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Source: Journal of Ethnobiology, 33(1) : 125-147

Published By: Society of Ethnobiology

URL: <https://doi.org/10.2993/0278-0771-33.1.125>

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ECOTOPES AND HERD FORAGING PRACTICES IN THE STEPPE/MOUNTAIN ECOTONE OF CENTRAL ASIA DURING THE BRONZE AND IRON AGES

Robert N. Spengler III, Michael D. Frachetti and Gayle J. Fritz

Eurasian mobile pastoralists living in semiarid environments focus on specific locations on the landscape where pasture resources and water are available. Ecotones –or intermediary zones between the mountain and steppe environments– create mosaic landscapes composed of forage-rich patches and other discrete enclaves of useful biota for pastoralist communities. Ecotopes (ecological patches) provide vital resources for the herding systems used in Central Asia today as well as in the past. We document and discuss wild seed composition of archaeobotanical samples from the Bronze and Iron Age site of Begash in southeastern Kazakhstan noting that much of the archaeobotanical assemblage represents carbonized animal dung, which is currently and historically used as fuel in this region by mobile pastoralists. The seeds offer a window into prehistoric herding patterns and provide a nuanced view of prehistoric land use, social interaction, and community formation across discrete ecological nodes in the Bronze and Iron Ages.

Key words: *ecotone, Central Asia, pastoralism, dung fuel, Begash*

В полусухих зонах Евразии, скотоводы используют территории, где имеются обильные пастбища и вода. Экотоны – или переходные зоны между горными и степными условиями – создают природную мозаику с богатыми ресурсами пастбищами и отдельными анклавами с полезной биотой для скотоводов. Экотопы (экологические участки) обеспечивают важные ресурсы для пастушеских систем, используемых в Центральной Азии как в прошлом, так и сегодня. В эту статью, мы обсуждаем археоботанический состав диких семян из памятников бронзового и железного века в юго-восточном Казахстане. Большая часть археоботанической сборки представляет обугленные навоз, который в настоящее и в историческое время использовался в качестве топлива скотоводов. Семена открывают окно в доисторическую систему землепользования и помогает понять нюансы древних пастушеских систем, взаимодействия и формирование скотоводческих сообществ бронзового и железного века.

Introduction

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. Archaeological distributions of Bronze (3500-900 B.C.) and Iron Age (900 B.C.-A.D. 400) settlements within Central Eurasia are, in many cases, concentrated in ecotones or transitional

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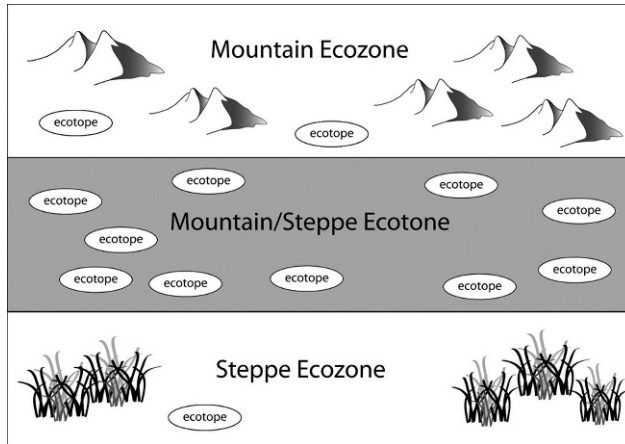


Figure 1. Relationships between ecozones, ecotones, and ecotopes in the Central Asian Mountains.

environments at the interface of two ecozones, such as between the steppe and mountains or forests and coastal regions. The concentration of archaeological remains in ecotones does not imply that the steppe itself was unused during the Bronze and Iron Ages, but it does suggest that a more specific understanding of Central Eurasian economies and strategies can emerge from analyzing the biologically diverse landscapes formed at the interface of major ecological matrices.

Senft (2009) concludes that although few species are endemic to ecotones, these transitional zones are composed of an array of species from 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 1). Ecotonal divides can be abrupt or gradual transitions, or –as in the case of the Central Asian mountain/steppe ecotone– a checkerboard of ecological pockets. Turner et al. (2011:5) see these alpine ecotones as “cultural edges,” with the biodiversity present in these settings supporting “social and economic activities and meeting places where knowledge and goods are produced and exchanged.”

We define ecotope following Troll (1950) as the smallest ecologically relevant unit on a landscape, synonymous with an ecological patch (Foreman and Gordon 1986), although this differs from 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 article we use the term as a contrast to the general steppe matrix. Therefore, distinct vegetation communities within or on the edge of the steppe zone are ecotopes. 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 grazing practices, both ethnohistorically and archaeologically. Herders moved their animals across a steppe or semiarid-steppe matrix dominated by nutrient-poor vegetation (e.g., *Artemisia* spp. and arid-land grasses), while focusing 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. The size, dimensions, and geographic dispersal of these ecological pockets are highly

variable; the specific ecotopes of interest in this article are moist and have denser vegetation than the surrounding matrix.

In this article, we argue that Bronze and Iron Age people living in ecotones at the edge of the steppe focused their economic activities on specific ecological loci; this in turn directly shaped mobility and population dispersal and density. We present results of the analysis of macrobotanical remains from the archaeological site of Begash, a long-term occupation site in the Semirech'ye region (Figure 2) of southeastern Kazakhstan (Frachetti 2008a; Frachetti and Mar'yashev 2007; Frachetti et al. 2010). We propose that the wild seeds obtained through soil flotation were primarily introduced into the carbonized ash by the burning of dung as fuel, although we discuss other vectors as well. Given the botanical composition of the area's steppe matrix (discussed below), we 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. We present the results of a dung burning experiment and discuss what the archaeobotanical seeds indicate from a depositional and taphonomic point of view. We also explore what can be inferred about herd pasturing practices from the wild seeds, specifically how they illustrate the use of ecotopes in herding strategies.

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); regions of the steppe dominated by mobile pastoralists traditionally contain around 1.5 individuals per km² (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). Ethnohistorically documented winter camps across Central Asia provided essential locales for community interaction and 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 2008b). The social geography of land use at rich, diverse patches is particularly important to pastoralists successfully living within mountain/steppe ecotones of Central Eurasia.

The Mountain/Steppe Ecotone

Loosely defined, the Eurasian steppe includes an area extending from the Black Sea to eastern Mongolia and from southern Siberia to the arid grassland

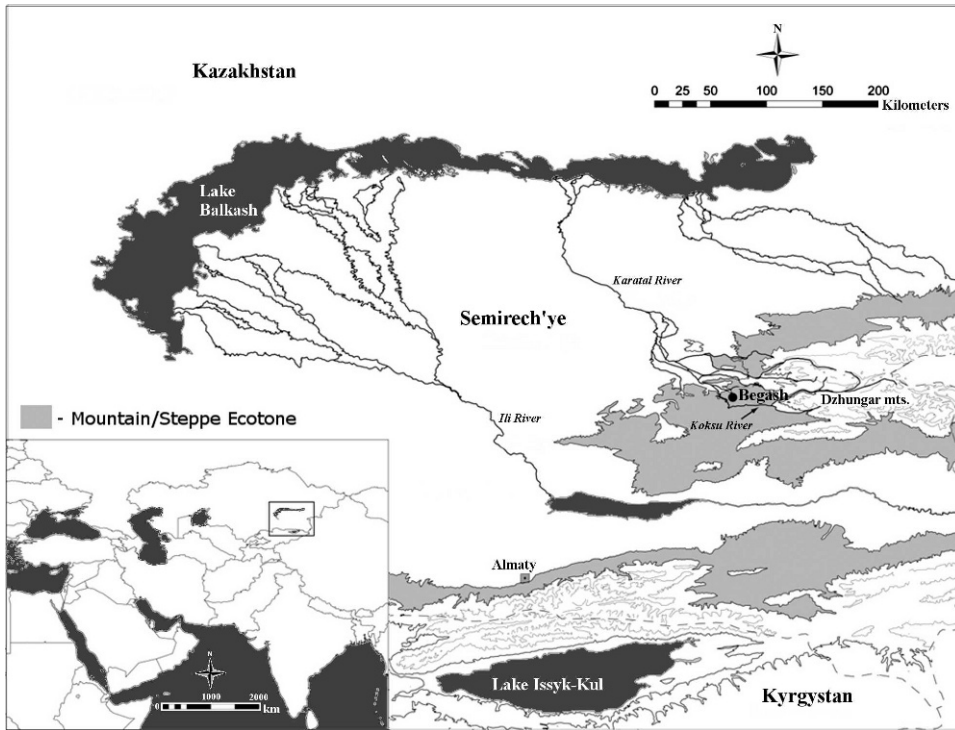


Figure 2. Map showing Begash and its geographic setting; mountain/steppe ecotone.

fringes and deserts of Kazakhstan, Uzbekistan, and Turkmenistan, covering 8,500 km east to west and 400-600 km north to south. The Eurasian steppe roughly falls between 58° and 47° north latitude. There is a distinctive vegetation community in this ecological zone, primarily devoid of woody trees or shrubs and dominated by low-growing herbaceous plants. The ecology of this zone is primarily determined by intercontinentality, which results in low rainfall, <500 mm per annum on average, and a high degree of seasonal variability (Kuz'mina 2008). This climate is suited for narrow-leaf perennial grasses with deep, well-established root systems, often bunch grasses.

The open steppe ecology is often presented as a causal factor for the spread of distinct cultural materials and technologies among mobile peoples in both the Bronze and Iron Ages (Abetekov and Yusupov 1999; Ishjamts 1999; Linduff 2006; Mei and Shell 1998). Common models of Eurasian cultural development envision the steppe as a vast 'highway' for the migration of horse-riding nomads dispersing their material culture from Ukraine to Mongolia, and south as far as Egypt (Li 2002). This model has been influential in studies of Bronze and Iron Age economies, prompting conceptions of the steppe belt as "an immense swath of landlocked grassland, [which] made possible the appearance of a unique historical phenomenon: the horse-breeding, highly mobile Eurasian nomad" (Soucek 2000:1). In recent years the functional reality of a vast steppe 'highway' has been called into question in preference to a model that views restricted ecotones –like the mountain foothills– as more likely contexts for social

interaction and long-distance diffusion of various commodities, innovations, and ideas (Frachetti 2012).

Rather than a homogenous tract of productive grassland, the steppe may be better conceptualized as a mosaic landscape with considerable patchiness and resource diversity (see Kuz'mina 2008:11; Mordkovich 1982). Disparate areas of available resources (e.g., water, herd forage, trees) condition different economic uses and strategies from region to region, especially among mobile pastoralists (Bendrey 2011). This is largely attributable to the biodiversity of vegetation and its usefulness to ruminant herds (Frachetti 2008a).

Lavrenko and Karamysheva (1993) characterize the semiarid steppe with three genera: *Artemisia*, *Carex*, and *Stipa*. In the territory of Semirech'ye, lowland semiarid and arid steppe zones yield a mosaic of saline surfaces, exposed sandy soils, *Artemisia* and dry-grass patches, rock outcroppings, and springs and riparian areas. *Artemisia* species are mixed throughout the more arid and saline areas, including *A. sublessingiana* (B. Keller) Krasch. and *A. heptapotamica* Poljakov (Goloskokov 1984). Saline and drought-tolerant species in the Amaranthaceae family are also present, including the shrubby *Haloxylon aphyllum* (Minkw.) Iljin and *H. persicum* Bunge. The steppe in general is most characterized by arid-land Poaceae such as *Bothriochloa ischaemum* (L.) Keng, *Festuca valesiaca* Schleich., *Stipa capillata* L., *S. caucasica* Schmalh., and *S. sareptana* A.K. Becker. Some of the forbs in the semiarid-steppe of Semirech'ye include *Adonis aestivalis* L., *Alcea nudiflora* (Lindl.) Boiss., *Allium* spp., *Convolvulus* spp., *Echinops nanus* Bunge, *Euphorbia rapulum* Kar. & Kir., *Goniolimon callicomum* (C.A. Mey.) Boiss., *Hypericum* spp., *Kochia prostrata* (L.) C. Schrad., *Tragopogon ruber* S.G. Gmel., *Vexibia alopecuroides* (L.) W.A. Weber, and *Ziziphora clinopodioides* Lam. (Evashenko 2008).

In light of this varied distribution of plant taxa, it may be more fruitful to think of the steppe territory in terms of a punctuated transition from *Artemisia*-dominant regions (often at lower elevations) to forb-dominant areas with higher rainfall or water inflow (often closer to the foothills). Likewise, the southern territories of the broader steppe region can be up to six times drier than those of the north. Precipitation varies from north to south from 600 mm to 150 mm per annum (Kuz'mina 2008:11). The further south, the more isolated the patches of forage are, and less nutrition can be obtained from the steppe-matrix vegetation, eventually leading to forms of oasis pastoralism as described by Hiebert (2002). We suggest that, as a result of the broad regional differences in ecotope distribution and composition, regional populations were variously brought into contact at nodal points on the landscape where shared resource catchments existed or when other patches were unavailable.

Begash, like most other archaeological sites in Eurasia, is located in the mountain foothill ecotone. In the Dzhungar Mountains, the vascular plant line is approximately 3,500 masl (Evashenko 2008). Between 3,500 and 2,800 masl, coniferous high-mountain forests (or taiga biome) are mixed with mountain meadows and rock outcrops (Evashenko 2008; Goloskokov 1984). Directly below this vegetation line is a highly productive area primarily defined by mountain meadows (Evashenko 2008). From roughly 2,000 to 3,500 masl, the meadows are primarily dominated by forbs, while the patches of meadows below this band are a mixture of high elevation grasses and forbs.

Foothill elevations (800–1,500 masl) offer both topographic and climatic conditions that mitigate the restrictedness of highland territories and the aridity and sparseness that characterizes the open steppe at lower elevations. Mountain streams fed from precipitation and glacial melt cut deep fluvial depressions into the alluvium, which are lined with rich riparian vegetation. In many cases, the transition between productive patches and the mesophytic environmental matrix is visually apparent and can be very sharp. Geographic uplift and other geomorphological forces shape the physical geography of foothill regions and the resulting vegetative distribution. Throughout the mountains of Inner Asia, foothill territories are defined by uplifted bedrock as well as eroded alluvium deposits and loess. Cliffs, rock outcroppings, rolling hills, and valleys all foster unique vegetation communities, distinct from lower elevation fluvial systems or the highland tree vegetation that dominates higher mountain landscapes.

Within the foothill ecotones across Semirech'ye, a variety of vegetation patches are essential to successful pastoralism. Water-rich patches are commonly surrounded by stands of *Phragmites australis* [Cav.] Trin. as well as *Typha angustifolia* L. and *Epilobium hirsutum* L. (Goloskokov 1984). A few tree species, including willows (*Salix songarica* Andersson and *S. wilhelmsiana* M. Bieb.), *Elaeagnus oxycarpa* Schldtl., *Populus talassica* Kom., *Tamarix ramosissima* Ledeb., and *Ulmus pumila* L., are also common to well-watered depressions and streambeds throughout the foothills of Semirech'ye (Goloskokov 1984). More water-demanding grasses, such as *Aeluropus* and *Leymus*, grow in large and small river valleys. However, these areas tend to be dominated by forbs, especially *Chenopodium* spp., *Convolvulus* spp., *Echium vulgare* L., *Hyoscyamus niger* L., *Hypericum* spp., *Galium* spp., *Lithospermum arvense* L., *L. officinale* L., *Malva neglecta* Wallr., *M. pusilla* Sm., and *Ziziphora clinopodioides* (Evashenko 2008; Goloskokov 1984).

Paleoenvironmental Changes

In this article, we use modern vegetation as analogous to past vegetation, although research does suggest that climatic changes may have taken place at various times in the past. Much of the paleoenvironmental research in Central Eurasia focuses on northern European pollen cores, which are applied to the rest of Eurasia. Discussions of this large body of literature are presented by Khotinskiy (1984) and Kuz'mina (2008:11–13). Some general trends in this literature include a gradual warming trend, which reached its maximum around 2000 B.C., and a drying trend that reached its peak in the 9th to 7th century B.C. The latter is often used to argue for an increased reliance on pastoralism and mobility on the steppe during the Iron Age. On a larger time scale, some recent pollen studies have argued for gradual or punctuated deforestation event(s) from about 8,000 B.C. to the present (Tarasov et al. 2007; Tchebakova et al. 2009). Kuz'mina (2008:11–15) provides two strong critiques of Eurasian paleoclimatic 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" (Kuz'mina 2008:13). Furthermore, Kremenetski (2003) claims that climatic fluctuations would have affected broad-leaf and conifer forests far more markedly than steppe lands, because the steppe is much more resistant to these changes.

Looking specifically at Semirech'ye, paleoclimatic reconstruction is complicated because the two established paleoenvironmental sequences for eastern Kazakhstan presented by Kremenetski (1997) and Khotinskiy (1984) seem contradictory for the Early Iron Age (discussed in Rosen et al. 2000:613). 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 transgressions and regressions of Lake Balkhash, and conclude that there was a climatic amelioration focused around 660 B.C. While climate changes at this time period are often used to argue for increased pastoralism across much of Eurasia, Rosen et al. (2000) see climate changes having led to a more agriculturally conducive climate in Semirech'ye during the early Iron Age. Chang et al. (2002) argue that this climatic shift may have led to an intensification of agricultural pursuits, which in turn led to a demographic shift with increased sedentism and archaeological visibility on the landscape.

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. While paleoclimatic studies—especially those of Rosen et al. (2000)—have provided a strong foundation for future research, until we obtain a more detailed data set specific to Semirech'ye, our best tool for understanding paleoenvironments is modern analogy. Therefore, we suggest that the modern geophysical environment, especially in the foothill zone, can generally be applied to the Bronze and Iron Age setting in Semirech'ye.

Ethnographic and Archaeological Reconstruction of Land-use Strategy

The economy in Semirech'ye, at least as far back as the Bronze Age, has had a major pastoralist component (Frachetti 2008a; Frachetti and Benecke 2010). 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. In studying ethnohistoric accounts of pastoralists in Semirech'ye, it becomes evident that small patches or ecotopes, such as river valleys, rock outcroppings, springs, and stream beds, 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 2004:165; 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,



Figure 3. Modern Kazakh herder's yurt located in a depression on the landscape, near Taldy Kurgan summer of 2008.

which are typically situated near these vegetation patches, indicate that they were also important in antiquity. Figure 3 shows a modern Kazakh yurt in a stream bed surrounded by *Artemisia*-steppe; the contrast between the rich ecotope and the arid steppe background matrix in the image is abrupt.

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 (Valikhnov 1961–1972, vol. I:531; Levishin 1840:311–312). The ethnographer Medvedskii (see Masanov 1995:88) recorded criteria used for selecting a winter camp by Kazakh pastoralists in the late 1800s: “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.” 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. Above all, Valikhnov (1961–1972, vol. I:533) notes that the main criterion for choosing winter encampments is the availability of herd forage. Cattle and sheep cannot reach grass buried below 10 to 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.

The Begash macrobotanical assemblage provides direct and indirect data to help reconstruct pastoralist mobility patterns and land use, more specifically

suggesting a parallel between the ethnographic and archaeological record (discussed below). Frachetti (2008a) further argues that the Bronze Age inhabitants at Begash employed vertical mobile herding patterns. Seasonal movements would likely have meant herders used the site only during the harsher winter months. While there is debate over how far herds moved during these seasonal movements, Frachetti (2008) argues that movements were relatively short-distance, roughly 20 to 30 km. Interestingly, steppe-land plants are conspicuously absent in the flotation samples from Begash. Instead, we recovered a variety of plants that are more water demanding such as *Chenopodium*, *Galium*, *Hyoscyamus*, *Hypericum*, Lamiaceae, *Lithospermum*, *Malva*, *Polygonum*, and *Tribulus*. 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, as described above.

Begash

The Begash site is located in a river valley of the Dzhungar Mountains at 900 masl, in the Semirech'ye region of eastern Kazakhstan. The landscape directly around the Begash site (discussed below) is predominantly semiarid steppe and is nearly lacking in large woody vegetation. Excavations at the Begash site were conducted by the Dzhungar Mountains Archaeology Project (DMAP) during the field seasons of 2002, 2005, and 2006 (Frachetti 2008b; Frachetti and Mar'yashev 2007). Frachetti and Mar'yashev (2007) have divided occupation at Begash into six archaeological occupation phases. With the exception of a notable abandonment of the site between A.D. 600 and 1100, the stratigraphy illustrates a seasonal or non-permanent occupation strategy with few substantial (multi-century) interruptions in occupation. The chronology of habitation documents the use of the settlement area at Begash for approximately 4,000 years, from 2460 B.C. to A.D. 1850. Three occupation phases show architectural construction, while intermediate phases may represent encampments composed of impermanent structures (Frachetti and Mar'yashev 2007:228–230).

The economy at Begash, like most prehistoric economies in Central Asia, had a large pastoral component. Domestic herd animals dominate the faunal assemblage from Begash, specifically sheep (*Ovis aries*), goat (*Capra aegagrus hircus*), cattle (*Bos taurus*), and horse (*Equus caballus*) (Frachetti and Benecke 2009). Frachetti and Benecke (2009) also present evidence for a small hunting component in the economy, including red deer (*Cervus elaphus*), goitered gazelle (*Gazella subgutturosa*), Siberian ibex (*Capra sibirica*), and argali (*Ovis ammon*).

Soil samples for flotation were collected systematically throughout the field campaigns. Soil was collected from most major features at the site, including domestic hearths, middens, and fill. The samples were floated using bucket flotation, as described in Fritz (2005:780–784), and broken down using water separation by means of manual agitation. A geological sieve of 0.355 mm was used to catch light fraction material. Sample sizes varied; in Table 1 varying sample sizes are accounted for using density ratios. In this paper we only discuss material from the Bronze and Iron Ages of Begash. A total of 18 Bronze Age and 13 Iron Age samples were floated and analyzed, totaling 130 L.

Table 1. Bronze Age and Iron Age flotation samples from Begash.

	FS #	Date range (cal B.C.)	Soil volume (L)	Context	Seed density*
Iron Age	FS 5	390-50	4.5	hearth/ash pit	4.7
	FS 6	390-50	9.0	hearth	44.6
	FS 7	390-50	1.9	ash pit	14.2
	FS 8	390-50	1.8	ash pit	40.2
	FS 9	390-50	2.0	ash pocket	1.0
	FS 31	390-50	0.85	orange-soil fill	2.4
	FS 30	390-50	0.8	orange-soil fill	13.8
	FS 34	390-50	1.05	soil fill	7.6
	FS 35	390-50	1.2	soil fill	12.5
	FS 11	760-400	2.0	fill above burial	23.5
	FS 13	760-400	2.0	fill below burial	32.0
	FS 14	760-400	3.5	burial	23.4
	FS 20	760-400	2.0	soil fill	55.5
	Sub total			32.6	
Late Bronze Age	FS 12	1625-1000	9.5	ash pit/hearth	23.5
	FS 10	1950-1700	9.0	ash lens	21.0
	FS 19	1950-1700	5.0	grid N. wall	85.8
	FS 36	1950-1700	0.4	soil fill	35.0
	FS 37	1950-1700	1.0	soil fill	9.0
	FS 38	1950-1700	5.0	soil fill	69.8
	FS 39	1950-1700	0.7	soil fill	30.0
	FS 40	1950-1700	3.1	soil fill	20.0
	FS 41	1950-1700	0.85	soil fill	18.8
	FS 43	1950-1700	1.8	soil fill	54.4
	Middle/Late B.A.	FS 42	2450-1950	6.2	fire pit
	FS 44	2450-1950	9.5	soil fill	28.1
	FS 45	2450-1950	3.1	soil fill	29.7
	FS 46	2450-1950	1.25	fire pit	24.0
	FS 47	2450-1950	30.8	human cremation	8.4
	FS 48	2450-1950	3.0	soil fill	24.0
	FS 49	2450-1950	5.0	soil fill	42.6
Sub total	FS 50	2450-1950	2.0	soil fill	33.5
			97.2		25.9†

* Seed densities (counts/L) exclude unidentifiable seed fragments and uncarbonized seeds, but they include unidentified seeds.

† Average seed density.

Archaeobotanical Data

Table 2 presents the plant remains recovered from Begash. As discussed in Frachetti et al. (2010) two types of domesticated grains were recovered from the Bronze Age layers at Begash, broomcorn millet (*Panicum miliaceum* L.) and a free-threshing variety of wheat (either *Triticum aestivum* L. or *T. turgidum* L.). Besides these types, foxtail millet (*Setaria italica* [L.] P. Beauv.) was found in an Iron Age sample. In addition to the domestic grains, there are 22 categories of wild seeds (Table 2), providing a total seed-category richness of 25 (*sans* unidentified seeds). Overall average seed density equals 26.0 seeds per liter of soil. Density in the Iron Age is 26.5 seeds/L, and Bronze Age density is 25.9 seeds/L.

The most abundant seed category is *Chenopodium* spp. (Figure 4e). Many of the larger specimens have traits that match with *Chenopodium album* L. (see Martin and Barkley 1973:151). Categories of Poaceae, Panicoid, and Pooid were used for all wild grasses other than *Stipa*-type. Caryopses of *Stipa*-type were

Table 2. Total seed-categories and abundance counts for Begash archaeobotanical assemblage by Age, and from the dung burning experiment (condensed).

Seed type		Iron age	Bronze age	Totals	Dung experiment
Domesticated	<i>Triticum aestivum/turgidum</i>	1	1	2	0
Grains	Cerealia	1	4	5	0
	<i>Panicum miliaceum</i>	24	26	50	0
	<i>Setaria italica</i>	20	0	20	0
	Millet	6	3	9	0
Poaceae	Poaceae	1	0	1	0
	Panicoid-Type	6	9	15	0
	Pooid (cf. <i>Aegilops</i>)	1	0	1	0
	<i>Setaria</i> (cf. <i>viridis</i>)	4	0	4	187
	<i>Stipa</i> -Type	81	92	173	0
Amaranthaceae	<i>Chenopodium</i> spp.	94	529	623	641
	Cheno-ams	66	514	580	0
	<i>Polycnemum</i> (cf. <i>arvense</i>)	5	0	5	63
Rubiaceae	<i>Galium</i> sp.	79	560	639	156
Solanaceae	<i>Hyoscyamus niger</i>	39	91	130	0
Malvaceae	<i>Malva</i> (cf. <i>sylvestris</i>)	23	40	63	14
Asteraceae	Asteraceae A	7	51	58	0
Polygonaceae	Polygonaceae	0	2	2	0
	<i>Polygonum</i> spp.	303	32	335	20
Boraginaceae	<i>Lithospermum arvense</i>	0	3	3	0
Lamiaceae	<i>Mentha/Nepeta</i> -Type	0	2	2	0
Rosaceae	<i>Fragaria/Potentilla</i>	3	0	3	19
Fabaceae	Fabaceae (cf. <i>Trifolium/Melilotus</i>)	3	1	4	23
	<i>Trigonella</i> -Type	84	522	606	19
Hypericaceae	<i>Hypericum</i> sp.	0	1	1	0
Zygophyllaceae	<i>Tribulus terrestris</i>	0	4	4	0
Brassicaceae	Brassicaceae	1	2	3	0
Caryophyllaceae	Caryophyllaceae	0	0	0	23
Unidentified seed		12	30	42	126
Totals without unidentifiable fragments		864	2519	3383	1291
Other	Unidentifiable seed fragment	255	465	720	271
	Awn	149	2	151	0
	Uncarbonized seed	329	42	371	*
Volume of Soil Floated		32.6 L	97.2 L	129.8 L	
Number of Samples Floated		13	18	31	1

* Uncarbonized and partially carbonized seeds were present and are included in the carbonized seed counts.

found in association with awns. *Stipa* is one of, if not the, most abundant grass genus on this part of the steppe. Carbonized *Galium* sp. nutlets from Begash are highly variable in size (Figure 4a), and have micropunctate surface structuring on the testa indicating that the mericarp was setose, a trait consistent with animal dispersed species (Moore 1975:877–893; Taylor 1999).

Hyoscyamus niger seeds range from C-shaped to oblong and are less than 2.00 mm in diameter (Figure 4c). Using Gunn and Gaffney's (1974:3) identification traits for Solanaceae, they are "moderate" sized. All of the seeds in the category *Polygonum* spp. have the distinct three-sided shape of many Polygonaceae. There is a great deal of variation in size and preservation quality of these fruits and kernels. All *Malva* seeds are smaller than 1.5 mm and round in lateral view (Figure 4f). These seeds are most likely from the species *M. sylvestris* L., or its two close relatives *M. neglecta* and *M. pusilla*. Asteraceae A are large

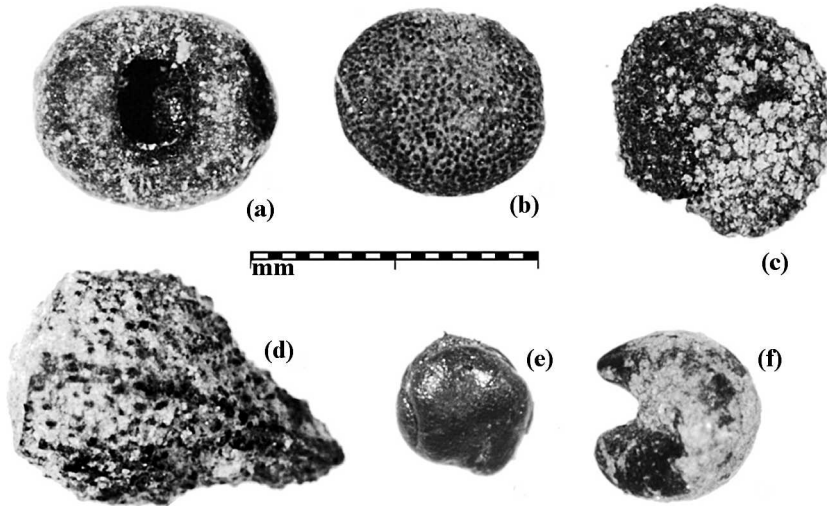


Figure 4. Selected wild seeds from Begash: a) *Galium* sp. from FS48; b) *Polycnemum* (cf. *arvense*) from FS6; c) *Hyoscyamus niger* from FS47; d) *Lithospermum arvense* from FS47; e) *Chenopodium* sp. from FS6; f) *Malva* (cf. *sylvestris*) from FS6.

carbonized kernels. The leading candidate for this plant in the botanical community present in the region today is *Onopordum acanthium* L. *Lithospermum arvense* seeds are found in all cultural layers (Figure 4d). *L. arvense* is the only species in this genus found in the Bronze Age samples, but *L. officinale* is found in several Iron Age samples in an uncarbonized state. The categories Brassicaceae, *Hypericum* sp., *Mentha/Nepeta*, *Polycnemum* cf. *arvense* (Figure 4b), and *Tribulus terrestris* all have low ubiquity and abundance.

Evidence for Dung Burning

A number of depositional processes might have contributed to the introduction of the wild herbaceous seeds into the Begash assemblage, including seed rain, bioturbation, dung burning as fuel, and human foraging. Human foraging and animal foraging can create similar macrobotanical assemblages (Hillman et al. 1997). 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). For example, the natural dispersal mechanism for setae-form *Galium* seeds (as with awned *Stipa* and *Tribulus*) is through adhering to animal fur, wool, or hair. Herd animals at Begash could have brought *Galium* seeds into the site; likewise, wool processing requires cleaning of sheep, goat, and possibly camel wool or hair. Miller (1989, 1990:9; Miller and Gleason 1994; Miller and Smart 1984; Moore et al. 1994) argues that the *Galium* and other wild seeds in macrobotanical assemblages from southwest Asia likely originate from 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.

We suggest that a significant portion of the wild seeds in the Begash assemblage 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 a result of mastication and digestion); (4) ethnographic analogies and other archaeological examples 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.

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 1984; Miller and Marston 2012); likewise, the potential availability of wood resources has been used to argue for or against dung burning (Popova 2006). 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 more than 200 pieces, total counts were not attempted. 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). Of the 32.6 L of soil analyzed from the Iron Age, there was a total of 57.81 g of wood fragments, whereas for the 97.2 L of Bronze Age soil analyzed, wood fragments weighed only 76.62 g.

Densities and Composition of Wild Herbaceous Seeds

When dung is burned it produces ash and charred matter dense in wild herbaceous seeds. The Begash samples are dense (Table 1) relative to other Old World samples. The total seed count 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) 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 some 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. Hitchcock (1951:445) and Miller (1997:656) note that the florets of certain species of *Stipa* can injure grazing animals, especially sheep; however, 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 that 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 produces alkaloids that are reported to be 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. 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, we personally observed

local Kazakh herders' goats, near the town of Taldy-Kurgan, eating the plant with its fruits during the summer of 2008 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 evidence to rule out dung burning. With additional research on the seed composition, the dung might be associated more accurately to a specific animal.

Fragmentary and Poorly Preserved Seeds

As stated above, 720 specimens from Begash were classified as unidentifiable seed fragments. The fragmentary and distorted nature of the unidentifiable, and even many of the identified, seeds in these assemblages is a qualitative observation that is not easily quantified. In archaeobotanical assemblages, seeds have been subjected to destructive processes for hundreds to thousands of years, in addition to the series of pre-depositional degrading processes, such as, carbonization. However, we suspect that there is more distortion here than would exist without the mastication and digestion processes acting on the seeds. This same argument was made by Miller (1984, 1990) for similar sites in southwest Asia and later supported by Klinge and Fall (2010). The argument for post-digestion is strengthened by looking at the properties of the preserved seeds. 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.

Ethnographic Analogies

Burning dung as fuel is still practiced in Semirech'ye by herders today (personal observation 2008–2011, Spengler and Frachetti) and is noted in ethnographic accounts from southern Central Asia and southwest Asia (Miller 1996, 1999). 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) cites 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. In environmental settings that lack wood resources, dung becomes a vital product of the pastoral system, providing fuel for warmth, cooking, and pottery firing.

The Dung Burning Experiment

During the field season of 2008, the DMAP excavated 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 archaeologists' field camp. This herder used a combination of wood collected from a stream near the encampment and dung as fuel. The wood was primarily *Populus* and *Salix*, and the dung was a combination of cattle patties and bricks of sheep and goat dung that were dug up 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 this accumulation of dried dung from the previous year (Figure 5). As mentioned, 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 lesser 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); however, they have not been used in archaeology on the Eurasian steppe, nor has the topic of dung burning been comprehensively addressed in archaeobotanical studies in this region. During mid-August of 2008, the first author collected 20 L of cattle dung patties from the modern herder's pens near Taldy-Kurgan. After clearing a surface down to sterile clay in order to reduce contamination from the soil seed bank, Spengler 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 the remains were collected. The 20 L of dung burned down to 18.51 g of fine ash and charred particles, a volume of about 0.5 L. 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.

None of the seeds from our dung experiment was larger than 2.00 mm. The total seed count was 1,291, 60 of which fall in the unidentified category, with many obviously belonging to the same species. In addition, there were 271 unidentifiable seed fragments (not included in the total seed count). Many uncarbonized or partially carbonized seeds were present in the experimental sample, similar to the archaeobotanical samples; due to the partially carbonized state of many of these seeds no attempts were made to differentiate carbonized from uncarbonized seeds. Density is unsuitable for comparison with other samples because there is no soil matrix. Richness is not considered, 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.



Figure 5. Image of drying, bricked-up sheep and goat dung in a modern Kazakh winter camp at Bryan-Zherek. Photograph taken during the summer when herds are pasturing in the mountains.

The second most abundant category was *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* species grow on the steppe and in river valleys around Semirech'ye today as well as being common agricultural weeds. *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* L., whereas, most of the *Galium* seeds in the archaeobotanical samples appear to be more like *G. aparine* L.; these are two of the many *Galium* species present in the region today. Other abundant categories include Caryophyllaceae, Fabaceae, *Fragaria/Potentilla*, *Malva*, *Polycnemum*, *Polygonum*, and *Trigonella*. All of these categories are also 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 size of these seeds (<2.00 mm); (3) low abundance of wood; (4) similarities in the actual seed categories present; (5) similarities in which categories are abundant; (6) presence of partially carbonized and uncarbonized seeds mixed in with carbonized ones; and (7) fragmentation of seeds and fruits. Therefore, we feel that most of the charred seeds in the Begash assemblage represent the result of burning animal dung. Shahack-Gross and Finkelstein

(2008) argue that a close analysis of the remains of burned dung in archaeological sites can help lead to a greater understanding of human economy and subsistence patterns. We agree, noting that 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.

Discussion

In this article, we hypothesize that Bronze and Iron Age herders were grazing and browsing their herds in small ecological patches –or ecotopes– for at least part of the year, and that this economic focus shaped mobility and population dispersal. We use experimental data among other lines of argument to show that the wild seeds in the archaeobotanical assemblage are the result of dung burning and that they represent herd dietary patterns. While dung burning has been discussed as a factor in shaping archaeobotanical assemblages in South Asia, it has not been discussed as a factor in archaeobotanical interpretations for northern Central Asia and on the steppe. In addition to adding a new interpretative perspective to research on the steppe, we attempt to use the wild seeds to understand how herds and humans moved and articulated on their landscape. As we suggest below, understanding how humans used their environment helps us understand how they partook in social exchange and constructed community networks.

We further link the seed categories in the assemblage to plants that grow in these ecotopes and not on the steppe proper. The majority of the seeds in the assemblage from Begash represent plants that do not readily grow among steppe vegetation. For example *Chenopodium*, *Galium*, *Malva*, *Polygonum*, and *Trigonella*-Type plants are all too water-demanding to survive in arid spots dominated by dry-land grasses and *Artemisia*. Furthermore, with the exception of some *Stipa* seeds, which grow in arid and moist locations, arid-land grasses are not present in the Begash assemblage. The lack of arid-land plants and dominance of seeds from plants that grow in more moist ecotopes, present in river valleys and near springs around Begash today, is explained by the favoring of these ecotopes by herders for their nutrient-rich forage plants. Herd animals primarily consume these highly palatable species and avoid steppe vegetation, which is often high in silica and low in nutrients. Herders lived in these nutrient-rich ecotopes with their herds, and as a result these locations became central to the economy as well as being social connection points; ultimately they became fundamental in the formation of concepts of community.

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 and 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 at least as early as 2500 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; Lee 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.

These moist ecotopes are important when we try to understand how the pastoral economy functioned in the past; however, they are also of interest when we try to interpret the nature of social organization and exchange as well as understanding early concepts of community and social boundaries. 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 2008b). In addition, these ecotopes were/are loci for social connections. People congregated at these spots during winter communal encampment as well as during summer festivals and celebrations. These nodes were geographic centers for the diffusion of ideas and led to the formation and propagation of social institutions. Communities of the steppe formed and interacted in networks joined at nodal points by these patches.

In this article, we 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 played a large 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, we may reconsider the reality of the Eurasian steppe as a vast uniform highway of grass and 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.

Acknowledgments

The Dzhungar Mountains Archaeological Project was funded by NSF (2005–2009), Grant Number 0535341. Archaeobotanical research was funded by NSF (2010–2011), Grant Number 1010678 “Doctoral Dissertation Improvement Grant: Plant Use and Domestic Economy Among Eurasian Mobile Pastoralists: Semirech’ye, Kazakhstan, during the Bronze and Iron Age Interface”, PI/Co-PI: M. Frachetti and R. N. Spengler III. We would also like to thank Heather Trigg and Virginia Popper, as well as our three anonymous reviewers for providing advice.

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