Unique Locality of Wooly Rhinoceros in Arctic Siberia

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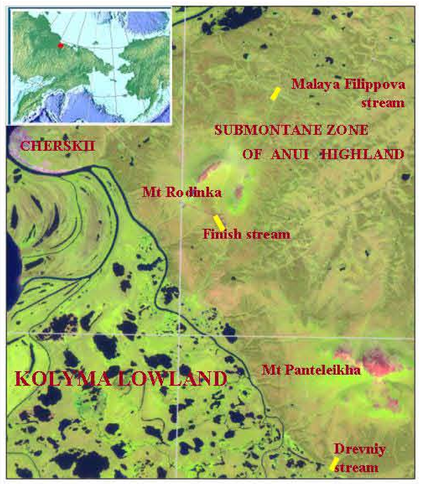
ABSTRACT

A permafrost goldfield area of stream valleys in northeastern Yakutia, Russia turns to be the richest locality of extinct woolly rhinoceros in the World. It has yielded fossil skulls and horns of about 50 rhino individuals, and recently the most complete mummified body of this extinct giant. The age of fossils is about 20–50 thousand years before present, but permafrost helped to preserve them in perfect condition. The fossils, and especially mummies, present a perfect material for paleontological and molecular-genetic studies. Woolly rhinoceros, *Coelodonta antiquitatis (Blum.),* is one of the symbols of the Ice Age and one of few large mammal species that disappeared from Eurasia about 10 000 years ago. Recently, a substantially complete mummy of woolly rhinoceros was found in permafrost at the Rodinka site near Cherskii, northeastern Yakutia, Russia (68.76°N, 161.63°E). The absolute age of mummy is 39 140± 390 years (OxA-18755). In recent years permafrost of low-order stream valleys of the Rodinka site has yielded an unprecedented number of woolly rhino fossils and is so far the richest locality for this extinct species. Enclosing sediments of fossil mammals are presented by icy loess-like loams with polygonal ice wedges that called "Yedoma" or "Ice Complex". The unusual abundance of rhino fossils in low hills of submontane area confirms an earlier hypothesis that such a terrain was especially attractive for these animals, although they could make long (probably, seasonal) excursions to the North along the plains. The collection of woolly rhino fossils from Cherskii is now under study by paleontologists and geneticists in Russia, Denmark, USA and the UK.

STUDY AREA



Numerous remains of animals of Mammoth Fauna Complex were found during the gold-mining works of permafrost what covering valleys of low-order streams in the submontane area of the Kolyma Lowland and the Anui Highland conjunction (Davydov, 2007). Enclosing sediments of fossil mammals were built by loess-like loams with polygonal ice wedges. This type of permafrost is very common in North-Eastern Siberia, and is usually called "Yedoma" or "Ice Complex" (see Sher et al., 1971 for details) and has the Late Pleistocene Age. In recent years this area has yielded an unprecedented number of woolly rhino fossils and is so far the richest locality for this extinct species. Hundreds of bones have been excavated at three stream goldfields on slopes of the Rodinka Mt. (351 m) and the nearby Panteleikha Mt. (632 m), in the area about 20 km² large.

FOSSILS OF THE MAMMOTH FAUNA IN SUBMONTANE AREA

FRAGMENTS OF BISON SKULLS WITH HORN SHEATHS

FRAGMENTS OF RHINO SKULL WITH TEETH

SOME FOSSILS COLLECTED DURING ONE FIELD TRIP

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FRAGMENTS OF ANTLERS AND SKULLS OF *CERVUS ELAPHUS*

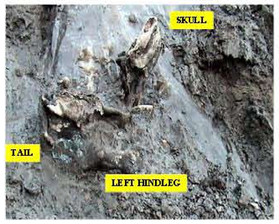
Fossil fauna is presented of various species – woolly mammoth *(Mammuthus primigenius)*, primeval bison *(Bison priscus)*, primeval horse *(Equus lenensis)*, red deer (*Cervus elaphus*), reindeer *(Rangifer tarandus)* , musk-ox *(Ovibos pallantis)* and unusual abundance of woolly rhino *(Coelodonta antiquitatis)* remains (mummy, parts of skulls, horns, fragments of skeletons and skins). Predators - cave lion *(Panthera (Leo) spelaea)* and grey wolf *(Canis lupus)* were found also.

The bone material appears rather fresh with partly preserved soft tissues and bone marrow inside with insignificant decay in addition to traces of predators gnawing (1, 2, 3).

LOCATION OF THE WOLLY RHINOCEROS MUMMY

In June 2007 an essentially complete mummy of woolly rhinoceros was found in Yedoma permafrost at the Rodinka site near Cherskii, northeastern Yakutia (68.76°N, 161.63°E) in a gold field at the upper reaches of the Malaya Filippova Stream. The locality is situated on the left valley slope of east exposition at approximately 130 m above sea level.

RHINO POSITION *IN SITU*



Apparently the rhinoceros fell into a trap, stuck in the mud and sunk after that. This is supported by the *in situ* position of the corpse in the icy Yedoma beds on the left side of body with its head extending upwards. The left part of the trunk was probably held by viscous liquid thixotropic soil of thawing Yedoma strata; as the rhino was suffocated in the muddy trap, it raised the head (Boeskorov et al., 2009). Some corpses of animals of the Mammoth Fauna were found in similar positions (Vereshchagin, 1979).

PRELIMINARY STUDY OF RHINOCEROS

Unknown painter. Paleolith Age. Cave Font-de-Gaume. France

Woolly rhinoceros, *Coelodonta antiquitatis* (Blum.), is one of the symbols of the Ice Age and one of few large mammal species that disappeared from Eurasia about 10 000 years ago. Although woolly rhino bones and mummified body parts have been known to scientists since the 18th century, the evolution and ecology of this extinct species remains essentially enigmatic. It is the body of an adult female, weighting almost 900 kg (hence, during its life, the animal was about 1.5 tons) with the preserved skull, lower jaw, one ear, fore and hind legs and tail (Fig. 1, 2). The length of the carcass is about 2 m; the live length of the animal is estimated as more than 3 m. No horns are preserved, the right legs are missing, and the chest and belly cavities are empty; almost all hair has been lost. Small bunches of short coarse light brown wool are preserved only on lower sites of legs (Fig. 2). Despite these defects, it is the most complete mummy of woolly rhino, ever found in permafrost. The body measurements of this individual are rather large, close to those of other adult female woolly rhinoceroses.

BODY MEASUREMENRS OF WOOLY RHINOCEROSES (cm) (Boeskorov et al., 2009)

Parameter	Yakutia		Rhinoceroses from Staruni, Western Ukraine (Nowak et al., 1930)	
	lower reaches of Kolyma, Malaya Filippova River, part of a corpse adult female	Lena–Aldan interfluve, village of Churapcha, skeleton of adult female*	1907, young female	1929, adult female
Body length from tail base to head end	about 350	323	355	358
Height at withers	145	155–165	153	153
Ear length	18–20	–	–	28
Tail length	47	–	–	49
Hind foot length	41	39	–	–
Anteroposterior diameter of hind sole	14.5	15.2	–	–
Transverse diameter of hind sole	15.7	about 16	–	–
Manus circumference in the middle	39	39	–	–

* In rhinoceros from Churapcha, the lower part of the right hind leg is preserved with soft tissues.

The famous Starunia rhino mummies found in early 1900's in Galicia (currently western Ukraine) – were conserved in ozokerite ("mineral wax") – a product of hydrocarbon formations, thus are not good for modern molecular studies. The Kolyma rhinoceros is the fourth of such a findings in the World and the best one by the preservation of soft tissues.

A fragment of rib from the rhino mummy was AMS dated to 39140±390 BP (OxA-18755). The same locality has yielded a number of specimens isolated from the body, i.e., the right pelvis, the lower part of the right hind leg with soft tissues (Fig. 2), and bones of the right foreleg. More mummified rhino remains were found in the same area in 2007 also. One is a part of a smaller body, probably of a young individual (the "baby"). It is represented by two hind legs, with the preserved hair of rusty and pale-brown color (Fig. 1, E; Fig. 2, D). Another is a tail, 47 cm long, with a part of skin from the croup (Fig. 1, D). This tail looks quite different from that of the carcass, so its identification was questioned. Mitochondrial DNA analysis, however, revealed that the tail really belonged to woolly rhinoceros. Moreover, judging by 97 basepairs of the mitochondrial d-loop, it has the same genotype as the "baby", and may be a part of the same individual. The "baby" and the tail do not seem maternally related to the main mummy.

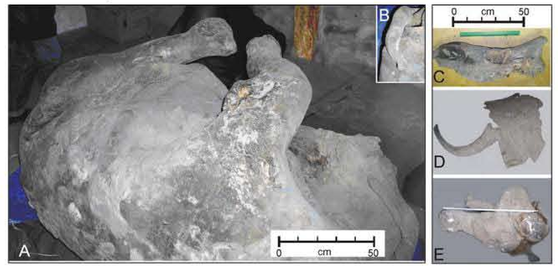
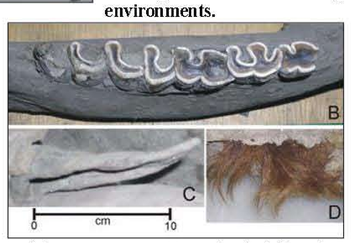


Figure 1. The body of the main mummy from the preserved left side (A); the tail (B) and skull (C) of the main mummy; the tail of the third individual (D); the hind legs of the "baby". The scale at the top is for B, C and D, at the bottom – for A and E. Blue stains are the deposits of mineral vivianite (blue ochre), forming in anaerobic bog environments.

Figure 2. Left anterior foot (A), lower teeth (B) and the ear (C) of the main mummy. D – remains of hair on the body of the rhino baby. The scale is for B and C only.



Paleoecological conditions in the habitat of the Kolyma rhinoceros were reconstructed based on palynological analysis that definitely shows the domination of grassland, i. e. steppe, meadow-steppe and meadow in the Late Pleistocene landscapes of study submontane area of Kolyma Lowland. The spreading of tree-shrub coenosises was extremely insignificant. It were predominantly steppe ecosystems with grass-sagebrush-forbs cryo-xerophytic communities with high floristic diversity, dry and firm ground and rich herbivore fauna, in which woolly rhinos acted the significant part (Boeskorov et al., 2009). Woolly rhino had a very wide distribution in the Late Pleistocene – from France to the Bering Strait and from China to the high-arctic islands. It was perfectly adapted to the variety of severe periglacial (tundra-steppe) environments. Intriguingly, it was the only large Siberian mammal that never crossed the Bering Land Bridge to Alaska. In the vast lowlands of N.-E. Siberia *Coelodonta* fossils are common, but much less abundant (below 1%), than those of the other large Ice Age mammals, such as mammoth, bison, or horse. Unusual abundance of rhino fossils at the low hills of Cherskii area confirms earlier hypothesis (Sher, 1976) that such a terrain was especially attractive for these animals, although they could make long (probably, seasonal) excursions to the North along the plains. The new mummy samples make an important supplement to the large series of *Coelodonta* bone samples from all over Eurasia, which are currently investigated for ancient DNA in Copenhagen in order to reconstruct the evolution, phylogeography, migration patterns and possible causes of extinction of the Ice Age giant. Of special interest are the hair samples of the mummies, as the fossil hair shafts have recently been shown to be an exceptional carrier for ancient DNA (Gilbert et al., 2007). Thus, the new mummies offer a unique opportunity to do in-deep genetic analysis. Currently, the collections of fossils from this area, kept in the Ice Age Museum in Moscow, includes about 50 horns of rhinos (complete or fragments) - more, than the total number of those rare fossils kept in all museums of the World, Mammoth Museum and Geological Museum in Yakutsk, North-East Science Station (Cherskii, Yakutia). At present, the corpse of the Kolyma rhinoceros is stored frozen in Yakutsk for further thorough comparative anatomical, molecular-genetic, histological, and microbiological studies.

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