

The first record of dormouse in Late Pleistocene of North-Western Altai (Russia)

Natalia V. Serdyuk

ABSTRACT. The article describes the second upper molar of the forest dormouse *Dryomys nitedula* from the Late Pleistocene deposits of the Paleolithic site Strashnaya Cave (Altai, Russia). The forest dormouse was in association with relatively thermophilous species. It is the first record of the forest dormouse in Altai area. The Strashnaya Cave is currently the easternmost Pleistocene record of the forest dormouse.

How to cite this article: Serdyuk N.V. 2022. The first record of dormouse in Late Pleistocene of North-Western Altai (Russia) // Russian J. Theriol. Vol.21. No.2. P.146–152. doi: 10.15298/rusjtheriol.21.2.05

KEY WORDS: *Dryomys*, Late Pleistocene, Strashnaya Cave, Altai.

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Первая находка лесной сони в позднем плейстоцене Северо-Западного Алтая (Россия)

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РЕЗЮМЕ. В статье приведено описание второго верхнего моляра лесной сони *Dryomys nitedula* из позднеплейстоценовых отложений палеолитического памятника Страшная пещера (Алтай, Россия). Лесная соня обнаружена в слоях вместе с другими умеренно теплолюбивыми видами. Ранее на Алтае ископаемые остатки лесной сони обнаружены не были. В настоящий момент это наиболее восточная точка среди плейстоценовых находок *Dryomys nitedula*.

КЛЮЧЕВЫЕ СЛОВА: *Dryomys*, поздний плейстоцен, Страшная пещера, Алтай.

Introduction

The dormice family Gliridae Thomas, 1897 is a small group including seven living and about 30 fossil species (Rossolimo *et al.*, 2001). Gliridae is one of the oldest families of rodents (Vianey-Liaud, 1989; Daams & Brujin, 1995). Earliest dormice are dated to Eocene. The maximal spread of this group corresponds to Early Miocene, when the first finds of the genus *Dryomys* are known (Jaeger, 1977).

Dormice are typical tree-dwelling rodents associated with arboreal vegetation. The Miocene forests of Eurasia were characterized by the exceptional diversity and species richness (Schwarzbach, 1950). Gradual climatic cooling during the Neogene shifted the zones of the tropics and subtropics to the south and reduced the area of thermophilous deciduous vegetation in high latitudes. Stronger cyclic cold spells of the Quaternary Period lead to periodic continental ice cover of significant areas during the Pleistocene. Diverse forest landscapes have given way to open landscapes. It is likely for this reason that finds of dormice in the Pleistocene and the Holocene are rare and few in numbers (Kowalski, 1963; Daoud, 1993; Nadachowski & Daoud, 1994; Motuzko, 2007; Agadjanian, 2009; Hautier *et al*., 2009; Aguilar & Michaux, 2011; Striczky & Pazonyi, 2014; Fadeeva *et al*., 2018).

The modern Russian fauna contains four genera of dormice. Three of them also inhabit Europe, Northern Africa, and Asia Minor, but only one, *Dryomys*, inhabits an area stretching more to the east, up to Mongolian Altai (Pavlinov *et al.*, 2001). As concerns the fossil record, despite many years of research and a huge amount of fossil material from Altai caves, fossil forest dormouse in the Altai region was previously unknown.

During 2017, the Institute of Archaeology and Ethnography of the Siberian Branch of RAS has been conducting multidisciplinary research in the Strashnaya Cave. The Strashnaya Cave is a well-known Paleolithic site in North-Western Altai Mountains (south Siberia, Altai Territory, 51.170742° 83.020843°) (Fig. 1). The cave deposits include 13 layers. The upper layers from 1 to 10 contain rich paleontological material. Layers 11, 12, and 13 lack archaeological and paleontological

Fig. 1. Schematic map showing the location of Strashnaya Cave in south Siberia.

content (Serdyuk & Zenin, 2016). The aim of the work was to determine the taxonomic composition of the small mammal fauna in the cave deposits, and to restore the environment of this fauna. In 2017, loose deposits in the central chamber were excavated with the layers 5 (lithological units 5.2–5.4) and 6 (lithological units 6.1 and 6.2) exposed at the area of 4 m^2. The excavations yielded new materials on small mammals including the right upper molar of Gliridae from the middle part the layer 6.1 (Fig. 2).

Material and methods

To obtain fossil material of small mammals from the cave deposits, we used method of washing on sieves with 1 mm mesh size with further drying and hand sorting of bone remains. All fossil bone material was sorted under binocular microscope MBS-10. The teeth were measured with an ocular micrometer according to the scheme by Daoud (1993). The teeth terminology and morphology follow Daams (1981) (Fig. 3A). The fossil tooth of dormouse was photographed using TESCAN VEGA–3 scanning microscope (Borissiak Paleontological Institute of RAS). The fossil molar was compared with the teeth of living dormice *Dryomys nitedula* Pallas, 1778 from Kazakhstan (locality Tarbagatai, Zaysan depression, Dzungarian Alatau) in the collections at the Zoological Museum of Moscow State University (Moscow, Russia).

Results

A detailed study of the fossil tooth revealed the characteristic dental features of upper molars of the forest dormouse *Dryomys*. The tooth has an almost quadrangular shape and three roots (Fig. 4).

M1 and M2 of dormice are approximately equal in size but when the teeth occur in the mandible, there are no difficulties with their identification. The reference of isolated molars to tooth types is more problematic.

Some researchers lump both molars together as a united group (Mansino *et al*., 2015). The others suppose that the teeth are different in shape with the first upper molar being wider in the rear, and the second upper molar, wider near its anterior side (Daams, 1981). The tooth from Altai Mountains is slightly wider anteriorly. In addition, there are facets for adjacent tooth loci in the anterior and posterior walls of the tooth (Figs 4B, C). These features are characteristic of M2. According to the morphotypes of teeth identified for recent *Dryomys nitedula* Pallas, 1778, the morphotype of Altai tooth is the closest in structure to the type, which is characterized by the presence of the main transverse ridges: anteroloph, protoloph, metaloph, posteroloph, additional anterior centroloph and endoloph. The right M2 from the Strashnaya cave belongs to the morphotype F (Fig. 3B). The length of the Altai dormouse tooth is 1.07 mm, width is 1.23 mm.

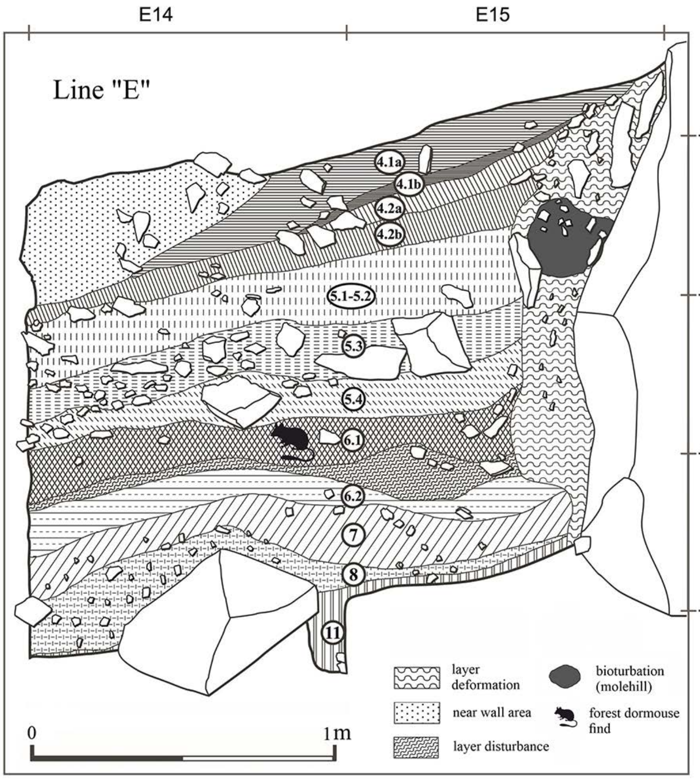

Fig. 2. Schematic stratigraphy of Strashnaya Cave. Southwestern wall of the excavation (after Anoikin *et al.*, 2018).

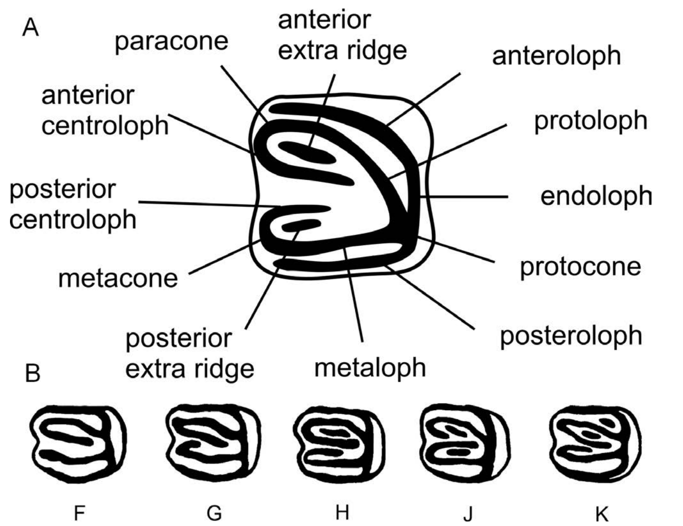

Fig. 3. A — Terminology of dental characters of the upper teeth of Gliridae (after Daams, 1981). B — Morphotypes of M2 of *Dryomys* (modified after Daams, 1981).

Discussion

We compared the fossil dormouse from the Strashnaya Cave with conspecific dormice of modern eastern populations. For the recent populations, we selected the samples from the most eastern points of the range, which are available in the collection of the Zoological Museum: Tarbagatai, the Zaisan Basin, and the Dzungarian Alatau. Only the maxillary teeth were measured. The results are presented in Table. Samples from the Zaisan Basin are scarce (n=3). P4 from these localities show a characteristic differences in shape with the oval prepmolars Tarbagatai, square ones from the Zaisan depression, and triangular premolars from the Dzungarian Alatau. Compared to fossils, modern dormouse from eastern points of the range has smaller upper premolars P4 (Table). Other dimensions overlap. The size of the fossil dormouse molar from Altai is within the range of variability of both modern and fossil populations (Table). The difference in shape of P4 may be a manifestation of the morphotype variability. The size decrease in premolars from the past to the present can be an evolutionary trend that needs a further study.

In general, the origin of the genus *Dryomys* remains unclear due to the paucity of finds. It is known that most modern species of small mammals had already formed by the Middle Pleistocene (Agadjanian, 2008). The forest dormouse from different Pleistocene localities, such as Loutra Almopias Cave (Tsoukala *et al*., 2006), Kozi Grzbiet (Daoud, 1993), Latomi-1 (Vasileiadou & Sylvestrou, 2022), Somssich Hill 2 (Striczky & Pazonyi, 2014), Ignatievskaya Cave (Fadeeva *et al*., 2018),

Table. Measurements (mm) of teeth of dormice *Dryomys nitedula* Pallas, 1778. Shaded areas refer to fossil specimens.

Teeth of maxilla / Locality	P4		M1		M2		M3	
	min–$\bar{x}$–max		min–$\bar{x}$–max		min–$\bar{x}$–max		min–$\bar{x}$–max	
	L	W	L	W	L	W	L	W
Tarbagatai, *n*=21	0.45–0.61–0.72	0.82–0.97–1.07	0.87–0.97–1.05	1.25–1.27–1.35	1–1.09–1.17	1.17–1.36–1.42	0.77–1.01–1.12	1.22–1.25–1.3
Zaysan depression, *n*=3	0.65–0.66–0.67	0.97–1.0–1.02	1–1.02–1.05	1.2–1.3–1.37	1.1–1.15–1.17	1.42–1.45–1.5	1.0–1.0–1.0	1.32–1.34–1.35
Dzungarian Alatau, n=12	0.6–0.62–0.75	0.8–0.94–1.1	0.95–1.05–1.27	1.22–1.27–1.37	1.02–1.1–1.17	1.32–1.37–1.42	0.87–0.94–1.0	1.2–1.26–1.32
Strashnaya Cave, Altai, *n*=1	—	—	—	—	1.07	1.23	—	—
Ignatievskaya Cave, South Urals (Fadeeva *et al.*, 2018), *n*=2	—	—	—	—	1.0	1.25	—	—
	—	—	—	—	1.08	1.32	—	—
Kozi Grzbiet, Poland (Daoud, 1993), *n*=5	0.94–0.97–1.0	0.73–0.74–0.77	1.0–1.03–1.06	1.4–1.17–1.2	1.10–1.14–1.16	1.22–1.26–1.30	—	—

Fig. 4. Second upper molar of *Dryomys nitedula* from the deposits of the Strashnaya Cave. A — occlusal view, B — cranial (anterior) view, C — caudal (posterior) view.

Fig. 5. Geographic position of Pleistocene finds of *Dryomys nitedula* (modified after Batsaikhan *et al*., 2016): 1 — Kozi Grzbiet, Poland; 2 — Somssich Hill 2, Hungary; 3 — Latomi-1, Greece; 4 — Loutra Almopias Cave, Greece; 5 — Voroncha, Belarus; 6 — Ignatievskaya Cave, South Urals, Russia; 7 — Teshik-Tash, Uzbekistan; 8 — Strashnaya Cave, Altai, Russia. Brown colour area indicates the modern range of *Dryomys.*

Teshik-Tash (Gromova, 1949), Strashnaya Cave show dental patterns similar to modern species. The modern ranges of small mammals date back to the Holocene. Changes in climate and surrounding vegetation affected boundaries of ranges of small mammals. The Holocene landscapes differed from the Pleistocene ones; the open and treeless spaces prevailed in the Pleistocene, which receded only during periods of warming. Fossil finds of dormouse are usually localized within the modern range of the family (Rossolimo *et al*., 2001). But as can be seen from Fig. 5, some of the Pleistocene finds are located outside the boundaries of the modern range. This is due to the spread of warm-loving and moisture-loving forest vegetation further north during warm intervals of Pleistocene and Holocene. All known finds of Pleistocene dormouse are attributable to different interstadial periods (Daoud, 1993; Tsoukala *et al*., 2006; Motuzko, 2007; Fadeeva *et al*., 2018; Vasileiadou & Sylvestrou, 2022).

The forest dormouse from the Strashnaya Cave was found in the same layer together with the red squirrel *Sciurus vulgaris* and Siberian flying squirrel *Pteromys volans*. All these species are relatively thermophilous and indicate wooded habitats. Another thermophilic species found in the same layer is the Late Pleistocene porcupine

Hystrix brachyura vinogradovi Argyropulo, 1941. It was found in layers 2, 3, 4, 5 also (Vasiliev & Zenin, 2009; Vasiliev *et al*., 2016). Radiocarbon dating of the porcupine tooth from the layer 5.1 showed an age of 35640–46370 cal BP (Kuzmin *et al*., 2017). This date correlates with MIS 3. At the same time, a marmot bone from the layer 6.1 yielded an uncalibrated ^{14}C date of 18625±294.7 (calibrated 21246–19996 cal BP, OxCal 4.4). This date corresponds to MIS 2 or the Sartan glaciation (late Pleniglacial). This inversion of dates can be accounted for the complex cave stratigraphy and the burrowing activity of marmots that used the cave as a refuge.

The burrowing of marmots is responsible for a certain taphonomic mixing of the deposits. For example, it likely introduced the bones of the Pleistocene porcupine into layers 2–5. According to Krivoshapkin *et al.* (2016), the marmot colony culminated in this area in the middle of the Sartanian time (MIS 2). The late Pleniglacial date from the layer 6.1 can be a taphonomic issue. The taxonomic composition of small mammals of the temperate appearance imply an older age corresponding to a warm pre-Sartanian time periods. More studies, including those based on dental morphotypes of *Microtus*, are required in Strashnaya Cave.

The fauna of small mammals from Strashnaya Cave is similar to the fossil faunas of other Altai caves. 3948 or about 4000 bones from Strashnaya Cave were identified in 2017. The collected bones belong to orders Chiroptera, Lipotyphla, Rodentia, and Lagomorpha. Rodents account for more than 90% of all remains. Earlier studies of the cave fauna indicated the Late Pleistocene–Holocene age of the deposits. Species typical of the Early and Middle Pleistocene are absent. The faunal compositions vary only slightly from layer to layer (Serdyuk & Zenin, 2016).

The rocky voles *Alticola*, narrow-skulled vole *Stenocranius gregalis*, red-backed voles *Clethrionomys* are dominant among rodents in the fossil fauna of the Strashnaya Cave.

The association includes the Altai mole *Asioscalops altaica*, marmot *Marmota* sp., long-tailed Siberian ground squirrel *Spermophilus undulatus*, steppe lemming *Lagurus lagurus*, yellow steppe lemming *Eolagurus*, mole vole *Ellobius*, and pika *Ochotona*. The northern three-toed jerboa *Dipus sagitta* from layer 6.2 and jerboas from the *Alactagulus–Pygeretmus* group were also described for the first time. Previously, only *Allactaga major* was recorded as a fossil in the Altai caves (Agadjanian & Serdyuk, 2005). A characteristic feature of the fossil fauna of Strashnaya Cave is the presence of forest species: the Siberian chipmunk *Eutamias sibiricus*, red squirrel *Sciurus vulgaris*, Siberian flying squirrel *Pteromys volans*, forest mice of the genus *Apodemus*, and birch mice *Sicista* (Serdyuk *et al*., 2017). All layers also yielded bones of marmots.

The overall composition of the fauna is mosaic, which is associated with the geographical position of the cave and the vertical mountain zonality. In addition, at present time, steppe lemming, yellow steppe lemming, rocky vole, mole vole and forest dormouse have not been found in Altai.

Conclusions

Dormice are rare fossils, but despite this, they play an important role in the paleoreconstruction of the environment, as they are indicators of deciduous forest with well-developed dense shrub undergrowth. In the Pleistocene the finds of forest dormouse outside the modern range suggest a wider distribution of deciduous forests that require uniform precipitation and relatively high average annual temperatures. In the Pleistocene this environment occurred only during interglacial periods.

The first record of forest dormouse in the section of Strashnaya Cave indicates the presence of forested landscapes during the accumulation of layer 6.1. The layer was formed during one of the last interstadials. Radiocarbon dating of bone remains from this layer cannot give a clear answer to which interstadial the dormice habitat belonged. At present, the Strashnaya Cave is the easternmost point of the Pleistocene finds of forest dormouse.

ACKNOWLEDGEMENTS. I am deeply grateful to Corresponding Member RAS Andrei Krivoshapkin for organization of the field excavations in 2017 and his kind help. I express sincere gratitude to Dr. Juan Manuel Lopez-Garcia, to Dr. Maksim Sinitsa and also to anonymous reviewer for theirs comments and suggestions that greatly improved the manuscript.

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