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The Role of Nutrition in the Biological Adaptation of the Medieval Population of the Cis-Ural Perm Region (Archeological and Anthropological evidence)

Natalya B. Krylasova[a], Natalya G. Brykhova[a] and Natalya D. Burova[b]

[a]Perm Scientific Centre of the Ural Branch of the Russian Academy of Sciences, Perm, RUSSIA; [b]Institute for History of Material Culture of Russian Academy of Sciences, Sankt-Petersburg, RUSSIA

ABSTRACT

The aim of this article is to reconstruct the nutrition system of the medieval inhabitants of the Perm Territory located in the western foothills of the Ural mountain range. The investigation is built on a comprehensive analysis of archeological sources available and on the basis if anthropological materials with involvement of radioactive tracer analysis. As a result of the measures taken within this examination it is possible to conclude that grain crops played a minor role in the diet of the medieval population of the Cis-Ural Perm Region, who relied predominantly on protein-rich food. The research is built on a comprehensive analysis of archeological sources and anthropological materials involving initial results of radioactive tracer analysis which was conducted on the territory under investigation. We have primarily examined the materials from burial grounds of the period when hoe agriculture was prevalent. The conclusions drawn from the anthropological and isotope analysis are in compliance with the notion that this kind of agriculture was low-yield and that grain crops played a minor role in the diet; protein-based foods dominated.

KEYWORDS
Nutrition of medieval population, the Cis-Ural Perm Region, reconstruction of the nutrition system, biological adaptation, paleoecology.

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Introduction

Food is one of the most vital needs of humans, and is a key element of life support. It is the key source of energy and gives humans substances that are essential for physiological functioning. The main kinds of economic activity are aimed at the procurement of foodstuffs.

The study of nutrition as it functioned in the past is an integral part of investigating biological and social types of adaptation of groups of humans. It has become one of the most topical trends in archaeology and anthropology in recent years (Fuentes, 2016). The complexity and diversity of this subject provide for addressing it only within the framework of interdisciplinary investigations, for which paleoecology provides sound methodological foundations (Martínez-Cabrera, Ramírez-Garduño & Estrada-Ruiz, 2014).

The variety of human food is embodied by a relatively small number of food models that are differentiated on the basis of the main sources of calories and

CORRESPONDENCE Natalya B. Krylasova ✉ n.krylasova@mail.ru

animal proteins (Petchey et al., 2011). The framework of these patterns we distinguish many food systems endemic to specific ethnic groups (Lassalle et al., 2014) or historical-ethnographic regions (Lanerolle, Thoradeniya & de Silva, 2013). That differ in the assortment of specific dishes, culinary techniques, principles of meal-taking (Fromme et al., 2009) as well as perception and interpretation of food in ritualistic, behavioral and symbolic terms (Kumanyika, 2008).

Its economic-cultural type determines the system of nutrition of any society. The medieval economy of the Cis-Ural Perm Region was based on agriculture in combination with cattle-breeding, with the secondary roles played by fishing, hunting, beekeeping and gathering.

Archeological sources provide for the establishment of the composition of foodstuffs of the medieval inhabitants of the Cis-Ural Perm Region. It is more difficult to ascertain culinary traditions. The existent bones of identified animals as well as cereals are evidence only of the species composition. No profound analysis of food remnants that would assist in identifying their components has been carried out yet. Indirect evidence of what the food looked like when prepared is offered by the shape of dishes and utensils.

Literature review

The application of paleoecology methodology to paleoanthropological materials led to the foundation of a new direction in anthropology, namely the historical ecology of humans (Caron & Jackson, 2008). This direction uses the methods of modern paleoanthropology and archeological sources to examine the processes of formation and the dynamics of biological characteristics of humans not only in the context of natural factors but of the social environment of ancient humans (Birks, 2013). The summarized data from sources of different sciences presents the pantophagy of humans as one of their specific characteristics, which determined, to a large extent, the picture of their migration and settlement, the complex social structure of society (Landecker, 2011). Nutrition transforms from an evolution factor into one of the ways of social and biological adjustment (Lindbladh et al., 2013). It affects the biological, psychological and behavioral patterns of humans (McCune & Kuhnlein, 2011). Nutrition systems are at the core of huge regional cultural traditions (Quinn & Kennedy, 1994).

Ethnologist S. A. Arutiunov (1989) made a classification, according to which nutrition systems are based on two types of nutrition. In one type, food is obtained through gathering, and in another type, through agriculture. Ethnologists' studies show that carbohydrates of vegetable origin prevail in the food of not only farmers but most cattle-breeders and hunters as well. When vegetable food is obtained through agriculture, its qualitative indicators change considerably. Consumption of one or two types of cultivated plants prevails, the consumption of starches increases as well. The way of obtaining meat food through hunting or cattle-breeding does not significantly affect either the quality of the meat obtained or its proportion in the entire system of nutrition (Arutiunov, 1989). According to this classification, the nutrition system of the medieval Cis-Ural Perm Region belongs to the agricultural type.

The medieval time inherited the hoe form of agriculture, which, starting from the bronze epoch, dominated until the 11th century. It should be said that hoe agriculture was low-yield and did not provide for all the needs in vegetable food (Harline, 2011). Grain was kept in large ceramic vessels (Gilchrist, 2010). Such containers with grains of barley, for instance, were discovered in the 8th-9th centuries layer of Lavryatskoye site (Yeleuov, Akymbek & Chang, 2014). Three kinds of wheat, common barley, and small amounts of oats, rye and hemp were found among some pieces of containers in a storage hole of Zaposelye settlement (Lychagina et al., 2013). Lebedeva, who investigated the samples from different parts of the hole, came to the conclusion that compositional differences in them testify to separation of cereals in storage (Lebedeva, 2014). The samples contain an insignificant amount of seeds of weed and chaff, which is an indicator of good grain cleaning, possibly even by hand. It is evident that the hole was used not for storing grain crops but for keeping foodstuffs made from them, i.e. weeded and husked wheat in the form of grits, bread, biscuits etc (D'Alpoim Guedes & Butler, 2014).

Grain was ground in stone grain bruisers with grating pestles (Lebedeva, 2014). This method of processing does not provide a sizeable amount of flour, being more convenient for preparing grits that were used in soups and skillies (Susanna & Prabhasankar, 2011).

The earliest implements of field agriculture appeared in the Cis-Ural Perm Region in the 10th-early 11th centuries, and became widespread at the turn of the 11th and 12th centuries (Mastyugina & Perepelkin, 1996). Specialized holes emerged in this period where specific types of grain were stored in specific sections (Caron & Jackson, 2008). Samples taken from grain holes showed presence of soft wheat, common barley, bottle-shaped and paleaceous barley, cultivated oats, two-grained spelt, rye, millet, field pea and hemp (Lebedeva, 2014). When agricultural productivity was increased, millstones appeared.

According to S. A. Arutiunov's classification, the grain subtype to which the nutrition system under investigation belongs is divided into two classes depending on the principal source of meat food. The first one relies primarily on cattle-breeding for its meat, in the second type the main source of animal proteins is appropriative economy, primarily fishing, and, to some degree, also hunting (Arutiunov, 1989).

One of the main branches of the economy in the agricultural type region was cattle breeding, mainly breeding of horses and cattle, and to a lesser degree, of pigs, sheep and goats. The small cattle was bred mainly for its wool, judging by the small number of these animals' bones among food remnants (Carvajal López & Day, 2015).

The meat of wild animals and birds was also used but the bones of domesticated animals are much more common than the bones of wild animals (Krenz-Niedbała, 2015). Among the hunting trophies were furs, obtained primarily for selling, but also moose, reindeer, bear, hazel grouse, wood grouse, ducks, geese etc (Kaupová et al., 2014). Fur-bearing animals were flayed in the

woods and their meat was not ordinarily consumed as food. Beavers, hares and squirrels were exceptions to this rule (Barbiera & Dalla-Zuanna, 2009).

Fish played a major part in nutrition. Among the big game fish, *Acipenseridae* prevailed (great sturgeon, sterlet, Russian sturgeon, starred sturgeon); pikes, catfish, inconnus, perches, pike perches, breams, orfes, chubs, blue breams were also obtained (Losey, Nomokonova & White, 2012). Sturgeons reached over two meters in length, great sturgeons up to 3.1 meters, pikes up to 1.8 meters, catfish up to 3.3 meters (Keskitalo & Kulyasova, 2009). Fish-bones were actively used in households, vertebrae were used in necklaces and fish skins were apparently used for making clothes for fishing, and cod-liver oil was also used in some way (Oborin, 1999).

In spite of the presence of a considerable number of products of the appropriative economy, the nutrition system under investigation belonged to the first class of classification, which emphasized grain growing and cattle breeding. It can be subdivided into two subclasses: with and without using milk. This was a significant factor, since, firstly, a special value and ritual system developed when milk began to be consumed. It was oriented to milking and making dairy foods. Secondly, a trend emerged with regard to maximal restriction of slaughtering (Arutiunov, 1989). No comprehensive analysis of osteologic materials of the Cis-Ural Perm Region has yet been conducted yet and it is difficult to evaluate the milk component in cattle-breeding of that time. According to existent evidence, beef stock farming was predominant until 10th-11th centuries and breeding cattle for milk started in the second half of the 11th century; cows started to be used for milking (Dyer, 1997). Milk started to be processed.

When Rodanovo site was excavated, a few containers were found with multiple needle punctures on their bottoms, or with one puncture, one centimeter in diameter, in the middle of the bottom. These vessels were used for wheying, and possibly, cheese-making (Losey et al., 2012). Similar vessels were discovered on Lavriatskoye and Anyushkar sites (Oborin, 1999). A vessel with through holes in its body was found in the food-storage hole in Zaposelye settlement which could be used for storage of cheese or curds. Indirect evidence of the spreading use of milk in the 11th-12th centuries was a considerable amount of jugs and milk jars found among the crockery imported from Volga Bulgaria in the 11th-12th centuries (Lychagina et al., 2013). These vessels were used for cream formation, evaporating milk, and jugs that were used mainly for raw milk. Such containers (pots with constricted stems and mugs) appeared among ceramic crockery of local manufacture. Thus the nutrition system of the Perm Region belonged to the first subclass (using milk), although the meat aspect of cattle-breading was also relevant to it (McCune & Kuhnlein, 2011).

Based on the method of cooking, dishes made from cereal products actually reflect the history of the establishment and development of grain farming (Das et al., 2006). Grain was first used as food in its raw and roasted forms m and then as flour in its raw and roasted forms. It was cooked with or without oil, with water or milk or other liquids added (Henry, Hudson & Piperno, 2009). The Komi-Permyaks, inhabitants of the present-day Perm Territory, everyday diet

consisted of thin flour dough and oatmeal diluted with water (Khuazheva, 2008). The existence of these dishes in antiquity is not confirmed by archeological evidence.

A more complex cooking procedure is involved in the boiling of grits, flour or pieces of dough. In the Finno-Ugrian ritualistic food, gruels held a prominent place, which testifies to ancient roots of this dish. The fact that the bowls of most medieval spoons are flat serves as indirect evidence of the prevalence of gruels as well as thick skillies in the Kama region (Henry et al., 2009).

A third way of processing cereal products was baked dough. It is difficult to establish whether any bread was baked the Cis-Ural Perm Region before the 10th-11th centuries. However, when field agriculture developed, bread appeared for sure. This is confirmed by the discovery of a charred piece of porous bread, made apparently from sour-type dough, in the 12th -century layer of Anyushkar site (Oborin, 1999).

Charbroiling and boiling were apparently among the ways of preparing meat in the Cis-Ural Perm Region. The construction of hearths and specifics of crockery do not point to any other ways of cooking meat. Analysis of animal bones shows that the bones of lower limbs and thighs are usually unbroken; most probably, legs and briskets were roasted in their entirety (Adams & Black, 2004). The cooking vessels of that time were too small to contain such sizeable portions. The remaining bones chopped into several parts could have been used in skillies and other boiled dishes (Dyer, 1997).

Komi-Permyak and Ob Ungrian folklores usually mention such ways of cooking meat. For instance, Kudym-Osh, the legendary Komi hero, is said to have put whole carcasses of large animals over a fire in order to cook them and "reindeer meat used to be boiled on fire with an appetizing smell. Meat was braised and stewed. Wildfowl was roasted in its entirety (Ozhegova, 1971). Nowadays, Komi-Permyaks still use the old ways of cooking fowl in a hot hole or a hare in an overturned pot covered with straw. These methods of cooking were common in ancient dwellings with earthen floors (Doldina, 1999).

Wild plants were sources of vitamins and other elements of nutrition. The inhabitants of the Cis-Ural Perm Region could have consumed wild berries, mushrooms and nuts. However, there is not much direct evidence to that effect. It is noteworthy that such shells were discovered among the bronze beads on Boyanovsky burial ground (Oborin, 1999). When Ye. Yu. Lebedeva conducted archebotanical investigations of Zapolesye settlement, most samples were found to contain seeds of wild raspberries, strawberries, bird-cherries and briar (Lebedeva, 2014). No objective data exists as regards garden crops.

Analysis of products and possible dishes that constituted the nutrition system of medieval society of the Cis-Ural Perm Region may present an idyllic view of the richness of diet and a high quality of nourishment. However, we are perfectly aware of the fact that this was not the case. Ethnographic data shows some major seasonal fluctuations in nutrition that were conditioned by the specifics of cattle-breeding and agricultural economy. Relative abundance of food in autumn and winter, when the bulk of vegetable and animal food was

consumed were replaced by a hungry springtime, when food reserves dwindled and the time of the new harvest and animal yield were still far off, then a meager summer, when predominantly wild vegetables and fruit were consumed. It is also necessary to consider such factors as the dependence of cattle-breeding and agriculture on climatic conditions, the imperfection of ways of storing food and other factors.

Aim of the Study

The aim of this study is to reconstruct a system of nutrition of the medieval inhabitants of the Perm Territory, which is located on the western foothills of the Ural mountain range.

Research questions

The overarching research question of this study was as follows:

What system of nutrition was developed in Perm territory during medieval period? What system of nutrition influenced on bio-adaptation of the population?

Methods

In order to examine the nutrition system of medieval population of the Cis-Ural Perm Region, an analysis was carried out with regard to bio-anthropological data about the dentofacial system and morpho-physiological characteristics of skulls (Razhev, 2009).

Materials from nine burial grounds were used, namely Mitinskoye (4^{th}-6^{th} centuries), Chaziovskoye (5^{th}-7^{th} centuries), Pyshtain II (7^{th}-9^{th} centuries), Demionkovskoye (7^{th}-9^{th} centuries), Kanevskoye (7^{th}-9^{th} centuries), Vazhgortskoye I (7^{th}- 9^{th} centuries), Boyanovskoye (10^{th} c.), Rozhdestvenskoye Moslem (11^{th}-13^{th} centuries), Plotnikovskoye (13^{th}-15^{th} cs. A.D.) The series of Mitinskoye and Chaziovskoye burial grounds are combined in view of their chronologic and territorial proximity. 185 individuals with the total number of 2530 teeth were analyzed.

The programme of investigation included registration of such indicators of the state of health as caries dentium, abscessus apicalis, calculus dentalis, parodontopathy, dental chipping, intravital tooth loss and enamel hypoplasia. Among the diet markers not pertaining to dentistry was porotic hyperostosis on cribra orbitalia.

Results

Evidence provided by natural sciences helps to elucidate the situation.

The bone material from the burial grounds varies in the degree of preservation. Low preservation is linked to the decomposition of bones in the ground, the looting of burial grounds, or with late economic activity. A great number of detached teeth were found in the materials of Boyanovskoye burial ground. This makes the diagnosis of such pathologies as parodontopathy, apical abscess and intravital loss of teeth difficult.

Analysis of gender differences is complicated by the small number of individuals in some sample groups and difficulties of gender identification, which are accounted for by poor preservation of bone remains.

Defects were recorded on the basis of the number of individuals with signs of the defect, taking into consideration their proportion in the sample group (individual count, %) (Table 1) and according to the number of damaged teeth and their proportion in the general number of the teeth investigated (teeth count, %) (Table 2) (Razhev, 2009).

Table 1. Incidence of dento-facial pathologies and traces of porotic hyperostosis (individual count, n)

Burial ground (number of individuals)	Enamel hypoplasia	Caries dentium	Paradontopathia	Abscesus apicalis	Tartar	Dental chipping	Intravital loss	Cr.orbitalia	Porotic hyperostosis
Mitiskoye + Chaziovskoye (9)	6 (66,6%)	4 (44,4%)	5 (55,5%)	3 (33,3%)	4 (44,4%)	6 (66,6%)	3 (33,3%)	4 (44,4%)	2 (22,2%)
Pyshtain II (13)	11 (84,6%)	6 (46,1%)	7 (53,8%)	3 (23%)	6 (46,1%)	10 (76,9%)	6 (46,1%)	3 (23%)	2 (15,3%)
Kanevskoye (5)	1 (20%)	2 (40%)	2 (40%)	1 (20%)	2 (40%)	2 (40%)	3 (60%)	1 (20%)	2 (40%)
Demionkovskoye (19)	9 (47,3%)	4 (21%)	6 (31,5%)	2 (10,5%)	9 (47,3%)	10 (52,%)	4 (21%)	6 (31,5%)	2 (10,5%)
Vazhgortskoye I (9)	5 (55,5%)	2 (22,2%)	8 (88,8%)	6 (66,6%)	4 (44,4%)	7 (77,7%)	4 (44,4%)	3 (33,3%)	7 (77,7%)
Boyanovskoye (84)	56 (66,6%)	9 (10,7%)	14 (48,2%)*	4 (15,3%)*	37 (44%)	64 (76,1%)	8 (40%)*	2 (25%)	3 (42,8%)
Rozhdestvenskoye Moslem (10)	6 (60%)	3 (30%)	3 (30%)	3 (30%)	5 (50%)	5 (50%)	5 (50%)	1 (1%)	2 (2%)
Plotnikovskiy (48)	29 (60,4%)	6 (12,5%)	31 (64,5%)	11 (22,9%)	30 (62,5%)	31 (64,5%)	17 (35,4%)	11 (23%)	10 (20,8%)
Total number of individuals (185)	123 (66,4%)	36 (19,4%)	76 (41%)	33 (17,8%)	97 (52,4%)	135 (73%)	50 (27%)	29 (28,7%)	27 (26,7%)

* the percentage indicated is not of the total number but of the number of individuals where a specific characteristic was recorded as present/missing

Table 2. Incidence of dento-facial pathologies (teeth count, n)

Burial ground (number of individuals)	*Caries dentium*	*Abscessus apicalis*	*Dental chipping*	*Intravital loss*
Mitiskoye + Chaziovskoye (147)	7 (4,7%)	5 (3,4%)	18 (12,2%)	26 (15%)
Pyshtain II (174)	16 (9,2%)	4 (2,3%)	44 (25,2%)	25 (12,5%)
Kanevskoye (44)	2(4,5%)	1 (2%)	7 (16%)	9 (16,9%)
Demionkovskoye (209)	5 (2,4%)	5 (2,4%)	49 (23,4%)	19 (8,3%)
Vazhgortskoye I (104)	3 (2,8%)	11(10,5%)	15 (14,4%)	7 (6,3%)
Boyanovskoye(1007)	14(1,4%)	8 (0,8%)	197 (19,5%)	23 (4,7%)*

Rozhdestvenskoye Moslem (155)	5 (3,2%)	6 (3,8%)	9 (5,8%)	7 (4,3%)
Plotnikovskoye (690)	8(1,1%)	28 (4%)	122(17,6%)	60 (8%)
Total number of individuals (2530)	60 (2,3%)	68 (2,6%)	461 (18,2)	176 (7%)

* the percentage indicated is not of the total number but of the number of teeth where a specific characteristic was recorded as present/missing

One of the analyzable characteristics is enamel hypoplasia – a defect of the adamantine substance of the tooth which is believed to cause delays in the period of development and growth of the crown of a tooth (Nelson et al., 2013). In the generalized sample the incidence of enamel hypoplasia of the low and medium severity is 66.4 percent. This characteristic is established in more than 50 percent of the individuals on most sites, and is expressed in the most degree, namely 84.6 percent, on Pyshtain II burial ground, where a case of rachitis is also recorded (Skinner & Pruetz, 2012). Among the common causes of the pathology of the adamantine substance of the tooth are food deficit, including lack of calcium, phosphorus, vitamins A, C, and D and some bacterial infections. The propagation of this characteristic among the medieval population of the Cis-Ural Perm Region was obviously triggered by seasonal food stresses (Neiburger, 1990).

Dental chipping and injuries to the crown of a tooth were the most common tooth injuries. They could have been caused by the biting of solid objects during a meal or when using teeth for work. Mechanical injuries were recorded in 73 percent of individuals on 18.2 percent of teeth. The biggest amount of people with mechanical injuries of teeth was observed on Pyshtain II (76.9 percent), Vazhgortskoye I (77.7 percent), and Boyanovskoye (76.1 percent) burial grounds. By the teeth count, they are supplemented by Demenkovskoye burial ground (23.4 percent of teeth). Dental chipping occurs with most individuals, including children, on other burial grounds. The youngest representative with chipping of dens molaris was a child who died at the age of seven or eight years. Damages of various degrees occur on all types of teeth, but more often on crowns of posterior teeth. The cases of carius dentium in the generalized sample are recorded in 19.4 percent of individuals on 2.3 percent of teeth. An isolated instance of the caries of a deciduous tooth was recorded in a seven- or eight-year-old child found on Plotnikovskoye burial ground. The propagation of caries dentium is accounted for by the development of agriculture and the growth of the share of cereals in food. A high carbon diet and consumption of starchy foods is said to have caused it (Bradshaw & Lynch, 2013).

However, the highest number of caries dentium was registered on early sites which belong to the period of hoe agriculture. These are the generalized series of Mitinskoye and Chaziovskoye (44.4 percent of individuals, 4.7 percent of teeth) and Pyshtain II burial grounds (46.1 percent and 9.2 percent respectively). Studies suggest that all the incidents of caries dentium were related to the damages of the crown of a tooth, when the destruction of the enamel integrity led to the cavity in the crown of a tooth and then an infection (Dreizen, 1966; Nishino et al., 1990; Salanitri & Seow, 2013). Mechanical

damage also resulted in caries dentium in most cases on other burial grounds. Thus, the propagation of caries among the medieval population of the Cis-Ural Perm Region was linked to multiple instances of mechanical injury, and not to prevalence of a carbon diet.

The propagation of abscessus apicalis, which is an inflammatory lesion around the apex of a tooth root, is also linked to dental damage. Its share in the summarized sample is 17.8 percent of individuals and 2.6 percent of the total of teeth. The largest number of abscessus apicalis is recorded in the series of Vazhgortskoye I burial ground (66.6 percent and 10.5 percent respectively). Such inflammation is often attributed to the mechanical injury of the crown of a tooth and intravital loss of teeth. Pyshtain II and Boyanovskoye burial grounds have the largest proportions of tooth loss by the number of individuals and the number of teeth (46.1 percent and 12.5 percent in Pyshtain II, and 40 percent and 19.5 percent in Boyanovskoye). The most frequent incidents of loss are posterior teeth, whereas incisor loss is only occasional.

Parodontosis of low and medium severity in the groups investigated was observed in all types of teeth, but it was more frequently and distinctly manifested on posterior teeth. The proportion of individuals with parodontic problems was 41 percent. In the group of Vazhgorstkoye I burial ground the proportion of individuals with parodontosis was 88.8 percent. This condition could have been caused by calculus dentalis, or tartar, a calcified paraplasm on the surface of a tooth that has complex etiology (Volozhin & Poriadin, 2010). In the generalized sample, the number of individuals with tartar is 52.4 percent. In some samples, its incidence is from 40 to 50 percent. The largest proportion of individuals with tartar, namely 62.5 percent, is recorded on Plotnikovskoye burial ground. Some tooth remnants of adolescents also bear traces of tartar formation.

Porotic alterations in the root of the orbit (cribera orbitalia) are observed in 28.7 percent of individuals in the generalized sample. This figure is 44.4 percent in the summarized series of Mitinskoye and Chaziovskoye, 33.3 percent in Vazhgortskoye I, and 31.5 percent in Demenkovskoye burial grounds. Vazhgortskoye I burial ground has the highest rate of individuals with various degrees of calvarial damage (from one point to 2-3 points of considerable porous defects), namely 77.7 percent. Abnormalities in cranial bones are caused by compensatory physiologic response to the decrease in blood hemoglobin. Some scholars have recently explained the emergence of porotic hyperostosis and some incidents of cribra orbitalia by megaloblastic anemia, caused by the deficiency of C and B12 vitamins. It may have been caused by a decrease in the consumption of food of animal origin, sedentarization and congestion of population, unsanitary living conditions, lengthy nursing time, infectious diseases and a rise in diarrhoeal diseases (Walker et al., 2009).

In order to establish the amount of vegetable and animal food in an average intake of people in the last years of their lives, we obtained the isotopic niche ($\delta^{13}C$ and $\delta^{15}N$ values) of eight bone samples from seven burial grounds of the Perm Terriory, namely Mitinskoye of the 4th-6th centuries, Boyanovskoye of the 10th century, and Plotnikovskoye of the 13th-15th centuries. The analysis of the

isotopic niche was conducted with mass spectrometer ThermoFinnigan Delta V with elemental analyzer CE/EA-1112.

A bone consists of an organic part, collagen, and an inorganic one, calcium hydroxylapatite. Collagen has an isotopic composition that was present in nature at the time of its formation. Carbon and nitrogen are consumed as food and are mineralized into bone tissue. Using isotope analysis allowed us to obtain some data about the ancient people's diet and the climatic conditions they lived in (Tables 3 and 4).

Table 3. Individual values of C-N ratio in the bone collagen of the materials from the medieval burial grounds of the Perm Territory

№ of sample	*№ of examination*	*Sample*	*Gender*	*Age, years*	δ^{13} C, ‰	δ^{15} N, ‰
1	2502,2526	Mitinskoye b. ground, section 43	♂	20-25	-20,9	9,0
2	1974, 1996	Plotnikovskoye b. ground,section 25	♀	> 35	-20,3	10,0
3	1975, 1997	Plotnikovskoye b. ground,section 42	♂	50-60	-20,9	9,1
4	2499,2523	Plotnikovskoye b. ground,section 92	?	14-16	-21,2	8,6
5	2500,2524	Plotnikovskoye b. ground,section 71	♂	45-60	-20,9	9,0
6	1976, 1998	Boyanovskoye b. ground, section 252(2)	♀	25-35	-21,0	9,4
7	2501,2525	Boyanovskoye b. ground, section 16	♂	30-40	-20,8	9,5
8	2008, 2035	Boyanovskoye b. ground, section. 252(1)	♀	25-30	-21,3	10,6

Table 4. Average values of the C-N ratio in the bone collagen of the materials from the medieval burial grounds of the Perm Territory

Gender (number of individuals)	δ^{13}C, ‰		δ^{15}N, ‰	
	x	*s*	*x*	*s*
♀ (3)	-20,8	0,5	10	0,6
♂ (4)	-20,9	0,05	9,1	0,2

Discussion and Conclusion

As the investigation suggests, all the series that participated in the research have similar features of biological adaptation as well as medical statuses. Mechanical injuries of tooth crowns and incidents of caries dentium, tooth loss and abscessus apicalis which are related to them. All the series are distinguished by wide propagation of tartar, parodontosis and enamel hypoplasia. The number of skulls with traces of anemia is insignificant. Taking all these factors into consideration, we may assume that protein-based food was prevalent with the medieval population of the Cis-Ural Perm Region including a minor amount of cereals; food shortage was not uncommon.

As for the degree of adjustment of various groups of the population, the earlier sites have higher numbers of the deceased, namely the summarized series of Mitinskoye and Chaziovskoye burial grounds (4^{th}-7^{th} centuries A.D.) and Pyshtain II and Vazhgortskoye I (7^{th}-9^{th} centuries A.D.) burial grounds. The

population represented by Demenkovskoye burial ground was the most biologically adapted. In spite of the existing difference in the proportion of stress indicators, all the samples have similar adaptive tendencies, which was accounted for by their common economic basis.

The carbon and nitrogen values suggest that the people under investigation lived in a climate noted for its cold winters and moderately warm summers.

Isotopic studies suggest mixed diets including vegetables of a temperate zone and a small amount of cereals.

Comparison of individuals from various burial grounds and the low values of variability rations (***s***) give grounds to conclude that the diet of the medieval population of the Cis-Ural Perm Region did not vary significantly throughout a whole millennium, that is, from the 4th to the 15th centuries. Minor differences are recorded in the gender distribution of food. An exception to this is a female the bone remnants of whom are represented by Sample 8 with the $\delta^{13}C$ of 21.3 percent and the $\delta^{15}N$ of 10.6 percent. These indicators suggest that she had better nourishment than others, with a higher animal food content. This could have been accounted for by her pregnancy at the time of death, since bones of a newborn baby were found next to her in the burial ground.

The least protein-based food was consumed by an adolescent from section No. 92 of Plotnikovskoye burial ground. It can be assumed that children's diets were different from adults' diets up to a certain age.

Thus, on the basis of the investigation conducted we can conclude that the medieval population of the Perm Territory fully used the foodstuff resources of the territory. The main branches of the economy, both productive and gathering, were aimed primarily at food procurement. However, it was uneven during the year, and the population experienced nutritional stresses.

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Notes on contributors

Natalya B. Krylasova is a Doctor of History, Chief Scientific Officer of the History, Archaeology and Ethnography Department, Perm Scientific Center of the Ural Branch of the Russian Academy of Sciences, Perm, Russia.

Natalya G. Brykhova is a Senior Researcher of the History, Archaeology and Ethnography Department, Perm Scientific Center of the Ural Branch of the Russian Academy of Sciences, Perm, Russia.

Natalya D. Burova is a Senior Researcher at the Institute for History of Material Culture of Russian Academy of Sciences, Sankt-Petersburg, Russia.

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