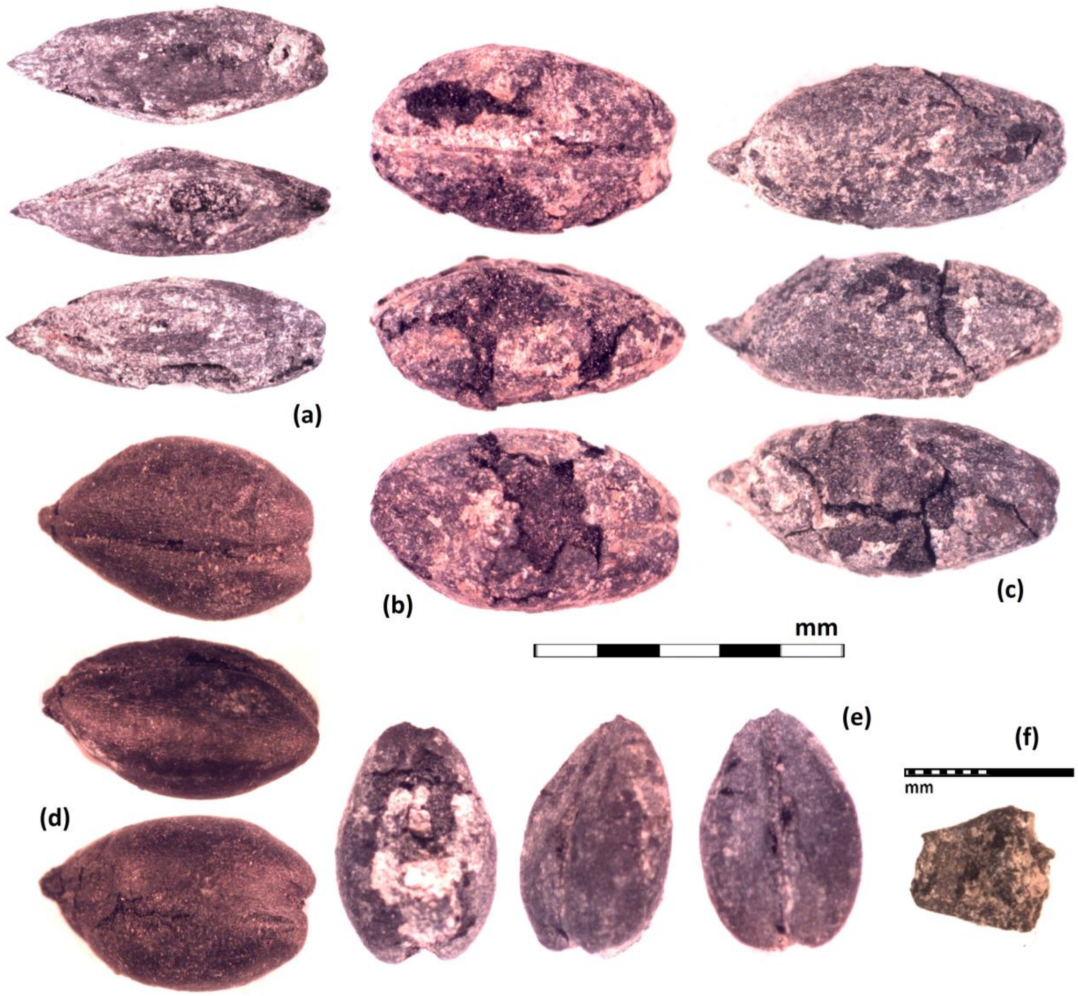

Figure 7.6. Barley – a) hulled barley from Tuzusai 2009 FS1; b) naked barley from Tuzusai 2009 FS1; c) hulled barley from Tuzusai 2009 FS6; d) naked barley from Tasbas 2011 FS17; e) naked barley from Tuzusai 2009 FS15; f) barley rachis from Tuzusai 2009 FS9

A single barley rachis was found in 2009FS9 at Tuzusai (Figure 7.6f); however, it is not well enough preserved to determine if it was from a two-rowed or a six-rowed variety of barley. Several rachises were found at Tasbas, all of them morphologically resemble a six-rowed naked barley variety (Figure 7.7c, d, e). Many of the barley grains from Tuzusai and Tasbas seem to have a lopsided apex (Figure 7.6a, b, d; Figure 7.8b), also suggesting that they are from a six-rowed variety of barley.

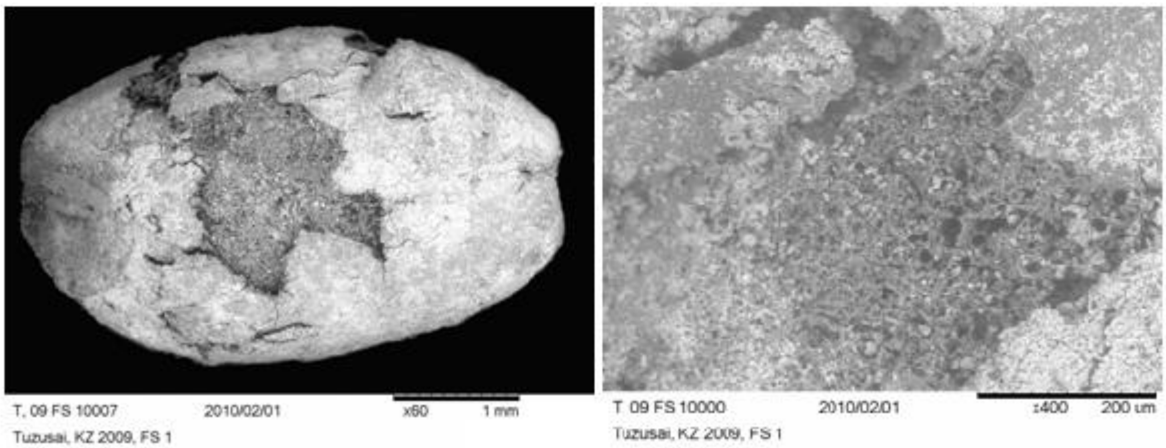

Figure 7.7. SEM of a naked barley grain from Tuzusai 2009 FS1

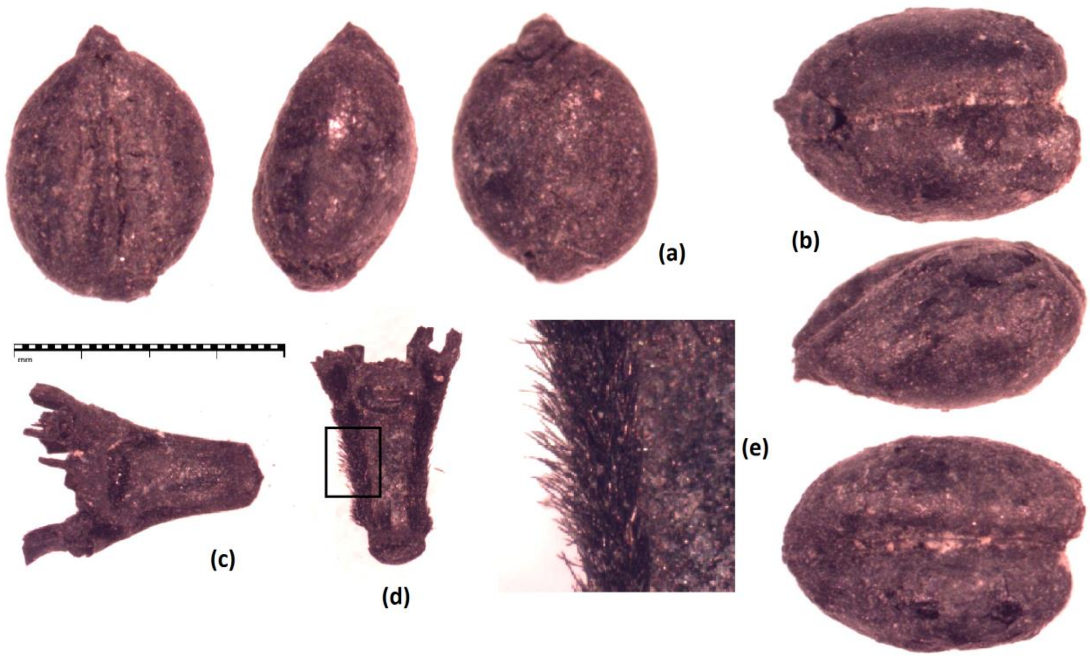

Figure 7.8. Short, round-grained naked barley from Tasbas – a) and b) from 2011 FS17; c) and d) six-rowed barley rachises, both from 2011 FS17; e) shows a close-up of the hairs on the edge of the rachis edge, depicting the level of preservation

Barley – Growing Conditions

Barley is a less water demanding crop than wheat (Miller 2003). According to Peterson (1965:52) modern barley varieties require 518 mm of annual rainfall. At many of the sites in southern Central Asia, barley abundance is far greater than wheat abundance. This could indicate a preference for more drought tolerant crops. Barley is often considered a high elevation crop and is grown at elevations well above the limits of wheat cultivation (over 4,000 masl in Tibet, China, personal observation 2008 – 2009).

7.2.4 Broomcorn Millet

Broomcorn millet is often associated with, or a complement to, foxtail millet at archaeological sites across Eurasia (Bellwood 2005:111-127; Chang et al. 2003; Crawford, G. 1992; Hunt et al. 2011; Hunt et al. 2008; Lisitsina 1984:290; Pashkevich 1984, 2003; Renfrew 1973; Rosen et al. 2000; Zohary and Hopf 2000:83-88). The two grains were domesticated on the northeastern grasslands of China near the Yangzi and Yellow Rivers (Bellwood 2005:111-127; Crawford, G. 1992; Kimata and Sakamoto 1992; Shnirelman 1989, 1992; An 1989; Zohary and Hopf 2000:83-88). Broomcorn millet is present in Eastern Europe by the Late Neolithic and may have spread through Central Asia from China very early on. While recent genetic work is inconclusive in the debate over separate centers of domestication, monophylly is still a possibility; the debate is ongoing (Hunt et al. 2011; Hunt et al. 2008). Further work is currently being conducted on materil from across Europe and Asia (Motuzaite-Matuzeviciute 2011 personal communication).

Pashkevich (1984:282) presents measurement ranges for remains of broomcorn millet in the archaeological record. Early Iron Age caryopses from Moldavia range in length from of 2.4 to 2.7 mm and in width from 1.9 to 2.0 mm (Pashkevich 1984:282). Broomcorn millet ceramic impressions or remains were also found at the culturally related sites of Zolotoy Mys, Zolotaya Balka, Lubimovka, and Gavrilovka (Pashkevich 1984:282). Among these four Scythian sites, during the early centuries of the first millennium A.D., the majority of the caryopses recovered are between 2.0 and 2.5 mm in length, with widths between 1.7 and 1.8 mm (Pashkevich 1984:282). A full discussion of the significance of broomcorn millet at Begash and Tasbas will follow in Chapter 7 of this dissertation.

Broomcorn Millet – Begash

Broomcorn millet grains were found in eight samples from Begash. FS2, a historic period sample, contained 45 grains, 37 of which were puffed or distorted. FS6, which is an Iron Age sample radiocarbon dated to 390 – 50 cal B.C. based on stratigraphic association, contained 24 grains or grain fragments. FS6 has been interpreted to be a domestic hearth feature and may have been associated with food preparation. Other samples that have been interpreted as domestic hearths include FS19, FS45, and FS48; each of these three samples contained a single broomcorn millet grain. FS47 is a Middle Bronze Age human cremation burial cist, and it contained 12 grains. In association with FS47, FS50 and FS44 are interpreted as funerary fire pits and each of them contained broomcorn millet grains, for a combined total of 14 grains.

Broomcorn Millet – Mukri

A total of 30 millet grains or fragments were recovered from the single Iron Age sample from Mukri. Of these grains 20 were well-preserved enough to classify as broomcorn millet. Of the other 10 (placed in the category millet), there was no particular reason to suspect foxtail millet.

Broomcorn Millet – Tuzusai

The third most abundant grain in the assemblage from Tuzusai was broomcorn millet (Table 7.4; Figure 7.9b – e; 7.10). A total of 396 broomcorn millet grains were identified. Similar to wheat and barley, MNIs were not used. The category ‘millet’ was assigned to most small fragments. In most cases at least 50 percent of the grain was needed to differentiate between broomcorn and foxtail millet. Total density from Tuzusai is 1.86 broomcorn grains per liter, and total ubiquity is 80 percent for broomcorn. Individual sample abundance ranged from 0 to 68 grains.

Broomcorn Millet – Tasbas

Broomcorn millet was also found at Tasbas (Figure 7.9a), where it appears in much lower ubiquity and abundance than barley but higher than wheat. The high percentages of barley and broomcorn millet may represent environmental adaptations. Growing wheat in mountain valleys may be a less reliable practice. There is a total of 41 broomcorn millet grains in the Tasbas assemblage. Total ubiquity is 50 percent and abundance ranges from 0 to 20. There is an average density of 0.38 grains per liter at Tasbas.

Broomcorn	Total	Whole[35]	Not Measurable	Average Length	Average Width	Embryo Length	Grain/ Domest
Begash (Iron Age)	24	11	13	2.2	2.2	0.8	42.1 %
Begash (Bronze)	29	9	20	1.7	1.6	0.8	76.5 %
Mukri	20		20				
Tuzusai	396	217	179	1.9	1.6	0.8	17.1 %
Tasbas	41	24	17	1.89	1.63	0.74	3.2 %
Total	510	241	196	1.90	1.61	0.77	13.5 %

Table 7.4. Totals, measurements, and ratios for broomcorn millet from all four sites

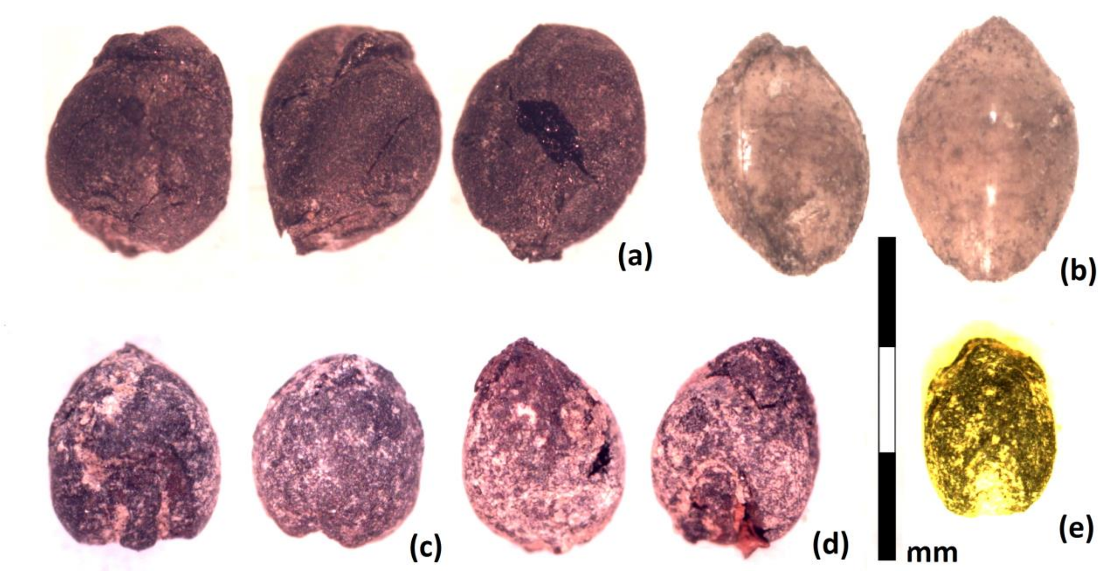

Figure 7.9. Broomcorn millet – a) from Tasbas 2011 FS17; b) uncarbonized intrusive grain from a rodent cache at Tuzusai 2009 FS 10 (ca. 200 yrs old); c) and d) from Tuzusai 2009 FS6; e) an immature grain from Tuzusai 2009 FS7

[35] Whole is determined by a judgment of whether or not reliable length and width measurements can be taken; therefore a whole puffed or distorted seed would count as 'not measurable'. Most fragmentary seeds smaller than half the total area were thrown into the category millet; therefore 'not measurable' seeds are usually larger than half. The ratio in the last column includes millet and cerealia.

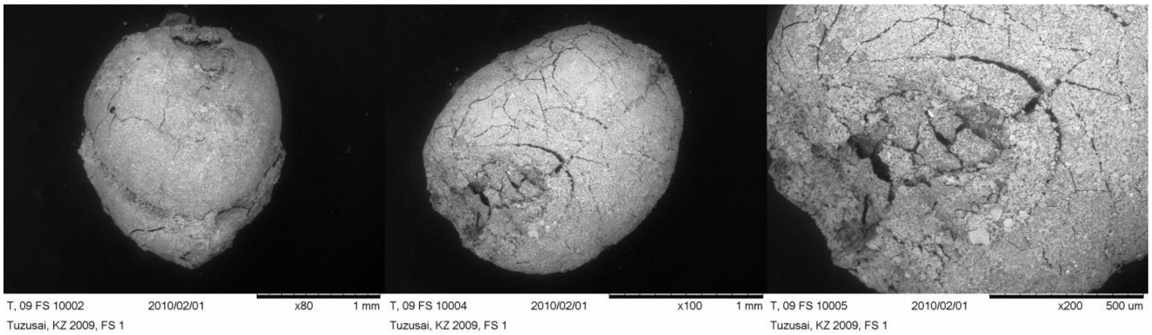

Figure 7.10. SEM of broomcorn millets from Tuzusai 2009 FS1

Broomcorn Millet – Growing Conditions

According to Peterson (1965:52), broomcorn millet requires 267 mm of annual rainfall. Shantz and Piemeisel (1927) note that millet generally requires about half as much water intake as wheat. Broomcorn millet is often associated with pastoralists in Eurasia and low-investment agriculture (Pashkevich 2003; Vainshtein 1980). In a mixed agricultural system where crops are diversified to reduce risk, millet can be a security crop, ensuring yields in drought years. The potential for low-investment agriculture at Begash during the Iron Age is discussed later in this chapter.

7.2.5 Foxtail Millet

It is mostly accepted that foxtail millet originated from wild *Setaria viridis* in northern China (see Zhao 2011). The oldest remains of the grain come from the site of Xinglongwa (ca. 5620 – 5460 cal B. C.) in the early Neolithic of northern China (Hunt et al. 2008; Liu et al. 2009). This argument is supported by molecular data and archaeobotanical remains (Lu et al. 2009). Differentiating between the wild and domesticated species is difficult because the earliest trait of domestication was a loss of the natural seed dispersal, brittle rachises; rachises are too small to be recovered archaeobotanically. Other early traits of domestication includes a reduced tillering and increase in condensed panicle size (de Wet 1995), neither of which would show up in the archaeological record. The spread of foxtail millet outside of China is still a problematic topic, complicated by issues of morphological overlap between wild *S. viridis* and domesticated broomcorn millet. As Zohary et al. (2012:71) note, "Identifying *Setaria italica* remains, and differentiating it from those of *Panicum miliaceum*, can be problematic". Hunt et al. (2008) complied all reports of early foxtail millet across Europe and West Asia and are currently in the process of parsing out the reliability of each of these reports (Motuzaite-Matuzeviciute 2011 and Xinyi Liu 2012 – both personal communication). While it is generally accepted that foxtail millet spread out of China later than broomcorn millet (assuming either crop was not independently domesticated in Europe), it is not clear how much later foxtail millet appears in Europe. Many of the earliest finds of the grain in the fifth millennium B.C. have been called into question (Hunt et al. 2011; Hunt et al. 2008).

Foxtail Millet – Begash, Tasbas, and Tuzusai

Foxtail millet grains were found in two samples from Begash (Figure 7.11b and e): FS2, which is a historic period sample; and FS6, dated to 390 – 50 cal B.C. It is possible that some of the grains in the samples are from wild *Setaria viridis* and not domestic *S. italica* (foxtail millet). If some of the caryopses in FS6 are from *S. viridis,* then they could have been introduced into the sample either as a cultivated (but not fully domesticated) grain or as a weedy crop inclusion associated with broomcorn and foxtail millet cultivation. The foxtail millet grains in samples FS2 and FS6 at Begash are within the size ranges for foxtail millet from most sites (Table 7.5). A typical length range for archaeological foxtail millet grains is 1.7 to 2.0 mm (Pashkevich 1984:282).

Foxtail	Total	Whole[36]	Not Measurable	Average Length	Average Width	Embryo Length	Grain/ Domest
Begash (Iron Age)	24	11	13	1.93	1.03	*[37]	35.1 %
Begash (Bronze)	0						
Mukri	0						
Tuzusai	133	75	59	1.48	1.21	0.90	4.5 %
Tasbas	11	7	3	1.66	1.34	0.90	0.9 %
Total	168	82	62	1.57	1.28	0.90	3.6 %

Table 7.5. Totals, measurements, and ratios for foxtail millet from all four sites

While I argue that all the caryopses presented here are actually domesticated foxtail millet, the width measurements of a few of the grains are rather small. I use the category, *Setaria* (cf. *viridis*), with the arbitrary cut off point of 1.0 mm in length as an indicator. The seeds with width measurements smaller than 1.0 mm are referred to as wild; all seeds 1.0 mm or wider (with their palea and lemma) are considered foxtail millet. Therefore, at Begash, with the three grains disarticulated from their palea and lemma included, there are nine foxtail millet grains and 13 wild seeds or fragments in FS 6. In FS 2 there are seven foxtail millet grains and four wild seeds.

[36] Whole is determined by a judgment of whether or not reliable length and width measurements can be taken; therefore a whole puffed or distorted seed would count as 'not measurable'. Most fragmentary seeds smaller than half the total area were thrown into the category millet; therefore 'not measurable' seeds are usually larger than half.
[37] Many of the foxtail millet grains from Begash were still in their paleo and lemma so scutellum measurements were not taken.

Foxtail millet had a lower abundance and ubiquity. From Tuzusai, there were 105 grains identified as foxtail millet (Table 7.5; Figure 7.11a, c, d, f, g). These were primarily differentiated from broomcorn millet by total size and the ratio of embryo notch (or scutellum) length to total seed length. However, hilum morphology was also loosely considered as a differentiation character. Total density at Tuzusai is 0.53, and ubiquity is 64 percent. Individual sample abundance ranged from 0 to 23 grains.

While she does provide length measurements, Pashkevich (1984) does not provide width measurements for archaeological foxtail millet grains. Zohary and Hopf (2000:86) provide scaled illustrations of grains after removal from their chaff from the Late Bronze Age at the site of Kastan as in Greece. These illustrations show naked grains with a length of 1.25 mm and a width of 1.0 mm (Zohary and Hopf 2000:85). Renfrew (1973:102) provides length and with measurements for modern uncarbonized foxtail millet grains; however, grains recovered from Late Neolithic and Bronze Age sites tend to be significantly smaller than this range (Crawford et al. 2005; Pashkevich 1984; Zohary and Hopf 2000:85). Renfrew (1973:102; Musil 1963:57) provides averages for modern foxtail millet grains of 2.5 – 2.75 mm in length and 1.5 mm in width. The Begash foxtail millet grains (1.7 – 2.0 mm in length and 0.9 – 1.2 mm in width) do not match this average length. Identification is made even more difficult by the fact the *S. viridis* can have very large caryopses as well. In fact, there tends to be overlap in the length and width of the two species. Renfew (1973:102; Musil 1963:57) notes that the length of wild *S. viridis* can be a much as 2.0 mm and the width can be as much as 1.0 – 1.25 mm. Based on these measurements the Begash foxtail millet grains could easily fall into the range of wild *S. viridis*. The reason for this overlap in size between domestic and wild species of *Setaria* in the early archaeological record is because the early traits of domestication were not based on grain size but rather seed dispersal biology (Zohary and Hopf 2000:86). In addition, the main traits of domestication are phenotypically expressed in the inflorescence, not in the caryopses. These changes in plant habit include a reduction in the number of flowering tillers and an enlargement of the inflorescence (Zohary and Hopf 2000:86). These traits are not morphologically expressed on the caryopsis.

Another morphological trait used for identification is the surface morphology of the palea and lemma. Renfrew claims *S. viridis* have “lemma roughened by minute tubercles” (1973:102). Crawford et al. also claim that they use the “surface pattern of the hulls” (2005:311) to differentiate between foxtail millet and *S. viridis*. While there is some mirco-structuring on the lemma of the Begash foxtail millet (Figure 7.11b), it is not as well pronounced as in wild populations.

Based on the morphological overlap in archaeological specimens of domesticated *S. italica* and wild *S. viridis* (especially from Begash and Tasbas), I cannot say confidently that all identifications are clear and distinct. Interestingly, the samples at Begash and Tasbas that contain domestic foxtail millet grains also contain what most researchers would call “wild” foxtail seeds – these wild seeds do not appear in any samples at Begash without their domesticated counterparts. For example FS6 at Begash contains 19 of the 20 domesticated foxtail millet grains; it also contains all four wild *Setaria* seeds. FS14 and 19 at Tasbas, combined, contain 10 of the 11 foxtail millet grains; they are also two of the three samples containing most of the wild *Setaria* from the site. Furthermore, no wild *Setaria* seeds were recovered from any Bronze Age samples from Begash or Middle Bronze Age samples from Tasbas. From FS2 there were three fragments, all of which had more than 50 percent of original surface area remaining. There were also seven caryopses with palea and lemma still articulated which were not too puffed to measure; their measurements are presented in Appendix C and D. There was also one seed without a palea and lemma with a well-represented hilum notch that extended well over half the length of the seed; this seed was longer than the others in this sample. The length measurement for the naked seed was 2.0 mm, width 1.4 mm, and hilum length was 1.3 mm. In sample FS6 there was one grain which was partially uncarbonized and therefore was not included in the table below; however, its length was 2.2 mm and width was 1.0 mm. There were also 11 fragmented or puffed caryopses, these were all over 50 percent remaining; therefore a MIN would be 11. There were also eight caryopses with their palea and lemma, which were measured; measurements are presented in Appendix D. Three seeds of foxtail millet were also present in the sample without their palea and lemma their measurements were: length – 1.3 mm, width – 1.0 mm, and hilum length 0.6 mm; length – 1.4 mm, width – 1.0 mm, and hilum length – 0.7 mm; and length – 1.2 mm, width – 1.0 mm, and hilum length 0.7 mm.

While the foxtail millet from Tasbas are highly problematic due to the poor preservation state and unclear identification of the 11 grains, they are important because, if properly identified, they represents the oldest remains of this grain in Central Asia. Most millet remains archaeologically recovered from Central Asia are broomcorn millet. Five grains or grain fragments were recovered from FS14, five from FS19, and one fragment was recovered from FS27; all of these samples are Late Bronze Age and date around ca. 1400 cal B.C. Their measurements are presented in Appendix D.

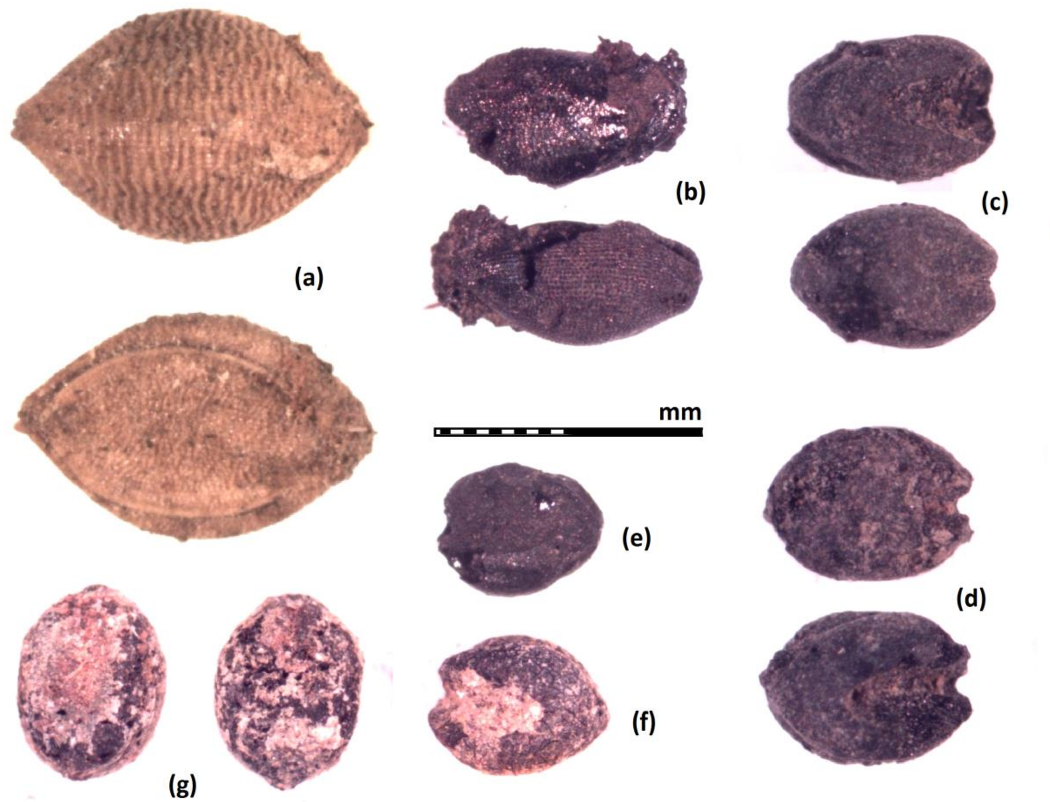

Figure 7.11. Foxtail millet – a) an uncarbonized grain from and intrusive rodent cache at Tuzusai (ca. 200 yrs old); b) a grain still retaining its paleo and lemma from Begash 2005 FS6; c) and d) from Tuzusai 2010 FS10; e) from Begash 2005 FS 6; f) from Tuzusai 2009 FS9; g) from Tuzusai 2009 FS6

The identification of the caryopses in FS6 at Begash is aided by a preserved clump of bristles from a *Setaria* inflorescence. The bristle clump from FS6 is likely from the same plants as the *Setaria* caryopses recovered from that sample. This *Setaria* bristle clump is smaller than modern foxtail millet and morphologically conforms more closely to wild *S. viridis*; however, there is a great deal of variation within grain size and bristle clump size among domesticated foxtail millet. There is actually a large distribution of size among grains on one inflorescence; grains at the end of the inflorescence may smaller than ones at the base of the inflorescence, or not fully matured.

7.2.6 Peas

As Zohary and Hopf (1973) pointed out, peas are associated with wheat and barley cultivation in southwest Asia from very early on; supplying a protein complement to the starchy energy stored in cereal crops. They are well suited to both warm and cool climates and were easily transferred as a key part of the southwest Asian agricultural package into the Mediterranean and eventually north into Europe as the first wave of agricultural adoption in the eighth millennium B.C. Peas are easily bred into “true breeding lines” due to their ability for selfing (Zohary et al. 2012:82), as was portrayed through Gregor Mendel’s early genetic work with basic Mendelian phonotypical traits. This selfing ability has led to a wide range of morphotypes or landrace varieties and a ready ability to adapt to new climatic constraints (through the assistance of artificial selection).

While there is evidence that wild peas were collected as far back as the Upper Paleolithic (ca. 21000 cal B.C.), evidence for cultivation does not show up until ca. 8500 – 8200 cal B.C. (Zohary et al. 2012:85). The earliest traits of domestication for many Old World legumes are hard to identify archaeologically, most notably an indehiscent pod. Therefore, it is hard to pinpoint when these crops became domesticated; the increase in seed size was gradual (wild populations ranging from 3 – 4 mm in diameter Zohary and Hopf 1973]). Another early trait of domestication is an elongation of the hilum, also occurring gradually over time. Although, the best trait for identifying domesticated verses wild peas is the surface morphology of the seed coat, which is rough and textured in wild populations. The testa is also reduced in thickness in domesticated varieties, increasing palatability but decreasing storability. Smooth-testa varieties appear at sites such as Çatalhöyük and Can Hasan I as early as the Late Pre-Pottery Neolithic (ca. 7300 – 6900 cal B.C.) (see Zohary and Hopf 1973; Zohary et al. 2012 for a discussion).

While peas start to spread west and south almost instantaneously after their domestication (along with wheat and barley), they take longer to move east. Interestingly, the earliest agriculture in southern Central Asia, at Jeitun ca. 6000 B.C., is based on glume wheats and hulled barley, but peas did *not* pioneer in the Kopet Dag Mountains when the founder grains did (Harris 2010). Peas do not show up in the Namazga Culture sites along the foothills of the Kopet Dag until Gonur Depe at roughly 2500 B.C. (Miller 1999). They make it as far east as Afghanistan at Shortughai by the second millennium B.C. (Willcox 1991). Willcox (1991:148-149) notes that peas are "relatively common throughout the occupation of the site", and he provides a range of diameters from 2.8 – 6.0 mm and an average diameter of 4.4 mm. Peas are associated with the earliest Harappan layers dating as far back as the third millennium B.C. in northern India (see Fuller 2002; Weber 1991). A cache of over 8,800 peas was recovered at the site of 1211 (ca. 1200 B.C.) on the Murghab Delta of southern Turkmenistan; this cache had, likely inadvertent, inclusions of lentils, grass peas (*Lathyrus*), wheat, and barley (Spengler et al. in review). The site of 1211 has material culture similarities to pastoralists further north in Central Asia and is interpreted as a temporary mobile pastoral camp. Spengler et al. (in review) argued that mobile pastoralists in southern Central Asia were obtaining agricultural goods from sedentary agriculturalists in large villages, such as Gonur Depe. In Chapter 8 of this dissertation, I argue that agricultural goods, such as peas, were spread by mobile pastoralist north through the mountains of Central Asia, eventually ending up at Tasbas in the Dzhungar Mountains.

Peas - Tasbas

Peas were only recovered from Tasbas (Figure 7.12). They date to the Late Bronze Age and are, to date, the oldest domesticated legumes in northern Central Eurasia. The peas from Tasbas vary in size, which is typical of early domesticated peas (see ranges from Willcox 1991; Zohary and Hopf 1973). In addition, even modern peas have a large range of variation, depending on where the pea is in the pod it can either be larger or smaller at maturity. The peas at Tasbas are spherical and vary in diameter from 2.5 to 6.0 mm. They all have the characteristic elongated hylum, and many of them have split along their cotyledon divide, creating split peas (Figure 7.12b). The testa surface in all cases is psilate and the coat is very thin. Fifty of the 59 peas/fragments came from FS19, the remaining nine fragments came from FS17, 24, and 27. All of these samples came from Phase 2 at Tasbas ca. 1400 cal B.C. The overall density of peas is 0.47 and the ubiquity is 3.5 percent.

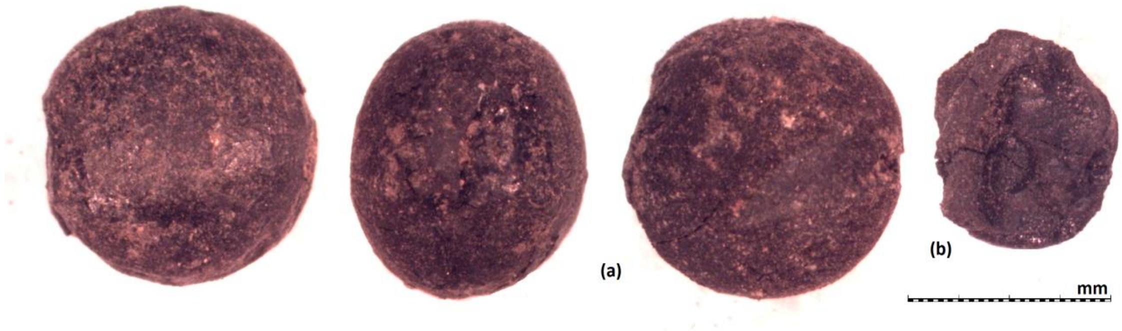

Figure 7.12. Peas – a) and b) both from Tasbas 2011 FS19, b) represents a split pea

Peas – Growing Conditions

Southwest Asian legumes (peas, chick peas, grass peas, lentils, and vetches) are far more water demanding and labor intensive than any of the cereal crops; according to Peterson (1965:52) peas require 884 mm of rain fall. However, legumes are often grown as a garden vegetable and may not have been produced on the same scale as wheat. If this is the case, then artificial watering could have been done by hand, and irrigation would not have been necessary.

7.2.7 Grapes

A few grape pips were found at Tuzusai (Figure 7.13); they are assumed to be cultivated and likely domesticated. One well-preserved pip came from 2009 FS5 and three fragments came from 2010 FS10. Miller (1996 unpublished) identified fragments of grape pips during the 1995 field season, and four more fragments (MNI = 3) were found in samples 2009FS5 and 2010FS10.

As Miller (2008) points out, the progenitor to the European wine grape (*Vitis vinifera* var. *sylvestris*) has had a geographic distribution since the mid-Holocene which covers a band from the Caspian to the Mediterranean. There are wild grape relatives from East Asia which have been found in archaeological sites in eastern and Central China dating back to the Late Neolithic (d'Alpoim Guedes personal communication 2010). The Flora of China notes 38 species of *Vitis* in China (Wu et al. 2006), most of which are restricted to subtropical regions. Assuming the archaeological examples of grapes found in Central Eurasia (including Xinjiang) are coming from the west, we can say that the Tuzusai grapes are outside their wild distribution.

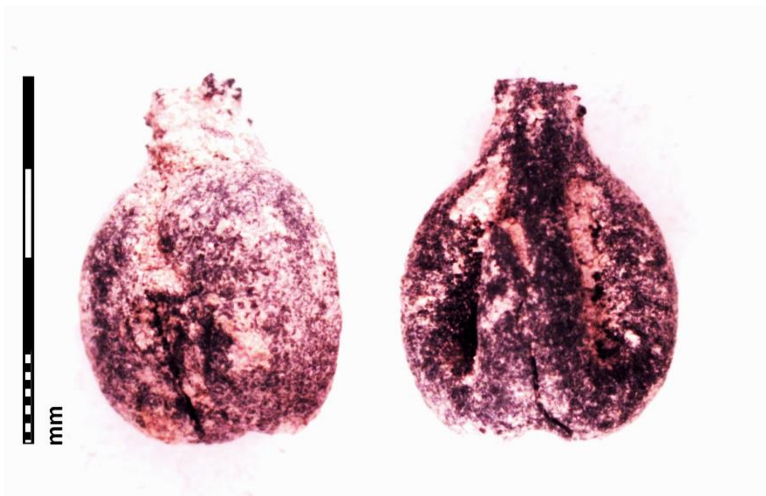

Figure 7.13. Grape pip from Tuzusai 2009 FS5

Morphologically, the seeds of wild and early domesticated grapes cannot be differentiated. Miller (2008) summarizes the data for the archaeological spread of viticulture from the Mediterranean, eastwards. She suggests that northern Central Asia was outside the range of wild *Vitis vinifera*, and therefore, these seeds must have been cultivated. The main reason why early domestic grape seeds are not differentiatable from their wild relatives is because the earliest trait for domestication was not larger fruits (i.e., polyploidy); instead, it was a switch from dioecious to hermaphroditic (monecious) flowers. This hermaphroditic trait allowed for the fixation of desirable phenotypical traits into the prodigy of a grape vine through selfing. Later, asexual propagation using vine clippings would have further fixed desirable traits. However, as Zohary (1994) points out, genetic crossing between wild, domestic, and feral grape varieties makes the history of grape cultivation very complicated and hard to interpret archaeologically.

7.3 Textile

Textile manufacture is one of several economic endeavors identified at Begash, attested to by the presence of spindle whirls. The use of textiles, that may or may not have been locally produced, is evident from imprints on ceramic sherds and carbonized fragmentary remains. An additional line of evidence for spun threads comes from small glass beads associated with an Iron Age burial and a few spun thread fragments from Bronze and Iron Age layers. Three spindle whirls were found in total, two were made of sandstone and one of ceramic. Three sets of fiber fragments were recovered from Begash. Two separate thread fragments and one textile fragment were found. A coarse fibered (likely wool) twine was identified in Late Bronze Age layers and a small fragment of spun thread from FS6 in the Iron Age. In addition, a fine woven, double-over single-under twilled textile fragment was recovered, of a linen-like fiber, found in an Iron Age hearth feature (also FS6). Unlike the utilitarian ceramic-imprinted textiles, the carbonized Iron Age fragment is finely woven, likely representing an exchange item transported along the early Silk Road.

7.3.1 Material Analysis

Due to their state of preservation the material of the two small spun thread, one Bronze Age and one Iron Age, was not identified. They were composed of thickly spun thread, the individual fibers were also thick in diameter. The material from the Iron Age textile fragment was better preserved and believed to be linen.

Iron Age Textile Fragment from Begash

The small fragment of carbonized textile (approximately 4.5 mm in length) was recovered from an Iron Age hearth feature dated using stratigraphic association to ca. 390 – 50 cal B.C. The preservation of this fragment through carbonization is likely due to the fact that it is vegetable based and not animal based. Plant fibers are made of either lignin or cellulose, which does not degrade as readily as the protein molecules of animal fibers when exposed to heat (Simpson and Ogorzaly 1995). Carbonization, in turn, made the fragment less susceptible to chemical or biological deterioration.

These threads are made of single celled bast fiber. Bast fibers (soft fibers) are associated with phloem tissue produced by the vascular cambium of certain plants that have secondary thickening (i.e., lignophytes excluding monocots). Phloem fibers are especially common in members of the Malvales clade and are present in certain Rosales (these are not the only plants bast is obtained from). Due to the carbonized state of these fibers, a phloroglucinol test is impractical.

The fibers are well processed and no pulp (undifferentiated block-cell tissue, parenchyma) tissue is left articulated. There are no associated cells of xylem tissue or bark. This makes it impossible to use certain traits for identification that rely on tissues other than the ultimate fibers. Kröber-Grohne (1985) uses stomata to help in his identification of *Cannabis sativa* (hemp). Stomata are used to identify *Linum usitatissimum* (flax) by Ilvessalo-Pfäffli (1995:337). In addition, calcium oxalate crystals, in the form of crystal druse (cystoliths in lithocysts), are present in epidermal cells of Urticaceae; however, in the case of fiber A, no epidermal tissue remains (Ilvessalo-Pfäffli 1995:338). The complete lack of parenchyma tissue is important to note, because this characteristic shows a high degree of processing including retting and decortication, which will be discussed shortly.

Fibers of hemp tend to be wider than those of flax; however, there is a range of variation in this characteristic. Ilvessalo-Pfäffli (1995:338) notes that the average width for hemp ultimate fibers is 25 μm and the range is 10 – 51 μm. Florain et al. (1990:49) note that the width range for flax can vary between 5 μm and 38 μm. The thin ultimate fibers in this specimen are more characteristic of flax than hemp; however, due to the overlap in width ranges this characteristic alone cannot exclude hemp. In addition, lamellae may actually pull apart during carbonization or as a result of taphonomic processes resulting in distortion and changes in width or diameter of fibers.

The natural end of an ultimate fiber can be used as another characteristic for identification. As can be seen in Figure 7.14, the natural ultimate end is slenderer and more pointed than is typical of a hemp ultimate. Flax ultimates tend to be more slender coming to a less blunt point than hemp fibers (Ilvessalo-Pfäffli 1995). While it is likely that they are linen fibers, the possibility of Urticaceae or another wild plant should not be over looked; although the dislocations of the fibers should exclude Urticaceae.

Figure 7.14. Ultimate fiber, showing thick cell wall, thin lumen, and tapered natural end

7.3.2 Technological Analysis

Processing the Fibers

The bast used to produce the finely spun fibers in the Begash textile was likely removed from stems using a retting technique. Retting or bacterial rotting would have facilitated the breakdown the gums and pectins that hold the soft tissue of the plant together. The thick lignified cell walls of the bast would have been relatively resistant to deterioration during such a retting process. The retting process may take anywhere from a few to several weeks, and continual monitoring of the fibers' progress was required (Simpson and Ogorzaly 1995). If the plant mass is retted for too long the fibers will start to break down. After the retting is complete the fibers would have been dried, washed, and the adhered xylem cells would have been removed. This is accomplished through a process called breaking, followed by beating and scrapping (scutching) (Simpson and Ogorzaly 1995). It is likely that a hackling process was also used on the fibers, which would have required separating and aligning the fibers.

Spinning

The Bronze Age thread fragments from Begash are spun in a S-twist (Figure 7.15a). In contrast, the individual fiber fragments from the Iron Age are spun in an Z-Twist (Figure 7.15b).

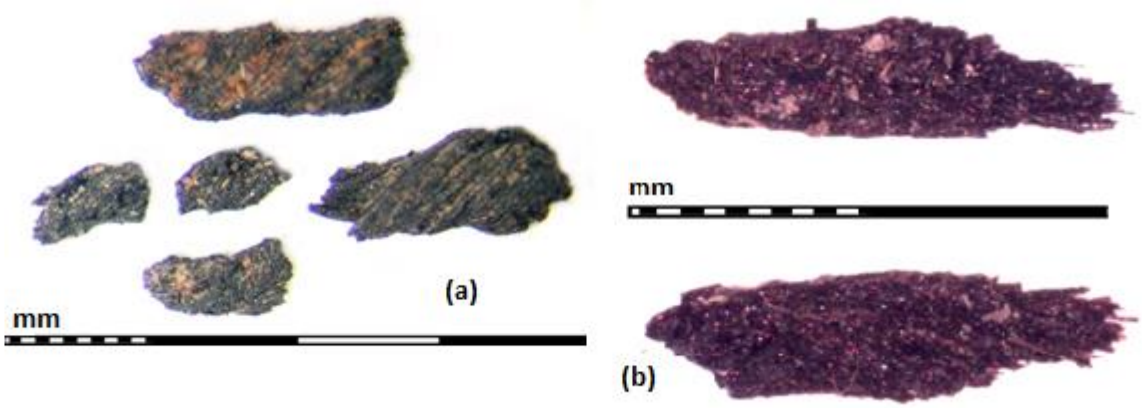

Figure 7.15. a) Bronze Age S-twist thread, from Begash; b) Iron Age Z-twist thread, from Begash

The twilled textile is made up of two elements (X and Y [Figure 7.16]). There is not enough of the textile left to determine, properly, the weft and warp (due to a lack of a salvage edge); however, for discussion purposes Y will be discussed as the warp and X will be discussed as the weft. The use of element Y as the warp and X as the weft is not arbitrary; the Y element is made of a thread produced by two-ply spun threads. Therefore, the Y element is much stronger and more likely to have been the warp. In addition, the X element is the active element while the Y element is passive, most often the active element is the weft. The X element is the one jumping over two and under one; if the warps are adhered to a loom only the weft will be active.

The textile from Begash was produced using a double-ply warp with a Z-twist, which can be seen in Figure 7.16. Shishlina et al. (2003:340) identified an S-twist spun warp in linen textile fragments from the Klady site of the Majkop Culture in the Bronze Age of the northern Caucasus. She describes the Eurasian twist traditions as follows:

> “There are two traditions of spinning, i.e. with an S-twist and a Z-twist: wool is spun in any direction, flax fibers are naturally spun in an S-twist, and cotton and hemp are spun in a Z-twist. It is interesting to note that flax threads from Nahal Hemar (the Levant), Çatal Hüyük (Anatolia) and from other Near East sites are spun with a Z-twist, while flax fibers from the Warrior Cave from the Levant have an S-twist; an S-twist dominates in Egypt, a Z-twist has been more frequently found in Europe and India.” [Shishlina et al. 2003:340]

While it is interesting to note that the Begash textile fragment has a Z-twist spun warp, it should not be taken as conclusive evidence of an association with an Indian or European weaving tradition. The individual plies that make up the two-ply warp are produced using an S-twist. It is necessary to reverse the twists when combining more than one ply. Therefore, seeing that the two-ply spin is Z-twist it is necessary to produce the single-ply spin with an S-twist

The textile fragment is also composed of finely spun weft fibers each about 20 µm in diameter. The warp is essentially made up of two of these fibers spun together. Figure 7.16 shows two individual fragments of weft fibers at the bottom. The weft fibers are single-ply and S-Spun.

Weaving

Barber (1991) has shown that a warp-weighted horizontal ground loom with two beams has been used since the Neolithic in southwest Asia and across Europe. In addition, spindle whorls have been identified from archaeological sites across Eurasia. While it is impossible to say what type of loom was used to produce the Begash textile fragment, it was likely similar to looms described by Barber (1991). However, Wild (2008) notes that twill could be produced with a vertical loom.

Figure 7.16. Iron Age textile fragment from Begash

The textile fragment shows a two-over-one twill pattern (2/1). This is an elaborate technique that can produce a negative image on one side of the cloth from the other. Wild (2008) describes this pattern, stating "if warp and weft are in contrasting colours, each colour dominates one face of the cloth, i.e. it is reversible". Twill not only makes the cloth more aesthetically pleasing, but also produce a more dense and durable material, which is simultaneously warmer. The pattern is illustrated in Figures 7.17.

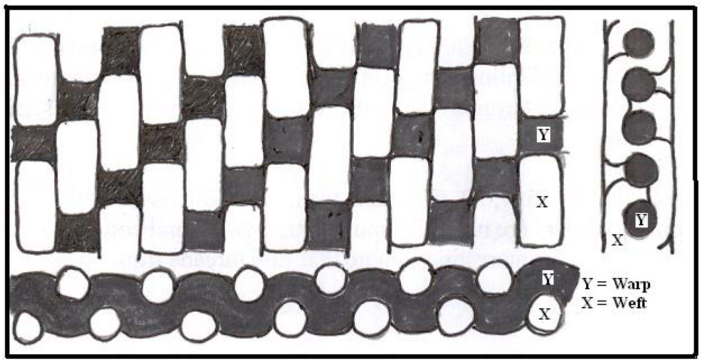

Figure 7.17. Illustration of textile fragment from Begash

7.4 Agriculture

Domesticated grains were available to mobile pastoralists living at Begash by the Middle Bronze Age – free-threshing wheat and broomcorn millet are present by 2200 cal B.C. By the Iron Age, foxtail millet was either grown near the site as part of a low-investment agricultural system or obtained through social interaction. By 400 B.C. at Tuzusai, there was a complex mixed agropastoral system, whereas at least a portion of the population was sedentary and focused on mixed agriculture, using wheats, barleys, and millets. Likewise, at Tasbas a mixed system appears as early as 1400 cal B.C. At Tasbas pastoralism was complemented by an agricultural system that relied on field grains such as broomcorn millet and naked barley but also peas, which may have been a garden crop.

7.4.1 Late Third Millennium B.C. Agriculture?

As a result of this dissertation and a few earlier studies, there is no longer dispute over the presence of farming among Iron Age agropastoral peoples of northern Central Asia (Chang et al. 2003; Chang et al. 2002; Rosen et al. 2000; Spengler et al. 2013); however, the earliest development of Bronze Age agriculture in the region is still an unresolved issue. Given the contexts of recovery and the nature of the assemblages from Middle Bronze Age layers at Begash and Tasbas, it cannot be determined with any certainty if these domesticates – namely broomcorn millet and free-threshing wheat – represent products of local farming or if they were obtained through exchange with more distant agricultural communities.

The dominant grain in the Begash assemblage during the Bronze and Iron Ages is broomcorn millet. Ease of cultivation, low investment value, drought tolerance, and minimal sowing quantity make millets an optimal grain for mobile pastoralist populations of the steppe. As I discussed in Chapter 5, ethnographic and ethnohistoric records describe cultivation of small fields of broomcorn millet by pastoralists during summer encampment, before the move to winter pasture. Low-investment agriculture and social interactions/exchange are equally likely as the means of procurement by which the millet at Begash was obtained. However, due to their low overall abundance, absence in domestic contexts, and presence in ritual contexts (a human cremation), Frachetti et al. (2010b) argue that agricultural grains played a minor role in the Bronze Age economy during the late third millennium B.C. at Begash. Without any botanical evidence for local farming or processing of the wheat or broomcorn millet on site, they propose these grains were likely obtained through exchange[38].

7.4.2 Late Bronze and Early Iron Age Agriculture

Mixed Agropastoralism at Tuzusai and Tasbas

The earliest solid evidence for agriculture in Central Eurasia come from the Late Bronze Age. The people living at Tasbas during the Late Bronze Age appear to have had a mixed agropastoral system with both field and garden crops. By the Early Iron Age, the sites in this study illustrate a spectrum of agricultural investment on the part of pastoralist communities, ranging from low-investment cultivation to intensive farming. The agricultural system implemented at Tasbas was likely less labor intensive than the field system used at Tuzusia; however, it was still a mixed agropastoral system and more complex than what I propose for the Iron Age at Begash. Barley and millet can be grown in small plots or large gardens and do not need to be maintained as readily as wheat does. Peas are often a garden crop and can be grown in plots near a domestic structure or by a water source.

The wheats, contrary to the millets, require a great deal more labor, water, and time input. The Talgar alluvial fan receives enough annual rainfall for dry agriculture; however, that rain is irregular and unpredictable, with most coming in the early spring. Masanov (1995:22-24) notes that much of Kazakhstan is in an environmental zone where

[38] For a more detailed look at the Middle Bronze Age agricultural grains at Begash and the potential roles they played in the economy see Frachetti et al. (2010).

maximum rainfalls rarely exceed 200 – 400 mm per year and droughts, soil erosion, soil salination, lack of access to water, and open winds make agriculture a risky endeavor. Therefore, agricultural risk would be reduced if labor and time were invested into irrigation. On the alluvial fan there would have been numerous streams and rivers fed by mountain rains and glacial melt; which could have been channeled for irrigation. Archaeologically, there is little solid evidence for irrigation canals in the area. However, Akishev (1969) did identify irrigation canals at the site of Aktas 2, also in Semirech'ye. He claims that these canals date back to the Wusun period of the late Iron Age. The dominance of wheat at Tuzusai raises the question of whether labor and time were diverted away from pastoral activities and into irrigation projects and field maintenance.

A one-to-one comparison of grain counts between millets and wheat is inadequate for understanding importance. Millets are a fraction the size of wheat and they have different properties, which would make their roles and importance different as a component in the economy. In addition, the smaller a grain the more likely it will get dropped and brushed into a fire. The two East Asian millets are more adapted to a mobile pastoral economy for three reasons: (1) they are more drought-tolerant; (2) they have a small sowing input value; and (3) they have a shorter growing season. Drought tolerance is necessary for any crop grown on the steppe or arid-steppe if labor inputs are not going to be diverted to irrigation projects, both construction and maintenance. The smaller sowing value means fewer seeds are required to reap a crop; consequently, fewer seeds need to be stored for next year and moved with seasonal camp changes. The shorter growing season, 60 – 65 days for the millets (Renfrew 1973), means that a plot can be sown when arriving at a summer camp and harvested before the fall move.

Barley is a hardier crop than the wheats but arguably not as hardy as the millets. Pashkevich (2003) notes that barley, as well as broomcorn millet, was planted by eastern European mobile pastoralists in the past in a low-input manner. Hulled barley is a hardier form of barley than naked barley and this may be one of the reasons why it was cultivated at Tuzusai instead of naked barley. Naked barley was grown in the Chalcolithic in southern Central Asia in the Kopet Dag Mountains and as far north as the Sarazm site (Moore et al. 1994; Spengler and Willcox in press; Willcox unpublished). However, it is clear that, even though people at Tuzusai had access to naked barley, they chose to grow the more labor intensive hulled barley.

The presence of numerous domestic grains at Tuzusai suggests crop diversification and possibly multicropping. The more crops cultivated the more complex the agricultural system gets, especially when the crops require different inputs and have different growing seasons. This does not suggest two growing cycle per year (winter and summer cropping); it simply suggests different planting and harvesting times.

The presence of grape pips at Tuzusai does not prove that viticulture was practiced. Grapes could have been shipped in from other areas in the form of raisins. However, there are grape vineyards on the Talgar Fan today. If viticulture was being practiced at Tuzusai in the Iron Age it not only means that the investment in plant cultivation was much greater, it also suggest a completely different concept of land tenure. Grapes are secondary crops. Secondary crops are usually only brought into an economic system after primary staple crops are well established (Fall et al. 2002; Sherratt 1981, 1983). Fruit trees and lianas represent an extreme form of delayed return. It takes many years for a grape vine to produce fruit. If people were planting and maintaining grape vines in the area, then they intended to live on the same plot of land for a long time. This long term view of land tenure is possessed by some mobile pastoralists; however, it is more characteristic of sedentary agriculturalists.

This agricultural system incorporated multiple crops, each of which required different input, labor, and knowledge about cultivation. The complex productive economy that was present at the site would have required a detailed understanding of seasonality. Mobile pastoralism and high-input agriculture are often thought of as mutually exclusive because of scheduling issues. However, as Chang et al. (2002) point out, there are ways of working these systems together, possibly by dividing the community for part of the year. It is also possible that the social dynamics and complexity in the Talgar area by this time period have been underestimated and in reality, population density on the landscape was greater than previously envisioned. If this is the case, social or community networks and exchange would have been very important in the economy, allowing for the utilization of large labor groups for irrigation projects, harvesting, or herd movements; possibly even leading to labor specialization and distinction between herding and agricultural populations. This macrobotanical study backs up recent arguments that the cultural changes in the early Iron Age were possibly a response to an increased focus on agriculture in the region (Baipakov 2008; Chang et al. 2002).

Previous models that characterized the transition as being toward a more mobile and pastorally reliant economy across the steppe may not hold up for the Semirech'ye region. Instead researchers should probably look at the economy more as a multiresource economic system, as described by Salzman (1971, 1972, 1982, 2002, 2004). It seems evident that Iron Age populations in the Tien Shan foothills were engaged in an agropastoral or mixed herding and farming system. The exact dynamics of this system remain to be illustrated in detail, but it is evident that variability and strategic flexibility were both important factors.

The almost complete lack of chaffing material at Tuzusai suggests that the crops were processed off-site and stored in a fully clean state. Often in examples of low investment agriculture, grains will be stored in an uncleaned state; grains would then be winnowed and cleaned as needed throughout the winter. When this is done large amounts of chaffing material, especially rachises, are incorporated into the assemblage (Fuller and Stevens 2009). Repeated events (especially daily events) are much more likely to show up in the archaeological record than discrete events (especially annual events). A single annual processing event, even if it took place over a several day period, would result in less chaff being incorporated into the assemblage at Tuzusai. Furthermore, it is likely that this event happened off-site at a processing center. If large labor forces were pooled from neighboring villages across the fan, then it is likely that communal processing centers existed. Communal threshing and winnowing platforms exist and are still used across Asia today (personal observations 2008 – 2011). The numerous storage pits across the site suggests that grain was stored in large amounts for winter use rather than moving it to seasonal camps.

Another important part of the economic system at Tuzusai was diversity. Diversification reduces risk. As Salzman (2004) notes, most Eurasian mobile pastoralists diversified their economy and rarely relied fully on pastoralism. Mobile pastoralism is a tactic of risk management, in that it allows the herder to move the entire productive economy away from stressors. People at Tuzusai seem to have utilized a sedentary agropastoral system rather than the typical mobile pastoral systems characteristic of Central Eurasia through time. Therefore, they diversified their economy in different ways than mobile populations. Relying too heavily on agriculture in an edge environment like Talgar would have been risky.

A diversified pastoral component was employed at Tuzusai, relying on different kinds of animals. Several ethnographers and archaeologists have noted that a diversified pastoral system reduces risk, with multiple types of herd animals employed in differing percentages helping reduce risk or uncertainty in varying settings (Bendrey 2011; Fernandez-Gimenez 1999; Pratt 1984). In addition, hunting, exchange, and craft production were all economic components (Chang et al. 2002). Agriculture was also diversified, in that it combined varieties of wheat and barley, as well as broomcorn and foxtail millet. Growing millet in tandem with wheat would provide a fallback crop when wheat failed. In addition, the prevalence of hulled barley over the naked variety shows that farmers preferred drought-tolerant crops. Naked barley requires far less post-harvest crop processing than hulled barley but is more water demanding.

Low-investment Agriculture: Begash

Childe's 'Revolution' inadvertently created a polarized view of economy with intensive and extensive agriculture at one end and everything else at the other, leaving no clear divide in the middle. However, over the last decade researchers are more readily acknowledging that there is a broad spectrum of agricultural pursuits filling the areas between these two extremes. As Smith (2007:2) puts it "this territory between hunting-gathering and agriculture is turning out to be surprisingly large and quite diverse; it has also proven to be quite difficult to consistently describe in even the simplest conceptual or developmental terms". As Etser Boserup (1990a:12) puts it: "in the past and today, we have a continuum of agricultural systems, ranging from the extreme of land which is never used for crops, to the other extreme of land which is sown as soon as the previous crop is harvested".

There is a huge body of literature primarily from the late 1980s and early 1990s, dealing with the wide spectrum of agricultural systems. A few examples of published studies in this discourse include: Crawford (2006, 2009); Flannery (1969); Fritz (1990); Ford (1979); Hanselka (2010); Jarman et al. (1982); Rhindos (1984); Smith (1995a; 2006; 1992, 1995b, 1997b, 1998, 2001); and Zvelebil (1996). Smith (2001) provides a good synthesis of much of this information, so I will only hit on a few key points and examples here.

Braidwood and Howe discuss a period at the Zarzian site in Iraq where food-collecting was the economic base. They suggest the potential for, what they refer to as "incipient cultivation" (1960:181-183). The concept of incipient cultivation is also used by Flannery to refer to the experimental period before the development of agriculture in Mesopotamia (1969:294).

In 1997, Smith (1997b) resurrected the term 'insipient cultivation' when discussing remains from the Ocampo Caves in Mexico state, Mexico. He discusses an "era of incipient cultivation" across Mesoamerica. This term, which is sometimes used interchangeably with 'incipient agriculture', has gradually given way to other synonyms such as 'low-investment agriculture' or 'low-level food production'. Smith (2001) discusses “low-level food production” in Mexico, where he notes that the oldest domesticated cucurbits dating back to 9000 B.C., whereas settled village agriculture does not appear until 2500 B.C. In this article, Smith refers to the area between hunter-gatherer and full-scale agriculturalists as the “middle ground”. Smith (2001:1) notes that “societies with low-level food production economies occupy the vast and diverse middle ground between hunting-fishing-foraging and agriculture”.

Crawford (2006:85) notes that “low-level food-resource-producing societies appear to be common, and are so long lasting that they ought to be considered stable adaptations and should be studies in their own right rather than being considered on the way to agriculture or from hunting and gathering”. Crawford (2006) further argues that low-investment rice cultivation was practiced in northeastern China as far back as 10000 B.C., based primarily on rice phytoliths (Zhao 1998) in Japanese pit house communities back 10000 – 7500 B.C. He notes that rice, while not morphologically domesticated, was being cultivated and was only a component in a broad spectrum economy.

Fritz (1990) discusses the ‘Multiple Pathways to Farming’ that took place in eastern North America. She approaches agricultural development regionally, clarifying the steps leading to agriculture, and emphasizing the time depth involved in the domestication process. Thousands of years of small-scale agriculture took place before the introduction of maize (*Zea mays* ssp. *mays*) and eventual intensification of the Three Sisters (Fritz 1990).

Hanselka (2010) notes that the first domesticates appear in Tamaulipas, Mexico, by at least 4000 cal B.C. whereas the first agricultural villages do not appear in the archaeological record until around 1500 – 1000 cal B.C. Hanselka (2010) uses his own ethnographic observations to argue that there was a period of low-level food production based on cultivation of cucurbits (and maybe other crops such as corn). He notes that modern people living in the region will haphazardously sprinkle cucurbit seeds, specifically, cushaw (*Cucurbita argyrosperma* ssp. *argyrosperma*), butternut (*C. moshata*), pepo (*C. pepo* ssp. *pepo*), and bottlegourd (*Laginaria siceraria* ssp. *siceraria*), in clearings in the forest or open areas and return in the fall to see if their seeds will produce fruit. This is an extremely low-investment form of agriculture; a form that can only be done with certain crops, most notably cucurbits or members of the extended family.

In parts of China today, similar forms of extremely low-investment agriculture are practiced (personal observation 2009 – 2011). On the Sichuan plain, in rural areas around the city of Chengdu, houses or house clusters are traditionally surrounded by thick walls of bamboo (Bambuseae). In addition to a multitude of other uses, these bamboo stands provide a natural trellis for climbing cucurbits. Seeds are randomly spread around the outer edges of these small cultivated bamboo forests and ignored for the summer (Figure 7.17), they specifically plant bottle gourd, pepos, Buddha hand gourd (*Sechium edule*), winter melon (*Benincasa hispida*); bitter melon (*Momordica charantia*), luffa gourd (*Luffa acutangula*), and wild Mongolian snake gourd (*Trichosanthes kirilowii*).

Figure 7.17. Low-investment agriculture on the Sichuan Plains in central China near Chengdu, photos taken in 2010: left) Buddha hand gourds; right) luffa gourds

Early cucurbit cultivation around the world likely took the form of low-investment cultivation (Smith 1997a). This may explain why cultivation of bottle gourds was taking place 10,000 years ago in the Americas (Smith 1997a), and previously domesticated bottle gourds were already incorporated into the hunter-gatherer economy thousands of years prior to full scale agriculture.

However, the question pertinent to this dissertation is whether crops other than cucurbits are viable for low-investment agriculture. Hanselka (personal communication 2011) has started small test plots of maize in Tamaulipas, Mexico, to see if plants will fruit with no human labor investment. There are many ethnographic examples of similar forms of low-investment agriculture being conducted using both broomcorn and foxtail millet in Eurasia.

The two millets are unique in their growing conditions, and to understand their importance at Begash and on the steppe, specifically in a mobile pastoral economy, we must look at their growing characteristics. Broomcorn millet is an exceptionally hardy grain crop and it can grow further north than any of the small-grained (millet) cereals (Renfrew 1973). The plant is highly cold tolerant (Crawford, G. 1992; Pechenkina et al. 2002). This trait is very important when looking at the environmental conditions and the need to avoid scheduling conflicts associated with seasonal movements. Broomcorn millet is successful as a spring sown crop, unless there is a true freeze, and can withstand cold harsh nights that frequent the early spring on the western steppe. One of the most important traits for a mobile economy is the grain's short growing season. Broomcorn millet matures and is ready to harvest in only 60 – 65 days (Renfrew 1973:100; Baltensperger 2002; Hunt et al. 2011; Zohary and Hopf 2000)[39]. This short growing season helps mobile groups avoid conflicts in scheduling associated with seasonal camp movements. Broomcorn millet also grows well in most soils except sands, and it can produce with relatively little water (Crawford, G. 1992; Pechenkina et al. 2002; Renfrew 1973). Renfrew (1973:100) claims broomcorn millet has the lowest water requirements of any cereal, but she may only be considering Eurasian cereals. This is very important on the steppe where most researchers argue the soil is generally poor and the conditions are too arid for agriculture. It is also important because in most ethnographic accounts of

[39] According to Baltensperger (2002) and Hunt et al. (2011) it can take 60 – 90 days for the crop to reach maturity.

low-investment millet cultivation, little attention is paid to the crops and in most cases no irrigation is conducted (Vainshtein 1980).

Foxtail millet requires a short growing season, but one that is slightly longer than that required for broomcorn millet. Foxtail millet matures in 70 – 90 days after sowing (Renfrew 1973:102; Zohary and Hopf 2000). The plant is also fairly cold tolerant (Crawford, G. 1992; Pechenkina et al. 2002). While it is more productive in moister environments, it can be cultivated in semiarid locations and is fairly drought resistant (Crawford, G. 1992; Pechenkina et al. 2002; Renfrew 1973). It can also tolerate most soil conditions.

There are many ethnohistoric analogies of mobile pastoralists incorporating small-scale, low-input agriculture into their economies (Pashkevich 2003; Vainshtein 1980). In Central Asia millets are traditionally associated with the poor and with herders (Willcox 1991). Herders sometimes planted small plots of drought-tolerant millets in river valleys or near naturally watered areas. These plots were often left completely unattended for most of the summer and little labor or time input was required. This type of plot was usually sown with broomcorn or foxtail millet (the dominant grains at Begash in the Iron Age), whereas at Tuzusai the most abundant grain is wheat.

Multiresource pastoralism was first discussed by Salzman (1971) in contemporary societies, but has since been revamped and applied to archaeological models in Eurasian pastoralism. For the purpose of this proposal, I use Salzman's (2004:139) definition of multiresource pastoralism, claiming that "subsistence production generally aims at a wide range of foodstuffs and other products to satisfy the broad scope of needs and desires of consumption". This multiresource system was present in Central Eurasian mobile pastoralist economies before Soviet intervention. These economies are described in ethnohistoric accounts, which note the interconnected roles of exchange, agriculture, pastoralism, hunting, gathering, and fishing (Basilov 1989; Chang et al. 2002; Di Cosmo 1994; Salzman 1982). By studying variability in resource use we can start to develop an understanding of the economic development and adaptation of these populations. However, our understanding requires in-depth regional comparisons of economic data from numerous sites in diverse ecological settings and a detailed understanding of their associated socioenvironmental landscape, data which currently do not exist.

The cultivation of these two grains together with barley as a three-grain mobile agropastoral package is attested to in the ethnographic record across Eurasia and argued for in the archaeological record. Vainshtien (1980) describes a mobile agropastoral system based on small-scale cultivation of broomcorn millet, foxtail millet, and barley. Ethnographic, specifically ethnohistoric, accounts exist from Eastern Europe and Central Asia of mobile pastoralists conducting low-investment millet cultivation (Priklonskii 1953 [1881]; Seebohm 1882; Vainshtein 1980). Typically, small-scale plots of foxtail millet, broomcorn millet, and/or barley are planted near summer pasture camps in moist areas, such as river valleys or near springs. These plots require little attention until they are harvested in the fall, before moving to winter pasture camps. A full discussion of low-investment agropastoral systems in Central Eurasia is presented in Chapter 5.

Due, in part, to the limited sample size, it is not possible to determine how important domestic millet was at Begash, or what percentage of the diet it comprised. It is also not possible to determine if it was a component of the low-investment mobile agropastoral system as described in Vainshtien (1980) or if it was obtained through social interactions, either within Semirech'ye or inter-regionally. However, by the early Iron Age domestic broomcorn and foxtail millet were part of the subsistence economy at Begash, and it is interesting to note that large grained crops like the wheats and barleys were not incorporated into the economy at this time, even though they were grown at contemporary sites only 200 km further south.

Chapter 8: The Central Eurasian Corridor of Crop Exchange

In 2009, Fuller presented a paper for the Harvard University roundtable on Ethnogenesis of South and Central Asia held in Kyoto, Japan, titled "Framing a Middle Asian Corridor of Crop Exchange and Agricultural Innovation" (Fuller 2009 unpublished). In this paper, he argued that there is a reciprocal flow of crops through a corridor of exchange from East Asia into Central Asia and eventually to Europe and *vice versa*. Fuller proposed that it was not the sedentary agricultural centers that fostered the spread of agricultural innovation across Eurasia, but rather the mobile pastoral groups of the mountainous regions. "These mobile groups helped to stitch together the previously separate worlds, of the jade-focused trading sphere of China (Late Yangshao-Qiujialing-Dawenkou-Liangzhu) and the metal-trading sphere of Western Asia (in which tin and copper figured importantly)" (Fuller 2009 unpublished).

There is a growing body of evidence attesting to this third and second millennia B.C. exchange network, the Silk Road millennia before its historical manifestation. Evidence for a reticulated network of exchange and trade existing along the "Inner Asian Mountain Corridor" (Frachetti 2012) of eastern Central Asia comes from exotic goods including carved stone wares, worked coppers, and beads made from carnelian, lapis lazuli, gold, turquoise, chalk, jasper, silver, and a variety of colorful stones and minerals excavated at nodal points along this exchange network, such as Sarazm, in Tajikistan. Sarazm is the most northerly outpost of agricultural villages that spanned southern Central Asia from the fourth through the second millennia B.C., and the last link in a chain of villages that spanned the Kopet Dag up to the Pamir Mountains (see Spengler and Willcox in press for discussion). There are finds of worked minerals and stones that researchers have argued were moved between the Indus Valley and Central Asia (Frachetti 2012; Kenoyer 2011; Law 2006; Possehl 2004). Archaeologists have discussed the long-distance diffusion of metals from Central Asia, south and east into Xinjiang (Kenoyer 2011; Mei 2009; Mei and Shell 1999; Thornton and Schurr 2004). Salvatori (2008:116) envisions an "intensive and complex 'international' system of long-distance exchange between the Iranian world (Hissar, Khinaman, Shahdad, Tepe Yahya and Susa), Central Asia (piedmont of southern Turkmenistan, Bactria and Margiana), and the Indus Valley" during the third millennium B.C. Salvatori (2008) uses numerous lines of evidence to support his conclusion, most notably finds of similar cylinder stamp seals across the southern branches of the corridor. A direct contact form of exchange has been promoted by several researchers, who argue that trading settlements (nodes in the network) linked these three regions since the middle third millennium B.C. (Crawford, H. 1992; Parpola et al. 1977; Salvatori 2008; Winkelmann 2000). Chen and Hiebert (1995:285-286) note that burial form and cultural material in Central Asia are similar to Xinjiang; they discuss the likelihood of interactions between Xinjiang and western Central Asia. Stylistic elements in textiles from Lopnor may indicate a link to peoples in the Ferghana valley and in Bactria across from the Pamir Mountains (Debaine-Francfort 1987:203). Other textile-based evidence for an exchange corridor include cotton, linen, and silk fragments from eastern Kazakhstan (although much later in time), silk from Uzbekistan (Kuzmina 1998:64), and hemp in Tuva in southern Russia (Askarov 1973 unpublished:133-134).

At this same time period (the third millennium B.C.) the “jade road” first started, moving stone across China from Khotan in the Himalayas to the Lungshan Culture and eventually throughout the realm of the Zhou Dynasty. Jade was also transported to the Chust Culture in the Ferghana valley of Uzbekistan and the Tashkent Oasis (Kuzmina 1998:82). During the Hellenistic period glass was transported all the way from the Mediterranean to China.

There are numerous lines of data showing that exchange was common between BMAC (and earlier southern Central Asian peoples) and Mehrgarh and Sibri (Gupta 1979; Jarrige 1988; Miller 2003; Santoni 1984). As Moore et al. (1994:421) suggest, sites such as Mehrgarh and Sibri may have played a role in the diffusion of new crops north from Late Harappan Culture or pre-Kushan groups on the eastern edge of Baluchistan in South Asia. The process of material culture spread from Harappan Culture groups northward into southern Central Asia, has also been advocated by other researchers (Casal 1961; Hiebert and Kurbansakhatov 2003; Hiebert et al. 1995; Kuz'mina 2008). The crops of the Southwest Asian agricultural complex spread down into Pakistan and northwestern India, into the Harappan Culture (2600 – 1300 B.C.) of the Indus River valley (Bellwood 2005). Foxtail millet, broomcorn millet, possible Indian dwarf wheat (and other wheats), and naked barley are all present at Harappan sites (Weber 1991, 1999). This exchange network is responsible for the spread of agricultural innovations and technology through Central Eurasia, consequently the Central Asian agricultural corridor effected the progression of economic development and historical events throughout the Old World.

Considerable research has been conducted on the topic of pre-Silk Road exchange through the mountains of Central Asia; much of the research centers on the study of steppe-style artistic forms in Eastern or Southern Asia, specifically looking at 'fighting animal motifs' in Xinjiang and Inner Mongolia, China (Abetekov and Yusupov 1999; Hemphill and Mallory 2004; Ishjamts 1999; Li 2002; Linduff 2006; Mei and Shell 1998, 1999) and material cultural diffusion across the Eurasian steppe region and southern Siberia (Li 2002; Linduff 2006; Mei and Shell 1998, 1999; Schwarz 1984). Looking beyond the animal motifs, the remaining research on the spread of archaeological material across Central Eurasia has focused on the spread of Indo-European languages, horse breeding and chariot technology, and bronze metallurgy into dynastic China, and the proliferation of novel metallurgic technology (Chernykh et al. 2004; Kuz'mina 1994; Mallory and Mair 2000; Mei and Shell 1998, 1999).

Agriculture is documented archaeobotanically in the oases and river valleys of Xinjiang in the Iron Age and Late Bronze Age (Di Cosmo 1994; Thornton and Schurr 2004; Wang 1983; Li et al. 2011; [CRAIXAR 2007: discussed in Hunt et al. 2011]), and among later Xiongnu groups (Di Cosmo 1994; Honeychurch and Amartushin 2007; Honeychurch 2004; Koroluyk and Polosmak 2010; Kuz'mina 2007, 2008; Wright et al. 2009). The Xiongnu Empire might have extended westward into Central Asia, likely having influenced cultural spread further west (Barfield 1989; Chaliand 2004; Di Cosmo 1994; Yu 1990, 2002). Agriculture is also archaeobotanically shown across southern Central Asia at sites such as Anau North and Gonur Depe (Miller 2003; Moore et al. 1994). The furthest north of these agricultural villages is the site of Sarazm (Figure 8.1; Spengler and Willcox in press). This dissertation looks at the points connecting the agricultural oases of Xinjiang and the mountain foothills and valleys of the Kopet Dag, along the ecotone between the Kara Kum. I argue that the mountain river valleys throughout the mountain corridor of eastern Central Asia fostered the spread of agriculture east and west.

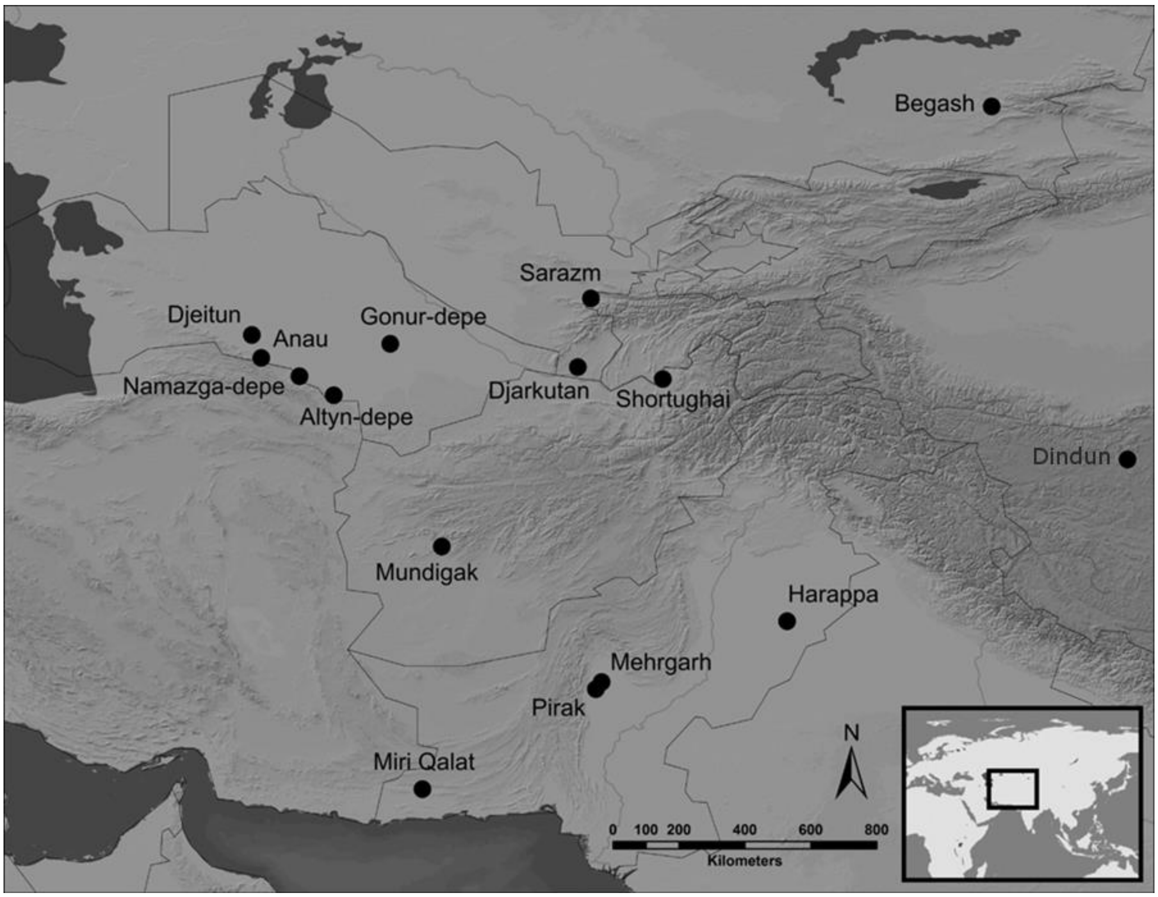

Figure 8.1. Key sites discussed in this section spanning the mountain corridor

8.1 The Wheat Road

One of the first crops to arrive in northern Central Asia was free-threshing wheat. The spread of wheat east into China has received a lot of attention over the past decade following what Lu (mentioned in Lawler [2009: 941]) calls the 'wheat road': a mountain corridor along which wheat may have diffused into China in the third millennium B.C. Li et al. (2007) note that by the middle to late second millennium B.C., free-threshing wheat became established as an important crop of the central China plains. However, remains of wheats have been excavated from earlier sites in Central China. Wheat remains were found at the Liangchengzhen site in the Longshan Culture (2600 – 1800 B.C.) (Crawford et al. 2005). However, as Flad et al. (2010) point out, the two well identified grains from this site are not directly dated. Flad et al. (2010) also call into question the antiquity of other Longshan wheat grains; notably from the sites of Baligang in Henan Province and Zhaojialai in Shaanxi Province. Wheats are present in burials in Xinjiang province, most notably at the cemeteries in Lopnor, i.e., Gumugou and Xiaohe (Wang 1983). While there are only a few direct dates on wheat from these sites none of them are older than 2000 B.C. A more interesting example of early wheat comes from the site of Xishanping in Gansu. Li et al. (2007) suggest that not only wheat but also barley and possible oats recovered from site date between ca. 2700 – 2350 B.C. Wheat from Xishanping is a lax-eared form, unlike most of the early Central Eurasian wheats. However, Flad et al. (2010) also call dating at this site into question.

Flad et al. (2010) present a set of directly dated free-threshing wheat and naked barley grains from the site of Donguishan in the Siba Culture. They suggest that occupation at the site may date between ca. 1550 – 1450 cal B.C. The free-threshing wheat at Donguishan is a compact form similar to most of the early wheat found in Eastern and Central Asia. Crawford, G. (1992) and Li et al. (2011) point out that all archaeological Asian wheats are hexaploid and most are a compact morphotype.

Crawford, G. (1992) specifically suggests that all wheats in East Asia, specifically early wheat in China (ca. 2600 cal B.C.) and later archaeobotanical wheat from Korea (ca. 1000 cal BC) and Japan (beginning of the first millennium A.D.) are hexaploid (Crawford and Lee 2003). Genetic studies of remains of wheat grains from cemeteries in the Lopnor region of Xinjiang have shown that these grains, some of the earliest wheat in China, are from a free-threshing hexaploid wheat (Li et al. 2011). On the Himalayan Plateau, at the site of Changguogou remains of naked barley, free-threshing wheat, oats, and even green peas were recovered (Fu 2001). Fu et al. (2000) note that naked barley at the site of Changguogou dates to around 1500 B.C.

8.2 Highly Compact Wheat

At the Bronze Age site of Shortughai in Afghanistan, Willcox (1991) identified two distinct varieties of free-threshing wheat based on ratios of length-to-width. Using the same approach, Spengler et al. (2013) attempt to differentiate between compact and lax-eared wheat at Tuzusai (discussed in Chapter 7; Figure 8.2). Differentiating between archaeological varieties of free-threshing wheats based on a length-to-width ratio has been practiced at several sites across the Old World (see Jacomet 2006 unpublished; Renfrew 1973). Often a 2/3 ratio of width to length is used as a cut-off point dividing compact and lax-eared varieties. However, in the third and second millennia B.C., highly compact wheats have been identified across Asia which do not fit the typical criteria for wheats in Europe. These highly compact wheats are often spherical or hemispherical in shape and range from 2.5 to 4 mm in diameter.

Figure 8.2. Lax-eared (left) and compact-eared (right) free-threshing wheat from Tuzusai

All of the Late Bronze Age wheat found in northern Central Asia is of a highly compact morphotype. The early grains from Begash and the Late Bronze Age wheat from Tasbas all express this morphology (discussed in Chapter 7; Figure 8.4). Highly compact round, free-threshing wheats were identified at Mehrgah in the Indus Valley by the mid-fifth millennium B.C. (Costantini 1984; Zohary and Hopf 2000) and at later Harappan sites, ca. 2500 – 2000 cal B.C. (Weber 1991; see for examples: Lone et al. 1993; Vishnu-Mittre 1972; Shaw 1943). Highly-compact wheat is present in southern Central Asia at Anau South and Gonur Depe by 2000 B.C. (Moore et al. 1994; Miller 1999; Miller 2003). This highly compact free-threshing wheat persists at Gonur Depe into upper BMAC layers (Moore et al. 1994). Similar free-threshing wheat has been identified in northern Central Asia at the site of Begash dating to 2200 cal B.C. (Frachetti et al. 2010b; Chapter 7).

Indian Dwarf Wheat

Discussions relating to the highly compact wheats have been cautious due to issues with subspecies level identification and the need for more archaeobotanical material for comparison, making correlations between highly compact morphotypes in Central Asia and South Asia problematic (see Fuller 2001). Landrace varieties of any crop exhibit a wide range of variation in characteristics, both within a variety and among disparate varieties. It is clear that this morphology-based category is not neatly defined and overlaps greatly with compact wheats.

Several studies on carbonizing modern wheat grains have shown that significant puffing and distorting can be caused by heating at various temperatures or under specific conditions. Kim (2013:520) states "the experiments demonstrated that the heating condition alone may produce a series of wheat assemblages with noticeable size variations". The same results were demonstrated by Braaddaart (2008). However, Kim (2013) argues that the short round grains found archaeologically in Korea and Japan are too morphologically distinct to be the result of carbonization alone.

One theory for the origin of highly compact wheat in Asia is that it may have originated from the same gene pool as an historically documented variety of highly compact free-threshing hexaploid wheat, "Indian dwarf wheat" (*T. aestivum* ssp. *sphaerococcum*), which was grown in Pakistan and western India before the Green Revolution (see for description Peterson 1965:89). Singh (1946) and Percival (1921) note that Indian dwarf wheat is a drought-tolerant variety of free-threshing wheat and that this may be the catalyst for its historical presence in Pakistan, Afghanistan, and northern India. The plausibility of this theory is increased due to known trade and interaction between peoples in southern Central Asia and the Indus valley during the third and second millennia B.C. (Casal 1961; Hiebert and Kurbansakhatov 2003; Hiebert et al. 1995; Kuz'mina 2008). Rao (1977) suggests that Indian dwarf wheat originated in the northwest area of India, based on a complete lack of any extant or archaeological remains of this crop or similar morphotypes in Europe or southwest Asia. Peterson (1965:89) hypothesizes that Indian dwarf wheat arose in Pakistan due to a mutation of a free-threshing bread wheat. Indian dwarf wheat is characterized by its short habit; however, it actually possesses a suite of distinctive traits, including dense strong culms and erect blades, a condensed spike which expresses with short awns, glumes, and a hemispherical grain. In addition, it has increased tillering and a reduced rate of lodging (Percival 1921).

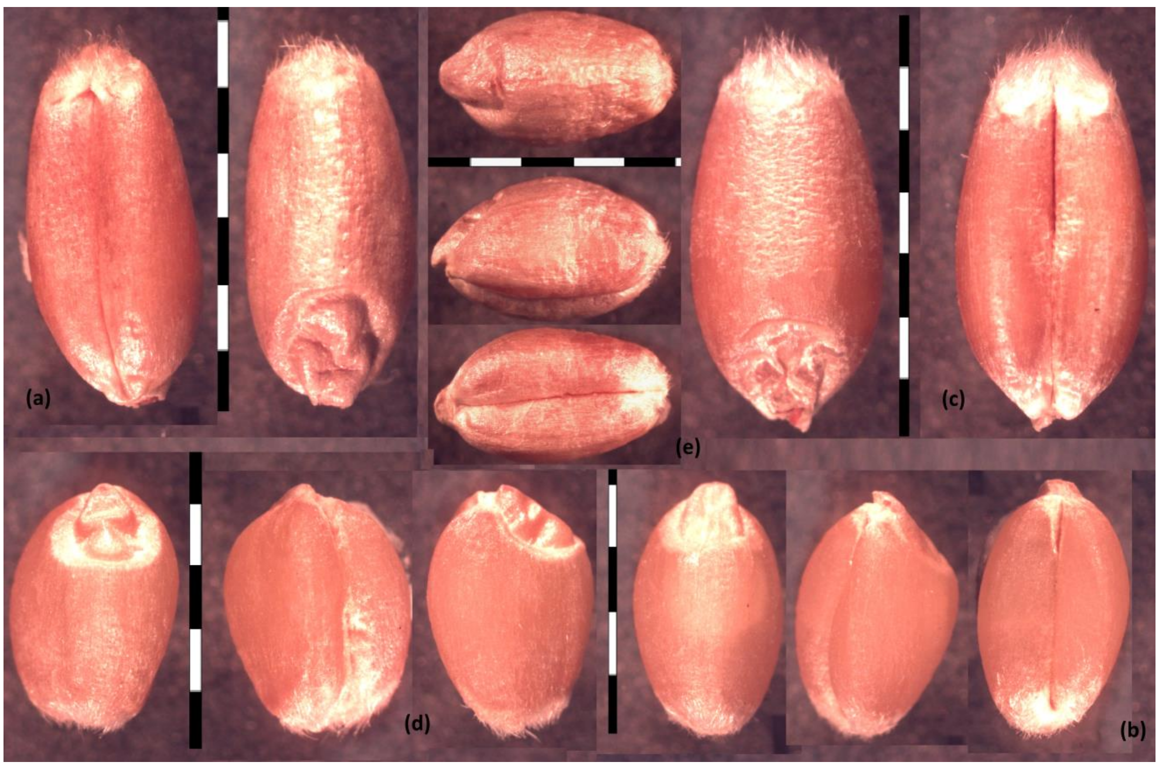

Figure 8.3. Five specimens of landrace wheat from the USDA NPGS: a) Norin 10 from Iwate, Japan; b) 132 from Uttar Pardesh, India; c) Norin 43 from Nara, Japan; d) 219 from Iraq; e) Type No. 6 from Punjab, Pakistan

Early and mid-twentieth century herbarium specimens of semidwarf wheat caryopses from this part of the world are spherical or hemispherical (Peterson 1965:17;

Leonard and Martin 1963:303; Figure 8.3b, d, e). In Figure 8.3 there are three characteristic examples of Indian dwarf wheat from the USDA National Plant Germplasm System (NPGS). Figure 8.3b is an example for NPGS number 4214, collected in Uttar Pardesh, India; Figure 8.3d is NPGS number 70711, from Iraq; and Figure 8.3e is NPGS number 40943, from Punjab, Pakistan. The plant has a spring wheat growth habit (i.e., erect culmed); however, historically it is often planted in the fall as a winter wheat. Most winter wheats have a prostrate growth habit, unlike dwarf wheats. The plant is heavily tillered, 60 – 70 cm tall, and the spikeletes can either be awned or not awned. Chaffing material can be white or red and glabrous or pubescent. Grains can either be red or white; interestingly many landrace varieties of Chinese spring wheat are also red grained.

Archaeological remains of highly compact free-threshing wheats which have been interpreted as Indian dwarf wheat have been identified at a number of northwestern Indian sites during Harappan and post-Harappan periods, e.g.: Burzahom (2325 B.C.) (Lone et al. 1993); Mohenjodaro (2250-1750 B.C.) (Stapf 1931); Harappa (2250-1750 B.C.) (Burt 1941); Chanudaro (2250-1750 B.C.) (Shaw 1943); Chirand, Bihar (1800 B.C.) (Vishnu-Mittre 1972); and Semthan (1500 B.C.) (Lone et al. 1993). The oldest remains of wheat suggested to be Indian dwarf wheat were reported by Costantini (1984), from the level III layers at Mehrgarh (ca. 5500 cal B.C.). A detailed discussion and description of potential archeological Indian dwarf wheat is presented in Lone et al. (1993), who base their discussion on 50 grains recovered from the Burzahom site and 14 grains recovered from the Semthan site, both in Kashmir. They describe these caryopses as "oval to subglobular, comparatively short and rounded, rather plump when viewed from the ventral side. They vary in length from 3.0 mm to 4.7 mm and in breath from 2.2 mm to 2.5 mm" (Lone et al. 1993:114). Renfrew (1973:63) provides measurements for modern comparative examples of Indian dwarf wheat of 4.0 to 5.5 mm in length and 3.0 to 3.7 mm in width; these measurements match those given by Percival (1921). Lone et al (1993) provide length-to-width ratios for modern uncarbonized grains of lax-eared free-threshing wheat of 2.68, compact eared free-threshing wheat of 2.44, and Indian dwarf wheat of 1.76. The archaeological specimens identified as Indian dwarf wheat have a much more compact length-to-width ratio for Burzahom (1.25) and for Semthan (1.37) (Lone et al. 1993:114-117). These latter ratios are comparable to remains recovered from Tasbas (Chapter 7).

Miller (1999:17) points out that there is a chronological gap between the Neolithic site of Jeitun in western Turkmenistan, which does not have highly compact wheat, and Chalcolithic Anau, which does have highly compact wheat. She suggests that the highly compact wheat at Anau, Djarkutan, and Gonur Depe could be related to Indian Dwarf wheat and that the time gap between these sites and Jeitun may indicate that the highly compact grains spread to southern Central Asia later in time from the east (Mehrgarh of Pirik). She states:

> "Given the chronological and possible cultural gap between Jeitun and Anau, one might ask: did those plump, naked hexaploids arrive from northern Iran with settlers or through trade, or rather, might they have reached Central Asia from Afghanistan or Pakistan across the mountains following the valleys of the Amu Darya tributaries." [Miller 1999:17]

Lone et al. (1993) also note that distinct characteristics in the outer surface of the fuzzed pericarp/testa of the caryopses match in both extant Indian dwarf wheat and the archaeological remains of possible Indian dwarf wheat. They claim that in both cases the cell pattern and cell alignment are similar and that they are distinct from other varieties of free-threshing wheats. Another trait that could possibly help with archaeobotanical links between the historic landrace and archaeological material is the shallow ventral furrow. This trait has not been discussed archaeologically; however, wheat grains from Tasbas as well as grains from the site of 1211 in Turkmenistan (Spengler et al. in review) have shallow furrows similar to herbarium specimens of Indian dwarf wheat.

There have been some studies attempting to understand the genetic basis of the collective suite of traits that make up the sphaerococcoid syndrome in wheat (see Josekutty 2008 for a discussion). Rao (1977) reported that the gene '*s*', responsible for the sphaerococcum traits, is located near the centromere of chromosome 3D. Koba and Tsunewaki (1978) mapped the sphaerococcum gene in hexaploid wheat using an isogenic marker line with genotype '*ss*'. The mutation that caused this phenotype is likely the result of gene duplication resulting during DNA recombination (Salina et al. 2000), and one that likely arose relatively late during *T. aestivum* domestication, see discusison in Gegas et al. (2010). Gegas et al. (2010) suggest that drastic mutation syndromes such as Sphaerococcum would have been selected against early on in wheat domestication due to the secondary traits associated with the mutation but were breed out relatively late, such as the late fourth millennia B.C. Josekutty (2008) studied the development of seedlings when exposed to GA3 (Gibberellin signal transduction) to determine if the semidwarfing trait is the result of an *Rht* gene. He concluded that the height reduced characteristic of Indian dwarf wheat is *not* a result of an *Rht* gene (discussed below).

Rht Genes and Green Revolution Wheats

The semidwarfing trait in most hexaploid wheats grown around the world today is the result of selected alleles in a series of *Rht* genes. Chen et al. (2012) note that there are 20 *Rht* loci and 25 alleles identified thus far, 11 of which occur naturally (14 alleles were obtained through induced laboratory mutations). There has been extensive research focused on these genes due to their importance in modern agriculture, specifically the Green Revolution. Like with the '*ss*' gene, *Rht* genes affect plant height, reducing lodging and increasing culm strength, as well as increasing tillering; however unlike sphaerococcum, they increase seed yield. The breeding work directed by Norman Borlaug in the decades after World War II at the Centro Internationale de Mejoramiento de Maiz Y Trogo (CYMMIT) in Mexico has become legendary, especially in India and China where the influence of the Green Revolution was most drastic and most immediately felt. Breeding the *Rht-B1* and *Rht-D1* alleles into wheat spawned the Green Revolution (Reynolds and Borlaug 2006). These alleles were obtained from a Japanese landrace variety of wheat called '*Norin 10*'. This genetic material is currently bred into over 90 percent of the semidwarf wheat grown around the world (Chen et al. 2012). In addition, Italian biologists working during the Mussolini period isolated *Rht8* out of another Japanese landrace variety called '*Akakomugi*'. This semidwarfing gene is introgressed into much of the wheat cultivated in Europe (Borojevic and Borojevic 2005). The *Rht* genes changed agriculture in many ways; however, they do not seem to be related to Indian dwarf wheat genetically. Josekutty (2008), however, does note that further research is required to understand what processes are causing the semidwarfing trait in Indian dwarf wheat.

A Northerly Spread of Highly-Compact Wheat

If we accept the hypothesis that early archaeobotanical remains of highly compact free-threshing wheat in Central Asia are linked genetically to historic varieties of Indian dwarf wheat (albeit still a hypothesis, requiring much additional work), then we can trace the spread of this genetic material through the mountain corridor. The oldest evidence of the grain comes from pre-Harappan agriculturalists in the Indus valley. It eventually spread into modern day Pakistan, Afghanistan, and possibly southern Central Asia by the second millennium B.C. This spread would have followed well established trade routes that connected sites like Pirak to Kopet Dag sites and as far north as Sarazm (Spengler and Willcox in press). The exchange of a drought-tolerant wheat variety would have readily taken place along with the movement of metal ore and mineral stones. Highly compact wheat is not present in Central Asia before the third millennium B.C. even though wheat was a major crop at earlier sites such as Anau and Sarazm. Most third millennium B.C. agricultural sites in Central Asia have lax- or compact-eared free-threshing wheat, which is not highly compact.

Once the phenotypically distinct variety of wheat was established in southern Central Asia, its spread through the mountain valleys, such as the Ferghana and Zarafshan, would have easily brought it through the "wheat road" and into western China. The earliest evidence of similar morphological grains north of the Kara Kum

Desert comes from Begash (2200 cal B.C.). The presence of the grain in the same region at Tasbas (1400 cal B.C.) suggests a continuity of use and possible cultivation in northern Central Asia. If we accept that the wheat road passed through the mountain valleys of northern Central Asia (such as the Dzungharian Gate) and across the oases of Xinjiang, it is quite plausible that the grains excavated at the site of Luanzagangzi (1300 – 900 cal B.C., Jia et al. 2011, Figure 8.4) could share the same genetic material and possibly the '*ss*' gene for the sphaerococcoid simplex. It is also important to note that all these grains share the same morphological trait of a shallow furrow.

The final connection that can be easily made by the archaeobotancial record involves the stretch from Xinjiang to Gansu. The Hexi or Gansu Corridor has been the main route for the movement of goods and people from the dynastic centers of China toward the 'West'. This stretch of land is biologically rich and supports extensive and highly intensive agricultural practices today. It is a swath of rich agricultural land surrounded by sand and rocky hills on all sides. The presence of a highly compact wheat variety at the site of Donghuishan (1609 – 1421 cal B.C., Flad et al. 2010) at the mouth of the Hexi corridor could possibly suggest that the sphaerococcoid traits spread as far as central China.

East Asian Highly Compact Wheat

It should also be repeated that highly compact free-threshing wheat varieties have been discovered at archaeological sites in South Korea at ca. 1000 B.C. (Crawford and Lee 2003). These grains were found in combination with barley. Furthermore, 2,000 year old sites in Japan have also provided highly compact grains of wheat as well (Crawford and Lee 2003). It is only speculative at this point to suggest that there could be any connection between these grains and those in Central Asia. Further archaeobotanical studies across Asia will likely clarify the possible spread of these genes across the continent. Genetic work seems to suggest that there is no connection between semidwarf landrace wheat varieties found in Japan in historic times, e.g. '*Akakomugi*' and '*Norin 10*', and Indian dwarf wheat.

USDA specimens of Japanese dwarf wheat from the NPGS do not show highly-compact traits. Figure 8.3a and b are both traditional Japanese landraces, 8.3a is an example of Norin 10 from Iwate, Japan, NPGS number 277364. Norin 10 is the landrace used by Borlaug. 8.3b is an example of Norin 43 from Nara, Japan, NPGS number 182586, and other dwarf variety. In comparison to the NPGS specimens of sphaerococcum wheat the Japanese landraces are rather lax and elongated. However, Kim (2013:518) notes that the *Rht8* genes in Japanese landraces originated in a Korean landrace (Anjeun baengyi mil). Kim (2013) also notes that this Korean landrace as well as many of the Japanese varieties had highly compact grains. He suggests a connection between the landraces introduced to Korea and Japan as far back as the Mumun Period (ca. 1500 B.C.) and small-grained remains found in China in the second millennium B.C. Kim (2013) notes that these plumper varieties became prevalent in southern Korea no later than the Three-Kings Period (ca. A.D. 300 – 668) (see also Crawford and Lee 2003). Kim (2013) points out that these varieties remained common (among other varieties) until the Jeseon Period (1392 – 1910). Grain size increases are a modern phenomenon in the region; however, Kim (2013) points out that a few farmers in the south grew traditional landraces which have smaller plumper grains.

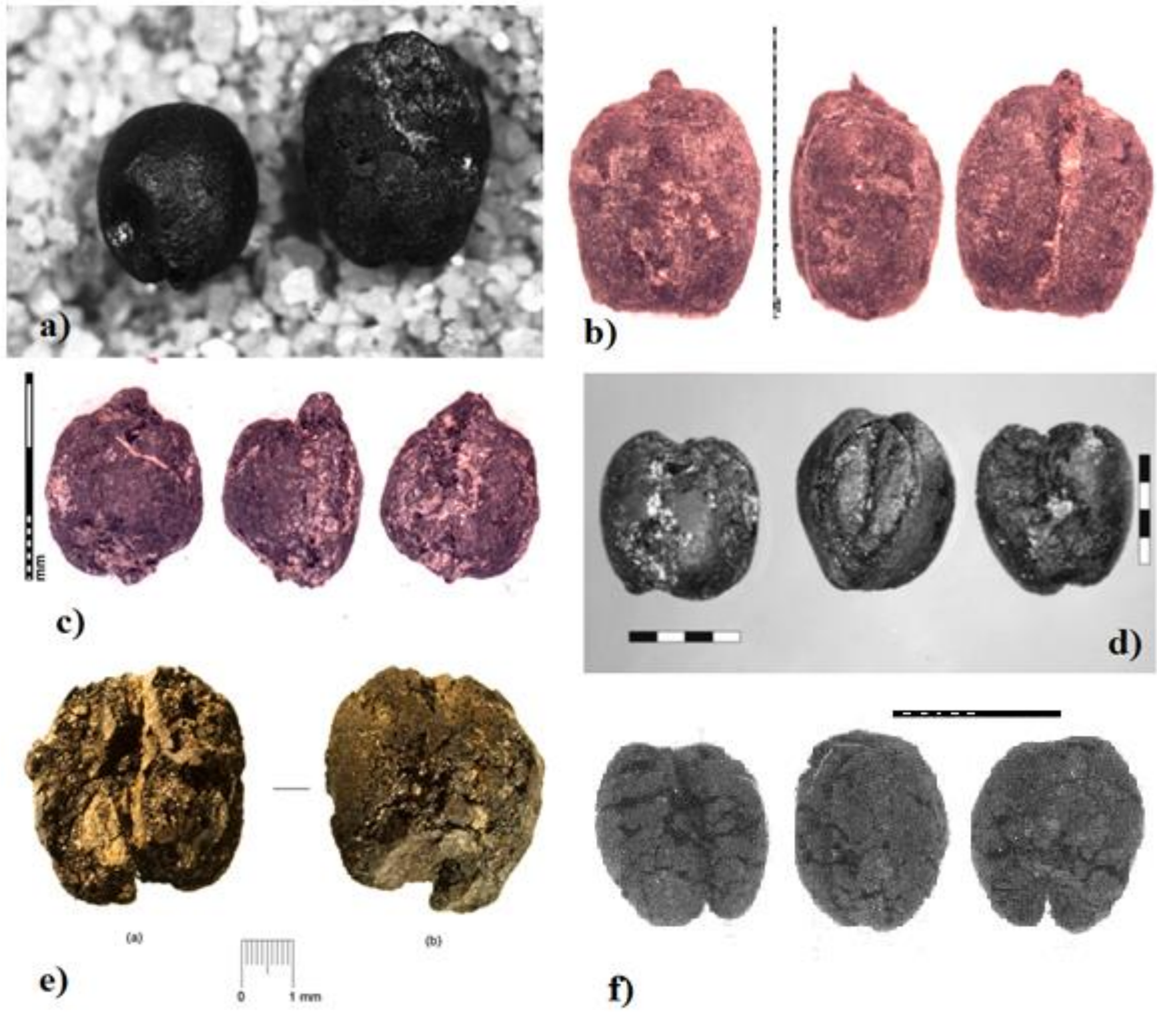

Figure 8.4. Highly compact free-threshing wheat grains from archaeological sites across the mountain corridor: a) Luanzagangzi – 1300 – 900 cal B.C. (Jia et al. 2011); b) Tasbas 1300 cal B.C. (Chapter 5); c) 1685 – 1400 cal B.C. (Spengler et al. in review); d) Donghuishan – 1609 – 1421 cal B.C. (Flad et al. 2010); e) Begash – 2200 cal B.C. (Frachetti et al. 2010b); f) site 1211 – 1200 cal B.C. (Spengler et al. in review)

The fact that *Rht* genes and the sphaerococcoid phenotype do not seem to be genetically related suggests that the theory of a spread of wheat across Central Asia may be more complex than it seems. A simple connect-the-dots model may not hold up to the test of phytogenetics. However, archaeobotanically it is a plausible model for spread. As I discuss in Chapter 7, there is extreme overlap between these supposed varieties in size.

Likewise a single historic landrace or a single archaeobotanical assemblage can express extreme range in size. Further research is needed to either confirm or reject the hypotheses presented here.

8.3 Barley

Bronze Age Naked Barley

Two varieties of barley were identified from these samples, naked and hulled. A combination of archaeological and genetic research over the past few years has clarified much of the picture of barley domestication. It is clear that six-rowed forms were cultivated by 6500 B.C., the mutation of the *Vrs 1* allele having possibly originated repeatedly in different geographic areas at different times (Komatsuda et al. 2007; Leon 2010). Naked barley (mostly six-rowed) was cultivated in southwest Asia by 6000 B.C. (Zohary and Hopf 2000) and was present at Mehrgarh by the fifth millennium B.C. (Costantini 1984). Taketa et al. (2008) suggest, based on genetic evidence, that a monophyletic mutation of the *nud* locus caused the naked phenotype in barley. In the fifth and fourth millennia B.C. there seems to be a trend across the Caucuses and the Mediterranean for replacing hulled populations by their naked equivalents. Late Neolithic and Early Bronze Age barley at Jeitun and Anau is a mix of hulled and naked morphotypes (Harris 2010). Hulled and naked barley grains were found mixed at Sarazm (Spengler and Willcox in press). By the Middle Bronze Age at Gonur Depe, the hulled form seems to be completely replaced (Miller 1999), and the same seems to be true at Djarkutan (Moore et al. 1994). Hulled barley is, however, found at Shortughai mixed with naked (Willcox 1991). The site of 1685 in the Murghab delta of Turkmenistan only has naked barley; however, the nearby site of 1211 has a mix of naked and hulled (Spengler et al. in review). In this dissertation, Tasbas has only naked barley, while Tuzusai is primarily hulled. While many early sites in southern Central Asia have a mix of hulled and naked barley (see Spengler and Willcox in press), by the second millennium B.C. most of the barley found in this region is naked. Hulled barley, however, is the dominant variety at Tuzusai in the Iron Age.

Farmers in Eurasia switched to a naked phenotype in the fifth and fourth millennia B.C. Hulled and naked barley are both present at Late Neolithic and Early Bronze Age sites in southern Central Asia, such as Anau and Jeitun in Turkmenistan (Harris 2010) and Sarazm in Tajikistan (Spengler and Willcox in press). Most of the early naked barley appearing in southern Central Asia by the late fourth and into the second millennia B.C. and in western China by the second millennium B.C. is morphologically short and semispherical (Figure 8.5). Relatively short and plump grains have been recovered from Sarazm in Tajikistan (Spengler and Willcox in press), 1685 in Turkmenistan (Spengler et al. in review), Miri Qalat, Makran (Tengberg 1999; Willcox 1994), and several sites in Pakistan (e.g., Mehrgarh and Nausharo [Costantini 1984; 1987]). Most of the grains at Tasbas (Chapter 7, Figure 8.5) have a similar condensed morphology. The earliest naked barley in western China (second millennium B.C.) is of a similar morphotype (Flad et al. 2010; Jia et al. 2011; Fu 2001). Miller (2003:130) contrasts naked barley grains at the site of Anau to grains from the site of Erbaba, Turkey and notes that those from Anau are plumper; however, she suggests that this plumpness could be the result of irrigation and not a distinct genetic variety.

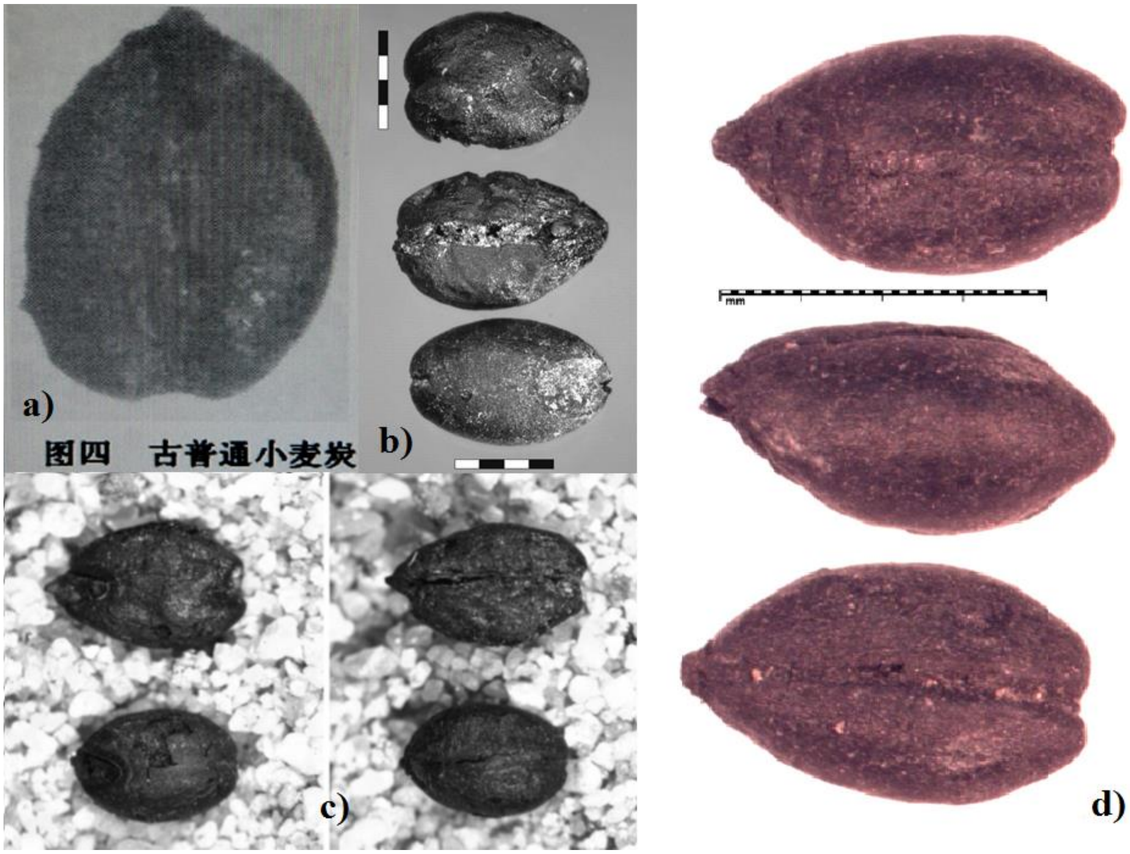

Figure 8.5. Compact naked barley grains from across the mountain corridor: a) Changguogou – 1400 – 800 cal B.C. (Fu 2001); b) Donghuishan – 1609 – 1421 cal B.C. (Flad et al. 2010); c) Luanzagangzi – 1300 – 900 cal B.C. (Jia et al. 2011); and d) Tasbas 1300 cal B.C. (Chapter 6)

Iron Age Hulled Barley

Early examples of barley in Tibet and Nepal (more recent than 500 B.C.) are all naked-form. In addition, recent discoveries of barley in China outside of Tibet have been naked-form as well; notably, 1000 B.C. grains from the site of Jimusa’er Luanzagangzi in Xinjiang (Jia et al. 2011). This is in contrast to the barley recovered from Tuzusai, most of which is hulled. In addition, the first century B.C. barley from Mebrak in Nepal is both hulled and naked (Knörzer 2000). Wagner (2011) notes similarities in material culture and economy between Bronze Age pastoralists in the Kunlun Mountains and groups further west on the steppe. Therefore, hulled forms of barley may have been preferred by mountain vertically mobile pastoralists in northern Central Asia and spread through this region during the Iron Age.

8.4 Millets

Broomcorn Millet

Interestingly, broomcorn millet is *not* present at Sarazm or the early agricultural village sites in southern Central Asia (Spengler and Willcox in press). This grain is completely absent from all of the Kopet Dag Mountain sites except Tahirbaj Depe (Herrmann and Kurbansakhotov 1994) and is not present in the earliest layer at Shortughai. It does appear in the second millennium B.C. at Shortughai (Level II, Period I - Willcox 1991). However, it is present in northern Central Asia by 2200 cal B.C. at Begash (Frachetti et al. 2010b; discussed in this dissertation). There is an ongoing debate over the origin of broomcorn millet (see Hunt et al. 2008; Hunt et al. 2011). However, the lack of any solid evidence for domesticated broomcorn millet across the western steppe, southwest Asia, and western Central Asia, seems to indicate that early broomcorn millet at Begash and Shortughai was originally brought from the area of the modern Autonomous Region of Xinjiang, China[40] (see Flad et al. 2010; Frachetti et al. 2010b). The lack of any of these grains at Sarazm or any site before the end of the third millennium B.C. suggests that this species did not spread into Central Asia from China

[40] This is not to reject the possibility of a Late Neolithic spread. The processes going on in the region during the Late Bronze Age hold no bearing on the arguments over monophyly or a Late Neolithic spread.

until after this date (see Spengler and Willcox in press for discussion). As Fuller (2009 unpublished:7) concludes:

> "I am prone to reject more dubious claims for earlier dispersals of Chinese millets and to suggest that these also came into northwest South Asia in the same general "Chinese" horizon at the start of the Second Millennium BC, or perhaps the late Third Millennium" [Fuller 2009 unpublished:7]

The millets are a late introduction to the agricultural assemblages of southern Central Asia. Broomcorn millet was found at the sites of 1685 and 1681 in Turkmenistan (Spengler et al. in review). Flotation sample 16 from site 1211 appears to be a small cache of broomcorn millet grains. There are 247 grains identified in that sample. A large number of unidentifiable seed fragments in the same sample are presumed to be millet fragments but were not quantified due to their fragmentary nature and high abundance. This material currently represents some of the earliest millet remains recovered from southern Central Asia. The sites of 1685, 1681, and 1211 are all located on the Murghab Delta about 20 km away from the agricultural village of Gonur Depe (Figure 8.6). Spengler et al. (in review) suggest that mobile pastoralists may have grown and used broomcorn millet in the region while neighboring irrigated agricultural villages preferred wheat, barley, and legumes.

Broomcorn and foxtail millet are absent at other sites in the Kopet Dag Mountains, such as Anau, Gonur Depe, or Djarkutan[41] (Hiebert and Kurbansakhatov

[41]Harris et al. note they left "small-seeded weeds" (1996:438) unidentified. The smallest sieve size used in their wet sieve method at the Jeitun site was 1.0 mm (Harris et al. 1996:429). Miller points out the flotation conducted by the excavating team at Gonur used a sieve size of 2.0 mm and sieve sizes for Anau

2003; Hiebert et al. 1995; Miller 1993, 1999; Moore et al. 1994). Spengler and Willcox (in press) suggest, based on current data, that broomcorn millet may have been introduced into Central Asia during the tail end of the third and the second millennia B.C. Data for second millennium B.C. broomcorn millet in Central Asia is rapidly growing: Begash, Kazakhstan (2200 cal B.C.); Shortughai, Afghanistan (second millennium B.C.); Tahirbai Depe (ca. 1000 B.C.), Dam Dam Cheshme rockshelter (1200 – 800 B.C.), and 1685 (1600 cal B.C.), Turkmenistan. Broomcorn millet also makes it to the Harappan world and is present at Pirak by 2000 B.C. (Costantini 1979).

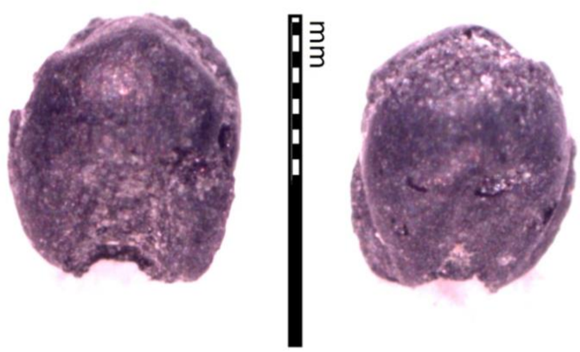

Figure 8.6. An image of broomcorn millet from the site of 1685 in Turkmenistan, some of the earliest evidence of the grain from southern Central Asia

Foxtail Millet

Foxtail millet appears to be a much later introduction and may not have come into Central Asia until the early formation of the Silk Road, although earlier finds in Europe complicate the story. The grain is present at Tuzusai by ca. 400 B.C. (Spengler et al.

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and Djarkutan were not provided (1999). For all four of these sites no botanical material except domestic grains with large caryopses was reported.

2013; Chapter 7) and appear to be present at Tasbas by 1400 cal B.C.; however the 11 millet grains identified as foxtail are poorly preserved and identification is tricky. At the Site of Anau South in Bronze Age layers (Namazga V and VI) dating to around 2500 B.C. Harrison (1995) identified '*Setaria* sp.' seeds, but these are more likely wild. The grain is found by the second millennium B.C. at sites in Xinjiang and Tibet. Foxtail millet also appears readily in Harappan and pre-Harappan contexts (Weber 1991).

8.5 Peas

Pulses are often considered secondary crops, following after grain crops in the Old World. Archaeobotanical remains of pulses are completely absent at most early sites in Central Asia. There are no well identified pulses in Early Bronze Age material from Sarazm (Spengler and Willcox in press) or the Neolithic and Early Bronze Age material from Jeitun and Anau (Harris 2010). One Fabaceae specimen, identified as *Lens* sp., was recovered from Sarazm, but its wild or domestic status is unclear. Middle and Late Bronze Age sites in southern Central Asia have chickpeas (*Cicer* sp.), lentils (*Lens* sp.), and green peas (*Pisum sativum*) (Miller 1999; Moore et al. 1994). Gonur Depe also has several probable grass peas (cf. *Lathyrus*) (Moore et al. 1994:422). However, fourth and early third millennia B.C. sites do not have any good evidence for pulses (Harris 2010). It seems likely that these domestic legumes were introduced to Central Asia from the Iranian Plateau in the Middle Bronze Age (ca. 2500 B.C.).

Peas appear in a large cache deposit at 1211 in Turkmenistan dating to 1400 cal B.C. (Spengler et al. in review). There are inclusions of grass peas (*Lathyrus* sp.) and lentils in this cache. This large cache contains over 10,000 peas, which range in diameter from 3 to 7 mm and all have a smooth testa surface. Peas were also identified in early layers at Shortughai by Willcox (1991) and are present across Pakistan and northern India (Weber 1991).

The peas found at Tasbas are possibly the best line of evidence supporting the notion of a second millennium B.C. spread of agriculture along the mountain corridor. Peas are found in South and southern Central Asia but they are absent across most of China, East Asia, and the rest of Central Asia. The only other site where peas have been identified is Changguogou in Tibet (Fu 2001; Figure 8.7). If we think of the mountain corridor as fitting to the shape of the Central Asia mountains, the two sites – Tasbas and Changguogou – are at extreme arms of the corridor. Changguogou is located on the Himalayan Plateau and Tasbas is located in the Dzhungar Mountains. The third arm of the corridor would be the extension of the Pamir into the Kopet Dag Mountains and along the edge of the Iranian Plateau. This third arm, too, has peas at its extent (i.e., site 1211, 1685; Figure 8.7). The fact that these contemporary archaeological sites (Changguogou, Tasbas, and 1685), which share little material culture similarity and are separated by thousands of kilometers, have the same agricultural suite of crops is the smoking gun needed to argue for the crop corridor.

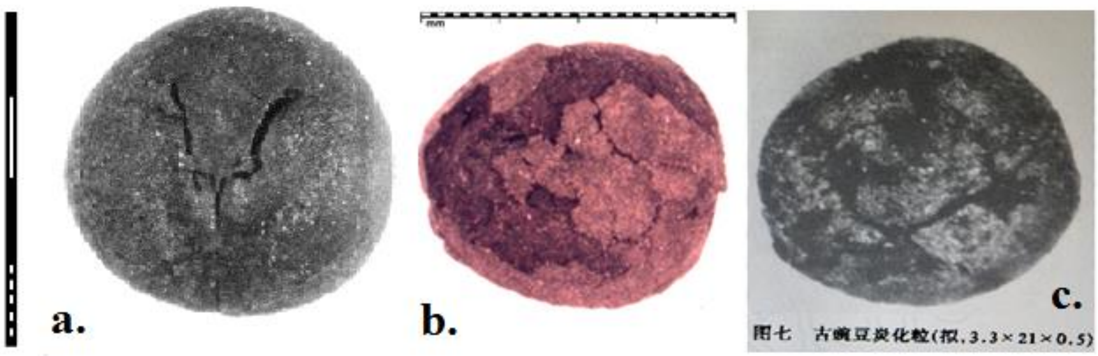

Figure 8.7. Peas from extreme ends of the mountain corridor, right – a) site 1685, 1400 cal B.C. (Spengler et al. in review); b) Tasbas (Chapter 7); and c) Changguogou, 1400 – 800 cal B.C. (Fu 2001)

8.6 Grapes

The earliest evidence for wine production comes from the sixth millennium B.C., at the site of Hajji Firuz in Iran. This site is on the edge of the modern range for wild grapes, and McGovern et al. (1996) suggest that wine was being produced from wild (not yet domesticated) varieties. The evidence comes from tataric acid residue recovered from a 50 liter ceramic vessel at the site. McGovern et al. (1996) further argue that a single household would not need 50 L of vinegar, therefore, it stands to reason that the residue is from wine. Fourth millennium B.C. tataric acid residue was recovered from ceramics at the site of Godin Tepe in Iran, possibly outside the wild range of grapes (McGovern and Michel 1994).

Syntheses of the macrobotanical evidence for grape use and cultivation in southwest Asia and Europe are presented in McGovern and Michel (1994), Miller (2008), Zohary (1994), and Zohary and Hopf (2000). The oldest macrobotanical evidence for grapes in Central Eurasia comes from Bronze Age (Namazga V and VI) (ca. 2500 B.C.)

levels at the site of Anau South in Turkmenistan (Harrison 1995). At the site of Mehrgarh in Pakistan, Harappan viticulture is well attested by 2000 B.C. based on the presence of grape wood (Miller 2008). Lone et al. (1993) identified grape vine wood at the site of Burzahom in Kashmir dating back to 1700 – 1000 B.C. Furthermore, other Namazga V (ca. 2000 B.C.) sites in southern Central Asia have grape pips, including Gonur Depe and Djarkutan (Moore et al. 1994). The grape pips from Tuzuai (Chapter 7) date to around 400 B.C.

During the early formation of the Silk Road, the 'Book of the Great Historian' (Shiji) notes that grapes were introduced to China from the west (Sima 1961 [ca. 80 B.C.]). Jiang et al. (2009) note this Han text specifically reference General Qian Zhang as bringing viticulture to China from the country of Dadiwan, which Jiang et al. suggest is the Ferghana valley of Uzbekistan, on his campaigns in 138 B.C. and 119 B.C. Qian Zhang was sent by the emperor to make connections with the Xiongnu, and after a long period of imprisonment he escaped and supposedly passed through the Ferghana valley on his long route back to Xi'an. Jiang et al. (2009) found a 116 cm long grape vine in a tomb in the Yanghai cemetery in Turpan, Xinjiang. This vine fragment shows that grapes were being cultivated in Xinjiang as far back as 390 – 210 B.C. Turpan was a major oasis-city along the ancient Silk Road and would have helped connect people between dynastic China (Xi'an, formerly Chang'an) and Central Asia.

While the most likely explanation for the spread of grapes across Eurasia is wine production, Miller (2008) suggests the alternative, that early domestic hermaphroditic (perfect) flowers were desired for the purpose of preserving sweeter varieties of grapes. Therefore, the main incentive for the transfer of viticulture technology would be sweetness. The pips from Tuzusai could indicate an exotic exchange good (raisins) or a locally grown horticultural product.

8.7 Domesticated Plant Fibers

Andrew Sherratt proposed and touted the 'secondary products revolution' throughout much of his career, until his death in 2006 (McCorriston et al. 1997; Sherratt 1999; Sherratt 1981, 1983). As part of this 'revolution' he discussed the importance of cash-crops as exchange goods (Sherratt 1999). He notes that the development of exchange networks was in part fostered by the cultivation of new crops, maintained purely for their 'cash' value. In an article titled "Cash-crops before Cash: Organic Consumables and Trade", Sherratt (1999) suggests that the development of a cash-crop industry helped lead to social stratification and political organization, in addition, promoting greater craft specialization. A key category of cash-crops in the ancient world was fiber plants. These crops lead to a product that is non-perishable, highly valued, and light weight, essentially the perfect long-distance trade good. The earliest products to move along the Silk Road may have been linen textiles, thousands of years before the official formation of the Road. If there was a trade in plant-based textiles from South Asia, this would counter the view that a pastoral revolution led to a focus on wool across the steppe.

The Iron Age textile fragment from Begash (Chapter 7; Figure 7:16) represents a well-processed, very finely spun, and elaborately woven twill. In addition, if the fibers are in fact from plants of domesticated linen their cultivation would have been labor intensive. Flax requires a fair amount of water; therefore, it is not likely that the plants would have been grown at or anywhere near Begash. Shishlina et al. (2003:331) suggest that flax could have been cultivated in well watered river valleys; however, she also notes that arable land must be replaced every five to six years for flax cultivation. It is likely that this textile fragment represents an imported exchange item. By the Iron Age, an elaborate exchange network was forming around the future routes of the Silk Road. Begash would have been a node along the northern routes. Begash also sits near an historically well documented pass through the barrier mountains of Central Asia called the Dzhungarian Gate (discussed in this dissertation). It is not possible to determine where this textile fragment would have been obtained from, seeing that linen was grown all over the Old World by this time.

Wool

The discovery of textiles made of plant fibers in Central Asia is interesting because researchers have argued that by about 3500 B.C. onward wool was the dominating material in textile manufacture across the entire Eurasian steppe (Mallory and Mair 2000. In addition, twill patterns are almost always produced with wool and not plant fibers (Mallory and Mair 2000). Barber (1991:650) notes that wool is "stretchy and breakable" allowing for the twill weaves. The "secondary products revolution" (Sherratt 1981, 1983) in Eurasia took place at different times in different areas; however, it is often suggested that the Iron Age was a period of transition toward a greater focus on pastoral products, such as wool. While the plant fibres from Begash may not have been locally produced, it seems evident that people were readily using non-wool textiles during the Iron Age and later periods.

Animal slaughter evidence shows that by 2000 B.C. people were keeping sheep to old age for the wool (Barber 1998:648). Good (1998:657) argues that there is no good evidence for woolly fleeces on sheep prior to 3500 B.C.; she notes that the earliest woolen textile fragments come from the mid-third millennium B.C. at the site of Shahr-I Sokhta in eastern Iran.

The earliest evidence for textile manufacture on the western steppe is plant-based. In Tripolye Culture, there is no evidence for wool use, and few sheep and goat in the overall economy. Instead, Kohl (2007:46) suggests linen, hemp, and other plant fibers were used; furthermore, he points out that tools for working leather were found. However, wool bearing sheep are thought to have moved into the steppe during the third millennium B.C. and eventually replaced plant fibres.

Sheep were introduced into China during the second millennium B.C. (Good 1998:659). They were likely brought in along the mountain corridor, accompanied by free-threshing wheat, naked barley, peas, horse breeding, and new methods in metallurgy. The largest Bronze and Iron Age preserved textile collection in the world comes from Xinjiang, China (discussed in Barber 1991; Barber 1995, 1998; Good 1995, 1998). The vast majority of these textiles are wool, for example the Chärchän wool textile fragments, these are strongly weft-faced and a 3/1 twill (Good 1998:666). In addition, frozen wool textiles were recovered from the Pazyryk Culture cemeteries in Tuva, Russia; these are mostly a 2/2 twill (Rudenko 1970).

Linen

Wild flax was used as a fibre source by early humans, arguably as far back as the Upper Paleolithic, ca. 30,000 years ago at Dzudzuana Cave, Georgia (Kvavadze et al. 2009). Domestic flax spread across western Eurasia during the Neolithic as part of the southwest Asian agricultural complex. Linen is a water-demanding crop requiring over 750 mm of rain fall or irrigation. Linen was probably the dominant textile source across Eurasia before wool.

Three "*Linum* sp." seeds were found in Period I, level 2 at Shortughai, Afghanistan, (late third, early second millennia B.C.); Willcox (1991:149) also notes that impressions of *Linum usitatissimum* were found in mud bricks at the site. Linen seeds were found in Bronze Age levels at Miri Qalat (Tengberg 1999), Pirik (Costantini 1979), and across the Harappan world (see Fuller 2008; Weber 1991). In addition, a single seed fragment identified as "cf. *Linum usitatissmum*" was found mixed into a cache of domesticated grains at 1211 in Turkmenistan (1400 B.C.) (Spengler et al. in review).

Cotton

The details of the earliest domestication of cotton are still unclear; however, two distinct species were domesticated in the Old World, *Gossypium arboretum* and *G. herbaceum*. The oldest evidence for cotton fibres comes from Mehrgarh, Baluchistan, where oxidized fibres were preserved on a copper bead (ca. 6000 – 4500 B.C.) (Moulherat et al. 2002). Researchers cannot distinguish between charred seeds or fiber of the two Old World cotton species.

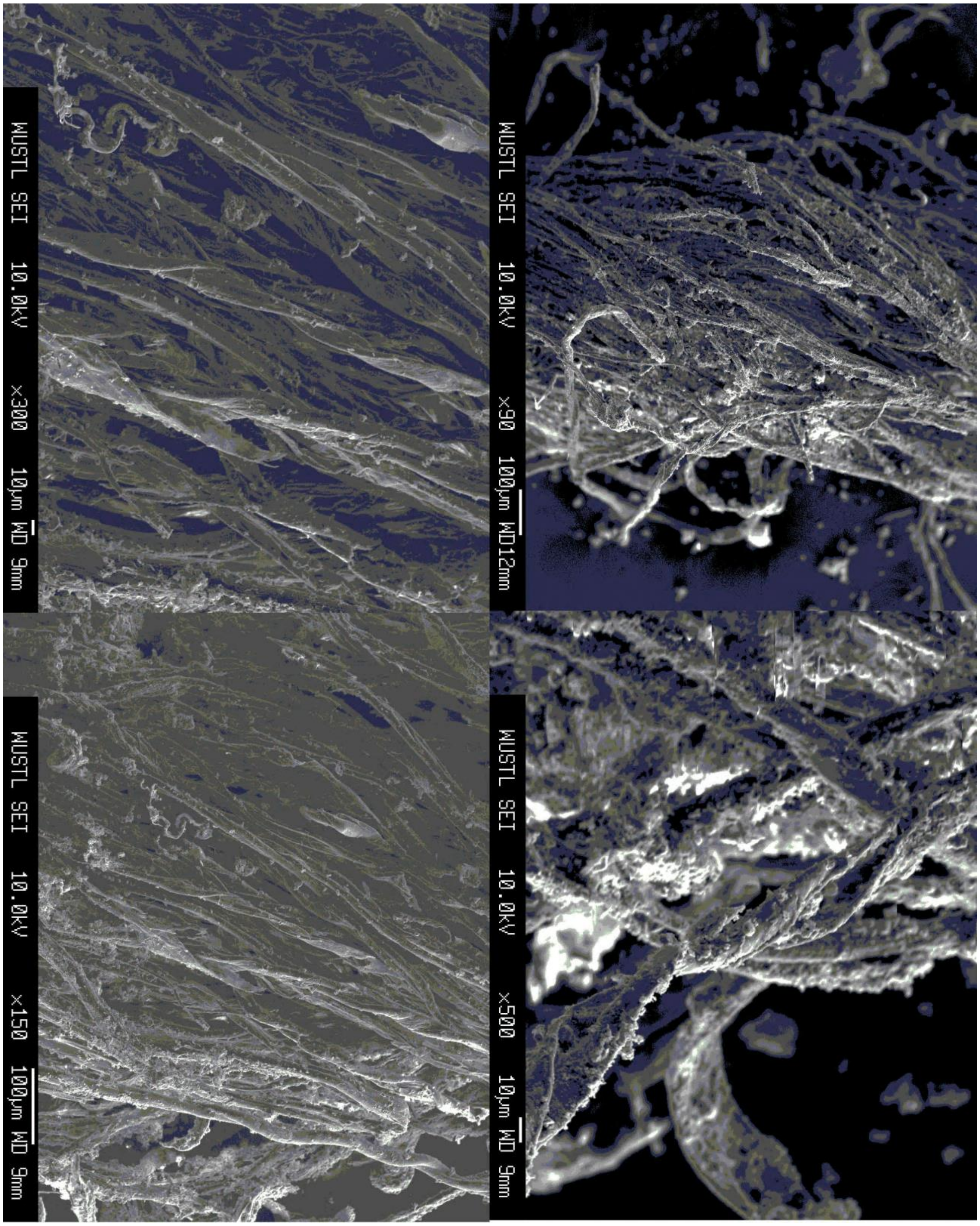

Figure 8.8. Four SEM images of a fragment of textile identified as cotton from a first millennium A.D. burial excavated near Begash (Spengler unpublished results)

Cotton processing is very labor and time intensive (see Fuller 2008). In addition, it requires a frost-free environment and at least 500 mm of rain evenly spread out over ca.

200 days (Fuller 2008:5, 6). These prerequisites do not exist in northern Central Asia, especially around Semirech'ye where late and early frosts are common. Cotton is grown in southern Central Asia today but requires far warmer and more seasonally stable climates than can be found in the north.

Meadow (1996) notes that cotton was used in the Indus valley as far back as the fifth millennium B.C., although, it is not clear if it was *arboretum* of *herbaceum*. Cotton seed and fibers are found all over the Harappan world, for a summary and discussion of finds see Fuller (2008).

There is no good evidence for cotton in southern Europe until the early Classical period, but it does appear at Merv, Turkmenistan, in the late Sassanian Period (A.D. sixth and seventh centuries) (Nesbitt 1993, 1994). Cotton and silk found in Pazyryk, Minusinsk, and eastern Kazakhstan, presumably from China (Kuzmina 1998). Cotton is also mentioned by Pliny the Elder in his "Naturalis Historia".

The fibers of cotton have a characteristic ribbon-like twist (Florian et al. 1990; Shishlina et al. 2003); because, cotton hair cells contain a primary cell wall and layers of secondary cell walls. In some cases the lamellae of cotton hairs pull apart producing flake-like or twisted fibers. In the case of cotton, fibers (hair fibers not bast) are made up of nearly 100 percent cellulose, and therefore, show up negative for a phloroglucinol test (Florian et al. 1990:40). True bast fibers, such as flax, hemp, and nettle, are composed of lignin. Lignin can be selectively stained for using a phloroglucinol test. A textile fragment, preserved through copper oxidation, on the leg of a burial near Begash is from cotton (Figure 8.8; Spengler unpublished results). The cotton fragment is the oldest evidence for cotton in northern Central Asia and further shows the importance of textiles on the Silk Road. A few ultimates fiber were mounted in five percent aqueous phloroglucinol solution and then irrigated with hydrochloric acid (HCl); indication that the fibers were *not* lignin-based. The distinct ribbon-like morphology of the fragment is visible in Figure 8.8.

Hemp

While there are gaps in the early record of hemp domestication and spread, it seems clear that it was domesticated in northern Asia in the third millennium B.C. (see Merlin 2003 for discussion). Hemp was used for fiber in northern China by 2500 B.C. (Merlin 2003). Interestingly, while both linen and cotton were common in the Harappan Culture, Hemp was rare, it was however, found at the Terminal Bronze Age site of Senuwar (1300 – 600 B.C.) (Saraswat 2004).

Hemp textiles were recovered from frozen tombs in Tuva in southern Russia, from the Pazyryk Culture (Askarov 1973 unpublished:133-134). Herodotus (2003 [ca. 431 - 425 B.C.]: book IV, section 75) provides us with the earliest textual evidence for hemp use as fiber and recreation. The following quote suggests that peoples north of Greece were familiar with hemp textiles, both cultivated and wild, and the effects of Tetrahydrocannabinol.

> “Now, hemp grows in Scythia, a plant resembling flax, but much coarser and taller. It grows wild as well as under cultivation, and the Thracians make cloths from it very like linen ones – indeed, one must have much experience in these matters to be able to distinguish between the two, and anybody who has never seen a piece of cloth made from hemp, will suppose it to be of linen. They take some hemp seeds, creep into the tent, and

throw the seeds on to the hot stones. At once it begins to smoke, giving off a vapor unsurpassed by any vapor-bath one could find in Greece. The Scythians enjoy it so much they howl with pleasure." [Herodotus 2003 [ca. 431 - 425 B.C.]: book IV, section 75]

Silk

The earliest silk outside of China comes from Sapalli-Tepe in southern Uzbekistan from the beginning of the second millennium B.C. (Askarov 1973 unpublished:133-134; Adshead 1993:32; Kuzmina 1998:64). Post-Mongol period silk was recovered from an intrusive burial at Tuzusai (Chang and Grigoriev 1999). Three silk swath fragments were preserved due to oxidation from being associated with a copper mirror.

Twist Style

It is also interesting to note that the fragments of Bronze Age thread are in an S-twist while one of Iron Age threads and the two-ply warp on the textile fragment are in a Z-twist. With such a limited sample size it is hard to make any determinative conclusions as to why different twists were used. However, as Shishlina et al. (2003) note, these two twists in Eurasian prehistory have often been associated with specific geographic groups of people. If the observations of Shishlina et al. (2003) hold true in this case it may suggest that a European or Indian influence in thread production was introduced by the Iron Age, supplanting the indigenous use of an S-twist. Shishlina et al. (2003) identified Bronze Age S-twist thread in the northern Caucuses.

Twills

The twill pattern of the Begash textile fragment is interesting because twills are not believed to have been known across all of Eurasia at this time. They are often associated with Europe (especially the Classical world) and Xinjiang, China (Mallory and Mair 2000). The majority of the Xinjiang textiles are woolen and two thirds of the textiles are twills (Barber 1998:650-651). It is not possible based on technology of the weave to source the fiber other than to say twills are not believed to have been used in China until the first millennium A.D. (Mallory and Mair 2000).

The Iron Age fragment from Begash is not a simple plain tabby (1/1); it is a two-over-one twill (2/1). It is often thought that a twill pattern was developed in northern Europe and is often associated with Roman or Anglo-Saxons in the archaeological record (Wild 2008). However, as Mallory and Mair (2000:211) point out, twill has archaeologically been identified as far back as the fourth millennium B.C. They state:

> "The earliest evidence for twill is from Anatolia and dates to the 4th millennium BC. This is followed by evidence from the Caucasus of the early 3rd millennium BC and then, after a considerable chronological gap, we recover evidence for twill in the Hallstatt culture in Austria (*c*. 1100-450 BC) and about the same time in Ferghana, the land of the 'blood-sweating horses', one of the western approaches to the Tarim Basin." [Mallory and Mair 2000:211]

However, twills have been identified in archaeological remains from the Tarim basin and Turpan in Xinjiang. The largest collections of archaeological textiles in the world come from these regions and varieties of manufacturing methods were used including felts, tabbies, and different twill patterns. The earliest eastern-most finds of twills date around 1000 B.C. and come from the Qizilchoqa Culture (Mallory and Mair 2000). A number of researchers have tried arguing for a link between the Tarim people in the early Iron Age and Celts or Proto-Celts based on the similarities in twills (Barber 1991; Barber 1995; Good 1995; Mallory and Mair 2000; Sylwan 1941). However, such conclusions are impossible to support on technology alone. The vast majority of these textiles are woolen and not bast. Flax textiles were more common in the Classical or Helenistic world at the time when the Begash textile was carbonized. Twills were well known throughout the Classical world.

The earliest known twills come from the Caucasus and are 2/2 twills, from Alishar, Turkey (late fourth millennium B.C.) and Markopi, Georgia (early third millennium B.C.) (Barber 1998:655). Barber (1991) discusses evidence for the spread of twill technology into Europe and throughout the early Classical world. Textiles from Lopnor share stylistic similarities (e.g., twills) to material from Ferghana valley and in Bactria across from the Pamir Mountains in the Chust Culture (1100 – 800 B.C.) (Sylwan 1941:89-98; Debaine-Francfort 1987:203; Di Cosmo 1994: 1109).

8.8 Conclusion

Social interactions among Middle and Late Bronze Age mobile pastoralists may have helped spread agriculture to Semirech'ye. Mobility patterns likely left people dispersed in an individually well planned but not interconnected pattern across the landscape (Frachetti 2004:viii). Contact was intensified between neighboring culture groups and the dynamics of social complexity increased on the cultural landscape during the Iron Age. In addition, social interactions through mountain passes between Xinjiang and eastern steppe peoples are visible in the archaeological record from the Bronze Age on (Linduff 2006; Mei and Shell 1998, 1999). The appearance of more intensive agriculture in Semirech'ye in the early Iron Age further attests to the process of material and intellectual culture moving into Central Asia at this time.

During the third and second millennia B.C. long distance exchange of goods moved material, such as metal, minerals, textile, and ceramics, along a trajectory that followed river valleys and foothills of the chains of mountains that divide East and Central Asia. The nature of this exchange, specifically how it took place and how well established the routes were, is a current topic of growing interest (see Frachetti 2012). In addition to craft goods and raw materials, these exchange networks allowed people to bring agriculture into Central Asia. During this process mobile people brought crops of Chinese origin south into southern Central Asia from western China and crops of southwest Asian origin into China proper.

Among the crops that moved along the corridor was wheat. Wheat was cultivated in southern Central Asia as far back as the Neolithic; however, it did not move north or east of Sarazm until the late third millennium B.C. when it appears at Begash (2200 B.C.). At the same site broomcorn millet was recovered, possibly suggesting a reverse flow of that crop from China into Central Asia. However, the story of broomcorn millet is complicated by finds of the grain in sites dated thousands of years earlier in Europe. (see Hunt et al. 2011 for a discussion).

By the second millennium B.C. an agricultural complex of distinct crops seems to characterize all three branches of this mountain corridor – the Kopet Dag, Dzhungar, and Kunlun Mountain ranges. These crops included a highly compact free-threshing (possibly genetically related to sphaeroccocoid) wheat, peas, compact naked barley, and broomcorn millet. This assemblage of crops is found at Tasbas in Kazakhstan, 1685 and 1211 in Turkmenistan, and Chongguogou in Tibet, China.

During the first millennium B.C. the assemblage seems to change. Highly compact wheat is replaced by lax and compact-eared wheat and compact naked barley is replaced by large-grained hulled barley, at least at Tuzusai. In addition, new crops were introduced, including grapes and foxtail millet. These changes in the mid-first millennium B.C. may have been a response to the increased exchange during the early formation of the Silk Road.

The presence of a linen textile fragment from the Iron Age at Begash is significant for two reasons, first, it likely represents an exchange good moving along the early Silk Road, and second, it is a plant fiber during a time when researchers have suggested that economy was focused on secondary pastoral products. Linen is a water-demanding crop and a secondary crop, which are often not incorporated until primary (grain) crops are well established as a key component in the productive economy. Therefore, it is likely that the linen textile was imported to Begash from somewhere in South Asia. Furthermore, it is interesting to note that the textile was produced using a 2/1 twill pattern. Twills are associated with wool; however, in this case the textile was produced from linen. Twills have been found all along the mountain corridor and have been used to argue for connection between Central Asia and western China.

Chapter 9: Conclusions

This dissertation is concerned with economics of the Bronze and Iron Ages of Central Eurasia, specifically focusing on the role of plants. The dissertation (as well as this conclusion) is parsed into three sections based on economic components – pastoralism, agriculture, and exchange.

This paleoethnobotanical study is significant in Central Asian archaeology because it helps researchers understand the regional adaptations and variations among Bronze and Iron Ages peoples. This analysis fills in one of the last major gaps in the picture of agricultural spread in the Old World. It also contradicts earlier models for economy in Central Asia by suggesting that agriculture was present in the Bronze Age and intensified in the Iron Age. This study also provides evidence for the complicated and dynamic aspects of social interactions and cultural adaptations to the political landscapes of the Bronze and Iron Ages. By conducting and interpreting the archaeobotanical data at these sites and other sites in Central Asia, a greater understanding of the nature of human plant interactions will ensue.

Exchange: The Mountain Corridor

The Silk Road has been a major vector of culture flow since the early Iron Age, with good archaeological evidence for exchange through the region going back to the second millennium B.C. (Frachetti 2002; Kuz'mina 2008). Movements through mountain-river valleys, such as the Koksu and the Ili, connected populations in modern day Kazakhstan with those in Xinjiang, China. One result of this culture flow may have been the spread and eventual intensification of agriculture. The Inner Asian corridor brought new crops and agricultural practices into the region starting as far back as the late third millennium B.C. In response to both increased exchange and an increase in agricultural pursuits manifested in the Late Bronze and early Iron Ages, there seems to be a correlative increase in social stratification and population demographics. As a crossroads of exchange and interaction, Central Asia has been influenced by many political entities throughout history, such as the Xiongnu, Kushan, Achaemenids, and Han. While agriculture may have originated in areas that became imperial centers of Eurasia, mobile pastoralists on the peripheries are responsible for the spread of agricultural innovations.

The Iron Age in Central Asia is often considered a seminal period for the development of nomadic confederacies, such as the Saka, Wusun, and Yuezhi (Anthony 2007). Archaeological evidence shows an increase in settlement and burial mound size, demographic shifts, and increased exchange (Kuz'mina 2007, 2008). The increased exchange identified in the archaeological and historic record is colloquially referred to as the Silk Road. Exchange through the mountainous regions of Central Asia is archaeologically evident as far back as the Early Bronze Age (ca. 3500 – 2000 B.C.) (Li 2002; Linduff 2006); however, systematic movement of goods through these mountains did not form before the founding of the Han Dynasty. Therefore, this early Iron Age period is a pivotal point in the development of Central Asian economy; Koryakova and Epimakov (2007:338) refer to the early Iron Age as “the most dramatic moment in the prehistory of Eurasia”.

By the late third and second millennia B.C. long distance exchange of goods and ideas was taking place through the mountain corridor of Central Asia (for a discussion see Frachetti 2012; Spengler and Willcox in press). Along with a multitude of other goods, agricultural goods and technology moved up and down this corridor as well. Wheat moved from southern Central Asia into western China by the late third millennium B.C., and broomcorn millet followed a reverse route at the same time. By the second millennium B.C. all stretches of the mountainous regions of Central Eurasia had adopted an agricultural package consisting of highly compact free-threshing wheat; semispherical split-apex naked barley, broomcorn millet, and peas. This package of crops seems to have been replaced during the first millennium B.C. by lax and compact-eared wheat and large-grained hulled barley, while retaining the broomcorn millet and also picking up grapes and foxtail millet.

Agriculture: Late Bronze and Early Iron Age Intensification

Early archaeological work in Semirech'ye was characterized by a unilinear paradigm and tended to portray a gradual transition to a more mobile economy wholly reliant upon pastoral products, which was argued to have fully formed during an early Iron Age transition (for a discussion of some of these Soviet publications see: Kuz'mina 2007, 2008). This model was called into question when work by Chang and her colleagues identified a semisedentary economy reliant upon agricultural goods on the Talgar alluvial fan (Chang et al. 2003; Chang et al. 2002; Rosen et al. 2000). Chang has subsequently argued for a cultural and demographic shift to accompany an increased importance of agriculture in the economy of the early Iron Age (Chang 2010 unpublished). This evidence for early Iron Age agriculture finally led to the publication of an article by Baipokav (2008), which essentially inverted the previous model, seemingly suggesting that the early Iron Age was actually a transition period to a more sedentary and agriculturally reliant economy than previously existed. This dissertation focuses on means of agricultural production and grain acquisition and shows that a complex agropastoral system was implemented in the Late Bronze and Iron Ages. This economic model is in contrast to the long-held model, which suggested an increase in pastoral mobility during the early Iron Age (Abetekov and Yusupov 1999; Ishjamts 1999; Koryakova and Epimakhov 2007).

Recent literature has suggested that there may be greater variability among the lifeways of Eurasian pastoralists than previously recognized. Some scholars have pointed out variations in forms of mobility patterns, systems of land use, subsistence, social organization, and resource acquisition (Frachetti 2008; Honeychurch and Amartushin 2007; Shishlina 2008). This variation is not only apparent between sites, but also among practices at an individual site through time. Many of these economies were likely based on a multiresource system, characterized by a high degree of flexibility, readily adjusted to adapt to changing socioenvironmental stressors.

The Bronze Age samples from Begash do prove that there was access to and use of domestic grains (at least free-threshing wheat and broomcorn millet) in the Semirech'ye region *circa* 2200 cal B.C. The data do not suggest that these domestic grains played a major role in the Bronze Age economy (Frachetti et al. 2010b). It is not until the Late Bronze Age at Tasbas and early Iron Age in the Talgar region that any good evidence shows up for the reliance on agricultural goods as a significant part of the economy. However, there is an almost complete lack of data from the Early and Middle Bronze Ages.

Late Bronze Age layers at Tasbas have grains from a semispherical form of naked barley and a highly condensed form of free-threshing wheat, as well as broomcorn millet and peas. Tasbas provides us with the best evidence currently available for Late Bronze Age agriculture in northern Central Asia.

The Talgar sites show a more sedentary form of land use than is present at other nearby sites in the Iron Age (Chang et al. 2002; Spengler et al. 2013). Phytolith, and now, macrobotanical analyses conducted at Tuzusai suggest a complex agricultural component (Rosen et al. 2000). Chang et al. (2002) describe occupation at Tuzusai as semisedentary. Based on ethnographic analogy, they suggest the site was occupied from early spring to late fall, with the majority of time and energy going into agricultural pursuits. A portion of the population might have remained at the site throughout the summer to maintain crops, while another kin-based group moved herds to summer pastures. Iron Age layers at Tuzusai have domestic grains – free-threshing hexaploid wheat (compact and lax eared), naked and hulled barley, broomcorn millet, foxtail millet, and grapes. Iron Age layers at Mukri have compact wheat and broomcorn millet; Begash has broomcorn millet and foxtail millet in the Iron Age layers.

Domestic grains were found in 100 percent of the samples from Tuzusai, representing most major contexts excavated during 2008, 2009, and 2010. In addition, the dominance of a free-threshing form of wheat may suggest more labor input than with low-investment millet cultivation. The presence of seven domestic crop varieties indicates that a multicropping or diversified system was used. The Talgar region has unpredictable rainfall, and diversifying crops would limit the risk involved in focusing time and energy on agriculture as opposed to herding. Agriculture requires a different set of risk mitigation techniques than pastoralism, such as planting millets in association with wheat and barley to ensure at least one crop will survive. In addition, choosing to focus on hulled barley when they had access to naked barley shows that they were interested in hardier varieties of crops. Economic variability and crop diversity indicates that local Iron Age occupants hedged their bets by diversifying. Planting more drought-tolerant crops along with more productive but water demanding crops allowed for fall-back crops when water was scarce. Pastoralism, itself, provided another risk management strategy.

In addition, the almost complete lack of chaffing material suggests that crops were processed off site, possibly in or near the fields. This also indicates that grain was stored in a fully cleaned form. Storing grain in a clean form required large amounts of labor during the harvesting season, when reaping, threshing, and winnowing would have been done (Fuller and Stevens 2009). This is in opposition to many lower investment agricultural systems, which will process small amounts of grain throughout the year, as needed[42]. However, the varying growing lengths of the different grains meant that harvest and planting time were variable; this would have drawn out the need for labor, rather than making them concentrated at once. Boserup (1990b:47) points out that the supply of labor during the peak season is the main restraint of agricultural development; therefore, by spreading out the peak season less labor is required for greater surplus. Labor might have been pooled for millet harvesting and again later for wheat and barley harvesting. Maintaining fields and possibly irrigation canals would also have required labor.

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[42] Note that many of the Iron Age foxtail millet grains from Begash are still in their palea and lemma, possibly indicating continual grain processing throughout the year.

Scheduling conflicts would have existed between agricultural demands and most forms of seasonal vertical transhumance. A complex agropastoral system likely existed, requiring a multifaceted schedule and a detailed knowledge of seasonality and the restraints of the productive economy. It is likely that labor demands were divided and that a complex kinship system was called upon at various times of the year. Labor forces could have been pooled for harvesting and crop processing as well as for irrigation projects. During summer months a portion of the population may have broken away for pastoral pursuits.

Pastoralism: Resource Patchiness and Social Nodes

While this dissertation proves that agricultural goods were part of the dietary economy, pastoralism was an important, if not the central, component. The categories of plants present in these assemblages seem to show that herders were grazing and browsing their herds in small ecological patches for part of the year. The use of ecotopes, which are produced by river valleys or rock outcroppings, by foraging animals, is still practiced in the region today. These environmental pockets, which vary greatly in size, are vital for the economic system, providing winter and summer shelter from the harsh weather for humans and animals, foraged plant material for humans and animals, as well as locations suitable for low-investment millet agriculture. Mobile pastoralists in Semirech'ye were shifting between these disparate locales, utilizing geographically and temporally variable plant resources.

Herders likely moved from one green patch to another to suit the herds' needs and mitigate vegetation limitations. Mobility is a risk management strategy, in that it provides the ability to move the entire economy away from biophysical stresses such as overgrazing (Barfield 1993; Bates and Lees 1977; Di Cosmo 1994; Lees and Bates 1974). Vertical mobile pastoralism brings people into contact with a number of diverse environmental settings. Botanical resource availability is geographically, as well as temporally, spread across the landscape as a result of orographic mechanisms. Successful use of these diverse resources would require an understanding not only of geographic distribution but also seasonal growth cycles at various elevations. It is evident that these herders had an intimate understanding of spatial and seasonal placement of forage resources on the varying landscape of the Semirech'ye steppe and foothills.

Like mobility, the social networking systems of pastoralists are also risk management tactics. A complex pyramidal kinship system, based on patrilineal lines, existed historically among most mobile Central Asian people (Barfield 1993; Basilov 1989). The communal nature of the extended family system in these nomadic communities provides people with support networks. During the winter months, when support networks are most needed, most ethnohistorically documented mobile pastoralists in Central Asia come together in large winter camps. These communal camps may house hundreds of herders in an extended kinship system. Camps are located in large forage-rich ecotopes, which also provide shelter from the weather. The close collective interactions between the kinship groups in these camps provide a complex and easily utilized support network to get both people and herds through the harsher portion of the year. In this way, forage-rich ecotopes become a central piece in the extended kinship network system and are central for forming concepts of community.

In addition, forage-rich ecotopes become a key component in the social interaction process when herders, moving from one ecotope to the next, came into contact. The low population densities that likely existed across much of the steppe before the Iron Age and the vast geographic expanse mean that people were dispersed very thinly on the landscape. If populations were evenly dispersed across these vast expanses, non-planned encounters would be limited. However, when populations are concentrated in small patches across the landscape, densities would seem much higher and it is more likely that people were coming into contact at various times during major seasonal movements and during smaller jumps between ecotopes.

The mobile pastoral community and kinship bonds were centered around nodes on what would look like a vast empty landscape to an outsider. However, in reality the steppe is a mosaic landscape containing patches of biodiversity, resource concentrations, and focal points for human contact and interaction. In this sense, we can look at the steppe not as a vast highway system but as a matrix of grass with a patchwork of nodal connection points in a network of communication, exchange, and social interaction (Frachetti 2012).

Concluding Remarks

To conclude, the key to understanding subsistence in Central Eurasia in the Bronze and Iron Ages is diversity and variability. Economic pursuits were diversified to reduce risk associated with unstable environmental and political landscapes. In addition, economic pursuits were variable between populations, sometimes within close geographic proximity; people chose to invest various amounts of time into one economic pursuit or another based on climatic, environmental, social, and culture-based preferential factors. To understand the decision making processes that went into these diverse and variable economic systems, further paleoethnobotanical studies are needed throughout Central Eurasia, producing a larger comparative data set.

References Cited

Abetekov, A., and H. Yusupov

1999 Ancient Iranian Nomads in Western Central Asia. In History of Civilizations of Central Asia: Volume II, The Development of Sedentary and Nomadic Civilizations (700 B.C. to A.D. 250). Janos Harmatta, B. N. Puri, and G. F. Etemadi, eds. Pp. 23-34. Delhi: UNESCO Publishing.

Adkins, Lesley

2003 Empires of the Plain: Henry Rawlinson and the Lost Languages of Babylon. New York: St. Martin's Press.

Adshead, S. A. M.

1993 Central Asia in World History. New York: St Martin's Press.

Akishev, K. A.

1969 Winter Settlement and Dwelling of Ancient Wusun [in Russian]. Izvestia AN Kaz SSR Ser. obshestv 1:39-46.

Aldenderfer, M.

2007 Modeling the Neolithic on the Tibetan Plateau. In Late Quaternary Climate Change and Human Adaptation in Arid China. D. B. Madsen, F. Chen, and X. Gao, eds. Pp. 149-161. Amsterdam: Elsevier.

Allard, Francis

2006 Frontiers and Boundaries: The Han Empire from its Southern Periphery. In Archaeology of Asia. Miriam T. Stark, ed. Pp. 233-254. Malden, Massachusetts: Blackwell Publishing.

Anthony, David W.

2007 The Horse, the Wheel, and Language: How Bronze Age Riders from the Eurasian Steppes Shaped the Modern World. Princeton, New Jersey: Princeton University Press.

1995 Is there a Future for the Past? An Overview of Archaeology in Western Russia and Ukraine. Journal of Archaeological Research 3(3):177-190.

1990 Migration in Archeology: The Baby and the Bathwater. American Anthropologist, 92(4):895-914.

Anthony, David W., D. Brown, E. Brown, A. Goodman, A. Kokhlov, P. Kosintsev, P. Kuznetsov, O. Mochalov, E. Murphy, D. Peterson, A. Pike-Tay, L. Popova, A. Rosen, N. Russel, and Alison Weisskopf

2005 The Samara Valley Project: Late Bronze Age Economy and Ritual in the Russian Steppes. Eurasia Antiqua 11:395-417.

Argybaev, K.

1973 Economic Features of Kazakhs of the Kopal' Region of the Semirech'ye Province. In Research on the History of Western Asia and Kazakhstan. S. M. Abramzon and A. Orazob, eds. Pp. 154-160. Lenningrad: Academia of SSSR.

Askarov, A.

1973 unpublished Sapallitepe. Tashkent.

Aubekerov, B. Zh., S. A. Nigmatova, and M. D. Frachetti

2003 Geomorphological Particulars in the Region of the Archaeological Monument Begash, Northern Dzhungar Alatau. In Actual Geosystemic Problems of Arid Territories. Pp. 287-289. Almaty: Kazakh National University.

Bacon, E.

1958 Obok: A Study of Social Structure in Eurasia. In Viking Fund Publications in Anthropology 25. New York: Wenner-Gren Foundation.

Bailey, Liberty. H.

1951 Manual of Cultivated Plants. New York: Macmillan.

Baipakov, Karl M.

2008 The City and Steppe in Antiquity: Sedentism and Agriculture in the Saka and Wusun of Semirech'ye [in Russian]. Izvestia 3-25.

1998 Srednevekovye Goroda Kazakhstana na Velikom Shelkovom puti [in Russian]. Almaty: Nauka.

Baltensperger, D. D.

2002 Progress in Proso, Pearl and Other Millets. In Trends in New Crops and New Uses. J. Janick and A. Whipkey, eds. Pp. 100-103. Alexandria, Virginia: ASHA Press.

Barber, Ellen J. W.

1995 A Weaver's-eye View of the Second Millenium Tarim Basin Finds. Journal of Indo-European Studies 23:347-355.

1998 Bronze Age Cloth and Clothing of the Tarim Basin: The Koran (Loulan) and Qumul (Hami) Evidence. In The Bronze Age and Early Iron Age Peoples of Eastern Central Asia, Volume One, Archaeology, Migration and Nomadism, Linguistics. Victor H. Mair, ed. Pp. 647-655. Philadelphia: The Institute for the Study of Man.

1991 Prehistoric Textiles: The Development of Cloth in the Neolithic and Bronze Ages with Special Reference to the Aegean. Princeton: Princeton University Press.

Barfield, Thomas J.

2001 The Shadow Empires: Imperial State Formation along the Chinese-Nomadic Frontier. In Empires: Perspectives from Archaeology and History. S. E. Alcock, T. N. D'Altroy, K. D. Morrison, and C. M. Sinopoli, eds. Pp. 10-41. Cambridge: Cambridge University Press.

1989 The Perilous Frontier. Cambridge, Massachusetts: Basil Blackwell.

1993 The Nomadic Alternative. Englewood Cliffs, England: Prentice Hall.

Barth, Fredrick

1961 Nomads of South Persia: The Basseri Tribe of the Khamseh Confederacy. Boston: Little, Brown And Company.

1964 Nomads of Southern Persia: The Basseri Tribe of the Khamseh Confederacy. New York: Humanities Press.

Bartol'd, Vasiliĭ Vladimirovich

1962 – 1963 Four Studies on the History of Central Asia. V. and T. Minorsky, transl. Leiden: E. J. Brill.

Basilov, Vladimir N.

1989 Introduction. In Nomads of Eurasia. Vladimir N. Basilov, ed. Seattle, Washington: Natural History Museum of Los Angeles County, University of Washington Press.

Bates, Daniel G., and Susan H. Lees

1977 The Role of Exchange in Productive Specialization. American Anthropologist 79:824-841.

Beck, L.

1986 The Qashga'i of Iran. New Haven: Yale University Press.

Beckwith. C. I.

2009 Empires of the Silk Road: A History of Central Eurasia from the Bronze Age to the Present. Princeton University Press, Princeton, New Jersey.

Bellwood, Peter

2005 First Farmers: the Origins of Agricultural Societies Malden, Massachusetts: Blackwell.

Bendrey, Robin

2011 Some Like it Hot: Environmental Determinism and the Pastoral Economies of the Later Prehistoric Eurasian Steppe. Pastoralism 1(8):1-16.

Benecke, Norbert, and Angela von den Driesch

2003 Horse Exploitation in the Kazakh Steppe during the Eneolithic and Bronze Age. In Prehistoric Steppe Adaptation and the Horse. Marsha Levine, Colin Renfrew, and Katie Boyle, eds. London: McDonald Institute Monographs.

Bennett, John W.

1969 Northern Plainsmen: Adaptive Stratagey and Agrarian Life. AHM Publishing Corporation, Arlington Heights, Illinois.

Berdyev, O. K.

1968 Chakmakly-Depe - Novyi Pamiatnik Vremni Anau IA. In Istoriia, Arkheologiia i Etnografiia Serednei Azii. Moscow.

Blattner, F., and A. Mendez

2001 RAPD Data do not Support a Second Center Barley Domestication. Genetic Resources and Crop Evolution 48:13-19.

Bojnansky, Vit, and Agata Fargasova

2007 Atlas of Seeds and Fruits of Central and East-European Flora: The Carpathian Mountains Region. New York: Springer.

Borojevic, Katarina, and Ksenija Borojevic

2005 The Transfer and History of ‘‘Reduced Height Genes’’ (Rht) in Wheat from Japan to Europe. Journal of Heredity 96(4):455–459.

Boserup, Ester

1983 The Impact of Scarcity and Plenty on Development. In Robert I. Rotberg and Theodore K. Rabb (eds.), Hunger and History: The Impact of Changing Food Production and Consumption Patterns on Society, Cambridge University Press, Cambridge, Pp. 185-210.

1990a Agricultural Growth and Population Change. In T. Paul Shultz (ed), Ester Boserup: Economic and Demographic Relationships in Development. The John Hopkins University Press, Baltimore, Pp. 11-24.

1990b The Impact of Population Growth and Agricultural Output. In T. Paul Shultz (ed), Ester Boserup: Economic and Demographic Relationships in Development. The John Hopkins University Press, Baltimore, Pp. 42-45.

Boulos, Loutfy

1985 The Middle East. In Plant Resources of Arid and Semiarid Lands: A Global Perspective. J. R. Goodin and David K. Northington, eds. Pp. 187-232. New York: Academic Press.

Bourdieu, P.

1977 Outline of a Theory of Practice. Cambridge: Cambridge University Press.

Bourgeot, André

1981 Nomadic Pastoral Society and the Market: The Penetration of the Sahel by Commercial Relations. In Change and Development in Nomadic and Pastoral Society. J. G. Galaty and P. E. Salzmann, eds. Pp. 116-127. Leiden, England: E.J. Brill.

Braadaart, F.

2008 Carbonization and Morphological Changes in Modern Dehusked and Husked *Triticum dicoccum* and *Triticum aestivum* Grains. Vegetation History and Archaeobotany 17:155-166.

Braidwood, Robert J., and Bruce Howe

1960 Observations, Questions, and Prospects. In Prehistoric Investigations in Iraqi Kurdistan. Robert J. Braidwood and Bruce Howe, eds. Pp. 175-184. Chicago: University of Chicago Press.

Browman, David L.

1983 Andean Arid Land Pastoralism and Development. Mountain Research and Development 3(3):241-252.

1986 *Chenopodium* Cultivation, Lacustrine Resources, and Fuel Use and Chiripa, Bolivia. The Missouri Archaeologist 47:137-172.

1987a Andean Pastoralism and Development in Bolivia and Peru. London: Pastoral Development Network, Agricultural Administration Unit.

1987b Arid Land Use Strategies and Risk Management in the Andes: a Regional Anthropological Perspective. Boulder, Colorado: Westview Press.

1997 Pastoral Risk Perception and Risk Definition for Altiplano Herders. Nomadic Peoples 1(1):22-36.

2008 Pastoral Nomadism in the Central Andes. In The Archaeology of Mobility: Nomads in the Old World and New World. H. Bernard and W. Z. Wendrich, eds. Los Angeles: Costen Institute of Archaeology, University of California.

Bulatov, V. E.

2000 The Kalmykav System of Seasonal Nomadism in the Nineteenth Century [in Russian]. In The Seasonal Economic Cycle of Populations of the Northwest Caspian in the Bronze Age. Pp. 131-142. Moscow: Proceedings of the National Historic Caspian in the Bronze Age.

Bunyatyan, E. P.

1999 On Correlation of Agriculture and Pastoralism in the Northern Pontic Steppe during the Bronze Age. In Late Prehistoric Exploitation of the Eurasian

Steppe. Marsha Levine, Y. Rassamakin, A. Kislenko, and N. Tataintseva, eds. Pp. 30-39. Cambridge

Burt, B. C.

1941 Comments on Cereals and Fruits. In Excavations at Harappa. M. S. Vats, ed. Pp. 466. New Delhi: Government of India Publications.

Cappers, René T. J., Renée M. Bekker, and Judith E. A. Jans

2006 Digitale Zadenatlas Van Nederland [in German]. Groningen, Germany: Barkhuis Publishing and Groningen University Library.

Casal, Jean-Marie

1961 Fouilles De Mundigak [in French]. Paris: Librairie C. Klincksieck.

Casimir, M. J.

1992 The Determinants of Rights to Pasture: Territorial Organization and Ecological Constraints. In Mobility and Territoriality: Social and Spacial Boundaries among Foragers, Fishers, Pastoralists and Peripatetics. M. J. Casimir and A. Rao, eds. Pp. 153-203. New York.

Chaliand, Gerard

2004 From Mongolia to the Danube: Nomadic Empires [translated from French]. London: Transaction Publishers.

Chang, Claudia

2010 unpublished Iron Age Demography and Socio-Political Interaction in SE Kazakhstan: Lecture at the Society of American Archaeology Meetings.

Chang, Claudia, Norbert Benecke, Fedor P. Grigoriev, Arlene M. Rosen, and Perry A. Tourtellotte

2003 Iron Age Society and Chronology in South-east Kazakhstan. Antiquity 77(296):298-312.

Chang, Claudia, and Fedor P. Grigoriev

1999 A Preliminary Report of the 1994-1996 Field Seasons at Tuzusai, an Iron Age Site (ca. 400 B.C.-100 A.D.) in Southeastern Kazakhstan. Eurasia Antiqua 5:391-410.

Chang, Claudia, P. Tourtellotte, K. M. Baipakov, and F. P. Grigoriev

2002 The Evolution of Steppe Communities from Bronze Age through Medieval Periods in Southeastern Kazakhstan (Zhetysu). Sweet Briar, Virginia: Sweet Briar College.

Chase-Dunn, Christopher, and Thomas D. Hall

1997 Rise and Demise: Comparing World-Systems. Boulder, CO: Westview Press.

Chen, Guiling, Qi Zheng, Yinguang Bao, Shubing Liu, Honggang Wang, and Xingfeng Li

2012 Molecular Cytogenetic Identification of a Novel Dwarf Wheat Line with Introgressed *Thinopyrum ponticum* Chromatin. Journal of Biological Science 37(1):149-155.

Chen, Kwang-tzuu, and Fredrik T. Hiebert

1995 The Late Prehistory of Xinjiang in Relation to its Neighbors. Journal of World Prehistory 9(2):243-300.

Chernykh, Evgennii, Evgenii Kuz'minykh, and L. B. Orlovskaia

2004 Ancient Metallurgy in Northeast Asia: From the Urals to the Saiano-Altai. In Metallurgy in Ancient Eastern Eurasia from the Urals to the Yellow River. Katheryn M. Linduff, ed. Pp. 15-36. Lewiston, Pennsylvania: Edwin Mellen.

Christian, David

1994 Inner Eurasia as a Unit of World History. Journal of World History, 5:2:173-211

2000 Silk Roads or Stepp Roads? The Silk Roads in World History. Journal of World

History, 11:1:1-26.

Clarke, Mari H.

1976 Farming and Foraging in Prehistoric Greece. In Regional Variation in Modern Greece and Cyprus, Dimen, Muriel and Ernestine Friedl, eds. Pp. 127-142, Annals of the New York Academy of Science, Vol. 268.

Costantini, L.

1979 Plant Remains at Pirak. In Fouilles dePirak. J.-F. Jarrige and M. Saontoni, eds. Pp. 326-333. Paris: Difussion de Boccard.

1984 The Beginning of Agriculture in the Kachi Plain: the Evidence of Mehrgarh. In South Asian Archaeology 1981. B. B. Allchin, ed. Pp. 29-33. Cambridge: Cambridge University Press.

1987 Appendix B. Vegetal Remains. In Prehistoric and Protohistoric Swat, Pakistan. G. Stacul, ed. Pp. 155-165. Rome: Instituto Italiano per il Medio ed Estremo Orientale.

Crawford, Gary W.

1992 Prehistoric Plant Domestication in East Asia. In The Origins of Agriculture: and International Perspective. C. W. and P. J. Watson Cowen, ed. Pp. 7-38. Washington D.C.: Smithsonian Institution Press.

2006 East Asia Plant Domestication. In Archaeology of Asia. Miriam T. Stark, ed. Pp. 79-95. Oxford: Blackwell Publishing.

2009 Agricultural origins in North China pushed back to the Pleistocene-Holocene boundary. Proceedings of the National Academy of Sciences 106(18):7271-7272.

Crawford, G. W., and G. A. Lee

2003 Agricultural Origins in the Korean Peninsula. Antiquity 77:87-95.

Crawford, Gary, Anne Underhill, Zhijun Zhao, Gyoung-Ah Lee, Gary Feinman, Linda Nicholas, Fengshi Luan, Haiguang Yu, and Fengshu Cai

2005 Late Neolithic Plant Remains from Northern China: Preliminary Results from Liangchengzhen, Shandong. Current Anthropology 46(2):309-328.

Crawford, Gary W., Xuexiang Chen, and Jianhua Wang

2006 Houli Culture Rice from the Yuezhuang Site, Jinan. East Asian Archaeology (Dongfang Kapgu) 3:247-251.

Crawford, H.

1992 En Early Dynastic Trading Network in North Mesopotamia. In La Circulation des Biens, des Personnes et des Idees dans le Proche-Orient Ancien. D. Charpin and F. Joannes, eds. Pp. 77-82. Paris: Recherche sur les Civilisations.

Cribb, R.

1991 Nomads in Archaeology. Cambridge.

Fu, Da-xiong, Xu Ting-wen, and Feng Zong-yun

2000 The Ancient Carbonized Barley (*Hordeum vulgare* L. Var. *nudum*) Kernel Discovered in the Middle of Yalu Tsanypo River Basin in Tibet. Southwest China Journal of Agricultural Sciences 13(1):38-41.

Dahl, Gudrun, and Anders Hjort

1976 Having herds: Pastoral herd growth and household economy. Dept. of Social Anthropology, University of Stockholm: Stockholm.

Dai, F., E. Nevo, D. Wu, J. Comadran, M. Zhou, L. Qiu, Z. Chen, A. Beiles, G. Chen, and G. Zhang

2012 Tibet is One of the Centers of Domestication of Cultivated Barley. Proceedings of the National Academy of Sciences.

Dandamayev, M. A.

1999 Media and Achaemenid Iran. In Ancient Iranian Nomads in Western Central Asia. In History of Civilizations of Central Asia: Volume II, The Development of Sedentary and Nomadic Civilizations (700 B.C. to A.D. 250). Janos Harmatta, B. N. Puri, and G. F. Etemadi, eds. Pp. 35-66. Delhi: UNESCO Publishing.

Davis, Linda W.

1993 Weed Seeds of the Great Plains: A Handbook for Identification. Lawrence, Kansas: University Press of Kansas.

Davydova, A. V.

1968 The Ivolga Gorodishche (A Monument of the Hiung-Nu Culture in the Trans-Baikal Region). Acta Archaeologica Academiae Scientiarium Hungaricae 20:209-245.

Day, R. L., K. N. Laland, and J. Odling-Smee

2003 Rethinking Adaptation: The Niche-Construction Perspective. Perspectives in Biology and Medicine 46:80-95.

de Wet, J. M. J.

1995 Foxtail Millet. In Evolution of Crop Plants, 2nd edition. J. Smartt and N. W. Simmonds, eds. Pp. 170-172. London: Longman.

Debaine-Francfort, Corinne

1987 Etude Comparative de Materiels Lithiques Protohistoriques Chinois (Chine Metropolitaine et Asia Centrale). L'Asie Centrale et es Rapports Avec les Civilisations Orientales, des Origines a l'age du fer:197-206.

1988 Archeologie du Xinjiang des Origines aux Han Premiere Partie [in French]. Paleorient 14(1):5-29.

1989 Archeologies du Xinjiang des Origines aux Han Ileme Partie. Paleorient 15(1):183-213.

di Castri, F.

1981 Mediterranean-type Shrublands of the World. In Ecosystems of the World. F. di Castri, D. W. Goodall, and L. Specht, eds. Pp. 1-52. Amsterdam: Elsevier.

Di Cosmo, Nicola

1994 Ancient Inner Asian Nomads: Their Economic Basis and Its Significance in Chinese History. The Journal of Asian Studies 53(4):1092-1126.

1999 State Formation and Periodization in Inner Asian History. Journal of World History 10(1):1-39.

Diamond, Jared

1999 Guns, Germs, and Steel. New York: W. W. Norton and Company.

Dioscorides

1959 [first century A.D.] The Greek Herbal Dioscorides. John Goodyer [1655], transl. New York: Hafner.

Dolukhanov, P. M.

1981 The Ecological Prerequisites for Early Farming in Southern Turkmenia. In The Bronze Age Civilization of Central Asia: Recent Soviet Discoveries. Philip L. Khol, ed. Pp. 350-358. New York: M. E. Sharpe, Inc.

Drennan, Robert. D., Bryan K. Hanks, and Christian E. Peterson

2011 The Comparative Study of Chiefly Communities in the Eurasian Steppe Region. Journal of Social Evolution and History 10(1):12–48.

Dvořák, J., P. di Terlizzi, H. B. Zhang, and P. Resta

1993 The Evolution of Polyploidy Wheats: Identification of a Genome Donor Species. Genome 36:21-31.

Dvořák, J., M. C. Luo, Z. I. Yang, and H. B. Zhang

1998 The Structure of the *Aegilops tauschii* Genepool and the Evolution of Hexaploid Wheat. Theoretical and Applied Genetics 67:657-670.

Dyson-Hudson, R., and N. Dyson-Hudson

1980 Nomadic Pastoralism. Annual Review of Anthropology 9:15-61.

Dyson-Hudson, Neville

1966 Karimojong Politics. Oxford: Clarendon Press.

Dzhangaliev, A. D., T. N. Salova, and P. M. Turekhanova

2003 The Wild Fruit and Nut Plants of Kazakhstan. In Horticultural Reviews. Jules Janick, ed. Pp. 305-372. New York: John Wiley & Sons, Inc.

El Hadidi, Nabil M.

1984 Food Plants of Prehistoric Dynastic Egypt. In Plants for Arid Lands. G. E. Wickens, J. P. Goodin, and D. V. Field, eds. Pp. 87-92. London: George Allen and Unwin.

Evashenko, Anna

2008 Flowering Plants of Southeastern Kazakhstan [in Russian]. Almaty, Kazakhstan: Associates to Preserve Biodiversity of Kazakhstan.

Fall, Patricia L., Steven E. Falconer, and Lee Lines

2002 Agricultural Intensification and the Secondary Products Revolution Along the Jordan Rift. Human Ecology 4(30):445-482.

Fernández-Giménez, María E.

1999 Sustaining the Steppe: A Geographical History of Pastoral Landuse in Mongolia. Geographical Review 89:315-342.

1994 The Role of Ecological Perception in Indigenous Resource Management: a Case Study From the Mongolian Forest-Steppe. In Nomadic Peoples International Union of Anthropological and ethnological Sciences Commission on Nomadic Peoples. Anders Hjort af Ornäs, ed. Pp. 31-46. Montreal, Quebec: Reprocentralen HSC.

Field, Henry, and Eugene Prostov

1938 Archaeology in the U.S.S.R. American Anthropologist 40(4, Part 1):653-679.

Flad, R., S. Li, X. Wu, and Zh. Zhao

2010 Early Wheat in China: Results from New Studies at Donghuishan in the Hexi Corridor. Holocene 17:555-560.

Flannery, Kent V.

1969 The Ecology of Early Food Production in Mesopotamia. In Environment and Cultural Behavior. Andrew P. Vayda, ed. Garden City, New York: The Natural History Press.

Fleure, Herbert J., and Harold Peake

1928 The Steppe and the Sown. New Haven: Yale University Press.

Flood, R. J., and G. C. Gates

1986 Seed Identification Handbook. Cambridge: National Institute of Agricultural Botany.

Florian, Mary-Lou E., Dale Paul Kronkright, and Ruth E. Norton

1990 Identification of Plant and Animal Fibers. In The Conservation of Artifacts Made from Plant Materials. Pp. 38-56. Oxford: Oxford University Press.

Ford, Anabel

2008 Dominant Plants of the Maya Forest and Gardens of El Pilar: Implications for Paleoenvironmental Reconstructions. Journal of Ethnobiology 28(2):179-199.

Ford, R. I.

1979 Paleoethnobotany in American Archaeology. In Advances in Archaeological Method and Theory. M. B. Schiffer, ed. Pp. 285-336. New York: Academic Press.

Foreman, R., and M. Godron

1986 Landscape Ecology. New York: Wiley.

Fowler, Cary, and Pat Mooney

1990 Shattering Food, Politics, and the Loss of Genetic Diversity. Tucson: The University of Arizona Press.

Frachetti, Michael David

2002 Bronze Age Exploitation and Political Dynamics of the Eastern Eurasian Steppe Zone. McDonald Institute Monographs. In Ancient Interactions: East and West in Eurasia. Katie Boyle, Colin Renfrew, and Marsha Levine, eds. Pp. 161-170. London: McDonald.

2004a Archaeological Explorations of Bronze Age Pastoral Societies in the Mountains of Eastern Eurasia. Silk Road 2(1).

2004b Bronze Age Pastoral Landscape of Eurasia and Nature of Social Interaction in the Mountain Steppe Zone of Eastern Kazakhstan. Philadelphia, Pennsylvania: Unpublished Ph.D. Dissertation, Department of Anthropology, University of Pennsylvania.

2006 The Dzhungar Mountain Archaeology Project: Reconstructing Bronze Age Life in the Mountains of Eastern Kazakhstan. In Beyond the Steppe and the Sown: Proceeding of the 2002 University of Chicago Conference on Eurasian

Archaeology. D.L. Peterson, L. M. Popova, and A. T. Smith, eds. Pp. 123-141. Boston: Brill.

2008a Pastoralist Landscapes and Social Interaction in Bronze Age Eurasia. Berkley: University of California Press.

2008b Variability and Dynamic Landscapes of Mobility Pastoralism in Ethnography and Prehistory. In The Archaeology of Mobility Old World and New World Nomadism. Hans Barnard and Willeke Wendrich, eds. Pp. 366-396. Los Angeles, California: Cotsen Institute of Archaeology.

2011 Migration Concepts in Central Eurasian Archaeology. Annual Review of Anthropology, 40:195-212.

2012 Multi-regional Emergence of Mobile Pastoralism and Non-uniform Institutional Complexity across Eurasia. Current Anthropology 53(1):2-38.

Frachetti, Michael D., and Alexei N. Mar'yashev

2007 Long-Term Occupation and Seasonal Settlement of Eastern Eurasian Pastoralists at Begash, Kazakhstan. Journal of Field Archaeology 32(3):221-242.

Frachetti, M., and N. Benecke

2009 From Sheep to (Some) Horses: 4500 Years of Herd Structure At The Pastoralist Settlement of Begash (Southeastern Kazakhstan). Antiquity 83(322):1023-1037.

Frachetti, Michael D., N. Benecke, A. N. Mar’yashev, and P. Doumani

2010a Eurasian Pastoralists and Their Shifting Regional Interactions at the Steppe Margin: Settlement History at Mukri, Kazakhstan. World Archaeology 42(4).

Frachetti, Michael D., Robert N. Spengler, Gayle J. Fritz, and Alexei N. Mar'yashev

2010b Earliest Direct Evidence for Broomcorn Millet and Wheat in the Central Eurasian Steppe Region. Antiquity 84:993-1010.

Fritz, Gayle J.

1990 Multiple Pathways to Framing in Eastern North America. Journal of World Prehistory 4(4):387-435.

2005 Palaeoethnobotanical Methodology and Applications. In Handbook of Archaeological Methods. Herbert D. G. Maschner and Christipher Chippindale, eds. Pp. 773-834. Lanham, Maryland: AltaMira Press.

Frye, Richard N.

1996 The Heritage of Central Asia from Antiquity to the Turkish Expansion. Princeton, New Jersey: Markus Wiener Publications.

Fu, Daxiong

2001 Discovery, Identification and Study of the Remains of Neolithic Cereals from the Changguogou Site, Tibet [in Chinese]. Kaogu 3:66-74.

Fuller, Dorian Q.

2001 Responses: Harappan Seeds and Agriculture: Some Considerations. Antiquity 75:410-414.

2002a An Introduction to Seed Anatomy. London: Unpublished Guide, Botany Department at University College London.

2002b Fifty Years of Archaeobotanical Studies in India: Laying a Solid Foundation. In Indian Archaeology in Retrospect, vol III Archaeology and

Interactive Disciplines. S. Settar and R. Korisettar, eds. Pp. 247-363. New Delhi: Manohar.

2008 The Spread of Textile Production and Textile Crops in India Beyond the Harappan Zone: An Aspect of the Emergence of Craft Specialization and Systematic Trade. In Linguistics, Archaeology, and the Human Past. Toshiki Osada and Akinori Uesugi, eds. Pp. 1-26. Kyoto Japan: Indus Project, Research Institute of Humanities and Nature.

2009 unpublished lecture Framing a Middle Asian Corridor of Crop Exchange ad Agricultural Innovation. 13th Harvard University Roundtable Ethnogenesis of South and Central Asia (ESCA) Kyoto Session Conference Paper.

Fuller, D. Q., and C. J. Stevens

2009 Agriculture and the Development of Complex Societies. In From Foragers to Farmers: Papers in Honour of Gordon C. Hillman. A. Fairbairn and E. Weiss, eds. Pp. 37-57. Oxford: Oxbow Books.

Fuller, D. Q., and H. Zhang

2007 A Preliminary Report on the Survey Archaeobotany of the Upper Ying Valley (Hennan Province). In School of Archaeology and Museology, Peking University and Henan Provincial Institute of Cultural Relics and Archaeology. Dengfeng Wangchengang, Faxian Yizhide, and Yu Yanjiu, eds. Pp. 916-958: Zheng Zhou: Great Elephant Publisher [in Chinese].

Gadyuchenko

2002 Organic Remains from Fortified Settlements and Necropoli of the "Country of Towns". In Regional Specifics in Light of Global Models BC

Complex Societies of Central Eurasia from the 3rd to the 1st Millennium. Volume 2: The Iron Age; Archaeoecology, Geoarchaeology, and Palaeogeography; Beyond Central Eurasia Karlene Jones-Bley and D. G. Zdanovich, eds. Pp. 400-418. Washington D.C.: Institute of Man.

Galaty, John G.

1981 Introduction: Nomadic Pastoralists and Social Change-Processes and Perspectives. In Change and Development in Nomadic and Pastoral Society. J. G. Galaty and P. E. Salzmann, eds. Pp. 4-26. Leiben, England: E.J. Brill.

Gardiner-Garden, John R.

1987a Apollodoros of Artemita and the Central Asian Skythians. Bloomington, Indiana: Papers on Inner Asia No. 3, Indiana University Research Institute for Inner Asian Studies.

1987b Ktesias on Early Central Asian History and Ethnography. Bloomington, Indiana: Papers on Inner Asia No. 3, Indiana University Research Institute for Inner Asian Studies.

Gegas, Vasilis C., Aida Nazari, Simon Griffiths, James Simmonds, Lesley Fish, Simon Orford, Liz Sayers, John H. Doonan and John W. Snape

2010 A Genetic Framework for Grain Size and Shape Variation in Wheat. The Plant Cell, 22:4:1046-1056

Golden, P. B.

2003 Nomads and Sedentary Societies in Medieval Eurasia. Washington D.C.: American Historical Association.

Goldschmidt, Walter

1979 A General Model for Pastoral Social Systems. In L'équipe écologique et anthropologique des sociétés pastorals, Pp. 20-27. Cambridge University Press, Cambridge.

Goloskokov, V. O.

1984 Flora of Dzungaria and Altai, [in Rssian]. Almaty, Kazakhstan: Ezstatelstvo NAUKA Kazakhstan SSR.

Good, Irene

1995 Notes on a Bronze Age Textile Fragment from Hami, Xinjiang with Comments on Significance of Twill. Journal of Indo-European Studies 23:319-345.

1998 Bronze Age Cloth and Clothing of the Tarim Basin: The Charchan Evidence. In The Bronze Age and Early Iron Age Peoples of Eastern Central Asia, Volume One, Archaeology, Migration and Nomadism, Linguistics. Victor H. Mair, ed. Pp. 656-670. Philadelphia: The Institute for the Study of Man.

Goriachev, A.

2004 The Bronze Age Archaeological Memorials in Semirech'ye. In Metallurgy in Ancient Eastern Eurasia from the Urals to the Yellow River. K. Linduff, ed. Pp. 109-138. Lampeter: Edwin Mellen Press.

Gregg, Susan A.

1988 Foragers and Farmers: Population Interaction and Agricultural Expansion in Prehistoric Europe. University of Chicago Press.

Grousset, Rene

1970 [1939] L’empire des Steppes: Attila, Gengis-Khan, Tamerlan [in French]. Paris: Bibliotheque Historique Payot.

2002 The Empire of the Steppes: A History of Central Asia. Naomi Walford, transl. New Brunswick: Rutgers University Press.

Gryaznov, M. P.

1969 The Ancient Civilizations of Southern Siberia. Geneva: Nagel Publishers.

Gunda, Béla

1949 Plant Gathering in the Economic Life of Eurasia. Southwestern Journal or Anthropology 5(4):369-378.

Gunn, C. R, and F. B. Gaffney

1974 Seed Characteristics of 42 Economically Important Species of Solanaceae in the United States. Washington D.C.: United States Department of Agriculture.

Gupta, Swarajya Prakash

1979 Archaeology of Soviet Central Asia and the Indian Borderlands. Delhi: B. R. Publishing.

Hanks, Bryan

2010 Archaeology of the Eurasian Steppes and Mongolia. Annual Review of Anthropology, 39:469-486.

Hanks, Bryan, and James Johnson

2012 unpublished Modeling Human-Environment Dynamics and Socio-Economic Change in the Bronze Age Eurasian Steppe (2100-1500 BCE). Paper given at Society of American Archaeology Meetings.

Hanselka, Kevin

2010 Informal Planting of Squashes and Gourds by Rural Farmers in Southwestern Tamaulipas, Mexico, and Implications for the Local Adoption of Food Production In Prehistory. Journal of Ethnobiology 30(1):31-51.

Hardin, Garrett

1968 The Tragedy of the Commons. Science 162:1243-1248.

Harlan, H. V.

1914 Some Distinctions in Our Cultivated Barleys with Reference to Their Use in Plant Breeding, Biochemistry, St. Paul: University of Minnesota.

Harlan, J., and D. Zohary

1966 Distribution of Wild Wheat and Barley. Science 153:1074-1080.

Harlan, Jack R.

1968 Barley: Origin, Botany, Culture, Winter Hardiness, Genetics, Utilization, Pests. In Agriculture Handbook No. 338. Pp. 9-31. Washington, D.C.: U.S. Department of Agriculture.

Harris, David

2010 Origins of Agriculture in Western Central Asia: An Environmental-Archaeological Study. Philadelphia: University of Pennsylvania Museum of Archaeology and Anthropology.

Harrison, N.

1995 Preliminary Archaeobotanical Findings from Anau, 1994 excavations. Progress Report, Harvard IuTAKE Excavations at Anau South, Turkmenistan:28-36.

Hastorf, Christine A., and Melanie F. Wright

1998 Interpreting Wild Seeds from Archaeological Sites: A Dung Charring Experiment from the Andes. Journal of Ethnobiology 18:211-227.

Helbaek, Hans

1952 Early Crops in Southern England. In The Prehistoric Society. Pp. 194-223. Copenhagen: National Museum, Copenhagen.

1959 Domestication of food plants in the Old World. Science 130:365-372.

1969 Plant Collecting, Dry-farming, and Irrigation Agriculture in Prehistoric Deh Luran. In Prehistory and Human Ecology of the Deh Luran Plain. Frank Hole, Kent Flannery, and James Neely, eds. Pp. 383-426. Ann Arbor, Michigan: Memoirs of the Museum of Anthropology, University of Michigan.

Hemphill, Brian E., and J. P. Mallory

2004 Horse-Mounted Invaders From the Russo-Kazakh Steppe or Agricultural Colonists From Western Central Asia? A Craniometric Investigation of the Bronze Age Settlement of Xinjiang. American Journal or Physical Anthropology 124:199-222.

Herodotus

2003 [ca. 431 - 425 B.C.] The Histories. Aubrey De Selincourt, transl. London: Penguin Books.

Herrmann, Georgina, and K. Kurbansakhatov

1994 The International Merv Project Preliminary Report on the Second Season (1993). Iran, British Institute of Persian Studies 32:53-75.

Hiebert, Fredrick T., C. C. Lamberg-Karlovsky, Murad Kurbansakhatov, Katherine M. Moore, Sharri Clark, Erika Evasdottir, Nathanial Harrison, Naomi Miller, and Steven Brann

1995 Progress Report. Harvard-IuTAKE Excavations at Anau South, Turkmenistan:28-36.

Hiebert, Fredrik T.

1994 Origins of the Bronze Age Oasis Civilization in Central Asia. Cambridge, Massachusetts: Peabody Museum of Archaeology and Ethnology.

2002 Bronze Age Interactions between the Eurasian Steppe and Central Asia. In Ancient Interactions: East and West in Eurasia. Katie Boyle, Colin Renfrew, and Marsha Levine, eds. Pp. 237-298. London: McDonald.

Hiebert, Fredrik T., and K. Kurbansakhatov

2003 A Central Asian Village at the Dawn of Civilization, Excavations at Anau, Turkmenistan. Philadelphia, Pennsylvania: University of Pennsylvania Museum of Archaeology and Anthropology.

Hillman, G. C., A. J. Legge, and P. A. Rowley-Conwy

1997 On the Charred Seeds from Epipalaeolithic Abu Hureyra: Food of Fuel? Current Anthropology 38(4):651-655.

Hitchcock, A. S.

1951 Manual of the Grasses of the United States. Washington D. C.: United States Department of Agriculture.

Hollenbach, Kandace D.

2008 unpublished Plant Remains from Taldy Bulak 2, Kazakhstan. Archaeological Research Laboratory Department of Anthropology University of Tennessee, Knoxville

Honeychurch, William H.

2004 Inner Asian Warriors and Khans: A Regional Spatial Analysis of Nomadic Political Organization and Interaction. Ann Arbor, Michigan Unpublished Ph.D. Dissertation, Department of Anthropology, University of Michigan.

Honeychurch, William, and Chunag Amartushin

2006 States on Horseback: The Rise of Inner Asian Confederations and Empires. In Archaeology of Asia. Mariam T. Stark, ed. Pp. 255-278. Malden, Massachusetts: Blackwell Publishing.

2007 Hinterlands, Urban Centers, and Mobile Settings: The ‘‘New’’ Old World Archaeology from the Eurasian Steppe. Asian Perspectives 46(1):36-64.

Humphrey, Caroline, Marina Mongush, and B. Telengid

1994 Attitudes to Nature in Mongolia and Tuva: a Preliminary Report. In Nomadic Peoples International Union of Anthropological and ethnological Sciences Commission on Nomadic Peoples. Hjort af Ornäs Anders, ed. Pp. 51-62. Montreal, Quebec: Reprocentralen HSC.

Hunt, Harriet V., Michael G. Campana, Matthew C. Lawes, Yong-Jin Park, Mim A. Bower, Christopher J. Howe, and Martin K. Jones

2011 Genetic Diversity and Phylogeography of Broomcorn Millet (*Panicum miliaceum* L.) across Eurasia. Molecular Ecology 20:4756-4771.

Hunt, Harriet V., Marc Vander Linden, Xinyi Liu, Giedre Motuzaite-Matuzeviciute, Sue Colledge, and Martin K. Jones

2008 Millets across Eurasia: Chronology and Context of Early Records of the Genera *Panicum* and *Setaria* from Archaeological Sites in the Old World. Vegetation History and Archaeobotany 17:S5-S18.

Huntington, E.

1907 The Pulse of Asia: A Journey in Central Asia Illustrating the Geographical Basis of History. Boston: Houghton, Mifflin and Company.

Ilvessalo-Pfäffli, Marja-Sisko

1995 Fiber Atlas: Identification of Papermaking Fibers. Berlin: Springer-Verlag.

Irons, William, and Neville Dyson-Hudson.

1972 Perspectives on Nomadism. Based on a symposium on nomadic studies held in New Orleans, Louisiana, 1969. Leiden, Netherlands: E. J. Brill.

Isakov, A.

1980 Excavations of the Bronze Age Settlement of Sarazm. Anthropology and Archaeology of Eurasia 19:273-286.

Ishjamts, N.

1999 Nomads in Eastern Central Asia. In Ancient Iranian Nomads in Western Central Asia. In History of Civilizations of Central Asia: Volume II, The Development of Sedentary and Nomadic Civilizations (700 B.C. to A.D. 250). Janos Harmatta, B. N. Puri, and G. F. Etemadi, eds. Pp. 151-170. Delhi: UNESCO Publishing.

Ivanov, I. V.

1996 Bronzovii vek Evpaziiskkikh Stepei. Ego Mesto v Sisteme Landshaftnoklimaticheskhikh Ismenenii Golotsena i v Istoricheskom Protsesse. In Drevnosti Volga-Donskhikh Stepei v Sisteme Vostochno-evropeiskgo Bronzogo veka. Volgagrad.

Jackson, Stephen T., and Jennifer B. Kearsley

1998 Quantitative Representation of Local Forest Composition in Forest-Floor Pollen Assemblages. Journal of Ecology 86:474-490.

Jacomet, S.

2006 unpublished Identification of Cereal Remains from Archaeological Sites.

Jarman, M., G. Bailey, and H. Jarman

1982 Early European Agriculture: Its Foundation and Development. Cambridge: Cambridge University Press.

Jarrige, J.-F.

1988 Le Complexe Culturel de Mehrgarh (Periode VIII) et de Sibri: le Tresor de Quetta. In Les Cites Oubliees de l'Indus. Pp. 111-128. Paris: Musée National des Arts Asiatiques Guimet.

Jettmar, K.

1965 L'art des Steppes le Style Animalier Eurasiatiqu, Genese et Arriere-plan Social [in French]. Sociologiques et Religieux. 1. ser. L'Art dans le Monde; Fondements Historiques, ed. Paris: Civilizations non Europeennes: Art dans le Monde A. Michel.

Jia, Peter W., Alison Betts, and Xinhua Wu

2011 New Evidence for Bronze Age Agricultural Settlements in the Zhunge'er (Junggar) Basin, China. Journal of Field Archaeology 36(4):269-280.

Jiang, Hong-En, Xiao Li, Chang-Jiang Liu, Yu-Fei Wang, and Cheng-Sen Li

2006 Fruits of *Lithospermum officiale* L. (Boraginaceae) Used as an Early Plant Decoration (2500 Years BP) in Xinjiang, China. Journal of Archaeological Science 34:167-170.

Jiang, Hong-En, Yong-Bing Zhang, Xiao Li, Yi-Feng Yao, David K. Ferguson, En-Gou Lu, and Cheng-sen Li

2009 Evidence for Early Viticulture in China: Proof of a Grape Vine (*Vitis vinifera* L., Vitaceae) in Yanghai Tombs, Xinjiang. Journal of Archaeological Science 36:1458-1465.

Josekutty, Puthiyaparambil Chacko

2008 Defining the Genetic and Physiological Basis of *Triticum sphaerococcum* Perc., Cellular and Molecular Biology, University of Canterbury.

Katz, N. Ja., Katz, S. V., and M. G. Kipiani

1965 Atlas and Keys of Fruits and Seeds Occurring in the Quaternary Depositsof the USSR [in Russian]. Moscow: Academy of Science of the USSR, NAUKA.

Katz, O., I. Gilead, P. Bar (Kutiel), and R. Shahack-Gross

2007 Chalcolithic Agricultural Life at Grar, Northern Negev, Israel: Dry Farmed Cereals and Dung-Fueled Fires. Paléorient 33(2):101-116.

Kenoyer, Jonathan M.

2011 Preface. In Inter-Regional Interaction and Urbanism in the Ancient Indus Valley: A Geologic Provenience Study of Harappa's Rock and Mineral Assemblage, Occasional Paper 11: Linguistics, Archaeology And the Human Past. R. W. Law, ed. Kyoto: Indus Project, Research Institute for Humanity and Nature.

Khazanov, A. M.

1984 Nomads and the Outside World. Julia Crookenden, transl. London: Cambridge University Press.

Khotinskiy, N. A.

1984 Holocene Vegetation History. In Late Quaternary Environments of the Soviet Union. A. Velichko, H. E. Wright, and C. W. Barnosky, eds. Pp. 179-200. Minneapolis: University of Minnesota Press.

Kim, Minkoo

2013 Wheat in Ancient Korea: A Size Comparison of Carbonized Kernels. Journal of Archaeological Science 40:517-525.

Kimata, Mikio, and Sadao Sakamoto

1992 Utilization of Several Species of Millet in Eurasia. Bulletin of the Field Studies Institute, Tokyo Gakugei University 3:1-12.

Klinge, JoAnna, and Patricia Fall

2010 Archaeobotanical Inference of Bronze Age Land Use and Land Cover in the Eastern Mediterranean. Journal of Archaeological Science 37:2622-2629.

Knight, Paul J.

1978 The Role of Seed Morphology in Identification of Archaeological Remains. Albuquerque, New Mexico: Unpublished Ph.D. Dissertation, The University of New Mexico.

Knörzer, Karl-Heinz

2000 3000 Years of Agriculture in a Valley of the High Himalayas Vegetation History and Archaeobotany 9(4):219-222.

Koba, T., and K. Tsunewaki

1978 Mapping of the s and Ch 2 Genes on Chromosome 3D of Common Wheat. Wheat Information Service 45-46:18-20.

Kohl, Philip. L.

2007 The Making of Bronze Age Eurasia: Cambridge World Archaeology. Cambridge: Cambridge University Press.

Komatsuda, T., P. Mohammad, C. He, A. Perumal, K. Hiroyuki, P. Dragan, N. Stein, A. Graner, T. Wicker, A. Tagiri, U. Lundqvist, T. Fujimura, M. Matsuoka, T. Matsumoto, and M. Yano

2007 Six-rowed Barley Originated from a Mutation in a Homeodomain-leucine Zipper l-class Homeobox Gene. Proceedings of the National Academy of Sciences 104(4):1424-1429.

Körber-Grohne, Udelgard

1985 Die Biologishen Reste aus dem Hallstattzeitlichen Fürstengrab von Hochdorf, Gemeinde Eberdingen (Kreis Ludwigsburg), [in German]. In Hochdorf I. Udelgard Körber-Grohne, ed. Stuttgart, Germany: Landesdenkmalamt Baden-Württemberg.

Korobkova, G. F.

1981 Ancient Reaping Tools and Their Productivity in the Light of Experimental Tracewear Analysis. In The Bronze Age Civilization of Central Asia: Recent Soviet Discoveries. Philip L. Khol, ed. Pp. 350-358. New York: M. E. Sharpe, Inc.

Korochkova, O., and V. Stefanov

2004 The Trans-Ural Fedorovo Complexes in Relation to the Andronovo. In Metallurgy in Ancient Eastern Eurasia from the Urals to the Yellow River. K. M. Linduff, ed. Lampeter: Edwin Mellen Press.

Koroluyk, E. A., and N. V. Polosmak

2010 Plant Remains from Moin Ula Burial Mounds 20 and 31 (Northern Mongolia). Archaeology Ethnology and Anthropology of Eurasia 38(2):57-63.

Koryakova, Ludmila, and Andrej Vladimirovich Epimakhov

2007 The Urals and Western Siberia in the Bronze and Iron ages. Cambridge: Cambridge University Press.

Koshelenko, G. A., and V. N. Pilipko

1999 Parthia. In Ancient Iranian Nomads in Western Central Asia. In History of Civilizations of Central Asia: Volume II, The Development of Sedentary and Nomadic Civilizations (700 B.C. to A.D. 250). Janos Harmatta, B. N. Puri, and G. F. Etemadi, eds. Pp. 131-150. Delhi: UNESCO Publishing.

Kosintsev, P. A.

2000 Kostnye Ostatki Zhivotnykh iz Ukreplennogo Poseleniya Arkaim. In Arkheologicheski Istochnik i Modelorovaniye Drevnikh Tekhnologii. S. Y.

Zdanovich, ed. Pp. 17-44. Chelyabinsk: Tsentr "Arkaim" Institute of History and Archaeology of RAS.

Koster, L.

1977 The Ecology of Pastoralism in Relation to Changing Patterns of Landuse in the Northeast Peloponnese, Unpublished PhD Dissertation for the Department of Anthropology, University of Pennsylvania.

Kotova, N., and S. Makhortykh

2010 Human Adaptation to Past Climate Changes in the Northern Pontic Steppe. Quaternary International 220:88-94.

Kremenetski, C. V.

1997 The Late Holocene Environment and Climate Shift in Russia and Surrounding Lands. In Climate Change in the Third Millennium BC. H. N. Dafes, G. Kukla, and H. Weiss, eds. Pp. 351-370. Berlin: Springer.

2003 Steppe and Forest-Steppe Belt of Eurasia: Holocene Environmental History. In Prehistoric Steppe Adaptation and the Horse. M. Levine, C. Renfrew, and K. Boyle, eds. Pp. 11-28. Cambridge: McDonald Institute for Archaeological Research.

Kremenetski, Constantin V., Olga A. Chichagova, and Nathalia I. Shishlina

1999 Paleoecological Evidence for Holocene Vegetation, Climate and Land-use Change in the Low Don Basin and Kalmuk Area, Southern Russia. Vegetation History and Archaeobotany 8:233-246.

Kuz'mina, Elaina

1994 Otkuda prishi Indoarii? Material'naia Kul'tura Plemen Andronovskoi Obshchnosti i Proiskhozhdenie Indiorantsev [in Russian]. Moscow: MGP Kalina.

2007 The Origin of the Indo-Iranians. Leiden, Netherlands: Brill.

2008 The prehistory of the Silk Road: Encounters with Asia. Victor. H. Mair, transl. Philadelphia: University of Pennsylvania Press.

2000 The Eurasian Steppes the Transition from Early Urbanism to Nomadism. In Kurgans, Ritual Sites and Settlements Eurasian Bronze and Iron Age. Jeannine Davis-Kimball, Eileen M. Murphy, Ludmila Koryakova, and Leonid T. Yablonsky, eds. Pp. 118-189. Oxford: BAR International Series.

1998 The Tarim Basin People and Pastoralists of the Asian Steppes. In The Bronze Age and Early Iron Age Peoples of Eastern Central Asia: Volume One: Archaeology, Migration and Nomadism, Linguistics. Victor H. Mair, ed. Pp. 63-93. Philadelphia: The Institute for the Study of Man.

Kvavadze, Eliso, Ofer Bar-Yosef, Anna Belfer-Cohen, Elisabetta Boaretto, Nino Jakeli, Zinovi Matskevich, and Tengiz Meshveliani

2009 30,000-Year-Old Wild Flax Fibers. Scinece 325(5946):1359.

Laland, K. N., and G. R. Brown

2006 Niche Construction, Human Behaviour and Adaptive-lag Hypothesis. Evolutionary Anthropology 15:95-104.

Laland, K. N., J. R. Kendal, and G. R. Brown

2007 The Niche Construction Perspective: Implications for Evolution and Human Behavior. Journal of Evolutionary Psychology 5:51-66.

Laland, K. N., and M. J. O'Brien

2010 Niche Construction Theory and Archaeology. Journal of Archaeological Methods and Theory 17:303-322.

Laland, K. N., J. Odling-Smee, and M. W. Feldman

2001 Cultural Niche Construction and Human Evolution. Journal of Evolutionary Biology 14:22-33.

Lamberg-Karlovsky, C. C.

1994 Forward: Initiating and Archaeological Dialogue: The USA-USSR Archaeological Exchange. In Origins of the Bronze Age Oasis Civilization in Central Asia (American School of Prehistoric Research Bulletins) (Vol 42). Fredrik Talmage Hiebert, ed. Pp. XVII-XXIX. Cambridge, Massachusetts: Peabody Museum Press.

Larkum, Mary

2010 Phytolith Analysis of Samples from On- and Off-Site Deposits at Jeitun. In Origins of Agriculture in Western Central Asia: An Environmental-Archaeological Study. David Harris, ed. Pp. 142-149. Philadelphia: University of Pennsylvania Museum of Archaeology and Anthropology.

Lattimore, Owen

1967 [1940] Inner Asian Frontiers of China. Boston: Beacon.

Lavrenko, E.M., and Z.V. Karamysheva

1993 Steppes of the former Soviet Union. In Natural Grasslands: Eastern Hemisphere and Resume. Ecosystems of the World. R.T. Coupland, ed. Pp. 3-60. Amsterdam: Elsevier.

Law, Randall

2006 Moving Mountains: the Trade and Transport of Rocks and Minerals within the Indus Valley Region. In Space and Spatial Analysis in Archaeology. Elizabeth C. Robertson, Jeffrey D. Seibert, Deepika C. Fernandez, and Marc U. Zender, eds. Pp. 301-313. Albuquerque: University of New Mexico Press.

Lawler, Andrew

2009 Millet on the Move. Science 325(21):942-943.

Lees, Susan H., and Daniel G. Bates

1974 The Origins of Specialized Nomadic Pastoralism: A Systemic Model. American Antiquity 39(2):187-193.

Leon, J.

2010 Genetic Diversity and Population Differentiation Analysis of Ethiopian Barley (*Hordeum vulgare* L.) Landraces using Morphological Traits and SSR Markers, Rheinischen Friedrich-Wilhelms-Universität.

Leonard, W. H., and J. H. Martin

1963 Cereal Crops. New York.

Leslie, Paul W., and Michael A. Little

1999 Turkana Herders of the Dry Savanna: Ecology and Behavioral Response of Nomads to an Uncertain Environment. Oxford: Research Monographs on Human Population Biology, Oxford Press.

Levin, M. G., and L. P. Potapov

1964 The Peoples of Siberia. Stephen Dunn, transl. Chicago: University of Chicago Press.

Levishin, A. I.

1840 Description des Hordes et des Steppes des Kirghiz-Kazaks ou Kirghiz-Kaissaks, par Alexis de Levchine. [in French] Ann Arbor, Michigan: Imprimerie Royale, Paris.

Lewontin, R. C.

1982 Organism and Environment. In Learning, Development and Culture. H. C. Plotkin, ed. New York: John Wiley.

1983 Gene, Organism, and Environment. In Evolution from Molecules to Men. D. S. Bendall, ed. Cambridge: Cambridge University Press.

Li, C., D. L. Lister, and H. Li

2011 Ancient DNA Analysis of Desiccated Wheat Grains Excavated from a Bronze Age Cemetary in Xinjiang. Journal of Archaeological Science 38:115-119.

Li, Shuicheng

2002 Interactions Between Northwest China and Central Asia During the Second Millenium BC: an Archaeological Perspective. In Ancient Interactions: East and West in Eurasia. Katie Boyle, Colin Renfrew, and Marsha Levine, eds. Pp. 171-182. London: McDonald.

Li, X., C. Xu, and Q. Zhang

2004 Ribosomal DNA Spacer-length Polymorphisms in Three Samples of Wild and Cultivated Barleys and their Relevance to the Origin of Cultivated Barley. Plant Breeding 123:30-34.

Li, Xiaoqiang, John Dodson, Xinying Zhou, Hongbin Zhang, and Ryo Masutomoto

2007 Early Cultivated Wheat and Broadening of Agriculture in Neolithic China. The Holocene 17:555-560.

Liberov, P. D.

1960 K istorii Skotovodstva i Okhoto na Territory Severnogo Prichernomoriya v Epokhu Rannego Zheleza. MIA 53:110-164.

Lightfoot, J.

1777 Flora Scotica. London: B. White.

Linduff, Katheryn M.

2006 Why Have Siberian Artifacts Been Excavated Within Ancient Chinese Dynastic Borders? In Beyond the Steppe and the Sown: Proceeding of the 2002 University of Chicago Conference on Eurasian Archaeology. D.L. Peterson, L. M. Popova, and A. T. Smith, eds. Pp. 358- 370. Boston: Brill.

Lisitsina, Gorislava N.

1969 The Earliest Irrigation in Turkmenia. Antiquity XLIII:279.

1981 The History of Irrigation Agriculture in Southern Turkmenia. In The Bronze Age Civilization of Central Asia: Recent Soviet Discoveries. Philip L. Khol, ed. Pp. 350-358. New York: M. E. Sharpe, Inc.

1984 The Caucasus - A Center of Ancient Farming in Eurasia. In Plants and Ancient Man. W. van Zeist, and W. A. Casparie, ed. Pp. 285-292. Balkema, Rotterdam.

Litivinskii, B. A.

1989 The Ecology of Ancient Nomads of Soviet Central Asia and Kazakhstan. In Ecology and Empire: Nomads in the Cultural Evolution of the Old World. Gary

Seaman, ed. Pp. 61-74. Los Angeles: Ethnographics/University of Southern California.

Liu, Xinyi, Harriet V. Hunt, and Martin K. Jones

2009 River Valleys and Foothills: Changing Archaeological Perceptions of North China's Earliest Farms. Antiquity 83(319):82-95.

Lone, F. A., M. Khan, and G. M. Buth

1993 Palaeoethnobotany: Plants and Ancient Man in Kashmir. New Delhi: Oxford and 1BH Publishers.

Lu, Houyuan, Jianping Zhang, Kam-biu Liub, Naiqin Wu, Yumei Li, Kunshu Zhou, Maolin Ye, Tianyu Zhang, Haijiang Zhang, Xiaoyan Yang, Licheng Shen, Deke Xu, and Quan Li

2009 Earliest Domestication of Common Millet (*Panicum miliaceum*) in East Asia Extended to 10,000 Years Ago. Proceedings of the National Academy of Sciences 106(18):7367-7372.

Luczaj, Lukasz, and Wojciech M. Szymański

2007 Wild Vascular Plants Gathered for Consumption in the Polish Countryside: a Review. Journal of Ethnobiology and Ethnomedicine 3(17):1-22.

Ma, D., T. Xu, M. Gu, B. Wu, and Y. Kang

1987 The Classification and Distribution of Wild Barley in the Tibet Autonomous Region. Scientia Agriculturae Sinica 20:1-6.

Mair, Victor H.

1998 The Bronze Age and Early Iron Age Peoples of Eastern Central Asia. In Journal of Indo-European Studies, no. 26 Washington D.C. Institute for the Study of Man in Collaboration with the University of Pennsylvania Museum Publications.

Majak, Walter, Barbara M. Brooke, and Robert T. Ogilvie

2008 Stock-Poisoning Plants of Western Canada. Ottawa: Canadian Department of Agriculture.

Mallory, J. P.

1989 In Search of the Indo-Europeans: Language, Archaeology, and Myth. New York: Thames and Hudson.

Mallory, J. P., and Victor H. Mair

2000 Ancient China and the Mystery of the Earliest Peoples from the West. London: Thames and Hudson.

Marshall, Fiona, and Elisabeth Hildebrand

2002 Cattle before Crops: The Beginnings of Food Production in Africa. Journal of World Prehistory 16(2):99-143.

Marston, John M.

2011 Archaeological Markers of Agricultural Risk Management. Journal of Anthropological Archaeology 30:190-205.

Martin, Alexander C., and William D. Barkely

1973 Seed Identification Manual. Berkeley, California: University of California Press.

Masanov, N.

1995 Northern Areas (Transoxania and the Steppes) Pastoral Production. In History of Civilizations of Central Asia: Development in Contrast: From the

Sixteenth to the Mid-nineteenth Century. K. M. Baipakov, S. Moosvi, and A. Burton, eds. Pp. 373-375: UNESCO Publishing.

Masanov, N. E.

2000 Features of Traditional Nomadic Kazakh Life-ways [in Russian]. In The Seasonal Economic Cycle of Populations of the Northwest Caspian in the Bronze Age. Pp. 116-130. Moscow: Proceedings of the National Historic Caspian in the Bronze Age.

Mayhew, Bradley, Greg Bloom, Paul Clammer, Michael Kohn, and John Noble

2009 Lonely Planet Central Asia (Multi Country Travel Guide): Lonely Planet Guide.

McCabe, J. Terrence

1990 Turkana Pastoralism: A Case against the Tragedy of the Commons. Human Ecology 18(1):81-103.

McCorriston, Joy, Susan Toby Evans, J. L. Huot, Mario Liverani, Kathleen Morrison, Dan Potts, Andrew Sherratt, Rita P. Wright, and Richard L. Zettler

1997 The Fiber Revolution: Textile Intensification, Alienation, and Social Stratification in Ancient Mesopotamia. Current Anthropology 38(4):517-549.

McGovern, P. E., D. L. Glusker, L. J. Exner, and M. M. Voigt

1996 Neolithic Resinated Wine. Nature 381:480-481.

McGovern, P. E., and R. H. Michel

1994 The Analytical and Archaeological Challenge of Detecting Ancient Wine: Two Case Studies from the Ancient Near East. In The Origin and Ancient History of Wine. P. E. McGovern, S. J. Fleming, and S. H. Katz, eds. Pp. 57-65. Philadelphia: Gordon and Breach.

McNeill, W. H.

1963 The Rise of the West. Chicago University Press, Chicago.

Meadow, R. H.

1996 The origins and Spread of Agriculture and Pastoralism in North Western South Asia. In The Origin and Spread of Agriculture and Pastoralism in Eurasia. D. R. Harris, ed. Pp. 390-412. London: University College London Press.

Mei, Jianjun, and Colin Shell

1998 Copper and Bronze Metallurgy in Late Prehistoric Xinjiang. In The Bronze Age and Early Iron Age Peoples of East Central Asia. V. H. Mair, ed. Pp. 581-603. Philadelphia, Pennsylvania: University of Pennsylvania Museum Publications.

1999 The Existence of Andronovo Cultural Influence in Xinjiang During the 2nd Millennium BC. Antiquity 73(281):570-578.

Mei, Jianjun

2009 Early Metallurgy and Socio-cultural Complexity: Archaeological Discoveries in Northwest China. In Social Complexity in Prehistoric Eurasia: Monuments, Metals, and Mobility. Bryan K. Hanks and Katheryn M. Linduff, eds. Pp. 215-234. Cambridge: Cambridge University Press.

Merlin, M. D.

2003 Archaeological Evidence for the Tradition of Psychoactive Plant Use in the Old World. Economic Botany 57:295-323.

Middleton, Nick

2005 Extremes Along the Silk Road, Adventures Off the World's Oldest Superhighway. London: John Murray.

Miller, Brian K.

2009 Power Politics in the Xiongnu Empire. Ph.D. Dissertation in the Antrhopology Department at the University of Pennsylvania, Philadelphia.

Miller, Naomi F.

1984 The Use of Dung as Fuel: And Ethnographic Example and an Archaeological Application. Paleórient 10(2):71-79.

1989 What Mean These Seeds: A Comparative Approach to Archaeological Seed Analysis. Historical Archaeology 23(2):50-59.

1990 Godin Tepe, Iran: Plant Remains from Period V, the Late Fourth Millennium B.C. Museum Applied Science Center for Archaeology Ethnobotanical Report 6:1-12.

1993 Preliminary Archaeobotanical Results from the 1989 Excavation at the Central Asian Site of Gonur Depe, Turkmenistan. Information Bulletin, International Association for the Study of the Cultures of Central Asia 19:149-163.

1996 Seed Eaters of the Ancient Near East: Human or Herbivore? Current Anthropology 37(3):521-528.

1996 unpublished Plant Remains from Tuzusai and Talgar City, Kazakhstan, 1994 and 1995 seasons University of Pennsylvania Museum - MASCA Museum Applied Science Center for Archaeology - Ethnobotanical Laboratory Report 16.

1997 Reply. Current Anthropology 38(4):655-659.

1999 Agricultural Development in Western Central Asia in the Chalcolithic and Bronze Ages. Vegetation History and Archaeobotany 8:13-19.

2003 The Use of Plants at Anau North. In A Central Asian Village at the Dawn of Civilization, Excavations at Anau, Turkmenistan. Fredrik T. Hiebert and Kakamurad Kurdansakhatov, eds. Philadelphia: University of Pennsylvania Museum.

2004 Long-term Vegetation Changes in the Near East. In The Archaeology of Global Change: The Impact of Humans on their Environment. C. L. Redman, S. R. James, P. R. Fish, and J. D. Rogers, eds. Pp. 130-140. Washington D.C.: Smithsonian Institution Press.

2008 Sweeter than Wine? The Use of the Grape in Early Western Asia. Antiquity 82:937-946.

Miller, Naomi F., and Kathryn L. Gleason

1994 Fertilizer in the Identification and Analysis of Cultivated Soil. In The Archaeology of Garden and Field. Naomi F. Miller and Kathryn L. Gleason, eds. Philadelphia, Pennsylvania: University of Pennsylvania Press.

Miller, N. F., and J. M. Marston

in press Archaeological Fuel Remains as Indicators of Ancient West Asian Agropastoral and Land-use Systems. Journal of Arid Environments.

Miller, Naomi F., and Tristine L. Smart

1984 Intentional Burning of Dung as Fuel: A mechanism for the Incorporation of Charred Seeds into the Archaeological Record. Journal of Ethnobiology 4:15-28.

Miller, Naomi, and Masoumeh Kimiaie

2006 Some Plant Remains from the 2004 Excavations of Tall-E Musshki, Tall-E Jari A and B, and Tall-E Bakun A and B. In The Origins of State Organization in Prehistoric Highland Fars, Southern Iran Excavations at Tall-E Bakun. Abbas Alizadeh, ed. Pp. 107-118. Chicago: Oriental Institute Publication 128.

Milt, Wright

1986 Le Bois De Vache: This Chip's For You. Saskatchewan Archaeology 7:25-28.

Molina-Cano, J., M. Moralejo, E. Igartua, and I. Romagosa

1999 Further Evidence Supporting Morocco as a Center of Origin of Barley. Theoretical and Applied Genetics 98:913-918.

Molina-Cano, J., J. Russell, M. Moralejo, J. Escacena, G. Arias, and W. Powell

2005 Chloroplast DNA Microsatellite Analysis Supports a Polyphyletic Origin for Barley. Theoretical and Applied Genetics 110(4):613-619.

Montgomery, F. H.

1977 Seeds and Fruits of Plants of Eastern Canada and Northeastern United States. Buffalo: University of Toronto Press.

Moore, Katherine, Maria Bruno, José M. Capriles, and Christine Hastorf

2010 Integrated Contextual Approaches to Understanding Past Activities Using Plant and Animal Remains from Kala Uyuni, Lake Titicaca, Bolivia. In

Integrating Zooarchaeology and Paleoethnobotany: A Consideration of Issues, Methods, and Cases. A.M. VanDerwarker and T.M. Peres, eds: Springer Scientific.

Moore, Katherine, Naomi F. Miller, Fredrik T. Heibert, and Richard H. Meadow

1994 Agriculture and Herding in Early Oasis Settlements of the Oxus Civilization. Antiquity 68:418-427.

Moore, R. J.

1975 The *Galium aparine* Complex in Canada. Canadian Journal of Botany 53:877-893.

Mordkovich, V. G.

1982 Stepnye Ekosistemy [in Russian]. Moscow: Nauka.

Morrell, P. L., and M. T. Clegg

2007 Genetic Evidence for a Second Domestication of Barley (*Hordeum vulgare*) East of the Fertile Crescent. Proceedings of the National Academy of Sciences 104:3289-3294.

Motuzaite-Matuzeviciute, G., S. Telizhenko, and M. K. Jones

2012 Archaeobotanical Investigation of Two Scythian-Sarmatian Period Pits in Eastern Ukraine: Implications for Floodplain Cereal Cultivation. Journal of Field Archaeology 37:51–61.

Moulherat, C., M. Tengberg, J.-F. Haquet, and B. Mille

2002 First Evidence of Cotton and Neolithic Mehrgarh, Pakistan: Analysis of Mineralized Fibres from a Copper Bead. Journal of Agricultural Science 29:1393-1401.

Mowart, Farley

1970 The Siberians. Atlantic Monthly Press Book, Little Brown and Company.

Musil, Albina F.

1963 Identification of Crop and Weed Seeds, Agricultural Handbook No. 219. Washington D.C.: U.S. Department of Agriculture.

Nabhan, Gary Paul

2008 Where Our Food comes From: Retracing Nicolay Vavilov's Quest to End Famine. Washington D.C.: Island Press.

Nesbitt, Mark

1993 Archaeobotanical Remains. In The International Merv Project Preliminary Report on the First Season (1992). K. Kurbansakhatov and G. Herrmann, eds. Pp. 56-58. Iran: Unpublished Field Report.

1994 Archaeobotanical Research in the Merv Oasis. In The International Merv Project, Preliminary Report on the Second Season (1993). K. Kurbansakhatov and G. Herrmann, eds. Pp. 53-75. Iran: Unpublished Field Report.

Odling-Smee, J., K. N. Laland, and M. W. Feldman

2003 Niche Construction: The Neglected Process of Evolution: Monographs in Population Biology 37: Princeton University Press.

Oka, Rahul, and Chapurukha M. Kusimba

2008 The Archaeology of Trading Systems, Part 1: Toward a New Trade Synthesis. Journal of Archaeological Research 16:339-395.

Okladnikov, A. P.

1959 Ancient Population of Siberia and its Cultures. Cambridge, Massachusetts: Russian Translation Series of the Peabody Museum of Archaeology and Ethnology, Harvard University, v. 1 no. 1 Peabody Museum.

Outram, Alan K., Natalie A. Stear, Robin Berdrey, Sandra Olsen, Alexei Kasparov, Victor Zaibert, Nick Thorpe, and Richard P. Evershed

2009 The Earliest Horse Harnessing and Milking. Science 323:1332-1335.

Paine, Robert

1970 Lappish Decisions, Partnerships, Information Management, and Sanctions: a Nomadic Pastoral Adaptation. Ethnology 9(1):52-67.

1971 Animals as Capital: Comparisons among Northern Nomadic Herders and Hunters. Anthropological Quarterly 44(3):157-172.

Parpola, S., A. Parpola, and Jr. R. H. Brunswig

1977 The Meluhha Village. Evidence of Acculturation of Harappan Traders in the Late Third Millennium Mesopotamia? Journal of the Economic and Social History of the Orient XX(II):129-165.

Pashkevich, Galina

1984 Palaeoethnobotanical Examination of Archaeological Sites in the Lower Dnieper Region, Dated to the Last Centuries BC and First Centuries AD. In Plants and Ancient Man: Studies in Palaeoethnobotany. W. van Zeist and W.A. Casparie, eds. Pp. 277-284. Boston: A.A. Balkema.

2003 Paleoethnobotanical Evidence of Agriculture in the Steppe and Forest-steppe of East Europe in the Late Neolithic and Bronze Age. In Prehistoric Steppe

Adaptation and the Horse. Marsha Levine, Colin Renfrew, and Katie Boyle, eds. Pp. 287-297. London: McDonald.

Pearsall, Deborah M.

2000 Paleoethnobotany A Handbook of Procedures. San Diego: Academic Press.

Pechenkina, Ekaterina A., Jr. Robert A. Benfer, and Wang Zhijun

2002 Diet and Health Change at the End of the Late Chinese Neolithic: the Yangshao/Longshan Transition in Shaanxi Province. American Journal of Physical Anthropology 117:15-36.

Percival, J.

1921 The Wheat Plant. London.

Peterson, R. F.

1965 Wheat, Botany, Cultivation and Utilization. New York.

Plentneva, S. A.

1982 Kochevniki Srednevekovia [in Russian]. Moscow: Nauka.

Pollan, Michael

2006 The Omnivore's Dilemma: a Natural History of Four Meals. London: Penguin Books.

Popov, A.A.

1966 The Nganasan the Material Culture of the Tavgi Samoyeds. Elaine K. Ristinen, transl. Indianapolis, Indiana: Indiana University.

Popova, Laura M.

2006a Pastoralism during the Late Bronze Age in Russia: Past Interpretations and New Goals for Future Research. In Beyond the Steppe and the Sown: Proceeding of the 2002 University of Chicago Conference on Eurasian Archaeology. D. L. Peterson, L. M. Popova, and A. T. Smith, eds. Pp. 459-468. Boston: Brill.

2006b Political Pastures: Navigating the Steppe in the Middle Volga Region (Russia) During the Bronze Age. Chicago: Unpublished Ph.D. Dissertation, Department of Anthropology, University of Chicago.

2007 A New Historical Legend: A Long-Term Vegetation History of the Samara River Valley, Russia. In Social Orders and Social Landscapes, L. M. Popova, C. W. Hartley, and A. T. Smith, eds. Pp. 95-119, Cambridge Scholars Publishing.

Possehl, Gregory L.

2004 The Middle Asian Interaction Sphere: Trade and Contact in the 3rd Millennium BC. Expedition 49(1):40-42.

Pratt, D. J.

1984 Arid Africa. In Development of Animal Production Systems. B. Nestel, ed. Pp. 155-164. Amsterdam: Elsevier.

Priklonskii, V. L.

1953 [1881] Three Years in the Yakut Territory (Ethnographic Sketches), Yakut Ethnographic Sketches, parts I and II. Sheldon Wise, transl. New Haven: Human Relations Area Files.

Pumpelly, Raphael, ed.

1908 Explorations in Turkestan: Expadition of 1904, Prehistoric Civilizations of Anau. Volume two. Washington: Carnegie Institution of Washington.

Sima, Qian

1961 [ca. 80 B.C.] Records of the Grand Historian, Translated from the Shih chi of Sima Qian. Burton Watson, transl. Volume 2. New York: Columbia University Press.

Rao, M. V. P.

1977 Mapping of the Sphaerococcum Gene 's' on Chromosome 3D of Wheat. Cereal Research Communication 5:15-17.

Razzokov, A.

2008 Sarazm. Dushanbe: Institute of History, Archaeology, and Ethnography. Dushanbe, Tajikistan: Academy of Sciences of Tajikistan A. Donish History, Archaeology and Ethnographic Institute.

Renfrew, Colin, and S. Shennan

1982 Ranking, Resource and Exchange. Cambridge: Cambridge University Press.

Renfrew, Jane M.

1973 Palaeoethnobotany: The Prehistoric Food Plant of the Near East and Europe. New York: Columbia University Press.

Reynolds, M. P., and N. E. Borlaug

2006 Impacts of Breeding on International Collaborative Wheat Improvement. Journal of Agricultural Science 144:3-17.

Rhode, D., D. B. Madsen, P.J. Brantingham, and T. Dargye

2007 Yaks, Yak Dung and Prehistoric Human Occupation of the Tibetan Plateau. In Late Quaternary Climate Change and Human Adaptation in Arid China. D. B. Madesen, C. Fahu, and G. Xing, eds. Pp. 205-226. Amsterdam: Elsevier.

Rindos, D.

1984 The Origins of Agriculture. Orlando: Academic Press

Roberts, Margaret F., and Michael Wink

1998 Alkaloids: Biochemistry, Ecology, and Medical Applications. New York: Plenum Press.

Rogers, Daniel J.

2007 The Contingencies of State Formation in Eastern Inner Asia. Asian Perspectives 46(2):249-274.

Rogers, J. Daniel, Erdenebat Ulambayar, and Mathew Gallon

2005 Urban Centres and the Emergence of Empires in Eastern Inner Asia. Antiquity 79:801-818.

Rosen, A. M., C. Chang, and F. P. Grigoriev

2000 Paleoenvironments and Economy of Iron Age Saka-Wusun Agro-pastoralists in Southeastern Kazakhstan. Antiquity 74:611-623.

Rosen, Arlene

1986 Cities of Clay: The Geoarchaeology of Tells. Chicago: University of Chicago Press.

Rosen, Arlene M.

2002 unpublished Taldy Bulak 2: Preliminary Phytolith Report for 2002 Sample Set. Institute of Archaeology University College London.

2003 unpublished-a Kazakhstan 2003 Season Phytolith Report. Institute of Archaeology University College London.

2003 unpublished-b Results of Phytolith Analyses from Tsegonka 8. Institute of Archaeology University College London.

Rosen, Steven A., Arkady B. Savinetsky, Yosef Plakht, Nina K. Kisseleva, Bulat F. Khassanov, Andrey M. Pereladov, and Mordecai Haiman

2005 Dung in the Desert: Preliminary Results of the Negev Holocene Ecology Project. Current Anthropology 46:317-327.

Rudenko, Sergei I.

1962 Khunnu Culture and the Kurgans of Noin Ula [in Russian]. Moscow: Nauka.

1970 Frozen Tombs of Siberia. San Francisco: University of California Press.

Sahlins, Marshall

1972 Stone Age Economics. New York:Aldine de Gruyter

Salina, E., A. Borner, I. Leonova, V. Korzun, L. Laikova, O. Maystrenko, and M. S. Roder

2000 Microsatellite Mapping of the Induced Sphaerococcoid Mutation Genes in *Triticum aestivum*. Theoretical and Applied Genetics 100:686-689.

Salvatori, Sandro

2008 A New Cylinder Seal from Ancncient Margiana: Cultural Exchange and Syncncretism in a “World Wide Trade System” at the End of the 3rd

Millennnnium BC. In The Bronze Age and Early Iron Age in the Margiana Lowlands Facts and Methodological Proposals for a Redefinition of the Research strategies. Sandro Salvatori and Maurizio Tosi, eds. Pp. 111-118. Oxford: BAR International Series 1806.

Salzman, Philip Carl

1971 Movement and Resource Extraction among Pastoral Nomads: The Case of the Shah Nawazi Baluch. Anthropological Quarterly 44(3):185-197.

1972 Multi-Resource Nomadism in Iranian Baluchistan. In Perspectives on Nomadism. W. Irons and N. Dyson-Hudson, eds. Pp. 60-68. Leiden: E. J. Brill.

1982 Contemporary nomadic and pastoral peoples: Asia and the North. Studies in Third World societies, publication no. 18. Williamsburg, Virginia: College of William and Mary.

2002 Pastoral Nomads: Some General Observations Based on Research in Iran. Journal of Anthropological Research 58(2):245-264.

2004 Pastoralist: Equality, Hierarchy, and the State. Boulder, Colorado: Westview Press.

Santoni, M.

1984 Sibri and the South Cemetary of Mehrgarh:Third Millenium Connections Between the Northern Katchi Plain (Pakistan) and Central Asia. In South Asian Archaeology 1981. B. B. Allchin, ed. Pp. 52-60. Cambridge: Cambridge University Press.

Saraswat, K. S.

2004 Plant Economy of Early Farming Communites at Senuwar, Bihar. In Senuwar Excavations. B. P. Singh, ed. Varanasi: Banares Hindu University.

Schwartz, Glenn M., and Naomi Miller

2007 The 'Crisis' of the Late Third Millenium B.C: Ecofactual and Artifactual Evidence from Umm El-Marra and the Jabbul Plain. Anatolica XIX:177-203.

Schwarz, Henry G.

1984 The Minorities of Northern China a Survey. Seattle: Western Washington.

Sedova, M. S.

2000 Poselenia Srubnoi Kul'turi. In Istoria Samarskovo Povolzh'ye s Drevneishikh Vremen do Nashikh Dnei: Bronzovii vek. Kolev Yu. I., A. E. Mamonov, and M. A. Turetskii, eds. Pp. 209-255. Samara: Tsentr Integratsiia.

Seebohm, Henry

1882 Siberia in Asia: A Visit to the Valley of the Yenesay in East Siberia: William Clowes and Sons.

Semenova, A. P.

2000 Pogrebalnie Pmyatniki Srubnoi Kul'turi. In Istoria Samarskovo Povolzh'ye s Drevneishikh Vremen do Nashikh Dnei: Bronzovii vek. A. E. Kolev, A. E. Mamonov, and M. A. Turetskii, eds. Pp. 152-208. Samara: Tsentr Integratsiia.

Senft, Amanda Ruth

2009 Species Diversity Patterns at Ecotones. Chapel Hill: University of North Carolina at Chapel Hill, Department of Biology, Masters Thesis

Shahack-Gross, Ruth

2011 Herbivorous Livestock Dung: Formation, Taphonomy, Methods for Identification, and Archaeological Significance. Journal of Archaeological Science 38:205-218.

Shahack-Gross, Ruth, Rosa-Maria Albert, Ayelet Gilboa, Orna Nagar-Hilman, Ilan Sharon, and Steve Weiner

2005 Geoarchaeology in an Urban Context: The Uses of Space in a Phoenician Monumental Building at Tel Dor (Israel). Journal of Archaeological Science 32:1417-1431.

Shahack-Gross, Ruth, and Israel Finkelstein

2008 Subsistence Practices in an Arid Environment: a Geoarchaeological Investigation in an Iron Age Site, the Negev Highlands, Israel. Journal of Archaeological Science 35:965-982.

Shahack-Gross, Ruth, Fiona Marshall, and Steve Weiner

2002 Geo-Ethnoarchaeology of pastoral Sites: The Identification of Livestock Enclosures in Abandoned Maasai Settlements. Journal of Archaeological Science 30:439-459.

Shahrani, M.

1979 The Kirghiz and Wakhi of Afghanistan: Adaptation to Closed Frontiers. Seattle: University of Washington Press.

Shantz, H. L., and L. N. Piemeisel

1927 The Water Requirement of Plants at Akron Colorado. Journal of Agricultural Research 34:1093-1189.

Shaw, F. J. P.

1943 Vegetation Remains. In Chnudaro Excavations 1935-36. E. J. H. Mackay, ed. Pp. 250-251. New Haven, Connecticut: New Haven.

Sherratt, A. G.

1981 Plough and Pastoralism: Aspects of the Secondary Products Revolution. In Patterns of the Past: Studies in Honour of David Clark. I. Hodder, G. Isaac, and N. Hammond, eds. Pp. 261-305. Cambridge: Cambridge University Press.

1983 The Secondary Exploitation of Animals in the Old World. World Archaeology 15:90-104.

1999 Cash-crops Before Cash: Organic Consumables and Trade. In The Prehistory of Food: Appetites for Change. C. Gosden and J. Hather, eds. Pp. 13-34. Routledge: London.

Shilov, V. P.

1975 Models of Pastoral Economies in the Steppe Regions of Eurasia in the Enolithic and Early Bronze Ages [in Russian]. Sovietskaya Arkeologiya 1:5-16.

Shishlina, Natalya I.

2000a Preface, [in Russian]. In The Seasonal Economic Cycle or Populations of the Northwest Caspian in the Bronze Age. Pp. 5-9. Moscow: Proceedings of the National Historic Caspian in the Bronze Age.

2000b Seasonal and Economic Cycles of Katakomba Culture: The Issue of Reconstruction in the North-West Caspian Sea Littoral Area. In Seasonal Economic Cycle of the Northwest Caspian in the Bronze Age. N. Shishlina, ed. Moscow.

2003 Preface [in Russian]. In Seasonal Economic Mobile Population of the North-West Caspian in the Bronze Age. Pp. 5-9. Moscow: Proceedings of the National Historic Caspian In Bronze Age, No. 120.

2008 Reconstruction of the Bronze Age of the Caspian Steppe: Life Styles and Life Ways of Pastoral Nomads. Oxford: BAR International Series 1876.

Shishlina, N., and V. E. Bulatov

2000 The Interpretation of the Archaeological Data of the Bronze Age (The Third Millennium B.C.). In Seasonal Economic Cycle of the Northwest Caspian in the Bronze Age. N. Shishlina, ed. Pp. 172-175. Moscow.

Shishlina, N. I., O. V. Orfinskaya, and V. P. Golikov

2003 Bronze Age Textiles from the North Caucasus: New Evidence of Fourth Millennium Fibres and Fabrics. Oxford Journal of Archaeology 22(4):331-334.

Shishlina, Natalya I., E.I. Gak, and A.V. Borisov

2008 Nomadic Sites of the South Yergueni Hills on the Eurasian Steppe: Models of Seasonal Occupation and Production. In The Archaeology of Mobility: Old World and New World Nomadism. Hans Barnard and Willeke Wendrich, eds. Pp. 230-249. Los Angeles: Cotsen Institute of Archaeology, University of California

Shishlina, Nathalia I., and Fredrik T. Hiebert

1998 The Steppe and the Sown: Interaction between Bronze Age Eurasian Nomads and Agriculturalists. In The Bronze Age and Early Iron Age People of Eastern Central Asia: Volume One: Archaeology, Migration and Nomadism, Linguistics. Victor H. Mair, ed. Pp. 222-237. Philadelphia: The Institute for the Study of Man.

Shnirelman, Victor A.

1989 The Emergence of a Food Producing Economy. Moscow: Nauka.

1992 The Emergence of a Food-producing Economy in the Steppe and Forest-Steppe Zones of Eastern Europe. Journal of Indo-Eurasian Studies 20(1,2):123-143.

Sillar, B.

2000 Dung by Preference: The choice of fuel as an example of how Andean pottery production is embedded within wider technical, social and economic practices. Archaeometry 42(1):43-60.

Simpson, Beryl, and Molly Ogorzaly

1995 Economic Botany: Plants in our World: McGraw-Hill Science/Engineering/Math.

Singh, R.

1946 *Triticum sphaerococcum* Perc. (Indian Dwarf Wheat). Indian Journal of Genetics 6:34-47.

Sinor, Denis

1990 Introduction. In The Cambridge History of Early Inner Asia. Denis Sinor, ed. Pp. 1-20. Cambridge: Cambridge University Press.

Smith, Bruce D.

1995a Origins of Agriculture in the Americas. Evolutionary Anthropology 3:174-178.

2006 Eastern North America as an Independent Center of Plant Domestication. Proceedings of the National Academy of Sciences 103(33):12223-12228.

1992 Rivers of Change. Smithsonian Institute Press: Washington DC.

1995b The Emergence of Agriculture. New York: W. H. Freeman.

1997a The Initial Domestication of *Cucurbita pepo* in the Americas 10,000 years ago. Science 276:932-934.

1997b Reconstructing the Ocampo Caves and the Era of Incipient Cultivation in Mesoamerica. American Antiquity 8:342-383.

1998 Between Foraging and Farming. Science 279:1650-1652.

2001 Low-Level Food Production. Journal of Archaeological Research 9(1):1-43.

2007a Niche Construction and the Behavioral Context of Plant and Animal Domestication. Evolutionary Anthropology 16:188-199.

2007b The Ultimate Ecosystem Engineers. Science 315:1797-1798.

Sokolov, A.

1968 Agrokhimichesky Kharakteristika Pochv SSSR - Kazakhstan i Chelyabinskaya Oblast' 8. Moscow: Nauka.

Soucek, Svat

2000 A History of Inner Asia. Cambridge, U.K.: Cambridge University Press.

Spengler, Robert N.

2008 Archaeobotanical Analysis of the Begash Site: Plants as a Component of Mobile Pastoralism. St. Louis: Unpublished Master's Paper, Available in the Anthropology Department at Washington University.

Spengler, Robert N. III , Michael D. Frachetti, and Gayle J. Fritz

in press Ecotopes and Herd Foraging Practices in the Steppe/Mountain Ecotone of Central Asia during the Bronze and Iron Ages. Journal of Ethnobiology.

Spengler, Robert N., III, Barbara Cerassetti, Margareta Tengberg, Maurizio Cattani, and Lynne M. Rouse

in review Agriculturalists and Pastoralists: Bronze Age Economy of the Murghab Delta, Southern Central Asia. Journal of Vegetation History and Archaeobotany.

Spengler, Robert N. III, Claudia Chang, and Perry A. Tourtellotte

2013 Agricultural Production in the Central Asian Mountains: Tuzusai, Kazakhstan (410-150 BC). Journal of Field Archaeology.

Spengler, Robert N., III, and George Willcox

in press Archaeobotanical Results from Sarazm, Tajikistan, an Early Bronze Age Village on the Edge: Agriculture and Exchange. Journal of Environmental Archaeology.

Spooner, B.

1971 Toward a Generative Model of Nomadism. Anthropological Quarterly 44:198-210.

1973 The Cultural Ecology of Pastoral Nomads. An Addison-Wesley Module in Anthropology No. 45.

Stapf, O.

1931 Comments on Cereal and Fruits. In Mohenjodaro and the Indus Civilization. J. Marshall, ed. Pp. 586. London: Arthur Probsthain.

Stegelmeier, B. L., S. T. Lee, L. F. James, D. R. Gardener, K. E. Panter, M. H. Ralphs, and J. A. Pfister

2007 Cut Leaf Nightshade (*Solanum triflorum* Nutt.) Toxicity in Horses and Hampsters. In Poisonous Plants: Global Research Solutions. K. E. Panter, T. L. Wierenga, and J. A. Pfister, eds. Pp. 296-300. Wallingford, UK: CABI Publishing.

Stein, Aurel

1925 Inner Most Asia: Its Geography and a Factor in History. The Geographical Journal 65(5):377-403.

Stein, G. I., Christopher Edens, Naomi Miller, Hadi Ozbal, Julie Pearce, and Holly Pittman

1996 Hacinebi, Turkey: Preliminary Report on the 1995 Excavations. Anatolica XXII:85-128.

Stone, Glenn Davis

2001 Theory of the Square Chicken: Advances in Agricultural Intensification Theory. Asia Pacific Viewpoint, 42:2/3:163-180.

Sugita, S., M.-J. Gaillard, and A. Brostrom

1999 Landscape Openness and Pollen Records: a Simulation Approach. Holocene 9(4):409-421.

Sugita, Shinya

1994 Pollen Representation of Vegetation in Quaternary Sediments: Theory and Method in Patchy Vegetation. Journal of Ecology 82:881-897.

Sylwan, Vivi

1941 Woolen Textiles of the Lou-lan People. Stockholm: Trycheri Aktiebolaget Thule.

Taketa, Shin, Satoko Amano, Yasuhiro Tsujino, Tomohiko Sato, Daisuke Saisho, Katsuyuki Kakeda, Mika Nomura, Toshisada Suzuki, Takashi Matsumoto, Kazuhiro Sato, Shinji Kawasaki, and Kazuyoshi Takeda

2008 Barley Grain with Adhering Hulls is Controlled by an ERF Family Transcription Factor Gene Regulating a Lipid Biosynthesis Pathway. Proceedings of the National Academy of Sciences of the United States of America 105(10):4062-4067.

Tarasov, Pavel, John W. Williams, Andrei Andreev, Takeshi Nakagawa, Elene Bezrukova, Ulrike Herzschuh, Yaeko Igarashi, Stefanie Muller, Kirstin Werner, and Zhuo Zheng

2007 Satellite- and Pollen-based Quantitative Woody Cover Reconstructions for Northern Asia: Verification and Application to Late-Quaternary Pollen Data. Earth and Planetary Science Letters 264:284-298.

Taylor, K.

1999 *Galium aparine* L. The Journal of Ecology 87(4):713-730.

Tchebakova, N. M., T. A. Blyakharchuk, and E. I. Parfernova

2009 Reconstruction and Prediction of Climatic and Vegetation Change in the Holocene in the Altai-Sayan Mountains, Central Asia. Environmental Research Letters 4:1-11.

Tengberg, Margarita

1999 Crop Husbandry at Miri Qalat, Makran, SW Pakistan (4000-2000 B.C.). Vegetation History and Archaeobotany 8(1-2):3-12.

Thornton, Christopher, and Theodore G. Schurr

2004 Genes, Language, and Culture: an Example from the Tarim Basin. Oxford Journal of Archaeology 23(1):83-106.

Troll, C.

1950 Die Geografische Landschaft und Ihre Erforschung. [in German] Heidelberg, Germany: Studium Generale 3. Springer.

Turner, Nancy J., Douglas Deur, and Carla Rae Mellott

2011 "Up on the Mountain": Ethnobotanical Importance of Montane Sites in Pacific Costal North America. Journal of Ethnobiology 31(1):4-43.

Utesheva, A. S.

1959 The Climate of Kazakhstan [in Russian]. Gidrometeorologicheskoe Izd., Leningrad.

Vainshtein, Sev'yan

1980 Nomads of South Siberia the Pastoral Economies of Tuva. Michael Colenso, transl. Cambridge: Cambridge University Press.

Valamoti, Soultana Maria, and Mike Charles

2005 Distinguishing Food from Fodder through the Study of Charred Plant Remains: An Experimental Approach to Dung-derived Chaff. Vegetation History and Archaeobotany 14:528-533.

Valikhanov, C. C.

1961 – 1972 Sobranie Sochinenii. Alma-Ata: Izd-vo Akademii nauk Kazakhskoi SSR.

Vishnu-Mittre

1972 Neolithic Plant Economy at Chirand, Bihar. Palaeobotanist 22(1):18-22.

Wagner, Mayke , Xinhua Wu, Pavel Tarasov, Ailijiang Aisha, Christopher Bronk Ramsey, Michael Schultz, Tyede Schmidt-Schultz, and Julia Gresky

2011 Radiocarbon-dated Archaeological Record of Early First Millennium B.C. Mounted Pastoralists in the Kunlun Mountains, China. Proceedings of the National Academy of Sciences 10(1073):2-6.

Wallace, Arthur

1987 The Niche in Competition and Evolution. New York: John Wiley and Sons.

Wang, Binghua

1983 Excavations and Preliminary Research on the Remains from Gumugou on the Kongque River. Socail Science in Xinjiang (in Chinese) 1983:117-127.

Wang, Binghua, Yidirisi Abudu, and Xing Kaiding

1985 The 3000 Year Old Site with Stone Structures at Lanzhouwanzi in Balikun County. Chinese Archaeology Annual (in Chinese) 1985:255-256.

Watson, Patty Jo

1976 In Pursuit of Prehistoric Subsistence: A Comparative Account of Some Contemporary Flotation Techniques. Mid-Continental Journal of Archaeology 1:77-100.

Weber, Steven A.

1991 Plants and Harappan Subsistence: An Example of Stability and Change from Rojdi. Boulder, Colorado: Westview.

1999 Seeds of Urbanism: Palaeoethnobotany and the Indus Civilization. Antiquity 73:813-826.

Wendrich, Willeke, and Hans Barnard

2008 The Archaeology of Mobility: Definitions and Research Approaches. In The Archaeology of Mobility: Old World and New World Nomadism. Hans Barnard and Willeke Wendrich, eds. Pp. 1-24. Los Angeles: Costen Institute of Archaeology, University of California.

Western, David, and Thomas Dunne

1979 Environmental Aspects of Settlement Site Decisions among Pastoral Maasai. Human Ecology 7(1):75-98.

Whittaker, R. H., S. A. Levin, and R. B. Root

1973 Niche, Habitat, and Ecotope. The American Naturalist 107(955):321-338.

Wild, John Peter

2008 Textiles in Archaeology Shire Publications.

Wilkinson, T. J.

2003 The Archaeological Landscape of the Near East. Tucson, Arizona: University of Arizona Press.

Willcox, George

1991 Carbonized Plant Remains from Shortughai, Afghanistan. In New Light on Early Farming: Recent Developments in Palaeoethnobotany. J. M. Renfrew, ed. Pp. 139-153.

1994 Inédit Rapport sur L'archéobotanique de Miri Qalat: Makran. Archaeobotanical Report.

2002 Evidence for Ancient Forest Cover and Deforestation from Charcoal Analysis of Ten Archaeological Sites on the Euphrates. In Charcoal Analysis. Methodological Approaches, Palaeoecological Results and Wood Uses. S. Thiébault, ed. Pp. 141-145: BAR Int. Series 1063.

unpublished Sarazm Papeoethnobotany Report. Institut de Préhistoire Orientale, CNRS, Jalès, Berrias

Winkelmann, S.

2000 Intercultural Relations between Iran, the Murghabo-Bactrian Archaeological Complex (BMAC), Northwest India and Failaka in the Field of Seals. East and West 50:43-95.

Winterhalder, B., R. Larsen, and R. B. Thomas

1974 Dung as an Essential Resource in a Highland Peruvian Community. Human Ecology 2:89-104.

Wollstonecroft, Michele M.

2011 Investigating the Role of Food Processing in Human Evolution: a Niche Construction Approach. Archaeological and Anthropological Science 3:141-150.

Wright, Joshua

2006 The Adoption of Pastoralism in Northeast Asia, Monumental Transformations in the Egiin Gol Valley, Mongolia. Ph.D Dissertation in the Anthropology Department at Harvard University, Cambridge.

2007 Organizational Principles of Khirigsuur Monuments in the Lower Egiin Gol Valley, Mongolia. Journal of Anthropological Archaeology, 26:350-365.

Wright, Joshua, William Honeychurch, and Chunag Amartuvshin

2009 The Xiongnu Settlements of Egiin Gol, Mongolia. Antiquity 83:372-387.

Wu, Zhengyi, Peter Ravens, and Missouri Botanical Gardens

2006 Flora of China. St. Louis: Missouri Botanical Gardens.

Xu, T.

1982 Origin and Evolution of Cultivated Barley in China. Acta Genetica Sinica 9:440-446.

Xue, Yining

2008 Study of Plant Remains from Haimenkou Site in Jianchuan County, Yunnan Province, Archaeological Science, Peking University (Beida).

Yablonsky, L. T.

1995 Some Ethnogenetical Hypotheses. In Nomads of the Eurasian Steppes in the Early Iron Age. Jeannine Davis-Kimball, V. Bashilov, and L. Yablonski, eds. Pp. 241-252. Berkeley: Zinat Press.

Yang, S., Y. Wei, P. Qi, and Y. Zheng

2008 Sequence Polymorphisms and Phylogenetic Relationships of Hina Gene in Wild Barley from Tibet, China. Agricultural Sciences in China 7(7):796-803.

Yang, X., C. Liu, J. Zhang, and H. Lü

2009 Plant Crop Remains from the Outer Burial Pit of the Han Yangling Mausoleum and Their Significance to Early Western Han Agriculture [in Chinese]. Chinese Scientific Bulletin 54:1738-1743.

Yu, Ying-shih

1990 The Hsiung-nu. In The Cambridge History of Early Inner Asia. Denis Sinor, ed. Pp. 118-150. Cambridge: Cambridge University Press.

2002 Nomads and Han China. In Expanding Empires: Cultural Interactions and Exchange in World Societies from Ancient to Early Modern Times. Wendy F. Kasinec and Michael A. Polushin, eds. Pp. 133-141. Wilmington, Delaware: A Scholarly Resource Inc.

Yong, Ma, and Sun Yutang

1999 The Western Regions Under the Hsiung-nu and the Han. In Ancient Iranian Nomads in Western Central Asia. In History of Civilizations of Central Asia: Volume II, The Development of Sedentary and Nomadic Civilizations (700 B.C. to A.D. 250). Janos Harmatta, B. N. Puri, and G. F. Etemadi, eds. Pp. 227-246. Delhi: UNESCO Publishing.

Zdanovich, G., and S. Zdanovich

2002 Trans-Urals and Some Aspects of Steppe Assimilation in the Bronze Age. In Ancient Interactions: East and West in Eurasia. Katie Boyle, Colin Renfrew, and Marsha Levine, eds. Pp. 249-264. London: McDonald.

Zhao, Zhijun

1998 The Middle Yangtze in China is One Place Where Rice Was Domesticated: Phytolith Evidence from Diaotunghuan Cave, Northern Jiangxi. Antiquity 278:885-897.

An, Zhimin

1989 Prehistoric Agriculture in China. In Foraging and Farming the Evolution of Plant Exploitation. David R. Harris and Gordon C. Hillman, eds. Pp. 643-649. London: Unwin Hyman.

Zohary, D.

1994 The Domestication of the Grape Vine *Vitis vinifera*. In The Origins and Ancient History of Wine. P. E. McGovern, S. J. Fleming, and S. H. Katz, eds. Pp. 23-30. Philadelphia: Gordon and Breach.

Zohary, D., and M. Hopf

1973 Domestication of Pulses in the Old World. Science 182:887-894.

Zohary, D., M. Hopf, and E. Weiss

2012 Domestication of Plants in the Old World: the Origin and Spread of Domesticated Plants in Southwest Asia, Europe, and the Mediterranean Basin, Fourth Edition. Oxford: Oxford University Press.

Zohary, Daniel, and Maria Hopf

2000 Domestication of Plants in the Old World: the Origin and Spread of Cultivated Plants in West Asia, Europe and the Nile Valley. Oxford: Oxford University Press.

Zvelebil, M.

1996 The Agricultural Frontier and the Transition to Farming in the Circum-Baltic Region. In The Origins and Spread of Agriculture and Pastoralism in Eurasia. D. Harris, ed. Pp. 323-345. Washington DC: Smithsonian Institute Press.

Appendixes

A. Photos of Excavations and Material Culture

Begash

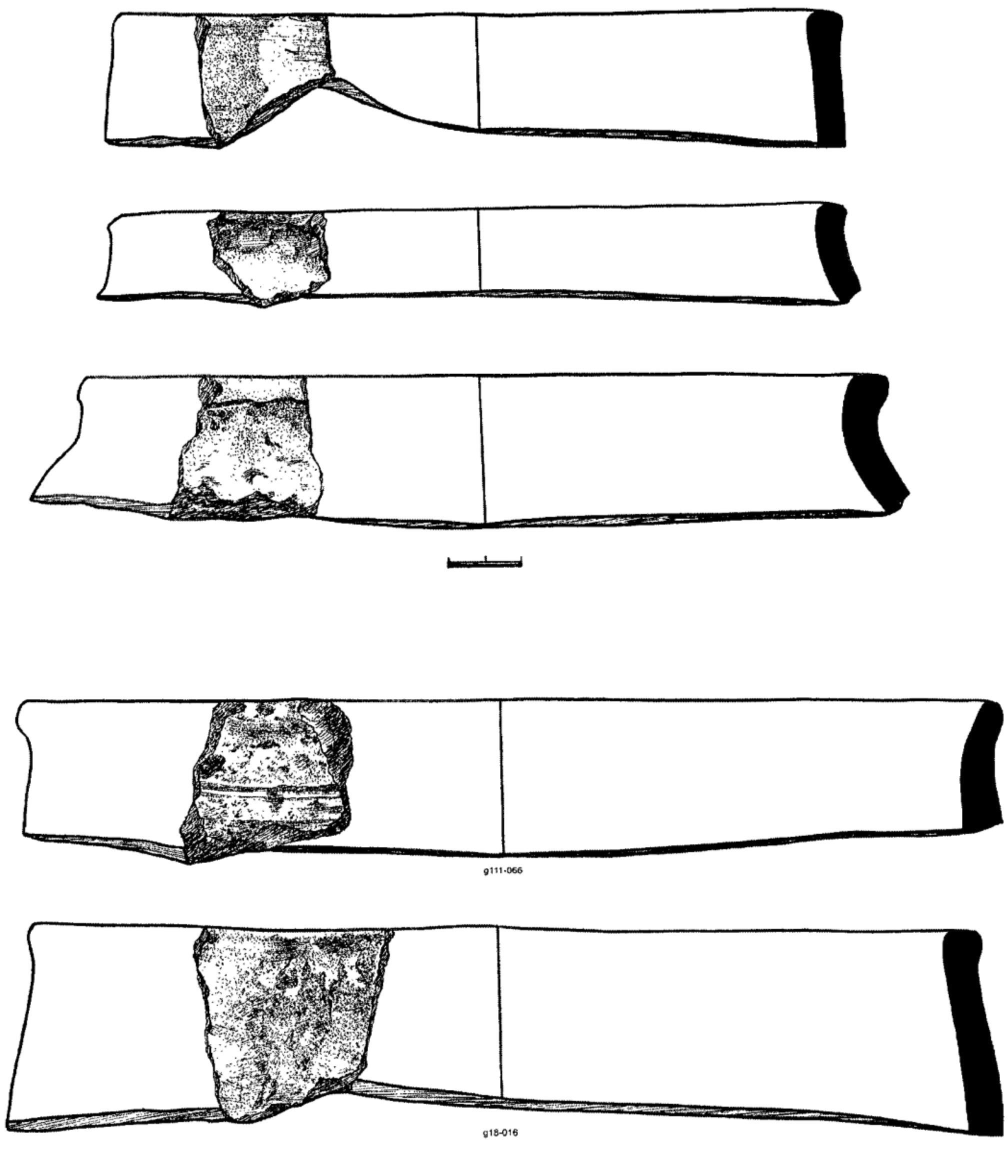


Figure 1. Large Ceramic Vessels from Phase 2 at Begash (Frachetti 2004:352)

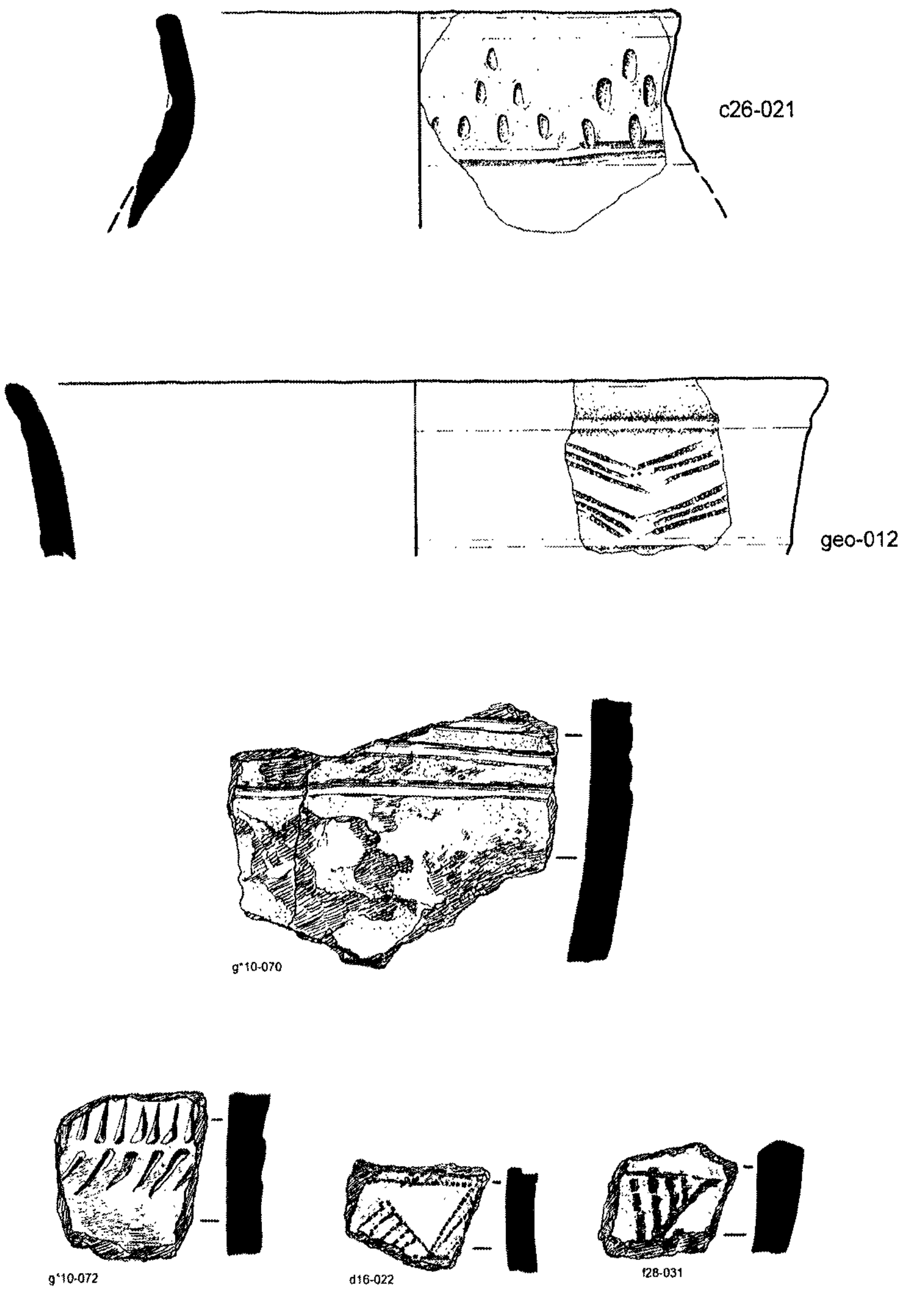


Figure 2. Decorated Ceramics, Typical Late Bronze Age Types, From Phase 2 at Begash (Frachetti 2004b:348)

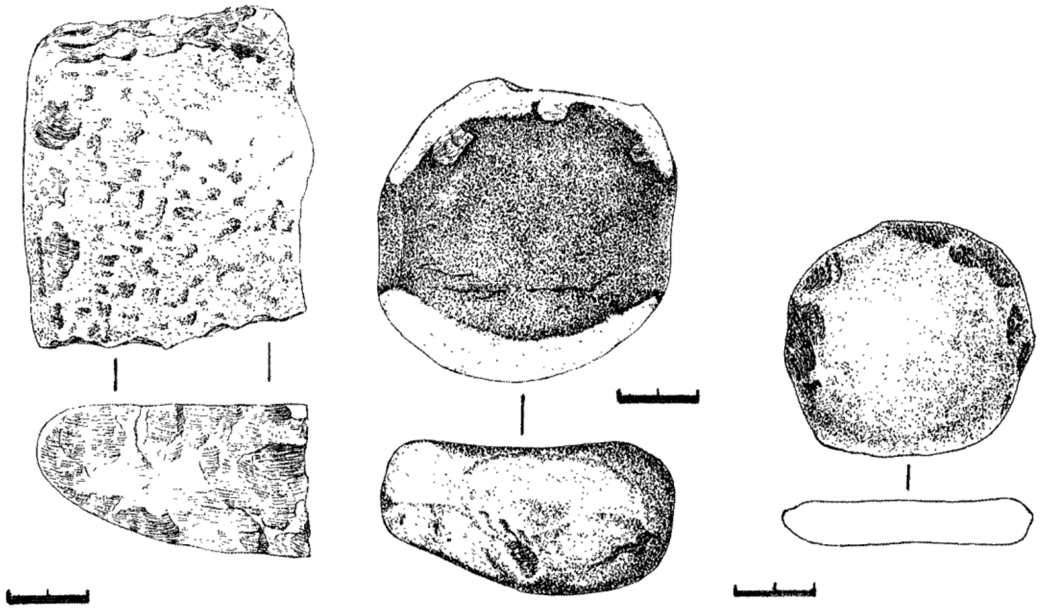


Figure 3. Stone Grinding Tools from Begash, Scale 1:2 (Frachetti 2004b:356)

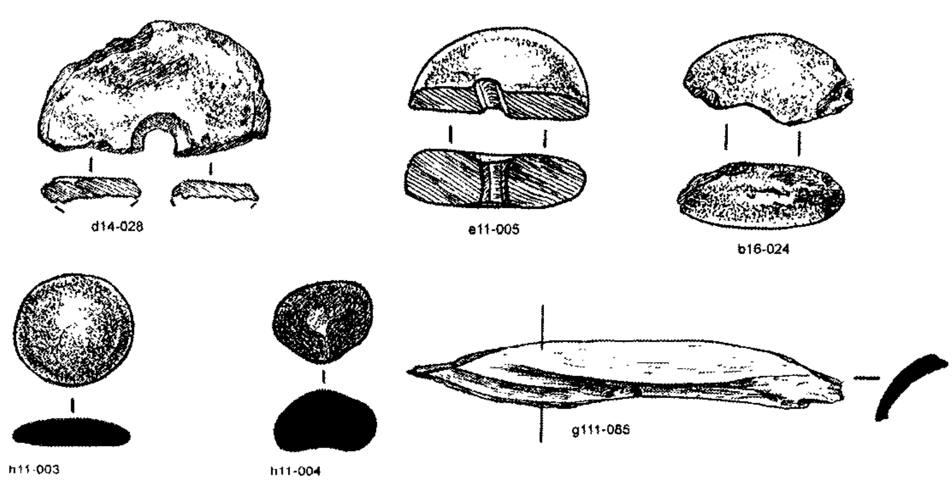
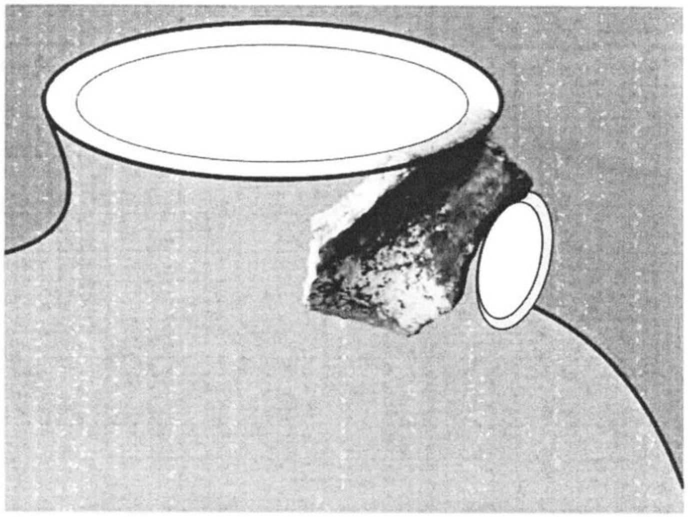
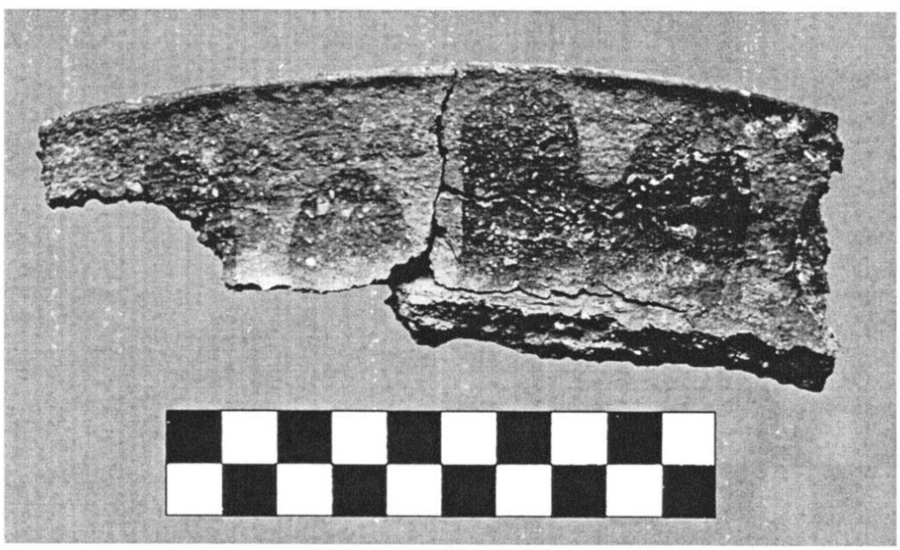


Figure 4. Spindle Whorls, Smooth Pebbles, and Bone Awe (Frachetti 2004b:356)

Mukri



(a)



(b)

Figure 5. Mukri Phase 2 Ceramics: a) Spouted Vessel; b) Painted Wear

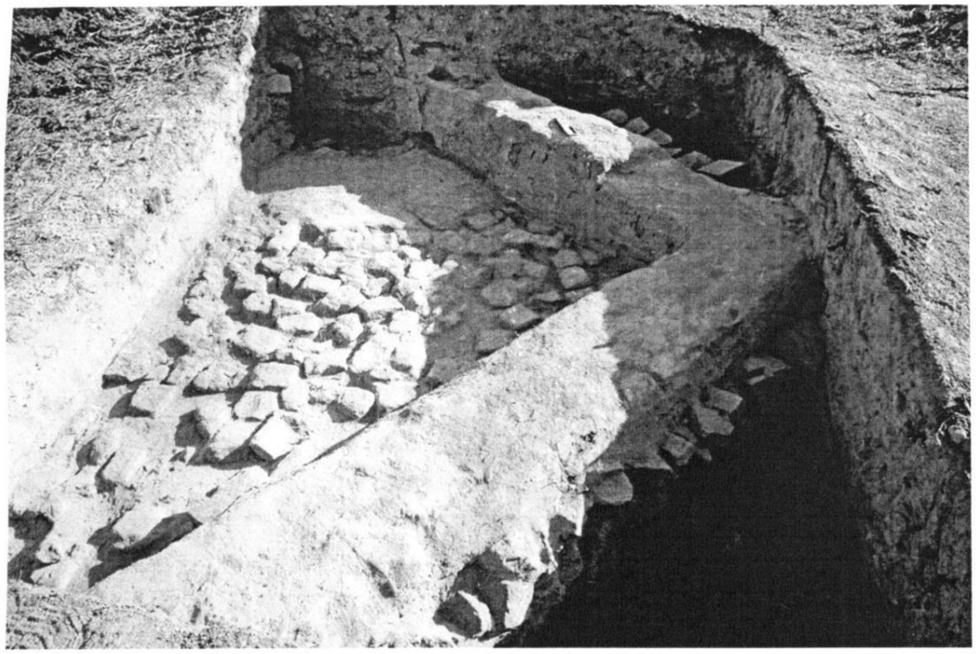


Figure 6. Phase 4 Structure at Mukri

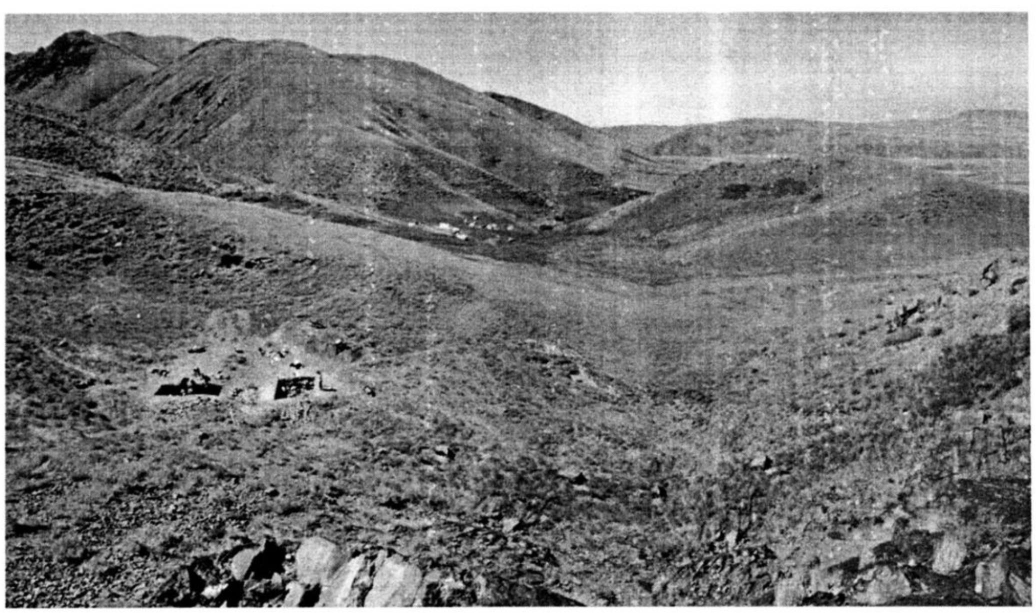


Figure 7. Natural Setting of the Murki Site with Site Depicted

Tuzusai

Figure 8. Feature 23 and 24, Possible Tandoori Oven at Tuzusai (ca. 410 – 150 B.C.)

Figure 9. Open Excavation Units from the 2010 Field Season at Tuzusai, Melted Mud Brick Architecture is Visible

Figure 10. Geoenvironmental Setting of the Talgar Alluvial Fan, View Looking South from the Tuzusai Site

Figure 11. Opening New 2010-2011 Excavation Units at Tuzusai

Figure 12. Open Excavation Units from 2009 at Tuzusai

Figure 13. Rim of a Large Ceramic Storage Vessel, From 2009 at Tuzusai

Figure 14. Open Excavation Units at Tasbas (2011), Excavating in the Deep Trench Unit

Figure 15. Open Excavation Units at Tasbas (2011) Excavated Down to Context 10

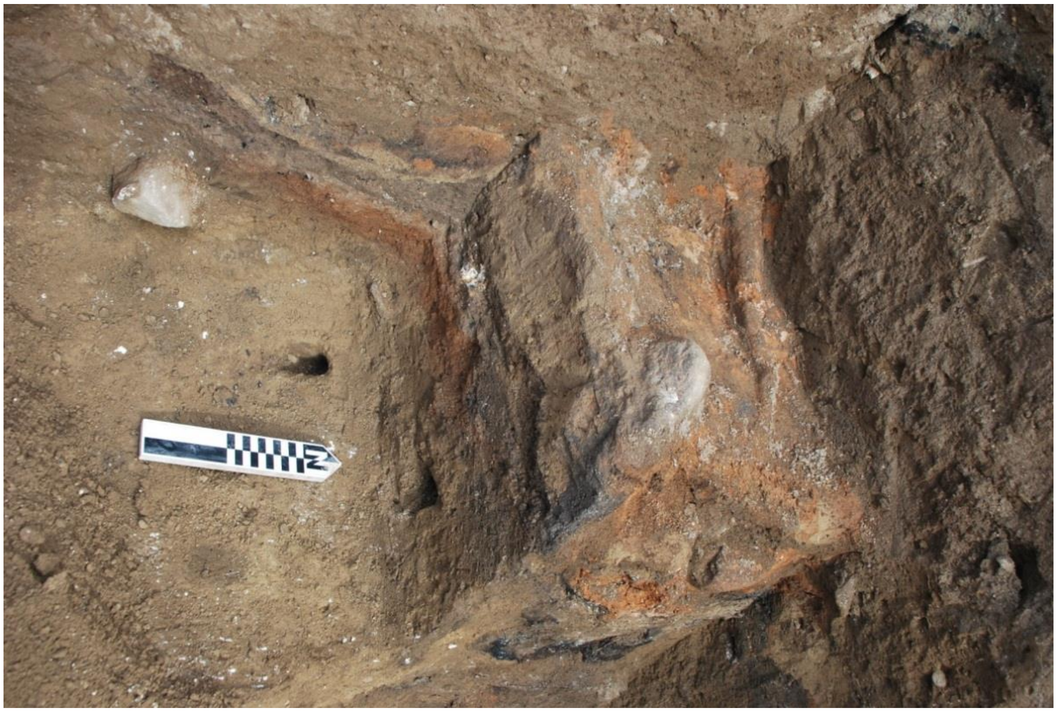


Figure 16. Partially Excavated Oven (Tandoori-Style) from Tasbas (ca. 1400 B.C.)

Figure 17. Environmental Setting around Tasbas, View into the Valley from the site, Showing a Modern Kazakh Herder Moving His Herds to Higher Summer Pastures

B. AMS Carbon 14 results

Calibrated AMS Dates from Tuzusai

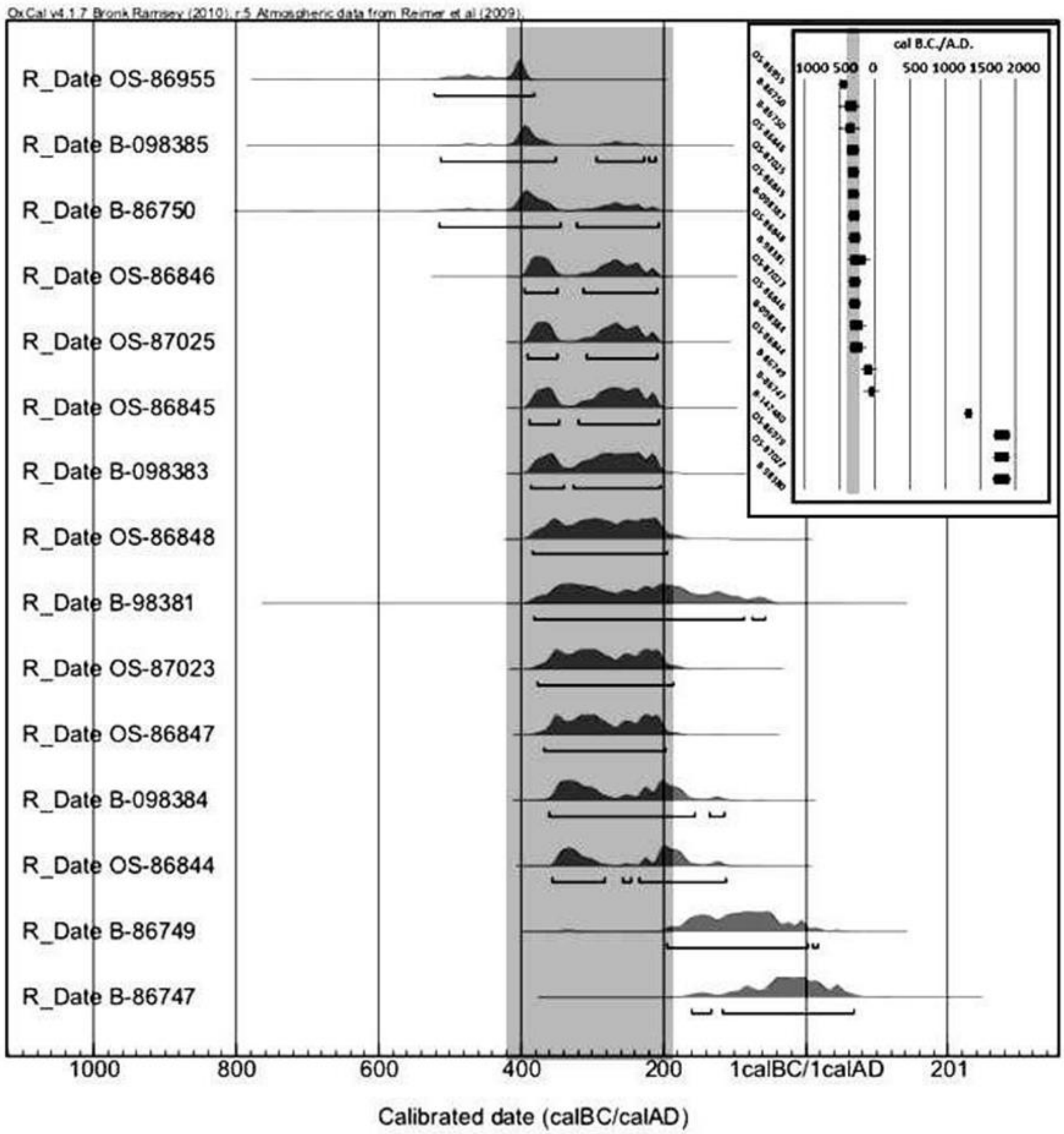


Figure 1. Calibrated AMS Dates for the Iron Age at Tuzusai, Oxcal Mountain Peak Curves, Insert is a Box Graph of the Total Site Dates.

1. OS Dates were run by Woods Hole Institute and are original to this publication, the other dates are from (Chang et al. 2003)

Calibrated AMS Dates from Murki

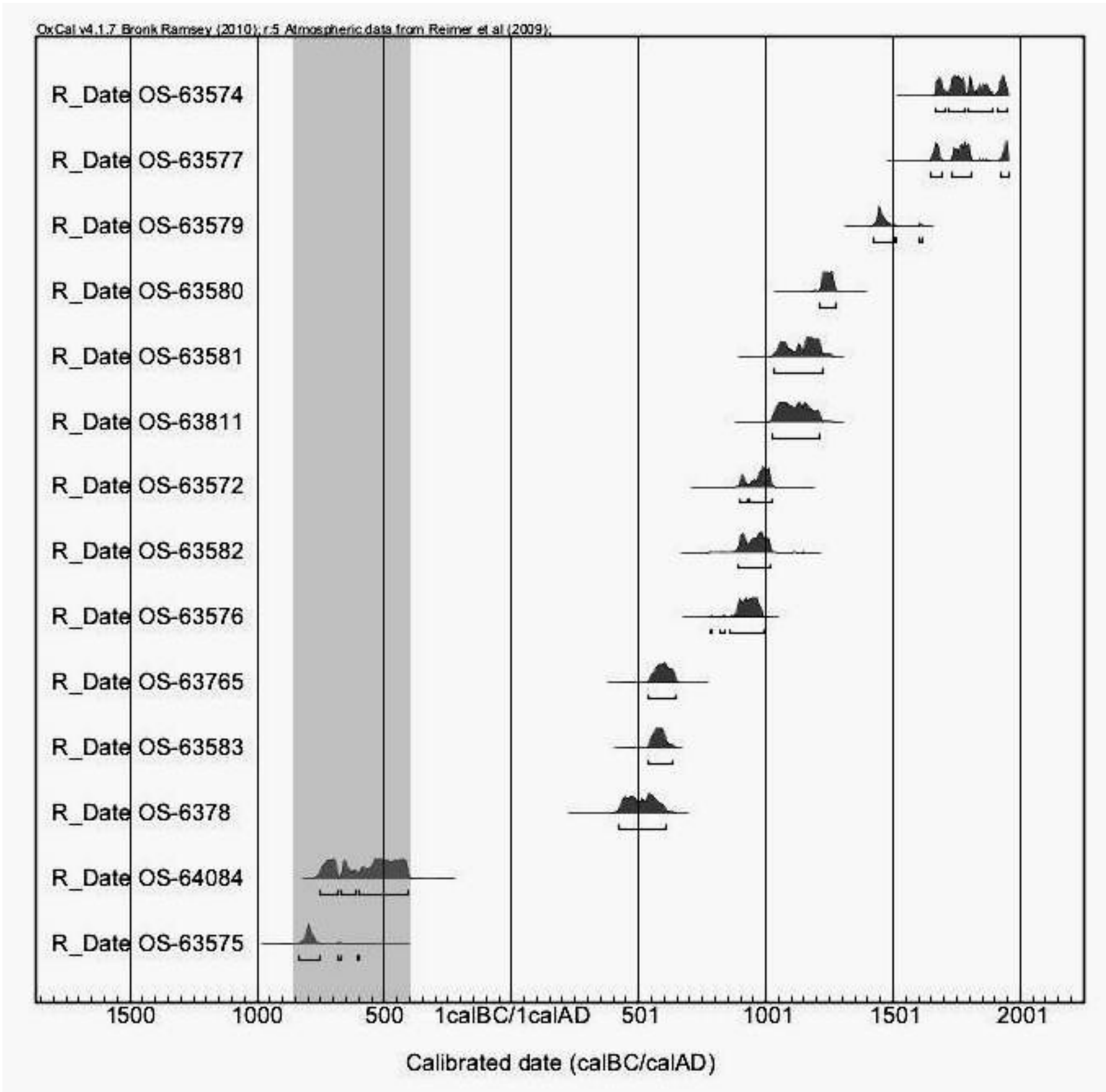


Figure 2. Calibrated AMS Dates for the multiperiod site, Mukri, Oxcal Mountain Peak Curves.

Calibrated AMS Dates for Begash

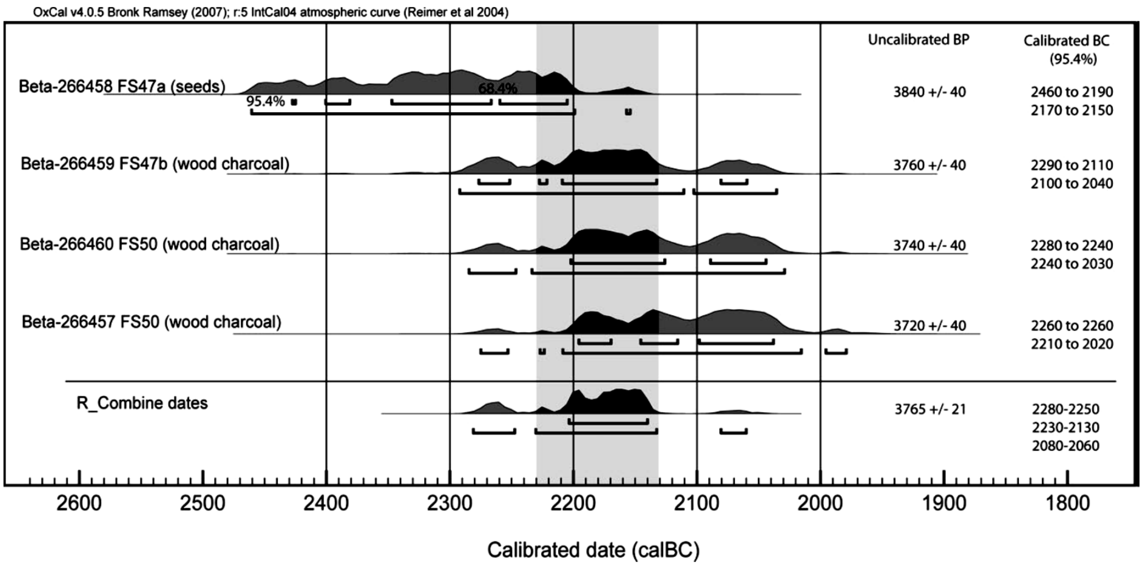


Figure 3. Four Radiocarbon Dates on Grains and Wood from the Middle Bronze Age at Begash

Frachetti (2009) built the chronology for the Begash site based on 39 radiocarbon dates. The four dates here were specifically sent to verify the age of the Middle Bronze Age grains from Begash. For a full Chronology see Frachetti (2009).

C. Average Measurements and Counts of Domestic Grains by Sample

Carbonized Barley Grains from Tuzusai

Sample #	Level	Unit	Vol. Liters	***Hordeum vulgare* var. *vulgare* (Total)**	Number of Fragmentary or Distorted	Number of Whole	Length of Whole	Width of Whole	**Cerealia (Total)**
2008 FS 1	10	Е-II	8.0	75	46	28	4.92	2.76	66
2008 FS 2	12	Д-II	8.0	6	4	2	5.30	3.20	3
2008 FS 3	15	Д-II	8.0						3
		Sub Totals	24.0	81	50	30	5.11	2.98	72
2009 FS 1	14	Д-II	5.0	9	6	3	5.27	2.83	21
2009 FS 2	12	Е-II	4.5						
2009 FS 3	12	Е-II	5.0						3
2009 FS 4	14	Е-II	5.0	3	1	2	4.75	2.60	7
2009 FS 5	15	Ж-II	14.0	5	3	2	4.45	2.75	20
2009 FS 6	16	Е-II	14.5	25	12	13	5.50	2.92	53
2009 FS 7	16	Е-II	12.0	49	32	17	4.92	2.79	59
2009 FS 8	14	Ж-VI	8.0	17	14	3	4.87	2.47	30
2009 FS 9	16	Е-II	6.0	4	1	3	5.13	2.67	45
2009 FS 10	16	Е-II	16.0	19	9	10			236
2009 FS 11	12	Д-VI	11.0	10	8	2	5.45	2.35	54
2009 FS 12	15	Ж-II	10.0	8	6	2	5.00	3.35	24
2009 FS 13	14	Г-II	10.0	14	12	2	5.10	2.65	24
2009 FS 14	13	Д-VI	10.0	12	9	3	5.57	2.80	58
2009 FS 15	14	Д-VI	10.0	1		1	4.50	3.00	18
2009 FS 25	18	Ж-III	10.0	27	24	3	5.33	2.53	30

2009 FS 31	16	E-VII	11.0	9	7	2	4.40	2.75	22
		Sub Totals	167.5	238	164	74	5.04	2.79	801
2010 FS 8	16	Ж-IX	6.0	3	3				4
2010 FS 10	16	Ж-IX	5.0	10	8	2	5.40	3.3	45
2010 FS 11	16	Ж-IX	9.0	11	7	4	5.10	2.88	44
2010 FS 12	7	Ж-1	2.0	2	2				
2010 FS 15	8	Ж-1	4.5						4
		Sub Totals	26.5	26	20	6	5.25	3.09	97
		Totals	191.5	319	214	104	5.13	2.93	873

Carbonized Barley Grains from Tasbas

Sample #	Culture Phase	Date Range	Vol. Liters	***Hordeum vulgare* var. *vulgare* (Total)**	Number of Fragmentary or Distorted	Number of Whole	Length of Whole	Width of Whole	**Cerealia (Total)**
2011FS 10	3a		7.2						
2011FS 11	3a		6.1						
2011FS 12	3a		6.5						
2011FS 13	2		4.3						
2011FS 14	2		6.6	11	5	6	4.58	3.13	13
2011FS 15	2		6.0						
2011FS 16	2		4.9						
2011FS 17	2		7.5	157	87	70	4.39	2.48	266
2011FS 18	2		4.0						
2011FS 19	2		6.8	215	107	108	4.61	3.14	238

2011FS 20	2		7.0						
2011FS 21	2			6					38
2011FS 22	2		4.7						
2011FS 23	2			31	22	9	4.10	2.89	23
2011FS 24	2		7.4	5	1	4	4.98	3.33	22
2011FS 25	1		6.2						5
2011FS 26	1		7.2						2
2011FS 27	1		6.4	21	12	9	4.56	3.12	22
2011FS 28	1		8.0						
2011FS 29	1								
2011FS 30	1								4
		Sub Totals	107.0	446	234	206	4.54	3.02	633

Carbonized Wheat Grains from Tuzusai

Sample #	Level	Unit	Vol. Liters	***Triticum aestivum/turigidum* (Total)**	Number of Fragmentary or Distorted	Number of Whole	Length of Whole	Width of Whole	**Cerealia (Total)**
2008 FS 1	10	E-II	8.0	25	10	15	3.79	2.89	66
2008 FS 2	12	Д-II	8.0	3	1	2	3.75	2.60	3
2008 FS 3	15	Д-II	8.0	2	1	1	3.90	2.50	3
		Sub Totals	24.0	30	12	18	3.81	2.66	72
2009 FS 1	14	Д-II	5.0	13	2	11	3.93	2.92	21
2009 FS 2	12	E-II	4.5	1		1	4.10	2.80	
2009 FS 3	12	E-II	5.0						3
2009 FS 4	14	E-II	5.0	11	6	5	3.74	2.36	7

2009 FS 5	15	Ж-II	14.0	17	11	6	4.09	2.82	20
2009 FS 6	16	E-II	14.5	40	19	11	3.90	2.82	53
2009 FS 7	16	E-II	12.0	30	14	16	3.86	2.70	59
2009 FS 8	14	Ж-VI	8.0	1		1	3.60	2.70	30
2009 FS 9	16	E-II	6.0	11	6	5	4.08	2.96	45
2009 FS 10	16	E-II	16.0	126	77	49	3.92	2.94	236
2009 FS 11	12	Д-VI	11.0	37	20	17	3.80	2.72	54
2009 FS 12	15	Ж-II	10.0	33	19	14	4.04	2.98	24
2009 FS 13	14	Г-II	10.0	9	5	4	4.10	2.93	24
2009 FS 14	13	Д-VI	10.0	24	14	10	4.12	2.88	58
2009 FS 15	14	Д-VI	10.0	14	8	6	4.05	2.73	18
2009 FS 25	18	Ж-III	10.0	16	6	10	4.12	2.76	30
2009 FS 31	16	E-VII	11.0	4	3	1	4.30	2.90	22
		Sub Totals	167.5	419	235	174	3.97	2.79	801
2010 FS 8	16	Ж-IX	6						4
2010 FS 10	16	Ж-IX	5	19	14	5	3.82	2.74	45
2010 FS 11	16	Ж-IX	9	11	9	2	3.90	2.60	44
2010 FS 12	7	Ж-1	2						
2010 FS 15	8	Ж-1	4.5	2	2				4
		Sub Totals	26.5	32	25	7	3.86	2.67	97
		Totals	191.5	449	247	192	3.89	2.71	873

Carbonized Wheat Grains from Tasbas

Sample #	Culture Phase	Date Range	Vol. Liters	***Triticum aestivum/turigidum* (Total)**	Number of Fragmentary or Distorted	Number of Whole	Length of Whole	Width of Whole	**Cerealia (Total)**
2011FS 10	3a		7.2						
2011FS 11	3a		6.1						
2011FS 12	3a		6.5						
2011FS 13	2		4.3						
2011FS 14	2		6.6						13
2011FS 15	2		6.0						
2011FS 16	2		4.9						
2011FS 17	2		7.5	1		1	3.90	2.90	266
2011FS 18	2		4.0						
2011FS 19	2		6.8	2		2	3.25	2.80	238
2011FS 20	2		7.0						
2011FS 21	2								38
2011FS 22	2		4.7						
2011FS 23	2								23
2011FS 24	2		7.4						22
2011FS 25	1		6.2						5
2011FS 26	1		7.2	1		1	3.50	2.80	2
2011FS 27	1		6.4						22
2011FS 28	1		8.0						
2011FS 29	1								
2011FS 30	1			4	3	1	3.90	2.80	4
		Sub Totals	107.0	8	3	5	3.64	2.83	633

Carbonized Broomcorn Millet Grains from Tuzusai

Sample #	Level	Unit	Vol. Liters	***Panicum miliaceum* (Total)**	Number of Fragmentary or Distorted	Number of Immature	Number of Whole	Length of Whole	Width of Whole	Hylum Length	Millet
2008 FS 1	10	E-II	8.0								
2008 FS 2	12	Д-II	8.0	4		1	3	2.03	1.57	0.87	
2008 FS 3	15	Д-II	8.0								
		Sub Totals	24.0	4	0	1	3	2.03	1.57	0.87	0
2009 FS 1	14	Д-II	5.0	16	3	2	11	1.90	1.59	0.69	6
2009 FS 2	12	E-II	4.5	1			1	2.00	1.70	0.90	
2009 FS 3	12	E-II	5.0	1			1	1.90	1.50	0.60	
2009 FS 4	14	E-II	5.0	3	1		2	1.90	1.70	0.75	1
2009 FS 5	15	Ж-II	14.0	8	7		1	2.20	1.60	1.00	5
2009 FS 6	16	E-II	14.5	25	15	2	8	1.91	1.63	0.71	7
2009 FS 7	16	E-II	12.0	23	10	4	9	1.87	1.52	0.73	20
2009 FS 8	14	Ж-VI	8.0	8	2	2	4	1.93	1.55	0.48	1
2009 FS 9	16	E-II	6.0	68	39	7	22	1.91	1.61	0.66	27
2009 FS 10	16	E-II	16.0	58	39	1	19	1.97	1.64	0.55	29
2009 FS 11	12	Д-VI	11.0	5	2	1	2	2.00	1.55	0.90	5
2009 FS 12	15	Ж-II	10.0	17	10	2	5	1.8	1.52	0.82	11
2009 FS 13	14	Г-II	10.0	1		1					
2009 FS 14	13	Д-VI	10.0	4	3		1	2.00	1.50	0.50	
2009 FS 15	14	Д-VI	10.0								
2009 FS 25	18	Ж-III	10.0	37	21	4	12	1.95	1.53	0.72	18
2009 FS 31	16	E-VII	11.0	2	1		1	1.90	1.50	0.60	5
		Sub Totals	167.5	392	217	39	136	1.93	1.57	0.69	153
2010 FS 8	16	Ж-IX	6.0	1	1						
2010 FS 10	16	Ж-IX	5.0	53	37	9	16	1.89	1.62	0.56	1
2010 FS 11	16	Ж-IX	9.0	61	26	4	21	1.76	1.42	0.50	17
2010 FS 12	7	Ж-1	2.0								

2010 FS 15	8	Ж-1	4.5.0								
		Sub Totals	26.5	115	64	13	37	1.82	1.52	0.53	18
		Totals	191.5	396	217	40	139	1.93	1.56	0.70	153

Carbonized Broomcorn Millet Grains from Tasbas

Sample #	Culture Phase	Date Range	Vol. Liters	***Panicum miliaceum* (Total)**	Number of Fragmentary or Distorted	Number of Immature	Number of Whole	Length of Whole	Width of Whole	Hylum Length	**Millet (Total)**
2011FS 10	3a		7.2								
2011FS 11	3a		6.1								
2011FS 12	3a		6.5								
2011FS 13	2		4.3								
2011FS 14	2		6.6	20	15		5	1.74	1.54	0.52	
2011FS 15	2		6.0								
2011FS 16	2		4.9								
2011FS 17	2		7.5	11	7		4	1.85	1.58	0.63	
2011FS 18	2		4.0	2	2						
2011FS 19	2		6.8	4			4	1.88	1.70	0.50	
2011FS 20	2		7.0								
2011FS 21	2										
2011FS 22	2		4.7								
2011FS 23	2			1			1	1.90	1.50	1.00	
2011FS 24	2		7.4	1			1	2.00	1.70	1.10	
2011FS 25	1		6.2	5							
2011FS 26	1		7.2	2							
2011FS 27	1		6.4	20			2	1.95	1.75	0.70	

2011FS 28	1		8.0								
2011FS 29	1										
2011FS 30	1			4							
		Sub Totals	107.0	70	24	0	17	1.89	1.63	0.74	

Carbonized Foxtail Millet Grains from Tuzusai

Sample #	Level	Unit	Vol. Liters	***Setaria italica* (Total)**	Number of Fragmentary or Distorted	Number of Immature	Number of Whole	Length of Whole	Width of Whole	Hylum Length	Millet
2008 FS 1	10	Е-II	8.0								
2008 FS 2	12	Д-II	8.0			1					
2008 FS 3	15	Д-II	8.0								
		Sub Totals	24.0	0	0	1	0	0	0	0	0
2009 FS 1	14	Д-II	5.0	3		1	2	1.80	1.60	1.05	6
2009 FS 2	12	Е-II	4.5								
2009 FS 3	12	Е-II	5.0	1	1						
2009 FS 4	14	Е-II	5.0								1
2009 FS 5	15	Ж-II	14.0	6	2		4	1.50	1.30	0.85	5
2009 FS 6	16	Е-II	14.5	3	1		2	1.40	1.25	1.00	7
2009 FS 7	16	Е-II	12.0								20
2009 FS 8	14	Ж-VI	8.0	2	1		1	1.50	1.20	1.00	1
2009 FS 9	16	Е-II	6.0	6	1		5	1.44	1.22	0.98	27
2009 FS 10	16	Е-II	16.0	20	13		7	1.39	1.17	0.87	29
2009 FS 11	12	Д-VI	11.0								5
2009 FS 12	15	Ж-II	10.0	10	8		2	1.65	1.45	0.9	11
2009 FS 13	14	Г-II	10.0	1	1						
2009 FS 14	13	Д-VI	10.0	1	1						
2009 FS 15	14	Д-VI	10.0								
2009 FS 25	18	Ж-III	10.0	23	9		14	1.63	1.26	0.92	18
2009 FS 31	16	Е-VII	11.0	1	1						5

		Sub Totals	167.5	105	48	1	56	1.52	1.27	0.93	153
2010 FS 8	16	Ж-IX	6.0	2	2						
2010 FS 10	16	Ж-IX	5.0	18	6		12	1.45	1.16	0.88	1
2010 FS 11	16	Ж-IX	9.0	8	1		7	1.40	1.04	0.81	17
2010 FS 12	7	Ж-1	2.0								
2010 FS 15	8	Ж-1	4.5								
		Sub Totals	26.5	28	9	0	19	1.43	1.10	0.85	18
		Totals	191.5	105	48	2	56	1.48	1.21	0.90	153

Carbonized Foxtail Millet Grains from Tasbas

Sample #	Culture Phase	Date Range	Vol. Liters	***Setaria italica* (Total)**	Number of Fragmentary or Distorted	Number of Immature	Number of Whole	Length of Whole	Width of Whole	Hylum Length	**Millet (Total)**
2011FS 10	3a		7.2								
2011FS 11	3a		6.1								
2011FS 12	3a		6.5								
2011FS 13	2		4.3								
2011FS 14	2		6.6	5	2		3	1.67	1.30	1.03	
2011FS 15	2		6.0								
2011FS 16	2		4.9								
2011FS 17	2		7.5								
2011FS 18	2		4.0								
2011FS 19	2		6.8	5	1		4	1.65	1.38	0.78	
2011FS 20	2		7.0								

2011FS 21	2										
2011FS 22	2		4.7								
2011FS 23	2										
2011FS 24	2		7.4								
2011FS 25	1		6.2								
2011FS 26	1		7.2								
2011FS 27	1		6.4	1							
2011FS 28	1		8.0								
2011FS 29	1										
2011FS 30	1										
		Sub Totals	107.0	11	3	0	7	1.66	1.34	0.90	

D. Total Measurements of Domestic Grains by Sample

Hordeum vulgare var. vulgare (Total of Whole, Unpuffed)

Length of Whole	Width of Whole
KTZ08FS01	
6.0	3.2
4.7	2.2
5.5	3.1
4.6	2.9
5.4	2.5
5.8	3.4
5.9	3.0
6.8	4.0
4.7	2.6
4.9	2.5
4.6	2.8
4.7	2.4
5.4	2.9
4.4	2.5
5.2	3.3
4.7	2.9
4.5	2.4
6.5	3.0
4.9	3.3
5.0	2.9
4.2	2.4
4.3	2.5
4.4	2.7
4.0	2.1
4.3	2.7
4.0	2.4
4.4	2.5
4.0	2.2
4.9	**2.8**
KTZ08FS02	
5.0	3.0
5.6	3.4
5.3	**3.2**
KTZ08FS03	
KTZ09FS01	
5.4	3.2
5.9	2.3
4.5	3.0
5.3	**2.8**
KTZ09FS04	
5.3	2.7
4.2	2.5
4.8	**2.6**
KTZ09FS05	
4.5	2.8
4.4	2.7
4.5	**2.8**
KTZ09FS06	
5.7	3.2
6.1	3.0
5.7	2.9
6.0	3.0
5.0	2.6
4.5	2.8
5.5	**2.9**
KTZ09FS07	
6.0	3.3
4.4	2.5
5.1	3.0
4.2	2.6
5.6	3.0
4.7	2.9
5.9	2.7
6.1	3.3
4.9	2.5
3.9	2.7
4.6	2.6
4.5	2.8
5.4	3.7
5.1	2.7
4.1	2.4
5.2	2.7
3.9	2.0
4.9	**2.8**
KTZ09FS08	
5.0	2.2
5.5	2.5
4.1	2.7
4.9	**2.5**
KTZ09FS09	
5.1	2.4
6.1	3.3
4.2	2.3
5.1	**2.7**
KTZ09FS10	
5.2	3.0
5.5	3.3
4.2	2.5
4.2	2.7
4.7	3.0
5.2	3.1
5.0	3.0
3.9	2.1
5.2	2.7
4.2	3.1
4.7	**2.9**

KTZ09FS11	
6.1	2.7
4.8	2.0
5.5	**2.4**
KTZ09FS12	
5.1	3.6
4.9	3.1
5.0	**3.4**
KTZ09FS13	
5.5	3.1
4.7	2.2
5.1	**2.7**
KTZ09FS14	
5.5	2.6
5.6	3.0
5.6	2.8
5.6	**2.8**
KTZ09FS15	
4.5	**3.0**
KTZ09FS25	
5.3	2.3
6.4	2.7
4.3	2.6
5.3	**2.5**
KTZ09FS31	
4.3	2.9
4.5	2.6
4.4	**2.8**
KTZ10FS08	
KTZ10FS10	
6.0	3.5
4.8	3.1
5.4	**3.3**
KTZ10FS11	
5.4	3.1
5.8	3.1
3.6	2.3
5.6	3.0
5.1	**2.9**
KTZ10FS12	
KTZ10FS15	

KTB11FS14	
4.7	2.8
4.0	2.2
4.2	2.6
4.3	3.7
5.1	3.5
5.2	4.0
4.6	**3.1**
KTB11FS17	
4.5	2.6
3.1	2.4
4.2	2.6
4.6	2.4
4.8	3.0
3.5	2.8
3.2	2.1
4.6	3.3
4.6	3.6
4.0	2.5
5.3	2.8
5.4	3.4
3.6	2.9
3.9	2.9
4.9	3.2
3.6	2.6
3.9	2.3
4.3	3.0
4.3	3.0
4.5	2.6
3.5	2.6
4.3	3.0
4.8	3.4
3.2	2.6
4.0	2.2
3.2	2.8
4.6	3.0
3.5	2.4
3.4	2.4
4.1	2.3
4.5	2.6
5.6	3.0
5.0	3.1

4.7	2.6
3.8	2.3
3.5	3.2
3.9	2.3
5.6	4.4
4.4	3.1
5.0	2.7
4.2	2.6
4.0	3.0
3.9	2.6
3.3	2.2
4.1	2.8
4.1	2.0
4.0	2.5
4.1	2.5
4.1	3.0
4.7	2.9
3.7	3.0
4.3	3.1
5.0	2.8
4.6	3.2
4.7	3.1
4.3	2.6
3.8	3.0
4.6	4.0
3.5	3.0
4.1	2.3
4.0	3.3
5.3	3.2
3.6	2.5
5.0	3.6
4.5	3.0
3.2	2.3
4.8	3.2
4.2	3.0
5.4	3.2
5.1	3.2
4.5	2.5
4.3	**2.8**
KTB11FS18	
KTB11FS19	
5.0	3.4

5.2	3.6
4.4	3.0
3.5	2.6
4.1	2.6
4.4	2.7
4.5	3.4
5.2	3.5
5.0	2.7
4.5	2.7
3.8	2.6
4.5	3.4
4.4	2.9
4.0	3.0
5.0	3.1
4.2	2.5
5.1	2.8
4.1	2.6
6.0	3.7
4.0	2.7
5.5	4.1
4.6	3.3
4.7	3.0
4.1	3.0
3.7	3.0
5.2	3.5
4.2	2.9
5.2	2.8
5.0	3.5
5.1	3.3
4.8	4.0
4.9	3.3
4.6	3.3
4.7	2.9
4.4	2.8
5.1	3.3
4.0	3.1
4.9	3.4
3.8	3.3
5.3	3.3
3.6	3.0
5.5	3.9
4.3	2.9
5.4	3.5
4.4	3.0
4.5	2.9
5.0	3.6
5.6	3.8
4.4	3.2
4.0	2.9
5.2	3.8
4.5	3.4
4.5	2.7
4.2	2.9
4.2	3.0
4.0	3.1
5.0	3.6
5.2	3.6
4.6	3.2
4.0	2.8
4.7	3.2
3.8	2.9
6.3	4.3
4.2	3.0
4.4	3.5
4.5	2.9
4.8	3.1
4.7	2.7
4.9	3.2
4.1	2.9
4.1	2.5
5.1	3.1
4.2	2.6
5.2	3.4
4.5	3.4
4.1	3.1
4.7	3.5
4.2	2.7
4.7	2.6
5.5	3.7
3.8	2.9
3.9	2.6
4.6	2.7
3.5	2.9
4.4	2.5
4.4	2.7
4.2	2.5
4.5	2.9
3.5	2.4
4.9	3.2
5.7	4.6
4.3	2.6
5.2	3.8
3.6	2.9
4.9	3.2
4.6	3.1
4.3	3.0
5.0	3.4
4.8	3.2
5.1	3.6
5.9	3.5
4.3	3.1
4.1	3.1
4.5	2.9
4.6	3.5
6.5	4.4
5.5	3.7
4.2	2.9
4.6	**3.1**
KTB11FS20	
KTB11FS21	
KTB11FS23	
3.9	3.1
4.5	3.0
4.3	3.4
4.4	3.3
4.3	3.2
3.6	2.4
4.2	2.3
3.8	2.5
3.9	2.8
4.1	**2.9**
KTB11FS24	
4.9	3.2
4.5	3.2
5.2	3.4
5.3	3.5
5.0	**3.3**
KTB11FS25	

KTB11FS26	
KTB11FS27	
3.8	3.0
4.7	3.3
5.7	3.6
4.2	2.7
4.8	3.3
4.3	2.6
4.5	3.0
4.3	3.0
5.0	3.2
4.6	**3.1**
KTB11FS28	
KTB11FS29	
KTB11FS30	

Triticum turgidum/aestivum (Total of Whole, Unpuffed)

Length of Whole	Width of Whole
KTZ08FS01	
3.2	2.4
3.7	2.4
3.6	2.9
3.8	3.0
4.4	3.3
3.8	3.0
3.2	2.6
4.0	3.2
3.7	2.8
4.3	3.3
3.6	3.2
4.4	3.2
3.5	2.5
3.6	2.5
4.1	3.0
3.8	**2.9**
KTZ08FS02	
3.6	2.4
3.9	2.8
3.8	**2.6**
KTZ08FS03	
3.9	**2.5**
KTZ09FS01	
4.0	3.3
4.5	3.4
4.3	3.3
4.1	3.0
4.1	3.0
3.0	2.2
3.4	2.8
4.0	2.4
4.0	2.8
3.8	2.9
4.0	3.0
3.9	**2.9**
KTZ09FS02	
4.1	**2.8**
KTZ09FS03	
KTZ09FS04	
4.3	2.6
3.3	2.4
3.8	2.6
4.0	2.2
3.3	2.0
3.7	2.4
KTZ09FS05	
3.8	2.3
4.0	3.3
4.4	2.9
4.5	3.1
4.0	2.9
4.0	3.0
3.4	2.7
4.3	3.1
4.0	2.6
4.2	2.8
4.5	2.7
4.3	2.6
3.8	2.7
4.1	**2.8**
KTZ09FS06	
3.4	2.8
3.5	2.9
4.0	2.1
4.0	3.2
4.1	3.2
3.9	3.2
4.2	2.9
4.0	2.5
3.6	2.7
4.1	3.0
4.1	3.0
3.9	**2.9**
KTZ09FS07	
3.8	3.0
3.3	2.5
4.4	2.7
3.6	3.1
4.3	2.7
4.8	2.6
3.6	2.5
4.1	3.2
3.3	2.1
4.0	3.1
3.6	2.5
3.7	2.9
3.9	2.9
4.5	2.5
3.3	2.4
3.6	2.5
3.9	**2.7**
KTZ09FS08	
3.6	2.7
KTZ09FS09	
4.3	3.1
4.1	3.1
3.7	2.8
3.7	2.4
4.6	3.4
4.1	**3.0**
KTZ09FS10	
3.2	2.6
4.1	2.9
3.8	2.7
4.1	3.2

4.1	2.8
3.6	3.0
4.1	2.5
4.1	2.7
3.7	2.6
3.7	2.9
3.9	2.9
3.6	2.9
3.9	3.0
4.0	3.2
4.1	2.7
3.9	3.1
4.1	3.1
4.0	2.7
4.2	3.2
4.3	3.1
4.3	3.3
4.0	2.6
3.8	3.5
4.0	3.5
3.6	3.0
3.7	2.8
3.4	2.8
3.8	2.6
3.9	2.9
4.0	3.1
3.6	2.6
3.9	2.7
3.4	3.0
3.8	3.0
4.1	3.1
3.8	3.1
4.6	3.7
4.5	2.8
4.0	3.4
3.8	2.6
3.5	2.6
3.5	2.5
4.6	3.0
4.3	3.3
3.5	2.9
4.2	2.9
4.5	3.3

3.6	3.0
4.1	3.0
3.9	**2.9**
KTZ09FS11	
4.1	2.7
3.7	2.8
4.2	3.0
3.0	2.2
3.9	2.8
4.8	2.3
3.5	2.6
4.5	2.5
4.1	3.0
3.1	2.8
3.2	2.3
4.0	2.8
4.2	3.6
4.1	3.4
3.0	2.2
3.7	2.9
3.5	2.4
3.8	**2.7**
KTZ09FS12	
4.1	2.9
3.9	2.5
4.2	3.1
4.1	3.6
4.5	3.2
4.4	3.2
4.0	2.8
3.7	2.6
4.7	3.5
4.0	3.0
3.8	3.1
4.3	3.1
3.3	2.5
3.5	2.6
4.0	**3.0**
KTZ09FS13	
3.9	3.0
3.6	3.0
5.0	3.4

3.9	2.3
4.1	**2.9**
KTZ09FS14	
4.2	2.6
4.3	3.8
4.0	3.1
3.8	2.9
4.3	2.9
4.0	1.9
3.9	2.8
4.1	2.5
4.1	3.0
4.5	3.3
4.1	2.9
KTZ09FS15	
3.4	2.5
4.5	3.6
4.9	3.3
4.2	2.5
4.3	2.3
3.0	2.2
4.1	**2.7**
KTZ09FS25	
3.8	2.7
4.6	3.2
3.5	2.6
4.0	2.7
3.2	1.7
4.0	3.1
3.9	2.5
3.8	3.3
4.5	3.3
5.9	2.5
4.1	**2.8**
KTZ09FS31	
4.3	**2.9**
KTZ10FS08	
KTZ10FS10	
3.8	2.4
3.6	2.6
3.2	2.2
4.5	3.0

4.0	3.5
3.8	**2.7**
KTZ09FS11	
4.0	2.9
3.8	2.3
3.9	**2.6**
KTZ09FS12	
KTZ09FS15	
KTB11FS14	
KTB11FS17	
3.9	**2.9**
KTB11FS18	
KTB11FS19	
3.0	2.7
3.5	2.9
3.3	**2.8**
KTB11FS20	
KTB11FS21	
KTB11FS23	
KTB11FS24	
KTB11FS25	
KTB11FS26	
3.5	**2.8**
KTB11FS27	
KTB11FS28	
KTB11FS29	
KTB11FS30	
3.9	**2.8**

Panicum miliaceum (Total of Whole, Unpuffed)

Length of Whole	Width of Whole	Hylum Length
KTZ08FS01		
KTZ08FS02		
2.1	1.6	0.6
1.9	1.3	0.9
2.1	1.8	1.1
2.0	**1.6**	**0.9**
KTZ08FS03		
KTZ09FS01		
1.7	1.2	0.5
1.6	1.4	0.4
2.0	1.8	0.6
2.0	1.8	0.7
2.0	1.7	0.7
2.2	1.9	0.9
1.9	1.5	0.6
1.8	1.6	0.8
1.9	1.4	0.9
1.9	1.6	0.9
1.9	1.6	0.6
1.9	**1.6**	**0.7**
KTZ09FS02		
2.0	**1.7**	**0.9**
KTZ09FS03		
1.9	**1.5**	**0.6**
KTZ09FS04		
1.9	1.6	0.6
1.9	1.8	0.9
1.9	**1.7**	**0.8**
KTZ09FS05		
2.2	**1.6**	**1.0**
KTZ09FS06		
2.0	1.6	0.9
1.6	1.5	0.6
1.7	1.5	0.5
2.0	1.7	1.0
2.5	1.8	0.8
2.1	1.7	0.6
1.8	1.8	0.8
1.6	1.5	0.5
1.9	**1.6**	**0.7**
KTZ09FS07		
1.6	1.2	0.5
2.1	1.6	1.0
1.8	1.6	0.6
1.7	1.4	0.6
1.7	1.5	0.7
1.9	1.6	0.8
2.0	1.3	0.7
2.1	1.9	0.8
1.9	1.6	0.9
1.9	**1.5**	**0.7**
KTZ09FS08		
2.0	1.6	0.5
1.8	1.6	0.4
2.0	1.8	0.5
1.9	1.2	0.5
1.9	**1.6**	**0.5**
KTZ09FS09		
1.9	1.7	0.8
1.9	1.7	0.9
2.0	1.7	0.5
2.0	1.6	0.5
1.9	1.6	1.1
2.1	1.7	0.9
2.0	1.6	0.7
2.0	1.7	0.8
1.7	1.5	0.5
1.9	1.6	0.7
1.6	1.5	0.5
1.8	1.7	0.7

1.9	1.5	0.6
1.7	1.5	0.4
1.6	1.4	0.5
2.1	1.7	0.8
2.1	1.7	0.6
1.9	1.7	0.7
2.0	1.5	0.5
1.6	1.3	0.3
2.0	1.6	0.7
2.1	1.7	0.9
2.2	1.8	0.6
1.9	**1.6**	**0.7**
KTZ09FS10		
2.3	2.0	0.6
2.0	1.5	0.9
1.8	1.7	0.4
2.0	1.7	0.4
1.8	1.4	0.3
1.9	1.8	0.4
2.1	1.6	0.5
2.1	1.6	0.6
2.3	1.8	0.5
1.7	1.7	0.6
1.9	1.4	0.3
2.0	1.7	0.5
2.0	1.4	0.5
1.9	1.9	0.6
1.9	1.7	0.7
1.8	1.4	0.5
2.1	1.7	1.0
1.8	1.4	0.5
2.0	1.7	0.6
2.0	**1.6**	**0.5**
KTZ09FS11		
2.3	1.5	1.2
1.7	1.6	0.6
2.0	**1.5**	**0.9**
KTZ09FS12		
1.6	1.4	0.7
2.0	1.5	0.8
1.4	1.3	0.6
1.8	1.7	0.9

2.2	1.7	1.1
1.8	**1.5**	**0.8**
TKZ09FS13		
TKZ09FS14		
2.0	**1.5**	**0.5**
TKZ09FS15		
TKZ09FS25		
1.7	1.8	0.7
1.6	1.4	0.6
2.1	1.2	0.6
2.1	1.6	0.9
1.5	1.3	0.7
2.0	1.6	0.8
2.2	1.3	0.9
2.1	1.6	0.5
2.1	1.7	0.6
1.9	1.6	0.9
2.0	1.6	0.7
2.1	1.6	0.7
2.0	**1.5**	**0.7**
KTZ09FS31		
1.9	**1.5**	**0.6**
KTZ10FS08		
KTZ10FS10		
2.0	1.6	0.5
1.8	1.6	0.5
1.9	1.7	0.5
1.8	1.5	0.4
2.0	1.6	0.6
1.8	1.6	0.3
2.0	1.6	0.4
2.0	1.9	0.4
2.1	1.7	0.5
1.6	1.4	0.4
2.0	1.8	0.4
2.2	2.0	1.2
1.7	1.6	0.4
1.8	1.5	0.5
1.6	1.2	1.0
2.0	1.6	1.0
1.9	**1.6**	**0.6**
KTZ10FS11		

2.0	1.5	0.6
1.5	1.5	0.3
1.9	1.6	0.5
2.1	1.7	0.5
1.8	1.3	0.3
1.7	1.2	0.3
2.0	1.2	0.5
1.9	1.5	0.6
2.1	1.5	0.6
1.6	1.4	0.4
1.5	1.3	0.4
1.3	1.2	0.4
2.0	1.6	0.6
1.8	1.4	0.6
1.8	1.4	0.5
1.8	1.6	0.7
1.7	1.4	0.3
1.6	1.3	0.7
1.6	1.3	0.3
1.7	1.7	0.7
1.6	1.3	0.7
1.8	**1.4**	**0.5**
KTZ09FS12		
KTZ09FS15		
KTB11FS14		
1.6	1.5	0.6
1.9	1.7	0.7
1.6	1.4	0.4
1.9	1.5	0.4
1.7	1.6	0.5
1.7	**1.5**	**0.5**
KTB11FS17		
1.9	1.6	0.6
2.0	1.7	0.6
1.7	1.5	0.6
1.8	1.5	0.7
1.9	**1.6**	**0.6**
KTB11FS18		
KTB11FS19		
2.0	1.7	0.6
2.1	1.8	0.8

1.7	1.7	0.3
1.7	1.6	0.3
1.9	**1.7**	**0.5**
KTB11FS20		
KTB11FS21		
KTB11FS23		
1.9	**1.5**	**1.0**
KTB11FS24		
2.0	**1.7**	**1.1**
KTB11FS25		
KTB11FS26		
KTB11FS27		
2.0	2.0	0.8
1.9	1.5	0.6
2.0	1.8	0.7
KTB11FS28		
KTB11FS29		
KTB11FS30		

Setaria italica (Total of Whole, Unpuffed)

Length of Whole	Width of Whole	Hylum Length
KTZ08FS01		
KTZ08FS02		
KTZ08FS03		
KTZ09FS01		
1.8	1.5	1.0
1.8	1.7	1.1
1.8	**1.6**	**1.1**
KTZ09FS02		
KTZ09FS03		
KTZ09FS04		
KTZ09FS05		
1.6	1.5	1.0
1.4	1.2	0.7
1.4	1.3	0.7
1.6	1.2	1.0
1.5	**1.3**	**0.9**
KTZ09FS06		
1.2	1.3	0.8
1.6	1.2	1.2
1.4	**1.3**	**1.0**
KTZ09FS07		
KTZ09FS08		
1.5	**1.2**	**1.0**
KTZ09FS09		
1.4	1.0	0.8
1.6	1.1	1.1
1.7	1.6	0.9
1.5	1.1	1.0
1.0	1.3	1.1
1.4	**1.2**	**1.0**
KTZ09FS10		
1.2	1.0	0.7
1.5	1.2	0.9
1.5	1.3	0.8
1.3	1.2	0.9
1.6	1.3	1.0
1.3	1.0	0.9
1.3	1.2	0.9
1.4	**1.2**	**0.9**
KTZ09FS11		
KTZ09FS12		
1.5	1.2	0.8
1.8	1.7	1.0
1.7	**1.5**	**0.9**
KTZ09FS13		
KTZ09FS14		
KTZ09FS15		
KTZ09FS25		
1.5	1.1	0.9
1.7	1.3	1.0
1.6	1.3	0.9
1.7	1.3	0.9
1.6	1.3	0.9
1.5	1.2	0.9
1.6	1.0	0.9
1.6	1.4	0.7
1.5	1.4	1.0
1.8	1.4	0.9
1.7	1.0	1.0
1.8	1.3	1.1
1.7	1.2	0.9
1.5	1.4	0.9
1.6	**1.3**	**0.9**
KTZ09FS31		
KTZ10FS08		
KTZ10FS10		
1.6	1.1	0.8
1.6	1.1	0.9
1.5	1.2	0.8
1.3	1.2	0.9

1.3	1.0	0.7
1.2	1.1	0.7
1.3	1.2	0.7
1.5	1.2	1.0
1.5	1.1	1.0
1.6	1.3	1.0
1.5	1.1	1.0
1.5	1.3	1.0
1.5	**1.2**	**0.9**
KTZ10FS11		
1.4	1.0	0.8
1.8	1.3	1.0
1.7	1.3	0.8
1.2	1.0	0.6
1.2	0.9	0.8
1.3	0.9	0.8
1.2	0.9	0.9
1.4	1.0	0.8
KTZ10FS12		
KTZ10FS15		
KTB11FS14		
1.7	1.3	1.1
1.6	1.3	0.9
1.7	1.3	1.1
1.7	**1.3**	**1.0**
KTB11FS17		
KTB11FS18		
KTB11FS19		
1.8	1.5	0.9
1.5	1.4	0.6
1.6	1.3	0.9
1.7	1.3	0.7
1.7	**1.4**	**0.8**
KTB11FS20		
KTB11FS21		
KTB11FS23		
KTB11FS24		
KTB11FS25		
KTB11FS26		
KTB11FS27		
KTB11FS28		

KTB11FS29
KTB11FS30

Measurments of whole carbonized *Panicum miliaceum* from the Begash

Sample Number & Age	Archaeological Context (liters floated L)	Total (n)	# of whole	# of frag. or puffed	Measurements of whole seeds: Length (mm)	Width (mm)	Scutellum height (mm)	Scutellum/ seed length Ratio
FS2 A.D.1220-1420	Domestic hearth (6L)	45	8	37	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 B.C.	Domestic hearth (9.5L)	24	11	13	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
FS19 1950-1700 cal B.C.	Domestic hearth (5L)	1		1				
FS47 2460-2040 cal B.C.	Burial Cist, Ash from Human Cremation (30.8 L)	12	2	10	1.6	1.4	0.6	0.40
					1.5	1.5	0.6	0.60
FS44 2260-2020 cal B.C.	Funerary fire-pit (upper level) (9.5 L)	10	4	6	1.6	1.5	0.5	0.31
					1.9	1.6	0.9	0.47
					2.2	2.1	1.1	0.50
					1.8	1.5	1.0	0.56
FS50 2280-2030 cal B.C.	Funerary fire-pit (lower level) (2.0 L)	4	1	3	1.6	1.5	1.0	0.63
FS48 2460-1950 cal B.C.	Domestic hearth (3.0 L)	1	1		1.5	1.4	0.9	0.60
FS45 2460-1950 cal B.C.	Domestic Hearth (3.1 L)	1	1		1.7	1.6	0.5	0.38

Measurments of whole carbonized *Setaria* from Begash.

Sample Number & Age	Archaeological Context (liters floated L)	Total (n)	# of whole	# of frag. or puffed	Measurements of whole seeds	
					Length (mm)	Width (mm)
FS2 A.D.1220-1420	Domestic hearth (6L)	45	8	37	1.8	1.0
					1.7	1.2
					1.8	1.1
					1.8	1.2
FS6 390-50 cal B.C.	Domestic hearth (9.5L)	24	11	13	2.0	1.2
					2.0	1.0
					2.0	1.1
					1.8	1.1
					1.8	1.1
					1.9	0.9
					1.9	1.0
					2.0	1.0
					2.0	1.0
					1.9	0.9

- Note that most *Setaria* measured were still in their Palea and lemma, and therefore, hylum measurements were not taken.

E. Contrasts Between other Eurasian Sites

Archaeobotany in Central Asia (Domesticated Grains/Legumes and Fruits)

	Site Name	*Hordeum vulgare var. nudum*	*Hordeum vulgare var. vulgare*	*Triticum aestivum/turgidum*	*T. "sphaerococcum"*	*T. cf. dicoccum*	*Panicum miliaceum*	*Setaria italica*	*Cicer*	*Lathyrus*	*Lens*	*Pisum*	*Pistacia vera*	*Vitis vinifera*	*Malva*	*Prunus*	*P. dulcis*	*Celtis*
Turkmenistan	Anua North (4500-3000 cal B.C.)	x		x												x		
	Anua South (3000-1700 cal B.C.)	x		x	x							x		x				
	Gonur-Depe (early 2nd Mill. B.C.)	x		x	x	x			x	x	x	x		x	x	x		
	Gonur-Depe, Loc. 43	x		x		x					x			x				
	Djarkutan (early 2nd Mill. B.C.)	x		x							x		x	x				
	Sites 1211/1219 (1400 B.C.)	x		x	x		x			x	x	x						
	Ojakly (1600 B.C.)	x		x	x		x											
	Dam Dam Cheshme (1200-900 cal B.C.)		x	?														
	Takhirbai Depe (c. 1000 B.C.)		x				x											
Kazakhstan	Tuzusai (410 - 150 cal B.C.)	x	x	x			x	x						x				
	Mukri (ca. 200 cal B.C.)			x			x											
	Tasbas (ca 1400 cal B.C.)				x		x					x						
	Begash (Iron Age)			x			x	x										
	Begash (Bronze ca. 2200 cal B.C.)				x		x											
Afghanistan	Mundigak (ca. 4th Mill. B.C.)			x														
	Shortughai (2nd Mill. B.C.)	x		x			x							x				
	Deh Morasi Ghundai (ca. 4000 B.C.)	?	?															
Uzbekistan	Sarazm (4th-3rd Mill. B.C.)	x	x	x									x			x	x	x

Table 1. Paleoethnobotanical Studies in Central Asia – Anau, Gonur-Depe, Djarkutan (Miller 1999; Moore et al. 1994); Sites 1211/1219, Ojakly (also called 1685, Spengler et al. in review); Dam Dam Cheshme, Anau (Harris 2010); Takhirbai Depe (Herrmann and Kurbansakhatov 1994); Tuzusai (Spengler et al. 2013); Begash (Frachetti et al. 2010b); Shortughai (Willcox 1991); Sarazm (Spengler and Willcox in press); Mundigak, Deh Morasi Ghundai (Kajale 1991)

Table 2. Select Categories from Archaeobotanical Assemblages from Sites in Southern Central Asia, on the Eastern Steppe, and in Semerich'ye

	Site Name	Liters Floated	*Hordeum vulgare*	*Triticum aestivum*	*T. aestivum/durum*	*T. "sphaerococcum"*	*T. cf. dicoccum*	Cereal	*Panicum miliaceum*	*Setaria italica*	*Cicer* sp.	*Lens* sp.	*Pisum sativum*	*Pistacia* sp.	*Vitis* sp.	*Malva* sp.	*Prunus* sp.	*Amaranthus* spp.	*Chenopodium album*	*Chenopodium* spp.	*Polygonum* sp.	*Rumex* sp.	*Galium* sp.
Southern	Anua North[1]	NK*	250-750	26-100												1-25							
	Anua South[1]	NK	250-750	26-100		1-25							1-25		1-25								
	Gonur Tepe[1]	NK	250-750	26-100		1-25	1-25				1-25	26-100	1-25		26-100	1-25	1-25						
	Djarkutan[1]	NK	>2000		26-100							26-100		1-25	26-100								
	Gonur Tepe Loc. 43[1]	NK	139	2				88				5			2								
Western Steppe	Krasosomarskoe F-10[2]	27																11	282	84	83	26	6
	Krasosomarskoe Lv 5, 6[2]	24																	1		3	1	
	Krasosomarskoe Lv 7+[2]	24																1	3		2		
	Peschanyi Dol 1[2]	1																10	1				
	Peschanyi Dol 2[2]	11																62	135	36			
	Peschanyi Dol 3[2]	4																24	25	3	1	1	
	Kibit 1 Lv 6[2]	3																	2				
	Kibit 1 Lv 7[2]	27																	6	5			1
	Kibit 1 Lv 8[2]	27																	7	5			
	Kibit 1 Lv 9[2]	18																1	17	14			
	Kibit 1 Lv 10[2]	5																	3	3			
Eastern	Tuzusai (Iron Age)[3]	NK	P*	P		2			P	P													
	Taldy Bulak2(Iron Age)[3]			1				26												14			1
	Begash (Iron Age)	18.5.							30	23									70	59	301		47
	Begash (Bronze Age)	13.5.																	62	320	15		157

*NK indicates unknown data, P indicates present (quantity unknown)

1. Data in table came from ([1]) Miller (1999), ([2]) Popova (2006), ([3]) Chang et al. (2002), Spengler (2008)

Appendix F. Table 1: Begash (pg 1 of 6) *Yellow columns indicate uncarbonized seeds

						Domestic Grains										Vitaceae			Poaceae								
Sample #	Culture Phase	Date Range	Vol. Liters	Wood (> 2.00 mm) Ct.	Wood (> 2.00 mm) Wt.	*Hordeum vulgare var. vulgare*	*Triticum aestivum/turigidum*	Cerealia	Spiklete Fork/Rachis	*Panicum miliaceum*	*Panicum miliaceum* *	*Setaria* bristle clump	*Setaria italica*	*Setaria italica* *	Millet	*Vitis vinifera*	*Pisum sativum*	Barley - immature or wild	Poaceae	Poaceae*	Panicoid-Type	Panicoid A	Pooid-Type	Pooid(*cf. Aegilops*)	*Setaria*(*cf. viridis*)	*Setaria*(*cf. viridis*) *	*Stipa*-Type
FS 1	Mongol	A.D. 1220-1420	16.5	87	0.58				1										2		3						29
FS 2	Mongol	A.D. 1220-1420	6	NC	128.78					45	1		11						2		8			1			
FS 33	Mongol	A.D. 1220-1420	1.35	250	1.63																						1
		Sub Totals	23.9	NC	130.99	0	0	0	1	45	1	0	11	0	0	0	0	0	4	0	11	0	0	1	0	0	30
FS 5	Saka	390-50 cal B.C.	4.5	NC	28.29																						
FS 6	Saka	390-50 cal B.C.	9	4	0.04					24		1	19	1	5										4		12
FS 7	Saka	390-50 cal B.C.	1.9	105	0.78								1								4						1
FS 8	Saka	390-50 cal B.C.	1.8	14	0.09										1												18
FS 9	Saka	390-50 cal B.C.	2	45	0.27																						
FS 31	Saka	390-50 cal B.C.	0.85	1	0.01																						
FS 30	Saka	390-50 cal B.C.	0.8	0	0																						1
FS 34	Saka	390-50 cal B.C.	1.05	NC	13.2		1																				1
FS 35	Saka	390-50 cal B.C.	1.2	NC	14.42																						
FS 11	Saka	760-400 cal B.C.	2	19	0.23																1						11
FS 13	Saka	760-400 cal B.C.	2	30	0.14			1																			11
FS 14	Saka	760-400 cal B.C.	3.5	21	0.18																1			1			6
FS 20	Saka	760-400 cal B.C.	2	24	0.16														1								20
		Sub Totals	32.6	NC	57.81	0	1	1	0	24	0	1	20	1	6	0	0	0	1	0	6	0	0	1	4	0	81

Appendix F. Table 1: Begash (pg 2 of 6)

						Domestic Grains										Vitaceae			Poaceae								
Sample #	Culture Phase	Date Range	Vol. Liters	Wood (> 2.00 mm) Ct.	Wood (> 2.00 mm) Wt.	*Hordeum vulgare var. vulgare*	*Triticum aestivum/turigidum*	Cerealia	Spiklete Fork/Rachis	*Panicum miliaceum*	*Panicum miliaceum* *	*Setaria* bristle clump	*Setaria italica*	*Setaria italica* *	Millet	*Vitis vinifera*	*Pisum sativum*	Barley - immature or wild	Poaceae	Poaceae*	Panicoid-Type	Panicoid A	Pooid-Type	Pooid(*cf. Aegilops*)	*Setaria*(*cf. viridis*)	*Setaria*(*cf. viridis*) *	*Stipa*-Type
FS 12	Fedorovo	1625-1000 cal B.C.	9.5	67	0.48																1						10
FS 10	Fedorovo	1950-1700 cal B.C.	9	144	1.2																2						
FS 19	Fedorovo	1950-1700 cal B.C.	5	11	0.03					1																	11
FS 36	Fedorovo	1950-1700 cal B.C.	0.4	4	0.03																						1
FS 37	Fedorovo	1950-1700 cal B.C.	1	6	1.03																						
FS 38	Fedorovo	1950-1700 cal B.C.	5	15	1.06																						9
FS 39	Fedorovo	1950-1700 cal B.C.	0.7	59	0.23																1						
FS 40	Fedorovo	1950-1700 cal B.C.	3.1	NC	13.55																						30
FS 41	Fedorovo	1950-1700 cal B.C.	0.85	4	0.02																						
FS 43	Fedorovo	1950-1700 cal B.C.	1.8	19	0.08																						1
FS 42		2450-1950 cal B.C.	6.2	688	7.13																						
FS 44		2450-1950 cal B.C.	9.5	NC	14.77					10											1						2
FS 45		2450-1950 cal B.C.	3.1	50	0.43					1											1						1
FS 46		2450-1950 cal B.C.	1.25	425	2.61																						8
FS 47		2450-1950 cal B.C.	30.8	NC	16.59		1	4		9					3						3						11
FS 48		2450-1950 cal B.C.	3	256	2.02					1																1	2
FS 49		2450-1950 cal B.C.	5	NC	6.13																						2
FS 50		2450-1950 cal B.C.	2	NC	9.23					4																	4
		Sub Totals	97.2	NC	76.62	0	1	4	0	26	0	0	0	0	3	0			0	0	9	0	0	0	0	1	92
		Totals	154	NC	265.42	0	2	5	1	95	1	1	31	1	9	0			5	0	26	0	0	2	4	1	203

Appendix F. Table 1: Begash (pg 3 of 6)

Amaranthaceae							Rubiaceae		Solanaceae			Malvaceae		Asteraceae					Polygonaceae					Caryophyllaceae			Boraginaceae						Lamiaceae		
Chenopodium spp.	*Chenopodium* spp. *	Cheno-ams	Cheno-ams *	*Polycnemum(cf. arvense)*	*Polycnemum(cf. arvense)* *	*Amaranthus* sp. *	*Galium* sp.	*Galium* sp. *	Solanaceae	*Hyoscyamus niger*	*Hyoscyamus niger* *	*Malva(cf. sylvestris)*	*Malva(cf. sylvestris)* *	Asteraceae	Asteraceae A	*Onopordon acanthium*	*Onopordon acanthium* *	*Xanthium* sp. (Fruit Coat)	Polygonaceae	*Polygonum spp.*	*Polygonum spp.* *	*Polygonum (persicaria*-Type)	*Rumex* sp. *	Caryophyllaceae *	Caryophyllaceae	*Vaccaria/Saponaria*	*Lithospermum arvense*	*Lithospermum arvense* *	*Lithospermum officiale*	*Lithospermum officiale* *	*Anchusa* sp. *	*Echium* sp. *	*Lamiaceae* *	*Mentha/Nepata*-Type	*Mentha/Nepata*-Type *
85	198	67	42	8	1		166			37	10	121		3	12		4		1	25	3		2		1										2
34	95	16	2	1	37		29	1		4	3	1	1		5					11	11	2													3
2	1						3			2																									
121	294	83	44	9	38	0	198	1	0	43	13	122	1	3	17	0	4	0	1	36	14	2	2	0	1	0	0	0	0	0	0	0	0	0	5
4	71	3			2		9			3	17		1		1					1															
14	54	7		2	5		2			5	5	1			1					300	5														
4	4	2					1				2	5																							
7	2	7					13			2	2	9			1																				
												1								1															
										1																									
		1					1			1																									
	20				2		2			2																									
3							6			2					1																				
11	3	2					9			4		1																							
7	2	17					4			4	2	2	2		1					1	1														
32	45	11	1				9			4	11				1																				
12	60	16		3			23			11	1	4			1								1												
94	261	66	1	5	9	0	79	0	0	39	40	23	3	0	7	0	0	0	0	303	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0

Appendix F. Table 1: Begash (pg 4 of 6)

Amaranthaceae							Rubiaceae		Solanaceae			Malvaceae		Asteraceae					Polygonaceae					Caryophyllaceae			Boraginaceae						Lamiaceae		
Chenopodium spp.	*Chenopodium spp.* *	Cheno-ams	Cheno-ams *	*Polycnemum(cf. arvense)*	*Polycnemum(cf. arvense)* *	*Amaranthus* sp.*	*Galium* sp.	*Galium* sp. *	Solanaceae	*Hyoscyamus niger*	*Hyoscyamus niger* *	*Malva(cf. sylvestris)*	*Malva(cf. sylvestris)* *	Asteraceae	Asteraceae A	*Onopordon acanthium*	*Onopordon acanthium* *	*Xanthium* sp. (Fruit Coat)	Polygonaceae	*Polygonum spp.*	*Polygonum spp.* *	*Polygonum (persicaria*-Type)	*Rumex* sp. *	Caryophyllaceae *	Caryophyllaceae	*Vaccaria/Saponaria*	*Lithospermum arvense*	*Lithospermum arvense* *	*Lithospermum officiale*	*Lithospermum officiale* *	*Anchusa* sp. *	*Echium* sp. *	*Lamiaceae* *	*Mentha/Nepata*-Type	*Mentha/Nepata*-Type *
40	3	32					28			11		39	4		4				2	12														2	
65		72					4			2	1	1								2															3
48		122					125								34					1															
		1					5																												
1	4				2					1																									
112		116					4			55					1																				
3		7																																	
9		4																		5							1								
		4					6			2																									
9		7					8			3					2					1															
5		15					78																												
21	1	21			1	1	121			1					1		1			6							1	1							
7	2	13					18			4										1															
2							15																												
57	2	50				1	79			9	10				1					1							1								
4	1	24					13			2					6					2															
138		24					32													1															
8		2					24			1					2																				
529	13	514	0	0	3	2	560	0	0	91	11	40	4	0	51	0	1	0	2	32	0	0	0	0	0	0	3	1	0	0	0	0	0	2	3
744	568	663	45	14	50	2	837	1	0	173	64	185	8	3	75	0	5	0	3	371	20	2	3	0	1	0	3	1	0	0	0	0	0	2	8

Appendix F. Table 1: Begash (pg 5 of 6)

Rosaceae			Fabaceae					Convolvulaceae		Hypericaceae	Zygophyllaceae	Cannabaceae	Plantaginaceae	Brassicaceae	Cyperaceae		Seed-Types											Unidentified		Unidentifiable						
Rosa	*Fragaria/Potentilla*	*Fragaria/Potentilla* *	Fabaceae	Fabaceae *	Fabaceae A	Fabaceae(*cf.Trifolium/Melilotus*)	*Trigonella*-Type	Convolvulaceae	Convolvulaceae *	*Hypericum* sp.	*Tribulus terrestris*	*Cannabis sativa* ssp. *ruderalis* *	*Plantago* sp. *	Brassicaceae	*Cyperaceae*	*Ajuga*	Seed A (*Malvaeae*)	Seed B (Euphorbia-like shape)	Seed C (wrinkly)	Seed D (New)	Seed F (Tear drop)	Seed G (minature prunus)	Seed H (Flat)	Seed J	Seed K (striations)	Seed L	Seed L*	Unidentified Seed	Unidentified Seed *	Unidentifiable Seed Fragments	Unidentifiable Seed Fragments *	Nut Shell	Awn	Thorn	Fibers	Totals with Uncarb., without Unident.
						10	412						1					4										8		248	16					1258
							36																					7		76			3			367
							1																							5						10
0	0	0	0	0	0	10	449	0	0	0	0	0	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	15	0	329	16	0	3	0	0	1635
																														5						112
	2																											3	1	103			149	1	5	473
							9																							24						33
	1	1					14																							35						78
																														4						2
							1																													2
							3																					4								11
							2																							1						30
							3																							2						15
							5							1														2	1	13				1		51
						1	15																							20						71
						2	12																					3	2	22						141
							20																						2	26	3					175
0	3	1	0	0	0	3	84	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	12	6	255	3	0	149	2	5	1194

Appendix F. Table 1: Begash (pg 6 of 6)

Rosaceae			Fabaceae					Convolvulaceae		Hypericaceae	Zygophyllaceae	Cannabaceae	Plantaginaceae	Brassicaceae	Cyperaceae		Seed-Types											Unidentified		Unidentifiable						
Rosa	*Fragaria/Potentilla*	*Fragaria/Potentilla* *	Fabaceae	Fabaceae *	Fabaceae A	Fabaceae(*cf.Trifolium/Melilotus*)	*Trigonella*-Type	Convolvulaceae	Convolvulaceae *	*Hypericum* sp.	*Tribulus terrestris*	*Cannabis sativa* ssp. *ruderalis* *	*Plantago* sp. *	Brassicaceae	*Cyperaceae*	*Ajuga*	Seed A (*Malvaeae*)	Seed B (Euphorbia-like shape)	Seed C (wrinkly)	Seed D (New)	Seed F (Tear drop)	Seed G (minature prunus)	Seed H (Flat)	Seed J	Seed K (striations)	Seed L	Seed L*	Unidentified Seed	Unidentified Seed *	Unidentifiable Seed Fragments	Unidentifiable Seed Fragments *	Nut Shell	Awn	Thorn	Fibers	Totals with Uncarb., without Unident.
							27				4			2														9		85			1	3		230
							40			1																				58						193
						1	81																					5		116					5	429
							7																							1						14
							6																					1		1						15
							52																							16						349
							10																						1	3						22
							12																					1		17						62
							4																													16
							67																							11						98
							12																							8						110
							82																						1	41	1					273
							44																					2		14						94
							5																							6						30
							28																					1		49						271
		1					18																						1	34						76
							16																							2			1			213
							11																					11		3						67
0	0	1	0	0	0	1	522	0	0	1	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	30	3	465	1	0	2	3	5	2562
0	3	2	0	0	0	14	1055	0	0	1	4	0	1	3	0	0	0	4	0	0	0	0	0	0	0	0	0	57	9	1049	20	0	154	5	10	5391

Appendix F. Table 2: Mukri and Tuzusai 2008 – 2010 (pg 1 of 6) *Yellow columns indicate uncarbonized seeds

Mukri	Wusun		0.45	18	0.21		1	1		20					10										61		
Sample #	Level	Unit	Vol. Liters	Wood (> 2.00 mm) Ct.	Wood (> 2.00 mm) Wt.	*Hordeum vulgare var. vulgare*	*Triticum aestivum/turigidum*	Cerealia	Spiklete Fork/Rachis	*Panicum miliaceum*	*Panicum miliaceum* *	*Setaria* bristle clump	*Setaria italica*	*Setaria italica* *	Millet	*Vitis vinifera*	*Pisum sativum*	Barley - immature or wild	Poaceae	Poaceae*	Panicoid-Type	Panicoid A	Pooid-Type	Pooid(*cf. Aegilops*)	*Setaria*(*cf. viridis*)	*Setaria*(*cf. viridis*) *	*Stipa*-Type
2008 FS 1	10	Е-II	8	26	0.45	75	25	66													2						1
2008 FS 2	12	Д-II	8	12	0.05		2	10		4									4		7						3
2008 FS 3	15	Д-II	8	2	0.02		2	3													1						
		Sub Totals	24	40	0.52	75	29	79	0	4	0	0	0	0	0	0			4	0	10	0	0	0	0	0	4
2009 FS 1	14	Д-II	5	NC	2	9	13	21	1	16			3		6						4				4		2
2009 FS 2	12	Е-II	4.5	0	0		1			1																	
2009 FS 3	12	Е-II	5	6	0.04			3		1			1								1				2		
2009 FS 4	14	Е-II	5	55	0.1	3	11	7		3					1					2				1	3		
2009 FS 5	15	Ж-II	14	27	0.16	5	17	20		8			6		5	1									15		1
2009 FS 6	16	Е-II	14.5	270	2.08	25	40	53		25			3		7					1					4		5
2009 FS 7	16	Е-II	12	65	0.64	49	30	59		23			7		20					1		5			11		7
2009 FS 8	14	Ж-VI	8	18	0.05	17	1	30		8			2		1				1						2		
2009 FS 9	16	Е-II	6	47	0.51	4	11	45	1	68			6		27				1						4		
2009 FS 10	16	Е-II	16	84	0.39	19	126	236		58	2		20	6	33				3		2				13	34	
2009 FS 11	12	Д-VI	11	98	0.43	10	37	54		5					5				2						2		2
2009 FS 12	15	Ж-II	10	80	0.37	8	33	24		17			10		11				4			2			13	1	1
2009 FS 13	14	Г-II	10	12	0.06	14	9	24		1			1						3						2		4
2009 FS 14	13	Д-VI	10	15	0.13	12	24	58		4			1														
2009 FS 15	14	Д-VI	10	17	0.28	1	14	18																			3
2009 FS 25	18	Ж-III	11	86	0.58	27	16	30	1	37			23		18				3	1		5			7		3
2009 FS 31	16	Е-VII	10	5	0.05	9	4	22		2			1		5				1						1		1
		Sub Totals	162	NC	7.87	212	387	704	3	277	2	0	84	6	139	1	0	0	18	5	7	12	0	1	83	35	29

Appendix F. Table 2: Mukri and Tuzusai 2008 – 2010 (pg 2 of 6)

Sample #	Level	Unit	Vol. Liters	Wood (> 2.oo mm) Ct.	Wood (> 2.oo mm) Wt.	*Hordeum vulgare var. vulgare*	*Triticum aestivum/turigidum*	Cerealia	Spiklete Fork/Rachis	*Panicum miliaceum*	*Panicum miliaceum* *	*Setaria* bristle clump	*Setaria italica*	*Setaria italica* *	Millet	*Vitis vinifera*	*Pisum sativum*	Barley - immature or wild	Poaceae	Poaceae*	Panicoid-Type	Panicoid A	Pooid-Type	Pooid(*cf. Aegilops*)	*Setaria*(*cf. viridis*)	*Setaria*(*cf. viridis*) *	*Stipa*-Type
2010 FS 8	16	Ж-IX	6	15	0.08	3		4		1			2						4								
2010 FS 10	16	Ж-IX	5	13	0.08	10	19	45	1	53			18		1	3			1		5				4		
2010 FS 11	16	Ж-IX	9	12	0.04	11	11	44		61			8	1	17				7		5			1	7		2
2010 FS 12	7	Ж-1	2	1	0	2															1						
2010 FS 15	8	Ж-I	4.5	2	0.01		2	4											1								
		Sub Totals	26.5	43	0.21	26	32	97	1	115	0	0	28	1	18	3	0	0	13	0	11	0	0	1	11	0	2
		Totals	213	NC	8.6	313	448	880	4	396	2	0	112	7	157	4	0	0	35	5	28	12	0	2	94	35	35

Appendix F. Table 2: Mukri and Tuzusai 2008 – 2010 (pg 3 of 6)

Chenopodium spp.	*Chenopodium* spp. *	Cheno-ams	Cheno-ams *	*Polycnemum*(*cf. arvense*)	*Polycnemum*(*cf. arvense*) *	*Amaranthus* sp.*	*Galium* sp.	*Galium* sp. *	Solanaceae	*Hyoscyamus niger*	*Hyoscyamus niger* *	*Malva*(*cf. sylvestris*)	*Malva*(*cf. sylvestris*) *	Asteraceae	Asteraceae A	*Onopordon acanthium*	*Onopordon acanthium* *	*Xanthium* sp. (Fruit Coat)	Polygonaceae	*Polygonum* spp.	*Polygonum* spp. *	*Polygonum* (*persicaria*-Type)	*Rumex* sp. *	Caryophyllaceae *	Caryophyllaceae	*Vaccaria/Saponaria*	*Lithospermum arvense*	*Lithospermum arvense* *	*Lithospermum officiale*	*Lithospermum officiale* *	*Anchusa* sp. *	*Echium* sp. *	*Lamiaceae* *	*Mentha/Nepata*-Type	*Mentha/Nepata*-Type *
84		4																																	
6							5											9		1	1				1		27	1	2						
11										1																	16								
2	10	1					1													1							10								
19	10	1	0	0	0	0	6	0	0	1	0	0	0	0	0	0	0	9	0	2	1	0	0	0	1	0	53	1	2	0	0	0	0	0	0
11		5					3					1						1		1							3								
								1															1												
3							3										5																		
12							2										3									1	1	1							
18	5	8				3	7										2	1		4							13								
6	3																	1		4							9								
30	2	6					6											2		8					3		13	1		1					
	14						2	2									12				7						4								1
2		2																							1		1	1							
5	46	1					5										19			2	23						13	34	1		1	2			
5	3	1				3	2			1										1	1									1					
3	3					3	2											1		2							2		1						
2	3						6											1		1						1									
3											1							2											2						
		1					1											2																	
14	8						5					1					3			2	1						1						1		
2	1	2				1	6											1								1			1						
116	88	26	0	0	0	10	50	3	0	1	1	2	0	0	0	0	44	12	0	25	32	0	1	0	4	3	60	37	5	2	1	2	1	0	1

Appendix F. Table 2: Mukri and Tuzusai 2008 – 2010 (pg 4 of 6)

Chenopodium spp.	*Chenopodium* spp. *	Cheno-ams	Cheno-ams *	*Polycnemum(cf. arvense)*	*Polycnemum(cf. arvense)* *	*Amaranthus* sp. *	*Galium* sp.	*Galium* sp. *	Solanaceae	*Hyoscyamus niger*	*Hyoscyamus niger* *	*Malva(cf. sylvestris)*	*Malva(cf. sylvestris)* *	Asteraceae	Asteraceae A	*Onopordon acanthium*	*Onopordon acanthium* *	*Xanthium* sp. (Fruit Coat)	Polygonaceae	*Polygonum spp.*	*Polygonum spp.* *	*Polygonum* (*persicaria*-Type)	*Rumex* sp. *	Caryophyllaceae *	Caryophyllaceae	*Vaccaria/Saponaria*	*Lithospermum arvense*	*Lithospermum arvense* *	*Lithospermum officiale*	*Lithospermum officiale* *	*Anchusa* sp. *	*Echium* sp. *	*Lamiaceae* *	*Mentha/Nepata*-Type	*Mentha/Nepata*-Type *
																										2	7								
8		1					3												4				2		1	74	6								
11		3				1			2	2													26			1	6								
																					1			1		1									
2	15						1																				1								
21	15	4	0	0	0	1	4	0	2	2	0	0	0	0	0	0	0	0	4	0	1	0	28	1	1	78	20	0	0	0	0	0	0	0	0
156	113	31	0	0	0	11	60	3	2	4	1	2	0	0	0	0	44	21	4	27	34	0	29	1	6	81	133	38	7	2	1	2	1	0	1

Appendix F. Table 2: Mukri and Tuzusai 2008 – 2010 (pg 5 of 6)

Rosa	*Fragaria/Potentilla*	*Fragaria/Potentilla* *	Fabaceae	Fabaceae *	Fabaceae A	Fabaceae(*cf.Trifolium/Melilotus*)	*Trigonella*-Type	Convolvulaceae	Convolvulaceae *	*Hypericum* sp.	*Tribulus terrestris*	*Cannabis sativa* ssp. *ruderalis* *	*Plantago* sp. *	Brassicaceae	*Cyperaceae*	*Ajuga*	Seed A (*Malvaeae*)	Seed B (Euphorbia-like shape)	Seed C (wrinkly)	Seed D (New)	Seed F (Tear drop)	Seed G (minature prunus)	Seed H (Flat)	Seed J	Seed K (striations)	Seed L	Seed L*	Unidentified Seed	Unidentified Seed *	Unidentifiable Seed Fragments	Unidentifiable Seed Fragments *	Nut Shell	Awn	Thorn	Fibers	Totals with Uncarb., without Unident.
																														37						181
	1																											3		207						226
							1																					1		45						60
						1	4																							10						36
0	1	0	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	262	0	0	0	0	0	322
								1													1									64						106
																														4						4
						1	1																							11						21
	1					1	3														1				1					23						58
1							2														1									40		4				143
			1														1					2								72						190
			1				1																					2		118						288
							3										2		2										3	30	1					114
																														83						174
			1	2					4			633											4				1	1	4	71						1354
						1																						1		42						137
						2	5					1																		52						149
							4					1					1				1				1			2		70						82
					3						1													2					1	61						114
																														32						40
							1																							30						208
							4																		1	1				9						67
1	1	0	3	2	3	5	24	1	4	0	1	635	0	0	0	0	4	0	2	0	4	2	4	2	3	1	1	6	8	812	1	4	0	0	0	3249

Appendix F. Table 2: Mukri and Tuzusai 2008 – 2010 (pg 6 of 6)

Rosa	*Fragaria/Potentilla*	*Fragaria/Potentilla* *	Fabaceae	Fabaceae *	Fabaceae A	Fabaceae(*cf. Trifolium/Melilotus*)	*Trigonella*-Type	Convolvulaceae	Convolvulaceae *	*Hypericum* sp.	*Tribulus terrestris*	*Cannabis sativa* ssp. *ruderalis* *	*Plantago* sp. *	Brassicaceae	*Cyperaceae*	*Ajuga*	Seed A *(Malvaceae)*	Seed B (Euphorbia-like shape)	Seed C (wrinkly)	Seed D (New)	Seed F (Tear drop)	Seed G (minature prunus)	Seed H (Flat)	Seed J	Seed K (striations)	Seed L	Seed L*	Unidentified Seed	Unidentified Seed *	Unidentifiable Seed Fragments	Unidentifiable Seed Fragments *	Nut Shell	Awn	Thorn	Fibers	Totals with Uncarb., without Unident.
																														15						23
	3		5		2			1																2				3		116				1		275
						3	2								3						3			3				1		102						242
																														2						6
																																				26
0	3	0	5	0	2	3	2	1	0	0	0	0	0	0	3	0	0	0	0	0	3	0	0	5	0	0	0	4	0	235	0	0	0	1	0	572
1	5	0	8	2	5	9	31	2	4	0	1	635	0	0	3	0	4	0	2	0	7	2	4	7	3	1	1	14	8	1309	1	4	0	1	0	4143

Appendix F. Table 3: Tasbas (pg 1 of 3) *Yellow columns indicate uncarbonized seeds

Sample #	Level	Unit	Vol. Liters	Wood (> 2.oo mm) Ct.	Wood (> 2.oo mm) Wt.	*Hordeum vulgare var. vulgare*	*Triticum aestivum/turigidum*	Cerealia	Spiklete Fork/Rachis	*Panicum miliaceum*	*Panicum miliaceum* *	*Setaria* bristle clump	*Setaria italica*	*Setaria italica* *	Millet	*Vitis vinifera*	*Pisum sativum*	Barley - immature or wild	Poaceae	Poaceae*	Panicoid-Type	Panicoid A	Pooid-Type	Pooid(*cf. Aegilops*)	*Setaria*(*cf. viridis*)	*Setaria*(*cf. viridis*) *	*Stipa*-Type
FS 14	2		6.6	NC	1.52	11		13		20			5					1	6		6		6		9		
FS 17	2		7.5	110	0.63	157	1	266	64	11							5		7		3		16		9		6
FS 18	2		4	151	1.15					2									1						1		
FS 19	2		6.8	NC	8.28	215	2	238	1	4			5				50	16			6		9		13		173
FS 20	2		7	12	0.06														3						1		
FS 21	2			64	0.25	6		38																	1		
FS 23	2			69	0.18	31		23	3	1								3									
FS 24	2		7.4	240	1.69	5		22		1							3	1	9		2				2		3
FS 25	1		6.2	NC	6.83			5																			
FS 26	1		7.2	NC	0.26		1	2																			
FS 27	1		6.4	232	1.8	21		22		2			1				1		6		3		1				2
FS 28	1		8	34	0.12																						
FS 29	1			NC	1.45																						
FS 30	1			NC	3.1		4	4																			
		Sub Totals	67.3	912	27.327	446	8	633	68	41	0	0	11	0	0	0	59	21	32	0	20	0	32	0	36	0	184
		Grand Totals	433	930	301.6	759	459	1519	73	552	3	1	154	8	176	4	59	21	72	5	74	12	32	4	195	36	422

Appendix F. Table 3: Tasbas (pg 2 of 3)

Chenopodium spp.	*Chenopodium* spp. *	Cheno-ams	Cheno-ams *	*Polycnemum(cf. arvense)*	*Polycnemum(cf. arvense)* *	*Amaranthus* sp.*	*Galium* sp.	*Galium* sp. *	Solanaceae	*Hyoscyamus niger*	*Hyoscyamus niger* *	*Malva(cf. sylvestris)*	*Malva(cf. sylvestris)* *	Asteraceae	Asteraceae A	*Onopordon acanthium*	*Onopordon acanthium* *	*Xanthium* sp. (Fruit Coat)	Polygonaceae	*Polygonum spp.*	*Polygonum spp.* *	*Polygonum* (*persicaria*-Type)	*Rumex* sp. *	Caryophyllaceae *	Caryophyllaceae	*Vaccaria/Saponaria*	*Lithospermum arvense*	*Lithospermum arvense* *	*Lithospermum officiale*	*Lithospermum officiale* *	*Anchusa* sp. *	*Echium* sp. *	*Lamiaceae* *	*Mentha/Nepata*-Type	*Mentha/Nepata*-Type *
23		2					1		1						3				2	5						6									
71		42					3		1											6						1108	1								
3		3																																	
214		24					14		1						1					16						1141									
		3					7																												
							1																			19									
1							3													4						2									
32	17	28					13			4										4	4					6									
	15						1																												
1	10	1																																	
31	591	22					3				2									1	10					4	1								
	1																																		
	2																						1												
	8																						2												
376	644	125	0	0	0	0	46	0	3	4	2	0	0	0	4	0	0	0	2	36	14	0	3	0	0	2286	2	0	0	0	0	0	0	0	0
1360	1315	823	45	14	50	13	943	4	5	181	67	187	8	3	79	0	49	21	9	434	68	2	35	1	7	2367	138	39	7	2	1	2	1	2	9

Appendix F. Table 3: Tasbas (pg 3 of 3)

Rosa	*Fragaria/Potentilla*	*Fragaria/Potentilla* *	Fabaceae	Fabaceae *	Fabaceae A	Fabaceae(*cf.Trifolium/Melilotus*)	*Trigonella*-Type	Convolvulaceae	Convolvulaceae *	*Hypericum* sp.	*Tribulus terrestris*	*Cannabis sativa* ssp. *ruderalis* *	*Plantago* sp. *	Brassicaceae	*Cyperaceae*	*Ajuga*	Seed A (*Malvaeae*)	Seed B (Euphorbia-like shape)	Seed C (wrinkly)	Seed D (New)	Seed F (Tear drop)	Seed G (minature prunus)	Seed H (Flat)	Seed J	Seed K (striations)	Seed L	Seed L*	Unidentified Seed	Unidentified Seed *	Unidentifiable Seed Fragments	Unidentifiable Seed Fragments *	Nut Shell	Awn	Thorn	Fibers	Totals with Uncarb., without Unident.
						1	6																					2		39						129
	2		1				37								14													8		221						1839
							43																							52						53
	3						60								3	4				6	10							4		681			10			2233
																														7			2			14
																														2						65
			2												2															14						75
	1		1				18								1													3		190			1			180
															1													1		6						23
							2																													17
	1						13								2	1												1	7	50						742
							2																							3						3
																													1	1						3
																														3						18
0	7	0	4	0	0	1	181	0	0	0	0	0	0	0	23	5	0	0	0	6	10	0	0	0	0	0	0	19	8	1269	0	0	13	0	0	5394
1	15	2	12	2	5	24	1267	2	4	1	5	635	1	3	26	5	4	4	2	6	17	2	4	7	3	1	1	90	24	3660	21	4	167	6	10	15109

Appendix F. Table 4: Tuzusai 1996 (pg 1 of 3) *Yellow columns indicate uncarbonized seeds

Sample #	Level	Unit	Vol. Liters	Wood (> 2.oo mm) Ct.	Wood (> 2.oo mm) Wt.	*Hordeum vulgare var. vulgare*	*Triticum aestivum/turigidum*	Cerealia	Spiklete Fork/Rachis	*Panicum miliaceum*	*Panicum miliaceum* *	*Setaria* bristle clump	*Setaria italica*	*Setaria italica* *	Millet	*Vitis vinifera*	*Pisum sativum*	Barley - immature or wild	Poaceae	Poaceae*	Panicoid-Type	Panicoid A	Pooid-Type	Pooid(*cf. Aegilops*)	*Setaria*(*cf. viridis*)	*Setaria*(*cf. viridis*) *	*Stipa*-Type
1996 FS24	A-3	Pit 4	3		0.04		0.05	0.08							1	1											
1996 FS25	A-3	Pit 4	2.4		0.14	0.01	0.06	0.06							5	1			1								
1996 FS26	A-4	Pit 8	2.4		0.21		0.03	0.03	7						1				1					1			
1996 FS27	A-4	Pit 8	3.3		0.45		0.1	0.03							2												
1996 FS1		Pit 17	5.1		0		0.03	0.02																1			
1996 FS2		Pit 17	4.65				0.03	0.01											1								
1996 FS4		Pit 17	5.45		0.03		0.02																				
1996 FS6		Pit 17	3.3		0.03			0.02							1												
1996 FS19		Pit 17	3.75			0.02		0.03							3												
1996 FS20		Pit 17	3.35		0.01		0.02	0.03																			
1996 FS22		Pit 17	3.6		0.02		0.02	0.04																			
1996 FS23		Pit 17	3.3			0.01	0.02	0.01							2	1											
1996 FS8		Pit 18	3.6		0.02	0.02	0.01	0.01																			
1996 FS9		Pit 18	3.3		0.03	0.01	0.02	0.01							1												
1996 FS11		Pit 18	3.9		0.08		0.02	0.01							2	1			1								
1996 FS12		Pit 18	3.9		0.11		0.05								4												
1996 FS14		Pit 18	3.6		0.23	0.01	0.06	0.03							2												
1996 FS15		Pit 18	3.3		0.13		0.02	0.05							1												
1996 FS16		Pit 18	3.6		0.16	0.01	0.05	0.02							3												
1996 FS17		Pit 18	3.9		0.04		0.04	0.07							2				1								
1996 FS32		Pit 19	3.3		0.02		0.03												1								
1996 FS29		Pit 22	2.4		0.01																						
1996 FS31		Pit 22	4.2		0.05		0.02	0.03																			
1996 FS28		Pit 23	3.3																								
1996 FS30		Pit 24	3.3		0.08			0.01							2												
		Sub Totals	89.2	0	1.89	0.09	0.7	0.6	7	0	0	0	0	0	32	4	0	0	6	0	0	0	0	2	0	0	0
		Mega Grand Totals	563	NC	298.89	759	456	1516	80	552	3	1	154	8	208	8	59	21	78	5	74	12	32	6	195	36	422

Appendix F. Table 4: Tuzusai 1996 (pg 2 of 3)

Chenopodium spp.	*Chenopodium* spp. *	Cheno-ams	Cheno-ams *	*Polycnemum*(*cf. arvense*)	*Polycnemum*(*cf. arvense*) *	*Amaranthus* sp.*	*Galium* sp.	*Galium* sp. *	Solanaceae	*Hyoscyamus niger*	*Hyoscyamus niger* *	*Malva*(*cf. sylvestris*)	*Malva*(*cf. sylvestris*) *	Asteraceae	Asteraceae A	*Onopordon acanthium*	*Onopordon acanthium* *	*Xanthium* sp. (Fruit Coat)	Polygonaceae	*Polygonum spp.*	*Polygonum spp.* *	*Polygonum* (*persicaria*-Type)	*Rumex* sp. *	Caryophyllaceae *	Caryophyllaceae	*Vaccaria*/*Saponaria*	*Lithospermum arvense*	*Lithospermum arvense* *	*Lithospermum officiale*	*Lithospermum officiale* *	*Anchusa* sp. *	*Echium* sp. *	*Lamiaceae* *	*Mentha*/*Nepata*-Type	*Mentha*/*Nepata*-Type *
												1		1														6							
																												6							
																		1																	
																		1									1								
1	1																	1																	
																										1									
1										1								1																	
																																		1	
2	4									1																									
1																		1																	
																		1								1									
1																																			
3																			1									2							
2							1																												
	4																																		
	3																																		
11	12	0	0	0	0	0	1	0	0	2	0	1	0	1	0	0	0	6	1	0	0	0	0	0	0	2	1	14	0	0	0	0	0	1	0
1371	1327	823	45	14	50	13	944	4	5	183	67	188	8	4	79	0	49	27	10	434	68	2	32	1	7	2369	139	53	7	2	1	2	1	3	9

Appendix F. Table 4: Tuzusai 1996 (pg 3 of 3)

Rosa	*Fragaria/Potentilla*	*Fragaria/Potentilla* *	Fabaceae	Fabaceae *	Fabaceae A	Fabaceae(*cf. Trifolium/Melilotus*)	*Trigonella*-Type	Convolvulaceae	Convolvulaceae *	*Hypericum* sp.	*Tribulus terrestris*	*Cannabis sativa* ssp. *ruderalis* *	*Plantago* sp. *	Brassicaceae	*Cyperaceae*	*Ajuga*	Seed A (*Malvaeae*)	Seed B (Euphorbia-like shape)	Seed C (wrinkly)	Seed D (New)	Seed F (Tear drop)	Seed G (minature prunus)	Seed H (Flat)	Seed J	Seed K (striations)	Seed L	Seed L*	Unidentified Seed	Unidentified Seed *	Unidentifiable Seed Fragments	Unidentifiable Seed Fragments *	Nut Shell	Awn	Thorn	Fibers	Totals with Uncarb., without Unident.
															1																	0.01				11
																																				13
			1												1																	1				5
																												1								3
																																				2
						1																										0.01				4
																																				0
																																				4
																																1				4
							1								1																					5
																																				1
																												1								11
																																				2
							2																													3
																																				6
																																				4
																																				3
																																				7
			1																																	4
																												1								4
							1							1														1								7
																																				0
																																				4
																																				0
																																				5
0	0	0	2	0	0	1	4	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	2.02	0	0	0	112
1	15	2	14	2	5	25	1271	2	4	1	5	635	1	4	29	5	4	4	2	6	17	2	4	7	3	1	1	94	24	3660	21	6.02	167	6	10	15200