Journal of Anthropological Archaeology 48 (2017) 295–308

Contents lists available at ScienceDirect

Journal of Anthropological Archaeology

journal homepage: www.elsevier.com/locate/jaa

Linking agriculture and exchange to social developments of the Central Asian Iron Age

Robert N. Spengler III[a,b,*], Naomi F. Miller[c,a], Reinder Neef[d], Perry A. Tourtellotte[e], Claudia Chang[e,a]

[a] Institute for the Study of the Ancient World, New York University, New York City, NY, United States
[b] Max Planck Institute for the Science of Human History (Max-Planck-Institut für Menschheitsgeschichte), Jena, Germany
[c] The University of Pennsylvania Museum, University of Pennsylvania, Philadelphia, PA, United States
[d] Head Office, German Archaeological Institute, Berlin, Germany
[e] Anthropology Department, Sweet Briar College, Sweet Briar, VA, United States

ARTICLE INFO

Keywords:
Iron Age
Central Asia
Agriculture
Social complexity
Exchange
Grain surplus
Scythians
Millet

ABSTRACT

Central Asia is commonly referred to as a pastoral realm, and the first millennium B.C. is often thought to mark a period of increased mobility and reliance on animal husbandry. The economic shift of the first millennium B.C. is usually interpreted as a transition toward specialized pastoralism in Central Asia, and the point in time when the Central Asian 'nomads' or Scythians appear. However, in this paper, we present evidence for farming, including the introduction of new crops, at four archaeological sites across the Talgar alluvial fan of southeastern Kazakhstan. In addition, we contrast this data with piecemeal evidence for agriculture at three other sites in the broader foothill ecocline of eastern Central Asia. Collectively, these data show that the people in this region were cultivating free-threshing wheat and hulled barley (long-season grain crops), as well as broomcorn and foxtail millet. There is also evidence for viticulture. These data warrant a reevaluation of the 'nomad'-based model for Iron Age economy in this region. This article highlights the need for further investigation into the links between agricultural intensity leading to grain surpluses, increasing exchange through Eurasia, cultural stratification, craft specialization, and population growth among peoples in the foothills of eastern Central Asia during the first millennium B.C.

1. Introduction

The long-held model for economic development through time in northern Central Asia (Kazakhstan, Uzbekistan, Tajikistan, and Kyrgyzstan) is marked by a key transitional point during the early Iron Age, starting around 800 B.C., as indicated by major social and demographic shifts. Researchers have long believed that this transition was precipitated by a significant change toward an economy dominated by highly mobile pastoralism, as the point of origin of the highly specialized 'steppe nomad' societies of Central Asia (Chernikov 1960; Cribb 1991; Davis-Kimball et al., 1995; Golden 2011; Gryaznov 1955; Khazanov 1994; Kuzmina 2000, 2008). While the linear evolution aspect of this traditional model has been rejected by scholars, many of them continue to focus on pastoralism as the driving force for change. During the late first millennium B.C., elaborate burials with rich deposits of grave goods become a hallmark of the archaeological record, illustrating both an increasing prominence in the level of social hierarchy and craft specialization (Davis-Kimball et al., 1995 and references therein). In direct opposition to the traditional economic model, we argue that people across the mountain foothill zone shifted their economy more toward agricultural pursuits in the early Iron Age, while maintaining some level of pastoral investment, a novel view first proposed by Chang et al. (2003; see also Chang 2017). We also argue that local economies became more diverse and people shaped their investment in agricultural pursuits to suit local ecological constraints. For example, at sites in less arable settings such as Begash, Mukri, and Kyzyl Bulak, the evidence for agriculture is less pronounced, and where present, seems to be dominated by drought-tolerant low-investment crops, specifically the millets. Occupants of these sites may have cultivated small plots of broomcorn (*Panicum miliaceum*) and foxtail millet (*Setaria italica*), which adapt more easily to a mobile pastoral economy, or obtained them through exchange with neighboring peoples. However, at sites on rich alluvial soils where rainfall in the summer months was high and glacial melt streams could easily be diverted for irrigation, such as at Tuzusai, Taldy Bulak 2, Tseganka 4 and 8, and Kyzyltepa (Fig. 1), agriculture was intensified. At this time, new agricultural

* Corresponding author at: Max Planck Institute for the Science of Human History (Max-Planck-Institut für Menschheitsgeschichte), Jena, Germany.
E-mail address: spengler@shh.mpg.de (R.N. Spengler).

http://dx.doi.org/10.1016/j.jaa.2017.09.002
Received 22 May 2017; Received in revised form 21 August 2017
Available online 16 October 2017

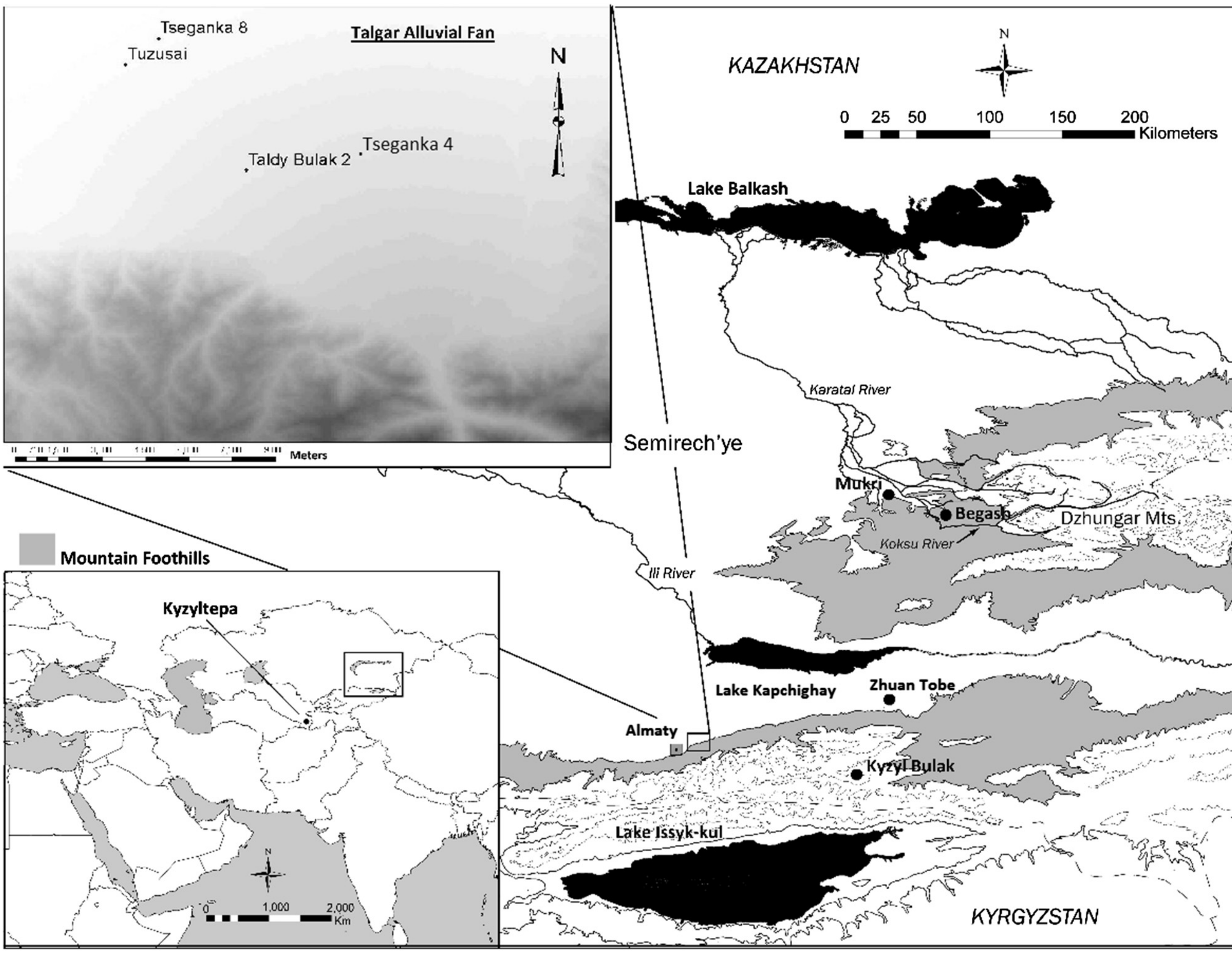

Fig. 1. Map of the eastern Central Asian foothills, focusing on southern Kazakhstan, with an inset map of the Talgar Alluvial fan with topography illustrated; on the main map the mountain foothills are highlighted in grey and all key sites from the text are indicated.

resources were incorporated into the economic repertoire, such as new varieties of free-threshing wheat (*Triticum aestivum*), hulled barley (*Hordeum vulgare* var. *vulgare*), foxtail millet, and grapes (*Vitis vinifera*), all of which also appear to have been cultivated more intensely through irrigation and expanded in cultivated area. While not covered in the scope of this paper, farming communities across southern Central Asia and the Iranian Plateau intensified their irrigation practices at this time, notably more readily incorporating water-demanding crops, such as free-threshing wheat, cotton (*Gossypium* sp.), and arboreal fruits (Miller et al., 2016). While the political driving factors of these irrigation practices may vary across the desert oases, during the second half of the first millennium B.C. more elaborate irrigation systems were implemented by people from the Murghab (Spengler et al., 2016b) to Khorezm (Brite et al., 2017). Furthermore, storage pits, while an understudied topic in this part of the world, are characteristic of many of these sites and attest to grain surplus; at the Talgar sites these storage pits are often two meters in diameter and some are plaster lined (Chang et al., 2002).

Over the past few years, many scholars have stepped away from simplistic models of economy in Central Asia, noting the broad diversity in economic practices that underline the prehistory of this part of the world. While Central Asia was long viewed as the pastoralist realm, the new literature is embracing a more complex economic system that relied on farming as well as herding. Local ecological factors likely played a significant role in the decision to invest more in farming over pastoralism or vice versa. For example, a number of scholars have shown that farming was either non-existant or limited during the second millennium B.C. on the western steppe (Hanks 2010; Anthony et al., 2005), whereas new data are showing that farming was prominent in the eastern steppe, especially in arable mountain valleys (discussed in this paper). Economic diversity has been an important characteristic of Eurasian economies through time, and this diversity was likely as important a factor in these social developments as the intensification of farming was. All aspects of economic production, including mobile pastoralism, need to be taken into consideration when discussing the social developments of the late first millennium B.C. In this paper we focus on farming, in part because it has been largely overlooked, but also because the data suggest that it was an important aspect in the economy of several key regions of Eurasia. In addition to identifying a diverse array of adaptive stratagies across Eurasia, scholars are noting increasingly more "complex" cultural traits of the third and second millennia B.C. (Hanks 2010; Frachetti et al., 2017). There is no doubt that the origins of social stratification, household-level craft specialization, the trans-Eurasian exchange, and larger political constructs lay in the Bronze Age (Frachetti 2012; Honeychurch 2013; Rogers 2017). This paper does not seek to identify the 'origins' of complex social systems – a popular theoretical topic over the past few decades and an impossible endeavor if you reject linear evolution models and see all human social groups as being 'complex'. However, in building on the research into social complexity in Central Asia over the past three decades, we are able to discuss the driving factors behind specific cultural changes that took place during the first millennium B.C. These factors include a diverse array of adaptive strategies, such as increased rates of food production, largely through a greater focus on farming, and increased levels of exchange.

The main purpose of this article is to present previously unpublished systematically collected datasets from the sites of Taldy Bulak 2, Tseganka 4, Tseganka 8, and Tuzusai (Fig. 1), and to further contrast them with the piecemeal macrobotanical evidence for agriculture from the northern Central Asian early Iron Age (800–100 B.C.). A growing interest in the role of agriculture in the prehistoric economic systems of Central Asia has gradually led to the conclusion that domesticated crops played a significant role in the diet through time. Work at sites across Central Asia, from the Kopet Dag to the Altai Mountains and east from Xinjiang down to the Himalayan Plateau shows that agriculture was present in the economy as far back as the third millennium B.C. (see Spengler et al., 2014a, 2014b; Spengler 2015). However, the role that agriculture played in the first millennium B.C. and which crops were cultivated at that time has largely been overlooked. The first millennium B.C. is of specific importance to the understanding of social developments across Eurasia, because it marks both the onset of a more organized exchange network, and has long been argued to mark the development of specialized steppe nomadism. These two phenomena are further argued to have dramatically reshaped trajectories of social development across the Old World and, therefore, merit special consideration. Archaeology of the first millennium B.C., in the mountain foothills, is marked by increasingly elaborate burials, specialized art forms and craft goods, and in some areas more elaborate architecture and larger settlement complexes (e.g., Akishev 1978, 1984; Yablonsky, 1995); we argue that these traits are intertwined with a greater investment in irrigated field agriculture and a resulting grain surplus as well as wider reaching social interactions.

While many cultural and environmental factors may lead to economic change and increased political complexity, ‘exchange’ has always attracted the greatest interest among Eurasian archaeologists. Renfrew and Shennan (1982) see exchange as the key driving force for social change, and Boserup (1990:43) lists increased exchange as one of the responses to population growth in her model for innovation and technological development. The archaeological study of social interactions in Central Asia, along the Eurasian exchange routes that many scholars call the ‘Silk Road’ or pre-Silk Road routes, is by no means new. However, there have been a number of new studies conducted on broader social interactions in recent years, several specifically focusing on trade between East and Central Asia (e.g., Frachetti, 2012; Frachetti et al., 2010; Hemphill and Mallory, 2004; Hiebert and Kurbansakhatov, 2003; Li, 2002; Linduff, 2006; Mei and Shell, 1998, 1999; Thornton and Schurr, 2004). In recent years, scholars have emphasized the antiquity of exchange along the mountain foothills of Inner Asia, illustrating that goods and ideas were moving through this ‘corridor’ (Frachetti, 2012) as far back as the third millennium B.C. (see also Kuzmina, 2008; Spengler, 2015; Spengler et al., 2014a). However, the first millennium B.C. (the period of focus in this paper) saw increased interaction between peoples across Asia, which was closely connected with the increased reliance on farming in Inner Asia at this time. This trans-Eurasian exchange played a key role in shaping the culinary traditions of people from across Europe and Asia. At various points in time, East Asian crops like broomcorn and foxtail millet and peaches (*Prunus persica*) spread to Europe; southwest Asian crops, like wheat, barley, and grape, spread to East Asia; and a variety of crops with poorly understood origins in the broad Asian mountainous region, like walnut (*Juglans regia*), apple (*Malus domestica*), Russian olive (*Elaeagnus angustifolia*), pistachio (*Pistacia vera*), and buckwheat (*Fagopyrum esculentum*) spread across the Old World. Understanding how the cultivation of these crops was adopted by prehistoric farmers in Central Asia directly influences our understanding of the development of culinary traditions and emergent social complexity across this vast geographic expanse.

2. Sites and chronology

2.1. Tuzusai

The Tuzusai site is located on the Talgar alluvial fan, in southeastern Kazakhstan, about 15 km east of Almaty, on rich alluvial deposits that support irrigated agriculture today. Excavations on the Talgar alluvial fan at Tuzusai, Taldy Bulak 2, Tseganka 8, and Tseganka 4 (Fig. 1; Table 1) 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 of the Saka (800 – 200 B.C.) and Wusun culture groups (200 B.C. – A.D. 500). The 15 radiocarbon dates from Tuzusai fall rather well within the range from 410 to 150 cal. B.C. (see Spengler et al., 2013; Chang et al., 2003). If we assume that the site represents a more restricted occupation and do a cluster analysis on the dates, it provides a range of 361–270 cal. B.C. at 2 sigma.

Despite the obvious importance of herding in the economy, as evidenced by the zooarchaeological data, the Talgar sites suggest a more sedentary form of land use when compared to other nearby Iron Age sites (Chang et al., 2002). Specifically based on herd composition and structure, Benecke's faunal analysis argues for year-round occupation. Benecke examined the 4000 animal bones collected from the 1994–1997 field seasons (Benecke 1999 unpublished report discussed in Chang et al., 2002). He found that sheep and goat (ovicaprid) were the most abundant category (53 percent of the total assemblage), followed by cattle (*Bos taurus*; 28 percent), and then horse (*Equus caballus*;15 percent). He also notes less numerous finds of camel (*Camelus* sp.), dog (*Canis lupus* ssp. *familiaris*), and ass (*Equus africanus* ssp. *asinus*) (Chang et al., 2002). In addition, over 20,000 domestic animal bones have been recovered from the 2013–2016 excavations. Hunting may have played a minor part in the economy but it is not well represented in the Tuzusai assemblage. There are some pig (*Sus* sp.), which may have been domesticated by this time, and wild fox (*Vulpes* sp.) (Chang et al., 2002).

The most notable feature of the site is the immense quantity of sun-dried mud brick architecture. Numerous overlapping storage pits and larger semi-subterranean pit houses also characterize the site. The site consists of nearly 2 m of accumulation, and AMS dates show it to represent ca. 200 years of occupation. This rapid accumulation is due to

Table 1
Chronologies and Masl for Key Archaeological Sites Discussed in this Text with Archaeobotanical Data.

Site	Calibrated range	masl	Free-threshing Wheat	Hulled Six-row Barley	Broomcorn Millet	Foxtail Millet	Grapes	Lentils	Cf. Flax	Cf. Grass Peas
Tuzusai (Main occupation)	410–150 cal B.C.	723	X	X	X	X	X			
Tseganka 8	400–60 cal B.C.	720	X	X	X		X			
Taldy Bulak 2	5th-1st Centuries B.C.	850	X							
Mukri	756–407 cal B.C.	850	X		X					
Begash (Phase 3 b)	390 cal B.C.-A.D. 30	950	X		X	X				
Kyzyltepa	6th-4th Centuries B.C.	480	X	X	X	X	X	X	X	X

successive mud brick rebuilding events and year-round deposition of cultural fill. This level of rapid cultural deposition is similar to that of 'tell' sites further south in Central Asia (Rosen, 1986). Tuzusai shares similarities with two other sites excavated on the Talgar fan, Taldy Bulak 2, and Tseganka 8 (Fig. 1; Chang et al., 2002). Survey work over the past 20 years has recovered over 90 large sherd scatters, which suggests that there were small village or hamlet settlements across the entire alluvial fan during the Iron Age. Tusuzai, unlike most of the other settlements, straddles a dry stream channel and covers an area of 15 hectares. Also, Tuzusai has a greater concentration of sherds and animal bones than the other sites on the alluvial fan and appears to be a larger-scale settlement, possibly a social or population center.

2.2. Tseganka 8

Tseganka 8 is a large settlement site, hamlet or village, exposed by a cut bank of the Tseganka River and located about 1.5 km northeast of Tuzusai. It was discovered during survey in 1998, recognized by animal bones and ceramic sherds eroding out of the river bank. In 1999–2000 excavations were conducted at the site by the Kazakh-American Talgar Project, led by Chang, Tourtellotte, and Fedor Grigoriev. As at Tuzusai, the site has semi-subterranean pit houses with plaster floors, post-molds used to support upright posts for thatched roofs, as well as storage pits and hearth areas. Also similar to Tuzusai, house features contain numerous layers of re-plastered and hard-packed floors, with plaster layers being around 15 cm thick. Low wall structures of unfired mud brick outline these floors. We assume that the numerous large storage pits at the site were used primarily for grain storage and the copious grinding stones were for grain processing. In addition, the ceramics are similar to Saka and Wusun sherds found throughout this region.

The chronology for Tseganka 8 is based on six radiocarbon dates (Chang et al., 2003), with an occupation range from the four most reliable dates at 2 sigma between 400 and 60 cal B.C. Two additional dates from the site have large ranges and long calibration tails, which reach much earlier in time (both tails at two sigma extending well beyond 750 cal B.C.). While it is possible that these two dates represent a slightly earlier occupation at the site; this period is not well defined by the radiocarbon signature. Furthermore, dates B-153900 and B-133612 both come from Pit house 3 and have hundreds of years between them, and the earliest date, B-129589, has a range at 2 sigma (95.4 percent) of 750–166 cal B.C. Hence, we conservatively use the four reliable dates and a range for the site at 400–60 cal B.C.

Occupation at Tseganka 8, like all small village or hamlet sites identified on the Talgar fan, was likely sedentary or semi-sedentary, with mixed investment in pastoral and agricultural strategies. In a zooarchaeological analysis at the site, conducted by Norbert Benecke in 1999 (unpublished, presented in Chang et al., 2002), 2518 bones were analyzed from a 100 m^2 area. Benecke found that sheep and goat bone (46 percent of NISP) dominated the assemblage. Cattle (16 percent) and horse (3 percent) make up less frequent finds; two camel, two donkey, and six dog bones were also identified. Deer and hare bones were also present.

2.3. Taldy Bulak 2

Taldy Bulak 2 is on the Talgar fan, at 850 masl, along a seasonally dry river bed. The site is deeply buried, with roughly 60 cm of alluvium over its occupation layers. Five trenches were opened in 2001 by the Kazakh-American Talgar Archaeological Project. Over seven field seasons, the excavators exposed 340 m^2 of deposits. While this excavation allowed for a good understanding of the site, shovel testing and survey led the investigators to estimate that it extends over an area of 7000 m^2. Taldy Bulak is similar to its companion sites, and is characterized by deposits of ceramic sherds, animal bones, a line of rectangular storage pits, a ditch, 2 pit houses and mudbrick architecture, stone-filled postmolds, and plastered floors. An excavation at the site of Tseganka 4, about 2.7 km east of Taldy Bulak 2 uncovered a similar, presumably contemporary rectangular pit house of 6.5 m in length. The pit house was found eroding out of the west stream bank. The pit house and the ceramics were all similar to those found at the other sites on the Talgar alluvial fan.

2.4. 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, 2008). Begash is only about 20 km from the site of Mukri and about 200 km north of Tuzusai (Fig. 1). The earliest botanical material from Begash comes from Phase 1 (see Frachetti et al., 2010; Spengler et al., 2014a). The recovered botanical remains from the Iron Age layers are mentioned in Frachetti et al. (2010) and presented in detail in Spengler (2013); we use this later Iron Age material to contrast to other sites in this paper. Iron Age occupation at Begash shows material culture similarities to that of the Talgar sites, discussed above, attributed to people in the Saka and Wusun groups, and is also marked by a stone house foundation. The complex chronology of Begash has been worked out by Frachetti and Mar'yashev (2010) based on 32 radiocarbon dates, of which nine securely place the Iron Age Phase 3b occupation between 390 cal B.C. – A.D. 30.

The economy at Begash and Mukri in the Bronze and Iron Ages was based on pastoral production (Frachetti, 2008). Domesticated herd animals dominate the faunal assemblage from Begash, specifically sheep, cattle, and horse (Frachetti, 2008; Frachetti and Benecke, 2009). The assemblage reported in the preliminary zooarchaeological study, conducted by Tleuberdina, at the National Academy of Science in Almaty, is almost exclusively sheep, cattle, and horse (Frachetti, 2008). A more detailed study conducted by Frachetti and Benecke (2009) showed 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).

2.5. Mukri

Mukri was excavated by Frachetti and Mar'yashev (2010) in 2006. The site is about 50 km west of Begash, nestled into low foothills overlooking a tributary of the Koksu River. Downstream from Begash, Mukri is located in an ecological pocket created by a freshwater spring in an otherwise environmentally marginal area (Fig. 1). The Dzhungar Mountains surrounding the site rise to peaks of 4500 masl and in the west the landscape flattens out to the Sari-Esik Desert at 350–500 masl. The occupation represents multiple phases of use and abandonment over a 3000-year period to the present, and is interpreted as a small-scale isolated pastoral seasonal encampment. A single radiocarbon determination dates the earliest level of the site to the Iron Age, between 756 and 407 cal B.C. at 2 sigma (Frachetti et al., 2010; OS-64084). The base of this level is a hard-packed clay layer at about 3 m below the surface. There was a carbon rich layer with material culture directly above the clay horizon; one sample was taken from this layer for flotation.

2.6. Kyzyltepa

Kyzyltepa is in southern Uzbekistan along the Surkhandarya River valley. The site is a fortified citadel or center of what was likely a large sedentary settlement, with material culture closely related to contemporary sites further south in Central Asia along the Kopet Dag where farming villages are well-attested by this time; it is quite different from all the sites presented already in this paper. Early excavations identified mud brick architecture, as well as fortified city walls and a moat (see Wu et al., 2015). In 2010 and 2011, Wu excavated several new areas at the site, suggesting that the site dates between the sixth and fourth centuries B.C. (Wu et al., 2015). The site is 20 ha, with a citadel and lower city, is flanked by more than ten contemporaneous smaller sites, and the large-scale architecture and elaborate domestic residence illustrates both collective labor and an elite class. The material culture has some similarities to that of the other sites discussed in this article, but is better likened to Achaemenid imperial sites further south. Zooarchaeological studies at Kyzyltepa found a wide range of domestic, commensal, and wild species. Domesticated animals included sheep and goat, cattle, pig (likely domesticated), horse, donkey, and camel, chicken (*Gallus gallus*), dog, and a single cat (*Felis* sp.) bone (Wu et al., 2015).

3. Materials and methods

In addition to presenting a comprehensive synthesis of archaeobotanical data from Central Asia for the first millennium B.C., this article presents previously unpublished data from the sites of Tuzusai and Tseganka 8 and 4 (Miller, 1996). The unpublished data consists of flotation samples from Tuzusai processed in the University of Pennsylvania Museum-MASCA by Naomi Miller in 1995 and 1996, and by Robert Spengler at Washington University in St. Louis in 2008, 2009, and 2010 (most of which was published in Spengler et al., 2013); as well as samples from Tseganka 8 and 4, processed at the German Archaeological Institute by Reinder Neef in 2000. The samples were all floated in the field using a SMAP-like machine as described by Fritz (2005:780–784), Pearsall (2000:29–33), and Watson (1976:79–80). The machine was operated by a gas-powered irrigation pump. An overflow spout allows buoyant material to pour into a geological sieve. A 0.355 mm-sieve caught the light fraction and a 1.00 mm-sieve caught the heavy fraction. Soil sediments were measured for volume to the nearest half liter and poured into the large water tank of the SMAP machine. The rising water agitated the organic material, which then floated to the surface and was decanted into a sieve. The remaining residue in the bottom of the machine was captured in another sieve and then processed for the heavy fraction. The water in the machine was allowed to run clean between each sample and every effort was made to prevent cross contamination between samples.

Once in the laboratory, the samples were passed through a series of sieves and carbonized organic material was systematically separated. Carbonized seeds or other identifiable plant parts were divided into categories and presented in Tables 2 and 3. Other non-plant materials such as bone were collected but not reported. Soil liter measurements were not taken for samples from Tseganka 8, limiting our ability for inter-site comparisons, likewise weights and not counts were used to quantify domesticated seeds from the 1996 excavations at Tuzusai. All necessary permits were obtained from the Institute of Archaeology in Almaty, Kazakhstan, for the described study, which complied with all relevant regulations.

4. Archaeobotanical studies

Several preliminary botanical studies have identified evidence of agricultural production from Iron Age sites on the Talgar Alluvial Fan. In addition, a number of microbotanical studies, mostly conducted by Arlene Rosen, have also provided clear evidence of an agricultural component in the economy. In this section, we summarize the results from these studies and provide a more detailed look at the unpublished macrobotanical studies of the Talgar sites.

Two preliminary macrobotanical studies were conducted at the site of Taldy Bulak 2, only a few kilometers from Tuzusai. Eight flotation samples from two seasons of excavation 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). These samples had poor preservation, densities and ubiquities were low; however, Hollenbach (2008) did identify "wheat, cf. bread (*Triticum,* cf. *aestivum*)" and a few fragments of unidentified nutshell. Additionally, a small macrobotanical study was conducted at the site by Jenny Jones in 1999 at University College London. This study found limited evidence for cultivated cereals; most samples were devoid of seeds and only contained some carbonized wood fragments. However, two samples from "Area 2" contained 27 unidentifiable cereal fragments and a possible wheat grain, and four other samples from the same context "were full of grains and seeds, although poorly preserved and therefore difficult to identify", these unidentified grains included possible wheat, a shell fragment of "Prunoideae", and five chenopod seeds (Chang et al., 2002).

A preliminary microbotanical study was conducted by Alexandra Golyeva at Tseganka 8 and Tuzusai. She identified what she refers to as cultivated barley phytoliths at both sites (1999, unpublished report discussed in Chang et al., 2002). Wheat was also identified, based on phytoliths, in this study at Tuzusai, and "evidence of wheat cuticles" was recovered from floor 4 in pit house 3 at Tseganka 8. Golyeva also argues for a summer occupation at the site based on the identification of "pollen from flowering plants". Furthermore, this preliminary study identified phytoliths from "reeds" (presumably *Phragmites*) at Tuzusai and Tseganka 8, likely used as construction material. Remnants of a woven grass mat were also recovered from an occupation floor at Tuzusai.

A more substantial 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; Rosen, 2002, 2003a, 2003b). At Tseganka 8, Rosen (2003b) found barley and Panicoid grass phytoliths that she calls "millet (*Setaria* sp.)". At Taldy Bulak 2, Rosen (2002; Rosen et al., 2000) identified phytoliths of millet (*Setaria* sp.) and possible rice (*Oryza sativa*). The possible finds of rice have not been supported by subsequent botanical studies at any of the other sites, although, one other claim for early rice in Central Asia does exist – a supposed cache from a cluster of sites (Nos 28, 29, and 61) in the lower Ferghana valley of Uzbekistan, dating to the early first millennium A.D. (Gorbunova, 1986:17). This Soviet-period report of rice is not supported with direct dates, photos, or grain descriptions. Based on the 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.

4.1. Macrobotanical studies on the Talgar alluvial fan

In 1995, a macrobotanical analysis conducted by Miller at the University of Pennsylvania Museum-MASCA identified wheat, barley, millets, grapes, and hawthorn (*Crataegus* sp.) in 26 flotation samples from Tuzusai. These samples varied in volume from 2.4 to 5.45 L (pre-flotation), for a total of 89 L of analyzed soil. She also analyzed an additional 51 L of sediment samples collected during the 1996 season. While the densities of domesticated grains in the flotation samples were relatively low, the ubiquities were high. Miller identified several grain crops and a few fruit seeds; the most abundant of these was wheat (*Triticum aestivum/durum*) "bread wheat (*Triticum aestivum* s.l., a hexaploid)", with a ubiquity of 80 percent and a total weight of grains and grain fragments summing up to 0.70 g (1995 samples). The millets were the second most abundant category with a collective ubiquity of 60 percent for the two millets; barley (*Hordeum vulgare*) ("differentiation between six- or two-row forms was not possible") was the least abundant of the four grains, with 28 percent ubiquity and a collective grain weight of 0.09 g (1995 samples). In addition, a number of undifferentiated Cerealia fragments were recovered from 80 percent of the samples, the fragments had a collective weight of 0.60 g. The grains were evenly spread out throughout the assemblage with a total grain ubiquity of 96 percent and no density pockets or cache areas (1995 samples). Four grape pip fragments, nut shell fragments ("probably

Table 2
Carbonized seed and wood counts and weights as well as sediment volume for samples from the 1994–1996 field seasons at Tuzusai (T); note that counts for wheat, barley, and Cerealia are not provided and totals only include non-cereal seeds.

Sample #	Vol. Liters	Wood (> 2.00 mm) Wt. (LF only)	*Hordeum vulgare* var. *vulgare*	*Triticum aestivum/turigidum*	Cerealia	Wheat Rachis	Millet (Both Species)	*Vitis vinifera*	*Crataegus* sp.	Poaceae	Pooid (cf. *Aegilops*)	*Bromus* sp.	*Setaria* cf. *viridis*	*Chenopodium* spp.	*Galium* sp.	Solanaceae	*Xanthium* sp. (Fruit Coat)	*Rumex* sp.	*Vaccaria* sp.	*Hypericum sp.*	Fabaceae	Fabaceae (cf.- *Trifolium/Melilotus*)	*Trigonella*-Type	Cyperaceae	Unidentified Seed	Nut Shell	Totals
1994 T1	n/a	0.1	0.13	0.02	0.08																						
1995 T24	3	0.04		0.05	0.08		1	1																1	2	1	5
1995 T25	2.4	0.14	0.01	0.06	0.06		5	1		1																	7
1995 T26	2.4	0.21		0.03	0.03	7	1		1	1	1										1			1	1	1	7
1995 T27	3.3	0.45		0.1	0.03		2																		1		3
1995 T1	5.1	0		0.03	0.02						1						1								1		3
1995 T2	4.65			0.03	0.01					1							1			1		1			1	1	5
1995 T4	5.45	0.03		0.02													1										1
1995 T6	3.3	0.03			0.02		2							1			1										4
1995 T19	3.75		0.02		0.03		3												1							1	4
1995 T20	3.35	0.01		0.02	0.03									1		1	1						1	1			5
1995 T22	3.6	0.02		0.02	0.04																				1		1
1995 T23	3.3		0.01	0.02	0.01		2	1						2		1									1		7
1995 T8	3.6	0.02	0.02	0.01	0.01									1			1										2
1995 T9	3.3	0.03	0.01	0.02	0.01		1																2				3
1995 T11	3.9	0.08		0.02	0.01		1	1				1					1		1								5
1995 T12	3.9	0.11		0.05			4												1								5
1995 T14	3.6	0.23	0.01	0.06	0.03		2							1													3
1995 T15	3.3	0.13		0.02	0.05		1							3				1			1						6
1995 T16	3.6	0.16	0.01	0.05	0.02		2						1											1			4
1995 T17	3.9	0.04		0.04	0.07		2			1															1		4
1995 T32	3.3	0.02		0.03						1				2	1								1		2		7
1995 T31	4.2	0.05		0.02	0.03																						0

(continued on next page)

Table 2 (*continued*)

Sample #	Vol. Liters	Wood (> 2.0-0 mm) Wt. (LF only)	*Hordeum vulgare* var. *vulgare*	*Triticum aestivum/turigidum*	Cerealia	Wheat Rachis	Millet (Both Species)	*Vitis vinifera*	*Crataegus* sp.	Poaceae	Pooid (cf. *Aegilops*)	*Bromus* sp.	*Setaria* cf. *viridis*	*Chenopodium* spp.	*Galium* sp.	Solanaceae	*Xanthium* sp. (Fruit Coat)	*Rumex* sp.	*Vaccaria* sp.	*Hypericum sp.*	Fabaceae	Fabaceae (cf.-*Trifolium/Melilotus*)	*Trigonella*-Type	Cyperaceae	Unidentified Seed	Nut Shell
Totals																										
1995 T30	3.3	0.08			0.01		2																		1	
3																										
1996 T3	2.6				0.02		1			1	1															1
3																										
1996 T4	3.3	0.3	0.01	0.02	0.02																					
0																										
1996 T7	3	0.16	0.01	0.01	0.06		1						2										1			
4																										
1996 T8	3	0.09	0.01	0.04	0.05	1												1					1			
2																										
1996 T18	5.7	0.22	0.03	0.11	0.21	1	9			1	1	1		11		3	1			1	2		1	1	19	
51	1996 T21	3.6			0.01	0.01		1							1											
2																										
1996 T23	n/a	0.23	0.05	0.14	0.21		1			1			2	1	2						6	1		1	2	
17	1996 T22	n/a	0.05	0.01	0.08	0.03		1																	2	
3																										
1996 T9	3	3.28											1											1		
2																										
1996 T10	3.3																							4		
4																										
1996 T11	3.3	2.14																						1	1	
2																										
1996 T5	3.3	0.03		0.01											1											
1																										
1996 T6	3.3	0.03		0.02	0.02																					
0																										
1996 T15	4.8	0.23		0.06																						
0																										
1996 T17	4.5	0.23		0.01	0.03																				3	
3																										
1996 T16	3.9	0.08			0.03																					
0																										
1996 T14	3				0.01																					
0																										
1996 T20	3				0.05		4			1				1												
6																										
Totals 194	140.1	9.05	0.34	1.23	1.43	9	49	4	1	9	4	2	6	25	4	5	8	2	3	2	10	2	7	14	37	5

Table 3
Carbonized seed and wood counts and weights for samples from the 1999–2000 field seasons at Tseganka 8 (T8), Tseganka 4 (T4), and Kyzl Bulak (KZ), note that the original volume of sediment for each sample is not provided.

Sample #	Wood (> 2.00 mm) Ct. (LF only)	Wood (> 2.00 mm) Wt. (LF only)	*Hordeum vulgare* var. *vulgare*	*Triticum aestivum/turgidum*	Cerealia	Wheat Rachis	*Panicum miliaceum*	*Vitis vinifera*	Poaceae	Pooid (cf. *Aegilops*)	*Bromus* sp.	*Arnebia linearifolia*	*Chenopodium* spp.	*Galium* sp.	*Scruphularia* sp.	*Malva* sp.	*Rumex* sp.	Fabaceae	Fabaceae (cf. *Trifolium/Melilotus*)	*Trigonella* Type	Cyperaceae	Unidentified Seed	Totals
1998 T8	35	0.75	4	8	8		4			1	1	5	5	1			3	3			1		24
1999 T8	24	0.69	16	13	2	1	2		2	1		3						1					9
2000 T8 a	5	0.18	5	5		1	2	1			2	11			1	7	3	190			1	8	226
2000 T8 b	25	1.5	5	16	6		5					5					1	3					14
1998 T4	5	0.13	3	3	5					1									2				3
1998 KB	15	1.04											32							1		1	34
Totals	109	4.29	33	45	21	2	13	1	2	3	3	24	37	1	1	7	7	197	2	1	2	9	310

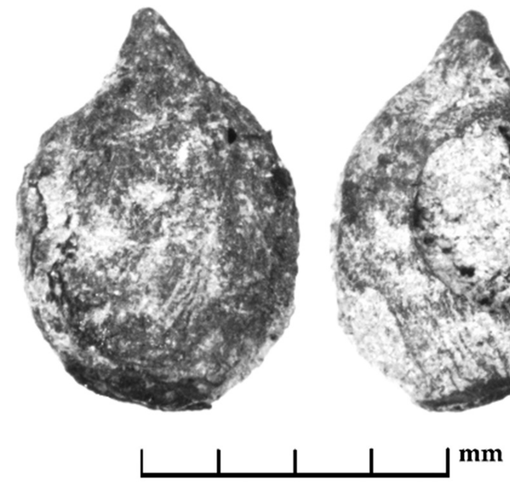

Fig. 2. A charred seed resembling apple (*Malus/Pyrus* sp.) recovered from FS10 of the 2010 field season at Tuzusai.

almond [*Prunus* sp.]"), and a hawthorn seed were also identified.

Spengler et al. (2013) followed up on this work at Tuzusai from 2008 to 2010, floating 25 additional sediment samples, which averaged in size around 8 L and ranged from 2 to 16 L of soil. They processed a total of 213 L of sediment and identified a similar range of domesticated crops. From the 25 samples a total of 3163 seeds (not including uncarbonized and unidentifiable seed fragments) were recovered, of which 2314 (73 percent) were domesticated grains/seeds and 849 (27 percent) represent seeds from small herbaceous wild plants. Seven domesticated crops were identified at Tuzusai, with a total density of 10.2 domesticated seeds per liter of soil. A total of 880 Cerealia and 157 undifferentiated millet grains were also recovered. The domesticated crops included: 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 [*Triticum aestivum/turgidum*]), broomcorn millet, foxtail millet, and grape seeds. While there is a range of morphological variation among the free-threshing wheats and many landraces express extreme variation within a single crop harvest, Spengler et al. (2013) argued that there is a wide-enough range to represent two crop varieties or distinct landraces. In addition, hulled and naked varieties of barley are genetically distinct and would have been cultivated separately to maintain their separate phenotypical traits. In addition, a single possible seed from an apple (*Malus/Pyrus* sp.) was identified in the assemblage (Fig. 2).

Wheat (Fig. 3) was the most abundant domesticated grain found in the 2008–2010 samples from Tuzusai. A total of 448 wheat grains and identifiable fragments were identified, averaging about 2.10 wheat grains per liter of sediment, and with a ubiquity of 88 percent. Of the "whole" fully measurable wheat grains (n = 199) the average length was 3.94 mm and the average width was 2.85 mm. Therefore, despite a complete absence of wheat rachises, these grains are likely to be from a bread wheat form. Naked and hulled forms of barley (Fig. 3) were not systematically differentiated; however, most of the barley appears to be hulled, with only a few naked morphotypes mixed in. Only one fragmentary barley rachis was recovered. Barley grains in the samples occur at a density of 1.47 grains per liter (n = 313), and a ubiquity of 88 percent. Broomcorn millet grains (Fig. 3) were recovered with a density of 1.86 grains per liter (n = 396), and an 80 percent ubiquity. There were 112 grains identified as foxtail millet (Fig. 3), which were primarily differentiated from broomcorn millet by total size and the ratio of embryo notch (or scutellum) length to total seed length. However, some morphological overlap does exist between the two grains. Total density of foxtail millet grains is 0.53, and the ubiquity is 64 percent. A few grape pips were also identified in the 2008–2010 material.

In 1998 a single flotation sample was taken from a test unit

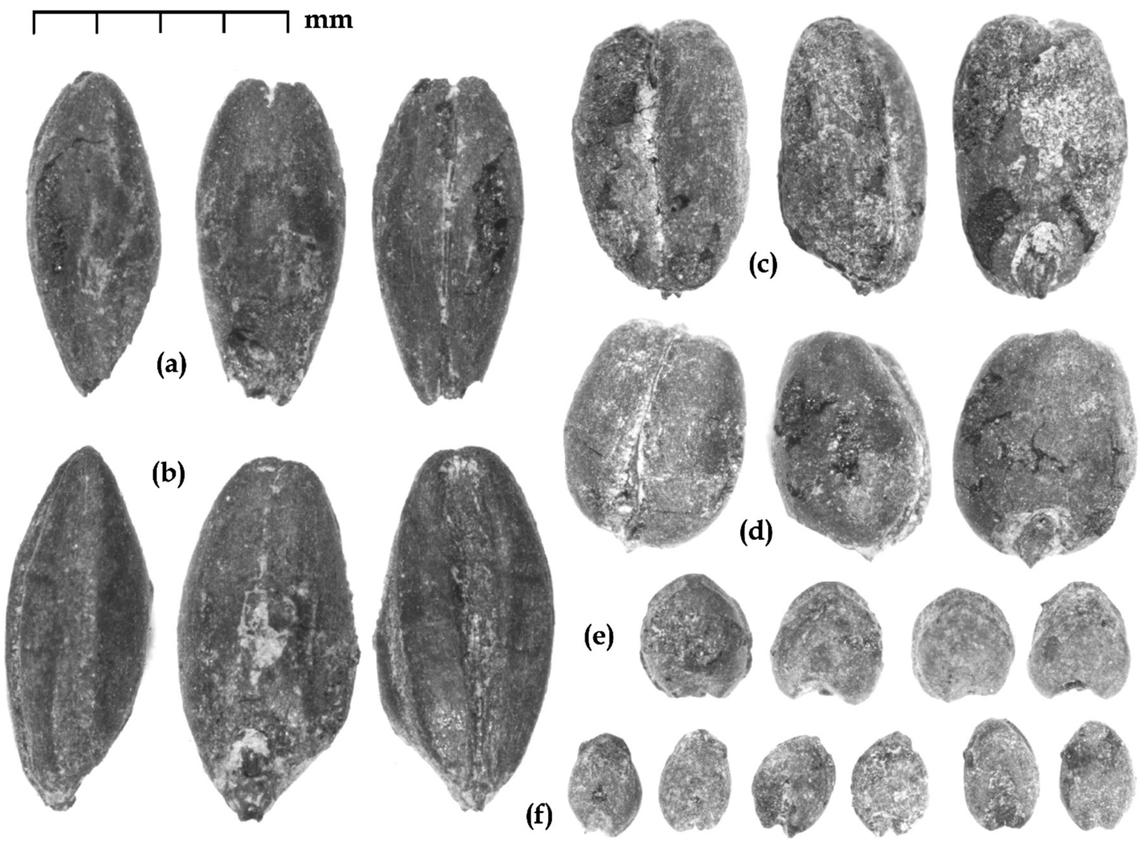

Fig. 3. Archaeobotanical grains from the Talgar region, all dating to the second half of the first millennium B.C.: (a) and (b) three views of two grains of hulled barley from the 2008 excavations at Tuzusai (FS 1); (c) three views of a hand-picked free-threshing wheat grain from Taldy Bulak 2; (d) three views of a free-threshing wheat grain from the 2008 excavations at Tuzusai (FS 1); (e) ventral and dorsal views of two broomcorn millet grains from the 2008 excavations at Tuzusai (FS 1); and (f) ventral and dorsal views of three foxtail millet grains from the 2010 excavations at Tuzusai (FS 10).

(4 × 5 m) at Tseganka 4. It was analyzed by Neef and provides additional evidence for agricultural pursuits across the alluvial fan. While the soil sample volume was not recorded, several domesticated grains were recovered, including three compact-eared wheat grains and three barley grains as well as five undifferentiated Cerealia fragments.

Neef also analyzed four sediment samples collected by Chang and her colleagues from Tseganka 8 test units in 1998, 1999, and 2000. While soil volumes were not recorded for the samples taken in 1999 and 1998 (one test sample from each season), the two samples from 2000 were large bulk samples. One consisted of roughly 100 L of soil and came from under floor four of pit house 6 and the other was from a different area of the same sub-floor context and comprised 60 L of soil. The sample from 1998 contained seven compact free-threshing wheat grains and one unspecified wheat grain, as well as four barley grains and eight Cerealia fragments and four millet grains. The 1999 sample contained 13 compact wheat grains, including one rachis, 16 barley grains, two Cerealia fragments, and two broomcorn millet grains. The two bulk samples, had extremely low densities and collectively contained 21 wheat grains, including one rachis, ten barley grains, 6 Cerealia fragments, seven millet grains, and one grape pip.

Table 4 presents length and width measurements for the grains that were well-preserved, not fragmented or distorted from carbonization, recorded from the four sites. The table also gives scutellum measurements for millet grains and length-to-width rations for a general measurement of plumpness. These data will help with comparisons to other sites in the future.

4.2. Other Iron Age archaeobotanical studies from northern Central Asia

A single sample of only 0.5 L of soil was collected from an especially rich hearth feature from the site of Mukri (Frachetti and Mar'yashev 2010). Despite the small sample size, one wheat grain and one fragmentary Cerealia grain were recovered, along with 20 broomcorn millet grains and ten undifferentiated millet fragments. The sample also contained a large amount of wild *Setaria* cf. *viridis* and *Chenopodium* seeds. Spengler (2013) also analyzed 13 flotation samples from Iron Age layers at the site of Begash, a summary of the domesticated grain finds from these samples was presented in Frachetti et al. (2010). The flotation samples varied in soil volume from 1 to 9 L, for a total volume of 32.5 L of processed Iron Age sediments from Begash. While domesticated grains do appear in these samples, they are in low ubiquity, with a single wheat grain from FS34 and an undifferentiated Cerealia fragment from FS13. Millet appeared in three samples, but only had a high density in FS6, where 24 broomcorn millet, 19 foxtail millet grains, and 5 millet fragments were recovered.

On the opposite end of the economic spectrum, agricultural villages are archaeologically well attested across much of southern Central Asia south of the Tien Shan Mountains and tell sites often have chronologies that span millennia. While the agricultural nature of these sites is not in question, almost no botanical studies have been conducted at any of these sites from time periods after the Bronze Age, with the sole exception of Kyzyltepa. Miller conducted a botanical study of the macroremains at Kyzyltepa (see Wu et al., 2015), and identified hulled six-row barley, free-threshing wheat, foxtail millet, broomcorn millet, lentils (*Lens*), a single flax seed (*Linum* cf. *usitatissimum*), and a single seed of probable grass pea (cf. *Lathyrus*). In addition, Miller identified four fragments of grape pips and a cherry or plum pit (*Prunus* sp.). Looking further south in Central Asia, sedentary farming communities are well-documented across the oases of the Kara Kum and river valleys of the Kopet Dag and Pamir (see Spengler et al., 2016b). In addition,

Table 4
Grain Measurements from Key Sites Discussed in the Text.

		Number Measured	Length	Width	Scutellum Notch	Length/ Width Ratio
Begash	Wheat					
	Barley					
	Broomcorn	11	2.20	2.20	0.80	1.00
	Foxtail	11	1.93	1.03	0.90	1.87
Mukri	Wheat	1	5.20	4.30		1.21
	Barley					
	Broomcorn					
	Foxtail					
Tuzusai (2008–1-0)	Wheat	247	3.90	2.70		1.44
	Barley	104	5.08	2.89		1.75
	Broomcorn	217	1.90	1.60	0.80	1.19
	Foxtail	75	1.48	1.21	0.90	1.22
Tuzusai (1996)	Wheat	10	4.12	3.06		1.35
	Barley					
	Broomcorn					
	Foxtail					
Tseganka	Wheat	4	3.90	3.21		1.20
	Barley	2	5.19	3.89		1.33
	Broomcorn					
	Foxtail					

further west, in the Khorezm Oasis, Soviet-period excavation reports mention finds of millet grains, as well as wheat, barley, and grape seeds during the first millennium B.C. (Brite et al., 2017).

It should also be briefly noted that two preliminary botanical investigations were conducted at an additional Iron Age site, Kyzyl Bulak, in the Tien Shan Mountains of Kazakhstan. The site is at 2400 masl, which leaves open the question of whether crops were being grown at higher elevations during this time period, for it sits at (or just beyond) the very limit of elevation for winter wheat cultivation in the northern Central Asian mountains. Two samples were analyzed by Jenny Jones from the 1997 excavation, conducted by the Kazakh-American Talgar Archaeological Project, and one sample was analyzed by Neef from the 1998 excavations. While no domesticated grains were recovered from either season's units, the old adage 'absence of evidence is not evidence for absence' should be used here. There seems to be poor preservation at the site, as attested by the low density of wild seeds, despite the presence of carbonized conifer wood. In addition, the exact chronology of the site is not well understood with apparent Late Bronze and Iron Age layers recovered in 1997. Redating of human remains from burials found in the same area as the site provided two Late Bronze Age dates of 1754–1541 cal B.C. and 1744–1536 cal B.C. (Motuzaite-Matuzeviciute et al., 2015). However, these small studies still merit mention because they constitute the only attempt at identifying agricultural material in a high-elevation pastoralist context, at the edge of the typical crop growing zones and speak to questions regarding seasonal transhumance.

5. Discussion

5.1. Agriculture

The macrobotanical data sets analyzed from roughly contemporaneous sites across the Talgar alluvial fan provide a comparative study, conducted by different specialists at different times, much of which is presented here for the first time. Highly similar crop assemblages (and wild seed assemblages) were recovered from Tseganka 4, Tseganka 8, Tuzusai, and Taldy Bulak 2. All of these assemblages show a prevalence of free-threshing wheat, barley, and broomcorn millet; wheat is likely all hexaploid, and the barley is mostly a hulled six-rowed form. In addition, less abundant finds of foxtail millet and grape pips were recovered. Interestingly, no pulse crops of any kind have been found at these sites; although, they are present at sites further south, such as Kyzyltepa. While the phytolith data support the main argument that agriculture played a key role at these sites, they differ slightly in the evidence for kinds of crops and in the level of specificity regarding crop varieties. The phytolith analyses focus on foxtail millet as a dominant grain and originally identified rice.

As Spengler et al. (2014a) have illustrated from sites across the mountain zone of Central Asia, there appears to be a broadly similar package of crops being grown from the Himalayas to the Tien Shan and south to the Kopet Dag during the second millennium B.C. Remarkably, this assemblage consists of a specific morphotype of highly compact free-threshing wheat, compact naked barley, broomcorn millet, and peas (*Pisum sativum*). While the first-millennium B.C. data synthesized in this paper is too fragmentary to discuss in terms of patterns or general dominance of certain crops in the Iron Age for the Central Asian mountain region, it does illustrate that a shift in crop preferences was taking place, at least regionally. Spengler (2015) observed that the highly compact morphotypes of wheat were replaced by larger-grained varieties. The compact naked forms of barley that dominated in the Bronze Age were replaced by hulled large-grained forms, a similar trend of hulled varieties drastically increasing in abundance took place across nearly all of Europe during the Iron Age/Roman period (see Lister and Jones 2013). In addition, foxtail millet, which may have been introduced at the tail end of the second millennium B.C. (Spengler et al., 2014b), as attested at Tasbas, spread across Central Asia and viticulture was introduced by at least the end of the first millennium B.C.

Isotope studies of human skeletal remains from across Kazakhstan, spanning a large chronological period, complement the data discussed throughout this paper. Motuzaite-Matuzeviciute and her colleagues (2015) argue that an increase in $\delta^{13}C$ values across the southern regions of Kazakhstan from the Bronze to the Iron Age, may indicate the adoption of millet into the diet (although, see Motuzaite Matuzeviciute et al., 2015 and Ventresca Miller et al., 2014 for limitations in interpreting this data). As was discussed earlier in this paper, preliminary investigations at Kyzyl Bulak have not provided any macrobotanical evidence for agricultural products in the diet. This seems to support conclusions of Motuzaite Matuzeviciute et al. (2015), which suggest that Late Bronze Age humans at the site had C_3-dominant diets. She notes that three of the four skeletons analyzed from the site had low $\delta^{13}C$ values, a possible indication that millet grains were not a regular part of the diet. This lack of millet in the diet at the site may illustrate that high-elevation populations were not closely intertwined with low-elevation populations and that rather than a vertical transhumance model, it may be worth considering the possibility of distinct populations with unique dietary adaptations to their specific localized environmental zones. Further investigation, however, is needed to justify such claims.

5.2. Changes in social orders

For decades archaeologists have debated the nature of social complexity and the emergence of state-level polities in Eurasia, even the seemingly simple semantics of the word 'complexity' have been heavily scrutinized. A long tradition of culture evolution models, often relying on mono-causal triggers, such as climate change or increased reliance on pastoralism, marks archaeological theory in this part of the world; we endeavor to step away from this tradition by focusing on the diversity of adaptive strategies used and by acknowledging the deep time depth of many of the factors that scholars use to identify 'complexity'. Furthermore, in an attempt to keep this paper focused on the significance of agriculture and out of the deeply entrenched debates surrounding the term 'social complexity', we will simply refer here to some of the interrelated traits associated with the shifts in social orders seen across the foothills of Central Asia in the first millennium B.C. In this sense, we follow a definition of social complexity more closely in line with that proposed by Flannery (1972), which focuses on segmentation within a society and the central integration of those segregated parts, although we acknowledge that the term has been reinvented many times over the past half century (for a discussion see Honeychurch, 2014). Large-scale burial mounds, in some cases filled with elaborate grave goods, illustrate the formation of social hierarchies, and elaborate art and craft production that indicate the development of a specialized artisan class – cultural traits characteristic of the first millennium B.C. in eastern Central Asia. One of the most iconic examples of this mortuary expression of social hierarchy is the Issyk Golden Man, an ornate gold-clad 'elite' excavated in 1969 from a sixty-meter-wide burial mound only about 20 km east of the Talgar alluvial fan (Akishev, 1978, 1984; Golden, 2011:4-5). The fourth to third century B.C. burial contained over 4000 golden objects (Hall, 1997), and is just one example of the thousands of large burial mounds from the region that date to the late first millennium B.C. Yablonsky (1995:232) estimated in 1995 that approximately 1000 burial mounds dating to the first millennium B.C. had been excavated in the Semirech'ye region alone, most of which were large-scale labor investments. He further noted that these large 'kurgans' in eastern Kazakhstan range from 20 to 100 m in diameter and eight to 10 m in height (1995:209).

One of the many contemporaneous burial sites in this region is the Zhuan Tobe cemetery near the town of Shelek not far from Almaty in southeastern Kazakhstan (Fig. 1). The site consists of nine large earthen mound (kurgan) burials. Mound 9 of the complex was excavated by the Kazakh-German Archaeological Expedition (Gass, 2016) in 2008, and is 19 m in diameter and 1.2 m high. While the burial was looted, some grave goods were still recovered and the grave radiocarbon dated between 169 cal B.C. – A.D. 48. Among the recovered grave goods (not directly in the grave) were carbonized and desiccated remains of grains, analyzed by Neef (Gass, 2016). A three-liter soil sample from the southern part of the grave contained 282 grains of wheat, most expressed a highly compact free-threshing morphotype. In addition, two grains of hulled barley, as well as 127 hexaploid wheat rachises, five glume wheat spikelet forks, and straw remains. A second three-liter sample was also taken from the southern end of the burial, which contained grains of millet, both broomcorn (n = 41) and foxtail (n = 49), as well as morphologically wild *Setaria* seeds (*Setaria* cf. *viridis*) and a variety of other wild seeds. Ceramic vessels in most of the mid-first millennium B.C. burials attests to the practice of offering food as a funerary rite; this ritual food appear to include cereal grains.

Extensive anthropological discussion has encompassed the topic of 'nomadic' complexity and the possibility of highly complex pastoral societies, possibly even states (see Honeychurch and Makarewicz, 2016 and references therein). Over the past few years there has been increased interest in illustrating that mobile pastoral communities of the past were self-sufficient, economically, and maintained complex political structures (Borgerhoff Mulder et al., 2010; Honeychurch, 2013; Lindasay and Greene, 2013; Rogers, 2012, 2017). However, there has been resistance toward the idea of nomadic states or empires and scholars often use alternative nomenclature to classify this phenomenon, such as nomadic confederations or polities. It has traditionally been argued that complexity, specifically through social hierarchy, among mobile pastoralists often arises from relationships they hold with sedentary populations that lead to unequal distributions of wealth (e.g., Khazanov, 1994). Similar arguments suggest that dispersed populations of largely pastoral groups across northern Central Asia organized themselves in a stratified social system as a response to the influx of craft goods and grain from neighboring sedentary peoples (Barfield, 2001; Kradin, 2002; Salzman, 2004). Ultimately, stepping beyond simple staples, such as grains, it is suggested that greater incentive to form collective confederacies spawned from the demand to publicly solidify the power of elites by means of luxury goods, also obtained through relations with sedentary neighbors (Kradin, 2008; Stark, 2012; Honeychurch, 2014). Still other views of these social developments focus on exchange, interconnectivity between groups, and participation in a larger social sphere (Frachetti, 2012). In every regard, it is clear that many of the classical traits of political development appear in parts of Eurasia during the late third millennium B.C. and do not appear everywhere in the same way; hence, simple mono-causal models and linear evolution analogies are not appropriate.

Interestingly, most of these models still rely on food surplus, whether that surplus is self-produced (as in greater reliance on herding) or obtained through exchange with or exploitation of neighboring groups. This idea of surplus has long been the pivot of social complexity studies, suggesting that centralized power ensures grain surplus and redistribution – ultimately solidifying stratified social orders (Cohen, 1978; Fried, 1967). As Kim and Kusimba (2008) remark, "Complex society archaeologists have emphasized the generation of surplus, and accumulation of wealth and investment in craft specialization as among the most important indices for determining levels of complexity". The earliest theorists of urbanization and social evolution saw agriculture as inherent to the evolution of societies. Morgan (1877) focused heavily on the linear development of subsistence practices; as did Childe (1936, 1950), in his discussion of the Urban Revolution. White (1959) saw the transition to agriculture as a step toward the "evolution of culture", and Sahlins (1974; Sahlins and Service, 1960) made it a cornerstone in his discussions of complexity and wealth. Most of the large body of research on the topic of social complexity produced from the 1950s through the 1970s subscribes to the underlining premise that the agricultural transition is an unavoidable stepping stone along the path of complexity (for a summary see Marcus and Sabloff, 2008). Population growth, circumscription, and resource availability remain salient features in complexity and state formation discussions (Carneiro, 1970; Mann, 1986; Schacht, 1988). While agriculture has gradually slipped out of the spotlight in discourse surrounding complexity, it remains indispensable in such discussions, regardless of whether you see it as a triggering factor for urbanism and state development or a response to population growth, increased exchange, and innovation.

The almost dogmatic view that northern Central Asian populations of the first millennium B.C. were highly specialized mobile pastoralists has skewed discussions of complexity in this part of the world, which have largely revolved around extracting grain surplus from neighboring groups or the unique existence of social complexity without grain surplus. However, as archaeobotanical methods are becoming more commonplace and more systematic excavation is being implemented, the myth of pastoral specialization is largely giving way to a complex economic system of non-urban agropastoralism (Di Cosmo, 1994; Spengler et al., 2014a, 2014b; Spengler et al., 2016a). Essentially, the growing archaeological evidence for economy in the first millennium B.C. in the mountain foothills of Central Asia are calling into question the very idea of 'nomadism'. While it is beyond the scope of this paper to debate whether any specific Central Asian peoples of the Iron Age were mobile or sedentary (or a mixture of both), it is clear that the general level of investment in agriculture among people in the Central Asian foothills was more intense than previously acknowledged and that this intensity coincides with tell-tale archaeological signs of increasing complexity.

Over two decades of research, on the Talgar alluvial fan by Chang et al. (2002, 2003), has shown a completely anthropogenic landscape by the first millennium B.C., with mud brick architecture and interlocked rooms, large storage pits, and extensive material culture. In addition, survey work has shown that the entire alluvial fan was covered with hamlets or small villages connected by broad expanses of irrigated field systems. The limited evidence for wood in any of the flotation samples, the high abundance of wild herbaceous seeds (likely illustrating dung use as fuel), the lack of foraged nuts or fruits, and limited evidence for hunting suggest that the native foothill forests of the region were converted to agricultural land before this time period. Research by Macklin et al. (2015) has suggested that irrigation systems on the Talgar fan relied on the large glacial melt and mountain-rain-fed streams, which still cut across the alluvial fan today. The adoption of viticulture across the Talgar fan in the second half of the first millennium B.C. further attests to the changing views of land tenure and level of mobility. Grapes are a delayed-return crop, providing the first harvest after a minimum of four years of growth depending on method of propagation, and vineyards need to be protected and maintained year-round. In addition, the dominance of long-season grain crops, like wheat and barley, as opposed to short-season crops like the millets, means that a greater investment in maintaining and watering fields was required, which further suggested that at least a portion of the population remained sedentary. As Miller et al. (2016) have suggested, the wider dispersal of millets in certain regions of Central Asia where irrigation systems were also elaborated may illustrate an adoption of crop rotation cycles and an entirely new level of agricultural investment at this time.

Boserup (1990b:47) points out that the supply of labor during the peak harvesting season is the main constraint of agricultural development; therefore, by spreading out the peak season through grain crops with differing growing seasons fewer workers are required to produce greater surplus. Labor might have been pooled for millet harvesting in the late summer and again later for wheat and barley harvesting in autumn (or early summer depending on the varieties of cereals that were cultivated). Maintaining fields and possibly irrigation canals would also have required labor. Pooled labor systems would have helped people maintain both pastoral herds and irrigated fields. In second millennium B.C. layers at the site of Tasbas, Spengler et al. (2014a) recovered an abundance of rachises, which are direct evidence for local grain processing. At the Talgar sites in the Iron Age rachises and chaffing material are rare, possibly suggesting off-site crop processing, this could be at a communal threshing platform or in the fields. Furthermore, in a Boserupian sense, we 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, 1990b). In discussions of early sedentary peoples, researchers have generally accepted as a given that intensive agriculture, high population density, elaborate material culture, architectural remains, craft specialization, and social complexity are tell-tale archaeological signs of sedentism. This new view of social development during the first millennium B.C. focuses on economic diversification and agricultural pursuits and takes some of the spotlight off the old models that relied on pastoral specialization; although, it is also clear that there was significant regional variability in the pathways of social development.

While agriculture seems to have been more commonplace than previously thought across much of Central Asia during the first millennium B.C., in the Talgar region agriculture was an important part of the economy. People living in the region stored grain surplus in subterranean storage pits and lived in mudbrick houses. Interestingly, this increased investment in agricultural surplus coincides with elaborate burials, notably that of the Issyk Golden Man which was excavated about 20 km from the Talgar sites. While the link between farming and social changes is never a clear-cut match, and farming is not testified in all areas of Central Asia at this time period, these data do call for a closer evaluation of the archaeological record and possibly a reassessment of economic models.

6. Conclusion

Archaeologists and historians working in Central Asia have long suggested that the first millennium B.C. was a period of increased specialization of pastoralism or as some scholars call it 'Central Asian nomadism', and marked the period of origin for the horse-riding warrior nomads, often referred to as the Scythians (Golden, 2011). However, recent archaeobotanical data summarized in this paper shows that agricultural goods were part of the economy at several sites across the mountain foothills of Central Asia. It has always been acknowledged that farming was at the center of economy in southern Central Asia, especially after the Achaemenid expansions of the sixth and fifth centuries. However, the identification of carbonized grains at six of the seven (Kyzyl Bulak has poor botanical preservation) archaeological sites discussed in this paper show that the traditional models of economic development do not apply for all of Central Asia. The archaeological sites on the Talgar alluvial fan show evidence for intensified agriculture, including multiple crops that had different lengths in growing seasons, likely irrigated fields, and viticulture. Agropastoralists at these sites grew free-threshing wheat, hulled barley, broomcorn and foxtail millet, and grapes. Even sites in more arid regions further to the north have evidence for agricultural goods in the economy, although the data from these sites are currently limited. Lowland sites to the south of Talgar in modern-day Uzbekistan and Turkmenistan show clear evidence for complex economic systems and elaborate agriculture by the first millennium B.C.

Central Asia was the long-held exception to the rule of intensive agriculture pre-dating elaborate social developments; now it seems to be the exception that proves the rule. The acceptance of the existence of intensified farming in Central Asia during the period of the classical formation of 'nomadic empires' or 'polities' takes archaeological studies of complexity back to earlier iterations of the idea, despite decades of scholarship in Central Asian archaeology centered around a hardwired focus on pastoralism (cf. Kradin 2013). We argue that two main factors drove cultural developments in this part of Central Asia at this time: 1) increased exchange; and 2) agropastoral food surplus, largely associated with the introduction of irrigation and new crop varieties (Miller et al., 2016). Cultural exchange often drives social complexity (Brosseder, 2015), in Central Asia this process is evident in the increased movement of goods and ideas associated with a more systematically organized Silk Road. This social transition coincides with the advent of craft specialization on a community level, elaborate urban architecture, and further development of an "elite" class beyond what existed in the Bronze Age. Following a Boserupian model (Boserup, 1990), we see both increased exchange and agricultural pursuits manifesting in the Late Bronze and early Iron Ages, resulting in a correlative increase in social stratification and shift in population demographics. The proposed trend is evident in the elaborate size of burial mounds, the luxury offerings in the burials, the dramatic increase in numbers of burials, and the overall increase in archaeological visibility during the first millennium B.C. in the foothills of Central Asia. The storage pits and grind stones found at the Talgar sites complement the idea that people were accumulating grain stores and consequently building wealth, increasing social stratification and craft specialization, and contributing to an overall growth in population. Many scholars have argued that food surpluses and the accumulation of wealth directly contribute to demographic changes, pooled labor, social cohesion, political stratification including an elite class, craft specialization, and ultimately the formation of the state (Kim and Kusimba, 2008).

While our understanding of social developments across Central Asia is currently in a state of reevaluation, there is no reason to believe that the trends observed in the Talgar region are indicative of a larger scale trend. Further archaeobotanical investigation may show that the progress towards cultural complexity followed a pastoral-specialization route in regions of the steppe where there was no clear connection with agricultural surplus. We wish to conclude this paper by pointing out that there is growing data that illustrates a high level of regional variability in trajectories of social and economic development across Central Asia. As examples, the role of irrigation farming and the nature of political centralization were different in the Murghab (Rouse and Cerasetti, 2014) than in Khorezm (Betts, 2006) or along the Amu Darya or in the Bukhara Oasis (Wu et al., 2015). Furthermore, increasing evidence from the Bronze Age on the western steppe (Hanks, 2010) and parts of Mongolia (Rogers, 2017) illustrate that politically complex societies were developing in the second millennium B.C. in the absence of any agricultural goods. However, by the time political systems in Mongolia began to centralize (Xiongnu) there is clear evidence for the local cultivation of grains, notably millet in rich river valleys of northern Mongolia (see Spengler, 2015); although, the importance of these crops in the diet is still unclear. Nonetheless, Central Asia remains an important region for testing and challenging the existing theories of social development, and increased research in this part of the world is needed, especially in true steppe ecologies, such as northern Kazakhstan, the southern Urals, and central Mongolia, areas that have no clear evidence for early farming. While archaeologists still need to parse out the details of the economic variability across Eurasia, it seems clear that farming (in many areas irrigated) played a more significant role in the cultures of Eurasia during the first millennium B.C. than previously acknowledged.

Acknowledgments

Norbert Benecke (German Archaeological Institute) conduced zooarchaeological studies at Tuzusai, which we discuss in this paper. Michael Frachetti directed excavations at Begash and Mukri and X. Wu directed excavations at Kyzyltepa.

References

Akishev, K.A., 1978. Курган Иссык: Искусство Саков Казахстана Москва (Issyk Mound: The Art of Saka in Kazakhstan). Искусство (Iskusstvo Publishers), Moscow.
Akishev, K.A., 1984. Иссkуство и мифология саков (The art and mythology of the Saka). Наука (Nauka), Alma Ata.
Anthony, D.W., Brown, D., Brown, E., Goodman, A., Kokhlov, A., Kosintsev, P., Kuznetsov, P., Mochalov, O., Murphy, E., Peterson, D., Pike-Tay, A., Popova, L., Rosen, A., Russel, N., Weisskopf, A., 2005. The samara valley project: late bronze age economy and ritual in the Russian steppes. Eurasia Antiqua 11, 395–417.
Barfield, T., 2001. The shadow empires: imperial state formation along the Chinese-nomad frontier. In: Alcock, S., D'Altroy, T., Morrison, K., Sinopoli, C. (Eds.), Empires: Perspectives From Archaeology and History. Cambridge University Press, Cambridge, pp. 10–41.
Betts, A.V.G., 2006. Chorasmians, Central Asian nomads and Chorasmian military architecture. In: Khozhaniyazov, G. (Ed.), The Military Architecture of Ancient Chorasmia. Editions de Boccard, Paris, pp. 131–158.
Boserup, E., 1983. The impact of scarcity and plenty on development. In: Rotberg, R.I., Rabb, T.K. (Eds.), Hunger and History: The Impact of Changing Food Production and Consumption Patterns on Society. Cambridge University Press, Cambridge, pp. 185–210.
Boserup, E., 1990a. Agricultural growth and population change. In: Paul Shultz, T. (Ed.), Ester Boserup: Economic and Demographic Relationships in Development. The John Hopkins University Press, Baltimore, pp. 11–24.
Boserup, E., 1990b. The impact of population growth and agricultural output. In: PaulmShultz, T. (Ed.), Ester Boserup: Economic and Demographic Relationships in Development. The John Hopkins University Press, Baltimore, pp. 42–45.
Brite, E.B., Kidd, F.J., Betts, A., Cleary, M.N., 2017. Millet cultivation in Central Asia: A response to Miller et al., The Holocene, Online First.
Brosseder, U.B., 2015. A study of the complexity and dynamics of interaction and exchange in late Iron Age Eurasia. In: Bemmann, J., Schmauder, M. (Eds.), Complexity of Interaction Along the Eurasian Steppe Zone in the First Millennium CE. Rheinische Friedrich-Wilhelms-Universität, Bonn, Vor- und Frühgeschichtliche Archäologie, pp. 199–332.
Borgerhoff Mulder, M., Fazzio, I., Irons, W., McElreath, R.L., Bowles, S., Bell, A., Hertz, T., Hazzah, L., 2010. Pastoralism and Wealth Inequality. Current Anthropol. 51 (1), 35–48.
Carneiro, R.L., 1970. A theory of the origin of the state. Science 169 (3947), 733–738.
Chang, C., 2017. Rethinking prehistoric Central Asia: shepherds, farmers, and nomads (Asian states and empires). Routledge, New York.
Chang, C., Benecke, N., Grigoriev, F.P., Rosen, A.M., Tourtellotte, P.A., 2003. Iron age society and chronology in south-east Kazakhstan. Antiquity 77 (296), 298–312.
Chang, C., Tourtellotte, P., Baipakov, K.M., Grigoriev, F.P., 2002. The evolution of steppe communities from bronze age through medieval periods in Southeastern Kazakhstan (Zhetysu). Sweet Briar College, Sweet Briar, Virginia.
Chernikov, S.S., 1960. О термине «ранние кочевники (On the term 'early nomads'). In: Краткие сообщения о докладах и полевых исследованиях Института истории материальной культуры (Brief Reports and Field Studies of the Institute of the History of Material Culture), vol. Volume 80. KSIIMK, Moscow, pp. 17–21.
Childe, V.G., 1936. Man Makes Himself. Watts and Company, London.
Childe, V.G., 1950. The urban revolution. Town Plann. Rev. 21, 3–17.
Cohen, R., 1978. Introduction. In: Cohen, R., Service, E. (Eds.), Origins of the state. ISHI Press, Philadelphia, pp. 1–20.
Cribb, R., 1991. Nomads in archaeology. Cambridge University Press, New York.
Davis-Kimball, J., Bashilov, V.A., Yablonsky, L.T. (Eds.), 1995. Nomads of the Eurasian Steppe in the Early Iron Age. Zinat Press, Berkeley.
Di Cosmo, N., 1994. Ancient inner Asian nomads: their economic basis and its significance in Chinese history. J. Asian Stud. 53 (4), 1092–1126.
Flannery, K., 1972. The cultural evolution of civilizations. Annu. Rev. Ecol. Syst. 3, 399–426.
Frachetti, M.D., 2008. Pastoralist landscapes and social interaction in bronze age Eurasia. University of California Press, Berkeley.
Frachetti, M.D., Evan Smith, C., Traub, C.M., Williams, T., 2017. Nomadic ecology shaped the highland geography of Asia's silk roads. Nature 543 (7644), 193–198.
Frachetti, M.D., 2012. Multi-regional emergence of mobile pastoralism and non-uniform institutional complexity across Eurasia. Current Anthropol. 53 (1), 2–38.
Frachetti, M.D., Spengler, R.N., Fritz, G.J., Mar'yashev, A.N., 2010. Earliest direct evidence for broomcorn millet and wheat in the Central Eurasian steppe region. Antiquity 84, 993–1010.
Frachetti, M., Benecke, N., 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, M.D., Mar'yashev, A.N., 2007. Long-term occupation and seasonal settlement of eastern eurasian pastoralists at begash, Kazakhstan. J. Field Archaeol. 32 (3), 221–242.
Fried, M., 1967. The evolution of political society. Random House, New York.
Fritz, G.J., 2005. Palaeoethnobotanical methodology and applications. In: Maschner, H.G., Chippindale, C. (Eds.), Handbook of Archaeological Methods. AltaMira Press, Lanham, Maryland, pp. 773–834.
Gass, A., 2016. Das Siebenstromland Zwischen Bronze- Und Früheisenzeit: Eine Regionalstudie (Semirech'ye Between the Bronze and Early Iron Ages: a regional study). Walter de Gruyter GmbH, Berlin.
Golden, P.B., 2011. Central Asia in World History. Oxford University Press, Oxford.
Gorbunova, N.G., 1986. The Culture of Ancient Ferghana: VI century B.C. – VI century A. D. vol. 281. BAR International Series, Oxford.
Gryaznov, M.T., 1955. Некоторые вопросы истории сложения и развития ранних кочевых обществ Казахстана и Южной Сибири (Some questions regarding the history of the formation and development of the early nomadic societies of Kazakhstan and South Siberia). Антология Советской Археологий (Anthology of Soviet Archaeology) 3, 141–147.
Hall, M.E., 1997. Towards an absolute chronology for the Iron Age of Inner Asia. Antiquity 71, 863–874.
Hanks, B., 2010. Archaeology of the Eurasian Steppes and Mongolia. Ann. Rev. Anthropol. 39, 469–486.
Hemphill, B.E., Mallory, J.P., 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. Am. J. Phys. Anthropol. 124, 199–222.
Hiebert, F.T., Kurbansakhatov, K., 2003. A Central Asian Village at the Dawn of Civilization, Excavations at Anau. University of Pennsylvania Museum of Archaeology and Anthropology, Philadelphia, Pennsylvania, Turkmenistan.
Hollenbach, K.D., unpublished-2008. Plant Remains from Taldy Bulak 2, Kazakhstan. Archaeological Research Laboratory Department of Anthropology University of Tennessee, Knoxville, Tennessee.
Honeychurch, W., 2013. The nomad as state builder: historical theory and material evidence from Mongolia. J. World Prehistory 26 (4), 283–321.
Honeychurch, W., 2014. Alternative complexities: the archaeology of pastoral nomadic states. J. Archaeol. Res. 22, 277–326.
Honeychurch, W., Makarewicz, C.A., 2016. The archaeology of pastoralism. Ann. Rev. Anthropol. 45, 341–359.
Kim, N.C., Kusimba, M.C., 2008. Pathways to social complexity and state formation in the Southern Zambezian Region. African Archaeol. Rev. 25, 131–152.
Khazanov, A.M., 1994. Nomads and the outside world. University of Wisconsin Press, Madison, Wisconsin.
Kuzmina, E., 2008. The prehistory of the Silk Road: Encounters with Asia. V. H. Mair (Transl.). University of Pennsylvania Press, Philadelphia, Pennsylvania.
Kuzmina, E., 2000. The Eurasian steppes the transition from early urbanism to nomadism. In: Davis-Kimball, J., Murphy, E.M., Koryakova, L., Yablonsky, L.T. (Eds.), Kurgans, Ritual Sites and Settlements Eurasian Bronze and Iron Age. BAR International Series, Oxford, pp. 118–189.
Kradin, N., 2002. Nomadism, evolution, and world-systems: Pastoral societies in theories of historical development. J. World-Syst. Res. 8, 368–388.
Kradin, N., 2008. Early state theory and the evolution of pastoral nomads. Soc. Evol. History 7, 107–130.
Kradin, N., 2013. Criteria of complexity in evolution: cross-cultural study in archaeology of prehistory. Soc. Evol. History 12 (1), 28–50.
Li, S., 2002. Interactions between northwest China and Central Asia during the second millennium BC: an archaeological perspective. In: Boyle, K., Renfrew, C., Levine, M. (Eds.), Ancient Interactions: East and West in Eurasia. McDonald, London, pp. 171–182.
Lindasy, I., Greene, A., 2013. Sovereignty, mobility, and political cartographies in Late Bronze Age southern Caucasia. J. Anthropol. Archaeol. 32, 691–712.
Linduff, K.M., 2006. Why have Siberian artifacts been excavated within ancient Chinese dynastic borders? In: Peterson, D.L., Popova, L.M., Smith, A.T. (Eds.), Beyond the Steppe and the Sown: Proceeding of the 2002 University of Chicago Conference on Eurasian Archaeology. Brill, Boston, pp. 358–370.
Lister, D.L., Jones, M.K., 2013. Is naked barley an eastern or a western crop? The combined evidence of archaeobotany and genetics. Vegetation History Archaeobotany 22, 439–446.
Macklin, M.G., Panyushkina, I.P., Toonen, W.H.J., Chang, C., Tourtellotte, P.A., Duller, G.A.T., et al., 2015. The influence of Late Pleistocene geomorphological inheritance and Holocene hydromorphic regimes on floodwater farming in the Talgar catchment, southeast Kazakhstan, Central Asia. Quatern. Sci. Rev. 129, 85–95.
Mann, M., 1986. The Sources of Social Power: Volume 1, A History of Power from the Beginning to AD 1760. Cambridge University Press, Cambridge.
Marcus, J., Sabloff, J. (Eds.), 2008. The ancient city: new perspectives on urbanism in the old and new world. SAR Press, Santa Fe, New Mexico.
Mei, J., Shell, C., 1998. Copper and bronze metallurgy in late prehistoric Xinjiang. In:

Mair, V.H. (Ed.), The Bronze Age and Early Iron Age Peoples of East Central Asia. University of Pennsylvania Museum Publications, Philadelphia, pp. 581–603.
Mei, J., Shell, C., 1999. The existence of Andronovo cultural influence in Xinjiang during the second millennium BC. Antiquity 73 (281), 570–578.
Miller, N.F., 1996. Plant remains from Tuzusai and Talgar City, Kazakhstan, 1994–1996 seasons. MASCA Ethnobotanical Laboratory Report 21. University of Pennsylvania Museum, Philadelphia.
Miller, N.F., Spengler, R.N., Frachetti, M., 2016. Millet Cultivation across Eurasia: Origins, Spread, and the Influence of Seasonal Climate. The Holocene 26, 1566–1575.
Morgan, L.H., 1877. Ancient society. MacMillan and Company, London.
Motuzaite-Matuzeviciute, G., Lightfoot, E., O'Connell, T.C., Voyakin, D., Liu, X., Svyatko, S., et al., 2015. The extent of cereal cultivation among the Bronze Age to Turkic period societies of Kazakhstan determined using stable isotope analysis of bone collagen. J. Archaeol. Sci. 59, 23–34.
Pearsall, D.M., 2000. Paleoethnobotany a Handbook of Procedures. Academic Press, San Diego, California.
Renfrew, C., Shennan, S., 1982. Ranking Resource and Exchange: Aspects of Archaeology of Early European Society. Cambridge University Press, Cambridge.
Rogers, J.D., 2017. Inner Asian polities and their built environment. Archaeol. Res. Asia 11, 1–14.
Rogers, J.D., 2012. Inner Asian states and empires: theories, data, and synthesis. J. Archaeol. Res. 20, 205–256.
Rosen, A.M., Chang, C., Grigoriev, F.P., 2000. Paleoenvironments and economy of iron age saka-wusun agropastoralists in Southeastern Kazakhstan. Antiquity 74, 611–623.
Rosen, A.M., 1986. Cities of clay: the geoarchaeology of tells. University of Chicago Press, Chicago.
Rosen, A.M., unpublished-2002. Taldy Bulak 2: Preliminary Phytolith Report for 2002 Sample Set. Institute of Archaeology University College London, London.
Rosen, A.M., unpublished-2003a. Kazakhstan 2003 Season Phytolith Report. Institute of Archaeology University College London, London.
Rosen, A.M., unpublished-2003b. Results of Phytolith Analyses from Tseganka 8. Institute of Archaeology University College London, London.
Rouse, L.M., Cerasetti, B., 2014. Ojakly: A Later Bronze Age mobile pastoralist site in the Murghab region, Turkmenistan. J. Field Archaeol. 39 (1), 32–50.
Sahlins, M., 1974. Stone Age Economics. Aldine de Gruyter, Hawthorne, New York.
Sahlins, M., Service, E.R. (Eds.), 1960. Evolution and Culture. University of Michigan Press, Ann Arbor, Michigan.
Salzman, P.C., 2004. Pastoralists: Equality, Hierarchy, and the State. Westview Press, Boulder, Colorado.
Schacht, R.M., 1988. Circumscription theory: a critical review. Am. Behav. Sci. 31 (4), 438–448.
Spengler, R.N., III, 2013. Botanical Resource Use in the Bronze and Iron Age of the Central Eurasian Mountain/Steppe Interface: Decision Making in Multi-resource Pastoral Economies. Ph.D. Dissertation for the Anthropology Department at Washington University in St. Louis, St. Louis, Missouri.
Spengler III, R.N., Chang, C., Tourtellotte, P.A., 2013. Agricultural production in the Central Asian mountains, Tuzusai, Kazakhstan (410–150 BC). J. Field Archaeol. 38 (1), 68–85.
Spengler III, R.N., Doumani, P.N., Frachetti, M.D., 2014a. Late Bronze Age agriculture at Tasbas in the Dzhungar Mountains of eastern Kazakhstan. Quatern. Int. 348, 147–157.
Spengler, R.N., Frachetti, M.D., Doumani, P.N., Rouse, L.M., Cerasetti, B., Bullion, E., Mar'yashev, A.N., 2014b. Early agriculture and crop transmission among Bronze Age mobile pastoralists of Central Eurasia. Proc. Royal Soc. B 281, 20133382.
Spengler III, R.N., 2015. Agriculture in the central asian bronze age. J. World Prehistory 28 (3), 215–253.
Spengler Jr., R.N., Tarasov, P., Wagner, M., 2016a. Introduction to the Special Issue: 'Introduction and intensification of agriculture in Central Eurasia and adjacent regions'. The Holocene 26 (10), 1523–1526.
Spengler, R.N., III, de Nigris, I., Cerasetti, B., Rouse, L. M. 2016b. The Breadth of Dietary Economy in the Central Asian Bronze Age: A case study from at Adji Kui in the Murghab Region of Turkmenistan. Journal of Archaeological Science: Reports, Online First.
Stark, S., 2012. Nomads and networks: elites and their connections to the outside world. In: Stark, S., Rubinson, K.S., Samashev, Z.S., Chi, J.Y. (Eds.), Nomads and Networks: The Ancient Art and Culture of Kazakhstan. Princeton University Press, Princeton, pp. 106–139.
Thornton, C., Schurr, T.G., 2004. Genes, language, and culture: an example from the Tarim Basin. Oxford J. Archaeol. 23 (1), 83–106.
Ventresca Miller, A., Usmanova, E., Logvin, V., Kalieva, S., Shevnin, I., Logvin, A., et al., 2014. Subsistence and social change in central Eurasia: Stable isotope analysis of populations spanning the Bronze Age transition. J. Archaeol. Sci. 42, 525–538.
Yablonsky, L.T., 1995. The material culture of the Saka and historical reconstruction. In: Davis-Kimball, J., Bashilov, V.A., Yablonsky, L.T. (Eds.), Nomads of the Eurasian Steppe in the Early Iron Age. Zinat Press, Berkeley, pp. 201–239.
Watson, P.J., 1976. In pursuit of prehistoric subsistence: a comparative account of some contemporary flotation techniques. Mid-Continental J. Archaeol. 1, 77–100.
White, L.A., 1959. The evolution of culture: the development of civilization to the fall of Rome. McGraw-Hill, New York.
Wu, X., Miller, N.F., Crabtree, P., 2015. Agro-pastoral strategies at Kyzyltepa, an Achaemenid site in southern Uzbekistan. Iran 53, 93–117.