The Environment and Health Condition of the Upper Palaeolithic Sunghir People of Russia

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Abstract Human bones from the Sunghir Late Palaeolithic settlement of the Northern-East part of the Eastern European Plane were observed by a gross study of possible skeletal lesions. The complex of pathological conditions we studied could mirror the features of the ancient environment. The climatic conditions of the Upper Palaeolithic, especially in its final stages, were severe. Thus environmental change and the fall of temperature is reflected in the distribution of pathological indicators. The comparative analysis of early and late Upper Palaeolithic populations demonstrates the increasing frequency of some stress markers. The analysis of physiological stress markers convincingly demonstrates that the Sunghir people had an active lifestyle without experiencing considerable negative stress. Living in the cold conditions and a humid climate, the Sunghir people had adequate reactions relative to their life conditions. Different types of physical activity were noted for both children and adult man. It could be that this is the result of the influence of gender diversity in labour. *J Physiol Anthropol Appl Human Sci* 24(4): 413–418, 2005 <http://www.jstage.jst.go.jp/browse/jpa> [DOI: 10.2114/jpa.24.413]

Keywords: human evolution, Upper Palaeolithic, Sunghir people, health status, stress markers

Introduction

The Sunghir Late Palaeolithic settlement from the Northern-East part of the Eastern European Plane has been studied for more than 40 years. The site is world famous for its richness of archaeological artefacts and the perfect preservation of human remains, so the literature devoted to Sunghir data includes several monographs and papers.

Nowadays the borders of anthropology have been extended considerably, especially along its ecological points in palaeoanthropology. One of the principal components of human biological history is the study of the interaction between the individual and the environment. This dynamic condition comprises a complex of interrelations between

separate organisms and various environmental components. The process of adaptation to the circumstances becomes especially pressing for a migrant population and people living in extreme ecological conditions. As a rule in this situation, a man is capable of showing insignificant morphological and functional changes promoting adaptation to the new life setting. From time to time the adaptation processes results in special or non-special diseases. Thus the complex of pathological conditions we studied in the ancient human remains could mirror the features of the environment. We can also glean more valuable information for the reconstruction of prehistoric times as for example in the Palaeolithic period of human history.

In the following paper we have tried to estimate the consequences of physiological adaptation of the Upper Palaeolithic people to different factors of the environment after one of the earliest migrations in human history to the Northern part of the European Plane.

Methods

Human bones were observed by a gross study of possible skeletal lesions. There were noted different variations providing initial evidence of pathological conditions such as abnormal bone formation, bone destruction, bone density, bone size and shape. In special cases there were abnormal postmortem modifications of bone (pseudopathologies) resulting from the immediate burial environment.

A special program of inspection of tooth disease and the pathological condition of the jaws were used in examination of the remains (Buzhilova, 1998). Radiographic images of all the human remains were used in palaeopathological analyses as an important tool for differential diagnosis. The angle of the neck of the femur was measured according to Martin's method (Alexeev, 1966). The parameter was taken into consideration in differential diagnosis.

Results

Interpretation of data in human skeletal palaeopathology

depends on the accurate differential diagnosis of diseases apparent in the archaeological skeletal remains. It also relies on the evaluation of other variables such as preservation of the skeleton and the pathological manifestations on it. Good preservation of the remains of an adult man (Sunghir 1) and two children (Sunghir 2, Sunghir 3) and the practically complete sets of bones permitted a detailed palaeopathological analysis.

The skeleton **Sunghir 1** consists of a skull, jaw, long bones (apart from the left radius and ulna) and both kneecaps, hand and foot bones as well as shoulder and pelvic girdles, and very fragmentary remains of the axial skeleton (incomplete sacrum, two thoracic vertebrae, small pieces of ribs). The sex was determined as male and the age at death was estimated as mature (Buzhilova et al., 2000).

All teeth are healthy, none are carious or paradontic. Dental calculus is absent. Dental attrition is uniformly distributed even in the front teeth. Because of the attrition, crown heights are low and the presence of enamel hypoplasia is difficult to detect. Nevertheless, on the preserved parts of the tooth crowns traces of hypoplasia are not detected.

On the right side of the frontal bone, close to the fragmentary craniostenosis a bone chip is noted. Among the morphological variations of the long bones, the bending of the forearm bones in the medial-lateral direction should be noted. There is a difference in the index values for the ulnae diaphysis, which is greater on the left side. In the lower extremities diaphyseal curvatures are mostly expressed in a medial-lateral direction for fibulae bones and in an anterior-posterior direction for both femora, the fibulae being more bent on the right side while the femora is more bent on the left. To estimate the extent of pathological diaphyseal bending the angle of the neck of the femur was calculated, equaling 125–130° and lying within the normal variation range of 115–140° (Mikhailov, 1989).

The X-ray analysis of the tibiae revealed Harris lines, which were more pronounced in the distal part of the bones but of less significant length in the proximal part.

The curvature of the diaphyses of some tubular bones as well as the presence of partial cranostenosis are important for possible diagnosis. Though those features are not very pronounced, together with the presence of Harris lines on the tibiae they can be considered, with approximation, as a set of traits indicating some metabolic disorder experienced in childhood and influenced by several factors. Differential diagnosis suggests miscellaneous conditions related to the described syndrome. Rickets, which develops with Vitamin D deficiency, is worth mentioning as the most probable metabolic disorder (Buzhilova, 2000). The suggested diagnosis seems disputable, as the set of pathologies observed is not highly specific. However, it should be taken into consideration that a mild degree of untreated rickets does not produce skeletal deformations. These particular changes have been noted in the Sunghir man.

Judging by clinical data, children born in cold weather

periods, lacking ultraviolet rays, fresh air and physical activity may experience Vitamin D deficiency, which contributes to the development of rickets. A vitamin deficit may be mainly explained by its insufficient formation in the skin where it is normally produced from a pro-vitamin by means of photolysis affected by ultraviolet rays. Under favourable conditions, sufficient quantities of Vitamin D is formed in a child's skin. However, in some cases its concentration may decrease, when, e.g. the exposed skin surface is small and the child does not spend enough time in the sunlight, or when certain natural factors, especially in autumn and winter reduce the intensity of ultraviolet radiation (Bratanov, 1983). Insufficient intake of Vitamin D with food is less important for rickets development as this vitamin is contained in a very limited number of food products.

Nowadays it is difficult to understand how widespread the disease was among Upper Palaeolithic populations. However, climatic data reconstructed by different scientific methods give some reason to suggest that the Upper Palaeolithic time (Bryansk interval) climate with lengthy periods of diffused sunlight could have contributed to the development of rickets particularly among nomadic people suffering extreme stress.

The skeleton **Sunghir 2** consists of a skull, jaw and long bones; hand and foot bones are preserved but not complete; pelvic bones and the axial skeleton are in good condition. The sex of Sunghir 2 was defined as male and age at death was 12–14 years old (Mednikova et al., 2000).

On the front tooth crowns there is a marked defect of enamel development—enamel hypoplasia. Reconstructed age at appearance and development of this anomaly suggests an approximate interval of 3 to 6 years. No caries or dental calculus is found.

On the frontal bone and partly on both parietal X-rays revealed finger-shaped impressions, which can serve as evidence of high intracranial pressure (Rokhlin, 1965). In the proximal part of the right humerus and fibula, near the metaphyseal area Harris lines are slightly pronounced. More visible lines of transversal orientation are noted on the middle phalanx of the first right toe.

The analysis of morphological variation of the tubular bones demonstrates considerable asymmetry of the lower extremities in shaft curvatures, which is higher on the right side. Moreover, the degree of diaphyseal curvature is small and lies within the variation range. The absence of pathological indicators can also be judged by the neck-shaft angle of the femur that equals 125–134° (right–left) and lies within normal variation range for this trait. The asymmetry of the neck-shaft angle is 9°, which also lies within the normal range of modern variation (Mikhailov, 1989).

The radiogram of one of the thoracic vertebrae in the lower third of the spine registers, on its lateral left surface, a sclerotised area first described by A. I. Bukhman (1984). It should be further noted that this area is autonomous without any osteoporotic traces around its perimeter. The diameter of the area does not exceed 3–4 mm (Buzhilova, 2000a). The

other vertebrae show evidence of destruction of the anterior bodies but there is no evidence of bone repair and the edges could easily be the result of post-mortem breakage.

Several possible reasons for the pathology may be suggested. The first is the presence of a cystic formation of oval shape with sclerotisation along the external margin. Cystoid formations are known from different parts of the skeleton, caused by epigenetic factors, and resulting in bone formation disorders (Ortner and Putschar, 1985: 366).

Moreover, oval cysts of a similar size can develop in parasitic infestations with helminths, e.g. echinococcus. Infestation normally occurs if helminth eggs get into the digestive system; in their adult stage helminths parasitize the intestines of wolves, jackals, polar foxes, etc. Helminth eggs may be present on plant leaves and berries, as well as in the fur or meat of sick animals. In infested humans a larva comes out of the egg and travels in the blood to any organ including bone. The most common is a hydatid (cystic) form with echinococcus growing slowly, for years. The size of the oval deformity noticed in the Sunghir adolescent may correspond to hydatid cysts registered on some palaeopathological specimens (Ortner and Putschar, 1985: 232).

The area on the spine under discussion may indicate a certain infectious process that the individual had experienced early in life. The chronic infectious process could be mirrored and by the low level of the Zn, which was analysed in the chemical probe of a bone sample by Maria Dobrovol'skaya (Kozlovskaya, 2000).

The localisation of pathology gives some grounds to suggest a possible inflammation of one of the lumbar muscles resulting, for example, from tuberculosis. However, no other traces of the inflammatory process can be seen, on either the preserved ribs, or on the vertebrae and long bones, which casts serious doubt on the presence of a specific bacterial infection. Given the link between most of the diagnostic options and the time of the primitive domestication of animals, the early date of tuberculosis and brucellosis would be troublesome for diagnosis, but mycosis infection is possible.

Thus, the presence of growth arrest lines together with the pathologies registered in the thoracic vertebra testify to a non-specific or mycosis infection suffered by the individual during his lifetime. The possibility of helminthiasis provoked by the contact with hunted fur animals should not be excluded. In any case, registered pathologies demonstrate the complexity of living conditions for the Sunghir 2 individual who nevertheless was successful in overcoming stresses associated with the environment.

The child has some markers reflecting mechanical load on the locomotor system. Entesopathies of moderate degree are documented on the right collarbone in the area of attachment of the sternoclavicular ligament, and by the development of bone morphology on the right humerus. On the radiogram of this bone in its proximal part clear architecture with a "crossing beams" pattern can be seen. The morphology of the left femur at the attachment sites of *m. gastrocnemius* and *m.*

popliteus is more developed than that of the right side. On the thoracic vertebrae bodies and on the ribs, in the area of attachment of the short and long rotators, slight impressions are noted, which might have contributed to the spine and trunk bending to one side with a simultaneous slight turn of the spine along its axis (Buzhilova, 2000a).

It can be assumed that the individual engaged in harmonious physical activity with the right upper extremity often performing throwing movements with simultaneous bending of the trunk aside, which would happen when throwing a dart or a spear, or using a harpoon for fishing.

The skeleton of **Sunghir 3** consists of a skull, jaw and long bones; pelvic bones and the axial skeleton, hand and foot bones are preserved well. The sex of Sunghir 3 was defined as female and age at death was 9–10 years old (Mednikova et al., 2000).

On the front tooth crowns there is a marked defect in enamel development—enamel hypoplasia. The reconstructed age at appearance and development of this anomaly suggests some time between 3 to 6 years, the lines being most frequently formed at the age of 3–4,5 years. No caries are found. Slight black dental calculus is present on the last maxillary left molar. The masticatory surface of the deciduous molars reveals extensive occlusal attrition, which probably indicates early consumption of coarse-fibre and firm food.

On both tibiae Harris lines are clearly present in both the proximal and distal ends. In the distal ends of both femora, the lines of growth arrest in the metadiaphyseal zones are also pronounced. The lines have a non-typical form.

Both Bukhman (1984) and Kozlovskaya (2000) point to a slight increase in mineralization of all tubular bones, and they used different methods (x-ray and chemical analysis respectively) to calculate the mineralization level.

The analysis of morphological variation shows a significant anterior-posterior bend in both femora with flattening in the mid-shaft. The bend is symmetrical with the highest point of curvature in the middle part of the diaphysis. The extent of femora bending is symmetrical and close to pathological values. The x-ray of the femora presents uniform sclerotisation in the dorsal part of the diaphysis due to physiological loads.

Tibiae and fibulae bending lie within the range of variation. However, the diaphysis of the right tibia is curved almost twice as much as of the left one. To estimate the extent of pathological bending for both femora the neck-shaft angle has been calculated as 142–134° (right–left), which lies within the normal range of modern variation. The asymmetry of the neck-shaft angle is 8°, which also lies within the normal range of modern variation (Mikhailov, 1989). Nevertheless the neck-shaft angle of the right femur is higher than we know for the Upper Palaeolithic adults (Khristianova, 1984). The general pattern in modern populations presents the ageing process of a decrease in the high angle from immature persons to adults, but we have no data to be certain of the pathological level of the neck-shaft angle of Sunghir 3.

Generally speaking, the stress indicators presented do

warrant separating this particular individual from the rest of the Sunghir site inhabitants, because the sharp and unusual bending of the femora is quite unique. A. I. Bukhman (1984) explained this phenomenon as an epigenetic (congenital) anomaly. We support his hypothesis but still provide further explanations. An increase in the general mineral content of the bones, asymmetrical bending of the tibiae shafts together with considerable deformations of the femora, asymmetry of the neck-shaft angles of femora with the higher than normal angle of the right side, the presence of a non-typical form of growth arrest lines (Harris lines) with thickening of the cortex layer in bending sites can all be considered as a combined manifestation of pathology.

In differential diagnosis we proposed possible variants of metabolic disorders including the very problematic case of familial hypophosphatasia. For example, there is the find from the Upper Palaeolithic site of the Arene Candide cave in Savon, Italy, which has been described by its researcher as a case of familial hypophosphatasia (Formicola, 1995). However, in our case we must admit that *physiological bending of femora* is the most probable cause of pathology, and could include a large group of congenital bowing of long bones (CBLB) (Bratanov, 1983). This phenomenon does not have any explanation as its factors are still hidden. What is known is that in physiological bending of the bone shafts, thickening of a cortical layer is registered on the radiograms. This is similar to our case. On the other hand, in the area of metaphyses of the femur and shinbones beak-like exostoses are often seen, which we have not registered. However, the metaphyseal area of the femora at its distal end has a specific shape and is characterised with clear-cut deformation prone to form beak-like exostosis. The high level of the neck-shaft angle of the right side is one of the traits of the physiological bending of the femora, because of the presence of *coxa valga* in such patterns. Being symmetrical and of similar extent, shaft bends also testify to the above diagnosis.

The diagnosis suggests the asymmetry of the neck-shaft angles of the femora with the bending of the tibiae could be the result of the high profile of a physical load from early age. In addition, indicators of occupational stress were noted in the areas of attachment of the *m. deltoideus*, *m. teres*, *biceps* and *brachialis* of the upper extremities; x-ray analysis reveals in the distal parts of both humeri a “crossing-beams” pattern; on the left scapula there are some signs of bone morphology at the attachment of the triceps muscle; in the lower extremities there is a similar development in the area of *m. popliteus* attachment; a certain flattening of the articular surface is noticed on the left second cervical vertebra; on the right collarbone a moderate entesopathia is registered in the area of attachment of the sternoclavicular ligament. Thus the analysis of locomotor indicators gives some evidence of the child’s labour specialisation with an activity load from an early age.

Conclusion

The analysis of physiological stress markers convincingly demonstrates that the Sunghir people had an active lifestyle without experiencing considerable negative stress.

Reconstruction of the climate at the Bryansk interval—the time period of site occupation—gives the length of the frosty period as circa 250 days per year. Negative average annual temperatures necessitated constant use of warm wear. According to O.N. Bader’s reconstruction (1998), the dress of the adult Sunghir man resembled the fur coats typical of modern Arctic peoples. This dress was supplemented with long trousers cut together with moccasin-like footwear. In addition there was a hat, and on top of it an overcoat of the poncho type.

As the analysis of soil-formative processes at the Sunghir site has shown, at that time soil formation took place in conditions of an increasingly cold, dry continental climate. The whole set of individual soils is similar to modern steppe soils of sharply continental regions of Eastern Transbaikalia and Mongolia (Gugalinskaya and Alifanov, 1998). Results of palinology studies at the Sunghir site indicates the sorts of plants which would have covered the territory in those days, with pine trees being the main forest species. However, forests did not stretch far at that period of time and were interspersed with meadows and marshes (Lavrushin and Spiridonova, 1998: 218). Probably, the cold climate, among other factors, contributed to prolonged periods of staying inside shelters at temporary sites. At the Sunghir excavations in 1956–1977 five associations of cultural remains with hearth pits representing former terrestrial dwellings were investigated, as well as dozens of camp-fires and hearth pits (Bader, 1998).

The childhood disease of Sunghir 1, due to its specificity, allows reconstruction of the conditions that humans lived in at the end of the Bryansk interval. We can imagine how the people of the Sunghir site tried to survive in a cold, continental climate. They probably wrapped infants in pelts, thus impeding the production of sufficient Vitamin D levels in diffuse sunlight. Apparently rickets was not treated, which promoted its recurrences in the cold periods of the year, i.e. it was a seasonal illness. It should be emphasised that the adult man from the Sunghir site may serve as an example of human adaptation to cold in Upper Palaeolithic times. The rickets he suffered in childhood did not contribute to the development of such bacterial infections as bronchitis or pneumonias. There is no evidence that the latter, complicated by rickets, took a serious, lingering course, thus contributing to the aggravation of rickets. Successful adaptation of the Sunghir man is also proved by a minimal number of physiological stress indicators which, taking into account his mature age, may serve as an evidence of his good health status.

Of further interest could be converse the pathology of the two children from grave no. 2. It is important to note that the two persons were buried at the same time, so we have the possibility of analyzing the physiological reactions of the two

persons to synchronous negative factors.

Among similarities the most expressed are as follows: the formation of enamel hypoplasia at the same age period, the absence of cold stress adaptations and of *Cribra orbitalia*. The children have healthy teeth, without caries. Both individuals have a partially preserved metopic suture, which is the indicator of biological relations from one side, and from the other, a marker of anomaly and of retardation of child growth. It has been also shown that Upper Palaeolithic children had a high profile of physical activity as reflected in their muscle-skeletal system.

Among differences, versions of the frontal sinus formation should be named, which mirror possible different genetic lines of the children. The presence of bone calculus in a younger individual (Sunghir 3), on the one hand, may simply be an individual characteristic, but on the other hand it may testify to a special type of diet, which is different from the nutrition of the elder child. Different types of physical activity were noted for both children. It could be that this is the result of the influence of gender diversity in labour.

Palaeozoologic analysis of the osteological material from the Sunghir site revealed clear hunting specialisation—hunting for fur-bearing animals. Among the major hunted species there were the polar fox, wolf, cave lion, bear, wolverine and marten (Alexeeva, 1998). Proceeding from the results of the reconstruction of physical activity of Sunghir 1 and Sunghir 2, it can be supposed that adult and subadult males of the group participated in hunts.

Apparently, the cold climate made it necessary to intensify this type of hunt to obtain materials for clothing. The reconstructed cloth makes it possible to see how adequate the fur used was and how ergonomic the cloth was (Bader, 1998). It is necessary to say that such labour could provoke the infestation of humans by helminths and mycosis (possible case of Sunghir 2) through contact with sick animals while cutting carcasses or pelts. The possibility of infestation through edible berries and plants, which could be infested with helminth eggs from sick animals' faeces, also cannot be excluded. Some zoologists have shown the extent of the spread of helminths in prehistory (Buzhilova, 2000a).

The Sunghirians' clothes ornamented with thousands of beads show how labour-consuming this work was. This type of locomotive activity is revealed only in the Sunghir 3 skeleton. It allows us to suppose that the work was done by females. Besides this, carrying of the weights on the head was the ordinary work of the female part of the community also.

The presence of gender differences in the group, when one or another type of activity is characteristic to men or women of the Sunghir site, is the important result of the study.

Fire pits, tens of fireplaces, agglomerations of bones, the places of bone and flint processing show high human activity at the site. Nevertheless, the fact that only surface dwellings existed across the site can be considered evidence of its seasonal use (Bader, 1998). Placed on the surface or slightly deepened dwellings of Anosov-Mesin type with the structure

of large mammoth bones or more complex constructions of the Kostjonky-Avdeev type reveals long usage duration, and consequently the settled life of the Palaeolithic groups (Yefimenko, 1953; Abramova, 1999).

Opposite to them, the Sunghir inhabitants were mobile, ready to move in one or another direction, following the needs of a night's lodging, processing of prey and obtaining necessary tools. The fact is notable that the settlement was located on a height eminence, far from natural streams. Probably there were springs, serving as sources of drinking water (Lavrushin and Spiridonova, 1998: 218). The tools with the traces of their usage in gathering were found at the site (Bader, 1998). Apparently, the Sunghirian group made full use of the peculiarities of the landscape and was actively adapted to the climatic factors of the environment.

The climatic conditions of the Upper Palaeolithic, especially in its final stages, were severe. Thus environmental change and the fall of temperature is reflected in the distribution of pathological indicators. The comparative analysis of early and late Upper Palaeolithic populations demonstrates the increasing frequency of such stress markers as enamel hypoplasia, Harris' lines and periostitis. The increase of stress indicators accords with the appropriate diminution of stature. Apparently, the people of the Upper Palaeolithic were in a state of "active adaptation" that led to victories and defeats on an individual and group level.

As was mentioned above, hereditary physiological deformations of lower extremities were revealed on the remains of the girl from Sunghir 3. Possibly, the variants of genetic anomalies, marked in the Upper Palaeolithic, prove the after-effect of consanguinity inside the population/group, when the appearance of anomalies was most probable.

Active discovery of the environment with the use of new hunting methods brought more intimate human-animal contacts and raised the level of helminthiasis and zoonosis morbidity. It must be underlined that following paleopathological data and obvious expansion of zoonotic infections is observed much later—in the Neolithic. Nevertheless, the presented mechanism of disease appearance does not exclude the probability of the existence of cases of zoonosis and helminthiasis in the Upper Palaeolithic.

Living in cold conditions and a humid climate required permanent cloth bearing. A consequence of this is the emergence of mycosis and other dermal diseases, which became a special stage of adaptation to cloth bearing. Apparently, the pathology of the boy (Sunghir 2) may be the after-effect of these conditions of an ancient hunter life.

The indicators of physiological stress were analysed for three Sunghirian individuals. The results showed that these people had adequate reactions relative to their life conditions. The quantity and the character of these indicators are known for the Upper Palaeolithic population. This circumstance allows us to consider the Sunghirian population as typical representatives of the Upper Palaeolithic.

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Received: March 18, 2005

Accepted: March 26, 2005

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