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New Stratigraphic Data on the Quaternary Sediments in the Peschanaya River Valley, Northwestern Altai

This paper presents new data on the structure and the lithological, pedological, paleontological, and paleomagnetic features of the Middle and Upper Quaternary sediments in the Peschanaya River valley, the foothills of northwestern Altai. Those horizons contain a loess-soil sequence and sediments relating to two Middle Pleistocene interglacials. On the basis of palynological characteristics of one of the Middle Pleistocene interglacials, the succession of floras during the respective stages is reconstructed. The Middle Pleistocene interglacial floras of Western Siberia are compared with that reconstructed on the basis of the Karama site, evidencing marked differences. The flora around Karama included broad-leaved taxa, which were absent during the Middle Pleistocene interglacials of Western Siberia, when apart from modern arboreal taxa, only cold-resistant broad-leaved ones were present (Tilia, Corylus, Ulmus, and Juglans). The Karama flora resembles the last Western Siberian thermophilic flora—Barnaul, which existed during the long climatic warming of the Early Pleistocene, corresponding to the Tiglian in northwestern Europe (2.23–1.59 Ma BP). Since the beginning of the Middle Pleistocene, interglacial floras of Western Siberia have resembled modern ones. In terms of phytocenotic and palaeoclimatic features, Middle Pleistocene interglacial environments of Western Siberia display a sharp contrast with those of Barnaul and Karama.

Keywords: *Stratigraphy, Quaternary, Paleolithic, Altai Mountains, Karama.*

Introduction

Determination of the geological age of Paleolithic sites beyond the possibilities of the radiocarbon method is a quite difficult task, which requires developing the fullest stratigraphic sequence of the Quaternary sediments located both in the area of archaeological studies and in the whole region. In the last decade, the discovery of Siberian Paleolithic sites, more ancient than those of the Late Pleistocene (Derevianko, 2005, 2009; Derevianko, Shunkov, 2009), has generated the need for development of detailed stratigraphy of the Middle and Early Pleistocene in this area. In this regard, special attention was paid to stratigraphic studies aimed at determining the stratigraphic position of Karama, the most ancient Early Paleolithic site in Northern Asia, whose geological age has been debated up to now (Bolikhovskaya, Shunkov, 2005, 2014; Zykin, 2012; Zykin et al., 2005; Zykin, Zykina, Smolyaninova, 2016). The recently obtained stratigraphic data (Baryshnikov, Maloletko, 1997, 1998; Bolikhovskaya, Shunkov, 2005, 2014; Derevianko, Laukhin, Kulikov et al., 1992; Derevianko, Laukhin, Malaeva et al., 1992; Derevianko, Laukhin, Shunkov, 1993; Derevianko, Ulyanov, Shunkov, 1999; Derevianko, Shunkov, Agadjanyan et al., 2003; Derevianko, Shunkov, Zykin et al., 2003; Zykin, 2012; Zykin et al., 2005; Zykin, Zykina, Smolyaninova, 2016; Zykina, Zykin, 2012; Popova et al., 1995) have allowed the considerable refinement of the structure, conditions of occurrence, and paleontological characteristics of the Quaternary sediments of the Altai Mountains. However, many regularities in their structure and formation, climate-stratigraphic breakdown, stratigraphic sequence of specific geological bodies, paleontological features of glacial and interglacial horizons, required for the development of Paleolithic periodization, remain insufficiently studied up to now. Creation of a reliable stratigraphic basis for periodization of the Paleolithic, and for dating the migration stages of ancient humans, implies that not only sections comprising culture-bearing layers are to be studied, but also geological features, in order to determine the complete sequence of Quaternary sedimentation, the characteristics of specific paleogeographic intervals, and the history of biota development.

In 2010, a team composed of V.S. Zykin, V.S. Zykina, and L.G. Smolyaninova conducted complex studies of a section of Quaternary sediments 60 km north of the Karama site. This section is located 6 km north of the place where a hillside surface of the piedmont plain leans against a sharp scarp (escarpment) of the Altai middle-mountains. It is a coastal cliff of the left valley-side slope of the Peschanaya River and the southeastern slope of the Anuy Ridge, 1.5 km below the village of Solonovka. The section was first mentioned in the paper by O.M. Adamenko (1974); however, its description was not provided. We have provided a detailed description, stratigraphic breakdown, and paleomagnetic study of the section. Bone remains of an ancient horse have been found by V.S. Zykin in the subaqueous lower portion of the section; they were studied by I.V. Foronova. Spore and pollen analysis of samples recovered from the lower portion of the section was conducted by N.A. Rudaya. Remains of small mammals have been collected and classified by D.G. Malikov. When indexing the genetic horizons of fossil soils, we follow the traditional system accepted in Russia at the present time (Klassifikatsiya… pochv SSSR, 1977; Klassifikatsiya… pochv Rossii, 2004). In addition, in this article, we adhere to the International (Chrono) Stratigraphic Scale (ISS) of the Quaternary System with the lower boundary at the level of 2.588 Ma BP, and subdivision of the Pleistocene to Lower, Middle, and Upper (Head et al., 2008). The boundary between the Lower and the Middle Pleistocene is drawn at a level of 0.78 Ma BP.

Subsurface geology of the Peschanaya River valley

In the Peschanaya River coastal cliff of 26 m height, 1.5 km below the village of Solonovka, the following strata, separated into subaerial and, predominantly, subaqueous series, are opened under the modern black soil from top to bottom (Fig. 1).

The subaerial series is represented by the following:

1. The Bagan loess (**bg**) is a loess-like loam: grayish-yellow, sandy, loosely compacted, porous, with numerous hollow root-holes and carbonates in the form of pseudomycelium and white soft spots. The transition to the underlying stratum is distinguishable by color and neoformations. The thickness is 1.5–2.8 m.

2. The Eltsovka loess (**el**) is a loess-like loam: grayish-brown, sandy, loosely compacted, porous, with carbonate pseudomycelium. In the medium portion of the stratum, accumulations of manganous specks, ferrugination spots and strips are observed. At a depth of 2.8–3.5 m, loose rounded gypseous concretions from 1.5 to 2.0 cm in size are encountered, while at a level of 4.3–4.8 m from the stratum's superface, vertical strips of gypseous concretions up to 1 cm in size are present. The transition to the underlying stratum is distinguishable by color. The thickness is 2.8–5.7 m.

3. The Iskitim pedocomplex (**is_1-is_2**), 1.85 cm thick, is represented by two fossil soils subdivided by a layer of loess-like loam 0.15 m thick. The upper soil profile consists of horizons Aca and BCca, cs. The humus (Aca) horizon, 0.45 m thick, is a sandy loam: gray with a slight brownish tone, porous, with root-holes, carbonate pseudomycelium, manganous specks, and small lenses of clay sand. The upper boundary is rough and clearly distinguishable in color, the lower boundary is undulating and distinguishable by color. The transition to the underlying stratum is gradual.

Loess-like loam lying between soils is grayish-brown, sandy, compacted, with carbonate pseudomycelium and small spots, porous, with root-holes. The transition, distinguishable by color, is a BCca, cs horizon of upper soil.

The lower soil profile includes the Aca, cs and Bca horizons. The humus (Aca, cs) horizon 0.55 m thick is a sandy loam: brownish-gray, compacted, porous, with carbonate pseudomycelium and root-holes filled

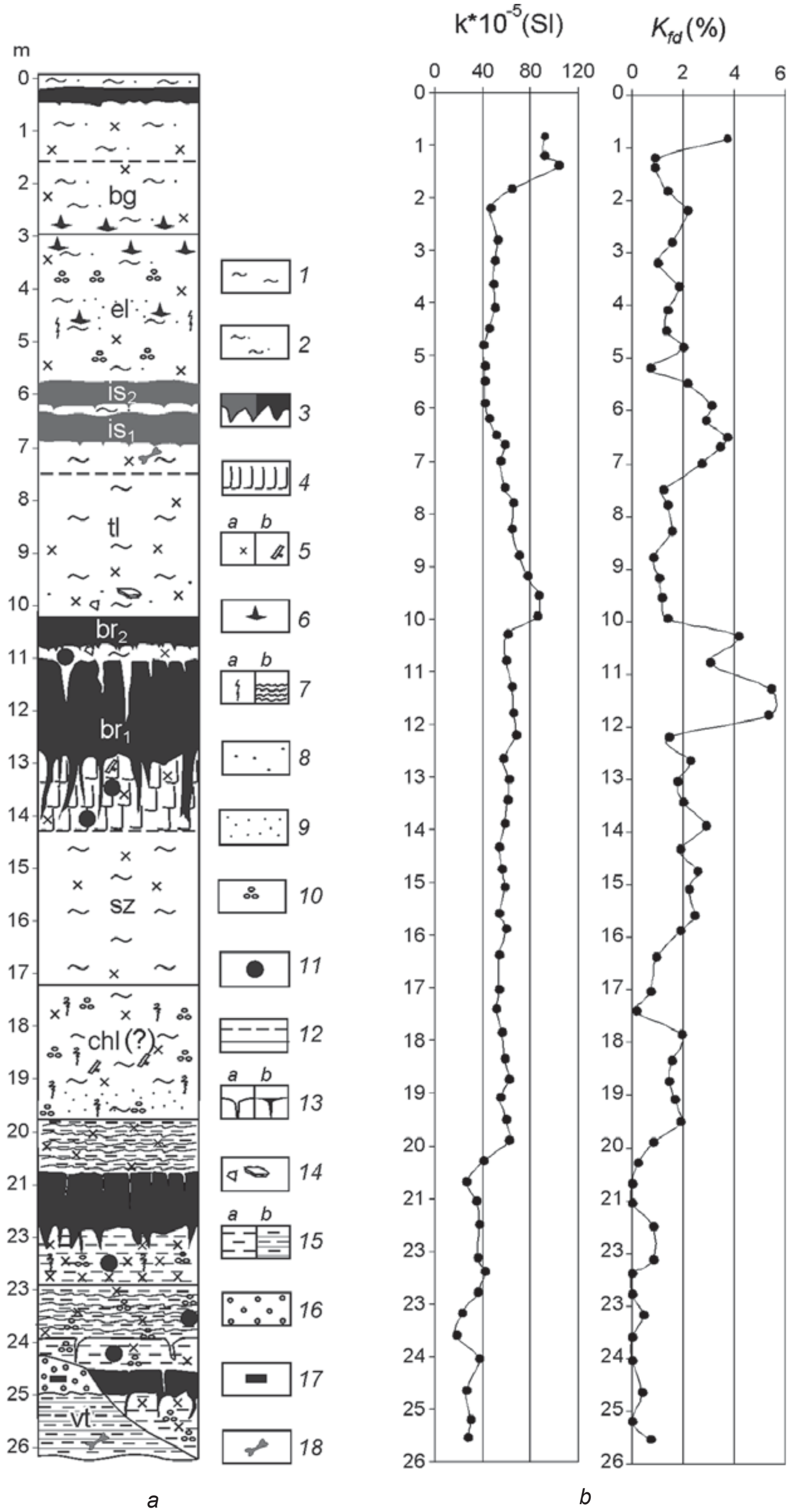

Fig. 1. Geological section (*a*) in the cliff of the left valley-side slope of the Peschanaya River near the Solonovka village, and its paleomagnetic characteristics (*b*).

1 – loam; *2* – sandy loam; *3* – humus horizon; *4* – illuvial horizon; *5*: *a* – carbonates, *b* – carbonate concretions; *6* – gypsum; *7* – Fe neoformations; *8* – Fe-Mn concretions; *9* – Mn specks; *10* – gleization; *11* – holes of burrowing animals; *12* – boundaries of horizons; *13*: *a* – shrinkage cracks; *b* – humus tongues; *14* – chippings and plates of slates; *15*: *a* – aleurite, *b* – horizontally laminated aleurite; *16* – gravel; *17* – remains of small mammals; *18* – remains of large mammals.

with humus loam; clay sand is present; small gypseous concretions of 0.5–1.0 cm are commonly found. The upper boundary is undulating and distinct, the lower boundary is gradual, discernible by color and abundance of black humus specks. The Bca horizon 0.7 m thick is a sandy loam: brownish-gray with a whitish tone, compacted, porous, with carbonate pseudomycelium and spots, with thin hollow root-holes, whose walls are commonly encrusted with humus. The transition to the underlying stratum is gradual.

4. The Tulinskoye loess (**tl**) is a loess-like loam: light brown, poorly porous, with carbonate pseudomycelium and a large number of root-holes filled with humus, which yields black specks and strips. In the lower part, loose small ferruginous pellets and chippings are encountered. The lower boundary is sharp and uneven. The thickness is non-uniform, from 2.9 to 7.3 m.

5. The Berdsk pedocomplex (**br_1-br_2**) is represented by two fossil soils subdivided by a layer of loess-like loam 0.3 m thick, which is the BCca horizon of the upper soil.

The upper soil is formed by the Aca and BCca horizons. The humus (Aca) horizon 0.4 m thick is composed of a dark gray, compact, poorly porous sandy loam with carbonate pseudomycelium and thin hollow root-holes outlined with humus. The upper boundary of the horizon is sharp and uneven, in the form of protruding elongated ovals, the lower boundary has humus tongues up to 10 cm deep and 2–5 cm wide. The BCca horizon 0.3 m thick is a grayish-yellow, compact, poorly porous loess-like loam with carbonate pseudomycelium and root-holes. Small plates of Paleozoic slates are encountered, and holes of burrowing animals are present. The transition to the underlying stratum is distinct.

Humus (Aca) and illuvial (Bca) horizons are clearly isolated in the lower-soil profile. The humus (Aca) horizon, 1.8 m thick, is represented by sandy loam: dark gray with a brownish tone, heavy, compact, poorly porous, with carbonate pseudomycelium and root-holes filled with humus; rare manganous specks and small pellets are observed. The upper boundary of the horizon is uneven: rounded projections alternate with cracks 10–15 cm wide and 0.4–1.6 m deep. The lower portion of horizon is in the form of humus tongues up to 1 m deep. The transition to the illuvial horizon is distinct in color. The illuvial (Bca) horizon 1.5 m thickness is composed of a loess-like loam: grayish-brown, heavy, compact, poorly porous, with carbonate pseudomycelium and carbonate concretions in the upper portion of the horizon. It contains many holes (10–15 cm in diameter) of burrowing animals. The transition to the underlying stratum is gradual.

6. The Suzun loess (**sz**) is formed by a loess-like loam: light grayish-brown, heavy, compact, poorly porous, with carbonate pseudomycelium and hollow root-holes, whose walls are encrusted with carbonates. The lower boundary is distinct. The thickness is 3.0 m.

7. The Chulym loess (**chl** (?)) is a loess-like loam: light brown, heavy, compact, poorly porous, with carbonate pseudomycelium and single carbonate concretions of size up to 3 cm in the middle portion of the horizon; small spots of gley are encountered in the upper portion, and spots of size up to 7 cm are present in the lower portion. The number of ferruginous neoformations in the form of Liesegang rings, spots 0.7–5.0 cm in diameter, strips, and dots increases throughout the horizon towards the base. Manganous specks are present in the lower portion of the horizon. The lower boundary is distinct and uneven. The thickness is 2.6 m.

The subaqueous sequence is predominantly composed of:

8. Aleurite: bluish-gray, compact, heavily clayed, poorly porous, carbonate, with multiple root-holes, the maximum number of which falls on the lower portion of the horizon. Iron neoformations, in the form of horizontal-undulating strips and specks, are observed throughout the entire horizon. The upper boundary of the horizon is distinct and uneven, with small shrinkage wedges. The transition to the underlying stratum is distinct in color. The thickness is 0.95 m.

9. Fossil soil with the AUg, f and Gca, f profile. The humus (AUg, f) horizon 1.1 m thick is represented by sandy loam: heavy, predominantly dark gray, with areas of brownish-ochreous and dark gray color with a bluish tone, compact, poorly carbonate, with common ferrugination and gleization, and with a large number of ferruginized root-holes. The upper boundary of the horizon is uneven, blurry, with thin vertical cracks, the lower boundary is in the form of humus tongues up to 0.6 m deep. The transition is distinguishable by color and abundance of carbonate neoformations. The gley (Gca, f) horizon 1.1 m thick is composed of gleic loam: heavy, greenish-gray with ochreous tone, compact, poorly porous, with rare root-holes and carbonates in the form of spots and dots concentrated within a circle, and pseudomycelium; ferrugination is represented by spots, vertical strips, and dots. Holes of burrowing animals filled with a dark gray sandy loam are encountered. The transition to the underlying layer is distinguishable by color. The soil profile thickness is 2.2 m.

10. Aleurite: bluish-gray, compact, heavily clayed, carbonate, poorly porous, with carbonate pseudomycelium and rare root-holes; common ferrugination in the form of horizontal-undulating strips. At the base, there are holes (5 cm in diameter) of burrowing animals. The lower boundary of horizon is in the form of narrow wedges penetrating the underlying layer to a depth of 14 cm. The transition to the underlying stratum is distinct. The thickness is 1 m.

11. Aleurite: greenish-gray, compact, clayey, poorly porous, with carbonate spots and pseudomycelium,

carbonate tubes along the pores and root-holes. The lower boundary is distinct. The thickness is 0.6 m.

12. Fossil soil with a profile, in which AUg and Gca horizons are distinguishable. The humus (AUg) horizon, 0.4 m thick, is composed of a heavy black sandy loam of crumb structure, compact, with a small number of root-holes, poorly carbonate, fractured by narrow vertical cracks 0.2–0.3 cm wide and up to 10 cm deep, which are filled with sandy loam from the overlying horizon. The base of horizon is uneven, and has the form of small tongues up to 2 cm wide and 10 cm deep. The transition is distinct in color and in boundary of accumulation of carbonate neoformations. The gleization horizon (Gca) 1.2 m thick consists of heavy sandy loam: bluish-gray with a whitish tone, compact, carbonate, poorly porous, with dark interlayers and spots. In the lower portion, there are holes (10 cm in diameter) of burrowing animals. Below is the water edge. Soil is only encountered in the lowering developed in stratum 14 during formation of stratum 13, in the range of 130–160 m downstream of the mouth of a large ravine.

13. Irregularly-grained poorly graded gravel with a large amount of differently rounded (including well-rounded) fine pebbles of Paleozoic rocks. There are many poorly rounded marl concretions up to 5 cm in diameter. The bedding is lenticular, sometimes diagonal. Scattered remains of small mammals and vegetative detritus are rare. The lower boundary is sharp and uneven, up to 0.5 m thick. It forms the lens of channel alluvium of a small river in an area 57–130 m long downstream of the mouth of a large ravine.

14. Gray aleurite, very compact, very clayey, with non-uniform, predominantly fine horizontal minute bedding. In the upper portion, there are many holes of burrowing animals, filled with the stratum material. At a height of 0.5 m above the water edge, 90 m downstream of the mouth of a large ravine, in the middle portion of the stratum, a small accumulation of mammal-bones has been discovered (two articulated upper molars and a metatarsal bone) belonging to *Equus nalaikhaensis* Kuznetsova et Zhegallo. The stratum extends beneath the water edge. The apparent thickness is 1.2 m.

The three series that constitute the section are separated by a considerable interruption in sedimentation. On the basis of soil morphotypical features, structure of pedocomplexes, and lithological properties of loess horizons, the subaerial sediments (strata 1–7) 19.8 m thick, composed of loess-like loams and pedocomplexes, may be compared with the loess-soil sequence of Siberia relating to the Upper and, partially, Middle Neopleistocene (Zykina, Zykin, 2012; Zykina, Zykin, 2008). In this section, we can clearly identify five loess horizons: Bagan (MIS 2), Eltsovka (MIS 2), Tulinskoye (MIS 4), Suzun (MIS 6) and, possibly, Chulym (MIS 8); and two pedocomplexes: Iskitim (MIS 3) and Berdsk (MIS 5c, e). The Iskitim pedocomplex is represented by two underdeveloped chestnut soils with typical carbonate neoformations and gypsum concretions in the profile. The soils were formed in the dry-steppe conditions during the Karga interstadial. The Karga interstadial, whose age limits, according to TL and radiocarbon dates, are in the range of 24–53 ka BP (Zykina, Volkov, Dergacheva, 1981; Zander et al., 2003; Frechen et al., 2005), may be compared with MIS 3 (Bassinot et al., 1994). The Berdsk pedocomplex consists of two black soils. The upper soil, represented by underdeveloped black soil, differs markedly from the lower soil of pedocomplex in the profile of small thickness, and in the smaller duration of formation time. It was formed in steppe conditions during one of the warm intervals of the Early Zyryanka period, which, according to the TL-data (Zander et al., 2003; Frechen et al., 2005; Zykina, Zykin, 2012), corresponds to the MIS 5c substage (Bassinot et al., 1994). The morphotypical features and micromorphological characteristics of the lower soil make it possible to diagnose it as a well-developed, thick, ordinary chernozem inherent in the lower soil of Berdsk pedocomplex, which formed in the steppe conditions, in a warmer and sufficiently humid climate during the Kazantsevo interglacial period, which was an equivalent of the MIS 5e stage (Bassinot et al., 1994). This soil in the Kurtak section in Western Siberia is dated to the interval of 119–143 ka BP (Zander et al., 2003). Two lower strata of subaerial series, differing considerably in their lithological features and pertaining to the Suzun and Chulym loess horizons of the loess-soil sequence of Siberia, are compared with MIS 6 and 8.

The middle series (strata 8–13), 6.35 m thick, is composed predominantly of aleurites that formed in shallow flood-plain water bodies. Two fossil soils of this portion of the section were formed on clayey aleurites in the central part of flood-plain, upon the drying of temporary water bodies under conditions of periodic water flooding and under the influence of ground waters, which were retained within the soil profile for a long time. These are alluvial meadow soils, which have a humus horizon of considerable thickness, with a distinct granular structure and traces of gleization, iron neoformations, and carbonates in the profile. The said soils are characterized by iron hydrogenous accumulation and gleization processes. Sharp boundaries of strata 8, 10, 11, and humus horizons of fossil soils with shrinkage cracks are indicative of periodic drying of flood-plain water bodies, and inconsiderable interruptions in sedimentation. Channel alluvium, preserved along the entire exposure only in the form of intermittent extended lenses up to 0.5 m thick, lies at the series base.

The lower series, rising to a height of 1.2 m above the water's edge in the river, has an erosion upper boundary and is composed of very compact, horizontally laminated, clayey aleurites. Taking into account the lithological features, their occurrence conditions, and paleontological characteristics, it can be assumed that the lower series was formed in the secondary flood-plain water-body, and pertains to the Vyatkino strata **(vt)** of the lower part of the Middle Pleistocene.

Remains of mammals

Fossil mammals have been recorded in two series of the section. Remains of an ancient horse have been found in the lower series (stratum 14), and the basal layer of middle series (stratum 13) contained remains of small mammals.

The upper molars (M2 and M3) and the metatarsal bone (MT III) from the lower series, according to analysis of morphometric data, belong to rather archaic gracile koulan-like horse of relatively small size. Such a form has been described as *Equus nalaikhaensis* Kuznetsova et Zhegallo (Kuznetsova, Zhegallo, 1996; Kuznetsova, 1996; Eisenmann, Kuznetsova, 2004) by the skull, fragments of jaws, and metapodial bones from the Nalaikha locality (Northern Mongolia). This peculiar horse is characterized by a mosaic combination of features of the Upper Eopleistocene (upper portion of the Lower Pleistocene according to the International Stratigraphic Scale) Asian *Equus sanmeniensis* Teilhard de Chardin et Piveteau and modern koulans, asses, and zebras (Kuznetsova, Zhegallo, 1996; Kuznetsova, 1996; Eisenmann, Kuznetsova, 2004). Obviously, *E. nalaikhaensis* is the most ancient koulan and is phyletically related to *E. sanmeniensis*, while emergence and evolution of the *Hemionus* subgenus took place within Central Asia (Kuznetsova, 1996). Horses of similar morphology were widespread during the said period also in Trans-Baikal region (Kalmykov, 1986) and in the south of Western Siberia (Foronova, 1990, 2001).

A complex of associated fauna (from sands and alluvial sandy clays of strata 6 and 7) from Nalaikha is represented by *Ochotona* sp., *Marmota* sp., *Citellus* sp., *Allactaga* sp., *Prosiphneus* sp., *Mammuthus* sp., *Coelodonta tologojensis* Beljaeva, *Equus nalaikhaensis* Kuznetsova et Zhegallo, *Equus* sp. (large), *Spirocerus kiakhtensis wongi* Teilhard de Chardin et Piveteau, *Gazella* (*Procapra*) cf. *Gutturosa* (Pallas), *Bison* sp., Megacerini gen. indet., *Xenocyon lycaonoides* Kretzoi, *Canis variabilis* Pei, *Ursus* sp., *Pachycrocuta brevirostris* (Aumard), *Panthera* cf. *gombaszoegensis* (Kretzoi) (Zhegallo et al., 1982; Sotnikova, 1988, 2016; Eisenmann, Kuznetsova, 2004; and others). The species composition and evolution level of this fauna suggest that the age of enclosing sediments corresponds to the Late Lower/Early Middle Pleistocene according to the International Stratigraphic Scale, or to the Upper Eopleistocene/Early Neopleistocene according to the General Stratigraphic Scale of Russia in the interval of 0.95–0.55 Ma BP (Zhegallo et al., 1982). The date range of this complex coincides with the period of the Vyatkino faunal complex of Western Siberia (Unifitsirovannaya regionalnaya stratigraficheskaya skhema…, 2000).

The structural features of dentition and limb bones indicate the adaptation of *E. nalaikhaensis* to arid herophytic expanses, i.e. to the conditions of open dry landscapes. The rather hypsodont teeth of this horse were adapted to feeding on grassland (mainly abrasive) vegetation of steppes and forest-steppes, while a relatively light gracile ("running") type of limb was suitable for intense movements across compact soils over large distances.

30 teeth of small mammals have been discovered in the basal layer of the middle series. Among these, representatives of 11 species of 8 geni have been determined: *Ochotona* sp., *Spermophilus* sp., *Myospalax* sp. (non-root-toothed), *Ellobius* ex gr. *talpinus* Pallas, *Clethrionomys rufocanus* Sundevall, *Clethrionomys rutilu* Pallas, *Eolagurus* cf. *luteus* Eversmann, *Lagurus lagurus* Pallas, *Microtus* sp., *Microtus oeconomus* Pallas, and *Microtus gregalis* Pallas. The presence of *L. lagurus* and *M. gregalis* gives evidence that this fauna belongs to the post-Vyatkino (post-Tiraspol) time. In the south of Western Siberia, these species are only known since the Middle Neopleistocene (Zazhigin, 1980; Krukover, 1992). The correspondence of the fauna's age to the Vyatkino period is supported by the fact that it contains red-backed voles *C. rufocanus* and *C. rutilu*, reliably known starting only from the Middle Neopleistocene, too (Zazhigin, 1980; Krukover, 1992).

All forms identified in this collection pertain to modern species and geni. The paucity of materials prevents from assessing the evolution-level of particular forms. However, it can be noted that the teeth of lemmings (*L. lagurus*, *E.* cf. *luteus*) have an almost modern structure. The teeth of *M. gregalis* also have the modern appearance, with three-flanged anteroconids and fully separated anteroconid triangles T4–T5. A relative abundance of remains of *L. lagurus* and *M. gregalis*, along with a small number of remains of *M. oeconomus*, *C. rufocanus*, and *C. rutilu*, allows the fauna of the site under consideration to be correlated with localities of the second half of the Middle Neopleistocene: Kartashovo, Bobkovo, Bolshaya Rechka, etc. (Zazhigin, 1980).

Thus, the fauna of small mammals of the locality of interest has a post-Vyatkino age. Its comparison with the fauna of other localities of Southern Siberia suggests formation of the locality in the Peschanaya River valley in the second half of the Middle Neopleistocene. This fauna has predominantly a steppe appearance, with the presence of forest and meadow species. The most probable landscape conditions include real steppes with areas of meadow and woody vegetation.

Palynological data

In order to conduct palynological analysis, 11 samples were recovered from strata 9–12 (with an interval of 0.3 m) of the middle series, from under the humus horizon of the upper soil. The samples were handled using Grichuk's separation technique (Pyltsevoy analiz, 1950) with addition of hydrofluoric acid to remove silicates. Sample-weights amounted to 35–42 grams of dry matter. Two club moss tables were added each time, to calculate the concentration. All samples, except one (Fig. 2), demonstrated low concentrations of pollen and spores. Quantity of pollen showing the signs of redeposition was small.

All the samples are dominated by conifer pollen. Dark coniferous species such as fir (*Picea*) and pine (*Pinus s/g Haploxylon*) play a key role. At a depth of 200 cm, predominance of fir pollen is changed to a dominance of pine pollen. All samples taken in the sediments lying above 200 cm contained pollen of silver fir (*Abies*). Foliage species are almost absent; small-leaved species such as birch, willow, and alder, and broad-leaved species such as walnut and lime occur occasionally. Exotic species are represented by a single pollen of hemlock at a depth of 150 cm. Spores are dominated by forest ferns such as bracken ferns (*Pteridium*) and grape ferns (*Botrychium*). Such a palynocomplex characterizes development of dark coniferous forests in the Peschanaya River neighborhood. Grass-pollen was produced mainly by wormwoods (*Artemisia*), grasses (*Poaceae*), sedges (*Cyperaceae*), pigweeds (*Chenopodiaceae*), and composite plants (*Asteraceae*). Generally, the range of herbs is sufficiently wide. This points to a close proximity of open steppe landscapes.

The composition of the palynological spectra of the section implies development of vegetable communities that were not associated with glacial periods. Such pollen spectra are typical rather for climatic conditions close to the modern, while the presence of walnut- and lime-pollen in them points to a somewhat warmer climate than exists today. Seed flora of the Vyatkino complex in the south of Western Siberia allows the reconstruction of open meadow associations. Tree species are represented by fir, willow, alder, and birch, which were grouped into small groves along the river valleys. Most probably, the Vyatkino flora indicates the warming phase (Ponomareva, 1982a). On the basis of palynological studies of the deep-water sediments of Lake Baikal (Kuzmin et al., 2008), the tendency to an increasing climate continentality in Eastern Siberia can be observed. Starting from the beginning of the Middle Pleistocene, the areas of pine, larch, and cedar growing increased, which reflects the rising diversity of vegetation living environments. From the mid-Middle Pleistocene and nearly up to its end, the role of silver fir in the forest vegetation of the region was reduced.

Paleomagnetic characteristics of the section

Three subsequent cuts of total thickness of 30 m, from the modern soil to the water's edge, have been studied. 63 hand specimens were selected with a step of

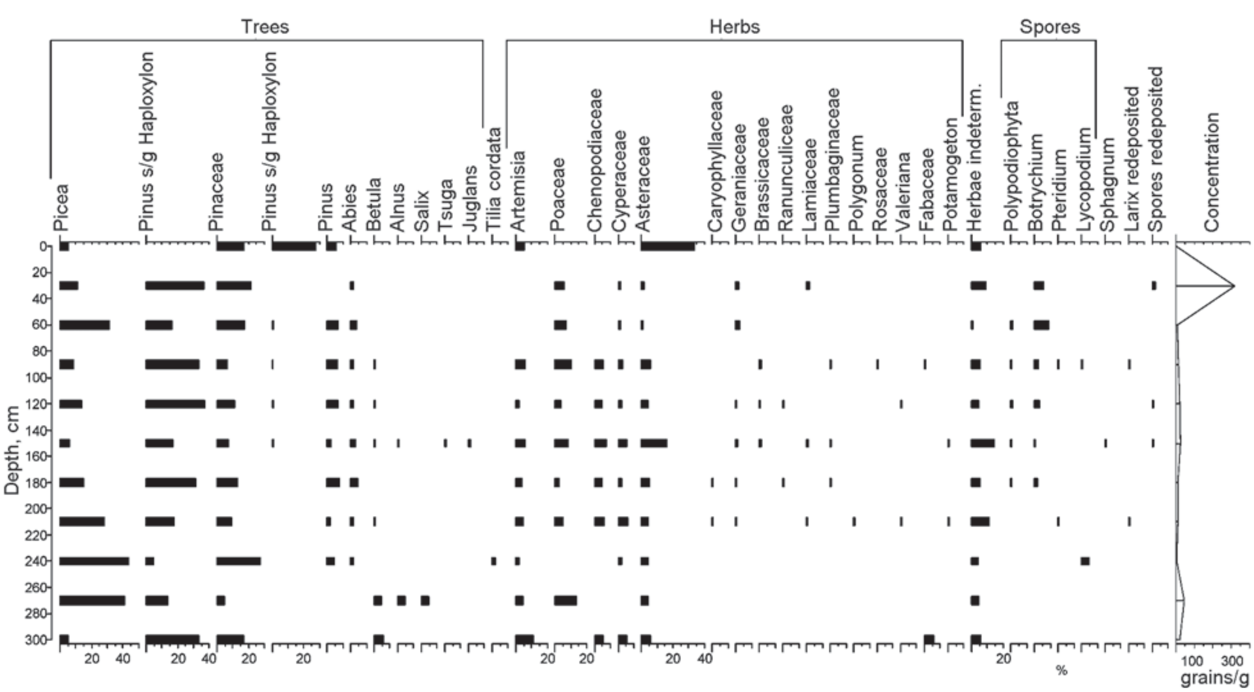

Fig. 2. Results of palynological studies of the section along the Peschanaya River.

30–40 cm, from which 378 oriented cube specimens with 2 cm edges were made.

Measurements of the magnetic susceptibility (*k*) and the frequency-dependent magnetic susceptibility (K_{fd}) were conducted using the MS2 system (Bartington, England). The magnetic susceptibility of sediments fluctuates from 22.6 × 10^{-5} to 103.0 × 10^{-5} SI units per volume of 11.15 cm^3. Parameter K_{fd} was calculated by formula: $(K_{fd})\ \% = (K_{lf} - K_{hf}) / K_{lf} \times 100$, where K_{lf} is the magnetic susceptibility at a measurement frequency of 460 Hz, and K_{hf} is the magnetic susceptibility at a frequency of 4600 Hz. The magnitude of frequency-dependent magnetic susceptibility K_{fd} reflects the presence of ferrimagnetic substances in the superparamagnetic state in the rock; these substances are usually formed during chemical reactions in soils (Pilipenko et al., 2010). The values of frequency-dependent magnetic susceptibility K_{fd} markedly increase in the first and second soils, while the soil in the lower portion of section is not distinguished by this parameter (see Fig. 1). Thermoanalysis of magnetic susceptibility *k* demonstrated that magnetite with a Curie temperature of 580 °C was the main carrier of magnetism in the section along the Peschanaya River.

Magnetic cleaning of specimens was performed using the method of stepwise thermal demagnetization on the TD-48 (USA) unit up to 600 °C. The remanent magnetization (*J*) was measured using the JR-6A magnetometer (Czech Republic). Remasoft 3.0 software was used to analyze the obtained data. Consideration of behavior of magnetization vectors during stepwise thermomagnetic cleaning in the section specimens has established that the direction of vectors changes insignificantly. At the same time, changes in the remanent magnetization values point to the presence of two components: an unstable viscous component in the interval of 200–300 °C, and a more stable primary detrital component from 200–300 °C to Curie temperatures (Fig. 3).

Distribution of remanence vectors before magnetic cleaning has the same character as after removal of viscous magnetization. This points to stability of the magnetic field direction in the interval from the time of sedimentation of the stratigraphic levels under study to the present day. Inclination $D^o = 352^o$ and dip $I^o = 69^o$, statistically average through the section, correspond to the direction of modern magnetic field (Fig. 4).

The results of paleomagnetic analysis allow the conclusion that all sediments of this section are normally magnetized. Taking into account the stratigraphic range of *E. nalaikhaensis* remains in the lower portion of the section, and the composition of fauna of small mammals represented in the lower portion of the middle series, the normally magnetized zone should be referred to the Brunhes orthozone.

Discussion

Stratigraphic, pedological, lithological, paleontological, and palynological data, obtained when studying the section along the Peschanaya River near Solonovka, have allowed us to distinguish three series thereof, separated by long interruptions in sedimentation. The upper subaerial series, corresponding to the upper part of the loess-soil sequence of Western Siberia, was formed within the Upper Pleistocene–Late Middle Pleistocene. The Chulym loess, lying at its base, corresponds to MIS 8 (Zykina, Zykin, 2012; Zykina, Zykin, 2008), whose age has been determined as falling in the interval of 301–242 ka BP (Bassinot et al., 1994).

According to the composition of small mammals, represented in its basal layer, the middle (subaqueous) series with two hydromorphic fossil soils is younger than the Vyatkino layers. Its fauna can be compared with the faunas of localities of small mammals dated to the second half of the Middle Pleistocene, which should be placed before the stratigraphic border of the beginning of the eight stage of the oxygen-isotope scale. Judging by the content of remains of modern plants in palynoflora of the middle series, among which walnut- and lime -pollen is present, its formation can be related to one of the interglacials of the second half of the Middle Pleistocene.

Taking into account the stratigraphic range of *E. nalaikhaensis* and the positive magnetization of the section sediments, the lower subaqueous series, obviously, pertains to the lower part of the Middle Pleistocene. It is conceivable that the time of its formation, according to paleomagnetic and paleontological data, corresponds approximately to the range from 0.78 to 0.55 Ma BP. The lithological features, stratigraphic position, paleomagnetic and paleontological data allow us to assign the lower subaqueous series to the Vyatkino layers in the south of Western Siberia described by O.M. Adamenko (1968), S.A. Arkhipov, A.A. Krukover, V.N. Shelkoplyas (1989), and V.S. Zazhigin (1980), and distinguished today at the base of the Middle Pleistocene (Zykina, Zykin, 2012; Unifitsirovannaya regionalnaya stratigraficheskaya skhema…, 2000). In the stratotype, the Vyatkino layers are characterized by the homonymous fauna of mammals (Arkhipov et al., 1989; Zazhigin, 1980). On the strength of all the biostratigraphic, paleomagnetic, and palaeoclimatic data, formation of the lower series, like the Vyatkino layers in general, apparently corresponds to MIS 17 of the Quaternary Chronostratigraphical Scale (Gibbard, Cohen, 2008) and pertains to the early interglacial of the Pleistocene. Detailed biostratigraphic characteristics of this interval, and the stratigraphic position of Vyatkino layers are of major importance for determining the stratigraphic position of the Karama site, formation of which, according to some researchers, could

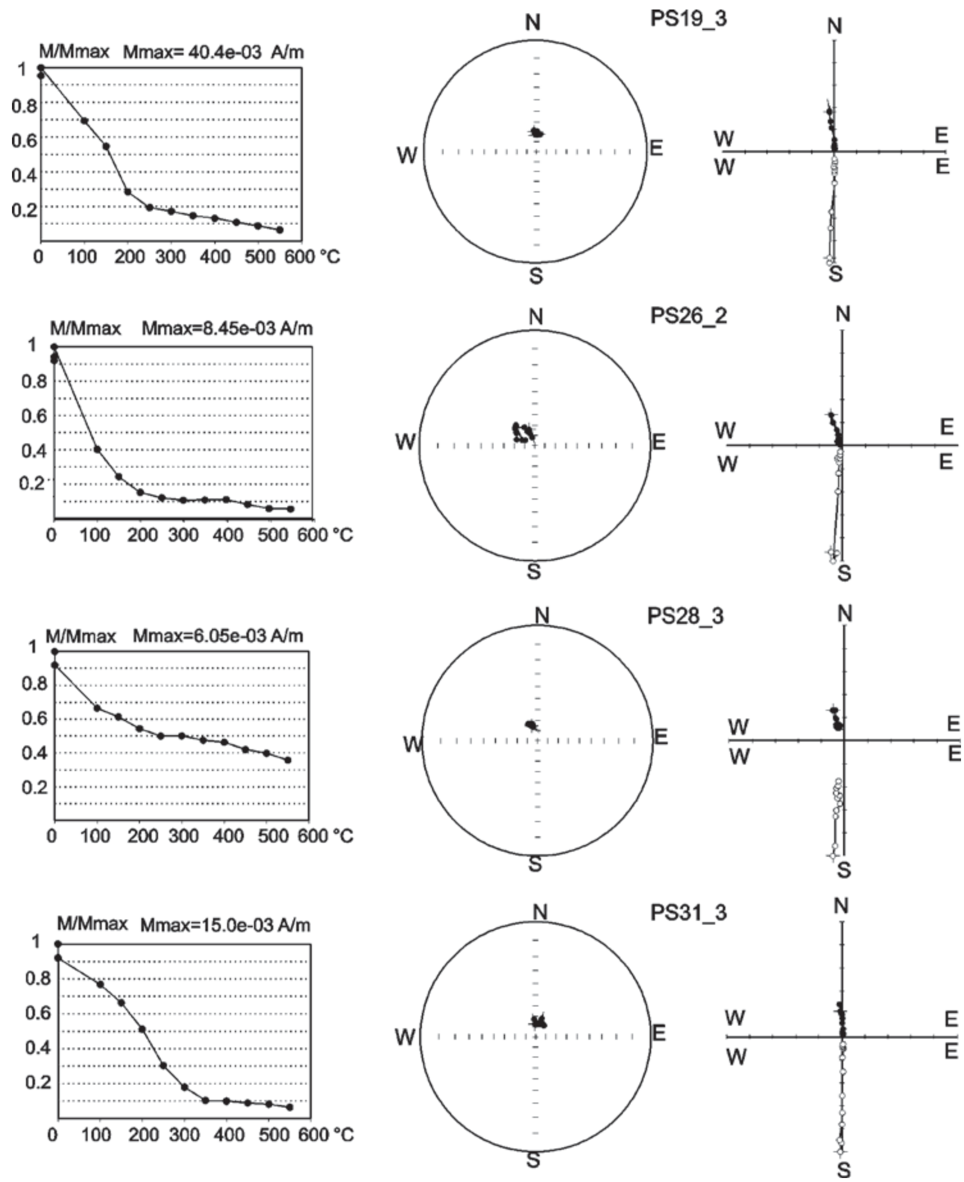

Fig. 3. Characteristic plots of varying values of remanence vectors (*J*), stereograms and Zuiderweld diagrams according to the results of stepwise thermal demagnetization of samples.

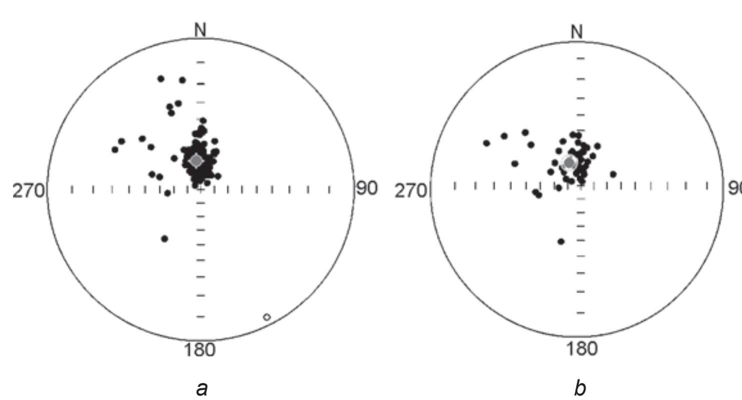

Fig. 4. Stereograms showing distribution of remanence vectors of the section along the Peschanaya River before (*a*) and after (*b*) the declination needle.

have also taken place in the second half of the Middle Pleistocene, within 800–400 ka BP (Bolikhovskaya, Shunkov, 2005, 2014; Derevianko, Shunkov, 2005). Since this presumption about the age of Karama is based mainly on interpretation of palynological data, it is necessary to conduct a comparative analysis of the flora that characterizes cultural layers of Karama, and interglacial flora of the Middle Pleistocene of Western Siberia. The systematic composition of Vyatkino flora is determined by seed flora of the Vyatkino stratotype established by E.A. Ponomareva (Arkhipov, Krukover, Shelkoplyas, 1989; Ponomareva, 1982a, 1986). This flora is characterized by the abundance of *Bunias sukaczewii* silicules and *Zannichellia pedunculata* endocarps. The flora is composed of swamp and mesophytic species. Among the latter, species of erosiofils are especially numerous. The presence of representatives of the pigweeds, pink family, and cabbage family points to some aridization of climate. Meadow associations can be reconstructed. Tree species are represented by fir, willow, alder, and birch, which were grouped into small forests along the river valleys. According to Ponomareva (1982b, 1986), the Vyatkino flora, unlike the preceding Erestnaya and Tishino floras, indicates a warmer and drier environment of one of the climate warming periods. In terms of the stratigraphic position, the Vyatkino layers are closely matched by the Gornofilenskoye layers, whose fossil seed floras, according to the data by Ponomareva, show resemblance to each other in the general composition (Volkova et al., 2002). In the stratoregion, these layers are associated with the buried valley in the lower reaches of the Irtysh River. Gornofilenskoye and Vyatkino layers pertain to the Gornofilenskoye interglacial horizon distinguished by Arkhipov (1987; Arkhipov, Volkova, 1994; Volkova et al., 2002). In the loess-soil sequence of Siberia, the said horizon is matched by the Belovo pedocomplex (Zykina, Zykin, 2012). In the Gornofilenskoye period, according to the palynology data presented by V.S. Volkova (1991; Arkhipov, Volkova, 1994), southern-taiga forest vegetation, which included only moderately thermophilic broad-leaved species such as lime and elm, was developed in Western Siberia. There were lots of silver firs and alders. As part of the grassland and aquatic vegetation, plants alien to the flora of the central part of Western Siberia lived out in the form of relics (Arkhipov, Volkova, 1994). Herbaceous-subshrub plants were dominated by pollen of grasses (up to 55 %), wormwoods, and composite plants. In general, the flora composition allows the drawing of a conclusion that the climate in the lower Irtysh was warmer than it is today. The Gornofilenskoye interglacial, like the Kazantsevo one, in the opinion of Volkova (Ibid.; Volkova et al., 2002), was one of the warmest interglacial epochs of the Middle and Upper Pleistocene of Western Siberia, which was characterized by moderately warm climate.

The subsequent (later) Talagayka interglacial was cooler (Ibid.). Talagayka sediments are distributed mostly in the lower Irtysh, where they are associated with the deeply incised river valley. In the southern region of the West Siberian Plain, this interglacial is matched by Volodarsk pedocomplex of the loess-soil sequence (Zykina, Zykin, 2012). According to palynological data, in that time, the central part of the plain was rich in forest middle-taiga vegetation, which occupied the entire periglacial and glacial zones. The vegetational zonation resembled the modern one, however, the boundaries of zones passed somewhat further north (Arkhipov, Volkova, 1994). No broad-leaved species have been revealed in the composition of Western Siberian forest vegetation for that time. Judging by the presence of walnut and lime pollen, the Middle Pleistocene flora of the studied section (see Fig. 2) was somewhat warmer than flora of the Talagayka, Gornofilenskoye and Vyatkino interglacials.

Thus, according to the published palynological and paleocarpological data (Arkhipov, Volkova, 1994; Volkova, 1977, 1991; Ponomareva, 1982a, 1986; and others) and materials of the studied section, apart from the modern plants, only the most cold-resistant broad-leaved plants such as *Tilia*, *Corylus*, *Ulmus*, and *Juglans* are present in the floras of interglacials of the Middle Pleistocene in Western Siberia. During these interglacials, the climate approached to the modern one or was somewhat warmer (Zykin, Zykina, Orlova, 2000).

The fossil palynoflora of Karama cultural layers, established by N.S. Bolikhovskaya (Bolikhovskaya, Shunkov, 2005, 2014; Bolikhovskaya et al., 2011; Derevianko et al., 2004), among 130 taxa of various ranks, contains a considerable number of nemoral dendroflora elements exotic for Western Siberia, including: *Picea* sect. *Omorica, P.* cf. *koraiensis, Alnus glutinosa, Corylus* sp., *C. avellana, Juglans mandshurica, Carpinus betulus, C. cordata, C. orientalis, Ostrya* sp., *Quercus* sp., *Q. robur, Tilia cordata, T. amurensis, T. mandshurica, T. sibirica, Ulmus pumila, Morus* sp., and others. The composition of fossil flora is in good agreement with the presence of compact soils in the section, which are formed in a warm climate; and this is indicative of the absence of pollen redeposition (Zykin et al., 2005). In the opinion of Bolikhovskaya expressed in 2005, the presence of pollen of *Ostrya* sp. and *Morus* sp., belonging to the group of American-Mediterranean-Asian species and represented in the Lower Neopleistocene sediments of the Lower Cis-Baikal region and the Upper Amur region, and the absence of pollen grains of subtropical broad-leaved species (*Pterocarya*, *Carya*, *Zelkova*, *Celtis*, *Ilex*, and others), hemlock, and other exotic taxa of the pine family that are typical of the Eopleistocene sediments of adjoining regions of Northern Eurasia, give no way of suggesting that the lower layers of Karama pertain to the Eopleistocene, but allow a conclusion to be drawn that they are not younger than the Middle Pleistocene according to the International Stratigraphic Scale (Early Neopleistocene, according to the General Stratigraphic Scale of Russia) (Bolikhovskaya, Shunkov, 2005). Later, pointing out that interglacial floras of Karama existed in considerably warmer and less continental climatic conditions than modern ones, and considering the climatic conditions of Barnaul flora expansion (without conducting a flora composition analysis) close to modern ones, Bolikhovskaya rejected the possibility of comparing the Barnaul and Karama floras (Bolikhovskaya, Shunkov, 2014). She relates the formation of strata 13–10 of the Karama section to MIS 19, or Gremyachye interglacial stage of the East European Plain, "which is dated to the interval of 790–760 ka BP according to correlation calculations" (Ibid.: 7), and formation of stratum 9—to a cold epoch corresponding to MIS 18. According to Bolikhovskaya, stratum 8 and the major part of stratum 7 were accumulated during the next interglacial, compared with MIS 17 or with the Semiluki interglacial.

Comparative analysis of the taxonomic composition of Western Siberian fossil floras, described in numerous papers (Arkhipov, Volkova, 1994; Volkova, 1977; Volkova et al., 2002; Giterman et al., 1968; Istoriya…, 1970; Nikitin, 2006; Ponomareva, 1982a, b; 1986), has revealed the greatest resemblance in the composition between the Karama and Barnaul floras. Notably, the latter is poorly characterized by palynological data, which are most comprehensively presented in a paper by Volkova (1977). Among modern broad-leaved plants, only lime and elm are included in the Barnaul palynoflora. A more comprehensive idea of the flora taxonomic composition is provided by paleocarpological data (Nikitin, 1970, 2006; Ponomareva, 1982a), which were not taken into account in the age interpretation of Karama fossil flora (Bolikhovskaya, Shunkov, 2005, 2014; Bolikhovskaya et al., 2011). The Barnaul flora is the last thermophilic flora in Western Siberia, which, along with the modern species (60 %), contains a considerable number of broad-leaved geni representatives (*Quercus, Ulmus, Tilia, Morus, Leitneria, Aralia, Weigela, Phellodendron, Phyllanthus, Vitis, Sumducus*) needing the same growing conditions as nemoral taxa of the Karama dendroflora. A noticeable share of exotic species in the composition of woody vegetation points to a relative antiquity of the compared floristic complexes. In terms of the taxonomic composition and a considerable content of thermophilic broad-leaved taxa, the Karama palynoflora resembles only the Barnaul flora. Correlation of the Barnaul suite of the south of Western Siberia with the Mukkur suite of the Northern Kazakhstan allows us to attribute the Barnaul flora to the Tegelenskoye period of prolonged moderately-warm climate in northwestern Europe (Zykin, 2012; Zykin, Zykina, Smolyaninova, 2016) dated to the 2.23–1.59 Ma BP (Zubakov, 1990).

The Middle Pleistocene early interglacial floras of Western Siberia show drastic differences with the flora of cultural layers of the Karama site. Many of broad-leaved taxa typical for the Karama palynoflora (*Carpinus cordata, C. orientalis, Ostrya* sp., *Quercus robur, Tilia cordata, T. amurensis, T. manshurica, Ulmus pumila, Morus* sp.) are absent in the Middle and Upper Pleistocene flora of the West Siberian Plain (Volkova, 1977, 1991; and others) and in the Middle Pleistocene flora of the Northwestern Altai (Derevianko, Malaeva, Shunkov, 2000; Razrez…, 1978; and others). The Barnaul flora and floras of early Western Siberian interglacials are separated by a long time interval filled with Tishino and Erestnaya floras, which were formed in a rather cool climate. The early interglacial floras of the Middle Pleistocene of Western Siberia, apart from the modern plants, contain only most cold-resistant broad-leaved plants such as *Tilia*, *Corylus*, *Ulmus*, and *Juglans*. During these interglacials, the climate approached to the modern one or was somewhat warmer.

Conclusions

The use of lithological, pedological, paleontological, and paleomagnetic data has allowed us to distinguish the Upper and Middle Pleistocene horizons of loess-soil sequence and sediments of two Middle Pleistocene interglacials in a section of the Altai Mountains foothills, in the Peschanaya River valley. Palynological characteristics of one of the Middle Pleistocene interglacials have also been obtained. Sequential analysis of the Middle Pleistocene interglacial floras of Western Siberia in comparison with palynoflora of cultural layers of the Karama site has revealed their marked differences. The palynoflora of the Karama cultural layers included a considerable number of broad-leaved taxa, which were absent in the Middle Pleistocene early interglacials of Western Siberia. In terms of the taxonomic composition and a substantial content of thermophilic broad-leaved taxa, the Karama palynoflora resembles only the last western Siberian thermophilic flora, Barnaul, which existed in Western Siberia during the long climatic warming of the Early Pleistocene, corresponding to the Tiglian in northwestern Europe (2.23–1.59 Ma BP). Since the beginning of the Middle Pleistocene, interglacial floras of Western Siberia have resembled modern ones in terms of their taxonomic composition. Apart from modern cold-resistant small-leaved Western Siberian taxa, they included *Tilia, Corylus, Ulmus, Juglans*—the most cold-resistant broad-leaved plants. In terms of floristic, phytocenotic, and paleoclimatic features, the Middle Pleistocene interglacial environments of Western Siberia display a sharp contrast with the warm period of Barnaul and Karama floras formation.

Acknowledgements

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A Comprehensive Study of Neolithic Stone Tools from Dwelling D on Suchu Island, the Lower Amur (1974, Excavation Area I)

We have analyzed stone tools unearthed in 1974 from the Neolithic dwelling D (excavation area I) on Suchu Island, the Lower Amur. The assemblage includes 1518 artifacts attributed to the Malyshevo, Kondon, and Voznesenovskoye cultures, to the Belkachi complex, and to the Final Neolithic. To identify the raw material, a microscopically guided petrographic analysis was carried out. The most frequently used rocks were sedimentary (siltstone, mudstone, and sandstone) and siliceous (flint, quartzite, chalcedony, and jasper). Also, typological and functional analyses were conducted. The distribution of artifacts on the floor of the dwelling was evaluated by planigraphic analysis, and the functional analysis has allowed us to reconstruct household activities relating to the procurement, processing, and consumption of food resources. A database concerning subsistence activities was generated in order to reconstruct various aspects of the prehistoric economy of the region.

Keywords: *Amur Basin, Neolithic, Suchu Island, stone tools, petrographic analysis, typology, planigraphy, use-wear analysis.*

Introduction

In 1974, archaeological research* was conducted on Suchu Island in its southeastern part, in excavation pit I (Fig. 1). These works became a continuation of the excavations made over the previous two years (Okladnikov, Medvedev, Filatova, 2015; Medvedev, Filatova, 2016) with the main focus on dwelling D, the study of which started in 1973 when its northwestern segment was uncovered (Medvedev, Filatova, 2016: 48–49). In 1974, the dwelling was completely unearthed (Fig. 2, *A*, *B*); it occupied almost the entire southern half of the excavation pit. Excavations of dwelling D were expected to yield very interesting results, primarily due to the fact that among the dugouts and semi-dugouts made on the high places of the island this was the outermost one. The dwelling pit was covered by a thick layer (over 2 m) of humified soil (Okladnikov, 1974: fol. 2); its outer contour was visible on average at a depth of 60–65 cm. The maximum depth of the dwelling pit was 2.2 m from the present-day surface; the outer diameter along the line N–S was 10.2 m, and along the line E–W, the diameter

*The excavations were made by the employees of the Institute of History, Philology, and Philosophy of the Siberian Branch of the Academy of Sciences of the USSR: V.E. Medvedev (the Head of the Unit), A.F. Felinger, N.I. Spiridonov, A.I. Loginov, and five students of the Khabarovsk Pedagogical Institute. General supervision of the work was carried out by A.P. Okladnikov.

Fig. 1. View of excavation I from the southwest (1974). Excavation in dwelling D.

was 12.8 m; the total area inside the outer contour was 130.56 m^2. A representative assemblage of artifacts was obtained from studying this dwelling.

Materials and methods

The materials for the analysis were lithic objects from dwelling D and the space immediately adjacent to the dwelling. Information was obtained from studying the collection kept in the funds of the Institute of Archaeology and Ethnography of SB RAS and from field reports. The lithic inventory was analyzed, relating to the Malyshevo, Kondon, and Voznesenovskoye cultures, as well as the Belkachi cultural and chronological complex of the final Neolithic type.

Archaeological materials were studied using a comprehensive interdisciplinary approach. For determining the lithic raw materials from which the tools were made, petrographic analysis of 42 samples was made in the Laboratory of Physical and Chemical Methods of Research at the Khabarovsk Innovation and Analytical Center (KhIAC) of the Institute of Tectonics and Geophysics of the Far-Eastern Branch of the Russian Academy of Sciences. Transparent sections were made of four samples out of 42, and were investigated using the method of optical microscopy*, with the Imager A2m polarization optical microscope. The type and function of the lithic objects were determined using morpho-typological and functional analysis. Planigraphic analysis was performed to identify the areas of human activity within the boundaries of the dwelling (Volkov, 1999: 105–124; Medvedev, Volkov, 2015).

*Petrographic analysis was performed by Dr. N.V. Berdnikov, the Head of the Laboratory of Physical and Chemical Methods of Research and Director of the KhIAC.

Research results

One thousand five hundred and eighteen lithic artifacts were found both in the filling of the dwelling pit (Fig. 2, *A*) and on the floor of the dwelling (Fig. 2, *B*). All finds can be divided into two groups: the first group includes the artifacts of primary reduction, laminar assemblage, and debitage; the second group includes tools, their fragments, and blanks (Table 1). More than half of the artifacts were concentrated in the lower part of the filling in the dwelling pit, which was quite natural given its depth. The largest part of the finds was debitage (flakes and spalls). The second largest group consisted of tools, including their blanks and debris. In the third place was the laminar assemblage (knife-like blades, laminar flakes, and spalls). The artifacts of primary reduction (cores, core-shaped objects and spalls, pebbles and tablets with flaking scars, split pebbles, and pebbles without the traces of processing) were the least numerous.

Raw materials. Petrographic analysis has shown that different types of rocks were used as raw materials (Table 2). Depending on their origin, all of them can be divided into three groups: 1) sedimentary rocks—sandstone, siltstone (including silicified siltstone), and mudstone (Fig. 3, *1*); 2) siliceous rocks—flint (Fig. 3, *2*, *3*), quartzite, chalcedony, and jasper; 3) igneous rocks—granite (including strongly silicified granite) and gabbro-basalt. Petrified wood also occurred (Fig. 3, *4*).

The selection criteria were the size, shape, color, and nature of the stone's surface. The dominant types of raw materials were siltstone and mudstone, mainly of medium gray, but also of light gray and dark gray colors. Judging by the size of the tools, large-sized pebbles (15–10 cm) and small-sized boulders (25–15 cm) were used (Kulik, Postnov, 2009: 14). Siliceous rocks occur in smaller quantities, mostly in the form of small-sized

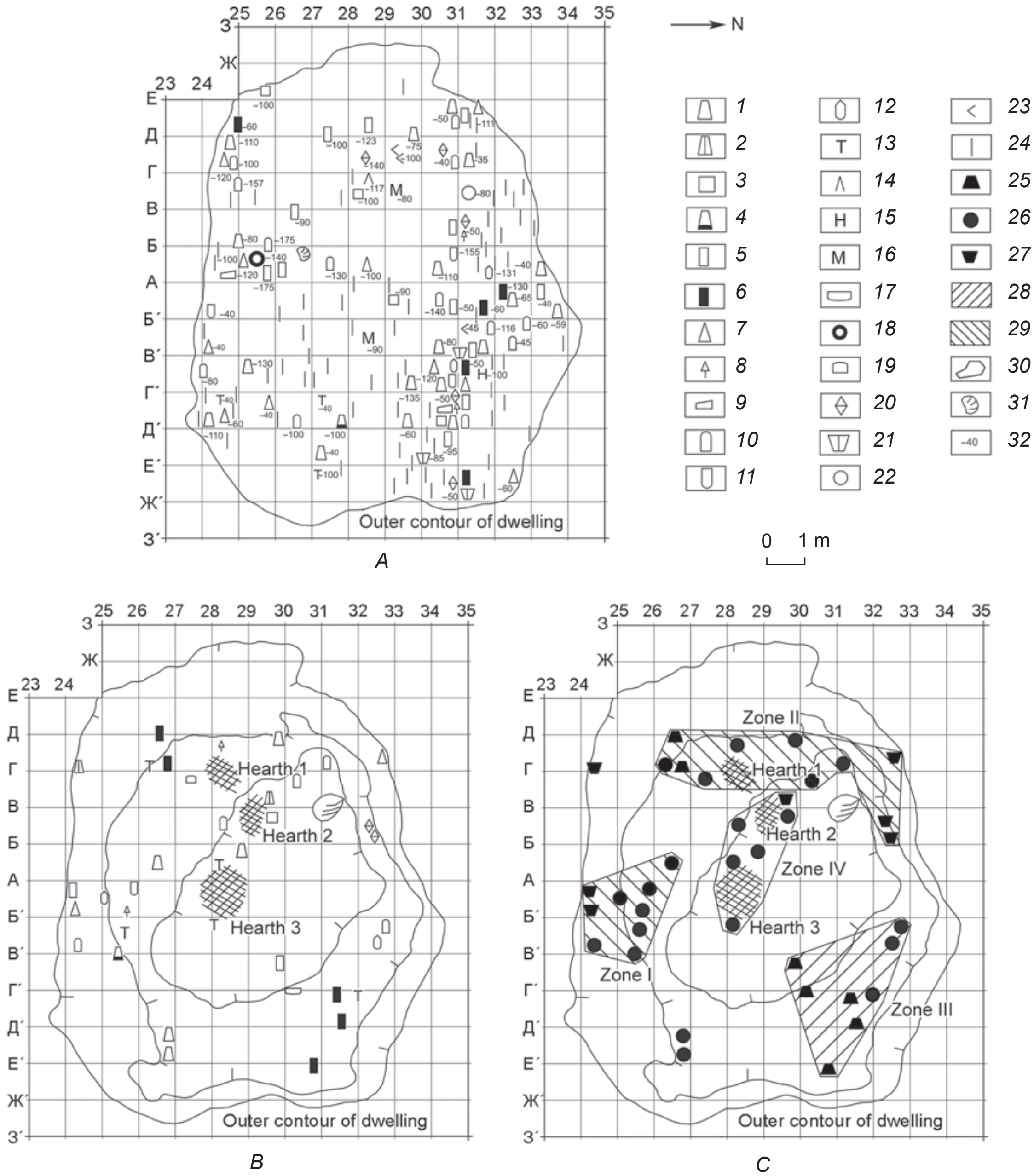

Fig. 2. Plans for the part of excavation I (1974) with finds at the level of the filling (*A*) and floor (*B*) of dwelling D; map showing the distribution of stone tools on the floor of the dwelling and the probable areas of activities carried out by the inhabitants (*C*).
1 – adze; *2* – chopping tool; *3* – axe; *4* – gouge; *5* – knife; *6* – knife-like bladelet; *7* – arrowhead, dart-head; *8* – piercing tool; *9* – saw; *10* – end-scraper; *11* – side-scraper; *12* – end-scraper knife; *13* – whetstone; *14* – polishing tool; *15* – anvil; *16* – hoe; *17* – grinder; *18* – mace; *19* – stone with a cavity; *20* – blank of a tool; *21* – core, core-shaped object; *22* – hammerstone; *23* – core-shaped spall; *24* – flake; *25* – tools for procurement; *26* – tools for processing; *27* – tools for consumption; *28* – area of tools for procurement and processing; *29* – area of tools for processing and consumption; *30* – "hearth" area; *31* – stone; *32* – depth from the present-day surface.

pebbles (10–5 cm) of various colors. Thus, jasper rocks have the shades of red, yellow, brown, and sometimes green; there are also variegated, banded, and spotty rocks. Chalcedony is represented mainly by a colored variety (carnelian). Flint is mostly brown and gray to black; quartzite is white, gray, red, yellow, brown, and their shades. Granite and basalt were used even less frequently (Table 3). Generally, siltstone and mudstone, as well as fine-grained sandstone, were the predominant materials for making tools. Their pebbles as a rule have

Table 1. **Distribution of lithic inventory according to groups and layers (spec.)**

Layer	Artifacts of primary reduction	Debitage	Laminar assemblage	Tools, incl. blanks and fragments	Total
Upper part of the filling	30	368	92	99	589
Lower part of the filling	41	492	127	189	849
Floor	2	35	11	32	80
Total	73	895	230	320	1518

Table 2. **Results of the petrographic analysis of artifacts**

Sample no.	Field record no.	Depth, cm	Rock type	Note
1	2	3	4	5
C-2	Cy-74/1254	50	Flint	
C-3	Cy-74/2610	40	"	Silicified siltstone
C-4	Cy-74/3501	60	Chalcedony	
C-5	Cy-74/4114	60	Flint	"
C-6	Cy-74/4121	60	Quartzite	With biotite
C-7	Cy-74/4311	50	Flint	Silicified siltstone
C-9	Cy-74/5353	50	Chalcedony	Opaline
C-10	Cy-74/5384	50	Flint	
C-11	Cy-74/5387	50	Quartzite	
C-15	Cy-74/6053	50	"	
C-16	Cy-74/6056	50	Chalcedony	
C-17	Cy-74/6993	50	"	
C-18	Cy-74/6995	50	Mudstone	
C-19	Cy-74/6996	50	Flint	
C-20	Cy-74/7009	50	Chalcedony	
C-21	Cy-74/7088	80	Siltstone	
C-23	Cy-74/7170	80	Chalcedony	
C-24	Cy-74/7482	80	"	Carnelian
C-25	Cy-74/7711	80	Quartzite	
C-26	Cy-74/8016	50	Jasper	
C-27	Cy-74/8189	100	Quartzite	
C-28	Cy-74/8352	50	Flint	
C-29	Cy-74/8374	100	Chalcedony	
C-34	Cy-74/9019	100	"	"
C-35	Cy-74/9328	100	Quartzite	
C-37	Cy-74/10178	100	Flint	
C-39	Cy-74/10793	150	Mudstone	
C-40	Cy-74/10833	150	Flint	Crystalline quartz is absent
C-45	Cy-74/11654	140	Jasper	
C-46	Cy-74/12250	140	Flint	Predominantly amorphous iron-stained silica
C-47	Cy-74/12296	140	Chalcedony	
C-48	Cy-74/12439	150	"	
C-49	Cy-74/12532	Floor	Petrified wood	Quartzous layers of wood structure
C-50	Cy-74/12692	175	Mudstone	
C-51	Cy-74/12694	175	Flint	

Table 2 (end)

1	2	3	4	5
C-53	Cy-74/13574	175	Mudstone	Fine-grained, predominantly loamy rock
C-54	Cy-74/13637	175	Flint	
C-55	Cy-74/13642	175	Jasper	
C-57	Cy-74/13958	175	Flint	
C-58	Cy-74/14145	160	Mudstone	
C-59	Cy-74/14352	130	Quartzite	
C-60	Cy-74/14445	Floor	"	

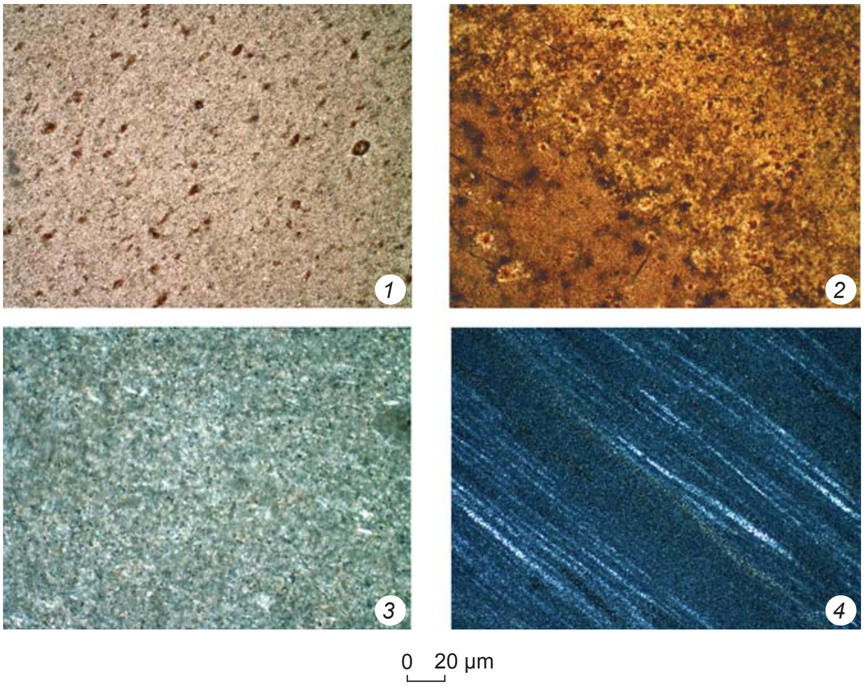

Fig. 3. Photographs of thin sections of lithic artifacts.
1 – mudstone (C-53); *2*, *3* – flint (2 – C-40; 3 – C-46); *4* – petrified wood (P-49).

Table 3. **Correlation between the types of rock and lithic inventory, %**

Name	Artifacts of primary reduction	Debitage	Laminar assemblage	Tools, incl. blanks and fragments	Total
Siltstone	1.4	40.1	9.7	11.9	63.1
Mudstone	0.1	2.2	0.7	0.5	3.5
Basalt	0	0.1	0	0	0.1
Granite	0	0.1	0	0.2	0.3
Quartzite	0.3	3.2	0.5	1.0	5.0
Flint	0.8	7.2	2.8	3.1	13.9
Petrified wood	0	0	0.1	0.1	0.2
Sandstone	0.3	0.9	0.1	1.0	2.3
Chalcedony	0.4	1.2	0.2	0.3	2.1
Jasper	1.5	4.0	1.0	3.0	9.5
Total	4.8	59.0	15.1	21.1	100

a fairly homogeneous structure and bar-like shapes convenient for processing.

The correlation between the petrographic composition of the raw material and the types of tools makes it possible to divide the rocks used for production into three groups: 1) universal raw materials (sedimentary rocks), which were equally often used for making different tools and optimally combined consumer properties and accessibility; 2) specialized (igneous rocks), which were suitable for producing tools only of certain types due to their technical qualities, and 3) highly specialized (siliceous rocks), which were used for producing tools only of a few types, since the production and operation of these tools had increased requirements for consumer properties of the raw materials.

Thus, the results of petrographic analysis of the lithic industry testify to selection of raw materials. The specific nature of the area in terms of procuring raw materials certainly compelled the ancient population of the island to adapt to local conditions. It was necessary to carefully select particular types of rocks that had the set of properties satisfying the technical requirements for producing specific tools and for subsequent performance of the needed functions by the tools.

Primary reduction. The artifacts of primary reduction (cores, core-shaped objects and spalls, pebbles and tablets with flaking scars, split pebbles, and pebbles without the traces of processing), the laminar assemblage (knife-like bladelets, laminar flakes and spalls), and debitage (flakes and spalls) amount to 1198 objects. Sixteen cores (Fig. 4, *1–4*) and four core-shaped objects were identified. Siliceous (including chalcedony and quartz) stones, as well as siltstone pebbles, were used mainly as cores. Cores with single platforms and one core with double platforms have been found. The platforms are even and are usually formed with one strike, sometimes against the natural pebble surface. In terms of shape, most cores are wedge-shaped (12 spec.), less often subprismatic (4 spec.). Their average dimensions are from 3.6 × 2.3 × 1.6 to 6.2 × 3.0 × 1.3 cm (13 spec.); the minimum size is 2.2 × 1.7 × 0.7 cm; the maximum size is 10.2 × 7.3 × 5.8 cm. Some core-shaped spalls (23 spec.), pebbles (18 spec.) and tablets (2 spec.) with flaking scars also occur, as well as split pebbles (2 spec.) and pebbles without the traces of processing (6 spec.).

The blade assemblage includes knife-like bladelets (35 spec.) and their fragments (5 spec.), as well as laminar flakes (80 spec.) and spalls (110 spec.). Dihedral and trihedral blades (Fig. 4, *5–12*) were found with even edges, with uneven edges, and with the irregular faceting of very large (over 5 cm), large (up to 5 cm), and medium (up to 4 cm) size. The maximum size is 6.5 × 2.4 × × 0.4 cm; the minimum size is 2.0 × 0.6 × 0.1 cm. Retouched knife-like bladelets (3 spec.) also occurred. Laminar flakes and blanks are mostly of irregular shape. Notches occur on many of them (45 spec.); some show traces of use (7 spec.) and retouching (8 spec.). Grouping according to size includes massive (over 10 cm), very large (up to 10 cm), large (up to 5 cm), medium (up to 4 cm), and small (less than 2 cm) objects.

Flakes (196 spec.) are mostly of medium size (not more than 4 cm), but there are also large, very large, and massive flakes. The minimum sizes are 1.7 × 2.1 × × 0.3 cm; the maximum sizes are 12.2 × 8.0 × 1.4 cm. A fairly large number of flakes have notches (38 spec.); some show traces of use (3 spec.) and retouching (3 spec.). Secondary frontal spalls dominate among the

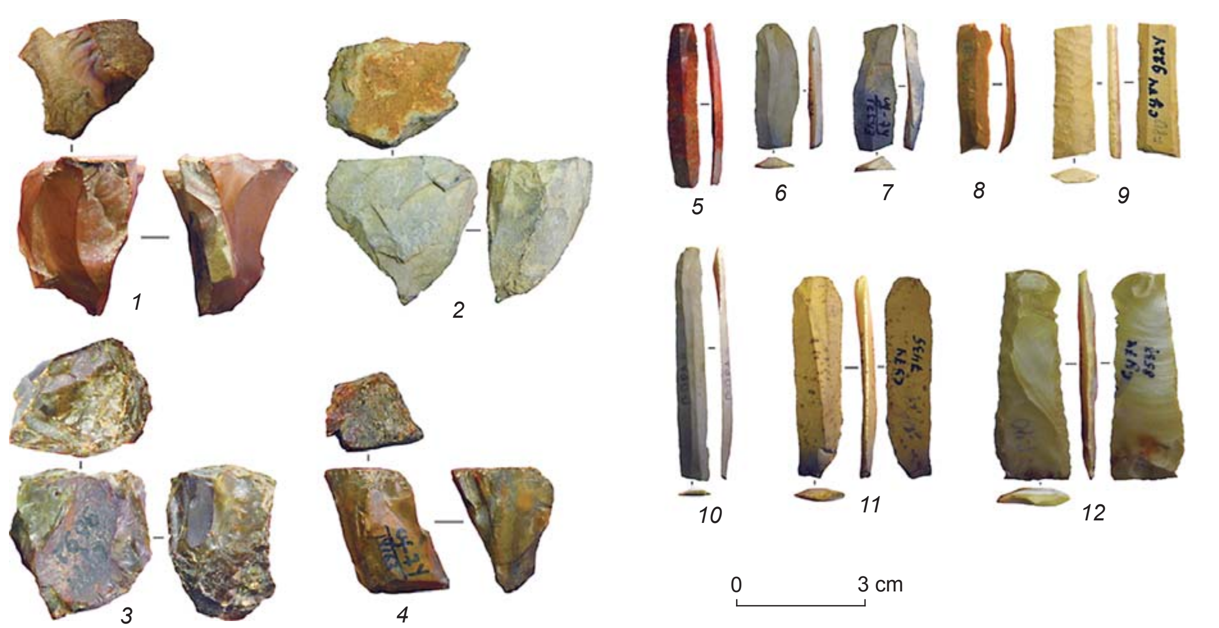

Fig. 4. Cores (*1–4*) and knife-like bladelets (*5–12*).

entire assemblage of spalls (699 spec.), but there are some primary technical spalls (173 spec.) preserving the areas of the natural surface. The presence of notches (51 spec.), traces of use (4 spec.) and retouching (11 spec.) have been observed. The size range varies from very large and large to medium and small; there are also quite massive spalls. The maximum sizes are 12.3 × 3.8 × 1.5 cm; the minimum sizes are 1.5 × 1.3 × 0.2 cm.

Thus, as we have already noted above, debitage makes up the largest group, and the blade assemblage is the third largest. This makes it possible to conclude that the pebble tradition dominated.

Tools. According to the results of the morpho-typological and functional analyses, stone tools (223 spec.), their fragments (78 spec.), and blanks (19 spec.) have been combined into three polymorphic groups on the basis of their assumed functional purpose (Table 4). The first category includes tools for procurement; the second category includes tools for processing, and the third category includes tools used for food consumption (Volkov, 1999: 80–81). Stone tools of the first category, associated with procurement of wild animals, fowl, fish, and various materials, were divided into five groups.

Table 4. **Typological list of stone tools (spec.)**

Category	Group	Functional type	Number
I. Tools for procurement and harvesting	1. Hunting tools	Arrowheads	24
		Dart-heads	10
		Specialized butcher-knives	10
	2. Fishing tools	“Fish” butcher-knives	9
		Mace head (weight for a fishing net?)	1
	3. Tools for procuring stone	Hammerstone	1
		Percussion tools	3
	4. Tools for harvesting wood	Chopping tools	16
	5. Tools for digging	Hoes	2
II. Tools for processing	1. Tools for processing stone	Retoucher	1
		Hammerstone-anvil	1
		Percussion tools-anvils	2
		Abraders	12
		Stand for bow-drilling (stone with a cavity)	1
	2. Woodworking tools	Axes	16
		Adzes	52
		Chisels	4
		Gouges	3
		Cutter	1
		Burin-drill	1
		Planing-knives	2
		Saws	4
	3. Skin/leather processing tools	Side-scrapers	12
		End-scrapers	67
		Scrapers-knives	10
		Scrapers-piercing tools	7
		Piercing tools	16
		Polishing tools	4
	4. Tools for processing grains	Pestles	2
		Grinder	1
III. Tools for consumption	1. Tools for meat and fish consumption	Knives for eating meat and fish	17
		All-purpose “meat” knives	8

Hunting tools (44 spec.) include arrowheads (19 intact, 4 fragments, and a blank), dart-heads (5 intact and 5 fragments), and specialized butcher-knives (5 intact and 5 fragments), made of siliceous rocks and siltstone. Arrowheads (Fig. 5, *1–5*) belong to three types. The first type is a leaf-shaped object with a straight base (subtype 1) or a base slightly protruding in the form of a tang (subtype 2); the second type is an elongated triangular object with a straight (subtype 1) or notched (subtype 2) base; the third type is an elongated diamond-shaped object with a slightly protruding tang. Bifaced tools were formed with continuous two-sided wavy retouching over the entire surface, and edge retouching for sharpening around the perimeter. Lateral edges and the tips on the points made on laminar blanks and flakes, and knife-like bladelets underwent marginal retouching for sharpening. The length of the objects varies from 2 to 5 cm and on average is 2.5–4.5 cm.

Dart-heads (Fig. 5, *6*) also belong to three types. The first type consists of leaf-shaped objects with a straight base (subtype 1) or a base slightly protruding in the form of a tang (subtype 2); the second type consists of elongated-triangular objects with a straight base; the third type consists of elongated-diamond-shaped objects with a slightly protruding tang. The surfaces of bifaces are treated by flattening retouching; the tip and edges along the perimeter are treated by bilateral edge retouching for sharpening. The lateral edges and tips of the objects made on knife-like bladelets were also sharpened by edge retouching. The length of the dart-heads varies from 5.5 to 9.5 cm.

Knives (Fig. 5, *7*) belong to two types. The first type was made of pebbles (bifaces); the second type—of flakes, laminar flakes, and spalls. Knives of both types are of asymmetric semilunar, leaf-shaped or elongated-subtriangular shape in plan view with a pronounced handle. Double-sided retouching for flattening fully covers the bifaced tools; around the perimeter they were additionally sharpened by double-sided edge retouching. The blade and tip, and more rarely the lateral sides of the knives made of flakes and spalls, were sharpened with edge retouching; the ventral surface shows traces of the shock wave. The length of the objects varies from 7.5 to 13.0 cm.

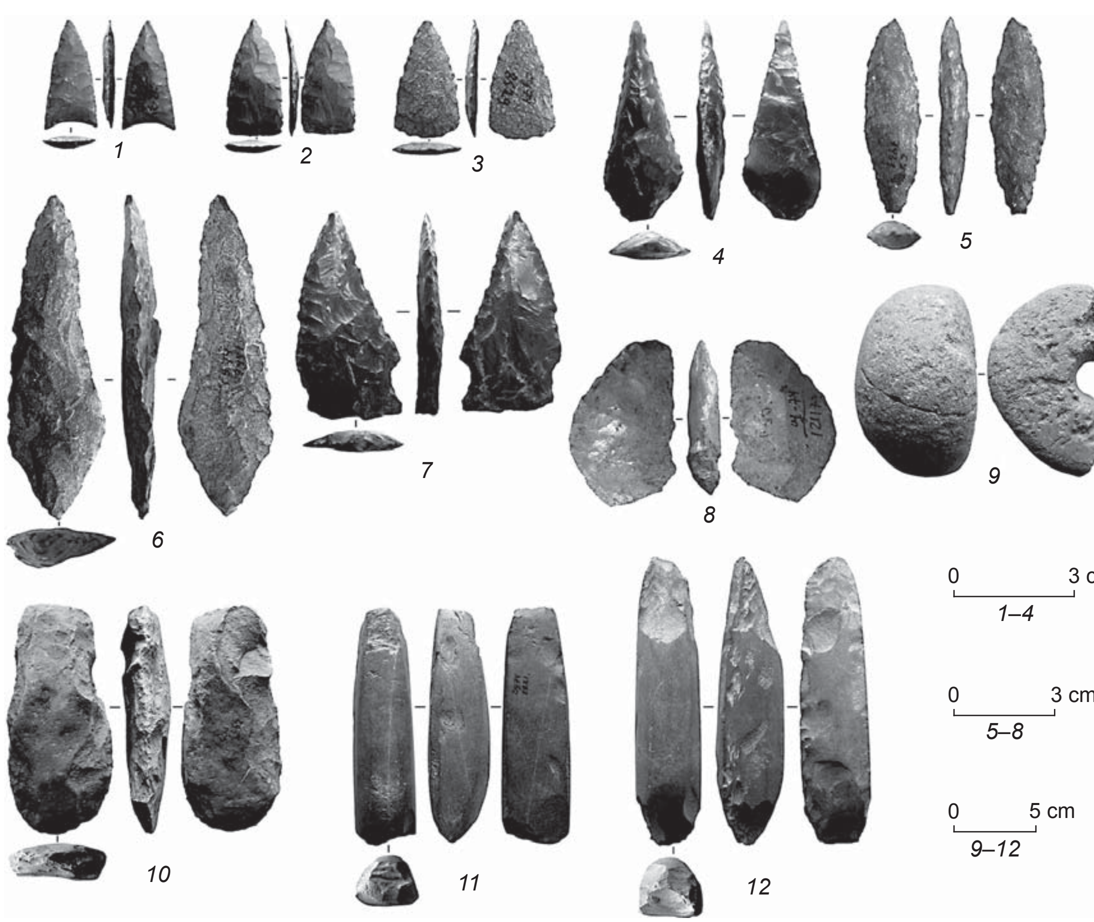

Fig. 5. Tools for procurement.
1–6 – arrowheads (*1–5*) and a dart-head (*6*); *7*, *8* – specialized butcher-knives for meat (*7*) and fish (*8*); *9* – fragment of mace head; *10* – hoe; *11* – percussion tool; *12* – chopping tool.

Fishing tools (10 spec.) include fish butcher-knives (6 intact, a fragment, and two blanks), mace head (weight for a fishing net?). “Fish” knives are of distinctive asymmetric elongated subtriangular or sub-trapezoidal (“curved”) shape in plan (Fig. 5, *8*); they were made of siliceous and siltstone flakes and blanks, including laminar blanks. The blanks were additionally treated on the dorsal surface and the cutting edge, sometimes by a wavy retouching for flattening on the dorsal surface. Along the perimeter, the blade was sharpened by edge retouching. The length of the objects varies from 3.0 to 7.5 cm; the average length is 5.0–5.5 cm. The mace head (the weight for the fishing net?) was made of a granite stone. One half of an object of round shape in plan view has been preserved measuring 12.2 × 6.5 × 5.2 cm (Fig. 5, *9*). Its original measurements presumably were 12.3 × 11.0 × 6.5 cm; the size of the hole is 2 × 6 cm. The surfaces are smoothened and polished. Dents are present on one wide side of the object.

Tools for procuring stone (4 spec.), including percussion tools (3 spec.) and a hammerstone (a fragment) were made of siltstone and sandstone pebbles and tablets. Percussion tools (Fig. 5, *11*) are of elongated subrectangular shape in plan view; they were made by direct percussion and polishing; the butts were sharpened by knapping. Side surfaces in one object (10.5 × 7.8 × × 3.9 cm) were trimmed by knapping for attachment; the cutting edge on the dorsal surface was sharpened asymmetrically. Two other tools (12.5 × 6.5 × 2.5 and 15.8 × 4.5 × 4.1 cm) have rounded cutting edges; the working edges were removed by knapping. The hammerstone is rectangular in shape and is suboval in cross-section. Both of its ends were broken off; dents are present on the sides. Its size is 6.1 × 2.4 × 2.0 cm.

Tools for harvesting wood (15 spec.) include chopping tools (3 intact, 12 fragments, and a blank) of two types (Fig. 5, *12*). The first type consists of elongated, suboval objects in plan view, which are semicircular in cross-section. The second type consists of rectangular objects in plan view which are rectangular (subtype 1), semicircular (subtype 2), or triangular (subtype 3) in cross-section. They were made by direct percussion and polishing. The butts were treated by knapping; the cutting edges are symmetrically sharpened and often show traces of wear. The raw material was siltstone and mudstone, in rare cases siliceous rock. The length of the tools varies from 11 to 20 cm, and on average is 12.5–15.5 cm.

Tools for digging (2 spec.) are hoes (Fig. 5, *10*) made by direct percussion of flat siltstone and argillaceous pebbles of oval and elongated sub-trapezoidal shape in plan view, which are of flattened lenticular shape in cross-section. All surfaces show spalling originated from modeling the form, and negative scars; the sides have recesses for attachment. The cutting edges are asymmetrically sharpened and show traces of wear. The sizes of the tools are 6.7 × 4.6 × 1.7 and 14.2 × 5.5 × 3.9 cm.

Thus, most of the tools for procurement are associated with economical activities intended for life support. Fishing tools are few in number. In addition, there were almost no weights, which may probably be explained by keeping the weights directly at the places of fishing on the riverbank.

Tools of the second category, associated with processing of various materials, were divided into four groups.

Tools for processing stone (17 spec.) include a retoucher, a hammerstone-anvil, percussion tools-anvils (2 spec.), abraders (9 intact and 3 fragments), and a stand for bow-drilling (a stone with a cavity). The retoucher (Fig. 6, *1*) of siltstone pebble has a rectangular shape with rounded corners in both plan view and cross-section. The working end shows the traces of wear and is abraded. Its size is 6.8 × 1.8 × 1.8 cm. Hammerstone-anvil is a sandstone pebble measuring 8.4 × 5.8 × 3.8 cm. Anvils-percussion tools (Fig. 6, *16*) are siltstone pebbles of sub-rectangular shape in plan view and cross-section. Dents, holes, and traces of repeated striking appear on their surfaces. Their sizes are 7.0 × 5.0 × 3.8 and 11.0 × 4.9 × × 2.9 cm. Grindstones (Fig. 6, *17*) of sandstone tablets from 5.7 to 35.0 cm long have traces of honing and sharpening of tools in the form of grooves on the flat surfaces and polishing on the side. A stand for bow-drilling is a spherical boulder with a diameter of 19.9 cm with three holes (in the center) on the top and a flat underside.

Woodworking tools (83 spec.) include axes (5 intact, 10 fragments, and a blank), adzes (28 intact, 22 fragments, and two blanks), chisels (4 spec.), gouges (one intact and two fragments), a cutter, burin-drill, planing-knives (2 spec.), and saws (3 intact and a fragment). The axes (Fig. 6, *19*) are similar in their characteristics to the tools for harvesting wood, but differ in length, measuring on average 8–10 cm. According to the processing technique, adzes (Fig. 6, *20*) can be divided into tools formed only by direct percussion or direct percussion with the subsequent polishing of the entire surface. Two types can be distinguished in terms of shape. The first type includes tools, elongated sub-rectangular in plan view, including sub-rectangular (subtype 1), sub-trapezoid (subtype 2), and semicircular (subtype 3) in cross-section, and elongated sub-trapezoid in plan view, including sub-rectangular (subtype 1) and lenticular (subtype 2) in cross-section. The cutting edges are rounded or straight, with asymmetrical sharpening. The length of the adzes varies from 5.5 to 11.5 cm; the average length is 9–10 cm. The adzes were made of siltstone, mudstone, and siliceous rocks.

Chisels (Fig. 6, *7*) and gouges (Fig. 6, *2*) are elongated sub-trapezoid in plan view, with carefully polished surfaces and sharpened lateral facets. The cutting edges are sharpened asymmetrically and can show notches and indentations; gouges may have a distinctive notch. The

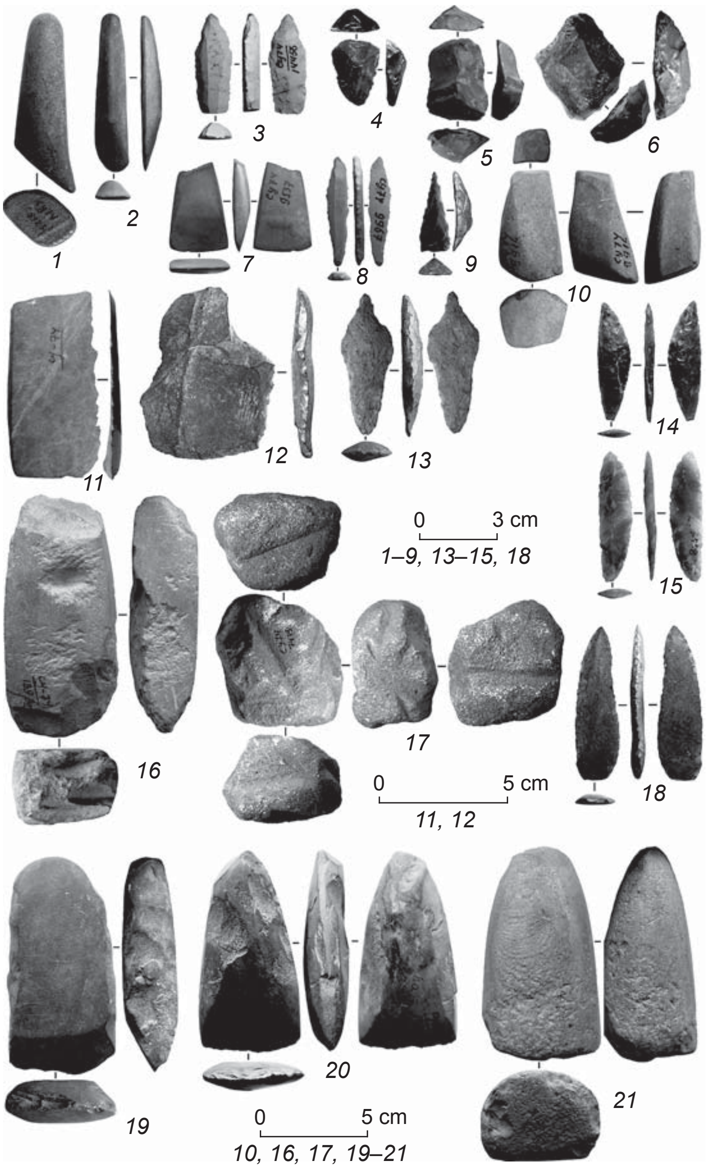

Fig. 6. Tools for processing and consumption.
1 – retoucher; *2* – gouge; *3*, *8*, *9*, *13* – piercing tools; *4–6* – end-scrapers; *7* – chisel; *10* – polishing tool; *11* – saw; *12* – side-scraper; *14*, *15* – all-purpose meat knives; *16* – anvil-percussion tool; *17* – abrader; *18* – knife for meat and fish consumption; *19* – axe; *20* – adze; *21* – pestle.

length of the chisels varies from 3 to 5 cm; the length of the gouges reaches 6 cm. The raw material was siltstone and siliceous rocks. The cutter is rectangular in plan view with a sharpened working edge. The burin-drill has a diamond-like shape in plan view, with a distinctive point, and the opposite working edge retouched by discontinuous edge removals. Miniature jasper pebbles 3.4 × 1.6 × 0.5 and 4.6 × 4.2 × 0.8 cm in size served as raw materials for these tools. Saws (Fig. 6, *11*) were made of siltstone laminar flakes and a knife-like blade. They are sub-rectangular in plan view with the length varying from 5.0 to 9.5 cm. The teeth on the blades were formed with special spalls. Planing-knives were made of quartz flake (3.0 × 2.4 × 0.5 cm) and siliceous laminar spall (4.7 × 1.5 × 0.6 cm); they are sub-triangular and sub-rectangular in plan view with recesses on the lateral sides.

It should be noted that the cutter, burin-drill, saws, and planing-knives might have also been associated with the processing of bone and horn. Trace analysis is needed for a more accurate definition.

Skin/leather processing tools (116 spec.) include side-scrapers (12 spec.), end-scrapers (53 intact, 4 fragments, and 10 blanks), scraper-knives (10 spec.), scraper-piercing tools (7 spec.), piercing tools (14 intact, a fragment, and a blank), and polishing tools (4 spec.). The latter were made of sandstone and siltstone; the rest of the tools were made of siltstone and mudstone, as well as siliceous rocks. Side-scrapers (Fig. 6, *12*) were made on very large (5.1–8.8 cm long) flakes and spalls (including laminar flakes) of square, diamond-like, rectangular, and sub-trapezoid shape in plan view. The lateral sides are treated with knapping; the blades are treated with uni- or bilateral continuous or intermittent edge retouching. Scrapers (Fig. 6, *4–6*) are represented by end-scrapers (predominantly), side-scrapers, with one or two terminal and lateral cutting edges, or of various types with two working ends. Most of them were made of pebbles, but there are some made of flakes and spalls, including laminar spalls and a knife-like blade. Virtually all of them are treated at the cutting edge by dorsal edge retouching, sometimes quite steep (45°), and measure from 2.2 × 1.6 × 0.7 to 7.1 × × 2.7 × 0.7 cm; the average length is 2.5–4.5 cm. Combined scraper-piercing tools and scraper-knives also occur. Piercing tools (Fig. 6, *3*, *8*, *9*, *13*) belong to four types, and include those close to angular, angular, shouldered, and objects with a "beak". They were made of pebbles, flakes, laminar spalls, and knife-like bladelets, and vary in size from 2.1 to 6.7 cm, on average from 3 to 5 cm. Polishing tools (Fig. 6, *10*) of square, rectangular, and sub-trapezoid shapes in plan view are rectangular in cross-section. All surfaces could serve as working surfaces; they are brushed, polished, and glossed. The size of the tools varies from 3.5 × 3.2 × 1.7 to 6.8 × 1.8 × 1.8 cm, but there is a relatively large tool (17.8 × 3.4 × 1.3 cm).

Tools for processing grains (3 spec.) include pestles (one intact and a fragment) and a grinder. Pestles (Fig. 6, *21*) were made of siltstone; the grinder was made of fine-grained sandstone. The working edges are flat and show traces of abrading. The intact pestle measures 9.8 × × 5.5 × 3.9 cm; the fragment measures 6.8 × 5.7 × 3.4 cm.

As we can see, the second category is dominated by tools associated with processing of skins / leather, which is not accidental given the general focus of economic activities pursued by the inhabitants of the dwelling on hunting and fishing. It is possible that not only the skins of animals were treated, but also the skins of fish.

The third category includes tools for consumption and consists of one group.

Tools for meat and fish consumption (25 spec.) include knives for eating meat and fish (12 intact and 5 fragments), and all-purpose knives (6 intact, a fragment, and a blank). They differ from the "meat" butcher-knives described above primarily by their sizes. Knives for consumption (Fig. 6, *18*) were made of flakes, laminar flakes, and spalls; their length varies from 3.0 to 5.3 cm. All-purpose "meat" knives (Fig. 6, *14*, *15*) are bifaces ranging from 5.5 to 6.2 cm in length. Cutting tools also include knife-like blades as well as laminar flakes and spalls with typical notches and traces of wear.

Thus, just as the first two categories, the tools are associated with products of hunting and fishing.

In general, the morpho-typological and functional analyses of stone implements have shown both the presence of artifacts resulting from primary splitting, and tools in the settlement complex. Those associated with processing of various materials (219 spec.) dominate among the tools. There were fewer tools intended for procurement (76 spec.) and consumption (25 spec.). Nevertheless, their presence testifies to the comprehensive nature of the economical activities pursued by the inhabitants of the dwelling, who were primarily focused on hunting and fishing.

In terms of cultural and chronological attribution of the lithic inventory, the pebble tradition of tool production is correlated mainly with the Malyshevo and Voznesenovskoye cultures, while the laminar tradition with the Kondon and Belkachi complex. Accordingly, the bifaces most likely belong to the "Malyshevo" population; polished adzes, gouges, and chisels belong to the "Voznesenovskoye" population, while the laminar complex belongs to the "Kondon" and "Belkachi" population.

Planigraphic analysis of the dwelling has made it possible to establish some regularities in the distribution of lithic artifacts (30 tools, including fragments and blanks, and 5 knife-like bladelets on the level of the floor) (see Fig. 2, *B*). The size of the horizontal ground where hearths and assemblages of artifacts were located, that is, the floor of the dwelling, was 6.5 × 5.5 m. The entire remaining internal space from the even part of the floor to the external contours was taken up by wide ledges, which were particularly distinctive in the southwestern and western parts of the dwelling pit.

Four areas of the artifacts clustering have been identified (see Fig. 2, *C*). Three of them are associated with ledges of the dwelling pit and the adjoining parts of the dwelling floor: the southern (I – grid 24–26 / Г′–А), west-northwestern (II – grid 26–32 / Б–Д), and northeastern (III – grid 29–32 / В′–Ж′) areas. One more area can be called "the hearth area" (IV – grid 27–29 / В–В′), since the tools in this area were concentrated around hearths 2 and 3. The west-northwestern area was the largest; it included hearth 1 and was located next to the "hearth area" almost joining it. The southern area was also not very far from hearths 2, 3, while the northeastern area was located at some distance; the distance from its boundary to the nearest hearth 3 was not less than 1.5 m.

Tools for procuring and processing meat (two arrowheads and a blank of an arrowhead, two knife-like blades, a knife, and a blank of a knife), stone processing (a grinding slab and whetstone, a stand for bow-drilling), wood processing (two adzes and a gouge), as well as skin and leather production (a side-scraper, three end-scrapers, a scraper-knife, and two piercing tools), were concentrated in relatively large numbers in the southern and western-northwestern areas. A huge boulder-"seat" was also located in the western-northwestern area (Okladnikov, 1974: fol. 15). Tools for processing stone (whetstone), skins and leather (side-scraper and end-scraper-piercing tool), grains (grinder), and for consuming meat (knife and three knife-like blades) were concentrated in the northeastern area. The area of the hearth contained only tools for processing various materials: stone (two whetstones), wood (two adzes and an axe), and skins (end-scraper). Three more tools associated with wood procuring (grid 24/Г) and processing (grid 26/Е′), were located outside the above mentioned areas.

Thus, the location of the lithic inventory makes it possible to conclude that ledge-beds were most comfortable for working and resting inside the dwelling. The concentration of the tools associated with processing various materials near the hearth is completely justifiable from a functional point of view. A cumulative analysis of tool distribution makes it possible to draw some conclusions regarding the spatial differentiation of internal space in the dwelling. There were two "working" areas (south and west-northwest) and one area (northeastern) primarily associated with food consumption. In conclusion, we should note that our analysis may serve as a basis for comprehensive planigraphic reconstruction of specific activities carried out by the inhabitants of the settlement on Suchu Island.

Discussion and conclusions

This study has established that sedimentary and siliceous rocks were the main raw materials for the inhabitants of dwelling D. The former included siltstone, mudstone, and sandstone; the latter—flint, quartzite, chalcedony, and jasper. The tool set clearly indicates the comprehensive nature of the economy, primarily oriented at hunting and fishing. Tools for hunting, fishing, and processing the procured animals, fowl, and fish have been found, as were tools for processing stone, wood, bone and horn, skin and leather, and tools which in some way were associated with processing the products of gathering and cultivation of land. All this makes it possible to conclude that by the 4th millennium BC, the Neolithic population of Suchu Island represented the economic and cultural type of hunters of taiga animals, fishermen, and gatherers, typical of the inhabitants of the valleys of large rivers.

The planigraphic analysis has shown that specific areas of activities of ancient inhabitants, associated mainly with processing and consumption of food, can be identified within the boundaries of the dwelling. The number and nature of the lithic inventory, as well as the overall structural features, make it possible to determine that this was a long-term winter dwelling.

We should note that dwelling D is not unique. Our later excavations on the island revealed dwellings (24 and 26) of the Malyshevo culture, somewhat similar in size, structure, and arrangement, but to a greater extent similar in the composition of the lithic inventory (Derevianko et al., 2000: 198–200; 2002: 178–181, 253–254). They also contained tools for hunting and fishing, procuring stone and wood, as well as processing various materials and food consumption (Derevianko et al., 2000: 178–181, 193–198; 2002: 253). The main raw material was siltstone; less frequently, siliceous rocks were used.

Concerning the internal arrangement of the dwellings, we should note the following feature. Although special ledges that could serve as beds were observed in the pit of dwelling 26 only in individual locations, three hearths were found on the floor of this dwelling, just as in dwelling D: two in the center and one on the side. A grinding slab was discovered next to the largest hearth (Derevianko et al., 2002: 253). On the contrary, ledge-beds in dwelling 24 were found practically along the entire inner perimeter of the dwelling pit. The hearth was missing in the center, but it was found directly at the eastern wall, or even on the ledge (Derevianko et al., 2000: 198–200). In dwelling D, one of the hearths (1) was also located on the ledge of the dwelling pit.

A date from the sample of charcoal found in the pit in the floor (5870 ± 45 BP) was obtained for dwelling 26 (Derevianko et al., 2002: 356). This date is close to the date of dwelling D (5830 ± 69 BP) (Medvedev, Filatova, 2016: 58–59). Dwelling 24 is slightly earlier (6070 ± 90 BP) (Derevianko et al., 2000: 203). Thus, the time when the dwelling complexes functioned was the late 5th to early 4th millennium BC.

The main result of the study was the creation of a database for the economic orientation of the ancient Neolithic population living on Suchu Island and in the entire Lower Amur Region for the subsequent reconstruction of the regional paleoeconomy.

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From Chauvet to Lascaux: 15,000 Years of Cave Art

The earliest art of Western Europe was evolving along with the Homo sapiens population of hunter-gatherers in the glacial environment of the northern hemisphere over the entire Upper Paleolithic (36–13 ka BP). The most important rock art sites (such as Altamira and La Garma in Spain, and Lascaux, Niaux, Cussac, and Chauvet in France) are relevant to the socio-cultural behavior and needs of anatomically modern humans. In this article, we intend to identify certain changes in the symbolic language, in the ways animals are rendered, and in the layout of artistic space over 15,000 years separating the two key rock art galleries with the best preserved representations: Chauvet (36 ka BP) and Lascaux (21 ka BP). Chauvet, discovered in 1994, is located in the Ardèche Valley, near the Mediterranean coast. In this large cave, numerous new kinds of Upper Paleolithic rock art have been documented, spanning two distinct occupation-periods between 37,000 and 30,000 years ago. The early stage is the Aurignacian, with black zoomorphic paintings, dating to 37,000–33,500 BP. Lascaux, discovered in 1940, is situated in the Vézère Valley, 120 km away from the Atlantic coast, among a large cluster of other sites of rock art in caves and rock shelters. Today, the cave is closed for the public, because intense tourist activities through the many years from its discovery until 1963 have disrupted the microclimate of the cave and endangered the paintings.

Keywords: *Western Europe, rock art, caves, Ice Age art, Upper Paleolithic.*

Introduction

In Western Europe and especially in the Atlantic zone, the western part of the Mediterranean, explosion of rock art is associated with *Homo sapiens*, carriers of a specific hunter-gatherer culture that developed over this territory during the glacial period*. The first manifestations of visual art are noted in the Aurignacian, the culture of the Upper Paleolithic, which was very long-lasting and widespread. This phenomenon covers a period of 36–13 ka BP.

The most expressive monuments of cave art, such as Altamira (Breuil, 1952), Trois-Frères (Breuil, 1952; Bégouën et al., 2009), Niaux (Breuil, 1952), Lascaux

*A phenomenon of cave art took place in the Atlantic zone, the Western Mediterranean, in the Upper Paleolithic (40–13 ka BP). The absence of examples of Upper Paleolithic rock art and portable art in the Eastern Mediterranean and the Middle East is a fundamental fact that seems to be related to another cosmological model, a different perception of the world, a different ontological concept (Cauvin, 2000), and different ways of transferring knowledge. This is a completely different world, where agriculture will later occur (see, e.g., (Bar-Yosef, 1997; Davidson, 2012)).

(Aujoulat, 2004; Geneste, 2012, 2015b), Cosquer (Clottes et al., 1992), Chauvet (Breuil, 1952; La Grotte…, 2001, Recherches…, 2005; Geneste, 2015a) and Cussac (Aujoulat et al., 2002), shed light on the sociocultural behavior of, and the areas of interest to, the anatomically modern humans. When visiting these monuments, it becomes obvious what an exceptional value the images rendered in the caves had in the ideology of their creators. These were manifestations of the first forms of mythology and religion as the concepts of understanding the world, represented in the form of graphics, drawings, and portable art.

In this paper, we provide an analysis of changes in symbolic language, in the ways animals are rendered, and in the layout of artistic space over 15,000 years. These are well traced primarily in two caves, where primitive art has survived in excellent condition. The Chauvet (36 ka BP) and Lascaux (21 ka BP) are amazing archaeological sites, which have no analogs. Like all the great masterpieces engendered by human consciousness, whether monumental statues or the most significant sacral sites, these are (in the perception of the early last century, as proposed by H. Breuil and R. Lantier (Breuil, Lantier, 1951; Breuil, 1952)) simultaneously unique works of art, and sanctuaries, inextricably connected with the environment. They depict deep cultural features or, in other words, fossil traces of human thought that are either arranged sequentially, or scattered in an unimaginably vast space of time. They tell us about commonalities and differences, about the continuation of traditions and novelties.

Art in the depths of caves

From the beginning of its spread over Western Europe at the early stages of the Aurignacian culture (more than 40 ka BP), primitive art looks not only mature, but full of dynamism and amazing creative potential. Its expressiveness is mainly the result of the imagination of people who were the creators of the first art*. In the darkness and silence, in the depths of the caves, this responded in the imagination, thereby giving birth to a myth. In the light of the day, a completely different art surrounded the everyday life of a human—the art of daily life, the present. The hidden cave-space, apparently, functioned quite differently: these were sacred places, where the spirits of humans, animals, and nature were somehow co-present (Geneste, 2012, 2015a).

By the example of the Chauvet cave*, with its dynamic and expressive images of animals (Fig. 1), located separately from each other or showed in complex compositions, we can see a permanent presence of imagination. Here, images of aggressive and powerful animals such as mammoth, lion, leopard, rhinoceros, giant deer, and bear prevail. Bison, aurochs, horses, deer, and goats are widely represented, too.

In Chauvet, as in Lascaux, only the representatives of individual species were depicted, except for fantastic zoomorphic images combining features of various animals. This was a sample made by a human from all the surrounding animal kingdom. Animalistic subjects, not very diverse over about 25 thousand years, were used as abstract symbols designating living beings (humans and animals) in the darkness of caves. During the Upper Paleolithic, a set of depicted animals evolved in accordance with cultural and climatic changes. In Lascaux, images of bison, aurochs, and horses already predominate (Fig. 2). At the same time, images of deer, bear, lion, and rhinoceros still occur, but already in a different status.

Other subjects in the cave art

In Lascaux, in addition to the animal images, there are quite a lot of abstract symbols (Fig. 3). These are signs of various geometric forms, sometimes figurative, but their meaning is unclear to us. Some symbols found in Chauvet Cave are typical of the Gorges de l'Ardèche: a sign in the shape of W and the so-called bilobed symbols (resembling a butterfly) made with a red pigment and divided by a line in the middle (Fig. 4). In Lascaux, as in most of the caves, there are no floral motifs. An exception is one image (executed using a red pigment) overlapping the figures of horses in the depth of the *Passageway* (Fig. 5).

Anthropomorphic images are often partial, and unrealistic, even "caricatured", and are always extremely rare. They are usually located far from the entrance, in the depths of the most distant gallery, where drawings are densely concentrated. In Lascaux, the only known depiction of a human is hidden at the bottom of a hard-to-reach well deepening. The image is rendered schematically, and its anthropomorphic features are combined with ornithomorphic ones (bird's head)

*Here, for simplicity of understanding, the term *art* embraces a variety of different categories connected with pictorial activities, from the decor of everyday objects to a purposefully rendered shape. This designation cannot be associated with anything besides aesthetic value, mythological and, in a broad sense, spiritual fullness; but at the same time, these categories have nothing to do with the modern understanding of this term (see, e.g., (Davidson, 1997, 2012; Conkey, 1997)).

*All the photos are taken by the author (copyrights of the Ministry of Culture and Communication of France).

Fig. 1. Alcove of Lions in the Hillaire Chamber of Chauvet Cave.

(Fig. 6). In contrast, the first image that opens the *Hall of the Bulls* is a figure of a mysterious and fantastic animal, a unicorn. Its body looks as if it consists of parts of animals of various species.

In Chauvet, anthropomorphic images are always placed in the structure of compositions. These are partial representations, and also symbolic images in the form of triangular female signs, represented in the *Megaloceros Gallery*. One anthropomorphic image is imprinted in the distant hall of the cave: a lower part of the female body is depicted on the hanging narrow conical salient. The drawing is compositionally connected with images of a bison, a lion, and a lioness, located in the same space (Fig. 7). It is comparable to others, painted in a similar manner. As far as the zoo-anthropomorphic images are concerned, there is only one example of such a fantastic creature in the Aurignacian period: representation of a human with a lion's head in Hohlenstein-Stadel Cave, in the Swabian Alps. In addition, there is one example known from the Magdalenian period: a "sorcerer" in Trois-Frères Cave, in the Pyrenees (Breuil, 1952). Thus, this pictorial tradition has existed for many millennia.

Arrangement of animal images in a cave

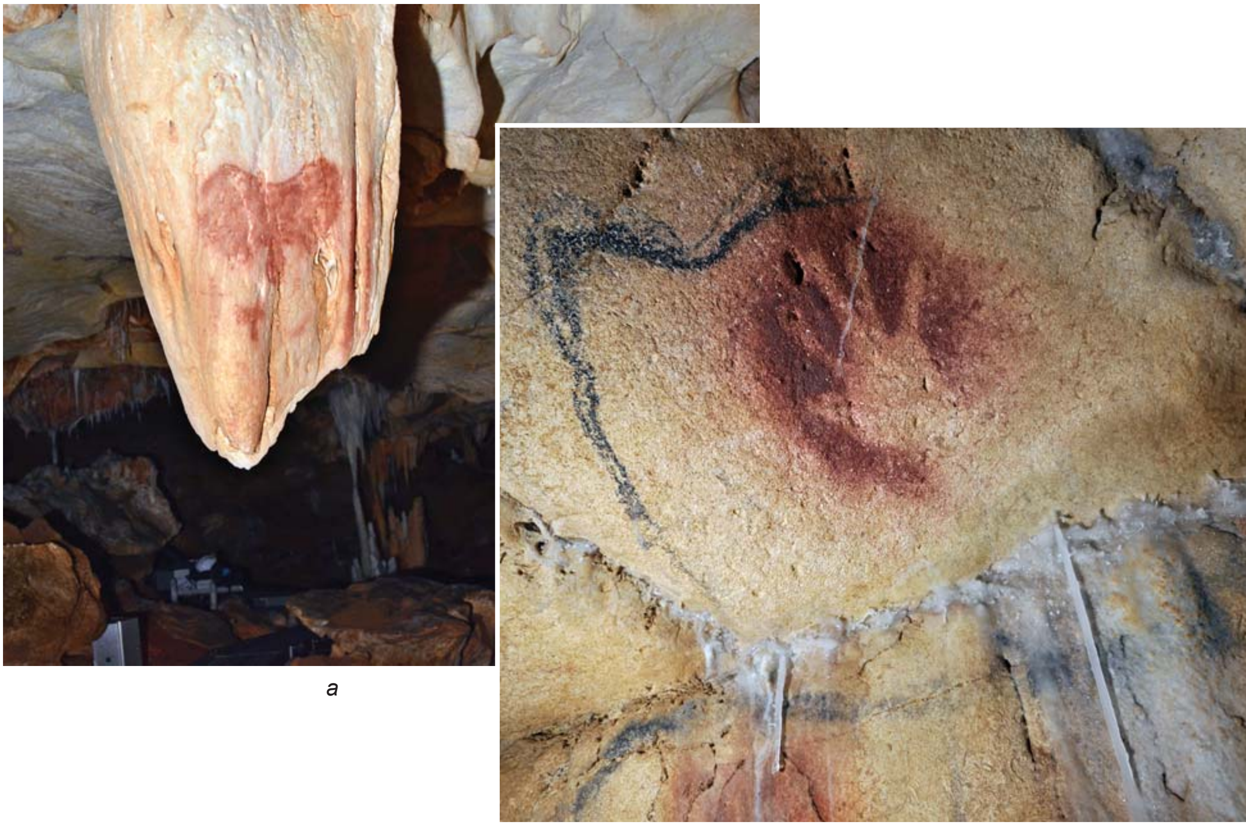
Locations of drawings in a cave are not accidental. Ancient "artists" intentionally chose special sites, and sometimes they made special preparations at these sites. The space with drawings constituted a harmonious meaningful ensemble. A. Leroi-Gourhan (1965) was the first to pay attention to the special arrangement of space in cave art, in the early 1960s.

In terms of delicacy of performance and compositional complexity, the ensembles of Chauvet Cave have no analogs, because here we see full-fledged compositions, in every sense of the word. Some of them contain several dozens of animal representations (Fig. 8). The soft, pliable surface-texture of many cave-walls allowed artisans to return to these compositions, permanently supplementing them. It is well seen here how the surface changed at various stages of creation of drawing series, and what successive changes were made before the completion of this complex artistic ensemble (Fig. 9).

In Lascaux, the sequence in which the images were drawn at various periods of time can be traced quite clearly,

Fig. 2. Images of ungulates (horses, aurochs, bison) in Lascaux Cave.

Fig. 3. A sign in the form of a lattice. Lascaux.



a

b

Fig. 4. A bilobed symbol divided by a line in the middle (*a*), and a handprint (*b*). Chauvet.

Fig. 5. Floral motifs. Lascaux.

Fig. 6. Anthropomorphic image with ornithomorphic features. Lascaux.

Fig. 7. Representation of a lower part of the female body, compositionally connected with the figures of bison, lion, and lioness, in the distant hall of Chauvet Cave.

Fig. 8. Complex compositions consisting of several images of animals, in Chauvet Cave.

Fig. 9. Panel-pictures made using an engraving technique on the soft surface of the wall of Chauvet Cave.

Fig. 10. Palimpsests in Lascaux Cave: overlapping the small figures of bulls and horses with a large painting of a bovid.

because it is associated with changes of subject. There is an imposition of images of large black bulls on the figures of horses and smaller red bulls, observed repeatedly in several places (Fig. 10). These palimpsests recorded in a number of galleries may be interpreted in various ways. The cases where the top drawings completely cover the lower ones may be explained by the fact that the drawing of images was connected with self-identification of various population groups. Newcomers attempted to hide the drawings associated with other communities and, as a consequence, to mark the given territory as their own. In the cases where the fragments of the lower images seem to peep out from under the upper ones (which could have been intentional), this might indicate the evolution of views and thoughts, but at the same time testify to the continuity of the development of a certain intent and respect towards the works of predecessors. This interpretation illustrates the concept of cultural differences. However, it should be borne in mind that the creators of these palimpsests were apparently separated by a fairly long period of time, which could have included alternation of generations, centuries, and even millennia.

Large spaces and secluded places

Recent observations in Chauvet Cave offer new prospects for possible interpretations. Some characters, such as bears, are located in hard-to-reach places (Fig. 11). One can find them only if one is very good at navigating in a pile of large, chaotically arranged stones, and only by oneself is it possible to penetrate this narrow space.

In the Paleolithic, people deliberately created monumental art ensembles intended for the community as a whole (for example, the surface with representations of horses and the distant hall of Chauvet or the *Hall of the Bulls* and the *Passageway* of Lascaux). However, at the same time, there were hidden, secret works of art, placed in narrow, remote places, where only the sight of a knowledgeable person could have recognized them. Such are, for example, the depictions located in the *Apse*, the *Shaft*, and the *Chamber of Felines* of Lascaux Cave. Within the same period, the cave could have had various functions and visited with various purposes. Chauvet is an example of amazing cave art and the greatest sanctuary. Here we can see various uses of one monument: on the one hand, large spaces with huge panel pictures; on the other, secluded places with separate images, not intended for the general public. However, this phenomenon could have also been associated with visiting the cave by various groups of people who expressed themselves in different ways.

Creation of life on the virgin walls of a cave

Within Western Europe, caves, being the abodes of dangerous animals, represented a completely different

Fig. 11. Image of a bear in a narrow passage. Chauvet Cave, Brunel Chamber.

world from the one humans created around them in open spaces. Take, for example, the light that humans had to "tame", in order to control the level of illumination using torches and hearths. The latter are quite numerous in Chauvet: at almost every site of the cave, remains of charcoal and traces of fireplaces were discovered. In Lascaux, the use of oil lamps was very probable.

At the times when hunter-gatherer-fishers came to symbolic thinking and had only begun to express their ideas graphically, they had at their disposal the untouched, virgin cave walls. And they chose the most suitable ones for creating meaningful performances rendered through animal images and abstract symbols. At the same time, even for the most masterfully reproduced paintings they used the simplest means. Creation of a dynamic image of an animal meant the creation of life. This principle made the art even more realistic, since the images of animals became the main characters and some kind of transport in a mythological narrative. The recurrent compositions on the walls of caves and similar subjects in portable art, represented at various sites and sometimes even in various regions, indicate the commonality of ideas connected with them, and consequently, the common oral traditions. This suggests the interaction between the population groups, which apparently used the same myth (Godelier, 2007).

Meanings in the cave art of Chauvet and Lascaux

At present, in social anthropology, the main types of worldview have been formulated, which allows us to attribute, at a conceptual level, the perception of the world by Paleolithic hunter-gatherers to one of these types (Ibid.). The world-perception of these people was not divided into categories of "living" and "lifeless", "human" and "animal" (Descola, 2006; La fabrique…, 2010). In the cave art both in Lascaux and Chauvet, probably for similar reasons, a deep empathy is observed: an unquestioned idea on the affinity between humans and the large mammals, both herbivores and carnivores, whose images prevailed.

The skill of the first "artists" was primarily due to the fact that they were hunters responsible for survival of their relatives. They hunted at the risk of their lives, meeting face to face the animal world, which they knew very intimately, up to the smallest habits; and they clearly realized that the animal that is to become food instantly turns into a spiritual ally, a mediator in the spiritual practice, embodied in the image. In the Paleolithic, animals became food for a human himself and for his imagination. Thus, the predominance of animalistic subjects in the cave art reflects the spiritual affinity existing between animals and humans.

Conclusions

Cave art had existed in Europe in Paleolithic over several dozens of millennia. Animals were the first thing that humans began to depict, to think about, and to recall in their imagination. This close relationship or spiritual symbiosis between animal and human is basic and life-giving. The masterpieces of Chauvet and Lascaux are separated from each other by 15,000 years, and reflect the difference in the content of the thought-processes of anatomically modern humans. These amazing paintings tell us about two peculiar cultures of the world that we can only slightly touch, the world of traditions, which knew both long succession and stability, and also turning points, novelties, and oblivion.

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New Engravings from Abri Du Poisson (Dordogne, France)

The Abri du Poisson rock-shelter is famous for a very realistic and detailed bas-relief of a fish (salmon). Representations of fish are quite rare in Paleolithic cave art. Another image present in this rock-shelter is a negative of a hand, made in black pigment (manganese oxide). Also, the National Museum of Prehistory in Les Eyzies de Tayac (Dordogne) owns several blocks of rock, painted red, with relief representations belonging to the Aurignacian levels of Abri du Poisson. Since the early 1900s, studies at that site have focused mostly on the famous representations. The 2016 field study was a preliminary stage in a new project. It focused on a detailed inspection, preceding the traceological analysis of engravings and bas-reliefs. During our examination, new engravings were discovered, and photogrammetry was used for 3D visualization of these. As a result, we have demonstrated that the newly discovered elements are indeed representations, rather than natural lines.

Keywords: *Cave art, rock art, traceology, 3D imaging, rock-shelter, Abri du Poisson, Dordogne, France.*

Introduction

The Abri du Poisson rock-art site is located on the right side of a small ravine known as Gorge d'Enfer, between the locality of Laugerie Basse and a bridge across the Vézère River, close to the railway station of the town of Les Eyzies-de-Tayac-Sireuil (Dordogne) (Breuil, 1952: 304–305; Delluc B., Delluc G., 2009: 51). It was discovered in 1892 by P. Girod. Since that time, repeated excavations have been conducted here: in 1898, by Galou*, in 1912, by J. Marsan, and in 1917–1918, by D. Peyrony (Roussot, 1984: 154).

On December 11, 1912, Marsan discovered a large bas-relief representation of a fish on the rock-shelter roof (Peyrony, 1932: 246; Delluc B., Delluc G., 1997: 171). In 1917, with the help of brushes and a large amount of water (Peyrony, 1932: 263), the roof was cleared of the moss, abundantly growing in the humid environment of Dordogne forests and often covering open areas of limestone, which forms the main elements of the terrain's relief in this region. According to Peyrony, no other images were found, apart from the fish and an adjacent unidentified relief representation that, obviously, preceded it (Ibid.). Since the limestone is rather soft, it can be assumed that some drawings from Abri du Poisson were not only damaged, but completely erased. Possibly, this fact influenced the selected line of research: only distinctive figurative elements were

*The first name of the researcher is not mentioned in publications.

studied. Much less attention was paid to small fragments and feebly-marked lines. Specialists point out that the roof was, probably, insufficiently examined: "A large number of engraved elements, which may represent lines of backs, legs, horns, tails, or eyes of animals, can be observed everywhere on the rock-shelter ceiling… Careful tracing over the outlines could reveal new images" (Roussot, 1984: 155).

As already mentioned above, Abri du Poisson is famous for a very bright realistic representation of a salmon (Fig. 1, *3*). This is a bas-relief located in the left part of the rock-shelter and being about 105 cm in length and 28 cm in the widest place, i.e. life-size, with a large number of anatomical details (Peyrony, 1932: 263; Roussot, 1984: 155). Roussot was also the first to record the barely perceptible traces of red pigment in the protruding areas of the bas-relief (Roussot, 1984: 155). The pigment is also present in the cultural deposits of Abri du Poisson (Cleyet-Merle, 2016: 10).

In December 1975, in the right part of the rock-shelter, S. Archambault and A. Roussot found a small (about 10 cm) negative of a hand, made in a black pigment, namely manganese oxide (Roussot, 1984: 154) (Fig. 1, *2*). In 1983, B. Delluc and G. Delluc identified the engraved lines on a large limestone block (about 2 m high), earlier mentioned by Peyrony, as an image of the female sign (Delluc B., Delluc G., 1991).

In addition to the above depictive elements and bas-relief on the rock-shelter's roof, several rock blocks with whole images (or fragments of them) were also found in the cultural layer (Peyrony, 1932: 259–263; 1952: 566). Some of these blocks, which are currently stored in the museum, show traces of red pigment similar to those on the rock-shelter's roof (Ibid.).

Chronological attribution of the images

Peyrony has identified five lithological layers, in two of which cultural remains were recorded: in the first case, they belonged to the Early Aurignacian (layer b), and in the second case, to the local Gravettian variant, of which the Noailles burins are typical (layer d) (Roussot, 1984: 154; Jaubert, 2008: 226; Cleyet-Merle, 2016: 10). It has been established that these cultural layers are separated by a sterile yellowish interlayer (layer c), presumably related to desquamation due to cryoclastism (Ibid.).

In the Aurignacian layer, several rock blocks were found with figurative elements in relief, such as the female sign, fragmentary images of ungulates, etc. Peyrony (1932: 259) did not find them *in situ*, but when studying the dump left by the previous excavations conducted by Girod. However, the lithic industry and the general archaeological context have made it possible to assign the limestone blocks with figurative elements to the Aurignacian (Ibid: 259–262). A schematic representation of the lower part of a female body is very typical for this period (Geneste, 2017). The closest analogs are discovered in the Chauvet-Pont-d'Arc Cave (about 35 ka BP) and at the open locality of La Ferrassie (Cleyet-Merle, 2016: 29). Thus, the majority of researchers have no doubt about attribution of these images to the Aurignacian. The only question is

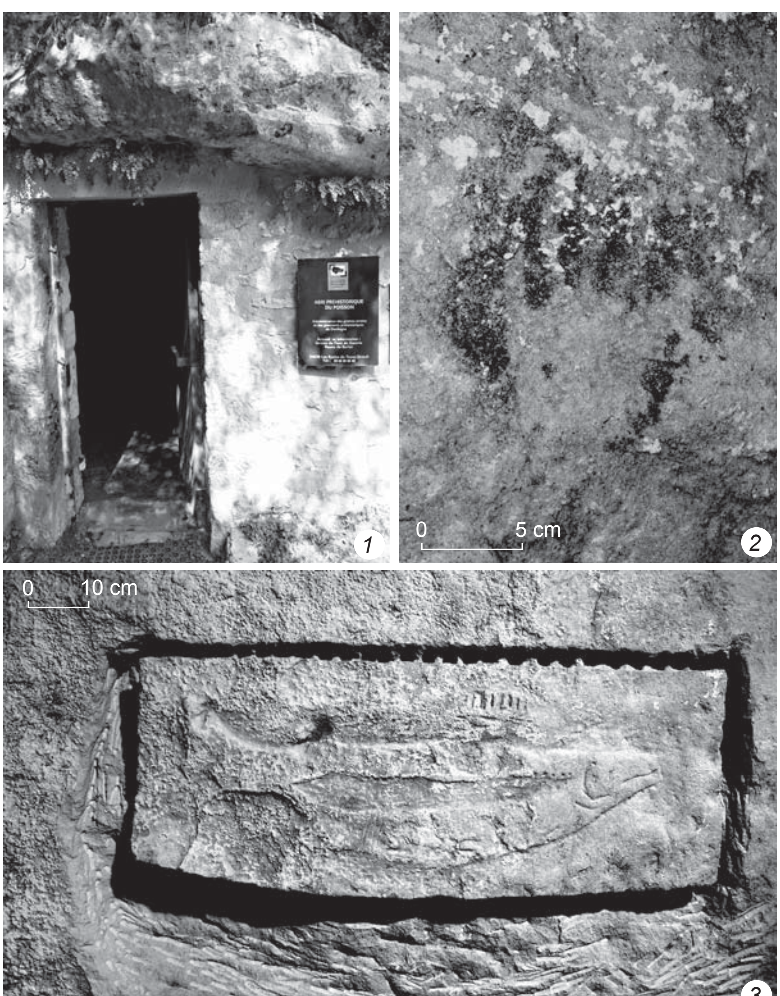


Fig. 1. Abri Du Poisson and the best-known images of this site. Photograph by L.V. Zotkina.
1 – general view of the site; *2* – negative of a hand, made in black pigment; *3* – bas-relief of a fish.

whether these blocks were specially brought to the site, or whether they split off from the roof (Ibid.).

It is commonly believed that since the Aurignacian layer is covered by a rather thick interlayer, which was presumably formed as a result of intense desquamative destruction of surface of the rock-shelter roof, the surviving images were made after completion of these natural processes. Thus, the appearance of the drawings and bas-relief can be referred to the later layer dated to the Gravettian (27 ka BP) (Ibid.: 28). However, at present, this argument is considered unreliable, since the geomorphology of the rock-shelter has not so far been studied comprehensively. It is reasonable to suppose that the roof was less affected by destructive processes than previously thought, and that external factors could have played a big role in filling the space between the floor and the ceiling of the rock-shelter (Ibid.: 10). Therefore, today we cannot state with full confidence that the destruction affected exactly the roof of the Abri du Poisson, where the images are represented, rather than other areas, from which limestone blocks could have been split off to create a sterile interlayer. So, the fact that the images are preserved on the roof does not prove that they pertain to the later periods than the Aurignacian.

Roussot draws attention to the technique used by an ancient artist to express the fish image. The bas-relief technique allows the representation of a salmon from Abri du Poisson to be correlated with the famous "Venus" of Laussel, which is reliably dated to the Gravettian (Roussot, 1984: 155). However, this cannot be a reason for referring the fish representation exclusively to this period, since such technique was typical not only of the Gravettian. Various types of relief were often used later: for example, in the Solutrean. One of the most striking examples is a rock block with representations of bulls from Fourneau du Diable, found in a layer attributed to that time (18.6–19.0 ka BP) (Cleyet-Merle, 2016: 57). Though certain tendencies in the development of image creation techniques can be traced in the cave art, none of them can be considered an unambiguous chronological marker.

Since the handprint in Abri du Poisson is made with manganese oxide, direct dating of the pigment is impossible. Nevertheless, many positive and negative prints known in the caves of the Franco-Cantabrian region are assigned to the Gravettian (some images in the Chauvet-Pont-d'Arc and Cosquer caves are made with charcoal, which has allowed their radiocarbon dating within 27–22 ka BP) (Foucher, San Juan-Foucher, Rumeau, 2007: 83). There are many directly dated images of this category, and most of them belong to the Gravettian period; however, the possibility of different chronological attribution of certain samples cannot be completely ruled out. Thus, at present, the scientific community is of the opinion that the handprint from Abri du Poisson pertains to the Gravettian (Cleyet-Merle, 2016: 29).

Apart from the most distinct images, which are clearly identified on the roof's surface, evident figurative elements, covered by a later bas-relief, are observed. First of all, this refers to an unclear image, on top of which the fish representation is made. This element was interpreted by researchers in different ways: Peyrony treated it as the head of a carnivorous bird (Peyrony, 1932: 267), Leroi-Gourhan as a fragment of the back of a bison, and Abbot Breuil, as the head of an eagle or rhinoceros (Roussot, 1984: 155). It is rather difficult to determine the subject of this representation, but it can be stated with confidence that this surface area was intentionally reworked. The problem consists in determining whether this transformation was related to a change in cultural tradition, and if this "hidden" fragment pertains to a more ancient period than the fish representation.

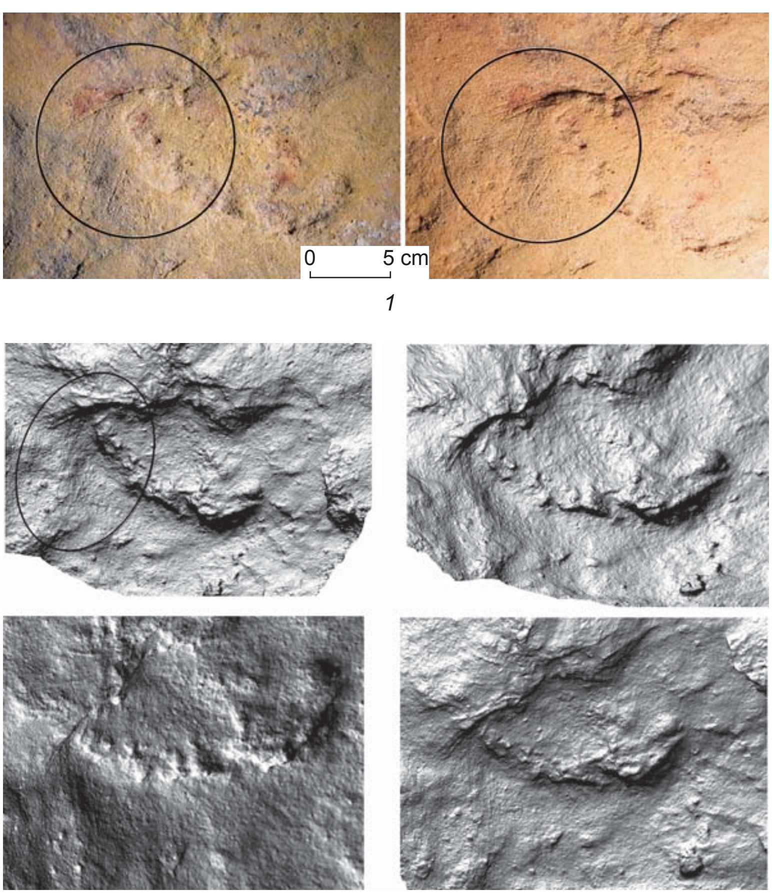
So, at the moment, at least two large periods of image creation, the Aurignacian and the Gravettian, can be distinguished in Abri du Poisson. Both are associated with the archaeological filling of the site. There is a great likelihood that separate stages can be also distinguished within these large periods. However, while attribution of the images found in the archaeological layer relating to the Aurignacian does not cause serious doubts, the issue of their belonging to the Gravettian should be considered open, since direct dating of each individual image or figurative element on the rock-shelter roof is impossible.

The "fish" rescue history

As was mentioned above, the salmon representation attracted many researchers, but not only these. The attempts of local people to recover and sell the bas-relief abroad are widely known. These precedents, actually right after the opening of the representation in 1912, provoked Peyrony to initiate a campaign to change French legislation as regards protection of historical and cultural heritage. Thus, the Abri du Poisson locality became one of the touchstones in the development of a system of measures and principles aimed at the preservation of cave art and archeology sites in general (Fig. 1, *1*). And as early as December 31, 1913, the first act on protection of historical sites was passed (Découvertes…, 1984: 31). But this factor, obviously, also influenced tendencies in the study of Abri du Poisson: researchers put a greater emphasis only on the fish representation. Naturally, such a subject, quite unusual for Paleolithic art, and the events around the site, aroused great interest from the public. Partly because of this, somewhat less attention was paid to other figurative elements of the site.

1 2

Fig. 2. Photographs of thin engraved lines illuminated by a modern LED lamp (*1*) and by a lantern manufactured in the 1960s (*2*). Photograph by H. Plisson.



1

2

Fig. 3. A partial zoomorphic image, made in the engraving technique. *1* – photographs; *2* – 3D reconstruction of the image at various angles and with various filters.

New Engravings from Abri Du Poisson

An important factor influencing the possibilities that researchers had in the past was the quality of illumination devices available in those years. Examinations of the rock-shelter walls and roof were conducted mainly before the advent of powerful light-emitting-diode lamps. In the preparation of this article, a small experiment was set up to demonstrate the difference between the modern possibilities and the means that were available to researchers of the past. Photographs were taken using different illuminating devices: a modern LED lamp and a lantern manufactured in the 1960s, with a similar arrangement of light sources (Fig. 2). They testify that the technical capabilities of the past rarely allowed all the finest details of relief to be revealed, which means that it was extremely difficult even to see some fragments of images. As can be clearly seen in the photographs, the LED lamp provides diffuse and even light, illuminating a larger surface area uniformly (Fig. 2, *1*), which cannot be said of the old lantern that gives too sharp lighting at the center and much fainter, insufficient illumination on the periphery (Fig. 2, *2*).

Several new images were identified during the approbation of traceological analysis on Dordogne cave art materials in 2016*. Earlier, some of these had been described in reports as series of disordered lines (Cretin et al., 2013: 54–60), while others were not mentioned by the researchers at all. Despite the artificial transformations experienced by the rock-shelter roof during cleaning, at a certain level of illumination, relief elements of various scale and intensity (from thin lines to bas-relief fragments) can be observed. The preliminary studies have resulted in discovery of the following representations.

1. A partial zoomorphic image made by engraving and with the use of the natural relief of the limestone surface (Fig. 3)*: a hind leg, a tail, and a croup,

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*No such studies had been conducted in the region before.

**All photographs and three-dimensional reconstructions (Fig. 3–6) were prepared by L.V. Zotkina.

rendered in a schematic manner. It is hard to tell exactly what kind of animal the ancient "artist" tried to depict, but the croup line passes smoothly into the back, which represents a natural convex relief (Fig. 3, *2*). The roof's surface in the area of this representation has a reddish tone (Fig. 3, *1*). Possibly, these are traces of artificial coloration, though the probability of natural ferrugination cannot be excluded either.

2. A schematic representation of a horse's head, made with the deep engraving technique (Fig. 4). Small details are absent, possibly owing to surface cleaning; however, at proper oblique illumination, the general outline of the head and neck can be seen fairly well. Furthermore, natural recesses were probably used to represent the neck and the mane. This relief is rather clearly seen in three-dimensional reconstructions (Fig. 4, *2*). However, it is still premature to conclude as to whether these recesses relate to the image, or are arranged in such an order by chance.

3. A detailed representation of a horse's head, made with the fine engraving technique (Fig. 5, 6). This is one of the most interesting images. The muzzle's outlines are clearly discernible, and a drop-like element, obviously rendering a nostril, is well traced towards the muzzle's end (see Fig. 5, *1*, *a*, *b*). Above the cheek contour, a thin line, seemly dividing the image into two parts, can be observed (Fig. 5, *1*, *c*). The ears are rendered by two small triangles (Fig. 5, *1*, *d*). It is also important to note that the face's contour is doubled (see Fig. 6). It cannot be ruled out as yet that two different images are presented here.

In one of the papers summarizing the cave art of France, A. Roussot points out that M. Sarradé recorded a representation of the front of a horse approximately one meter from the fish bas-relief image, close to the entrance of Abri du Poisson. Judging by the text, this message was oral; however, the author was skeptical of it (Roussot, 1984: 155). Thus, there is a probability that the image found by us in 2016 was the one earlier recorded by Sarradé.

Other lines and various elements of artificial surface preparation were also discovered, such as bored recesses

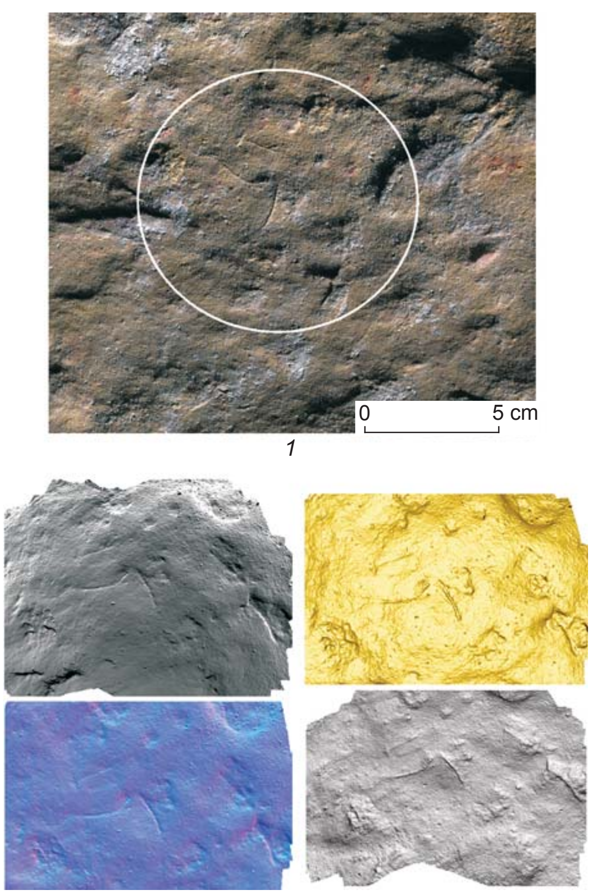

Fig. 4. A representation of a horse's head and neck, made in the deep engraving technique.
1 – photograph; *2* – 3D reconstruction of the image at various angles and with various filters.

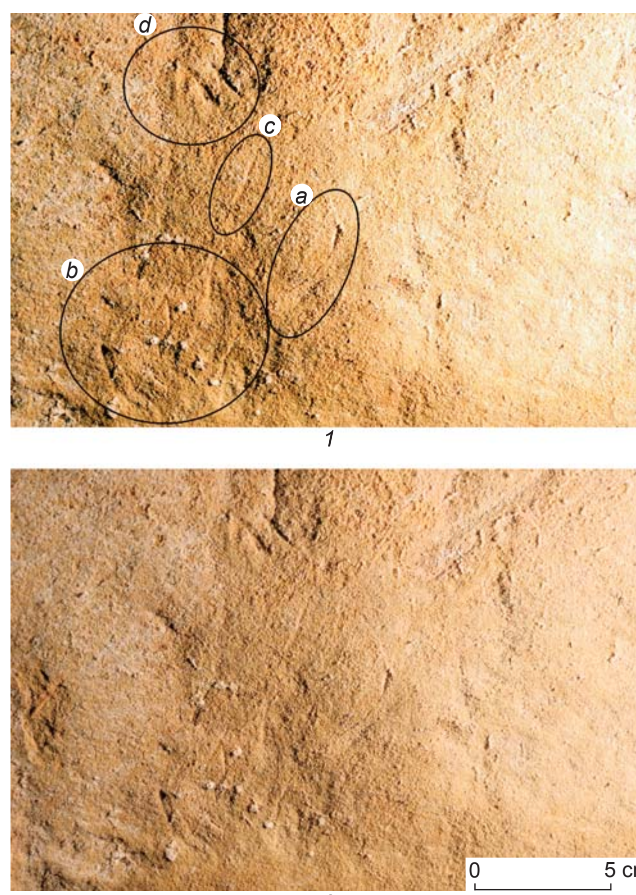

Fig. 5. A detailed representation of a horse's head, made in the fine engraving technique (photographs at various illumination).
a – cheek contour; *b* – nostril and muzzle contour; *c* – muzzle-dividing line; *d* – ears.

Fig. 6. 3D reconstruction of the horse-head image (see Fig. 5) at various angles and with various filters.

in the right part of the rock-shelter, similar to those observed on the fish image; however, these finds are not described in this article, because they require further systematic and more detailed studies taking into account the context, natural surface relief, etc.

Conclusions

In certain cases, these are traceological criteria and 3D visualizations that allow depictive elements to be revealed, including the presence of compacted smoothed surface; a pronounced artificial relief, differing from the desquamation cracks; an inclination angle of protruding parts, close to 90°; etc. Such features, taken together, can provide additional information about artificial treatment of a surface, since it is not always possible to discover distinctive figurative elements. For example, sometimes it is not easy to determine immediately whether a deep grooved line represents an image fragment. However, from the type of traces and traceological characteristics, it can be established whether we deal with a treated area, or with natural changes of the limestone surface. Probably, such approach will allow us to reveal more depictive elements or whole images in Abri du Poisson, where many disordered lines are observed that cannot be interpreted as yet.

At present, the lines of research that seem to become topical for Abri du Poisson in future may be defined as follows:

1) consistent examination and study of the roof and walls, in order not merely to reveal new depictive elements, but also to understand the relationship between the already-known images and those discovered during the last examination;

2) producing of a technical drawing that would allow the designation of the location of each figurative element and whole image in Abri du Poisson;

3) monitoring of the degree of preservation of the whole surface and of individual traces of artificial treatment;

4) traceological analysis of all images, including those on rock blocks stored in museum collections, and correlation of their technological characteristics and degree of preservation with regard to different conservation conditions (comparison of images in the rock-shelter and in the museum);

5) traceological analysis of stone inventory (collections obtained mainly during excavations conducted by Peyrony);

6) study of pigments of various shades and intensity, and of various degrees of preservation, determining the limits of their distribution on the rock-shelter roof, and establishing the genesis of traces of red pigment;

7) geomorphological and karstological study of the rock-shelter as a whole, and of its individual areas relating to images.

Comprehensive studies and systematic documentation of this site will facilitate not only the refinement of the available data and, possibly, the identification of new images, but will also enable the monitoring of the processes of surface degradation of the rock-shelter's roof and walls.

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The Techniques of Modeling and Decorating Upper Paleolithic Anthropomorphic Figurines from Malta, Eastern Siberia

We present the results of a microscopic analysis of anthropomorphic figurines from Malta, southeastern Siberia. The bulk of the collection comprises "classical" specimens unearthed by M.M. Gerasimov in 1928–1958. Recent studies by G.I. Medvedev and others in Irkutsk focused on the chronology, microstratigraphy, and cultural subdivision of the deposits. The analysis of the figurines excavated by Gerasimov has revealed the manufacturing sequence, as well as modeling and decoration techniques. The process included the primary processing of mammoth ivory, preparation of a blank with key elements being marked, final modeling, and decoration. At each stage, specific tools were used. Especial attention is paid to decorative elements: patterns, engraving, rendition of clothing and accessories, and painting. Tools included planing-knives, scrapers, cutters, burins, and reamers. The decoration process was subject to a certain canon, which concerned key elements of design, their combination, and choice of the decorated area. One of the most intriguing facts about the decoration of Malta figurines is that in certain instances, traces of several pigments such as scarlet, green, and blue were revealed.

Keywords: Siberia, Malta, Upper Paleolithic, anthropomorphic figurines, ivory processing, decoration.

Introduction

Archaeologists mostly agree that the pieces of portable art might have had various purposes, and their function, semantics, and attribution can be interpreted in various ways (Abramova, 1960; 1966: 195–199; Gerasimov, 1958; Demeshchenko, 2008; Larichev, 1999: 148–160, 180–196; Lbova, 2014a; Lipnina, 2008; Okladnikov, 1960; Frolov, 1987; Conroy, 1993: 180–196; Marshack, 1991; and others). Siberian Paleolithic anthropomorphic figurines, including fragments and blanks, represent series of articles and isolated specimens from the key Upper Paleolithic sites in Northern Eurasia (Malta, Buret, Krasny Yar, Listvenka, Shestakovo, Yana, etc.) (Abramova, 1966: 195–200; Okladnikov, 1960; Akimova, 2002; Derevianko et al., 2003: 66–71; Pitulko et al., 2004; and others).

On the basis of technological, morphological, functional, and stylistic features, the Malta collection of "classical" artifacts, made of ivory, bone, horn, and stone, was classified into groups of "conventionally synchronous articles" (Kamennyi vek…, 2001: 67). The anthropomorphic portable art represents the largest assemblage (about 40 specimens*). The Buret figurines (5 spec.) generally fit well into the same stylistic canon of typical postures and elements characteristic of the Malta tradition (Okladnikov, 1960).

Use of microscopic analysis and modern digital technologies for investigation of modeling, detailed elaboration, and decoration of the Malta anthropomorphic figurines provides new methodic approaches to assessment of the available materials. The sample under study contains 29 specimens (including blanks and fragments) from the "classical" collection (the artifacts are deposited in the State Hermitage Museum in St. Petersburg, and the State Historical Museum in Moscow).

This paper addresses mostly the cultural specificity of the technology (various manufacturing techniques, tools used, properties of raw material, and artisan skills) rather than interpretation of the symbolic significance and reconstructions of ideology, which issues represent popular issues in the archaeological literature.

Research methods

Methods of technological and use-wear analysis of the Malta collection were based on the research approaches elaborated by S.A. Semenov (1957) and his scientific school. For comparative analysis, materials from the reference collection of experimental traceological specimens of the Institute of Archaeology and Ethnography SB RAS (Novosibirsk, Russia) were used. Manufacturing techniques and tools were defined using the terminology developed in the course of experimental use-wear and technological studies (Volkov, 2013: 94–154; Lbova, Volkov, 2016). Archaeological and experimental specimens were examined using the binocular microscope and Altami digital camera with 7, 15, 20, and 25-fold magnification.

Apart from manufacture and use-wear signs, microscopic examination has shown traces of various pigments on the surfaces of figurines. Pigments were analyzed using the BRUKER M1 Mistral Micro X-ray Fluorescence Spectrometer (held by the State Historical Museum, Moscow). This is a nondestructive method, requiring no preliminary sample-preparation. This method enables elemental analysis of composite and multilayered samples. The M1 Mistral microfocus X-ray tube reveals the elemental composition of a sample by irradiating it with a thin beam of X-rays on a spot sized as small as 100 μm, depending on the collimator settings. The video microscope ensures that measurement takes place at the specific spot. The spectrometer ensures detection limits as low as 0.01 %. Such detectors, system of digital pulse processing, and optimized system geometry ensure maximum quantum efficiency and accurate information on the elemental composition of the material. This article provides the preliminary results of the analysis of three pigment types, obtained using collimator setting of 0.4 mm and a processing time of 180 sec.

3D spatial images were generated mainly by photogrammetry. A series of photographic images was taken from various positions in order to get a stereoscopic view of an object. The images should have covered the entire object and overlapped one another for at least 30 %. Then, the special program transformed the photographs into a 3D-model. An electromechanical rotary table regulated by a controller was used for automatic shooting. Each object was subjected to double, sometimes triple, scanning with a step of 5° in order of avoid dead-zones. On the rotary table, a colored pattern with established squares was fixed, which made it possible, after the creation of a model, to reconstruct the correct colors of the texture and automatically to correlate the size of the model with that of the original object. Agisoft Photoscan and Geomagic Studio software were used for processing the photographs and generating the 3D-images. Apart from the high presentational potential of 3D-models, this technique is useful in distant examination of artifacts and in creation of high-quality and accurate replicas of them.

Materials and discussion

Using the results of technological analysis, we propose the following classification of the aggregated collection of anthropomorphic figurines:

1) blanks—prepared ivory bars with profiled or marked out heads, shoulders, and hips (6 spec.);

2) ready artifacts, including fragmented ones (19 spec.):

– profiled, with modeled parts of the body (ornamented and unornamented),

– slightly profiled (with marked out heads and engraved details),

– flat (ornamented and unornamented),

– fragments of anthropomorphic figurines;

3) figurine details (heads) as separate objects (4 spec.) (Lbova, Volkov, 2015).

For the blanks of anthropomorphic figurines, elongated fragments of mammoth ivory were used (rods, bars, and

*Statistical analysis of this collection has not yet been finished. The artifacts are deposited in four different museums and have not been consolidated into a single set. Publications provide discrepant data. In the course of our research, new artifacts have been added to the category of anthropomorphic figurines.

chips). Analysis of parameters of the main group of figurines and blanks supported the correctness of the proposed classification. The categories of blanks and ready artifacts display practically identical parameters, classifiable into three main classes: small (3–5 cm), middle-sized (6–8 cm), and long (10 cm and more) figurines. The artifacts of the "heads" category have not been taken into account in the statistical analysis of parameters, yet the size of the heads (exceeding 3 cm) suggests rather large anthropomorphic sculptures (exceeding 10 cm), the missing parts of which might have been made of a different material.

Judging by the processing of the tops and bottoms of the figurines, we can propose that the mammoth tusk, initially split longwise, was then cut into blanks of the intended length using a planing-knife (Fig. 1, *1*, *b*), which was also utilized as a saw (Fig. 1, *1*, *d*). Surfaces and separate details of objects were processed mostly with two tools: a planing-knife (Fig. 1, *1*, *c*; *2*, *d*) and a burin (Fig. 1, *1*, *a*). Surfaces were finished using a burin with a considerably wide working-edge (Fig. 1, *1*, *a*), and a scraper (Fig. 1, *2*, *a*). Ornamentation and detailed elaboration of the objects were carried out with the aid of burin, knife, or cutter (Fig. 1, *3*). A burin was used for processing surfaces simulating fur, elements of clothing, hair, and personal accessories (Fig. 1, *3*, *b*, *c*). In some cases, certain details (arms, legs, loins, and breasts) were deeply cut out with a knife and finished with a cutter (Fig. 1, *3*, *a*). Drilling was executed with a reamer (Fig. 1, *3*, *d*).

The ornamentation of a part, or an entire artifact, shows stable decorative patterns. Decoration of only heads is most typical (11 spec.). Decoration all over the body is observed in seven specimens (all these figurines, except for one specimen, belong to small artifacts). Additional ornamentation with small holes and parallel lines marking elements of clothing or accessories (parka's edge, sash, belts, and bracelets) is noted on three specimens (Fig. 2).

Anthropomorphic figurines were decorated with various combinations of four main graphical motifs: small pits, straight lines, crescents, and "waves" or zigzag lines (Fig. 3) (Lbova, 2014b).

1. Simple pattern of recurrent parallel lines executed with a knife. In rod-like blanks, these lines sometimes go around, or form a zigzag pattern (Fig. 3, *1*). This pattern is typical of the anthropomorphic figurines of children (State Hermitage Museum, 370/753, 759; State Historical Museum, 1820/207, 1822/629).

2. Decoration with small depressions ("pit" design). This design is more complicated in terms of composition and technology: the pits usually form circles or spirals; linear patterns are less common. The manufacturing process

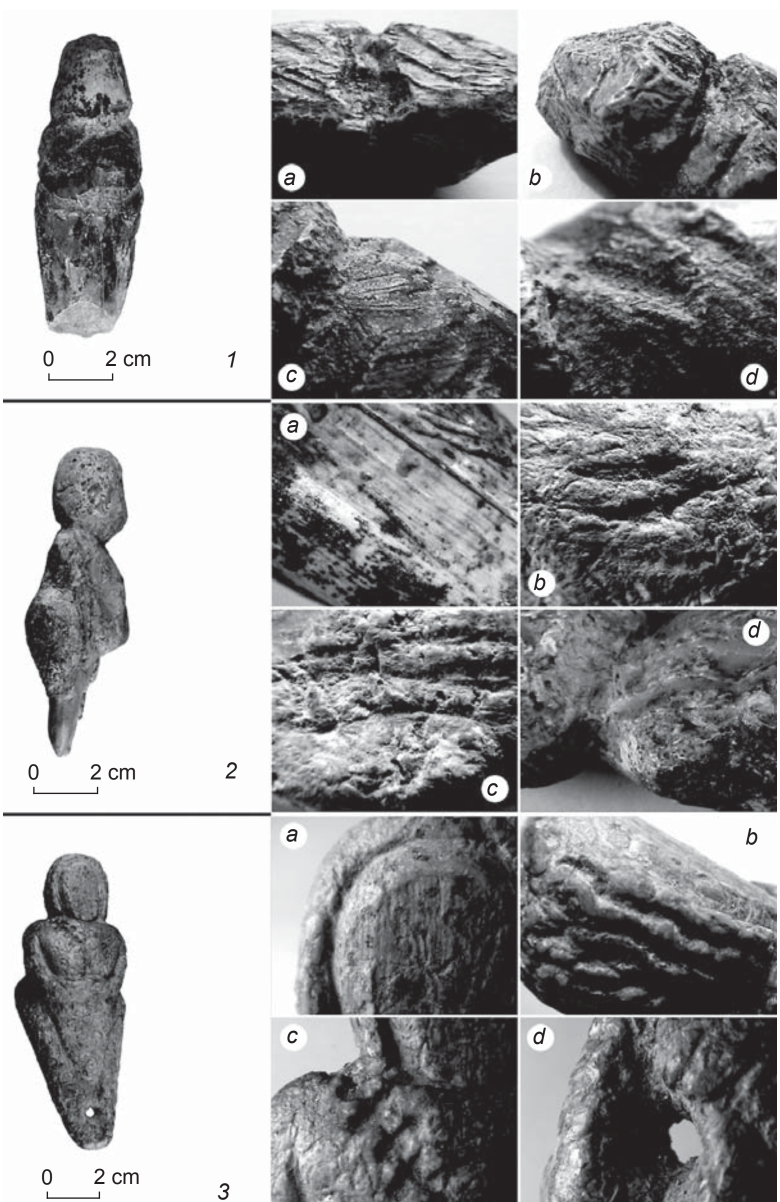


Fig. 1. Stages of figurine-modeling, and traces of the tools used.
1 – stage 1: *a* – traces of burin, *b*, *c* – traces of planing-knife, *d* – traces of knife used as saw (State Hermitage Museum, 370/760); *2* – stage 2: *a* – traces of scraper, *b* – traces of burin, *c* – traces of cutter, *d* – traces of planing-knife (State Historical Museum, 1822/622); *3* – finale stage 3: *a* – traces of cutter and planing-knife, *b* – traces of burin and cutter, *c* – traces of burin, *d* – traces of reamer (State Historical Museum, 1820/208).

included preliminary marking (circular or spiral) of the surface, where artisans made dots for future pits using a burin, and then shallow irregular pits using a reamer or burin. The elements were approximately equidistant from one another (Fig. 3, *2*, *3*). Such a pattern is observed on the figurines' heads, imitating hair (State Historical Museum, 1820/209, 506) or the fur trimming of headgear (State Hermitage Museum, 370/748, 755).

3. Crescent, or C-shaped, pattern. In terms of technology, this was made either deep with a cutter (Fig. 3, *4*), or shallow-carved with a burin. Such a pattern often covers the entire surfaces of large objects, but prevails on the heads of figurines (State Historical Museum, 1820/206, 208; State Hermitage Museum, 370/748, 752).

4. Zigzag pattern. This was usually made with a burin (Fig. 3, *5*). Its variety of wavy pattern, was additionally finished with a cutter over the traces of burin processing (Fig. 3, *6*). Such a pattern is observed mostly on the figurines' heads (State Hermitage Museum, 370/743, 746, 766).

The rendering of elements of clothing, shoes, and accessories (bags, belts, adornments, and sashes) is of especial interest. A.K. Filippov believed that the Malta collection included figurines with and without clothes; the "naked" figurines were subsequently either painted or dressed like dolls (2005: 122). In this collection, we recognize such types of clothing as *kamleya* (the traditional closed overcoat of indigenous Siberian peoples; State Hermitage Museum, 370/748), and fur overall, or *kerker* (typical clothing of Koryak children and women) (Lbova, 2014a). Notably, overalls were more typical of miniature figurines (State Hermitage Museum,

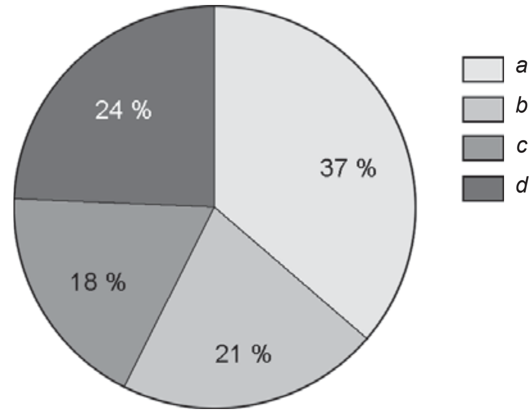


Fig. 2. Ratio between decorated areas on anthropomorphic figurines.
a – head; *b* – body; *c* – details; *d* – no decoration.

370/752–754, 757, 759; State Historical Museum, 1820/206, 1822/629). The surfaces were decorated with two main motifs: crescent-shaped cut-outs made with a cutter, and transverse circular incised lines made with a knife (Fig. 3, *1*, *4*).

The design of the figurines' heads attracts special attention. Currently, researchers argue whether there was hair or headgear rendered on the Paleolithic anthropomorphic figurines (Abramova, 1960; Gvozdover, 1985; Soffer, Adovasio, Hyland, 2000); we can state that specimens of the analyzed sample of the Malta collection display variations in both headgear (helmets, hats, hoods) and hair (Lbova, 2014a). Their combination has also been noted (for example, figurine from the State Hermitage Museum, 370/751)

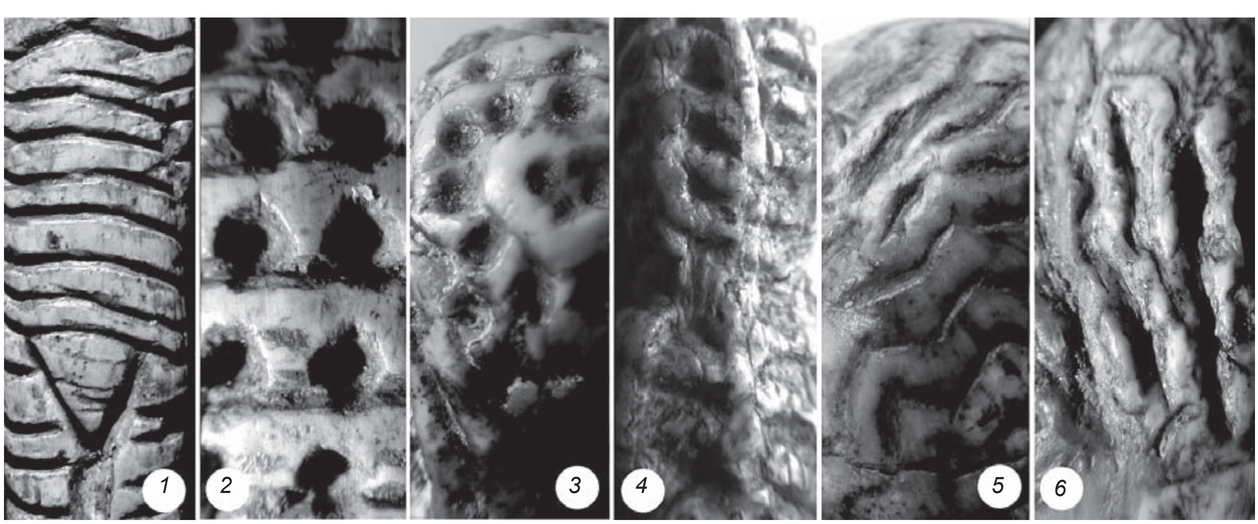
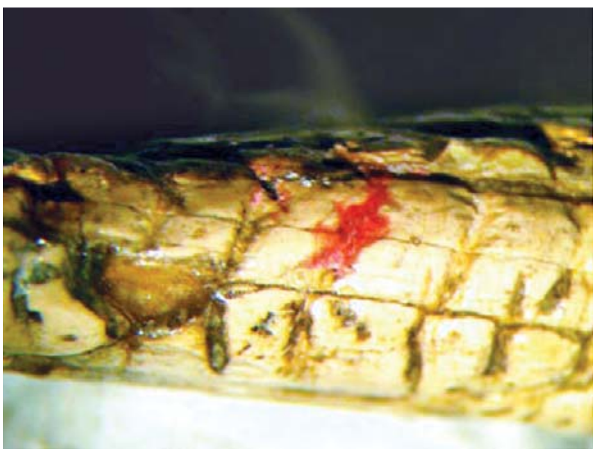


Fig. 3. Types of decoration and traces of the used tools.
1 – type 1, traces of knife (State Hermitage Museum, 370/753); *2*, *3* – type 2, traces of reamer and burin (State Historical Museum, 1820/506, 209); *4* – type 3, traces of burin (State Hermitage Museum, 370/752); *5*, *6* – type 4, traces of burin and cutter (State Hermitage Museum, 370/743, 766).

(Lbova, Volkov, 2015). The lowermost parts of almost all finished figurines (that are not fully decorated) demonstrate manufacturing traces of shaping (whittling).

Only three figurines show marked out shoes, resembling *torbasa* (‘fur boots’); these are represented by shallow carved lines at the front and back sides of the knee area. The distal ends of the majority of figurines are broken off; in some cases, such ends have fixing-holes.

In the iconography of the Paleolithic figurines from Europe and the Russian Plain, elements like belts, sashes, and strings are distinctly marked, and their interpretation is unambiguous. Differences can be identified only in the materials of accessories (leather braided straps, fur, shells, fabric, etc.) (Abramova, 1960; Gvozdover, 1985; Soffer, Adovasio, Hyland, 2000; and others). The macroscopic examination of the Malta collection revealed six subjects of this kind (Lbova, 2014a). Belts are clearly seen; these are rendered with thin lines carved on the front and back surfaces of the figurines. In one case, the belt is shown with regular pits. There are thin cord-like girdles, and wide belts rendered with parallel lines. In one figurine (State Hermitage Museum, 370/748, or figurine No. 1 of 1956



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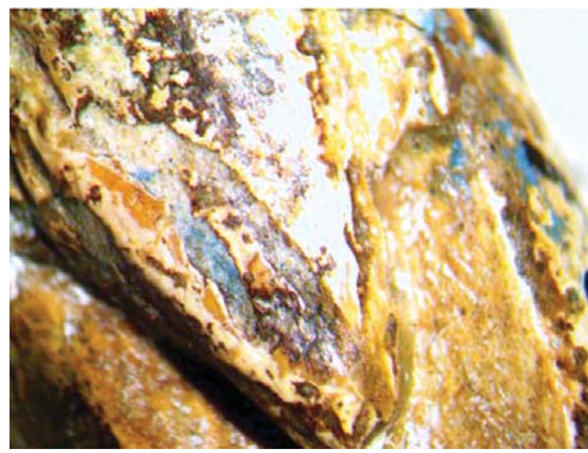

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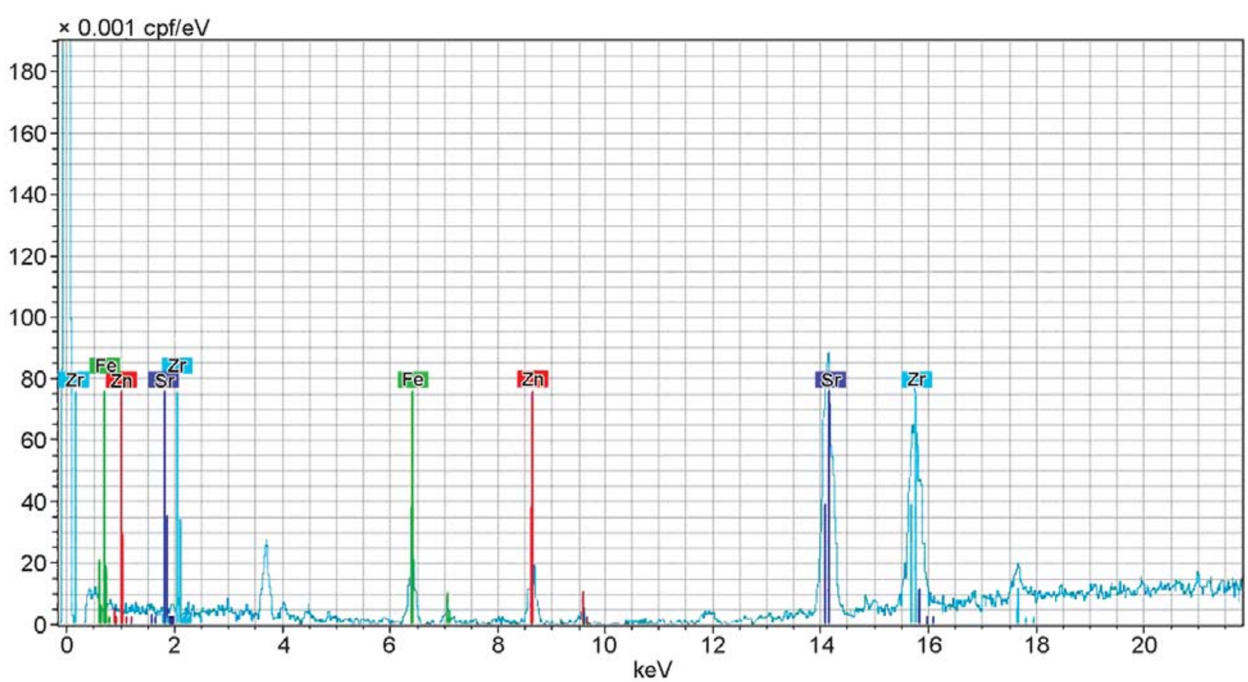

3

Fig. 4. Traces of scarlet (*1*) and blue (*2*) pigments on the surface of anthropomorphic figurines (State Historical Museum, 1822/629; 1957/625), and the results of micro X-ray fluorescence spectrometry analysis of the scarlet pigment (*3*).

after (Abramova, 1960)), there are two transverse lines on the left arm above the elbow, possibly representing an armlet. In another case (i.e. State Historical Museum, 1820/208), armlets are rendered in relief, in a form of convex rolls, and a cross belt is noted (see Fig. 1, *3*, *c*). Exactly in such position (in the middle of a shoulder), armlets and cross belts (including leather straps, sinew strings with suspended beads, and other items) are known to be worn next to the skin (Bogoraz, 1991: 189–192; Lbova, 2014a). Notably, the Malta collection includes fractured and intact bracelets made of boghead coal and ivory, and also narrow bracelets of thin twisted ivory plates.

One of the most interesting discoveries during examination in 2016 of the Malta collection from the State Historical Museum was detection of traces of scarlet, green, and blue pigments on some figurines (Fig. 4). At present, only preliminary identification of their chemical composition is possible using the equipment available at the State Historical Museum. The scarlet pigment is observed on two figurines (State Historical Museum, 1820/208, 1822/629) on the loins and at the bottom of the heads (Fig. 4, *1*). It contains iron, strontium, zinc, and zirconium (Fig. 4, *3*). The blue pigment is noted on two figurines (State Historical Museum, 1820/209, 1957/625) on the loins and at the heads (Fig. 4, *2*). Its chemical composition includes strontium, calcium, iron, zinc, and bromine. The green pigment was detected on two figurines (State Historical Museum, 1820/206, 208), in the form of spots on the heads and in the knee-areas. In composition, it is close to the blue pigment, but contains chromium.

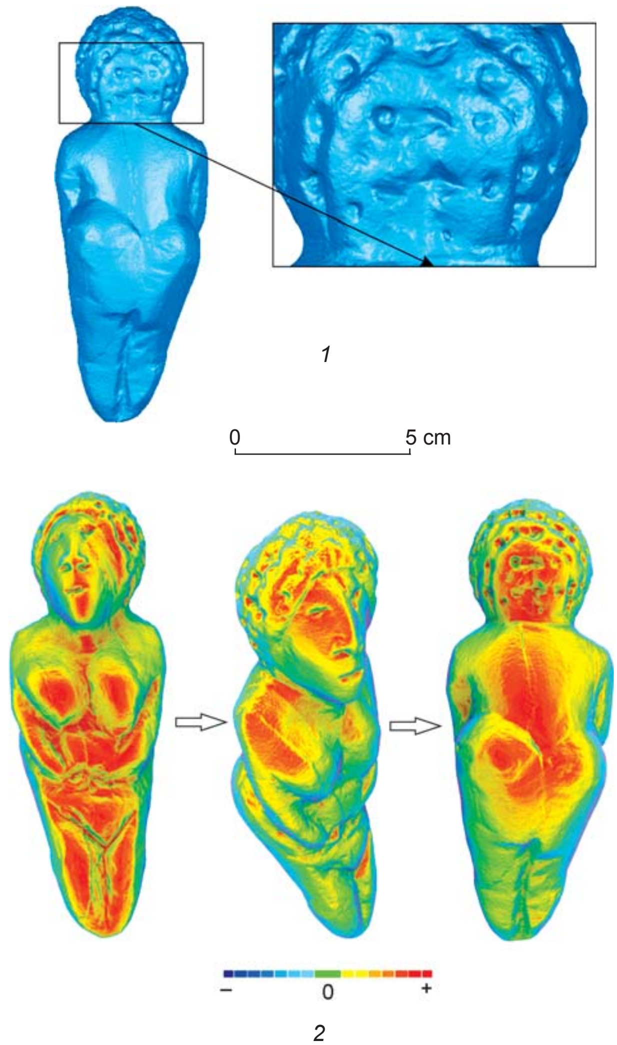

Fig. 5. 3D-model of anthropomorphic figurine (State Historical Museum, 1820/209).
1 – details of a figurine's relief; *2* – model of surface relief generated by Geomagic Studio program.

Conclusions

Descriptions and studies of the anthropomorphic portable art and the art of ivory carving of the Paleolithic population of Malta have been addressed in numerous publications. M.M. Gerasimov, A.P. Okladnikov, Z.A. Abramova, V.E. Larichev, and other researchers have focused on various features of figurines' decoration, body-ornamentation, rendering of clothing, headgear, and adornments. In most cases, scholars made attempts to interpret the decoration-motifs (Abramova, 1960; Larichev, 1999: 148–160, 180–196; Soffer, Adovasio, Hyland, 2000; Frolov, 1987; Marshack, 1991, and others). In this situation, the microscopic study of the ivory artifacts, aimed at identification of the specificity of manufacture, tools, decoration techniques, and use-wear signs, represents a new approach.

Summarizing the obtained data on the manufacturing techniques of the Malta anthropomorphic figurines from the collections of the State Hermitage Museum (St. Petersburg) and the State Historical Museum (Moscow), it should be noted that the figurines were manufactured according to certain standards of modeling and decoration. Processing of mammoth tusks at the site looked like stable serial production. Modeling and decoration of articles were performed using a certain set of tools. Ornamentation and engraving of the finished figurines represented strictly standardized elements of décor and stylistic composition.

No clear use-wear signs (suspending, fastening) have been recognized on the figurines. Holes are observed only on six figurines (five figurines show damage at the leg-ends). The majority of figurines demonstrate slight traces of polishing (use-wear) as a result of contact with some soft resilient material (leather or fur). It can be hypothesized that the figurines were either stored or worn in pouches (or were dressed, according to A.K. Filippov);

they were also often held in hands and used in everyday life through attaching them with a cord to some fur or leather object—not necessarily to clothing.

The technological analysis of the figurine's modeling and decoration, performed though 3D visualization, allows us to gain more information about ivory processing and to identify new elements (Fig. 5, *1*), general techniques of preparation (marking) for subsequent ornamentation, changes in the figurine's surface-relief (Fig 5, *2*), main forms, compositions, and motifs typical of the Malta culture. In archaeological study of Paleolithic art, technological analysis of the context of a site, and its set of goods and toolkit, makes it possible to recognize certain cultural, chronological, and other distinctions. The approach of understanding through the "visual arts", and trends towards identify symbolic behavior through the links of art-objects with particular population groups (D'Errico et al., 2003) and their phylogenetic features, have recently become quite popular in studies of Paleolithic art and the Prehistoric period in general.

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A Comparative Analysis of Paints on the Karakol Burial Slabs

We have analyzed paintings on six stone slabs from Bronze Age burial sites of the Karakol culture in the Altai, Karakol, and Ozernoye. Most represent anthropomorphic figures, depicted in a mixed technique including pecking, engraving, abrasion, and painting in various combinations. Paintings are superimposed on previously made petroglyphs, which had not initially been painted. Samples of paint were analyzed using optical microscopy, scanning electron microscopy with X-ray spectrometry, and synchrotron powder X-ray diffraction. Results make it possible to differentiate, using the instrumental analysis, intentional painting from natural coloration. The composition of pigments suggests that both the images and the contouring lines were made with one and the same red paint. However, while the pigment's composition is homogeneous in each burial, it differs between the burials. Paint was found not only on slabs but on human bones as well, with its color varying from light red to black. Further analysis will hopefully shed light on the Karakol burial rite.

Keywords: *Altai, Bronze Age, Karakol culture, paintings, pigments, prehistoric art, petroglyphs.*

Introduction

About 40 years have passed since the time of the excavations at the burial sites of the Karakol culture near the Ozernoye village, the Ongudaysky District, in the Altai Republic, one of which accommodated a slab with an anthropomorphic image (Pogozheva, Kadikov, 1979). More than 30 years ago, at the center of the Karakol village in the Ongudaysky District of the Altai Republic, burials in stone cists, constructed using slabs and stelas with petroglyphs, were discovered. During secondary use, graphical images were often placed horizontally, superimposed with impressive anthropo-zoomorphic figures depicted with paint (Kubarev V.D., Soenov, Ebel, 1992; Kubarev V.D., 1988, 2013; and others). The Karakol images are among the most vivid manifestations of artistic and ritual human activities of the Bronze Age in this region (Molodin, 2006); taken together, these constitute a unique example of painting in prehistoric art of Eurasia. Therefore, the eagerness of researchers to clarify the technical and technological peculiarities of the images, using new methods and techniques, is comprehensible.

The pigments used in the burial rite have always been of interest to archaeologists and anthropologists in terms of both technologies and burial rite semantics. In recent years, analytical studies of the use of red and other pigments in funerary practices and decoration of rock surfaces at the archaeological sites of Russia have changed meaningfully, owing to the involvement of numerous analytical methods (Esin et al., 2014; Pakhunov et al., 2014; Mednikova, 2015; Trifonov et al., 2015).

Substantial supplementation of our understanding of the artistic activities of the Karakol culture bearers, including the use of red pigment in the decoration of Karakol and Ozernoye slabs, has become possible with the application of digital image enhancement, reflection transformation imaging, etc. (Devlet E.G., Pakhunov, Devlet M.A., 2016). The objective of this study was to conduct a comparative analysis of paints on slabs from the same burial and from different burials and burial mounds, in order to determine the principles of selecting paint materials, differing in their tone and composition, by scanning electron microscopy with X-ray spectrometry and synchrotron powder X-ray diffraction methods. A comprehensive analysis has allowed us to draw a reliable distinction between the ferruginous crusts and the surface areas colored with pigment; to refine the details of images and the composition of pigments used to perform figurative and non-figurative elements; and to compare the composition of the paints used at the various stages of decoration of slabs from different burials and burial mounds. In total, the color decoration has been analyzed of five slabs from three Karakol burials and of one slab from Ozernoye, the slabs being exhibited in the Museum of History and Culture of the Peoples of Siberia and the Far East of the Institute of Archaeology and Ethnography of the SB RAS*.

According to the historical and cultural concept common for Western and Southern Siberia, the sites of the Karakol culture belong to the group of Early and Middle Bronze Age cultures contemporaneous with Okunev and Krotovo. Consequently, taking into account the calibrated radiocarbon dates, these sites can be assigned to the second half of the 3rd to the beginning of the 2nd millennium BC (Molodin, Epimakhov, Marchenko, 2014: 145, fig. 2).

Materials and methods

The composition of pigments is determined by various analytical methods, which are selected depending both on the research goal and the specimen's size. Usually, scanning electron microscopy with X-ray spectrometry is applied for elemental analysis of paint samples. The possibilities of this method are used to obtain images of samples at high magnifications, in order to provide a comparative analysis of pigment particles based on their morphology, characteristic sizes, and distribution in a sample (Clottes, Walter, 1990; Vignaud et al., 2006; Balbín Behrmann, de, González, 2009; Iriarte et al., 2009; Podurets et al., 2016). A complementary method for elemental analysis is X-ray diffraction (Beck et al., 2014). Elemental analysis provides information only on the quantity and distribution of elements, while X-ray diffraction allows mineral phases identification. The methods can be used simultaneously (Scott, Scheerer, Reeves, 2002; Dayet, d'Errico, Garcia-Moreno, 2014). Analysis of X-ray diffraction patterns makes it possible to determine some characteristics of pigment, such as the presence or absence of calcination, particle size distribution, and degree of their crystallinity (Pomies, Morin, Vignaud, 1998; Pomies, Menu, Vignaud, 1999; Gialanella et al., 2011; Salomon et al., 2015; Podurets et al., 2016). Powder X-ray diffraction of paint samples is often performed using synchrotron radiation sources (Wess et al., 2001; Huntley et al., 2014; Zubavichus, Slovokhotov, 2001) or specially designed laboratory

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*Karakol: slabs 1–3 from burial 2, mound 2; slab 1 from burial 3, mound 2; and slab 1 from burial 5, mound 2. Ozernoye: a slab from burial 4, mound 1 (Kubarev V.D., 2013: 10, 15, 17, 19, 21; Pogozheva, Kadikov, 1979).

devices (Wainwright et al., 2002; Salomon et al., 2012; Kovalchuk et al., 2016). Both methods allow operation with minimal quantities of pigment, which is the crucial factor when studying rock art. Analysis of the Karakol pigments was conducted by the methods of scanning electron microscopy coupled with X-ray spectrometry, and powder X-ray diffraction at synchrotron radiation facility, which allow us to analyze grains of pigment.

The studies have been carried out under the agreement on cooperation between the National Research Center "Kurchatov Institute" (NRC KI) and the Institute of Archaeology of the RAS for joint research of the application of analytical methods to humanities in the NRC KI. The studies were conducted using a specialized synchrotron radiation source, the only one in the former Soviet Union, and a unique facility of the *Nanozond* resource center of the Kurchatov Complex of NBICS (Nano-, Bio-, Information, Cognitive, Socio-Humanistic) technologies: a scanning electron-ionic microscope Versa 3D DualBeam (FEI, USA) equipped with a nitrogen-free silicon sdd-detector Octane Plus (EDAX, USA) with the resolution of 128 eV. The microscope camera allows operation both in high-vacuum mode and in natural-environment mode (pressure up to 2700 Pa). Back-scattered electrons are detected using segmented solid-state detectors (CBS for high vacuum, Annular GAD for environment operations); and Helios Nanolab 600i (FEI, USA)—a scanning electron-ionic microscope equipped with an energy-dispersive X-ray microanalysis system (EDAX, USA), with the Omniprobe micromanipulator, and with gas injection systems (GIS) allowing to spray Pt, W, C films on the sample surface. The device resolution is 0.8 nm with an accelerating voltage of 30 kV. Samples were studied using electron microscopes after evaporating a gold layer less than 1 nm thick.

Studies of samples by powder X-ray diffraction were conducted at the *Belok* station at NRC KI synchrotron radiation facility, using the Rayonix SX165 two-dimensional detector, with wavelength $\lambda = 0.9752$Å. A small sample of pigment was secured under the microscope in a polymerous loop using Apiezon grease. Data accumulation was conducted for 10 minutes, while the sample was rotating through 360°. The use of synchrotron radiation facility allowed to analyze minute samples (Kheiker et al., 2007). In order to preserve the initial particle-size distribution of the pigment, the sample was not ground for analysis. Formally, this method is nondestructive; however, it is almost impossible to use samples for additional analyses because of their contamination with the grease by means of which the samples are secured in a vertically oriented holding-tool. Analysis can be carried out using samples of approximately 40 μm; however, the paint layers on the slab from burial 4, mound 1 in Ozernoye, and on slab 1 from burial 5 in Karakol were too thin, so it was impossible to prepare samples for study.

The Ozernoye and Karakol slabs were documented using Nikon D800 and OM-D E-M10 Mark II cameras, Nikkor 60/2,8 Micro, Nikkor 105/2,8 Micro lenses, and a remote flash.

The colors of paints were determined visually using the NCS S Index 1950 palette. Conversion to the Munsell color system was performed by means of the translation keys (NCS-Munsell…, 2008); the differences of the pairs did not exceed 2 ΔE. Daylight fluorescent lamps and a LED-panel with the color-rendering index of more than 88 units were alternately used as illuminating devices. The colors of paints on slab 1 from burial 3, mound 2 at the Karakol site were also determined under the bright diffused daylight*.

Samples

At both sites, the images are depicted on schist slabs. The inward decorated surface of the burial has a weathering layer, non-uniform in color and composition, and differing from the host rock.

To obtain a reliable result, at least two samples of each paint were taken. Also, the following criterion was fulfilled: the sampling-places should be small, and located within inconspicuous areas. In total, 22 samples were analyzed: 14 samples of red paints from six slabs, 1 sample of black paint, and 7 samples from the surface of slabs without paint (Fig. 1, *1–4*, *6*, *7*, *a*). Samples were taken mainly by scratching with a small steel ophthalmic scalpel. The samples of pigments were placed into

*The colors of paints are most frequently determined using atlases of two color systems: Munsell (1912) and NCS (Hård et al., 1996). Despite the differences in the color-models, both systems allow the color definitions to be recorded in a universal encoding, which contains numerical characteristics of colors; the Munsell system also provides names for colors (Judd, Nickerson, 1975; Nayatani, 2005; Ferguson, 2014).

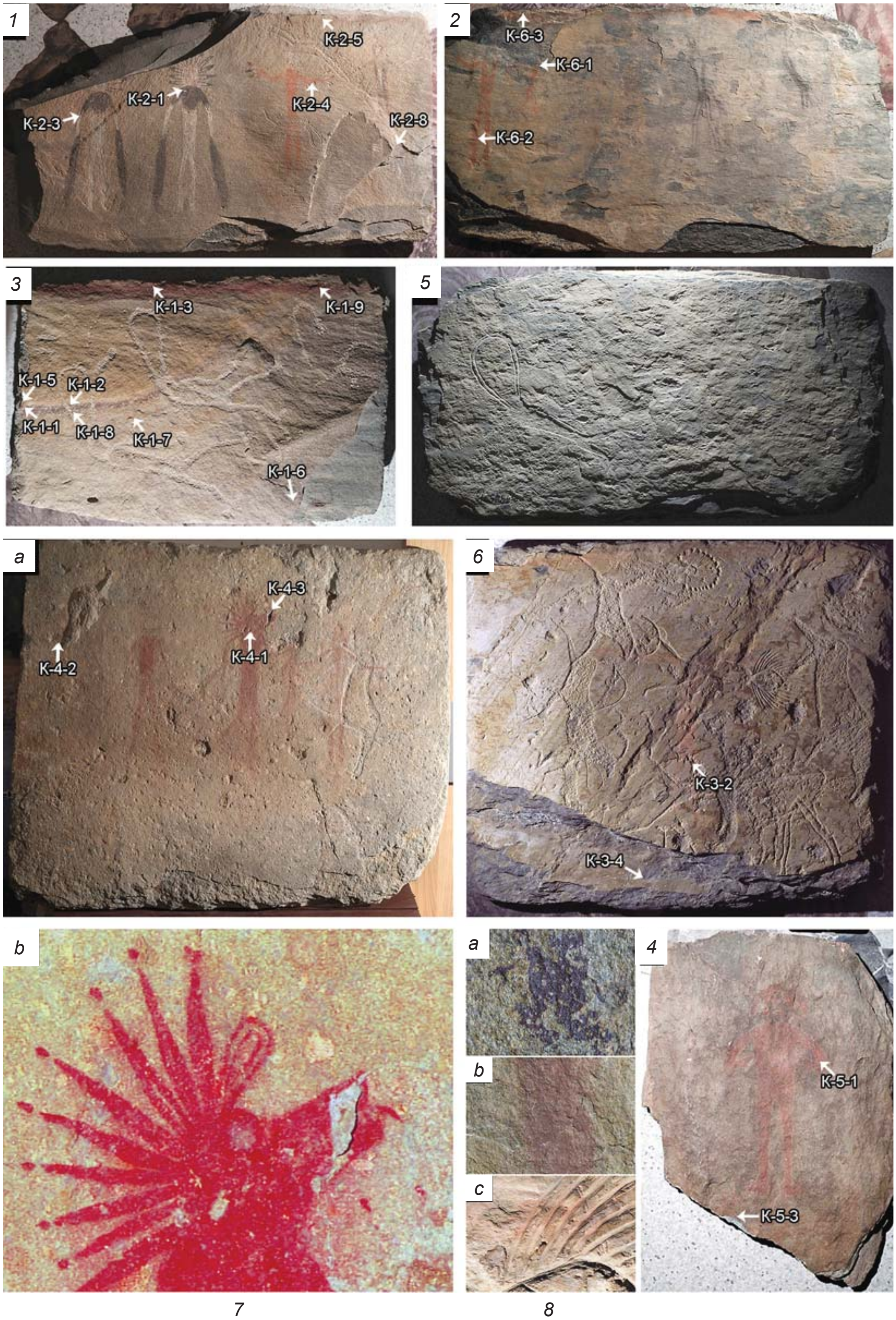


Fig. 1. Slabs from the Karakol (*1–3*, *5–8*) and Ozernoye (*4*) sites, with designation of sampling locations.
1 – slab 1 from burial 2, mound 2, a raking light image; *2* – slab 2 from burial 2, mound 2, a raking light image; *3* – slab 1 from burial 3, mound 2, a raking light image; *4* – a slab from burial 4, mound 1, a diffused-light photograph; *5* – slab 2 from burial 2, mound 2, the side without drawings; *6* – slab 3 from burial 2, mound 2, a raking light image; *7* – slab 1 from burial 5: *a* – a raking light image; *b* – image of the central figure's head after color enhancement; *8* – macrophotographs of areas of the paint layer on various Karakol slabs: *a* – slab 1 from burial 3, mound 2; *b* – slab 1 from burial 3, mound 2; *c* – slab 3 from burial 2, mound 2.

Characteristics of slabs

Slab No.*	Size, cm*	Color of the outline / color of drawings on the slab*	Color of paint	Color according to NCS S	Color according to Munsell
			Karakol		
1 from burial 3, mound 2	67 × 46 × 3	Dry dark red ocher –	Red Reddish brown arc-shaped line	NCS S 5030-R – S 6020-R NCS S 8010-Y90R – S 8010-R10B	5 R 3/6–5 R 3/4 7.5 R 2/2–5 R 2.5/2
1 from burial 2, mound 2	97 × 57 × 3	Dark red ocher Red paint	Light red "	NCS S 2070-Y80R NCS S 2070-Y80R	8.75 R 4/12 8.75 R 4/12
2 from burial 2, mound 2	109 × 58 × 3	Dark red ocher Bright red ocher	" "	NCS S 2070-Y80R NCS S 2070-Y80R	8.75 R 4/12 8.75 R 4/12
3 from burial 2, mound 2	71 × 61 × 5	Dark red ocher "	" "	NCS S 2070-Y80R NCS S 2070-Y80R	8.75 R 4/12 8.75 R 4/12
1 from burial 5	120 × 89 × 5	Absent Dark crimson ocher	– Red	– NCS S 5030-R	– 2.5 R 3/6
			Ozernoye		
Slab from burial 4, mound 1	54 × 39 × 3	Absent Dry ocher	– Red	– NCS S 3560-Y90R	– 10 R 3/10

*Data by V.D. Kubarev (2013).

the sterile micro-tubes, rock fragments without paints were placed into polyethylene zip bags. In view of the fact that the sample preparation imply their contamination, the samples were split into several sub-samples, so as to use a unique sample for each analysis.

Results

The colors of paints determined according to the NCS Atlas belong to four groups, with different ratios of the yellow and red hues (the content of yellow component is from 20 % to zero (see *Table*)). The color of paints on all slabs from burial 2, mound 2 is stable and typical for red ocher. The red line on slab 1 from burial 2, mound 2, and the figures on slab 1 from burial 5 are made with a paint of another tone, which color does not contain the yellow component; it was probably pure hematite. The arc-shaped line on slab 1 from burial 3, mound 2 is reddish brown. This probably indicates the complex composition of the material—a mixture of various substances and to its non-uniform distribution (Fig. 2, *1*, *a*).

Karakol site

Slab 1 from burial 2, mound 2. The decorated surface of the slab is flat; the losses in the lower right part were formed before drawing the images (see Fig. 1, *1*). The spalls in the upper left part are modern*.

Three figures are depicted on the slab, using pecking and engraving techniques. The slab was placed in the burial horizontally, following which, four characters were depicted on it with black and red paints, and by engraving. The black pigment layer is uniform and dense. On the rightmost figure, streaks underneath the rock layer overhanging by 1–2 mm have been found. The upper edge of the slab is marked with a red line. The combination of RTI and color enhancement has allowed us to reveal a partial sketch of the figure.

The largest aggregates of hematite particles reach 5 μm in samples 2-4, 2-8. The iron content

*"The left upper part was spalled during the opening of the mound before starting the excavation" (Kubarev V.D., 2013: 15).

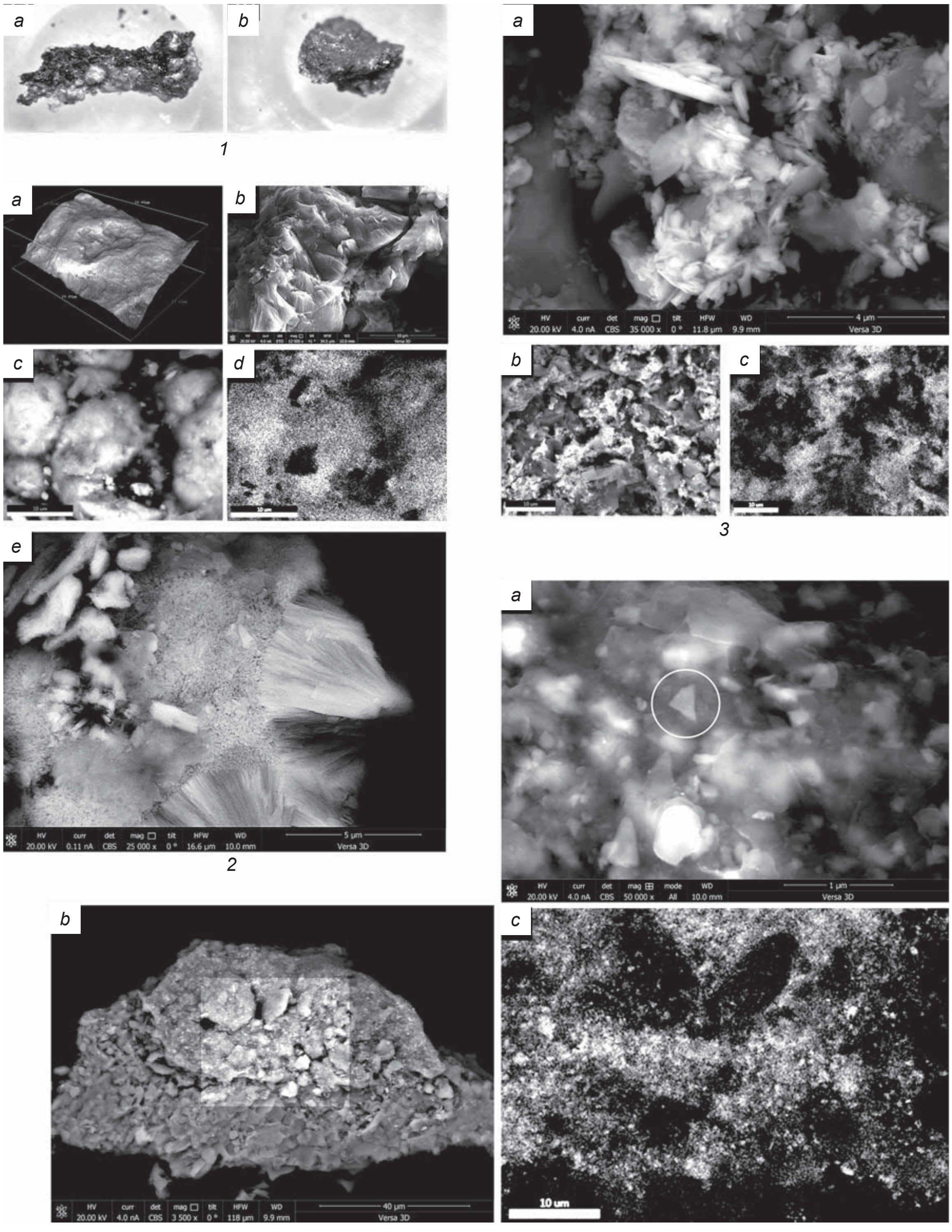


Fig. 2. Microphotographs of samples, back-scattered electron photographs, and iron-distribution maps of three samples.

1 – microphotographs of paint samples: *a* – K-1-7, *b* – *K*-1-9; *2* – sample K-1-7: *a* – 3D model of surface; *b* – a back-scattered electron image of spherulites; *c* – back-scattered electron image of the analyzed area; *d* – iron-distribution map in the 2c image area; *e* – needle-shaped particles of goethite; *3* – sample K-1-9: *a* – a back-scattered electron image; *b* – a back-scattered electron image of the analyzed area; *c* – iron-distribution map in the 3b image area; *4* – sample K-4-3: *a* – a back-scattered electron image; *b* – a back-scattered electron photo of the analyzed area; *c* – iron-distribution map in the 4b image area.

in the red paint samples is about 20% wt. The paints from the figures are similar to each other both in the elemental composition and in the size of pigment particles. The sample from the red line shows a somewhat smaller iron content: visually, the line color looks less saturated, and the paint layer is thinner.

Slab 2 from burial 2, mound 2. The slab's surface is flat, with some losses (exfoliation) of the weathered layer, which had been formed before the images were made: the head of the second figure on the left overlaps the boundary of the decay (see Fig. 1, *2*). In the right part of the slab, the engravings are partially overlapped by a black-paint drawing; the layer is uniform and dense. In the left part of the slab, only red images appear. The upper boundary of the slab is marked with a red line. The back shows different-depth engravings representing bull-headed figures (see Fig. 1, *5*).

The main fraction of red pigment is up to 2.5–3.5 μm. Large aggregates of more than 10 μm are actually absent. The paint sample from the red line has no particles of more than 4 μm.

Slab 3 from burial 2, mound 2. The slab's surface is flat, the loss in the lower right part had been formed before the slab was placed in the burial. Numerous pecked and engraved images pertain to the initial period of art activities (see Fig. 1, *6*). The central figure is made by engraving (the head with horns) and painting (the body). The upper boundary of the slab is marked with a red line. The figure is hardly discernible due to the small thickness of paint layer, the line is very thin too.

The drawings are made with liquid paint covering the slab surface with embossed engravings (see Fig. 1, *8*, *c*). The iron content in the analyzed samples from the figure and the line is within 10–20% wt, and depends in a greater degree on the sample's characteristics (its size and orientation) than on the paint's consistency. The calcium content in the weathered layer is considerably increased as compared to the host rock, which determines the specific hardness of the stone surface, and allows the possibility of deep engraving.

Slab 1 from burial 3, mound 2. This slab has a strong relief. This is not related to the arrangement of the figures. Two completed images and one sketch (a partial figure of a bull-headed figure, a spectacle-shaped sign, and two short parallel lines) are made by the pecking technique. Inside the burial, the slab was turned around in such a way that the figures were placed horizontally; the upper edge of the slab is marked with a red line.

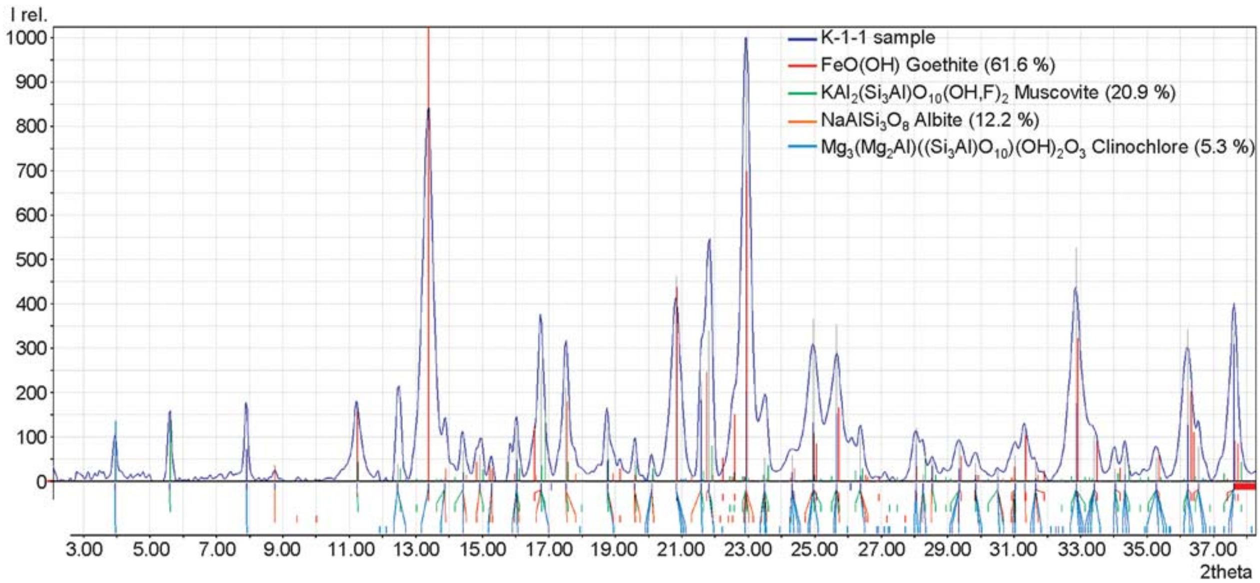
The slab's surface color is non-uniform, and only the upper right part, limited by an arc-shaped line, is uniformly yellow. The arc-shaped reddish brown line is very dense, and fully covers the stone surface; three samples were taken from it. X-ray microanalysis has determined a large amount of iron (30–40% wt), which is indicative of an iron-containing mineral forming a compact layer on the surface; using elemental mapping, a uniform distribution of iron throughout the entire analyzed area has been revealed, which is not typical for paints*, and suggests natural pigmentation of this line (see Fig. 2, *2*, *d*).

The surface morphology of selected samples was assessed by constructing a 3D model in secondary electrons. It has been shown that the colored material is composed of spherical particles, with some losses at the center (see Fig. 2, *2*, *a*). These particles have the divergent structure typical for goethite (see Fig. 2, *2*, *b*). The ends of needle-like goethite crystals in the back-scattered electron mode look like bright spots; however, at high magnification, it can be seen that they are not separate particles (see Fig. 2, *2*, *e*). The orientation of spherical particles is consistent throughout the entire layer, which tightly adjoins the rock's surface (see Fig. 2, *2*, *c*).

Regular-shaped hematite crystals are encountered in the paint sample from the bounding line. The typical size of pigment particles is 0.5–0.9 μm, though large elongate particles 1.2–3.3 μm in size and small crystals less than 0.3 μm are also encountered. The paint contains up to 0.6% wt of manganese, which is atypical of the paint itself; manganese is also present in the weathered layer, but absent in the host rock. Weathered layers on the slab's surface differ in their content of iron and manganese; the yellowish layer contains iron, while manganese is almost absent.

The powder X-ray diffraction was employed to study two samples: K-1-1 and K-1-3 (Fig. 3). Samples K-1-1, -2, and -8 were taken from the arc-shaped line; these are similar to each other, and therefore the most representative diffraction pattern of sample K-1-1 is published.

*In paints, a pigment is suspended into a binding media and, when a surface is painted, the pigment is distributed non-uniformly owing to the difference in the sizes of particles, their aggregation, and other factors (see Fig. 2, *3*).



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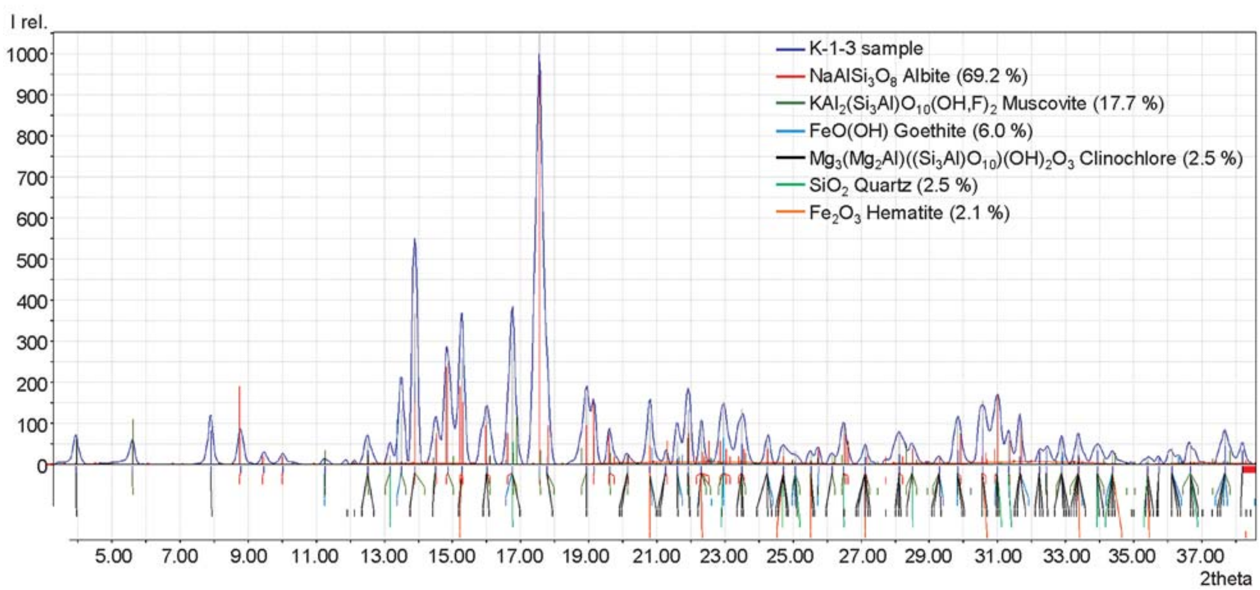

2

Fig. 3. X-ray diffraction patterns of samples K-1-1 (*1*) and K-1-3 (*2*).

In the samples from the dark arc-shaped line, the main components are goethite, albite, muscovite, and clinochlore. In goethite, iron ions fill a half of the octahedral cavities formed by oxygen ions in hexagonal packing. Parameters of an elementary cell (in angstroms) of goethite are a = 4.57; b = 9.93; c = 3.036 in the dark paint, and a = 4.56; b = 9.96; c = 3.04 in the red paint. The natural diversity of goethite reveals itself in a varying degree of hydration and substitution. Weakly hydrated particles have a grain-oriented fibrous-needle-like structure, and are strongly anisotropic. But strongly hydrated particles are usually isotropic, while the size of crystals is smaller. The shift in elementary-cell parameters, which can be observed in the X-ray photographs, is related to partial replacement of iron in the goethite lattice by other elements. A high value of parameter b is indicative of high isomorphic substitution for iron in the lattice; this results in the formation of an aggregate of irregular conglutinated particles instead of needle-like individuals, typical for goethite. Then the color gets brown tones (Belenky, Riskin, 1974; Vodyanitsky, 2003).

The absence of quartz in the samples argues for the following presumption against the dark-line nature: the goethite layer was formed as a result of natural processes during the formation of the rock, i.e. it was not a weathering product; the layer was easily separated from the slab during sampling.

Hematite, which ensures an intense red color, has been identified in the sample from the red line, in addition to quartz, albite, and mica group minerals (Mas et al., 2013).

Slab 1 from burial 5. The slab is flat, with local defects on the surface. The weathered layer of the slab surface, including the pecking area, is uniform in color (see Fig. 1, *7*, *a*). The stone texture can be seen under the paint layer, which is not very dense. Owing to the high resolution of the obtained photographs, new additional details of the image have been revealed, e.g. teeth in the mouth of the central figure. The artist probably worked using a thin brush (see Fig. 1, *7*, *b*).

The pigment particles of small size (0.1–0.5 μm) are distributed uniformly in the paint. The hematite crystals have a sharp shape, so we have discovered plate-like particles of various sizes. Obviously, the artist used paint with a high content of hematite to be grinded during the paint preparation, which resulted in formation of small crystal fragments (see Fig. 2, *4*, *a*). Fig. 2, *4*, *a*, *b* shows a schist particle with a paint layer in the upper part of it*.

Ozernoye site

A slab from burial 4, mound 1. Unlike the Karakol slabs, the surface of this slab is non-uniform. An anthropomorphic figure is made by a thin layer of red paint (see Fig. 1, *4*). Apart from this figure, no other traces of drawing have been revealed on the slab. The fragmented yellow outlining is modern, and no pecking or engraving traces on the surface are found by RTI.

The aggregates of hematite particles in the bulk of the paint reach a size of less than 1 μm, while separate particles are indiscernible. The difference between the iron content in the weathered layer and in the paint is less than 50 %: 5 and 9% wt., respectively. Large calcite inclusions have been found in the sample.

Discussion and conclusions

Red and black are the basic colors in prehistoric art. In nature, the most widespread and available red pigment is red ocher. The color of iron-containing paints is determined by their composition. Iron compounds determine yellow (goethite, lepidocrocite, jarosite), red (hematite), or black (magnetite) color. The presence of these chromatic components, as well as quartz, calcite, gypsum, and other minerals, in various ratios, and also variations of the shape and size of goethite and hematite crystals (the color of large crystals and aggregates of goethite and hematite is black) ensure diversity of the tones of natural materials (Torrent, Schwertmann, 1987; Schwertmann, 1993; Elias et al., 2006; Froment, Tournie, Colomban, 2008; Mastrotheodoros, Beltsios, Zacharias, 2010).

Comparison of the descriptions of the paint colors contouring lines and figures on the slabs from burial 2, mound 2 at Karakol, presented by V.D. Kubarev (who mentions dark red, dark crimson, red, and bright red paints) (see *Table*) allows us to presume that figures were done using various red tones, while the line was always made by dark red paint (see, e.g., (Kubarev V.D., 2013: 15–16)). However, determining the color with the use of the NCS color chart has allowed us to establish that the lines were made with the same paint as the figures. Notably, bodies of the deceased were drawn using paints of various tones; and also for painting and drawing, different paints were selected (Ibid.: 17).

Images on the Karakol slabs are made by various red pigments. Analysis of samples showed the similarity between the paints used for painting of all three slabs from burial 2, mound 2, not only in color, but in their elemental composition as well. The light red paint is red ocher with a hematite content of 10–20% wt. The particles of pigment are small, in the form of aggregates up to 5 μm in size; however, larger particles of more than 10 μm are also encountered. Taking into account that no differences have been found in the composition of the paints, the differences in the size of hematite

*The photograph was taken in the phase contrast mode, which allowed the pigment particles (bright points) to be distinguished against the background of rock (gray mass). The boundary of the paint layer extends in parallel to the lower boundary of the frame at 1/5 of the maximum height.

aggregates can be related to the degree of pigment grinding: pigment that was not fully ground might have remained at the bottom of the vessel in which the paint was prepared.

The dark red paint sampled on slab 1 from burial 5 contains small hematite particles. They are uniformly distributed in the bulk of the samples taken from the central figure, whereas the sample from the small figure in the right part of the composition shows aggregation of particles forming local areas with a high content of hematite particles. This can be related to the technical process of paint preparation and the procedure for drawing the images: at first, two large central figures were made, after which, two small ones were depicted in the left part of the slab using the remaining paint. All figures were probably depicted with the same paint, since no differences in color and elemental composition are observed.

The color of the paint that was used to make the red outline on slab 1 from burial 3, mound 2, is the same as that of the paint on slab 1 from burial 5; however, the shape of hematite particles is different: it contains more crystals of elongate shape and naturally faced crystals.

The red line extending along the upper boundary of the slabs from the majority of Karakol burials was applied after the placing the slabs in the grave. This conclusion was prompted by the displaced slabs, for example, those constituting the northern wall in burial 3 of mound 2 (Kubarev V.D., 2009: 155, fig. 75): the line on them was made in the same paint that was used for the figurative images.

In the Paleolithic, black pigment was provided most frequently by carbon-containing materials such as charcoal or soot (Prinsloo et al., 2008; Iriarte et al., 2013), or by manganese minerals such as pyrolusite, romaneshite, etc. (Chalmin, Menu, Vignaud, 2003; Lahlil et al., 2012; Pitarch et al., 2014). Analysis of black paint from slab 1 from burial 2, mound 2, has demonstrated that this was soot. The paint forms a very thin and dense layer, which is typical for fine pigments: separate particles cannot be seen at 2000x magnification, and the images made by the scanning electron microscope also show that the pigment layer uniformly covers the painted surface.

Gypsum (Mawk, Nobbs, Rowe, 1996; Wainwright et al., 2002), calcium carbonate (Scott, Hyder, 1993), white clay (Ward et al., 2001), or their mixtures (Koski, McKee, Thomas, 1973; Hall, Meiklejohn, Arocena, 2007) were probably used as white pigments by the artists who made open-air rock art images. No white paint was used in the Karakol paintings; however, in order to render white color for the depicted figures, the stone was scraped off on slab 1 from burial 2, mound 2 (Kubarev V.D., 2013: 15). As a result, small rock crystals were formed on the surface. They scattered light in all directions, which determined the white color of the surface after scraping-off.

Thus, the results of analysis point to the natural origin of coloring of the arc-shaped line on slab 1 from burial 3, mound 2, to the use of one red paint for decorating slabs from burial 2, mound 2, to the application of soot as a black pigment, and to the absence of white pigments. The differences in color and composition of red pigments suggest that in order to prepare paints, the available material was selected rather than a specific one. This conclusion is confirmed by the features of pigments at the Karakol and Ozernoye sites.

Subsequently, on the basis of the imaging and analytical studies performed, a reconstruction of the operating procedure can be carried out, implying the repeated, intentional symbolical use of some stelae and slabs with images for decoration of the Karakol funerary stone cists. Studies of the pigments that were used by the bearers of the Chemurchek culture, contemporaneous with the Karakol culture, appear to be promising (Kovalev, Erdenbaatar, 2014: 277–279; and others). We are talking about the first and the second Turochak rock art sites near the Biya River, which are very likely to belong to the Karakol culture (Molodin, 2016), and about the Okunev culture imagery (see, e.g., (Pyatkin, Martynov, 1985)). Comparison of the said pigments with those from geographically and chronologically close images from the Tom River (Tomskaya Pisanitsa rock art site) (Kovtun, Rusakova, 2014; Rusakova, 2015) and the Altai Mountains (Kurmantau) (Kubarev G.V., 2003) may provide important scientific results. Another promising direction of studies may be provided by analysis of the stone cist slabs from the studied Okunev culture burial grounds by means of optical microscopy, which could reveal remains of decayed colorants.

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Petroglyphs from Northeast China: New Sites and Interpretations

This article is based on the results of field studies in Northeast China (Dongbei) in 2012–2014. We describe 18 petroglyphic sites, most of which were hitherto unknown or little known to Russian, European, or Chinese scholars. All the petroglyphs are located on vertical or horizontal open rock surfaces. Two techniques were used—painting and carving. The most common paint was ocher of various shades: from red-brown or maroon to bright orange; in rare cases, black paint was used. The distribution areas of the two techniques largely coincide with those of the ethno-cultural groups occupying various parts of the region: paintings were distributed mostly in areas of mountain taiga, whereas most carvings were found in the mountain steppe. Figurative images and abstract signs are discussed in detail. Most figurative images are either anthropomorphic or zoomorphic. Abstract signs include dots, circles, crosses, and other geometric figures. Petroglyphs of Dongbei show numerous parallels with those of Mongolia, Trans-Baikal, Korea, and the Amur region.

Keywords: *Petroglyphs, East Asia, Northeast China, Dongbei, cultures, religions, ethnic groups.*

Introduction

Northeast China or Dongbei is a geographically relatively isolated and historically distinctive region of East Asia, which was previously also known as Manchuria. It is surrounded by fairly high mountain systems almost on all sides. The ridge of the Greater Khingan, which forms the northwestern border separating Dongbei from Mongolia and accordingly Central Asia from East Asia, stretches for 1200 km from north to south. The highlands of Liaoxi (Rehe) are in the south. The northeastern boundary is the mountain massif of the Lesser Khingan; the highlands of Laoeling (Laoling) and the Manchu-Korean Mountains are in the southeast. The great Manchurian Plain (Songliao) of about 300,000 km^2 is surrounded by these mountain systems. Two large corridors, formed by the floodplains of the large rivers Liao and Sungari, open the plain to the Yellow Sea in the south and to the Amur River in the east.

This integral region, which is diverse in terms of landscape and climate, provided a wide range of opportunities for the life and development of humans who practiced an appropriating economy of hunting, fishing, and gathering, as well as a producing economy of agriculture and cattle breeding. For tens of thousands of years, the Northeast of China was one of the most important centers of anthropogenesis and the emergence of ancient cultures and human populations. During the Early Iron Age and the Middle Ages, tribal associations and state entities, which played an important role in the history of East and Central Asia, were formed here.

The importance of this region for the history of East Asia has long been recognized by archaeologists and anthropologists. Already in the first third of the 20th century, Russian archaeologists from the Society for the Study of the Manchurian Region, as well as Chinese, Japanese, and Western European scholars, conducted field research there. Despite the outstanding discoveries made in the last century, the study of this region was still on the periphery of the main studies, partly determined by the idea of the monocentric origin of the Chinese civilization, and primarily focused on the sites of North China and the Yellow River basin. For a long time, the access of Russian and other foreign scholars to Dongbei was hindered due to political reasons.

In recent decades, the situation has changed significantly. On the one hand, the concept that the Chinese civilization was formed on the basis of integrating cultures which emerged relatively autonomously in different adjacent regions of China, started to dominate. Scholars have recognized that the Paleolithic and Neolithic cultures of the Northeast played a paramount role in the genesis of the Chinese civilization, and this approach fostered the study of the Dongbei cultures. On the other hand, Chinese and international scholars have gained new opportunities for studying the history of the region and for sharing their knowledge. Nevertheless, the study of ancient and medieval cultures, including the rock art of Northeast China, is at an early stage.

Dongbei petroglyphs in publications by Chinese scholars

Dongbei rock art is still an understudied phenomenon. Owing to historical issues (political instability, military conflicts, etc.), inaccessibility of many sites in this vast region, and other factors, the study of petroglyphs in Manchuria has been slow. The results of studying rock paintings of Dongbei by Chinese scholars are presented in books and articles by Wang Yulang (2011), Liu Wuyi (2010), Zhang Xirong (2010), Yasha Zheng (2014), Chen Zhaofu (2009), etc. The works of Dong Wanlun (1998) and Ge Shanlin (2004) are distinguished among the Chinese publications by the completeness of the description of the petroglyphs.

Some rock representations (such as Jiaolaohedao, Qunli, Daheishan) have been thoroughly analyzed, dated, and placed into historical context in the studies by Chinese authors; some drawings have been compared with rock art of the adjacent territories (primarily Inner Mongolia and the Lower Amur region). The publications have reproduced, as a rule, in black and white, the compositions and individual representations of the Dongbei petroglyphs. A summarized overview and brief interpretations of several sites of the region were published in 2014 by the Chinese scholar Yasha Zheng (2014).

With all due respect to the studies of Chinese scholars, we should however note that most publications typically contain only very approximate geographical coordinates of the sites, show high degree of conventionality in image reconstruction, and often provide inaccurate and incomplete descriptions of the compositions. Almost all the works lack information about archaeological finds which as a rule accompany the petroglyphic complexes. Obviously, the authors did not attach importance to collecting surface materials and did not conduct systematic archaeological research at the sites. They limited themselves to reproducing the images, and in the interpretation of images only relied upon written sources. The date when the rock representations were created was neither reliably confirmed by archaeological sources or by the results of comparative studies of the petroglyphs originating from the adjacent territories—the Amur region, Korea, Trans-Baikal region, and Mongolia. The map of rock representations of China in the region of Dongbei, which appeared in the article by Zhang Yasha, is far from reality. The works by Chinese scholars published before 2012, mention only eight or nine sites with rock representations, and the publications of Russian and international western scholars contain practically no information about them.

Field studies of the Dongbei petroglyphs 2012–2014

It is known that significant petroglyphic complexes in terms of quantity and quality are located on the territories adjacent to Northeast China. Hundreds of sites have long been discovered in the Amur region, Yakutia, the Trans-Baikal region, and Mongolia. In the 1970s, petroglyphs were discovered in Korea; at the present time, about sixteen sites have been found on the peninsula. In this context, at the beginning of our field research, the map of petroglyphs of Northeast China looked almost like a complete blank spot.

The starting point of our study into the petroglyphs of Northeast China was an examination of the publications of Chinese scholars (Wang Jianlin, Zabiyako, 2012). During the search for information about the locations of petroglyphs, we studied information of local administrations, regional newspapers, Chinese Internet sites, and some other sources along with scholarly publications.

In 2012–2014, we organized several expeditions to the territory of Northeast China. In 2012, field studies were conducted on the Liaodong Peninsula near the city of Anshan and adjacent areas. The main results were obtained during field surveys in April–May and July–August, 2013. At this stage, the survey covered all three provinces of Northeast China and the northern part of Inner Mongolia. Particular attention was paid to the Greater Khingan. It was studied along its entire length from north to south, from the taiga town of Mohe in the hills to the village of Hujiha sumu located on the border of the Mongolian sands and the mountains of Liaoxi. The village of Qunli, located on the slopes of the Laoeling Ridge not far from the Russian Primorye, and the Xianrendong Cave on the Liaodong Peninsula were chosen as the points of the survey route in the east, and Mount Dongmazongshan in Inner Mongolia was chosen in the western part of the area. In 2014, our route ran along the western part of Dongbei in Inner Mongolia, and a number of sites, primarily Daheishan, were re-examined.

During the field research, the previously discovered sites of rock art were examined and new sites were discovered. The study of the already known sites revealed new data concerning both rock representations and the context of the petroglyphic complexes. It turned out that, unfortunately, many Chinese publications contained minor and even significant inaccuracies. We could not find the site of Jiaolaohedao located in the very north of the area because of the lack of even approximate geographical coordinates in the Chinese sources; neither the local residents nor authorities had any information about that site. However, we do not doubt that this monument did exist and was on the most part correctly described by the Chinese scholars. The lines on the rocks in the Qianshan Mountains, which in the Chinese publications were interpreted as rock representations, were not petroglyphs, but resulted from natural processes. Thus, we excluded that site from the monuments under investigation. We were able to discover new rock representations through preliminary systematic research of local mass media (newspapers, websites), gathering information from local historians and residents who had good knowledge of the neighboring areas, and by surveying the most promising locations on the terrain. We collected information on eighteen rock art locations; more than half of them were previously unknown to specialists. We have managed to substantially refine and supplement the materials on the previously published sites (with the exception of Jiaolaohedao) with new empirical data and theoretical interpretations. New compositions and representations were discovered at each of the previously published sites; for example, over 140 new representations were found in Aniangni.

Our field work on the territory of China was regulated by the legislation of the country and was limited to searching, determining the geographical coordinates, as well as mapping and photographing rock representations. The archaeological finds from the territories adjacent to the monuments were available to us only in the collections of universities (scientific centers) and museums of the provinces and cities of Dongbei. In a number of cases, it was possible to gather surface finds near the representations. The collected empirical data have been analyzed and published (Zabiyako, Wang Jianlin, 2015). In this article, we summarize the main results of our research and suggest some new interpretations of rock representations and compositions of Dongbei.

Geographical coordinates of the sites

The scope of this article does not allow us to give a detailed description of the locations of sites with rock art. Thus, we only provide their geographic coordinates recorded by the GPS receiver:

Aniangni – 51.816782° N, 121.436722° E, 672.5 m above sea level; Lumingshan – 51.5587996° N, 122.331.68° E, 732.7 m above sea level; Gaxiandong – 50.624854° N, 123.608758° E, 501.5 m above sea level; Tianshuling – 50.701232° N, 123.788514° E, 714.9 m above sea level; Shenzhifeng – 49.956888° N, 122.975492° E, 806.2 m above sea level; Longtoushan – 50.584676° N, 123.746682° E, 432.5 m above sea level; Shenxiandong – 50.253202° N, 119.587686° E, 674.8 m above sea level; Duxiufeng – 47.5257.036° N, 121.15524556° E, 702 m above sea level; Dongmazongshan – 43.537581° N, 119.907776° E, 448.3 m above sea level; Qunli – 44.54223128° N, 129.39266364° E, 213.6 m above sea level; Yushan – 41.100833° N, 123.039695° E, 122 m above sea level; Yagou – 45.4816° N, 127.136094° E, 307.4 m above sea level; Shijiangshan – 41.387671° N, 120.410908° E, 336 m above sea level; Xianglushan – 41.089676° N, 120.59283° E, 500.6 m above sea level; Yufoshan – 41.100833° N, 123.039695° E, 122 m above sea level; Xianrendong – 40.185634° N, 122.165095° E, 57.2 m above sea level; Daheishan – 44.11062808° N, 120.52489972° E, 332 m above sea level.

Main features of the Dongbei petroglyphs

All petroglyphs of Northeast China are located on open vertical or horizontal rock surfaces. Some compositions are associated with caves (Gaxiandong, Xianrendong) or grottoes (Tianshuling 1), but all of these representations were made on rock walls just outside of the cave entrances or inside the cavity near the entrance. Even in the large cave of Gaxiandong with a natural length reaching about 60 m, which was populated by humans as early as the Stone Age, the drawings were located next to the entrance. This type of placement is an important feature of all rock representations of Dongbei, which shows similarity to the huge world of non-cave petroglyphs in the east of Eurasia.

A.P. Okladnikov observed a similar placement of rock representations in the Trans-Baikal region. He noted that the drawings associated with caves were located near the entrances to the cavity, “not in the darkness, but in the light. <…> Therefore, all these are not cave drawings in a real sense of the word, but ordinary rock representations” (Okladnikov, Zaporozhskaya, 1970: 65). This conclusion is fully applicable to the Dongbei petroglyphs: “The people who drew these images clearly did not try to hide them from someone else’s eyes (from the uninitiated) in the dark depths of the underworld, as was the case with the cave art of the Paleolithic. On the contrary, for their drawings they chose the most picturesque rocks visible from afar and attracting the attention of everyone who would appear in this valley” (Ibid.).

The rock representations of Dongbei were created using two main techniques: applying a layer of paint, and pecking and incising. The sites with images made with paint include eleven locations: Jiaolaohedao, Aniangni, Lumingshan, Gaxiandong, Tianshuling, Shenzhifeng, Longtoushan, Shenxiandong, Duxiufeng, Dongmazongshan, and Qunli. Ten sites are located in the mountain taiga area on the slopes of the Greater Khingan; all of them tend to be concentrated in the north, and only one (Dongmazongshan) is far beyond the taiga zone at the southern extremity of the ridge. At the location of Qunli, the drawings were made on one of the cliffs of the Laoeling Mountains, which flank the Lesser Khingan to the south.

Mostly ocher of various shades—from red-brown and maroon to bright orange—was used as a pigment. In rare cases, black paint was applied. The images on the greatest part of rock compositions were created with lines, spots, and contours. The figures which were drawn in the technique of complete filling, dominate only at one site, that of Qunli. Notably, Qunli is located far to the east of the main group of sites with painted representations. The figures relating to different compositions or planes differ significantly at some sites (for example, Aniangni) in terms of color, thickness of line, and size, which indicates the gradual creation of drawings and rock paintings. There are no palimpsests; most likely, the formation of rock compositions by alternating generations or cultures occurred in a conflict-free environment.

The sites with rock representations made in the technique of pecking and incising belong to seven locations: Yushan, Yagou, Shijiangshan, Xianglushan, Yufoshan, Xianrendong, and Daheishan. They all tend to be concentrated in the south of Dongbei, in the mountain steppe and coastal mountain landscapes. Only the site of Yagou (a composition pecked on the rock) is located far to the northeast in the mountain taiga area near the Lesser Khingan; its emergence is associated with the migrations of the Mongols and their allies in the 13th century. Most of the representations of this group were created using groove pecking. A stone chisel with worn-out striking surfaces was found on the mountain of Xianglushan near a rock wall with pecked representations. It probably served as a tool for making drawings. Petroglyphs made in the techniques of grooved pecking (plane 1) and abrading (plane 2) coexist at the Daheishan site. This indicates that the compositions were created at different times and represent different cultural traditions. Notable are the representations incised by thin contour lines and carving at the Shijiangshan site, as well as cup-like holes which were pecked on large flat boulders and form different configurations, at the sites of Yufoshan and Xianrendong.

Almost all the rock representations made in the technique of applying a layer of paint, do not show signs of using other techniques (for example, pecking or incising), and vice versa. This indicates that the petroglyphs resulting from different techniques belonged to different cultural traditions. In addition, we may speak about the differences in the geographical location of these traditions which must have been associated with different ethnic communities, and also about the coexistence of different cultures bordering each other but retaining their distinctive identities in Dongbei.

Localization of types of rock representations makes it possible to establish with a certain degree of accuracy the boundaries of ethnic and cultural communities historically located within the region and to determine their relations with the groups which settled in the adjacent territories. It is obvious that in terms of their technique, stylistic features, and content, the painted rock representations tend to show similarities to painted petroglyphs from the adjacent mountain taiga territories, while the pecked rock representations look similar to the drawings typical of the mountain-steppe landscapes to the south and west of the Greater Khingan. According to archaeological and ethnographic sources, different ethnic and cultural communities historically existed in different natural conditions. At this stage of research, we will refrain from reconstructing a comprehensive picture of ethnic and cultural static and dynamic processes where the areas of petroglyphs belonging to various types emerged.

Both figurative images and non-figurative abstract signs are depicted among the rock drawings of Dongbei. The most numerous group among the figurative representations are anthropomorphic images. Anthropomorphic figures were mostly drawn in a very stylized manner in the form of a vertical line denoting the body and head, from which slanting lines to the right and to the left signified the arms and legs. Some drawings represent different versions of the representation of the head (round, rhombic, or pointed), arms, etc. An anthropomorphic (anthropozoomorphic) three-fingered creature appears on plane 3 at Aniangni. An important feature of many anthropomorphic representations is their hypertrophied phalluses. At the sites of Shenzhifeng and Tianshuling, the anthropomorphic figures are depicted in the typical posture of women giving birth (Fig. 1). Notable details of many anthropomorphic images include horns, headdresses, spears or rods (staves), bows, and round objects (possibly tambourines) in their hands. Several figures on the planes of Dongmazongshan, Aniangni, and Qunli are drawn by contour lines or are made in the technique of continuous filling of the contour. Anthropomorphic images are usually represented in a static position; only in individual compositions (Shenzhifeng, Qunli, and in some other locations), the figures are depicted dynamically, possibly during dancing, performing a ritual, doing archery, pulling a deer, etc.

Several distinctive figures are depicted at the sites of Yushan and Yagou. A large (about 110 × × 60 cm) figure with quite realistically rendered details of face and clothing was incised on a separately lying boulder on Mount Yushan near a burial structure of the 4th century AD. Relatively large (about 185 × 105 cm) male and female figures, whose clothing dates back to the Yuan dynasty, were pecked on the rock of Yagou in a different technique but also in a realistic manner.

A special group consists of pecked and polished rock drawings of Daheishan with the predominant representations of anthropomorphic face-masks.

The figurative images that constitute a smaller group in quantitative terms are zoomorphic representations. The images of elk and deer prevail; both can be found on painted and pecked petroglyphs. All the drawings are relatively small, varying from 10 to 25 cm in length. At all the sites except Qunli, animal figures are rendered by contour lines without filling.

Special attention should be given to the images of jumping deer with circles on the antlers, pecked on Mount Xianglushan (Fig. 2). It is generally

Fig. 1. Composition of anthropomorphic figures and representation of a woman giving birth (above). Tianshuling 2.

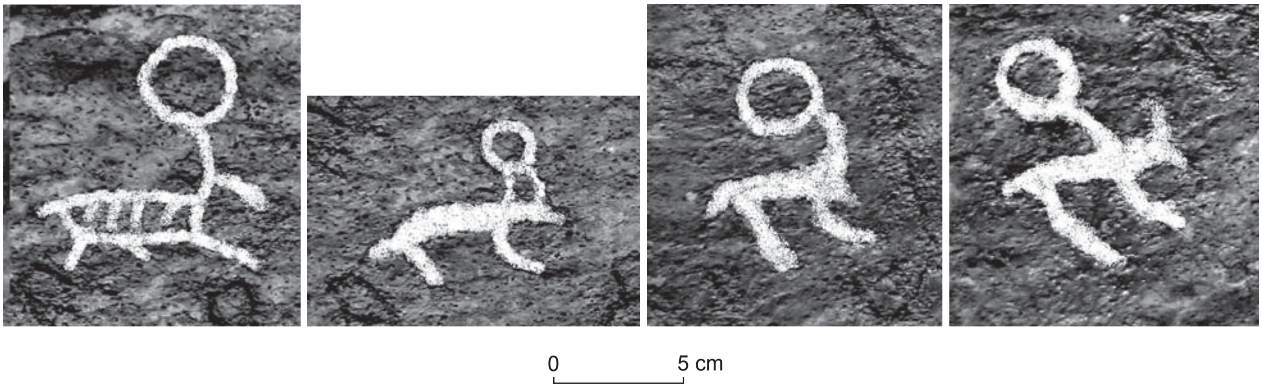

Fig. 2. Deer with circles on their antlers. Xianglushan.

accepted that figures in the form of a circle are a symbolic representation of the sun which the celestial deer carries on its antlers. The image of the celestial deer-sun is common for ancient religious and mythological traditions. “The deer and a little later the horse as symbols of the sun, as animals dedicated to the solar deity, played an important role in the solar cults of many peoples of the steppes of Europe and Asia in the first millennium BC. However, the cult of the solar deity is even more ancient. In North Asia and Europe, symbols of the sun are already found among the Neolithic drawings in petroglyphic complexes” (Okladnikov, Martynov, 1972: 225). Images of the cosmic deer or elk, the animal-sun, are often found among the petroglyphs of Eurasia. Such images on the Kamennye Islands on the Angara River, on the rocks in Mongolia, stone massifs on the Tom River, and other locations are interpreted precisely as symbols of the zoomorphic sun.

The image of the deer-sun was the main focus of publications by Okladnikov, who found local modifications of the Golden-Antlered Deer not only on the rocks of Eurasia, but also on the “deer stones” of the Trans-Baikal region and Tuva. “Animals on deer stones are also solar symbols. Not only do they fly through the air; they are also equipped with the symbols of the sun: circles depicted above, in front of the muzzles of the animals. The deer fly upward, as if following a solar disk” (Ibid.). A vivid example of such symbolism according to the interpretation of Okladnikov was the composition pecked on the Ivolga Stele. In the article “Deer Stone from the Ivolga River”, Okladnikov focused on the circles, discs, pecked above the heads of the deer, and wrote, “… On the obverse of our stone, a circle grows immediately and directly from the antlers of the deer; in addition, a rod on which it is depicted, resembles the side handle of a mirror which commonly occurs among the antiquities of our Black Sea region” (Okladnikov, 1954: 215). In the subsequent publications, while interpreting the circle as a mirror, Okladnikov emphasized the paramount importance of solar symbolism which is the key to the semantics of the symbol. In the book, *The Golden-Antlered Deer*, Okladnikov thus noted, “Since old times, the shining mirror served as a counterpart and a symbol of the solar disk in the mythology of various ancient peoples. In turn, even in the Stone Age, the sun was conceived as a living cosmic being, a deer with golden antlers shining with unbearable brilliance, who runs across the entire sky from day to day, from east to west. And that is why, so that there were no doubts, the artist of the Bronze Age pecked not just a deer on the stone, but a deer with the solar disk above the antlers—the Golden-Antlered Deer” (Okladnikov, 1989: 132). The deer with discs on the antlers, pecked at the top of Mount Xianglushan, are a local version of the image of the deer-sun: a zoomorphic deity or heavenly companion of the sun-god.

Some figures on the rocks of Xianglushan can be interpreted as images of goats. According to the publications of Chinese scholars, the drawings of Jiaolaohedao might have represented dogs (Chen Zhaofu, 2009: 42).

Red-orange ocher images of two large animals, most likely boars, appear on Mount Tianshuling, on a rock plane measuring 30 × 40 cm. We should note that even today many wild boars which are dangerous for people live in these areas. The animals were drawn in a vertical projection one above the other and almost touch each other with their heads. The creator of the composition apparently wanted to depict the scene of a fight between two wild boars and used the vertical projection of the representations to emphasize the unusual nature of the clash. One of the animals is attacking from above, and the other one is approaching it from below. We can assume that the composition conveys a mythological subject with the motive of a struggle between magical animals. Such motives are typical for cosmogonist, eschatological, etiological, shamanistic, and some other types of mythological narratives. It is known that wild boars are characterized by enormous strength, fury, and courage, and play an important role in the religious and mythological beliefs of many peoples.

The composition on Mount Shijiangshan is distinguished by a great variety of zoomorphic imagery. According to the publication of Chinese scholars, in 1986–1987 there were figures of deer, horses, cows, tigers, and other animals depicted on a rock wall covering an area of about 80 m^2 (Liaoning…, 2004). They were incised with fine lines in an elegant and realistic manner, far from the archaic style. When surveyed in 2013, the area of rock surface with representations was already about 20 m^2. Most of the drawings were lost due to the destruction of the rock during the extraction of building stone. By now, only two images of deer have survived.

A naturalistic image of a bird is also depicted on Mount Shijiangshan. We have found no other unmistakable ornithomorphic images among the Dongbei petroglyphs.

Teratomorphic images were created in the form of various monstrous creatures including dragons. Images of dragons (currently lost) were represented at the Shijiangshan site. A fragment of the composition on plane 1 at Shenzhifeng can be confidently interpreted as a serpentine horned creature.

Usually, figurative images on the planes represent independent characters which do not have an obvious connection with other creatures. On some surfaces, anthropomorphic and zoomorphic creatures are shown in interaction. Thus, among the petroglyphs of Shenzhifeng, Tianshuling, and Gaxiandong, anthropomorphic figures form chains and other compositions which can be interpreted as ritual dance, collective prayer, or as social, family bonding. The image of a woman giving birth and surrounded by anthropomorphic figures manifests the relationship of birth and kinship, originating from the woman. An anthropomorphic creature pulling a deer is depicted at the site of Qunli and must have represented the scene of domestication of deer. The two boars, depicted at the site of Tianshuling, represent the mythological subject of the clash between two adversaries. A sophisticated composition of anthropomorphic figures enclosed in a rectangle at the Longtoushan site, some of which were drawn upside down, possibly shows the connection between the living and the dead: the dual structure of the community consisting of people living in this world and their relatives, ancestors, who reside in the other world.

The most common abstract imagery of Northeast China includes dots, lines (vertical, horizontal, or slanting), crosses (straight and slanting), circles, arrow-shaped and V-shaped signs, "goose paws" ("tridents"), or cup-shaped depressions (concavities). The semantics of these signs, individually or in combination, are ambiguous and controversial. Since this has been analyzed with varying degrees of conclusiveness by many authors, we will not offer our own interpretations.

Another group of abstract images are structurally complex signs and compositions combining geometric figures, straight and curved lines, dots, etc. The semantics of abstract compositions is as ambiguous as the semantics of simple abstract signs. The reconstructions of their meaning and function highly vary. From our point of view, several types of complex symbolic compositions can be distinguished among the petroglyphs of Dongbei.

On the petroglyphs of Aniangni, Gaxiandong, Shenzhifeng, and Dongmazongshan, some signs formed by the combinations of geometric figures and lines are *tamgas*.

Some rock compositions at the sites of Longtoushan and Tianshuling represent stylized images of important fragments of the worldview or the image of the society. As we have already noted, a rectangle is depicted with ocher paint on the rock at Longtoushan; anthropomorphic creatures are drawn inside, some upside down. It is possible that the rectangle represents one of the versions of "fences", representations of which can often be found on petroglyphs. Thus, rock representations of the Selenga type are widespread in the north of Mongolia and in the Trans-Baikal region. "The most typical subjects of these representations are 'fences' with oval or round spots…" (Okladnikov, 1981: 68). Other objects, such as anthropomorphic figures, are often shown inside the "fence". Okladnikov suggested that the "fences" recreated the image of the universe, and symbolized "simultaneously the community-family clan or tribe, while small human figures or spots placed within them signify the members of that community" (Okladnikov, Zaporozhskaya, 1970: 91). Some "fences" are divided into two halves. Such a structure "reminds us of the division into two halves, typical of the nomadic societies in Siberia and Central Asia" (Ibid.). According to Okladnikov, this "reveals the dual organization of the primitive community, a universal, global phenomenon". From this perspective, the double "fences" acted as "a symbolic image of a community consisting of two exogamous halves" (Ibid.: 92).

We should consider the petroglyphs from the site of Longtoushan in light of this idea of Okladnikov. The composition at Longtoushan is a rectangle with anthropomorphic figures inside. It depicts the community, family clan, or tribe. The dual structure of the composition, consisting of anthropomorphic figures, shown in the upper part in the normal position and in the lower part with their heads down, reflects the division of the archaic community into two halves: those living in this world and those dwelling in the other world. Beliefs concerning the dual structure of a community as consisting of two parts (the living relatives and deceased relatives) are typical of archaic cultures. Being a symbol of the community's unity and the link between the generations, the petroglyphs of Longtoushan might serve as markers of the zone where the rituals of the ancestors' cult or community rituals with similar meaning were performed for strengthening the cohesion of the tribal collective and its self-identity.

Two representations of a labyrinth were pecked on the rocks on Mount Xianglushan. Similar images have been found on the rocks in the Trans-Baikal region, Mongolia, and North America (for example, in the Grapevine Canyon). In the study of the petroglyphs of the Mongolian Altai (Zagaan-Salaa and Baga-Oyuogura), V.D. Kubarev, D. Tseveendorj, and E. Yakobson interpreted figures visually similar to compositions of Xianglushan as "mazes", "networks", or as "indeterminate" or "unidentifiable" representations (Kubarev, Tseveendorj, Yakobson, 2005: 605) (Fig. 3). Clearly, labyrinths are one of the most difficult symbols for study. Graphic visualizations of labyrinths are devoid of ethnic and cultural details, which makes it difficult to carry out their identification, date them, and determine their function. Judging by the materials of Paleolithic cave art, analyzed by A. Leroi-Gourhan, the image of the labyrinth was not typical of the Paleolithic, therefore, the graphic representations of labyrinths must have not appeared until the Neolithic (Leroi-Gourhan, 2009). The initial enigmatic nature of the labyrinths complicates their semantic interpretation (Zabiyako, 2015).

Determining the time of creation and functioning of petroglyphs is usually problematic. This fully applies to the images at the sites known from the Chinese publications and the sites which we have discovered.

The date for the Paleolithic petroglyphs of Dongbei is controversial. Relying on the studies on Chinese

Fig. 3. Representation of a net or labyrinth. Mongolian Altai (*a*), Xianglushan (*b*).

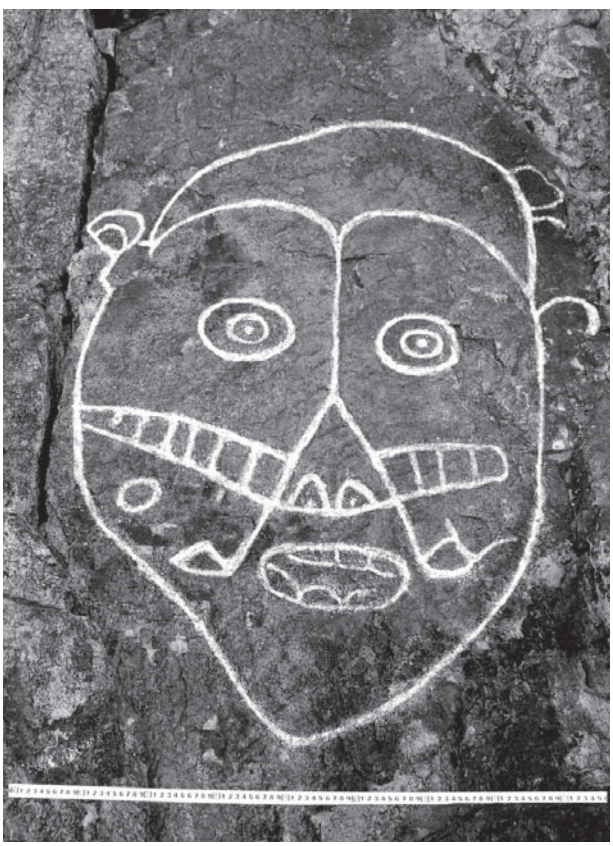

Fig. 4. Face. Daheishan.

petroglyphs, Zhang Xirong suggested that images in the form of cup-shaped depressions in Liaoning Province (Heicheng, Anshan, Yufoshan, etc.) were created in the Late Paleolithic–Bronze Age. Zhang Xirong cited the data of Chinese scholars that, for example, the petroglyphs of Tamedi (the Ningxia Hui Autonomous District) were created in 13,000 BP; the petroglyphs of Lianyungang (Shandong Province) in 8000 BP; the petroglyphs of Daishan (Shandong Province) in 6500 BP; the petroglyphs of Jucishan (Henan Province) in 4000 BP, and the petroglyphs of Daheishan (Inner Mongolia) in 5500–4200 BP (Zhang Xirong, 2010: 95–98). According to Zhang Xirong, the petroglyphs of the Anshan-Heicheng region appeared before many of the above-mentioned rock representations were made. An important argument in favor of such a conclusion is that the Heicheng site is located 10 km from the Paleolithic site of Xiaogushan, the cave where humans of the Upper Paleolithic Age lived (ca. 19,000 BP). According to Zhang Xirong, it was precisely the inhabitants of the cave that were the first creators of the petroglyphic representations (2010). We have studied rock representations of this region. Indeed, there are man-made cup-shaped cavities on large boulders mentioned by Zhang Xirong in the Anshan and Yufoshan areas, as well as on the boulders at the Xianrendong site in the same region, which were discovered by us. However, the presence of such cavities at the locations near the Xiaogushan site does not give us sufficient grounds for dating the object to the Paleolithic. Cup-shaped cavities widely occur in different regions of the world and belong to different periods from the Paleolithic to the Middle Ages. From our point of view, none of the petroglyphic complexes on the Liaodong Peninsula and in Northeast China as a whole, which we examined, can yet be reliably dated to the Paleolithic.

In our opinion, some compositions from Aniangni, Gaxiandong, Tianshuling, Shenzhifeng, Shenxiandong, Dongmazongshan, Xianglushan, Yufoshan, and Xianrendong belong to the Late Neolithic. Some compositions and images from Aniangni, Gaxiandong, Tianshuling, Shenzhifeng, Shenxiandong, Longtoushan, Dongmazongshan, Xianglushan, Yufoshan, and Xianrendong belong to the Paleometal. The petroglyphs of Yagou, Shijiangshan, Yushan, Daheishan, and Qunli were created in the Middle Ages.

The proposed dates are preliminary. At present, the dates of rock representations of Northeast China and Inner Mongolia remain controversial. Thus, the Chinese scholars consider the faces represented on the rocks of Daheishan, as well as some other geographically close representations, as belonging to the Neolithic. Drawing upon the historical reconstruction of shamanism practiced by the peoples of Northeast China and Inner Mongolia, and the ideas of the role of shaman masks in the genesis of the petroglyphs, Ge Shanlin and Ge Zhihao came to the conclusion that the petroglyph-masks of Inner Mongolia were pecked following the images of masks of ancient shamans (2002: 347). The scholars believe that the tradition of creating petroglyph-masks "begins in the Neolithic, flourishes in the Bronze Age, and gradually fades in the New Era by the Tang Dynasty"; in the period of decline, "there was a tendency towards an increase in the number of images in the form of square petroglyph-masks, in which the facial features were rendered in an abstract manner" (Ibid.: 358). The end of the Tang Dynasty (616–907) was the time when the Khitan people created the Great Liao State on the territory where the face-masks of Daheishan were found. The practice of creating rock representations and using shamanic masks, including burial masks, might have continued to exist in the Daheishan area in the Tang period and could have been associated with the Khitan culture (Fig. 4).

The faces of Daheishan show similarities to the faces of Inner Mongolia, primarily to rock representations of Yinshan, Denkou, Alpas, Hoyarbogda, and some other locations. Russian archaeologists have proposed their own dating for the petroglyphs of this type. Thus, E.G. Devlet and M.A. Devlet noted the difficulties of dating the images of the faces from Inner Mongolia, since these images were created at different times. At the same time, they believed that the earliest of the above representations dated back to the Chalcolithic, while the latest went back to the Late Bronze Age–Early Iron Age and could be dated to the late second–early first millennium BC. E.G. Devlet and M.A. Devlet did not exclude the possibility that individual images could have been represented on the rocks at a later time (Devlet E.G., Devlet M.A., 2005: 289–290). Obviously, this chronological framework offered by E.G. Devlet and M.A. Devlet significantly differs from the dates proposed by the Chinese scholars, especially from the definitions of the late stages of the functioning of the masks from Inner Mongolia.

The dates suggested by the Russian and Chinese scholars result from studying the imagery, semantic content, and stylistics of the Dongbei petroglyphs, as well as their comparison on these grounds with the rock representations of the adjacent territories (Mongolia, Trans-Baikal region, Amur region, etc.), which have a generally accepted periodization. It is clear that these methodologies are not sufficient for considering the conclusions on the dates, ethnic and cultural attribution, and functioning of petroglyphic complexes to be fully substantiated. Our study has shown that the petroglyphic complexes of Manchuria require further research.

Conclusions

The petroglyphs of Northeast China are very rich in historical, cultural, and religious terms. First, they serve as a source for reconstructing the way of life and spiritual culture of the population living on a huge and extremely important territory from a historical point of view. Some of the original ethnic and cultural traditions which originated in Manchuria, evolved and merged with the traditions of the neighboring populations, and spread outward, influencing the cultures not only of the nomadic peoples of East Asia, but also of the population of China. Second, the rock art of Dongbei is a part of the numerous petroglyphs of Eurasia, and is closely associated with the rock art of Mongolia, the Trans-Baikal region, Amur region, and Korea. The study of the petroglyphs of Manchuria is a necessary stage in the formation of a comprehensive idea of chronology, styles, meanings, functions, and other aspects of rock representations in the Northeast of Eurasia, as well as the history and culture of this part of the Eurasian continent.

Acknowledgements

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Paint on Deer Stones of Mongolia

This study focuses on traces of paint on stone stelae ("deer stones") of Mongolia, dating from the late second to the mid-first millennia BC. The painting was made in various shades of red. In all cases, remains of paint were found on facets which had been protected from weathering because the stelae had collapsed or been reused. Additional protection might have been provided by a calcite crust formed where the stelae were in contact with the ground. On the basis of the role of painting in visual imagery, two groups of paintings are described: supportive (filling in the engraved figures) and independent. The first group is the largest. In terms of composition, stelae fall into two types: 1) those whose front is on the narrow vertical facet, carrying images of deer in the Mongolian-Transbaikalian style; 2) and those whose front is on the wide vertical facet, where the upper tier is emphasized, and neither deer nor belts with weapons are represented. The relative chronology of the two types is established by the fact that in certain instances, stelae of the first type were reshaped into those of the second type. The first type is related to funerary and memorial sites of the Khereksur and Deer Stone culture of Central Mongolia; the second, to burials of the Slab Grave culture. The tradition of decorating engraved figures with red mineral paint originated among eastern Eurasian steppe pastoralists in the Early Bronze Age.

Keywords: *Mongolia, Trans-Baikal, Bronze Age, Early Iron Age, khereksurs, Slab Grave culture, deer stones, stelae.*

Introduction

The tradition of making stone stelae was an important element of the culture of pastoralists who lived in the eastern part of the Eurasian steppe belt in the late second–mid-first millennia BC. Currently, the popular name of "deer stones" (from the Mongolian *bugan hushuu* – 'deer stela', or *bugan chuluu* – 'deer stone') has become widely used in the literature, since deer are often depicted on them. Usually, three types of stelae are distinguished according to the presence or absence of such representations and the style of the imagery. These types are named after the main areas where they occur: the Mongolian-Transbaikalian, the Sayan-Altaian, and the Pan-Eurasian type (Volkov, 2002: 19). The archaeological context points to the use of these stone monuments in burial and memorial rituals. Belts, necklaces, weapons, and earrings, reproduced on the stone, as well as their location, indicate that the stelae are stylized representations of a human figure; it is also possible to identify the individual parts of the stone and the images on the stone with parts and objects of space. A significant number of publications have focused on these stone monuments, but some basic technological aspects have still remained unexplored. One of them is the use of paint for decorating the stelae, and the reconstruction of their original appearance. It is important to note that no major work on deer stones has mentioned the use of paint and analyzed this aspect, although the possibility of painting was sometimes suggested. For example, it was assumed that carefully polished areas of stone in the upper tier of the front surface in some stelae might have been intended for representing a human face using painting rather than pecking (Fitzhugh, 2009: 3). It was also suggested that paint might have been used for creating a sketch on the stone, after which pecking was performed (Gryaznov, 1984: 78).

Only recently, research in Central (Gantulga et al., 2013) and Western (Tishkin, 2013a: 81, 88) Mongolia has revealed information on the presence of red pigment on some deer stones. In addition, there is some information on the traces of red paint on individual stelae of the Pan-Eurasian type from the western edge of the Eurasian steppe belt (Olkhovsky, 2005: 53). This article presents newly discovered facts of the presence of paint, as well as classification and comparative historical analysis of such painting.

Review of the studied materials

This article is primarily based on materials from Central Mongolia, where the joint archaeological expedition of the Museum of Prehistoric Anthropology of Monaco and the Institute of History and Archaeology of the Mongolian Academy of Sciences have been conducting research for a number of years. Currently, over a hundred deer stones have been found in the area of archaeological works on the Khoid Tamir River. Traces of paint have been found on five of these stones. In addition, during the survey trips to the sites in the neighboring areas, paint was found on deer stones in the valleys of the Khunui and Khanui Rivers, near Lake Khubsugul (Khövsgöl), and in other locations (Fig. 1). In all cases, the paint was detected visually; analysis using natural scientific methods has not yet been carried out. Nevertheless, our previous experience of studying the painting on the stelae of the Early Bronze Age from Southern Siberia, including analysis based on laboratory tests (Essin et al., 2014), leaves no doubts as to the presence of the remains of painting on deer stones.

Here is brief information on some of the objects.

1. Stele No. 11 in the location of Tsatsyn-ereg, the valley of the Khoid Tamir River; pinkish granite, 201 × × 41 × 60 cm. The stele was used as a wall of a slab grave excavated by V.V. Volkov (2002: 36, pl. 8, *2*), and was set up vertically in 2007. Documentation of the stele was performed in 2013 (Fig. 2)*. The front surface of the stele is higher than the back surface. The images were made by pecking and subsequent polishing. Traces of red paint, partially covered with a thin layer of calcite deposits, were found inside the outlines of the representations of deer, an earring, and a dagger on the right broad facet. Apparently, this facet was hidden by earth and stones, when the stele was a part of the burial structure.

2. Stele No. 24 in the location of Tsatsyn-ereg, the valley of the Khoid Tamir River; grey granite, 253 × 27 × × 80 cm. The stele was previously studied by Volkov (Ibid.: 34, pl. 7, *1*), and was set up vertically in 2008. Documentation was performed in 2013 (Fig. 3). The front surface of the stele is higher than the back surface. The images were made by pecking and subsequent polishing. On the right side of the stele, traces of red paint, partially covered with a thin layer of calcite deposits, were found inside the outlines of the representations of deer, a necklace, and a belt. The necklace and deer were simply painted, and slanting lines forming large triangles were probably painted on the belt (Fig. 3, *3*).

3. Stele No. 68 in the gorge of Shivertiyn-am, the valley of the Khoid Tamir River; light gray granite, 340 × 41.5 × 92 cm. This stele was set up 10 m east of the large slab grave No. 3 excavated in 1978 (Ibid.: 29, No. 19), and was studied in 2012–2013 (Fig. 4). The representations were made by pecking with subsequent polishing. Additions to the composition and its alteration have been detected. Originally it was a classic deer stone of the Mongolian-Transbaikalian type with the front surface on a narrow facet (Fig. 4, *2*); its height might have reached 4.5 m. The upper part of the stele, associated with the head of the anthropomorphic figure, was emphasized by the representation of a necklace of beads with a pendant made of a claw or fang. Paired large and small rings, which can be interpreted as earrings, were pecked on the sides of this "head". A wide belt with a weapon suspended from it is represented at the bottom of the stele. On the reverse side (on the "back"), a pentagonal shield with a sophisticated decoration and a round onlay in the center is depicted. The space between the belt and the necklace is filled with images of deer in the Mongolian-Transbaikalian style. A round mirror is shown in the same place between the figures of the animals. Two additional circles pecked in the upper part of the right wide side of the stele stand out from the above composition, which indicates that it was changed several times. After some time, the lower part of the stele was broken along the belt; images of rings,

*All photographs and drawings of the deer stones were made by Y.N. Esin. For making the painting more visible, the saturation of red color was slightly increased in the photographs published here using Adobe Photoshop software.

Fig. 1. Location of the studied monuments with painting.
a – archaeological sites with the stelae of the Late Bronze–Early Iron Age; *b* – site of rock art.

Fig. 2. Deer stone No. 11 in the valley of the Khoid Tamir River.

Fig. 3. Deer stone No. 24 in the valley of the Khoid Tamir River and a possible reconstruction of its original coloring.

necklaces, and antlers of the upper deer on one side were broken off, and a new necklace represented by an arched line with an amulet in the form of a claw or fang, was depicted instead. As a result, this wide facet became the front surface, which is emphasized by earrings in the form of rings with pendants, pecked symmetrically on both narrow facets. The reworked deer stone was dug into the ground almost halfway (information of Volkov) and became significantly tilted. Traces of red paint were found in the lower part of the obverse side 2. They are noticeable on the pecked representations of some deer and the mirror, partially covered with calcite deposits. In addition, narrow slanting lines made with red paint, survived on the belt. They might have once formed a slanting grid.

4. Stele No. 6 in the valley of Khushuun-tal, the left bank of the Khunui River; light gray granite, 270 × 70 × × 36 cm. The stele was first studied by Volkov (Ibid.: 43, pl. 23, *1*); later it was examined several times by other scholars, and was documented in 2013 (Fig. 5). The front surface of the stele is higher than the back surface. In the middle of the right side of the stele, traces of red paint partially covered with a thin layer of calcite deposits were found inside the pecked and polished outlines of the belt, weaponry, and deer figures (Fig. 5, *2*). This was clearly the bottom side of the fallen stone, since the images on the left facet, as opposed to the right facet, were badly affected by the external environment. This indicates that the stele lay horizontally for a long time and only recently was set up vertically.

Fig. 4. Deer stone No. 68 in the valley of the Khoid Tamir River.

Fig. 5. Deer stone No. 6 in the valley of the Khunui River and a reconstruction of its original coloring.

5. Stele No. 1-9 in the locality of Jargalant, the upper reaches of the Khanui River; light gray granite, 253 × × 69 × 33 cm. The stele was previously studied by Volkov (Ibid.: 48, pl. 29, *2*), as well as Mongolian and Korean archaeologists (Tseveendorj, Jang Seogho, Tsengel, 2009: 423; Turbat et al., 2011: 76). It was set up vertically in 2009. We studied this stele in 2011 (Fig. 6). A wide slanting line was painted in red on the upper part of the front surface. Traces of red paint were also found inside the pecked and polished outlines of the upper deer figures on the same facet.

6. Stele No. 1 in the locality of Ulan-Tolgoi to the south of Lake Khubsugul (Khövsgöl). Over the past decade, this monument was studied by Mongolian, Korean, and American archaeologists. A most exact copy was made by Korean scholars (Khyn Sun et al., 2008: 188, 189). In 2015, we photographed the stele. Traces of orange color were found inside the pecked and polished contours of the images in the middle part of the front and right facets of the stele (Fig. 7, *1*). This was clearly the bottom side of the fallen stone, since the images on the upper half of the left facet and the back facet were badly damaged by the environment.

7. Stele from the Onon River near the village of Suduntui in the Trans-Baikal region; light gray granite. The stele was located at the burial ground Ulba I of the Slab Grave culture, at a distance of about 10 m to the east of one of the fences (Okladnikov, Zaporozhskaya, 1970: 61, pl. 85, *2*). The stele was studied in 2014 (photographed) in the Open Air Historical and Architectural Museum of the Institute of Archaeology and Ethnography of SB RAS (Fig. 8). The upper edge of the front surface is rounded. The images are depicted only on that side. A wide band of red paint is preserved along the entire upper edge of the stele. The slanting line in the upper tier of the front surface (partially inside the pecked and polished groove) was made with similar paint. The stele was restored from two parts. Perhaps earlier, when the upper part was broken off, it fell face down, which allowed the paint to survive.

In general, the study of the above monuments indicates that the preservation of paint is determined by the conditions in which the deer stone existed. In all cases, the traces of paint were found on the fallen stelae (or their fragments), on those facets and parts that were maximally protected from the adverse effects of the environment (water, wind). Sometimes, the preservation of paint was

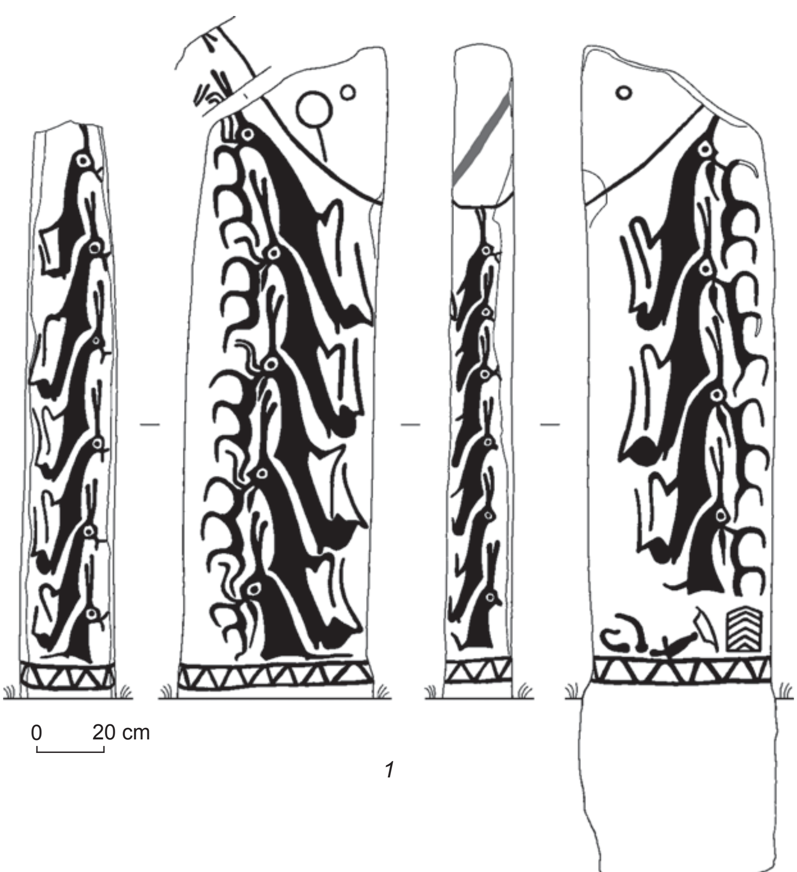


Fig. 6. Deer stone No. 1-9 from the locality of Jargalant.

Fig. 7. Paint on deer stones No. 1 from Ulan-Tolgoi (*1*) and No. 1-10 from Jargalant (*2*).

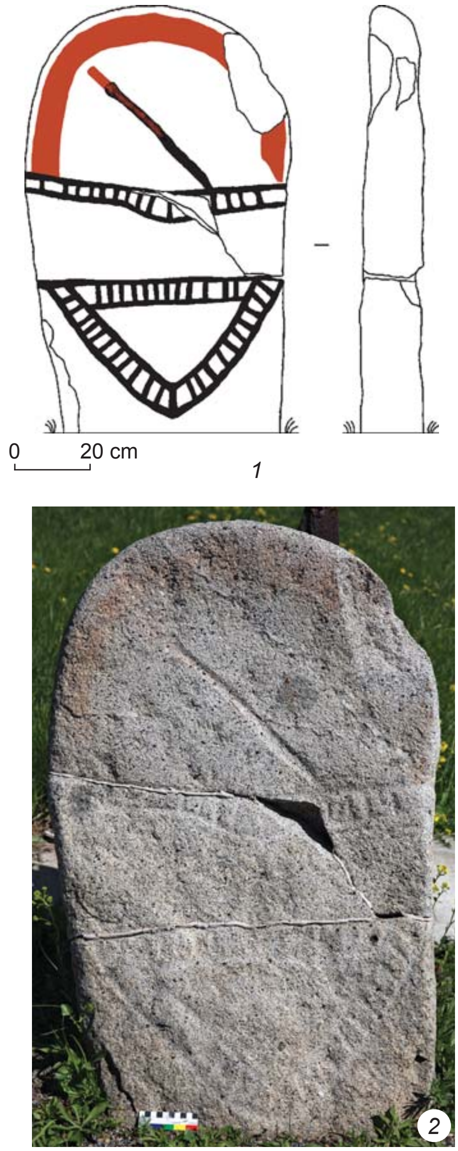


Fig. 8. Stele from the Onon River, the burial ground of Ulba I.

further enhanced by a crust of calcite deposits formed at the place where the stone touched the ground. In this case, the preserved paint in most cases has lost its brightness, and under regular conditions some experience is needed for recognizing its traces on the surface of the stone. Possibly, the paint was not noticed for a long time for exactly that reason. The case was similar when identifying the paint on the stelae of the Early Bronze Age in the Minusinsk Basin (Esin et al., 2014: 79).

Not very many deer stones with traces of paint were found: only 5 % of the total number surveyed by us in the valley of the Khoid Tamir River, and 20 % at the site of Jargalant. However, such a situation, apparently, is merely the result of the strong vulnerability of the painting to various external natural factors as opposed to pecked representations. Probably, in the Late Bronze and Early Iron Age, paint could have been applied to the majority of deer stones, but has not survived until this day.

Classification of the stelae according to composition and their dating

In terms of composition, the stelae described above can be divided into two types.

1. Classical deer stones of the Mongolian-Transbaikalian type with the front surface on the narrow vertical facet and division into tiers using representations of a belt and necklace (A) (see Fig. 3, 5, 6) or without the necklace (B) (see Fig. 2). Stelae of type 1A can be further

subdivided depending on the location of the weapon below the belt (a) or above the belt (b). On the stelae of type 1B, the images of the weapon are located among the figures of deer at different heights.

2. Stelae with the facial side on a wide facet, emphasis on the upper tier (correlated with the human head), but without the images of deer, belt, or weapons (see Fig. 8).

The palimpsest on the stele No. 68 in the gorge of the Shivertiyn-am (Fig. 4) shows the chronological sequence of the compositions of the types 1A and 2 on the territory of Central Mongolia. In addition, they are associated with different archaeological contexts and could have had a different cultural background. The stelae with compositions 1A and 1B were originally set up at ritual sites near the *khereksurs*, and could be reused in the construction of slab graves as building material. The radiocarbon analysis of animal bones from the altars associated with deer stones of type 1 in the Tsatsyn-ereg locality makes it possible to date these structures and stelae to 1210–760 BC, and the altars near the deer stones of type 1A are earlier than the altars near the stelae of type 1B. This fact may indicate the transformation of the composition on deer stones of the Mongolian-Transbaikalian type from more realistic with the representation of a belt and weaponry to more stylized and decorative compositions. The advent of a new stage in the culture of the local population is demonstrated by reusing the broken stelae of type 1B as building material in the construction of slab grave 92 (Khoid Tamiryn…, 2011: 27). The human bones from this burial gave the radiocarbon date (2σ) of 730–690 or 540–390 BC (Beta-290942).

Unlike the deer stones of type 1, both stelae of type 2 described above are associated only with slab graves; they were set up 10 m east of the burials. Stone monuments with similar composition were found near the slab graves in the Dundgovi aimag (Fig. 9, *2*) (Volkov, 2002: 102; Amartuvshin, Jargalan, 2010: 15-r zurag). A whole series of similar stelae is known from the Trans-Baikal region. In the absence of images of deer on them,

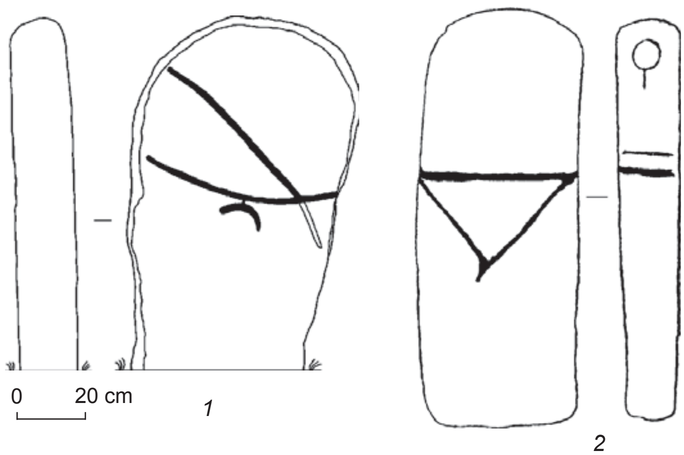
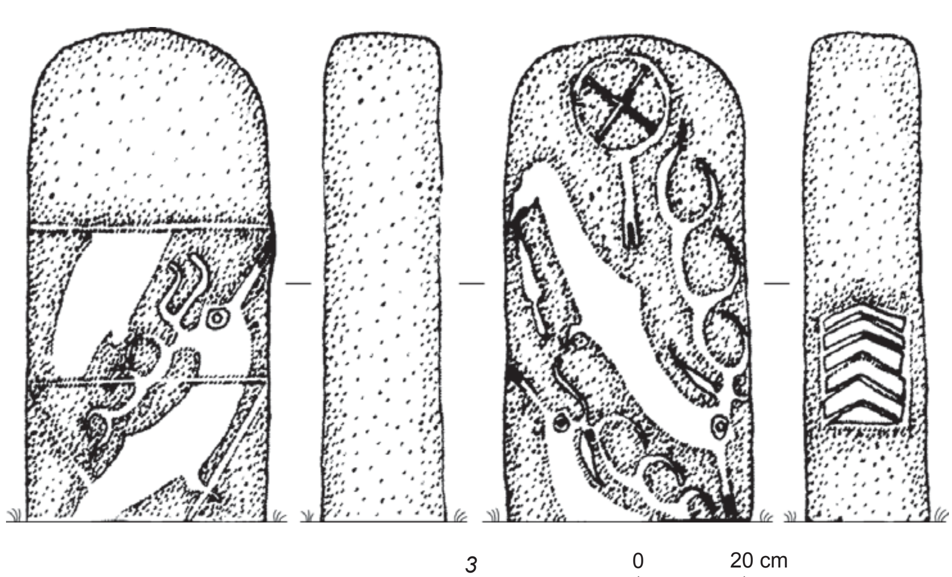


Fig. 9. Stelae associated with the Slab Grave culture.
1 – stele from the Onon River from the collection of the Open Air Historical and Architectural Museum of the Institute of Archaeology and Ethnography of SB RAS; *2* – stele from the Dundgovi aimag (Volkov, 2002: Pl. 125); *3* – stele from Yamaaldai-uulyn, Uvurkhangai aimag (after: (Enkhbat, Davaatseren, Purevlkham, 2011: 81, No. 12), with adjustments).



it became customary to refer to them in the Russian literature as “guarding stones”, or “hitching stones” (Fig. 9, *1*) (Okladnikov, Zaporozhskaya, 1970: 58, 61; Dashilkhamaev, 2012: 66), whereas in Mongolia such stelae were considered in connection with deer stones. We should also note that the palimpsest on the stele from Yamaaldai-uulyn in the Uvurkhangai aimag (Fig. 9, *3*) is almost the same as the palimpsest on the deer stone No. 68, but contains a final composition like that on the stele from the Ulba I burial ground. Thus, the composition of type 2 is contemporaneous with the slab graves and was made on the stones by the bearers of that culture. According to the dates obtained from the human bones from slab graves 92 and 94 in the area of Tsatsyn-ereg (2σ), structurally similar to the slab grave next to which stele No. 68 was set up, they belong to 760–390 BC.

Classification of the painted objects and their comparative historical analysis

To this day, only the color of red with various shades has been found on deer stones. Sometimes, different shades appear on the same stele and apparently depend only on the amount of pigment that has been preserved on the surface of the stone (see Fig. 7, *2*). The composition of the paint has not been analyzed. This is a separate issue coupled with the problem of obtaining the samples for laboratory analysis, since the paint is embedded into the surface of the stone, usually hard granite. So far, based on the experience of studying rock paintings in the culture of pastoralists living in the eastern part of the Eurasian steppe belt during an earlier period (Essin et al., 2014), we may assume the use of hematite or ochre. We should note here that there is a significant outcrop of hematite at a distance of about 1.5 km from deer stones No. 11 and 24 in the valley of the Khoid Tamir River, which we examined in the summer of 2015. It might have been the source of raw materials for the paint.

For the classification of painting on the deer stones under consideration, it is important to take into account their interrelation with other techniques of stelae decoration: pecking of relief representations, as well as smoothening and polishing of specific areas of the stone surface. The key criterion for classification in this approach is the independent or supportive role of painting in creating a visual image. From this point of view, two main varieties can be distinguished among the materials known to us.

1. Paint was applied to a previously pecked and polished image. Thus, from the technological point of view, paint plays the role of an additional means of strengthening the expressiveness of the already created representation. This variant was most common on the deer stones that we studied. The same applies to the painting that was recently found on the stelae of the Mongolian-Transbaikalian and Eurasian types in Western Mongolia. Thus, red paint was found inside pecked slanting lines in the upper tier of the stele, inside the contour of the dagger and on the animal figures on deer stones from the archaeological complexes of Bayanzürkh, Bayan-Bulag I (*khereksur* No. 3, deer stones No. 1 and 2) and from the locality of Elsen-Tolgoi near the city of Khovd (Tishkin, 2013a: 81, 88, fig. 8, 9; 2013b: 226). Red paint was well preserved inside the pecked images (three slanting lines on the place of the face and necklace) on the front side of a stele of the Eurasian type from the mouth of the Elegest River in Tuva (the stele was re-used in the construction of burial mound 4 of the Sagly culture at the cemetery of Krasnaya Gorka-3), which we examined in August, 2015*. The same version of painting appears on two examples from the most western stelae of the Pan-Eurasian type: the representation of an earring on one facet, a diadem, and belt were painted on a stele from the mound of a barrow in the vicinity of the village of Novoaleksandrovka (Rostov Region), and a representation of earrings were painted on the Olbia-Chersonesus stele (Olkhovsky, 2005: 44, 53). Currently, paint has been preserved only in certain areas, but initially all the relief images must have been painted (see Fig. 5, *3*). Close parallels to this method of decorating stone monuments were found on the stelae of the Okunev culture of the Early Bronze Age in the Minusinsk Basin, where it also commonly occurred (Esin et al., 2014: 81; Essin et al., 2014).

2. Paint was applied to a prepared (smoothened, polished) stone surface, but unlike the previous version, painting played an independent role in the creation of the individual elements of the composition. Thus, two instances of painting slanting lines with red color in the place of the face have been observed (see Fig. 6, *2*; 8). It seems that decoration was painted on the polished image of a wide belt on two more stelae. In all cases known today, the independent use of painting was combined with coloring other elements, which had been executed in the technique of pecking and polishing. In addition, it can be noted that there remained unpainted areas, which were lighter than the untreated surface of the stone slab when geometrical ornamental décor was painted on the polished representation of the belt (see Fig. 3, *3*). In practical terms, this gave one more color, obtained without the use of paint. In the earlier period, this method played an important role in creating polychrome images of the Karakol culture of the Russian Altai (Essin et al., 2014: Fig 6b).

The fact that paint was used independently for creating individual elements of composition on the stelae show

*We would like to thank M.E. Kilunovskaya for the opportunity to consult the materials of the excavations by the Tuva Archaeological Expedition of the Institute for the History of Material Culture of RAS.

Fig. 10. Painting on the upper part of the vertical stone block at the Nistaforovka site.

that the role of painting was not less important than the role of pecking, and it cannot be considered merely a secondary technique for decorating stone monuments. The stelae were intended for being placed in the open air in harsh external conditions, thus painting inside the pecked areas made it possible to achieve greater durability of coloring and the greatest expressiveness of the composition. In addition, while assessing the role of paint in the decoration of stelae, it should be kept in mind that painting might have had its independent ritual and magical significance. The ritual function of red paint, for example, is testified to by instances of its discovery in the burials of the Late Bronze Age (burial mound 126, 1500–1480 / 1460–1400 BC (2σ), excavations of 2011) and in slab graves (burial mound A94, 760–480 / 460–420 BC (2σ), excavations of 2011) at Tsatsyn-ereg.

Representations typical of deer stones could also be painted on rocks. Thus at the site of rock art Nistafarovka on the right bank of the Us River in the Ermakovsky District of the Krasnoyarsk Territory, triple slanting lines painted by red paint, typically appearing on the upper part of the Sayan-Altaian stelae, have been found (Fig. 10).

Another issue, which requires attention, is the case of reusing the stelae. Thus, the composition of deer stone No. 68 from the gorge of Shivertiyn-am was changed several times during the Late Bronze–Early Iron Age. This might have been caused by the large size and good quality of stone among all other stelae of the same site. Examples of such practices can be found throughout the entire area where deer stones occur (Chlenova, 1984: Fig. 1–4; Volkov, 2002: Pl. 113, *3*). In the earlier period, reusing of stelae was typical of the Karakol, Okunev, and Chemurchek cultures of the Sayan-Altai (Esin, 2010: 141). Apparently, there was a close relationship between the performance of a ritual and creation of the image. The representation did not just have to follow the accepted iconography, but also had to be associated with a specific ritual. Among other things, it could ensure the personification of the stylized representation using non-pictorial means and successful performance of an act of communication with the image. Consequently, it was impossible to reuse the stele: either a new stele had to be created, or the old stele had to be altered or supplemented with new representations to become included into a new ritualistic context. Therefore, the facts of addition (the appearance of "extra" images of weaponry, necklaces, or earrings) or changing the composition of deer stones can be viewed as a reflection of rituals performed near the stele. Such manipulations could have been accompanied by the addition and renovation of paintings. Thus, paintings on the stelae that show the signs of reusing require more careful study for their dating. In the situation with deer stone No. 68, it can be suggested that the discovered painting was created before the stone was broken off and dug near the slab grave. This is testified to by the lines painted on the pecked image of the belt, which could have been made only while the stele was intact, although one cannot exclude that some painted elements on the upper part of this stele were renewed at the very last stage of its use. Painting with red paint was typical of many monuments of rock art in the Trans-Baikal region and North-Eastern Mongolia, which are associated with the Slab Grave culture, and was also found on the stele from the burial ground of Ulba I of the same culture.

Conclusions

This study significantly expands our knowledge concerning the use of paint in the art of pastoralists who lived in the eastern part of the Eurasian steppe belt in the Late Bronze and Early Iron Age. The original appearance of stelae of that time was reconstructed for the first time. A classification of paintings, based on the technological role (independent or supportive) of paint in creating the composition, was proposed.

Taking into account iconographic and stylistic features, as well as the archaeological and geographical contexts, the instances of using paint on the stelae of the early nomads of the Eurasian steppes indicate that this tradition appeared in various territorial and chronological groups of the materials under consideration. Painting is present among the images associated with different iconographic types of deer stones, and appears on stelae used in different contexts (special ritual grounds with altars near the *khereksurs* in Central Mongolia, stone structures of the *khereksurs* in Western Mongolia, mounds of barrows of different constructions in Eastern Europe, or ritual places near the slab graves in Central Mongolia and the Trans-Baikal region). Thus, we can conclude that the use of red paint is one of the aspects of the phenomenon of deer stones in general. Taking into account parallels among the materials of the Okunev art, we can add that this tradition has a prehistory in the culture of pastoralists living in the Asian steppes in the Early Bronze Age.

The coloring of the stelae of the Late Bronze–Early Iron Age and in particular the pigment composition undoubtedly require further study. At the same time, a certain threat to the preservation of paint in the future is the tradition that has recently become widely spread in Mongolia, to re-erect vertically in the steppe the stelae that for a long time lay in the ground. This can lead to gradual destruction of the traces of paint preserved under the ground as a result of the resumed impact of the natural conditions. This aspect should be taken into account by specialists while making such decisions.

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Old Turkic Stone Statues from Taldy-Suu, Kyrgyzstan

Anthropomorphic stone statues, discovered near Taldy-Suu, the Issyk-Kul region of Kyrgyzstan, are described with reference to the earlier (19th to early 21st century) scholarship, and are attributed to the Old Turkic tradition. One of them shows a male warrior. We focus on his costume, belt, weapons, and the vessel held in his right hand. The other statue is of a woman. The chronology and cultural affinities, specifically in relation to Old Turkic statues of other areas of the Tian Shan, are assessed.

Keywords: *Old Turks, stone statues, memorial constructions, Tian Shan, Issyk-Kul Basin.*

Introduction

The intermountain depression where Lake Issyk-Kul is located is one of the areas of the greatest spread of medieval Old Turkic anthropomorphic stone statues on the territory of Kyrgyzstan and the entire Central Asian region. During the long history of studying archaeological sites in the Tian Shan, Russian scholars have found many anthropomorphic stone statues associated with the Old Turkic culture of the early Middle Ages, in the Issyk-Kul Basin. This article presents the history and main results of research into Old Turkic stone statues on the territory of the intermountain depression where Lake Issyk-Kul is located.

According to D.F. Vinnik, information about several dozen "stone figures" on the northern shore of the lake appeared as early as the beginning of the 19th century (1995: 160–162). Later, Russian researchers described, made drawings, and proposed chronological and cultural attribution of these sites. In 1856, during a trip to Issyk-Kul, the Russian military officer C.C. Valikhanov, a famous Kazakh scholar and traveler, described and drew several medieval stone sculptures from the area along the coast of the lake "from Sarybulak to the Kurmet River" (*Күрмөнтү*) (1984: 341–342). The following year the famous Russian traveler P.P. Semenov-Tyan-Shansky visited the lake and examined several stone statues on the northeastern shore in the valley of the Tyup River (Semenov, 1946: 182–183). Some information about these studies was published by the authors of the present article earlier (Hudiakov et al., 2015: 109). From the 1850s–1870s, stone statues on the shore of Issyk-Kul were mentioned by other Russian scholars, local historians, and lovers of antiquities. In 1859, stone sculptures in the Tyup Valley to the northeast of the Lake were examined by A.F. Golubev. In 1869, G.A. Kolpakovsky found face stelae on the northern shore in the Koy-Suu area; he discovered one of the statues under the water near the shore of Issyk-Kul (Vinnik, 1995: 160–162).

In the 19th century, information about medieval "stone figures" in the Tian Shan, including Lake Issyk-Kul, attracted the attention of some Russian researchers of Siberia and Mongolia. The famous traveler in Siberia and Central Asia N.M. Yadrintsev wrote about the similarity of these sculptures to "stone figures" found in Southern Siberia and Mongolia, and noted both male and female sculptures among the finds in Tian Shan. As with some of his predecessors, Yadrintsev associated the stone sculptures from the vicinity of Issyk-Kul with the ancient nomadic Wusun tribes. At the same time, he did not reject the views of other scholars that the figurative representations from Central Asia might have belonged to the Old Turks. Yadrintsev was one of the first scholars who tried to systematize the stone sculptures on the territory of Kyrgyzstan by identifying two groups of statuary: those only representing facial features, and those depicting a human figure with a vessel and weapons on the belt (1885: 19–21). In the late 19th century, stone statues in the vicinity of Lake Issyk-Kul were mentioned by other Russian lovers of antiquities. For example, A.V. Selivanov noted that there were many such sculptures in the Issyk-Kul Basin. One of the lovers of antiquity D.L. Ivanov suggested a "Kalmyk" origin of the medieval stone figures. The researcher A.N. Krasnov wrote that "stone figures" were set on burial mounds. In the late 19th century, several stone sculptures on the southern shore of Issyk-Kul were examined by A.M. Fetisov, who associated them with the Mongols (Ploskikh, Galitsky, 1975: 19). Several medieval "stone figures" near Lake Issyk-Kul were discovered by F.V. Poyarkov (Vinnik, 1995: 162–164). In the 1890s, the famous Russian expert in the history of Central Asia V.V. Bartold surveyed a number of stone statues in the Issyk-Kul Basin, and presented his considerations on their chronological and cultural attribution, as well as the functioning of the stone sculptures, in an article on the results of his field research in 1893–1894. He attributed these figures to the Early Middle Ages and to the culture of the Old Turks of the 7th–8th centuries (Bartold, 1966a: 38–39). Later, in a special article, Bartold suggested that the anthropomorphic stone sculptures were set up by the Old Turks on the burial complexes of their dead relatives (1966b).

From the 1930s–1950s, the stone statues in the Issyk-Kul Basin were studied by the archaeologist A.N. Bernshtam. Several sculptures were surveyed on the northern shore of the Lake, in the vicinity of the villages of Oy-Bulak and Kurmenty. These were statues of warriors with vessels in their right hands, daggers, and swords in a sheath hanging from their belts, and a figure without weapons (Bernshtam, 1952: 79–81, fig. 42, *1–3*; 43). Old Turkic sculptures in the works of Bernshtam and some other archaeologists working in Central Asia, were often called the *balbals* (Bernshtam, 1952: 79; Albaum, 1960: 96). In the 1960s, during the study of stone sculptures in the Altai-Sayan, a discussion about whom exactly the Old Turkic stone statues represented emerged among archaeologists. According to the majority of scholars, the representations rendered the appearance of the Turks who were commemorated at the time of the memorial ritual, and not their "main enemies", while the *balbals* (stone posts) symbolized dead enemies (Grach, 1961: 66; Kyzlasov, 1966; 1969: 37–43). Scholars argued that there were no *balbals* found at the memorial complexes of the Western Turks and Turgeshes, while stone sculptures included female and children's figures (Tabaldiev, 1996: 61–82; Hudiakov, Tabaldiev, 2009: 68–88).

In the 1960s, Y.A. Sher continued the study of stone statues in Semirechye and Tian Shan. The materials that he gathered were analyzed in a special monograph. Sher systematized the sculptures and suggested the chronological and cultural attribution of the types of sculptures that he identified. He noted that the statues were located near some ritual enclosures (Sher, 1966: 14, 22–29, 40, 90, 106). At the same period, D.F. Vinnik studied Old Turkic stone sculptures in Kyrgyzstan and found a significant number of previously unknown medieval stone sculptures in the vicinity of Lake Issyk-Kul (1995: 174–175).

In the 1970s to early 1980s, many stone figures were transported from their original locations to museums, cultural centers, and schools in various places of the Chuy Valley and the Issyk-Kul Basin. Unfortunately, memorial constructions were not investigated in the process, and the locations from which the stone sculptures were taken were not recorded. During this period, V.P. Mokrynin studied stone statues in the Issyk-Kul Basin (Mokrynin, Gavryushenko, 1975). He paid special attention to the analysis of sculptures represented as wearing a "three-horned" headdress. Mokrynin suggested that these monuments were associated with the ancient nomadic tribes of the Ephthalites (1975). The well-known Kyrgyz archaeologist K.S. Tabaldiev made a great contribution to the study of stone statues in the territory of Kyrgyzstan (1996: 61–70; 2011: 130–143). In the course of his field research in the Central Tian Shan, he discovered Old Turkic funeral enclosures with stone statues, belonging to memorial complexes. Tabaldiev discovered some rare sculptures, which survived in the places of their original setting. His joint research with the co-author of this article resulted in confirmation that stone sculptures in Tian Shan and the entire Central Asia were set up at Old Turkic memorial sites (Tabaldiev, Hudiakov, 2000: 66–70; Hudiakov, Tabaldiev, 2009: 68–87).

A large number of medieval stone statues have been discovered in the territory of the Issyk-Kul Basin in Kyrgyzstan, and a considerable part of them have been published. In the valley of the River Ton in the southeastern part of the Issyk-Kul Basin, the authors of this article together with their Kyrgyz colleagues took part in the study of distinctive fully or partially preserved stone sculptures, which were attributed to the culture of Western

Turks and Turgheses of the 7th–8th centuries (Hudiakov et al., 2015: 113). Despite the fact that such sculptures have been studied in the Issyk-Kul Basin for many decades, archaeologists still continue to find and study previously unknown medieval stone anthropomorphic figures on its territory.

Description of stone statues

During the expedition to the Issyk-Kul Basin in August 2014, which was organized as a part of the project, "History of Warfare of Ancient and Medieval Peoples of Southern Siberia and Central Asia", supported by the Interstate Development Corporation, in the area of the village of Taldy-Suu in the eastern part of the basin, the authors of this article examined two original anthropomorphic stone statues, currently located in the private household of a local resident. The figures are set up on both sides of the gate at the entrance to the fence of this household. According to the owner of the estate V. Fomenko, he discovered these stone sculptures during agricultural work on the field of a collective farm, located near the village. He also informed us that the female statue had been associated with a structure resembling a mound built of stones, which looked like a stone "barrow". In connection with cleaning collective farm fields from stones, which could impede plowing, both stone figures were relocated by this resident of Taldy-Suu and were set up at the entrance to his household*.

According to the attributes preserved on the statues, it can be established that one sculpture is the representation of a male, probably a warrior (Fig. 1, 2). The height of the sculpture above the ground is 1.43 m; the width is 0.42 m. The figure has a distinctive, large head. Probably, the warrior was represented wearing a spherical headdress, although presently it is not possible to see any of its details, since the head, in particular the facial section, has been partially damaged. However, arched eyebrows and large almond-shaped eyes marked with low relief, a partially broken off straight nose, a long mustache with pointed ends, and an arched lower lip can still be seen on the head. A face of smooth oval shape prominently expands from the massive neck. Wide lapels of upper robe-like clothing, probably a *khalat*, converging in the middle of the chest, are depicted on the shoulders and chest of the statue. The right arm is shown bent at the elbow. With bent fingers, the figure is holding, at the level of his chest, a vessel with the rim folded outward and a spherical body. There is a protrusion resembling a small, somewhat curved conical tray, shifted to the side under the bottom of the vessel. The left arm is shown slightly bent at the elbow; the palm of the left hand rests on the belt. Narrow cuffs are marked on both sleeves of the *khalat*. The belt is represented in the frontal area of the waist. A bent dagger, which is suspended from the belt on hanging straps, is shown below the belt on the left side. The dagger has a sheathed blade, with the crossbar and the handle bent at an angle. The belt is marked by a continuous horizontal band. A longer sheathed bladed weapon with smoother curve can be discerned below the dagger. It is likely a sheathed saber, suspended from the belt. The features on the lower part of the statue are not clearly visible. We may assume that initially the belt with the weapons could have been seen more distinctively, but the prominent features of relief were abraded over time. According to some distinctive details represented on other Old Turkic sculptures that were discovered on the territory of the Tian Shan and Semirechye, the figure in question can be attributed to the first type of stone statues (male statues with a vessel in the right hand and weapons on the belt) identified by Sher (1966: 25–26, 90).

Another, relatively large and robust stone sculpture from the village of Taldy-Suu represents an Old Turkic woman (Fig. 3, 4). The height of the statue above the ground is 1.72 m; the width is 0.6 m. Three semicircular protrusions separated by depressions are located on the head, forehead, and temples of the figure. They may represent a "three-horned" female headdress typical of many sculptural representations of Old Turkic women, or long hair combed back and divided into three parts in front above the forehead, indicating a certain hairstyle with the hair joined together on the top and back of the head, forming a wide wedge converging in the upper part of the back. There are reasons to suggest that a soft felt headdress similar to a cap or hood, common to many nomadic peoples, is thus depicted. The sculpture has a large, broad face of oval shape with arched eyebrows, almond-shaped eyes, straight nose, narrow, tightly pressed lips, and softly outlined chin. Relatively large ears decorated with earrings with pendants are represented on both sides of the head. Two necklaces are shown on the neck and upper chest. There is a large bead in the central part of the upper necklace. In the center of the lower necklace, three large spherical beads are shown. A similar large round bead is suspended from the middle bead. The right arm of the woman is bent at the elbow; her fingers are holding the tray of a vessel, which looks like a goblet with a tray. The vessel has a rim, folded outward, and a spherical body attached to the tray. The left arm is also bent at the elbow; the fingers are represented. The shoulders and elbows of the woman are covered with clothing resembling a cloak or cape without sleeves. This female statue does not show a belt—an attribute of the Old Turkic male outerwear complex, which was usually depicted on female figures. This sculpture can be

*We express our gratitude to the owner V. Fomenko for the information about the circumstances of the discovery of sculptures and for the opportunity to examine them.

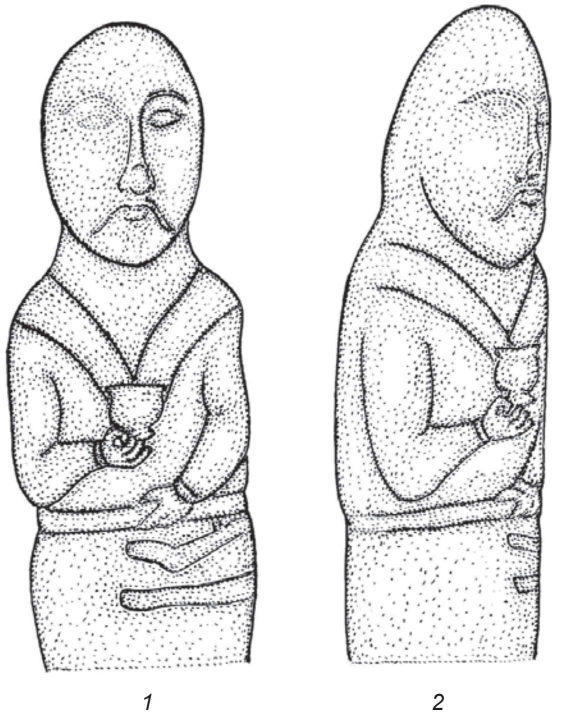

Fig. 1. Stone statue of a male warrior from the vicinity of the village of Taldy-Suu. Drawing.
1 – front view; *2* – profile view.

Fig. 2. Stone statue of a male warrior from the vicinity of the village of Taldy-Suu.
1 – front view; *2* – profile view.

attributed to the type of female stone sculptures with a vessel. According to Sher, this sculpture shows the image of a male (Ibid.: 26, 106), which is difficult to agree with.

This female statue attracts our attention by its hairstyle divided into three parts, and some features of the headdress. The analysis of these elements makes it possible to clarify the shape of the "three-horned" headdresses represented on many female stone statues found in the area of the western version of Old Turkic culture, including the Tian Shan and Semirechye (Hudiakov, Tabaldiev, 2009: 75–79; Tabaldiev, 2011: 134–135).

Given the style of representations, the postures, which aim at rendering a specific image, the features reproduced, and the presence of the vessel in the right hand, both figures can be identified as stone sculptures set up at memorial monuments of Old Turkic people. Judging by the detailed treatment of features, the figurative sculptures under consideration belong to the period when the Western Turkic and Turgesh Khaganates existed in Central Asia and the adjacent territories in the 7th–8th centuries AD. At that time, the art of creating Old Turkic stone sculptures in the Cis-Tian Shan region, Semirechye, and the adjacent territories of Central Asia and Eastern Turkestan reached a high level of development. It is quite possible that the sculptures found in the vicinity of the village of Taldy-Suu were originally set up at Old Turkic memorial complexes. As noted above, the female

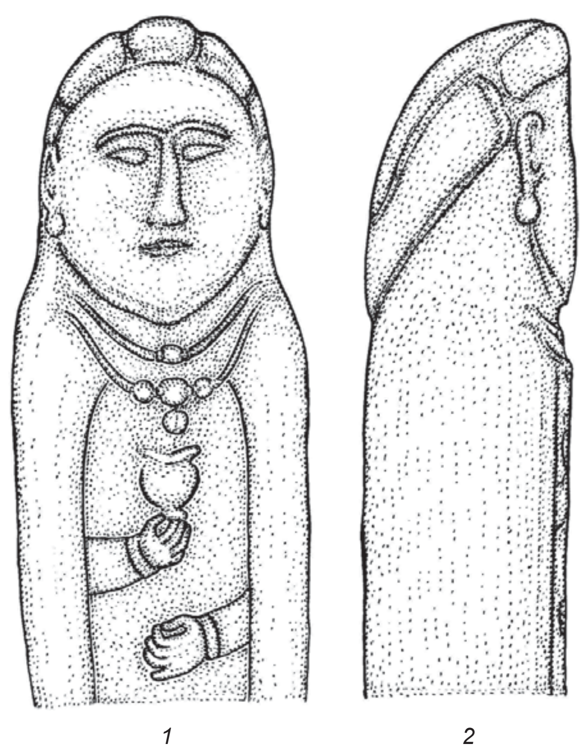

Fig. 3. Stone statue of a woman from the vicinity of the village of Taldy-Suu. Drawing.
1 – front view; *2* – profile view.

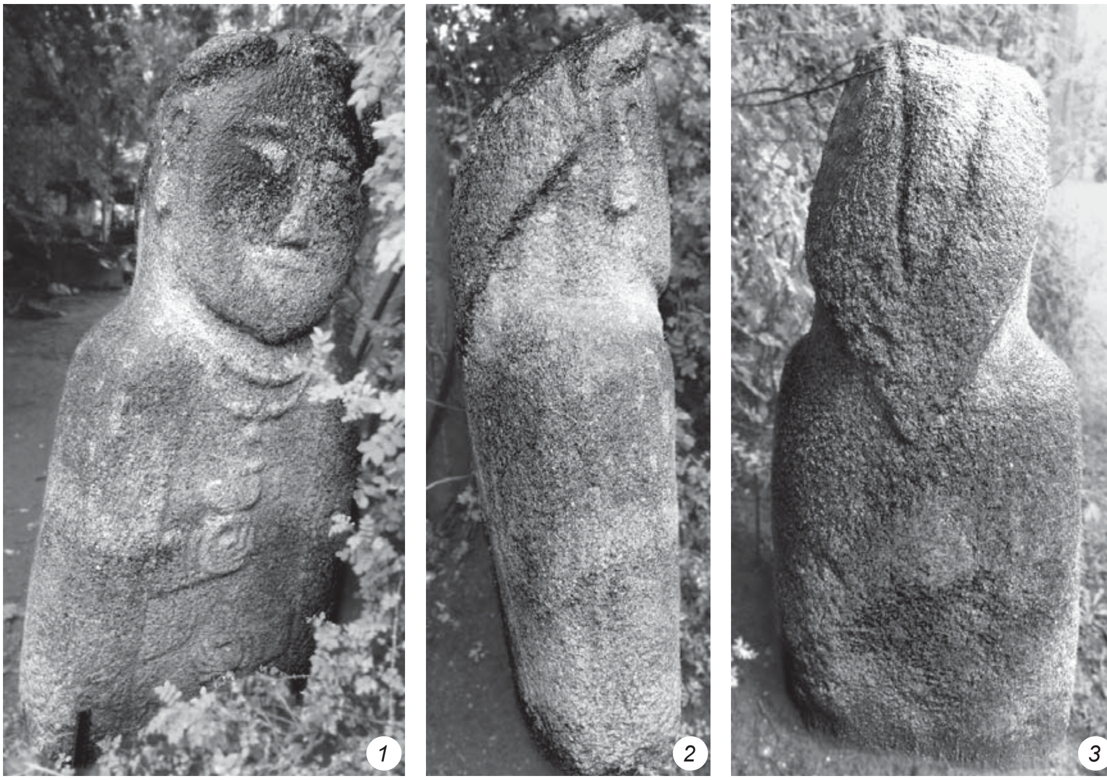

Fig. 4. Stone statue of a woman from the vicinity of the village of Taldy-Suu.
1 – front view; *2* – profile view; *3* – back view.

representation was discovered on the surface of a stone structure, a "barrow", which could have been a memorial complex. It is also possible that our sculptures were associated with the memorial complexes of the nomadic elite of the Western Turks or Turgeshes. The impressive size of the statues and the thoroughness of treatment of certain details argue in favor of this suggestion. Along with the common features typical of many Old Turkic stone sculptures, both sculptures from the village of Taldy-Suu have their own distinctive features.

Conclusions

Old Turkic stone figures that were found and explored by the authors of this article near the village of Taldy-Suu have a great value for the medieval history and culture of Kyrgyzstan. The fact that the sculptures were found by one of the local residents and were moved to his household in order to preserve them, shows the careful attitude of the population toward the monumental artifacts. It is known that in the late 1950s to early 1960s, on the initiative of the Kyrgyz authorities, many stone statues in the Tian Shan were transported from their initial locations to museums of local history, cultural centers, and schools. Thus, the sculptures have survived until today and are available for study. Unfortunately, the places of the original finding of sculptures were not always recorded, which was probably caused by the perception of Old Turkic anthropomorphic stone sculptures as independent monuments outside of their relationship with funeral enclosures. At the same time, examples of negative attitudes toward stone statues are also known in the Central Asian region: during the period of the spread of the world's proselytist religions, people would break off faces and heads from the sculptures, and in some cases they used the statues as hitching posts and even building material for modern buildings. It is to be hoped that in time, the medieval stone statues from the village of Taldy-Suu will find their place in one of the museums of Kyrgyzstan.

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Scythian Age Barrows with Burials on the Ground Surface in the Southern Ural Steppes: Features of the Funerary Rite

This article describes burials on the buried soil horizon in the Southern Urals, associated with the culture of nomadic animal breeders. The database includes published data on 37 barrows. Instead of digging graves, the nomads built above-ground wooden or adobe structures. Sometimes bodies were placed on wooden floors or platforms. Weapons found in burials include swords, daggers, arrowheads, and items of horse harness. In female burials, small stone altars, adornments, mirrors, and utensils are found. Clay vessels are common. In the late 6th and 5th centuries BC, the tradition of placing bodies on the level of the ground surface was common in the eastern part of the southern Ural steppes. By approximately 400 BC, this tradition had virtually disappeared.

Keywords: *Early Iron Age, nomads, Southern Urals, old ground surface burials, funerary rite, accompanying goods.*

Introduction

A number of distinctive burial complexes (barrows with burials at the level of the old ground surface) were investigated in the steppe regions of the Southern Urals. Burials on the natural ground or in very small pits in the soil layer were studied by F.D. Nefedov in 1888 in barrow 3 near the village of Preobrazhenka, and in barrows 3 and 4 near the village of Pavlovskaya. However, these sites can hardly be recognized as adequately studied sources, since scholars of that time did not always understand the structure of barrows and might have taken joint burial grounds for burials on the ground surface or on the natural ground (Smirnov, 1964: 82). In 1928, D.I. Nazarov excavated a burial at the level of the ground surface in barrow 7 near the village of Sara (Ibid.). Findings from this barrow have been published in books by K.F. Smirnov and in the corpus of archaeological sources, *Savromaty Povolzhya i Yuzhnogo Priuralya* (Smirnov, 1961: 17, 82–84, 102, fig. 2, *5*; pp. 122–124, fig. 21, A, B; 22, *1–18*; p. 147, fig. 45, *1*; p. 148, fig. 46, *4*; p. 152, fig. 50, *1–4*; 1964: 82, 328–329, fig. 35, A, B; Smirnov, Petrenko, 1963: 16, pl. 11, *17*; 16, *14*; 18, *15*; 25, *3*; 28, *2*, *13*; 29, *3*, *4*, *7*). Unfortunately, the map of those excavations has never been published (Fedorov, 2013: 141). The results of the partial excavations of the barrow near the village of Varna, where a burial was also found on the ground surface, have been published in the article of V.S. Stokolos (1962: 23–24). The first comprehensive publication of a fully excavated burial of this type belongs to M.G. Moshkova. The study, presenting the research of burial mounds near the villages of Alandskoye and Novyi Kumak, contains the plan of barrow 1 at the Alandskoye I cemetery, where that burial was discovered, as well as drawings of things and their description. In addition, in her study, Moshkova also pointed to the similarity of that complex to the burial in barrow 7 near the village of Sara, and suggested that the ritual of cremation was a cultural heritage of some groups of the Andronovo population living in the Bronze Age (1961: 119–122). In the corpus *Savromaty Povolzhya* *i Yuzhnogo Priuraliya* and in the monograph *Savromaty*, burials on the old horizon were considered a specific, rare type of burial, found predominantly in the barrows of the Southern Urals (Smirnov, Petrenko, 1963: Pl. 1, II; Smirnov, 1964: 56, 82, 310). Data on similar burials were published in later studies, which also mention some of their specific features, describe burial complexes of a number of cemeteries or their groups in individual areas of the Southern Urals steppes, and analyze the distinctive features of burials belonging to the representatives of the social elite (Moshkova, 1972: 62–69, 73; Smirnov, 1975: 42–44; Kadyrbaev, Kurmankulov, 1976: 147–149; 1977: 105; Pshenichnyuk, 1983: 33–38, 44, 49, 56, 62–63, 90; 1995: 69–77; 2012: 45–46, 59–60; Kadyrbaev, 1984; Vasiliev, Fedorov, 1994: 127; Ageev, Sungatov, Vildanov, 1998; Zhelezchikov, Klepikov, Sergatskov, 2006: 26; Balakhvantsev, Yablonsky, 2007; Tairov, Botalov, 1988; Gutsalov, 2004: Pl. 4, 7; Tairov, 2006; Gutsalov, 2010: 55–61; Morgunova, Kraeva, 2012; Mamedov, Tazhibaeva, 2013: 44; Myshkin, 2013).

Recently, some materials enriching the source base for the study of burials on the ground surface have been published, which make it possible to conduct a special study of such burial complexes. This article describes the main traditions followed during the burials on the level of the ground surface in the steppes of the Southern Urals, the time of their existence, and specific aspects of their localization. In this article, published data from the excavations of 37 barrows (Fig. 1) is used.

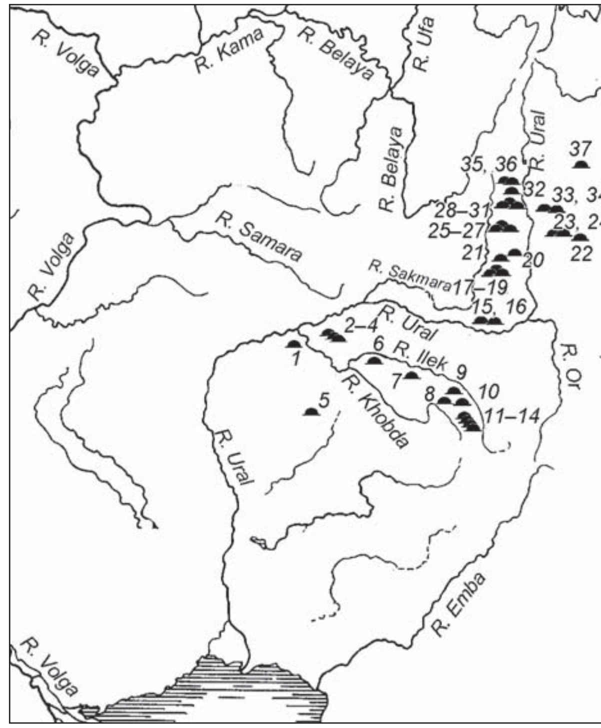

Fig. 1. Location of barrows with burials on the level of the ground surface.
1 – Kyryk-Oba II, barrow 18; *2–4* – Filippovka I, barrow 9, barrow 15, burial 1, barrow 24, burial 1; *5* – Lebedevka VI, barrow 26, burial 1; *6* – Tara-Butak, barrow 3; *7* – Akoba II, barrow 1, burial 1; *8* – Nagornoye, barrow 1; *9* – Zhalgyzoba; *10* – Syntas I, barrow 2; *11–14* – Besoba, barrows 2, 4, 5, 9; *15*, *16* – Sara, barrows 6, 7; *17–19* – Perevolochan I, barrows 6–8; *20* – Ivanovka III, barrow 1; *21* – Sagitovo III, barrow 1; *22* – Solonchanka II, barrow 1; *23* – Alandskoye I, barrow 1; *24* – Alandskoye III, barrow 6; *25–27* – Bish-Uba I, barrows 1–3; *28–31* – Sibay II, barrows 12, 13, 17, 19; *32* – Tselinnoye, barrow 1; *33*, *34* – Marovyi Shlyakh, barrows 2, 3; *35*, *36* – Almukhametovo, barrows 8, 14; *37* – barrow near the village of Varna.

Description of burials at the level of the ground surface

This group of sites is distinguished by the tradition of making burials not in grave pits, typical of the majority of nomadic burials in the barrows of the Scythian time in the Southern Urals, but at the level of the ground surface. The deceased were placed in burial structures of logs, poles, branches, reeds, or sometimes of adobe, which were built above the ground. In many cases, the design of the structures could not be determined due to their poor state of preservation.

Several varieties of wooden burial structures have been identified (Fig. 2, A). One variety (Fig. 3, *1–4*) comprises square, rectangular, or octagonal structures in plan view with walls made of logs and fastened by poles which were dug into the ground in pairs on two sides. In some cases, a second perimeter of walls was built inside the outer walls. The structures had flat roofs or covering in the form of a tent. Square structures were oriented with their walls along the four directions; rectangular structures were oriented with their long axis along the lines north–south or west–east with some deviations (Smirnov, 1964: Fig. 17, *1*, *2*; 1975: 42–43; Pshenichnyuk, 1983: 37–38, pl. XXVIII, 1; p. 44, fig. 12; pp. 56–57, fig. 14; Kadyrbaev, 1984: 89; Mamedov, Tazhibaeva, 2013: 44, fig. 1, *2*). The basis of another version of burial structures were poles vertically dug into the ground and held tight by pits which sometimes contained the remains of wood as a filling (Tairov, 2006: 79–87; Morgunova, Kraeva, 2012: 161–163). The poles were placed around the burial area, giving it a round or rectangular shape in plan view. They were installed in one, or sometimes in two rows (Fig. 4, *1–5*). Walls made of logs were absent. It is possible that the walls could have consisted of bundles of reeds or branches. A covering made of logs rested upon the poles. In one barrow, the covering had the shape of a tent (Fig. 4, *1*). Burial 1 in barrow 15 of the Filippovka I cemetery was covered by radially placed logs (Balakhvantsev, Yablonsky, 2007: 143). As a rule, the entrance to the structures was located in the southern and western parts. In some barrows, it was possible to trace the ground entrance corridors formed by parallel rows of vertically dug poles (Fig. 4, *2*).

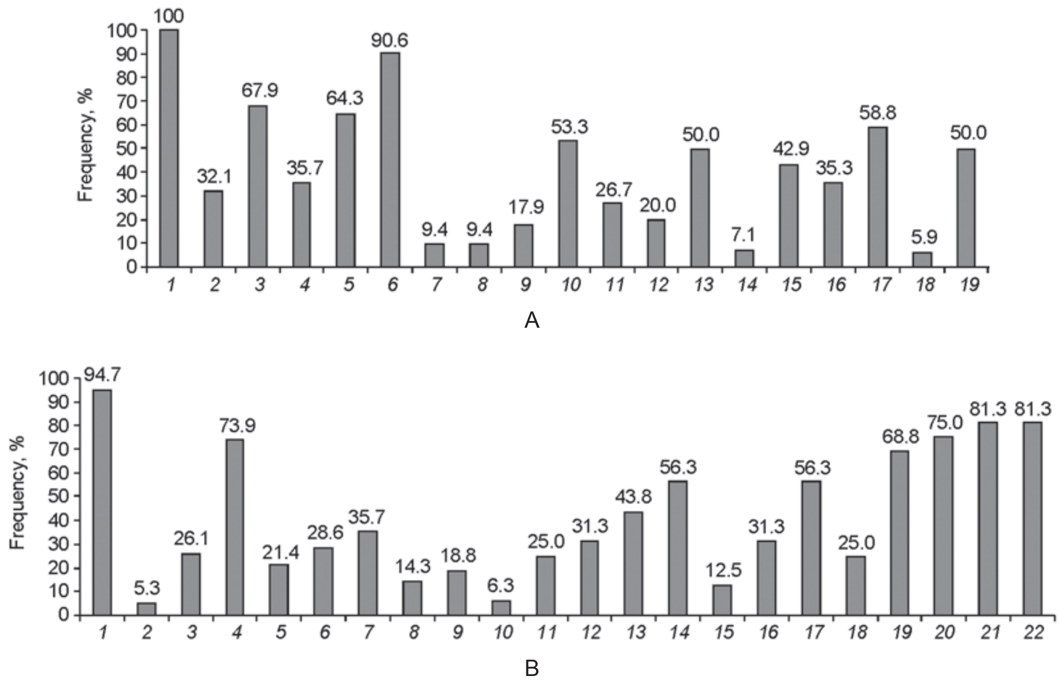

Fig. 2. Specific features of burials at the level of the ground surface.

A – features related to burial mounds and burial structures: *1* – burial under an individual mound; *2* – height of the mound less than 1.7 m; *3* – height of the mound 1.7 m and more; *4* – diameter of the mound 28 m and more; *5* – diameter of the mound less than 28 m; *6* – earth mound; *7* – stone mound; *8* – surface of the mound covered with stone; *9* – embankment of earth or stone; *10* – cribwork; *11* – pole structure; *12* – floor / platform; *13–15* – covering: *13* – tent-like covering, *14* – imitation of tent-like covering, *15* – flat covering; *16–18* – shape of the structure in the plan: *16* – round/oval, *17* – square/rectangular, *18* – octagonal; *19* – burning of the structure.

B – features characterizing the treatment of the deceased person, the presence of funeral food and accompanying goods: *1* – communal burial; 2 – single burial; *3* – cremation; *4* – inhumation; *5–8* – orientation of the buried people: *5* – to the west, *6* – to the southwest, *7* – to the south, *8* – to the southeast; *9–11* – parts of animal carcasses: *9* – horses, *10* – bovine animals, *11* – sheep; *12* – objects of gold / with gold onlays; *13* – sword; *14* – arrows; *15* – spear; *16* – sword-belt fittings; *17* – horse harness; *18* – altar; *19* – mirror; *20* – personal adornments; *21* – vessels; *22* – other objects.

Burials in barrow 6 at the Alandskoye III cemetery (Fig. 4, *7*) and in the barrow near the village of Varna, were probably made on platforms rising above the ground (Moshkova, 1972: 62–64; Stokolos, 1962; Tairov, Botalov, 1988: 100, fig. 1), while burial 1 in barrow 26 at the cemetery of Lebedevka VI (Fig. 4, *6*) was made on a wooden floor (Zhelezchikov, Klepikov, Sergatskov, 2006: 26).

The buried persons in barrow 18 at the Kyryk-Oba II cemetery were placed in a structure made of adobe, which had a covering of logs in the form of tent (Gutsalov, 2010: 58). The burial structure in barrow 6 at the Sara cemetery had a tent-like covering resting upon a circular wall of crude stone plastered by a thick layer of clay (Vasiliev, Fedorov, 1994: 127).

In several burial mounds, the upper soil layer was leveled at the funeral area (Kadyrbaev, 1984: 85, 89; Gutsalov, 2010: 58). There were some instances when the surface of the burial place was coated with liquid clay, sprinkled with chalk (Kadyrbaev, 1984: 85, 89), or was covered with birch bark (Pshenichnyuk, 1983: 57). The funeral platform could be separated from the rest of the space by a small ditch. Some of the buried were placed on beds represented by stretchers (Kadyrbaev, 1984: 89, fig. 3; Mamedov, Tazhibaeva, 2013: 44, fig. 1, *2*). The central part of several funerary sites had clay enclosures, square in plan view, which might have imitated hearths. Parts of animal carcasses were laid around or inside such walls. Judging by the calcined surface, coal, and ash, a fire was made in the "hearths" during the funerary rite (Stokolos, 1962: 24; Kadyrbaev, 1984: 86, 88; Balakhvantsev, Yablonsky, 2007: 143). In one burial, a rectangular structure made of crude stone slabs was found (Kadyrbaev, Kurmankulov, 1977: 105).

A specific feature of the burials under consideration is their collective nature (see Fig. 2, B). A single burial was found only in barrow 3 at the Tara-Butak cemetery (see Fig. 3, *3*) (Smirnov, 1975: 43). The deceased were placed in an extended supine position in the center of the funerary site, along its perimeter, or near some wall of the burial structure. Sometimes the buried were placed diagonally in the structure (see Fig. 3, *4*). Cases of orthogonal placement of the deceased have been observed (Kadyrbaev, 1984: 86–89; Balakhvantsev, Yablonsky, 2007: 143, fig. 1;

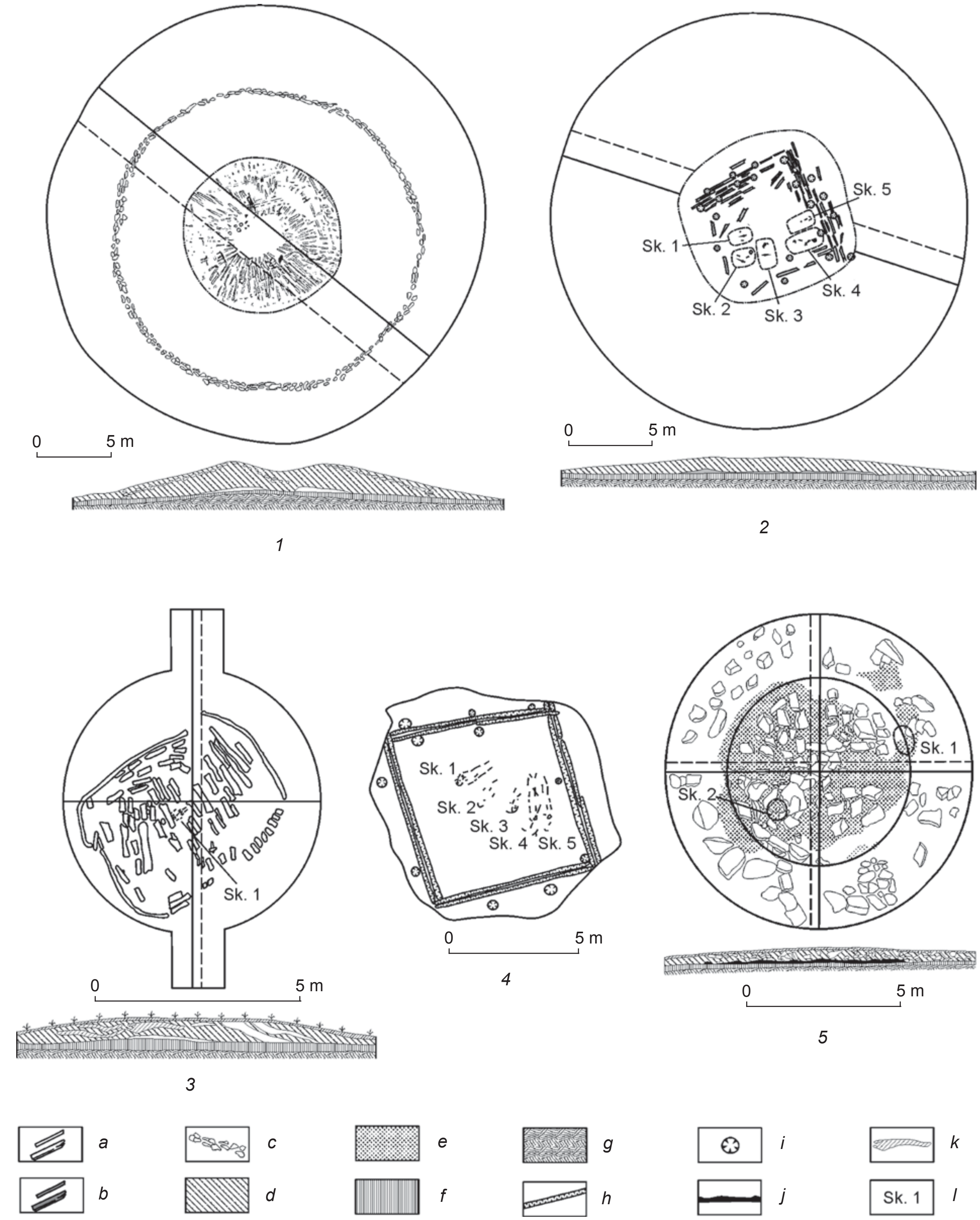

Fig. 3. Plans and sections of barrows with burials at the level of the ground surface.
1 – Almukhametovo, barrow 8 (after: (Pshenichnyuk, 1983: Fig. 12)); *2* – Sibay II, barrow 17 (after: (Ibid.: Fig. 14)); *3* – Tara-Butak, barrow 3 (after: (Smirnov, Petrenko, 1963: Pl. 1, *3*, *4*)); *4* – Ivanovka III, barrow 1, burial structure (after: (Pshenichnyuk, 1983: Pl. XXVIII, *1*)); *5* – Alandskoye I, barrow 1 (after: (Moshkova, 1961: Fig. 45)).
a – wood; *b* – burned wood; *c* – stones; *d* – burial mound; *e* – soil saturated with charcoal, layer of charcoal; *f* – buried soil; *g* – native ground; *h* – ditches; *i* – holes from the posts; *j* – soil saturated with charcoal, charcoal layer in the section; *k* – interlayers of clay or clay loam in the mound; *l* – skeleton or calcified bone remains of the buried person.

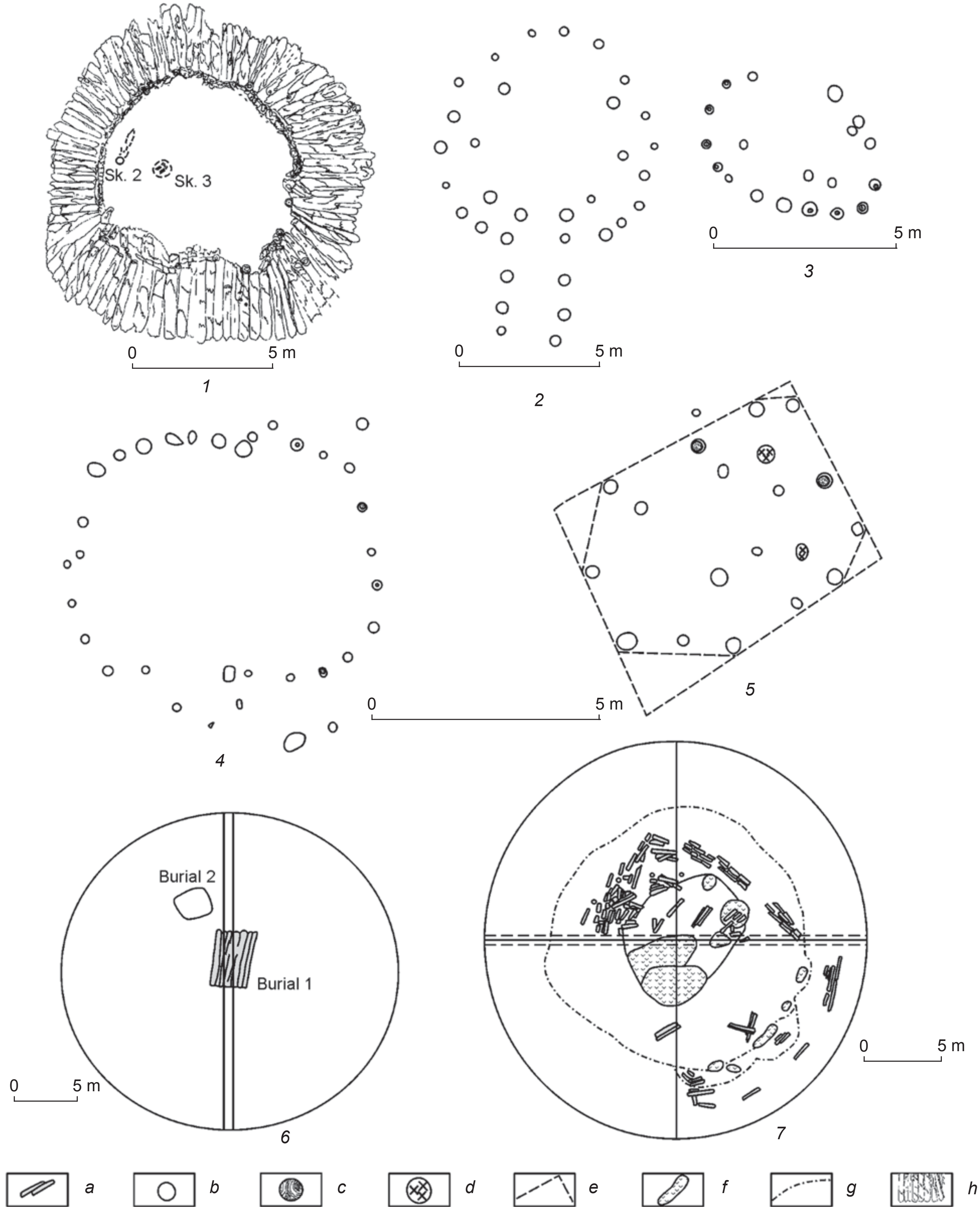

Fig. 4. Plans of the lower layer of logs of the burial structure (*1*), holes from the poles (*2–5*), and ground plans of the burial mounds (*6*, *7*).

1, *2* – Akoba II, barrow 1, burial 1 (after: (Morgunova, Kraeva, 2012: Fig. 6, *2*; 7, *1*)); *3* – Solonchanka II, barrow 1 (after: (Tairov, 2006: Fig. 5, *1*)); *4* – Marovyi Shlyakh, barrow 3 (after: (Ibid.: Fig. 3, *1*)); *5* – Marovyi Shlyakh, barrow 2 (after: (Ibid.: Fig. 8, *1*)); *6* – Lebedevka VI, barrow 26 (after: (Zhelezchikov, Klepikov, Sergatskov, 2006: Fig. 56, *2*)); *7* – Alandskoye III, barrow 6 (after: (Moshkova, 1972: Fig. 6, *1*)).

a – burned wood of the structure or floor; *b–d* – holes from the poles (*c* – with fragments of wood, *d* – with charcoal); *e* – reconstructed structure boundaries; *f* – areas of the most intense burning of fire; *g* – borders of the calcined part of the ground; *h* – wood of the structure.

Gutsalov, 2004: Pl. 7, *5*). The orientation of the heads of the buried towards the south is prevalent; a western orientation has also been found (see Fig. 2, B). A stable tradition was the burning of burial structures (Moshkova, 1961: 119; 1972: 62–64, fig. 6; Kadyrbaev, Kurmankulov, 1976: 148; Pshenichnyuk, 1983: 33–34, 56–60, 62–63; Tairov, Botalov, 1988: 100; Ageev, Sungatov, Vildanov, 1998: 97, 99; Tairov, 2006: 84; Gutsalov, 2010: 58) resulting in cremation of the deceased (see Fig. 3, *2*, *5*; 4, *7*) (Stokolos, 1962: 24; Moshkova, 1961: 119–122; 1972: 64–66; Pshenichnyuk, 1983: 57–60). The number of burials containing burned remains of the deceased is about a quarter of the total number of complexes in the investigated sample (see Fig. 2, B). Accompanying burials of dependent people have been found in some burial mounds (Kadyrbaev, Kurmankulov, 1976: 149; Kadyrbaev, 1984: 90; Gutsalov, 2010: 58, fig. 5, *2*). In one such burial (Kyryk-Oba II, barrow 18, burial 1), the posture of the buried person in a flexed position on his side (Gutsalov, 2010: 58, 61) was untypical for the nomads. Judging by the few published anthropological definitions, males, females, and children were buried at the level of the ground surface (Smirnov, 1975: 43; Gutsalov, 2010: 61; Morgunova, Kraeva, 2012: 163).

When describing the composition of the accompanying goods, it should be noted that the barrows in question most often contain clay vessels, which served as containers for food and drink (see Fig. 2, B), and mostly consisted of handmade flat-bottomed pots (Fig. 5, *1–5*, *9–11*). Most burials contained objects of everyday life and household production, such as knives, needles, awls, whetstones, or spindle whorls (see Fig. 2, B). Quiver sets of arrows with bronze (rarely iron) socketed and sometimes tanged arrowheads prevailed among the objects of military use (see Fig. 2, B) (Fig. 6, *33*, *34*, *38*, *39*, *42*). Swords were the next most frequent type of weaponry (Fig. 6, *35*, *36*). Almost a third of all the burials contained implements for sword belts. Spears occurred rarely. The materials of over a half of the burial mounds contained objects of horse harnesses (Fig. 6, *1–30*). The accompanying goods also included various kinds of feminine items (see Fig. 2, B). Personal adornments such as beads, earrings, bracelets, or sewn plaques have been most often found in burials (see Fig. 5, *27–33*, *36*). Mirrors were also a common type of find (see Fig. 5, *12–20*). Small portable stone altars have been found in a quarter of all burials (see Fig. 5, *21–25*). Many burials are distinguished by a large number of accompanying goods, including objects of social prestige made of gold or overlaid with gold foil (Kadyrbaev, 1984: 88–89; Balakhvantsev, Yablonsky, 2007: 144; Gutsalov, 2010: 61). Parts of carcasses of horses, sheep, or cattle were placed in the burials as food for the deceased (see Fig. 2, B). In general, a large percentage of burials contained rich and varied funeral goods.

The diameter of the barrows varied from 10 to 60 m; their height varied from 0.35 to 4.85 m. Notably, many burial mounds of the investigated sample were of large size (height $\geq$ 1.7 m, diameter $\geq$ 28 m). The mounds were mostly earthen. Stratigraphic observations have made it possible to determine that two burial mounds (Marovyi Shlyakh, barrow 2; the barrow near the village of Varna) were initially made as stepped pyramids round in plan view (Tairov, Botalov, 1988: 110–114; Tairov, 2006: 79). The practice of encasing earthen mounds with stone or making stone mounds was not very common (Fig. 2, A).

The tradition of burials on the level of the ground surface was most widespread among nomadic cattle breeders, whose pastures were located in the upper reaches of the Ural, Sakmara, Ilek and Khobda rivers. Barrows with such burials in the basins of these rivers are found in a strip (see Fig. 1) stretching from north to south, which could have been caused by meridional seasonal migrations of groups of nomads who were close in ethnic and cultural terms. In the Southern Ural steppes, which extend west of the above area, such complexes have been found in smaller numbers (see Fig. 1).

Burials on the level of the ground surface in the barrows of the nomadic cattle breeders of the Southern Urals go back to the second half of the 6th–4th centuries BC. However, burial complexes with relatively "narrow" dates are distributed unevenly within this chronological range. Two complexes (the barrow near the village of Varna, and barrow 2 at Marovyi Shlyakh) are dated to the second half of the 6th century BC (Tairov, Botalov, 1988: 107; Tairov, 2006: 90). Twelve burial mounds (Marovyi Shlyakh, barrow 3; Solonchanka II, barrow 1; Sara, barrow 7; Tara-Butak, barrow 3; Kyryk-Oba, barrow 18, burial 5; Syntas I, barrow 2; Besoba, barrow 2; Sibay II, barrow 17; Bish-Uba, barrow 1, burial 5, and barrows 2 and 3; Almukhametovo, barrow 8) were made in the late 6th to first half of the 5th centuries BC (Tairov, 2006: 89; Smirnov, 1964: 153; 1975: 42–44; Gutsalov, 2010: 64; Kadyrbaev, Kurmankulov, 1977: 103, 114; Tairov, 2004: 3, 6–9, fig. 3, *8*, *15*; 8, 91; Ageev, Sungatov, Vildanov, 1998: 100; Berlizov, 2011: 183–186; Treister, 2012: 268, 270–271). Four burial mounds (Alandskoye I, barrow 1; Alandskoye III, barrow 6; Sara, barrow 6; Akoba II, barrow 1, burial 1) were dated to the 5th century BC or, more precisely, to the second half of the 5th century BC (Moshkova, 1961: 122; 1972: 68–69; Vasiliev, Fedorov, 1994: 127; Morgunova, Kraeva, 2012: 196, pl. 1). Barrows 7 and 8 at the Perevolochan I cemetery can be dated to the second half of the 5th to the turn of the 5th–4th centuries BC (Sirotin, 2016: 253–256). Barrow 6 of the same cemetery is a part of funerary complexes dated to the late

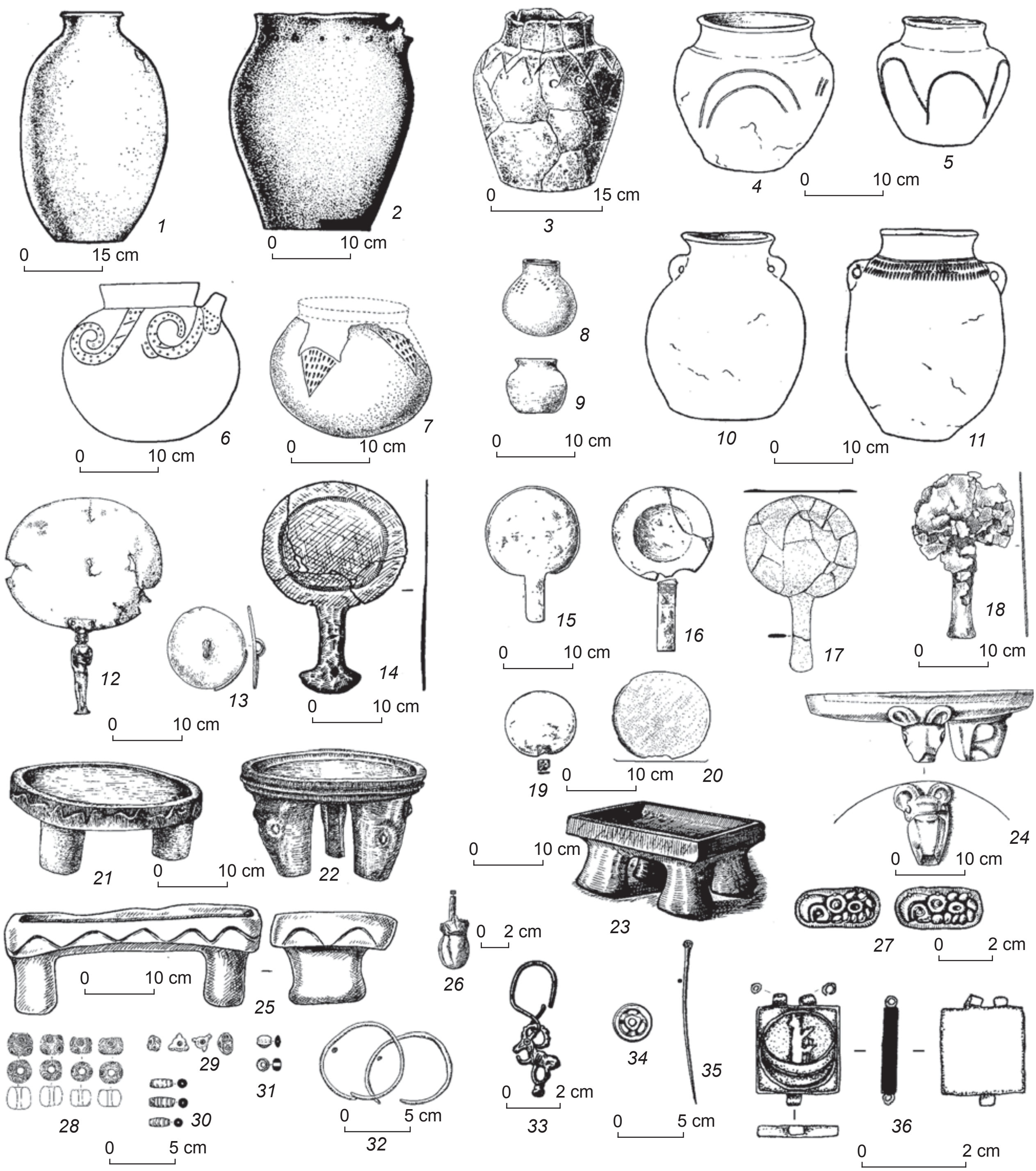

Fig. 5. Main types of accompanying goods from the barrows with burials at the level of the ground surface.
1–11 – vessels; *12–20* – mirrors; *21–25* – altars; *26* – bag and stick; *27* – sewn plaques; *28–31* – beads; *32* – bracelets; *33* – earring; *34* – wheel amulet; *35* – pin; *36* – medallion, a part of a composite adornment.
1–11 – clay; *12–20*, *32*, *34* – bronze; *21–25* – stone; *26* – leather and wood; *27*, *33* – gold; *28–31* – glass; *35* – silver; *36* – gold, enamel.
1, *2*, *14*, *23*, *27*, *30*, *31* – Besoba, barrow 4 (after: (Kadyrbaev, 1984: Fig. 1, *10–13*, *16–22*, *51*; 2, *1–3*)); *3* – Ivanovka III, barrow 1 (after: (Pshenichnyuk, 1983: Pl. XXVIII, *11*)); *4*, *5*, *10*, *11* – Alandskoye III, barrow 6 (after: (Moshkova, 1972: Fig. 8, *4–7*)); *6* – barrow near the village of Varna (after: (Tairov, Botalov, 1988: Fig. 3)); *7–9*, *12*, *21*, *29*, *34* – Almukhametovo, barrow 8 (after: (Pshenichnyuk, 1983: Pl. XXIII, *1–5*, *19*, *21–22*)); *13* – Solonchanka II, barrow 1 (after: (Tairov, 2006: Fig. 8, *4*)); *15*, *16*, *19*, *26*, *33*, *35* – barrow 7 near the village of Sara (after: (Smirnov, 1964: Fig. 35B, *7–9*, *12*, *14*, *15*)); *17*, *28* – Akoba II, barrow 1, burial 1 (after: (Morgunova, Kraeva, 2012: Fig. 8, *3–6*; 9, *1*)); *18*, *25* – Zhalgyzoba (after: (Gutsalov, 2004: Pl. 7, *17*, *37*)); *20* – Alandskoye I, barrow 1 (after: (Moshkova, 1961: Fig. 46, *11*)); *22* – Sibay II, barrow 13 (after: (Pshenichnyuk, 1983: Pl. XLIII, *36*)); *24* – Marovyi Shlyakh, barrow 3 (after: (Tairov, 2006: Fig. 5, *5*)); *32* – Tselinnoye, barrow 1 (after: (Pshenichnyuk, 1983: Pl. XXV, *12*, *13*)); *36* – Filippovka I, barrow 15, burial 1 (after: (Balakhvantsev, Yablonsky, 2007: Fig. 3)).

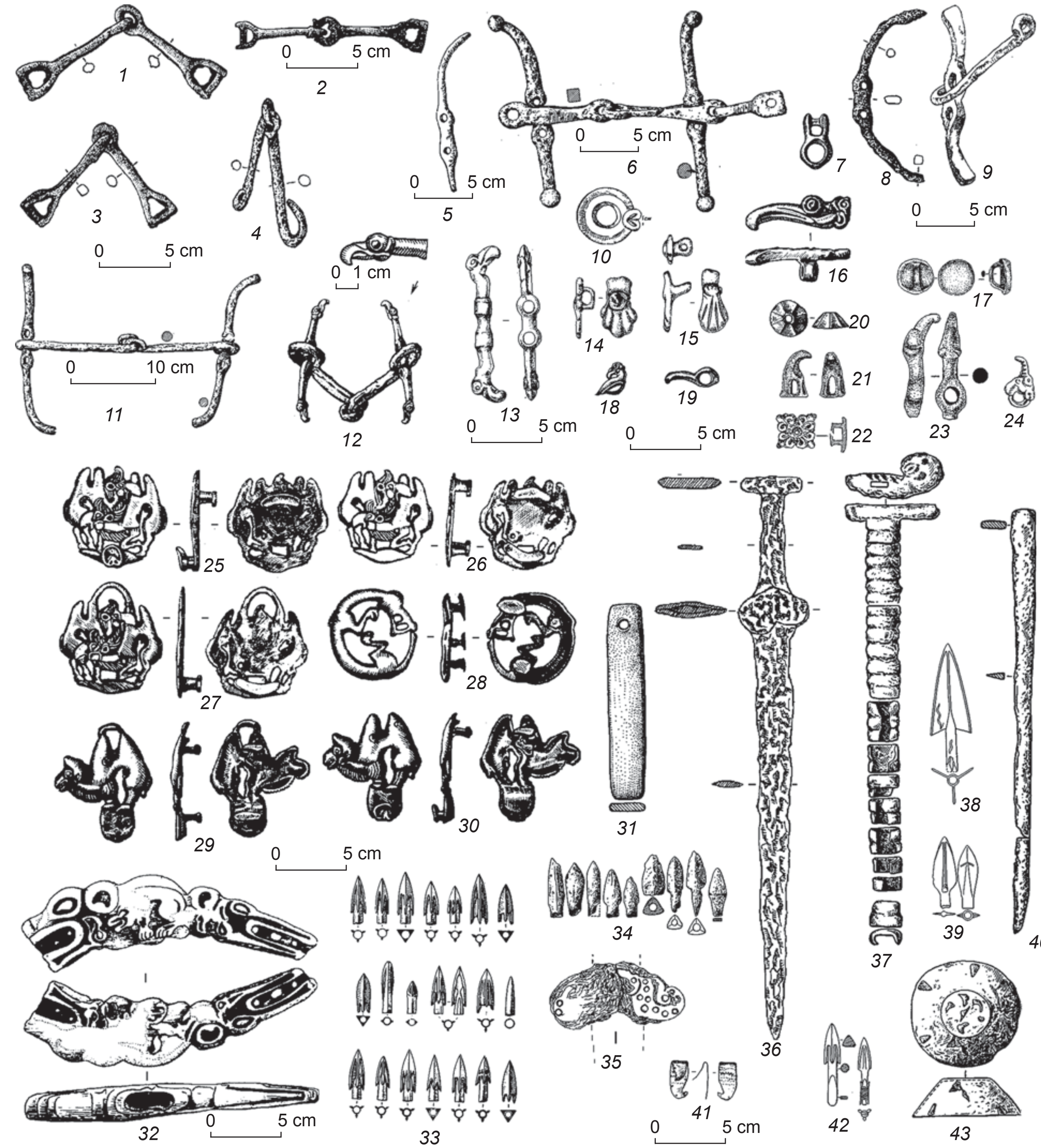

Fig. 6. Main types of accompanying goods from the barrows with burials at the level of the ground surface.

1–4 – bridle bit; *5*, *8*, *13*, *23* – cheek-pieces; *6*, *9*, *11*, *12* – bridle bits and cheek-pieces; *7*, *10*, *25–30* – buckles and plaques of horse harness; *14–19*, *21*, *22*, *24* – pendants and plaques of horse bridle; *20* – tassel bead; *31* – whetstone; *32* – object decorated with a representation in animal style; *33*, *34*, *38*, *39*, *42* – arrowheads; *35* – crossbar of a sword; *36* – sword; *37* – sheath of a knife; *40* – knife; *41* – braces (decorations of wooden vessels?); *43* – umbo or decoration of a quiver.

1–6, *8*, *9*, *11*, *34*, *36*, *37*, *40*, *43* – iron; *7*, *10*, *13–19*, *21–30*, *33*, *38*, *39*, *42* – bronze; *12* – iron and bronze; *20* – gold; *31* – stone; *32* – bone; *35* – iron and gold.

1–4, *8*, *14, 15*, *32* – barrow near the village of Varna (after: (Tairov, Botalov, 1988: Fig. 2–5)); *5* – Sibay II, barrow 19 (after: (Pshenichnyuk, 1983: Pl. XLIII, 32)); *6*, *11*, *31*, *34*, *37–40*, *42*, *43* – barrow 7 near the village of Sara (after: (Smirnov, 1964: Fig. 35, A, B)); *7*, *12*, *16*, *19*, *20*, *33*, *41* – Besoba, barrow 4 (after: (Kadyrbaev, 1984: Fig. 1, *1*, *3*, *7*, *8*, *15*, *23–43*)); *9*, *10*, *24* – Almukhametovo, barrow 8 (after: (Pshenichnyuk, 1983: Pl. XXXIII, 15, 18, 20)); *13* – Marovyi Shlyakh, barrow 3 (after: (Tairov, 2006: Fig. 5, *2*)); *17*, *21*, *23* – Akoba II, barrow 1, burial 1 (after: (Morgunova, Krayeva, 2012: Fig. 9, *2–5*)); *18*, *25–27* – Besoba, barrow 5 (after: (Kuznetsova, Kurmankulov, 1993: Fig. 3, *8*, *11*, *13*)); *22* – Sibay II, barrow 17 (after: (Pshenichnyuk, 1983: Pl. XLIV, 24)); *28–30* – Besoba, barrow 9 (after: (Kadyrbaev, 1984: Fig. 5, *1*, *2*, *6*; Kuznetsova, Kurmankulov, 1993: Fig. 3, *6*, *9*, *12*)); *35*, *36* – Kyryk-Oba II, barrow 18 (after: (Gutsalov, 2010: Fig. 5, *3*, *10*)).

5th–4th century BC (Ochir-Goryaeva, 2012: 260, 271, ill. 285). Four more burials (Lebedevka VI, barrow 26, burial 1; Filippovka I, barrow 15; Sagitovo III, barrow 1; Tselinnoye, barrow 1) were possibly made in the 5th century BC, most likely in its second half, or in the 4th century BC (Zhelezchikov, Klepikov, Sergatskov, 2006: 37; Pshenichnyuk, 1983: Pl. XXVIII, 4–5, 11; XXXIII, XXXVII, XLIII, 1–11, 34–35: 37–38; Tairov, 2004; Balakhvantsev, Yablonsky, 2007: 147–149).

Conclusion

The burials of nomads of the Southern Urals, overviewed in this article, are distinguished by a stable set of features characterizing the funerary rite. These features include the tradition of burials on the level of the ground surface or on wooden floors or platforms, the collective nature of burials, and the orientation of the heads of the buried to the south. The deceased were buried in above-ground burial structures (mostly built of logs), which had square or rectangular plans and a flat or tent-like covering. This set of features also includes the tradition of burning the burial structures. A significant number of burial mounds were of large size (height ≥ 1.7 m, diameter ≥ 28 m). During the burial process, sophisticated burial structures were erected. In case of several mounds, the accompanying burials of dependent people were made. The majority of burials contained rich funeral goods and food. Therefore, there is reason to believe that this set of ritual traditions is to a large extent associated with the subculture of the nomadic elite of the Southern Urals.

Burials at the level of the old ground surface are concentrated in the eastern regions of the southern Ural steppes. It is possible that their location in a strip stretching from the south to the north in the basins of the upper reaches of the Ural, Sakmara, Ilek, and Khobda rivers was caused by meridional seasonal migrations of nomadic communities inhabiting these territories.

Ritual standards manifested in the burials under consideration, shows the specific local nature of the culture of cattle breeding tribes that roamed in the eastern regions of the southern Ural steppes. These traditions were most widespread in the second half of the 6th to the first half of the 5th century BC. From the turn of the 5th–4th centuries BC, their importance began to diminish. In the 4th century BC, this set of traditions of funerary rite ceased to exist.

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The Megaliths of Korea and Japan: An Analysis of Origins and Functions

This publication focuses on the origins and features of Neolithic and Bronze Age megaliths in the marginal areas of Eurasia, a topic infrequently addressed in Russian scholarship. The objective of this study is to describe the phenomenon of megalithism in Korea and the adjacent areas of Japan using archaeological evidence and science-based methods. In Korea, the megalithic sites, more than 30 thousand in number, are concentrated in the west and south, along the estuaries of major rivers flowing into the Yellow and East China Seas. Most dolmens in Korea date to the Bronze Age, and served as burial structures. In Japan, the megaliths belong to two traditions of different origin. One is local, originating from the Middle Jōmon, the other was introduced from Korea. Most specialists attribute dolmens with burials to the Yayoi culture (3rd century BC to 3rd century AD). They are distributed on Kyushu Island (prefectures of Fukuoka, Nagasaki, and Saga) and in the western and central parts of Honshu Island. The analysis of megaliths in both regions suggests that their appearance and spread were only partly related to a farming economy. The principal factors were social changes such as the emergence of tribal elites and the redistribution of territories.

Keywords: *Korea, Japan, Jōmon, Yayoi, Kofun, Bronze Age, megaliths, dolmens, burials.*

Introduction

Megaliths are a type of archaeological monument representing structures made of one or more large stones. They are both outstandingly spectacular and difficult in terms of dating and interpretation. Megaliths were built in many cultures beginning with the Stone Age. The most famous and well-studied megalithic structures (menhirs, dolmens, cromlechs, trilithons, and other varieties) are those of Western Europe and Western Asia, while other regions (Southern and Southeastern Asia) have so far been considered only preliminarily in the Russian archaeological literature (Vorobiev, 1997: 47–49; Larichev, 1978: 71; Butin, 1982: 149–155; Tikhonov, Kang Man-Gil, 2011, 56–59).

The Korean Peninsula is one of the world's largest centers of megaliths. In this region, they amount to over 30,000 complexes (Hanguk jiseonmyo…, 1999: 19, 1207). According to the dominant theory, it is precisely the megalithic tradition that accompanied the spread of agriculture and metallurgy from the Korean Peninsula to the Japanese Archipelago at the turn of the eras, and was a typical feature of the Yayoi culture (Derevianko, 1975).

We think that the most important problems in the study of megaliths are the origin, purpose, and mutual influence of various traditions of megalithic architecture in neighboring regions. Are megaliths an indicator of exclusively agricultural societies? Is it possible to view them as a special type of burial complex? It is from this perspective that we consider the phenomenon of megaliths on the Korean Peninsula and the adjacent territories of the Japanese Archipelago, using the data of archaeology, natural science, and experimentation.

Megalithic structures on the Korean Peninsula

The megalithic culture of the Korean Peninsula is mainly represented by dolmens—structures in the form of a box made of two or more large stones covered by a stone slab. Separately standing stones (menhirs) are also known (Hanguk jiseonmyo…, 1999: 1203). Because of the lack of associated finds, the time of construction and cultural context of menhirs cannot be established, so they will not be considered in this article. The largest centers where dolmens occur are Jeollanam-do Province of the Republic of Korea, as well as the provinces of Pyeongannam-do, Hwanghaenam-do, and Hwanghaebuk-do in the Democratic People's Republic of Korea (DPRK) (Ibid.: 13, 1132–1134; Ha Moon-Sig, 1999: 165, 166). The greatest concentration of these monuments is observed on the coasts of the Yellow and East China Seas, as well as in the basins of rivers that flow into these seas: the Chongchon, Taedong, and Imjin in the DPRK, and the Han, Geum, Yeongsan, Seomjin (with the tributary Boseong), and the Nakdong (with the tributaries Hwang and Nam) in the Republic of Korea. The number of dolmens is small in the central and eastern regions of the Korean Peninsula: only 267 dolmens are known in Gangwon-do Province, and 207 dolmens are known in Chungcheongbuk-do Province (Fig. 1).

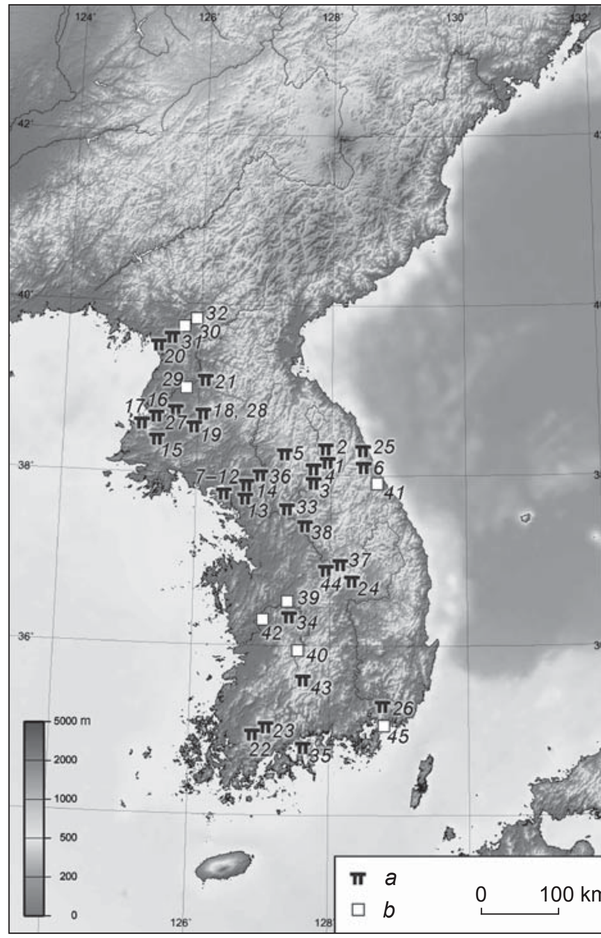

Fig. 1. Monuments of the Bronze Age on the Korean Peninsula.
a – dolmens; *b* – other megaliths.
1 – Gongsuri; *2* – Godae-ri; *3* – Cheonjeon-ri; *4* – Chujeon-ri; *5* – Taeseong-ri; *6* – Beombu-ri; *7* – Bugeun-ri; *8* – Bugeun-ri Jeomgol; *9* – Samgeo-ri; *10* – Bugeun-ri (Hado-ri); *11* – Osang-ri; *12* – Daesan-ri; *13* – Gyoha-ri; *14* – Deokeun-ri; *15* – Noam-ri; *16* – Yaksa-dong; *17* – Gwansanri; *18* – Odok-ri; *19* – Sokchonsan; *20* – Yongdeok-ri; *21* – Munhung-ri; *22* – Daegokri; *23* – Daesinri; *24* – Jinmok-ri; *25* – Joyang-dong; *26* – Nae-dong; *27* – Cheonjin-dong; *28* – Odok Peongchon; *29* – Namgyeong; *30* – Guryonggang; *31* – Mukbangri; *32* – Sejuk-ri; *33* – Yangsu-ri; *34* – Birae-dong; *35* – Hwajang-dong; *36* – Okseokri; *37* – Hwangseok-ri; *38* – Sangjapo-ri; *39* – Sindae-dong; *40* – Anja-dong; *41* – Bangnae-ri; *42* – Songguk-ri; *43* – Ungok-ri; *44* – Hamam-ri; *45* – Janghang.

Typology of dolmens. There are three main types of dolmens: northern (in the form of a table), southern (with a foundation), and without supporting stones. In some studies, one more type of *wiseoksik* with ring stonework is distinguished. Dolmens of the northern type are "classical": they have the burial chamber on the surface, and are composed of two–four slabs covered with a stone lid (Fig. 2, *1*). Such structures have been found in all areas, but the majority are located on the territory of the DPRK and in the central part of the Korean Peninsula. Thus, about 120 dolmens of the northern type are known in Gyeonggi-do Province. Most of them are located on Ganghwa Island and on the territory north of the Han River. Typical dolmens of the northern type are Bugeun-ri No. 18, Bugeun-ri Jeomgol No. 24, Samgeo-ri No. 39, Bugeun-ri (Hado-ri) No. 5, Osang-ri No. 56, Daesan-ri, Gyoha-ri No. 11, and Deokeun-ri A, B1. Thirty five dolmens (Noam-ri, Yaksa-dong, Gwansanri, Odok-ri, Sokchonsan, Yongdeok-ri, and Munhung-ri) can be attributed to that type out of 93 dolmens in North Korea. A small number is known in the central regions and in the far south of the Korean Peninsula.

The burial chamber among the dolmens of the southern type is located in a ground pit, and in some cases there is no stone structure inside the grave. Several small amorphous stones, which were not a part of the burial chamber, were set up on the ground and supported a stone lid (Fig. 2, *2*). In most cases, a box of flagstone was used as a burial chamber in the dolmens of the southern type; less often a tiled coffin, and sometimes simply a ground pit. Such monuments have not been found on the territory of North Korea; they appear sporadically in the eastern and central regions of the Peninsula except

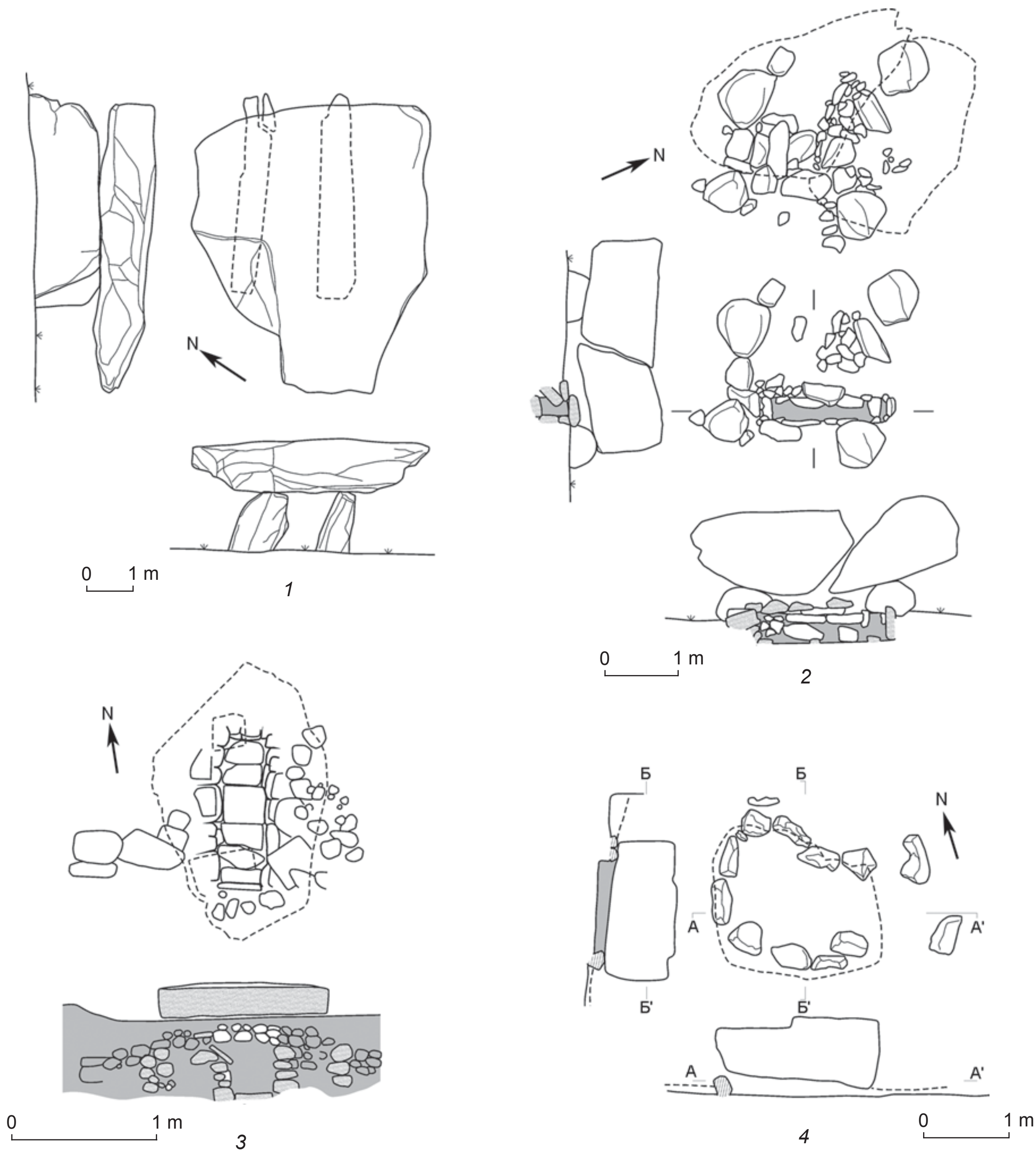

Fig. 2. Types of dolmens on the Korean Peninsula (after: (Hanguk jiseonmyo…, 1999; Jeonnam-ui…, 1996)).
1 – northern: Bugeun-ri No. 18, Ganghwado Island; *2* – southern: Naeu Usanri No. 44, Jeollanam-do Province; *3* – without supporting stones: Daebong-dong-5 No. 1, Gyeongsangbuk-do Province; *4* – *wiseoksik*: Bokgyo-ri No. 5, Jeollanam-do Province.

for Chungcheongnam-do Province, where this type is predominant. Dolmens of the southern type are abundantly present in the coastal areas of South Korea, including the provinces of Gyeongsangbuk-do, Gyeongsangnam-do, Jeollabuk-do, and Jeollanam-do. The largest dolmens have been discovered in Hwasun County of Jeollanam-do Province: one at the site of Daegokri (with size of lid 7.1 × 4.0 × 3.7 m, and weight about 210 tons), the other at the site of Daesinri (with size of lid 7.6 × 4.2 × 4.1 m, and weight about 260 tons) (Hanguk jiseonmyo…, 1999: 967). The majority of dolmens on Jeju Island also belong to the southern type.

In the case of dolmens without supporting stones, the structure of the burial chamber was the same as with dolmens of the southern type, but the lid was placed directly over the burial chamber (Fig. 2, *3*). This type is common throughout the entire territory of the peninsula. The structures of dolmens without supporting stones also show regional differences. In the northern and central regions (the territory of the DPRK, and the Gangwon-do and Chungcheongbuk-do provinces of South Korea), a tiled coffin was primarily used as a burial chamber, while a box made of flagstone was used in the south.

Upon visual examination, the dolmens of the *wiseoksik* type resemble those of the southern type. However, as opposed to the latter, the burial chamber in the *wiseoksik* dolmens is located on the surface, and the supporting stones serve as walls (Fig. 2, *4*). The placement of the stones usually forms a round-amorphous shape in plan view, since it repeats the shape of the lid, and is not equipped with additional covering. In rare cases, the burial chamber was a ground pit, which was slightly deepened into the native soil, and stones supporting the lid were set up in the upper part of the walls. Dolmens of this type appear only in the southern regions of the Korean Peninsula and on Jeju Island (with the exception of dolmen Jinmok-ri No. 4 in Chungcheongbuk-do Province).

Inventory assemblages. Despite the diversity of structural variants of the Korean dolmens, they are the monuments of a single culture. This is evidenced by the assemblage of archaeological materials associated with the dolmens. The main type of find is smooth-walled pottery (Kim Won Yong, 1986: 66, 67; Kim Jangsuk, 2007: 74): top-shaped pottery, with holes or appliquéd roll along the edge of the rim, of the Misongri and Mukbangri type, and red and black polished pottery. Dolmens of the northwestern part of the Korean Peninsula are associated with top-shaped pottery, as well as Misongri and Mukbangri pottery. Vessels with holes along the edge of the rim have been found in the megaliths of the northeastern and central regions. A large number of undecorated and red polished pottery, as well as a number of vessels with painted ornamental decoration and black polishing of the surface, have been found in the dolmens of the southern and central part of the Peninsula. The unique pottery tradition of the megaliths of Jeju Island consists of modified pottery with holes or appliquéd roll along the rim.

Stone daggers with thin tangs, tanged arrowheads, semilunar knives, discoid and serrated maces, rectangular axes, adzes, chisels, stone spindles, "stone coins", as well as adornments made of stone (cylindrical beads), bone, shell, and bronze, have been found at the sites with top-shaped pottery. The assemblages with the vessels with holes on the rim have stone hilt daggers, tanged and triangular arrowheads, rectangular axes, discoid maces, adzes, chisels, stone and ceramic spindle whorls, ceramic weights, and semilunar knives. A bronze celt was found at one site (Joyang-dong No. 1, Gangwon-do Province). Ritual objects are represented by stones with an "eyelet", with a carved cross, and with an anthropomorphic representation.

Some differences can be found in the burial inventory of the dolmens in the southern regions. In addition to rectangular axes, adzes, chisels, ceramic and stone spindle whorls, weights, pestles, triangular and semilunar knives, and other household objects typical of the megalithic culture of the Korean Peninsula, stone hilt daggers with wide tangs, weighting elements for the hilt, tanged arrowheads, axes with groove and ledge, bronze arrowheads, lute-shaped daggers and a spearhead, as well as jade adornments, have been found there, while adornments made of bronze, bone, and shells have not been discovered. The inventory included a narrow-bladed bronze dagger and black pottery typical of the period from the Late Bronze Age to the Early Iron Age (Nae-dong No. 1 in Gimhae, Gyeongsangnam-do Province) (Kim Jeong-hak, 1983). Ritual objects were represented by stones with "eyelets" and carved crosses.

Chronology. At present, there are no doubts that most of the dolmens on the Korean Peninsula belong to burial sites of the Bronze Age, since they contain a typical assemblage of inventory, but there are also some reservations. First, in comparison with the huge number of megalithic structures studied in this territory, the accompanying inventory is extremely scarce. Second, the amount of absolute dates for the dolmens is insufficient. Finally, most of the dates were obtained in the 1960s–1990s, and their accuracy raises some doubts. That is why, in order to establish the chronological framework for the existence of the megalithic culture on the Korean Peninsula, the method of cross-dating was also used in addition to absolute dates.

Top-shaped pottery and the pottery of the Mukbangri type play a special role in determining the dates of the dolmens of North Korea. Top-shaped pottery has been found in most of those dolmens. The fragments of rims from the dolmens of Noam-ri, Cheonjin-dong No. 6, and Odok Peongchon No. 10 are similar to the fragments found in the dwelling Namgyeong No. 1, and its style of ornamental decoration in the form of notches resembles the pottery from the Guryonggang site. A fragment with broad bottom typical of the modified top-shaped pottery which appears among the materials of dwelling No. 2 of the Namgyeong site was found in the dolmen of Noam-ri. The cultural layer of the Bronze Age at this site is divided into three periods according to the specific features of dwelling structures, top-shaped pottery, and other aspects. Coal from dwelling No. 36, attributed to the first period, gave the date of 2890 ± 70 BP (13th–10th centuries BC). The date of 2740 ± 70 BP (11th–8th centuries BC) was obtained for the Guryonggang site. Thus, the 11th–10th centuries BC can be taken as the lower boundary of the period when the dolmens were made (Ha Moon-Sig, 1999: 270).

Among the sites of North Korea, the site of Mukbangri in the vicinity of the city of Gaecheon in Pyeongannam-do Province belongs to a relatively late period. In terms of their structure, the dolmens of Mukbangri differ from other similar structures of this region: they do not have supporting stones, and their burial chamber has the form of a box made of flagstone. A pottery vessel of the Mukbangri type was found in dolmen No. 24 of that site. Such pottery is considered to be a late version of pottery of the Misongri type. Fragments of pottery of the Mukbangri type were also found in the dwellings of the second layer of the Sejuk-ri site. The third layer, which covered it, contained about 2500 Ming Dao coins; in accordance with the period of their use, the layer belongs to the late Zhanguo period (3rd century BC). Thus, the layer below with the pottery of the Mukbangri type can be dated to the 4th–3rd centuries BC (Butin, 1982: 197–200, 210; Ha Moon-Sig, 1999: 157, 271).

The Bronze Age in South Korea dates back to the 13th/10th–3rd/2nd centuries BC (Kim Won Yong, 1986: 68; Choi Sung-rak, 1998: 105, 129, 229, 231). The absolute dates of dolmens (see *Table*) generally fit the Bronze Age and show that the megaliths were built throughout the entire period. An exception is the date of the dolmen of Yangsu-ri (second millennium BC), which belongs to the Middle Neolithic. Most likely, this can be explained by incorrect sampling.

The earliest absolute date was obtained at the site of Birae-dong No. 1 (12th–9th centuries BC). A lute-shaped dagger, red polished pottery, and stone triangular arrowheads with notches in their bases were found in the burial chamber. At the settlements of Sindae-dong and Anja-dong in the same area, stone daggers with stepped hilts and blood grooves were found in similar inventory assemblages instead of lute-shaped daggers. The settlement of Sindae-dong existed in the 10th century BC, which is consistent with the dating of the dolmen of Birae-dong No. 1. The inventory of dolmen Joyang-dong No. 1 (the city of Sokcho), which included a fan-shaped bronze celt and triangular arrowheads, is similar to the finds from the settlement of Bangnae-ri near the city of Gangneung. The settlement is of the Heunamni type, which is dated to the 9th century BC, but judging by the absolute dates (1279–980, 1230–395, 1208–544, 794–431 BC), it is earlier (10th century BC). In the tiled coffin of dolmen Songguk-ri in Buyeo County, stone narrow-bladed arrowheads, a dagger with a solid hilt, and a lute-shaped dagger were found. The dates of 979–762 and 894–412 BC (9th century BC) were obtained for the associated dwelling. In the dolmens of the Hwajang-dong site, stone daggers with a solid hilt have also been found. They are considered to be of a later date than the daggers with stepped hilts. At this site, the dates of 1024–801, 976–811, and 895–769 BC have been obtained, which makes it possible to assign it to the 9th–8th centuries BC. A dwelling at Okseokri, discovered in the layer below a

Absolute dates of the dolmens in South Korea*

Site	Location	Material of the sample	^{14}C-date, years BP	Index of the laboratory, year	Calibrated date, years BC
Yangsu-ri	Yangpyeong County, Gyeonggi-do Province	Charcoal	3900 ± 200	–	1950 (2910–1783)
Birae-dong No. 1	Daejeon City, Chungcheongnam-do Province	"	2860 ± 50	–	1005 (1145–900)
Hwajang-dong No. 1	Yeosu City, Jeollanam-do Province	"	2770 ± 40	SNU00-076, 2000	910 (1000–820)
Hwajang-dong No. 4-1	"	"	2630 ± 40	SNU00-075, 2000	840 (900–760)
			2744 ± 60	R 24842, 2000	907 (1012–802)
Okseokri	Paju County, Gyeonggi-do Province	"	2590 ± 105	GX0554, 1965	640 (930–410)
Daesinri No. 27	Hwasun County, Jeollanam-do Province	"	2500 ± 80	SNU00-072, 2000	555 (796–415)
Hwangseok-ri No. 13	Jecheon County, Chungcheongbuk-do Province	Anthropological	2360 ± 270	GX0555, 1965	410 (1120 BC to 212 AD)
Sangjapo-ri No. 4	Yangpyeong County, Gyeonggi-do Province	Charcoal	2170 ± 60	AERIK-91, 1972	220 (378–56)

*Compiled after: (Hanguksa…, 1997: 28; Hanguk jiseonmyo…, 1999: 399, 702; Lee Young Moon, 2002: 258; Kim Jae-Won, Youn Moo Byong, 1967: 49, 124, 125; Lee Young Moon, Kim Jin Young, 2001: 109–114; Lee Young Moon et al., 2002: 165–168).

dolmen of the northern type, was dated to the second half of the 9th century BC on the basis of the date of 930–409 BC. It seems that the lower boundary of the megalithic culture in the south of the Korean Peninsula can be moved back to the 11th–10th centuries BC (Lee Young Moon, 2002: 258–260).

The dolmens with vessels with appliquéd roll on the rim, black polished pottery, narrow-bladed bronze daggers, and other materials from the Late Bronze–Early Iron Age have been found on the territory of South Korea. Absolute dates have been received only for two monuments with narrow-bladed bronze daggers: for the dolmen of Sangjapo-ri No. 4 (3rd century BC) and for a stone box with a wooden coffin of Daegokri (Jeollanam-do Province) (early 8th–2nd century BC). Judging by these dates, as well as by the presence of narrow-bladed bronze daggers, which began to be used on the Korean Peninsula in the 3rd century BC, the monuments can be dated to the 4th–3rd centuries BC (Ibid.: 261). The dolmen Nae-dong No. 1, with a similar assemblage of inventory, also goes back to that period. Fragments of roller pottery typical of the Early Iron Age, were found at the site of Ungok-ri (Chungcheongbuk-do Province), in the layer with non-decorated vessels. According to the pottery fragments, the dolmens of that site were dated to the late 3rd–2nd century BC (Hanguk jiseonmyo…, 1999: 230). Iron slag was discovered in the dolmen of Hamam-ri No. 5 (Chungcheongbuk-do Province). This find confirms the existence of such megaliths in the Early Iron Age. In addition, the upper boundary of the dates of the dolmens on Jeju Island is ca 1st–2nd centuries (Ibid.: 1108).

Thus, the time when the megalithic culture existed was the 11th–4th/3rd centuries BC in the northern part of the Korean Peninsula and the 11th–3rd/2nd centuries BC in the southern part. In the future, the upper limit of this period may be dated to the turn of the eras.

The origin of the phenomenon of megaliths seems to be complicated. Traditionally, the emergence of the megalithic culture on the Korean Peninsula was explained by the change of the populations (the Paleo-Asiatics were replaced by the Tungus-Manchu people) (Butin, 1982: 153; Vorobiev, 1997: 100; Tikhonov, Kang Man-Gil, 2011: 47, 48). However, the popular theory on the spread of megaliths from north to south (from the territory of Southern Manchuria) is not entirely justifiable in the light of radiocarbon dating. In any case, the origin of the Korean megaliths cannot be attributed solely to migrations. Local tradition might have played some role at the initial stage, which is partly confirmed by the use of stone in the burial and ritual-funerary practices of the Neolithic. Some of the skeletons at the recently investigated Janghang burial ground on Gadeaodo Island, in the vicinity of Busan, are covered with stones. A territory with contemporaneous stonework and pits constituting a commemoration complex associated with a burial ground, joins the Janghang site to the southwest (Kim Sang Hyeon, 2011: 27). Janghang is still the only monument of the Neolithic where stone was used in the structures. Further identification of Neolithic burial grounds and individual burials, as well as ritual complexes, will make it possible to solve the problem of the origin of the tradition of the megaliths' construction. Nevertheless, it can be confidently argued that megaliths were not typical of the Neolithic on the Korean peninsula, and the flourishing of the megalithic culture occurred in the Bronze Age.

As far as the purpose of Korean dolmens is concerned, most of them undoubtedly constitute burial structures. Moreover, dolmens prevail among the forms of burial typical of the Bronze Age on the Korean Peninsula (dolmens, tiled coffins, stone boxes, or urns). The results of reconstruction and experiments show that the construction of dolmens required a high level of concentration of human resources and social stratification (Lee Young Moon, 2002: 329–330; Yu Tae Young, 2000: 220, 221). Whether the emergence of megaliths on the Korean Peninsula was associated with the development of agriculture is a question that does not find an unequivocal answer. The earliest evidence of agriculture in the region goes back to the Neolithic (Lim Sang Taek, 2007: 60, 61; Goseong Munam-ri…, 2013: 172–181, 267, 268, 271), and therefore the origin of the Korean megaliths cannot be explained exclusively by the transition from an appropriating economy to a producing economy.

Traditions of megalithic structures on the islands of the Japanese Archipelago

Archaeological data suggest that on the territory of the Japanese Archipelago, megaliths were built starting from the Jōmon period, and in the Yayoi and Kofun periods. Various megalithic structures, the most famous of which are stone circles, were made in the Jōmon period. The most representative group among the megaliths of the later period consists of dolmens.

From the 3rd century BC to the 3rd century AD, radical changes took place in almost all cultural components on the islands of the Japanese Archipelago. These changes included the replacement of an appropriating economy by a producing economy, the emergence of new technologies, and the improvement of available technologies, as well as changes in the burial rituals and social structure. The earliest evidence of the construction of dolmens belongs to the final stage of the Final Jōmon period, while the flourishing of the construction of dolmens occurred in the early and first half of the Middle Yayoi period.

In the Japanese tradition, dolmens were associated with burial practices. Structures above the grave have been found in the Jōmon culture starting from the late period, and represent stonework with a central stone in the middle; stone boulders or slabs placed around the grave form a structure of rectangular, square, oval, or round shape.

The megalithic structures of the Yayoi period are represented by dolmens. Their main area is confined to the northwestern prefectures of Kyushu - Fukuoka, Nagasaki, and Saga. In the western part of Honshu, this tradition is represented by the Late Yayoi burial complex of Tatetsuki (Okayama Prefecture). In total, over 50 sites with dolmens are known as of now. This figure is approximate, since soil graves with stone lids are also included in the number of burials with dolmens (Sim Bong-geun, 1999: 174; Yayoi bunka…, 1991: 97–103).

The Kinryu group of dolmens (Saga Prefecture) is of particular interest. It is dated to the end of the Final Jōmon to first half of the Early Yayoi period. These dolmens are located on the territory of the later burial ground of Kuboizumi-Maruyama, which belongs to the Kofun culture (5th–6th centuries AD). Sixteen dolmens, one grave with a burial urn, two stone coffins in the shape of a box, eight burial mounds, and three stone tombs have been found there. The dolmens have five or six supporting stones; the length of the slabs reaches 3 m. In total, 118 burials of the Final Jōmon to the Early Yayoi period, and 12 burials of the Kofun period have been excavated at that site (Morita Takashi, 1997).

At the burial ground of Shinmachi (Fukuoka Prefecture), 57 soil graves have been discovered, including graves with dolmens on three or four supporting stones, and graves with burial urns (Yayoi bunka…, 1991: 99). The complex of Shito (Fukuoka Prefecture) can be considered a dolmen without supporting stones. The complex is represented by ten graves covered with stone slabs, and eight graves with burial urns. In some cases, the walls of soil graves with dolmens were strengthened by stone slabs (Shito shisekibo gun…, 1956: 5–8). The accompanying inventory included Early Yayoi pottery of the Yūsu style (flat-bottomed pots with a widened rim, jars with narrow necks, bowls on a stand), as well as cylindrical beads *kudatama*, and globular beads *kodama*, retouched arrowheads, and individual bronze objects (Yayoi bunka…, 1991: 97–103).

Burials in ceramic urns and earthen embankments gradually started to replace burials with dolmens. Megalithic structures of the middle and late Yayoi period are represented by the unique complexes of Sugu Okamoto (Fukuoka Prefecture) and Tatetsuki (Okayama Prefecture). The former includes graves with mounds, funeral urns, as well as traces of workshops for manufacturing bronze implements. At the burial ground, sector D is especially notable, containing a megalithic construction of two stone slabs over a ground grave with a burial urn (Fig. 3, *1*). One stone, 3.6 m long, 2 m wide, covers the grave pit, while the other stone is located vertically at the edge of the first stone; its height is 1.5 m and width is 1.2 m. The thickness of the slabs varies from 30 to 40 cm. Three hundred burials with inventory, including adornments, bronze swords, halberds, arrowheads, and mirrors, were found at the burial ground. The presence of such a rich inventory and a megalithic structure over the burial suggests that the woman whose remains were found in the urn was a representative of the elite, possibly a chief (Shizen…, 2013: 138–140).

A second unique complex belongs to the Final Yayoi period and is represented by the Tatetsuki burial mound. The mound consists of three parts located along the northeast-southwest line, and consists of a central part of round shape (43 m in diameter) and two lateral rectangular parts (up to 4.5 m high). Stonework can be seen along the entire outline of the burial mound. A structure of five vertically standing stones (up to 2 m high) around the

1 2

Fig. 3. Megalithic structures of the Yayoi period. The Japanese Archipelago.
1 – Sugu Okamoto complex (by: (Shizen…, 2013)); *2* – Tatetsuki complex (after: (Kondō Yoshirō, 2002)).

central burial was located on the surface of the burial mound (Fig. 3, *2*). A wooden burial chamber (3.5 × 1.5 m) with a wooden coffin (2 m long, 0.7 m wide) containing an iron sword, over 2000 glass beads, and clay *magatama*, was found inside the burial mound. It can be assumed that the grave belonged to a person with high status (Kondō Yoshirō, 2002: 10–15, 114–116).

Thus, speaking of the megalithic structures of the Yayoi culture, we primarily imply burials with dolmens. Despite the fact that during the Late-Final Jōmon period, stone structures were used in burial practices on the territory of Kyushu Island, the tradition of constructing dolmens goes back to the time when the population migrated from the Korean Peninsula.

Conclusions

Thus, the phenomenon of megaliths not so much consists of the size and shape of the structures, but of a specific relationship between the viewer and the object, of the symbolism of culture, and of the forms of cultural self-identification and differentiation.

While the chronology of the megaliths on the Korean Peninsula and the Yayoi dolmens on Kyushu Island generally fits the Metal Ages (not earlier than the third millennium BC), the chronology of the early megalithic tradition in the northern part of the Japanese Archipelago still remains an open question. Complexes with stone circles started to be created there already in the Middle Jōmon period, ca 4500 BP.

Notably, making a connection of megaliths with burials on the Korean Peninsula and the Japanese Archipelago is by no means mandatory, and in the cases when the megalithic structures were accompanied by burials, they belonged to the members of the tribal elite. It is also clear that megaliths are not an unequivocal mark of agricultural and cattle breeding societies both on the Korean Peninsula and in the Japanese Archipelago. Agriculture on the Korean Peninsula emerged in the Middle Neolithic, that is, in the pre-megalithic time (Choe Chong Pil, 2001: 49). The Jōmon tradition of constructing megaliths is in no way associated with agriculture. This phenomenon deserves a special study.

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Traditional Tailoring Technology as an Ethnographic Source (the Case of Eastern Slavic Clothing in Southern Siberia)

The techniques of manufacturing men's and women's shirts by late 19th to early 20th century Russian peasants in Southern Siberia are described in the context of ethno-confessional studies. The sewing together of various parts, types of seams, and general modeling are analyzed using the descriptive and graphic system adopted in tailoring technology with a view of assessing similarities and differences between Southern Siberian peasant clothing and that common in other Eastern Slavic groups. Traditional terms are listed and interpreted on the basis of field-studies in the 1970s–1990s, and the analysis of museum collections of traditional clothing. We describe shirts with rectangular inserts on the shoulders (polik shirts), including those where the inserts are connected with sleeves (non-polik shirts). The technique was based on using straight pieces of fabric. Technological analysis suggests that such shirts were sewn by a group of Russian Old-Believers, known as "Polyaki". The absence of parallels with another group of Old-Believers, known as "Semeyskie" and living in Trans-Baikal, suggests that the latter had begun to use store-bought fabrics and sew oblique sleeves comparatively early. The clothing worn by Old-Believers (who had migrated from the Dnieper-Desna interfluve), and by non-Old-Believers (migrants from Vetka near Gomel and the adjacent areas of Chernigov region) was generally similar.

Keywords: *Southern Siberia, Old-Believers, migrants, traditional clothing, tailoring technology.*

Introduction

Thus far, ethnological studies have paid insufficient attention to the development and advancement of methods for the research of the real objects of material culture, museum collections, and in particular traditional clothing. In the 1920s, in the period of intense studies of the material heritage of the USSR nations and their local varieties, ethnologists focused on the ways of wearing, styles, and terminology of the traditional clothing (Grinkova, 1927; Danilin, 1927; Zelenin, 1991). G.G. Gromov (1966: 63–76), in his textbook on the techniques of ethnological research, addressed the procedures and methods of field work, including identification of materials, motifs of decoration, and sewing-patterns. He did not focus on the techniques of clothing manufacture, such as seams or fabrication of separate units (collar, clasps, etc.), though he advocated making sketches of building techniques in descriptions of dwellings (Gromov, 1966: 59). G.S. Maslova, an eminent researcher of the Slavic traditional costume, proposed classifying the types of garment on the basis of their style, and for more exact classification, to consider fabric, manufacturing techniques, color, and decorative patterns (Lebedeva, Maslova, 1967: 193). Notably, such a criterion as tailoring technology was not well elaborated in Maslova's works. Analysis of the techniques of processing and sewing deerskin, as well as of types and names of seams, was first performed by Russian ethnologists during the study of the traditional clothing of peoples of Siberia; they also proposed a detailed program of ethnological research (Khomich, 1970: 104; Prytkova, 1970: 208).

Comparative-historical analysis of the traditional tailoring technology of the Eastern Slavic peoples in Siberia allows us to identify their cultural composition, to confirm or disprove hypotheses as to their possible origin, and to trace the migration-routes of the first settlers and those who moved to Siberia in the late 19th to early 20th century. Construction traditions—in particular, for types of sarafan (a women's full-body garment)—have been described by us in detail earlier (Fursova, 2015a). This paper addresses the uses of manufacturing techniques for certain types of clothing (shirts) by the peasants of Southern Siberia in the late 19th to early 20th century in the context of ethno-confessional studies. The analysis was based on the typology of stitches and seams, and on their methods of graphic representation, adopted in tailoring technology (Savostitsky, Melikov, Kulikova, 1971: 104–111: Kryuchkova, 2010: 22–39).

Traditional tailoring technology implies methods of modeling clothes using the two-dimensional cutting elements by manually connecting them together, and also methods of processing of clothing details, which methods were passed across the generations and could have been culturally specific (along with the style* and the construction**). Tailoring was a typical female occupation, and every girl learned sewing techniques, names of stitches, seams, etc. from her mother and grandmother.

In this paper, we describe only one type of traditional clothing that was sewn manually from home-made linen fabric. According to the ethnological data, such clothing was worn in Siberia in the 19th to early 20th century by various population groups: *Polyaki* ('Poles') Old-Believers, Bukhtarma Kerzhaks, and migrants from Ukraine, Belarus, and southern parts of Russia. Clothing from these groups, in its archaic form, has survived in the museum collections of Barnaul, Krasnoyarsk, Novosibirsk, Omsk, Tomsk, and St. Petersburg. Natives of Siberia, including the Chaldons, the migrants from the northern parts of Russia, and later also some groups of Old-Believers (e.g., *Dvoedans*), comparatively early began to use cheap Chinese and Russian fabrics and sewing machines, and to place orders at professional tailors. This paper focuses on the analysis of techniques for sewing the underwear (shirts) of the peasants who migrated to Southern Siberia from the Dnieper-Desna interfluve (Gomel, Chernigov, and Bryansk regions), the area which is also known in scientific literature as Pogranichye.

*The style pertains to the way the clothing is worn on a human body (either on the shoulders or on the waist).

**Clothing construction pertains to the cutting-details of which a 3-D model is created; construction is graphically represented in a sewing pattern.

Clothing "for the Kingdom to come"

The most significant information for our research has been obtained through the study of the hand-sewing techniques practiced by the Old-Believer groups. The oldest features of the Old-Believer culture display certain old and even rather ancient realia, because the Old-Believers used to live in isolation and followed old traditions. In the 1970s–1980s, we discovered the burial costumes of the Old-Believers* and the custom of preparing a special set** from home-made linen fabrics. Burial clothes were not sewn with the *vtachkyu****or back-stitch, like the clothes for living people, but with the *zhivulka* ('basting') or fore-stitch. When sewing with a *zhivulka* stitch, it was forbidden to make knots on the thread: elderly women believed that knots, as well as cross-seams, might serve as obstacles on the way of a person to Heaven. An explanation for such customs was given by D.K. Zelenin, a famous researcher of the late 19th to early 20th century, who has recorded a peasants' legend from the northern parts of Russia, that the deceased might have come back for the other family members: having seen his burial clothes sewn with non-*zhivulka* stitch, the deceased would allegedly like to take someone of the relatives with him (1991: 347). For that reason, the sharp end of the needle, which was used for sewing the burial clothes, should have been symbolically directed away from the sewer towards the deceased.

Another technique for sewing burial clothes was to joint the straight pieces of fabric butt-to-butt with a diagonal "over the edge" stitch (Fig. 1, *c*). However, our informants also mentioned the more detailed differentiation: burial clothes manufactured for future use were sewn "over the edge" (i.e. the edges of the fabric-pieces were attached butt-to-butt), but the seams on the clothes for the deceased were, surprisingly, made by *zhivulka* stitch. Different methods of burial-clothing manufacture apparently represented the distinction between the "good" deceased and the "bad" ones, who died suddenly or unnaturally (Ibid.: 352). So, clothing for "bad" deceased was distinguished by the special sewing technique. Notably, the ladder stitch is the most labor-consuming: in order to get with a needle into the edge of the joining pieces of fabric (one or two threads are

*The costume is clothing with headgear, shoes, and personal decorations.

**The set is special attire and necessary accessories intended for some purpose; the burial set includes towels, on-lays, birch broom, etc.

***The sewing terms were recorded by the author during field-works by the Eastern Slavic Ethnological Expedition (1981–1999) organized by the Institute of Archaeology and Ethnography of SB RAS (before 1990, the Institute of History, Philology and Philosophy of SB AS USSR).

grasped), an artisan needs special skill and proficiency. The basting stitch (Russian *zhivulka* (possibly derived from *zhivoy* ('living') or *zhivo* ('quickly')) is performed far more quickly, and can be applied for fast sewing of clothing for a suddenly deceased person. The *zhivulka*, "over the edge", and *vtachkyu* stitches were used for sewing from linen fabric not only burial shirts, but also sarafans, pants, shrouds, and shoes (Fig. 2). The majority of burial sets investigated by us were sewn with white threads matching the color of the costume; red threads were found only in the clothes of the *Polyaki* Old-Believers. According to archive materials, in the mid-19th century, in the Arzamassky Uyezd, Nizhny Novgorod Governorate, red threads occurred in the burial clothes of only young women (Yavorsky, (s.a.)). However, the traditional clothing of the *Polyaki* Old-Believers always stood out among the many modest and ascetic costumes of other Old-Believer groups in Siberia and Russia in general, owing to its bright colors and rich decoration.

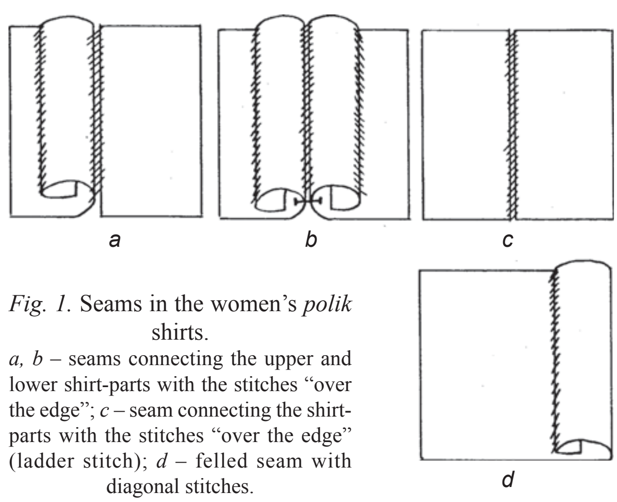


Fig. 1. Seams in the women's *polik* shirts.
a, b – seams connecting the upper and lower shirt-parts with the stitches "over the edge"; *c* – seam connecting the shirt-parts with the stitches "over the edge" (ladder stitch); *d* – felled seam with diagonal stitches.

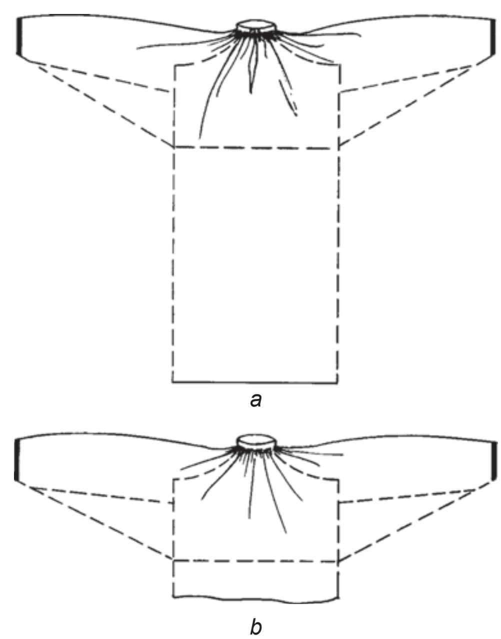


Fig. 2. Construction of the women's linen burial shirt. The village of Bystrukha, Vladimirskaya Volost, Byisky Uyezd. 1902. Division of the East-Kazakhstan Regional Museum of History and Local History, GIK–IX.
a – front view; *b* – back view.

Shirts of the *Polyaki* from the Altai of the middle–second half of the 1800s

Of special interest are women's *polik** shirts (most likely, wedding dresses) of the *Polyaki* Old-Believers, sewn manually approximately in the middle–second half of the 19th century (Fig. 3). These shirts are also known as the shirts with *kul* sleeves, which were sewn with their bottom parts folded like envelopes so that openings for hands were executed without shirring (Fig. 4). The unwillingness of Old-Believers to make shirrs on clothes (except for collars) is explained by their beliefs about the sinfulness of pleats (Field Materials of the Author (FMA), 1978–1979). Below, we will discuss the techniques of connecting pieces of fabric, fabrication of separate units (collar, placket, cuff, etc.) of shirts; their construction features were described by us earlier (Fursova, 2015a: 136). Technology of colorful embroidery will also be described. In the early 20th century, *Polyaki* women wore shirts with unusual sleeves together with gored sarafans resembling the same clothing of smallholder groups from the Chernozem region and the Kursk-Belgorod frontier region (Alferova, 2008: 33; Tolkacheva, 2012: 168).

The technology of manufacturing linen shirts always corresponded strictly to the quality and especially the width of the fabric (40–42 cm). We have found three *Polyaki* linen shirts in museum collections: one short shirt without the stitched lower part, and two shirts with the stitched lower part. According to informants, the upper part was called *chekhlik*, *kul*, and the lower part *stan*, *stanushka*. Each part of the shirt was turned down and hemmed with a felled seam. Then, the hemmed edges were attached together with small diagonal "over the edge" stitches (see Fig. 1, *a*, *b*). This method of attaching the two parts of a shirt together supports the hypothesis that such shirts originated from ancient unsewn types of outer- and underwear clothes (Moszynski, 1967: 446–448). The bottom hem of a shirt was hemmed by diagonal stitches with a felled seam (see Fig. 1, *d*).

In *Polyaki* shirts, the sleeves with *polik* inserts, extended with red strips, are attached together with open-

*Polik is a rectangular insert on shoulders.

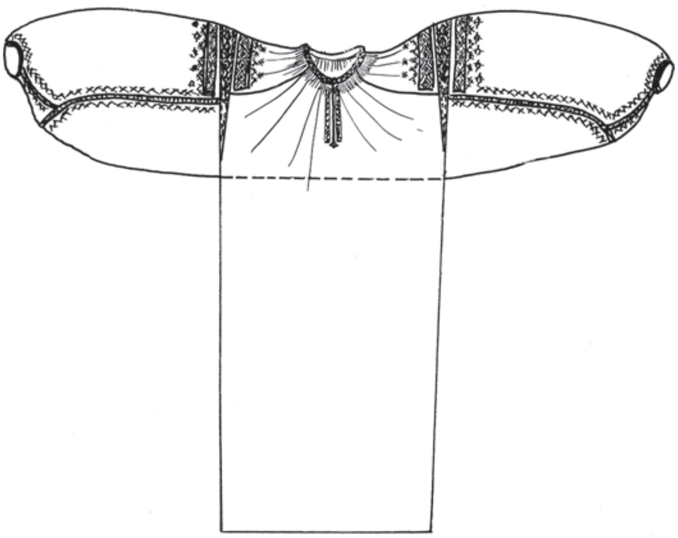
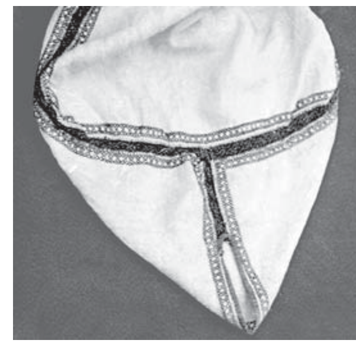


Fig. 3. Women's white linen shirt. The village of Bystrukha, Vladimirskaya Volost, Byisky Uyezd. OSMLH No. 2351.

Fig. 4. *Kul* sleeve. OSMLH No. 2351.



and closed-lap seams: the folded edge of one cloth piece is laid on the cut edge of another and stitched (Fig. 5, 6). Such stitches, executed in two or three lines, had both connecting and decorative functions. In the shirt from the "Novoselov's collection"*, which is currently deposited in the Omsk State Museum of Local History (OSMLH, No. 2351), the first and the third lines of stitches are executed with white threads, while the second line is blue and has the form of alternating trines of stitches (see Fig. 5). Connections of sleeves with the body-part look simpler than the above-mentioned: they are executed in two lines, where one of the seams is decorative (see Fig. 6). The side-pieces are attached with double seams, as in the similar shirt with *kul* sleeves, from the collection of the Altai State Regional Studies Museum (Fig. 7). The typologically later shirts were sewn by craftswomen from store-bought fabrics using lap seams executed with back-stitches and diagonal stitches (Fig. 8). Such seams were designated by elderly women from the village of Topolnoye, Soloneshinsky District, Altai Territory, as "blind" (FMA, 1988/14). Lap seams became popular in the first third of the 20th century, when *Polyaki* women began to replace linen homespun cloth by store-bought fabrics, which were wider than the shirt width. In this case, when cutting the fabric-piece, the edges were turned down so as to prevent the unweaving of threads.

The wide collar, formed by the front and back cloths, and by *polik* inserts, was gathered through several threads, resulting in small folds around the neck (shirt No. 2351 from OSMLH shows eight threads gathering the collar). The later *Polyaki* shirts sewn from store-bought fabrics had collars gathered through not more than three threads. Such execution of the neckline was made with *zhivulka* stitch. This technique distinguished the *Polyaki* women's shirts from those of the Bukhtarma and most of the Uimon Old-Believers, who shirred fabric at the collar with a *vtachkyu* stitch (FMA, 1978, 1981; Fig. 9, 10).

Another specific technique of tailoring the shirts under study was the connection of *polik* inserts with sleeves, as well as connection of sleeve-details with each other, using a lace *proshva* insert, which was crocheted or hand-knitted. Similar techniques have been noted in the traditions of the *Semeyskie* Old-Believers from Trans-Baikal region, which (like *Polyaki*) were deported to Siberia from Vetka near Gomel in the 18th century (Fig. 11). The sleeve-bottoms of linen shirts were edged with red strips or *pleteshki*-plaits attached by diagonal stitches (Fig. 12). The shirts made of store-bought or silk fabrics were also often decorated with plaits, but sleeve-bottoms were additionally edged with textile strips by the lap seams.

A collar represented a strip of textile, which was stitched from the wrong side with a felled seam using small invisible back-stitches, and from the right side it was turned down and stitched likewise (see Fig. 9). Such a method of attachment allowed the edges of fabric to be carefully concealed. The examined shirts from the Omsk and Altai local museums showed collars and plackets, which were stitched at the edges with a felled seam using red threads (Fig. 13). Such execution of collar-edges with red threads was aimed at strengthening the fabric (so that the detail maintained its shape) and at decoration. Apparently, this trend reflects the belief that harm to person's health can be inflicted through the openings in the clothing. It's no coincidence that our informants called this seam *zamok* ('lock'), and used it also for the attachment of

*Collection of clothes brought by A.E. Novoselov in 1912–1914 from his expedition to Zmeinogorsky Uyezd of the Altai Mountains region (Zakharova, Ivanova, 2002: 125) (Archive of the Russian Museum of Ethnography. F. 1, Inv. 2, No. 437, fol. 1).

sleeve-parts (see Fig. 7). Geometric patterns on the *polik* inserts, collar, and at the joints of sleeves with inserts were embroidered using the *verkhoshov*, *nabor*, and counted-thread embroidery techniques, which G.S. Maslova considered the most archaic in the Russian handicrafts (1978: 41, 42). An Old-Believer women's linen shirt with *kul* sleeves (Russkiy narodnyi kostyum…, 1984: 217), brought from the Narymsky Cossack settlement (of the former Semipalatinsk Governorate) to the Russian Museum of Ethnography, showed typological similarity to the *Polyaki* shirts (Fig. 14).

In terms of tailoring technology, the studied women's shirts obviously pertain to wedding clothing and are close to the *Polyaki* men's linen shirts, which are now kept in the "Novoselov's collection" of OSMLH. However, the latter, unlike the *polik* women's shirts, have a tunic-like design: the whole cloth is bent over the shoulders with a cut-out neck and two side cloth-inserts. Men's shirts have their structural seams additionally decorated with embroidered patterns and red strips. For instance, shirt No. 3134 from OSMLH demonstrates the following design: three pieces of the body-part, about 40 cm wide each, are sewn together with diagonal ladder stitch; upon these, red strips 4 cm wide are sewn, which are covered with meander pattern using chain stitch (Fig. 15). All other strips are also attached with lap seams, for example, at the joint places of sleeves with the side cloth-pieces. In a similar way, strips are sewn on the sleeve- and shirt-bottoms, and red gussets* are attached to the sleeves and the body-part of the shirt (Fig. 16). In the shirt under study, sleeve-details are sewn together with a lap seam, as in the similar men's shirt from the same collection (OSMLH, No. 3497). The

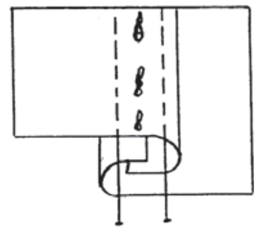


Fig. 5. Closed-lap seam.

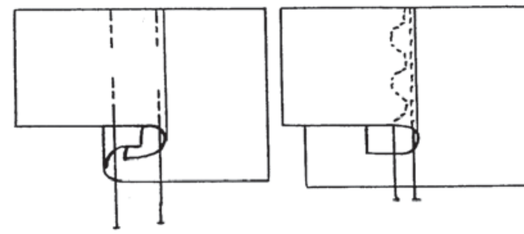


Fig. 6. Open- and closed-lap seam.

Fig. 7. Women's wedding shirt. Altai Mountains region, Tomsk Governorate. The second part of the 19th century (Istoki…, 2011: 47).

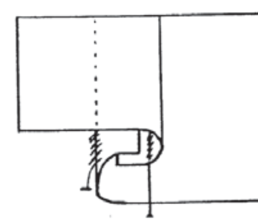


Fig. 8. Closed-lap seam.

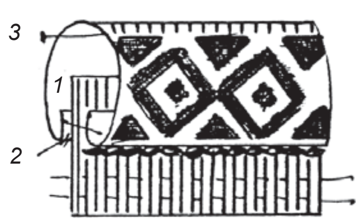


Fig. 9. Shirt's collar. The village of Sekisovka, Vladimirskaya Volost, Altai Mountains region. Late 19th century. FMA, 1978.

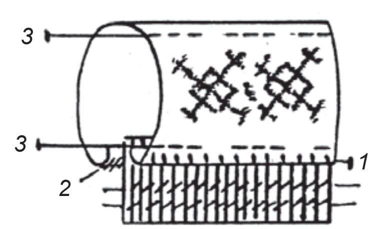


Fig. 10. Shirt's collar. The village of Belaya, Verkh-Bukhtarminskaya Volost, Altai Mountains region. Late 19th century. FMA, 1978.

Fig. 11. Semeyskie Old-Believers' shirts. The village of Bichura, Bichursky District, Republic of Buryatia, 1920s. FMA, 1977.

*A gusset is a rectangular insert in the underpart of the sleeve.

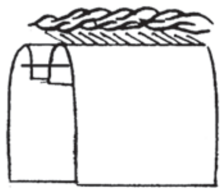


Fig. 12. Edging the sleeve-bottoms with *pleteshki*-plaits.

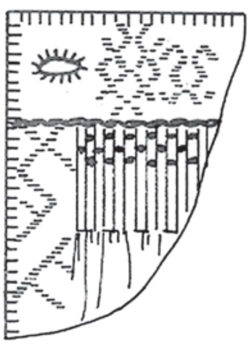


Fig. 13. Execution of a collar and a placket.

Fig. 14. Old-Believer women's shirt. Narymsky Cossack settlement (of the former Semipalatinsk Governorate). Middle 19th century. (Russkiy narodnyi kostyum…, 1984: 217).

Fig. 15. Wedding dress of an Old-Believer bridegroom. The village of Sekisovka, Zmeinogorsky Uyezd, Semipalatinsk Governorate, middle 19th–early 20th century. (Russkiy narodnyi kostyum…, 1984: 217).

placket in such shirt is usually located at the left; neckline and collar are edged with decorative *pleteshki*-plaits made of red linen threads. The plaits were also used for making buttonholes of conical shape (one buttonhole in each shirt); the buttonholes are also held by such plaits. These men's shirts, like women's shirts with the *kul* sleeves, are decorated with sophisticated embroidery using the *verkhoshov*, *nabor*, and counted-thread techniques. As has been already shown in our papers, according to their origin, these shirts of the Altaian *Polyaki* groups can be correlated with the clothing of migrants from Bryansk, Gomel, and Chernigov regions, descending from the culture of Ancient Rus (clergy clothes) and medieval Western Europe (clergy and noble clothes) (Fursova, 2015b: 162).

Shirts of Vetka migrants from the Gomel region of the late 19th century

Migrants from the Gomel region settled down in the village of Irbey, Irbeysky District, Krasnoyarsk Territory, in the late 19th century. They originated from the village of Neglyubka, near Vetka settlement, which was the common ancestral homeland of the *Polyaki* from Altai and the *Semeyskie* from Trans-Baikal. The collection of Krasnoyarsk Regional Museum of Local History contains non-*polik* shirts (wherein inserts are connected with sleeves) of the Gomel migrants (KMLH, No. 6861-1, 6861-15). The Irbey shirts tailored in the late 19th century differ from the above *Polyaki* shirts of their appearance: design, color, and location of the decorative patterns.

The upper part of shirt No. 6861-15 consists of two pieces of bleached linen; the lower part is made of three unbleached pieces 46–47 cm wide (Fig. 17). The hemmed edges are attached together with small diagonal "over the edge" stitches, like in *Polyaki* shirts (see Fig. 1, *b*, *d*). The sleeves are sewn of two straight pieces of fabric of unequal lengths in the manner different from that of *Polyaki* women's shirts, in which the corners of the long piece are folded in *kul*. Vetka women from the southern regions of Krasnoyark Territory positioned the long piece of fabric such that it started from the neckline, while the straight sleeve was shirred at the wrist. Such features as shirring at the sleeve-bottoms, stand-up collar, and type of decoration pattern make this clothing very similar to

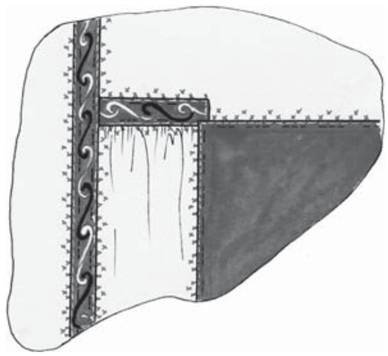


Fig. 16. Connection of a sleeve with a body-part and a gusset. Shirt of the middle 19th century. Novosibirsk State Museum of Local History and Nature, No. 9718.

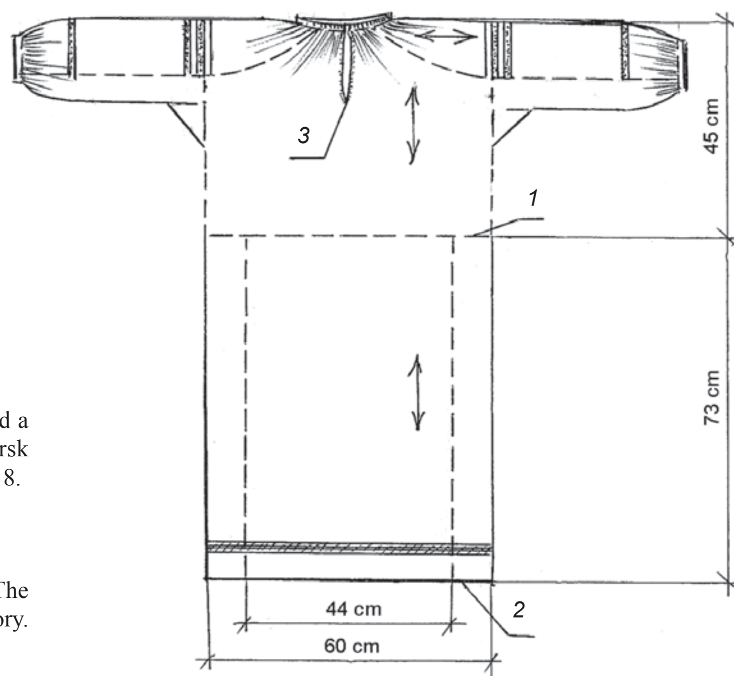


Fig. 17. Gomel migrant women's non-*polik* shirt. The village of Irbey, Irbeysky District, Krasnoyarsk Territory. KMLH, No. 6861-15.

the shirts of Gomel residents (Lobachevskaya, Zimina, 2013: 259). In the middle of the 20th century, the village of Neglyubka, Vetkovsky District, Gomel Region, was the only place in Belarus where such shirts (including *polik* ones) were still in use together with the open-fronted clothing, *poneva* skirt (Ibid.: 22).

The techniques of hand-sewing the Irbey (and Neglyubka) and *Polyaki* shirts are simple and efficient. The straight fabric-pieces are attached butt-to-butt, the hemmed edges of the upper (*stanushka*) and lower (*podstava*) parts are joined together with diagonal "over the edge" stitches. The Irbey and Neglyubka shirts, like the *Polyaki* ones, show collars and plackets executed with felled seams using red linen threads (Fig. 18). The same seam is used in sewing together the details of sleeves additionally decorated with the woven strip of red linen threads (Fig. 19). The pattern, in the form of geometric figures (rhomboids and squares with extended sides) decorating the shoulders, at the joints with the body-part of the shirt, is close to the original Neglyubka patterns but not identical to them (Ibid.: 265). The bottom hems of the Irbey shirts are decorated with woven bands of checker pattern made of red (6851-15) and white (6851-17) linen threads.

Shirts of migrants from the Chernigov region of the first quarter of the 20th century

During the field studies of the 1980s–1990s, we have recorded abundant women's linen shirts of the Ukraine migrants. Archives of Siberian museums and private collections contain mainly shirts with the body-parts made of one cloth (*dodilna* shirt), which makes them distinct from the shirts of the Russian and partly Belarusian Old-Believers. K. Moszynski (1967: 446–448) considered this type of clothing to be unrelated to the common two-part shirt, and made an assumption about the origin of the one-cloth shirts from the archaic overcoat (poncho). As is known, in the Middle Dnieper region, such shirts were worn together with homemade closed- and open-fronted clothing (*andarak* and *plakhta* skirts), which quickly fell out of use in Siberia (like Gomel *poneva* skirt) and survived only in some museum collections.

Migrants from the northern regions of Chernigov, adjacent to Vetka settlement, brought to Siberia the tradition of stitching the *polik* inserts of shirts along the weft. Subsequently, this tradition became very popular in tailoring the clothes of Siberian women of Ukrainian origin. One shirt, belonging to the descendant of Chernigov migrants, D.E. Lakizo*, shows a pattern on the shoulders, in the form of a "floral vine", embroidered with linen threads dyed red and black, and the same pattern is executed at the bottom hem, on the loose fabric (Fig. 20). The body-part of the shirt is sewn of three cloths 45 cm wide, and the sleeves are attached with diagonal "over the edge" stitches. Shoulder-inserts are attached to the sleeves and to the body-part with lap seams using back-stitches

*Darya Efimovna Lakizo, born in 1913 in the village of Pryamskoye of the Nikolaevskaya Volost, Barnaulsky Uyezd, Tomsk Governorate, was a citizen of the village of Penkovo, same district. Her parents migrated from the Chernigov Governorate. FMA, 1989.

Fig. 18. Shirt-collar. KMLH, No. 6861-15.

Fig. 19. Connection of sleeve-parts. KMLH, No. 6861-15.

Fig. 20. Connection of polik-insert, body-part with sleeve, and gusset. D.E. Lakizo's *polik* shirt. The village of Penkovo, Maslyaninsky District, Novosibirsk Region. FMA, 1989.

and diagonal stitches. Gussets under the arms are sewn in the same way. In this shirt, as in Irbey shirts, a special seam (here, a faggot seam) is used to mark the joints of inserts with sleeves and back-pieces on the back (Fig. 20). The sleeves are made of linen pieces shirred at the wrist and fixed with cuffs. Unlike the *Polyaki* shirts, the shirt under consideration has the neckline gathered on one thread and fixed with a narrow stand-up collar. The collar is a strip 1 cm wide; it is attached to the shirred neckline with a lap seam, and from the wrong side it is hemmed by tiny, nearly invisible diagonal stitches with a felled seam (Fig. 21). Additional back-stitching enforces the collar shape. Along the collar edge, scallops are made by embroidery stitches. The collar is fastened with one metal button and a linen loop buttonhole. The cuffs, without any clasps, are attached in the same way.

Fig. 21. Collar. D.E. Lakizo's *polik* shirt. The village of Penkovo, Maslyaninsky District, Novosibirsk Region. FMA, 1989.

Another shirt of Daria Lakizo's is composed of three linen pieces of the body-part attached butt-to-butt, with *sutselny* sleeves*, shirred at the cuffs (Fig. 22). The cloths of the sleeves are cut step-wise; the protruding parts serve as gussets; and into the formed benches, pieces of the body-part are inserted. This type of cutting of *sutselny* sleeves differs from that of the abovementioned shirts (where fabric-pieces of different lengths are used), but is identical to the style of the *Polyaki* burial shirts (see Fig. 2). Such shirts with one-piece sleeves, attached along the weft, were broadly used in the Middle Dnieper at the end of the 19th to early 20th century (Nikolaeva, 1988: 82–84).

In terms of tailoring technology, this shirt of Lakizo's is substantially the same as that described above. It also shows the joints of back pieces with the sleeves marked with faggot seams, and edges of the collar and cuffs executed with embroidery stitches. The shoulders are decorated with a weaved zigzag line and embroidery executed with red and black linen threads in cross and half-cross stitch technique (Fig. 23). According to Lakizo, she weaved, sewed, and embroidered all these clothes herself in 1927–1928.

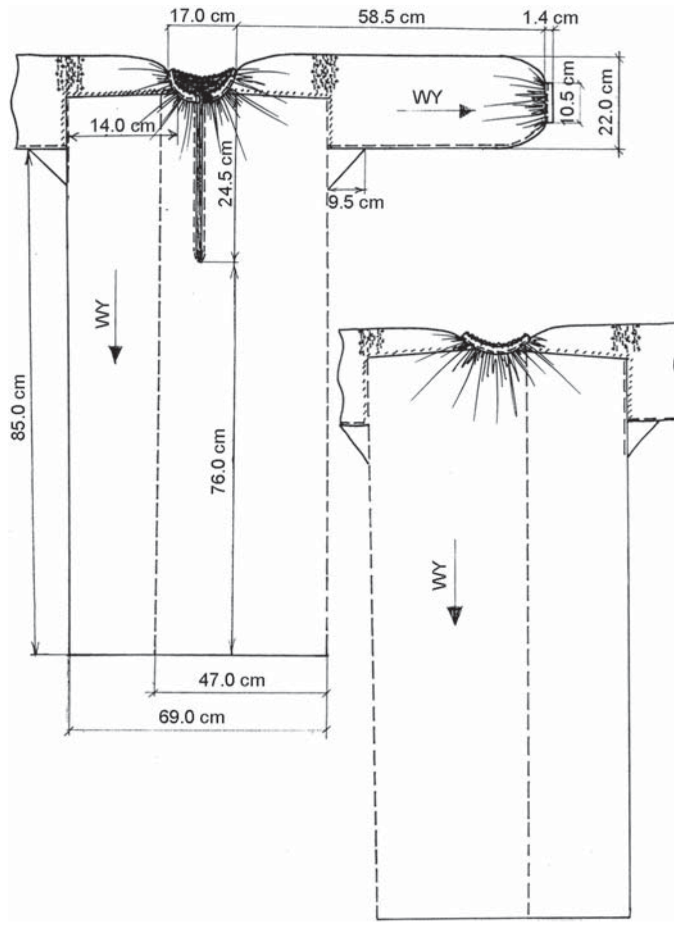


Fig. 22. Construction of D.E. Lakizo's shirt with one-piece sleeves. The village of Penkovo, Maslyaninsky District, Novosibirsk Region. FMA, 1989.

Fig. 23. Connection of sleeve with body-part. D.E. Lakizo's *polik* shirt. The village of Penkovo, Maslyaninsky District, Novosibirsk Region. FMA, 1989.

Conclusions: adherence to traditions

Analysis of the underwear shirt tailoring technology of the Old-Believers and non-Old-Believers who had migrated from the Dnieper-Desna interfluve allows some conclusions to be drawn. Apparently, the home-made ritual, burial, and wedding linen clothing of the *Polyaki* Old-Believers demonstrates the most ancient sewing techniques. This conservatism is explained not only by the predominance of manual labor, but also by the special attitude to clothing of the people who lived in the not-so-distant past. Historical materials provide evidence of the long persistence of many pre-Christian superstitions among the population of Russia, including the members of the royal family, up until the 17th century (Gromov, 1979: 205). The technology of tailoring the shirts under study reflects the old remnant ideas on the necessity to protect oneself from dangerous deceased who died unnaturally, and also to protect the body from evil forces, illnesses, and incantations. This was probably the reason for using the felled seam (loop-and-knot

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**Sutselny* sleeve is a sleeve cut as a single piece with a *polik*-insert.

stitch*), edging the collar and the sleeve bottoms with plaits, embroidery in the form of geometric pattern at the bottom hem, at the joint places of *polik*-inserts and sleeves with the body-part, and of sleeve-pieces with each other.

The process of *polik* shirt modeling, including non-*polik* shirts, required special technical skills. Types of seams and stitches were adapted to sewing straight pieces of fabric, where cloths were connected with minimal seam allowance (one or two threads) for the sake of fabric economy and aesthetics. The connecting seams (along with their main function) also served as symbolic and decorative elements.

In the clothes of the discussed groups of population of Altai, Krasnoyarsk, and the Novosibirsk region of the Ob, gored details in the sleeves of shirts made of store-bought fabrics began to be used considerably later than in the residents of the European part of Russia. This was accompanied by the spread of the so-called blind seams (lap seams with closed edges). For example, even in 1920s–1930s, in Siberia, there were no shirts with oblique sleeves, which were common in shirts of the population of Central Russia and its non-Slavic neighbors (Maslova, 1987: 268; Manninen, 1957: 107–111).

In the middle 19th to early 20th century, traditional shirts of Russian *Polyaki* Old-Believer women, as well as migrants from Gomel and Chernigov regions, were shirred at the neckline, and had wide sleeves made of straight fabric-pieces (such shirts, so-called Renaissance shirts, are known among European peoples) (Gaborjan, 1988: 31). However, in the ethnographic materials, no *Polyaki* women's shirts with *kul* sleeves have been found that would be identical to such Renaissance shirts in terms of design and ornamentation. Analysis of the clothes kept in a number of capital and local museums, which sometimes don't have the required documentation, allows a conclusion to be drawn about a single tailoring technology for men's and women's shirts, and hence, about the belonging of their owners to the single group of Russian Old-Believers known as *Polyaki*.

At the same time, the techniques of manufacturing women's underwear in the studied Old-Believer and non-Old-Believer groups of Southern Siberia, which migrated from contiguous territories of Bryansk, Gomel, and Chernigov regions (Pogranichye), have shown many features in common. Moreover, all sewn clothes of these migrants demonstrate features typical of industrial production rather than of hand-made articles, which attests to the high tailoring skills of the artisans, and supports the assumption of some ethnologists on the common Slavic origin of *polik* shirts (Lebedeva, Maslova, 1967: 218). For instance, shirts of the *Polyaki* women and the Vetka migrants living in the Krasnoyarsk region demonstrate distinct design and sleeve construction, but show common tailoring features: butt joint of pieces of the body-part, hemming of the bottom with a felled seam, etc. Most indicative is the common method of connecting the upper and lower parts in *polik* and non-*polik* shirts (attachment of folded edges with diagonal stitches), which allowed repeated replacement of the lower part. This tailoring technology was less popular among the Ukrainian migrants; the bodies of their shirts were made mostly of one piece of fabric. The techniques of hemming the sleeve-bottoms (other than cuffs) in the shirts of Belarusian/Ukrainian migrants and of *Polyaki* women were different, owing to the difference in the sleeves' design. Similar technology (connection of sleeve-parts with knitted lace strips) was used by *Semeyskie* Old-Believer group in Trans-Baikal, which are related to *Polyaki*. However, *Polyaki* and *Semeyskie* underwear clothes do not show many common features, because the Trans-Baikal Old-Believers began comparatively early to use store-bought fabrics and to cut oblique sleeve details, which required special tailoring techniques. *Polyaki* women, while showing similarity to Belarusian/Ukrainian migrants in many sewing techniques and execution of collar through gathering, still differed from them and from their Altaian neighbors (Bukhtarma and most part of the Uimon Old-Believers), who shirred fabric at the collar with a *vtachkyu* stitch.

The analysis of the underwear of the population who migrated to Southern Siberia in the 18th–early 20th centuries from the Pogranichye region, where three branches of the Eastern Slavs met, intermixed, and separated (Russians, Ukrainians, and Belarusians), gives grounds for the interpretation of the further development of their culture and ethnographic transformations.

*Its protective function is indirectly supported by the available information that incantations were often composed while making the knot stitch (Ibid.).

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Robusticity of Hand Phalanges: Relevance to the Origin of the Altai Neanderthals

The cross-sectional geometry of middle phalanges of hand digits 2–4 in five European and Asian Neanderthals (La Ferrassie 1, Kiik-Koba 1, Okladnikov 2 and 5, and Chagyrskaya 16-3-12) and five Cro-Magnons (Kostenki 14, Telmanovskaya TII 175 and TII 173, Sungir 1, and Abri Pataud 26227) was assessed by means of microtomography. Both taxons reveal a wide range of individual variability in their indices of inner robusticity. Both the most robust and the most gracile variants in Neanderthals were recorded in the Altai (Okladnikov and Chagyrskaya caves, respectively), which confirms previous observations about the high morphological diversity among Neanderthals in that area, and the presence of at least two morphological variants among them. In European Upper Paleolithic Homo sapiens, inner phalangeal robusticity is generally higher than in Neanderthals, attaining medullary stenosis in the Kostenki 14 male. Neither sex nor age nor even mechanical stress appear to have affected robusticity. Hyper-robust variants were recognized in both Cro-Magnons and Neanderthals of supposedly hybrid origin. Genetic studies suggest that Kostenki 14 belonged to an ancestral European metapopulation that had absorbed some Neanderthal admixture. The ancestors of the Altai Neanderthals, on the other hand, included not only Denisovans but also early anatomically modern humans before their migration to Siberia. Extreme phalangeal robusticity in Middle and Upper Paleolithic Eurasians, then, might be a legacy of early anatomically modern humans.

Keywords: *Microtomography, hand phalanges, inner robusticity, tubular bones, biological age, sex, physical stress, Neanderthals, European Upper Paleolithic Homo sapiens.*

Introduction

The diaphyseal structure of tubular bones of ancient and modern humans is usually considered in terms of their activity patterns. The biomechanical analysis of human remains, which is based on “engineering” approaches to assessing the level of robustness of skeletal elements, has been the most popular in recent decades (Ruff, 2000a: 71). The shape of bone is determined by many different factors. In early ontogeny, genes play the main role, while non-genetic factors can act generally or locally as well. The systemic change in skeletal robusticity can occur as a result of hormonal regulation, malnutrition, or pathology. Local hypertrophies reflect more limited and specific influences on the bone tissue, and can in some cases be used for the reconstruction of behavioral patterns.

The results of the research on the temporal dynamic of the inner robusticity of the greater tubular bones became the basis for the conception of the leading role of mechanical influences during bone morphogenesis (Ruff et al., 1993). According to the latter, the inner robusticity of the humerus and femur has been steadily decreasing from the Early Pleistocene to modern times. In terms of inner skeletal robusticity, the Paleolithic anatomically modern humans are closer to archaic humans than to modern populations. But *H. erectus* display the most distinctive pattern: their diaphyseal robusticity is a result of both narrowing of the medullary cavity and an extension of the periosteal layer. This concept explains the temporal trends in corticalization of the greater tubular bones by the gradual decrease of the mechanical stress experienced by the postcranial skeleton. The authors of the concept noted that the trends were parallel to the progress of encephalization and cultural shifts, but emphasized the lack of direct link between cognitive abilities and the corticalization of the skeleton.

Archaeological, paleogenetic, and anthropological researches of the recent years have led to numerous discoveries of new groups of Paleolithic humans, such as Denisovans, Altai Neanderthals, "hobbits" from Flores Island, and *Homo naledi*. The remains of some of these species are rather fragmentary, e.g. represented by isolated finger-phalanges. Comprehensive description and comparative analysis of these remains with the use of modern research techniques remains an important task.

The morphology of the lesser tubular bones (medial phalanges) of the hands of the Middle and Upper Paleolithic specimens from Europe and Asia has been the focus of the present study. Choosing such an object for our research, we assume that those phalanges display a significant correlation with long bones and, consequently, can be used as a "model" of the whole skeleton. This is particularly important when studying isolated and unique finds of fossil humans. Notably, the robustness of the bones of the upper limb, as compared to the lower limb, is less dependent on the total body-mass (Ruff, 2000b: 285). On the other hand, we can expect the bones of the hands of ancient humans, producing and repeatedly using stone tools, to display the most prominent structural changes due to the working hypertrophy of bone.

We set out to study variation of the inner robusticity of the medial phalanges of the hands of Neanderthals and Cro-Magnons, and to discuss possible factors shaping this variation.

Materials and methods

The bones of the 2nd and 4th digits of the hand composed the bulk of the sample for our comparative analysis. The sample included specimens belonging to various taxa of genus *Homo*: the Neanderthals of Europe and Asia, and the Early and Late Paleolithic *H. sapiens* (Table 1). Notably, not all of the individuals studied were living in periglacial conditions: the climate of the low-elevation zone of the Altai was milder than in Europe, and there were no glaciers there (Prirodnaya sreda…, 2003).

This study is based mostly on observations of the authors. The European Neanderthals are represented by the specimens from the Musée de l'Homme in Paris and the Museum of Anthropology and Ethnography (Kunstkamera) RAS in St. Petersburg. The remains of an adult male La Ferrassie 1 were found in Dordogne in 1909 (Capitan, Peyrony, 1912). The remains of an adult Neanderthal from Kiik-Koba 1, found in the Crimea in 1925, were identified and comprehensively described by the head of excavations (Bonch-Osmolovsky, 1941).

The Altai Neanderthals are represented by the skeletal remains from Okladnikov and Chagyrskaya caves.

Table 1. **Sample**

No. of specimen	Specimen	Taxon	Hand medial phalanx	Sex	Age, years
1	La Ferrassie 1	European Neanderthal	4th digit, right	Male	40–55
2	Kiik-Koba 1	"	2nd digit, right	"	40–49
3	Okladnikov 2	Altai Neanderthal	4th digit, left	"	30–39
4	Okladnikov 5	"	2nd digit, right	Female	25–39
5	Chagyrskaya Cave 16-3-12	"	"	"	25–39
6	Kostenki 14	Upper Paleolithic *H. sapiens*	4th digit, right	Male	25–29
7	Kostenki 8 TII 175	"	3rd digit (?)	"	25–39
8	Kostenki 8 TII 173	"	4th digit, right	"	25–39
9	Sungir 1	"	2nd digit, right	"	35–45
10	Abri Pataud 26227	"	"	Female	20–29

Archaeological findings provide the strongest evidence of a " Mousteroid" pattern of the stone tool industries of these cave sites, which were named "Sibiryachikha facies of the Altai Middle Paleolithic" (Derevianko, 2011; Derevianko, Markin, Shunkov, 2013; Derevianko, Shunkov, Markin, 2014). From the anthropological specimens from Okladnikov Cave, mtDNA of Neanderthal type was extracted (Krause et al., 2007). A morphological examination of the specimens has confirmed their Neanderthal affinity (Viola, 2009; Mednikova, 2011a; Mednikova, 2011b, c). The fragments of the mandible (Viola et al., 2012) and the ulna (Mednikova, 2013a) from Chagyrskaya Cave also display Neanderthal anatomical features.

Okladnikov 2. A medial phalanx of the 3rd or 4th digit of the left (?) hand was found in the sq. Г-4 of the layer 4 at Okladnikov Cave in 1984. It is relatively short and broad, and hence fits well into the range of Neanderthals' morphological variation (Mednikova, 2011b: 55). If it is a phalanx of the 3rd digit, then, according to the lengths and breadths of its proximal and distal epiphyses, it must have been male. But the breadth and height of its shaft put it closer to Neanderthal females. If it is a phalanx of the 4th digit, then it is even more probably male, since it is larger than phalanges of Shanidar males (Ibid.: 71).

Okladnikov 5. A medial phalanx from layer 3–1. Identified as a female right phalanx of the 2nd digit (Ibid.: 67–68). Like Okladnikov 2, it displays a flattened head and a relatively thick shaft (Ibid.: 70–71).

*Chagyrskaya 16-3-12***.** A medial phalanx, found at Chagyrskaya Cave in 2012, also exhibits some "archaic" features (Mednikova, Potrakhov, Bessonov, 2012). It was determined by the authors to be a female right phalanx of the second digit.

The Upper Paleolithic *H. sapiens* are represented in this study by one of the earliest anatomically modern individuals in Europe from the site of Kostenki 14 (Markina Gora) (Marom et al., 2012; Nalawade-Chavan, McCullagh, Hedges, 2014). The remains from the nearby site of Kostenki 8 (Telmanovskaya site) are far less famous. They were found by an expedition of the Leningrad branch of the Institute of Archaeology of the Academy of Science of the USSR, led by A.K. Rogachev, presumably in 1959. The larger specimen (TII 175), with destruction in its proximal portion, was identified as a medial phalanx of the 3rd (?) digit of the hand. The medial phalanx TII 173 is completely preserved, and belonged to the 4th digit of the right hand (Mednikova, Moiseev, Khartanovich, 2016). The remains of another early Eastern European *H. sapiens* (the male from Sungir 1) has been for decades the focus of research. The main features of the morphology of his hand have been discussed recently (Mednikova, 2012; Trinkaus et al., 2014). The medial phalanx from Abri Pataud (Musée de l'Homme, No. 26227) represents the morphology typical of later Western-European *H. sapiens* of the Proto-Magdalenian time.

The medial phalanges of all the individuals listed above were subjected to microtomography in order to study non-destructively the internal structure of the specimens. The La Ferrassie 1, 2, and Abri Pataud specimens were studied using the equipment of the Musée de l'Homme. All other fossils were scanned using the Xradia Versa XRM-500 X-ray 3D microscope at the laboratory of LLC "Systems for Microscopy and Analysis" (Moscow). The same scanner was previously used for studying the phalanx of the girl from Denisova Cave (Mednikova et al., 2013).

Virtual cross-sections at the middle of diaphysis have been compared in our study. We employed a number of variables conventionally used for description of the cross-sectional geometry of objects (the formula for the ellipse): area of the cortical layer (CA)—a measure of the resistance of a tubular bone to compression and tension; total area of the section (TA)—characterizes the external robusticity of the diaphysis of a phalanx; section area of medullary cavity (MA); and index of corticalization (% CA)—describes the inner robusticity of the diaphysis, i.e. relative thickness of the cortical layer. The polar moment of inertia (J) characterizes the resistance of the bone to compression and torsion. But the use of the latter variable for the reconstruction of biomechanical loadings in humans has been criticized (Lieberman et al., 2004), so we use it cautiously. Also, the polar moment of inertia and the length of the diaphysis (length of tubular bone) are correlated more strongly than are the length and area of the cortical layer (Ruff, 2000b: 284). In our opinion, the index of the relative development of the cortex of medial phalanges is the most informative variable. In order to reduce the influence of the total size of the tubular bones on our results, we will discuss variation of the index of relative development of the cortex in more detail.

Results

We examined 10 phalanges in total, among which there were male and female, large and small, robust and gracile specimens. The longest and thickest phalanges belonged to the Neanderthals La Ferrassie 1, Okladnikov 2, and *H. sapiens* TII 173, while the shortest and narrowest belonged to the Kostenki 14 and Abri Pataud 26227 individuals (Fig. 1).

The differences in general cross-sectional geometry between the specimens are already apparent during a visual examination of the microCT images (Fig. 2). In the vast majority of cases, the shape of the cross-section is elongated (sub-oval). The phalanges of La Ferrassie 1, Okladnikov 2 and 5 (Neanderthals), and (to a lesser extent)

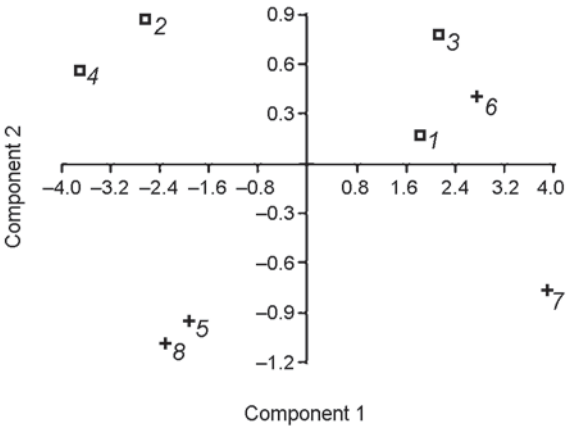

Fig. 1. Principal component analysis of the medial phalanx measurements. Variables: articular length, midshaft height, midshaft width, midshaft circumference.
1 – La Ferrassie 1; *2* – Kiik-Koba 1; *3* – Okladnikov 2; *4* – Chagyrskaya 16-3-12; *5* – Kostenki 14; *6* – Kostenki 8 (TII 173); *7* – Sungir 1; *8* – Abri Pataud 26227.

from Telmanovskaya and Sungir (Upper Paleolithic *H. sapiens*) are the most oval in cross-section. It can be explained by the fact that the palmar ridges are not clearly developed at the level of the middle of diaphysis in all individuals: these external structures are best defined in La Ferrassie 1 and Kostenki 14 (both males), but far less prominent in Kiik-Koba 1, Chagyrskaya, Kostenki 8, and Sungir individuals.

On the basis of the total area of the section (TA), the males from La Ferrassie rock shelter (France) and Okladnikov Cave (Altai) display the most robust diaphyses. Among the Upper Paleolithic *H. sapiens*, TA decreases in the row from Kostenki 8 (both phalanges), Sungir, Kostenki 14, and Abri Pataud.

Abri Pataud 26227, Kostenki 14, and Okladnikov 5 are the individuals with the narrowest diaphyses. The first and third specimens are female from different taxa, the second (according to genetic data) is male.

The index of corticalization displays a notably wide range of inter-individual variation, which is typical of both Neanderthals and *H. sapiens* (Fig. 3, Table 2).

The % CA is less variable among the European and Siberian Neanderthals as compared to the individuals of the same species from the Altai, from Okladnikov and Chagyrskaya caves. The range of variation of the % CA among the Neanderthals is delimited by these two female individuals: Okladnikov is hyper-robust, while Chagyrskaya is hyper-gracile.

The % CA is quite variable among the European Upper Paleolithic *H. sapiens* as well, though the difference between the most thick-walled phalanx of Kostenki 14 and the most thin-walled phalanx of Sungir 1 is less, as compared to the same difference among the Neanderthals.

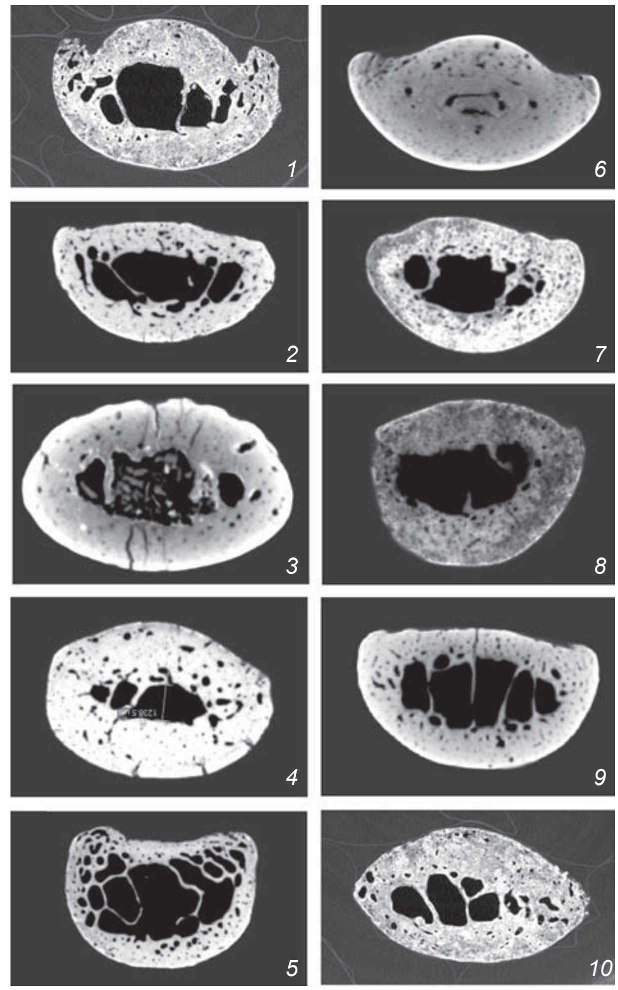

Fig. 2. Cross-sections of the medial hand-phalanges at the level of the middle of the diaphysis in Neanderthals (*1–5*) and European anatomically modern humans (*6–10*). The palmar surface is on the top. Numeration of the specimens is the same as in Table 1.

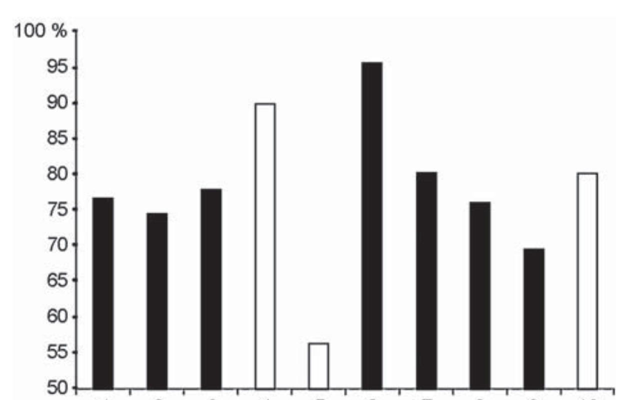

Fig. 3. Distribution of the index of corticalization (% CA) of the medial phalanges according to sex. Numeration of the specimens is the same as in Table 1. Black – males, white – females.

Table 2. **Comparative description of inner robusticity of the hand medial phalanges at the level of the middle of the diaphysis in fossil *Homo* of different taxa**

No. of specimen	CA	TA	MA	% CA	J
1	41.48	54.17	12.69	76.57	507.52
2	28.96	38.93	9.97	74.39	255.19
3	35.36	45.41	10.05	77.88	330.65
4	33.88	37.7	3.82	89.87	231.58
5	22.92	40.70	17.78	56.32	231.71
6	34.33	35.93	1.61	95.6	2.47
7	38.17	47.62	9.45	80.15	373.22
8	34.53	45.45	10.92	75.97	333.52
9	26.37	37.89	11.52	69.61	230.82
10	26.47	33.02	6.55	80.17	168.46

Contrary to our expectations, the inner robusticity of the medial phalanges among the Upper Paleolithic *H. sapiens* was in general higher than in most Neanderthals. Also, the most thin-walled diaphysis was observed in the Neanderthal from Chagyrskaya.

Judging from these observations, we can make a preliminary conclusion: such factors as sex, taxon, and biological age do not affect the inner robusticity of the small tubular bones of fossil humans. This makes us consider the results and possible interpretations in more detail.

Discussion

Inner robusticity of small tubular bones as a function of biological age. The thickness of the walls of tubular bones depends on biological age, i.e. status of an individual. During ontogeny, the thickness of the walls is initially increasing, but then, after a stable period of maturity, post-definitive changes occur. These include gradual loss of bone, and thinning of the cortex, and finally lead to osteoporosis.

Importantly, owing to good preservation of the remains of the La Ferrassie 1 and Kiik-Koba 1 Neanderthals and the Sungir 1 and Abri Pataud *H. sapiens*, their ages are reliably confirmed by other skeletal elements. The La Ferrassie 1 "classical" Neanderthal is the oldest among the fossils studied. He exhibits numerous degenerative changes in various parts of the skeleton, and sutural obliteration. His biological age was estimated at 40–55 years (Fennell, Trinkaus, 1997: 987). But the microCT of his medial phalanx has not shown the bone resorption typically associated with osteoporosis—neither in dorsal, nor in ventral walls of diaphysis, which are fairly robust. The zones of intense bone-remodeling, visible on virtual cross-section of the phalanx, join the palmar ridges, and probably have a functional etiology, reflecting the development of the digital flexors (see Fig. 2, *1*).

The Sungir 1 male is the oldest among the *H. sapiens*, though he is younger than the La Ferrassie 1 Neanderthal. According to an initial assessment made by G.F. Debets (1967: 160), the degree of obliteration of the cranial sutures of Sungir 1 correspond to an age of 55–65 years. V.V. Bunak (1973: 3) determined the age of this individual as "late maturity". Analysis of various trait systems has shown that senile degenerative change can be excluded (Buzhilova, Kozlovskaya, Mednikova, 2000: 56). Another recent thorough examination of various age-markers suggests that the Sungir 1 male died between the ages of 35 and 45 years (Trinkaus et al., 2014: 76). This estimation was completely confirmed by a histological study of his bone tissue (Dobrovolskaya, Mednikova, 2015).

Summing up, even the oldest individuals in our sample do not exhibit signs of severe osteoporosis or, otherwise, maximal functional hypertrophy. Thus, the factor of biological age does not influence the degree of robusticity of the phalanges studied.

The role of physical exercise. In 1892, the German anatomist Julius Wolff hypothesized that the shape of a bone was a result of the displacement of bone-elements in the direction of functional tension, which can lead to either increase or decrease in bone-mass (Wolff, 1892). But the possibility of using "Wolff's law" for assessing the level of physical activity has been debated. Taking into account that the process of gain/loss of bone mass is also affected by age, disease, hormonal status, and heredity (Ruff, Holt, Trinkaus, 2006: 485), the term "functional adaptation of bone" is more in use today.

The presence of the marginal ridges on the palmar surface of the hand phalanges is considered undeniable evidence of a great development of flexor muscles of the digits. Our results show that this trait varied among the Upper and Middle Paleolithic individuals. It can be reasonably supposed that the ridges become more prominent with age. Indeed, La Ferrassie 1 shows a strong hypertrophy of the ridges at the level of the middle of diaphysis. The young male from Kostenki 14 exhibits a very similar pattern. Considering this fact in terms of biomechanics, one should come to the conclusion that the Kostenki 14 individual was more hard-working than the Sungir one, as the bone tissue of the latter has not developed such "working hypertrophy" as a response to long years of physical exercise. This conclusion undoubtedly sounds paradoxical. However, such a formal approach seems to be erroneous, as it does not take into account individual variation in the development of the attachment-sites of digital flexors. For instance, the Kiik-Koba Neanderthal had palmar ridges, and fairly developed ones, but they are found proximal to the midshaft.

There is no doubt that the use and making of stone tools has had an outstanding biomechanical influence on the hand of Paleolithic man. Among numerous studies on this topic published in the last 150 years, the most remarkable are the recent works describing the suite of morphological traits favoring the most effective manufacture and use of scrapers and choppers (Marzke, 2013: 3). M. Marzke's question is whether the human hand has, during its evolution, become adapted to the manufacture and use of stone tools. Today, there is a consensus among specialists that the adaptation to the use of tools cannot be considered as the only factor of natural selection driving the evolution of the humans' hands. Different features of the human hand have evolved in different periods, and might reflect the foraging strategy of survival of the early humans. However, it is obvious that the hands of our ancestors have experienced a lengthy and strong influence from toolmaking.

Some modern experiments show the results of stone toolmaking. For example, a study of the activity of the 17 muscles, moving the hand and digits, during the use of Oldowan tools has shown that in early *Homo* the 1st and 5th digits experienced the maximal loadings (Marzke et al., 1998).

Exploitation of most Paleolithic tools implied two techniques of holding (Marzke, Shackley, 1986). In the first, holding the tool with the palm was accompanied by movements of the digits. In the second, the tool was strongly held with the thumb and the tips of the 2nd and 3rd digits. The robusticity, typical of the Neanderthal's hand, was a result of the power control of a certain position of the digits, as well as of a permanent manipulation of tools. The hypertrophy of transverse dimensions of the phalanges, particularly distal ones, in Neanderthals indicates that they were probably more capable of a power transverse grip of the tool than were *H. sapiens* (Churchill, 2001; Niewoehner et al., 2003).

Even if all cultural and technological differences between the Middle and Upper Paleolithic populations are taken into account, it can be concluded that any physical loadings inevitably led to working hypertrophy of small tubular bones of hands. Some Upper Paleolithic individuals (e.g. Sungir 1), while belonging to *H. sapiens*, had certain "Neanderthaloid" features: widening of the ungual phalanges, robust ridges on the palmar surface of the proximal phalanx. These features point towards an intense biomechanical loading experienced by the right hand (Mednikova, 2012).

Another factor in the hand's morphogenesis was the landscape typical of the areas inhabited by many populations of *Homo* in the Middle and Upper Paleolithic: these populations were usually living in mountainous or hilly terrains. Experimental data on rock-climbing might be important for understanding the skeletal features associated with the physical activity of humans. Modern qualified sport-climbers display a number of structural changes in their hands and certain digits (Sylvester, Christensen, Kramer, 2006). According to that study, climbing exerts an intense and lengthy mechanical influence on the hand's bones. Specifically, a remodeling leading to a thickening of the cortex occurs in the metacarpals and phalanges. Compared to the control group, the climbers show an increased cross-sectional area and secondary moment of the area. They display a larger total width of the hand-bones, which is due to additional subperiosteal deposits but not to a widening of the medullary cavity. The robustness of the hand-bones is associated with modern styles of climbing and so-called "scrambling on large boulders". These styles require maximal athletic training, which, in turn, leads to the strongest change in the hand.

The Neanderthals studied were living in mountainous conditions (cliffs of Dordogne, Crimea, Altai) and could have experienced the physical loadings described above. But the anatomically modern humans from Kostenki and Sungir were surrounded by the landscape of the East European Plain, which requires climbing skills much more rarely.

As can be seen, the hypothesis as to exclusively biomechanical influence on the inner robusticity of the hand phalanges cannot fully explain our observations.

Robusticity of the hand-bones of the Middle and Upper Paleolithic humans in the light of their origins. Thanks to the emergence of paleogenetics, we now know much more about the time of divergence of human clades, and about their genetic relationships. In our sample, three groups of the Middle and Upper Paleolithic humans are represented: "classical" European Neanderthals, Altai Neanderthals, and anatomically modern *H. sapiens* (AMH).

Let us consider the results of the present study in terms of the origins of these groups.

The "classical" Neanderthal from La Ferrassie 1 (as well as, probably, the Kiik-Koba 1 Neanderthal) represents the Eurasian human population of the time before contact with the AMH.

The Altai Neanderthals are a genetically separate group: Southern Siberia is part of the contact zone between Denisovans and Neanderthals. The results of a high-coverage sequence of genomes of humans from the Denisova Cave clearly document the genetic contacts between the two species (Krause et al., 2010; Prüfer et al., 2014).

There are remains from three Altai caves that were genetically assigned to Neanderthals. An overview of existing data on the postcranial remains of Altai Neanderthals shows a high level of inter-individual variability in this group of fossil humans and some trends of this variability (Mednikova, 2014, 2015). A proximal toe-phalanx and a distal finger-phalanx from Denisova Cave (Mednikova, 2011c, 2013b), as well as tubular bones of various individuals from Okladnikov Cave display a thickness of the walls that is exceptional even for Neanderthals. But the postcranial remains from Chagyrskaya Cave belonged to more "typical" Neanderthals (see, e.g., (Mednikova, 2013a)) and did not exhibit extraordinary inner robusticity.

The results of the present examination of the medial hand-phalanges fully confirm the previous conclusions regarding differentiation of the Southern Siberian Neanderthals into at least two morphological variants. It has been hypothesized that these variants might be related to different waves of migration of *H. neanderthalensis* to the Altai. On the other hand, it might be a result of genetic contact by the Neanderthals with humans of different taxa: for example, Denisovans (Mednikova, 2015). Taking into account the close proximity of the said caves, genetic contact between their inhabitants cannot be excluded either. In any case, the wide range of morphological variation is a phenotypic reflection of the complicated population history of the Altai Neanderthals.

The term "Altai Neanderthals" emerged during study of the complete genome of a female from Denisova Cave (Prüfer et al., 2014). We know that this individual belonged to the "hyper-robust" variant of the medullary cavity morphology (Mednikova, 2011c). It would be logical to assume that the thickening of the walls of tubular bones in that population was due not only to biomechanical loading, but also to the influence of hereditary factors: for example, admixture with relict Denisovans. However, the results of this study demonstrate that some European AMH were also characterized by thicker walls of small tubular bones, as compared to the "classical" Neanderthals and to the Chagyrskaya humans. This observation is based mostly on the morphology of the Upper Paleolithic specimens from the sites in the Middle Don basin—among which the Kostenki 14 male is the most interesting, since his phalanges are particularly robust. The skeleton of this individual is very well preserved; for instance, the bones of both hands were present in full. A study of the skeleton has led to the conclusion that it was more robust as compared to modern Eurasian population (Mednikova, Moiseev, Khartanovich, 2016). A radiological examination has shown the presence of numerous medullary stenoses (i.e. displacement of the marrow by cortical bone) in the distal and medial phalanges of both hands, as well as in the proximal phalanges of the left hand (see Fig. 2, *6*). A variant of congenital hypothyroidism seems to be the most plausible differential diagnosis. An extreme degree of medullary stenosis of tubular bones of the hand among the Upper Pleistocene human fossils was previously observed only in the ungual phalanx of the Neanderthal from Denisova Cave (Mednikova, 2013b)

A paleogenetic study has shown that the Kostenki 14 individual belonged to the metapopulation ancestral to many modern humans and Upper Paleolithic *H. sapiens*, including the Abri Pataud specimen. But the Kostenki 14 genome contains longer Neanderthal tracts (Seguin-Orlando et al., 2014).

Thus, weighting of the skeleton due to the thickening of the walls of tubular bones was observed among the Middle and Upper Paleolithic Eurasian individuals in two hybrid populations. One of them is considered as the ancestor of the Upper Paleolithic and, partially, modern Europeans, and displays a Neanderthal admixture. The second is the Neanderthals admixed with Denisovans (samples from Denisova and Okladnikov caves).

However, a recent study of the Altai Neanderthals' genome has revealed some unexpected details of their "mixed ancestry": an admixture from *H. sapiens* (Kuhlwilm et al., 2016). Before this study, it was widely accepted that the admixture between Neanderthals and AMH occurred outside Africa some 65–47 ka BP. M. Kuhlwilm and co-authors compared the genomes of the Altai Neanderthal and the Denisovan with sequences of 21 chromosomes of two Neanderthals from Spain and Croatia. They found out that a population that had early diverged from the rest of African ("sapient") population made a contribution to the gene-pool of the ancestors of the Altai Neanderthals some 100 ka BP. But in Denisovans and the two European Neanderthals, such a "sapient" ancestry was not detected. According to these findings, it was concluded that the admixture between the Altai Neanderthals and modern humans took place probably in the Near East, some several tens of thousands of years earlier than was previously thought.

Thus, since the inner hyper-robusticity of the Kostenki 14 tubular bones is definitely not a Denisovan heritage, early AMH could have been the link between that individual (and, in broader sense, his metapopulation) and the Altai Neanderthals. Then, the hypertrophy of the walls of tubular bones was genetically determined. The origin of this genetic heritage was migration (in the case of Kostenki 14) or admixture (in the case of the Altai Neanderthals) from the AMH from a lower latitude.

Conclusions

At the beginning of our study, we expected to find confirmation for the hypothesis as to the increased inner robusticity of tubular hand bones in Neanderthals as compared to the Upper Paleolithic European *H. sapiens*. These expectations were based on the existing view that Neanderthals were relatively more capable of the power-grip of a tool and, finally, on the idea of the leading role of biomechanical influences in the thickening of the bone walls. However, our results demonstrate that the phalanges of the European AMH were usually more thick-walled. Contrary to our expectations, inner robusticity does not depend on either the sex or the age of an individual. Obviously, it does not depend on formal taxonomic status either. For instance, the Altai Neanderthals from Okladnikov Cave also exhibit an inner hyper-robusticity. If the results of the study of other small tubular bones are taken into account, the same applies to the Denisova Cave Neanderthals.

According to paleogenetic studies, the Altai Neanderthals of Denisova (and, we believe, Okladnikov) caves are to some extent the descendants of *H. sapiens* who lived more than 100 ka BP. Thus, our answer to the question "what Pleistocene *Homo* population was the 'origin' of the exceptionally robust skeleton of the Altai Neanderthals?" is: the early anatomically modern humans from the tropics.

This study has confirmed an earlier hypothesis as to the morphological heterogeneity of the Altai Neanderthals. This variation probably reflects the complicated population history of this group, which has acquired the genetic heritage of two other taxa. In future, other traces of admixture from Denisovans or early AMH might be detected through the study of the Altai Neanderthals' morphology.

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Human Teeth from Strashnaya Cave, the Altai Mountains, with Reference to the Dental Variation in Stone Age Siberia

Human teeth found in layer 3_1a of Strashnaya Cave, northwestern Altai Mountains, in 1989, are described. The layer is related to the Upper Paleolithic and has been dated to 19,150 ± 80 BP. However, owing to the nature of sedimentation in the areas adjacent to the cave's walls, where the teeth were found, these may be either earlier or later. The objective of this study is to examine the possible biological continuity between the Upper Paleolithic and Neolithic populations of the Altai-Sayan highland because the teeth from Strashnaya may postdate their layer. In view of the chronological ambiguity, we compared them with both the Paleolithic and Neolithic specimens from southwestern Siberia. Marked affinities have been demonstrated between the Strashnaya teeth and those from the Upper Paleolithic sites of Malta, Listvenka, and Afontova Gora II in Southern Siberia, suggesting that the Upper Paleolithic population of the Altai Mountains represented the same Southern Siberian dental complex. Certain features link the Strashnaya child with people associated with the Neolithic and Chalcolithic cultures of the Altai-Sayan region, such as the Kuznetsk-Altai and Bolshoy Mys cultures, possibly evidencing evolutionary conservatism.

Keywords: *Upper Paleolithic, Neolithic, Altai Mountains, Strashnaya Cave, dental anthropology, Southern Siberian Upper Paleolithic dental complex.*

Introduction

Strashnaya Cave in the Northwestern Altai, in the middle Inya River (Charysh River basin), has been excavated several times since 1966, and has yielded rich archaeological and faunal materials (Okladnikov et al., 1973; Derevianko, Zenin, 1997; Zenin, Kandyba, 2006; Krivoshapkin et al., 2015). Thirteen lithological layers, 10 m thick in total, were distinguished in the stratigraphic profile (Fig. 1). Upper layers 1 and 2 are of Holocene age, while layers from 3 to 13 represent the Pleistocene. Layers 11–13, in the base of the profile, are archaeologically sterile (Zenin, Ulyanov, 2007).

The cave has been referred to as an etalon Middle and Early Upper Paleolithic site in Altai (Derevianko, Zenin, 1997; Rybin, Kolobova, 2009). Radial flaking, with the presence of a remarkable Levallois component and some signs of laminar flaking (represented mostly by end products), is typical of the Middle Paleolithic stone tool complexes of layers 5–10. The toolkit includes scrapers, notched-denticulate tools, and flakes with irregular retouch. The Upper Paleolithic deposits of the Strashnaya Cave (layers 3 and 4) represent several chronological and cultural shifts during the existence of the site (Krivoshapkin, Zenin, Shalagina, 2014). The origin of one of the complexes is related to the Middle Paleolithic industry. It is characterized by discoidal and Levallois flaking, and by the prevalence of scrapers and notched-denticulate tools. Another complex is associated with the Upper Paleolithic Kara-Bom tradition (blade

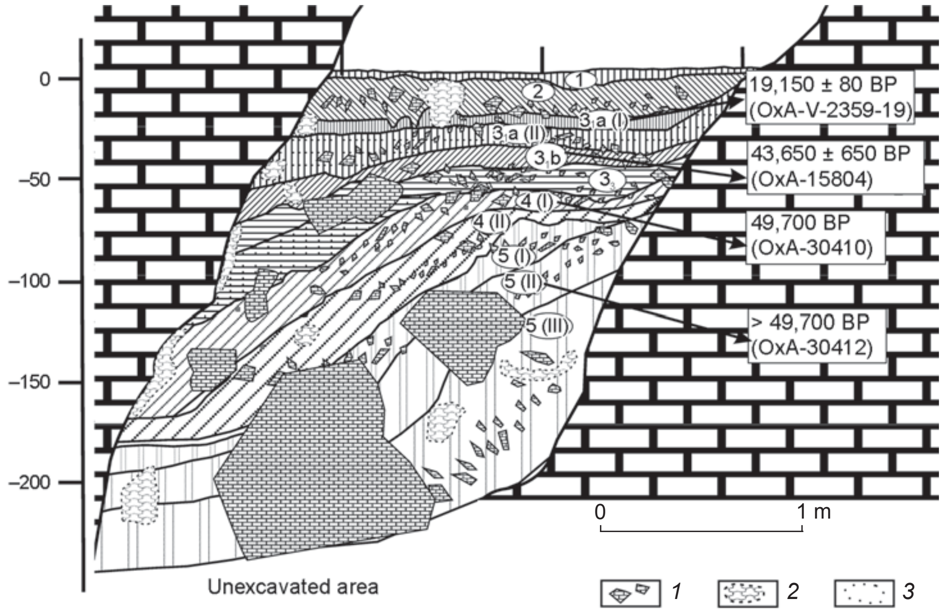

Fig. 1. Scheme of the stratigraphic section in Strashnaya Cave.
1 – debris, blocks; *2* – molehill; *3* – disruption of the layer.

flaking). Finally, one more episode of the inhabitation of the cave is represented by the Late Upper Paleolithic industry characterized by small-blade production and the availability of bone tools.

In 1989, eight teeth from a subadult individual and a fragment of the distal part of the humerus of an adult individual were found in layer 3_1a, near the northeast wall of the cave. These bones were initially studied by B. Viola, who determined the age of the subadult's teeth and assigned it to the modern human species, but pointed out its numerous plesiomorphic features (2009: 197). There has so far been no detailed comparison of the remains from Strashnaya Cave with samples from other Siberian Upper Paleolithic sites, since the stratigraphic context of the finds has not been clearly defined (Ibid.).

Layer 3_1a, where the remains were found, was dated to Upper Paleolithic times, more specifically 19,150 ± ± 80 BP (OxA-V-2359-19) (Derevianko et al., 2015: 10). But taking into account the specific conditions of sedimentation in the area of the cave that slopes down to the wall with a positive inclination (Zenin, 1998: 98–99), these fossils might be either younger (Krivoshapkin, Zenin, Shalagina, 2014) or older. At the moment, they are probably the most ancient remains of *Homo sapiens sapiens* in Altai. But even if they are re-dated to the Holocene in future, it will not make them less important for the reconstruction of the population history of southwestern Siberia. The earliest Neolithic dental specimens in this region are dated to the second half of the 7th to early 6th millennia BC (Molodin, 2001: 115), while the latest of all the Western Siberian Upper Paleolithic specimens, the mandible from Listvenka, was found in the layer dating within the range between 13,910 ± 400 and 13,100 ± 410 BP (Khaldeyeva et al., 2016). So, there is a 6000 years long hiatus between the two, and it is virtually impossible to objectively assess the degree of biological continuity between the populations of the Altai-Sayan region during that period. If the younger date for the studied samples is confirmed, it will help to partially fill this gap.

This study was focused on a detailed morphological analysis of the teeth from Strashnaya Cave and on identification of the degree of similarity between them and other Neolithic, Upper and Middle Paleolithic specimens found in Siberia and Altai.

Materials

Our sample includes deciduous lower left canine and two molars; permanent lower left incisor, canine, and first premolar; lower second molar; and an upper left second premolar. All these teeth belonged to one subadult individual, 7–9 years of age (Viola, 2009: 197). The deciduous teeth are heavily worn, signs of erosion, fractures, scratches, and post-mortem loss of enamel are observed. The permanent teeth are well-preserved unerupted buds. Only the lower second incisor has erupted during the individual's lifetime. This tooth was initially determined as an upper one (Ibid.: 183). But there is a number of features that contradict to this determination: prominent mesio-distal flattening of the root; distal groove (visible despite the post-mortem damage); bit-shaped, narrow, and tall crown, which is flattened in the mesial plane; distal inclination of the cutting edge; more elevated position of the mesial corner of the crown as compared to the distal corner; and the indentations of the cutting edge.

Table 1. **Grade scales of the dental traits used in this study**

Trait	Grades	
	Russian dental protocol	ASUDAS
Distal accessory ridge $C_н$	+	2–5
Mesial accessory ridge $C_н$	+	2–5
Shape of the P_1	(1–2), (4–5)	0, 1–9
Cingulum M_2	+	+
t6M_2	+	2–5
5M_2	+	Hypoconulid grades 1–5
4M_2	+	Hypoconulid grade 0
(+)M_2	"+"	"+"
(X)M_2	"X"	"X"
(Y)M_2	"Y"	"Y"
Anterior fovea M_2	+	3, 4
Posterior fovea M_2	+	+
3YM_2	+	3-cusped M2
Protostylid M_2	2–5	2–7
Fovea of the protostylid	+	1
Tami (C7) M_2	+	1–4
Distal trigonid crest M_2	+	+
Epicristid	+	+
Deflecting wrinkle of metaconid M_2	+	2, 3
2med(II)	+	The groove distally delimiting the axial metaconid crest falls into the fissure separating the metaconid and protoconid
2med(III)	+	The groove distally delimiting the axial metaconid crest falls into the fissure separating the metaconid and entoconid

Methods

The samples were studied using an extended set of dental traits (Table 1) including: ASUDAS protocol (Turner, Nichol, Scott, 1991); conventional set of traits used in Russian dental anthropology (Zubov, 1968, 2006); complete description of the odontoglyphic pattern of the buccal teeth crowns (Zubov, Khaldeyeva, 1989); Neanderthal complex markers (Bailey, 2002); and, finally, so-called archaic markers, i.e. plesiomorphic traits marking the relationship between the Paleolithic and Meso-Neolithic population (Zubova, 2013). Based on the full set of traits, each tooth was compared at the individual level with the Middle Paleolithic specimens from Chagyrskaya and Okladnikov caves belonging to *Homo neanderthalensis* (Shpakova, 2001) (unpublished results of A.V. Zubova), the Upper Paleolithic specimens from Malta, Afontova Gora, and Listvenka sites (Zubova, Chikisheva, 2015b), Khaiyrgas (Zubova, Stepanov, Kuzmin, 2016), and the Neolithic sites of Itkul, Ust-Isha, Kaminnaya Cave, Vaskovo-4, Lebedi-2, Solontsy-5, Vengerovo-2a, Sopka-2, Protoka-1 (Zubova, Chikisheva, 2015b), Diring-Yuryakh, Kamenka-2, Matta, and Pomazkino-2 (unpublished results of A.V. Zubova).

Morphological description

Permanent upper left second premolar (Fig. 2, *3*). The vestibular cusp of the crown is larger than the lingual cusp, but in general they are of similar size. The mesial, distal, and central segments, the 1pa, 2pa, 1pr, and 2pr grooves are clearly seen on each of the cusps. The grooves of the paracone do not fall into intertubercular fissure II but they are connected by a groove of the third order, and form a separated triradius delimiting the apex of the cusp. The grooves of the second order of the protocone form a diradius that falls into the intertubercular fissure. There are elements of a strongly reduced metacone with inchoate elements of 1me and 2me in the crown pattern. In the protocone, groove 3pr is present, which delimits an accessory mesial cusp. An analogous accessory cusp on the distal side is formed by fissure II and groove 2me. Dimensions of the crown are very large (Table 2), above average sizes of the upper premolars in modern populations (Zubov, Khaldeyeva, 1993, Suppl. data, Tab. 3). The closest parallels are the premolars of the Sungir 2 individual.

Permanent lower left second incisor (Fig. 3, *4*). This tooth is characterized by a prominent lingual shoveling (Table 3) and a very weak development of the vestibular marginal ridges. Enamel of the basal part of the crown is destroyed. The mesio-distal diameter of the crown is very large (see Table 2). The closest parallels to such a morphology can be found in some Upper Paleolithic

Table 2. **Dental metrics of the teeth from Strashnaya Cave and the Upper Paleolithic dental samples from Siberia**

Variable	Afontova Gora II	Malta 1	Malta 2	Listvenka	Strashnaya
MD cor P^2	–	–	–	–	7.3
VL cor P^2	–	–	–	–	11.3
MD cor I_2	–	–	–	–	6.8
MD cor $C_{\text{н}}$	–	–	–	–	7.6
VL cor $C_{\text{н}}$	–	–	–	–	8.5
MD cor P_1	–	–	–	–	8.3
VL cor P_1	–	–	–	–	8.7
MD cor M_2	11.7	–	–	–	12.8
VL cor M_2	10.8	–	–	–	11.7
MD cor m_1	–	8.5	8.4	9.5	10
VL cor m_1	–	7.8	7.1	7.1	8
MD cor m_2	–	9.7	10.8	10.9	11.6
VL cor m_2	–	8.4	8.7	9.5	10.1
MD cor $c_{\text{н}}$	–	–	6.2	6.8	7
VL cor $c_{\text{н}}$	–	–	5.5	5.5	6.5

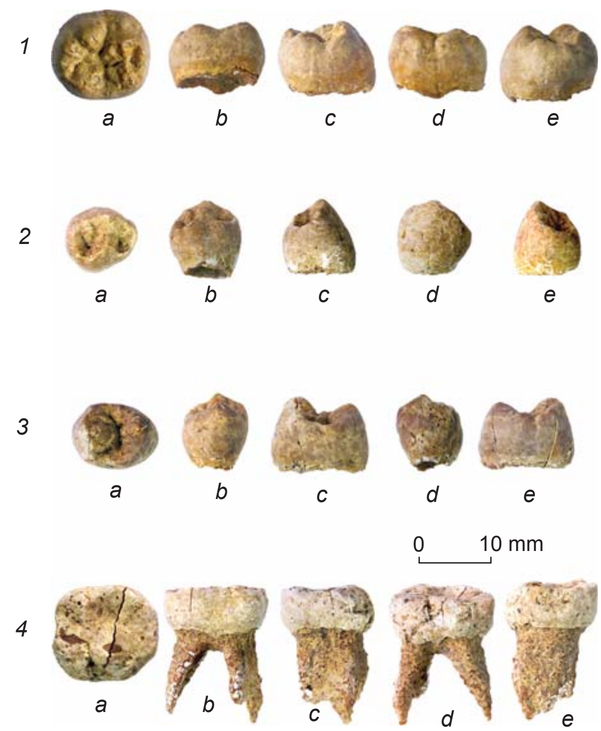

Fig. 2. Dental specimens from Strashnaya Cave.
1 – permanent left M_2; *2* – permanent left P_1; *3* – permanent left P^2; *4* – deciduous left m_2.
a – occlusal norm; *b* – lingual, *c* – mesial, *d* – vestibular (buccal), *e* – distal.

specimens from Western Europe (Lachaud, Les Rois, Paglicci-12) and European Russia (Sungir 3). Notably, in the samples from Vindija, Předmostí, Grotte des Enfants, and Les Rois, there are specimens of larger size (Voisin et al., 2012).

Permanent lower left canine (Fig. 3, *2*). A prominent shoveling and the presence of an accessory distal ridge are observed (see Table 3). The lingual cusp in the basal part is fairly developed. The tooth, like the two previous ones, is large (see Table 2). The closest analogs are found in Western Europe and North Africa (Arene Candide, Lachaud, Taforalt) (Ibid.).

Permanent lower left first premolar (see Fig. 2, *2*). The crown is asymmetrical and has an extended talonid with a hypoconid and elements of entoconid. The metaconid is located along the central axis of the crown, and it is slightly inferior to the protoconid. The two cusps are connected by a transversal ridge, which is partially disrupted by intertubercular fissure II. The degree of variation of the crown complies most with point 4 of the Zubov scale, as there is an element of its own apex observed on the lingual

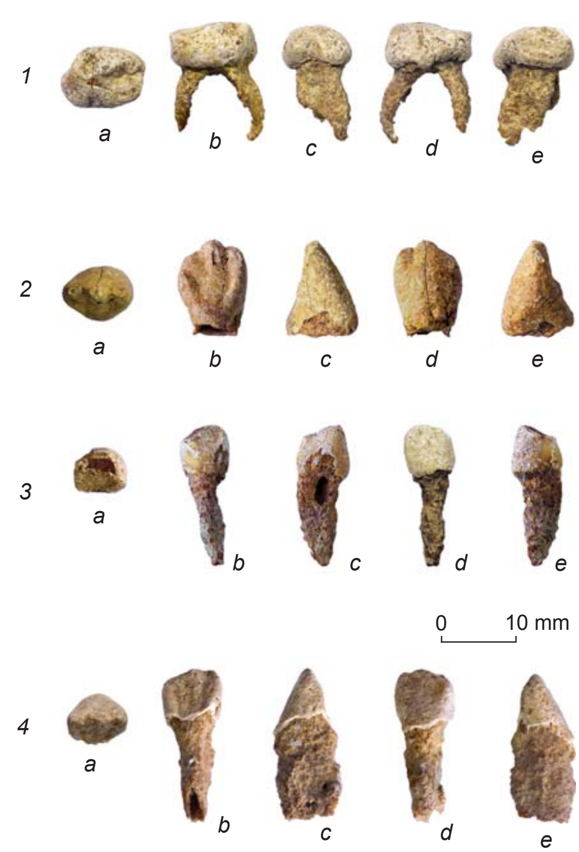

Fig. 3. Dental specimens from Strashnaya Cave.
1 – deciduous left m_1; *2* – permanent lower left C; *3* – deciduous lower left C; *4* – permanent left I_2.
a–e – see the legend for Fig. 2.

Table 3. **Dental traits of the mandibular teeth from Strashnaya Cave and the Upper Paleolithic dental samples from Siberia**

Trait	Tooth		Malta 2	Listvenka	Afontova Gora II	Strashnaya	Khaiyrgas	Malta 1
1	2		3	4	5	6	7	8
Shoveling	I2	right	–	–	–	–	–	–
	–	left	–	–	–	2	–	–
	C	right	0	–	–	–	–	–
		left	–	–	–	3	–	–
Distal accessory ridge	C	right	0		–	–	–	–
		left	–	–	–	+	–	–
Premolar shape	P1	right	–	–	–	–	–	–
		left	–	–	–	3–4	–	–
Cingulum	P1	right	–	–	–	–	–	–
		left	–	–	–	+	–	–
	M1	right	+	+	0	–	–	–
		left	+	+	0	–	–	–
	M2	right	–	–	0	–	–	–
		left	–	–	0	+	–	–
	m2	right		+	–	–	–	+
		left		+	–	+	0	+
Molar shape	M2	right	–	–	X6	–	–	–
		left	–	–	X6	X6	–	–
	m2	right	Y5	Y5	–	–	–	Y6
		left	Y5	–	–	Y6	Y6	Y6
Protostylid	M1	right	0	P	P	–	–	–
		left	0	P	P	–	–	–
	M2	right	–	–	P	–	–	–
		left	–	–	P	2–3	–	–
	m2	right		1	–	–	–	+
		left		–	–	+	–	+
Distal trigonid crest	M1	right	0	0	0	–	–	–
		left	0	0	0	–	–	–
	M2	right	–	–	0	–	–	–
		left	–	–	0	0	–	–
	m2	right	0	0	–	–	–	0
		left	0	–	–	–	+	0
Medial trigonid crest	M1	right	0	0	0	–	–	–
		left	0	0	0	–	–	–
	M2	right	–	–	0	–	–	–
		left	–	–	0	0	–	–

Table 3 (end)

1	2		3	4	5	6	7	8
Deflecting wrinkle of metaconid	M1	right	0	0	0	–	–	–
		left	0	0	0	–	–	–
	M2	right	–	–	0	–	–	–
		left	–	–	0	0	–	–
	m2	right	0	0	–	–	–	0
		left	0	–	–	–	–	0
Fa	M1	right	0	+	+	–	–	–
		left	0	–	+	–	–	–
	M2	right	–	–	+	–	–	–
		left	–	–	+	+	–	–
	m2	right	+	+	–	–	–	+
		left	+	–	–	+	0	+
Fp	M1	right	0	0	+	–	–	–
		left	0	0	–	–	–	–
	M2	right	–	–	+	–	–	–
		left	–	–	+	0	–	–
Central cusp	M1	right	0	0	0	–	–	–
		left	0	0	0	–	–	–
	M2	right	–	–	0	–	–	–
		left	–	–	0	+	–	–
Tami	M1	right	0	0	1	–	–	–
		left	0	0	1	–	–	–
	M2	right	–	–	0	–	–	–
		left	–	–	0	1	–	–
	m2	right	0	0	–	–	–	+
		left	0	–	–	–	0	+
1med/1prd	M1	right	–	1	1	–	–	–
		left	–	–	–	–	–	–
	M2	right	–	–	1	–	–	–
		left	–	–	1	2	–	–
	m2	right	3	–	–	–	–	1
		left	1	–	–	–	1	1
2med	M1	right	Fc	Fc	Fc	–	–	–
		left	II	III	–	–	–	–
	M2	right	–	–	III	–	–	–
		left	–	–	II	II	–	–
	m2	right	Fc	III	–	–	–	III
		left	II	–	–		III	III

cusp. The odontoglyphic pattern includes intertubercular fissures I and II, which separate the hypoconid and protoconid on the one side, and the protoconid and metaconid on the other side. Fissures III–V are inchoate: they originate from the basin of the talonid but do not reach the margins of the crown. The grooves of the second order 1med and 1prd are well pronounced in the mesial portion, while in the middle part, there is the 2prd, which delimits the transversal ridge from the distal side. The basins of the trigonid and talonid are deep and long. On the vestibular side of the crown, the projection of the cingulum and the presence of a moderately pronounced mesial marginal ridge are observed. There is a small fovea, highly atypically for modern *Homo sapiens*, around the place where the ridge merges with the cingulum. The crown of the tooth is very large (see Table 2), its size exceeds the dimensions of the lower first premolars not only in modern, but also in the Upper Paleolithic populations (Zubov, Khaldeyeva, 1993; Voisin et al., 2012).

Permanent lower left second molar (see Fig. 2, *1*). The crown is of oval shape and comprised of six cusps. On its lingual side, there are the metaconid and entoconid, on vestibular side—protoconid, hypoconid, and a large hypoconulid. The sixth cusp is in the center of the distal side of the crown, effectively in an extension of its sagittal axis. All the cusps display tall apexes inclined towards the center of the crown. The markedly prominent cingulum and the presence of the protostylid in the form of cingular cog, branching from the vestibular groove, are observed on the vestibular surface. A large anterior fovea is formed by the 1prd and 1'med grooves in the mesial portion. The *Tami* trait is present in the metaconid; the crown pattern is "X"; the distal and medial ridges of the trigonid, as well as the deflecting wrinkle of the metaconid, are absent (see Table 3). The odontoglyphic pattern comprises the full set of intertubercular fissures I–VI and grooves 1 and 2 of the metaconid, protoconid, hypoconid, entoconid, and hypoconulid. The 3med element and the grooves 2'med, 4hyd, and 4hld are also observed. The latter two grooves, together with fissure V, delimit the fragments of the axial ridges of the hypoconid and hypoconulid, adjacent to the central fovea, as a separate cusp. The second groove of the metaconid falls into fissure II, which is typical of the second molars of various Western and Eastern populations. The first groove falls into fissure I below the 1prd: a morphological pattern neutral in terms of taxonomic classification (Type 2). The crown is very large, its dimensions approach the upper limits of size variation of the Upper Paleolithic lower second molars. The most similar combination of parameters is observed in the Předmostí 9 and Taforalt XV-C2 specimens (Voisin et al., 2012).

Deciduous lower left canine (see Fig. 3, *3*). The tooth is very massive. The shape of the crown is sub-triangular, with a prominent vestibular cingulum. On the lingual side, the marginal ridges and the axial ridge, running from the base of the crown to its cutting edge, are well defined. Vestibular shoveling is absent.

Deciduous lower left first molar (see Fig. 3, *1*). The crown is massive, trapezoid, broadened in the mesial portion, with a very prominent cingulum and the presence of a moderately developed protostylid. The anterior fovea is divided into two elements, situated in the vestibular and lingual portions of the crown. But it is impossible to determine to what extent this separation reflects the true morphology of the tooth and to what extent it is due to attrition. The type of contact of the main cusps is "Y".

Deciduous lower left second molar (see Fig. 2, *4*). The crown is very massive, sub-rectangular, with a prominent tuberculum molare, and a strongly developed vestibular cingulum. It is formed by six cusps with the "Y" type of contact. *Tami* was probably also present in the crown pattern. A moderately developed protostylid and the fovea of the protostylid are observed in the protoconid, and a dentated cingular eminence in the hypoconid. Elements of the anterior fovea are present in the mesial portion. Fragments of intertubercular fissures II–IV, VI, and the groove of the second order 1med are observed. According to the direction of the 1med, the deflecting wrinkle of the metaconid is absent.

Results of the comparative analysis

The results of the comparison between morphology of the teeth found in Strashnaya Cave and those of Altai Neanderthals have shown the complete absence of similarity between them. As was previously shown by Viola, the teeth from this cave do not exhibit typical markers of the Neanderthal complex (2009: 197). The only feature that could be considered a sign of biological relatedness between the individual from Strashnaya and the Neanderthals from Okladnikov Cave is the presence of the central cusp on the occlusal surface of the lower molar, which was observed both in the second molar from Strashanaya Cave and in specimens 2, 4, and 5 from Okladnikov Cave. However, a detailed analysis has shown that the genesis of this feature in the former and in the latter is entirely different. In specimens 4 and 5 from Okladnikov, the cusp is located on the metaconid and formed by the accessory groove 4med. In Okladnikov tooth 2, it is delimited by the groove 4hyd as a part of the hypoconid. But in the individual from Strashnaya it has a complex genesis: it is formed by the hypoconid and hypoconulid simultaneously, which differs it from the pattern mentioned above. The metrics of the teeth that, according to the study by Viola, reach the upper limit of variation in Neanderthals, and exceed the values typical for the Upper Paleolithic *Homo sapiens* (Ibid.), cannot be considered an evidence of the biological continuity as well. The specimens from

Okladnikov and Chagyrskaya caves display small values of metric variables and, consequently, the macrodontia of the Strashnaya individual cannot be explained by his relationship with the Altai Neanderthals.

The degree of morphological similarity between the specimens from Strashnaya and the Upper Paleolithic or Neolithic dental samples from Western Siberia has been assessed in the context of taxonomic variation of their dental complexes. On the basis of results of previous research, an independent locus of dental morphogenesis, denoted as "Southern Siberian Upper Paleolithic", was described for the Altai-Sayan highlands (Zubova, Chikisheva, 2015b: 142). The populations formed in this area were different both from the Upper Paleolithic Europeans, who started showing the specialized Caucasoid complexes very early, and from the early modern humans from Asia. The dental pattern of the latter is known from finds in Fuyan Cave in Daoxian (southern China, Hunan Province) that are probably not younger than 80 ka BP. The sixth accessory cusps are not observed in the lower molars from Fuyan, but such an important marker of the Eastern dental stock as the distal trigonid crest is present (Liu et al., 2015).

The specific of the dental pattern of the Southern Siberian Upper Paleolithic specimens includes the following features: absence of shoveling of the upper incisors; the advanced variation of the crowns of the lower permanent molars; the increased frequency of the cingular derivatives in the same molars; the fovea of the protostylid and the fovea of the sixth cusp; and the absence of the distal trigonid crest and the deflecting wrinkle of the metaconid. This set of traits exhibits a certain chronological dynamics. It is least pronounced in the permanent teeth of the most ancient of the specimens—the oldest of the subadults buried at Malta (Zubova, Chikisheva, 2015b: 140–141). In the Late Upper Paleolithic samples from Afontova Gora II and Listvenka, the prevalence of the traits typical of the Southern Siberian Upper Paleolithic dental complex is increased and reaches its maximum. In the Neolithic samples, one or two archaic dental phenes can be observed in some individuals, but Mongoloid complexes of the Eastern origin dominate in the Altai-Sayan populations (Zubova, Chikisheva, 2015a: 123).

The permanent and the deciduous second molars were found to be the most informative teeth in terms of comparison of the Strashnaya individual with the population of Southern Siberia and Altai. According to the traits that were traceable on the deciduous molar, its morphology completely complies with the pattern found in the same tooth of the Malta 1 individual (the youngest child buried at the site) (see Table 3). One of his molars exhibits a six-cusped crown

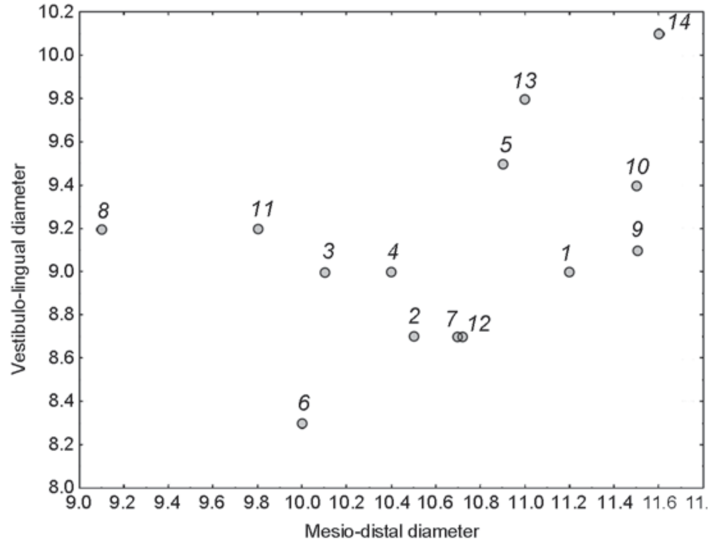

Fig. 4. Comparison of the sagittal and transverse diameters of the crowns of the deciduous lower second molars with the Upper Paleolithic and Neolithic samples from Siberia.

1, *5–8*, *12–14* – Upper Paleolithic: *1* – Khaiyrgas, *5* – Listvenka, *6* – Malta 1, *7* – Malta 2, *8* – Sungir 3, *12* – Gorodtsov site (Kostenki-15), *13* – Kostenki-14-01, *14* – Strashnaya Cave; *2–4*, *9–11* – Neolithic specimens from Yakutia and Baraba forest-steppe.

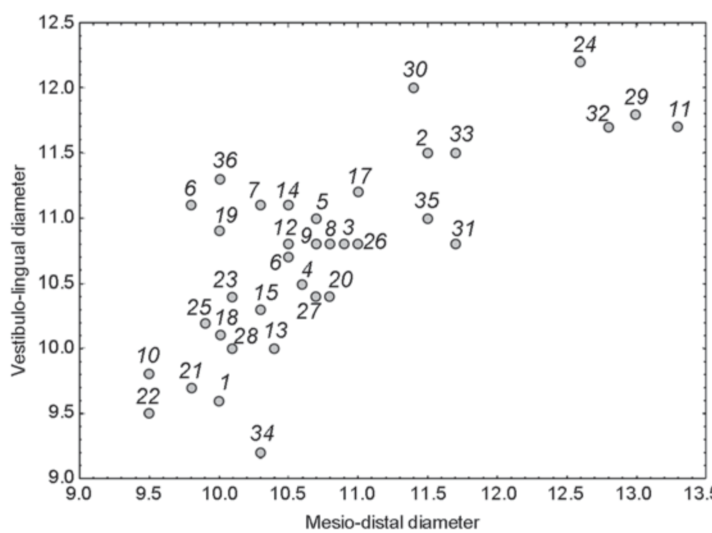

Fig. 5. Comparison of the sagittal and transverse diameters of the crowns of the permanent lower second molars with the Upper Paleolithic and Neolithic samples from Siberia.

1–30 – Neolithic specimens from Baraba forest-steppe and the Altai-Sayan highlands; *31–36* – Upper Paleolithic specimens: *31* – Afontova Gora II, *32* – Strashnaya Cave, *33* – Sungir 2, *34* – Sungir 3, *35* – Kostenki-14, *36* – Kostenki-18.

with the "Y"-pattern, anterior fovea, marked cingulum, and elements of the system of protostylid and *tami*. The observations listed above confirm the affinity of the individual from Strashnaya Cave to the Upper Paleolithic genetic cluster, which includes the Malta 2 and Afontova Gora II individuals (Fu et al., 2016), though the dimensions of this tooth (see Table 2) contrast it to most specimens of the reference sample (Fig. 4).

Morphology of the permanent lower second molar from Strashnaya Cave is similar to the pattern observed in the mandibular teeth of Afontova Gora II (see Table 3). The second molars of this mandible are also six-cusped and display the "Y"-pattern of the crown. The distal and medial trigonid crests, as well the deflecting wrinkle of the metaconid, are absent in these teeth; the odontoglyphic phene 2med(II) is present on one side, while the protostylid fovea is present on both, which is compatible with the presence of the protostylid in the Strashnaya tooth. A substantial difference between the shape of the crowns of the two specimens is observed: they are more angular in the molars from Afontova Gora. The dimensions of the tooth under study distinguish it from the other Upper Paleolithic finds (see Table 2) but align it with some Neolithic ones (Fig. 5).

In general, the comparison of the individual from Strashnaya Cave with the Neolithic samples (see data in (Zubova, Chikisheva, 2015a)) has shown it to be intermediate between the Neolithic and Upper Paleolithic populations but definitely closer to the latter. Similarity with the Neolithic samples is seen mostly in the presence of non-specific traits, which are found at the individual level in antipodal regions of Eurasia and at all times: distal accessory ridge of the canines, anterior fovea and the 2med(II) variant of the lower second molars. The concentration of archaic markers, similar to that observed in the molar from Strashnaya, has not been observed in any of the Neolithic teeth.

Conclusions

The results of our morphological analysis of the dental finds from Strashnaya Cave point towards a remarkable archaism of the dentition of the individual under study, and the presence of the key markers of the Southern Siberian Upper Paleolithic dental complex in the preserved permanent teeth. This conclusion should not in any sense be considered as an evidence of the Upper Paleolithic age of the finds, until the latter are directly dated or until the context of their position in the archaeological layer is better specified. However, our findings help to specify the population structure of the Altai-Sayan region during the final Pleistocene and early Holocene, and they also evidence that the area of the undifferentiated Southern Siberian Upper Paleolithic dental complex should be extended to include not only Sayan region but also the Altai Mountains. The question regarding the direct biological link between the Upper Paleolithic and Neolithic population of this area remains open. The similarity of dental metrics of the individual from Strashnaya Cave and some Neolithic samples can be considered more or less solid evidence for the biological relatedness between this individual and the Neolithic groups of Western Siberia.

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Prevalence of Caries Among Siberian Tatars of the Omsk Region in the 17th to Early 20th Centuries

This study addresses the prevalence of caries in Ayaly and Kaurdak-Sargat groups of Siberian Tatars living in the Omsk Region of the Irtysh. Judging by dental remains from the Okunevo VII and Bergamak II cemeteries (16th–17th centuries), the frequency of caries among those people was similar to that in the late medieval population of northwestern Siberia. The diet of both these populations apparently consisted mostly of meat. However, a somewhat higher frequency of caries among Siberian Tatars indicates a greater amount of carbohydrates. Later (18th to early 20th century) Tatars of Chertaly I, Toksay I and II, Tyulchakovo, and Letniy Kaurdak) exhibit a frequency of caries similar to that found in 18th–19th century Russian peasants of the western Urals, possibly evidencing a similar proportion of refined carbohydrates in the diet. The difference between earlier and later Tatar groups attests to an increasing role of agriculture due to the immigration of Russians; and, later, of Tatars from the Volga-Ural region.

Keywords: *Dental pathology, caries, Siberian Tatars, diet, agriculture.*

Introduction

The Siberian Tatars constitute one of the largest Turkic-speaking ethnic groups of Western Siberia. They populate mostly the middle flow of the Irtysh River and its inflows, including Tobol, Pyshma, Iset, Vagay, Tura, Ishim, Tara, Uy, Tuy. This area includes southern forest, forest-steppe, and, partially, steppe climatic zones (see *Figure*). Ethnographers have described several sub-ethnic groups among Tobol-Irtysh Tatars: Tuymen-Tura, Tobol, Kaurdak-Sargat, and Ayaly (Tomilov, 1981: 5–6). Analysis of anthropological data has not revealed any substantial morphological differences between the above-mentioned groups; thus they can be considered as a unified complex of mixed Caucasoid-Mongoloid populations (Bagashev, 1993: 15–40, 143).

The reconstruction of the diet of Siberian Tatars based on the status of their dental health, which is put forward in this study, is the first one to employ such a comprehensive dental sample. Specifically, the prevalence of caries was examined. This dental disease has multiple etiologies, among which the leading factor is diet, and, particularly, an increase in the consumption of carbohydrates. According to existing views, caries develops when the physiological balance between the mineral component of the tooth and bacterial dental calculus is broken. The regular consumption of the food enriched with easily digestible carbohydrates creates favorable conditions for secretion of organic acids, bacterial metabolic products. This, in turn, leads to demineralization of enamel and the onset of caries (Fejerskov, Nyvad, Kidd, 2008; Baelum et al., 2008). Thus, the prevalence of this pathological condition in a population is one of the most important sources of information about diet, health, social stratification, and the type of economic activity (Varrela, 1992; Watt, Lunt, Gilmour, 1997; Barthelemy et al., 1999).

The aim of this study is to investigate the prevalence of caries among the Ayaly and Kaurdak-Sargat Tatars, trace the temporal dynamics of this indicator in different chronological groups of Siberian Tatars, and put our results in the context of caries rates in other populations of Western Siberia. Further, we set out to reconstruct the type of economic activity, and the pattern and structure of diet in the studied groups.

Geographical location of the Siberian Tatars' cemeteries employed in the present study.
1 – Toksay I; *2* – Toksay II; *3* – Okunevo VII; *4* – Bergamak II; *5* – Chertaly I; *6* – Letniy Kaurdak; *7* – Tyulchakovo.

Materials and methods

The Ayaly group of Tobol-Irtysh Tatars was studied using samples from the following cemeteries: Okunevo VII (16th–17th cc), Bergamak II (17th c), Chertaly I (18th–19th cc), Toksay I (18th–19th cc) and II (19th to early 20th cc) (Mogilnikov, 1997; Matyushchenko, 2003; Tikhonov, Tataurov, 1996; Melnikov, 1991; Zdor, Tataurov, Tikhomirov, 2000: 19–66; Bagashev, 1993: 7–10). The Kaurdak-Sargat group was studied via the skeletal remains from Tatar cemeteries of Tyulchakovo (Sargat Tatars) and Letniy Kaurdak (Kaurdak Tatars) dated to the 19th to early 20th centuries (Bagashev, 1993: 7–10) (see *Figure*; Table 1). According to the 1897 census, these cemeteries belonged to native Siberian Tatars. In some villages, a negligible number of Central Asian migrants were living alongside the Tatars (Patkanov, 1911: 17, 73, 106).

Sex and age of the individuals were determined using the standard protocol (Alekseyev, Debets, 1964: 29–39). Edentulous skulls of senile individuals, as well as the skulls of adolescents with immature dentition, were not included in the sample.

The assessment of the dental rows was carried out using the categories described by J.E. Buikstra and D. Ubelaker (1994: 47–49). All available teeth were included in the sample and were examined in daylight. A dental probe was used when necessary. Caries was diagnosed if a cavity, even if very small, was visually observable. As the influence of the soil could not have been accounted for reliably, focal changes of the color of enamel (blemishes) were not scored as caries lesions. In case of the absence of the third molar, a genetically determined agenesis or a lack of eruption was suspected. But if its antagonist displayed traces of attrition, the tooth was scored as lost ante-mortem. All the teeth available for examination were divided into two groups: the first included anterior teeth (incisors and canines); the second, masticatory teeth (premolars and molars)*.

Prevalence of caries was scored in two different ways: as "dental count", i.e. the observed caries rate (OCR), and as "individual count"—the percentage of individuals in a sample having at least one tooth affected by caries. The rates based on these approaches, as some scholars point out, cannot perfectly reflect the real prevalence of the disease in ancient populations (Lukacs, 1992, 1995; Kerr, Bruce, Cross, 1988; Duyar, Erdal, 2003). But the abundance of comparative data on various times and

*Such a separation is partially explained by the different functions of these groups of teeth and hence different susceptibility to caries (Whittaker et al., 1981; Kerr, Bruce, Cross, 1988; Erdal, Duyar, 1999). On the other hand, the anterior teeth, unlike masticatory ones, are often lost during either excavation or transportation and storage. As the prevalence of caries depends largely on the pattern of the post-mortem tooth loss, mixing of the teeth of both groups will lead to an artificially increased prevalence if the anterior teeth are poorly preserved, or to a decreased rate if many masticatory teeth are absent. However, in the former case, the change in caries frequency will be minimal, as the anterior teeth are only rarely affected by caries (Duyar, Erdal, 2003).

Table 1. **Description of the dental sample**

Site	Date	Number of individuals		Number of teeth	
		♂	♀	♂	♀
Okunevo VII	16th–17th cc	16	12	288	182
Bergamak II	17th c	7	17	123	191
Chertaly I	18th–19th cc	13	12	196	174
Toksay I	18th–19th cc	14	6	273	134
Toksay II	19th to early 20th c	14	7	313	166
Letniy Kaurdak	19th to early 20th c	20	15	348	271
Tyulchakovo	19th to early 20th c	28	16	565	313
Total		112	85	2106	1431

cultures, obtained using these counting methods, is their undoubted merit. In this study, the populations of Western Siberia were compared using both "dental" and "individual" counts.

In order to approximate the rates of caries in the groups of Siberian Tatars to real values as closely as possible, correction coefficients were used. The first of these was the caries correction factor (CCF) developed by J.R. Lukacs (1995). The prevalence of caries in the teeth lost post-mortem was assessed using the proportional correction factor (PCF) proposed by I. Duyar and Y.S. Erdal (2003) (See Table 2). The latter method has many merits but some flaws as well: it assumes that teeth were lost owing to caries or severe attrition only. But there might have been other causes for the ante-mortem tooth loss, such as periodontal disease, traumas, etc. (Lukacs, 1992; Lukacs, Minderman, 1992; Lukacs, Pal, 1992).

The samples of Siberian Tatars were divided into three chronological groups: 1) 16th–17th cc (Okunevo VII, Bergamak II); 2) 18th–19th cc (Chertaly I, Toksay I); and 3) 19th to early 20th century (Toksay II, Tyulchakovo, Letniy Kaurdak). The statistical significance of differences between these groups was assessed using the χ^2 criterion, the representation error using the following formula:

$$s\% = \sqrt{\frac{p \times (100 - p)}{n}},$$

where $s\%$ stands for the mean sampling error (%), p is the percentage of a variant in the general population, and n is the number of individuals in a sample (Lakin, 1990: 101–105).

Results

In total, 3537 permanent teeth from 197 individuals were examined, of which 2106 belonged to males and 1431 to females (see Table 1). The highest level of OCR was observed in Tyulchakovo (Sargat Tatars), the lowest in Okunevo VII, Bergamak II, Toksay I and II; while Chertaly I and Letniy Kaurdak displayed intermediate values (Table 3). The percentage of individuals having at least one tooth affected by caries was the highest in Toksay I and Tyulchakovo, the lowest was in Okunevo VII and Bergamak II, and the intermediate in Chertaly I, Toksay II, and Letniy Kaurdak (Table 3).

The lowest values of PCF are found in Toksay I, Okunevo VII, and Bergamak II, and higher values in Toksay II, Chertaly I, Letniy Kaurdak, and Tyulchakovo (Table 4). In the Okunevo VII and Bergamak II samples, PCF was higher in females, while in all other populations, it was higher in males.

Most of the caries lesions detected in the studied samples are observed in masticatory teeth. The females of Toksay I are an exception: in this sample, only two incisors of one individual were affected. But this is probably because of the low size of the sample (five individuals).

The comparison of caries rates in the groups of Siberian Tatars dated to the 16th–17th centuries (Okunevo VII, Bergamak II) and in the later groups has revealed a statistically significant increase of its prevalence in more recent samples ($\chi^2 = 5.53$). However, Siberian Tatars of the 18th–19th centuries (Chertaly I, Toksay I) display statistically significant differences neither from the earlier nor from the later population of the studied region ($\chi^2 = 0.36$ and $\chi^2 = 0.36$).

Discussion

The comparison of the groups of Siberian Tatars of the 16th–17th centuries (Okunevo VII and Bergamak II) with other populations of the northwestern Siberia using the "individual count" revealed their closest similarity to the hunters and fishers from the sites of Zeleny Yar (13th c), Bederevsky Bor III (13th–14th cc), Saygatinsky-4 (13th–14th cc), and Bederevsky Bor II (17th c). The OCR in Okunevo VII and Bergamak II was slightly higher than in the above-mentioned northwestern Siberian populations, while it was close to the rate in a sample of the Selkups from Vargananzhino (19th to early 20th cc). Notably, in the latter, the "individual count" was higher than in the Siberian Tatars of the 16th–17th cc (see Table 3). The geographical location of the northwestern Siberian sites listed above virtually excludes the possibility that their own agricultural activity was a source of carbohydrates for these populations. Only the intensification of the trade and exchange contacts of northern hunters and fishermen with the population of the southwestern Siberia in Late Medieval times has made the products of agriculture more accessible to people from the North (Zykov, 2006). This, in turn, probably led to the increase in caries rates in the latter. The high frequency of carious lesions in more recent groups of Selkups (Bederevsky Bor III, Vargananzhino) is most probably related to the consumption of "flour" foods, export of which has increased manyfold during the period of Russian colonization of Siberia (Razhev, Rykun, Svyatova, 2011). Thus, it can be concluded that the diet of Siberian Tatars who left the cemeteries of Okunevo VII and Bergamak II found the closest parallel in the Late Medieval northwestern Siberian population. Meat probably predominated in the diet. The Siberian Tatars were pastoralists and fishermen, the northwestern Siberian people were fishers and hunters. But the higher prevalence of caries in the former points towards a higher consumption of carbohydrates.

The "individual count" in the late groups of Siberian Tatars (Chertaly I, Toksay I (18th–19th cc); Toksay II, Tyulchakovo, Letniy Kaurdak (19th to early 20th cc)) was substantially higher than that of the Late Medieval northwestern Siberian hunters and fishermen and of the Siberian Tatars from Bergamak II and Okunevo VII. Rather, it is similar to the Russian population of the 18th–19th cc from Revda, Verkhoturye, Kamensk-Uralsky, to the Selkups from Vargananzhino (19th to early 20th cc) and Ust-Balyk (17th to early 20th cc), and to the Tobol Tatars from Ostrovnye Yurty (19th to early 20th cc). The closest similarity, according to

Table 2. **Data used for calculation of the proportional correction factor (PCF)**

Indicator	Okunevo VII			Bergamak II			Chertaly I			Toksay I			Toksay II			Letniy Kaurdak			Tyulchakovo		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Number of teeth examined	117	352	469	82	232	314	99	271	370	145	262	407	190	289	479	206	413	620	311	567	878
Number of teeth with carious lesions	1	10	11	0	7	7	1	12	13	3	5	8	1	8	9	1	20	21	2	43	45
Number of teeth lost post-mortem	103	92	195	142	87	229	173	125	298	54	43	97	42	41	83	179	105	284	153	109	262
Number of teeth lost ante-mortem	1	34	35	0	0	0	18	52	70	3	8	10	14	55	69	18	84	102	50	158	208
Number of teeth with carious lesions penetrating into the pulp	0	1	1	0	0	0	2	6	8	0	1	1	0	6	6	1	10	11	0	23	23
Total number of teeth with open pulp	0	1	1	1	1	1	4	6	10	2	2	4	2	6	8	2	10	12	2	23	25

Note: A – anterior teeth, B – masticatory teeth, C – all teeth.

Table 3. **Prevalence of caries in different populations grouped according to their occupational activity***

Sample	Base of economy	Number of individuals	Caries rate ("individual count"), %	Number of teeth	Caries rate ("teeth count"), %
8th to early 12th cc					
Zeleny Yar	Hunting, fishery	1	0	16	0
Nekh-Uriy-3.5	"	7	0	53	0
Saygatinsky-1	"	19	0	227	0
Saygatinsky -3	"	13	0	192	0
Saygatinsky-6	"	40	2.5 ± 2.5	603	0.2 ± 0.2
Ust-Balyk	"	4	0	41	0
Late 12th–16th cc					
Bederevsky Bor I	"	9	0.0	151	0
Bederevsky Bor III	"	9	11.1 ± 10.5	158	0.6 ± 0.6
Saygatinsky -1	"	2	0	14	0
Saygatinsky -3	"	5	0	36	0
Saygatinsky -4	"	65	7.7 ± 3.3	987	1.0 ± 0.3
Zeleny Yar	"	9	11.1 ± 10.5	98	1.0 ± 1.0
Ust-Balyk	"	9	0	107	0
17th to early 20th cc					
Native population					
Bederevsky Bor II	"	33	12.1 ± 5.7	659	0.6 ± 0.3
Ust-Balyk	"	2	50.0 ± 35.4	55	5.5 ± 3.1
Fort Nadym	"	4	0	36	0
Vargananzhino	"	12	50.0 ± 14.4	1049	1.4 ± 0.4
Russian population					
Verkhoturye	Agriculture	22	54.5 ± 10.6	448	5.8 ± 1.1
Kamensk-Uralsky	"	18	77.8 ± 11.5	747	3.7 ± 0.7
Revda	"	13	53.8 ± 13.8	281	6.0 ± 1.4
Siberian Tatars					
Ostrovnye Yurty	"	34	57.1 ± 8.5	818	3.3 ± 0.6
Okunevo VII	…	28	10.7 ± 5.8	469	2.3 ± 0.7
Bergamak II	…	24	16.7 ± 7.6	314	1.9 ± 0.8
Chertaly I	…	25	28.0 ± 9.0	370	3.5 ± 1.0
Toksay I	…	20	45.0 ± 11.1	407	1.3 ± 0.6
Toksay II	…	21	28.6 ± 9.9	479	1.4 ± 0.5
Letniy Kaurdak	…	35	31.4 ± 7.8	619	3.3 ± 0.7
Tyulchakovo	…	44	47.7 ± 7.5	878	5.1 ± 0.7

*Compiled after (Razhev, Rykun, Svyatova, 2011; Slepchenko, 2015).

Table 4. **Proportional correction factor (PCF) for populations with different occupational activities**

Sample	Period	*N*	PCF, %
Rural population of Ibiza (Punic period) (Márquez-Grant, 2009)	6th–2nd cc BC	66	12.8
Antandros (Erdal, Duyar, 1999P	7th–2nd cc BC	60	18.5
Iznik (Ibid.)	13th c AD	365	14.9
Erzurum (Ibid.)	20th c AD	62	24.0
Ostrovnye Yurty (Slepchenko, 2015)	19th to early 20th cc	36	11.6
Okunevo VII	16th–17th cc	28	3.8
Bergamak II	16th–17th cc	24	5.5
Chertaly I	18th–19th cc	25	12.7
Toksay I	18th–19th cc	20	2.8
Toksay II	19th to early 20th cc	21	11.6
Letniy Kaurdak	19th to early 20th cc	35	14.8
Tyulchakovo	19th to early 20th cc	44	17.5

both "individual count" and OCR, is observed for the late groups of Siberian Tatars from Chertaly II and Tyulchakovo. This observation might suggest that the proportion of easily digestible carbohydrates in the diets of those two groups of Siberian Tatars was similar to that of Russian population from Urals, but much higher than in paleopopulations of the 16th–17th cc from Bergamak II and Okunevo VII.

Data on the prevalence of caries adjusted using the correction factors are still scarce. Thus, available reference data from Siberia are lacking, and we were only able to compare our groups with geographically remote populations. The comparison of the PCF in different groups of Siberian Tatars has shown that the samples from Okunevo VII, Bergamak II, and Toksay I display very similar values, while in all other groups it is more than three times higher. This points towards a substantial change in the diet of Siberian Tatars in the 18th–19th cc, relating to an increase of the consumption of digestible carbohydrates. The comparison of the chronological groups leads to the following conclusions. According to caries rate, the lowest amount of easily digestible carbohydrates was consumed by the Siberian Tatars of the 16th–17th cc, and the highest in the 19th to early 20th cc. The difference between the chronological groups is statistically significant. The samples from Toksay I and Chertaly I (18th–19th cc) probably represent the transitional time between the periods of low and substantial consumption of carbohydrates. Since these burial-grounds are not precisely dated, it can be hypothesized from the observed caries rates that the first site is more ancient, because the PCF in its sample is similar to that of the earlier populations. The second cemetery is probably more recent. However, other explanations of the apparent difference in caries rates between Toksay I and Chertaly II, such as different subsistence strategies or a different accessibility of carbohydrates, cannot be ruled out.

The PCF in the late populations of Siberian Tatars is mostly similar to that in the rural population of Ibiza Island of the 6th–2nd cc BC and the populations of Anatolian farmers from Antandrus (7th–2nd cc BC), Iznik (13th c AD), and Erzurum (20th c AD). It is known that the diet of the rural population of Ibiza consisted predominantly of agricultural products and only small amount of meat (Márquez-Grant, 2009). Thus, in the recent groups of Siberian Tatars, the products of agriculture probably predominated in the diet, while the products of cattle-breeding and fishing were supplementary foods. The lower values of the PCF in Okunevo VII and Bergamak II, as compared to the farmers from Anatolia and Ibiza, seem to confirm the hypothesis as to the main role of the products of cattle-breeding and fishing for those groups of Siberian Tatars, and the supplementary role of agricultural products (see Table 4).

An explanation of the difference in caries rates between the early and late chronological groups of Siberian Tatars can also be found in historical and ethnographic data. Many researchers note that in the economy of the Tara Tatars in the 17th century agriculture “was only an ancillary occupation” (Volkov, 1965: 113). V.I. Shunkov points out that the farming of all Siberian Tatars of that time “was primitive and, according to its economic importance, was only an aid to hunting and herding” (1956: 34). Thus, the relatively low frequency of caries in the Okunevo VII and Bergamak II samples might be related to a decreased consumption of agricultural products as compared to the later populations. In the economy of the Ayaly Tatars, who buried at those cemeteries, cattle-breeding, hunting, and fishing also played the leading role.

The further gradual increase of caries rates in Siberian Tatars, beginning from the end of the 17th century, is most probably related to the intense immigration of ethnically Russian population, and later—Tatars from the Volga-Ural region, to the Irtysh region. In 1667, the peasants from Tara city asked the government to relocate them to new lands because their own arable had been exhausted. They were asking to let them go to the Tara River, where “the land is good” and “has never been ploughed”. A settlement there was created by 1670. The *Inventory Book of 1701* of the Tarsky Uyezd, which contains information about the Birgamatskaya (spelling of that time) Sloboda, has been preserved until the present time (Berezhnova, (s.a.)). The appearance of Russian peasants, and later—Kazan Tatars, led to a gradual increase in farming production in the area inhabited by Siberian Tatars. Hence, agricultural products became more available. Such intensification of agricultural activity was earlier described for Baraba Tatars in the second half of the 19th to the first third of the 20th century (Myagkov, 2008). R.K. Satlykova (1976) and F.T. Valeev (1980: 70–103) report that agriculture started playing the leading role in the economy of Siberian Tatars in the late 19th to the early 20th century. This was probably one of the main reasons for the increase in caries rates among Tatars of Siberia in that period.

Other reasons for that increase are the improvement in quality of flour and the consumption of sugar. Notably, the peak of consumption of the refined carbohydrates mentioned above in Europe in the middle of the 19th century coincided with a substantial increase in caries prevalence. According to researchers, the industrial production of sugar and availability of the flour of higher quality had increased the cariogenicity of diet and, consequently, the frequency of caries (Moore, Corbett, 1975; Moore, 1993; Saunders, De Vito, Katzenberg, 1997).

Our results for the OCR and PCF have shown that anterior teeth were less affected by caries than masticatory teeth. Other researchers have arrived to similar conclusions (Kerr, Bruce, Cross, 1988). This is a natural result of the complexity of the occlusal surface of molars and premolars (presence of fissures), a longer contact with food items during mastication, and a longer retention of plaque and small fragments of food.

Conclusions

According to both observed caries rate (OCR) and the percentage of individuals in a sample having at least one tooth affected by caries (“individual count”), the Siberian Tatars of the 16th–17th centuries from Okunevo VII and Bergamak II demonstrate the closest similarity with the Late Medieval population of northwestern Siberia. The diet of both northwestern Siberians and the Tatars probably included only minimal amounts of flour-dishes, but the higher prevalence of caries in the latter points towards a higher proportion of carbohydrates in their diet.

According to the same measures of the prevalence of caries, the groups of Siberian Tatars from Chertaly I, Toksay I and II, Tyulchakovo, and Letniy Kaurdak (18th to early 20th cc) were similar to the ethnically Russian population from Revda, Verkhoturye, and Kamensk-Uralsky (18th–19th cc), Selkups from Vargananzhino (19th to early 20th cc) and Ust-Balyk (17th to early 20th cc), and the Tobol Tatars from Ostrovnye Yurty (19th to early 20th cc). This observation suggests a similar, and substantial, amount of digestible carbohydrates consumed by the groups of Siberian Tatars and Russians from Urals listed above.

The comparison of the populations of Siberian Tatars carried out using the proportional correction factor (PCF) for caries rate has detected a more pronounced and statistically significant difference between the early (16th–17th cc) and late (18th to early 20th cc) groups. This finding points towards a substantial change in the structure of diet during the 18th–19th centuries relating to an increased consumption of easily digestible carbohydrates, which, in turn, indicates an increased role of agriculture and its products in the economy and diet of Siberian Tatars. The intense colonization of the Irtysh region by Russian peasants in the 17th century, and later by Tatars from the Volga-Ural region, led to a gradual increase in farming-production in the area inhabited by Siberian Tatars; after which, agricultural products became increasingly available.

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To the Anniversary of Dr. Lyudmila Mylnikova

On March 9, 2017, the archaeologist Lyudmila Mylnikova, Leading Researcher at the Institute of Archaeology and Ethnography of the SB RAS, Doctor of Historical Sciences, Laureate of the State Award of the Novosibirsk Region, has celebrated her anniversary. Lyudmila is a representative of the "old guard" of our Institute; her first teachers were Academicians A.P. Okladnikov, A.P. Derevianko, and V.I. Molodin. In the Institute, she has worked her way up from Laboratory Assistant to Leading Researcher.

Lyudmila Mylnikova was born in the town of Toguchin in the Novosibirsk Region. From her early childhood, she was well familiar with all difficulties of life of a simple worker-and-peasant family. The father of Lyudmila, Nikolai Alexandrovich, worked as a driver in a local motor transport facility. Her mother, Pavlina Pavlovna, took part in the construction of the Toguchin hydro-electric power station and worked at a collective farm. Hardships of childhood and probably strict but right upbringing by her parents developed such remarkable qualities of Lyudmila Mylnikova as honesty, integrity, and humaneness. Lyudmila is respected and loved by her friends, colleagues, and students.

In 1974, after completing her studies in the secondary school, Lyudmila entered the Historical and Pedagogical Department of Novosibirsk State Pedagogical Institute, which she successfully graduated in 1979. At the first year in the institute, her meeting with the future Academician V.I. Molodin, the doctoral student of Academician Alexey Okladnikov, became life-changing for her. After graduation from the institute, Lyudmila was invited to work in the Archaeological Sector of the Institute of History, Philology, and Philosophy of the SB AS USSR, in the group of Academician A.P. Okladnikov. Together with V.D. Zaporozhskaya, A.K. Konopatsky, and E.A. Skorynina she participated in the preparation of the monograph by A.P. Okladnikov, *The Ancient Settlement of Kondon (the Amur region)* (Novosibirsk: Nauka, 1983) for publication. Alexey Okladnikov suggested Lyudmila the topic, "Pottery of the Neolithic Tribes in the Lower Amur Region (Based on Materials of the Kondon Pochta Settlement)", which at that time was little researched. After the death of the Academician A.P. Okladnikov, the supervisor of the selected topic became V.E. Medvedev. In 1992, Lyudmila Mylnikova defended successfully her doctoral dissertation. She deals with the issues of pottery in Siberia and in the adjacent territories until today.

A thorough knowledge of archaeological materials, and the use of innovative methods of comprehensive analysis of pottery allowed L.N. Mylnikova to brilliantly defend her post-doctoral dissertation, *Pottery of the Transitional Period from the Bronze Age to the Iron Age in the Forest-Steppe Zone of Western Siberia: A Dialogue of Cultures*, in 2015.

Since 1993, Dr. Mylnikova has been carrying out her own research on settlements and cemeteries of Western Siberia. Under her supervision and with her direct participation, many well-known sites were thoroughly studied: Tanai-7, Linevo, Berezovy Ostrov, Chicha, Tartas, Vengerovo-2, etc. The results of the technological, physical, and chemical analyses of ancient pottery obtained by Lyudmila Mylnikova, and their interpretation have perfectly entered into many of her comprehensive studies of archaeological sites. In fact, these works have made Lyudmila Mylnikova one of the leading experts in the ancient pottery of North and East Asia from the Early Neolithic to the Middle Ages.

The system of comprehensive study of ancient pottery techniques developed by Lyudmila Mylnikova, with the mandatory application of various natural scientific methods of analyzing the materials of the site under study, and the use of similar artifacts from the adjacent territories, contributes to the development of global issues of reconstruction of ethnic and cultural history of the population of North and East Asia. Dr. Mylnikova always harmoniously balances intense field research in Western Siberia and the Far East with analytical work and teaching in Novosibirsk State University. She authored over 200 publications, including 12 monographs and guidebooks. A special place among her works is taken by the studies on technological and ornamental-morphological research of ancient ceramics. Lyudmila Mylnikova's studies are in great demand in national and international scholarly community. Some works of Lyudmila Mylnikova has been published in the Republic of Korea, Japan, China, Germany, Ukraine, and USA. Dr. Mylnikova is an active participant in many Russian and international scientific conferences, symposia, and congresses, and is often invited to make reports. For over fifteen years, Lyudmila Mylnikova has been a Scientific Secretary at the Department of Metal Ages Archaeology of the Institute of Archaeology and Ethnography of the SB RAS, and an Expert at the Department of Field Research at the Institute of Archaeology of the Russian Academy of Sciences.

Lyudmila Mylnikova has celebrated her anniversary in the prime of her creative energy. We wish her many new expeditions, new books, new students, and new successes.

V.I. Molodin, E.I. Derevianko, V.P. Mylnikov, S.P. Nesterov, N.V. Polosmak, T.A. Chikisheva, A.I. Soloviev, A.P. Borodovsky, A.V. Tabarev, Y.S. Hudiakov

AN SSSR – USSR Academy of Sciences

CNRS – Centre national de la recherche scientifique (Paris)

DRAC – Direction régionale des affaires culturelles

IA RAN – Institute of Archaeology, Russian Academy of Sciences (Moscow)

IAE SO RAN – Institute of Archaeology and Ethnography, Siberian Branch of the Russian Academy of Sciences (Novosibirsk)

IGiG SO AN SSSR – Institute of Geology and Geophysics, Siberian Branch of the USSR Academy of Sciences (Novosibirsk)

IIFF SO AN SSSR – Institute of History, Philology and Philosophy, Siberian Branch of the USSR Academy of Sciences (Novosibirsk)

IIMK RAN – Institute for the History of Material Culture, Russian Academy of Sciences (St. Petersburg)

IIYAL UNC RAN – Institute of History, Language, and Literature, Ufa Research Centre, Russian Academy of Sciences (Ufa)

KhakNIIYaLI – Khakass Research Institute of Linguistics, Literature, and History (Abakan)

KSIA – Brief Communications of the Institute of Archaeology, Russian Academy of Sciences

MIA – Materials and Investigations on Archaeology in the USSR

NGU – Novosibirsk State University (Novosibirsk)

NIC OIGGM SO RAN – Scientific Publishing Center of the Joint Institute of Geology, Geophysics and Mineralogy, Siberian Branch of the Russian Academy of Sciences (Novosibirsk)

RASHN – Russian Academy of Agricultural Sciences

RGO – Russian Geographical Society

SAI – Collection of Archaeological Sources

SB RAS – Siberian Branch of the Russian Academy of Sciences

SNIIGGiMS – Siberian Research Institute of Geology, Geophysics and Mineral Resources (Novosibirsk)

UNC RAN – Ufa Research Centre, Russian Academy of Sciences (Ufa)

VEGU – Academy of Economics, Law and Humanities (Ufa)

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