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Biostratigraphy of the Late Palaeolithic site of "Bajslan-Tash cave" (the Southern Urals)

Anatoly Yakovlev[a], Guzel Danukalova[a,*], Pavel Kosintcev[b], Liliana Alimbekova[a], Evgenija Morozova[a]

[a]*Institute of Geology, Ufa-Scientific Centre, Russian Academy of Sciences K. Marx St., 16/2, 450000 Ufa-centre, Bashkortostan, Russia*
[b]*Institute of Ecology of Plants and Animals, Ural Branch, Russian Academy of Sciences, 8th March st., 202, 620008 Ekaterinburg, Russia*

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Abstract

The Bajslan-Tash cave locality is situated in the southern part of the Urals in the Belaja River valley (Russian Federation). The post-glacial period of environmental development of the Southern Urals is represented in the Bajslan-Tash cave site. Unconsolidated sediments were studied with the help of faunal, palynological and radiocarbon methods. Descriptions of the unconsolidated deposits of the cave are given in this article. Preliminary results of a stratigraphical subdivision of the investigated sediments and palaeo-environmental reconstructions are submitted.

1. Introduction

The Bajslan-Tash cave is situated along the Belaya River in the extreme south of the Urals (Fig. 1). Late Cenozoic deposits of this territory have not been studied before. Only limited data were obtained during geological mapping and archaeological expeditions (Obydennov, 1997) because the mountainous part of the Urals is difficult to access.

The Bajslan-Tash cave was discovered and first described by Lepekhin (1772) in 1770. Detailed biostratigraphical and archaeological investigations in this cave were made only in 1999 on the occasion of the building of the Yumaguzino reservoir.

A comprehensive study of the Late Quaternary Bajslan-Tash cave locality with faunal and floral finds was the aim of these investigations. Such geological information is necessary for the reconstruction of the palaeoenvironment and may promote the preservation of this unique locality. The following points were determined: the stratigraphic disjunction of the deposits and radiocarbon dating of separate stratigraphical horizons, the reconstruction of the history of the vegetation associations and the determination of the species composition of different faunal groups (large and small mammals, molluscs).

2. Methods

Material for the investigations was collected during joint-cooperation field work in 1999–2000 with archaeologists of the Institute of History, Language and Literature of Ufa Scientific Centre, Russian Academy of Sciences. The excavations and sampling for palynological, faunal and radiocarbon investigations were executed according to standard methods (Gromov, 1955a,b; Grichuk and Zaklinskaya, 1948; Pokrovskaya, 1950, 1955; Arslanov, 1987). The soil was taken from the excavation pit in splits of 15–20 cm and then washed and sieved (0.8–1.0 mm) (Agadjanyan, 1979; Zhadyn, 1952) and separated by water plant (Guslitcer, 1979; Synitckikh, 1982). The base of calculation of the percentages for the various taxa is the sum of all pollen grains and spores (100%) in the sample. Species determination was done according to the "Mammals catalogue of the USSR" (1981), Zhadyn (1952), Likharev and Rammelmeier (1952) and Starobogatov (1970). Radiocarbon data were determined by the Geochronological Laboratory of the Geological Institute (GIN) RAS (Moscow) and the Institute of Evolutionary

*Corresponding author.
E-mail address: danukalova@anrb.ru (G. Danukalova).

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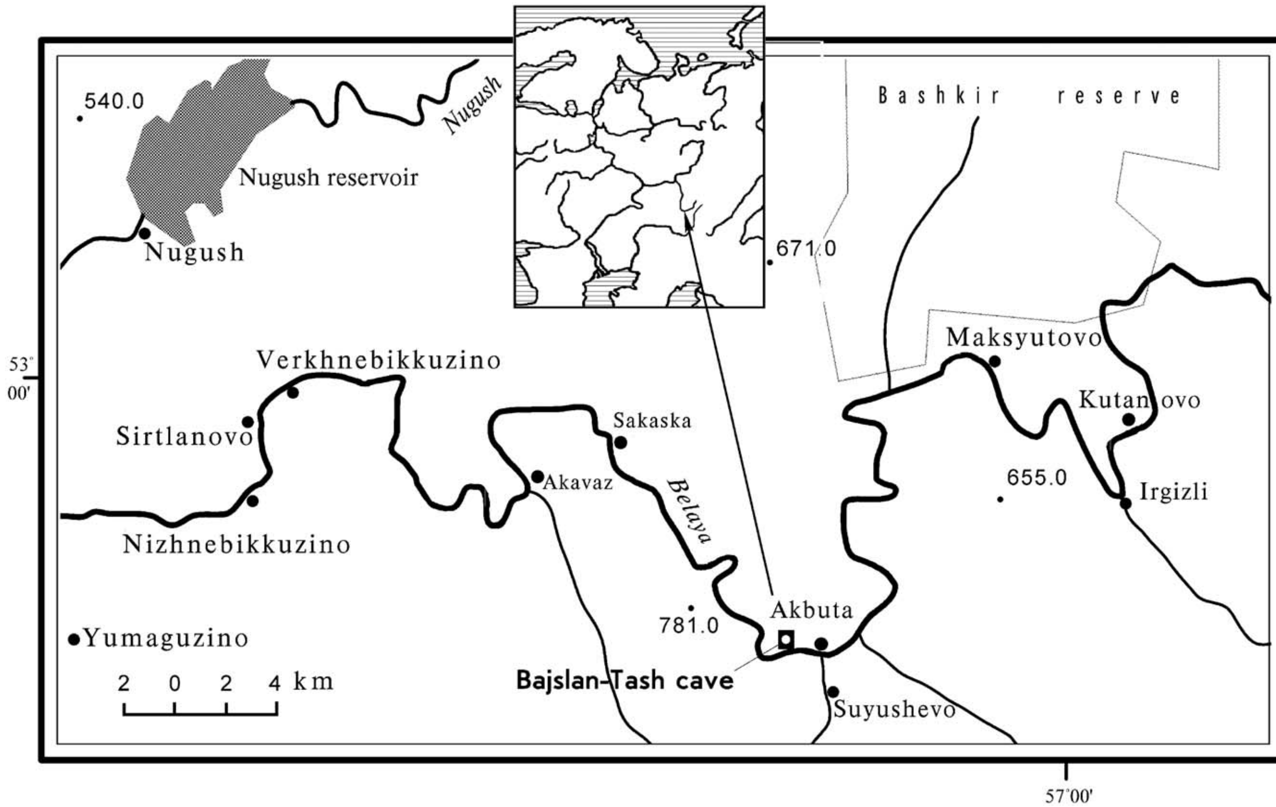

Fig. 1. General scheme of the territory and area map with the location of the Bajslan-Tash cave.

Morphology and Ecology of Animals (IEMEZH) RAS (Moscow).

3. Site description

The Bajslan-Tash cave is situated at the base of a rock in the surroundings of Akbuta village on the right bank of the Belaya river. The rock is of lower carboniferous (Vise stage) dark grey massive limestone. The entrance to the cave has a southeasterly exposure (Figs. 2, 3).

The excavation was made in the entrance of the cave by V.G. Kotov. Artefacts from the Late Palaeolitic to the Early Iron Age were found.

4. Stratigraphy and sampling

The following eluvial-slope deposits formed this section, from top to bottom (Fig. 4):

Upper Holocene:

1. Brown-grey and grey humid loam with separate (length 10–15 cm) limestone rock debris and rock debris lens (thickness 0.4 m).
2. Dark-grey humid loam with limestone rock debris (length 20 cm) and charcoal (thickness 0.95 m).

Middle Holocene:

3. Brown-grey sandy loam with limestone rock debris (0.5–1 m) (thickness 0.9 m).

Upper Neopleistocene–Lower Holocene:

4. Brown loam with limestone rock debris and blocks. In the middle part of this layer Late Paleolithic artefacts were found (thickness 2.25 m).

The Neopleistocene is a unit of the Russian stratigraphical scale. It is correlated with the Middle and lower part of the Upper Pleistocene of southern Europe (Berggren et al., 1995), and with the Cromerian—the Upper Weichselian of The Netherlands (Zagwijn, 1996). Its lower boundary is at the age level 800 Ka, its upper boundary is at the level 10 Ka.

In 1999, the thickness of the unconsolidated deposits in the entrance was found to be nearly 3 m. In 2000, the lower horizons of layer 4 were described to a depth of 4.5 m. In the bottom of the pit huge blocks of limestone were discovered.

5. Results

5.1. Radiocarbon dating

Results of the radiocarbon dating of some stratigraphical intervals of the section are presented below (Table 1). These data permitted identification of the intervals of the Late Neopleistocene–Early Holocene, and the Middle and Late Holocene.

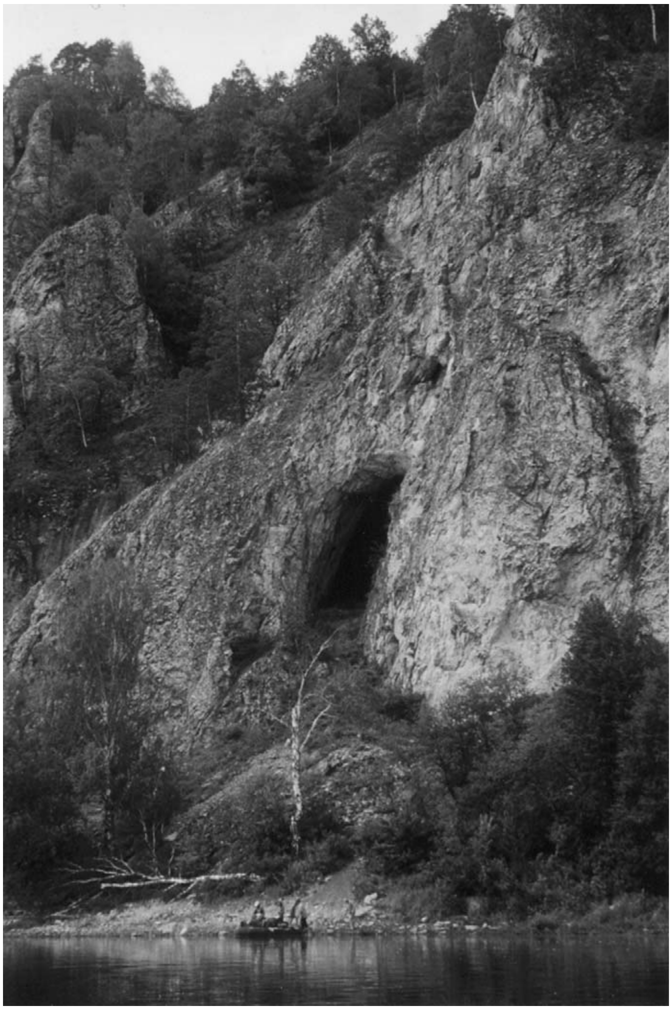

Fig. 2. Bajslan-Tash cave entrance (photo by V.A. Kniss).

5.2. The pollen record

Eighteen samples of unconsolidated deposits from the Bajslan-Tash cave were palynologically investigated. All samples of separated pollen and spores were examined completely. There are 58–381 pollen and spores in samples 1 and 7–18. Pollen and spores in samples 2–6 are single (Fig. 4). Pollen and spore spectra are characterized by very high numbers of Polypodiaceae spores, with the smooth spores prevailing. *Woodsia ilviensis* R.Br. and *Woodsia fragilis* (Trev.) Moore prefer a rocky substratum. *Athyrium filix-femina* (L.) Roth. and *Dryopteris cristata* (L.) A.Yray. are the forest species which prefer moist and boggy coniferous and broadleaved forests. High numbers of Polypodiaceae spores in the spectra could be explained by their immunity to the alkaline conditions of fossilization (Berezina and Turemnov, 1973; Abramova and Berezina, 2002). However, the presence of delicate pollen of Lamiaceae in the spectra testifies to favourable conditions for preservation of both the spores and the pollen. Probably the predominance of the spores was stimulated by the local abundance of ferns on the rocks and in humid gallery forests. The obtained spectra correspond with the forest–steppe types, ignoring the spores (Grichuk, 1950).

Periglacial forest–steppe with a noticeable participation of Asteraceae, Chenopodiaceae and Poaceae were predominant at the end of the Late Neopleistocene–Early Holocene in the cave surroundings. In the Middle Holocene, herbage–*Artemisia*–Chenopodiaceae forest–steppe covered the open woodlands. In the Late Holocene, broadleaved coniferous forests predominated. Gallery forests of *Betula*, *Tilia* and *Alnus* grew in the river valleys, and *Pinus* appeared on the slopes exposed to the south.

5.3. Molluscs

A total of 372 molluscan shells (and fragments) were found and identified from deposits of the Bajslan-Tash cave. The molluscan fauna is represented by terrestrial and freshwater species of Gastropoda and Bivalvia. Several molluscan complexes were described during stratigraphical investigations (the number of each species found is indicated in brackets behind the species name).

Late Neopleistocene–Early Holocene molluscan complex:

Succinia oblonga (Drap.) (3), *Succinia* sp. (1), *Cochlicopa lubrica* (Müll.) (2), *Vallonia costata* (Müll.) (14), *Chondrula tridens* (Müll.) (1), *Nesovitrea hammonis* (Strom) (2), *Pupilla muscorum* (L.) (4), *Euconulus fulvus* (Müll.) (2), *Bradybaea fruticum* (Müll.) (1), *Gyraulus gredleri* var. *borealis* (Loven) (1), *Ancylus fluviatilis* (Müll.) (1), *Pisidium amnicum* (Müll.) (1).

Middle Holocene molluscan complex:

Succinia oblonga (Drap.) (2), *Columella edentula* (Drap.) (2), *Vallonia costata* (Müll.) (5), *Chondrula tridens* (Müll.) (1), *Discus ruderatus* (Ferus.) (3), *Bradybaea fruticum* (Müll.) (8), *Euomphalia strigella* (Drap.) (4), *Anisus* sp. (1).

Late Holocene molluscan complex:

Succinia oblonga (Drap.) (6), *S. putris* (L.) (3), *Succinia* sp. (1), *Cochlicopa lubrica* (Müll.) (8), *Columella columella* (G. Mart.) (2), *Vertigo pygmaea* (Drap.) (1), *Pupilla muscorum* (L.) (4), *Vallonia costata* (Müll.) (95), *Ena montana* (Drap.) (9), *Ena* sp. (3), *Chondrula tridens* (Müll.) (30), *Discus ruderatus* (Ferus.) (3), *Nesovitrea hammonis* (Strom) (2), *Euconulus fulvus* (Müll.) (4), *Bradybaea fruticum* (Müll.) (89), *Euomphalia strigella* (Drap.) (22), *Pseudotrichia rubiginosa* (Schm.) (1), *Ancylus fluviatilis* (Müll.) (1), *Gyraulus gredleri* var. *rossmaessleri* (Auers.) (4), *Gyraulus* sp. (1), *Unio* sp. (10), *Pisidium amnicum* (Müll.) (12), *P. nitidum* (Jenyns) (2).

The Late Holocene molluscan complex is characterized by a greater species variety than are the other complexes. The majority of the land molluscs preferred moist habitats under leaves and rocks on the ground in the cave, under the bark of old trees and stumps, and in grass and bushes. *Succinia oblonga* (Drap.), *Succinia putris* (L.), *Nesovitrea hammonis* (Strom) and *Pseudotrichia rubiginosa* (Schm.) preferred moist meadows and the banks of streams. *Chondrula tridens* (Müll.) lived on the warm and often

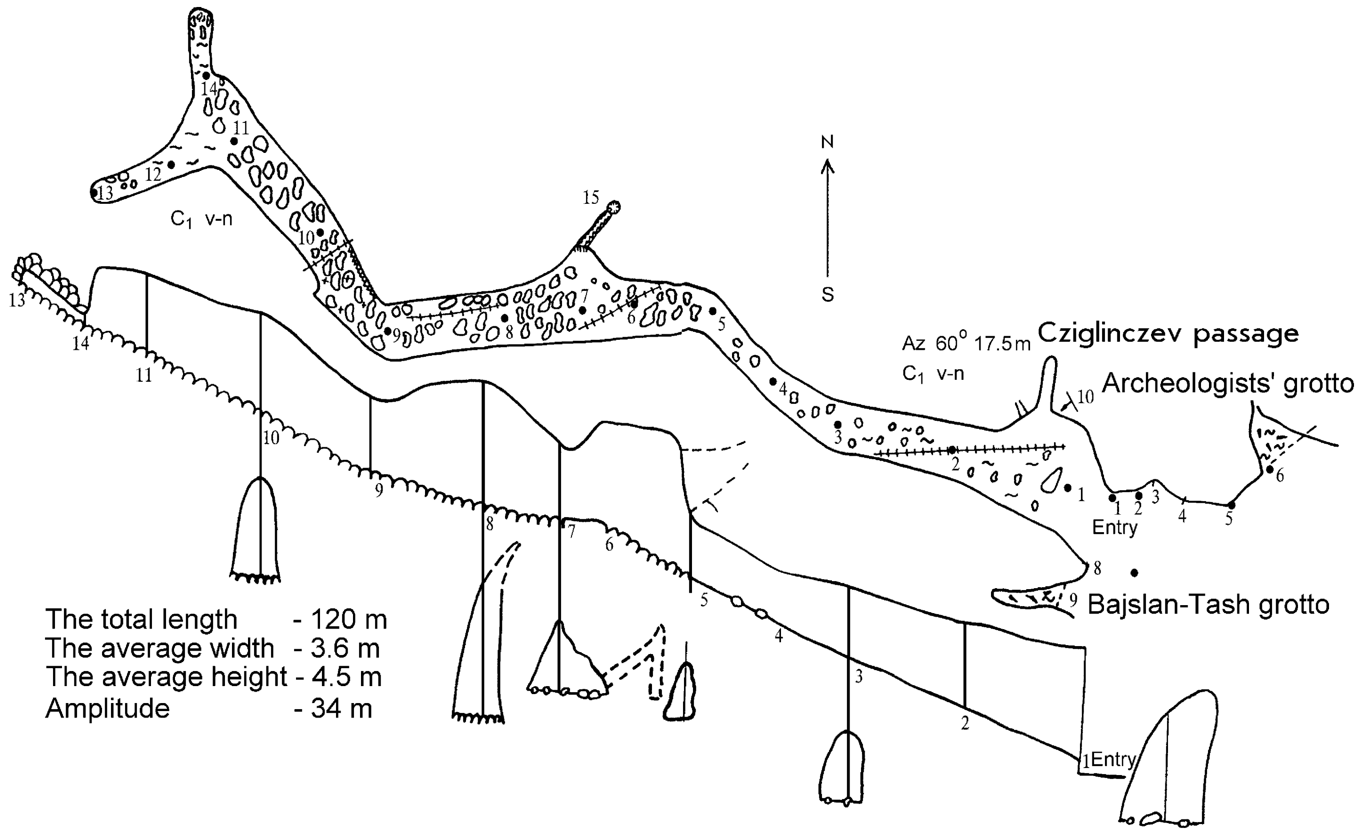

Fig. 3. Bajslan-Tash cave—profile and plan (by A.I. Smirnov, Yu.V. Sokolov, V.I. Martin; unpublished data).

dry slopes. Freshwater molluscs lived on the silty bottom of streams. They could crawl, bury themselves (*Pisidium amnicum* (Müll.), *Unio* sp.), or attach themselves to rocks and water plants (*Ancylus fluviatilis* Müll.). Land molluscs accumulated naturally in the cave deposits. Probably the freshwater molluscs accumulated in the cave as food for animals.

5.4. Small mammals

More than 150,000 bone remains of fishes, reptilia, amphibia, birds and small mammals (chiroptera, insectivora, rodentia, carnivora) were collected from this locality; 18,594 bones of small mammals were recovered (Table 2). The preservation of the bones is good. The bones are light yellow, and accumulated in beds through human and natural agents. The quantity of bones in layers 1 and 2 is two to three times smaller than in layers 3 and 4.

Radiocarbon data (Table 1) and the composition and correlation of small mammal species (Table 2) indicate the following points. The small mammal associations of layers 1 and 2 belong to the Late Holocene fauna (early stages). The number of species from forest biotopes is high in this fauna, including *Clethrionomys* sp., *Sorex* sp., and bats. The number of steppe species is sizeable, because of the southerly position of the locality, and includes *Microtus gregalis*, *Lagurus lagurus* and *Ochotona* sp. The number of steppe species in similar faunas of the Southern Urals located north of this site is considerably smaller (Sukhov, 1978; Smirnov et al., 1990; Yakovlev, 1997, 1998).

The composition and correlation of small mammal species in layers 3 and 4 are very similar. The number of steppe species in these faunas is sizeable (*Microtus gregalis* and *Lagurus lagurus*). The number of *Clethrionomys* sp., *Microtus arvalis*, bats, and insectivores is smaller than in layers 1 and 2. The fauna of layers 3 and 4 is possibly of Late Neopleistocene–Middle Holocene age. Probably the small mammal fauna at the end of the Late Neopleistocene assumed the aspect of the Holocene fauna and essentially did not change during the Early–Middle Holocene. *Lemmus* sp. and *Dicrostonyx* sp. were typical of the Early Holocene and Late Neopleistocene faunas in the Southern Urals (Smirnov et al., 1990; Yakovlev, 1997, 1998; Yakovlev et al., 2000). The absence of these two species in the lower layer of the Bajslan-Tash cave may be caused by the southern location of this site.

5.5. Large mammals

There were several reasons for the accumulation of large mammal bones in the Bajslan-Tash cave. Bones of *Castor fiber*, *Ursus arctos*, *Capreolus pygargus*, *Alces alces*, *Bos taurus*, *Capra* and *Ovis* and *Equus caballus* were included in the deposits as a result of human activity. Bones of *Sciurus*

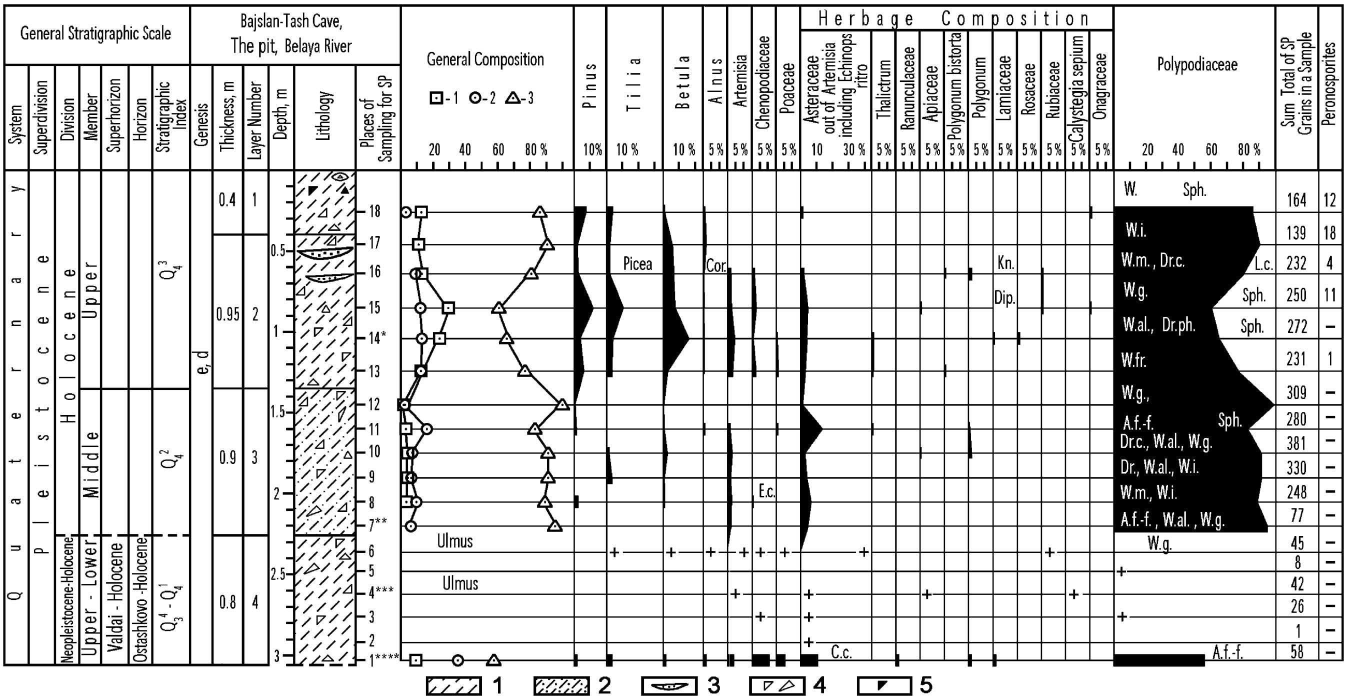

Fig. 4. Bajslan-Tash cave—section showing the sequence of unconsolidated sediments in the cave. The section of the Quaternary deposits and percentage pollen diagrams for the main taxons (by G.A. Danukalova and L.I. Alimbekova). Legend: A.f.-f.—*Athyrium filix-femina* (L.) Roth.; Cor.—*Corylus*; *C.c.—Centaurea cyanus* L.; *Dip.—Dipsacaceae*; Dr.—*Dryopteris* sp.; Dr.c.—*Dryopteris cristata* (L.) A.Yray.; Dr.ph.—*Dryopteris phegopteris* (L.) C.Christens.; *E.c.—Eurotia ceratoides* (L.) C.A.M.; *Kn.—Knautia* sp.; *L.c.—Lycopodium clavatum* L.; *Sph.—Sphagnum* sp.; Ulmus—*Ulmus* sp.; W.—*Woodsia* sp.; W.al.—*Woodsia alpina* (Bolton) Yray.; W.fr.—*Woodsia fragilis* (Trev.) Moore; W.g.—*Woodsia glabella* R.Br.; W.i.—*Woodsia ilviensis* R.Br.; W.m.—*Woodsia manchuriensis* Hook. General composition: 1—trees and bushes, 2—grass, 3—sporophytes. SP—spores and pollen. Radiocarbon data: *—GIN-10852: 1600±50 yr BP; **—GIN-10854: 7140±170 yr BP; ***—IEMEZH-1340: 9616±62 yr BP; ****—GIN-10853: 13560±250 yr BP. Lithology: 1—loam; 2—sandy loam; 3—rock debris lens; 4—limestone rock debris; 5—charcoal. Stratigraphic data: Q_3^4—Upper Neopleistocene, Ostashkovo horizon; Q_4^1—Lower Holocene; Q_4^2—Middle Holocene; Q_4^3—Upper Holocene; e, d—eluvial-slope deposits.

Table 1
Radiocarbon dating results

Sampling places (layers)	Age in yrs BP	Number of specimens	Material
2	1600±50	GIN-10852	Wood coal
3	7140±170	GIN-10854	Bone
4	9616±62	IEMEZH-1340	Bone
4	13,560±250	GIN-10853	Bones of small mammals

vulgaris, *Tamias sibiricus*, *Mustela nivalis*, *M. erminea* and *M. eversmanni* arrived mainly through bird activity. Bones of *Equus* sp., *Rangifer tarandus* and *Bison priscus* are prey remains of predatory animals. Bones of *Lepus* sp. and *Marmota bobac* come from prey remains of birds and predatory animals. *Canis lupus*, *Vulpes vulpes*, *Martes martes*, *Gulo gulo*, *Meles meles*, *Lutra lutra* died in the cave and their remains survived in the deposits. In beds 3 and 4, bones accumulated by natural agents. In beds 1 and 2, human and natural agents were responsible (Table 3).

Analysis of the species composition and the correlation of bone remains allow distinguishing of three stages of large mammal fauna development in the mountain part of the Southern Urals. The first stage is represented by materials of layer 4 and is characterized by the presence of species which are typical of the Mammoth complex: *Lepus tanaiticus*, *Bison priscus*, and *Equus* (*Equus*) sp. This stage characterized the fauna of the end of the Late Pleistocene. The second stage is represented by materials of layer 3. This stage reflected the transition from the Mammoth to the Holocene complex. The lower horizons of this layer contain bones which are typical representatives of the Mammoth complex—*Lepus tanaiticus* and *Equus* (*Equus*) sp.—and which are absent in the upper horizon of this layer. In different horizons of this layer remains of species have been found which are typical of the Holocene complex—*L. timidus*, *Castor fiber*, and *Capreolus pygargus*. In the future, it will be possible to determine the boundary between this and the next stages and to determine the transitional stage of the fauna with the relicts. Most likely this boundary will be marked by the replacement of *L. tanaiticus* by *L. timidus*, in the Middle Holocene according to the history of the teriofauna of the Middle and Northern Urals (Kosintcev, 1995, 1996).

Materials from beds 1 and 2 represent the third stage. Remains of Pleistocene species are absent and the fauna is

Table 2
Bajslan-Tash cave

Species	Bed number			
	1	2	3	4
Chiroptera	37/23[a]	168/100	35/19	92/56
Talpa sp.	4/3	15/9	6/3	8/5
Sorex sp.	33/29	79/62	53/39	236/169
Crocidura sp.	2/2	1/1	4/3	7/5
Erinaceinae	—	—	—	1/1
Lepus sp.	2/1	2/2	4/2	20/5
Ochotona sp.	117/10	118/16	820/90	1124/129
Sciurus vulgaris	—	1/1	—	—
Spermophilus sp.	—	—	1/1	10/3
Marmota sp.	—	—	—	5/1
Sicista sp.	—	4/2	8/6	26/11
Allactaga major	—	1/1	—	3/1
Alactagulus sp.	—	—	—	1/1
Apodemus uralensis	2/2	7/7	7/7	22/22
*A.*ex.gr. *uralensis-agrarius*	17/12	37/26	42/28	158/100
A. flavicollis	2/1	10/8	3/3	2/2
Ellobius talpinus	27/5	41/11	83/14	156/25
Cricetulus migratorius	4/3	3/3	17/7	40/19
Allocricetulus eversmanni	5/1	7/4	20/6	78/23
Cricetus cricetus	11/4	20/9	46/10	175/37
Clethrionomys rufocanus	4/1	26/13	8/5	41/11
*Cl.*ex gr.*glareolus-rutilus*	146/37	999/269	342/87	661/133
Lagurus lagurus	118/28	134/39	788/157	1643/377
Eolagurus luteus	—	2/2	—	23/9
Arvicola terrestris	16/4	33/13	56/12	208/41
Microtus gregalis	45/45	68/68	245/245	763/763
M.oeconomus	12/12	15/15	52/52	198/198
M. agrestis	8/5	77/41	57/53	197/121
M. arvalis	48/48	145/145	93/93	220/220
M. sp.	404	778	1399	4410
Mustela nivalis	2/1	2/2	3/2	11/5
Mustela erminea	—	—	2/2	2/2
Total	1066/277	2793/869	4194/946	10541/2495

Species composition and number of bone remains of fossil small mammals.
[a]Quantity of bone remains/quantity of individuals.

Table 3
Bajslan-Tash cave

Species	Bed number			
	1	2	3	4
Lepus europaeus	2/1[a]	—	—	—
Lepus timidus	7/3	159/12	1/1	—
Lepus tanaiticus	—	—	1/1	155/11
Lepus sp.	3	104	40	—
Sciurus vulgaris	—	2/1	—	—
Tamias sibiricus	1/1	—	—	—
Marmota bobac	10/2	131/10	12/2	34/5
Castor fiber	1/1	38/4	1/1	—
Canis lupus	—	11/2	1/1	1/1
Vulpes vulpes	8/2	26/3	—	—
Ursus arctos	—	5/5	—	—
Martes martes	1/1	24/4	1/1	31/3
Gulo gulo	—	2/1	—	—
Mustela nivalis	6/2	7/3	32/6	33/5
Mustela erminea	2/1	86/12	24/4	21/3
Mustela eversmanni	4/2	18/3	1/1	—
Meles meles	1/1	2/1	—	—
Equus (*Equus*) sp.	—	—	1	5
Capreolus pygargus	149/7	549/2	2/1	—
Alces alces	—	14/2	—	—
Rangifer tarandus	—	1/1	—	1/1
Bison priscus	—	—	—	4/2
Bos taurus	5/2	8/2	—	—
Capra et *Ovis*	32/4	43/8	—	—
Equus caballus	13/2	41/3	—	—
Mammalia indet.	49	302	21	24

Species composition and number of bone remains of fossil large mammals.
[a]Numerator—the total quantity of bone remains; denominator—the quantity of individuals.

typical of the Holocene complex with *Lepus europaeus*, *Lepus timidus*, *Sciurus vulgaris*, *Tamias sibiricus*, *Castor fiber*, *Ursus arctos*, *Meles meles*, *Lutra lutra*, *Capreolus pygargus*, *Alces alces* and domestic forms. This species composition characterized the fauna of the mountain part of the Southern Urals during the second half of the Middle Holocene–first half of the Late Holocene.

6. Conclusions

In accordance with the radiocarbon dating results the following stratigraphical complexes of eluvial-slope deposits were determined during investigations in the Bajslan-Tash cave: Upper Neopleistocene (Ostashkovo horizon)—Lower Holocene—layer 4 (GIN-10853: 13.560 ± 250 yr BP; IEMEZH-1340: 9616 ± 62 yr BP); Middle Holocene—layer 3 (GIN-10854: 7140 ± 170 yr BP); Upper Holocene—layers 1 and 2 (GIN-10852: 1600 ± 50 yr BP). Periglacial forest–steppe with a noticeable participation of Asteraceae, Chenopodiaceae and Poaceae were predominant at the end of the Late Neopleistocene–Early Holocene in the cave surroundings. In the Middle Holocene, herbage–*Artemisia*–Chenopodiaceae forest–steppe covered the open woodlands. In the Late Holocene, broadleaved coniferous forests predominated. Gallery forests of *Betula*, *Tilia and Alnus* grew in the river valleys, while *Pinus* appeared on the slopes exposed to the south.

The small mammal species composition and the species ratio were determined for the Late Neopleistocene–beginning of the Late Holocene faunas. *Microtus gregalis*, *Lagurus lagurus* are characteristic for the Late Neopleistocene–Middle Holocene faunas. The predominance of *Clethrionomys* and *Microtus arvalis* is typical of the early stage of the Late Holocene fauna. The studied Holocene and Neopleistocene faunas are more southerly than those known so far in the Urals.

The predominance of meadow–steppe and forest–steppe species and evritope species is characteristic for the large mammal fauna from all investigated deposits. The transition from the Late Neopleistocene (Mammoth) mammal complex to the Holocene was relatively gradual: the number of meadow–steppe species decreased and the number of forest–steppe and forest species increased.

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