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Climate change and the expansion of the Scythian culture after 850 BC: a hypothesis

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Abstract

In south-central Siberia archaeological evidence suggests an acceleration of cultural development and an increase in the density of nomadic populations around 850 BC. We hypothesize a relationship with an abrupt climatic shift towards increased humidity caused by a decline of solar activity. Areas that initially may have been hostile semi-deserts changed into attractive steppe landscapes with a high biomass production and high carrying capacity. Newly available steppe areas could be invaded by herbivores, making them attractive for nomadic tribes. The central Asian horse-riding Scythian culture expanded, and an increased population density was a stimulus for westward migration towards southeastern Europe.

Keywords: Carrying capacity; Chronology; Climate change; Eurasia; Migration; Scythian culture; Solar forcing

1. Introduction

Scythian cultures occupied the steppe and forest-steppe zones of Eurasia from northern China to the Danube River during the 1st millennium BC. Most archaeological sites are located between 42° and 55° N and 30° and 100° E (Fig. 1). The origin, evolution, and spread of this nomadic culture is an important issue in archaeology. Absolute radiocarbon dating is increasingly important [1,7,15], but in many cases radiocarbon dates are still lacking, and indirect chronologies based on similarities of artefact styles, seriation and dateable imported artefacts still play an important role. The Scythian history can be subdivided into three phases: a pre-Scythian and initial Scythian phase from the 9th to the middle of the 7th century BC, a second, Early Scythian phase from the 7th to the 6th century BC, and a third phase—the classical Scythian phase—from the 5th to the 3rd century BC. The 'elite' barrow Arzhan-1, located in Tuva, which was discovered in 1971 [18,19], is a key monument of the early Scythian phase in Eurasia, radiocarbon-dated to the 9th–8th century BC. Other elite barrows (Arzhan-2 and those of Tuekta and Pazyryk), also located in the area of the Sayan-Altai Mountains of southern Siberia and central Asia (Tuva Republic), have been dated to the period between the end of the 7th to the middle of the 3rd century BC. On the basis of archaeological data it is evident that a wave of pre-Scythian nomads from the eastern Eurasian steppe zone appeared in the northern Black Sea region during the 9th century BC [21]. The most ancient known Scythian monument in Europe (Steblev group barrows, grave 15, located on the right bank of the Dnieper

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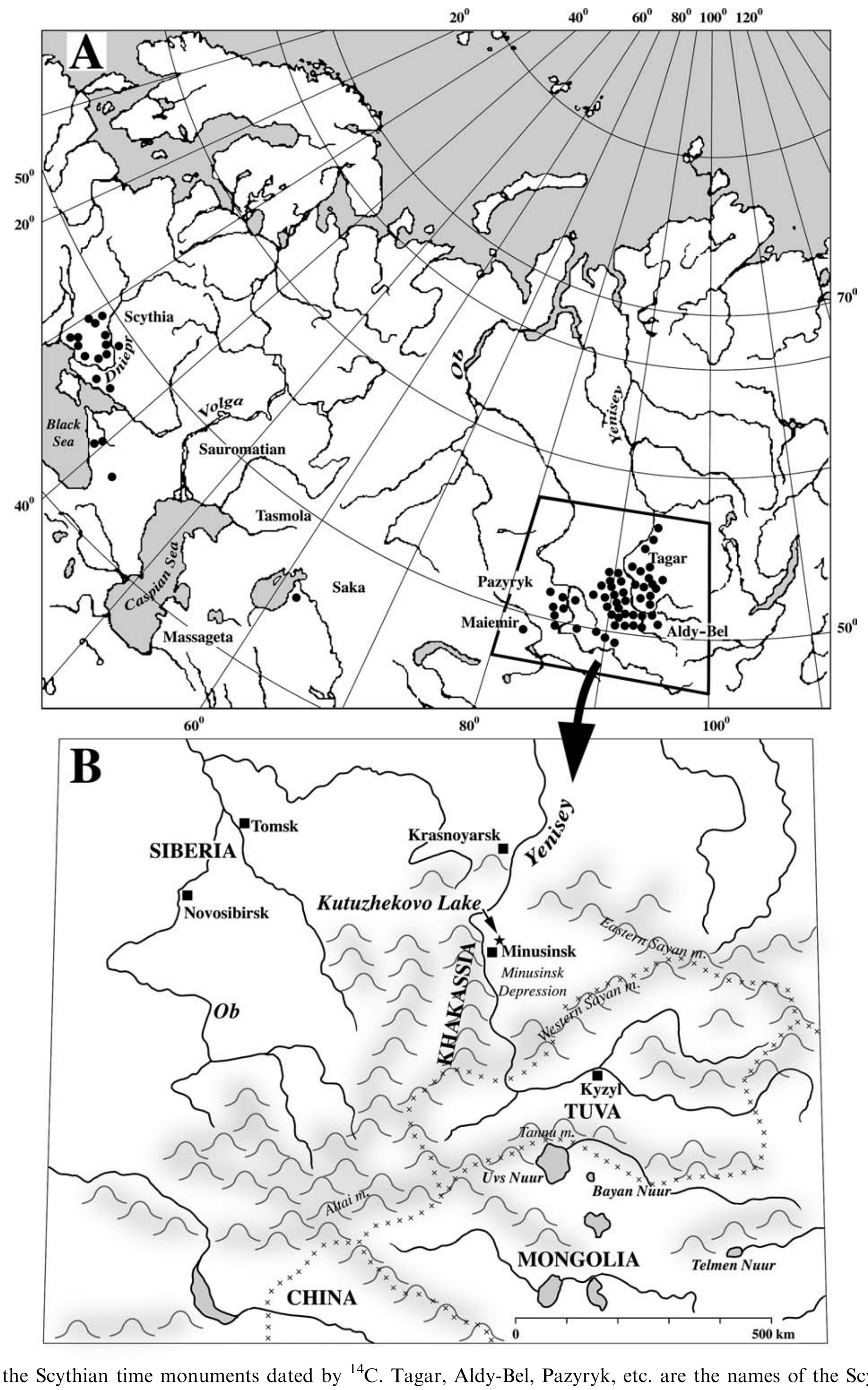

Fig. 1. (A) Map with the Scythian time monuments dated by ^{14}C. Tagar, Aldy-Bel, Pazyryk, etc. are the names of the Scythian time cultures in different parts of Eurasia. (B) Detailed map with various locations mentioned in the text.

River) was dated to the 8th century BC. On the basis of palaeoclimatic studies in Europe, southern Siberia, and Mongolia, we present a hypothesis about a possible climatic cause of the cultural blooming and the expansion of the nomadic Scythian culture, starting during the 9th century BC.

In this paper radiocarbon dates from cited articles are given in radiocarbon years Before Present (BP: before 1950), but high precision dates based on ^{14}C wiggle-matching and dates based on or supported by archaeological/historical links are given in calendar years Before Christ (cal BC).

2. A climatic shift around 850 BC in Eurasia

In northwest Europe a sharp climatic shift during the early 1st millennium BC to cooler, wetter conditions was a prime reason to distinguish the transition between a (warm, dry) Subboreal and a (cool, wet) Subatlantic period [29]. The climatic shift, as reflected in the botanical composition of raised bog deposits, was recently dated precisely to ca. 850 cal BC, and a relationship with reduced solar activity became evident [5,11,12,20]. A possible causal link was hypothesized between the climatic shift and cultural changes (Bronze Age/Iron Age transition) as well as the following sharp increases in human population densities in northwest Europe [9]. This climatic shift was also recorded by raised bog vegetation in central Europe [30] and had strong climatic effects in eastern Europe, including rapid and total flooding of the Upper Volga region [16].

To strengthen our hypothesis it is relevant to examine evidence for abrupt climate change during the 1st millennium BC in southern Siberia and central Asia. The climatic shift in Europe at the Subboreal–Subatlantic transition was characterized by enhanced westerly winds [10] and may have affected central Asia. Lake Telmen, Mongolia, has terraces dated between 2710 and 1260 BP, indicating a greater than present-day effective moisture balance [25]. Reconstructed lake-level fluctuations in lakes Uvs Nuur and Bayan Nuur [17], situated just south of the Russian–Mongolian border and only 100–200 km south of lowlands in Tuva, an area with rich archaeological evidence for the Scythian time cultures (Tagar and Aldy-Bel), show a decline from ca. 5000 BP onwards, indicating a decrease in precipitation. A sudden rise of lake levels, glacial readvances, and solifluction started between 3000 and 2000 BP, pointing to enhanced rainfall and lower temperatures. Pollen analysis of a peat deposit showed wetter climatic conditions since ca. 2500 BP [22], and the vegetation around Bayan Nuur showed a transition from steppe to a temporary forest.

Studies of lake sediments from southern Siberia and the central Asian republics Khakassia and Tuva are in progress [8] (and Dirksen, unpublished data). The pollen record of Kutuzhekovo Lake (southern Siberia, 53° 36′ N, 91° 56′ E) shows the late-Holocene vegetation history (Fig. 2 and Table 1) of the Minusinsk depression, which is surrounded by the Sayan and Khakassian mountains.

Zone KTH-I in predominantly sandy sediments has *Betula* sect. Nanae/Fruticosae (shrub birch), *Artemisia*, and *Cannabis* as dominant taxa, pointing to a dry steppe or even a semi-desert, with open soils and low biomass productivity. The transition from zone KTH-I to zone KTH-II, dated at ca. 2800 BP, is relevant for the discussion in this paper. It reflects large-scale environmental changes. The xerophytic taxa show a strong decrease. Shrub birch is replaced by tree birch (*Betula* sect. Albae), and Cyperaceae show a sharp rise, reflecting a change from dry to humid climate. Pollen of *Triglochin* (not shown in Fig. 2) also appears at the start of zone KTH-II, which supports the idea of less dry conditions and a wetland origin of the cyperaceous pollen.

The vegetation changes coincide with a sedimentation change from sandy to predominantly organic lake deposits, an extra indication for a dense vegetation cover in the catchment of the lake (less erosion), probably combined with high local organic productivity in the lake. We conclude that a climatic shift at the Subboreal–Subatlantic transition to cooler, wetter (less dry) climatic conditions also occurred in southern Siberia and central Asia and the increased precipitation may have changed landscapes with a semi-desert character into steppe, with an enhanced vegetation biomass production, and thus with an increased carrying capacity, which was of vital importance for nomadic people.

3. Cultural developments in southern Siberia and Tuva (central Asia)

Fig. 1A shows the geographical distribution of the Scythian culture in the Eurasian steppe, located between 42° and 55° N and 30° and 100° E. The occupied regions are closely linked to environmental conditions (dry, continental climate with steppe vegetation). Before further discussing environmental aspects, the major cultural developments of central southern Siberia and Tuva are presented (see also Table 2). The archaeological development in the Minusinsk depression (Fig. 1B), including part of Khakassia and part of the Krasnoyarsk province north of the Sayan Mountains, differs from that in Tuva which is situated to the south of those areas. Therefore, the archaeological developments of these areas are discussed separately.

3.1. Central southern Siberia (Minusinsk depression)

After more than 200 years of archaeological research in the Minusinsk depression there is now evidence for a sequence of cultures [32]. The Palaeolithic Aphontovo culture is represented by many sites, but the Mesolithic and Neolithic (8th to 4th millennium BC) are poorly represented [33]. Mesolithic–Neolithic sites are found in the present-day taiga and mountain zones (Eleneva cave, Nyasha, Unyuk, Karasevo, etc.) and not in the steppe zone. Occupation of the steppe started at the end of the Neolithic period. The Afanasievo (4th to 3rd millennium BC) is the first barrow culture of a europeid population and the easternmost one among the stock-breeding cultures of Eurasia. The Bronze Age starts with

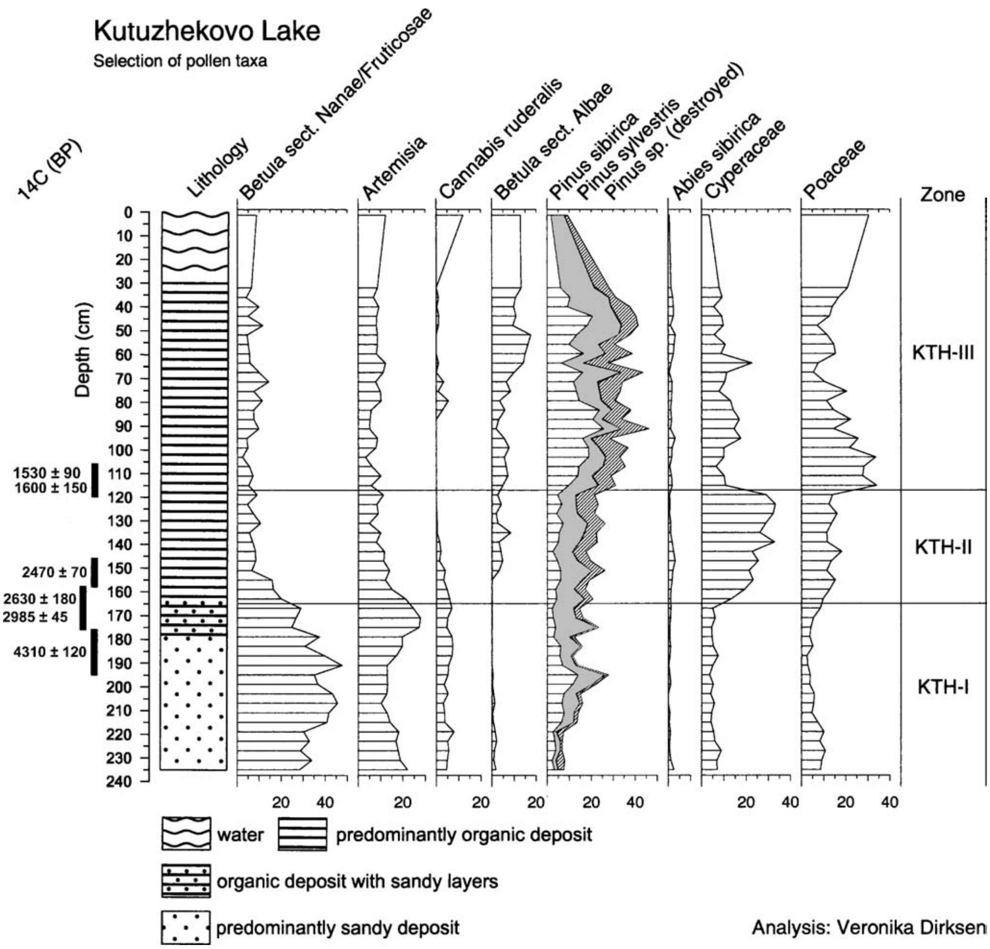

Fig. 2. Pollen diagram (selection of taxa) of a sediment sequence from Kutuzhekovo Lake (for location see Fig. 1B).

the Okunevo culture. The beginning of this culture is dated to the end of the 3rd millennium BC [14]. In spite of some similarities in the material culture of the Afanasievo and the Okunevo cultures, the populations were not genetically connected with each other, because the population of the Okunevo culture had Mongoloid features. Most probably the Okunevo culture originated from Neolithic communities in western Siberia and the forest zone of eastern Siberia.

The northern part of the Minusinsk depression was the southernmost region where the Andronovo culture occurred (Middle Bronze Age; 18th to 14th century BC). Compared to neighbouring territories such as Kazakhstan and western Siberia, a relatively low number of Andronovo sites were found in the Minusinsk depression. It is difficult to explain why the Andronovo population did not move to the southern part of the Minusinsk depression, but it might well be that environmental conditions were a limiting factor (see below).

The best represented Late Bronze Age culture in the Minusinsk depression is the Karasuk culture (14th to

Table 1
Radiocarbon dates of the sediment sequence from Kutuzhekovo Lake

Depth (cm)	Laboratory code	Dated material	^{14}C age (BP)	Calibrated age (1σ range)
106–120	Le-6234a	Peaty sediment	1530 ± 90	430–600 cal AD
106–120	Le-6234b	Humic acid	1600 ± 150	260–600 cal AD
146–158	Le-6231	Peaty sediment and humic acid	2470 ± 70	760–410 cal BC
158–176	Le-6232	Humic acid	2630 ± 180	980–410 cal BC
156–176	GrA-20687	Humic acid	2985 ± 45	1310–1130 cal BC
176–195	Le-6233	Humic acid	4310 ± 120	3100–2680 cal BC

Table 2
Cultural developments in Tuva and in Khakassia and the Minusinsk depression

	Neolithic	Bronze Age (early, middle, late)	Iron Age
N			
Khakassia and Minusinsk depression	Afanasievo Culture	Andronovo Culture Karasuk Culture Okunevo Culture	Tagar Culture (Scythian)
Tuva	only in Sayan canyon of the Yenisey River	"EMPTY TUVA" SEMI-DESERT →	Aldy-Bel Culture (Scythian) STEPPE
S			
		2000 BC	850 BC

10th century BC) [4]. Thousands of burial mounds and also settlements of this culture were discovered in the steppe zone of the Yenisey River Basin. The local variants of the Karasuk artefacts were found in the huge territory from central Kazakhstan up to Mongolia and China [6,24]. The archaeological and osteological material shows that in this period horse-riding became important and that the transition to a nomadic stock-breeding economy occurred.

The Karasuk culture developed into the early Iron Age Tagar culture (1st millennium BC), which is contemporary and closely related to the Scythian cultures in other parts of the Eurasian steppe-belt. The change from the latest phase of the Late Bronze Age to the beginning of the Tagar culture does not represent a break in the cultural development [23]. A long series of radiocarbon dates clearly shows that the transition from the Late Bronze Age to the Tagar culture should be placed around the 9th century BC [2,27,28]. In the context of the present paper it is important to note that this fits with the period of evidence for climate change at the Subboreal–Subatlantic transition. However, in the whole region to the North of the Western Sayan mountains, no cultural developments point to a causal relationship with climatic change.

The Tagar culture was one of the most pure nomadic cultures, with stock-breeding, complicated burial traditions, weapons, and arts. In the earlier Tagar culture monuments one can recognize elements pointing to connections with the preceding Karasuk culture, and also cultural innovations reflecting contacts with Kazakhstan–central Asia.

3.2. Central Asia region (Tuva republic)

Compared to the northern sites, the archaeological evidence from the area south of the Sayan Mountains (Tuva) offers a different picture. Palaeolithic sites were located on the banks of Yenisey River and its tributaries [3]. Neolithic sites were found only in the Sayan canyon of the Yenisey River (Toora-Dash and Ust'-Khemchik III) [26]. At the turn of the 3rd/2nd millennium BC most of these settlements were abandoned and a large gap in the prehistory of Tuva follows. Actually we do not know if any cultures spread along the Upper Yenisey River during the first half of the 2nd millennium BC, when the Andronovo culture dominated the Minusinsk depression. In the second half of the 2nd millennium BC the situation is not much different, especially in the northern and central parts of Tuva. Despite intensive archaeological research, the Karasuk culture of the Late Bronze Age until now is only represented by isolated finds. This scarcity of archaeological records in Tuva is remarkable. The situation changed completely after the 9th century BC, when the Scythian culture emerged in Tuva, much earlier than in the western parts of the Eurasian steppe zone. The Arzhan-1 barrow, excavated by Gryaznov, yielded very early Scythian material dated to the late 9th/early 8th century BC [18,19]. This early date is confirmed by dendrochronology combined with ^{14}C wiggle-matching, as well as by archaeological arguments, because certain types of horse bridles from the central grave can be connected with the pre-Scythian phase in the Black Sea region. The Mayemir phase of the Altai region also may start that early, but in western Siberia during the 9th and 8th century BC the Scythian culture still does not show up, and this period is represented there by the so-called transition from the Late Bronze to Early Iron Age, which culturally is a continuation of the Late Bronze Age.

In Tuva, soon after the middle of the 9th century BC immigration, an increase in human population density and a cultural development took place that had a major impact in the whole Eurasian steppe zone. In Tuva the Aldy-Bel culture of the Scythian type emerged earlier than in any other part of the steppe. In our search for evidence we consider the possibility that climatic change played an important role. The cultural acceleration and increased population density in Tuva may have been the result of different interacting factors; for example, an impulse coming from the Southeast (Mongolia, northern China) may have had strong effects on the cultural development in Tuva. People needed a reason to migrate into Tuva where they came in contact with Mongolia and southern China. Here we come back to the factor of climatic change as a trigger for migration. The coincidence of climatic change to less dry conditions (start of Subatlantic period; mid 9th century BC) and the population density increase and cultural development in Tuva is remarkable. Prehistoric communities living in marginal areas of food production may react in a very sensitive way to environmental changes, because such changes can have an enormous impact on their way of life and even survival.

We postulate that the emergence and expansion of the nomadic culture of the early Scythians in Tuva was only possible after a climate shift towards higher humidity (higher plant biomass production and thus a higher carrying capacity). We suggest this climatic shift changed Tuva from a dry area into a steppe attractive for groups with a nomadic way of life. With our multidisciplinary Russian–Dutch–German project we search for further support for our hypothesis concerning an important and interesting problem of Eurasian prehistory. Studies of sediments from Tuva and Khakassia are in progress, and these indeed may show further evidence for climatic change as a major factor for the recorded archaeological developments.

4. Evidence derived from radiocarbon data

Based on the St. Petersburg Radiocarbon Database the geographical distribution and age of the different monuments can be compared. Not all of the discovered monuments have been radiocarbon dated, but a representative number of sites do present a consistent picture. The ^{14}C dataset for the Holocene is plotted as frequency diagrams (Figs. 3 and 4). Large numbers of ^{14}C dates plotted as histograms can be used to establish a chronology of periods. More than 40 dates per millennium have statistical significance [13]. Our histograms are shown in bars of 200 ^{14}C year intervals. Typical errors for the ^{14}C dates from the database are 50 radiocarbon years (1 s). Fig. 3 shows (1) the frequency of radiocarbon dates from all Holocene archaeological sites (2200 ^{14}C dates from about 650 sites) in the territory of the Eurasian steppe between 42° and 55° N, and (2) the separate dates (315 from about 100 sites) from southern Siberia (Khakassia) combined with those from central Asia (Tuva).

Fig. 3 shows that the similarity between the distribution of ^{14}C dates of all archaeological sites located in the Eurasian steppe zone and those from southern Siberia and central Asia only starts during the Bronze Age. Unlike the rest of Eurasia, where Mesolithic and Neolithic cultures are represented between 10000 and 4000 BP, the occupation of southern Siberia (Khakassia) only started during the Bronze Age. Both curves demonstrate the sharp increase of the occupation after 3000 BP. It is even more important to separate and compare the radiocarbon dates of archaeological sites situated in the Minusinsk depression with dates from sites in Tuva. Fig. 4 shows that during the Mesolithic and Neolithic periods both regions were practically uninhabited. Almost no ^{14}C dates are available for these periods. As mentioned above, the first nomads belonging to the Afanasievo culture arrived in the Minusinsk depression from elsewhere. A limited number of radiocarbon dates from Khakassia and Tuva reflect the presence of Bronze Age cultures (Afanasievo up to Karasuk), but the records show a sharp increase around 3000 BP. The histograms (Figs. 3 and 4) are constructed as a function of ^{14}C time in BP (i.e. not calibrated into calendar ages). Non-linearity of the ^{14}C timescale in terms of calendar years may overrepresent certain periods of time [31]. However, this does not change our findings: the ^{14}C dataset, plotted as a frequency histogram, shows that in southern Siberia an acceleration of cultural development took place shortly after 3000 BP. Based on the archaeological record and the radiocarbon database, it is evident that an almost unoccupied Tuva suddenly became densely populated.

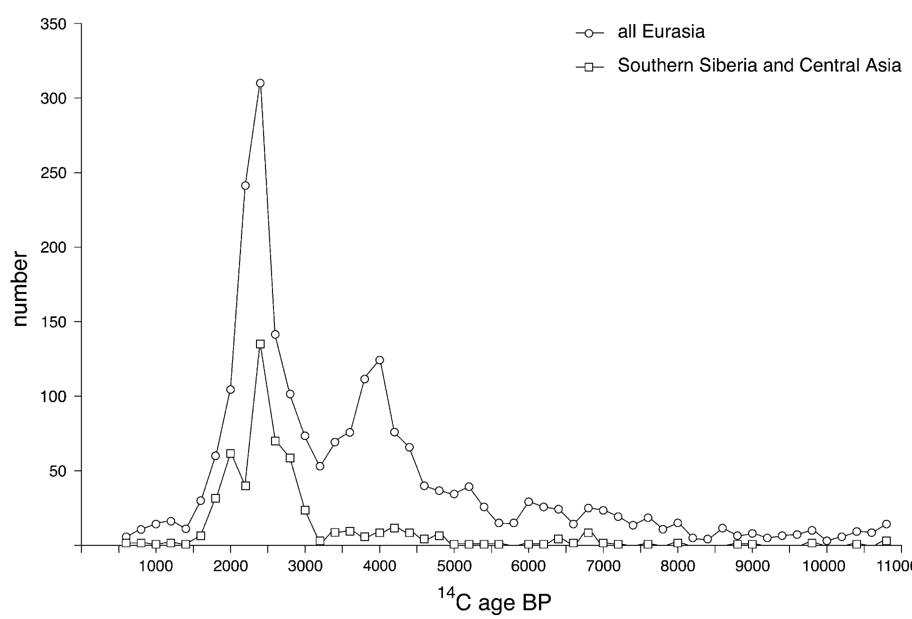

Fig. 3. Distribution of ^{14}C dates of Holocene archaeological sites for all of Eurasia and for southern Siberia and central Asia (the regions of Khakassia and Tuva). From the St. Petersburg Radiocarbon Database.

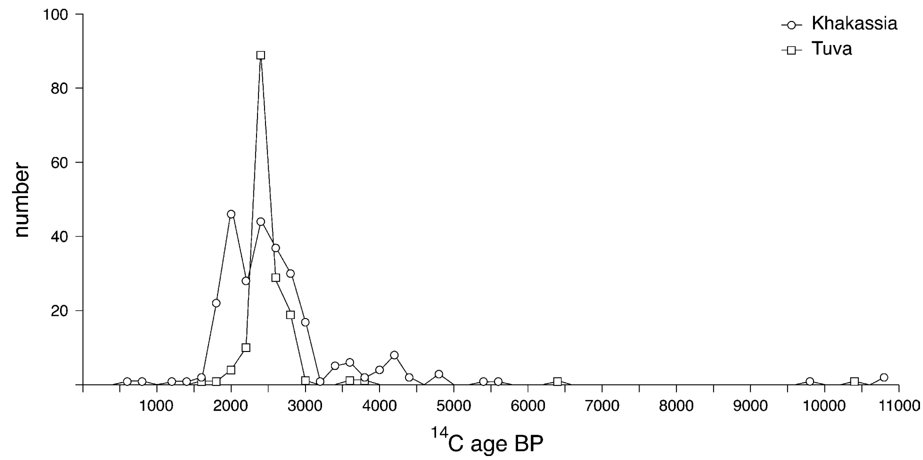

Fig. 4. Distribution of ^{14}C dates of Holocene archaeological sites for southern Siberia (Khakassia) and central Asia (Tuva). From the St. Petersburg Radiocarbon Database.

5. Conclusion

We suggest that a climatic shift towards wetter (less dry) climatic conditions was responsible for a suddenly increased carrying capacity (higher biomass production) of the Tuva area. The climatic change after 3000 BP was triggered by a temporary decline of solar activity, and thus we hypothesize that the sun was a major factor, indirectly influencing the cultural blooming and expansion of the Scythian culture.

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