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The Origin of Culturally Diversified Individuals Buried in the Early Iron Age Barrow Cemetery at Chultukov Log-1 (Upper Altai) in Light of the Analysis of Stable Oxygen Isotopes

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ABSTRACT

Chultukov Log-1 is a large barrow cemetery, located in the valley of Lower Katun river (Northern Altai, Russia), in which various cultural traditions of the Scythian era are represented (Pazyryk, Karakoba, Bystrianka). The main goal of this study was to determine whether the individuals buried in the cemetery and representing different cultural traditions are uniform in terms of their geographical origin. In order to reconstruct the origin of individuals an analysis of the isotopic composition of oxygen was performed within bone apatite phosphates from well preserved samples. To verify the state of preservation of human and animal osseous remains, diagenetic indices were calculated based on Fourier Transform Infrared Spectrometer (FTIR). One of the most important conclusions is that the individuals from the cemetery probably originated in the north. The most probable scenario includes population movements of the Bystrianka culture people from the steppe and piedmont zones to the south, to the mountainous valley of Lower Katun river in the Northern Altai, where they assimilated with the North Pazyryk communities. However, the contact of the inhabitants of the Norhern Altai with the south was not the result of migrations, but rather of the trade and the common genesis of the North Pazyryk groups and the Pazyryk culture from Central and South-Eastern Altai. Some people of local origin had different eschatological beliefs and accordingly buried their dead in stone boxes (Karakoba type).

Key words: *isotope analyses, mobility of Scythian people, Pazyryk culture, Karakoba culture, Bystrianka culture, Northern Altai in the Early Iron Age*

introduction

In search for answers to the constantly emerging questions concerning prehistoric and historic human populations, contemporary bioarchaeological research makes wide use of biochemical methods related to the analysis of stable isotopes. Among all the elements whose isotope concentrations have the potential to broaden our knowledge about our ancestors, it is oxygen that can be informative of the origin and mobility of particular individuals. Examining human remains, scholars increasingly often look for information about social relationships in the past, both those among groups and those of an indigenous-newcomer type[1,2].

Combined with hydrological observations which confirm a link between the isotope composition of oxygen in environmental water and local geographical and climatic conditions, the method based on the analysis of stable oxygen isotopes allows for the reconstruction of the places of origin of single individuals and entire groups[2,3-6]. More-

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over, the analysis of stable oxygen isotopes in bone tissue has proven to be particularly useful in tracing seasonal migrations of animals and humans[7-11], migrations of individuals between groups, and the settlement origins of particular territories[2,12-13]. The method also makes it possible to analyse climate changes of the past[14-18].

Over the centuries, decisions to change a place of settlement and to choose one migration route or another may have been affected by a number of factors, such as attempts to avoid epidemics, conflicts with hostile neighbours, or to adopt a new adaptive strategy, or such choices may have had an urbanistic or political background[1,3,13,19-21]. Human migrations, and this holds true today, involve the resettlement of individuals, small groups, or even entire communities. Applying the stable oxygen isotope analysis method makes it possible to identify individuals of non-local origin among those found in an archaeological site. It is worth noting that the comparative materials typically used in isotope research are environmental water and the remains of animals representing the same chronological period and place as the analysed individual[10,22-25]. Given the animal mode of life and the possibly local occurrence of certain animal species, one can assume that the isotopic composition of their bones reflects the isotopic proportions characteristic of the region they inhabit. Therefore, the isotopic composition of oxygen in local fauna offers a good environmental background for isotopic research.

The concentration of stable oxygen isotopes in body water correlates with the isotopic composition of drinking water. The latter, along with the water contained in food and the atmospheric oxygen, is the primary source of oxygen which ultimately absorbs into body tissues as a result of metabolic processes[5,14,26-28]. The isotopic composition of oxygen in bone phosphates ($\delta^{18}O_p$) is the outcome of the balance between the isotopic composition of the water introduced to and removed from the organism[29]. Stable oxygen isotopes build in the mineral fraction of bone tissue, first of all in the phosphate and carbonate groups in hydroxyapatite[30]. Due to a greater stability of inter-atomic bonds in phosphate groups, and in consequence their greater resistance to diagenetic factors operating after burial, these bone phosphates may be examined for the isotopic composition of oxygen. Taking into consideration the potential possibility of determining the origin of individuals and their mobility by oxygen isotope research, an attempt was made to identify the place of origin of 22 individuals representing various cultural traditions, buried in the barrow cemetery of Chultukov Log-1 in the northern part of Upper Altai, Russia.

Environmental background

Situated in the central part of Eurasia, the Altai Mountains are the highest range in South Siberia. The main ranges, known as the Katun, the Northern Chuya, and the Southern Chuya reach over 4000 m a.s.l., and the highest summit is Belukha (4506 m a.s.l.) at the Russia-Kazakhstan border. The major Altai rivers are the Bija and the Katun (which merge near Barnaul to form the Ob river), the Buchtarma, the Chuya, and, in the Northern Altai, the Anui, the Charysh, and the Pieschana. In prehistory, these river valleys were natural, convenient communication routes allowing deeper access into the mountains[31]. Some of them (the Katun and Chuya valleys in particular) have maintained this role until today, leading to the south-east, towards the Mongolian border. This makes these sub-regions (river valleys) of paramount importance for studying the links among the peoples inhabiting the Altai, its foothills, and the nearby steppe and forest-steppe areas in the upper Ob river basin. A distinct concentration of archaeological sites observable in river valleys may to some extent stem from the state of research and the methodology of surface surveys, but on the other hand it surely reflects settlement preferences of prehistoric populations inhabiting the region. The areas between the major valleys were simply not suitable for occupation and economic activity. These were barely accessible mountains, with elevations often reaching 1100-1300 m a.s.l., up to as high as 2500 m in the southern part of the Northern Altai.

According to Pietkievich's classification, the site of Chultukov Log-1 analysed here lies in the north-eastern zone of the Upper Altai[32-33]. The northern boundary of this territory is marked by the border between the Altai Foothills and the adjacent steppe plain, which is easily discernible on a physical map (Figure 1a). The south-western and southern boundaries are delineated by the upper course of the Charysh River, which in this section flows parallel from the east to the west. Further to the east, the boundary runs along the Sema Range, which encloses the region in question from the south and south-east. The range is up to 2500 m high, and the place where its north-eastern extremity meets with the Katun Valley marks a conventional boundary of the Northern Altai; the place where the Ursul River empties into the Katun is another characteristic landmark on this boundary. Today an important point on the Chuya Route (a road built in the early 20th century, linking the Northern Altai with Mongolia), the Sema Pass piercing the Sema Range has been used as a convenient gate to the south since prehistoric times. The eastern boundary of the region of our interest is marked by the River Bija, beyond which lie the Western Sayan Mountains.

The region in question is distinguished by high humidity, large areas of forest cover, and relatively rich vegetation of a kind of Siberian taiga. Mountain slopes are steep, rocky, and densely forested in places, which generally makes them for the most part inaccessible. The predominant rock types are conglomerates and sandstones, as well as breccia and tuffs. The lower Katun Valley is part of the Katun anticlinorium – a series of early Caledonian folds extending from the Chuya Valley to the region where the Maima River empties into the Katun in its northern, lower course. From the perspective of archaeological research, an important feature of the Northern Altai climate is the relatively rapid pace of the process of stone barrows becoming covered with turf[35].

Geographical conditions in particular regions of the Altai varied, which affected settlements and subsistence

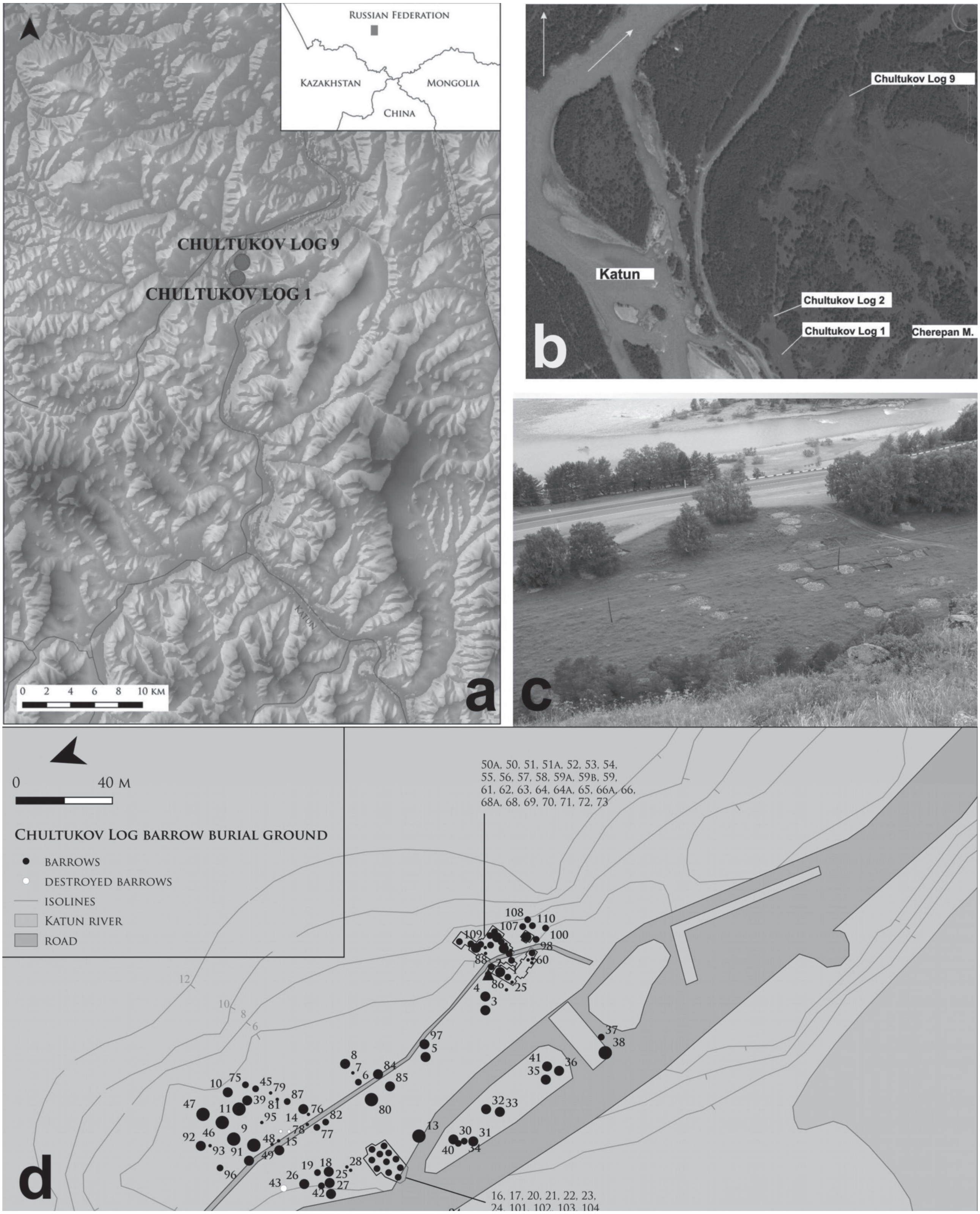

Fig 1. The location of Chultukov Log-1 site: a – drawn by P. Töth, b – after Google Earth, c – photo Ł. Oleszczak.; d – plan of the site (drawn by P. Töth after: Borodovskiy, Borodovska 2013, fig. 34).

patterns. The area of Northern Altai as defined here was surely a geographically distinct micro region with a specific climate and landscape. In the Scythian Period this resulted in the development of local variants of the Pazyryk culture, which were influenced by the local environment and by contact with neighbouring cultural groups. The specific geographical conditions and the proximity of another, different ecumene were the main reasons behind the formation of the North Pazyryk variant in the Northern Altai, and the development of a zone of intercultural contact there. The latter phenomenon was connected with the proximity to a relatively narrow (from several to several dozen kilometres wide) stretch of piedmont areas (small hills covered with forest-steppe vegetation) and to the steppes of the West Siberian Plain.

Despite its relatively rapid current, the Katun River was not particularly difficult for prehistoric people to cross. Nevertheless, its two banks differ considerably, in terms of both climate and archaeology. The right bank, of the Lower Katun in particular, was much more intensively settled. Between the north-eastern extremity of the Sema Range (considered the southern boundary of the Katun lower course) and the end of the mountain section of this river (near its confluence with the Maima), one can count 15 Scythian Period sites along the right bank of the Katun, as compared with only one Tavdushka cemetery on the opposite bank. This stems from a better climate: the eastern side is much less humid due to the predominantly southern and western exposures of the slopes. Such conditions were favourable for the complex economy practiced by the Iron Age population, which was based on mobile herding with an important contribution from stationary farming. Furthermore, in the northern course of the river its right bank is more easily accessible, while the left bank has remained more difficult to penetrate even today. This could lead one to assume that this glaring disproportion in the number of finds stems from the state of research as well. This is indeed true to some extent, although surface surveys have been carried out on the left bank of the lower Katun (admittedly on a smaller scale than on the right bank) and they only have confirmed the sparse occupation of that region (P.I. Shulga, personal information).

The Northern Altai foothills is an area of low-mountain landscape with thick snow cover in winter, which makes year-round cattle grazing difficult or even impossible. This made the region a natural boundary for Northern Altai nomads, given their mode of subsistence. Pastoralist groups could have stayed there only temporarily, due to climate changes or competition over this territory between the northern and southern tribes. Another drawback of the region was seismic activity – traces of earthquakes have been recorded on Scythian Period sites, among other places[35]. In this respect, however, the region is no different from the rest of the Upper Altai.

The individuals whose remains were subjected to isotope analyses for the reconstruction of mobility represent several Early Iron Age archaeological groupings from the Northern Altai. The most important of them is the Pazyryk culture, belonging to what is known as Scythian-type groups, which developed from the mid-6th to the 3rd/2nd centuries BC. According to recent research, the 3rd century BC was when the Pazyryk culture reached its heyday. Contrary to the traditional dating to the second half of the 5th century BC[36], the more recent research demonstrated that the five princely kurgans from the eponymous site of Pazyryk were erected ca. 300-250 BC[37]. A variant of this culture identified in the Northern Altai is called the North Pazyryk variant[38], and it bears distinct local traits different from the classic variant known from the princely kurgans (e.g. Pazyryk, Bashadar, and Tuekta) and from the finds in the Ukok Plateau. In the Northern Altai, the sites linked with the North Pazyryk variant show evidence of influence from the steppe areas adjoining the region from the north. Another trait which distinguishes the region in question from the high-mountain (classic) variant of the Pazyryk culture is the presence of long-used settlements, such as Muny I[39], including defensive ones - Barangol site 5 and Manzherok site 3. With respect to the latter site (situated approx. 3 km from the Chultukov Log-1 cemetery), it was suggested that its fortifications had not been built before the Hunnic Period[40], but in our opinion they should rather be linked with the Scythian Period, which is also corroborated by more recent radiocarbon dates[41]. The presence of permanent settlement structures, tools such as querns and grinders, and the paleodietetic data from cemeteries of Barangoł-1,2, and 4[42], all indicate that farming played a more important (supplementary) role in the Northern Altai than in higher parts of the Altai Mountains, more favourable for herding.

Site description - the Chultukov Log-1 barrow burial ground

The Chultukov Log-1 cemetery is comprised of 123 barrows and flat inhumations. It is considered to be the biggest nomadic burial grounds in the Upper Altai and Sayan Mountains found so far. Furthermore, the graveyard was not robbed, like many others in this region[34] (Figure 2). All samples have been collected from barrow inhumations. The barrows were circular in shape and relatively flat (about 0.2-0.3 m high), the diameters range from 4 to 13 m. The main chamber was located in the middle of the large circle that was built of irregular boulders (the so-called *crepidoma*). Barrows are sited in binary pairs, in clusters or arranged in a straight N-S running lines. Collected material is considered to be representative for major nomadic cultural traditions of the Scythian period in the Manzherok region. The cemetery is associated with three archaeological cultures that inhabited the territory of Northern Altai in the Early Iron Age (6th century B.C- 2nd century B.C.), but they seem to represent distinct ethnic groups: the Pazyryk culture, the Bystrianka culture, the Karakoba cultural tradition. Some samples were also collected from Maima culture barrow of the Xiongnu-Xianbei-Rouran period (2nd century B.C - 5th century A.D).

One of the still unresolved problems is connected with the presence in the Pazyryk culture cemeteries of burials in stone boxes, known as the Karakoba type. Burials in

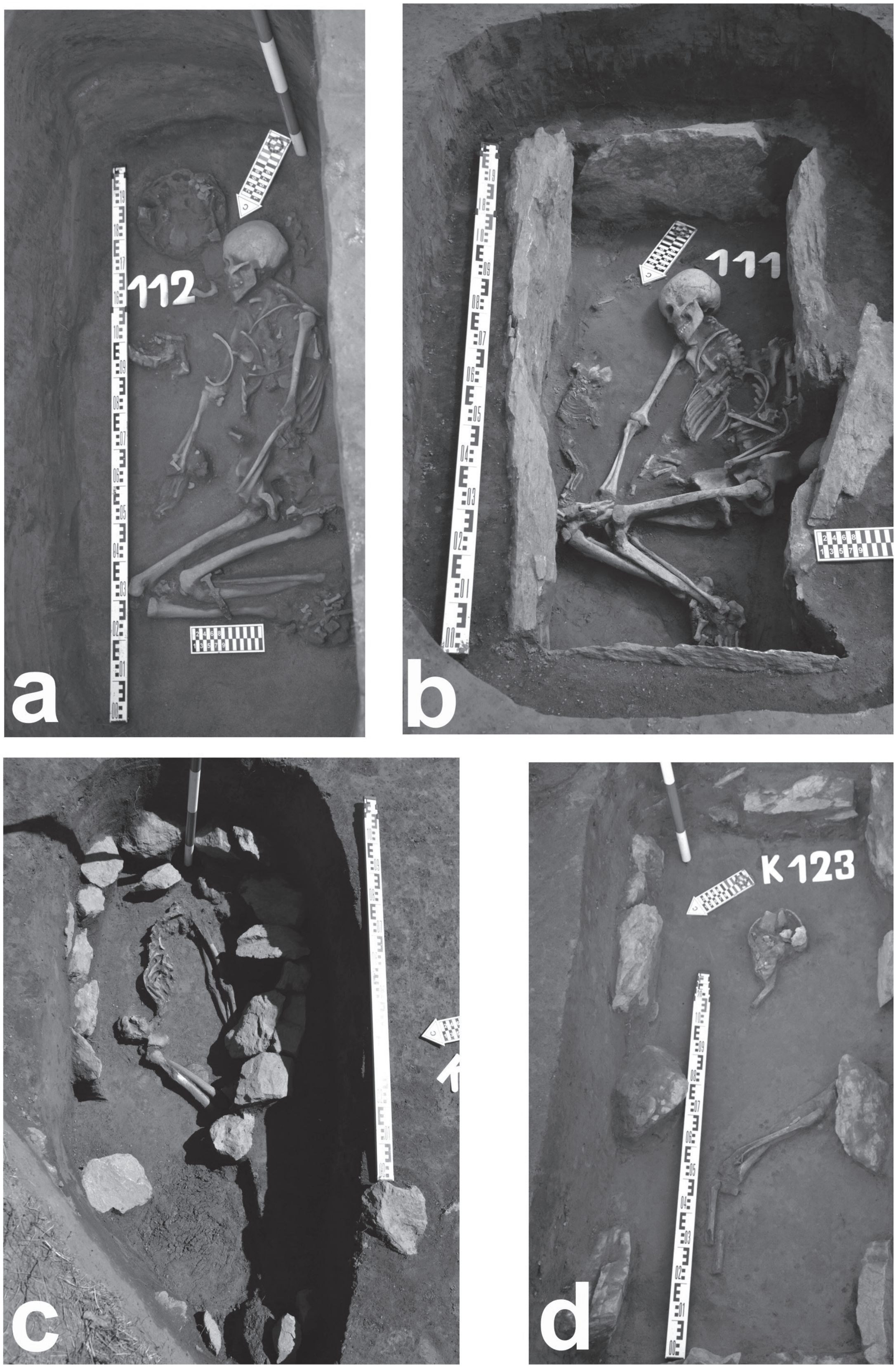

Fig 2. Examples of skeletal burials from the archaeological site of Chultukov Log-1, barrows: a – 112, b – 111, c - 122, d – 123. Photo A.P. Borodovskiy, Ł. Oleszczak.

stone boxes occurring in Scythian Period cemeteries in the Altai provided grounds for distinguishing the Karakoba culture[43], today more often referred to as the Karakoba type, and such burials have also been recorded in Pazyryk culture cemeteries, where the majority of the deceased were buried in chamber graves, in chambers built from timber[44]. Our most recent calculations show that the proportion of such burials in the Northern Altai cemeteries approaches 6%. The reason why a segment of the Scythian Period Altai population buried their dead in stone boxes remains unclear. Therefore, the authors of this paper have recently proposed a multidisciplinary approach to the issue[45]. The analysis of the mobility of the deceased from the Karakoba-type burials using oxygen isotopes can be expected to provide new arguments for this discussion.

Another important issue concerns the mutual relationship between the people known as the Bystrianka and North Pazyryk cultures. The former communities occupied the borderland between the mountains and the steppes adjoining the Altai from the north. In the Scythian Period, a cultural contact zone developed in the Northern Altai, with tribes from South Siberian steppes establishing contact with the Upper Altai peoples. In this context, it is worth emphasising that the cemetery of Chultukov Log-1 is the southernmost site where Bystrianka culture burials were recorded. This opens interesting research questions concerning the infiltration of the Northern Altai by steppe tribes. Data about the mobility of the deceased buried in graves attributed to the Bystrianka culture in Chultikov Log-1 can be very informative in this respect.

Burials linked with the Maima culture of the Hunnic Period present another research issue. Beginning from the 2nd century BC, the inhabitants of the Altai, the Lower Katun valley included, started to adopt a model of material culture typical of the Xiongnu cultural complex. Whether this was due to migration or cultural borrowings (perhaps in the period when the Xiongnu tribes rose to prominence in Central Asia) remains open to question.

Aim of the study

The variety of cultural traditions co-occurring in the discussed necropolis creates an opportunity to address unresolved problems concerning migrations and the mobility of people representing particular Iron Age communities from the Northern Altai.

The main goal of this study is to determine whether the individuals buried in the barrow cemetery of Chultukov Log-1 and representing different cultural traditions are uniform in terms of their geographical origin. The examination of stable oxygen isotopes will be used to determine whether the diversity of cultural traditions represented in the cemetery reflects the physical movements of particular individuals, or stems from the migration of ideas while the biological substrate remained unchanged.

Materials

The bone material used in our research comprised fragments of phalanxes and ribs originating from 22 individuals (14 males, 6 females, and 3 of undetermined sex). The environmental background was determined based on 8 samples of animal bones (roe deer and horse) recovered during the excavation of the nearby Hunnic Period settlement at Chultukov Log-9. The detailed data are presented in Table 1. It is worth emphasising that the necropolis from which the animal bones were recovered is situated in the northern part of the Upper Altai (Russia), in the mountain valley of the Lower Katun and on the river's right bank. The site is part of what is called the Manzherok micro region. In addition, the environmental variability of oxygen isotope concentrations in precipitation water was determined based on data from environmental calculators (The Online in Isotope Precipitation Calculator - OIPC).

TABLE 1
SEX, AGE AT DEATH, THE RESULTS OF DIGENETIC CHANGES ANALYSES (CI VALUES AND CARBONATE-TO-PHOSPHATE RATIO) AND OXYGEN ISOTOPE COMPOSITION IN HUMAN AND ANIMAL SKELETON SAMPLES FROM ALTAI (X- MATERIAL SHOWS DIGENETIC CHANGES)

Sample	Sex	Age (years)	Culture / species	Crystallinity index (CI)	Carbonate/phosphate ratio (C/P)	Oxygen isotope ratio ($\delta^{18}O$, VSMOW)
A- 1	Male	40-50	Bystrianka	3,57	0,48	11,53
A - 2	Male	30-45	Karakoba	3,23	0,41	11,11
A - 3	-	14-15	Karakoba	3,92 x	0,39	11,11
A - 4	Male	30-45	Karakoba	3,17	0,48	13,20
A - 5	Male	25-35	Bystrianka	2,76	0,36	11,89
A - 6	Male	25-35	Pazyryk	2,77	0,27	13,47
A - 7	Male	25-35	Pazyryk	2,18	0,35	12,30
A - 8	Female	20-25	Pazyryk	3,74 x	0,30	12,71
A - 9	Male	14-15	Pazyryk	2,60	0,46	12,59
A - 10	Female	20-35	Pazyryk	3,03	0,42	14,18
A - 11	Male	30-45	Karakoba	2,80	0,28	12,44
A - 12	Female	25-30	Pazyryk	2,89	0,42	12,90

Sample	Sex	Age (years)	Culture / species	Crystallinity index (CI)	Carbonate/phosphate ratio (C/P)	Oxygen isotope ratio ($\delta^{18}O$, VSMOW)
A - 13	Male	30-45	Maima	2,94	0,27	13,62
A - 14	Male	35-45	Maima	3,34	0,25	11,60
A - 15	Female	25-45	Maima	3,22	0,24	11,97
A - 16	Male	40-50	Maima	3,24	0,26	12,12
A - 17	Female	35-45	Maima	2,94	0,22	12,09
A - 18	Female	Adultus	Karakoba	2,85	0,39	12,61
A - 19	Male	30-40	Pazyryk	2,51	0,71 x	12,44
A - 20	Male	30-40	Pazyryk	3,09	0,33	12,58
A - 21	-	25-45	Pazyryk	3,38	0,16	11,79
A - 22	-	8-9	Pazyryk	3,24	0,20	13,55
CH-L Z-1	Animal		Horse	2,64	0,41	11,80
CH-L Z-2	Animal		Horse	2,73	0,28	15,50
CH-L Z-3	Animal		Roe	3,00	0,27	12,22
CH-L Z-4	Animal		Roe	3,23	0,24	14,53
CH-L Z-5	Animal		Roe	3,05	0,27	13,11
CH-L Z-6	Animal		Roe	3,45	0,41	13,13
CH-L Z-7	Animal		Roe	4,10 x	0,49	16,30
CH-L Z-8	Animal		Roe	3,01	0,41	15,23

Methods

Analysis of diagenetic changes – FTIR

In order to verify the condition of preserved of human and animal osseous remains, diagenetic indices were calculated based on spectroscopic spectra (Fourier Transform Infrared Spectrometer or FTIR) obtained for hydroxyapatite of each bone sample examined using the procedure developed by Wright and Schwarcz (1996). FTIR spectra analysis was carried out by the Essential FTIR software.

The resulting spectra presenting peaks characteristic of phosphate and carbonate groups of bone apatite were used to calculate the crystallinity index and the carbonate/phosphate ratio. On the basis of information contained in the spectrum of each of the samples collected for analysis, the Crystallinity Index (CI) was calculated from the following equation: $CI = (A_{565}+A_{605})/A_{595}$ where: A – absorbance at infrared wavelength; 565, 605 – values corresponding to two wavelengths absorbed by the PO_4 group[46]. The carbonate/phosphate ratio (C/P) defines the degree of biogenic apatite contamination with exogenous carbonates. It is expressed by the equation: $C/P=A_{[1415]}/A_{[1035]}$, where: $A_{[x]}$ – absorbance for the band in the x [cm^{-1}] area; 1415, 1035– spectra specific to PO_4 and CO_3, respectively.

Isolating bone phosphates and isotope measurements

An analysis of the isotopic composition of oxygen was performed within bone apatite phosphates. The analytical procedure for the isolation of bone phosphates was carried out according to a study published by O'Neil et al.[47]. After washing bone fragments in distilled water using an ultrasonic cleaner, the material was dried and then ground in a ball mill (Retsch MM 200). Sodium hypochlorite (NaOCl) was added to a 0.4 mg pulverized sample of osseous tissue. Following 24-hour incubation, the sample was rinsed and sodium base was introduced, with which the material was incubated for 48 hours. Incubated bone dust obtained in the process, cleaned of humic substances and other organic impurities, was then incubated in hydrofluoric acid for 24 hours. The apatite dissolved in the acid was neutralized with a potassium base and, after the addition of silver nitrate buffer, incubated at 70°C. Crystallized, filtered and dried silver phosphates were weighed (250±20µg) and placed in silver capsules. The sample was weighed three times, which allowed us to obtain greater measurement accuracy. The isotopic composition of samples was tested at the Institute of Radioisotopes of the Silesian University of Technology in Gliwice using the IsoPrime mass spectrometer coupled with the EuroVector elemental analyzer. The results of the spectrometric analysis in the form of delta notation ($\delta^{18}O_{sample}= [(R_{sample}-R_{standard})/R_{standard}]*1000$) for the samples referenced to isotopic composition values of a laboratory reference standard (NIST 120c) were expressed in the VSMOW scale after standardization to standard mean ocean water. The $\delta^{18}O$ level for the NIST 120c standard was 21.7‰, with a measurement uncertainty of 0.17‰.

Determining environmental background – OIPC

In order to determine the local isotopic composition in the Chultukov Log-1 region, where human osseous material was found, and the Chultukov Log-9 region, where the analysed animal remains originate from, an electronic tool in the form of the Online Isotopes in Precipitation Calculator (OIPC) was used. Oxygen isotope delta values were estimated using the OPIC, since monitoring the isotopic composition of precipitation water is not carried out in those geographic areas. Additionally, by means of the OIPC application, environmental oxygen isotopic composition was estimated in the areas surrounding the skeleton find site within a radius of 500 km (at about 100 km intervals north/south and east/west) to determine the isotopic variation of the macro region as a potential migration area of the analysed individuals.

Results and Discussion

Diagenesis

The analysis of the diagenesis of the material was performed based on the study of the FTIR spectra, according to which two diagenesis indices: the crystallinity index (CI) and the carbonate/phosphate ratio (CO_3/PO_4) were determined. The crystallinity index of the analysed human samples is contained within 2.18-3.92 range, whereas the carbonate/phosphate ratio ranges from 0.15 to 0.71. Diagenetically unaltered samples are those whose CI values do not exceed 3.6, and for which the CO_3/PO_4 index ranges from 0.15 to 0,7[49-50]. Three analysed human bone samples went beyond the above ranges. Samples from subjects 7 and 35 showed increased values of the crystallinity index (respectively 3.92 and 3.74), while the CO_3/PO_4 ratio for the bone sample collected from individual 112 was 0.71, which means that it, too, exceeded the acceptable level for this parameter. The results indicate that the three above bone samples were subject to *post-mortem* degradation. For the above reason, the samples were excluded from the interpretation of the results of the oxygen isotope analysis.

Meanwhile, the diagenetic analysis of animal bone samples showed that the crystallinity of the analysed human samples is contained within 2.18-4.10, whereas the carbonate/phosphate ratio ranges from 0.24-0.49. The CI index of one sample (no. 3; CI=4.10) exceeded 3.6; as a consequence, the results of oxygen isotope analysis for this sample were not taken into account further in this study.

In addition, it was verified whether there is any relationship between CI and CO_3/PO_4 indices, as well as between individual indices and the oxygen isotope level. The analysis was made performed jointly for human and animal bone samples. As discussed earlier, the samples which exceeded reference ranges for the indicators were excluded from the analysis. The results reveal lack of dependence both between CI and CO_3/PO_4 indices ($r=0.14$, $p=0.000$) as well as between the CI index and $\delta^{18}O$ level ($r=0.11$, $p=0.000$), and also the CO_3/PO_4 ratio and $\delta^{18}O$ level ($r=0.05$, $p=0.000$). This confirms the fact that the test samples were not diagenetically altered.

Environmental isotopic background

During the first stage of oxygen isotope analysis local environmental isotope background was determined for areas covered by archaeological excavations, in which the individuals analysed in the study and animal remains were found. The Chultukov Log-1 site, where human skeletons were unearthed is located at the altitude of 296 meters a.s.l., coordinates: 51°50´17.1744´´ N and 85°43´58.1988´´ E. On the basis of OIPC estimates the site is characterized by the mean annual oxygen isotope level of -13.1‰, while values recorded over the months range from -26.4‰ to -6.7‰, with the lowest values recorded in December and the highest in July. In the case of the region where animal remains were found (Chultukov Log-9), situated at the altitude of 379 meters a.s.l., coordinates: 51°50´45.8772´´ N and 85°44´11.8932´´ E, mean $\delta^{18}O$ values for precipitation water are similar and amount to -13.3‰ (from -26.6‰ in December to -6.8‰ in July).

The variability range of the isotopic composition of oxygen in precipitation water from the Chultukov Log-1 site was determined in reference to the mean value with the confidence interval of 95%, which, according to the OICP, is 1‰[25]. Therefore, local range of oxygen isotopes ranges between -14.12‰ and -12.08‰, which translates into isotope concentration values of bone phosphates in individuals of local origin from 12.73 to 14.05‰[23]. The range was used as the reference interval relative to $\delta^{18}O_p$ measurements for the bone samples of test subjects.

In order to determine potential migration directions, at the next stage of analysis the environmental characteristics of oxygen isotopes within a radius of 500 km from the archaeological site were performed, also with the help of the OIPC. To standardize the results, all estimates were made at a height of 296 meters a.s.l., i.e. corresponding to the location where the burial sites had been found. The results of the analysis are shown in Figure 3. The map indicates a tendency for mean annual values of oxygen isotopes in precipitation to decrease to the value -15.1‰ ($\delta^{18}O_p$=11.75‰), measured in areas located 500 km away in a straight line from the Chultukov Log-1 site to the north. As regards the southbound direction, an increase in $\delta^{18}O_w$ levels up to -9.7‰ ($\delta^{18}O_p$=15.26‰) is reported in the analysed area. The situation looks different in the case of the east/west direction. The difference in $\delta^{18}O_w$ values between the site and areas located 500 km away is merely 0.6‰ to the east and 0.2‰ to the west. Thus, it can be assumed that the factor of the highest differentiating potential in relation to the environmental level of oxygen isotopes is the gradient change of $\delta^{18}O_w$ in the north/south direction.

Local stable oxygen isotope level can also be represented by animals with a limited range of migration, living in the immediate vicinity of humans or hibernating. Animals co-occurring temporally and spatially with the analysed human population incorporate isotopes of a unique level (pre-determined by climate, geology and hydrology) into their tissues. In this case, local $\delta^{18}O$ level was established on the basis of measurements of 7 animal

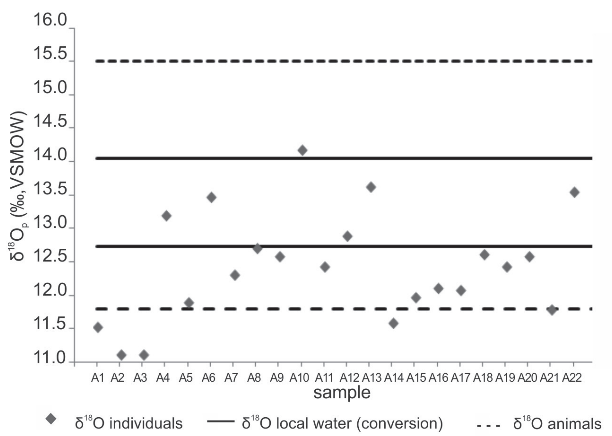

Fig. 3. Stable oxygen isotopes composition for all investigated individuals referenced to oxygen isotopic ratios of control animal bone samples and local water precipitation range.

bones found at the Chultukov Log-9 site (sample no. 3 was excluded from the analysis due to diagenetic alterations). Mean oxygen isotope level for phosphate samples obtained from animal bones was 13.65‰ (SD=1.35‰). The range of local isotope levels was determined by the minimum and maximum value obtained in the analysis of oxygen isotopes from animal remains found at the site at Chultukov Log-9; these values ranged from 11.80‰ to 15.50‰. As we can observe, the range determined on the basis of animal bone measurements is wider than the one determined on the basis of precipitation water. This may be due to the fact that animals included in the analysis (i.e. horses and roe deer) are mobile, and their isotope level may reflect a wider area than estimates of isotopic composition of oxygen based on precipitation water.

In order to reconstruct migration processes of individuals found at the site in Chultukov in Altai, their $\delta^{18}O$ measurements were referenced to the variability of $\delta^{18}O$ determined in bone samples of the control group of animals (Figure 3, dashed lines) and environmental water (Figure 3, solid lines). On the basis of results we may observe that $\delta^{18}O$ values of four individuals (A-1, A-2, A-3 and A-14) exceed the lower limit of the local oxygen isotope range both for animals and precipitation water. The results suggest a non-local origin of the above individuals. Considering the distribution of isotope values within a radius of 500 km, it can be assumed that they came from areas located to the north or north-east, far away from the burial site. $\delta^{18}O$ levels for the remaining individuals are within the range determined on the basis of animal bones, whereas 11 individuals (A-5, A-7, A-9, A-11, A-15, A-16, A-17, A -18, A-19, A-20, A-21) have values lower than the low limit of the reference range of precipitation, with one value (A-10) having a higher $\delta^{18}O$ value than the above range.

Given the fact that the animals included in the analysis were able to move over greater distances, and therefore represent a broader acreage around the location in question, we observe greater differentiation of $\delta^{18}O$ among them. Therefore, in the case of individuals who did not exceed the $\delta^{18}O$ level range for animals, but did exceed the limits of $\delta^{18}O$ for precipitation water, we cannot unequivocally determine if they were of local origin or had arrived in this area. If we assume the hypothesis that they were of non-local origin, the above 11 individuals most likely came from north or north-east, while specimen A-10 from areas south of the Chulutkov site.

At the same time, a group of 5 individuals (A-4, A-6, A-8, A-13 and A-22) was characterised by $\delta^{18}O$ levels contained in both reference ranges. It can therefore be concluded that the individuals had spent at least over a dozen years toward the end of their lives in the area where their burials were found.

Archaeological interpretation

From the perspective of cultural attribution of particular individuals, the data presented above can be summarised as follows:

1. According to the oxygen isotope data, the majority of individuals linked with the Pazyryk culture of the Scythian Period (6^{th}-3^{rd} centuries BC) either spent the last dozen or so years of their lives in the vicinity of the Chultukov Log-1 cemetery, where they were buried (individuals from barrows 16, 35, 47, and 123), or the results do not allow their local or extra local origin to be determined. None of the deceased buried in accordance with the typically Pazyryk-culture rite have been proven to have originated from outside of the mountain valley of the Lower Katun River.
2. Among the 5 individuals buried in stone boxes (Karakoba tradition of the Scythian Period), one spent the last 10-15 years of his life near the place of burial (male, 30-45 years old, buried in barrow 8), two were allochthones (male, 30-45 years old, from barrow 6, and a teenager of undetermined sex from barrow 7), and the remaining two were possibly allochthones from the north, but this cannot be confidently determined. With the reservation that the conclusion is based on the examination of a relatively small group, one can still assume that this burial rite was applied to both the people of local origin and those who settled near the analysed necropolis only as adults. The Karakoba cultural tradition should perhaps not be regarded as foreign to the inhabitants of the mountain valley of the Lower Katun. The reasons behind burying the dead in stone boxes were ideological, and should be sought in the beliefs and spiritual culture of the region. It is worth noting, too, that no burials in Karakoba-type stone boxes have as yet been found north of the Chultukov Log-1 site.
3. Keeping in mind that the method applied identifies the place of stay over the last several years of life rather than the place of birth of an individual, we can nevertheless conclude that the deceased linked with the Bystrianka culture of the Scythian Period (males: 40-50 years old from barrow 4 and 25-35 years old from barrow 13) came from the area of the compact

range of that culture (i.e. approx. 50 km north of Chultokov Log and further towards the steppe zone) relatively shortly before their deaths. This argues for interpreting the presence of the burial rite foreign to this part of the Katun valley as a result of the burying in the cemetery of people of extra-local origin, who were placed in graves according to traditions practiced by their kinsmen (i.e. in the supine position).

4. With respect to the deceased linked with the Maima culture of the Xiongnu-Xianbei Period (2nd century BC – 5th century AD), the results are ambiguous: one individual (male, 35-45 years old, barrow 62) seems to be an allochthone, one is of local origin (male, 30-45 years old, barrow 60), and in three cases the origin could not be determined. Therefore, there are no grounds for drawing any conclusions about the mobility and migrations of this population.

Conclusion

In summary, the isotope analyses corroborate findings previously formulated on the basis of archaeological data, namely that in the Scythian Period the Pazyryk burial rite was strongly established in local tradition in the Chultukov-Log-1 region, while some people of local origin had different eschatological beliefs and accordingly buried their dead in stone boxes (Karakoba type)[45]. The identification in the cemetery of individuals probably originating from the north is a very important conclusion. This supports the view, previously formulated on archaeological grounds, about contact with the Altai piedmont zone and the adjacent steppe areas[34]. The connections with the territories where the Bystrianka and Bolshaya Rechka cultures developed were probably strengthened by migrations of individuals rather than groups, with the newcomers settling in the mountain valley of the Katun River. The deceased buried in the Chultukov Log-1 cemetery in the supine position were associated, in terms of both culture and physical origin, with tribes known to archaeologists as the Bystrianka culture. (Figure 4)

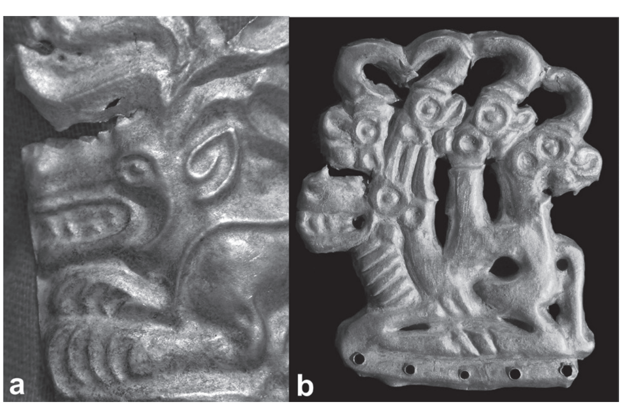

Fig. 4. Iconography of fantastical creatures from Pazyryk culture cemeteries: a – Chultukov Log-1 (Borodovskiy, Borodovskaya 2013, fig. 114:1,2); b – Karban II (ibidem, fig. 114:4).

The archaeological sources record influences from the south – a similarity to the classic, high-mountain variant of the Pazyryk culture (e.g. the presence of "Pazyryk jars", the similarities in iconography of fantastical creatures between the analysed cemetery and Karban-II – Figure 4) – as well as from the north-east. The latter, evidenced, among other things, by the discovery in Chultukov Log-1 of pottery typical of the steppe areas ("beaded" decoration, known as *zhemchuzhnik*), and by metallographic analyses (silver artefacts from Chultukov Log-1, Bystrovka-2, and Nowotroickoe-2)[48] is now also corroborated by the results of oxygen isotope analysis. The most probable scenario includes population movements from the steppe and piedmont zones to the south, where they assimilated with the North Pazyryk communities such as the one who used the Chultukov Log-1 cemetery. On the other hand, in light of the analyses presented here the contact with the south relied more on trade, and was connected with the common genesis of the North Pazyryk groups (in the mountain valley of the Lower Katun River) and the Pazyryk culture from Central and South-Eastern Altai. Migrations were probably limited to single individuals, maybe within marital exchange – a possibly southern origin can be ascribed only to one deceased female aged 20-35, buried in barrow 37.

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PODRIJETLO KULTURNO RAZLIČITIH POJEDINACA POKOPANIH NA GROBLJU IZ RANOG ŽELJEZNOG DOBA NA LOKALITETU CHULTUKOV LOG-1 (GORNJI ALTAJ) U SVJETLU ANALIZE STABILNIH IZOTOPA KISIKA

SAŽETAK

Chultukov Log-1 je veliko groblje, smješteno u dolini donjeg toka rijeke Katun (Sjeverni Altaj, Rusija), u kojem su zastupljene različite kulturne tradicije iz skitske ere (Pazyryk, Karakoba, Bystrianka). Glavni cilj ove studije bio je utvrditi jesu li pojedinci pokopani na groblju koji predstavljaju različite kulturne tradicije homogeni po zemljopisnom podrijetlu. Za rekonstrukciju podrijetla pojedinaca izvršena je analiza izotopnog sastava kisika iz apatitnih fosfata u kostima dobro očuvanih uzoraka. Radi procjene stanja očuvanosti ostataka kostiju ljudi i životinja, izračunati su dijagenetski indeksi pomoću Fourierovog infracrvenog spektrometra (FTIR). Jedan od najvažnijih zaključaka je da su pojedinci na groblju vjerojatno podrijetlom sa sjevera. Najvjerojatniji scenarij je migracija stanovništva naroda Bystrianke iz planinskih i pijemontskih zona na jugu, prema planinskim dolinama donjeg toka rijeke Katun u Sjevernom Altaju, gdje su se asimilirali sa zajednicama Sjevernog Pazyryka. Nasuprot tome, kontakt stanovnika sjevernog Altaja sa jugom nije posljedica migracija, već trgovine i zajedničke geneze zajednica Sjevernog Pazyryka i kulture Pazyryk iz srednjeg i jugoistočnog Altaja. Neki ljudi lokalnog podrijetla imali su različita eshatološka uvjerenja i pokapali su svoje mrtve u kamenim kutijama (tip Karakoba)