

The late Holocene climate in south-central Siberia and its potential influence on settled farming versus nomadic cattle herding

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Fig. 1. The Minusinsk Hollow in the background of the Altai-Sayan mountains. Study sites: Dikoe Lake (blue) and Kutuzhokovo Lake (red) located at distance of 100 km

Methods. We used a combination of paleo ecological approaches and bioclimatic models to reconstruct vegetation and climates and predict then climate-based potential pasture and grain crop during the late Holocene since 6000 BP.

Three different methods were employed to reconstruct vegetation from the fossil pollen (Fig. 2) of sediment cores of two mountain lakes in the study area (Fig. 1) at eleven time slices relating to successive human cultures back to the mid-Holocene.

The methods were: the pollen "biomization" method of Prentice et al. (1996); the Russian method of "actualization" of Markov and Velichko (1967), similar to the "analog" method (Davis, 1963, McAndrews et al., 1966); our montane bioclimatic model (Tchebakova et al. 2009).

We constructed two climate-based regression models that predicted the annual grain and pasture yields from climate variables.

Introduction. Prehistoric and early historic human cultures are known to be closely connected to and dependent on their natural environments. Historic security and food accessibility for ancient peoples, given limited technical advances and knowledge, likely controlled human development and migration towards natural resources.

Goal. In the Minusinsk Hollow, south-central Siberia (Fig. 1) we tested the hypothesis: climate change altered the means of subsistence of ancient tribes and forced them to migrate for uncovering new lands with resources.

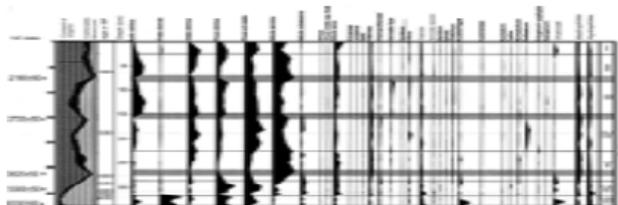


Fig. 2. Diagram of microfossils (pollen, spores) of a sediment sample from Dikoe Lake

Table. Reconstructed vegetation, climates and potential crop at periods of ancient human cultures since 6000 BP in the Minusinsk Hollow

Periods, BP, Human culture	Vegetation Distribution (grey), Forest-steppe (green), Forest (white)	Vegetation	Annual moisture index, AML, GDD/ann precip	Growing Degree-days, GDD, °C	Climate change	Area, Grasslands, % to total	Potential grain yield, % to current	Potential pasture yield, % to current
Contemporary		Light conifer			No change	4/50	100	100
620 Russian colonization agriculture		Light conifer			Dryer	4/50	100	100
1300 The Kirgiz settled farming, semi-nomads		Dark conifer			Wetter/ Cooler	2/40	110-120	120-130
1800 The Tashtyk predominantly nomadic		Forest-steppe			Dryer/ Warmer	22/63	70-90	70-80
2600 The Tagar (Scythians) predominantly farming, semi-nomadic		Dark conifer			Wetter	2/40	110-120	120-130
3200 The Karasuk Cattle herding, decreased farming		Light conifer			No change	22/50	70-90	70-80
3650 The Andronovo primitive agriculture		Light conifer			Cooler	22/50	70-90	70-80
4630 The Okunevo Cattle herding		Forest-steppe			Dryer/ Warmer	22/63	70-90	70-80
5100-5770 The Afanasievo a complex economy (hunting, fishing, primitive agriculture and cattle herding)		Dark conifer			No change	10/57	80-100	80-90

Burial mounds in Khakassia, the Minusinsk Hollow. The Afanasievo culture (the 4th to 3rd millennium B.C.) was known the first to build up burial mounds in southern Siberia. The graves were bounded with vertical sandstone plates dug deep into the ground. Later, the graves could be modified and repeatedly used

Archeological background. Khakassia within the Minusinsk Hollow was recognised as a real "melting pot of ethnogenesis" of humans migrating in Eurasia during several millennia.

Neolithic time. Archeological evidence showed that in the Neolithic time, the plains of the Hollow were not colonized by people until 6000 BP.

Afanasievo culture, formed in the 6th to 5th millennium BP by tribes of Indo-Europeans that migrated from southwestern areas of Eurasia to Khakassia. They hunted and fished, primitive agriculture and cattle herding.

Okunevo culture is dated to the Early Bronze Age, the end of 5th to the beginning of 4th millennium BP. Developed locally, it was close in many features to Afanasievo culture, although these people had some Mongoloid features.

Andronovo culture, dated to the middle Bronze Age, 4th beginning of 3rd millennium BP. Culture was formed by martial tribes of Indo-Irans (Arians). Cattle herding became increasingly important, as did horse breeding. They practiced a sedentary life style, developing agriculture and cattle herding around their settlements on the rivers valleys.

Karasuk culture, dated to the late Bronze Age, end of 4th millennium BP. Human tribes from Ordos migrated with herds of sheep from China. Their main occupation was cattle breeding with seasonal transhumance. Farming played an ancillary role in this culture.

Tagar culture (Dinlin tribes, part of the Scythians, in Khakassia), the early Iron Age, 3th century BP. The economy of Tagar tribes was complex and the lifestyle sedentary. Both cattle breeding and agriculture were employed, with a slight predominance of agriculture.

Tashtyk culture and Yenisey-Kirgiz culture, dated to the late Iron Age, the end of the 3rd - the 2nd millennium BP. The Tashtyk culture developed parallel with the Tagar culture. Initially, the Kirgiz peoples penetration on the Dinlin (Tagar) tribe territory in Khakassia was peaceful, however later, military conquests resulted in the extermination of most of the Dinlins.

Lifestyles of the Yenisey Kirgiz culture basically followed the Tagar and Tashtyk traditions based on a settled and semi-nomadic agricultural and cattle breeding economy.



Conclusions (Table)

•Our pollen-based reconstruction of climate in the Minusinsk Hollow during the late Holocene uncovered at least three dryer periods when steppe and forest-steppe lands dominated up to 85% of the area and four wetter periods when forests dominated up to 60% of the area. •Grasslands increased one order of magnitude during the dry periods and provided extensive open space likely suitable for pastoralism. The dry periods favored nomadic rather than farming activities. Agriculture became less productive in dry climates and agricultural tribes gradually weakened. New mobile, nomadic tribes migrated from other regions and easily conquered local tribes which caused a shift in the archeological human cultures.

•During wetter climates, both grain and pasture yields could increase twofold and support humans remaining settled for farming and herding cattle around their settlements.

•Thus, during the times of wetter climates, human tribes that practiced agriculture had some advantage over tribes who practiced pastoralism. On the other hand, grasslands severely decreased during wet stages, and nomadic migrants were likely gradually assimilated by agricultural tribes.

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