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Small mammal fauna of Istykskaya Cave (Eastern Pamir, Tajikistan)

Natalia V. Serdyuk*, Nuritdin Sayfulloev & Svetlana V. Shnaider

ABSTRACT. The paper describes the fossil fauna of small mammal from Istykskaya Cave, a high-mountain archaeological site from the Eastern Pamir. The total amount of material is insignificant, but it is unique. The fauna includes pikas, hares, dwarf gray hamsters, mountain and Pamir voles, and marmots. The fauna of the Istykskaya Cave is similar to faunas of other cave sites in Central Asia, but is poorer in species. A study of the fauna of small mammal showed that people visited the Istykskaya Cave regularly with varying intensity throughout its existence.

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KEY WORDS: Pamir, small mammals, Late Pleistocene, Holocene, Mesolithic.

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Фауна мелких млекопитающих Истыкской пещеры (Восточный Памир, Таджикистан)

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РЕЗЮМЕ. В работе описана ископаемая фауна мелких млекопитающих из Истыкской пещеры, высокогорного археологического памятника из Восточного Памира. Общее количество материала незначительно, но он уникален. В составе фауны отмечены пищухи, заяц, серые хомячки, скальные и арчовые полевки, сурок. Фауна Истыкской пещеры сходна с фаунами пещерных местонахождений Средней Азии, но более бедна видами. Исследование фауны мелких млекопитающих показало, что человек посещал Истыкскую пещеру регулярно с разной интенсивностью на протяжении всего ее существования.

КЛЮЧЕВЫЕ СЛОВА: Памир, мелкие млекопитающие, поздний плейстоцен, голоцен, мезолит.

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Introduction

The Pamir is a mountainous country located in the very south-east of Central Asia. The climatic conditions of the Pamir are harsh, sharply continental; closed mountain valleys contribute to the stagnation of cold air masses. Vegetation is determined by climatic features and shows vertical zonation. According to the nature of the relief, the Pamir is divided into the Eastern Pamir with ancient middle altitude mountains and the Western Pamir with high mountain landscapes. Now in the Eastern Pamir the vegetation is low-growing, sparse, and lacks arboreal forms. It is characterized by high desert landscapes and rocky highlands. The modern appearance of the Pamir is associated with the tectonic processes of the Cenozoic, which are on-going.

Questions about the settlement of ancient humans across the territory of Eurasia and their settlement of high mountain regions are of interest to archaeologists and stimulate a comprehensive study of this region. Previous studies discovered numerous elevated archaeological complexes of the Paleolithic on the territory of the Pamir (Ranov & Khudzhageldiev, 2005). There were identified several stratified sites such as Istykskaya Cave (Zhukov, 1986), Oshhona, Kurteke, and Shakhti (Ranov, 1961). At that period, these sites yielded the first systematic data that served as a base of general cultural interpretations (Ranov & Khudzhageldiev, 2005).

In 2018, the joint Russian-Tajik expedition resumed the study of these harsh regions. The main goal of the field investigations was a re-study of the known archaeological sites to collect new archaeological material and to provide a new data on the palaeoenvironment of the region. In the frame of this work, the Istykskaya Cave site was studied too. The cave is situated in the south-eastern part of the Pamir on the left bank of the Istyk River (Fig. 1A–C). The absolute altitude of the cave is 4060 m above sea level. The excavations on the site were carried out in 2018 and 2019. The total area of 2 m^2 was excavated and with 6 main layers defined (Fig. 1D).

Layer 0: Grayish, dusty, structureless sand with small limestone fragments. The thickness of the layer is 0.2 meters.

Layer 1: Gray, dusty, structureless sand with no clastic material. The thickness of the layer varies from 0.2 to 0.4 meters. Traces of a large burrow filled with rodent droppings were found in the lower part of the layer. The layer contains fire places, bones (most of them burnt), coals, few pieces of pottery, pieces of wood and few lithics. For bottom part of layer was obtained date 4410–3981 years BP (GV02109) (Zelenkov *et al*., 2021).

Layer 2: This layer consists of brown, humified, dusty sand. It is subdivided into three sub-layers:

Sub-layer 2.1: Composed of brown sand, this sub-layer shows traces of a single hearth. Lithic artifacts and faunal remains were found within this sub-layer, along with a significant amount of burnt debris.

Sub-layer 2.2: This sub-layer consists of dung-layers, which, based on preliminary morphological analysis, belong to the genus *Bos*. The concentration of finds is lower compared to sub-layer 2.1.

Sub-layer 2.3: Composed of dark brown sand, this sub-layer contains four traces of hearths, lithic and bone artifacts, and faunal remains.

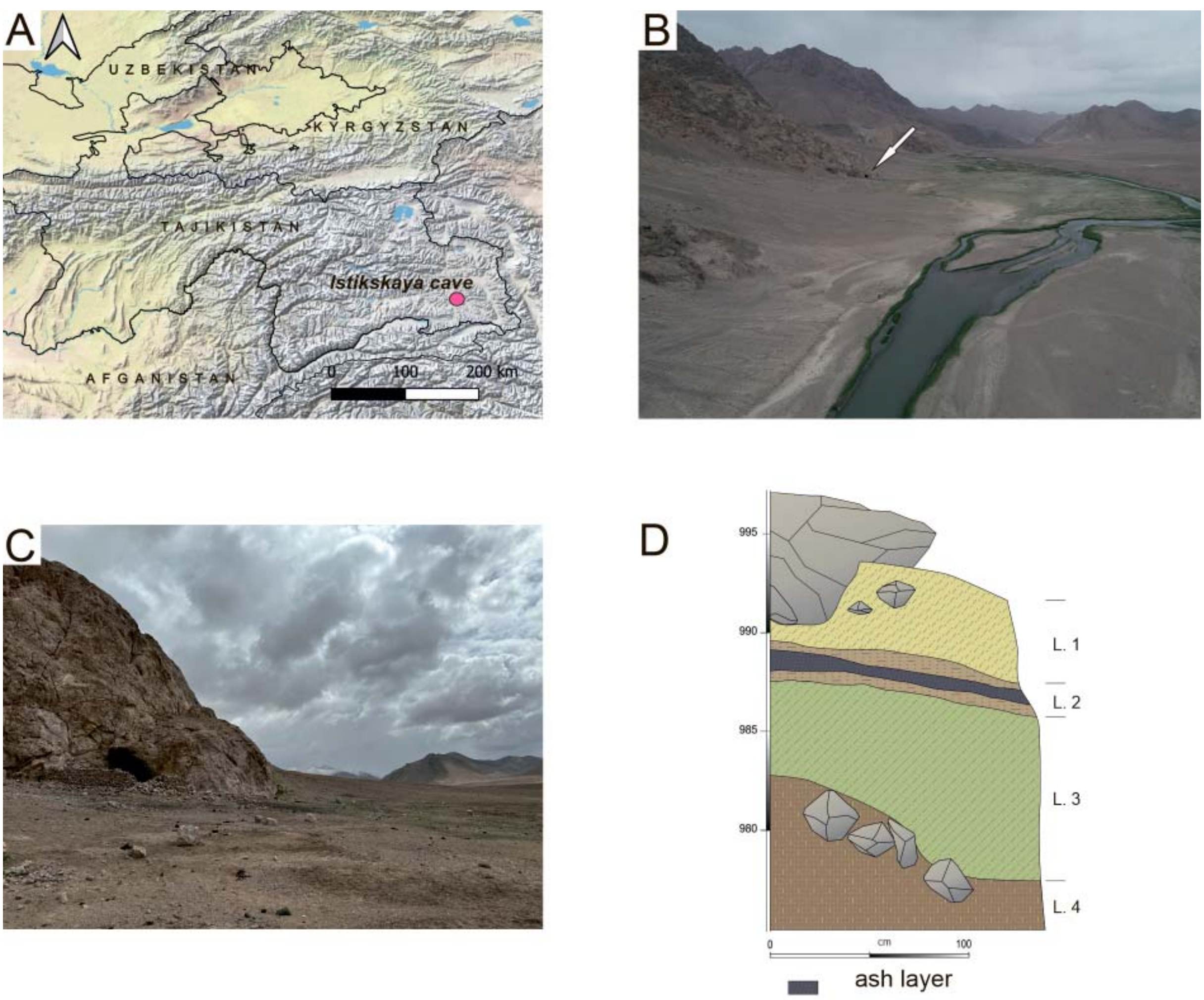

Fig. 1. Schematic map of the study area. A — map with the location of Istykskaya Cave; B — general view to the Istyk Valley, white arrow points to the Istykskaya Cave; C — view to the entrance of Istykskaya Cave; D — stratigraphic profile of NE profile in Istykskaya Cave.

For the layer 2 was obtained one date 8635–8192 years BP (GV 02111) (Zelenkov *et al*., 2021).

Layer 3: Gray, dusty, structureless sand. A sterile sub-layer is present at the boundary between layers 2 and 3. Lithic artifacts and faunal material were found within this layer. The thickness of the layer ranges from 0.3 to 1.5 meters. The layer is dating between 14 and 13.5 kaBP (Zelenkov *et al*., 2021).

Layer 4: This layer is represented by well-sorted gray river sand without any inclusions. Archaeologically, the layer is sterile and reaches a thickness of up to 1 meter.

Layer 5: Underlying layer 4, this layer consists of thin interbeddings of sand and silt, possibly indicating episodes of water ingress into the cave. Archaeologically, the layer is sterile. During excavations, the rocky floor was not reached, and the visible thickness of the layer is 0.5 m (Shnaider *et al*., 2019).

The cultural layers at the site were formed in the period of 14–1.5 kaBP. According to radiocarbon dating, layer 1 is aged between 4.4–1.5 thousand years ago, layer 2 is aged 8.6–7.1 thousand years ago. Layer 3 is aged 14–13.1 thousand years ago (Shnaider *et al*., 2021).

The results of the paleofaunal analysis indicates that the main object of hunting for the ancient populations were medium-sized mammals (*Ovis ammon* (Linnaeus, 1758) / *Capra sibirica* Pallas, 1776), while in the period from the final Pleistocene to the middle Holocene man additionally hunted birds and small mammals (Shnaider *et al*., 2021).

The purpose of this work was to determine and study the species composition of small mammals from the Istykskaya Cave, since there are currently no detailed data for the fossil faunas of small mammals of the Eastern Pamir.

Materials and methods

In 2018, clearings of the SW and NE profiles were done in the Istykskaya Cave. A small area of 2 m^2 was excavated in 2019. The field study was carried out using conventional methods of the modern archaeology. The stratigraphic sequence was constantly monitored during the excavations. Each sample and artifact were recorded with a tacheometer to ensure clear reference to the coordinate system of the site. By means of a tacheometer and a Trimble Nomad field controller with the specialized software "EDM mobile" installed, all measurements and contextual information were automatically collected and stored. Each bucket of sediment was sieved or washed on a 1 mm mesh sieve in order to collect small artifacts and bone elements.

The collection of micromammalian remains from the cave was carried out in a traditional way by layer-by-layer screening/washing the rock on fine mesh sieves, followed by the extraction of osteological remains. Material on small mammals was determined under an MBS-10 binocular microscope. Vole teeth were measured using an eyepiece micrometer with ×4

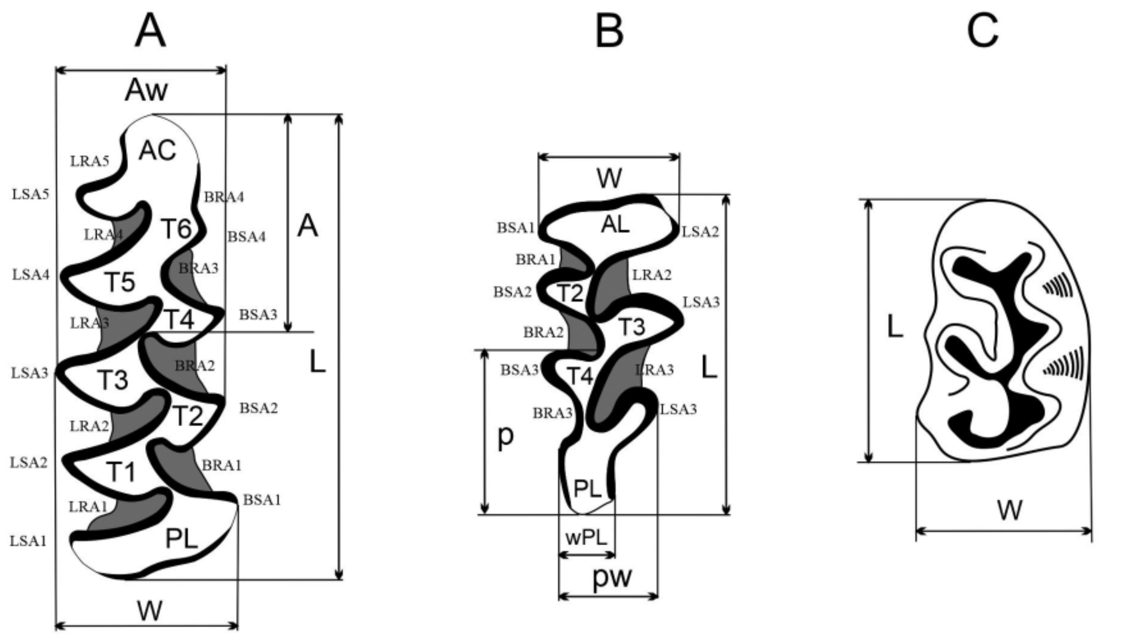

Fig. 2. Morphological features and dental measurements of small mammals. A — right lower m1 of rootless voles, B — right upper m3 of rootless voles, C — upper m1 of grey hamsters. Morphology: T1–T7 — triangles; AC — anterior cap, AL — anterior lobe, PL — posterior lobe, BRA — buccal reentrant angles, BSA — buccal salient angles, LRA — lingual reentrant angles, LSA — lingual salient angles. Measurements (m1): L — length, W — width, A — length of anteroconid complex, Aw — width of anteroconid complex, p — length of posterocon complex, pw — width of posterocon complex, wPL - width of posterior lobe.. Grey — cement deposits.

magnification, and marmot teeth using a caliper. The results of the determinations were entered into a common database. We did not carry out calculations based on the minimum number of individuals, because the quantitative relationship between species layer by layer remains the same as in the case of calculations of the ratio of species based on the minimum number of individuals (MNI — minimum number of individuals) (Ivleva, 1990).

The terminology and morphology of vole teeth is given according to van der Muelen (1973), Rabeder (1981), and Rekovets & Nadachowski (1995) (Fig. 2). The Corel Draw software package was used to create graphic images and process photographs. The work involved comparative collections of small mammals from the Borissiak Paleontological Institute (PIN RAS) and the Zoological Museum of Moscow State University named after M.V. Lomonosov (ZM MSU).

Radiocarbon dating was carried out at the AMS Golden Valley, Novosibirsk (Shnaider *et al*., 2021). The material of small mammal described here is deposited in the Archaeological Department of Institute of History, Archaeology and Ethnography (Dushanbe, Republic of Tajikistan).

Results

The material on small mammal was obtained from three layers: layer 1, layer 2, layer 3. It is yellow-brown in color, characteristic of fossil cave finds. The remains are highly fragmented; more than half of the bone elements cannot be identified to the level of species. No remains of insectivores or bats, commonly occurring in cave taphocenoses, were found. Skeletal remains of small mammals except lagomorphs are not analyzed in this study. The number of bone elements identified to species and genus level amounts to 96 specimens (Tab. 1). Preliminary results of the small mammal study were previously published in the monograph "Man on the Roof of the World" (Shnaider *et al*., 2021).

Table 1. List of small mammal species in the Istykskaya Cave

	Layers		
Species	**1**	**2**	**3**
Lepus sp.			3
Ochotona sp.		9	26
Marmota cf. *baibacina*			1
Marmota sp.			8
Nothocricetulus migratorius		8	16
Alticola cf. *argentatus*			4
Alticola sp.		4	11
Microtus juldaschi	1	1	1
Microtus sp.	2	1	
total	3	23	70

Fossil small mammals

Order Lagomorpha Brandt, 1855

Family Leporidae Fischer, 1817

Subfamily Leporinae s. str.

Tribe Leporini s. str.

Genus *Lepus* Linnaeus, 1758

Lepus sp. (Fig. 3A)

Material. 3 fragments of isolated upper cheek teeth.

Description. The teeth are hypsodont, have no roots, the chewing surface has sharp enamel edges, the enamel folding characteristic of hares is present.

Remarks. In the upper molars, the lingual edge of the crown is higher than the buccal one (Gromov & Erbaeva, 1995). The linear parameters of the teeth of the hare from the Istykskaya Cave are smaller than those of other representatives of the family, which gives reason to assume that the remains belong to the tolai hare. Modern *Lepus tolai* Pallas, 1778 has good ecological plasticity, but prefers open spaces with shrubs and herbaceous vegetation; it can be found in mountains up to 3000 m above sea level (Gromov & Erbaeva, 1995) and it penetrates into deserts.

Family Ochotonidae Thomas, 1897

Subfamily Ochotoninae s.str.

Genus *Ochotona* Link, 1795

Ochotona sp. (Fig. 3B–L)

Material. 5 isolated incisors, 2 fragments of the maxillary bone, 9 fragments of isolated mandibles, 2 fragments of right mandibles, 11 fragments of cheek teeth, 3 fragments of the humerus, fragment of the femur, calcaneus, fragments of atlas.

Remarks. The severe fragmentation of the material makes species diagnosis difficult. Also, no p3 necessary for species identification was found. Some postcranial fragments have specific anatomic features. The humerus on the distal epiphysis does not have a foramen epicondiloudeum, crista epicondylus lateralis is weakly expressed, the tuberositas deltoidei is not obvious. On the femur trochanter major is located at or below the caput femoris, the trochanter minor is well expressed and almost equal to the trochanter major. Calcaneus has a narrow corpus calcanei, the sustentacular facet and posterior calcaneal facet are close together, the fibular facet has a characteristic cylindrical shape. Thus, all skeletal elements have characteristic features of the family, which allows us to confidently attribute them to the genus of pikas.

All pikas are inhabitants of mountainous areas, preferring stone screes. They are active all year round and make provisions for the winter including grass and twigs.

Order Rodentia Bowdich, 1821

Family Sciuridae Fischer, 1817

Subfamily Marmotinae Pocock, 1923

Tribe Marmotini Pocock, 1923

Genus *Marmota* Blumenbach, 1779

Marmota cf. *baibacina* Kastschenko, 1899 (Fig. 4A)

Material. Left isolated p4.

Description. p4 has a large mesoconid and a small hypoconid.

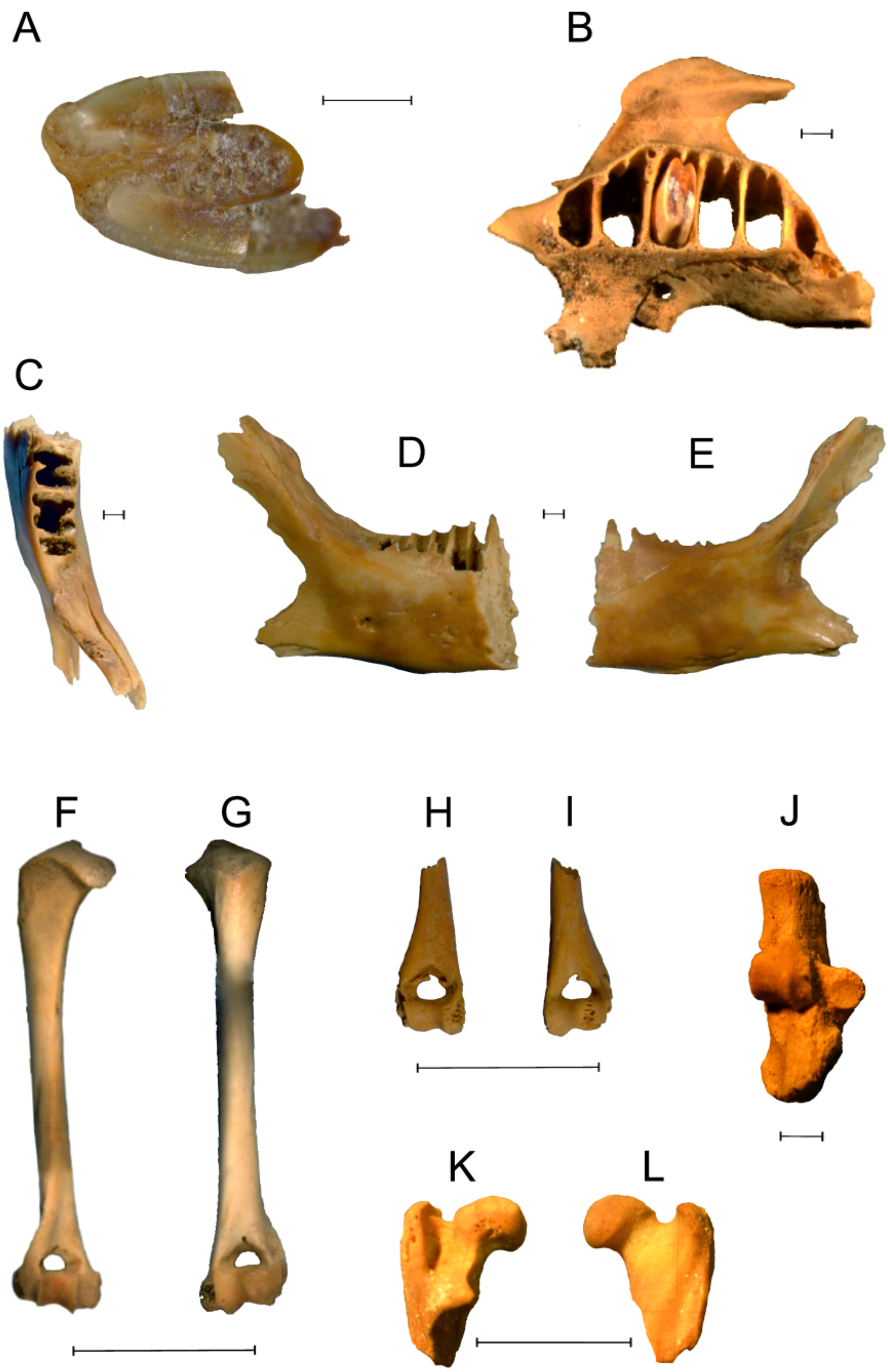

Fig. 3. Remains of lagomorphs. A — upper cheek tooth of *Lepus* sp., B–L – remains of pikas: B — maxilla with P4, view from the masticatory surface, C — mandibula, view from the masticatory surface, D — mandibula, lateral view, E — mandibula, medial view, F — humerus (sin), caudal view, G — humerus (sin), cranial view, H — humerus (sin), caudal view, I — humerus (sin), cranial view, J — calcaneus (sin), dorsal view, K — femur (sin), proximal fragment, caudal view, L — femur (sin), proximal fragment, cranial view. Scale bar is 1 mm.

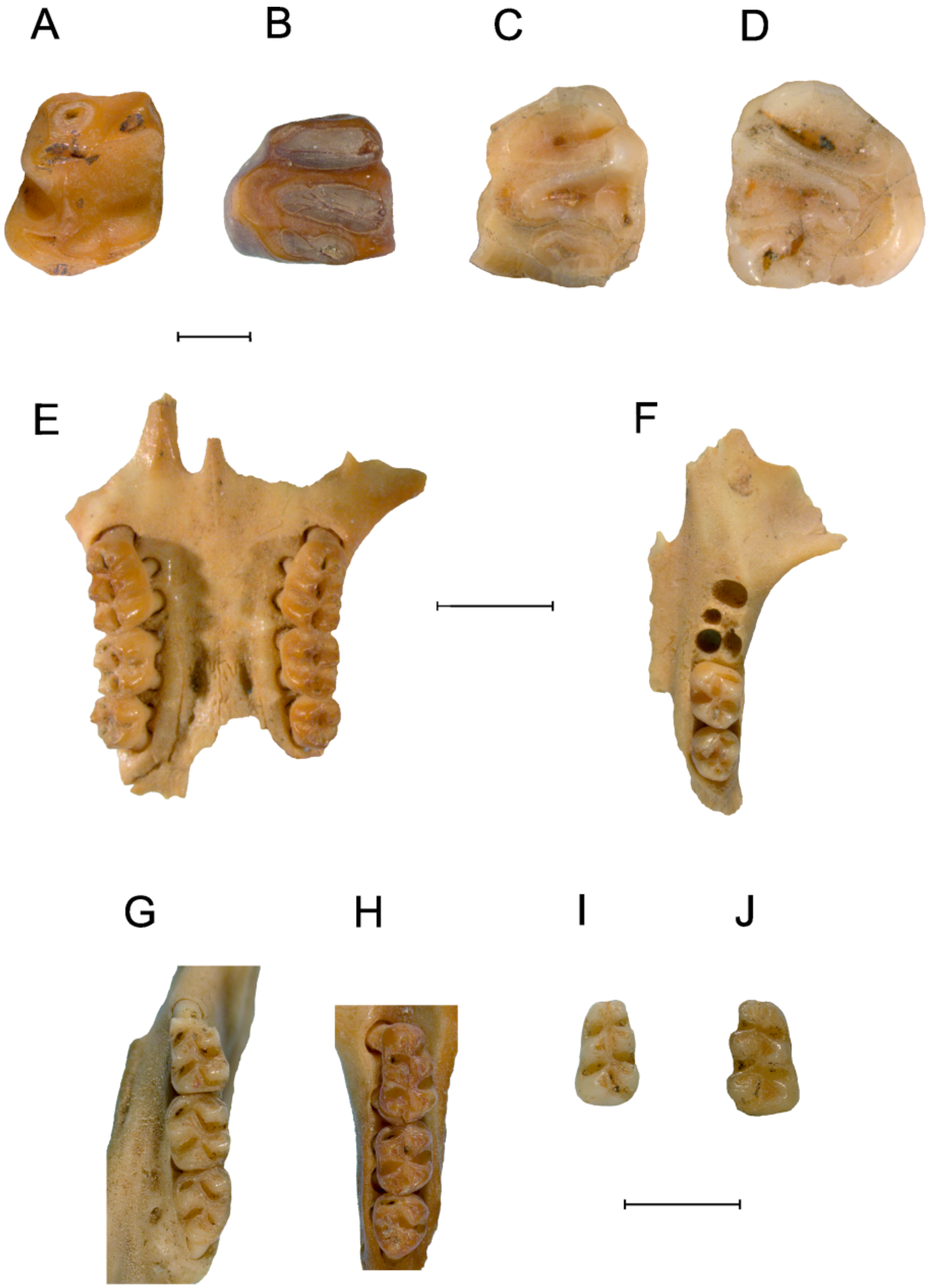

Fig. 4. Remains of small mammals from Istykskaya Cave. A–D — cheek teeth of *Marmota*: A — p4 of *Marmota* cf. *baibacina*, B — M1, left; C — M3, left; D — M3, right; E–J — remains of *N. migratorius*: E, F — maxilla; G, H — mandibula; I, J — m1, left and right. Scale bar is 1 mm.

Measurements. Coronal length — 5.38 mm; anterior width — 3.62 mm; posterior width — 4.4 mm.

Remarks. It is typical for the *Marmota baibacina* Kastschenko, 1899 that the posterior width of p4 is 10–12% less than the length and the same amount greater than the anterior width (Gromov *et al*., 1965). According to our data, this value for *M. baibacina* is 13%, for *M. caudata* (Geoffroy, 1842) the ratio is 10%. For the p4 from Istykskaya Cave it is 14%. The linear characteristics and morphology of this tooth are closest to those of the modern *M. baibacina*. But since there are no other p4 from this cave, we use the open nomenclature.

Marmota sp. (Fig. 4B–D)

Material. 3 cheek teeth, 2 fragments of jaws with upper and lower incisors, respectively, 3 metacarpal bones.

Remarks. The cheek teeth probably also belong to *M. baibacina*. The dimensions of fossil marmots from the Istykskaya Cave fall within the average modern values (Tab. 2).

A series of fossil teeth is necessary for an accurate species determination. Both *M. baibacina* and *M. caudata* could be present near the Istykskaya Cave. Both of these species are found as fossils in cave localities (Vinogradov & Gromov, 1952). All marmots are inhabitants of open biotopes from steppe hills to alpine xerophytic tundra or mountain deserts. Currently, the *M. baibacina* has been almost completely exterminated in the territory of the Pamir.

Family Cricetidae Fischer, 1817

Subfamily Cricetinae s. str.

Genus *Nothocricetulus* Lebedev, Bannikova, Neumann, Ushakova, Ivanova et Surov, 2018

Nothocricetulus migratorius (Pallas, 1773) (Fig. 4E–J)

Material. 9 left and 5 right mandibular branches, 5 maxillary bones, 3 isolated teeth, 2 fragments of isolated teeth.

Description. On m1, six tubercles are well developed, located in pairs opposite each other, between which depressions are formed. All lower teeth have 2 roots. The upper molars have completely opposed cusps, there are no cingulums on M2 and M3, there are 4 and 3 roots, respectively. According Lebedev *et al*. (2018) "in the upper M1 and M2, the median mures formed by the posterior ridges of the para- and protocones and anterior ridges of the meta- and hypocones are characteristically X-shaped… Mesolophids absent". The sizes of the teeth of fossil hamsters correspond to the sizes of the teeth of modern hamsters (Tab. 3, Tab. 4).

Remarks. It differs from the *C. barabensis* and *C. longicaudatus* (Milne-Edwards, 1867) by its more strongly developed incisors, shape of M3 (Lebedev *et al*., 2018), and from the *Allocricetulus eversmanni* (Brandt, 1859) by the opposite arrangement of cusps on the teeth. Fossil hamsters are somewhat larger than modern ones, but are not outside the range of variability. This may be due to the lack of fossil material. The modern gray hamster inhabits forest-steppe and desert biotopes. It is also found in lowland and mountain steppes. Typical seedeater.

Table 2. Measurements of marmot teeth, lim (min–mean–max), in mm.

	Marmota caudata (modern) *n*=12			*Marmota baibacina* (modern) *n*=12			Marmots from Istykskaya Cave		
	L, length	W1, width anterior	W2, width posterior	L, length	W1, width anterior	W2, width posterior	L, length	W1, width anterior	W2, width posterior
p4	6.58–6.76–7.31	4.61–5.49–5.86	5.77–6.2–6.85	4.65–5.36–6.21	3.09–4.24–5.27	3.56–4.93–6.05	5.38	3.62	4.44
m1	4.1–4.41–4.6	4.3–4.92–5.6		4.3–4.7–5.7	4.5–5.32–5.9		–	–	
m2	4.6–4.76–5.2	3.5–5.1–5.9		4.3–4.78–5.5	5.3–5.69–5.9		–	–	
m3	5.3–5.98–6.7	4.5–5.6–6.4		4.2–5.97–6.9	5.3–6.09–6.5		–	–	
length of the lower dentition	18.9–20.18–21.9			19.3–20–20.6			–		
P3	3.3–3.53–3.7	3.2–3.65–4.3		1.7–3.11–4.1	1.6–3.3–4.3		–	–	
P4	5.1–5.34–5.8	5–5.22–5.9		4–5.05–5.6	3.7–5.22–6.1		–	–	
M1	4.3–4.71–5.2	4.6–5.32–6.2		4.2–4.73–5.3	5.2–5.5–6		–	–	
M2	4.1–4.8–5.5	4.7–5.5–6.1		4.7–4.9–5.2	5.5–5.83–6.8		4.25	4.75	
M3	5.2–5.5–5.8	4.9–5.73–6		5.2–5.5–5.8	5.6–6.19–6.9		5.9	5.9	
							5.6	–	
length of upper dentition	22.1–21.97–23.3			18.6–20.95–22.4			–		

Subfamily Arvicolinae Gray, 1821
Tribe Clethrionomyini Hooper et Hart, 1962
Genus *Alticola* Blanford, 1881
Alticola cf. *argentatus* (Severtzov, 1879) (Fig. 5)

Material. Fragment of the right mandible with m1–2, right isolated m1, 2 left isolated m1.

Description. Teeth without roots, hypsodont. Deposits of external cement in the reentrant angles are insignificant. The enamel is not thick, poorly differentiated according to the *Microtus* (positive) type. Four triangles (T1, T2, T3 and T4) are present, while the triangle prism T5 is fused with the anterior cap (AC).

The measurements are presented in Tab. 5.

Remarks. It differs from *A. strelzowi* (Kastschenko, 1899) in the length of M3, which is less than the length of M1, while in the flat skull vole it is equal or greater. It differs from *A. strelzowi* also by the wide fusion of T4 in m1 and smaller sizes of m1 (Serdyuk, 2000). The morphological characteristics of the fossil vole indicate that the teeth belong to the Silver mountain vole, *A. argentatus*. Modern mountain or rock voles inhabit cracks in rocks and accumulations of boulders as habitats. They feed on green parts of plants (Gromov & Erbaeva, 1995).

Table 3. Measurements of the length of molars of dwarf hamsters, lim (min–mean–max), in mm.

teeth	*n*	*N. migratorius* **(modern)**	*n*	*C. barabensis* **(modern)**	*n*	*N. migratorius* **Istykskaya Cave**
m1	90	1.15–1.58–1.85	42	1.1–1.56–1.9	9	1.7–1.59–1.85
m2	90	1.05–1.15–1.37	42	0.8–1.07–1.25	13	1–1.18–1.32
m3	90	0.85–0.9–1.15	41	0.65–0.84–1.85	7	1.25–1.42–1.55
M1	90	1–1.51–1.7	42	1.15–1.43–1.6	5	1.975–2.02–2.07
M2	90	1–1.25–1.4	42	0.82–1.04–1.25	5	1.4–1.48–1.55
M3	90	1–1.16–1.4	42	0.8–1.01–1.75	4	1–1.15–1.25

Table 4. Measurements of the width of molars of dwarf hamsters, lim (min–mean–max), in mm.

teeth	*n*	*N. migratorius* **(modern)**	*n*	*C. barabensis* **(modern)**	*n*	*N. migratorius* **Istykskaya Cave**
m1	90	0.9–0.98–1.25	42	0.8–1–1.15	12	0.9–1.1–1.17
m2	90	0.95–1.04–1.25	42	0.7–0.92–1.1	12	1.42–1.48–1.62
m3	90	0.8–0.85–1.05	41	0.6–0.83–1.7	7	1–1.125–1.25
M1	90	1.75–0.85–1.1	42	0.7–0.87–1	4	1.25–1.28–1.35
M2	90	0.85–1.04–1.7	42	0.8–0.9–1.05	5	1.2–1.22–1.22
M3	90	0.85–0.95–1.1	42	0.65–0.77–0.9	4	1.05–1.1–1.15

Table 5. Measurements of m1 and M3 of *A. argentatus*, lim (min–mean–max), in mm (for explanations, see Fig. 2).

m1					M3				
Measurements	*n*	modern	*n*	Istykskaya Cave	Measurements	*n*	modern	*n*	Istykskaya Cave
L	23	2.55–2.82–3.2	3	2.5–2.56–2.62	L	23	1.85–2.16–2.4	0	–
W	23	0.95–1.07–1.2	5	1–1.03–1.07	W	23	0.6–0.89–1.05	0	–
A	23	1.05–1.27–1.45	4	1.1–0.95–1.25	p	22	0.7–1.08–8.5	0	–
Aw	23	1–1.06–1.2	5	0.9–1.03–1.07	pw	23	0.5–0.58–0.85	0	–
					wPL	20	0.3–0.31–0.45	0	–

Table 6. Measurements m1 and M3 of *M. juldaschi* lim (min–mean–max), in mm (for explanation, see Fig. 2).

m1					M3				
Measurements	*n*	modern	N	Istykskaya Cave)	Measure-ments	*n*	modern	*n*	Istykskaya Cave
L	26	2.45–2.96–3.3	2	2.63–2.71–2.8	L	26	1.35–1.94–2.15	0	–
W	26	0.85–1.49–1.25	2	0.98–0.98–0.8	W	26	0.8–1.01–1.15	0	–
L anc	26	1.65–1.41–1.65	3	1.2–1.26–1.35	p	26	0.35–0.91–0.85	0	–
W anc	26	0.85–1.05–1.45	3	0.88–0.96–1.05	pw	26	0.5–0.86–1	0	–
					wPL	11	0.35–0.47–0.55	0	–

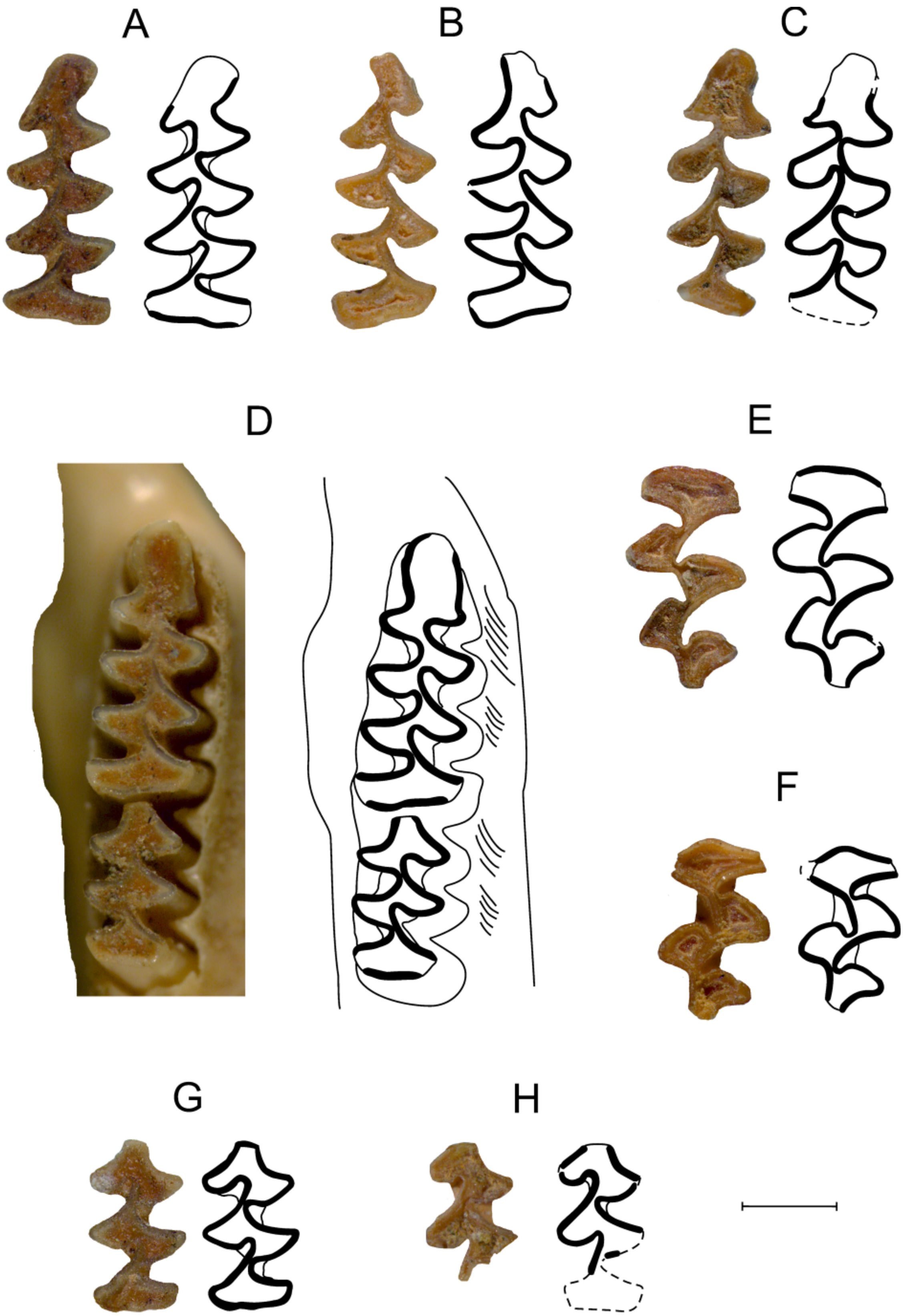

Fig. 5. Best preserved molars of mountain voles (left is photo, right is drawing). *Alticola* cf. *argentatus*: A–C — m1, A, C — left, B — right, D — right mandibula with m1–m2, E–F — upper cheek teeth of *Alticola* sp., E — right M1, F — right M2, G–H — lower cheek teeth, G — left m2, H — fragment of left m2. Scale bar is 1 mm.

Alticola sp. (Fig. 5)

Material. Isolated teeth of varying degrees of preservation: caudal part of right m1, 3 left m2, 2 right m2, left m3, left M1, 2 right M2, left M2, part of left M3, 5 fragments of prisms.

Remarks. The isolated cheek teeth apparently belong to *Alticola* cf. *argentatus* too.

Genus *Microtus* Schrank, 1798

Microtus juldaschi (Severtsov, 1879) (Fig. 6)

Material. 2 right isolated m1, left mandibula with m1–2.

Description. The teeth have no roots and are high-crowned. Deposits of external cement are insignificant. Enamel differentiated by *Microtus* (positive) type. On the chewing surface of m1 there are five dentin fields, three triangles (T1, T2, T3) are isolated, T4 and T5 fused with the anteroconid part.

Measurements. The main measurements of m1 are presented in Tab. 6.

Remarks: The fossil vole differs from the *Blanfordimys afghanus* Thomas, 1912 in its smaller size, more complex shape of the anteroconid part and wide fusion of adjacent triangular loops. It lives in the forest belt, in shrubs, and inhabits meadows of the subalpine and alpine zones at altitudes from 1300 m to 4500 m above the sea level and it avoids rocky biotopes.

Discussion

As our study demonstrated, the total amount of fossil small mammal remains is insignificant, but since there are currently no fossil material on small mammals from the territory of the Eastern Pamir, any information from this region is interesting. Also, of interest is the occupation of high mountain regions by humans. Traces of presence of ancient man in the cave were found in each of the studied layers. However, the distribution of ceramic fragments, burnt bones, bone and stone tools across the layers is uneven. The largest number of them was found in layer 1, slightly less in layers 2 and 3. At the same time, layer 3 turned out to be the richest in finds of small mammal remains, the least amount

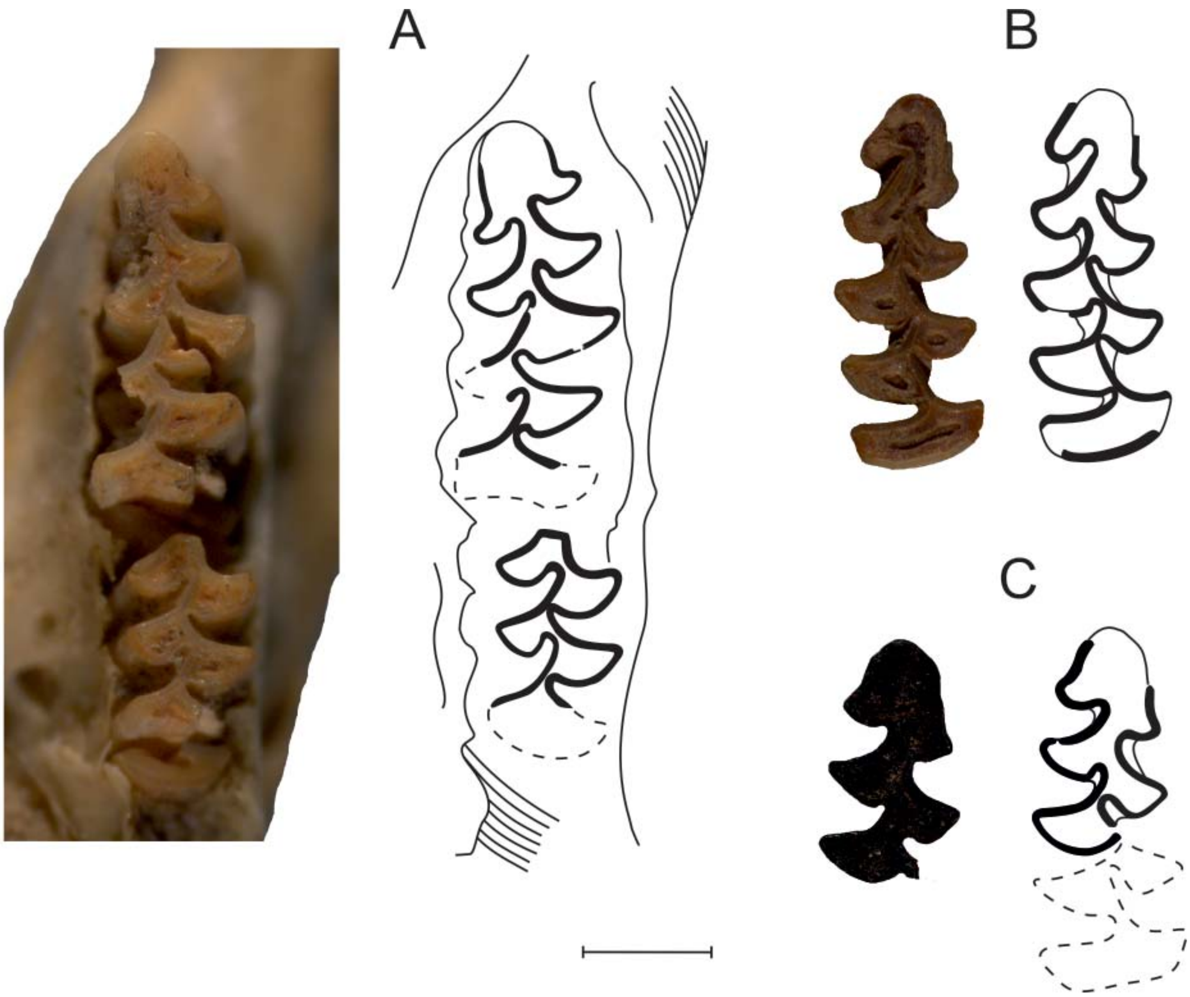

Fig. 6. Remains of *Microtus juldaschi* (left is photo, right is drawing): A — left mandibula with m1–m2, B — right m1, C — fragment of right m1. Scale bar is 1 mm.

of material is contained in layer 2, and only isolated finds were found in the layer 1. That is, finds of traces of human presence and remains of the fauna of small mammals are in antiphase. This may indicate human presence at each specific time interval. Active human visits and occupation of the cave during the accumulation of layers 2, 1 and 0 could disturb the animals as taphonomic agents and make the cave unattractive for their habitation.

The fossil fauna of small mammals of the Istykskaya Cave is characterized by the predominance of remains of pikas and dwarf gray hamster, with slightly fewer remains of mountain voles. Finds of marmot, hare and Pamir vole are rare. In general, the fauna of small mammal of the Istykskaya Cave has similar features to the faunas of other cave localities in Central Asia (Markova, 1992; Serdyuk *et al*., 2023), but is notably less diverse.

When comparing the fossil fauna of the Istykskaya Cave with the modern fauna of the Pamir, it became clear that one of the distinctive features of the modern fauna of lagomorphs and rodents is the low species diversity (Qadamshoev, 2009). According to modern zoological research (Odinashoev, 1979), there are three species of lagomorphs (*Lepus tolai*, *Ochotona rutila* (Severtsov, 1873), *Ochotona macrotis* (Günther, 1875)) and nine species of rodents (*Marmota caudata*, *Nothocricetulus migratorius*, *Microtus juldaschi*, *Alticola argentatus*, *Rattus turkestanicus* (Satunin, 1903), *Ellobius tancrei* (Blasius, 1884), *Apodemus uralensis* (Pallas, 1811), *Mus musculus* Linnaeus, 1758, *Dryomys nitedula* (Pallas, 1778)) living in the Pamir. Moreover, the modern fauna of the Eastern Pamir is approximately twice as poor in species as the fauna of the Western Pamir. *L. tolai* and *O. macrotis*, *M. caudata*, *N. migratorius*, *A. argentatus*, and *M. juldaschi* have been found in the territory of the Eastern Pamir (Odinashoev, 1979). As can be seen, the list of modern fauna of the Eastern Pamir is the same as the fossil composition of the Istykskaya Cave, with the exception of the marmot. The modern fauna includes *M. caudata*, for the fossil assemblage we assume the presence of *M. baibacina*. As already indicated earlier, both species of marmots were found in the Pleistocene, at present time the *M. baibacina* in the Pamir is exterminated. We also cannot yet confidently classify pikas to species level. It could equally represent *O. rutila* or *O. macrotis.* Thus, in the harsh conditions of the highlands, the fauna remained unchanged throughout the Late Pleistocene–Holocene. This is related to the geological processes, geographical and climatic features of the Pamir. According to radiocarbon dating, layer 3 of Istykskaya Cave is dated to MIS2, the last Pleistocene glaciation (Shnaider *et al*., 2021). All Late Pleistocene glaciers in the Pamir were valley glaciers (Abramowski *et al*., 2006). In conditions untouched by the glacier, the fauna of the Istykskaya Cave area did not experience major changes in the environment during the Late Pleistocene and early Holocene. The composition of the fauna has remained virtually unchanged from that time to the present day.

Almost all species identified from the Istykskaya Cave in one way or another have ecological plasticity, but prefer to settle in open biotopes. Thus, the predominant pikas are inhabitants of the mountains, where they choose rock block streams (kurums) or rocks; some species live in mountain steppes or penetrate far to the northeast of Siberia into the tundra zone (Vinogradov & Gromov, 1952). *Alticola argentatus*, like pikas, is a petrophile and co-occur with them in rocky habitats. It settles high altitudes (up to 2000–3000 m). *Nothocricetulus migratorius* is most common in the mountain steppe, occupying natural shelters — voids and cracks in rocks; in the Pamir it is found at altitudes up to 4300 m above the sea level (Gromov & Erbaeva, 1995). *Microtus juldaschi* chooses high-mountain meadows with low grass, settling at altitudes of 2500–3000 m above the sea level and higher. The modern *L. tolai* is a typical inhabitant of deserts and semi-deserts; in the Pamir it is found high in the mountains along river valleys with sparse bushes, although it is able to do without water for a long time.

Neither skeletal nor cranial remains of insectivores and bats, which are usually abundant in cave taphocenoses, were found. This may be due to both complex taphonomic processes and various biological factors. It is known that birds of prey, which are the main collectors of the fauna of small mammal (Andrews, 1990), have pronounced food selectivity, and certain types of rodents may be of little interest to them, and accordingly, they subsequently do not accumulate in bird pellets and bone-bearing horizons. But in the case of the fauna of the Istykskaya Cave, everything is probably explained by the harsh climatic conditions and sparse high-mountain vegetation. The Eastern Pamir, with its sharply continental, dry climate, insignificant amount of precipitation and winters with little snow, are characterized by high-mountain deserts, sparsely grassed steppes, and cushion plants. Very few animals are able to survive in such conditions. All species of small mammals from the Istykskaya Cave are adapted to living in these conditions.

The palaeoreconstruction based on this fauna suggests the presence of open biotopes in the cave area, such as mountain sparsely vegetated steppes, high-mountain deserts, and rock landslides. According to it, the constant presence of large water spaces is unlikely, since there are no near-water species among the remains of small mammals. However, in the contemporary fauna of small mammals there are no typical inhabitants of coastal biotopes also. It is likely that the hydrological regime of the Istyk River has not changed significantly over the past 15 thousand years. But fossil avian fauna, on the contrary, clearly indicates the presence of significant water spaces in the Late Pleistocene-Holocene in the study area (Zelenkov *et al*., 2021). This fact can be explained both by the hunting selectivity of predatory bird and by the mobility of animals. Since small mammals have individual habitats of several hundred to thousands of square meters, they are strictly tied to their habitats and, as a rule, do not move far from them.

Birds, unlike small mammals, are able to cover significant distances thanks to active flight, and their remains may well end up far beyond their usual habitats.

Thus, a palaeoreconstructions of the natural environment based only on data of small mammals will be of a purely local nature, describing the nearby landscapes of the cave that provided the fossil material, which will probably not fully reflect the true picture of the entire area. For palaeoreconstructions over large areas, data should be used not only on small, but also on large mammals, as well as the results of studies of avifauna and chiropteran fauna. The presence in the past of a permanent water reservoir in the areas adjacent to the Istykskaya Cave is unlikely, but it is possible that they existed in the distance or emerged as temporary seasonal reservoirs that attracted aquatic avian fauna. This assumption fully explains the presence of remains of semi-aquatic and aquatic birds.

Conclusions

A study of the fauna of small mammals showed that the high-mountain fauna of the Istykskaya Cave is similar to other fossil faunas of Central Asia. But the number of species in the fauna of the Istykskaya Cave is insignificant. At the same time, the species composition of small mammals in the Istykskaya Cave is almost identical to the modern list of species from the Eastern Pamir. This suggests minor biotopic changes in the study area during the final Late Pleistocene–Early Holocene. The small mammal based restoration of the environment shows that during sedimentation in the area of the Istykskaya Cave there were abundant rocky and stony areas, alternating with high-mountain deserts, and sparsely grassed steppes. The valleys of mountain streams and rivers were covered with sparse shrub vegetation with narrow strips of meadow vegetation. These biotopes were inhabited by high-mountain mammal species. At some distance from the cave there were temporary or seasonal water reservoirs. Humans visited the cave regularly with varying intensity throughout its existence.

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References

Abramowski U., Bergau A., Seebach D., Zech R., Glaser B., Sosin P., Kubik P.W. & Zech W. 2006. Pleistocene glaciations of Central Asia: results from 10Be surface exposure ages of erratic boulders from the Pamir (Tajikistan), and the Alay-Turkestan range (Kyrgyzstan) // Quaternary Science Reviews. Vol.25. P.1080–1096. DOI: 10.1016/j.quascirev.2005.10.003

Andrews P. 1990. Owls, caves and fossils: predation, preservation and accumulation of small mammal bones in caves, with an analysis of the Pleistocene cave faunas from Westbury-sub-Mendip. Chicago: University of Chicago Press. 231 p.

Gromov I.M. & Erbaeva M.A. 1995. [Mammals of the fauna of Russia and adjacent territories. Lagomorphs and rodents]. Saint Petersburg: ZIN RAS. 522 p. [in Russian].

Gromov I.M., Bibikov D.I., Kalabukhov N.I. & Meyer M.N. 1965. [Terrestrial squirrels. (Marmotinae)]. Moscow: Nauka. 466 p. [in Russian].

Ivleva N.G. 1990. [Microteriological materials from the caves named after Okladnikov and Denisov in Altai] // [Comprehensive studies of Paleolithic objects of the Anuj River basin]. Novosibirsk: IIFF. P.82–104 [in Russian].

Lebedev V.S., Bannikova A.A., Neumann K., Ushakova M.V., Ivanova N.V. & Surov A.V. 2018. Molecular phylogenetics and taxonomy of dwarf hamsters *Cricetulus* Milne-Edwards, 1867 (Cricetidae, Rodentia): description of a new genus and reinstatement of another // Zootaxa. Vol.4387. No.2. P.331–349. DOI: 10.11646/zootaxa.4387.2.5

Markova A.K. 1992. Fossil rodents (Rodentia, Mammalia) from the Sel'-Ungur Acheulian cave site (Kirghizstan) // Acta Zoologica Cracoviensia. Vol.35. P.217–239.

Odinashoev A. 1979. [Distribution and biology of lagomorphs and rodents of the Pamir]. Abstract of Dissertation for the degree of candidate of biological sciences. Sverdlovsk Institute of Plant and Animal Ecology, Ufa Scientific Center, USSR Academy of Sciences. 20 p. [in Russian].

Qadamshoev M. 2009. [Study of fauna in Pamir for 40 years (1969–2009)] // News of the Academy of Sciences of the Republic of Tajikistan, Department of Biological and Medical Sciences. Vol.169. No.4. P.18–24 [in Russian with English abstract].

Ranov V.A. 1961. [Study of Stone Age sites in the Eastern Pamir in 1958] // Archaeological Work in Tajikistan. Vol.6. P.31–35 [in Russian].

Ranov V.A. & Khudzhageldiev T.U. 2005. [Stone Age] // Bubnova M.A. (ed.). [History of the Gorno-Badakhshan Autonomous Region. Vol.1. From ancient times to the modern period]. Dushanbe: Payvand. P.51–107 [in Russian].

Rabeder G. 1981. Die Arvicoliden (Rodentia, Mammalia) aus dem Pliozän und alteren Pleistozän von Nieder Österreich // Beitragie zur Paläontologie von Österriech. Vol.8. P.1–373.

Rekovets L. & Nadachowski A. 1995. Pleistocene voles (Arvicolidae) of the Ukraine // Paleontologia i Evolucio. Vol.28–29. P.145–246.

Serdyuk N.V. 2000. [Morphological differences between the first lower molar in *Alticola strelzowi* and *Alticola macrotis*] // [Systematics and phylogeny of rodents and lagomorphs]. Moscow: KMK Scientific Press. P.153–156 [in Russian].

Serdyuk N.V., Syromyatnikova E.V., Zelenkov N.V., Abdykanova A., Alisher kyzy S. & Shnaider S.V. 2023. Holocene vertebrate fauna in Fergana Valley, Kyrgyzstan, based on fossils from the Obishir-5 rock shelter // Geobios. Vol.76. P.37–51.

Shnaider S.V., Sayfulloev N.N., Alisher kyzy S., Rudaya N.A., Dedov I.E., Zotkina L.V., Zhukov V.A., Karaev A. & Navruzbekov M. 2019. First research results at the multilayered site of Istikskaya Cave (Eastern Pamir, Tajikistan) // Derevianko A.P. & Molodin V.I. (eds.). Problems of Archaeology, Ethnography, Anthropology of Siberia and Neighboring Territories. Vol.25. Novosibirsk: IAET SB RAS. P.293–298. DOI: 10.17746/2658-6193.2019.25.293-298

Shnaider S.V., Zelenkov N.V., Fedorchenko A.Yu., Kurbanov R.N., Alekseytseva V.V., Alisher kyzy S., Serdyuk N.V., Rudaya N.A., Rendu U., Abdykanova A. & Saifuloev N.N. 2021. Man on the "Roof of the World": results of studying the Stone Age monuments of the Eastern Pamir and the Alai Valley in 2017–2021. Novosibirsk: IAET SB RAS. 92 p.

van der Muelen A.J. 1973. Middle Pleistocene smaller mammals from the Monte Peglia (Oriveto, Italy) with special reference to the phylogeny of *Microtus* (Arvicolidae, Rodentia) // Quaternaria. Vol.17. P.1–144.

Vinogradov B.S. & Gromov I.M. 1952. [Rodents of the fauna of the USSR]. Moscow-Leningrad: Izdatel'stvo Akademii Nauk USSR. 396 p. [in Russian].

Zelenkov N.V., Sayfulloev N. & Shnaider S.V. 2021. Fossil birds from the Roof of the World: The first avian fauna from High Asia and its implications for late Quaternary environments in Eastern Pamir // PLoS ONE. Vol.16. No.10. P.e0259151.

Zhukov V.A. 1986. [Excavations of the cave "Istykskaya" (1978–1979)] // Archaeological Work in Tajikistan. Vol.19. P.51–56 [in Russian].