Human adaptation to past climate changes in the northern Pontic steppe

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**Abstract**

The northern Pontic steppe in the southern part of Eastern Europe has reacted to climate changes. It is characterized by a historically constant moisture deficiency, and is an advantageous area for study of diverse types of human adaptation to climate changes. Two main types of such adaptations, which occurred during the 6th–1st millennium BC, have been distinguished. The first is connected with the early historical migrations, and the second with changes in the economy of local steppe populations.

1. Introduction

The northern Pontic steppe is a vast region stretching from the Dniester River in the west to the northern Caucasus in the east, from the Black Sea and the Azov Sea in the south to the East European forest–steppe zone in the north (Fig. 1). It is extremely rich in archaeological sites of all types and many ages. This impressive wealth of archaeological materials would appear to be closely linked to the key geographic position between Europe and Asia and to the combination of its various natural assets: the major rivers, moderate climate, fertile soils and biotic diversity.

This paper presents results of environmental archaeology studies of the different types of human adaptation reflecting the past climate changes during some key historical periods: the Neolithic, Eneolithic, and Early Iron Age in the northern Black Sea area. The main aim was to reconstruct the past climate changes and the related environmentally dependent cultural adaptation patterns. The Neolithic and Eneolithic periods were marked by the spread of agriculture and animal husbandry. The Early Iron Age was characterized by nomadism in the Eurasian steppes. The appearance of these innovations in ancient economies of local communities was a reaction to climate fluctuations.

At present, about 300 settlements and cemeteries of the Neolithic and the Eneolithic have been excavated in the northern Pontic steppe (Telegin, 1986; Kiyashko, 1994; Kotova, 2003, 2008; Rassamakin, 2004). Four Neolithic cultures are known in this region. In the northern Azov Sea area, the Rakushechny Yar culture (6900–5650 BC) and the Lower Don culture (6000–5300 BC) existed. Sites of the Surskaja culture (6300–5100 BC) and the Azov–Dnieper culture (5950–4800 BC) occupied the territory adjacent to the western Azov Sea and the Dnieper basin. The Neolithic population was engaged in animal husbandry and early agriculture. Hunting and fishing played the main role only in the economy of the Surskaja culture, but its people also knew agriculture and bred (although not numerous) domestic animals.

The transition to the Early Eneolithic (5250–5100 BC) was connected with a collapse of the Neolithic cultures. The new Sredny Stog culture (5250–4200 BC) was involved in animal husbandry and agriculture.

The beginning of the Early Iron Age in the Pontic steppe was connected with the Cimmerian culture (1000–650 BC). Its economy is characterized as nomadic cattle-herding with winter camps along the Black Sea coast and summer camps in the northern border of the steppe. At present, there are more than 250 burials, hoards and other type of archaeological monuments belonging to this culture (Makhortykh, 2005).

2. Regional setting

The northern Pontic steppe forms a geographical junction between the Pontic lowland and the southern slopes of the Ukrainian crystalline shield. It includes the Dniester, Dnieper, and Don rivers and the basins of a few smaller tributaries. The regional climate is temperate, though rather continental, with the Black Sea coastal region experiencing milder winters. Temperatures range from about −6 °C in January to about +21 °C in July. Annual precipitation averages 615 mm; it is highest in the west and north and lesser in the east and southeast. Winters vary from cool along the Black Sea to cold farther inland. Summers are warm across the greater part of the area, but generally hot in the south.

The landscape consists mostly of fertile plains or steppes and plateaus, crossed by the rivers flowing into the Black Sea. The natural vegetation is grassland steppe dominated by Festuca sulcata and Stipa. The soil types mainly include chernozems and luvisols.

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The Black Sea coastal zone is densely populated, containing a present human population of approximately 16 million.

The northern Pontic steppe is characterized by constant moisture deficiency. The dryness in the southern areas of the steppe is six times greater as that for the northern areas (Mordkovich, 1982). The vegetative cover of the steppe, determined by climatic conditions, is also varied. Phytomass increases from the northern limits of the steppe (28 t/ha) to the centre (48 t/ha) and declines to 9 t/ha on its southern limits. The centre of the steppe zone is optimal with a combination of heat and sufficient precipitation.

Summer drought, linked to limited precipitation in spring and autumn, is characteristic for the steppes from the Dniester to the Don River basins. Here, in comparison to the more eastern territories, there are more mesophytes than xerophytes, the latter with a large underground phytomass. This makes the northern Black Sea steppe more vulnerable and responsive to climatic changes, such as increasing drought or moisture. The small amount of xerophytes with advanced root systems cannot prevent the rooting of woody vegetation. With increasing moisture, this permits easy invasion of trees into steppe territories and the southward expansion of the forest–steppe zone.

The eastern steppes from the Don to the southern Fore-Ural area are characterized by greater dryness in comparison with the (western) Ukrainian steppe. During arid periods, the landscapes of the southern areas became similar to deserts. There are numerous xerophytes in the eastern steppe. During moist periods, this limits the southward expansion of the forest–steppe zone. The drier character of the eastern steppe region as compared to the Black Sea area is very important for understanding the cultural processes which took place in the prehistory of Eurasia.

3. Materials and methods

In the current study, the archaeological materials of the Neolithic, Eneolithic and Cimmerian cultures are analysed on the background of the Holocene climate change history in Eastern Europe. In the past, the climate was not invariable. The northern Pontic steppes with the constant deficiency of moisture easily reacted to climatic variations with changes of landscape (Kremenetskiy, 1991; Gerasimenko, 1997). The past climates and environments in the northern Black Sea region have been reconstructed on the basis of palynological analyses. The palynological spectra of four settlements in the Azov Sea area (Matveev Kurgan, Chapaevka, Kamennaja Mogila, and Razdolnoe) have been examined (e.g. Bezusko et al., 2000, 2006). The Ukrainian evidence added a detailed scheme for the climate and landscape changes of the Holocene in Eastern Europe (Fig. 2) developed by Spiridonova and Lavrushin (1997). According to the present scheme, the Holocene included several sub-periods of climatic fluctuations. During the wet sub-periods, the forests spread in the river valleys in the southern steppe and the amount of motley grass in the assemblage increased. At the time of the dry sub-periods the forests in the south of the steppe zone disappeared, the role of motley grass decreased and the quantity of wormwood increased in the grassland vegetation assemblage.

However, all the wet sub-periods during the Atlantic period were drier than the current climate and the northern border of the steppe was on the territory of the modern forest–steppe zone. This situation lasted until the beginning of the Sub-Boreal, when the vegetation border became similar to the recent one.

In comparison to the Neolithic and Eneolithic, the climate in 1300–500 BC was closer to the current one. During the arid stages, the northern steppe border moved to the southern area of the modern forest–steppe zone. During wet periods, forest–steppe landscapes occupied the northern region of the present-day steppe zone.

The archaeological materials were analysed in two aspects: in respect to evidence of ancient migrations triggered by climate variations, and changes of economy of the steppe inhabitants. The most important data were obtained from osteological collections, which form the basis for the reconstruction of animal husbandry and hunting practices.

4. Results

In the northern Pontic steppe with constant moisture deficiency, a decrease in the amount of rain and snow caused a deterioration of
living conditions for an ancient population (Fig. 3). A rise in precipitation improved existence in the steppe. The most important factor for steppe inhabitants was therefore aridity, especially in the drier southern part. Climate aridity caused deteriorating living conditions in the steppe zone. The forest in river valleys disappeared together with forest animals. The steppe animals suffered from dryness as well. According to the paleozoological data, pronounced aridity essentially produces a vitamin imbalance and negatively affects other qualities of biological life (Ognev, 1951: 215). The lack of nourishing substances in forage negatively influenced reproduction of herbivorous animals. As a result, livestock was reduced sharply. Mortality due to starvation, diseases in exhausted animals, number of victims of natural disasters and predator activity increased. The same problems faced the domestic animals, contributing to an environmentally based economic crisis for local population. There were two variants of human adaptation to the climate fluctuations: migration and transformation of the economy.

4.1. Migration as human adaptation

During climate aridity, the steppe inhabitants experienced a crisis in their traditional way of life and a part of the population migrated to the north (middle and northern steppe). During the arid stages, the southern type of steppe vegetation spread. If aridity was strong, steppe landscapes also occupied the southern modern forest–steppe area.

These migrations also regulated the quantity of the population, which subsisted in a part of the steppe zone during the arid intervals. The migrating population retained a traditional way of life in the new regions. The newcomers continued their economy. This is evident from the archaeological records of the Surskaja culture. The Semenovka 1 site occupied the bank of a small river in the south steppe during moist climate. Surskoy Island 2 is located in the Dnieper River in the northern region of the steppe, and developed during aridization. However, both sites have similar proportions of wild and domestic animals (Fig. 4).

Cultural contacts of migrants with the local population considerably changed the material cultures of both population groups. In addition, some differences between cultural changes during strong and weak aridity can be identified. For the Atlantic period, two strong and eight weak arid climate oscillations have been documented. During strong aridity, numerous migrants moved along the steppe and new cultures formed in the southern part of the modern forest–steppe zone, which was occupied with steppe landscapes. These cultures included both the traditions of migrants from the southern steppe and the local cultures of the forest–steppe zone.

The initial strongest aridity of the Atlantic period in Eastern Europe is dated about 6300–6000 BC (Spiridonova and Lavrushin, 1997). It was not a local phenomenon, also noted in Anatolia and in different parts of Europe. This time is connected with the spread of farming and the beginning of Neolithization in Europe (Todorova, 1998; Weninger et al., 2005; Budja, 2007).
A similar situation developed in the northern Black Sea area. In the mid-7th millennium BC, the population of the Rakushechny Yar Neolithic culture lived in the steppe Don Basin. The builders of Grebeniki monuments occupied a steppe between the Dniester and South Bug rivers, and some penetrated into the Azov Sea area (Matveev Kurgan group). Steppe inhabitants were engaged in animal husbandry and agriculture, but pottery is known only for the Rakushechny Yar culture.

This marked aridization of climate seriously reduced available hunting resources of the steppe region. Local populations began to move to more humid areas – the basins of such rivers as the Dnieper, Dniester, and Don, and the northern steppe. In these regions the Early Neolithic population kept the old type of economy with a considerable role for hunting. At the same time, these migrations changed the cultural situation in southeastern Europe.

At the beginning of this aridity, about 6300 BC, two new Neolithic cultures originated. One was the Surskaja culture in the middle Dnieper basin. Migration of the Grebeniki population from the steppe Azov Sea area to the Dnieper valley, where this river moderated the dry conditions, caused its coexistence with local Kukrek inhabitants and the formation of a new culture on the bases of their traditions. This aridization could have been the impulse that resulted in the spreading of domesticated animals and borrowing of pottery from the Rakushechny Yar culture.

The oldest site of the Surskaja culture is Surskoy Island 1, located in the northern part of the steppe zone in the Dnieper basin. Migration of the Grebeniki population from the steppe Azov Sea area to the Dnieper valley, where this river moderated the dry conditions, caused its coexistence with local Kukrek inhabitants and the formation of a new culture on the bases of their traditions. This aridization could have been the impulse that resulted in the spreading of domesticated animals and borrowing of pottery from the Rakushechny Yar culture.

The oldest site of the Surskaja culture is Surskoy Island 1, located in the northern part of the steppe zone in the Dnieper basin. Most likely this site correlates to the beginning of the aridity, when forest with numerous wild animals (red deer, roe, wild boar and wild bull) was preserved in that region as indicated by the species composition of skeletal materials from archaeological sites with only a minor presence of cattle and domestic pig. The forest in the Dnieper valley was a favorable place for pasture for only those types of domestic animals.

About 6200 BC, during the peak of aridity, the native vegetation zones moved north. The steppe landscape occupied the forest-steppe zone (Spiridonova and Lavrushin, 1997). The southern steppe became unfavorable for life. The middle steppe could not provide sustenance for numerous pastouralist populations, and some groups of the Rakushechny Yar and Surskaja cultures moved along the rivers further to the north to find a more favorable environment to retain the traditional economy. Due to that expansion, the Neolithization of modern forest–steppe and forest zones of Ukraine and adjacent areas of Russia began, with the major Dnieper–Donets culture established in Ukraine (Kotova, 2003).

Probably in this period, the valleys of the small rivers in the southern and central parts of the steppe became depopulated or were only occasionally visited by people. According to the radiocarbon dates obtained for the Semenovka 1 and Kamennaja Mogila 1 sites, some Surskaja inhabited the basin of the Molochnaya river (Kotova, 2003). At the same time, the principal inhabitation area of the Surskaja culture included the northern part of the modern steppe zone in the Dnieper valley.

During the arid period, Surskoy Island 2 was inhabited. Cattle herding and wild-animal hunting (red and roe dear, boar) gave equal percentages of meat to the Surskaja population (Kotova, 2004). Cattle were the most numerous in herds, but some horses, pigs and few small cattle were bred as well. Fishing played an important role.

Another aridization about 4500–3800 BC with short humid periods was weaker but longer. This event is also identified on the Balkan Peninsula, correlated with an ecological catastrophe (Todorova, 1998) recorded in the southern areas of Macedonia, Albania, Italy, Thessaly and Thrace about 4500 BC. In Eastern Europe, the eastern steppe areas were most affected by this climate aridity. In the northern Pontic steppe, the dry climate first influenced the eastern variant of Sredny Stog culture located near the Don River, and this event played an important role in the cultural development in the Eneolithic Ukraine. Probably already at the beginning of this arid stage, a part of the population of the eastern variant of the Sredny Stog culture, formerly occupying small river valley habitats, was forced to move to the west, in the steppe middle Dnieper basin (Kotova, 2008). This migration initiated formation of the western variant of the Sredny Stog culture about 4350 BC.
In 4350–4200 BC, the settlements of the Sredny Stog culture were only known in valleys of the Don and Dnieper as well as in the forest–steppe border zone (the Seversky Donets basin). These sites were absent from open steppes as a result of the increased aridity and deterioration of living conditions in the southern zone and in valleys with small rivers.

A part of the Sredny Stog population migrated from the southern steppes to the southern region of modern forest–steppe zone, where the migrants assimilated with the local Dnieper–Donets Neolithic population to form a new Eneolithic Dereivka culture (Kotova, 2008) chronologically correlated with the stage of climate aridity (4300–3800 BC). Most of the documented settlements and burials were found only in the northern present-day steppe and the southern forest–steppe zone.

Probably, during a 100 year-interval, two co-existent Eneolithic cultures occupied the southern regions, with the Dereivka culture established under more favorable environmental conditions in a border zone of steppe and forest–steppe, with some woods on watersheds and biotically richer river valleys. In the steppe zone of the Dnieper valley, marginal populations of the Late Sredny Stog culture practicing agriculture and animal husbandry suffered from regular droughts, causing reduction of parkland habitats.

Another situation took place at the time of climatic moisture. During weak arid events (e.g. 5650–5500 BC, 5300–5100 BC and 4750–4650 BC) another situation existed in the steppe zone. In the eastern part of the arid steppe, some cultures with small populations disappeared (the Rakhushchny Yar culture, ca. 5650–5500 BC) or were newly formed (the Sredny Stog culture from the Lower Don and Surskaja cultures about 5300 BC).

The most progressive cultural development reflecting the environmental transformations is evident in the western part of the northern Pontic steppe, reflecting a wetter climate. Only minor changes of landscapes are documented with the steppe close to the modern forest–steppe limits. A small part of the population migrated to the north. Contacts of migrants with the local culture of the forest–steppe zone were not intensive and the local cultures retained their traditional characteristics.

The aridity peak about 5200 BC coincided with a transition from the first period of Azov–Dnieper culture to the second period. This included a significant component of the Dnieper–Donets culture of the present forest–steppe zone evident in the pottery decoration with strokes and incised lines replaced the comb impressions on the Azov–Dnieper pottery. Geographically dispersed Eneolithic populations were assimilated by environmentally better-adapted cultures (for example, people of the Sredny Stog culture assimilated populations of the Surskaja and Azov–Dnieper cultures about 5100–4800 BC).

Another situation took place at the time of climatic moisture. More favorable natural conditions starting at ca. 6000 BP increased the local Neolithic populations with expansion of the northern occupation zone into the southern steppe regions. Establishment of pine woods in the western Azov Sea area (Bezusko et al., 2000) correlated with the beginning of the Middle Neolithic in the southern part of Eastern Europe. New cultures (the Lower Don and Azov–Dnieper) appeared in the northern Pontic steppe (Kotova, 2003). Population migrated to the southern steppe region, reflecting increased precipitation. The archaeological sites of the wet periods are most numerous in the steppe zone with relatively stable populations.

A similar process took place during the Late Bronze Age (15th–12th centuries BC) with a relatively cool and wet climate in Eastern Europe (Spiridonova and Lavrushin, 1997: 154–159). In these favorable climatic conditions, the Late Bronze population of the Pontic steppes experienced economic development. Archaeological evidence for this time is represented by large, long-term settlements with stone, clay and wooden architecture. The economy was based on settled agriculture reflected in the continuous use of the land (Chernyak, 1985). Many settlements were located in regions which today experience regular shortage of water and are often uninhabited.

About the 11th century BC, a period of long climate aridity is recorded in Eastern Europe (Gerasimenko, 1997; Spiridonova and Lavrushin, 1997). Worsening climatic conditions had negative effect on the Pontic steppe archaeological cultures (Belozerska and Post-Srubnaja) with a mixed pastoral–agricultural economy. The environmental crisis may have been strengthened by the anthropogenic pressure on the local environment (intensive ploughing, destruction of steppe vegetation due to pasturing of animals, etc). In the first half of this arid stage, at the beginning of the 9th century BC, a new Cimmerian culture formed on the basis of the Late Bronze cultures. Progressive regional aridity caused the Cimmerian expansion in the Pontic steppe from Northern Caucasus to the Danube.

At the aridity maximum at ca. 950 BC, the Cimmerians moved from the Pontic steppe region to the northern areas with a more favorable environment. These migrations probably occurred in several stages. The pastoral nomadic way of life persisted during the ecological crisis caused by lack of forage during the droughts, or during military events (Rudenko, 1961). Migration of the Cimmerians took place in several directions into the zones with a positive moisture budget (Fig. 5): the Dnieper forest–steppe zone, the Crimea Peninsula, the Northern Caucasus and the Great Hungarian plain.

Cimmerian migrations provoked armed conflicts with local inhabitants. The early military aggression of the Cimmerians is indicated by the destroyed settlements of the Chernolesskaia and Bondarikha cultures (Subbotovo, Buzovka etc.) in the forest–steppe zone between the Dnieper and Don rivers (Terenozhkin, 1976; Makhortykh, 2005).

The migrations and the formation of new cultures are only one aspect of human adaptation to the climate changes and landscape transformations. Another side of this process lies in the adaptation of an ancient economy.

4.2. Transformation of economy as adaptation

Proxy data of human adaptation of the Neolithic and Eneolithic populations in the northern Pontic steppe to the mid–Holocene climate variations include paleozoological and archaeological evidence (with prints of cultivated plants on the ceramics). From the Early Neolithic, the prehistoric steppe inhabitants practiced agriculture. Barley, wheat and millet were cultivated in the region, but the basic aspects of the economy were hunting and cattle–herding. The climatic variations forced people to adjust with intensification of one or another type of economic production depending on the climate conditions and landscape type.

During the climatically favorable wet periods, cattle herding and hunting gave an equal percentage of meat to the Neolithic and Eneolithic population, or the contribution of hunting dominated. Wild boar, red deer, roe, bison, and auroch (Bos primigenius) occupied wooded river valleys, whereas saiga and wild donkey were hunted in open steppes. During arid climate periods with reduction of natural forest habitats, the steppe animals became the basic objects for hunting (saiga, donkey, badger, marmot and hare) and the role of animal husbandry in the economy increased. These adaptive pattern changes are well demonstrated at Eneolithic sites (Semenovka 1 and Sredny Stog sites of the Sredny Stog culture, correlated with humid and arid periods, respectively) (Fig. 6).
Numerous bones of domestic animals from the Neolithic and Eneolithic settlements include remains of cattle, sheep, goat, horse and pig. Some differences between herd structure in the dry and wet periods can be observed. During regional aridity, sheep and goats prevailed in herds of the steppe populations. In the wet periods, the amount of cattle and horses increased as shown at the Sredny Stog sites (i.e., Semenovka 1 and the 2nd layer of the Sredny Stog).

The quantity of pigs was stable for the entire period. Pigs at all were not numerous in herds of all Neolithic and Eneolithic cultures east of the Dnieper River, a specific feature of the Eastern European form of animal husbandry (Kotova, 2003).

About 1000–950 BC, when weak but prolonged aridity began (Spiridonova and Lavrushin, 1997), the Late Bronze population of the Pontic steppe changed from the traditional pastoral-agricultural economy to nomadic cattle-herding. Probably, already in the Late Bronze Age, cattle herding in the economy, gradually taking more mobile forms, began to increase. The crisis of agriculture was occurring simultaneously. In these conditions, the role of horses increased, and pig as well as cattle production decreased. These were the principal preconditions for the transition to nomadic and to semi-nomadic pastoralism that soon spread not only over the Pontic steppes, but became the principal economy in the broad steppes of Eurasia.

At the beginning of this arid period, the steppe population, already involved in nomadic cattle herding, moved from the Pontic steppe region to the areas with more favorable and stable environments. These migrations probably took place in several stages. This nomadic pastoral economy existed in conditions of the ecological crisis caused by the lack of forage during the droughts, or during military events (Machortykh and Ievlev, 1992). The Cimmerians nomadic or semi-nomadic forms of economy were determined by the occupied ecological niches. During this long arid period, the first nomads developed an effective economic cycle with seasonal migrations into the northern part of steppe/southern steppe areas of the forest–steppe during summer, and into the southern steppe regions around the Azov and Black Seas during winter.

5. Discussion and conclusions

The contextual environmental archaeology study of the cultures of the Pontic steppe on the background of the climate change has shown some regularities of human adaptation in prehistory and early history. Two main types of adaptation to climatic variations were characteristic for the steppe populations. The first type involved migrations during progressive climatic aridity, when reduced natural resources forced the southern steppe inhabitants to migrate to the northern steppe. In this more humid zone, migrants could continue their traditional life and keep their economy, because the climate and landscape in the northern region of the steppe during arid periods are similar to the climate and landscape in the southern steppe region during moist events. The environmental variations contributed to the progressive adaptive cultural development with introduction of new technologies promoted by cultural links with other regions.

The second type of the adaptation was connected with changes of economy of steppe populations. During the Neolithic and
Eneolithic, the steppe populations intensified hunting during moist periods, when forests occupied river valleys, replaced by animal husbandry during arid periods. In the later Early Iron Age at the beginning of the arid periods, the traditional pastoral–agricultural economy was replaced by nomadic cattle-herding. Some modifications of herd husbandry depended on climate fluctuations. The Neolithic and Eneolithic populations that continued to live in the southern steppe during aridity bred mainly sheep and goats. In wet periods the quantity of cattle and horses increased. In the Early Iron Age, sheep and horses became more numerous reflecting the arid climate shifts, changing the former animal husbandry of the more humid Late Bronze period based on cattle and pigs.

References


