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GENERAL BIOLOGY

A Finding of the Red Squirrel (Rodentia, Sciuridae, *Sciurus vulgaris* Linnaeus, 1758) and Forest Dormouse (Rodentia, Gliridae, *Dryomys nitedula* Linnaeus, 1778) in the Pleistocene of the Southern Urals

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Abstract—The study deals with a new sample of the mammalian fossils from the Pleistocene deposits of the Ignatievskaya Cave in Southern Urals (54°53' N, 57°46' E). Among the rodent fossils, the teeth of red squirrel (*Sciurus vulgaris*) and forest dormouse (*Dryomys nitedula*) have been identified. The enamel differentiation quotient (SDQ) of the water vole teeth matches the *Arvicola terrestris* species from locations of the end of Middle and Late Pleistocene (oxygen isotope stages, OIS 6 and OIS 5–2, respectively). The high SDQ value for the water vole and the presence of the squirrel and dormouse in the fauna allow dating the finding near the end of the Middle Pleistocene and beginning of the Late Pleistocene (OIS 6 and OIS 5e, respectively). The widespread open and forest landscapes were inhabited by this fauna.

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Northern Eurasian landscapes differed significantly from the contemporary geographical spaces during the larger part of the Pleistocene: open and semi-open landscapes predominated [1]. Because of this, forest-related species and temperately thermophilous ones were extremely rare in the Pleistocene fauna. The red squirrel belongs to the former group (*Sciurus vulgaris* L., 1758), while dormice, including the forest dormouse (*Dryomys nitedula* L., 1778), to the latter. The findings of their fossils in the Pleistocene fauna of Eastern Europe and Northern Asia are extremely rare. A few squirrel bones have been found in two Pleistocene locations of the East European Plain [2], two locations of the Urals [3, 4], seven locations of the Altai [5, 6], and one location of Primorye [7]. The bone fossils of dormice are even scarcer. They have been found in four locations of the East European Plain. In two locations, the fossils of the edible dormouse (*Glis* sp.) were found [2, 8]; in one, those of the forest dormouse (*Dryomys* sp.) [8]; and in one, those of the hazel dormouse (*Muscardinus avellanarius* Linnaeus, 1758) [4].

Squirrel fossils have been found on the East European Plain and Urals in deposits of the interglacial period [2, 4]. One location of the European part and two in the Urals date back to the last interglacial or close to it period (Mikulino, Kazantsevo, Eemian; Oxygen Isotope Stage 5e) [2, 3]. Locations in the Altai and Primorye date to the Kazan interglacial period (OIS 5e) and the second part of the Late Pleistocene (OIS 3 and OIS 2) [5–7]. The dormouse fossils originate from locations of the Pleistocene interglacial periods; one of them dates to the Mikulino period [4, 8]. Thus, all of the red squirrel and dormouse findings in the East European Plains and Urals date to interglacial periods, while in the Altai and Primorye they date to the Late Pleistocene, including the interglacial (OIS 5e) and stadials (OIS 4–2). Currently, the red squirrel species range spans the entire forest zone of northern Eurasia, and the dormouse range encompasses the southern half of the East European plain, including the western slope of the Southern Urals inhabited now by the garden dormouse (*Eliomys quercinus* L., 1766) [9].

Here, we report new evidence obtained in the Ignatievskaya Cave (54°53' N, 57°46' E). A new sample of bone fossils has been derived from layer 10, excavation 5 [10]. Layer 10 consists of light-brown viscous and silty clay containing small crushed limestone and mammalian bones. This layer lies at a depth of 3.1

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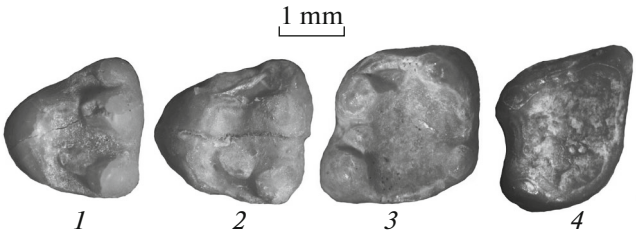

Fig. 1. Teeth of *Sciurus vulgaris* from the deposits of Ignatievskaya cave. *1*, P4 sin (depth of 3.75–3.90 m); *2*, P4 sin (depth of 4.70–4.80 m); *3*, m1 sin (depth of 4.70–4.80 m); *4*, m3 sin (depth of 3.75–3.90 m).

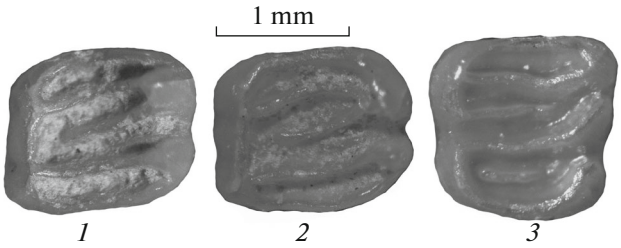

Fig. 2. Teeth of *Dryomys nitedula* from the deposits of Ignatievskaya cave. *1*, M2 sin (depth of 3.45–3.55 m); *2*, M2 sin (depth of .65–3.75 m); *3*, m2 dex (depth of 3.65–3.75 m).

to 5.2 m and fills the cracks in the limestone bed of the cave bottom. More than 10 000 identifiable fossils of rodents and lagomorphs, as well as about 600 fossils of predators and ungulates, were excavated from this layer. In addition, chiropteran, insectivore, bird, amphibian, and fish fossils were found.

Squirrel teeth were found in two horizons. An intact P4 sin and m3 sin were derived from the conventional horizon of 3.75–3.90 m. In the horizon of 4.70–4.80 m, the intact P4 sin and m1 sin were found (Fig. 1). The teeth belonged to adult individuals. The crown structure and size of teeth found did not differ from those of the modern red squirrel teeth.

Dormouse teeth were derived from two conventional horizons. An intact M2 sin and two intact M2 sin and m2 dex of the forest dormice were found in the horizons 3.45–3.55 m and 3.65–3.75 m, respectively (Fig. 2). The M2 sin teeth have three roots, rectangular crowns, and slightly concave grinding surface. The crowns have six main ridges. Anterior centroloph is longer than the posterior centroloph. The protoloph and metaloph are almost parallel. The endoloph is well developed. No additional ridges were observed. The tooth belongs to the G morphotype [11]. Dimensions: L 1.00 mm, W 1.25 mm (1); L 1.08 mm; L 1.32 mm (2). The m2 dex tooth has two roots. The crown is trapeziform and grinding surface is slightly concave. The tooth has five main ridges and one additional (posterior) ridge between the mesolophid and the posterolophid. The endolophid is absent. The tooth belongs to morphotype 2 [11]. Dimensions: L 1.20 mm, W 1.23 mm. Tooth dimensions fall within a range of variation characteristic of the modern forest dormouse from Poland and forest dormouse from Kozi Grzbiet, a Middle Pleistocene location [12].

In the rodent and lagomorph fauna, open-landscape species predominated (in the order of decreasing proportion): narrow-skulled vole (*Microtus gregalis*), steppe lemming (*Lagurus lagurus*), steppe pika (*Ochotona pusilla*), gray hamster (*Cricetulus migratorius*), Eversmann's hamster (*Allocricetulus eversmanni*), yellow steppe lemming (*Eolagurus luteus*), spermophilus (*Spermophilus* sp.), steppe marmot (*Marmota bobak*), arctic and Siberian lemmings (*Dicrostonyx* sp. and *Lemmus sibiricus*, respectively), and southern birch mouse (*Sicista subtilis*), the amount of whose fossils reach 67 to 87% in various horizons. The species depending on the woody-shrub vegetation make up 3 to 15%: field vole (*Microtus agrestis*), forest voles (*Clethrionomys rufocanus*, *Cl. rutilus, Cl. glareolus*), forest mice (*Sylvaemus flavicollis, Sylv.* ex gr. *uralensis-sylvaticus*), garden dormice (*Eliomys quercinus*) and red squirrel (*Sciurus vulgaris*). Near-water species are relatively numerous (from 5 to 22%): water vole (*Arvicola terrestris*) and root vole (*M. oeconomus*). Large mammals are represented by the mountain hare (*Lepus timidus*), wolf (*Canis lupus*),

Table 1. The coefficient of enamel differentiation (SDQ) of the water vole (*Arvicola terrestris* L., 1758) from the Pleistocene and Holocene locations of the Eastern Europe and Urals

Location	Area	Age	*n*	SDQ, min–*M*–max
Novonekrasovka (upper layer)	Eastern Europe	Mikulino (OIS 5e)	18	60–*87*–140
Novonekrasovka (lower layer)	Eastern Europe	Mikulino (OIS 5e)	14	60–*92*–110
Malutino[1]	Eastern Europe	Mikulino (OIS 5e)	4	42–*61*–100
Krasny Bor[2]	Eastern Europe	Mikulino (OIS 5e)	15	64–*74*–88
Ignatievskaya	Southern Urals	Mikulino (?) (OIS 5e)	14	83–*97*–111
Zygan	Southern Urals	Late Holocene	14	57–*70*–75
Nugush	Southern Urals	Modern times	40	55–*74*–97

[1] [15], [2] [4]; *M*, average SDQ value; min and max, the limits of SDQ range; *n*, the number of determinations.

fox (*Vulpes vulpes*), Arctic fox (*Vulpes lagopus*), small cave bear (*Ursus savini*), weasel (*Mustela nivalis*), stoat (*Mustela erminea*), wolverine (*Gulo gulo*), the cave lion (*Panthera leo spelae*a), argali (*Ovis ammon*).

The fauna structure suggests that flat-interfluve open landscapes predominated during the fauna existence. At the same time, forest vegetation spanned significant areas along the mountain slopes and river valleys, which are favorable for the red squirrel populations. The faunal species composition and, first of all, the fact that the red squirrel and forest dormouse were included, are indicative of the interglacial or related fauna. The fauna age can be determined more exactly from the ratio of enamel thickness on the antero- and posteroconid walls of the water vole teeth, i.e., from the coefficient of enamel differentiation (SDQ) [13]. As determined from the ratio of enamel thickness on the walls of the first molar conids (m1) of the water vole from the layer 10, the coefficient of enamel differentiation varied within a range of 83.0–111.3 and averaged 96.7 ($n = 14$). This SDQ value matched the species *A. terrestris* from European locations of the Middle Pleistocene (Dnieper, Saalian, OIS 6) and the entire Late Pleistocene (Mikulino, Valdai, Eemian, Weichseliann, OIS 5–2) [14, 15]. The relatively high SDQ value (Table 1) corresponds to the early stage of this species history and suggests that the fauna dates to Dnieper Glaciation of the late Middle Pleistocene (OIS 6) or early Mikulino Interglaciation (OIS 5e) of the late Pleistocene beginning.

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