Archaeological Research in Asia 26 (2021) 100264

Contents lists available at ScienceDirect

Archaeological Research in Asia

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

Full length article

The earliest herders of East Asia: Examining Afanasievo entry to Central Mongolia

William Honeychurch [a,*], Leland Rogers [b], Chunag Amartuvshin [c], Erdenebaatar Diimaajav [d], Nasan-Ochir Erdene-Ochir [c], Mark E. Hall [e], Michelle Hrivnyak [f]

[a] Dept. of Anthropology, Yale University, New Haven, CT, USA
[b] Institute of Prehistoric and Protohistoric Archaeology, Kiel University, Kiel, Germany
[c] Institute of Archaeology, Academy of Sciences, Ulaanbaatar, Mongolia
[d] Dept. of Archaeology, Ulaanbaatar University, Ulaanbaatar, Mongolia
[e] U.S. Bureau of Land Management, Winnemucca, NV, USA
[f] Dept. of Anthropology, Western Michigan University, Kalamazoo, MI, USA

ARTICLE INFO

Keywords:
Afanasievo
Pastoralism
Mongolia
Altai
Eneolithic
Bronze Age
DNA

ABSTRACT

The Afanasievo world reportedly overlaps the borders of five nations including two countries of East Asia: Mongolia and China. Across these several regions, the first appearance of domestic herd animals (sheep, goat, cattle) and the initial practice of copper and bronze metallurgy are associated with Afanasievo communities. Since mobile pastoralism has long been a significant part of the Mongolian cultural tradition the question of when, where, and how Afanasievo groups entered Mongolia is of extreme interest to archaeologists. Over the past 50 years several important sites have been reported and analyzed but these are still little known among Western scholars. In this study we provide a brief overview of Afanasievo archaeology, its peripheries, and its recent analytical breakthroughs and then develop a unique perspective on the Afanasievo world from its farthest eastern edge in central Mongolia. We assess the different roles of migration and diffusion in the process of herd animal introduction and present two current hypotheses explaining the intensification of pastoralism in this region during the late 3rd and early 2nd millennium BC. We argue that the impact of Afanasievo entry into East Asia was a transformative process but must be understood in the context of significant innovations made by East Asian indigenous communities, eventually leading to a unique form of eastern steppe pastoralism in Mongolia.

1. Introduction

Mongolian archaeologists will soon be marking the 50th anniversary of the 1971 discovery of the first Afanasievo cemeteries in Mongolia at the sites of Altan Sandal and Shatar Chuluu (Fig. 1). The Afanasievo archaeological record has been vigorously debated by Russian, Mongolian, and Western scholars ever since it was first proposed as the earliest pastoral and copper-working culture in South Siberia (ca. late 4th millennium BC) and possibly related to migrating communities from the western Eurasian steppe (Kiselev, 1951; Gryaznov, 1999:52–53; Anthony, 2007:307–311). Excavations at these Mongolian burial sites were carried out by V. V. Volkov, D. Navaan, and D. Tseveendorj providing the first strong indication that the Afanasievo archaeological horizon extends deep into East Asia (Volkov, 1980). Although this work is still little known among Western scholars, thanks to improved analytical techniques we can now affirm that these discoveries 50 years ago provide the earliest evidence for pastoralism in Mongolia.

Interestingly, the Altan Sandal and Shatar Chuluu cemeteries are not located in the Altai Mountain heartland of Afanasievo archaeological culture, but rather in the Khangai Mountains of central Mongolia, more than 1000 km to the east of where they would be expected. Initial reports of these sites were received with some skepticism and as late as the early 2000s scholars attempted to decipher how these burial grounds might relate to core Afanasievo material culture in the Altai and the Minusinsk Basin of the Middle Yenisei River (Tsybiktarov, 2002). At issue is not just a documentation of transferred technologies and practices including herding, traction techniques, and metallurgy; but also an understanding of the emergence of unique pastoral lifeways on the Mongolian steppe. Beginning with the Afanasievo entry, this process occurred in fits and starts and through multiple pathways relying upon

* Corresponding author at: Yale University, Department of Anthropology, 10 Sachem Street, New Haven, CT 06511, USA.
E-mail address: William.honeychurch@yale.edu (W. Honeychurch).

https://doi.org/10.1016/j.ara.2021.100264
Received 23 July 2020; Received in revised form 21 January 2021; Accepted 26 January 2021
Available online 12 February 2021
2352-2267/© 2021 Elsevier Ltd. All rights reserved.

experimentation, knowledge enhancement, and innovation. Such early diversity set a foundation for Mongolia to become a center of mobile pastoralism during the Late Bronze and Early Iron Age (late 2nd to 1st millennium BC), which had profound effects on the surrounding regions of North, East, and Inner Asia (Honeychurch, 2015).

Over the past seven years, Mongolian researchers, in collaboration with Russian and Western teams, have added significant new evidence refining earlier hypotheses about Afanasievo communities and generating new ideas to explain the role of these people in constructing initial East Asian pastoralism and hunter-herder amalgams. While this uptick in scholarship has mostly concentrated on the South Siberian archaeological record, there have been exciting advances in dating, genetics, material culture, and subsistence analysis of what might be considered the far eastern edges of Afanasievo cultural influence. Archaeologists have returned to sites originally excavated during the second half of the 20th century in Mongolia, Tuva, and northern Xinjiang to reanalyze artifact assemblages, landscapes, human and faunal skeletal material, and botanical remains. Employing a suite of powerful analytical techniques, these efforts are reinvigorating discussion over the earliest herders of East Asia. The present study focuses on our team's return to the sites of Altan Sandal and Shatar Chuluu and what these field visits along with new analyses of the original excavated assemblages reveal about the Afanasievo presence in central Mongolia. We present maps of both sites and report chronological, genetic, and isotopic evidence from Shatar Chuluu supplementing several recently published studies on the Early Bronze Age of Mongolia. Our intention is to assess the connection of these eastern sites to the main body of Afanasievo material culture and to explore the impact these Afanasievo migrants might have had on the earliest development of Mongolian pastoralism. Based on this research, we offer a new model for the gradual emergence of pastoralism in central and eastern Mongolia with the intent of encouraging future fieldwork, data collection, and analysis.

2. Afanasievo culture, controversies, and new evidence

The Afanasievo (also Afanas'ev, Afanasyevo) period is alternately described as the Eneolithic or Early Bronze Age of the Altai-Sayan Mountain region of South Siberia based on evidence for the initial presence of copper and copper alloy metallurgy. Despite substantial debate over its chronology, the beginning of this period, at least in the Altai highlands, is now securely dated to no later than the late 4th millennium BC. Controversies over timing, origins, and economy have led some to regard the Afanasievo record as poorly understood and somewhat undefined. To the contrary, since its initial formulation as a distinct material culture in the 1920s by Sergei Teploukhov, Afanasievo archaeology has seen substantial investment in burial and settlement excavations followed by thorough analyses of artifacts, faunal and human remains, and rock art genres (Vadetskaia et al., 2014; Jacobson, 2015). There has been a concerted effort to document the geographical distribution of Afanasievo sites as well as regional variability in mortuary practices, subsistence, and material culture. This effort has produced a clearer conception of Afanasievo lifeways and a much better

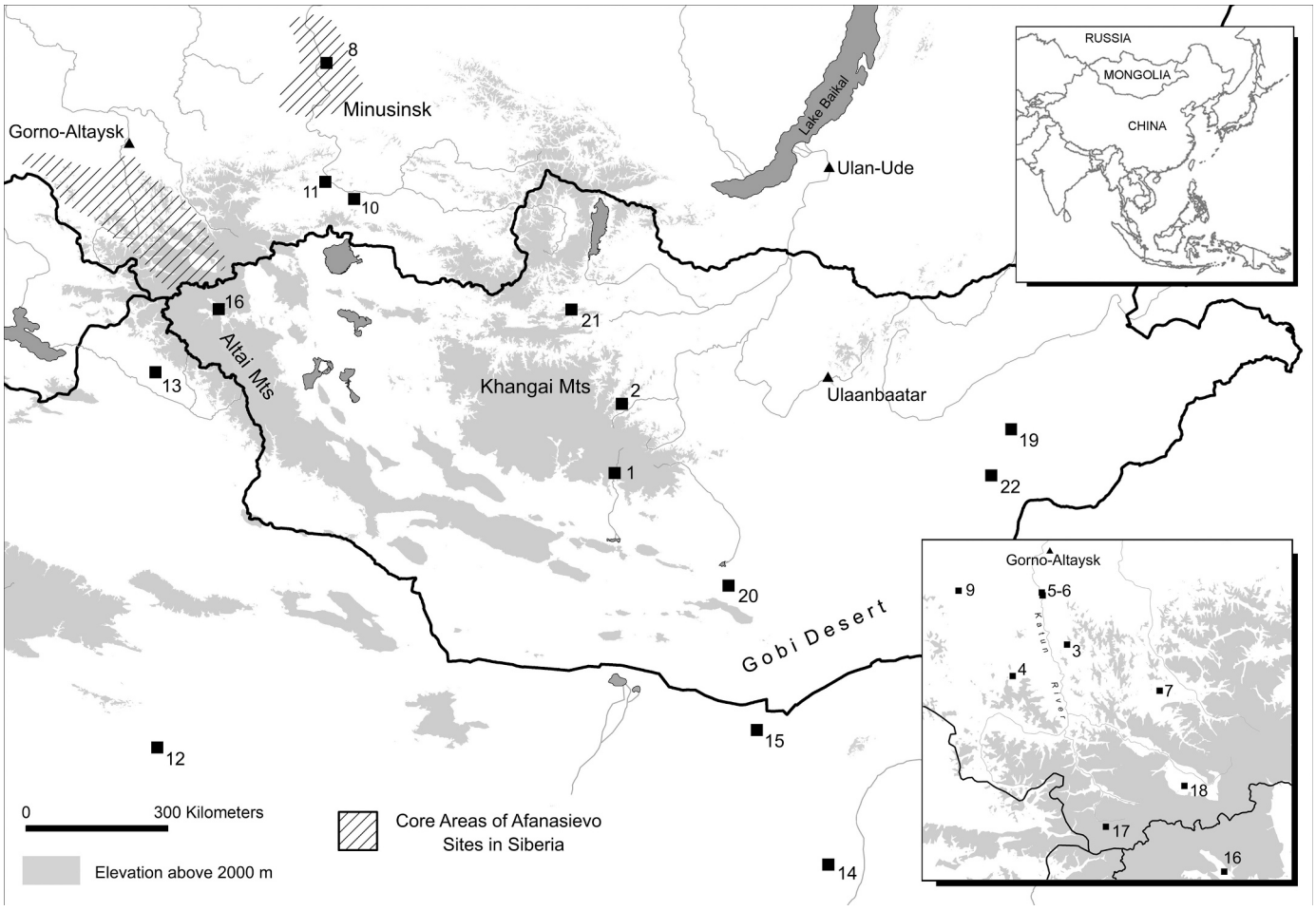

Fig. 1. Major archaeological sites mentioned in the text. Lower inset shows an enlargement of the Katun River valley and its tributaries in the Altai Mountains of Russia. 1. Shatar Chuluu, 2. Altan Sandal, 3. Kara-Tenesh, 4. Nizhniaia Sooru, 5. Malyi Dugan, 6. Uznezia-I, 7. Balyktyiul', 8. Tepsei-X, 9. Denisova Cave, 10. Khaiyrakan, 11. Toora-Dash, 12. Qäwrighul, 13. Ke'ermuqi, 14. Toudaoshazi, 15. Suhongtu, 16. Khondii Govi & Khuurai Govi, 17. Bertek 33, 18. Mukhor-Tarkhata I, 19. Delgerkhaan uul and the Ulaanzuukh site, 20. Bayanzag, 21. Khovsgol khirigsuur sites, 22. Chandmani Khar Uul.

understanding of the significance these early pastoral communities held for the prehistory of adjacent regions.

Russian archaeologists identify two major centers of Afanasievo occupation: one in the Siberian Altai concentrated along the Katun River and its tributaries; and the other, more than 400 km to the northeast, along the Middle Yenisei River of the Minusinsk Basin (Fig. 1). These core areas were occupied at slightly different times during the Afanasievo period and have underlying similarities but also have interesting differences in their material patterning (Vadetskaia et al., 2014:329–336). Recent overview publications list 100 documented Afanasievo sites from the Altai region including burial grounds, settlements, and cave, ritual, and mining sites. If we include locations with surface finds and various subtypes of Afanasievo burials, such as those in neighboring Altaiskii Krai, the documented site count rises to approximately 148. To the northeast, archaeologists working in the Minusinsk Basin, neighboring Khakassia, and west Krasnoiarsk have recorded about 77 sites of which 46 have had some forms of collection and excavation, with the remainder identified from surface features and occasional finds alone (Krasnienko, 2010; Vadetskaia et al., 2014).

2.1. Mortuary practices

Most of what we know of the Afanasievo period comes from mortuary studies of the kurgan or tumuli style burials which appear for the first time in these regions. Altai Afanasievo burial constructions consist of a low earth and stone mound retained by one, or occasionally two, stone rings made of upright slabs or heavy cobbles (Fig. 2). The burial chamber is located in the center of this circular feature usually with a single individual interment and sometimes with two or three individuals. The Minusinsk burial kurgans are similar in shape but often contain multiple burial pits within a single enclosure. The interment of more than one individual per pit, especially in the form of secondary burials, is also a much more common occurrence in Minusinsk than in the Altai. A difference in site organization between these two regions is also apparent with Altai Afanasievo kurgans grouped into cemetery clusters of 10 to 40 features, while Minusinsk burials tend to be single or more rarely in small groups of fewer than 10 (Poliakov et al., 2019:247). The size of Afanasievo burials varies from a surface feature as small as 0.8 m to as large as 17 m in diameter and burial pits range from between 0.7 m and 2 m in depth. Burial chambers are usually marked by stone slab or wood constructions covering the opening of each pit (Vadetskaia et al., 2014).

Within the burial chamber individuals are placed in a supine position oriented most commonly but not exclusively to the west or southwest with knees bent to one side and slightly raised. Grave goods include distinctive pottery forms with complex geometric ornamentation and rounded or ovoid bases, shallow thick-walled bowls, lithic toolkits with microblade core reduction, retouched large flakes, bifaces, and polished stone implements such as pestles, axes, and adzes. Wild and domestic animal offerings are also common, as are bone and antler items, beads, and small tools or personal decorations of copper or bronze. A distinctive red coloring in burial chambers from sprinkled or deposited ochre is another diagnostic feature but more common in the Altai than at Minusinsk sites (Stepanova, 2015). These burials practices were given to both adults and subadults with subadults being well represented in the mortuary population. Based on a skeletal assemblage of 230 individuals from Altai contexts, 36% are subadults. Of those adults whose sex could be determined (n = 96), 57% are male and 43% female (Vadetskaia et al., 2014:320). Based on a similarly large skeletal sample from Minusinsk, the demographic distribution is not dramatically different except for quite a few more infants under the age of two recovered (Griaznov, 1999:61). Altai skeletal assemblages provide some evidence for a moderate degree of interpersonal violence, especially among males, including cases of blunt force trauma and two instances of embedded arrowhead fragments (Tur and Rykun, 2014).

2.2. Settlement archaeology

Mortuary archaeology provides the primary record for both South Siberia and Mongolia with research on settlements and other site types a distant second. In the Altai highlands and in the adjacent district of Altaiskii Krai, 34 settlements and 4 cave sites have been excavated, tested, or collected to some degree (Stepanova and Poliakov, 2010:13–15). The Minusinsk region has only two habitations sites and another eight such sites have been studied in Khakassia (Vadetskaia et al., 2014). Some of the settlements with the most excavation and analysis in the Altai include Kara-Tenesh, Nizhniaia Sooru, Malyi Dugan, Uznezia-I and Balyktyiul'; while in the Minusinsk region the Tepsei-X encampment has been the most systematically studied habitation (Fig. 1). Despite their geographical distribution, all sites have remarkably similar characteristics most notably multiple stone lined hearths and abundant diagnostic pottery similar to that recovered from Afanasievo burials. Settlement sites are located nearby rivers and floodplains, often at or near the base of high ridges and they can be characterized as multi-dwelling habitations. In sections of the Middle Katun River valley, settlement densities are quite high with some sites having a mere 0.5 to 1.5 km separation. Archaeologists believe that in these areas many more such settlements are still to be identified (Vadetskaia et al., 2014:5). Since most sites have multiple occupation phases and some degree of natural and cultural disruption, it is not always easy to determine the original extent of Afanasievo habitation, but the excavators of at least one site, that of Uznezia-I, estimate Afanasievo settlement size to be

Fig. 2. Cleared surface feature of the Khuurai Govi 1 Afanasievo burial, Mongolian Altai. (Photo by D. Erdenebaatar and A.A. Kovalev).

about 5700 m^2 (Vadetskaia et al., 2014:29).

The primary diagnostic features of these settlements are hearths ringed by stones, measuring approximately one meter in diameter, with a stone lining throughout the fire pit. At sites with sufficient horizontal exposure, up to six such hearths spaced at intervals of 4–6 m have been recorded. In and around these hearths, numerous pit features, ash and charcoal lenses, and burnt soil stains also are common. At the sites of Tepsei-X, Uznezia-I, and Balyktyiul' the bottom portions of ovoid based Afanasievo pots were found dug 13–20 cm into soil next to hearths, and often sherds of these vessels are scattered in and around hearth rings confirming their use for food preparation (Vadetskaia et al., 2014:30, 36, 218). The exact nature of Afanasievo dwellings is still undefined since areas surrounding hearths tend to lack evidence for postholes or foundation stones. The site of Kara-Tenesh, however, provides some evidence for two semi-subterranean dwellings with internal hearths that excavators argue may have been enclosed by a free-standing timber structure (Molodin, 2001:4). Other finds that are typical for settlement sites are lithic assemblages, similar to those found from burials, but also include work areas for lithic tool use and production, especially areas with pestles for grinding, probable wood working toolkits, and areas where horn, antler, and bone materials were fashioned (Vadetskaia et al., 2014:24–25). Copper and arsenical bronze items are rarely found at settlements and indeed such artifacts are rare overall with fewer than 100 known artifacts according to an analysis by Khavrin (2010:187; but see Stepanova 2015:182). The small number of faunal assemblages recovered and analyzed suggests a mixed pattern of wild and domestic animal use, discussed in greater detail below (section 2.4).

2.3. Origins and chronology

That which makes Afanasievo communities so interesting – the building of kurgan style burials, seeming discontinuity with prior Neolithic cultures, and the appearance of domestic herd animals and copper metallurgy – all give rise to some of the region's notable controversies among scholars. In particular, the issues of chronology, origins, and economy have at times generated acrimonious debates which are only now subsiding thanks to recent analytical breakthroughs. The questions of start and end dates for the Afanasievo period and periodization of the Altai and Minusinsk phases have recently been addressed through a series of studies by Svyatko, Poliakov, and colleagues (Svyatko et al., 2009, 2017; Poliakov et al., 2019). Their work responds to an earlier radiocarbon study that argued for back-dating the Afanasievo period more than a millennium prior to conventional start dates proposed by a majority of archaeologists, from c. 3000 BC back to 3700 BC (Poliakov et al., 2019:245-246; Svyatko et al., 2009; Görsdorf et al., 2001). This radical shift overturned decades of careful typological analysis, relative dating, and migration models connecting Afanasievo material culture to that of Yamnaya pastoral communities of the Volga-Ural region 2000 km west of the Altai Mountains. Yamnaya herding communities and their cattle-drawn wagons (c. 3300–2600 BC) are associated with Afanasievo groups based on clear similarities in burial practices, material culture, arsenical bronze metallurgy, and pastoral economies (Morgunova, 2014). However, the newly proposed start date rendered Afanasievo significantly older than Yamnaya sites leading to exacerbation on the part of Russian experts and prompting new or refined hypotheses in the West (Frachetti, 2012:10–17; Anthony, 2007:307–311).

Within the past four years, improved AMS radiocarbon analysis combined with human aDNA studies has significantly clarified these problems. Poliakov et al. (2019) provide evidence that many of the existing dates from Afanasievo contexts suffer from an old wood effect as well as inordinately large error ranges and, as many have long suspected, the current radiocarbon chronology is much too old (Anthony, 2007:495, Note 9). Based on a series of recent AMS dates on human and animal bone from burial contexts, Poliakov et al. (2019:254) derive a new chronology for the Altai Afanasievo mortuary sites dating from the 31st to 29th centuries BC and for the Minusinsk region dating from the 29th to the early 25th centuries BC. Using the Bchron package in R we recalculated the Altai Afanasievo range by supplementing the 14 AMS dated burials from Poliakov's analysis with four AMS dates from the Altai habitation sites of Nizhniaia Sooru and Malyi Dugan and nine new dates from cemetery contexts. These radiocarbon results are reported in Poliakov et al. (2019), Hermes et al. (2020), and Narasimhan et al. (2019). We calibrated these 27 dates and constructed kernel density estimates (KDEs) from the sampled posteriors to provide a 68% credible interval (CI) of 3084–-2904 BC and a 95% CI of 3295-2758 BC, inclusive of both mortuary and settlement sites (see supplement for analysis details).

If comparing these Altai start dates with the most recent radiocarbon analysis of Yamnaya contexts by Morgunova and Khokhlova (2013), we find that Early Yamnaya Repin phase (4000–3300 BC) and Classic Yamnaya phase (3300-2600 BC) significantly predate Afanasievo emergence in the Altai. However, we must point out that much like the Afanasievo situation, Yamnaya chronology also has its controversies surrounding the consumption of riverine foods and the potential for reservoir effects and questions about the reliability of ceramic dating (Shishlina et al., 2014; Kuznetsov and Mochalov, 2017). In support of the chronological priority of Yamnaya groups and their probable eastward migrations, a growing number of aDNA studies have found uncontestable evidence for genetic relationships between Yamnaya and Afanasievo populations (Allentoft et al., 2015; Hollard et al., 2018; Narasimhan et al., 2019). Based on the strength of their results, the authors of some of these studies refer to the association between Yamnaya and Afanasievo populations in robust terms as "genetically indistinguishable" (Allentoft et al., 2015:169). However, it is also important to emphasize initial findings of genetic diversity among individuals who, based on their burial style and associated material culture, were clearly considered as part of the Afanasievo community. Khuurai Govi Burial 1 is one such context (see 3.4 below, Fig. 3) in which a sub-adult was found to have a genetic make-up different from most Afanasievo individuals and having no relation with Yamnaya groups at all (Wang et al., 2020 bioRxiv preprint). Although this is so far only a single case, analytical discoveries like this one might eventually support the idea that Afanasievo communities were not completely homogeneous and perhaps included contributions from indigenous Altai peoples in addition to that of western Eurasian groups.

2.4. Pastoralism and farming

Yet another debate concerns the nature of the Afanasievo subsistence economy. Researchers have called for definitive and directly dated evidence for domestic herd species, they challenge the presence of domesticated horses, and cast doubt on whether farming was ever practiced. Afanasievo subsistence was originally assessed based entirely on mortuary assemblages which are not a reliable reflection of daily diet because of their ritual nature. Zooarchaeologists have gradually been able to study more remains recovered from habitations and while the results are not radically different from what is known from burials, the variation between different settlements is of interest and argues for some geographical and chronological diversity in subsistence. A comparison of percentages of identified specimens from the settlements of Nizhniaia Sooru, Kara-Tenesh (L4), Malyi Dugan, and Balyktyiul' documents a pattern of sheep/goat focused subsistence. The average percent and percent range of NISP for these faunal assemblages are: sheep/goat 69% (56–82%), cattle 12% (4–21%), and 5% horse (1–9%, possibly wild); with wild animals averaging 13% (1–18%) represented mostly by deer species *Cervus elaphus* and *Capreolus pygargus* (data from Kosintsev and Stepanova, 2010; see also Frachetti, 2012). The settlement of Tepsei-X in the Minusinsk region has the same ranked order of domestic fauna at similar proportions (caprines 81%, cattle 15%, horse 4%) although the identified specimen count is quite low in this case (Vadetskaia et al., 2014:218).

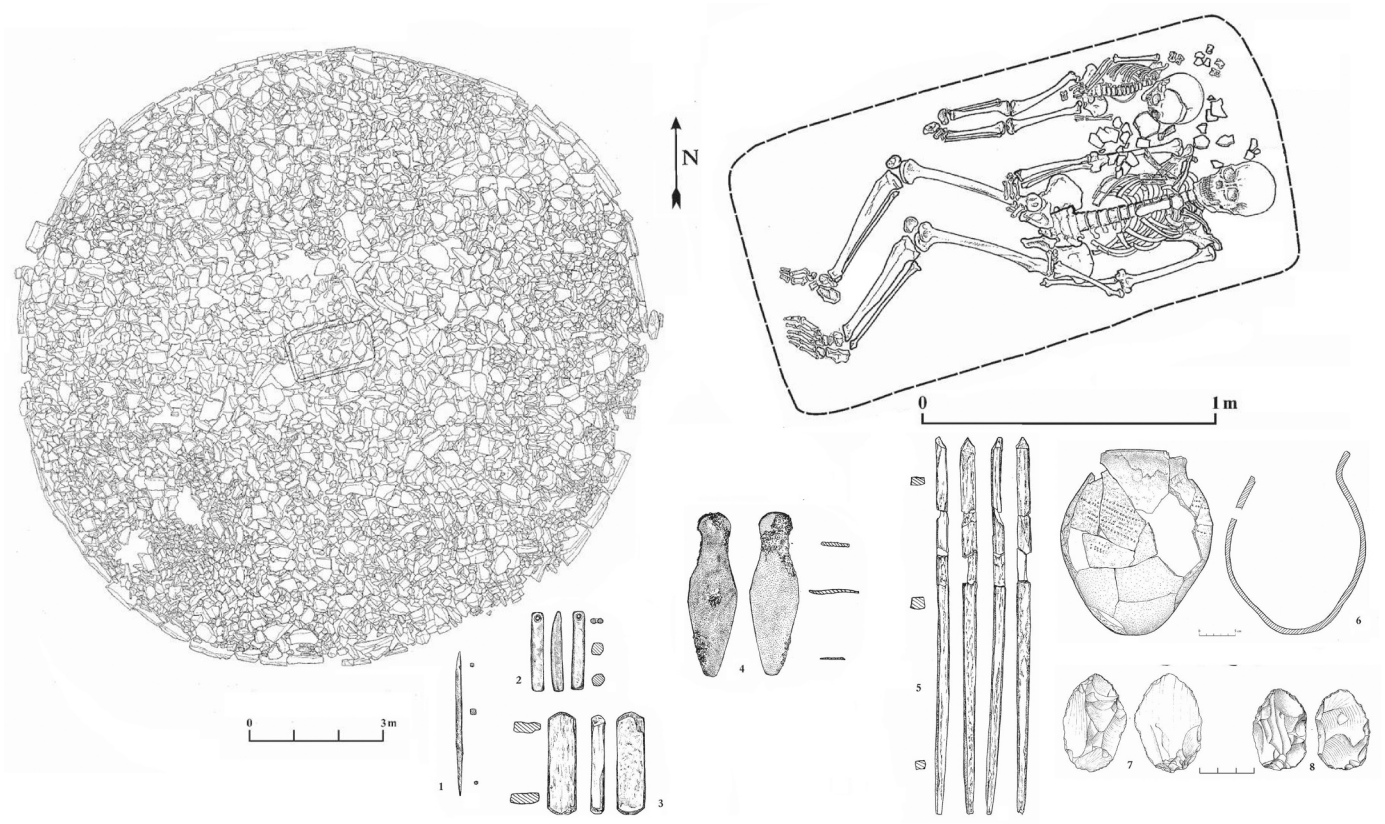

Fig. 3. Khuurai Govi 1 surface feature and burial chamber plans and artifact drawings. 1. Bronze awl, 2. Animal tooth pendant (probably boar incisor); 3. Bone plates, 4. Bronze knife, 5. Bone arrow points, 6. Ovoid shaped pot with geometric decorations, 7–8. Retouched flakes, (all adapted from Kovalev and Erdenebaatar, 2010).

The wide ranges in the above calculations are notable as are a small number of settlements that diverge decidedly from this pattern and have either a majority of wild specimens (e.g., 33% horse at Partizanskaia Katushka) or a species profile that is entirely wild (e.g., Uznezia-I) (Shul'ga, 2012:205). Diets that included fish also seem to be represented differently across regions with clear isotopic signatures for fish consumption in the Minusinsk Basin but not identified so far in the Altai region (Svyatko et al., 2017). In short, the evidence points to a degree of variability in Afanasievo subsistence practices although this result contrasts somewhat with the isotopic ranges discussed further below (section 4.2.3). There is little doubt among archaeologists, however, that these communities indeed kept the first domesticated herd animals in the region. Herding among Afanasievo groups has now been confirmed beyond any doubt by mtDNA analysis on faunal samples from the Nizhniaia Sooru settlement which demonstrates the presence of domesticated sheep dated directly to c. 3000 BC and related to Southwest Asian lineages of domestic caprines possibly introduced through southern mountain corridors (Hermes et al., 2020). In addition, calculus on human teeth from Afanasievo burial contexts reveals proteins consistent with the consumption of dairy including sheep, goat, and cow milk (C. Makarewicz, unpublished results). Excavation and material analysis have also provided additional lines of evidence for animal husbandry including animal pens with caprine dung in the Afanasievo layers of Denisova Cave (Derevianko and Molodin, 1994:129, Fig. 1), spindle whorls recovered from Nizhniaia Sooru (Larin et al., 2005:200), and the use of ruminant dung for ceramic temper at Kara-Tenesh (Vadetskaia et al., 2014:24). The local geography of settlement locations suggests that herd animals were likely moved only short distances in a transhumant cycle from lower to higher altitudes on a seasonal basis (Molodin, 2001:15). Given these results, archaeologists argue in favor of a tripartite subsistence system based on hunting and gathering and herding, even though it is still too early to address proportions of each activity or probable regional variation in subsistence practices.

One critical point of contention still unresolved by scholars is the status of domestic horses among Afanasievo groups, a question that has figured notably in debates among Western archaeologists (Anthony and Brown, 2011:143; Frachetti, 2012:10). A primary problem is that natural morphological variation of horses makes it difficult to determine whether a given individual is domesticated, especially when wild equids were present and regularly hunted. Russian archaeologists admit that equid identifications from Afanasievo contexts may represent either domesticated or wild animals (Shul'ga, 2012:205; Kosintsev and Stepanova, 2010:127; Kosintsev, 2005:163) and so far there is little direct evidence to decide one way or the other. A single possible data point arises from horse remains in layers 11 and 12 of Denisova Cave in which numerous diagnostic ceramics, stone lined hearth features, and a series of radiocarbon dates confirm an Afanasievo period encampment (Derevianko and Molodin, 1994:112). DNA analysis of this equid reveals the allele for a chestnut colored coat, which appears simultaneously with alleles for several other coat colors in early managed horse populations from central and northern Eurasia (Ludwig et al., 2009:485, Table S1; Wutke et al., 2016). An increase in coat color variation is considered to be the product of human selection and therefore a plausible hallmark of horse domestication (Cieslak, 2011). However, future work will be needed to resolve the management status of Afanasievo horses as well as the relationship between chestnut coat color and domestication.

Much like the problem with domestic horses, the question of whether Afanasievo communities consumed domestic grain as part of their diet has also not been fully resolved. To provide some context, the so-called 'Neolithic' of Mongolia and southern Siberia is defined based on the production and use of pottery rather than possession of animal and plant domesticates, as is the case in the Near East (Janz et al., 2017:14).

Therefore the introduction of domesticates, in this case millet, wheat, and barley, among pottery using hunter-gatherer groups during the Eneolithic and Early Bronze Age remains a major research question for this entire region. The pestle-like grinders that are most often mentioned as possible evidence for grain use are universally acknowledged as insufficient since wild plants, pigments, and other materials would likely have required grinding (Shul'ga, 2012:208). The most comprehensive studies on this issue are by Svyatko et al. (2013); Svyatko et al. (2017) who conclude that at least millet is not evidenced in the Afanasievo diet in the form of C_4 isotopic signatures. Isotopic analysis has difficulty attesting to C_3 based crops such as wheat and barley in areas where C_3 plants are naturally abundant and, consequently, there is so far little evidence to argue for the production or use of cultivated grain. The gathering of wild plant and root foods was likely the primary complement to hunting and animal husbandry among Afanasievo groups. However, recent identification of what is likely Southwest Asian wheat and barley at a cave site in northern Xinjiang dated to c. 3200-3100 BC suggests that domesticated grain was indeed present within the greater region (Zhou et al., 2020).

3. On the fringes of the Afanasievo world

This brief introduction to Afanasievo archaeology already demonstrates the multi-regional nature of this culture. Strong archaeological and genetic evidence supports an initial contribution from Yamnaya groups in the west, but there are also indications that input from distant communities to the southwest may have been influential. For example, Frachetti's (2012) Inner Asian Mountain Corridor model proposes an introduction of Near Eastern herd animals and cultigens along mountain routes consisting of the Pamir, the Tengri Tagh (or Tian Shan), and the southern Altai mountain chains. As mentioned, growing evidence supports the appearance of domesticated bovids and barley, wheat, and millet, contemporary with the Afanasievo period and potentially associated with this intermontane migration route; but there is as yet little suggestion of direct contact with southernmost Afanasievo communities (Hermes et al., 2019; Zhou et al., 2020). Just as important as long distance influences were probable interactions with existing Late Neolithic and Eneolithic groups in the Altai who likely encountered and, to some degree, shaped the development of what were small groups of migrating newcomers. On-going research in southwestern Siberia (Altaiskii Krai) suggests that the Eneolithic Novoilinka-3 and 6 settlements possibly represent an extension of the Botai-Borly culture sphere, in which people practiced subsistence strategies narrowly focused on horses but with a minor exploitation of sympatric aurochs (T. Hermes, unpublished results). How such groups as these may have intermingled with arriving Yamnaya communities is still unclear but does raise the important question of whether Yamnaya migration was indeed the only and primary catalyst to the Afanasievo phenomenon. Perhaps we might better understand this process as a complex synthesis of local and external interactions, as some archaeologists have argued (Kiryushin and Kiryushin, 2005; Hermes et al., 2021 In press).

3.1. Afanasievo traces from Central Asia

This question becomes even more pertinent as Afanasievo research extends beyond the traditional core areas of the Russian Altai and Minusinsk Basin into the Afanasievo peripheries both westward and eastward. On the western side of the Afanasievo world, fieldwork has brought a number of mortuary and mining sites to light as well as numerous surface finds across eastern and northeastern Kazakhstan (Merts, 2014). Far to the southwest in Uzbekistan's Zerafshan River Valley (16 km east of Samarkand) archaeologists have recently documented the Zhukov site with ceramics and stone artifacts linked to both Afanasievo and Yamnaya material culture. The feature is neither a burial nor a habitation but consists of a 3 m stone ring with a stele erected in the center and two areas along a NW-SE alignment with burnt soil and charcoal lenses where two fires had once been built, most likely for ceremonial purposes (Avanesova, 2012). Archaeologists describe the artifacts as belonging to a Yamnaya-Afanasievo mixed assemblage which argues in favor of the existing Yamnaya migration hypothesis (Merts and Merts, 2010). However, the site's geographical location near the Zerafshan Mountains, as well as additional evidence for at least one Afanasievo style burial at the nearby site of Sarazm (west Tajikistan), and surface finds of diagnostic pottery, taken together also lend support for the Inner Asian Mountain Corridor hypothesis (Frachetti and Rouse, 2012). Just as interesting is the evidence at Zhukov for significant participation by Late Neolithic groups in the use of this ritual site based on lithic tools and ceramic decorations, thereby affirming the proposal that indigenous communities played a role in the construction of peripheral variants of Afanasievo archaeological culture (Avanesova, 2012:17).

3.2. Afanasievo sites in Tuva

Attention to the eastern side of the Afanasievo world centers on the Upper Yenisei River of Tuva in South Siberia, Xinjiang province of northwestern China, and growing evidence from Mongolia. Tuvan Afanasievo sites are 200 or more km south of the Minusinsk Basin core region and are relatively few in number, comprising the burials grounds of Orug-Asky and Khaiyrakan and the stratified settlements of Khadynnykh (3rd layer) and Toora-Dash (5th layer, Fig. 1). Afanasievo material culture in this region is differentiated enough from neighboring Minusinsk patterns to be considered a regional variant with significant influence from Late Neolithic groups within Tuva (Semenov, 2012:165). The Toora-Dash settlement is one of the most comprehensively studied habitations in all of southern Siberia (Semenov, 2018) and, interestingly, the single radiocarbon date for the settlement's Afanasievo phase is rather late in the sequence (c. late 3rd to early 2nd millennium BC) (Semenov, 2018:329). Moreover, there is no definitive evidence for domestic herd animals from the substantial faunal assemblage recovered from the 5th layer of Toora-Dash, complicating the assumption that the presence of Afanasievo materials indicates an introduction of animal husbandry (Semenov, 2018:121; Kosintsev and Stepanova, 2010:128). Finally, there is little reason to believe that metallurgy was known or practiced at Toora-Dash since no metal items or smelting evidence have been recovered. However, copper ore was discovered in layer 5 suggesting that copper was of some interest and being collected and stored on site (Semenov, 2018:114).

3.3. Weighing the evidence from Xinjiang and Inner Mongolia

Far to the south, a few examples of burials and ceramics have been identified as having similarities with Afanasievo material patterns at sites in northern and eastern Xinjiang province. These claims have garnered international attention but with greater analysis and radiometric dating it is now clear that Afanasievo communities, as known from the Altai highlands and Minusinsk Basin, were probably not present this far south. The Early Bronze Age cemetery of Qäwrighul (also Gumuguo) (c. 2000–1800 BC, Fig. 1) in eastern Xinjiang has received the most attention as one possible link to Afanasievo groups in the north. These arguments, however, originated from craniometric studies with little consideration for site contexts, materials, or funerary practices which have little in common with Afanasievo archaeological culture (Molodin and Alkin, 2012; Betts et al., 2019:207–208). Other examples include burials from the cemetery of Ke'ermuqi in northern Xinjiang (Fig. 1) as well as surface finds of pottery resembling that of Afanasievo wares, but in all cases the comparisons are not especially compelling (Vadetskaia et al., 2014:278–279). Moreover, genetic analyses on human samples from burials sites thought to be associated with Afanasievo groups argue against that association (Hollard et al., 2018:105). Rather, finds reminiscent of Afanasievo material culture are best understood as associated with the Chemurchek tradition (also

Qiemu'erqieke, Shamirshak, Khemtseg, 2700–1900 BC). This Early Bronze Age mortuary tradition is well-represented in northern Xinjiang, it overlaps Late Afanasievo chronologically, and may have first emerged among Late Afanasievo period communities in the Mongolian Altai (Taylor et al., 2019; Kovalev, 2017). Finally, archaeologists report ceramic vessels and decorated sherds possibly related to Afanasievo pottery at the sites of Toudaoshazi and Suhongtu in eastern Alshaa aimag, Inner Mongolia (Jaang, 2015:198, Fig. 1). Indeed the pottery finds include ovoid vessel shapes, rounded bases, and geometric decorations which are certainly not of local production but without greater context information and dating this pottery, like that in Xinjiang, might best be attributed to Chemurchek interactions (Wen, 2012:92–93,118–119). In either case, these finds are of great interest and point to an early interaction sphere between Mongolia and Inner Mongolia through which some scholars suggest herd animals could have been introduced southwards into China (Jaang, 2015:194; Brunson et al., 2020:7).

3.4. The East Asian diaspora: Afanasievo sites in Mongolia

Our overview reveals that the eastward expansion of Afanasievo groups, whether in the north or south, was geographically limited beyond its core regions. Evidence from western Tuva suggests diverse forms of Afanasievo material culture, some of which may be younger than expected, not far removed from the core Minusinsk area, while in Xinjiang the presence of Afanasievo groups is altogether questionable. To some degree, a similar trend occurs in western Mongolia where relatively few Afanasievo sites so far have been discovered. Five sites, with 1–3 burials each have been documented as Afanasievo burial grounds, but subsequent excavation and analysis indicate that most of these are likely Afanasievo-Chemurchek transitional sites similar to those in Xinjiang, while a few date to much later periods and were simply misidentified (Aldarmonkh, 2016; Bayarsaikhan et al., 2019). Erdenebaatar and Kovalev (2007:36) report two Afanasievo burials at the site of Khondii Govi based on surface features with typical Afanasievo construction. These burials also closely match a third burial that this team excavated fully at the nearby site of Khuurai Govi (Fig. 1). Burial 1 at Khuurai Govi is by far the most thoroughly studied example of an Afanasievo context from the Mongolian Altai and may constitute a type site for the kind of burial traditions we might expect will become better known as archaeological survey increases in the western mountains.

The Khuurai Govi site is located in Bayan-Olgii province and is about 100 km southeast of the nearest Afanasievo sites in the Russian Altai across the border (Bertek-33, Mukhor-Tarkhata I, Fig. 1). Burial 1 consists of a stone built circular feature 14 m in diameter with retaining slab stones standing up to 70 cm above the original soil surface (Fig. 2). From a 2 m deep burial pit the team recovered the skeletons of an adult male and a sub-adult arranged in typical Afanasievo posture but positioned to the east rather than the standard western orientation. Another uncommon aspect was possible evidence for a wooden cart or wagon that would have carried the bodies to the funeral. Artifacts unearthed include a copper alloy knife and awl, bone arrowheads, several worked bone and chipped stone items, and fragments of a rounded bottom ceramic pot, similar to Altai Afanasievo forms but of lesser quality (Fig. 3). Faunal evidence includes a drilled pendant made from what is likely a wild boar incisor and several caprine astragalus bones (Kovalev and Erdenebaatar, 2010). Taylor and colleagues' analysis of the available radiocarbon dates for this burial, as well as Afanasievo-Chemurchek transitional contexts in western Mongolia, provides a date range during the first half of the 3rd millennium BC, although their sample size is quite small (Taylor et al., 2019:3, 10). Sampling issues aside, according to available information, Afanasievo movement eastward into the Mongolian Altai seems to have chronologically coincided with the northeastern migration into Khakassia and Minusinsk (Poliakov et al., 2019:254). In all likelihood, inter-area ties between these different communities were probably maintained in the form of an Afanasievo interaction sphere.

4. The central Mongolian expansion: Altan Sandal and Shatar Chuluu

Given the geographical concentration of Afanasievo sites far to the west, the discovery of two cemeteries in the Khangai Mountains of central Mongolia exhibiting analogous constructions, practices, and artifacts was wholly unexpected, even for the original excavators (Tseveendorj, 1975:69). Radiocarbon dates from the Shatar Chuluu site fall within the early phase of the Afanasievo record (see section 4.2.1), possibly indicating that members of an initial migration settled briefly in the Altai highlands and then continued moving eastward. Although evidence for wagon technology is quite limited, consisting only of enigmatic rock art images (Jacobson, 2015:62–63) and the wooden components found in the Khuurai Govi 1 burial, the 1200 km extent of this migration would have been consistent with the use of some form of transport technology. In addition to a number of diagnostic Afanasievo ceramics found in the greater region (Novgorodova, 1989:81; Yesin et al., 2012), these two burial grounds are the only reported Mongolian sites east of the Altai. In 1971, three burials were excavated at Altan Sandal and two at Shatar Chuluu, followed by a third excavation at Shatar Chuluu in 1975 (Volkov, 1980). Our team revisited these sites in 2018 for site mapping, surface collections, and re-examination of backdirt piles. Although we provide details for both sites, our analysis consists primarily of materials from Shatar Chuluu obtained from our reconnaissance and from collections in Ulaanbaatar. Additional bioarchaeological analyses of human remains from this site provide important supplementary evidence in support of our study (Wilkin et al., 2020a, 2020b; Taylor et al., 2019).

4.1. Setting, site descriptions, and fieldwork (1971–2018)

The Altan Sandal and Shatar Chuluu burial grounds are 130 km apart located on opposite sides of the Khangai Mountain range: Altan Sandal on the north slopes and Shatar Chuluu to the south (Fig. 1). Like other Afanasievo cemeteries, both are located along the upper reaches of major rivers (Tuin and Khoit Tamir rivers respectively) situated on broad open terraces nearby small tributary streams. Today, these areas are on the ecotone between high elevation forest-steppe in the north and arid steppe to the south, but paleoclimatic studies for central Mongolia argue for a somewhat humid and warmer forested environment 5000 years ago (Klinge and Sauer, 2019:44; Janz et al., 2017:25). What once were inter-montane grasslands, well protected from winter winds by surrounding peaks and having reliable sources of water, altitudinal graze, timber, and wildlife would have been ideal habitation sites for early hunter-herders. A recent sampling survey in and around the site of Shatar Chuluu has identified a number of seasonal campsites (Lowry, 2020:80) and even though the area in the immediate vicinity of the burials may not have been residential, our 2018 reconnaissance recovered ceramic scatters from the surrounding foothills confirming Lowry's finds. This beneficial mix of landscape and resources proved sustainable over the long-term evidenced in both areas by numerous burials, monuments, and ritual sites from subsequent periods ranging from the Late Bronze Age to the medieval period. To this point, both sites are still occupied today by contemporary pastoral households.

The Afanasievo burial group at Altan Sandal is a cluster of low flat mounds on the south side of the prominent rise after which the site is named and located beside an old tributary stream channel (Fig. 4). Volkov (1980) reports six features in this area of which three were excavated; however, our reconnaissance found five burial features with four more immediately to the east of which several had been excavated subsequent to the 1971 project. In 1975, Tseveendorj mapped the Altan Sandal site which helped to identify the most likely locations of the three Afanasievo burials (Fig. 5). These features ranged in diameter from 4 to 4.3 m and consisted of a stone retaining circle around mixed stone and

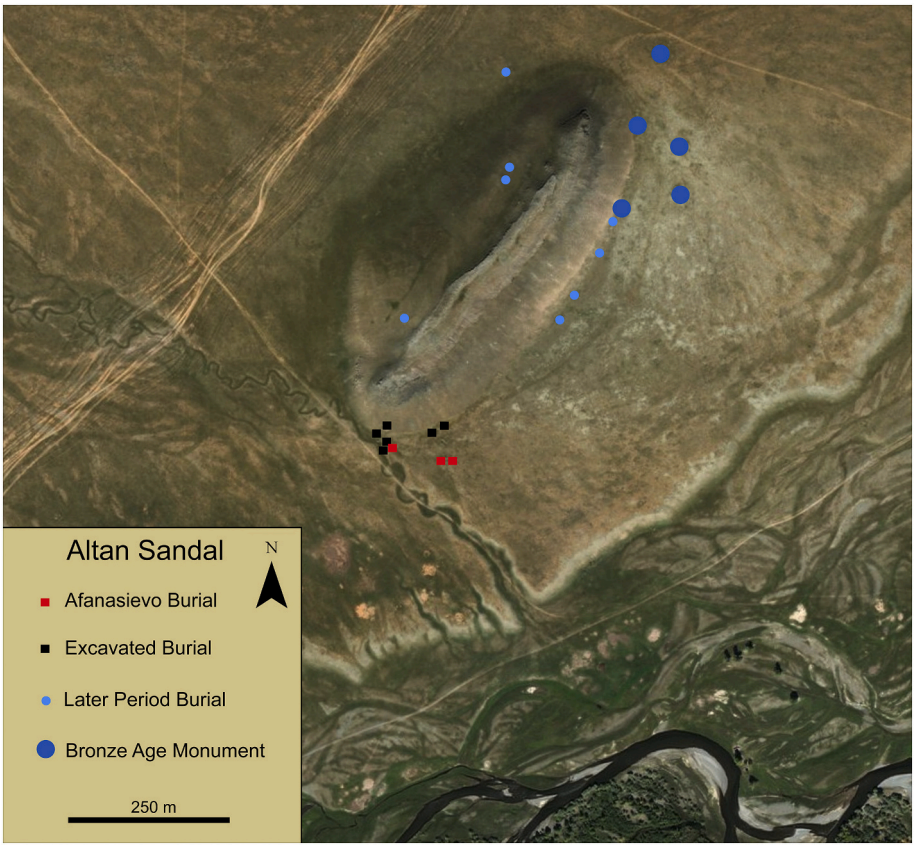

Fig. 4. Altan Sandal site plan based on 2018 reconnaissance.

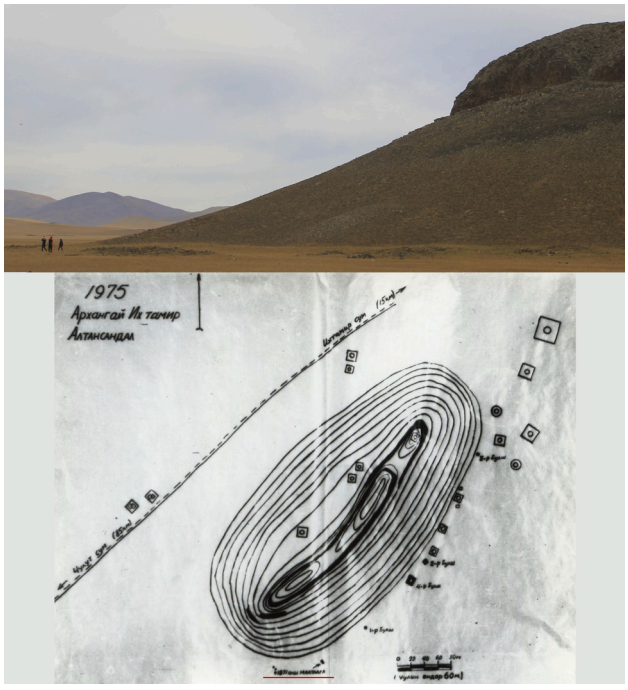

Fig. 5. Altan Sandal landscape and the 1975 field map drawn by Tseveendorj (1975). The area on the map marked in red showing Afanasievo burials corresponds to the area shown in the landscape photo as seen from the southeast. Note that most of the sites documented by Tseveendorj were re-recorded in 2018 although a few have subsequently been excavated and were difficult to verify.

earthen flat mounds estimated to be up to 35 cm above the original soil surface. Burial chambers were usually not exactly centered within each circular feature and ranged in depth from 0.8–1.20 m with each interred individual placed in the typical Afanasievo burial posture: supine with legs bent at the knees, slightly raised, and sprinkled with ochre. These Afanasievo burials differ from classic Altai burials in two important ways. First, the individuals were interred with a mix of orientations, two oriented eastward and one to the west; and second, none of the burials contained identifiable furnishings (Volkov, 1980:13–14). While items fashioned from organic materials may have been originally included, Afanasievo burials such as these without evidence for artifact inventories are not typical but are also not uncommon in the Altai region, comprising 20% of excavated contexts (Stepanova, 2015:179). The Altan Sandal skeletal assemblage is stored in the collections of the Institute of Archaeology in Ulaanbaatar but has had no analysis whatsoever. Burial constructions and interment practices leave little doubt that these are indeed Afanasievo contexts and their similarity to three other burials at Shatar Chuluu supports that identification.

The Shatar Chuluu site has received greater attention from archaeologists probably because diagnostic Afanasievo artifacts were recovered from burials in 1971 and 1975. The burial grounds in question are at the southwestern edge of the site located along a terrace above the Tuin River and near a tributary channel to the south (Figs. 6 and 8). The three excavated contexts were easily located based on a detailed map again made by Tseveendorj (1975) during the 1975 field season. A unique feature of the Shatar Chuluu burials is the presence of an inner ring slightly smaller than the outer retaining stones producing a double ring construction similar to a small number of burials known from the Altai cemeteries of Kurota, Bertek 33, and Boitygem 2 (Vadetskaia et al., 2014:325; Tsybiktarov, 2002:45). Burial 1 comprised a circular mound 0.7 m high and 10 m in diameter that exceeded the retaining stones that were discovered beneath its stone and earthen overlay. The outer and

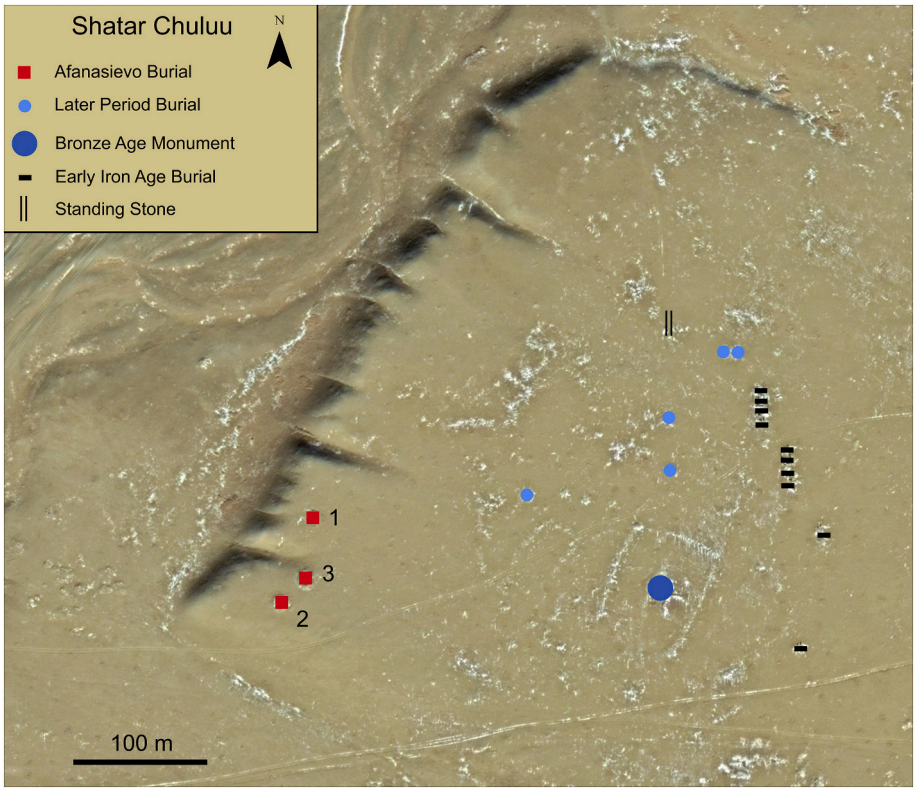

Fig. 6. Shatar Chuluu site plan based on 2018 reconnaissance. A more expansive map of this site has recently been published (Lowry, 2020:102) which encompasses the map presented above. The only differences between the two are a series of features, recorded by Lowry as ring and circle burials, that were recorded by our team as satellite features commonly associated with Bronze Age monuments (i.e., khirigsuurs) and therefore not labeled as separate sites.

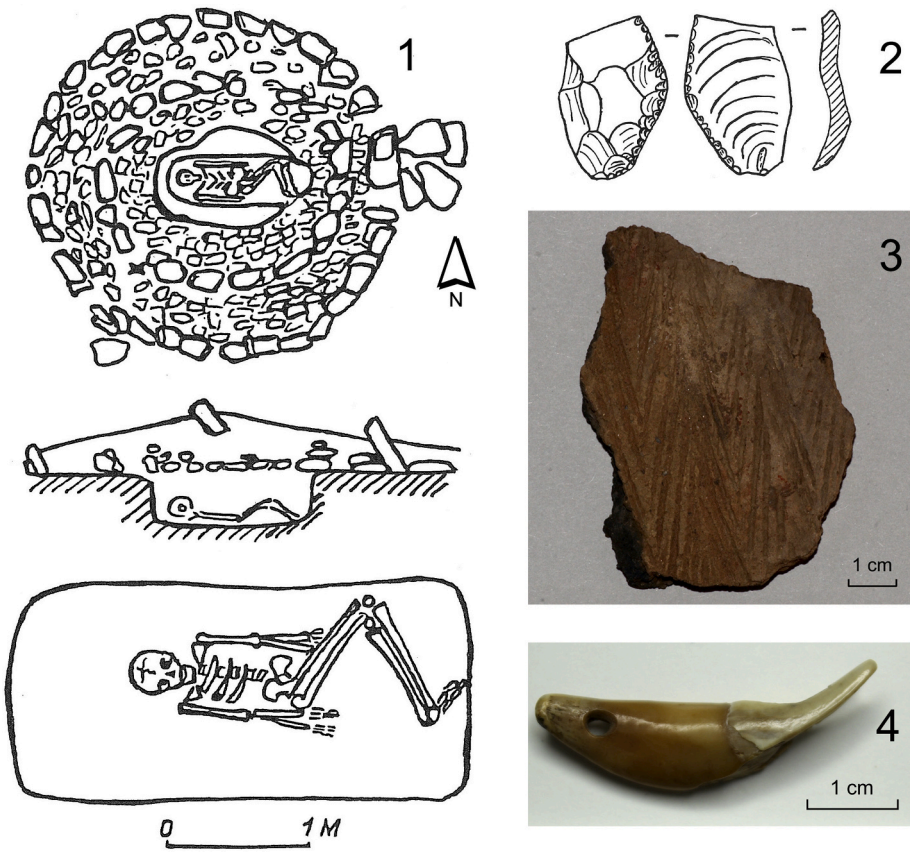

Fig. 7. Shatar Chuluu burial plans and artifacts. 1. Plan of what is likely Shatar Chuluu Burial 2 based on orientation and positioning (adapted from Novgorodova, 1989). Note that the stone extension on the east was attributed to Burial 3 and not Burial 2 and should probably be regarded as an error. This particular plan appears in Rogers et al., 2019 and Tsybiktarov, 2002 as Burial 3 but we now believe this to be an incorrect attribution. No burial identification is given in the original Novgorodova monograph. 2. Red jasper retouched flake from Burial 2 (from Novgorodova, 1989). 3. 'Nested chevron' decorated red coarse ware pottery fragment found in the backdirt pile of Shatar Chuluu Burial 3 (photo by *C. Carolus*). 4. Pendant made from the canine of a medium to large carnivore (Canis sp.) found in Burial 3 (photo by E. Amarbold).

inner ring made of standing slabs were 6 m and 5.5 m respectively and between these two features on the north side, excavators recovered numerous fragments of pottery with linear impressions made by a fine tooth serrated implement typical of Afanasievo ceramics found in the Altai and Minusinsk (Tsybiktarov, 2002:45; Tsybiktarov, 2006:230). Within the centrally placed burial chamber, 1.7 m deep, the ochre sprinkled skeleton of an adult male was recovered with remnants of birch bark overlaying the skull. The interred individual was placed in a supine position with flexed legs raised at the knees and oriented to the east (Volkov, 1980:14; Tumen, 1985:24).

Burial 2 is the southernmost feature and likewise comprised a circular flat mound retained by a 6.5 m diameter slab-built ring 0.4 m high with an internal secondary ring beneath the mound (diameter unspecified) made of river cobbles (Fig. 7). On the northern side of these ring features excavators found a finely retouched red jasper flake described as a cutting tool. The interred individual was again an adult male discovered within a central burial pit at 0.7 m depth, sprinkled with ochre, and positioned in standard Afanasievo manner but in this case oriented to the west (Volkov, 1980:14–15; Tumen, 1985:23). The third burial is the central feature of the group and had a circular low mound retained by a slab-built ring 7 m in diameter and 0.4 m high with a 2 m stone addition extending outward on the east side (Fig. 8). Again, an internal ring of slabs, 4.5 m in diameter, was discovered beneath the mound. In a central burial pit at 1.1 m depth, an adult individual of unspecified sex was found with sprinkled ochre, oriented to the east, but in a non-typical position placed on the right side rather than supine. From the burial pit emerged fragments of red coarse-ware pottery with thick walls and a mixed horizontal and vertical 'nested chevron' decoration made with a rocker-stamp, another Afanasievo diagnostic decoration (Tsybiktarov, 2002:45; Volkov, 1980:15–16, Fig. 7). The only faunal item recovered at the site was a drilled animal tooth pendant described in all reports as that of a wild boar (Tseveendorj, 1975:70; Volkov, 1980:15). However, on further examination, the pendant is more likely made from the canine of a medium to large carnivore (Canis sp.) (S. Pleuger, personal communication, Fig. 7).

4.2. Shatar Chuluu material analyses

Russian and Mongolian archaeologists are in broad agreement that the Altan Sandal and Shatar Chuluu burials represent the easternmost extension of Afanasievo material culture (Vadetskaia et al., 2014:274–276; Aldarmonkh, 2016:31). Our analyses of materials from Shatar Chuluu with specific analytical focus on dating, stable isotopes, and the genetics of human skeletal samples from Burials 1 and 2 add additional confirmation for this idea. Shatar Chuluu contexts, artifacts, and skeletal assemblages have been curated according to four different numbering systems and our first step was to inter-relate the various context designators. This allows us to compare and supplement our analytical results with those published in three overview studies that include skeletal samples from Shatar Chuluu but labeled according to the AT numbering system of the Mongolian National University (Taylor et al., 2019; Wilkin et al., 2020a, 2020b). We refer to published analysis from Shatar Chuluu Burial 1 (i.e., AT-26) and Burial 2 (i.e., AT-25) using the archaeological contexts originally published by Volkov (1980) and used comprehensively in the Russian archaeological literature (see supplement).

4.2.1. Comparative radiocarbon chronology

AMS radiocarbon analyses for the two Shatar Chuluu individuals were carried out by our team and by Taylor et al. (2019) independently. Both teams dated human skeletal samples labeled according to the numbering system used at the National University of Mongolia for a total of four reliable AMS dates. Based on our interpretation of available information, we believe that issues exist with the labels attached to these skeletal samples and propose that field curation in 1971 was likely the source of this confusion (Rogers et al., 2019:220; see supplement for details). Although our interpretation might prove to be incorrect based on future research, for the present study we have chosen to follow our best assessment of the available data and designate three of the fours dates as pertaining to Burial 1 and one date as pertaining to Burial 2. We pooled dates for Burial 1 using the CALIB program, calibrated the radiocarbon dates for both contexts using the R package Bchron, and created kernel density estimates (KDEs) from the sampled posteriors. The KDE has a 68% credible interval (CI) of 3078–2958 BC and a 95% CI of 3252-2929 BC. In order to assess how long Afanasievo communities might have inhabited the Shatar Chuluu region, we compared the two burial events and calculated a distribution of probabilities for two to five generations (per 20 years) based on posterior difference of the sampled calibrated dates.

Our analysis indicates that the absolute minimum elapsed time was zero, i.e., the two burials were contemporaneous events and there is also a small probability ($p = 0.17$) that Burial 2 was constructed prior to

Fig. 8. Shatar Chuluu landscape looking westward from Burial 3 where our team is checking the feature for uncollected ceramics.

Burial 1. The majority of probability, however, falls on the opposite side of the time scale where our chronological comparison suggests that Burial 1 likely postdates Burial 2 by at least one generation if not more ($p = 0.66$). Although we cannot rule out the contemporaneity of these two funerary events, the fall-off of probabilities between 40 and 100 or more elapsed years indicates that there is a good chance that the groups practicing these styles of burial inhabited the area for multiple generations. Finally, we pose the question of time elapsed between the Shatar Chuluu community and the start date for Afanasievo arrival in the Altai Mountains in order to quantify a timeline for this presumed migration. Using the 68% CI and the 27 AMS dates available for Altai Afanasievo burials and settlements for comparison (see section 2.3), we calculate the possible range for time differences. The Shatar Chuluu burials could be contemporaneous with the first appearance of Altai Afanasievo practices, although this scenario would be implausible. The maximum difference between the two start dates is 126 years which suggests that the central Mongolian migration occurred relatively early in the Afanasievo period (Fig. 9).

4.2.2. *Shatar Chuluu genetics*

Shatar Chuluu radiocarbon chronology is therefore consistent with that proposed for the Afanasievo period generally, and the mortuary patterns are also analogous in many respects, but material culture does not equate to "people" per se. Material styles, artifacts, and practices can be readily transferred through exchange and culture contact. Using genetics to further evaluate who these Shatar Chuluu groups were, we sequenced post-cranial skeletal samples from Burial 1 and 2 in order to determine mtDNA haplogroups. Rogers et al. (2019) describe the methodology for contamination control, extraction, amplification, and sequencing. Based on our genetic analysis, the single-nucleotide polymorphisms lead us to identify our Burial 1 sample with the N1a1a1a mtDNA haplotype and our Burial 2 sample with the U5a1a1 haplotype.

Both of these mtDNA haplotypes are generally considered "western" Eurasian matrilines and are consistent with Yamnaya-Afanasievo contexts. Haplotype N1a1a1a has been found in a wide distribution of modern populations in Eastern Europe and Western Asia and was common among Neolithic peoples of Central Europe. The N1a1a1a haplogroup has also been associated with Eurasian Steppe populations, in particular with those of the Poltavka, Potapovka, and Srubnaya archaeological cultures (*c*. 2700–1200 BC), all considered descendants of the Pontic-Caspian Yamnaya groups (Juras et al., 2017). The Burial 2 haplotype, U5a1a1a1, is found in highest frequency among the modern Slavic speaking peoples of Eastern Europe (Malyarchuk et al., 2010). The more basal U5a1 haplogroup has been found in populations of the Yamnaya archaeological culture and has been identified in individuals from the Afanasievo archaeological culture of the Altai region (Allentoft et al., 2015; Nikitin et al., 2017; Hollard et al., 2018). These mtDNA results, genetically linking Shatar Chuluu individuals to western Eurasian populations, were first presented by Rogers (2016); Rogers et al. (2019) and have since been supported by genome-wide sequence data for each of the Shatar Chuluu individuals (Jeong et al., 2020).

4.2.3. *Animal herding and isotopes*

These analyses support the presence of Afanasievo populations and material culture in central Mongolia but they cannot directly attest to the lifeways of the Shatar Chuluu community. This is of crucial importance since the Afanasievo entry into Mongolia has long been regarded as the earliest introduction of domestic herd animals and the beginning of a hunter-herder subsistence tradition that developed over millennia into the pastoral nomadic culture for which Mongolia is so well-known (Honeychurch, 2017). No domesticated faunal remains have been recovered from the Altan Sandal or Shatar Chuluu sites and until recently there was no evidence by which to consider these groups as keeping herds, other than their association with core Afanasievo hunter-herder communities. A recent groundbreaking analysis of human dental calculus has now documented ruminant dairy consumption in the individual from Burial 1 at Shatar Chuluu providing direct evidence that domesticated herds were maintained and milked as part of local Shatar Chuluu subsistence. The specific milk proteins discovered were not species specific but could be confidently assigned to either the subfamily Bovinae or *Ovis* genus (Wilkin et al., 2020a:348). Notably, once dairying appears among the Afanasievo groups of the Altai Mountain region it continues as a dietary feature into the Chemurchek period and probably continues into subsequent periods as well. In sharp contrast, in the central, southern, and eastern regions of Mongolia we have no additional evidence for milk consumption for roughly another 1500 years (Janz et al., 2020; Wilkin et al., 2020a).

Based on this evidence, we expect that Afanasievo communities of central Mongolia practiced a hunting, gathering and herding lifeway similar to that known from the Altai. To explore the issue of local diets further we compare stable isotopic values ($\delta^{13}C$ and $\delta^{15}N$) from human bone and dental collagen for Shatar Chuluu ($n = 2$) to Neolithic hunter-gatherers ($n = 5$) and Bronze Age pastoralists ($n = 30$) from Mongolia (see supplement for analysis details). We also include 20 stable isotopic results for Afanasievo individuals from the Altai Mountains based on the work of Svyatko et al. (2017). The majority of Mongolian samples have been directly dated by AMS radiocarbon analysis: Neolithic samples predate the Afanasievo period by up to a millennium and the Bronze Age

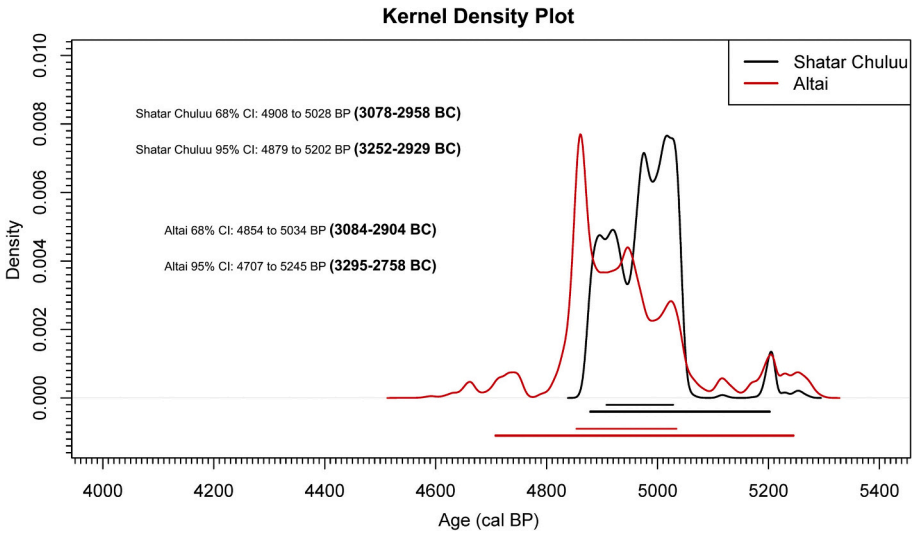

Fig. 9. Comparison of the 68% and 95% credible intervals for Shatar Chuluu and Altai Afanasievo AMS dates based on kernel density estimates.

samples range in date from c. 2500 to 1000 BC (i.e., Early to Late Bronze Age). Details of the methodology involved in paleodietary reconstruction from stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopic analysis of human remains has been widely documented (Ambrose, 1993; Pate, 1994; Schwarcz and Schoeninger, 2012). These analytical techiques have increasingly been utilized to examine contexts across the Eurasian steppe region (e.g. Machicek, 2011; Fenner et al., 2014; Svyatko et al., 2017; Ventresca-Miller and Makarewicz, 2019; Hrivnyak and Eng, 2020; Wilkin et al., 2020b).

In brief, the technique involves the analysis of bone or dentinal collagen to estimate the relative abundance of certain plant types and protein influence in an individual's diet, reflecting a multi-year average of their dietary intake during life. Stable ^{13}C isotopes provide a relative indication of plant types in the diet that undergo differences in photosynthetic pathways, mainly C_3 or C_4 varieties (Katzenberg, 2000; Leethorp, 2008). C_3 plant types occur naturally in temperate environments, whereas C_4 plants are more abundant in locations that experience higher temperatures, increased aridity, and tropical climates. Important C_4 agricultural crops of interest in dietary reconstructions include millet and maize, while major C_3 cultigens include wheat, rice, and barley. It is not possible to distinguish input from agricultural crops and naturally occurring plant types that make their way into an individual's diet. However, when local faunal remains are also analyzed to reconstruct a potential diet for human inhabitants, and where C_4 influence is identified when these plants are not naturally abundant, inferences can be made about dietary intake and related subsistence strategies (Schwarcz and Schoeninger, 2012). Nitrogen isotopic ($\delta^{15}N$) analysis provides an indication of trophic level spacing in the local food web reflective of animal protein in the diet (Katzenberg, 2000). In addition, $\delta^{15}N$ signatures may be enriched in humans and animals that inhabit more arid environments (Heaton et al., 1986; Sealy et al., 1987; Schwarcz et al., 1999).

The resulting comparison proves consistent with what we would expect for groups subsisting as mixed hunters, gatherers, and herders (Fig. 10). The two Shatar Chuluu samples overlap the upper $\delta^{13}C$ and $\delta^{15}N$ values for the Altai Afanasievo group (mean ± SD: $\delta^{13}C$ –18.9 ± 0.32; $\delta^{15}N$ 10.5 ± 0.55) and at least one individual from Shatar Chuluu also falls into the range of the Neolithic hunter-gatherers (mean ± SD: $\delta^{13}C$ –18.2 ± 0.23; $\delta^{15}N$ 10.6 ± 0.35). Constrained ranges for the Altai Afanasievo and Neolithic samples suggest a degree of homogeneity in diet, even though it is important to note the very small sample size for Neolithic individuals. These results contrast sharply with the ranges for Bronze Age pastoralists whose values display large variation in both isotopic carbon and nitrogen ratios. With a mean of −17.03 ± 0.67, the $\delta^{13}C$ values of Bronze Age individuals are significantly higher than those from both the Afanasievo and Neolithic samples, possibly due to environmental differences in aridity and vegetation (t = 7.22–13.14, all tests, $p < 0.0001$, Hrivnyak and Eng, 2020). On the other hand, the mean Bronze Age $\delta^{15}N$ value of 13.8 ± 1.0 is about three per mil higher than Altai Afanasievo and Neolithic results, most likely due to higher meat and dairy consumption (t = 13.60–15.20, all tests, $p < 0.0001$). Three per mil spacing is commonly cited as marking one trophic level of average ^{15}N enrichment in the food web demonstrating the transition in diet that came about as pastoralism intensified during the Bronze Age (DeNiro and Epstein, 1981; Minagawa and Wada, 1984).

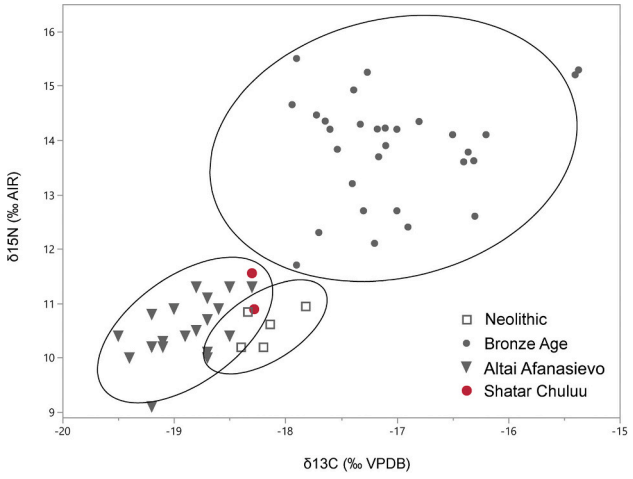

Fig. 10. Comparison of human stable isotopic values ($\delta^{13}C$ and $\delta^{15}N$) for Shatar Chuluu, the Mongolian Neolithic and Bronze Age, and Russian Altai Afanasievo samples. Neolithic, Bronze Age, and Altai Afanasievo groups are each shown with a 95% confidence ellipse to visualize variance and overlap.

However, environmental variation between regions as distant as these can make a difference in isotopic results and requires some discussion. The ecology of the Siberian Altai from which the comparative Afanasievo samples come is a mosaic of alpine meadows and tundra at higher altitudes with subalpine conifer forests transitioning into meadow steppe at lower altitudes. In contrast, the northern Mongolian Neolithic samples come from a region of comparatively drier environment comprising mixed steppe and forest steppe landscapes (Chuluun et al., 1999). Variation in Inner Asian plants and grasses shows a latitudinal trend from naturally occurring C_3 grasses and plant types in the north to more abundant C_4 vegetation in the southern regions of Mongolia where aridity is greater and average temperature is higher (Pyankov et al., 2000). The Mongolian Bronze Age samples come from sites along the middle zone of these north and south regions characterized by a mix of classic and dry steppe environments, all of which fall within the same latitudinal zone as the Shatar Chuluu samples (46° latitude). Interestingly, the region from which the Shatar Chuluu individuals are from is environmentally much more similar to that of the Bronze Age sample set; yet their isotopic results align with those individuals from the Altai Afanasievo group and the Neolithic individuals. This strengthens the notion that the dietary intake of these individuals likely represents similar subsistence choices rather than non-dietary environmental factors. Despite some level of dairy consumption in Afanasievo communities, these isotopic results suggest that the hunting and collecting of wild species were still a major part of Afanasievo subsistence.

In summary, these multiple lines of evidence associating Altan Sandal and Shatar Chuluu with Afanasievo mortuary practices in the Altai are robust and compelling. We have documented diagnostic funerary practices and burial constructions as well as artifact types, all of which match what is known from the core Altai region. Chronologically the Shatar Chuluu burials fall neatly within the Afanasievo time frame and the evidence for milk consumption and for local hunter-herder subsistence likewise supports this cultural connection. Finally, perhaps the most convincing evidence is our discovery of genetic links between the two Shatar Chuluu individuals and populations associated with both Afanasievo and Yamnaya communities. However, the central Mongolian cemeteries are not exact analogs of any single known site from the Altai, Minusinsk, Tuva, or from western Mongolia and, in fact, the two sites themselves show many differences in mortuary practice. The distinctive features of these cemeteries, i.e., the occurrence of double stone rings, a lack of artifacts in some features, and alternating orientations between east and west, are not individually unique and have been noted at the Khaiyrakan site in Tuva and for the Aragol subtype of Altai burials (Tsybiktarov, 2002:46, 50). Even so, as a set of composite practices they are so far only found in central Mongolia. In keeping with the high degree of local variability that archaeologists have described in reports and publications, Altan Sandal and Shatar Chuluu present yet another local variation upon Afanasievo mortuary traditions.

5. Assessing the Afanasievo impact on the rise of Mongolian pastoralism

The geographical location of Shatar Chuluu and Altan Sandal in

relation to the nearest Altai Afanasievo sites is notable and suggests a likely route of travel between the two regions. What might be called the southern Khangai corridor is a continuous broad basin between the Khangai Mountains to the north and the southeastern extension of the Altai Mountain chain to the south (Janz et al., 2017:6). The corridor consists of numerous rivers and lakes fed by discharge from both mountain ranges and, as such, it constitutes a natural pathway with ample water sources easily accessible from areas along the Russian-Mongolian Altai border and coming to an end at the Tuin River south of Shatar Chuluu. Given the proximity of our two central Mongolian sites, Altan Sandal was likely occupied by groups moving from Shatar Chuluu over the high elevation ridge to the north and down into the neighboring valley of the Khoit Tamir River. If indeed the central Mongolian communities departed from the Altai regions, likely starting in the vicinity of Afanasievo sites such as Bertek 33, Mukhor-Tarkhata I, and Khuurai Govi (Fig. 1), the hypothesized route would have covered roughly 1200 km to Shatar Chuluu and another 130+ km to Altan Sandal. The corridor passes many of the regions in Mongolia least studied by archaeologists and lacking entirely in systematic regional survey. Given this observation, the possibility of discovering additional Afanasievo sites between the Altai and central Mongolia should not be dismissed.

5.1. Pastoralism beyond the Khangai Mountains and eastward

Afanasievo migrants traveling the southern Khangai corridor would have had great potential to introduce novel subsistence regimes and technologies to Late Neolithic communities along the way. However, the entry of herding communities into central Mongolia at c. 3000 BC raises many of the same theoretical issues associated with Afanasievo arrival in the Altai and Minusinsk regions. Namely, how did these hunter-herders interact with local Late Neolithic groups; what was their role in the circulation of domestic herd animals and metallurgical technologies; and, finally, how do we conceive of the tandem processes involved here – migration on the part of outsiders and selective adoption and innovation on the part of indigenous communities? One of these topics can be dispensed with immediately since as of now we have no evidence for copper metallurgy among the Altan Sandal and Shatar Chuluu communities. Presumably, these groups carried metallurgical technology with them and, indeed, there is plentiful evidence for copper ore processing and smelting at sites considered to be Late Neolithic and Early Bronze Age in chronology (Janz et al., 2017, 2020), but we cannot directly tie these activities to an Afanasievo presence.

The topics of herd animal introduction and the development of pastoralism are likewise problematic due to a critical dearth of evidence for these periods. Very few Late Neolithic habitation sites have been systematically excavated, faunal analysis is a skillset still under development in the Mongolian academic setting, and absolute chronology is minimal. Recent fieldwork and analysis by Janz, Odsuren, Bukhchuluun, and Cameron have made the greatest recent contributions on all three fronts and they are best situated to propose hypotheses based on the current evidence available (Janz, 2016; Janz et al., 2017, 2020). To frame the issue diachronically, Janz et al. (2020) describe three phases of pastoral development in Mongolia. Their first phase marks the arrival and introduction of Near Eastern herd animals in the greater region with a primary geographical focus on the western Altai where Afanasievo and Chemurchek communities acted as the primary agents for herd animal circulation. While the transition from hunter-herder to fully pastoral lifeways in western Mongolia seems to have been a fairly continuous process subsequent to Afanasievo arrival in the Altai (Taylor et al., 2020), there was a distinct interlude in central, southern, and eastern Mongolia during which time evidence for domesticated herd animals is lacking. The second phase is marked by regional transformations in material culture indicating an expansion of exchange and interaction networks during the late 3rd millennium BC. Not until Janz's third phase, between 2000 and 1400/1300 BC, is there widespread indication that herding practices were being adopted across Mongolia in conjunction with the building of impressive stone ritual and mortuary monuments (Amartuvshin, 2020; Erdenebaatar, 2002; Houle, 2009). These highly visible site contexts have provided the majority of human and faunal skeletal evidence attesting to the rise of pastoral lifeways and diets at this time. After 1000 BC, a highly mobile form of pastoralism came about across the Mongolian plateau with the advent of horse riding as a routine practice (Honeychurch, 2015:128–129, 210; Taylor, 2017; Janz et al., 2020).

5.2. Current models and hypotheses, 3000–1500 BC

The key period for consideration, therefore, is the early to mid-3rd millennium BC when domestic herd animals were definitely present in western Mongolia but the nature of their presumed circulation among central, southern, and eastern indigenous hunter-gatherers of the Late Neolithic is still unclear. Janz and colleagues focus their research primarily on the Mongolian and Inner Mongolian Gobi Desert but their ideas are pertinent for a wide periphery of mountains and plains bordering on what are today quite arid regions. As mentioned, the Gobi Desert of the Late Neolithic and Eneolithic was wetter, lightly forested, and contained a great deal more surface water including numerous wetlands. Janz et al. (2017, 2020) make a compelling argument for a broad-spectrum foraging lifeway among Neolithic hunter-gatherers focused on increased diet breadth largely by exploiting these rich wetland environments. Based on evidence from land-use, settlement location, and artifact assemblages, this pattern of occupation continued well into the Eneolithic and Early Bronze Age seemingly unabated despite the arrival of hunter-herders in the neighboring Khangai mountain periphery. In fact, broad-spectrum foraging was such a successful subsistence strategy that there may have been little incentive to include a novel food source such as domestic animals with which hunter-gatherers had no experience. Therefore, Janz and colleagues view Afanasievo arrivals as isolated, small-scale, and having little apparent impact on the greater region during the crucial 3rd millennium (Janz et al., 2020). Instead, according to Janz et al., domestic herd animals were possibly introduced at a later period through inter-community diffusion from the west in association with either Chemurchek expansions (middle 3rd to early 2nd millennium BC) or with later groups located even farther westward.

The question remains, however, of why evidence for pastoralism occurs so late across this central and eastern region and what, if anything, does the emergence of stone monuments and monumental burials indicate about this belated process. In response, Janz et al. (2020) point to evidence that by 2000 BC a number of major changes seemed to be occurring related to craft production and exchange as well as regional politics. In particular, they identify an interregional exchange system that circulated wealth items in the form of semi-specialized craft goods, most notably lapidary beads and fine-ware ceramics. Evidence for the production of sophisticated personal adornment items, including carnelian, turquoise, jasper, and eggshell beads, appear at habitation sites in the South Gobi of Mongolia and in the Alshaa and Etsin Gol regions of western Inner Mongolia. These same items appear across the region interred with their owners in massive stone chambered tombs, known as "prone burials," along with the first faunal evidence for domesticated herd animals (Janz et al., 2020). Even though land-use, site locations, and lithic tool assemblages are not terribly different from earlier Neolithic periods, by 1600–1500 BC habitation sites and burials both provide evidence for dairy consumption and the presence of domesticated sheep based on aDNA analysis (Janz et al., 2020; Rogers, 2018; Wilkin et al., 2020a:348). This evidence leads Janz and colleagues to argue for an emergent emphasis on wealth exchange and accumulation between 2000 and 1500 BC that may have articulated with the rise of major centers in Inner Mongolia, such as the Shimao fortified settlement (Jaang et al., 2018). An emphasis on wealth production and transfer would encourage new means for the conversion and storage of

wealth, and in many parts of the world, herd animals play a major role in facilitating such wealth systems (Janz et al., 2020; Honeychurch, 2014:287–288). In other words, the novel focus on wealth spurred interest in herd animals as items of value and encouraged their rapid adoption among hunter-gatherer groups. Not only was interregional wealth exchange a major incentive for the adoption of herd animals, but it may have also increased local status differentiation that came to be marked by the earliest prone burial tradition (cf. Wright et al., 2019:407–408).

5.3. Evaluating the current model

Janz's model is consistent with a lack of evidence for pastoralism up until 1600–1500 BC in these regions, but several factors should be considered in assessing the very sudden occurrence of pastoral evidence from new kinds of burial contexts. We might consider whether these novel site types simply incorporated and preserved the skeletal evidence attesting to an animal husbandry tradition that had already long existed in the region. Notably, with the exception of Shatar Chuluu, the regions of central, southern and eastern Mongolia have not yielded a single human or faunal skeletal assemblage dated to the 3rd millennium BC by which to test these ideas for subsistence practices. As such, greater weight could conceivably be placed upon the existing evidence for herding at c. 3000–2900 BC as it is already known from Shatar Chuluu. An alternative hypothesis, therefore, proposes that Afanasievo migrants to central Mongolia introduced domestic sheep/goat and cattle and these animals began to circulate in Late Neolithic networks prior to an intensification of pastoralism between 2000 and 1500 BC (Janz et al., 2017:61; Honeychurch, 2017:516). Several observations lend support to this hypothesis beginning with environmental and climatic research based on pollen studies, charcoal from anthropogenic burning and clearing events, sedimentology, and plant phytolith analysis that detect anthropogenic changes in local landscapes. Paleo-environmental studies conducted in central, southern, and eastern parts of Mongolia converge on a timeframe with the earliest possible indications of herding suggested by grassland pollen changes at c. 3000 BC (Klinge and Sauer, 2019:45–46). These are followed by a major increase in herd associated vegetation and landform transforms at c. 2300–1600 BC and subsequent environmental shifts into the 1st millennium BC as mobile pastoralism came to the fore (Klinge and Sauer, 2019:45–46; Rosen et al., 2019:307; Tarasov et al., 2019).

Another issue is the presumption that Afanasievo communities at Shatar Chuluu and Altan Sandal were isolated in mountain valleys, a notion that might be reassessed in light of results from systematic pedestrian surveys in other parts of Mongolia. Full-coverage survey in landscapes having resources and environments similar to Shatar Chuluu and Altan Sandal tend to have high densities of Middle and Late Neolithic habitation. As an example, prior to beginning our current survey project at Delgerkhaan Uul (DKU) in eastern Mongolia (Fig. 1), the national catalog of the Mongolian Institute of Archaeology confirmed 14 Neolithic sites within an area covering 175 km outwards from our survey center. Since 2013, systematic transect walking has documented 86 Neolithic habitations just within 10 km of the survey center (Zoljargal, 2020). The same database shows only three Neolithic habitations recorded within a 175 km range of Shatar Chuluu. Based on our experience, the Shatar Chuluu valley and surrounding areas very likely contain Neolithic site counts similar to those documented at DKU. Although dating is problematic, a recent pedestrian survey using sampling blocks in the vicinity of Shatar Chuluu and along the middle Tuin River encountered significant numbers of potential Neolithic activity areas and habitation sites (Lowry, 2020:82).

Another way to assess isolation is through genetics, asking to what degree the presence of Afanasievo populations in the Altai and Khangai regions ($n = 27$) contributed to the makeup of later Mongolian groups (see supplement for analysis details). Based on what are still relatively small sample sizes, the central Mongolian population of the Early Iron Age (1st millennium BC) shares notably more mtDNA gene frequencies (Fst 0.06257, $n = 24$ slab burial contexts) with the Altai-Khangai Afanasievo population than do northern and eastern populations. While these genetic similarities are clear for central Mongolia, they are not apparent in either northern or eastern Mongolian populations from the 2nd to 1st millennium BC (Bronze and Early Iron Age). Based on genetic data made recently available (see supplement), we find little similarity in mtDNA frequencies with Late Bronze and Early Iron Age groups in northern Mongolia ($n = 22$ khirigsuur contexts, Fst 0.11259) and, likewise, little similarity with Late Bronze populations in eastern Mongolia ($n = 19$ prone burial contexts, Fst 0.16235). This suggests that the central Mongolian region in particular had a substantial component of Afanasievo-like matrilines during the Early Iron Age and possibly during the Bronze Age as well. Unfortunately, the current paucity of central Mongolian Bronze period samples makes this difficult to evaluate. While it is clear that some later local populations had inconsequential contributions from an earlier Afanasievo-like population (e.g., Jeong et al., 2020), other local populations, particularly in western and central Mongolia, carried substantial numbers of Afanasievo-like matrilines in frequencies similar with regional Afanasievo populations. This finding indicates that the Afanasievo migrant groups were not isolated but instead interacted and most likely intermarried with indigenous communities.

A final observation of interest is the regional timing for the appearance of early pastoralist evidence across central, southern and eastern Mongolia, including indications for widespread dairy consumption. Janz et al. (2020) analyzed surface collected ceramics from the South Gobi habitation site of Bayanzag (also Shabarakh-usu, Fig. 1) and detected ruminant dairy fats dating to 1615–1438 BC (95% probability, 3246 ± 39 uncalibrated BP). Likewise, Wilkin et al. (2020a) discovered dairy proteins in human tooth calculus from Burial 42 at the Ulaanzuukh cemetery in eastern Mongolia dating to 1608–1581, 1562–1416 BC (95% probability, 3215 ± 40 uncalibrated BP, Fig. 1), and Jeong et al. (2018) report similar dairy evidence from Khovsgol khirigsuur 24 in northern Mongolia at 1607–1582, 1561–1370, 1360–1299 BC (95% probability, 3174 ± 53 uncalibrated BP, Fig. 1). The earliest aDNA evidence for domestic sheep (haplogroup B) comes from faunal remains excavated at the eastern Mongolian site of Chandmani Khar Uul (Burial 04) dating to 1527–1382, 1341–1310 BC (95% probability, 3170 ± 40 uncalibrated BP, Rogers 2018, Fig. 1). These four sites and their respective analytical results represent the first evidence for pastoralism across a vast section of Mongolia east of the Khangai Mountains. What is still more surprising is that these dates cannot be statistically differentiated from one another (all $p > 0.10$), indicating the possibility of contemporaneous or relatively closely spaced time events (i.e., over 1–2 centuries) within regions separated by an average distance of 762 km. We suspect the chronological grouping of these dates is not fortuitous. Rather, the trend represents a rapid intensification of herding practices based on what we hypothesize was a pre-existing, albeit low-level, experience with animal husbandry among groups that were primarily hunters and gatherers. As might be expected, the knowledge, techniques, and practices of caring for and breeding domestic herds would not have been immediately apparent or readily transmissible based on a sudden diffusion of domestic animals (e.g., Honeychurch and Makarewicz, 2016:344). Rather, we argue that Late Neolithic peoples most likely experimented with and invented their own understandings of domestic sheep/goat and cattle that had been introduced by central Mongolian Afanasievo communities early on.

5.4. Afanasievo agency in pastoral beginnings: An alternative hypothesis, 3000-1500 BC

If indeed domestic animals had been circulating at low levels among Late Neolithic groups for centuries, why did a transition to more intensive herding occur during the early to mid-2nd millennium BC? We propose several factors to explain the emergence of pastoralism from

Late Neolithic 'experimental' animal husbandry. Most importantly, we suggest that the domesticated animals encountered by Late Neolithic communities at c. 3000–2900 BC may not have been regarded as sources of food, but likely were seen as extremely interesting curiosities, perhaps endowed with ceremonial importance and status value (e.g., DeFrance 2009; cf. Russell 2017). According to our new hypothesis, these exotic animals were circulated gradually but widely through a process of inter-community gifting. Some communities may have rejected the presence of these strange beings outright, while others failed to care for them adequately. In some places, however, herd animals were not only regarded with great interest and managed to reproduce, but they also figured prominently in the creation of ties between Late Neolithic communities. During this early period, knowledge of animal needs, behaviors, and pertinent skillsets were developed and shared among groups. At the same time, a slow process of adaptation to zoonotic diseases was almost certainly in progress and this condition would have slowed the diffusion of domesticates (Morand et al., 2014). Another slowing variable may have been the lack of tolerance for dairy products among hunter-gatherer populations who did not have the genetic predisposition to readily digest milk (Jeong et al., 2018; Segurel et al., 2020). These combined circumstances would account for a heightened interest in herd animals and their differential transmission, as well as some substantial impediments to a more rapid diffusion.

By the early 2nd millennium BC several important changes converged to inspire a widespread and more intensive version of pastoralism across Mongolia. We identify six cultural, technological, and environmental factors responsible for driving and sustaining pastoral intensification during this time. The first factor was maturing indigenous knowledge pertaining to herd animals after centuries of experimentation, learning, and the gradual transfer of skills between hunter-gatherer communities that came into possession of domestic animals. A second factor was the innovation and adoption of dairy technologies that made milk products tolerable to populations without the lactase producing LCT gene variant. It is still not clear the degree to which lactase persistence was characteristic of Yamnaya and Afanasievo populations (Segurel et al., 2020), nor to what degree they practiced bacterial modification of raw milk in order to consume it. What we do know is that evidence for these practices appears in the arid regions of Xinjiang as early as 1900–1800 BC (Xie et al. 2016; Yang et al., 2014) and this possibly marks the beginning of an Inner Asian dairy tradition that is notable for its great variety, uniqueness, and technological sophistication (Bae et al., 2002). This of course would have promoted a sustainable and nutritious subsistence source that did not require the killing of an animal.

The third factor arises from Mongolian archaeologists' focus on habitation site studies through which they have discovered evidence for portable dwelling technologies suggestive of pastoral lifeways. The earliest indications of a tent-like structure surrounding a hearth has been dated to c. 2500 BC in western Mongolia (Taylor et al., 2020) and the next such evidence is a campsite having a yurt or Mongolian *ger*-like structure in northern Mongolia dating to c. 450 BC (Gardner and Burentogtokh, 2018). Between these two time periods we expect experimentation that gradually transformed the large portable tent into the highly versatile yurt or *ger* structure that is still in use today. Such mobile domiciles are quite different from the heavy timber-based dwellings documented at the Kara-Tenesh settlement discussed above (section 2.2) and are likely indigenous innovations that enabled the regular seasonal movements important to sustaining larger herds.

The fourth factor is an innovation of social technology in the form of inter-area visitations and impressive burial constructions that underwrote agreements for pastoral alliances and local identities linked to pastoral resource territories. Archaeologists have just begun to document what is known as the 'prone burial tradition' (formerly Ulaanzuukh-Tevsh culture) representing some of the earliest stone-built monumental burial practices east of the Khangai Mountains (Amartuvshin, 2020; Wright et al., 2019). These burial features are also among the earliest sites beyond the western Altai to regularly include the ritually deposited remains of herd animals including sheep and horse that have now been positively identified based on genetic analyses and absolute dating (Rogers 2018). In contrast to the proposal that prone burials mark early status differentiation, an entirely different explanation for the construction of such labor intensive monumental sites has been developed by Burentogtokh (2017) and colleagues Burentogtokh et al. (2019). Burentogtokh explains monumental burial sites in light of the pastoral intensification process that seemingly occurred in concert with their initial construction in many parts of central, south and eastern Mongolia from 1600 to 1400 BC.

Stone monuments had two additional roles besides their use as burial facilities. First, as pastoralism became a greater subsistence focus, resource territories and the community identities associated with local resources were intentionally demarked by monument building. This occurred in northern Mongolia where khirisguur stone mounds were placed within areas of prime winter and summer pasture and in eastern Mongolia where prone burials are clustered along waterways, outflow channels, and adjacent pasturelands (Burentogtokh, 2017:230; Honeychurch, 2015:125). The second role consisted of an activity set that organized inter-community visitations in support of pastoral alliance building. Networks of external relations were, and still are, a critical part of maintaining herds in the face of drought, cold snaps, and epizootic disease outbreaks (Honeychurch, 2015:103–104, 145–146). Monumental funerals not only served as an occasion for extended visits by alliance partners but also produced an enduring material mnemonic affirming the alliance relationship and an obligation for assistance (Burentogtokh et al., 2019:62–63). We hypothesize that such alliance networks initially stretched over distances of 50 to 100 km (Honeychurch, 2015:145–146), but given multiple generations of 'down-the-line' network building these practices in support of sub-regional to regional alliances would have replicated across an incrementally larger region. Local tastes and innovations eventually resulted in the pattern we see today in terms of regional prone burial practices; i.e., mixed burial types with underlying similarities but having local variations in structural detail.

Not surprisingly, the distances involved in alliance building, the appearance of portable dwellings, and the seasonal mobility that accompanied an intensification of herding would have eventually encouraged the fifth factor in our model: experimentation with modes of transport. We might imagine that the hypothetical use of wagons by Afanasievo migrants introduced the concept of animal traction to central Mongolia but there is no evidence for such animal use until the late 2nd millennium BC. However, from prone burial contexts along the southeastern edge of the Gobi Desert we encounter what is among the earliest genetic evidence for domesticated horses interred in Mongolian mortuary contexts, as mentioned above. Genetic data from Bronze Age horse samples excavated at Delgerkhaan Uul (1444–1271 cal BC, 95%) exhibit SNPs in the first hypervariable region of the mtDNA that are primarily found in modern horse populations of northeastern Italy and the Carpathian mountain region, as opposed to modern Mongolian horse populations (Rogers, 2018). These data are consistent with a scenario in which western domesticated horses were brought across the steppe into Mongolia. Although the uses and purpose of these early horses is not clear, we surmise that they were associated with the gradual development of traction or riding technologies evidenced by harness-related nasal pathologies on northern Mongolian horses dated to c. 1250-1200 BC (Taylor, 2017; Taylor et al., 2018). These Gobi equids may well have been those exchanged in the earliest horse transfers to the Ordos region of Inner Mongolia and eventually to the Shang Dynasty capital where horses were highly valued and used to pull elite chariots (Honeychurch, 2015:189–191). We expect that as faunal aDNA progresses in Mongolia, our early evidence for interest in transport animals will be confirmed and will be detected at prone burial sites in Inner Mongolia as well (Burentogtokh et al., 2019:59–60).

The sixth and final factor effecting pastoral intensification is the

documented shift in regional climates towards aridification in the Gobi and diverse sub-regional climate regimes in central and northern Mongolia, beginning at c. 2000 BC. As Janz et al. (2017) have argued, aridification in the southern Gobi and eastern Mongolia tended to diminish the rich wetland environments that had sustained hunting and gathering communities over the prior millennium. The disappearance of many of these extensive shallow lakes may have made pastoral subsistence and flexible herding lifeways much more attractive. In central and north central Mongolia the record is complex and characterized by high variability in environmental and climatic conditions depending on the interface of macro-regional weather systems with local topography and rain shadow effects (S. Fowell, personal communication). High variation over this large region would also have favored the flexibility of pastoralism, especially with a more mobile component. Perhaps more importantly, it would have encouraged the kind of alliance networks between areas that we hypothesize were a major form of social infrastructure in support of investments in herding. These gradual climatic changes were important not because they made pastoralism an environmentally logical alternative, but because these conditions produced a setting wherein the first five human factors synchronized and reinforced the construction of what was primarily a unique 'social and cultural niche' (Honeychurch and Makarewicz, 2016:353). This process of niche construction included diverse pastoral knowledge and technologies, novel social relationships, herd centered concepts of value, and newly structured interaction networks; all of which promoted greater dependence on herd animals. Variable climates and environmental factors were indeed implicated in this process, but likely played a relatively minor role in comparison to the human factors.

6. Conclusion

In this study of Afanasievo archaeology we have collated and examined three sets of regional evidence. First, we have provided an overview of Afanasievo archaeology as known from the Altai Mountains and the Minusinsk Basin, including several important analytical breakthroughs that have helped archaeologists to understand the lifeways of these early hunter-herder communities. The latest research suggests that the Afanasievo development was not simply a migration resulting in transposed Yamnaya groups, but also that interactions with indigenous West Siberian, Altai, and Minusinsk groups were significant and formative. Following in this vein, we considered evidence for Afanasievo expansions to the west and east, leading to an analysis of the central Mongolian sites of Altan Sandal and Shatar Chuluu. In presenting our own research results and synthesizing recently published data, we confirm the earlier hypothesis that Shatar Chuluu, and probably Altan Sandal, were associated with Afanasievo communities likely originating in the Altai Mountains. Moreover, our results indicate that these migrant communities arrived quite early during the Afanasievo period and brought with them the first domestic herd animals to appear in central Mongolia. Based on the evidence provided by these three compiled datasets, we then recount the latest hypotheses for the emergence of pastoralism in Mongolia east of the Khangai Mountains, including an existing model by Janz and colleagues and an alternative explanation presented in this study. In doing so, we intend to provide researchers with at least two different models to evaluate against their own future fieldwork, data, and analysis.

To summarize the major points of our alternative hypothesis for pastoral emergence, the highlights are as follows. We propose an early introduction of herd animals by the Afanasievo communities in central Mongolia followed by an extended interval best understood as a 'learning curve' period. During this time, a small number of sheep/goat and possibly cattle circulated among Late Neolithic hunter-gatherer groups, not as subsistence resources but as curious and exotic animals of value and likely gifted as such between hunter-gatherer communities. We expect that several slowing factors were involved during this learning curve period. These would have included selective acquisition and differential success in caring for animals, the problem of newly introduced zoonotic diseases, and a genetic inability to digest dairy products. These factors presumably made early herd animals functional for gifting and ritual purposes, and perhaps also for wool and fiber use, but less so for sustainable subsistence.

Between 2000 and 1500 BC, given a regional context of gradual aridification in some areas and climatic variability in others, we contend that several mutually reinforcing factors led to an intensification of pastoralism based on this existing but low-level form of animal husbandry. Long-term experience with herd animals leading to a better understanding of their needs and behaviors was a primary enabling condition. The appearance of lactose reducing dairy technologies to make yoghurts, cheeses, curds, and milk based alcohols was fundamental to making a primary subsistence source available. In support of larger herds and their growing importance, communities occupying resource rich wetlands initiated new forms of local identities focused on pastoral resource territories as well as alliances with external communities to guarantee assistance during times of need. Both of these processes involved stone-built ritual and mortuary monuments constructed during funerals and in conjunction with visitation by external partners. These features served to memorialize a person and a lineage group, to ensure verbal agreements made during visitations, and cumulatively they marked a resource territory associated with a local identity group. Experiments with early animal traction and portable dwellings enhanced an existing mobility ethic already deeply embedded in hunter-gatherer lifeways that translated quite well in support of the seasonal mobility needed for pastoralism. As a combined dynamic, we suggest that these factors generated a social, cultural, and technological setting in which more intensive pastoralism developed and flourished.

Both proposed hypotheses for the rise of East Asian pastoralism described here view this transition as a long-term process involving a complex continuum of subsistence and lifeways progressively modified by discovery, technical innovation, and experimentation. The human niche is primarily a cultural and social niche and simple ecological models for explaining the transfer and adoption of herd animals fail to capture the singular dynamic of this complicated and diachronic process. In Mongolia, the earliest introduction of herd animals may or may not have been the start of this major transformation because ultimately their migration into the greater region explains little. The two models presented above both focus on a mix of processes including migration, diffusion, and gradual learning, all of which played out differently at variable scales and rates across Mongolia. These processes were not dependent on ecology as much as on unique human-animal relationships and social configurations that embedded human relationships within the sphere of human-animal relations. As such, Mongolian pastoralism did not arise from the mere presence of herd animals or a simple change in climate. Rather, this unique and sophisticated steppe adaptation arose from novel social bonds among human beings that increasingly referenced and depended upon new animal communities of domesticated sheep, goat, cattle, horses, and camels.

Funding

This work was supported in part by grants from the U.S. National Endowment for the Humanities [Grant RZ-249831-16], the Wenner-Gren Foundation, and the U.S. National Science Foundation [NSF-1737687, NSF-1822559].

Declaration of Competing Interest

The authors declare no conflicts of interest.

Acknowledgements

This study was made possible by the contributions and assistance of many experts across the globe. These include A.R. Nelson, D.

Bukhchuluun, A. Cameron, C. Carolus, A.D. Tsybiktarov, D. Tumen, G. Galdan, B. Batdalai, T. Hashbat, S. Pleuger, E. Jacobson, T. Hermes, L. Janz, A. Womack, J. Honeychurch, and C. Makarewicz. We thank these colleagues for their opinions, suggestions, and especially for helping to obtain information and publications. We also would like to recognize the exceptional work of Alex Cherkinsky at the University of Georgia CAIS who produced our AMS dates and isotopic results. This project would not have been possible without the generous collaboration of the Institute of Archeology, Mongolian Academy of Sciences. We express our gratitude to the families of Altan Sandal and Shatar Chuluu whose hospitality and local knowledge helped us immensely. Thanks are also due to the two anonymous reviewers whose comments were helpful and much appreciated.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ara.2021.100264.

References

Aldarmonkh, P., 2016. Afanes'evyn soel bulsh. In: Eregzen, G. (Ed.), Mongolyn ertnii bulsh orshuulga. Tuukh, Arkheologiin khureelen, Ulaanbaatar, pp. 31–35.
Allentoft, M.E., Sikora, M., Sjögren, K.-G., Rasmussen, S., Rasmussen, M., Stenderup, J., Damgaard, P.B., Schroeder, H., Ahlström, T., Vinner, L., Malaspinas, A.-S., Margaryan, A., Higham, T., Chivall, D., Lynnerup, N., Harvig, L., Baron, J., Casa, P. D., Dabrowski, P., Duffy, P.R., Ebel, A.V., Epimakhov, A., Frei, K., Furmanek, M., Gralak, T., Gromov, A., Gronkiewicz, S., Grupe, G., Hajdu, T., Jarysz, R., Khartanovich, V., Khokhlov, A., Kiss, V., Kolár, J., Kriiska, A., Lasak, I., Longhi, C., McGlynn, G., Merkevicius, A., Merkyte, I., Metspalu, M., Mkrtchyan, R., Moiseyev, V., Paja, L., Pálfi, G., Pokutta, D., Pospieszny, Ł., Price, T.D., Saag, L., Sablin, M., Shishlina, N., Smrčka, V., Soenov, V.I., Szeverényi, V., Tóth, G., Trifanova, S.V., Varul, L., Vicze, M., Yepiskoposyan, L., Zhitenev, V., Orlando, L., Sicheritz-Pontén, T., Brunak, S., Nielsen, R., Kristiansen, K., Willerslev, E., 2015. Population genomics of bronze age Eurasia. Nature 522, 167–172.
Amartuvshin, Ch., Ochir, A., Torbat, T.S., 2020. Turuulge n' kharuulsan orshuulgat bulsh. In: Arkheologiin sudalgaa: Mongolchuudyn garal, ugsaa-soelyn khogjil. Institute of Archaeology, Ulaanbaatar, pp. 22–51.
Ambrose, S.H., 1993. Isotopic analysis of paleodiets: Methodological and interpretive considerations. In: Sandford, M. (Ed.), Investigations of Ancient Human Tissue: Chemical Analyses in Anthropology. Gordon and Breach Science Publishers, Langhorne, pp. 59–113.
Anthony, D., 2007. The Horse, the Wheel, and Language. Princeton University Press, Princeton.
Anthony, D., Brown, D., 2011. The secondary products revolution, horse-riding, and mounted warfare. J. World Prehist. 24, 131–160.
Avanesova, N.A., 2012. Sviatilishe rannikh nomadov Zaravshana. In: Stepanova, N.F. (Ed.), Afanas'evskii sbornik 2. Azbuka, Barnaul, pp. 8–27.
Bae, I., Burenjargal, S., Kang, K.-H., Yang, C.-J., Kong, I.-K., 2002. Traditional dairy products by lactic acid Bacteria in Mongolia. Korean J Food Sci. Ani. Resour. 22 (2), 183–191.
Bayarsaikhan, J., Houle, J.-L., Seitsonen, O., Bayandelger, Ch., Eguez, N., 2019. Mongol-Amerikiin khamtarsan "Baruun Mongol" tusliin 2018 ony kheeriin sudalgaany tovch ur dun. Mongol. Arkheol. 49–52.
Betts, A., Jia, P., Abuduresule, I., 2019. A new hypothesis for early bronze age cultural diversity in Xinjiang, China. Archaeol. Res. Asia 17, 204–213.
Brunson, K., Ren, L., Zhao, X., Dong, X., Wang, H., Zhou, J., Flad, R., 2020. Zooarchaeology, ancient mtDNA, and radiocarbon dating provide new evidence for the emergence of domestic cattle and caprines in the Tao River valley of Gansu Province, Northwest China. J. Archaeol. Sci.Rep. https://doi.org/10.1016/j.jasrep.2020.102262.
Burentogtokh, J., 2017. Pastoralists, Communities, and Monumentality During the Mongolian Bronze Age. Yale University unpublished PhD dissertation.
Burentogtokh, J., Honeychurch, W., Gardner, W., 2019. Complexity as integration: pastoral mobility and community building in ancient Mongolia. Soc. Evol. Hist. 18/2, 54–71.
Chuluun, T., Tieszen, L.L., Ojima, D., 1999. Land use impact on C4 plant cover of temperate East Asian grasslands. In: NIES Workshop on Information Bases and Modeling for Land-use and Land-cover Changes Studies in East Asia. Center for Global Environmental Research, pp. 103–109.
Cieslak, M., 2011. Coat Colours and Mitochondrial Lineages of Ancient Horses to Document Domestication. Der Freien Universität Berlin unpublished PhD dissertation.
DeFrance, S., 2009. Zooarchaeology in complex societies: political economy, status, and ideology. i 17/2, 105–168.
DeNiro, M., Epstein, S., 1981. Influence of diet on the distribution of nitrogen isotopes in animals. Geochim. Cosmochim. Acta 45, 341–351.
Derevianko, A.P., Molodin, V.I., 1994. Denisova Peshera. Nauka, Novosibrisk.
Erdenebaatar, D., 2002. Mongol nutgiin dorvoljin bulsh, khirigsuuriin soel. Mongolian Academy of Sciences, Ulaanbaatar.
Erdenebaatar, D., Kovalev, A.A., 2007. Mongol Altain bus nutgiin arkheologiin soeluud. Mongolian J. Anthropol. Archaeol. Ethnol. 3 (287), 35–50.
Fenner, J., Tumen, D., Khatanbaatar, D., 2014. Food fit for a khan: stable isotope analysis of the elite Mongol empire cemetery at Tavan Tolgoi, Mongolia. J. Archaeol. Sci. 46, 231–244.
Frachetti, M., 2012. Multiregional emergence of mobile pastoralism and nonuniform institutional complexity across Eurasia. Curr. Anthropol. 53, 2–38.
Frachetti, M., Rouse, L., 2012. Central Asia, the steppe, and the near east, 2500-1500 BC. In: Potts, D. (Ed.), A Companion to the Archaeology of the Ancient near East, vol. 2. Wiley-Blackwell, New Jersey, pp. 687–705.
Gardner, W., Burentogtokh, J., 2018. Mobile domiciles of the Eurasian steppe: archaeological evidence of possible dwelling space during the early Iron age. J. Field Archaeol. 43/5, 345–361.
Görsdorf, J., Parzinger, H., Nagler, A., 2001. New radiocarbon dates of the north Asian steppe zone and its consequences for the chronology. Radiocarbon 43 (2B), 1115–1120.
Gryaznov, M.P., 1999. Afanas'evskaia kul'tura na Yenisee. Dmitrii Bulanin, St Petersburg.
Heaton, T., Vogel, J., von la Chevallerie, G., Collett, G., 1986. Climatic influence on the isotopic composition of bone nitrogen. Nature 322, 822–823.
Hermes, T., Frachetti, M., Doumani-Dupuy, P., Mar'yashev, A., Nebel, A., Makarewicz, C., 2019. Early integration of pastoralism and millet cultivation in Bronze Age Eurasia. Proc. R. Soc. B. https://doi.org/10.1098/rspb.2019.1273.
Hermes, T., Tishkin, A., Kosintsev, P., Stepanova, N., Krause-Kyora, B., Makarewicz, C., 2020. Mitochondrial DNA of domesticated sheep confirms pastoralist component of Afanasievo subsistence economy in the Altai Mountains (3300-2900 cal BC). Archaeol. Res. Asia. https://doi.org/10.1016/j.ara.2020.100232.
Hermes, T., Shnaider, S.V., Semibratov, V.P., Kungurov, A.L., Tishkin, A.A., 2021. Revisiting the transition from hunting and gathering to pastoralism in the Altai Mountains. Archaeol. Res. Asia. In press.
Hollard, C., Zvénigorosky, V., Kovalev, A., Kiryushin, Iu., Tishkin, A., Lazaretov, I., Crubezy, E., Ludes, B., Keyser, C., 2018. New genetic evidence of afffinities and discontinuities between bronze age Siberian populations. Am. J. Phys. Anthropol. 167, 97–107.
Honeychurch, W., 2014. Alternative complexities: the archaeology of pastoral nomadic states. J. Archaeol. Rev. 22/4, 277–326.
Honeychurch, W., 2015. Inner Asia and the Spatial Politics of Empire: Archaeology, Mobility, and Culture Contact. Springer Publications, New York.
Honeychurch, W., 2017. The development of cultural and social complexity in Mongolia. In: Habu, J., Lape, P., Olsen, J. (Eds.), Handbook of East and Southeast Asian Archaeology. Springer Publications, New York, pp. 513–532.
Honeychurch, W., Makarewicz, C., 2016. The archaeology of pastoral nomadism. Annu. Rev. Anthropol. 45, 341–359.
Houle, J.-L., 2009. Socially integrative facilities and the emergence of societal complexity on the Mongolian steppe. In: Hanks, B., Linduff, K. (Eds.), Monuments, Metals, and Mobility: Trajectories of Complexity in the Late Prehistory of the Eurasian Steppe. Cambridge University Press, Cambridge, pp. 358–377.
Hrivnyak, M., Eng, J.T., 2020. Environmental dynamics and stable isotopic signatures in early inner Asian steppe communities. In: Robbins Schug, G. (Ed.), The Routledge Handbook of the Bioarchaeology of Environmental Change. Routledge, London, pp. 473–492.
Jaang, L., 2015. The landscape of China's participation in the bronze age Eurasian network. J. World Prehist. 28, 179–213.
Jaang, L., Sun, Z., Shao, J., Li, M., 2018. When peripheries were centres: a preliminary study of the Shimao-centred polity in the loess highland, China. Antiquity 92 (364), 1008–1022.
Jacobson, E., 2015. The Hunter, the Stag, and the Mother of Animals. New York, Oxford.
Janz, L., 2016. Fragmented landscapes and economies of abundance: the broad Spectrum revolution in arid East Asia. Curr. Anthropol. 57/5, 537–564.
Janz, L., Odsuren, D., Bukchuluun, D., 2017. Transitions in palaeoecology and technology, hunter-gatherers and early herders in the Gobi Desert. J. World Prehist. 30 (1), 1–81.
Janz, L., Cameron, A., Bukhchuluun, D., Odsuren, D., Dubreuil, L., 2020. Expanding frontier and building the sphere in arid East Asia. Quat. Int. https://doi.org/10.1016/j.quaint.2020.04.041.
Jeong, C., Wilkin, S., Amgalantugs, T., Bouwman, A.S., Taylor, W.T.T., Hagan, R.W., Bromage, S., Tsolmon, S., Trachsel, C., Grossmann, J., Littleton, J., Makarewicz, C. A., Krigbaum, J., Burri, M., Scott, A., Davaasambuu, G., Wright, J., Irmer, F., Myagmar, E., Boivin, N., Robbeets, M., Rühli, F.J., Krause, J., Frohlich, B., Hendy, J., Warinner, C., 2018. Bronze age population dynamics and the rise of dairy pastoralism on the eastern Eurasian steppe. Proc. Natl. Acad. Sci. 115, E11248–E11255. https://doi.org/10.1073/pnas.1813608115.
Jeong, C., Wang, K., Wilkin, S., Taylor, W.T.T., Miller, B.K., Ulziibayar, S., Stahl, R., Chiovelli, C., Bemmann, J.H., Knolle, F., Kradin, N., Bazarov, B.A., Miyagashev, D. A., Konovalov, P.B., Zhambaltarova, E., Miller, A.V., Haak, W., Schiffels, S., Krause, J., Boivin, N., Myagmar, E., Hendy, J., Warinner, C., 2020. A dynamic 6,000-year genetic history of Eurasia's eastern steppe. Cell 183 (4), 890–904. https://doi.org/10.1016/j.cell.2020.10.015.
Juras, A., Krzewińska, M., Nikitin, A.G., Ehler, E., Chyleński, M., Łukasik, S., Krenz-Niedbała, M., Sinika, V., Piontek, J., Ivanova, S., Dabert, M., Götherström, A., 2017. Diverse origin of mitochondrial lineages in Iron age Black Sea Scythians. Nat. Sci. Rep. 7, 43950.
Katzenberg, M., 2000. Stable isotope analysis: A tool for studying past diet, demography and life history. In: Katzenberg, M., Saunders, S. (Eds.), Biological Anthropology of the Human Skeleton. Wiley-Liss, New York, pp. 305–327.

Khavrin, S.V., 2010. Drevneishii metall Gorno Altaia. In: Stepanova, N.F., Poliakov, A.V. (Eds.), Afanas'evskii sbornik. Azbuka, Barnaul, pp. 187–189.
Kiryushin, Iu.F., Kiryushin, K.Iu., 2005. K voprosu o roli neoliticheskogo komponenta v slozhenii afanas'evskoi kul'tury Gornogo Altaia. In: Korol, G.G. (Ed.), Arkheologiia iuzhnoi Sibiri: Idei, metody, otkrytiia. RIO KGPU, Krasnoiaarsk, pp. 26–28.
Kiselev, S., 1951. Drevniaia istoriia Iuzhnoi Sibiri. Nauka, Moscow.
Klinge, M., Sauer, D., 2019. Spatial pattern of late glacial and Holocene climatic and environmental development in western Mongolia - a critical review and synthesis. Quat. Sci. Rev. 210, 26–50.
Kosintsev, P.A., 2005. Fauna poseleniia Nizhniaia Sooru. In: Larin, O.V. (Ed.), Afanas'evskaia Kul'tura Gornogo Altaya: Mogil'nik Sal'diar-1. Izdatel'stvo Altaiskogo gosudarstvennogo universiteta, Barnaul, pp. 160–167.
Kosintsev, P.A., Stepanova, N.F., 2010. Fauna Afanas'evskogo poseleniia Malyi Dugan. In: Stepanova, N.F., Poliakov, A.V. (Eds.), Afanas'evskii sbornik. Azbuka, Barnaul, pp. 121–129.
Kovalev, A.A., 2017. Afanas'evskaia kul'tura v Sin'tsziane. Kratkie Soobsh. Inst. Arkheol. 247, 245–266.
Kovalev, A.A., Erdenebaatar, D., 2010. Afanas'evsko-Chemurchekskaia kurgannaia gruppa Kurgak gobi (Khuurai gobi) i voprosy vneshnikh sviazei afanas'evskoi kul'tury. In: Stepanova, N.F., Poliakov, A.V. (Eds.), Afanas'evskii sbornik. Azbuka, Barnaul, pp. 91–108.
Krasnienko, S.V., 2010. Formirovanie arkheologicheskoi karta afanas'evskoi kul'tury na Yenisee. In: Stepanova, N.F., Poliakov, A.V. (Eds.), Afanas'evskii sbornik. Azbuka, Barnaul, pp. 129–133.
Kuznetsov, P., Mochalov, O., 2017. Radiocarbon dating of pottery from bronze age sites in eastern European steppes (Russia). Radiocarbon 59 (1), 109–116.
Larin, O.V., Kungurova, N.Iu, Stepanova, N.F., 2005. Poselenie afanas'evskoi kul'tury Nizhniaia Sooru. In: Larin, O.V. (Ed.), Afanas'evskaia Kul'tura Gornogo Altaya: Mogil'nik Sal'diar-1. Izdatel'stvo Altaiskogo gosudarstvennogo universiteta, Barnaul, pp. 199–204.
Lee-thorp, J.A., 2008. On isotopes and old bones. Archaeometry 50, 925–950.
Lowry, K.B., 2020. Tracing a Transition: The Political Economy of Bronze and Iron Age Mongolia. University of Chicago, unpublished PhD dissertation.
Ludwig, A., Pruvost, M., Reissmann, M., Benecke, N., Brockmann, G., Castaños, P., Cieslak, M., Lippold, S., Llorente, L., Malaspinas, A., Slatkin, M., Hofreiter, M., 2009. Coat color variation at the beginning of horse domestication. Science 324, 485.
Machicek, M., 2011. Reconstructing Diet, Health, and Activity Patterns in Early Nomadic Pastoralist Communities of Inner Asia. University of Sheffield, unpublished PhD dissertation.
Malyarchuk, B., Derenko, M., Grzybowski, T., Perkova, M., Rogalla, U., Vanecek, T., Tsybovsky, I., 2010. The peopling of Europe from the mitochondrial haplogroup U5 perspective. PLoS One 5/4, e10285. https://doi.org/10.1371/journal.pone.0010285.
Merts, I.V., 2014. Pamiatniki afanas'evskogo tipa Bostochnogo Kazakhstana. In: Vadetskaia, E.B., Poliakov, A.V., Stepanova, N.F. (Eds.), Svod pamiatnikov afanas'evskoi kul'tury. Azbuka, Barnaul, pp. 369–372.
Merts, V.K., Merts, I.V., 2010. Pogrebeniia "iamnogo" tipa Bostochnogo Kazakhstana i Severo-Bostochnogo Kazakhstana (k postanovke problemy). In: Stepanova, N.F., Poliakov, A.V. (Eds.), Afanas'evskii sbornik. Azbuka, Barnaul, pp. 134–142.
Minagawa, M., Wada, E., 1984. Stepwise enrichment of 15N along food chains: further evidence and the relation between δ15N and animal age. Geochim. Cosmochim. Acta 48, 1135–1140.
Molodin, V.I., 2001. Bronzeit im Berg-Altai. Eurasia antiqua: Zeitsch. Archäol. Eurasiens 7, 1–51.
Molodin, V.I., Alkin, S.V., 2012. Pamiatniki afanas'evskogo vremeni na severo-zapade Kitaia (Sin'tszian). In: Stepanova, N.F. (Ed.), Afanas'evskii sbornik 2. Azbuka, Barnaul, pp. 149–154.
Morand, S., McIntyre, K.M., Baylis, M., 2014. Domesticated animals and human infectious diseases of zoonotic origins: domestication time matters. Infect. Genet. Evol. 24, 76–81.
Morgunova, N.L., 2014. O kharaktere kul'turnogo vzaimodeistviia naseleniia iamnoi kul'tury stepnogo Volgo-Ural'ia i afanas'evskoi kul'tury Altae-Saianskogo regiona. Bestnik Arkheol. Antropol. Etnogr. 26/3, 4–13.
Morgunova, N.L., Khokhlova, O.S., 2013. Chronology and periodization of the pit-grave culture in the region between the Volga and Ural Rivers based on radiocarbon dating and paleopedological research. Radiocarbon 55 (2–3), 1286–1296.
Narasimhan, V.M., Patterson, N., Moorjani, P., Rohland, N., Bernardos, R., Mallick, S., Lazaridis, I., Nakatsuka, N., Olalde, I., Lipson, M., Kim, A.M., Olivieri, L.M., Coppa, A., Vidale, M., Mallory, J., Moiseyev, V., Kitov, E., Monge, J., Adamski, N., Alex, N., Broomandkhoshbacht, N., Candilio, F., Callan, K., Cheronet, O., Culleton, B.J., Ferry, M., Fernandes, D., Freilich, S., Gamarra, B., Gaudio, D., Hajdinjak, M., Harney, É., Harper, T.K., Keating, D., Lawson, A.M., Mah, M., Mandl, K., Michel, M., Novak, M., Oppenheimer, J., Rai, N., Sirak, K., Slon, V., Stewardson, K., Zalzala, F., Zhang, Z., Akhatov, G., Bagashev, A.N., Bagnera, A., Baitanayev, B., Bendezu-Sarmiento, J., Bissembaev, A.A., Bonora, G.L., Chargynov, T.T., Chikisheva, T., Dashkovskiy, P.K., Derevianko, A., Dobeš, M., Douka, K., Dubova, N., Duisengali, M.N., Enshin, D., Epimakhov, A., Fribus, A.V., Fuller, D., Goryachev, A., Gromov, A., Grushin, S.P., Hanks, B., Judd, M., Kazizov, E., Khokhlov, A., Krygin, A.P., Kupriyanova, E., Kuznetsov, P., Luiselli, D., Maksudov, F., Mamedov, A.M., Mamirov, T.B., Meiklejohn, C., Merrett, D.C., Micheli, R., Mochalov, O., Mustafokulov, S., Nayak, A., Pettener, D., Potts, R., Razhev, D., Rykun, M., Sarno, S., Savenkova, T.M., Sikhymbaeva, K., Slepchenko, S.M., Soltobaev, O.A., Stepanova, N., Svyatko, S., Tabaldiev, K., Teschler-Nicola, M., Tishkin, A.A., Tkachev, V.V., Vasilyev, S., Velemínský, P., Voyakin, D., Yermolayeva, A., Zahir, M., Zubkov, V.S., Zubova, A., Shinde, V.S., Lalueza-Fox, C., Meyer, M., Anthony, D., Boivin, N., Thangaraj, K., Kennett, D.J., Frachetti, M., Pinhasi, R., Reich, D., 2019. The formation of human populations in south and Central Asia. Science 365, eaat7487. Doi:https://doi.org/10.1126/science.aat7487.
Nikitin, A.G., Ivanova, S., Kiosak, D., Badgerow, J., Pashnick, J., 2017. Subdivisions of haplogroups U and C encompass mitochondrial DNA lineages of Eneolithic–early bronze age kurgan populations of western north Pontic steppe. J. Hum. Genet. 62, 605–613.
Novgorodova, E.A., 1989. Drevniaia Mongoliia. Nauka, Moscow.
Pate, F.D., 1994. Bone chemistry and paleodiet. J. Archaeol. Method Th. 1, 161–209.
Poliakov, A.V., Svyatko, S., Stepanova, N.F., 2019. A review of the radiocarbon dates for the Afanasyevo culture (Central Asia): shifting towards the "shorter" chronology. Radiocarbon 61 (1), 243–263.
Pyankov, V.I., Gunin, P.D., Tsoog, S., Black, C., 2000. C4 plants in the vegetation of Mongolia: their natural occurrence and geographical distribution in relation to climate. Oecologia 123, 15–31.
Rogers, L., 2016. Understanding ancient human population genetics of the eastern Eurasian Steppe through mitochondrial DNA analysis: Central Mongolian samples from the Neolithic, Bronze Age, Iron Age and Mongol Empire periods. Indiana University unpublished PhD dissertation.
Rogers, L., 2018. Communications of Sequencing Results for Ancient Mongolian Domesticates. Unpublished report on file at the Dept. of Anthropology. Yale University.
Rogers, L., Honeychurch, W., Amartuvshin, Ch., Kaestle, F., 2019. U5a1 mitochondrial DNA haplotype identified in Eneolithic skeleton from Shatar Chuluu, Mongolia. Hum. Biol. 91/4 https://doi.org/10.13110/humanbiology.91.4.01.
Rosen, A., Hart, T., Farquhar, J., Schneider, J., Yadmaa, Ts, 2019. Holocene vegetation cycles, land-use, and human adaptations to desertification in the Gobi Desert of Mongolia. Veg. Hist. Archaeobotany 28, 295–309.
Russell, T., 2017. 'Where goats connect people': cultural diffusion of livestock not food production amongst southern African hunter-gatherers during the later stone age. J. Soc. Archaeol. 17, 115–137.
Schwarcz, H.P., Schoeninger, M.J., 2012. Stable isotopes of carbon and nitrogen as tracers for paleo-diet reconstruction. In: Handbook of Environmental Isotope Geochemistry. Springer, Berlin and Heidelberg, pp. 725–742.
Schwarcz, H.P., Dupras, T.L., Fairgrieve, S.I., 1999. 15N enrichment in the Sahara: in search of a global relationship. J. Archaeol. Sci. 26, 629–636.
Sealy, J.C., Van Der Merwe, N.J., Thorp, J., Lanham, J.L., 1987. Nitrogen isotopic ecology in southern Africa: implications for environmental and dietary tracing. Geochim. Cosmochim. Acta 51, 2707–2717.
Segurel, L., Guarino-Vignon, P., Marchi, N., Lafosse, S., Laurent, R., Céline Bon, C., Fabre, A., Hegay, T., Heyer, E., 2020. Why and when was lactase persistence selected for? Insights from central Asian herders and ancient DNA. PLoS Biol. 18/6 https://doi.org/10.1371/journal.pbio.3000742.
Semenov, Vl.A., 2012. Pannekeramicheskie sotsiumy Tuvy i ikh sootnoshenie c afanas'evskoi kul'turoi. In: Stepanova, N.F. (Ed.), Afanas'evskii sbornik 2. Azbuka, Barnaul, pp. 155–165.
Semenov, Vl.A., 2018. Toora-Dash: Mnogosloinaia stoianka na Yenisee v Tuve. IIMK RAN and Neva Book Printing House, St. Petersburg.
Shishlina, N., Sevastyanov, V., Zazovskaya, E., van der Plicht, J., 2014. Reservoir effect of archaeological samples from steppe bronze age cultures in southern Russia. Radiocarbon 56 (2), 767–778.
Shul'ga, P.I., 2012. O khoziaistve afanas'evtsev Gornogo Altaia. In: Stepanova, N.F. (Ed.), Afanas'evskii sbornik 2. Azbuka, Barnaul, pp. 204–209.
Stepanova, N.F., 2015. K kharakteristike inventaria iz afanas'evskikh pogrebal'nykh kompleksov (Gornyi Altai). In: Tishkin, A.A. (Ed.), Arkheologiia Zapadnoi Sibiri i Altaiia: Opyt mezhdistsiplinarnykh issledovanii. Izdatel'stvo Altaiskogo gosudarstvennogo universiteta, Barnaul, pp. 178–183.
Stepanova, N.F., Poliakov, A.V., 2010. Afanas'evskaia kul'tura: Istoriia izucheniia i sovremennoe sostoianie. In: Stepanova, N.F., Poliakov, A.V. (Eds.), Afanas'evskii sbornik. Azbuka, Barnaul, pp. 4–15.
Svyatko, S., Mallory, J., Murphy, E., Polyakov, A., Reimer, P., Schulting, R., 2009. New radiocarbon dates and a review of the chronology of prehistoric populations from the Minusinsk Basin, southern Siberia, Russia. Radiocarbon 51, 243–273.
Svyatko, S., Schulting, R., Mallory, J., Murphy, E., Reimer, P., Khartanovich, V.I., Chistov, Yu.K., Sablin, M.V., 2013. Stable isotope dietary analysis of prehistoric populations from the Minusinsk Basin, Southern Siberia, Russia: A new chronological framework for the introduction of millet to the eastern Eurasian steppe. J. Archaeol. Sci. 40, 3936–3945.
Svyatko, S., Polyakov, A.V., Soenov, V.I., Stepanova, N.F., Reimer, P., Ogle, N., Tyurina, E.A., Grushin, S.P., Rykun, M.P., 2017. Stable isotope palaeodietary analysis of the early bronze age Afanasyevo culture in the Altai Mountains, southern Siberia. J. Archaeol. Sci. Rep. 14, 65–75.
Tarasov, P.E., Demske, D., Leipe, C., Long, T., Müller, S., Hoelzmann, P., Wagner, M., 2019. An 8500-year palynological record of vegetation, climate change and human activity in the Bosten Lake region of Northwest China. Palaeogeogr. Palaeoclimatol. Palaeoecol. 516, 166–178.
Taylor, W., 2017. Horse demography and use in bronze age Mongolia. Quat. Int. 436, 270–282.
Taylor, W., Bayarsaikhan, J., Tuvshinjargal, T., Bender, S., Tromp, M., Clark, J., Lowry, K., Houle, J.-L., Staszewski, D., Whitworth, J., Fitzhugh, W., Boivin, N., 2018. Origins of equine dentistry. P. Natl. Acad. Sci. 115, 6707–6715.
Taylor, W., Wilkin, S., Wright, J., Dee, M., Erdene, M., Clark, J., Tuvshinjargal, T., Bayarsaikhan, J., Fitzhugh, W., Boivin, N., 2019. Radiocarbon dating and cultural dynamics across Mongolia's early pastoral transition. PLoS One 14/11, e0224241. https://doi.org/10.1371/journal.pone.0224241.

Taylor, W., Clark, J., Bayarsaikhan, J., Tuvshinjargal, T., Jobe, J.T., Fitzhugh, W., Kortum, R., Spengler, R.N., Shnaider, S., Seersholm, F.V., 2020. Early pastoral economies and herding transitions in eastern Eurasia. Sci. Rep. 10, 1–15.

Tseveendorj, D., 1975. 1975 ony 7, 8-r saruudad MZTSKhE-iin bureldekhuund oroltsoj Bayankhongor, Arkhangai, Khovsgol aimguudad ajillasan tukhai tovch tailan. Unpublished report on file at the Mongolian Institute of Archaeology, Ulaanbaatar.

Tsybiktarov, A., 2006. Tsentral'naia Aziia na zare bronzovogo veka. Izdatel'stvo Buriatskogo gosudarstvennogo universiteta, Ulan-Ude.

Tsybiktarov, A.D., 2002. Mogil'niki afanas'evskogo tipa Mongolii i Tuvy (Voprosy kul'turnoi prinadlezhnosti i datirovki). In: Konstantinova, M.V., Tsybiktarov, A.D. (Eds.), Tsentral'naia Aziia i Pribaikal'e v drevnosti. Izdatel'stvo Buriatskogo gosudarstvennogo universiteta, Ulan-Ude, Chita, pp. 42–52.

Tumen, D., 1985. Paleoantropologicheskaia Nakhodka gory Shatar-Chulu. Arkheol. sudlal 7, 23–31.

Tur, S.S., Rykun, M.P., 2014. Travmaticheskie povrezhdeniia v paleoantropologicheskikh kollektsiiakh afanas'evskoi kul'tury Gornogo Altaia. In: Vadetskaia, E.B., Poliakov, A.V., Stepanova, N.F. (Eds.), Svod pamiatnikov afanas'evskoi kul'tury. Azbuka, Barnaul, pp. 373–375.

Vadetskaia, E.B., Poliakov, A.V., Stepanova, N.F., 2014. Svod pamiatnikov afanas'evskoi kul'tury. Azbuka, Barnaul.

Ventresca-Miller, A., Makarewicz, C., 2019. Intensification in pastoralist cereal use coincides with the expansion of trans-regional networks in the Eurasian steppe. Sci. Rep. 9, 8363.

Volkov, V.V., 1980. Kurgany afanas'evskogo tipa v Mongolii. Arkheol. sudlal 9, 13–16.

Wang, C.C., Yeh, H.Y., Popov, A.N., Zhang, H.Q., Matsumura, H., Sirak, K., Cheronet, O., Kovalev, A., Rohland, N., Kim, A.M., Bernardos, R., Tumen, D., Zhao, J., Liu, Y.C., Liu, J.Y., Mah, M., Mallick, S., Wang, K., Zhang, Z., Adamski, N., Broomandkhoshbacht, N., Callan, K., Culleton, B.J., Eccles, L., Lawson, A.M., Michel, M., Oppenheimer, J., Stewardson, K., Wen, S.Q., Yan, S., Zalzala, F., Chuang, R., Huang, C.J., Shiung, C.C., Nikitin, Y.G., Tabarev, A.V., Tishkin, A.A., Lin, S., Sun, Z.Y., Wu, X.M., Yang, T.L., Hu, X., Chen, L., Du, H., Bayarsaikhan, J., Mijiddorj, E., Erdenebaatar, D., Iderkhangai, T.O., Myagmar, E., Kanzawa-Kiriyama, H., Nishino, M., Shinoda, K., Shubina, O.A., Guo, J.X., Deng, Q.Y., Kang, L. L., Li, D.W., Li, D.N., Lin, R., Cai, W.W., Shrestha, R., Wang, L.X., Wei, L.H., Xie, G. M., Yao, H.B., Zhang, M.F., He, G.L., Yang, X.M., Hu, R., Robbeets, M., Schiffels, S., Kennett, D.J., Jin, L., Li, H., Krause, J., Pinhasi, R., Reich, D., 2020. The genomic formation of human populations in East Asia. BioRxiv. https://doi.org/10.1101/2020.03.25.004606.

Wen, C., 2012. Neimenggu Alashan diqu shiqian wenhua yanjiu. Beijing University unpublished Master's thesis.

Wilkin, S., Miller, A.V., Taylor, W., Miller, B., Hagan, R.W., Bleasdale, M., Scott, A., Gankhuyg, S., Ramsøe, A., Uliziibayar, S., Trachsel, C., Nanni, P., Grossmann, J., Orlando, L., Horton, M., Stockhammer, P.W., Myagmar, E., Boivin, N., Warinner, C., Hendy, J., 2020a. Dairy pastoralism sustained eastern Eurasian steppe populations for 5,000 years. Nat. Ecol. Evol. 4, 346–355. https://doi.org/10.1038/s41559-020-1120-y.

Wilkin, S., Miller, A.V., Miller, B., Spengler, R.N., Taylor, W., Fernandes, R., Hagan, R. W., Bleasdale, M., Zech, J., Ulziibayar, S., 2020b. Economic diversification supported the growth of Mongolia's nomadic empires. Sci. Rep. 10, 1–12.

Wright, J., Ganbaatar, G., Honeychurch, W., Byambatseren, B., Rosen, A., 2019. The earliest bronze age culture of the South-Eastern Gobi Desert, Mongolia. Antiquity 93 (368), 393–411.

Wutke, S., Benecke, N., Sandoval-Castellanos, E., Döhle, H., Friederich, S., Gonzalez, J., Hallsson, J.H., Hofreiter, M., Lõugas, L., Magnell, O., Morales-Muniz, A., Orlando, L., Pálsdóttir, A.H., Reissmann, M., Ruttkay, M., Trinks, A., Ludwig, A., 2016. Spotted phenotypes in horses lost attractiveness in the Middle Ages. Sci. Rep. 6, 38548 https://doi.org/10.1038/srep38548.

Xie, M., Shevchenko, A., Wang, B., Shevchenko, A., Wang, C., Yang, Y., 2016. Identification of a dairy product in the grass woven basket from Gumugou cemetery (3800 BP, northwestern China). Quat. Int. 426, 158–165.

Yang, Y., Shevchenko, A., Knaust, A., Abuduresule, I., Li, W., Hu, X., Shevchenko, A., 2014. Proteomics evidence for kefir dairy in early bronze age China. J. Archaeol. Sci. 45, 178–186.

Yesin, Iu.N., Magail, J., Eruul-Erdene, Ch., Gantulga, J., 2012. K probleme vydeleniia naskal'nogo iskutsva afanas'evskoi kul'tury Mongolii: Novye materialy i podkhody. In: Kul'tury stepnoi Evrazii i ikh vzaimodeistvie s drevnimi tsivilizatsiiami. IIMK RAN, St. Petersburg, pp. 205–211.

Zhou, X., Yu, J., Spengler, R., Shen, H., Zhao, K., Ge, J., Bao, Y., Liu, J., Yang, Q., Chen, G., Jia, P., Li, X., 2020. 5,200-year-old cereal grains from the eastern Altai Mountains redate the trans-Eurasian crop exchange. Nat. Plants 6 (78), 78–87.

Zoljargal, A., 2020. Delgerkhaan uul orchmyn chuluun zevsgiin sudalgaa. National University of Mongolia unpublished Master's thesis.