DOI: 10.1134/S1563011006020010

S.K. Vasiliev, A.P. Derevianko and S.V. Markin
Institute of Archaeology and Ethnography, Siberian Branch, Russian Academy of Sciences,
Akademika Lavrentieva 17, Novosibirsk, 630090, Russia
E-mail: markin@archaeology.nsc.ru

LARGE MAMMAL FAUNA OF THE SARTAN PERIOD FROM THE NORTHWESTERN ALTAI (Based on Materials from Kaminnaya Cave)*

Introduction

Numerous Paleolithic sites have been discovered in diverse Altai landscapes, ranging from piedmont areas to intermontane depressions, but there are great disparities in the amounts of information known from these localities. Most sites located on the piedmonts do not have precise litho-stratigraphic, bio-stratigraphic, or chronological descriptions. However, the multilayered open-air (Anui-2, Ust-Karakol-1 and others) and cave (Denisova, Okladnikov, Iskra) sites in the mountainous zone of the Northwestern Altai, particularly in the Anui River valley, have been the focus of multidisciplinary investigations of the paleoenvironmental and prehistoric human cultural record using modern methods of analysis (Prirodnaya sreda…, 2003).

Kaminnaya Cave is located in mountains of middle elevation at an altitude of 1100 m asl, a higher elevation than the Paleolithic sites of the Anui valley. The topography of the Kaminnaya area mostly comprises smooth, partly eroded accumulative formations interspersed with abrupt alluvial slopes. The cave faces southeast and constitutes a grotto with a wide entrance and narrow rear gallery. The gallery slopes downward and its rear portion is filled with sediment. The cave formed through karstic activity under the influence of flowing water and daily and seasonal fluctuations in temperature. The first test pit in the cave sediments was dug in 1982, and controlled excavations were carried out from 1984 – 1990 and 1995 – 2004 (Derevianko, Grichan, 1990; Arkheologiya, geologiya…, 1998).

Archaeological remains have been recovered from all of the stratified sedimentary layers except the alluvium. The stone artifacts retrieved from the deposits underlying the Sartan strata demonstrate Levallois, radial and parallel reduction strategies, and the toolkit is dominated by sidescrapers, knives, notches and denticulates. Artifacts found in association with the Sartan deposits demonstrate mostly Upper Paleolithic technology (prismatic flaking including elements of microblade production) and typology (endscrapers, rare burins, borers, peculiar chisel-like tools, flakes and blades with traces of retouch, backed blades and microblades, and a few bifaces). The Sartan collection also includes various parallel and Levallois cores, sidescrapers, knives with prepared backs, notches and denticulate tools. Tools are mostly made from local raw materials including volcanic and sedimentary rocks, jasperoids and hornfels; outcrops of these rocks are located in the vicinity of the cave (Kulik, Markin, 2001). The collection of bone tools comprises needles with circular and ovoid cross-sections, tools with flattened bases, and personal decorations made out of the canine teeth of various animals. Strata 9 – 1 have yielded archaeological materials dating from the Neolithic to the beginning of the modern era.

The microfaunal remains from Kaminnaya suggest that the Sartan sediments accumulated under open

* The work has been carried out under the financial support of the Russian Foundation for the Humanities (Project N 04-01-00528a) and the Siberian Branch of the Russian Academy of Sciences (Integration Program "Evolution of Natural Processes, Humans and Human Cultures in the Late Cainozoic of Siberia and the Impacts on Stability of Eco- and Geo-systems").

Table 1. **Number of bones in the Pleistocene deposits of Kaminnaya Cave (specimens)**

Taxa	Layers																	
	10a	10c/3	10c/4	10d	10e	11a	11b	11c	11d	12	13	14a	14b	14a/1	14b/1	15/1	15/2	16g	18
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Chiroptera	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Asioscalops altaica	–	–	–	7	–	27	32	30	8	3	2	2	–	1	–	–	–	–	–
Lepus cf. *tanaiticus*	1	–	–	–	–	5	16	1	3	–	–	–	–	2	1	1	–	–	–
Lepus tolai	5	1	–	2	–	30	39	11	8	1	6	1	–	–	–	–	–	–	–
Ohotona sp.	–	–	–	–	–	5	2	4	–	–	–	–	–	–	–	–	–	–	–
Citellus sp.	3	–	1	1	–	59	67	65	11	4	3	3	–	–	2	–	–	–	–
Marmota baibacina	15	1	1	17	–	30	79	48	26	12	14	5	3	7	5	4	1	–	–
Cricetus sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–
M. myospalax	–	–	–	–	–	20	19	33	2	–	–	–	–	1	2	1	–	–	–
Microtus sp.	1	–	–	–	–	11	132	236	–	–	–	–	–	–	–	–	–	–	–
Vulpes vulpes	–	–	–	–	–	2	8	8	–	1	–	1	1	–	–	–	1	–	–
Canis lupus	1	–	–	–	–	12	12	11	9	–	1	4	1	–	2	–	1	–	–
Ursus arctos	–	–	–	–	–	1	1	1	1	2	–	1	–	–	–	–	2	–	–
Mustela nivalis	–	–	–	–	–	1	–	3	–	–	–	–	–	–	–	–	–	–	–
Martes zibellina	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
Meles meles	–	–	–	–	–	–	–	–	–	–	–	1	1	3	–	–	–	–	–
Gulo gulo	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Crocuta spelaea	4	–	–	–	–	18	28	17	14	–	–	7	–	8	2	3	1	–	–
Panthera spelaea	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	1	–	–
Lynx lynx	–	–	–	–	–	–	1	–	–	–	–	2	–	–	–	–	–	–	–
Felis manul	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–
Mammuthus primigenius	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Coelodonta antiquitatis	5	1	–	8	–	33	53	59	53	2	–	1	–	14	17	1	–	–	–
Equus (E.) ferus	3	9	1	16	–	40	65	45	75	6	2	11	1	27	8	–	2	–	–
E. ex.gr. *hydruntinus*	–	–	–	–	–	1	2	1	–	–	–	–	–	–	–	–	–	–	–
Alces alces	–	–	–	–	–	–	2	1	–	–	–	2	–	–	–	–	–	–	–

Table 1 continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cervus elaphus	–	–	–	–	–	–	–	11	2	–	1	1	–	4	1	1	–	–	1
Capreolus pygargus	–	–	–	–	–	–	3	1	3	–	–	–	1	6	1	–	2	–	4
Poëphagus mutus	–	–	–	–	–	1	1	1	–	1	–	–	–	–	–	–	–	–	–
Bison priscus	–	–	–	–	–	1	24	17	23	–	–	5	7	5	2	–	–	–	–
Bison-Poëphagus	6	1	1	7	1	20	18	24	14	3	–	7	–	31	12	1	1	–	–
Saiga borealis	–	–	–	–	–	2	–	18	26	–	–	17	2	8	5	7	1	–	1
Capra sibirica	13	2	4	17	1	24	53	39	26	12	3	14	1	13	9	4	2	–	1
Ovis ammon	–	2	–	1	–	9	11	10	22	7	1	1	–	3	1	–	1	–	1
Capra-Ovis	15	–	–	12	–	29	101	21	85	5	30	13	–	50	17	1	–	–	–
Aves	3	–	–	5	–	20	39	31	6	1	1	–	–	–	–	–	–	–	–
Indefinable fragments	354	43	54	295	7	1270	2583	2458	1141	115	97	381	52	746	417	389	158	16	92
Total	429	61	62	388	9	1671	3395	3206	1559	176	161	480	70	930	504	414	174	16	100

landscape conditions with a predominance of dry steppes. The collection of small mammal bones is dominated by steppe (*Lagurus lagurus*, *Microtus gregalis*, *Myospalax myospalax*, *Marmota* sp. and others) and mountain-steppe (*Alticola strelzowi*, *A. macrotis*) taxa (Dupal, 2004).

The stratigraphic unit dating from 12.2 – 10.3 ka BP records several stages of climatic and environmental development in the mountains of middle elevation in the Northwestern Altai. The broader region, which includes both Kaminnaya Cave and the Karakol River valley with its surrounding watersheds, was a zone of alternating steppe, forest-steppe and forest vegetation. Neither tundra, nor tundra-steppe, nor periglacial tundra – forest-steppe has ever dominated the local environment. Cold-adapted species such as *Betula fructicosa*, *B. sect. Nanae*, *Alnaster fruticosus*, *Botrychium boreale* and others are present in the floral communities that existed during both stadial and interstadial periods. The presence of *Alnus glutinosa* and such cold-resistant broadleaf species as *Tilia sibirica* and *Ulmus* cf. *laevis*, which do not exist in the region under modern interglacial conditions, together with remains of cryophytic taxa in the relevant pollen spectra, provide botanical evidence of refugium conditions in the Altai (Bolikhovskaya, Markin, 2002).

Large mammal bones recovered from the Pleistocene deposits at Kaminnaya from 1983 – 1988 were analyzed by N.D. Ovodov. He recognized the following taxa: *Lepus* cf. *timidus*, *Marmota baibacina*, *Canis lupus*, *V. vulpes*, *Ursus arctors*, *Crocuta spelaea*, *Felis lynx*, *Coelodonta antiquitatis*, *Equus* sp., *Cervus elaphus*, *C. capreolus*, *A. alces*, *Bison* or *Poëphagus*, and *Ovis* or *Capra* (Derevianko, Grichan, 1990). I.V. Foronova carried out paleontological analyses of the bones collected from 1995 – 1997 (Derevianko et al., 1999). The present paper mostly addresses osteological materials recovered from 1995 – 2003, as well as a portion of the bone collection from those entrance zone sediments stratigraphically correlated to strata 11b-d in the cave interior. The collection under study includes an abundant microfaunal component that is not discussed in the present paper. Our analysis allows for the classification of the available faunal remains into eight mammalian orders: Insectivora, Chiroptera, Lagomorpha, Rodentia, Carnivora, Proboscidea, Perissodactyla, and Artiodactyla, within which at least 33 taxa have been identified (Table 1). The present paper contains a short review of the bone material of 25 species and sub-species of mammals.

Stratigraphy and chronology of the cave sediments

The total sediment depth inside Kaminnaya Cave is 8 m, including 7 m of sediments attributable to the

Pleistocene. The initial stage of sediment accumulation is linked with the formation of alluvial floodplain deposits (stratum 20), consisting of thin laminations of loam and clay. The overlying stratum 19 contains gravel and small pebbles from the bed of the brook flowing in the immediate vicinity of the cave. Stratum 18 contains thin laminations of loam from the floodplain alluvium. The following strata have been established overlying the loam of stratum 18 and "elevated" bedrock surfaces in some portions of the cave: gravel and small pebbles (strata 17 and 16j); lenses of medium-grained sand (strata 16h and 16i); coarse-grained sand (stratum 16g); thin laminations of plastic clay (stratum 16f); sand saturated with gravel and small pebbles (stratum 16e); intercalations of multicolored loam, dense clay and sandy loam with inclusions of gruss and gravel (stratum 16d); alternating laminations of loam and fine-grained sandy loam (stratum 16c); gravel and pebbles filled with sand and mud (stratum 16b), and small pebbles and gravel filled with sand (stratum 16a).

The next sedimentary unit is a loam deposit. It begins with stratum 15 (slightly porous loam with inclusions of gruss and gravel), which contains sediments of varying colors and several gravel lenses (strata 15/1, 15/2 and 15/3). The border between the first two substrata represents a hiatus in sedimentation. Further up the profile (following the break in sedimentation), there are loam strata (strata 14a/1 and 14b/1) with abundant inclusions of debris and large and coarse fragments of rock from the cave walls. Overlying these are loamy sediments (strata 14a, 14b, 13, 12, 11a, 11 b, 11c, and 11e) with inclusions of limestone debris and various minerals that were transported from outside. Sediments overlie bedrock at the cave bottom and cover rock-fall (caused by an earthquake that damaged the walls and roof), or else overlie the middle portion of the deposits following a hiatus in sedimentation (strata 14a/1 and 14b/1). During the final stages of the formation of stratum 11, the sediments on the left side of the cave were washed out. Washout processes are indicated in the humic sediments (strata 10c/1 – 10c/4 and 10d). One of the subdivisions of this stratum (loamy sediments of stratum 10e) shows possible cryoturbation features. These sediments are covered by the loam included in stratum 10a.

The most recent cycle of sedimentation resulted in the formation of thin, alternating laminations of pale brown phosphate-rich and gray humus-rich sandy loam (strata 9 – 1).

Paleomagnetic analyses of the lower portion of the profile have revealed zones of normal and reversed magnetic polarity. The borders between strata 14b/1 and 15/1 and strata 15/2 and 16a mark polarity reversals. However, according to K.A. Chirkin, it has not been possible to directly link the polarity shifts recorded in the sediments with changing coordinates of virtual magnetic poles during different episodes in the history of Earth's magnetic field (international database DRAGON). The infinite radiocarbon date of > 40 ka BP (AA-38041) from stratum 14a/1 does not represent a reliable age estimate. The overlying loam, including strata 14a – 11a and displaying normal polarity, corresponds to the Sartan Period of the Upper Pleistocene. This inference is supported by available radiocarbon dates generated on charcoal and large mammal bones: 15,350 ± 240 BP (SOAN-3923) for stratum 14b; 14,550 ± 230 BP (SOAN-3922) for stratum 14a; 14,120 ± 95 BP (SOAN-3921) for stratum 13; 13,870 ± 390 BP (SOAN-3920) for stratum 12; 13,550 ± 140 BP (SOAN-3919) for stratum 11d; 12,160 ± 225 BP (SOAN-3918) for stratum 11c; 10,860 ± 360 BP (SOAN-3514) for stratum 11b; 10,870 ± 150 BP (SOAN-3702) for stratum 11a (middle portion) and 10,310 ± 330 BP (SOAN-3402) for stratum 11a (uppermost portion). An infinite date of > 41 ka BP (AA-38045) has been generated on two woolly rhinoceros tooth fragments recovered from stratum 11c, while another date of 21,530 ± 69 BP (SOAN-3917) has been obtained on a large mammal bone fragment from stratum11b. These samples were likely redeposited on the Sartan surface as a result of rodent or human activities. Dates generated on woolly rhinoceros tooth enamel and large mammal bones (13,850 ± 140 BP (AA-38042) for stratum 10c/2; > 39,400 BP (AA-38043) for stratum 10c/3 and 13,920 ± ± 130 BP (AA-38044) for stratum 10c/4) contradict the established relative chronology of the Kaminnaya sediments and suggest transport and redeposition of the dated materials by slow-flowing water from the rear of the cave. It should be noted that humus-rich strata 10c/4 – 10c/1 are discontinuous and inserted into the washed out deposits of stratum 11. Stratigraphic data suggest that this portion of the cave sediment was washed out at the end of its deposition; judging by the date of stratum 11a, this event occurred around 10,310 ± 330 BP. There are two radiocarbon dates for the middle portion of stratum 10a: 8850 ± 120 BP (SOAN-3700) and 8685 ± 100 BP (SOAN-3701), suggesting an Early Holocene age for this layer.

The chronology of strata 9 – 1 is based on numerous radiocarbon dates ranging from 5860 ± 75 to 410 ± ± 65 BP (Orlova, 1995; Arkheologiya, geologiya…, 1998; Markin et al., 2001).

Systematic review of species

Lepus cf. *tanaiticus* (Gureev, 1964). Judging from the available bone specimens, the body size of this species was similar to that of hares from the Don region and three times smaller than that of tolai hare. The present collection does not contain diagnostic mandible specimens, preventing a more precise species assessment. The dimensions of the few postcranial bones suitable for measurement suggest a size similar to the Late Pleistocene species *L. tanaiticus*, which had a wide distribution extending from Eastern Europe to Eastern Siberia, and also to the modern *L. timidus* (Kuzmina, 1971; Averianov, Kuzmina, 1993; Averianov, 1995). The breadth of the collum scapulae is 7.2 mm; the maximal transverse diameter of the distal end is 13 mm; the breadth of the glenoid cavity is 12.8/11.5 mm. The breadths of two distal humeri are 11.8 and 12.8 mm. The medial breadths are 8.5 and 9.5 mm, while the minimal breadths at the distal ends are 6.3 mm in both specimens. Three tibia specimens have yielded the following breadths and minimal transverse diameters at the distal ends: 15.8; 15.2; 14.7/ 9.9; 9.5; 10.4 mm.

Lepus tolai (Pallas, 1778). Bone specimens of tolai hares have been recovered from strata 10a – 14a. Nearly all the specimens are well preserved, while one specimen shows traces of acid corrosion. Tolai hare remains were probably transported into the cave by birds (from pellets). The only available mandible fragment yielded a P_2 height (11.2 mm) and diastema length (15.8 mm). Morphometric data on the majority of the postcranial elements of *L. tolai* are presented in Table 2.

Vulpes vulpes (Linnaeus, 1758). All of the available fox specimens are tooth and postcranial fragments not suitable for morphometric analyses. The only measurable pieces are the head of a femur (12.8 mm in diameter) and the minimal breadth of the distal portion of a humerus (9 mm). Judging by the bone and tooth dimensions, these remains belong to a common fox; no fragments comparable in size with specimens of *Vulpes corsac* or *Alopex lagorus* from Denisova Cave (Prirodnaya sreda…, 2003) have been found at Kaminnaya.

Canis lupus (Linnaeus, 1758). Among the carnivore remains, wolf ranks second to cave hyena in abundance of bone specimens. Most of the remains are isolated teeth and tooth fragments, and distal fragments of extremities. Judging by a few measurements of upper and lower teeth, the Sartan *C. lupus* did not differ greatly in size from the modern West-Siberian *C. l. lupus*. Only the P_3 is smaller and comparable to the smallest specimens of modern wolves (Table 3). The teeth of *C. lupus* from Denisova Cave are even greater in size (Ibid.). Only a few postcranial bones are suitable for measurement. The distal epiphysis of a humerus has a minimal breadth of 14.7 mm, while the proximal end of a metacarpal IV has breadth to transverse diameter ratios of the epiphysis and diaphysis of 8.7/14.2 and 7.7/6.7 mm, respectively. A partially fused metapodial fragment has been recovered from stratum 11d.

Table 2. **Dimensions of Lepus tolai bones from Kaminnaya Cave (mm)**

Measurements	n	lim	M	Measurements	n	lim	M
Scapula:				Pelvis:			
Collum scapulae breadth	5	5.1–5.7	5.44	Articular length	7	8.5–10.7	9.67
Distal breadth	3	9.2–10.7	10.0	Articular transverse diameter	7	8.5–9.2	9.00
Articular length	3	9.1–10.6	9.90	Minimal ilium breadth	7	7.2–8.0	7.77
Articular transverse diameter	4	7.9–9.7	8.65	Femur:			
				Distal breadth	2	14.7–14.8	14.8
Humerus:				Distal transverse diameter	2	13.4–14.3	13.9
Proximal breadth	1	–	13.5	Tibia:			
Proximal transverse diameter	1	–	15.4	Distal breadth	1	–	11.3
Diaphysis breadth	1	–	4.5	Distal transverse diameter	1	–	6.7
Diaphysis transverse diameter	1	–	5.5	Astragalus:			
Distal breadth	3	8.9–9.0	8.97	Bone length	2	11.4–11.7	11.6
Distal medial transverse diameter	2	6.5–6.8	6.65	Articular breadth	2	5.6–6.2	5.9
Minimal transverse diameter	3	4.8–5.0	4.90	Calcaneus:			
				Bone length	2	24.8–25.1	25.0
Radius:				Distal breadth	2	9.5–9.9	9.70
Proximal breadth	1	–	6.7	Distal transverse diameter	2	8.6–8.8	8.70
Proximal transverse diameter	1	–	4.5	Diaphysis breadth	2	4.5–5.2	4.85
Distal breadth	1	–	7.9	Breadth of tuber calcanei	2	5.6–6.0	5.80
Distal transverse diameter	1	–	4.2	Transverse diameter of tuber calcanei	2	4.8–5.0	4.90

Table 3. **Dimensions of Canis lupus teeth, mm**

Measurements	Kaminnaya Cave		Denisova Cave (Prirodnaya sreda…, 2003)			Modern specimens from the southern part of Western Siberia		
			n	lim	M	n	lim	M
P^3:								
Crown length	17.4	–	–	–	–	17	13.8–17.5	15.6
Crown breadth	7.2	–	–	–	–	17	5.5–8.1	6.9
P_3:								
Crown length	12.5	–	2	14.9–15.3	15.1	21	12–14.8	13.6
Crown breadth	6.2	–	2	6.4–7.0	6.7	20	5.4–8.0	6.4
P_4:								
Crown length	15.5	15.8	2	15.4-17.0	16.2	21	13.3–17	15.7
Crown breadth	8.0	7.8	2	7.4–7.9	7.7	21	6.2–8.8	7.7
M_1:								
Crown length	27.8	–	1	–	29.7	21	24.5–31.5	28.3
Crown breadth	11.1	–	3	11.2–11.4	11.3	21	9.9–13.2	11.2
M_3:								
Crown length	6.1	–	2	5.0–5.8	5.4	7	5.6–6.5	6.1
Crown breadth	6.2	–	3	4.5–5.3	5.0	7	5.2–6.0	5.7

Ursus arctos (Linnaeus, 1758). A few bone specimens of brown bear, mostly distal fragments of extremities, have been recovered from Kaminnaya Cave. A first phalanx showing signs of severe acid corrosion has been recovered from stratum 14b; apparently, the bear carcass was eaten by cave hyenas. Stratum 11 has yielded a fragment of an upper canine tooth: the length of the enamel part of the tooth crown is 24 mm, its diameter measured at the cingulum is 18.5/14.7 mm. A third metatarsal, two first phalanges and a tibia, all well preserved, have been recovered from stratum 15/2, the age of which is > 40 ka BP based on an infinite radiocarbon date from the overlying stratum. All of these bones belonged to large *U. arctos* individuals (Table 4).

Mustela nivalis (Linnaeus, 1766). Weasel bones have been recovered from strata 11a and 11c. The collection comprises only proximal humerus fragments. One specimen has a breadth of 5 mm and a transverse diameter of 4.2 mm; the transverse diameters of three other specimens are 5.2, 5 and 5 mm, respectively. G.F. Baryshnikov has identified two species of weasel based on mandible fragments from the Pleistocene sediments of Denisova Cave: a small form similar to modern West-Siberian *M. n. nivalis*, and a larger one reminiscent of *M. n. stoliczkana*, which presently inhabits the arid zone of Central Asia (Ibid.).

Martes zibellina (Linnaeus, 1758). Only one specimen has been identified as sable: it is an M^1 from stratum

Table 4. **Dimensions of extremities of *Ursus arctos* from Kaminnaya Cave, mm**

Measurements	Tibia	MT III dex	Phalanx I (hindlimbs)	
			IV sin	V dex
Bone length	290.0	81.5	49.0	44.4
Proximal breadth	73.0	19.7	24.8	23.5
Proximal transverse diameter	76.0	31.0	19.0	17.3
Diaphysis breadth	31.0	16.2	16.0	16.8
Diaphysis transverse diameter	36.0	14.5	–	–
Distal supra-articular breadth	70.7	21.2	18.5	17.8
Distal articular breadth	–	18.5	16.9	15.5
Distal transverse diameter	40.5	18.0	12.4	10.0

Table 5. **Dimensions of *Crocuta spelaea* teeth, mm**

Measurements	Kaminnaya Cave			Denisova Cave (Prirodnaya sreda…, 2003)			Crimea (Baryshnokov, 1997)		
	n	lim	M	n	lim	M	n	lim	M
P^4:									
Crown length	4	38.5–41.7	40.10	1	–	40.50	20	37.5–43.9	40.00
Crown breadth	1	–	22.80	2	22.0–23.1	22.55	16	20.4–24.2	22.14
P_4:									
Crown length	3	22.1–23.7	22.77	3	23.2–24.3	23.90	22	22.0–26.2	23.54
Protoconid length	3	12.1–13.1	12.60	3	12.6–14.1	13.57	22	12.3–15.2	13.47
Crown breadth	3	13.7–14.6	14.07	3	13.9–15.4	14.53	23	13.7–17.3	14.81

11c. Its dimensions (6.1 mm long and 8.3 mm wide) are considerably larger than the average dimensions of the first upper molar of modern *M. zibellina*, but notably smaller than those of the Holocene forest marten *M. martes* of the Baraba steppe (6.4 – 7.0 – 7.7 mm and 8.3 – 9.1 – 10 mm, n = 9). A few sable specimens have also been recovered from Pleistocene deposits at Denisova Cave (Ibid.).

Meles meles (Linnaeus, 1758). Fragments of badger bones have been recovered from strata 14a, 14b and 14b/1. It was possible to measure only a few postcranial specimens: the diaphysis of a humerus from stratum 14b/1 (breadth/transverse diameter is 12.3/13 mm) and the distal part of a humerus from stratum 14a (breadth is 31.3 mm, articular surface breadth is 20 mm, lateral transverse diameter is 15 mm, minimal transverse diameter is 9.2 mm). The bone fragments have been attributed to a large *M. meles* similar in size to modern badgers.

Gulo gulo (Ibid., 1758). The only specimen belonging to this species is a carpal bone (radiointermedium) recovered from stratum 11b. Its size (length/greatest transverse diameter is 22/19.5 mm, transverse diameter without protruding part is 13.4 mm) suggests a large wolverine individual.

Crocuta spelaea (Goldfuss, 1810). Cave hyena is common in the bone assemblage from Kaminnaya Cave. It is the most abundant carnivore and constitutes 4.6 % of the total identified faunal remains. Complete and fragmented teeth make up 83.5 % of the total collection of hyena remains. Among the postcranial bones, only one metacarpal and a few first and second phalanges are fully preserved. Teeth and bones of *C. spelaea* do now show any traces of acid corrosion, suggesting that there were no cases of cannibalism in Kaminnaya Cave unlike at Denisova (Ibid.). According to Baryshnikov's classification (2005), Kaminnaya Cave demonstrates nearly all the major features of a seasonal or temporary shelter for cave hyenas.

The length of a complete right metacarpal IV is 94 mm, breadth/transverse diameter of the proximal end is 13.5/ 21.5 mm; that of the diaphysis is 11.9/ 10.1 mm; the distal supra-articular breadth is 16 mm, that of the articular surface is 14.8 mm, and the distal transverse diameter is 16 mm. A few teeth are suitable for measurement, namely upper and lower fourth premolars (Table 5). Judging by the P^4 dimensions, the hyena remains from Kaminnaya Cave do not differ substantially from specimens of *C. spelaea* from Denisova Cave (Prirodnaya sread…, 2003), the Crimea and Poland (Baryshnikov, 1995). By contrast, the P^4 specimens from Kaminnaya are considerably smaller than the specimens from other mentioned sites. This might indicate a reduction in the body size of *C. spelaea* before this species became extinct in the Altai.

Panthera spelaea (Goldfuss, 1810). Stratum 11b yielded the distal third of a tibia with gnawing marks. The minimal diameter of the diaphysis is 30.2 mm. The breadth/transverse diameter of the diaphysis of the distal part of a metacarpal II is 15.5/15.7 mm, the distal supra-articular breadth /articular breadth 24.6/22.3 mm, and the transverse diameter is 21.6 mm. Stratum 15/2 has yielded a practically complete upper canine tooth. The total length is 114.5 mm; the length of the enamel part of the crown along the frontal surface is 54 mm; the diameter of the crown measured at the cingulum is 31/25.3 mm; and the maximal breadth/transverse diameter of the middle part is 36.2/29.5 mm. All the bones discussed here belong to large cave lion individuals.

Lynx lynx (Linnaeus, 1758). A fragment of the posterior half of a P^4 has been recovered from stratum 11c, the second phalanx of the fifth digit of a foreleg has been found in stratum 11b and first phalanx of the second digit of a hind leg has been recovered from stratum 14a. The length of the first phalanx is 33 mm; the breadth/transverse diameter of its proximal end is 10.1/9.5 mm; that of the diaphysis in the middle is 5.6/5/2 mm; the breadth of the distal end is 8.7 mm. The length of the second phalanx is 18 mm, the breadth/

transverse diameter of its proximal end is 8/7.4 mm, the breadth of diaphysis is 6.2 mm; the distal end is partially destroyed. Modern lynx phalanges have similar epiphysis and diaphysis breadth dimensions, but are slightly longer than those from Kaminnaya Cave. This trait probably has to do with reduced snow cover during the Upper Pleistocene.

Felis manul (Pallas, 1776). Stratum 11d has yielded an incomplete right M_1 with missing anterior and posterior portions. The transverse diameter of the crown is 3.9 mm (a specimen of a modern sub-adult manul cat from the collection of the Institute of Archaeology and Ethnography has a crown transverse diameter of 3.8 mm). Stratum 12 yielded an incomplete left P^4: the crown length is 13.2 mm, considerably longer than that of modern *F. manul* (10.4 – 12.2. mm (Geptner, Sludsky, 1972).

Mammuthus primigenius (Blumenbach, 1799). Stratum 11b has yielded an incomplete astragalus, representing the only securely identified mammoth bone specimen from Kaminnaya Cave. This bone belonged to a large adult individual. The width of the facet for the tibia is more than 111 mm, its breadth is more than 113 mm. The maximal transverse diameter of the bone exceeds 138 mm. The maximal length of this bone exceeds 138 mm. The size of this bone likely excludes the possibility of redeposition. It can be assumed that around 10.5 – 11 ka ago the Northwestern Altai possessed one of the latest surviving mammoth populations in Eurasia. Currently, the youngest known mammoth site in western Siberia is Lugovskoe in the vicinity to Khanty-Maniysk. According to radiocarbon estimates, this site has an age of 10.7 ka BP. The latest mammoth populations inhabited southern areas of Western Siberia as late as 13.3 – 12.9 ka BP. However, a date of 11,090 BP for the Volchiya Griva site suggests that relict mammoth populations might have inhabited this territory during later periods (Orlova, Kuzmin, Dementiev, 2002, 2005).

Coelodonta antiquitatis (Blumenbach, 1799). Out of a total of 250 specimens of woolly rhinoceros, 93 % are tooth chips and fragments and only 10 teeth are relatively complete. Only 18 specimens belong to a postcranial skeleton, and nearly all of them have gnawing marks. Strata 11b – 11d (about 11 – 13.5 ka BP) have yielded large bone specimens: ulna fragments more than 130 and 200 mm long, a radius diaphysis, a complete calcaneum, and a few astragali. The large size of the bones seems to preclude the possibility that they were redeposited from older layers by burrowing animals. Comparison of the Kaminnaya rhinoceros specimens with Late Pleistocene rhinoceros bones recovered from other sites in southern Western Siberia allows one to make certain inferences. The sizes of the radius, calcaneum and astragali of the Sartan rhinoceros are close to the minimal sizes of relevant specimens of *C. antiquitatis* from the Kazantsevo and Karga periods (Table 6). The only exception is the large and thick calcaneum from stratum 11c, which exceeds the maximal dimensions in the comparative sample. Stratum 15/1 (> 40 ka BP) has yielded a femoral head of more than 104 mm in diameter. Measurements of the femoral head of Late Pleistocene woolly rhinoceros specimens from Belgium range from 92 – 105.1 – 128 mm, n = 13 (Germonpre, 1993). Based on the small available bone sample, the final extinction of the woolly rhinoceros in the Altai was preceded by a substantial reduction in body size probably driven by a climatic change. Remains of *C. antiquitatis* from Kaminnaya Cave are probably the youngest ones among the rhinoceros remains in Eurasia. Other late bones of woolly rhinoceros have yielded radiocarbon dates of 12,300 BP in the Southern Urals and 10,700 BP in the central part of Western Siberia (the Lugovskoe site) (Orlova, Kuzmin, Dementiev, 2005). A radiocarbon date on a scapula fragment from Lobva Cave in the Middle Urals is 9500 ± 250 BP (Kosintsev, 1995).

Equus (Equus) ferus (Boddaert, 1785). Specimens of large caballine horse are common in the Kaminnaya bone assemblage. This species comprises 13.6 % of the total identified bone collection, and more than 98 % of the horse bones are tooth fragments. Only 25 specimens are measurable. Stratum 11d has yielded a distal tibia fragment belonging to a large individual. Its breadth is 83.5 mm and transverse diameter is 52 mm. Distal tibia dimensions of Karga Period horses from the site of Krasny Yar are 73 – 77.5 – 85.4 mm (n = 19) and 44 – 48.0 – 53.5 mm (n = 27); those from Taradanovo are 70.2 – 77.0 – 90 mm (n = 41) and 41.7 – 47.9 – 55.2 mm (n = 42). The breadth of the articular surface of incomplete third phalanx, possibly of a hind leg, is 50.3 mm, the transverse diameter in the middle is 29 mm (45 – 50.8 – 58.2 mm (n = 57) and 23 – 27.8 – 31.5 mm (n = 62) are the relevant data on *Equus ex. gr. gallicus* from Taradanovo). A complete horse metatarsal has been recovered from stratum 11c. Its measurements are as follows (after (Eisenmann, Beckouche, 1986)): length along the dorsal surface is 274 mm, breadth/ diaphysis transverse diameter at the middle portion of the bone is 36/32.5 mm, the relevant index for the proximal end is 55.1/43.5 mm. The diameter of the facet for tarsal III is 48 mm; that for tarsal IV is 13 mm. The distal supra-articular breadth is 50.7 mm, and that on the articular surface is 51.7 mm. The transverse diameter of the distal end on the sagittal line is 37.8 mm, the minimal transverse diameter of the medial condyle is 27.7 mm, and the maximal diameter of the medial condyle is 30 mm. The size and proportions of the metatarsal are close to the mean dimensions of metatarsal bones of *E. ex. gr. gallicus* of the Karga Period from the sites of Krasny Yar and Taradanovo (Vasiliev, 2004, 2005).

Analyses of bone specimens from Altai caves (Logovo Gieny, Okladnikov and others) have shown that

Table 6. **Dimensions of extremities of *Coelodonta antiquitatis*, mm**

Measurements	Kaminnaya Cave W_3			Krasny Yar, layer 4 W_2			Taradanovo W_2		
	n	lim	M	n	lim	M	n	lim	M
Radius:									
Diaphysis breadth	1	–	55.3	18	55.3–73.5	62.6*	4	52.7–61.2	57.2
Diaphysis transverse diameter	1	–	33.0	18	32.5–45.5	37.6	4	34.0–40.3	36.5
Metacarpale IV:									
Diaphysis breadth	1	–	37.5	4	34.5–38.8	36.8	11	32.0–43.5	38.9
Diaphysis transverse diameter	1	–	22.0	4	20.4–26.5	23.5	11	20.3–28.2	23.3
Astragalus:									
Maximal breadth	2	87–92	89.5	5	92–103	95.3	10	90.0–108.7	97.1
Articular breadth	4	74.7–84.7	78.0	5	83–86	84.8	11	76.0–89.5	83.9
Minimal height at the middle	4	63–68.5	65.7	5	66–72	69.0	11	61.0–73.6	68.1
Distal articular breadth	3	70.7–76.8	74.7	5	73.8–79.7	76.6	10	73–81	77.2
Medial height	4	71.3–73	72.2	5	77.5–83.2	80.3	10	67.5–81.5	75.8
Calcaneus:									
Bone length	1	–	129.0	2	130–131	130.5	8	116.0–136.7	122.2
Distal breadth	1	–	85.3	2	80.0–81.5	80.8	9	72.0–82.5	77.2
Distal transverse diameter	1	–	77.0	2	75–76	75.5	8	63–70	65.9
Minimal diaphysis breadth	1	–	57.7	2	45.8–50.5	48.2	9	39.5–48.8	44.1
Transverse diameter at tuber calcanei	1	–	73.5	–	–	–	8	63.0–76.4	68.8

* Radius from Krasny Yar, R-W (layer 6).

during the second half of the Late Pleistocene, the region was populated by a distinctive horse species, rather large with thick metapodia, which differed considerably from the horse inhabiting the contiguous plains (*E. ex. gr. gallicus*). Judging by tooth measurements (Table 7), this form of caballine horse became smaller by the end of the Sartan Period. Comparisons of graphical reconstructions of metapodial bones suggest close similarities among caballine horses recorded over a vast region from Eastern Europe to Western Siberia during the second half of the Late Pleistocene. All the known forms, including *E. latipes*, *E. uralensis*, and *Equus ferus* from the Altai and *E. ex. gr. Gallicus*, seem to represent closely-related species or else spatial and temporal sub-species of a single, formerly widespread horse species.

Equus ex. gr. hydruntinus (Regalia, 1907). Sartan deposits at Kaminnaya have yielded a few bones of a smaller form of equid along with the large caballine horse specimens. According to tooth measurements and indices of $M^{1\text{-}2}$ protocone length, the small horse from Kaminnaya is similar to the Pleistocene wild ass from Denisova Cave described by G.F. Baryshnikov (Prirodnaya sreda…, 2003). First phalanges similar to those of the small horse from Kaminnaya have been recovered from the Taradanovo site (W_2) in the Upper Ob basin and from Krasny Yar (R-W) in the environs of Novosibirsk (Tables 8 and 9). Bone collections from various cave sites of the Altai contain specimens belonging to both subspecies: large and thick bones with clear caballine features and a smaller, slim form with some archaic features in the anatomy of the teeth and metapodials. Some time ago, such bones were mostly attributed to koulan (Vereschagin, 1956; Galkina, Ovodov, 1975) while recently new available data allow for their attribution to the Pleistocene wild ass. In this respect, it is necessary to revise all the available osteological materials on Pleistocene horses from Southern Siberia and to re-analyze them on the basis of new analytical methods.

Alces alces (Linnaeus, 1758). Elk maxillary tooth fragments have been recovered from strata 11b-c and 14a. An adult elk fragmentary maxilla with partially decayed teeth (P^3 – M^2) has been recovered from the entrance zone.

Cervus elaphus sibiricus (Severtsov, 1873). Most of the red deer bone fragments have been recovered from strata 10 and 11 and show a state of preservation typical of Holocene bone specimens. They were apparently redeposited from the upper strata during the burrowing activities of carnivores and rodents. However, a few bones (mostly teeth fragments) appear

Table 7. **Dimensions of lower and upper teeth of equids, mm**

Measurements	Kaminnaya Cave W_3			Krasny Yar W_2			Krasny Yar R-W		
	n	lim	M	n	lim	M	n	lim	M
P^{3-4}:									
Crown length	9	25.2–29.7	27.67	16	27.0–33.2	29.86	22	26.0–33.3	28.91
Protocone length	10	9.4–14.8	12.16	17	12.5–15.5	14.09	22	10.0–17.7	13.86
Tooth breadth	8	25.8–28.3	26.83	17	25.8–31.0	28.54	22	25.5–31.2	28.48
Protocone index	9	37.8–54.8	43.95	16	39.4–55.4	47.19	22	38.0–60.4	47.94
M^{1-2}:									
Crown length	4	23.5–26.2	24.70	21	24.7–29.5	26.83	22	23.5–29.0	25.96
Protocone length	4	10.7–13.7	12.48	20	12.2–14.9	13.61	20	10.7–16.6	13.80
Tooth breadth	2	24.3–26.1	25.20	20	25.1–29.2	27.40	20	24.8–30.5	27.62
Protocone index	4	44.4–57.5	50.53	20	43.1–58.9	50.73	20	45.5–61.7	53.16
M^3:									
Crown length	5	25–31	26.52	4	28.8–30.5	29.70	7	25.7–31.2	28.39
Protocone length	6	11.2–16.2	13.47	4	12.5–15.0	13.50	5	11.8–14.3	13.40
Tooth breadth	4	21.0–26.3	23.35	4	22.3–25.0	24.28	5	23.4–24.7	23.94
Protocone index	5	44.8–53.6	50.79	4	43.4–49.2	45.45	4	45.9–52.9	47.20
P_2:									
Tooth length	1	–	30.60	4	30–37	33.63	11	30.6–37.0	34.04
Postflexide length	1	–	13.70	3	14.7–15.8	15.40	10	10.8–19.0	15.49
Tooth breadth	1	–	15.70	4	14.7–18.5	16.70	10	15.5–18.7	16.80
Postflexide index	1	–	44.77	3	44.5–49.1	45.79	9	34.4–52.9	45.51
M_{1-2}:									
Tooth length	3	26.8–29.0	27.67	22	22.5–30.5	26.59	31	22.5–33.2	27.41
Postflexide length	3	10–11	10.40	21	9.0–16.8	11.91	29	6.7–14.5	11.11
Tooth breadth	3	14.2–14.8	14.43	20	13–20	16.29	30	14.8–19.3	17.15
Postflexide index	3	45–63	51.67	21	34.6–67.2	44.79	29	29.5–51.5	40.53
M_3:									
Tooth length	1	–	31.00	10	31.5–34.0	32.68	15	28.5–37.4	34.17
Postflexide length	1	–	8.00	11	7.7–12.7	10.64	14	8.1–13.5	10.93
Tooth breadth	1	–	13.30	12	13.1–17.0	14.83	16	12.8–17.4	14.50
Postflexide index	1	–	25.81	9	23.1–37.5	32.56	13	25.0–38.4	31.99

Table 8. **Dimensions of upper molars (M^{1-2}) of *Equus ex. gr. hydruntinus*, mm**

Measurements	Kaminnaya Cave		Denisova Cave (Prirodnaya sreda…, 2003)		
			n	lim	M
Crown length	23.6	23.2	8	20.5–26.9	24.6
Protocone length	10.8	10.8	8	9.4–12.2	11.1
Crown breadth	25.8	24.7	7	22.5–27.8	25.9
Protocone index	45.8	46.6	8	40.1–48.6	45.1

Table 9. **Dimensions of first phalanges of *Equus ex. gr. hydruntinus*, mm**

Measurements	Kaminnaya Cave W_3		Taradanovo W_2			Krasny Yar R-W
	Hindlimbs	Forelimbs	Forelimbs			Forelimbs
1. Bone length	75.6	85.1	84.0	85.2	85.3	83.0
2. Sagittal length, min	70.4	78.6	79.3	78.7	79.6	76.0
3. Proximal breadth	44.7	44.8	44.7	47.0	45.0	48.1
4. Proximal transverse diameter	32.2	31.6	32.0	34.7	30.5	35.3
5. Diaphysis breadth	27.8	28.7	28.3	30.4	27.6	27.5
6. Distal breadth	35.2	40.0	40.2	41.8	41.0	38.9
7. Distal transverse diameter	21.5	22.7	21.2	23.0	21.5	23.0
Indices:						
3:1	59.1	52.6	53.2	55.2	52.8	58.0
5:1	36.8	33.7	33.7	35.7	32.4	33.1
6:1	46.6	47.0	47.9	49.1	48.1	46.9

to be of Pleistocene age. Table 1 provides data only on the Pleistocene specimens of Siberian red deer (and roe deer). The entrance zone layers corresponding to strata 11b – 11d inside the cave have yielded two measurable specimens. The maximal length of the first phalanx is 65.5 mm, the length along the dorsal surface is 59.5 mm, the breadth/transverse diameter of the upper end is 28/34.4 mm; that of the lower end is 27.6/23.8 mm; the diaphysis breadth is 22.6 mm. The length of the calcaneum is 141.5 mm; the breadth/transverse diameter of the distal part is 49/52.2 mm; the smallest diaphysis breadth is 19.8 mm; the breadth/transverse diameter of the tuber calcanei is 32.3/37.7 mm. The size of the calcaneum from Kaminnaya is close to the mean calcaneum size for Late Holocene red deer populations in the Altai (Vasiliev, Grebnev, 1994).

Capreolus pygargus (Pallas, 1773). Abundant roe deer bone fragments in Holocene layers were mostly redeposited from the overlying sediments (mostly in stratum 10a) in the same way as the red deer bones. Isolated roe deer bone specimens have been recovered from stratum 11b down to stratum 18. Only a few bones are suitable for measurement. The proximal part of a metatarsal has been recovered from stratum 11c. Its breadth is 24.7 mm; the transverse diameter is 27.3 mm. The relevant measurements of the Holocene roe deer in the Altai are 21.8 – 23.6 – 26.6 mm (n = 30) and 23.5 – 25.2 – 27.3 mm (n = 27). The length of M_3 from stratum 15/2 is 20.5 mm, its breadth is 10.5 mm (16 – 18.2 – 20.3 mm, n = 25; and 8.9 – 9.4 – 10 mm, n = 27) (Ibid.). Thus, available isolated bones suggest a rather large size for the Late Pleistocene *C. pygargus* of the Altai.

Poëphagus mutus baicalensis (Vereschagin, 1954). At least three bone specimens are securely identified as Baikalian yak. These include two complete metacarpals, one of which has been recovered from entrance zone deposits, the other from stratum 11b. The dimensions of the metacarpals from Kaminnaya Cave (Table 10) are close to the maximal dimensions of female Pleistocene yak metacarpals from Southern Siberia (Ovodov, 2005). An incomplete distal humerus fragment with numerous gnaw marks also seems to belong to yak. This specimen has been recovered from stratum 11c, and its dimensions are considerably smaller than the minimal distal humerus size of *Bison priscus*. The breadth of its lower articular surface is 79.5 mm, while that of *Bison priscus* of the Kazantsevo Period from the Ob basin near Novosibirsk is 94 – 109.3 – 124.5 m (n = 62); while the medial transverse diameter of the lower part of the bone is about 86.5 mm (compared to 102.3 – 118.6 – 132mm, n = 56), the minimal transverse diameter is 38.6 mm (44 – 51.0 – 58 mm, n = 64), the height of the medial condyle is 50.3 mm (59 – 67.9 – 76.5 mm, n = 65). Apparently, this bone can be attributed to a female Baikalian yak.

Bison priscus (Bojanus, 1827). Bone fragments identified as belonging to bison-yak constitute 10.3 % of the total identified large mammal bones. Judging by the size of the bone and tooth fragments, most of the large bovine specimens are *B. priscus*. Only a few distal extremities are complete specimens. The dimensions of the Sartan bison bones from Kaminnaya are close to the minimal dimensions of bones of the Karga bison from Taradanovo and the Kazantsevo bison from Krasny Yar (Table 11). Comparisons of measurements of five front first phalanges are noteworthy. However, a few bones (two astragali, centrotarsal, tarsal III) from Kaminnaya apparently derived from large old males; the dimensions of these bones are close to the average and even

Table 10. **Metacarpal dimensions of female *Poëphagus mutus baicalensis*, mm**

Measurements	Kaminnaya Cave		Southern Siberia (Ovodov, 2005)
1. Bone length	188	184.5	172–192
2. Proximal breadth	70	65.5	58.0–68.5
3. Proximal transverse diameter	40	37.3	–
4. Diaphysis breadth	39.8	40.7	39.2–46.5
5. Transverse diameter	29.6	27	–
6. Distal breadth	69.6	69.2	62.7–69.0
7. Distal transverse diameter	–	35.5	–
Indices:			
2:1	37.2	35.5	–
4:1	21.2	22.1	–
6:1	37.0	37.5	–

Table 11. **Dimensions of postcranial bones of *Bison priscus*, mm**

Measurements	Kaminnaya Cave W_3			Krasny Yar R-W			Taradanovo W_2		
	n	lim	M	n	lim	M	n	lim	M
1	2	3	4	5	6	7	8	9	10
Axis:									
Frontal articular breadth	1	–	132.0	24	108.3–141.0	131.4	–	–	–
Dens ephistrophei breadth	1	–	54.0	24	54.0–65.5	59.6	–	–	–
Vertebral length	1	–	95.5	20	112.7–127.6	120.4	–	–	–
Minimal vertebral breadth	1	–	85.3	24	70.0–94.0	86.6	–	–	–
Humerus:									
Articular breadth	2	96.0–106.5	101.3	62	94.0–124.5	109.3	–	–	–
Minimal transverse diameter	2	52.5–56.3	54.4	64	46.1–63.2	52.5	–	–	–
Medial condyle height	2	64.0–68.0	66.0	65	59.0–76.5	67.9	–	–	–
Radius:									
Distal breadth	1	–	90.5	36	93.2–123.6	109.9	13	82.3–111.2	96.9
Distal transverse diameter	1	–	58.0	42	56.5–76.0	67.2	12	52.5–71.0	61.3
Metacarpale:									
Distal breadth	1	–	79.2	57	73.7–100.2	87.0	37	72.2–93.0	81.3
Distal transverse diameter	1	–	42.3	53	39.5–51.8	46.6	33	39.0–50.3	44.2
Phalanx I (forelimbs):									
Maximal length	5	72.0–80.5	76.6	34	72.5–91.6	79.9	72	70.0–93.0	80.3
Sagittal length, min	5	63.2–73.2	68.0	34	63.5–82.0	71.7	73	61.0–82.7	71.7
Proximal breadth	5	35.0–43.0	40.0	34	36.5–49.5	43.8	72	34.7–52.7	45.6
Proximal transverse diameter	5	40.5–50.0	45.1	33	38.0–56.0	46.3	72	38.5–55.2	47.1
Diaphysis breadth	5	34.5–43.0	38.3	34	34.0–47.0	41.1	73	33.0–51.2	42.3
Distal diaphysis breadth	5	36.8–44.3	40.6	32	35.3–49.0	43.6	69	35.4–56.0	45.4
Astragalus:									
Lateral length	2	89.5–94.7	92.1	65	82.1–102.5	91.5	128	76.2–104	88.7
Medial length	2	83.2–84.0	83.6	65	77.8–95.1	84.8	125	70.3–92.3	82.2

Table 11 continued

1	2	3	4	5	6	7	8	9	10
Distal breadth	3	52.1–67.0	61.7	65	53.3–67.3	60.5	115	47.5–63.6	57.2
Medial transverse diameter	2	54.2–57.3	55.9	57	46.5–58.0	52.1	87	42.5–55.3	49.7
Centrotarsale:									
Breadth	1	–	86	53	68.2–91.4	80.1	67	63.5–88.4	76.2
Transverse diameter	1	–	81	49	61.0–84.0	73.1	61	62–85	71.0
Phalanx I (hindlimbs):									
Maximal length	1	–	81.0	25	74.0–90.0	82.3	64	73.7–89.5	82.3
Sagittal length, min	1	–	72.0	26	72.2–88.0	73.1	64	64.8–81.5	73.6
Proximal breadth	2	36.0–42.8	39.4	25	33.2–47.0	40.7	59	35.3–48.5	40.8
Proximal transverse diameter	2	43.0–47.5	45.3	25	39.5–52.5	46.7	60	40.7–54.0	46.1
Diaphysis breadth	1	–	36.5	28	30–43	36.6	63	29.0–42.5	36.6
Distal breadth	1	–	41.6	26	34.2–44.7	40.2	64	31.2–47.2	39.9
Phalanx II (hindlimbs):									
Maximal length	1	–	54	20	50.2–59.0	54.8	56	50–63	56.4
Sagittal length, min	1	–	45.7	18	43.1–49.3	46.6	56	41.4–53.7	47.7
Proximal breadth	1	–	34.5	18	35.5–45.0	39.6	57	35.9–52.0	42.3
Proximal transverse diameter	1	–	37	19	37–49	43.5	45	37–54	45.6
Diaphysis breadth	1	–	28	19	28.0–34.7	31.6	56	28.8–39.3	33.2
Distal breadth	1	–	27.8	16	28.8–37.0	33.6	52	29.5–42.4	35.1
Tarsale III:									
Length	2	53.0–56.0	54.5	8	48.0-53.5	51.4	2	50.0–54.2	52.1
Breadth	3	33.5–37.6	35.1	8	30.7–34.8	33.0	2	32.0–33.7	32.9
Medial height	3	14.8–16.6	15.8	8	16.2–22.0	18.6	2	14.8–16.0	15.4

maximal dimensions of bones of *B. priscus* from the comparative sample. Materials from other Altai cave sites, like Okladnikov and Logovo Gieny (Ovodov, 1974) and others provide evidence that the Altai region was populated by a large form of *B. priscus* during the second half of the Late Pleistocene. This large form of bison was similar in size to bison forms from other regions of Southern Siberia in the Middle and Late Pleistocene. In conclusion, the rather small sample of bison bones from Kaminnaya suggests that during the final Sartan Period, before their extinction in the Altai, bison became smaller; however, some individuals were still very large, nearly the same size as the bison of preceding periods.

Saiga cf. *borealis* (Tscherskii, 1876). Saiga antelope remains have been recovered from nearly every layer of the Pleistocene profile starting with stratum 11a. The collection comprises nearly exclusively distal fragments of extremities: phalanges, tarsal and carpal bones, and tooth fragments. Some bones display considerable acid corrosion damage that hampers morphometric analysis. Postcranial bone measurements (Table 12) show that saiga from Kaminnaya Cave is considerably smaller than Upper Pleistocene *S. borealis* from the Crimea and slightly larger than modern *S. tatarica* (Baryshnikov, Kasparov, Tikhonov, 1990). It is worth noting that the available data on Karga saiga from the Novosibirsk region of the Ob basin (isolated horn cores) suggest that the smallest Pleistocene saiga were comparable in size to modern individuals (Vasiliev, 2005). It looks like the Altai and southern parts of Western Siberia were populated by a particular form of *S.* cf. *borealis* that was smaller that the saiga forms in the western parts of its habitat during the Karga – Sartan period.

Capra sibirica (Pallas, 1776). The large mammal bone collection of Kaminnaya Cave comprises more than 30 % of *Capra-Ovis* specimens. About half of this amount (mostly small tooth fragments) has been conventionally attributed to *Capra-Ovis*. Among the identifiable bones, the proportion of *Capra sibirica* specimens is three times greater than that of *Ovis ammon*. Some bones, especially first and second phalanges, have traces of severe acid corrosion. Whole bones are mostly distal extremities (Table 13). The dimensions of *Capra sibirica* phalanges from Kaminnaya do not differ from

Table 12. **Dimensions of extremities of *Saiga borealis*, mm**

Measurements	Kaminnaya Cave			Crimea, Late Paleolithic (Baryshnikov, Kasparov, Tikhonov, 1990)		
	n	lim	M	n	lim	M
Carpi 2+3:						
Bone breadth	3	14.2–15.0	14.5	–	–	–
Bone transverse diameter	4	16.7–17.0	16.9	–	–	–
Maximal height	4	9.5–9.7	9.6	–	–	–
Phalanx I (forelimbs):						
Maximal length	1	–	49.0	46	46.5–54.5	49.9
Sagittal length, min	1	–	44.4	–	-	–
Proximal breadth	1	–	12.5	69	12.2–15.7	13.5
Proximal transverse diameter	1	–	17.2	59	14.5–18.5	16.5
Diaphysis breadth	1	–	9.8	–	–	–
Distal breadth	5	8.9–11.7	10.4	91	10.1–13.5	11.8
Distal transverse diameter	5	9.3–11.6	9.9	126	9.3–13.0	11.6
Phalanx II (forelimbs):						
Maximal length	2	23.0–23.0	23.0	40	22.0–27.5	24.8
Sagittal length, min	2	21.0–21.0	21.0	–	–	–
Proximal breadth	1	–	10.6	43	10.3–12.3	11.3
Proximal transverse diameter	1	–	14.6	44	12.2–15.4	13.6
Diaphysis breadth	1	–	8.5	–	–	–
Distal breadth	2	8.2–8.5	8.4	42	9.0–11.3	10.1
Distal transverse diameter	1	–	11.0	43	10.1–13.7	11.8
Astragalus:						
Lateral length	2	30.0–30.0	30.0	33	30.4–35.1	32.2
Medial length	3	27.1–27.9	27.4	31	28.2–32.6	29.7
Distal breadth	4	16.7–18.6	17.6	34	16.2–20.7	18.8
Lateral transverse diameter	4	15.0–17.0	16.2	25	16.1–19.3	17.2
Centrotarsale:						
Bone breadth	1	–	25.1	8	23.2–27.5	24.8
Bone transverse diameter	1	–	24.8	8	23.5–25.6	24.2
Phalanx I (hindlimbs):						
Maximal length	1	–	42.3	100	37.3–46.4	42.4
Sagittal length, min	1	–	38.0	–	–	–
Proximal breadth	2	10.3–10.8	10.6	81	11.3–14.7	12.9
Proximal transverse diameter	2	15.2–15.4	15.3	85	13.3–16.7	15.2
Diaphysis breadth	1	–	7.8	–	–	–
Distal breadth	2	9.7–9.9	9.8	92	8.6–12.9	10.8
Distal transverse diameter	2	9.8–10.5	10.2	92	9.1–11.7	10.5

those of Siberian goat from the Pleistocene deposits of Denisova Cave, while the Kaminnaya astragali are slightly smaller than those from Denisova (Prirodnaya sreda…, 2003).

Ovis ammon (Linnaeus, 1758). Only a few argali sheep bones are measurable. The breadth of the frontal articular surface of a second cervical vertebra is 65.2 mm, and its length is 62 mm. The length of a radial carpal

Table 13. **Dimensions of extremities of *Saiga sibirica* from Kaminnaya Cave, mm**

Measurements	n	lim	M	Measurements	n	lim	M
Humerus:				Metatarsale:			
Distal breadth	1	–	40.0	Diaphysis breadth	1	–	19.8
Articular breadth	1	–	38.0	Distal breadth	1	–	33.1
Minimal transverse diameter	1	–	19.1	Distal transverse diameter	1	–	24.0
Medial condyle height	1	–	24.0	Phalanx II (forelimbs):			
Metacarpale:				Maximal length	3	29.5–32.8	31.0
Proximal breadth	1	–	32.8	Sagittal length, min	2	26.2–27.3	26.8
Distal breadth	2	35.1–39.0	37.1	Proximal breadth	4	16.7–19.5	18.3
Distal transverse diameter	1	–	24.0	Proximal transverse diameter	3	17.5–21.3	18.8
Phalanx I (forelimbs+hindlimbs):				Diaphysis breadth	2	13.2–14.5	13.9
Proximal breadth	1	–	15.7	Distal breadth	1	–	15.0
Distal breadth	6	14.0–17.2	16.5	Phalanx II (hindlimbs):			
Tibia:				Maximal length	5	29.0–34.5	30.8
Distal breadth	1	–	35.2	Sagittal length, min	5	25.8–29.2	27.4
Distal transverse diameter	2	26.6–27.0	26.8	Proximal breadth	4	15.2–17.2	16.4
Astragalus:				Proximal transverse diameter	3	15.7–19.4	17.1
Lateral length	3	36.5–39.0	37.5	Diaphysis breadth	3	11.0–12.5	11.7
Sagittal length	4	27.0–31.5	29.1	Distal breadth	3	11.3–13.0	12.0
Medial length	3	32.5–36.2	34.4	Phalanx III (forelimbs+hindlimbs):			
Distal breadth	2	24.0–24.7	24.4	Bone length	4	30.0–37.3	34.2
Medial transverse diameter	2	19.5–22.0	20.8	Dorsal length	4	23.8–31.5	28.0
Centrotarsale:				Bone height	4	16.2–21.5	18.6
Bone breadth	2	33.5–36.5	35.0	Articular length	4	14.0–15.2	14.8
Transverse diameter	2	30.2–30.8	30.5	Articular breadth	4	10.3–11.8	11.1

Table 14. **Dimensions of the first phalanges of *Ovis ammon* from Kaminnaya Cave, mm**

Measurements	Forelimbs	Hindlimbs		
		n	lim	M
Maximal length	52.2	2	56.8–57.5	57.2
Sagittal length, min	44.5	2	51.7–53.0	52.4
Proximal breadth	–	3	18.1–20.3	18.9
Proximal transverse diameter	22.0	2	23.8–28.4	26.1
Diaphysis breadth	17.5	2	15.3–16.5	15.9
Distal breadth	20.3	1	–	18.6
Distal transverse diameter	17.5	1	–	15.3

is 30 mm, the maximal width of the frontal part is 18.7 mm, and the minimal width at the middle is 12.7 mm. The length of an os malleolare is 23.3 mm, its width is 23.6 mm, and the transverse diameter is 13 mm. The diameter of a femoral head is 34 mm. The lateral, longitudinal and medial length measurements are 46, 36.5 and 42.7 mm, respectively; the breadth of the distal end is 29.7 mm; and the medial and lateral transverse diameter of the bone are 25 and 25.6 mm, respectively. The diaphysis breadth of the distal end of a metatarsal is 19.8 mm, and the measurements of breadth/transverse diameter of the distal end are 33.1/24 mm. Measurements of three specimens of M_3 are 38.2/14; 35.2/12 and 12.5 mm. Table 14 provides measurement data on first phalanges.

Taphonomy

The Pleistocene faunal collection from Kaminnaya Cave totals 13,800 bone specimens. Most of the bones in the collection are fragmented. In order to estimate the degree of fragmentation, unidentified bones have been divided into four size classes: 1 – 2, 2 – 5, 5 – 10, and more than 10 cm (Table 15). The degree of bone fragmentation varies only slightly across the profile; only in subdivisions of tenth strata are there relatively fewer specimens in the smallest size class. In general, the bones from Kaminnaya are more complete than are those from Denisova. The proportions of specimens in the first two size classes (1 – 2 and 2 – 5 cm) are close to one another in the two collections: 73.1 and 21.6 % for Kaminnaya and 74.2 and 24.7 % for Denisova; however, the proportions in the other two size classes (5 – 10 cm and > 10 cm) differ substantially: 4.8 and 0.5 % for the Kaminnaya collection and 0.5 and 0.05 % at Denisova. The two collections have different percentages of identified specimens: 25.4 % of bone fragments from Kaminnaya could be assigned to taxon, while no more than 1 % of the Denisova assemblage could be identified (Ibid.). Unlike Denisova, Kaminnaya has yielded large whole bones, including a horse metatarsal, two Baikalian yak metacarpals, four astragali and a calcaneum belonging to woolly rhinoceros, and a mammoth astragalus among others.

Most bones are yellowish brown, indicating a good state of preservation. The surface of bone fragments is smooth and dense and does not show signs of exfoliation. Most bone specimens are practically unweathered (Behrensmeyer, 1978). Bones recovered from the entrance zone show significant degree of weathering, fissures (weathering stages 2 – 3) and root etching.

Taphonomic data suggest that the bones were collected by carnivores, birds and humans. Hyenas used the cave as a shelter and as a den for breeding their cubs and seem to have been the main occupants of the cave (Baryshnikov, Vereschagin, 1997). This inference is supported by the large number of deciduous teeth (about 15 % of identified remains of *Crocuta spelaea*), the high degree of bone fragmentation, the occurrence of gnaw marks on many of the large bone fragments, the presence of coprolites in the cave sediments, and the abundance of bones and teeth with traces of acid corrosion. Baryshnikov has argued that the majority of

Table 15. **Size classification of large mammal bone fragments from the Pleistocene deposits in Kaminnaya Cave**

Stratum	Size class							
	1–2 cm		2–5 cm		5–10 cm		> 10 cm	
	n	%	n	%	n	%	n	%
10a	150	42.9	130	37.1	61	17.4	9	2.6
10c/2	23	53.5	13	30.2	7	16.3	–	–
10d	133	49.8	102	38.2	29	10.9	3	1.1
10e	4	44.4	4	44.4	1	11.1	–	–
11a	890	74.0	227	18.9	79	6.6	6	0.5
11b	1647	77.6	411	19.4	57	2.7	7	0.3
11c	1471	70.4	509	24.4	96	4.6	14	0.7
11d	1222	71.6	387	22.7	81	4.7	16	0.9
14a	933	83.5	158	14.1	25	2.2	1	0.1
14b	20	44.4	19	42.2	5	11.1	1	2.2
14a/1	584	80.8	119	16.5	20	2.8	–	–
14b/1	304	71.2	103	24.1	20	4.7	–	–
15/1	123	91.1	12	8.9	–	–	–	–
15/2	180	63.2	76	26.7	28	9.8	1	0.4
16 g	46	83.6	8	14.5	1	1.8	–	–
18	69	72.6	23	24.2	3	3.2	–	–

small bone fragments occurring in cave sediments derive from decayed hyena coprolites (Ibid.). Hyenas could have transported the body parts of animals they killed as well as the scavenged remains of animals killed by other carnivores, like cave lion, wolf, and probably humans. At Kaminnaya, carnivores left body parts with relatively low nutrient value like heads and distal leg extremities. N.M. Przevalsky (1948) noted a similar distribution of yak, koulan and mountain sheep body parts in the high elevated steppe zone of the Tibet Plateau. At another Altai cave site, Logovo Gieny (Hyena's Den), which was not occupied by humans, hyenas mostly collected bones they had scavenged from the carcasses of animals killed by other carnivores: heads and distal parts of extremities of horse, Pleistocene ass, bison, Baikalian yak, woolly rhinoceros and even juvenile mammoth (Ovodov, 1974; Ovodov, Martynovich, 2004, 2005). Hyenas gnawed and digested these remains; as a result, only the most resistant skeletal elements, like isolated teeth, severely gnawed metapodials, astragali and calcanea, remained in the cave sediments. On the other hand, most of the smaller bones like carpals, tarsals and phalanges were digested completely by cave hyenas.

The Kaminnaya bone collection is also dominated by teeth and distal bone fragments, yet the degree of their fragmentation is much higher than at Logovo Gieny. Since isolated bones but no deciduous teeth of cave lion and brown bear have been recovered from the cave, we can infer that the cave was used by these large carnivores as temporary shelter. Some old and ill animals died in the cave and were subsequently consumed by cave hyenas: among the specimens from the cave are the heavily gnawed distal end of a cave lion tibia and the acid-corroded first phalanx of a brown bear. The cave might have also been episodically inhabited by smaller carnivores like wolf, fox and possibly manul cat.

Bones of rodents, hares and birds accumulated in the cave due to the activities of large predatory birds, mostly eagle owls and owls. More than one quarter (27.7 %) of the total identifiable bones consist of various species of small animals and birds; these bones appeared in the cave sediments from decayed pellets. No fish bones have been identified in the Kaminnaya collection and only one bat mandible has been found.

At present, the role of humans in the accumulation of bones inside the cave is difficult to assess. C. Turner (Arizona State University, USA) has examined a part of the Kaminnaya bone collection. He recognized fine cut marks resulting from stone tool contact on a few long bones of mountain goat from strata 11b – 11d. Similar marks have been noted on the distal end of a marmot tibia. He has also identified several large fragments of long bones (e.g., a diaphysis fragment of a bison humerus from stratum 11c) that might have been fractured by percussive contact with a stone tool. No burnt bones have been noted within the examined portion of the collection. Apparently, some of the small bone fragments might have accumulated as a result of human butchering activities and bone splitting in search of marrow. However, it is impossible to distinguish bones split by humans from those fractured by cave hyenas and other predators. For the most part, Kaminnaya Cave was not permanently occupied by humans during the Pleistocene. Humans might have lived in the cave for short intervals, for instance, during certain seasons of the year. Most of the time, the cave was occupied by large carnivores: cave hyenas, cave lion, brown bear and wolf. Consequently, it is difficult to make zooarchaeological interpretations. Damage marks left by carnivores overlay traces of human activities, disguising the latter. During periods when humans did not live in the cave, it was visited and occupied for extended periods by carnivores, mostly hyenas, who consumed the food refuse of ancient humans. Sedimentation processes inside the cave were rather slow, so relatively large bones and fragments were buried only as a result of rock fall or the burrowing activities of animals. This, along with feeding activities of cave hyenas and other carnivores, can explain the notable predominance of small bone fragments and teeth in the Kaminnaya bone collection.

Paleoecology

Kaminnaya Cave can be regarded as a preserved record of the faunal community in the environs of the cave throughout the final Pleistocene and entire Holocene. Animal remains were transported into the cave by carnivores, birds and humans. The diversity of species reflected in the cave, together with the abundance of bones of particular species, provides reliable grounds for paleoecological reconstructions.

The bone collection from the Sartan deposits of Kaminnaya Cave is dominated by open landscape species with respect to both the number of identified species and the amount of bone specimens. The most abundant taxa are horse (14.3% of the total number of identified large mammal bones); woolly rhinoceros (11.2 %); bison (about 9 %), argali sheep (less than 10 %), saiga antelope (3.4 %); marmot (13.1 %), and hare tolai (5.4 %). Bone fragments of Baikalian yak (not less than 0.2 %), Pleistocene ass (0.2 %), and manul cat (0.1 %) are less numerous. Remains of Siberian mountain goat, representing the mountain biota, constitute around 20 % of the total collection.

Animals inhabiting the taiga zone are represented by only one specimen: a tooth of a sable (stratum 11c). This suggests that some areas of deep river valleys and mountain slopes had taiga forest vegetation. Wolverine, represented by a single bone fragment from stratum 11b, cannot be considered simply a forest animal. Currently, the wolverine range extends into tundra and steppe ecozones for several hundreds of kilometers (Mlekopitayuschie..., 1967). Lynx (three bones recovered from strata 11b and 14 b) mostly inhabits forest zones, but it can live in woodlands and floodplains vegetated with shrubs (Geptner, Sludsky, 1972), where it mostly hunted hare during the Pleistocene. Brown bear, especially when it is rare, cannot be considered diagnostic of paleoenvironmental conditions. Przevalsky (1948) noted that brown bear (*Ursus arctos pruinosus*) populated high elevated steppes of Tibet where it subsisted on pika and marmot.

Bones of elk and Siberian red deer are not numerous in the Sartan deposits, constituting only 0.3 % and 0.8 % of identified specimens, respectively. Recently it has been recognized that in the Middle and Upper Pleistocene, elk and red deer were part of the mammoth fauna and their habitat differed from the modern one. Morpho-functional features of their mandibles suggest that these animals preferred semi-open and forest steppe biotas rather than forest zones (Boeskov, 1999, 2001; Vasiliev, 2005). Roe deer (0.4 % of the identified collection) inhabits shrub-woodland along steppe river valleys and forest-steppe zones rather than open steppe landscapes (Geptner, Nasimovich, Bannikov, 1961).

The habitat of Baikalian yak hardly differed from that of the modern Tibetian yak *Poëphagus mutus* and likely included high elevated semi-desert steppes characterized by a dry and cold climate with little snow (Przevalsky, 1946). Other representatives of the Central Asian faunal complex, tolai hare and manul wild cat, currently inhabit southern steppe regions of the Altai. Manul populates rough-country regions where it can find shelter in rock outcrops and does not inhabit areas where the snow cover exceeds 20 cm (Sludsky, Geptner, 1972).

The habitat of tolai hare is also confined to steppe and desert regions of western Central Asia with limited snow cover. Saiga is specialized for steppe and semi-desert habitats and does not inhabit areas where the snow cover exceeds 15 – 20 cm (Vereschagin, Baryshnikov, 1980). Isolated remains of Pleistocene ass recovered from strata 11b and 11c suggest a restricted habitat and consequently a smaller population of wild ass during the Sartan cold episode, rather than a significant aridization of the climate and expansion of open landscapes as was proposed by I.V. Foronova (Derevianko, Markin, Bolikhovskaya et al., 1999). The Karga deposits of the Logovo Gieny cave site have yielded an assemblage of more than 2400 equid bones, within which the share of specimens of the relatively heat-tolerant Pleistocene ass is several times greater than that of the large caballine horse (Ovodov, Martynovich, 2004).

The original inferences of Foronova (Derevianko et al., 1999) that large mammal remains from subdivisions of the

Table 16. **The rates of large mammal bone remains from the Sartan and pre-Sartan layers in Kaminnaya Cave**

Taxa	Strata 10 a – 14 b		Strata 14a/1 – 18	
	n	%	n	%
Lepus cf. *tanaiticus*	26	1.4	4	1.3
Lepus tolai	104	5.4	–	–
Marmota baibacina	251	13.1	17	5.5
Canis lupus	51	2.7	3	1.0
Ursus arctos	7	0.4	2	0.6
Crocuta spelaea	88	4.6	14	4.5
Coelodonta antiquitatis	215	11.2	32	10.3
Equus (E.) *ferus*	274	14.3	37	11.9
Equus ex. gr. *hydruntinus*	4	0.2	–	–
Alces alces	5	0.3	–	–
Cervus elaphus	15	0.8	7	2.3
Capreolus pygargus	8	0.4	13	4.2
Bison-Poëphagus	183	9.5	52	16.7
Saiga borealis	65	3.4	22	7.1
Capra-Ovis	584	30.5	101	32.5
Total	1 880	100	304	100

tenth strata provide evidence of reduced open landscapes and the spread of forests were based on erroneous interpretations of the zooarchaeological materials. The total bone collection from stratum 10 comprises 28 roe deer fragments and six red deer specimens. All of these remains demonstrate a state of preservation typical of Holocene materials, i.e., they were likely redeposited from the overlying sediments.

Substratum 14a/1 and below can be attributed to the Karga and pre-Karga periods on the basis of the infinite date of > 40 ka BP for stratum 14a/1 (Derevianko, Markin, 2005). This unit yielded only 318 identifiable bone specimens, while all the bones recovered from stratum 16 are unidentifiable and the bone collection from stratum 18 comprises just a few identifiable bones (see Table 1). Despite the significant difference in the number of identifiable specimens in the faunal samples from Sartan versus pre-Sartan horizons (almost by a factor 9), some comparisons can be made. Over time, the relative abundance of bones attributable to woolly rhinoceros, cave hyena and Capra-Ovis is comparable in all horizons. In contrast, the number of bison remains increased by a factor of 1.8, those of saiga by a factor of 2.1, and those of red deer by a factor of 2.9. The number of roe deer specimens increased dramatically (by a factor of 10.5). On the other hand, the proportion of steppe species decreased: horse, by a factor of 1.2; marmot, by a factor of 2.4; and the tolai hare disappeared (Table 16). Hence, available data allows for reconstruction of forest-steppe landscapes for the period of formation of the lower, pre-Sartan horizons of Kaminnaya Cave. These horizons (at least strata 14a/1 – 15/2) seem to have been deposited during an interstadial, most probably the Karga Period.

Conclusion

In sum, based on the faunal remains from Kaminnaya Cave, we can reconstruct a cold steppe environment with limited snow cover in the northwestern part of the Altai Mountains during the final Sartan Period. During warm episodes, forest-steppe landscapes might have appeared. Forests likely occupied river valleys and northern mountain slopes. The presence of manul cat, saiga, tolai hare and Baikalian yak suggests that the average thickness of snow cover did not exceed 15 – 20 cm throughout this period. The faunal community from the lower pre-Sartan part of the profile is consistent with a forest-steppe environment. Numerous saiga specimens provide evidence to indicate that the average thickness of snow cover was no greater than during the succeeding Sartan Period.

According to available radiocarbon dates, during the period up to the final Sartan (no later than 11 – 10.5 ka BP), the northwestern Altai Mountain region was populated by all members typically included in the mammoth faunal group. These would include such large animals as mammoth, woolly rhinoceros, bison, Baikalian yak, horse, Pleistocene ass, saiga, cave hyena, cave lion as well as many species populating the area today. This region seems to have been among the last refuge areas for the mammoth fauna in Eurasia. Kaminnaya osteological materials provide evidence for reduction in the mean sizes of the teeth and postcranial bones (and accordingly body size) of woolly rhinoceros, bison, horse and, possibly, cave hyena over the course of the late Upper Pleistocene.

For the most part, the Pleistocene faunal remains from Kaminnaya Cave were accumulated by large carnivores, mostly cave hyenas and to a lesser extent wolves, cave lion, brown bear, fox, and predatory birds. Only a few bones possess cut marks resulting from the butchery activities of Paleolithic humans. Human hunters mostly targeted abundant species such as mountain goat, argali sheep, saiga, bison, and horse. The faunal evidence suggests that humans did not inhabit the cave permanently. The cave seems to be inhabited by humans episodically, probably, seasonally. Most of the time, the cave served as predator's den, usually for cave hyenas. When the cave was not occupied by humans, carnivores consumed or carried away, partially or completely, the remains of animals hunted by humans. This fact hampers a clear zooarchaeological interpretation of the faunal assemblage.

References

Averianov A.O. 1995
Pozdnepleistotsenovyi zaiats Lepus tanaiticus (Lagomorpha, Leporidae) Sibiri. *Trudy. Zoologicheski institut RAN*, vol. 263: 121 – 162.

Averianov A.O., Kuzmina I.E. 1993
Donskoi zaiats, Lepus tanaiticus Gureev, 1964, iz pozdnepaleoliticheskih stoianok Kostenki. *Trudy. Zoologicheski institut RAN*, vol. 249: 66 – 91.

Arkheologiya, geologiya i paleogeografiya pleistotsena i golotsena Gornogo Altaya. 1998
A.P. Derevianko, A.K. Agadjanian, G.F. Baryshnikov, M.I. Dergacheva, T.A. Dupal, E.M. Malaeva, S.V. Markin, V.I. Molodin, S.V. Nikolaev, L.A. Orlova, V.T. Petrin, A.V. Postnov, V.A. Ulianov, I.K. Fedeneva, I.V. Foronova, M.V. Shunkov. Novosibirsk: Izd. IAE SO RAN.

Baryshnikov G.F. 1995
Peschernaya giena Crocuta spelaea (Carnivora, Hyaenidae) iz paleoliticheskoi fauny Kryma. *Trudy. Zoologicheski institut RAN*, vol. 263: 3 – 45.

Baryshnikov G.F. 2005
Peschernaya giena (Crocuta spelaea): Tafonomiya i adaptatsiya. In *Aktualnye voprosy evraziiskogo paleolitovedenia*. Novosibirsk: IAE SO RAN, pp. 15 – 16.

Baryshnikov G.F., Kasparov A.K., Tikhonov A.N. 1990

Saiga paleolita Kryma. *Trudy. Zoologicheski institut RAN*, vol. 212: 3 – 48.

Baryshnikov G.F., Vereschagin N.K. 1997

Kratkii obzor chetvertichnykh gien (semeistvo Hyaenidae) Rossii i sopredelnykh territorii. *Trudy. Zoologicheski institut RAN*, vol. 270: 7 – 65.

Behrenmeyer A.K. 1978

Taphonomic and ecologic information from bone weathering. *Paleobiology*, N 4: 150 – 162.

Boeskorov G.G. 1999

K sistematicheskomu polozheniyu i istorii blagorodnykh olenei (Cervus elaphus L.) Yakutii. In *Redkie vidy mlekopitaiuschikh Rossii i sopredelnykh territorii*. Moscow: Teriologicheskoe obschestvo RAN, pp. 40 – 53.

Boeskorov G.G. 2001

Sistematika i proiskhozhdenie sovremennykh losei. Novosibirsk: Nauka.

Bolikhovskaya N.S., Markin S.V. 2002

Klimatostratigraficheskoe raschlenenie otlozhenii stoyanki Kaminnaia i pozdnelednikovye etapy razvitiya rastitelnosti Severo-Zapadnogo Altaya. In *Tretie Vserossiiskoe soveschanie po izucheniiu chetvertichnogo perioda*: *Materialy soveschaniya*, vol. 1. Smolensk: n.p., pp. 18 – 20.

Derevianko A.P., Grichan U.V. 1990

Issledovanie peschery Kaminnaya. Predvaritelnye itogi raskopok v 1983 – 1988 gg. (pleistotsenovaia tolscha). Preprint. Novosibirsk: IIFF SO AN SSSR.

Derevianko A.P., Markin S.V. 2005

Rekonstruktsiya prirodno-klimaticheskikh sobytii v verkhnem paleolite srednegornogo poyasa Severo-Zapadnogo Altaya (po rezultatam kompleksnogo issledovaniya peschery Kaminnaia). In *Evoliutsia zhizni na Zemle*: *Materialy III Mezhdunarodnogo simposiuma.* Tomsk: Izd. Tomsk. Gos. Univ., pp. 333 – 335.

Derevianko A.P., Markin S.V., Bolikhovskaya N.S., Orlova L.A., Foronova I.V., Dupal T.A., Gnibidenko Z.N., Efremov S.A., Tsynert I.I. 1999

Nekotorye itogi kompleksnykh issledovanii peschery Kaminnaia (Severo-Zapadnyi Altai). In *Problemy arkheologii, etnografii, antropologii Sibiri i sopredelnykh territorii*. Novosibirsk: IAE SO RAN, pp. 98 – 104.

Dupal T.A. 2004

Perestroika soobschestv melkikh mlekopitayuschikh na rubezhe pleistotsena i golotsena Severo-Zapadnogo Altaya. *Paleontologicheski zhurnal*, N 1: 78 – 84.

Eisenmann V., Beckouche S. 1986

Identification and discrimination of metapodials from Pleistocene and modern Equus, wild and domestic. In *Meadow H.P., Ürpmann (eds.). Equids in the Ancient World*. Beihefte zum Tübinger Atlas des Vorderen Orients, Reihe A. Wiesbaden: n.p., pp. 116 – 163.

Galkina L.I., Ovodov N.D. 1975

Antropogenovaya teriofauna pescher Zapadnogo Altaya. In *Sistematika, fauna, zoogeografia mlekopitaiuschikh i ih parazitov*. Novosibirsk: Nauka, pp. 165 – 180.

Geptner V.G., Nasimovich A.A., Bannikov A.G. 1961

Mlekopitaiuschie Sovetskogo Soyuza, vol. 2, pt. 1 Moscow: Vysshaya shkola.

Geptner V.G., Sludsky A.A. 1972

Mlekopitayuschie Sovetskogo Soiuza. vol. 2, pt. 2. Moscow: Vysshaya shkola.

Germonpre M. 1993

Osteometric data on Late Pleistocene mammals from the Flemish Valley, Belgium. *Documents de travail de L' I. R. Sc. N. B.* (Brussels), N 72.

Kosintsev P.A. 1995

Ostatki krupnykh mlekopitaiuschikh iz Lobvinskoi peschery. In *Materialy po istorii sovremennoi bioty Srednego Urala*. Ekaterinburg: Ekaterinburg, pp. 58 – 102.

Kuzmina I.E. 1971

Formirovanie teriofauny Severnogo Urala v pozdnem antropogene. *Trudy. Zoologicheski institut RAN*, vol. 49: 44 – 122.

Kulik N.A., Markin S.V. 2001

K petrograficheskoi kharakteristike kamennoi industrii peschery Kaminnaya (Gornyi Altai). In *Problemy arkheologii, etnografii, antropologii Sibiri i sopredelnykh territorii*. Novosibirsk: Izd. IAE SO RAN, pp. 136 – 141.

Markin S.V., Jull E.J.T., Orlova L.A., Kuzmin Y.V. 2001

Interpretatsia novykh radiouglerodnykh dat po peschere Kaminnaya (Severo-Zapadnyi Altai). In *Sovremennye problemy evraziiskogo paleolitovedeniya*. Novosibirsk: Izd. IAE SO RAN, pp. 262 – 266.

Mlekopitayuschie Sovetskogo Soyuza. 1967

V.G. Geptner, N.P. Naumov, P.B. Yurgenson, A.A. Sludsky, A.F. Chirkova, A.G. Bannikov, vol. 2, pt. 1. Moscow: Vysshaya shkola.

Ovodov N.D. 1974

Ostatki krupnykh Bovidae v peschere Logovo Gieny na Altae. In *Pervyi mezhdunarodnyi teriologicheskii kongress*, vol. 2. Moscow: n.p., p. 87.

Ovodov N.D. 2005

Buivol (Bubalus sp.) v paleolite Yuzhnogo Primoria na fone paleofaunisticheskikh idei. In *Problemy arkheologii, etnografii, antropologii Sibiri i sopredelnykh territorii*. Novosibirsk: Izd. IAE SO RAN, pp. 173 – 180.

Ovodov N.D., Martynovich N.V. 2004

Peschera Okladnikova na Altae. Predvaritelnaya tafonomicheskaya otsenka. In *Problemy arkheologii, etnografii, antropologii Sibiri i sopredelnykh territorii*. Novosibirsk: Izd. IAE SO RAN, pp. 175 – 184.

Ovodov N.D., Martynovich N.V. 2005

"Strannosti" v povedenii peschernyh gien (Crocuta spelaea Goldf.). In *Problemy arkheologii, etnografii, antropologii Sibiri i sopredelnykh territorii*. Novosibirsk: Izd. IAE SO RAN, pp. 181 – 183.

Orlova L.A. 1995

Radiouglerodnoe datirovanie arkheologicheskikh pamyatnikov Sibiri i Dalnego Vostoka. In *Metody estestvennykh nauk v arkheologicheskikh rekonstruktsiakh*, pt. 2. Novosibirsk: IAE SO RAN, pp. 206 – 231.

Orlova L.A., Kuzmin Y.V., Dementiev V.N. 2002

Istoriya mamonta v Sibiri v pozdnelednikovie, 15000 – 10000 let nazad (po dannym radiouglerodnogo datirovania). In *Osnovnye zakonomernosti globalnykh i regionalnyh izmenenii klimata i prirodnoi sredy v pozdnem kainozoe Sibiri*. Novosibirsk: Izd. IAE SO RAN, pp. 356 – 369.

Orlova L.A., Kuzmin Y.V., Dementiev V.N. 2005
Prostranstvenno-vremennaya model vymiraniya pleistotsenovoi megafauny Sibiri: novye dannye. In *Evoliutsiya zhizni na Zemle: Materilay III Mezhdunarodnogo simposiuma*. Tomsk: Izd. Tomsk. Gos. Univ., pp. 368 – 369.

Prirodnaya sreda i chelovek v paleolite Gornogo Altaya. 2003
A.P. Derevianko, M.V. Shunkov, A.K. Agadjanian, G.F. Baryshnikov, E.M. Malaeva, V.A. Ulianov, N.A. Kulik, A.V. Postnov, A.A. Anoikin. Novosibirsk: IAE SO RAN.

Przevalsky N.M. 1946
Mongoliya i strana tangutov. Moscow: Gos. izd. geogr. lit.

Przevalsky N.M. 1948
Iz Zaisana cherez Hami v Tibet i na istoki zheltoi reki. Moscow: Geografgiz.

Vasiliev S.K. 2004
Tafonomicheskie osobennosti Taradanovskogo vtorichnogo alliuvialnogo mestonahozhdeniya. In *Problemy arkheologii, etnografii, antropologii Sibiri i sopredelnykh territorii*. Novosibirsk: Izd. IAE SO RAN, pp. 164 – 168.

Vasiliev S.K. 2005
Krupnye mlekopitaiuschie kazantsevskogo i karginskogo vremeni Novosibirskogo Priobia (po materialam mestonahozhdeniya Krasnyi Yar). Cand. Sc. (History) Dissertation. Novosibirsk.

Vasiliev S.K., Grebnev I.E. 1994
Fauna mlekopitaiuschikh golotsena Denisovoi peschery. In *Derevianko A.P, Molodin V.I. Denisova peschera*, pt. 1. Novosibirsk: VO “Nauka”, pp. 167 – 180.

Vereschagin N.K. 1956
O prezhnem rasprostranenii nekotorykh kopytnykh v raione smykania Evropeisko-Kazahstanskikh i Tsentralnoaziatskikh stepei. *Zoologishecki zhurnal*, vol. 35, iss. 10: 1541 – 1553.

Vereschagin N.K., Baryshnikov G.F. 1980
Paleoekologiya pozdnei mamontovoi fauny v arkticheskoi zone Evrazii. *Bull. Moskovskogo obschestva ispytatelei prirody. Otd. biol.*, vol. 85, iss. 2: 5 – 19.

Received 27 March, 2006.