Archaeological Research in Asia 22 (2020) 100180

Contents lists available at ScienceDirect

Archaeological Research in Asia

journal homepage: www.elsevier.com/locate/ara

Full length article

Images of camels on a mammoth tusk from West Siberia

Yury N. Esin[a,*], Jerome Magail[b], Fabrice Monna[c], Yury I. Ozheredov[d]

[a] Khakassian Research Institute for Language, Literature and History, 23, Shchetinkin Street, 655017 Abakan, Republic of Khakassia, Russia
[b] Museum of Prehistoric Anthropology of Monaco, 56, boulevard du Jardin exotique, 98000, MC, Monaco
[c] ARTEHIS, UMR CNRS 6298, université de Bourgogne–Franche Comté, 6 Boulevard Gabriel, Bat.Gabriel, 21000 Dijon, France
[d] Independent researcher, 48-513, Govorov Street, 634057 Tomsk, Russia

ARTICLE INFO

Keywords:
West Siberia
Mammoth tusk
Late Upper Paleolithic
Paleolithic art
Two-humped camel

ABSTRACT

This study introduces the engravings on a mammoth tusk from the lower reaches of the Tom River in West Siberia. The tusk was found in 1988 during construction works and was later transferred to the Tomsk State University, but it remained almost unknown to specialists until now. Radiocarbon dating by AMS reported the age of the tusk as 13,100–13,005 Cal BP (95% confidence level). The surface of the tusk is engraved with images of two-humped camels arranged in two pairs. In addition, arrows and wounds within the contours of the animals can be seen. The comparative analysis of the stylistic features of the camel figures shows that they correspond to the age of the tusk itself, making them, at present, the oldest camel images in Asia. The discovery of the engravings in this region is consistent with the theory of mobile population groups moving to western Siberia from the periglacial steppe to the south in the Late Upper Paleolithic.

1. Introduction

The repertoire of Paleolithic art in Eurasia is versatile and has already been quite well studied. Among the typical zoomorphic images of this art are large representatives of mammoth fauna from the north of the continent. Recent studies, however, have provided new material from the eastern part of the region, allowing us to add another animal to the repertoire – a two-humped camel. For instance, one painted image of this animal has been found in Ignatievskaya (Yamazy-Tash) cave, another became widely known after its recent discovery during the cleaning of calcite deposits in Kapova (Shulgan-Tash) cave, both in the Urals (Shirokov and Petrin, 2013; Devlet et al., 2018a, 2018b). Our paper introduces camel images from another unique artifact – a fragment of a mammoth tusk from the Tom River in West Siberia. It was accidentally discovered in 1988, but it has remained almost unknown to international scholars. There are several short publications and mentions in the Russian literature, but this find obviously deserves a new and deeper study. At this stage, the main purpose of this new study is to confirm the Late Pleistocene age of the animals carved on the tusk through a systematic analysis of all available data.

This article addresses outstanding questions about the tusk by presenting new research on: 1) the history of research on the tusk and clarification of its find location; 2) the radiocarbon date of the tusk and new documentation of the images on it, as carried out for the first time by the authors using 3D modeling and macro photography; 3) the identification of the figures and visual composition on the tusk based on the results of new documentation; 4) the application method and stylistic features of the images used to test their hypothesized Late Pleistocene age; 5) the geographical distribution of the most ancient images of two-humped camels and parts of their skeletons from the Late Pleistocene Epoch used to evaluate the overlapping of camel and human ecological niches; and 6) the new interpretation of the images based on composition, camel behavioral traits, and paleogeographic data.

2. The discovery and further study of the tusk

In June 1988, Tomsk State University (TSU) received some information about fragments of mammoth skeletons discovered while digging a car inspection pit in a previously constructed garage at the outskirts of Seversk in the Tomsk region. Archaeologists S.A. Terekhin and A.D. Gaman, together with A.N. Kondrashev, a history department student, went to the location to confirm the information. At the construction site they witnessed three unearthed fragments of tusks (one of a large diameter and the other two 1.5 times smaller) covered with a crust of sand. They also saw a jawbone of a young mammoth with two teeth in good condition and more than 20 fragments of large teeth (perhaps totaling two teeth). In addition, the workers informed the

* Corresponding author.
E-mail addresses: esin2006@yandex.ru (Y.N. Esin), jerome.magail@map-mc.com (J. Magail), fabrice.monna@u-bourgogne.fr (F. Monna), nohoister@gmail.com (Y.I. Ozheredov).

https://doi.org/10.1016/j.ara.2020.100180
Received 26 June 2019; Received in revised form 18 January 2020; Accepted 3 February 2020

archaeologists about a stone with chipped edges, similar to an ax, found at the same location. Unfortunately, the stone had already been lost. No other artifacts or evidence of a cultural stratum were found during the short investigation in the pit.

The find location is located on the second or third fluvial terrace of the Tom River, the east tributary of the Ob River, 2 km away from the current stream bed of the river (Fig. 1). This location is known as Parusinka. The terrace is composed of quartzite sand that was mined at an earlier-established quarry. The fragments of mammoth skeletons were found about 1.5–2 m away from the bottom of the quarry and no less than 3–4 m below the surface of the terrace, on the smooth gravel layer.

TSU scientists were not that interested in the fragments of the mammoth skeletons, so these bones were stored at A.N. Kondrashev's house. Later, he cleaned a layer of the sand from the largest tusk and discovered strange thin lines cut on its surface. Some of them formed images that could be interpreted as two-humped camels and arrows. Assuming the lines were human-made, Kondrashev brought the tusk to the students' research lab at the history department in TSU. Due to the absence of a Stone Age specialist and the opinion of S.A. Terekhin that the lines had a natural origin, the tusk did not attract much attention at that time. It was forgotten until 1994, when the lab was relocated to a new building, and the tusk was given to the Museum of Archaeology and Ethnography of Siberia (MAES) at TSU. The inspection of the tusk in the MAES TSU confirmed the engravings were human-made. A.N. Kondrashev had graduated from the university and become an archaeologist by then, but he shared the details of the discovery with the director of MAES, Yu. Ozheredov, and later published the information (Kondrashev, 1996; Ozheredov, 2016: 183).

Due to inappropriate storage conditions, the tusk had already dried out and cracked. The surface had partially crumbled off, the tip of the tusk had partially broken off, the cracked surface bulged up, and parts of the pulp had started to spill out. This made it very difficult to study the engravings and endangered the conservation work. To prevent any further deterioration, the director of the museum followed the advice of paleontologists from TSU and coated the surface of the tusk with a glue solution. To stop the cracks along the tusk, it was bound with three bandages.

In 1995, the director of the MAES invited an archaeologist, V.E. Larichev from Novosibirsk, and an artist, V.I. Zhalkovsky, to study the tusk. Another Novosibirsk Paleolithic researcher, V.T. Petrin, visited the find location in Seversk. The scientists recognized the authenticity and importance of the engravings, but they were unable to obtain a good copy of them. V.E. Larichev suggested that the rows of short lines engraved on the surface of the tusk represented an ancient calendar (Vesnina, 1995; Kondrashev, 1996).

At the same time, the tusk was studied by the director of the paleontological laboratory at TSU, S.V. Leshchinskiy. He saw it as part of a group of tusks and tusk objects that were engraved and pierced during the Upper Paleolithic in the south-eastern part of West Siberia (Leshchinskiy, 1997: 120). In 1996, Yu. Ozheredov made a first sketch of the engravings and published the results in two papers (Ozheredov, 1997, 2016). Brief information about this discovery, based on the sketch made by Ozheredov, was later published by another Tomsk archaeologist (Vasil'ev, 2004).

In autumn 2016, new documentation of the engravings was conducted by two of the authors, J. Magail and Yu. Esin. In 2019, we managed to identify the find location rather precisely in the modern town Seversk with A.N. Kondrashev's help (other archaeologists who had been there are no longer alive). It is worth noting that an undeveloped area of the terrace overgrown with trees has remained nearby (on the south side) (Fig. 1, *c*). This area may be suitable for future excavation in order to conduct a more detailed study of the find location's geological context.

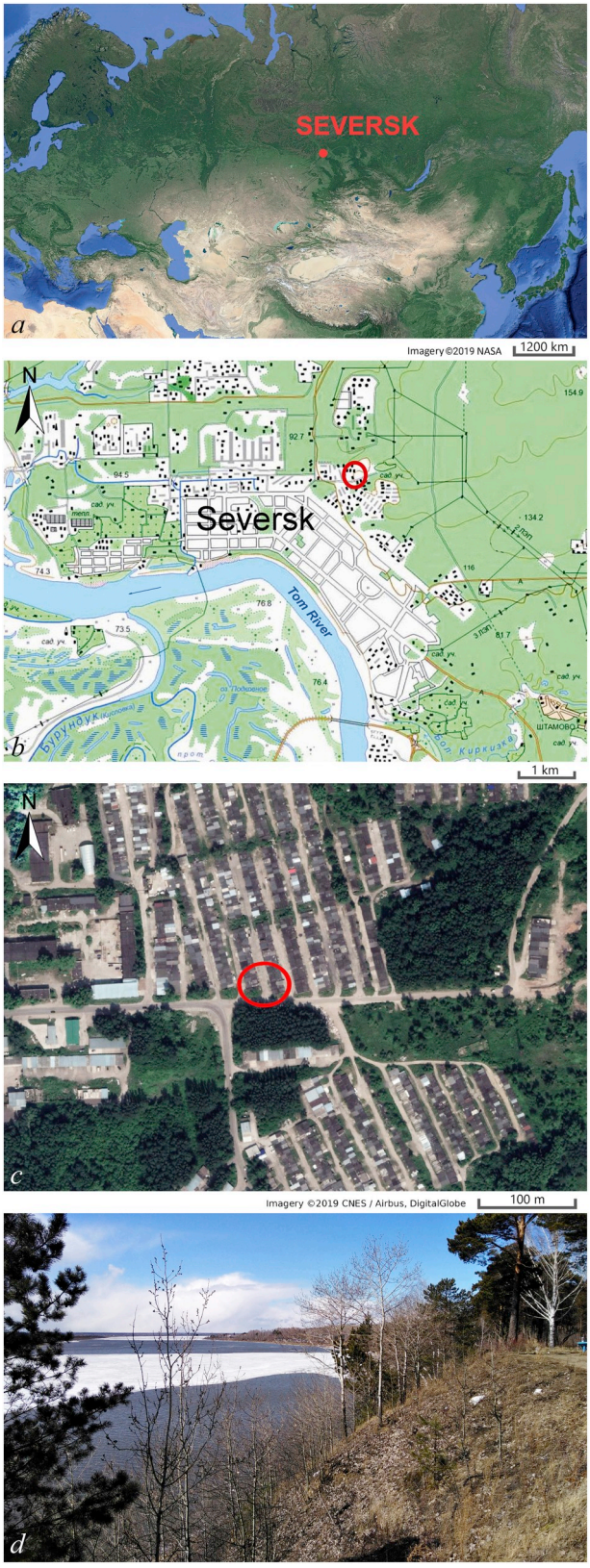

Fig. 1. Maps (*a*–*c*) with the location of the mammoth tusk discovery (circled in red) and (*d*) general view from the right bank of the Tom River in Seversk (Photo by A. Kondrashev). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

3. Characteristics of the tusk and its age

Close examination of the artifact indicates that it is a fragment of a bigger tusk (Fig. 2, *c*). The length of its outer surface is 74 cm, the inner surface is 63 cm. The diameter of the thicker end is 9.4 cm. According to S.V. Leshchinskiy (consulted by MAES in 1996), who based his estimations on the size and signs of natural attrition at the tip of the tusk, the artifact is a frontal fragment of a 1.5 m long tusk which belonged to a 35–40-year-old male mammoth. The fragment was cut before it was separated from the main tusk, after which it fractured.

According to V.E. Larichev and V.T. Petrin, the age of the tusk could be as old as 18,000–20,000 years BP; E.V. Vasil'ev estimated the age at 16,000–17,000 years BP (Vasil'ev, 2004: 7). These assessments are based on the dates of the most well-known Paleolithic sites at the lower reaches of the Tom River (Tomskaya, Mogochino). Yu. Ozheredov had a different approach: considering certain similarities of the engraving style with Magdalenian art from western Europe, he estimated them to date to around 15,000–10,000 years BP (Ozheredov, 1997).

In 2014, the Museum of Prehistoric Anthropology of Monaco provided a radiocarbon date for the sample extracted from the inner part of the tusk by Yu. Esin and Yu. Ozheredov. This measurement gave the first objective data about the age of the tusk (Beta-400624): 11,180 ± 40 BP (conventional radiocarbon age); 13,080–13,045 Cal BP / 11,130–11,095 Cal BC (68% confidence level) or 13,100–13,005 Cal BP / 11,150–11,055 Cal BC (95% confidence level; calibration was performed using IntCal13 database). In accordance with the existing Upper Paleolithic periodization system for western Siberia, the tusk falls into the Late Sartanian period (15,000–10,000 BP), which is known by such sites as Chernoozer'e II, Lugovskoe etc. (Zenin, 2002; Vasil'ev et al., 2005: 56–63; Makarov, 2009). According to the geological periodization system developed for Siberia, the tusk can be dated back to the end of the third phase of Sartanian period. This is generally characterized by a warmer climate, as compared to the previous phase, and by developed aeolian activity (Tseytlin, 1979: 262).

However, since the dating of the tusk's archaeological and geological context has not been established, studying the engraving technique, as well as the style and composition of the images, is necessary to determine if the date of the engravings corresponds to the date of the tusk itself.

4. Methods of documentation and new results

The engravings on the tusk from the Tom River have special features, which make them difficult to document: 1) they have very thin and shallow lines, making them barely visible and tedious to trace; 2) the engravings are on the surface of a round, long, curved and heavy object which does not allow all the imagery to be seen and recognized without rotating the tusk; 3) the poor condition of the tusk (cracked and crumbling on many parts of the surface) does not permit us to see a complete and coherent composition.

The first researchers who worked with the images, V.E. Larichev and V.I. Zhalkovskiy, tried to document the tusk by contouring the engraved lines with a pencil on the surface of the tusk itself, to make them more recognizable for further sketches or photos. We could see what was left of these, sometimes incorrect, pencil outlines when we studied the tusk in 2016.

The method used by Yu. Ozheredov in 1996 involved visual examination of the lines on the surface of the tusk, several measurements and sketching parts of them on paper at a 3:1 scale. This method allowed him to recognize four images of camels (Ozheredov, 2016), however there were still some uncertainties about the objectivity of the results.

In 2016, J. Magail and Yu. Esin photographed the surface of the tusk in order to make a 3D model using 'Structure-from-Motion' photogrammetry. Both sides of the tusk were modeled separately with a consumer-grade camera (SONY DSC-HX10V, sensor 1/2.3″, 18 Mpix, 24–384 mm equivalent on a full frame 35 mm camera, set at 24 mm), using 397 and 243 pictures, respectively (Fig. 2). The tusk was placed on a highly textured grayscale print to facilitate the removal of the background. Both sides were then merged using several control points and scaled to produce a textured 3D model possessing more than 80 million vertices. The whole procedure was undertaken using Agisoft's

Fig. 2. 3D models of two sides of the tusk with engravings (*a, b*) and final result (*c*) after support removal and merging. Provided by F. Monna.

Fig. 3. Unfolded surface of the tusk obtained by cylindrical projection after straightening the tusk. Provided by F. Monna.

PhotoScan. As the tusk naturally appears bent and twisted, it was first straightened using Blender 2.78. Then, the texture was unrolled by projection from the longitudinal axis onto a cylinder which 'unwrapped' the artifact (Fig. 3). The final, unfolded image corresponds to two full revolutions around the tusk, which was necessary to facilitate the drawing and interpretation of the engravings without any gaps in the figures. More details about the general photogrammetric workflow and principles can be found in elsewhere (Monna et al., 2018).

In the final stages, the 2D image was processed in Photoshop. Using additional layers and a graphic tablet, Yu. Esin, who has many years of experience in documenting ancient petroglyphs, traced the engravings for a graphic sketch. Creating a graphic sketch is essential for any further analytical work. However, the sketch itself represents the first stage of the analysis, and, in large portion is defined by the purpose of this analysis. When documenting the surface of the tusk we found quite a few cut lines of different depth, width and length. Some lines crossed each other, although their contemporaneity and attribution to the same composition was not evident. Moreover, there were segments of the surface covered with a sequence of small notches, while other parts also had chopping marks. Sketching all these details would inevitably create "information noise", preventing overall study of the engravings. There were also naturally occurring limits of such a sketching technique, since it is impossible to include all thin lines in a sketch with the intention to make them recognizable if the large object is published on a smaller scale. For these reasons, our task was not to sketch all the engravings, but rather to focus on identifying the lines that formed images and repeated combinations. If the lines were engraved relatively deep, they were also included in the sketch (Fig. 4). A more complete understanding of the relief of large areas of the surface can be obtained from the published photos (Fig. 5). The fragments were shot using oblique lighting, which allowed for better recognition of the engraved lines and the order in which some lines were created. These photos were used to verify the lines in the drawing made according to the photogrammetric model.

We also took macro photographs of the engravings with a camera and a portable microscope (Fig. 6). Despite the glue coating on the surface of the tusk, we were able to identify similarities of the engravings to others made by stone tools. The photographs also helped illuminate the smoothness of the edges, due to the aging of the material. The engravings were created with a very sharp cutting tool, which, depending on the amount of pressure applied, could produce a line about 0.1–0.15 mm thin, or even less. In order to make some elements of the images more visible, cuts were made repeatedly one right next to

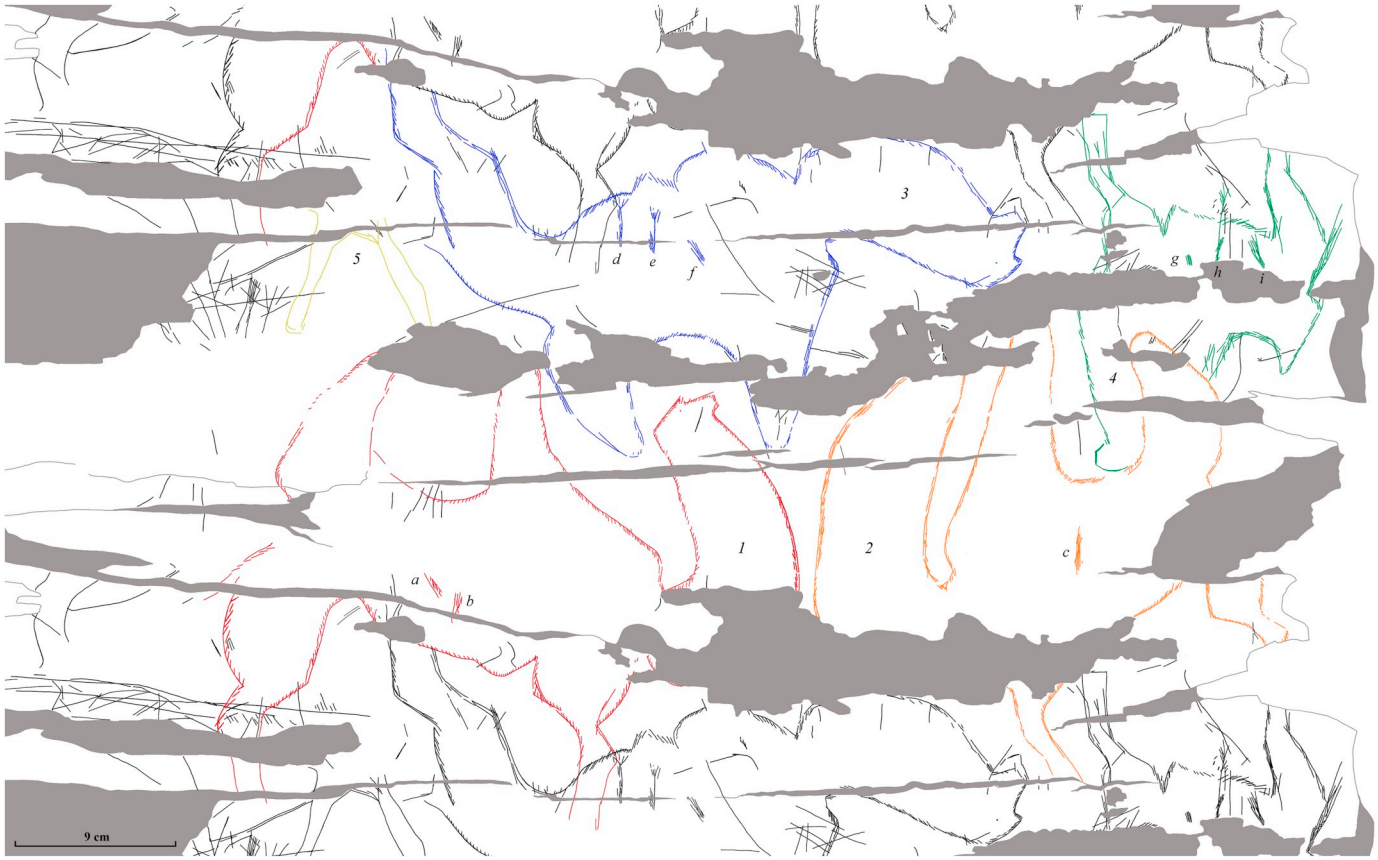

Fig. 4. Engravings on the tusk from the Tom River. Numbers from *1* to *5* and letters from *a* to *i* mark main images and their details. Drawing by Yu. Esin.

Fig. 5. Some fragments of the tusk with engravings: *a* – the head of camel 1; *b* – the front leg of camel 1 and the rear leg of camel 3; *c* – the base of the front hump of camel 3; *d* – larger end of the tusk with a figure of a camel 4. Photo by Yu. Esin.

another, which increased their width by about 2–3 times. In some parts, we noticed vague lines that could have served as 'drafts' for the final images. Other notable features on the tusk surface are traces of abrasive polishing (Fig. 6, *e, f*). They are probably indicative of surface preparation before the camels were applied, which will be discussed later in the article, because the engraved images overlay the polishing traces. Alternatively, the surface treatment with something abrasive could have served to remove some earlier engravings, the lines of which are visible in some places. In general, the application technique of the images on the tusk from the Tom River does not contradict the hypothesis of their Late Pleistocene age.

5. Identified images, their style and composition

5.1. Camels

The study of the engravings from the 2D model of the tusk surface identified four images of two-humped camels. They are depicted in different colors and each given a number on the sketch (#1–4 in Fig. 4). All four animals were executed in the same style, using similar techniques and tools. The main stylistic feature of these images is that they combine the figures' outlines with a series of short transverse cuts on the inner side. In some places, the outline is missing and the short cuts themselves serve as the contour. All camels are depicted with only two legs. The lower ends of the foot contours, in most cases, are not connected. The camels have patches of thick fur sticking out from the upper parts of their forelegs, bellies, under their necks, at the base of the humps (between the front hump and the neck, the back hump and the croup) and on their foreheads. The heads are all small and angular. On two figures (#1 and 3), single dots inside the heads probably indicate eyes. The tails are stretched out and down. All in all, the figures of the animals are quite realistic and demonstrate a good knowledge of the subject.

According to their location on the surface of the tusk and in relation to each other, the camels can be divided into two pairs: a) camels 1 and 2; b) camels 3 and 4. The animals from each pair face each other and are situated on a horizontal line. What is important is that the contours of the animals from the same pair do not cross or touch each other. We see, however, another situation with the animals from the different pairs: the belly of camel 3 is depicted above the front leg of camel 1, and the length of his rear leg is reduced because of camel 1's belly (the lines of this leg are also engraved over the belly of camel 1– Fig. 6, *d*); the contour of the front hump and the neck of camel 4 is created by the contour of the back hump from camel 2. This demonstrates in what order the pairs of camels were engraved. It also shows the order in which the parts of each body were depicted: camel 3 and 4 were engraved starting from the humps and heads, which fit neatly in the space between the humps and the head of previously engraved camels 1 and 2; the legs of a small-sized camel 4 could also be placed between the legs of camel 2, and no belly and leg lines of camel 1 and 2 crossed.

The analysis of the size, proportions, and placement of the figures allows us to reconstruct the order in which they were engraved in the second pair. The humps of the large camel 3 fit in the space on both sides of the head of camel 1; in order to avoid crossing the head of camel 2, its neck is stretched forward (not upwards, as with camels 1 and 2). Hence, when creating camel 3, the engraver was limited by the contours of camels 1 and 2. After depicting camel 3, there was very little space on the surface of the tusk for camel 4. This is likely the reason why the contour of the neck and the front hump of camel 4 partially coincides with the contour of the back hump of camel 2. Due to its small size, this fourth camel is the only one that does not require rotating the tusk in order to be seen.

Every animal was placed on the surface in such a way that they would not, as much as possible, interfere with any other one. In this sense, they can all be considered as parts of a bigger composition. At the same time, the order in which the figures were engraved, and the contraposition of the paired figures depicted twice, allows us to view each pair as an independent composition. The autonomy of each pair can also be supported by the difference in orientation on the surface of the tusk: the position of the camels from one pair in relation to the other pair, when the tusk is rotated around its longitudinal axis, appears to be upside down.

Fig. 6. Some fragments of the tusk with engravings: *a, b* – an arrow inside the belly of camel 4 (full image and part of the lower end of the shaft with fletching); *c, d* – lines of the back leg of camel 3, engraved over the belly of camel 1; *e* – the lower part of the front hump of camel 3; *f* – the fragment of the neck of camel 2. Photos by Yu. Esin (*a*) and J. Magail (*b-f*).

5.2. Arrows and wounds on the camels

There are several repeated images within the contours of the camels. According to the form and location on the animals' bodies, 3 of them can be recognized as arrows (or light darts) with fletches at the end, piercing the belly (*#d, e, h* in Fig. 4; Fig. 6, *a*). The arrowheads are not shown, and the fletches are depicted by several lines stretching from the end of the shaft. All arrows point up, so they are completely or halfway inside the contour of the animal. Among the important features related to the content and style of this imagery, there are several parallel lines close to the front end of each arrow which could represent wounds or bleeding.

In addition, there are independent groups of parallel lines similar to those depicted near the top of the arrows. They are located on the bellies of each animal (*#a-c, f, g, i* in Fig. 4). In our opinion, they can also be viewed as wounds, however, the weapon itself is not shown in these cases. What is also important is that the camels from the first pair only have wounds, and all the arrows are depicted in the animals from the second pair. This feature supports implicitly the compositional independence of each pair.

5.3. Anthropomorphic figure (?)

Between the rear legs of camels 1 and 3 we can see a complex figure, which was depicted intentionally. It resembles two legs walking to the right (however, without any outlined feet). It is shown under number 5 and highlighted in yellow (Fig. 4). It is possible that what we see here is an anthropomorphic figure with its upper part delineated by the legs of the animals (Fig. 7). A similar technique of sharing the same outline between two figures is used on the tusk for camel 4. The whole figure can be

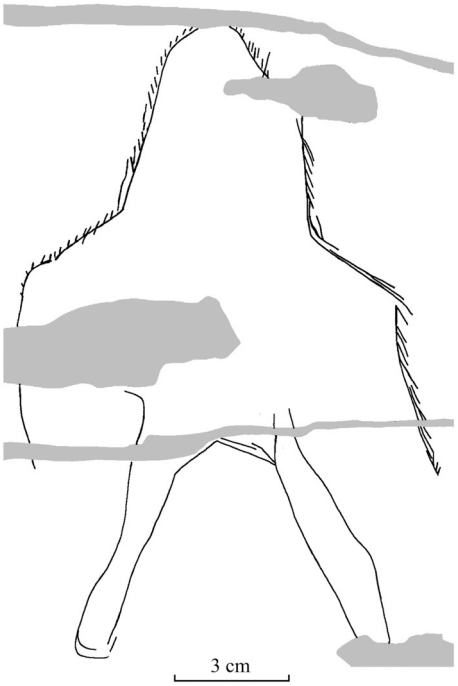

Fig. 7. Possible anthropomorphic figure. Drawing by Yu. Esin.

viewed as a human wearing a skin cloak. On the surface of the tusk, the upper part of this figure is oriented the same way as the first pair of camels. Its head is located on the same level as the belly of camel 1, and the whole figure is placed between the bellies and legs of both pairs of camels.

The main characteristic of the proposed human figure is the very generalized contour of its upper body and how its legs are separated from the upper part. A similar composition is exemplified by two images interpreted as anthropomorphic figures that were engraved during the Upper Paleolithic on a mammoth tusk from the Yana River in Yakutia. However, it should be noted that they differ stylistically and are 15,000 years older than the tusk from the Tom River (Pitulko et al., 2012: Fig. 11C). Although our identification of these engravings as an anthropomorphic figure is an interpretation, it may be of interest for further comparative studies that will make it possible to test.

6. What does the composition on the tusk represent?

Similar images of camels facing each other are quite common in the art of different cultures of the Bronze Age, Early Iron Age and Medieval period in southern Siberia and Central Asia (Mukhareva, 2007: Fig. 4–7). Such frequency indicates that the composition conveys a memorable and important natural characteristic of camel behavior. In many cases, the composition combines two male rivals that are fighting or are about to fight (Fig. 8). Such behavior is seasonal by nature and occurs annually during the mating season (this usually happens in January or February among modern domesticated two-humped camels). Fascination with these battles inspired the tradition of camel fight festivals in some cultures.

It seems that the composition engraved on the tusk from the Tom River illustrates a similar moment in the life of these wild animals. The poses of the first two camels are typical for the beginning of the fight, when males demonstrate their power to make the opponent retreat. The outstretched neck of camel 3 indicates that the animal is about to attack (compare with Fig. 8, *b*). Camel 4 stands out among the rest of the animals for its smaller humps. This may have been because camel 4 uses the contour of camel 2, due to the lack of space on the surface of the tusk. Another reason for this might be the intention to portray a younger camel. Importantly, the camel with a larger neck and humps is placed on

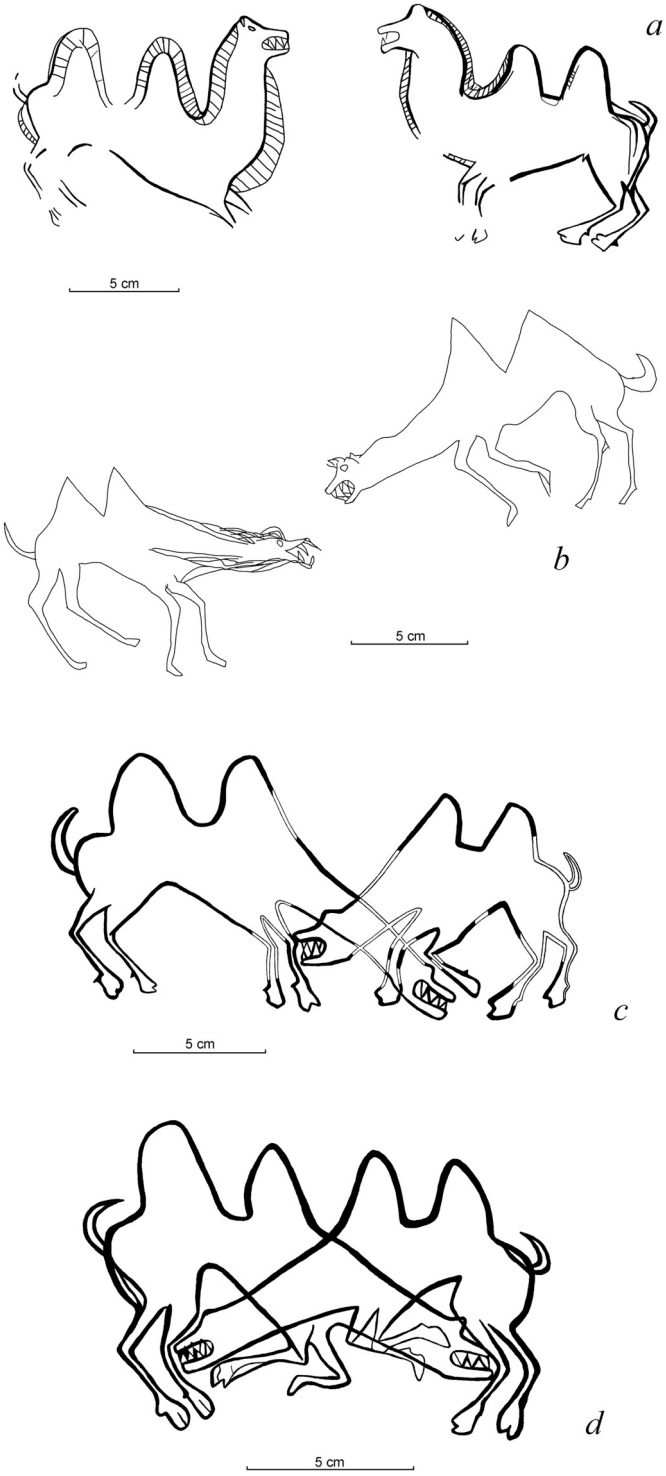

Fig. 8. Compositional variants of contrapositioned camels of the ancient Turkic period from the Sulek rock art site in the Minusinsk Basin, which depict different stages of camel fights. Drawing by Yu. Esin.

the right in each pair. It may indicate the opposition of right and left, as related to certain qualities. It should be noted that opposite orientation of the same animals also occurs in the Paleolithic art in Europe (Clottes and Lewis-Williams, 1997: Abb. 102, 107; Roussot, 2003: 7).

Arrows and wounds on the animal bodies indicate that the camels engraved on the tusks were wild and could be hunted. Stone Age images are often interpreted within the context of “hunting magic” – asking for assistance during hunting – and are well documented in cave art studies (Clottes and Lewis-Williams, 1997: 66–72; Okladnikov, 1967: 65, 66).

In this context, the proposed anthropomorphic figure may also be associated with hunting camels. It could be a camouflaged hunter approaching the animal, or any other character that could somehow assist the hunting process. However, the human figure is formed by the outlines of the animals' legs, which hides it among the camels and makes it less obvious for a viewer. There could also be magic logic underlying this way of portraying a human figure: if the figure of a disguised hunter manages to be very close to the animal it could ensure a successful outcome.

7. Comparative analysis of the style

The most important stylistic feature of the engravings on the tusk from the Tom River is that the contours of the figures are made either by continuous lines combined with a series of short parallel cuts, or by parallel cuts only. In the context of Eurasian art history, such a way of outlining is typical for the Upper Paleolithic period in Europe. It is related to multiple types of animals and human-like representations at different sites and could be applied to different materials by different techniques: cutting (the most typical technique; e.g. the human-like figure from Mas-d'-Azil and a horse at Trois Frères - Clottes and Lewis-Williams, 1997: Abb. 47, 109); engraving/pecking (e.g. the ibex at Foz Côa - Ibid: Abb. 101), or painting (e.g. the bison at Niaux - Ibid: Abb. 60). The most realistic cases clearly show that the short parallel lines along the contour of the figures represent fur. The widespread use of this representation technique could be related to the cutting technique, especially on bone, because the parallel cuts could make a thin contour line more visible. Over time, such a technique could have gained independent decorative significance, as for example on the mammoth tusk found in the Kirillovskaya Upper Paleolithic settlement in Ukraine (Okladnikov, 1971: Fig. 1) or on a fragment of a bone plate from the Chernoozer'e II settlement on the Irtysh River in western Siberia (Fig. 9).

Different types of throwing weapon and the wounds depicted on the animal bodies are also typical for Upper Paleolithic art in Europe, which reflect the worldview shared by the hunters of this period. However, the fletches of the arrows engraved on the tusk with camels are quite peculiar and different from their analogues in European art. The shape of the fletches, the position of the arrows within the animal body, and the short-tilted lines along one side of the front part of the shafts bear the closest resemblance to the drawings of arrows from the Cosquer Cave (Clottes and Lewis-Williams, 1997: Abb. 61). These are generally dated to several millennia prior to the tusk from Siberia. During the Holocene, images of wounds on animals are very rare in Siberia and Central Asia, and arrows are different than the arrows on the Tom River tusk: the fletches are different, the arrows themselves are often pointing downward or sideways, and they are depicted outside the contour of an animal.

Images of two-humped camels from the Paleolithic period have been discovered in two caves in the southern Urals, in Ignatievskaya and Kapova (Fig. 10, *a, c*). In Ignatievskaya, the drawing is in black

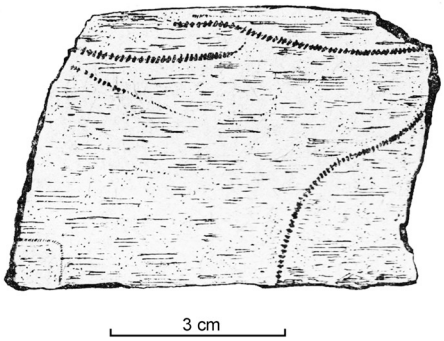

Fig. 9. Contour of a figure created by short parallel lines from a fragment of a bone plate, Chernoozer'ye II (Petrin, 1986: Fig. 53, *5*).

Fig. 10. Images of camels and horses from caves in the southern Urals: *a, b* – Ignatievskaya (Shirokov and Petrin, 2013: Photo 100, 103); *c, d* – Kapova (Devlet et al., 2018a: Fig. 1).

paint and is about 70 cm long (Shirokov and Petrin, 2013: 65). Similar to the camels on the tusk from the Tom River, it shows only contours of two legs (the front leg is also bent a little at the knee, but has not been well preserved), and it has protrusions at the base of the humps. The shape of the belly is also very similar, but the fur hanging down from the belly is depicted by a thicker line in this example. A layer of thick fur is especially emphasized on the neck as well. The head is narrow, and there is also a small tail pointing down. We believe there is a short vertical line on the belly of the camel, which could represent a wound or a throwing weapon. There are also images of horses of the same colour and style portrayed next to the camel (Fig. 10, *b*).

The camel from Kapova cave is 63 cm tall and portrayed in red paint (Devlet et al., 2018b: 142; Zhitenev, 2018: 185). There is a vertical line on the body between the two high humps. It is possible that the line, similar to the image from the Tom River, represents a wound or a weapon. There is also a little protrusion at the base of the back hump and a tail pointing down. The shape of the belly is similar to the image from the Tom River. Unlike the Tom River tusk, the Kapova camel has four legs, its feet are outlined, and it has a long, narrow head. It is also portrayed next to images of horses, and the feet are outlined in the same way as the horses' feet (Fig. 10, *d*).

It is notable that there are common stylistic features which connect images of camels from the Ural caves with the horses painted next to them. Since the horse image is much more widely represented in Paleolithic art, this opens more opportunities for comparative studies. In particular, the rather specific shape of the Ural horses' head finds parallels in the Paleolithic art of western Europe (Shirokov, 2014: Fig. 2), which can serve as an additional indirect argument for the Upper Paleolithic age of the camel images.

The data obtained from organic material samples in Ignatievskaya cave can serve as a chronological marker for the period when it was visited. Cave activity is dated from 14,200 ± 660 BP (ИЭРЖ-54; animal bone) / 16,952–13,539 Cal BC (95.4% confidence level) until 10,400 ± 465 BP (COAH-2468; charcoal) / 11,268–8814 Cal BC (95.4% confidence level) (Shirokov and Petrin, 2013: 80, 86; Shirokov, 2018: Table 2). Uncalibrated radiocarbon dating of the Upper Paleolithic layers in Kapova cave range from 16,010 ± 100 BP (KN-5023) to 13,930 ± 300 BP (ГИН-4853), which, when calibrated, is 19,500–16,000 BP (Zhitenev, 2018: 9). Uranium and thorium isotopes in samples collected next to the image of the camel in Kapova cave date the layers of calcite (including the layers formed on top of the image) from 40,000 to 14,500 BP (Devlet et al., 2018b: 146). It should be noted that application of the U/Th method for cave art dating is controversial (Sauvet et al., 2017), but in this case the U/Th dates do not contradict the ^{14}C dates. Hence, according to the similarity in style and dating, the camel image from Ignatievskaya cave is the closest parallel to the camels on the Tom River tusk.

An image of a two-humped camel from the Khoit Tsenker cave in Mongolia was also classified as Paleolithic art (Okladnikov, 1972). However, the images and their dating have recently been debated (Varenov, 1995; Kubarev, 1999; Molodin and Cheremisin, 1999). Hence, we will not use it for comparative purpose until new data confirms or undermines existing doubts. We can only note that the style of the camel from this cave is significantly different from the style of the camels on the tusk.

We have argued that the camel images from the Tom River tusk are Paleolithic based on their style. For comparison, we also analyzed Holocene-age images of two-humped camels found further south from western Siberia. Some of these images have been discovered in the relatively well-studied Minusinsk Basin, in South Siberia. The earliest is dated to the 1st millennium BC; the majority of the images and stylistic variants, however, were created during the Mediaeval Age (Fig. 11). Based on the contexts of all the camel images we analyzed, these animals were already domesticated. The earliest camel bone from the Holocene in the Minusinsk Basin is also dated to around the beginning of the 1st millennium BC and was probably from a domesticated type

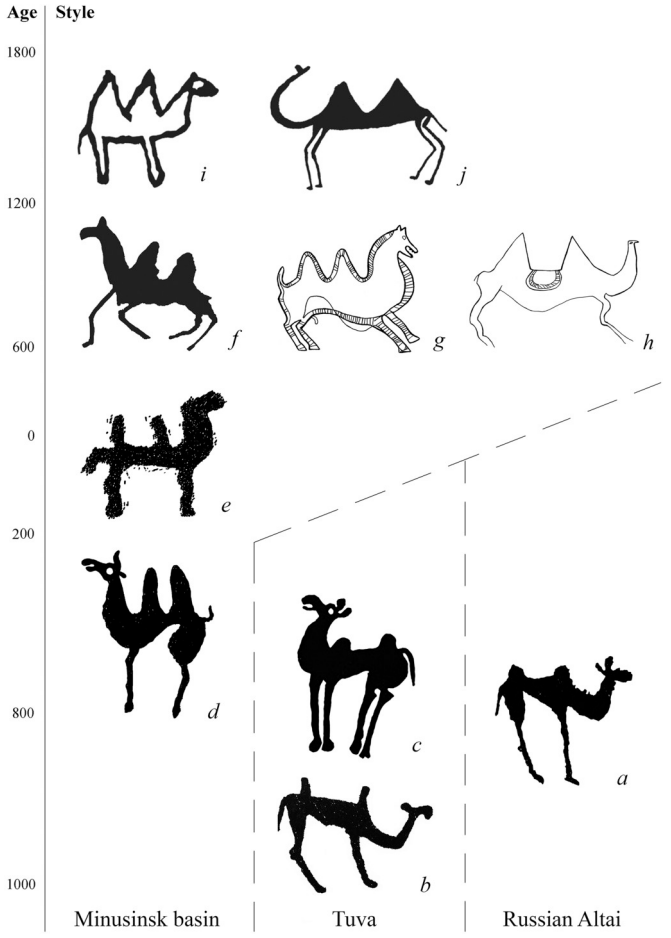

Fig. 11. Dating of some stylistic variants for camel images in South Siberian rock art: *a* – Bertek (Cheremisin and Slyusarenko, 1994: Fig. 52, *3*); *b, c* – Arzhan-2 (Chugunov et al., 2006: Fig. 14; Chugunov, 2008, p. 59); *d, e, j* – Oglakhty (*d* – drawing by Yu. Esin based on the photo by Ya. Sher; *e* – drawing by Yu. Esin; *j* – Kyzlasov and Leont'ev, 1980: Table 30); *f* – Ulazy (Mukhareva, 2007: Fig. 2, 3); g, *h* – Sulek (drawing by Yu. Esin); *i* – Bel'tyry (Kyzlasov and Leont'ev, 1980: Table 46, *4*).

(Kiselev, 1951: 142; Kyzlasov, 1989: 25). Wild camels, likely, did not live in this region during the Holocene. We see similar ages of camel imagery in the northern part of the Altai-Sayan region, although some of the images might be a little older. Camel images stylistically similar to those from the Tom River tusk are not found here.

The two-humped camel motif is much older in the art of Central Asia and in the neighboring territories of Iran. Particularly, an image resembling a camel was discovered on a pottery fragment dated to the 4th millennium BC from Tepe Sialk (Fig. 12, *a*). Camel imagery becomes more common from the 3rd millennium BC. These images do not represent hunted camels, but rather portray domesticated animals (often with reins, ties on their feet, or harnessed to pull carts) (Sarianidi, 1989: 161, Fig. 7; Murgabaev, 2013: Fig. 6, 8, 11, 21, 29; Kircho, 2009: 30). Stylistically, the images of the camels in Central Asia from the 3rd–2nd millennium BC can be divided into two common traditions: 1) realistic, found on the artifacts produced by the ancient agricultural, as well as neighboring pastoralist, cultures (Fig. 12, *b, c*); 2) geometrical, found so far only on the Saymaly-Tash site in Kyrgyzstan (Fig. 12, *d*). The regions where early camel images have been discovered – Bactria, Margiana and adjacent areas – coincide with the zoological data on the location and dating of two-humped camel domestication (Larson and Fuller, 2014; Peters and von den Driesch, 1997: 656–662). In the 2nd and especially in the 1st millennium BC, the distribution of camel images expands greatly, and new types of

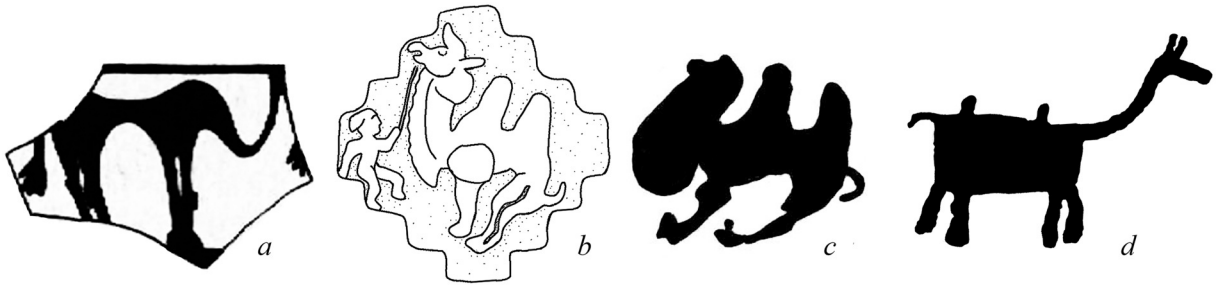

Fig. 12. Some early images of two-humped camels from Western and Central Asia: *a* – Sialk III, painting on a vessel (Ghirshman, 1938: Pl. LXXIX, A2); *b* – Baktria-Margiana archaeological complex, stamp (*b* – drawing by Yu. Esin based on the photo by: Sarianidi, 1976: Fig. 18); *c* – Karatau, petroglyph (Murgabaev, 2013: Fig. 8); *d* – Saimaly-Tash, petroglyph (Sher, 1980: Fig. 107, *12*).

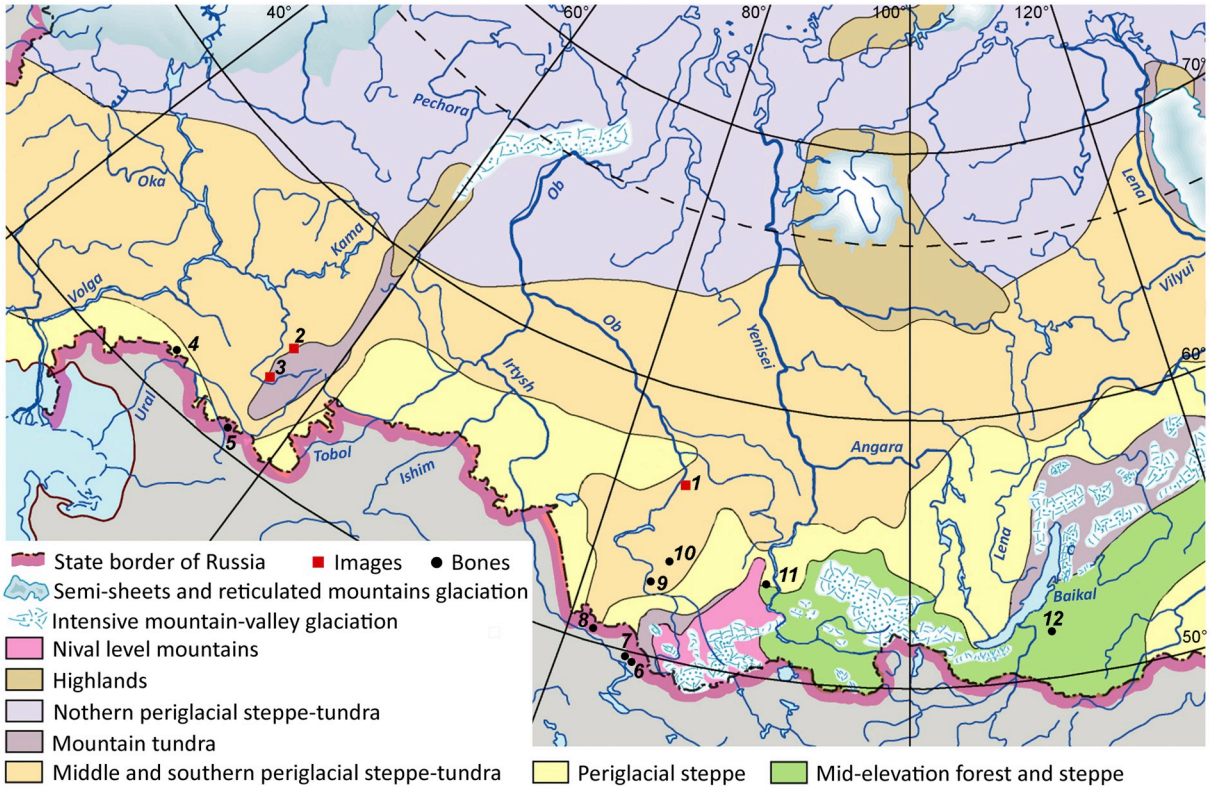

Fig. 13. Map with the locations of camel images (red squares) and two-humped camel bones (black circles) dated to the Late Pleistocene in northern Eurasia with the borders of the ecosystems for the period 23,300–16,000 years ago: *1* – tusk from the Tom River; *2* – Ignatievskaya cave; *3* – Kapova cave; *4* – Rubezhka; *5* – Martuk; *6* – Zyryanovsk; *7* – Ust-Bukhtarma; *8* – Kamyshinka; *9* – Barnaul; *10* – Chumysh; *11* – Uzunzhul; *12* – Kamenka-1 (provided by Yu. Esin based on: Borodko and Sveshnikov, 2004–2008; Titov, 2008; Kozhamkulova, 1981; Malikov, 2015a; Klement'ev, 2011; Vasil'ev, 2016). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

composition emerge (for example images of riding camels) (Korol'kova, 2006: 84–104). This demonstrates the growth of the domesticated camel populations (including southern Siberia), the development of new household applications for these animals, and also the inclusion of camel imagery in different artistic traditions.

As a whole, the Tom River tusk engravings have no stylistic analogues among the known Holocene examples. At the same time, the stylistic features of the engravings on the Tom River tusk have the most commonalities with images from the end of the Late Paleolithic in Europe and western Siberia, which also coincide with the carbon dating of the tusk itself. Stylistic differences among the ancient camel images from all three sites in the Urals and Siberia are quite understandable, since there are chronological and regional differences between them, as well as different methods of depiction.

8. Engravings on the tusk in paleogeographic context

The discovery of two-humped camel engravings on a mammoth tusk in western Siberia, together with the images of these animals among the paintings in the caves of the southern Urals, require an overall analysis in relation to the context of different life activities of prehistoric hunter-gatherers. It is obvious that the appearance of camel images is not accidental – it should be seen as a reflection of the regional specifics of Upper Paleolithic art conditioned by the characteristics of the local fauna.

In order to better understand how the ecological niches of human and two-humped camels were correlated, it is necessary to compare the distribution of camel images and camel bones dated to the Late Pleistocene. There are two species of two-humped camel that can be identified based on bone remains from the Late Pleistocene in northern Eurasia: *Camelus knoblochi* and *Camelus bactrianus*. *C. knoblochi* was the

largest type of camel in Eurasia that lived in the steppes and forest-steppes from eastern Europe to the north-east of China during the Middle and Late Pleistocene (Titov, 2008). This type had the largest distribution and population in the Late Middle Pleistocene. By the beginning of the Late Pleistocene, *C. knoblochi* disappeared from the territories to the west of the Urals, as it was unable to adapt to climate cooling, but it survived in Asia. Thereafter, it was replaced by *C. bactrianus*, which appeared in Central Asia and was more adaptive to an increasingly arid climate. More precisely, according to molecular genetics, it was replaced by two types of *C. bactrianus*, one of which survived until the present day in domesticated form (Burger, 2016). It is argued that *C. bactrianus* differs from its more ancient predecessor because of its relatively smaller size and better-formed, higher humps (Titov, 2003). The Late Pleistocene finds related to *C. knoblochi* were found in the middle course of the Ural River, in the Upper Ob, Upper Irtysh and in Transbaikalia (Fig. 13). Unfortunately, descriptions of Late Pleistocene camel remains are scanty, and it is quite possible that some finds identified earlier as *C. knoblochi* may actually represent *C. bactrianus* (Titov, 2008).

The currently known Late Pleistocene camel bones closest to the Lower Tom were found near Barnaul and on the Chumysh River. They are dated back to around 55,000–30,000 years BP, and according to the size, belong to *C. knoblochi* (Vasil'ev, 2016; Buynovskiy and Khaveson, 1953). A bone from the Uzunzhul stream in the Minusinsk Basin belongs to *C. bactrianus* and are supposedly from the Sartarian period (Malikov, 2015b: Tabl. 1, 238; Shpanskiy, 2019: Fig. 4). Thus, the extent of both camels expanded to the northern foothills of the Altai-Sayan region, however their presence there could be demarcated by the beginning of the last Ice Age. During the Late Pleistocene, two-humped camels were more common in Kazakhstan, including the North Caspian region and Upper Irtysh, where these animals could be hunted and eaten (Kozhamkulova, 1981: 61–63). The Upper Paleolithic date and special stylistic features of the camel engravings on the tusk from the Tom River (two high humps, long and thick fur) demonstrate a close resemblance with modern two-humped camels, which allow us to assume that these figures are of *C. bactrianus*. The same conclusion can be suggested regarding the camel images from the caves in the Urals.

The tusk with engravings represents a form of mobile art, but the "mobility" of such a heavy tusk would have been restricted. However, a person able to portray a camel with so much attention to detail, no doubt, had to be very familiar with the exterior features of the animal. Therefore, when interpreting the camel images from the Tom River and southern Urals, we might consider two possible scenarios: 1) camels were present in the area and local people witnessed them; 2) mobile people saw these animals in a different region.

At the time the Kapova camel image was created, this cave was near the border of the southern periglacial steppe-tundra (Fig. 13). Thoroughly dated Late Pleistocene bones of two-humped camels were discovered 250 km south of the cave at the northern outskirts of the Caspian steppes. However, there were no sharp boundaries between these climate zones – a dry and cold steppe with some patches of forest-steppe could temporarily accommodate species from the northern region (European-Siberian), as well as some species from the southern regions (Central Asian) (Vangengeym, 1977: 136). Climate fluctuation could further facilitate these processes. E.G. Devlet supported the idea of camel areal expansion to the north (Devlet et al., 2018b: 146). According to another hypothesis, the camel images appeared in Kapova cave due to the migration of people from the Caspian region to the Urals (Zhitenev, 2018: 131). Taking into consideration the distance between the cave and Caspian steppes, seasonal moving could also take place.

Based on the current available information, we should not completely rule out a scenario where, in a short space of time, *C. bactrianus* moved from the southern regions or from the interfluve of the Ob River and the Irtysh River closer to the lower reaches of the Tom River. However, there have not been any camel bones found in the Tomsk region so far. In fact, the situation here is the same as in the Urals, where the images of late Pleistocene camels were found several hundred kilometers north of the nearest reliable camel bone finds. The problem of clarifying the northern border of the camel's habitat in both regions certainly deserves further special research by paleontologists. Currently, the alternative hypothesis of mobile people witnessing camels in other regions seems more probable. This corresponds to the theory of southern migratory routes in western Siberia in the Upper Paleolithic, and about the high mobility level of these people (Petrin, 1986: 108, Fig. 1; Zenin, 2002: 40, 42; Leshchinskiy, 1997). V.T. Petrin importantly argued for the connection of the west Siberian site, Chernoozer'e II, which is chronologically similar to the Tom River tusk, to Stone age sites in north and north-east Kazakhstan. Taking this into consideration, we can suggest that hunter-gatherers who portrayed the camels on the tusk arrived from the south or south-west, where they were familiar with this animal and hunted it.

However, if camels did not inhabit the Lower Tom River valley, the "hunting magic" interpretation of the camel engravings is doubtful or incomplete (since it is not clear why these animals needed to be portrayed). Considering the high probability that the image creator moved from the south, we can suggest another more complicated hypothesis to explain the images on the tusk. Perhaps the reason for creating this imagery was the importance of the camel fights and camel hunting in the culture of a particular community. It is likely that hunting was seasonal. Such an event as a camel fight could mark an important moment in the annual cycles of nature and in the life of the community. If the arrival of people was seasonal, they could move north along the rivers, when it was warm, and by the beginning of camel mating season they would return. If this group moved for a long period of time outside the camel area, the images might reflect an established tradition which could be re-enacted on the tusk for ritual purposes in the appropriate season.

9. Conclusion

Overall, the aforementioned stylistic features of the images on the tusk, their composition and current condition, the engraving technique, paleogeographic context and the depth within the terrace of the Tom River where the tusk was discovered correspond to the carbon dating of the tusk. This evidence dates the images to the final stage of the Upper Paleolithic (even if we assume some time gap between the death of the mammoth and engraving of the tusk). Thus, the images on the tusk from the Tom River are, at present, the earliest two-humped camel depictions in Asia, and together with the cave paintings in the southern Ural Mountains, they are considered among the most ancient in the world.

The resemblance of some stylistic features and content seen in the images on the Tom River tusk and in Upper Paleolithic European art is highly significant. Importantly, such a resemblance corresponds to some material culture analyses from Siberian sites. V.N. Shirokov, in his study of the cave sanctuaries in the Urals (Shirokov, 2014: 74–77), hypothesizes connections between some traditions in the Siberian and European Upper Paleolithic. Researchers have also noted some European features of objects and in decorations, made of bone and stone, found at Chernoozer'e II, in western Siberia (Petrin, 1986: 107; Vasil'ev, 1990). This suggests that the reason for the similarities are not only epochal features of human culture, but also that some traditions were inherited through space and time. This requires further study. The Tom River tusk itself demonstrates that engraving different materials was an important part of cultural tradition in the Upper Paleolithic. In this case, stylistic techniques could be consolidated and passed down through generations, as a particular part of labor skills.

Declaration of Competing Interest

None.

Acknowledgements

The authors would like to express their gratitude to Evgeny Barsukov (Tomsk State University), for supporting the research on the mammoth tusk, and to Andrey Kondrashev (State Guard Service for Cultural Heritage Objects in the Khanty-Mansi Autonomous District – Yugra), for his very important assistance in our search for the place of this unique discovery. We wish to thank paleontologist Dmitry Malikov (V.S. Sobolev Institute of Geology and Mineralogy) and three reviewers, who read through the manuscript and gave their comments. We also thank Courtney Nimura (School of Archaeology, University of Oxford) for her important editorial assistance.

References

Borodko, A.V., Sveshnikov, V.V. (Eds.), 2004–2008. Natsional'nyy atlas Rossii: in 4 vol. [National Atlas of Russia: in 4 vol.] Moscow.

Burger, P.A., 2016. The history of Old World camelids in the light of molecular genetics. Trop. Anim. Health Prod. 48 (5), 905–913.

Buynovskiy, N.A., Khaveson, Y., 1953. Pervaya nakhodka cherepa pleystotsenovogo verblyuda v Sibiri [The first find of the skull of the Pleistocene camel in Siberia]. Byulleten' Komissii po izucheniyu chetvertichnogo perioda [Bulletin of the Quaternary Commission] 19, 79–81.

Cheremisin, D.V., Slyusarenko, I.Y., 1994. Nachal'nyy period epokhi rannego zheleza [The initial period of the Early Iron Age]. In: Drevniye kul'tury Bertekskoy doliny (Gornyy Altay, ploskogor'ye Ukok) [Ancient cultures of the Bertek Valley (Russian Altai, Ukok Plateau)]. Novosibirsk, pp. 135–137.

Chugunov, K.V., 2008. Plity s petroglifami v komplekse kurgana Arzhan-2 [Slabs with petroglyphs in the complex of Arzhan-2 barrow]. In: Tropoyu tysyacheletiy [By millenniums path]. Kemerovo, pp. 53–69.

Chugunov, K.V., Nagler, A., Partzinger, G., 2006. Arzhan-2: materialy epokhi bronzy [Arzhan-2: materials from the Bronze Age]. In: In.: Okunevsky sbornik 2: Kul'tura i eye okruzheniye [Okunev digest 2: Culture and its surroundings]. St.-Petersburg, pp. 303–311.

Clottes, J., Lewis-Williams, D., 1997. Schamanen: Trance und Magie in der Höhlenkunst der Steinzeit. Sigmaringen.

Devlet, E.G., Pakhunov, A.S., Agadzhanyan, A.K., 2018a. Popolnenie bestiariya Kapovoy peshchery (ob izobrazhenii verblyuda v zale Khaosa) [Kapova bestiary replenished (on the image of camel in the Chamber of Chaos)]. Rossiyskaya arkheologiya [Russian archaeology] 2, 19–32.

Devlet, E.G., Guillamet, E., Pakhunov, A.S., Grigor'ev, N.N., Gaynullin, D.A., 2018b. Predvaritel'nye dannye ob izobrazhenii verblyuda v zale Khaosa peshchery Shul'gan-tash (Kapovoy) [Preliminary results of studies of the camel figure at the Chamber of Chaos at Shulgan-Tash (Kapova) cave]. Ural'skiy istoricheskiy vestnik [Ural Historical Journal] 1 (58), 141–148.

Ghirshman, R., 1938. Fouilles de Tépé Sialk près de Kashan I. P.

Kircho, L.B., 2009. The earliest wheeled transport in southwestern Central Asia: new finds from Altyn-depe. Archaeol. Ethnol. Anthropol. Eurasia 37 (1), 25–33.

Kiselev, S.V., 1951. Drevnyaya istoriya Yuzhnoy Sibiri [The ancient history of South Siberia]. Moscow.

Klement'ev, A.M., 2011. Landshafty basseyna reki Udy (Zabaykal'e) v pozdnem neopleystotsene (po faune krupnykh mlekopitayushchikh): Avtoref. dis. ... kand. geogr. nauk [Landscapes of the Uda River Basin (Transbaikalia) in the Late Neopleistocene (on the fauna of large mammals): Abstract of a thesis ... Cand. of geogr. sciences]. Irkutsk.

Kondrashev, A.N., 1996. Kosti mamonta na Parusinke [Mammoth bones on Parusinka]. Dialog. Gorodskoy ezhenedel'nik [Dialogue. Town weekly newspaper] 47 (320), 14 21.11.

Korol'kova, E.F., 2006. Zverinyy stil' Evrazii. Iskusstvo plemen Nizhnego Povolzh'ya i Yuzhnogo Priural'ya v skifskuyu epokhu (VII–IV vv. do n.e.). Problemy stilya i etnokul'turnoy prinadlezhnosti [The animal style of Eurasia. Art of the Lower Volga and South Urals tribes in Scythian epoch (7–4 centuries BC). Problems of style and ethnocultural affiliation]. St.-Petersburg.

Kozhamkulova, B.S., 1981. Pozdnekaynozoyskie kopytnye Kazakhstana [Late Cenozoic Ungulate Animals of Kazakhstan]. Alma-Ata.

Kubarev, V.D., 1999. O nekotorykh problemakh izucheniya naskal'nogo iskusstva Altaya [On some problems of Altai rock art studies]. Drevnosti Altaya [Antiquities of Altai] 4, 186–201.

Kyzlasov, L.R., 1989. Drevnyaya i srednevekovaya istoriya Yuzhnoy Sibiri (v kratkom izlozhenii) [Ancient and medieval history of Southern Siberia (in brief)]. Abakan.

Kyzlasov, L.R., Leont'ev, N.V., 1980. Narodnye Risunki Khakasov [The Khakass Folk Drawings] Moscow.

Larson, G., Fuller, D.Q., 2014. The evolution of animal domestication. Annu. Rev. Ecol. Evol. Syst. 45, 115–136.

Leshchinskiy, S.V., 1997. Zavisimost' rasseleniya paleoliticheskogo cheloveka ot migratsiy krupnykh travoyadnykh mlekopitayushchikh yugo-vostoka Zapadno-Sibirskoy ravniny [The influence of Pleistocene large mammals migrations to distribution of an Paleolithic man within Southeast region of Western Siberia Plain]. In: In.: Evolyutsiya zhizni na zemle. Materialy I mezhdunarodnogo simpoziuma [Evolution of life on the Earth. Materials of the I-st International Symposium]. Tomsk, pp. 120–121.

Makarov, S.S., 2009. Dinamika kul'turnogo razvitiya i osvoenie Zapadno-Sibirskoy ravniny v pozdnem pleystotsene [The cultural dynamic and the colonization of Western Siberia plain in Late Pleistocene]. Vestnik Novosibirskogo gosudarstvennogo universiteta. Seriya: Istoriya, filologiya [Novosibirsk State University Bulletin. Series: History and Philology] 8 (3), 63–75.

Malikov, D.G., 2015a. Krupnye mlekopitayushchie srednego-pozdnego neopleystotsena Minusinskoy kotloviny, stratigraficheskoe znachenie i paleozoogeografiya: Avtoref. dis. ... kand. geol.-mineral. nauk [Large mammals of the Middle-Late Neopleistocene of the Minusinsk Basin, stratigraphic value and paleozoogeography: Abstract of a thesis ... Cand. of geol.-mineral. sciences]. Tomsk.

Malikov, D.G., 2015b. Zoogeograficheskaya kharakteristika mamontovoy fauny yuga Sibiri [Zoogeographical features of mammoth fauna of the South of Siberia]. Vestnik Tomskogo gosudarstvennogo universiteta [Tomsk State University Journal] 398, 233–242.

Molodin, V.I., Cheremisin, D.V., 1999. Drevneyshie naskal'nye izobrazheniya ploskogor'ya Ukok [The most ancient rock-depictions of the Ukok plateau]. Novosibirsk.

Monna, F., Esin, Y., Magail, J., Granjond, L., Navarro, N., Wilczek, J., Saligny, L., Couette, S., Dumontet, A., Chateau, C., 2018. Documenting carved stones by 3D modelling – example of Mongolian deer stones. J. Cult. Herit. 34, 116–128.

Mukhareva, A.N., 2007. Camel scenes in the rock art of the Minusinsk Basin. Archaeol. Ethnol. Anthropol. Eurasia 4 (32), 102–109.

Murgabaev, S.S., 2013. Problemy khronologii i kul'turnykh svyazey rannikh petroglifov Karatau [Problems of chronology and cultural relations of the Karatau early petroglyphs]. Nauchnoe obozrenie Sayano-Altaya [Sayan-Altai Scientific Review] 1 (5), 52–65.

Okladnikov, A.P., 1967. Utro iskusstva [The morning of art]. Leningrad.

Okladnikov, A.P., 1971. Iskusstvo epokhi paleolita [Paleolithic art]. In: In.: Istoriya iskusstva narodov SSSR [History of the Art of the Peoples of the USSR] 1. Moscow, pp. 10–22.

Okladnikov, A.P., 1972. Tsentral'no-aziatskiy ochag pervobytnogo iskusstva (peshchernye rospisi Khoyt-Tsenker-Aguy) (Sengri-Aguy, Zapadnaya Mongoliya) [Central Asian center of prehistoric art (cave paintings of Hoyt-Tsenker-Agui) (Sengri-Agui, Western Mongolia)]. Novosibirsk.

Ozheredov, Y., 1997. K voprosu o pozdnepleystotsenovoy faune po materialam arkheologii [To the question of the Late Pleistocene fauna on data of archeology]. In: In.: Evolyutsiya zhizni na zemle. Materialy I mezhdunarodnogo simpoziuma [Evolution of life on the Earth. Materials of the I-st International Symposium]. Tomsk, pp. 126–127.

Ozheredov, Y., 2016. Gravirovannyy biven' mamonta iz «Parusinki» [Engraved mammoth tusk discovered in "Parusinka"]. In: In.: Arkheologicheskoe nasledie Sibiri i Tsentral'noy Azii (problemy interpretatsii i sokhraneniya): materialy mezhdunarodnoy konferentsii [Archaeological Heritage of Siberia and Central Asia (problems of interpretation and preservation): Proceedings of the International Conference]. Kemerovo, pp. 182–192.

Peters, J., von den Driesch, A., 1997. The two-humped camel (Camelus bactrianus): new light on its distribution, management and medical treatment in the past. J. Zool. 242, 651–679.

Petrin, V.T., 1986. Paleoliticheskie pamyatniki Zapadno-Sibirskoy ravniny [Paleolithic sites of the West Siberia Plain]. Novosibirsk.

Pitulko, V.V., Pavlova, E.Y., Nikolskiy, P.A., Ivanova, V.V., 2012. The oldest art of the Eurasian Arctic: personal ornaments and symbolic objects from Yana RHS, Arctic Siberia. Antiquity 86, 642–659.

Roussot, A., 2003. Glossariy pervobytnogo iskusstva [Petit Glossaire de l'art prehistorique au Paleolithique]. Kemerovo.

Sarianidi, V.I., 1976. Pechati-amulety murgabskogo stilya [Stamps-amulets of the Murghab style]. Sovetskaya arkheologiya [Soviet archaeology] 1, 42–68.

Sarianidi, V.I., 1989. Protozoroastriyskiy khram v Margiane i problema vozniknoveniya zoroastrizma [Proto-Zoroastrian temple in Margiana and the problem of the origin of Zoroastrianism]. Vestnik drevney istorii [Journal of Ancient History] 1, 152–169.

Sauvet, G., Bourrillon, R., Conkey, M., Fritz, C., Gárate-Maidagan, D., Rivero Vilá, O., Tosello, G., White, R., 2017. Uranium–thorium dating method and Palaeolithic rock art. Quat. Int. 432, 86–92.

Sher, Y., 1980. Petroglify Sredney i Tsentral'noy Azii [Petroglyphs of Central and Inner Asia]. Moscow.

Shirokov, V.N., 2014. Peshchernoe paleoliticheskoe iskusstvo Urala i Franko-Kantabrii: opyt sopostavleniya [Uralic and Franco-Cantabrian Paleolithic cave art: an attempt of comparison]. In: In.: Ot Baltiki do Urala: izyskaniya po arkheologii kamennogo veka [From the Baltic to Urals: Essays on the Stone Age archaeology]. Syktyvkar, pp. 69–88.

Shirokov, V.N., 2018. Arte Paleolítico de los Urales. NAILOS 5, 133–148.

Shirokov, V.N., Petrin, V.T., 2013. Iskusstvo lednikovogo veka. Ignatievskaya i Serpievskaya 2 peshchery na Yuzhnom Urale [Ice Age Art. The Ignatievskaya and Serpievskaya 2 caves in the South Urals]. Ekaterinburg.

Shpanskiy, A.V., 2019. Chetvertichnye krupnye mlekopitayushchie Zapadno-Sibirskoy ravniny: usloviya obitaniya i stratigraficheskoe znachenie: Avtoref. dis. … dokt. geol.-mineral. nauk [Quaternary large mammals of the West Siberia Plain: habitat conditions and stratigraphic significance: Abstract of a thesis ... Dr. of geol.-mineral. sciences]. Tomsk.

Titov, V.V., 2003. Nakhodka cherepa drevnego verblyuda vozle stanitsy Razdorskoy [The find of the skull of an ancient camel near the village of Razdorskaya]. In: In.: Istoriko-kul'turnye i prirodnye issledovaniya na territorii Razdorskogo etnograficheskogo muzeya-zapovednika [History-cultural and natural studies on the territory of the Razdorsky ethnographic museum-reserve] 1. Rostov-na-Donu, pp. 45–48.

Titov, V.V., 2008. Habitat conditions for Camelus knoblochi and factors in its extinction. Quat. Int. 179 (Issue 1), 120–125 (March).

Tseytlin, S.M., 1979. Geologiya paleolita Severnoy Azii [The geology of Paleolithic of

North Asia]. Moscow.
Vangengeym, E.A., 1977. Paleontologicheskoe obosnovanie stratigrafii antropogena Severnoy Azii (po mlekopitayushchim) [Paleontological substantiation of the stratigraphy of the anthropogen of Northern Asia (by mammals)]. Moscow.
Varenov, A.V., 1995. K utochneniyu datirovki peshchernogo iskusstva iz Khoyt-Tsenker Aguy, Mongoliya [On specification of the date of cave art from Hoyt-Tsenker Agui, Mongolia]. In.: Naskal'noe iskusstvo Azii [Rock art of Asia] 1. Kemerovo. pp. 17–18.
Vasil'ev, S.A., 1990. Pozdniy paleolit Urala i Zaural'ya: k voprosu o granitsakh Evropeyskoy i Severoaziatskoy zon razvitiya kul'tury [Late Palaeolithic of the Urals and Trans-Urals: on the issue of the borders of the European and North-Asian zones of cultural development]. In: In.: Metodologiya, istoriografiya i istochniki izucheniya istoricheskogo opyta regional'nogo razvitiya: Tezisy dokladov i soobshcheniy Vsesoyuznoy nauchnoy konferentsii [Methodology, historiography and sources for the study of the historical experience of regional development: Abstracts of reports of the scientific conference]. Sverdlovsk, pp. 83–84.
Vasil'ev, E.A., 2004. Kul'tura drevneyshikh obitateley nizoviy Tomi [Culture of the ancient inhabitants of the Lower Tom]. In: In.: Po reke vremeni. Putevoditel' k ekspozitsii [By the river of time. Exhibition guidebook]. Seversk, pp. 5–18.
Vasil'ev, S.K., 2016. Novye nakhodki verblyuda Knoblokha (Camelus knoblochi Nehring, 1901) na predaltayskoy ravnine [New finds of the camel Knobloch (Camelus knoblochi Nehring, 1901) on the Pre-Altai Plain]. In: In.: Teriofauna Rossii i sopredel'nykh territoriy. Materialy mezhdunarodnogo soveshchaniya [Theriofauna of Russia and adjacent territories. Materials of the International Conference]. Moscow, pp. 69.
Vasil'ev, S.A., Abramova, Z.A., Grigor'eva, G.V., Lisitsyn, S.N., Sinitsyna, G.V., 2005. Pozdniy paleolit Severnoy Evrazii: paleoekologiya i struktura poseleniy [Late Paleolithic of Northern Eurasia: paleoecology and settlement structure]. St.-Petersburg.
Vesnina, T., 1995. Na meste Severska uzhe v kamennom veke zhili intellektualy [intellectuals lived in the place of Seversk already in the stone age]. Tomskiy vestnik [Tomsk Bulletin] 96 (30.05), 4.
Zenin, V.N., 2002. Major stages in the human occupation of the west Siberian plain during the Paleolithic. Archaeol. Ethnol. Anthropol. Eurasia 4 (12), 22–44.
Zhitenev, V.S., 2018. Kapova peshchera – paleoliticheskoe podzemnoe svyatilishche [Kapova cave – paleolithic underground sanctuary]. Moscow.