RESEARCH PAPER

THE PALAEOENVIRONMENT OF THE CENTRAL RUSSIAN PLAIN DURING THE END OF THE VALDAI GLACIATION BASED ON SMALL MAMMAL DATA FROM THE LATE PALAEOLITHIC SITE BYKI 7 (SEIM R. BASIN)

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ABSTRACT. The analysis of the Late Pleistocene small mammals' faunas from the three cultural layers of the Late Palaeolithic site Byki 7 (the Seim River basin) consist of a combination of steppe and tundra species. Steppe species definitely prevail and include Ochotona pusilla, Marmota bobac, Spermophilus sp., Spalax microphthalmus, Ellobius talpinus, Lagurus lagurus and Lasiopodomys (Stenocranius) gregalis. Tundra species (collared lemming and Siberian lemming) are only represented by a small amount of remains. The lack of forest dwellers in the Byki 7 small mammal assemblage indicates of the absence of a continuous forest zone on the Central Russian Plain during the end of the Valdai glaciation. The Eurasian geographical distribution of the Rodentia and Lagomorpha species represented in the Byki–7 assemblages, have been reconstructed for the period of deposition of the site. Radiocarbon dates indicate that the multilayer Late Palaeolithic Byki 7 site correlates with the second part of the Valdai Glaciation Maximum cooling (LGM) (22–17 ka BP). Based on the small mammal data the former palaeoenvironmental conditions of the non-analogue periglacial tundra-steppe are reconstructed.

KEYWORDS: Late Palaeolithic; small mammals; species composition; palaeoenvironment reconstruction; Seim River basin; periglacial tundra-steppe

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INTRODUCTION

The complex investigation of the archaeological sites, including the Late Palaeolithic ones, are relevant both for the discovering of the features of archaeological tools and cultures, as well as for reconstructing the environments during the human occupation based on palaeontological materials. There are many Late Palaeolithic sites discovered on the Russian Plain. The studies of these sites include archaeological researches, the studies of their geological and geomorphologic position of the site, and also paleontological investigations of remains of large and small mammals, mollusks and plants. These complex researches permit to reconstruct the past environments surrounding ancient humans. Such comprehensive studies have been carried out on the Late Palaeolithic site Byki 7.

The Byki 7 site has been discovered in 2000 by archaeologist N.B. Akhmetgaleeva. The site is a part of the "Byki Sites complex" that includes the following sites: Byki 1, Byki 2, Byki 3, Peny (Byki 4), Byki 5, Byki 6, and Byki 8 (Fig. 1). The sites of this complex have been studied by a several archaeologists and geographers (Grigorieva and Fillipov 1978; Chubur 2001; Akhmetgaleeva et al. 2010; Akhmetgaleeva 2015; Akhmetgaleeva and Burova 2021).

A specific Upper Palaeolithic culture with triangular microlites (crystalloids) has been detected in the 4 upper cultural layers of Byki 7. The lowermost II cultural layer includes the gravettoid industry. Archaeological data show that humans seasonally inhabited the Byki 7 site, as well as other sites of the Byki complex. Unique zoomorphic artefacts produced from mammoth and other animals' bones have been found at the site (Akhmetgaleeva 2015). Archaeological studies at the site are, for many years, conducted under the leadership of N.B. Akhmetgaleeva (Akhmetgaleeva 2015; Akhmetgaleeva and Burova, 2021). The geological deposits have been studied by Yu.N.

Gribchenko and E.V. Voskresenskaya (Akhmetgaleeva et al., 2020), and by A.V. Panin and colleagues in 2019-2020 yrs. Large mammals' remains were studied by N.D. Burova (Akhmetgaleeva and Burova 2021). Small mammal remains have been handed over for identification in 2019 by the archaeologist N.B. Akhmetgaleeva to A.K. Markova.

MATERIALS AND METHODS

General description of the site Byki 7

Byki 7 site is located on the south-western slope of the Central Russian Upland (51°38′N, 35°30′E, Fig. 1a), on the high dune formed on an ancient terrace, which is not younger than the Middle Pleistocene, on the River Seim left bank (the Desna R. basin), Kursk Region. The significant distance from the site to the riverbed indicates that the water resources were not the main factor to Palaeolithic people in choosing a place to this site (Akhmetgaleeva 2015, A.V. Panin per. comm.) (Fig.1b). The site location is within the boundaries of the modern forest-steppe zone with the temperate continental climate. The mean annual temperature in the region ranges between +5.9C (in the north) and +7.1C (in the southwest). The annual precipitation is 627 mm. The main vegetation type is a meadow and forbs steppes with the patches of oaks.

The archaeological finds excavated at most of the Byki sites belong to the so-called "Bykovian" archaeological culture. A large number non-calibrated radiocarbon dates fall within 25,000-14,300 BP and most of calibrated dates of the Byki 7 site fall within the 22000-17000 cal BP interval (Akhmetgaleeva 2015) (Table 1). It is important to note that the Byki 2, Byki 3, Byki 6, and Byki 8 assemblage consist of surface finds.

There are more than 60 mammal species in the Kursk region nowadays. The modern faunal assemblage includes simultaneously forest (elk, roe deer, wild boar, red squirrel, Eurasian beaver, yellow-necked mouse, forest dormouse, bank vole, etc.) and meadow and steppe species (steppe polecat, brown hare, great jerboa, bobac-marmot, greater mole-rat, European hamster, grey hamster, steppe lemming, etc.).

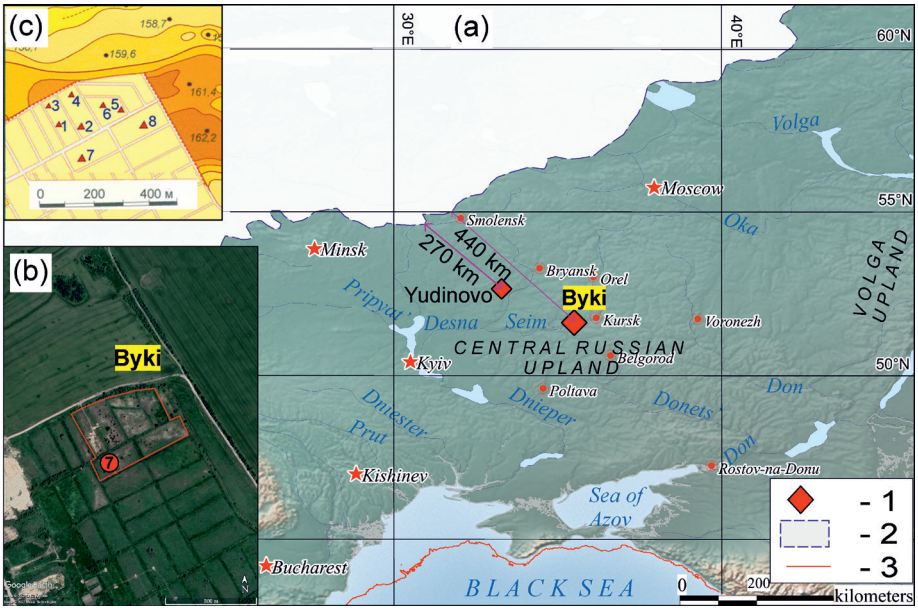


Fig. 1. a – The geographical position of the Upper Palaeolithic Byki sites. Legend to Fig.1a: 1 – Upper Palaeolithic sites Byki 7 and Yudinovo, 2 – the Scandinavian Ice Sheet during the last glaciation (after Svendsen et al. 2004), 3 – isobate 125 m indicated the coast line. The minimum distances between the Byki and Yudinovo (52°40′N, 33°17′E) sites and the edge of Scandinavian Ice Sheet shown on the map (after J. Ehlers and P. Gibbard (2008)), b – Byki sites complex and the location of Byki 7 site; c – the plan of the Byki sites complex with the position of the Byki 1 – 8 sites (after N.B. Akhmetgaleeva and N.D. Burova (2021))

Table 1. Radiocarbon Dates of Byki 7 site. Dates calibrated with OxCal 4.4.0 software and the calibrated curve IntCal20 was used (after (Akhmetgaleeva and Burova 2021)

Layer	Lab code	Material	Conventional ^{14}C date, BP	Calibrated date, ca BP
Layer Ia	GIN–13082	fragments of bones of mammals and birds	14,300 ± 370	17,430 ± 500
	GIN–11755	broken bones of reindeer and horse	16,000 ± 130	19,300 ± 160
	IGAN–7582	fragments of bones of hare, fox, reindeer, horse and birds	17,250 ± 45	20,820 ± 80
	LE–7794	hare and fox bones	17,320 ± 640	21,050 ± 800
	IGAN–7581	fragments of bones of hare, fox, reindeer, horse and birds	17,350 ± 45	20,920 ± 60
	IGAN–7583	- // -	17,440 ± 40	21,020 ± 90
Layer Ib	GIN–13083	fragments of bones of mammals and birds	14,600 ± 250	17,800 ± 320
	GIN–11754	- // -	16,600 ±140	20,050 ± 200
	LE–11703	horse scapula	17600 ± 300	21,360 ± 400

Layer I	IGAN–7585	?	13,250 ± 35	15,910 ± 70
	GIN–13084	broken bones of reindeer and horse	15,600 ± 400	18,960 ± 450
	IGAN–7584	?	16,570 ± 45	20,020 ± 80
	IGAN–7590	broken bones of reindeer and horse	16,800 ± 40	20,320 ± 70
Layer II	IGAN-7576	?	18,190 ± 45	22,150 ± 70

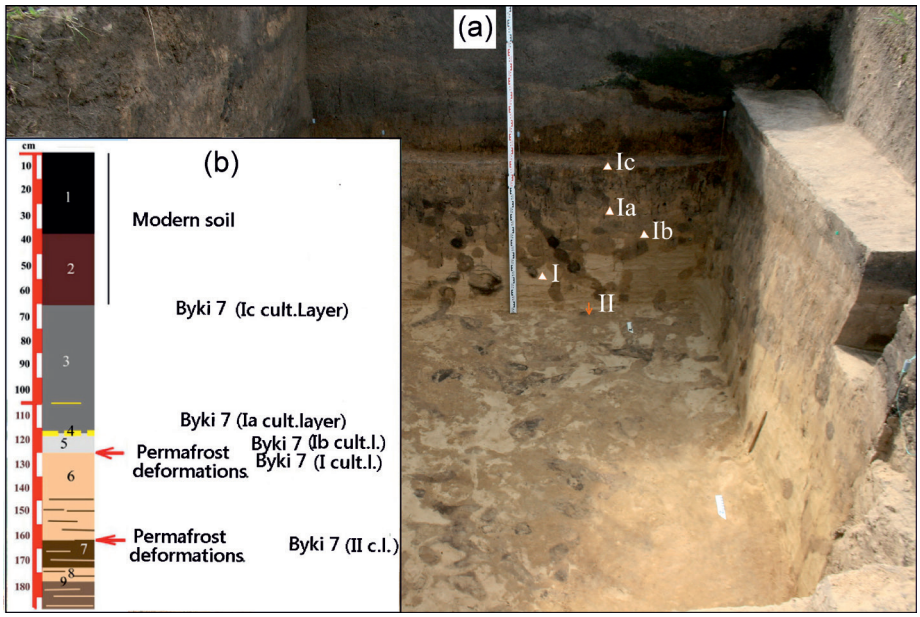


Fig. 2. The photo of the east, south and west walls of the Byki 7 site excavation (a) and the diagram with the position of the cultural layers of the Byki sites on a generalized stratigraphic column (modified after Akhmetgaleeva and Burova (2021). The photo of the excavation was provided by N.B. Akhmetgaleeva

Geology

Byki 7 is a multilayer site that includes the following cultural layers: Ic, Ia, Ib, I, II. (Fig. 2).

The following geological horizons are detected at the sequence exposed at the site Byki 7 (from the top downwards) (Fig. 2) (Akhmetgaleeva and Burova 2021):

1–recent (modern) soil A horizon (thickness – 0.5-0.60 m)

2–recent (modern) soil B horizon (thickness – 0-0.40 m)

3–grey-brown loessic sandy clay (thickness – 0.50-0.80 m).

Cultural layer Ia forms the lower part of this horizon)

4– greenish sand lenses (thickness - 0 – 0.06 m)

5– brown clay loam (thickness - 0.10-0.25 m), with two generation of cryogenic wedges. Cultural layer Ib is from this horizon

6– yellow sand with clay loam strata in the lower part (thickness - 0.05-0.55 m). Cultural layer I is from the top of this horizon, and cultural layer II, from the base

7–brown laminated clay loam (thickness - 0.1-0.5 m)

8–laminated sands (thickness - 0.2 m).

Cryogenic deformations are located between the horizons 5 and 6, as well as between the horizons 6 and 7.

Time interval

The time interval for the "Bykovian" archaeological culture existence in Byki 7 site is estimated as ~22.2–17.0 ka BP. The single date only falls outside the upper limit of this interval (IGAN–7585, Table 1). The interval corresponds to the "cold" Greenland Stadial 2.1 (2.1c – 2.1b) (Rasmussen et al. 2014) and the end of R1 and the beginning of R2 retreat phases of the Scandinavian Ice Sheet (Boulton et al., 2001). During the retreat phase R2, it was a large net and retreat in the southern sector of the Ice Sheet whilst the eastern sector was probably stationary or advancing to the maximum extent (Boulton et al., 2001; Demidov et al., 2006). According to conceptions of different authors Last Glacial Maximum (LGM) duration covered the wide time interval: 26.5–20 (19) ka BP (Clark et al., 2009), 25–23 ka BP (Velichko et al. 2011), 25–20 ka BP (Patton et al. 2017), 22–20 ka BP (Boulton et al. 2001), 22–18 ka BP (Ehlers and Gibbard 2008), 20–15 ka BP (Svendsen et al. 2004), 18–16 ka BP (Demidov et al., 2006). The time of the coldest interval of the Last Glaciation differs depending on the accepted data proxy. According to Greenland oxygen isotope (δ18O) series, the maximum cooling may be corresponded to the stadial GS-3 (27.54–23.34 ka b2k) (Rasmussen et al., 2014). If the marine benthic δ18O series is used as the data proxy (Lisiecki and Raymo 2005), the most cooling period is defined between 22 and 17 ka BP or even between 20 and 18 ka BP. P.U. Clarke et al. (2009) suggested that the duration of the maximum extent of most global ice sheets correlated with the global sea-level lowstand. Thus, the maximum cooling possibly began after the maximum expansion of ice sheets. S.O. Rasmussen et al. (2014) did not define the Last Glacial Maximum and the Late Glacial at all within the INTIMATE stratigraphical scheme, in contrast with such intervals as the Bølling-Allerød and the Younger Dryas chronozones. The different authors' opinions make us use the concepts of the LGM with caution, as well as the Late Glacial Transition, in applied palaeozoological studies. In this study we correlate the time of "Bykovian" archaeological culture existence within the second part of the Late Glacial Maximum before the "Lateglacial" sensu stricto. The last one is defined in different ways: 16–10 ka BP (Nakagawa et al. 2021), 15–12 ka BP (Nenasheva 2013), 15–11.5 ka (Doughty et al. 2012), 14.7–11.7 ka BP (Asch et al. 2013; Šeirienė et al. 2021). Thus, since the dates of Byki 7 temporal interval falls within the 22-17 ka BP, we put this interval within the Late Glacial Maximum (LGM).

Fossil material

About 1800 small mammals (Lagomorpha and Rodentia) remains were found in the three cultural layers (Ia, Ib and I). The fossil material was studied with SMC 4, ASKANIA binocular microscope and with reference material stored at the Institute of Geography Russian Academy of Sciences. Approximately 600 teeth of Lagomorpha and Rodentia were identified up to the species level. The bone material is heavily mineralised and difficult to clean. A significant number of mandibles and maxilla's with well-preserved molars indicate that the material have not been transported over a large distance.

RESULTS

Large mammals

The large mammal remains from the site Byki 7 site were investigated by N.B. Burova (Akhmetgaleeva and Burova 2021) who indicated that ancient men mainly hunted for: broad-fingered horse *Equus ferus* Boddaert, 1985, reindeer *Rangifer tarandus* (Linnaeus 1758), arctic fox *Vulpes (Alopex) lagopus* (Linnaeus 1758), and Don hare *Lepus tanaiticus Gureev*, 1964. Remains of mammoth *Mammuthus primigenius* (Blumenbach 1799), woolly rhinoceros *Coelodonta antiquitatis* (Blumenbach, 1799), and bison *Bison priscus* Bojanus, 1827 are extremely rare. The fossil assemblages includes, in addition, a small nubber of remains of wolf *Canis lupus* Linnaeus, 1758, brown bear *Ursus arctos* Linnaeus, 1758, wolverine *Gulo gulo* (Linnaeus 1758), and polecat *Mustela (Putorius) eversmanni* (Pallas 1779).

Small mammals

The cultural layers Ia,Ib, and I yielded small mammal remains: there are so far no small mammal remains found in the layers Ic and II are so far lacking. The majority of the small mammal finds are from the cultural layers Ia and Ib; only very few Lagomorpha and Rodentia remains derived from the cultural layer I (Table 2).

The analysis of the BYKI 7 small mammal fauna resulted in the following data: remains of 11 rodent and lagomorphs species have been found in the upper cultural layer Ia and 8 species in cultural layer Ib, respectively (Table 2). Remains of only two species were detected in the cultural layer I: steppe pika Ochotona pusilla (Pallas, 1769) (5) and collared lemming Dicrostonyx torquatus (Pallas, 1778) (Table 2).

Byki 7 fauna includes the subarctic collared lemming *Dicrostonyx torquatus* and the Siberian lemming (*Lemmus sibiricus* (Kerr, 1792)), as well as many steppe species, and one subaquatic species (*Microtus oeconomus* Pallas, 1773). A composition that is characteristic for the majority of late Palaeolithic faunas in Eastern Europe which includes often also Subarctic species. Remains of forest species which prefer a forested biotope, the common inhabitants of the modern forest-steppe zone, are not represented in the Byki 7 fauna (Table 2).

The collared lemming is a typical inhabitant of the modern dry, and well drained, tundra a biotope that occurs from the White Sea in the West to Chukotka in the East of Eurasia. During the Last Glacial Maximum (LGM, MIS2, 28.6–22.5 ka BP), the range of this species was larger, including the British Isles in the west and it expanded southward in Eastern Europe to 48° N, and in Western Europe up to 45° N (Fig. 3a). During the Lateglacial, the range of collared lemming decreased; its remains were found in the Desna R. Basin and in the south of the Urals. During the Bølling–Allerød interstadial (14.7–12.9 ka BP) the range of the collared lemming began to degrade: the species only occurred in the isolated areas in Western Europe (a.o. in the south of the British Isles), in the upper basin of the River Don, as well as in the Urals (Smirnov 1996; Markova et al. 2019; Ponomarev and Puzachenko 2015). At the end of Pleistocene, collared lemming did not longer inhabit Eastern Europe, except for the Urals. In Western Europe, isolated findings are known from the Rheine Basin and from the British Isles (Markova et al. 1995; 2019).

Table 2. Species composition of small mammals from cultural layers 1a and 1b of the Byki 7 site

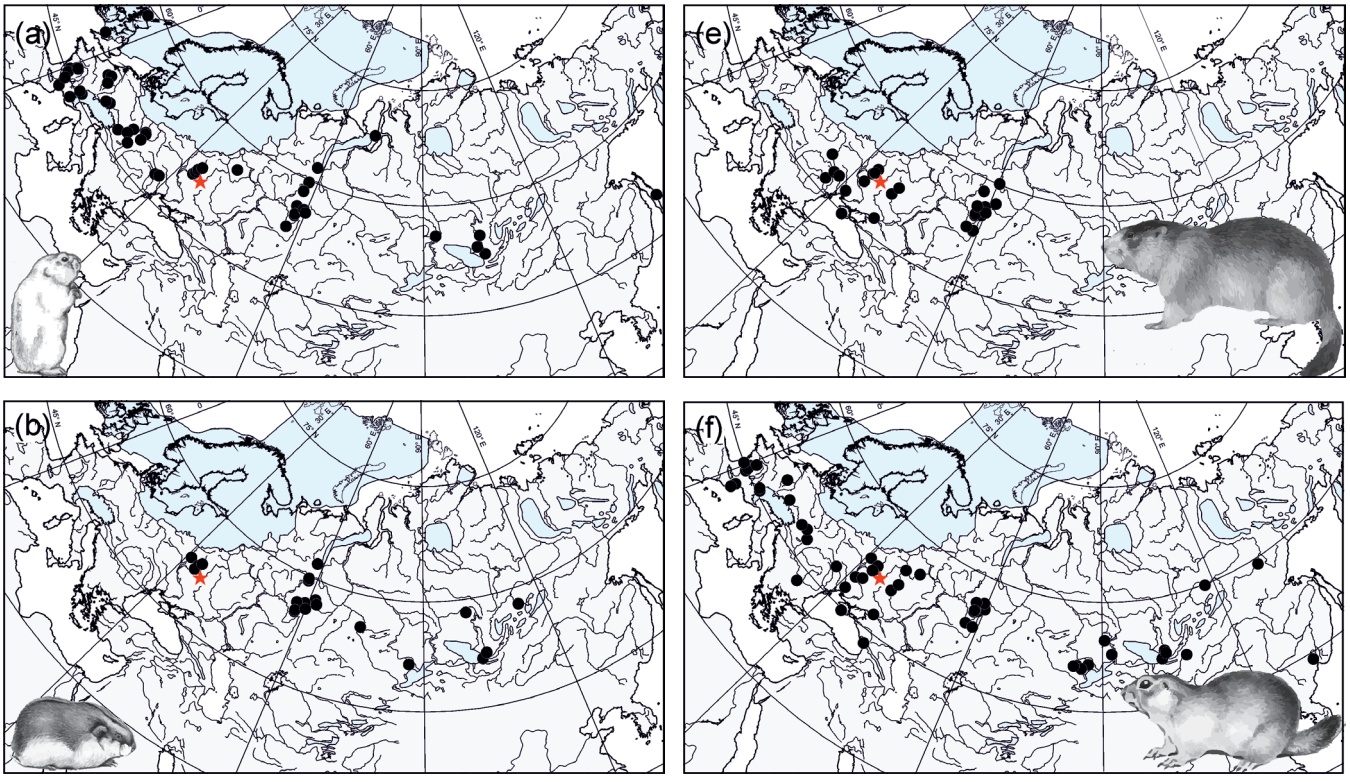
Species	Cultural layer Ia		Cultural layer Ib	
	N	%	N	%
Lagomorpha – lagomorphs				
Ochotona pusilla Pallas, 1762 – steppe pika	75	35,55	120	41,20
Rodentia – rodents				
Marmota bobac Müller, 1776 - bobac-marmot	1	0,47		
Spermophilus sp. – ground squirrel	12	5,68	1	0,34
Spalax microphthalmus Gueldenstaedt, 1770 – Russian mole rat	8	3,79	2	0,68
Ellobius talpinus Pallas, 1770 - Northern mole-vole	3	1,42		
Cricetus cricetus (Linnaeus, 1758) – East European hamster	8	3,79		
Lemmus sibiricus (Kerr, 1792) – Siberian lemming	13	6,16	15	5,10
Dicrostonyx torquatus Pallas, 1778 – collared lemming	14	6,64	15	5,10
Lagurus lagurus (Pallas, 1773) – steppe lemming	4	1,90		
Microtus (Alexandromys) oeconomus Pallas, 1776 – root vole	3	1,42	6	2,04
Lasiopodomys (Stenocranius) gregalis (Pallas, 1779) – narrow-skulled vole	70	33,18	130	44,18

The presence of only a few collared lemming remains in the Byki 7 small mammal assemblage (Table 2), indicates a significant geographical distance between this site and the borders of Valdai ice sheet (~ 440 km). It should be noted, that the collared lemming is a dominant in the assemblage from the Late Palaeolithic Yudinovo site (Sudost River basin) with a comparable age (Markova 1995). The explanation is the fact that the Yudinovo site is located closer to the border of Valdai ice sheet (only ~270 km) (Fig. 1). That points out unfavourable, too arid conditions for this species as evidenced by some climate reconstructions (Ludwig et al. 2016; Višnjević et al. 2020).

During the second half of the Late Pleistocene, the range of Siberian lemming expanded south- and westward (Fig. 3b). The Siberian lemming is represented in the fauna of Byki 7 site, though the number of remains is very low (Table 2). During the LGM the lemming inhabited Upper Dnieper River basin at ~ 50º N, and in the Urals at ~ 54º N. During the Lateglacial, the Siberian lemming inhabited the Upper Dnieper River. basin and the Mid-Urals (Markova et al. 2019). Nowadays, the species inhabits the Eurasian tundra and forest-tundra, and prefers moist bushy, sedge, cotton sedge and moss tundra (Gromov and Erbaeva, 1995).

The steppe pika and narrow-skulled vole *Lasiopodomys (S.) gregalis* (Pallas, 1779), are dominant in the assemblage from all the Byki 7 cultural layers. The steppe pika is a typical representative of open landscapes (steppes, forest-steppes and semi-deserts). Nowadays, it inhabits the rocky slopes of ravines and gullies covered with bushes and open areas with Chernozem or sandy clay soils along the forest edge. The species occurs in the area that stretches from Middle Volga R. Basin (Samara Region) to the foothills of the Altai Mountain range. During the second part of the. During LGM time steppe pika expanded its range far to the west and even reached the British Isles. The species was an indicator of periglacial landscapes that covered significant European areas (Markova et al. 2019) (Fig. 3c). The species was an indicator of periglacial landscapes that covered significant European areas (Markova et al. 2019). During the Lateglacial, the range of steppe pika decreased slightly, and its westernmost occurrence was in the northern foothills of the Alps, at 5º E (Markova et al. 2019). In Central Europe, this species was widespread between 50–60ºN. In Eastern Europe the steppe pika inhabited the Dniester, Dnieper, Desna and Don River' basins, and the Crimea (Fig. 3c), as well as the Urals (Markova 2011; Markova et al. 2019).

The narrow-headed vole *Lasiopodomys (S.) gregalis* was one of the dominant species in the Byki 7 small mammal fauna. Nowadays, the species inhabits variety open landscapes. The northern subspecies *L. (S.) gregalis major* Ognev, 1923, is an inhabitant of the tundra biotope. It is endemic to this natural zone, where it forms quite large colonies (Sheftel et al. 2020). During the Pleistocene, the narrow-skulled vole was a representative of the mammoth fauna that was widely distributed during the glacial epochs, when periglacial steppe and tundra-steppe prevailed (Markova et al. 1995; 2019; Markova and Puzachenko 2007). Low temperatures were in no way a hurdle for this animal. The species was widely distributed during the interglaciations in steppe and forest-steppe zones, as well as during glaciations in periglacial steppes and tundra-steppes (Markova et al. 1995; 2019; Markova and Puzachenko 2007). The remains of narrow-headed vole are present at almost all Late Palaeolithic sites and Late Pleistocene localities of Eastern Europe (from the Black Sea coast to the Subarctic Region) (Agadjanian, 2009, Rekovets, 1973; Markova et al. 2019; Baryshnikov and Markova 2002). The range of this species covered huge territories: during LGM it reached the British Isles in the west (Fig. 3d). In the Lateglacial the range of the narrow-skulled vole was also quite broad and differed insignificantly from its area during the LGM. The expansion of its range was connected with the wide prevalence of open periglacial landscapes and the degradation of the continuous forest zone in Europe during the period of the Last Glaciation.



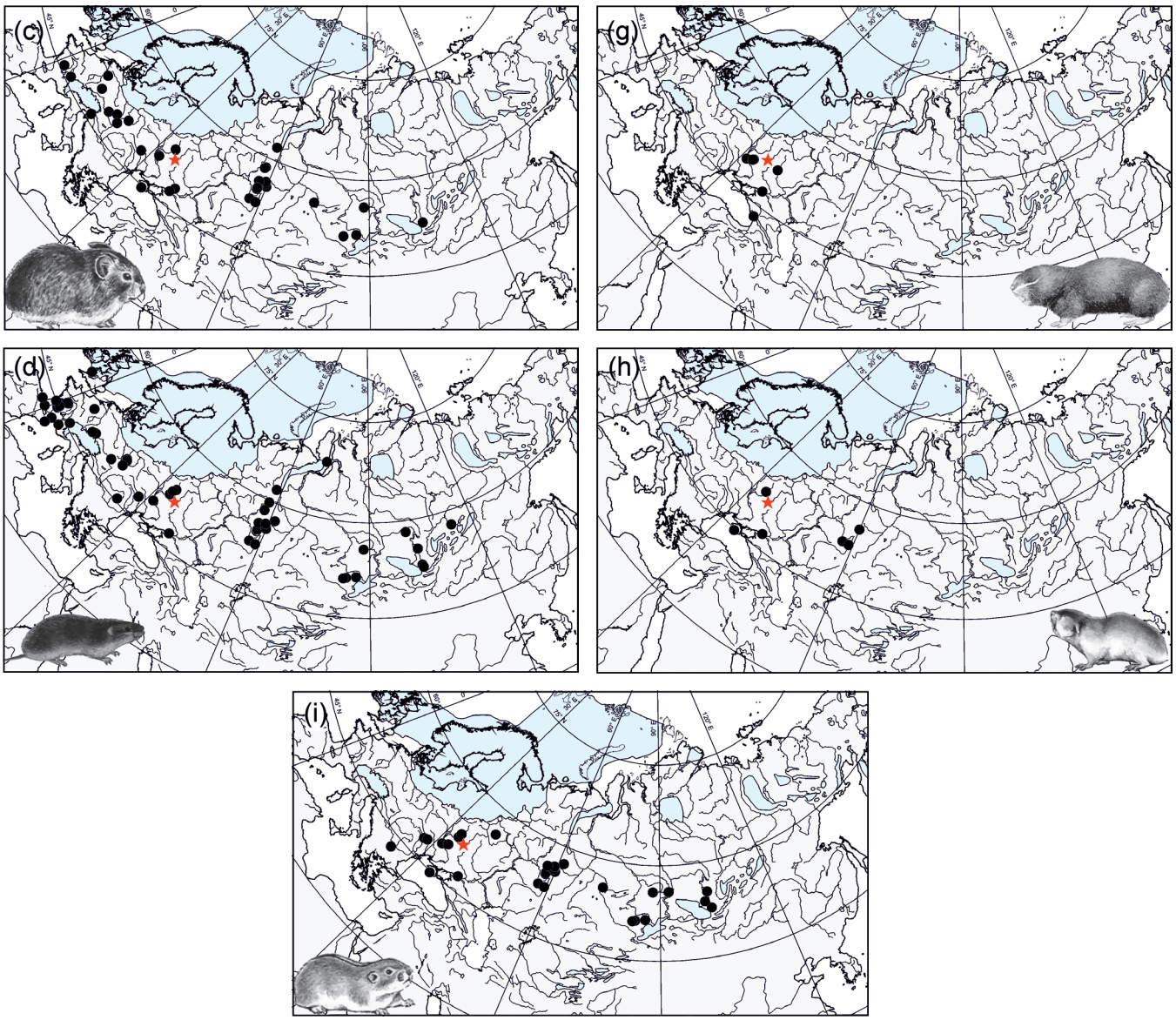


Fig. 3. a – The European localities of *Dicrostonyx torquatus* (a), *Lemmus sibiricus* (b), *Ochotona pusilla* (c), *Lasiopodomys S gregalis*, (d), *Marmota bobac* (e), *Spermophilus sp.* (f), *Spalax microphthalmus* (g), *Ellobius talpinus* (h), and *Lagurus lagurus* (i) during the occupation of the Byki 7 site (the maps were prepared by the authors of this article). The red asterisk indicates the location of the Byki 7 site. The blue contours indicate the borders of the Scandinavian Ice Sheet and mountain glaciations during the Valdai Glaciation Maximum (LGM) (Svendsen et al. 2004; Velichko 2009)

Other small mammals which are the typical inhabitants of the open landscapes have few numbers of remains (Table 2). In cultural layer Ia, one mandible of the bobac-marmot *Marmota bobac* Müller 1776 was found. This species inhabits the modern steppe and forest-steppe zones of Northern Eurasia. Its historic range spanned from Hungary to the Irtysh River basin. Its preferred habitats are cereal-forb steppes. The bobac-marmot is an intensive digger; the tunnels (krotovinas) they make, during the winter time, are up to 7 meters deep and their dwellings are 2-3 meters below the surface (Gromov and Erbaeva 1995). The presence of the bobac-marmot in the Byki 7 fossil assemblage indicates the absence of permafrost during human occupation of the site. Bobac remains are known from Late Pleistocene faunal assemblages from localities in the south of the Russian Plain, the Crimea, the Mid- and Southern Urals, and in Kazakhstan (Markova 1995, 2011; Markova et al. 1995) (Fig. 2e).

Remains of ground squirrels (*Spermophilus* sp.) are rare in the layers Ia and Ib (Table 2). Ground squirrels inhabit forest-steppe, steppe, and semi-desert zones. During the Late Pleistocene the geographical range of the ground squirrels expanded west- and southward due to the wide dispersal of various types of open landscapes - periglacial tundra-steppe and steppe (Markova et al. 2019) (Fig. 2f).

Greater mole-rat *Spalax microphthalmus* Gueldenstaedt, 1770 is also a characteristic representative of the forest-steppe and steppe faunas. Nowadays, it inhabits an area that stretches from the Caucasus foothills in the south up to the border of the forest zone in the north of the Russian Plain. The mole rat is a fossorial species lives underground except young growth period. Its nests may be located at a depth of 3–4 meters below the surface (Topachevsky 1969). Their presence in the fossil record of the Byki 7 cultural confirms the absence of continuous permafrost during time of deposition. Fossil, Late Pleistocene, remains are known from many localities and sites of Eastern Europe (Fig. 2g), but the amount of the remains was always insignificant (Markova et al. 2019).

The Northern mole-vole *Ellobius talpinus* Pallas, 1770 is a typical representative of faunas that inhabit steppes and semi-deserts. It prefers to dwell in habitats with unconsolidated soils. The species inhabits the steppe zone of Eastern Europe, the Trans-Urals, Kazakhstan, and the Central Asian foothills. Northern mole-vole is fossorial animal and its burrows reach to a depth of 0.5 meters

(Gromov and Erbaeva 1995). The Late Pleistocene fossil record demonstrates that the mole-vole occurred during the Pleistocene in Eastern Europe (including the Crimea) and the Fore-Caucasus (Markova 2011; Markova et al. 2019) (Fig. 2h). The Late Palaeolithic Byki 7 fossil, found at ~ 51^0 N is an exception in the Eastern European record. A few *E. talpinus* remnants are known from the site Yudinovo, another Late Palaeolithic site on the Central Russian Plain (Markova 1995).

Only 4 specimens of the steppe lemming, *Lagurus lagurus* (Pallas, 1773) were found in cultural layer Ia (Table 2). This animal is a typical inhabitant of open landscapes (forest-steppes to semi-deserts). Nowadays, the steppe lemming prefers to live in a herb-bunch grass steppe, a feather-fescue steppe, and a sagebrush steppe. Burrows of this species reach to a depth of 50-60 cm (Gromov and Erbaeva 1995). The phylogeny of the steppe lemmings during the last 1.5 Ma is rather well-know due to the studies of the fossil record from several Early– Late Pleistocene localities (Markova 1974, 1982, 2006, 2011, 2017; Rekovets 1994; Topachevsky 1965; Terzea 1995; Janossy 1986). It should be mentioned, that the Pleistocene steppe lemmings' remains are found in interglacial, as well as in the glacial faunas. During glacial periods (including the Valdai Glaciation), the range of the species expanded to the north as well as to the west, while during the interglacial periods, the northern border of its distribution area shifted south- and eastward (Fig. 2i). The latter was caused by the formation of a continuous forest zone during the warmer interglacials. The steppe lemming is represented by a great number of remains at most Late Palaeolithic sites located in the area of the Russian Plain and the Crimea (Markova et al. 1995, 2019). However, at the Byki 7 site steppe lemming remains were only found in one layer and in low numbers.

DISCISSION

The analysis of small mammals from the Site Byki 7 allows a palaeoenvironmental reconstruction. The fauna belongs to the so called "mixed" or "non-analogue" faunas that were widely distributed during the Valdai (= Vistulian) Glaciation, and during previous Pleistocene glacial periods (Dnieper, Oka, Don glaciations) (Agadjanian 2009; Baryshnikov and Markova 2002, 2009; Vereshchagin 1979; Rekovets 1994; Markova and Puzachenko 2007; Markova et al. 2019). The species composition of the "non-analogue" faunas consists of species that occur nowadays in different natural zones, steppe and tundra in particular. Species that usually inhabit forests are absent, or occur in very small quantities. Middle and Late Palaeolithic sites as well as non-archaeological sites dates to the second part of Late Pleistocene located on the Russian Plain yield this kind of "non-analogue" faunas (Markova et al. 1995, 2019; Markova and Puzachenko 2007). These faunas reflect the broad prevalence of open landscapes – periglacial tundra-steppes, periglacial tundra-forest-steppes and periglacial steppes. Zones with continuous forest did not exist during that glacial epoch. The dispersal of steppe animals to the far north indicates the absence of a continuous forest zone at that time (Grichuk 1989). The forest species survived in refugees in mountainous areas where a variety of environments occur and in the river valleys. The presence of the high number of large herbivores, extinct by the end of the Pleistocene – beginning of the Holocene, also characterise these "non-analogue" assemblages. The huge geographical range of many tundra species during the second part of the Late Pleistocene, indicates cold climatic conditions and the wide distribution of periglacial types of vegetation in Northern and Central Europe. Steppe animals also extended their ranges and migrated to the open landscapes in north as well as to those in the west. The open landscapes were favourable for such assemblages.

It is important to keep in mind, that small mammal species that prefer to live in a forested environment are lacking. Nowadays, southern forest steppes prevail the region and not only steppe, but also forest species are well represented (Table 3), but the last group was totally absent during the LGM. The number of remains of subarctic species (collared and Siberian lemmings) in the Byki 7 assemblage is low in comparison to other Late Palaeolithic sites on the Russian Plain. At the Yudinovo site, with radiocarbon dates close to those of the Byki 7 site, subarctic species were predominated (Markova 1995). At the Byki 7 site their number is only ~11–12 % of all small mammalian remains (Table 3). An explanation could be the significant distance between the site and the border of the Valdai ice sheet (Fig. 1). As mentioned above, the dominant small mammal species at Byki 7 are typical representatives of open landscapes, steppe pika and narrow-skulled vole. These species are well adapted to the low temperatures that characterize the second half of the Late Pleistocene. However, the determining factor of their occurrence was the presence of open landscapes with periglacial tundra-steppe, forest-steppes and steppes.

Table 2. Lagomorphs and rodents from the cultural layers of the Byki 7 site (Kursk Region)

Small mammals from Byki 7 site				Present time	Proposed ecology in the Late Pleistocene
Species	Cult. layer Ia	Cult. Layer Ib	Cult. Layer I		
Lagomorpha – lagomorphes					
Lepus europaeus – European hare				+	Steppe, forest-steppe
Lepus tanaiticus – Don hare (N.D. Burova' definition)	+				Steppe, tundra-steppe
Ochotona pusilla – steppe pika	+	+	+		Steppe
Rodentia – грызуны					
Sciurus vulgaris – Eurasian red squirrel				+	Forest
Marmota bobac – bobac-marmot	+			+	Steppe
Spermophilus suslicus – spotted ground squirrel				+	Steppe
Spermophilus sp. – ground squirrel	+	+			Steppe, periglacial steppe

Castor fiber – Eurasian beaver				+	Aquatic biotopes
Sicista severtzovi – Severtsov birch mouse				+	Steppe
S. subtilis – southern birch mouse				+	Steppe
S. strandi – Strandi birch mouse				+	Steppe
Allactaga major – great jerboa				+	Steppe, periglacial steppe
Cricetus cricetus – European hamster	+			+	Steppe, periglacial steppe
Spalax microphthalmus – greater mole rat	+			+	Steppe, forest-steppe, periglacial steppe
Ellobius talpinus – Northern mole-vole	+				Open landscapes of different types
Mus musculus – house mouse				+	Steppe
Micromys minutus – dwarf mouse				+	Steppe, glades
Sylvaemus uralensis – small forest mouse				+	Forest
S. flavicollis- yellow-necked mouse				+	Forest
Apodemus agrarius –striped field mouse				+	Floodplain meadows, meadows
Dryomys nitedula – forest dormouse				+	Forest
Arvicola amphibius – water vole				+	Hydrogenous biotopes
Clethrionomys glareolus – bank vole				+	Forest
Lagurus lagurus – steppe lemming	+			+	Steppe, periglacial steppe
Dicrostonyx torquatus – coloured lemming	+	+	+		Dry tundra
Lemmus sibiricus – Siberian lemming	+	+			Wet tundra
Microtus arvalis – common vole				+	Meadows
M. rossiaemeridionalis – East European vole				+	Meadows
M. (Alexandromys) oeconomus – root vole				+	Hydrogenous biotopes, Meadows
Lasiopodomys (Stenocranius) gregalis – narrow-headed vole	+	+			Open landscapes of different types including periglacial tundra-steppe and periglacial steppe

CONCLUSIONS

The fossil mammal data from the site Byki 7 indicate the occurrence of periglacial steppes in the central part of the East European Plain. The fact that the site is located relatively far from the borderline of the Valdai ice sheet (~440 km) impacted the fauna composition. Typical tundra species are present in small quantities in the Byki 7 assemblage whereas the steppe species dominate and forest species are absent.

Our data indicate that during the LGM a periglacial mesic and dry tundra-steppe with wormwood-haze steppe vegetation, sparse pine-birch forests with alder (Alnus), fir (Picea), pine (Pinus) and Asteraceae, Cichoriaceae, Sphagnum, Polypodiaceae, etc prevailed in the centre of East European Plain. The rich mammal assemblage included: woolly mammoth, woolly rhinoceros, primitive bison, reindeer, broad-fingered horse, saiga, cave lion, brown bear, fox, arctic fox, steppe lemming, bobac-marmot, ground squirrel, mole rat, Northern mole vole, collared and Siberian lemmings (Dicrostonyx and Lemmus), steppe and yellow lemmings, narrow-headed vole, etc.

Based on result of this study, a moderate climate is proposed during ancient men settled the site Byki 7.

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