ANTHROPOLOGIE • XLVIII/1 • pp. 13–18 • 2010

ANAHIT KHUDAVERDYAN

AN ANALYSIS OF PHYSIOLOGICAL STRESS INDICATORS IN THE ANCIENT POPULATIONS OF THE ARMENIAN HIGHLANDS AND EURASIA

ABSTRACT: Just as with the concept of physiological stress today, in the distant past man was also exposed to the negative influence of his environment. Changing conditions when populating new areas, along with changes in nutrition; the type and character of diet and the impact of a complex range of climatic and geochemical factors considerably influenced the success of adaptation. Previously studied paleopathological indicators have allowed the characterization of stressors in the territory of Eurasia from the Mesolithic to the bronze age along with adaptation strategies that existed in the environment of the studied populations. The overestimated frequency of the occurrence of such indicators as anemia, vascular reaction to the bones of the skull, enamel hypoplasia, dental caries, lifetime loss of teeth owing to inflammatory processes, cases of odontogenic andosteomyelitis, etc., testify to the fact that the experience of people here varies in relation to the force and duration of internal and external stressors. The results of analysis of physiological stress indicators in Eurasia demonstrate that people had adequate reactions to their living conditions. As a whole, at the heart of interethnic distinctions between the indicators of physiological stress are genetic mechanisms reflecting the biological history of the formation of actual populations. Each of the factors ecological and ethnic brings a contribution to the character of the adaptive reaction of the organism.

KEY WORDS: Palopathological – Cryogenic stress – Nutrition stress – Enamel hypoplasia

INTRODUCTION

A prominent modern approach to the study of the development of any branch of study connected with man is the ecological approach, meaning the research of any phenomenon from the point of view of the unity of an organism and its relationship to the environment. In effect, this approach represents a system ("personal environment") where the person is considered dominant. From examples of populations in the Mesolithic and Bronze Age, an attempt is made to estimate the consequences of physiological adaptation of the ancient population of Eurasia to natural and social factors in the environment.

The complex procedure of processing data regarding the population health dynamic in the territory of Eurasia requires of the use appropriate generalizing concepts. One such concept has been created by long-term research into the processes of human adaptation and general pathology. The research of adaptive structures of the world and regional genofunds of mankind leads one to the conclusion that in a modern condition this structure basically represents a heritage of the Paleolithic past (Balanovskaya, Richkov 1990), a heritage of the adaptations which, taking place ten thousand years ago and having been generated in regions of the world and, in the world as a whole, demonstrates steady proportions of the frequencies of polymorphic genes of the person. The genofund operates on a population in the following way: the process of gene mutations results in changed genes and, consequently, the properties of organisms coded by them. The rate of change depends

on the mutagen activity of the environment, the casual drift of genes, and the casual change of a genofund in new generation. Most importantly, there is a considerable discrepancy between a potentially infinite variety of possible genotypes of new generation and a small, final number of their real carriers in small and mainly isolated endogamous populations. In populations all these factors of genetic dynamics operate, but their relative density is distinguished in different groups. Genetic change in a population occurs continuously and is shown ultimately in hereditary polymorphism – a variety of people – and in the differentiated distribution of various hereditary diseases in different groups.

The profile of a genofund and the profile of the illnesses of a population from extreme antiquity were and are in constant interaction, supporting conformity of their geographic distributions of natural ash value of the environment. There is history behind the geography of illnesses. Such an assumption corresponds to representations of theoretical medicine about the laws of development of illnesses, which are covered not only in the depths of ontogenesis but also in the depths of the evolutionary history of the person. Any ancient pathology can pass into modernity only by means of a genofund. In the same way, modern natural ash value in the geography of illnesses can be transferred from the past only through genofund geography.

MATERIALS

In total, the analysis included 32 series from the territory of Eurasia. Archaeological and anthropological monuments in the Armenian highlands (Shiraksky plain, average height, 1500–1800m. above sea level) are common in two basic periods: the first half of the IV–III millennium BC (Lanjik) and the beginning of II millennium BC (Black fortress) (Khudaverdyan 2009). Anthropological monuments in the Levant (Jericho) are common in two basic periods (Pleistocene/early Holocene) (Smith *et al.* 1984), monument in the Northern Mesopotamia (Tell-Hazna) estimated period, the beginning of III millennium BC (Dobrovolskaya, Mednikova 2008). The analysis of data from groups in Turkmenistan [Gonyr Depe (2300–1500 millennium BC)] (Dubova, Kufterin 2008), Russian plain [Sahtysh IIa (Ljalovskaya, Early Volosovskaya, Volosovskaya, stage of the developed cultures)] (Kozlovskaya 2002), Kalmykia Chograj-9 (cultures Yamnaya, North Caucasian, East Manichskaya) (data taken from work A. Zubova), Kuban (early Bronze, Bronze epoch, cultures Catacomb and Srubnaya) (data taken from work A. Zubova), Ukraine (Mesolithic-Neolithic) (Lille, Richards 2000), Wasilewka II, Wasilewka III, Iasinowka, Osipovka (data taken from work M. V. Kozlovskaya), Siberia [Western Siberia (Afanasevo culture), Black lake-1, Elovkski-1, Elovkski-2 (Andronovo culture), Elovkski-2 (Elovskaya culture), Zhuravlevo-4, Tanai-7, Zarechnoe-1 (Irmenskaya culture), Old Garden (epoch of late bronze)] (Zubova 2008).

DISCUSSION AND RESULTS

The analysis of markers of *anaemia* on paleopathological level shows the influence of natural factors and living conditions (change of diet, population density, migration, population transition to other types of management, etc.). The histogram (*Figure 1)* shows distributions cribra orbitalia in various ancient populations of the world. The studied populations differ in the ethnic and climatic-geographically. Among them: representatives of the Armenian highlands (Lanjik, the Black fortress), Forward Asia (Jericho, Tell-Hazna), Central Asia (Gonyr Depe) and Russian plain (Saxtish IIa).

A geographical correlation has been discovered in the distribution of this marker. On the histogram it is visible, that for inhabitants of the Russian plain, the basic statistical characteristics of anaemia markers appear lowest. This limited information allows us to assess the widespread prevalence of this stress marker among the population of Armenian highlands, Near Asia and Central Asia during the period of the Bronze Age that will be well coordinated with data regarding communication of the frequency of occurrence of indicators with the geographical location (the more southern the population, the higher prevalence) and features of a landscape (prevails in valley groups) (Khudaverdyan 2005, Dubova, Kufterin 2008). It is necessary to explain the high percentage of the occurrence of markers and the consequences of biological adaptation to the high maintenance of pathogenic microorganisms in the environment.

Cryogenic stress. A decrease in the partial pressure of oxygen in atmospheric air is one of the factors of severe climatic conditions of high mountains. The low temperature and humidity of air, gale-force winds, increasing intensity of solar radiation (especially in its ultra-violet part) create difficult weather conditions in the mountains that

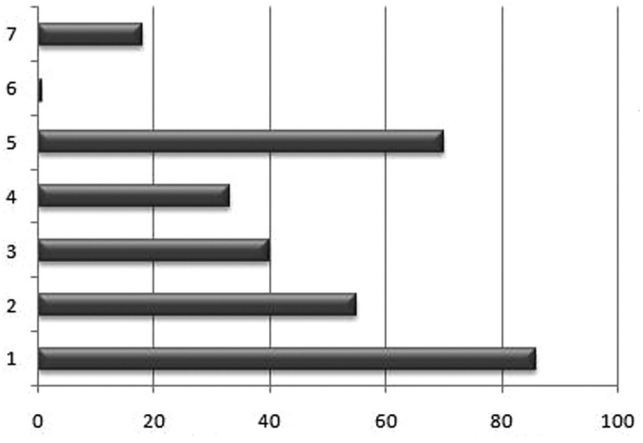

FIGURE 1. Distribution of markers of anaemia in various ethnoterritorial groups: 1. Lanjik, 2. Black fortress, 3. Jericho, 4. Tell-Hazna, 5. Gonur Depe, 6. Saxtish IIa (Ljalovskaya culture), 7. Saxtish IIa (Volosovskaya culture).

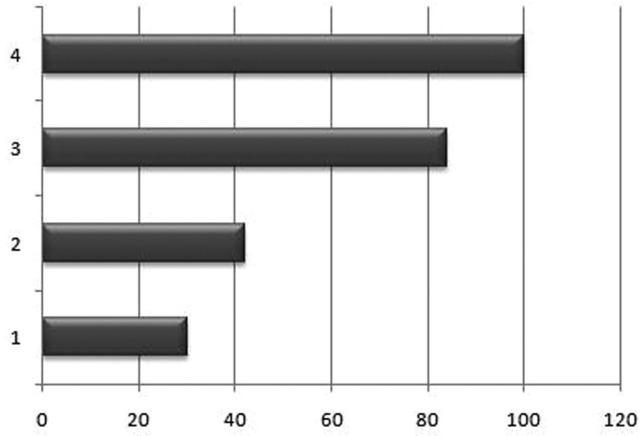

FIGURE 2. Distribution of markers of cryogenic stress in various ethnoterritorial groups: 1. Lanjik, 2. Black fortress, 3. Saxtish IIa (Ljalovskaya culture), 4. Saxtish IIa (Volosovskaya culture).

have a stressful (cryogenic) affect on the human body. In paleoanthropological materials vascular reactions of bone material are more frequent – wider nutritious aperture, which form the drawing resembles the porous surface of an orange-peel (Buzhilova 1995). A bright example of interethnic distinctions of physiological stress are data on distribution of cryogenic stress. Distinct distinctions are found in populations living on the Russian plain and in the Armenian highlands (*Figure 2*). A reasonable conclusion is expected. The presence of this marker in groups of the Russian plain testifies that they have spent a long time in the open-air and their vascular system is adapted for such conditions.

In conditions of elevated cryogenic stress, an economy with a diet containing a high percentage of fibers and fats is formed. On the contrary, with a fall in the cryogenic extremities of an environment regarding food availability, the relative density of products with the high maintenance of carbohydrates, that is characteristic for an agricultural type of economy, increases. A number of diseases are caused by food stresses. We observe insufficient, low-calorie food, periods of starvation, shortage of those or other elements to the number of negative factors in a diet, and so forth. Among the general cariogenic factors, a considerable role is played by the following: nosogeographical conditions of district, food, drinking mode, and security of an organism mineral substances, microcells, and vitamins. From comparative groups it is visible (*Figure 3*), that for the inhabitants of the bronze age of the Armenian highlands and Turkmenistan the basic statistical characteristics of dental caries are the highest. High frequency of the marker is found in the tribes of Western Siberia [Tanaj-7 (Irmenskaya culture)]. Low level of the marker is found in some populations from the territory of Western Siberia (Black lake-1, Zhuravlevo-4, Zarechnoe-1) and Forward Asia (Jericho). In people from Kalmykia, Zaporozhe and Western Siberia at buried epoch of late bronze (Old Garden), tribes of cultures Andronovo (Elovkski-2), Elovskaya (Elovkski-2) and Afanasevo the marker does not appear.

Other tooth pathology is characterized by loss of teeth over a lifetime. One of the widespread reasons for complication is dental caries; another is the strengthened loading on dentoalveolar device; the third is connected with systemic pathologies (for example, endocrine infringements or early teenage parodontosis). For southern groups it is

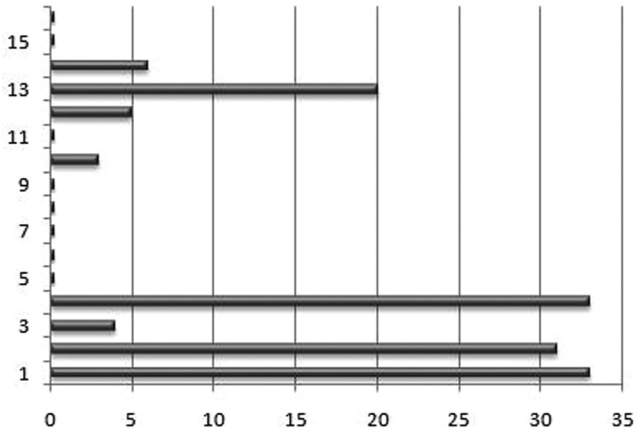

FIGURE 3. Distribution of dental caries in various ethnoterritorial groups: 1. Lanjik (Kura-Araks culture), 2. Black fortress (epoch of Late Bronze), 3. Jericho, 4. Gonyr Depe, 5. Chograj-9 (Yamnaya culture), 6. Chograj-9 (North Caucasian culture), 7. Chograj-9 (East Manichskaya culture), 8. Zaporozhye (Mesolithic-Neolithic groups), 9. Elovkski-2 (Andronovo culture), 10. Black lake-1 (Andronovo culture), 11. Elovkski-2 (Elovskaya culture), 12. Zhuravlevo-4 (Irmenskaya culture), 13. Tanaj-7 (Irmenskaya culture), 14. Zarechnoe-1 (Irmenskaya culture), 15. Old Garden, 16. Western Siberia (Afanasevo culture).

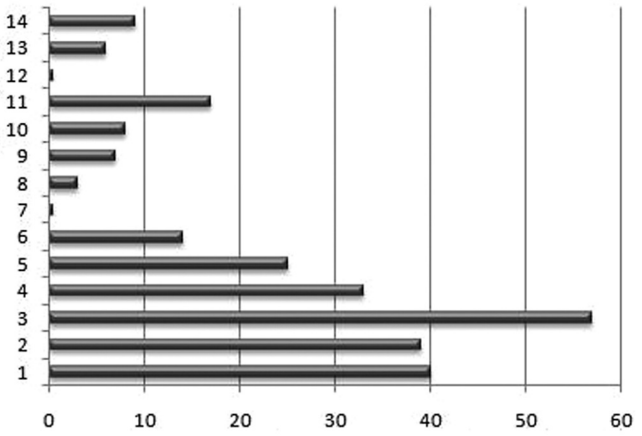

FIGURE 4. Distribution of lifetime loss of a teeth in various ethnoterritorial groups: 1. Lanjik (Kura-Araks culture), 2. Black fortress (epoch of Late Bronze), 3. Tell-Hazna, 4. Gonyr Depe, 5. Chograj-9 (Yamnaya culture), 6. Chograj-9 (North Caucasian culture), 7. Chograj-9 (East Manichskaja culture), 8. Elovkskij-2 (Andronovo culture), 9. Black lake-1 (Andronovo culture), 10. Elovkskij-2 (Elovskaya culture), 11. Zhuravlevo-4 (Irmenskaya culture), 12. Tanaj-7 (Irmenskaya culture), 13. Zarechnoe-1 (Irmenskaya culture), 14. Old Garden.

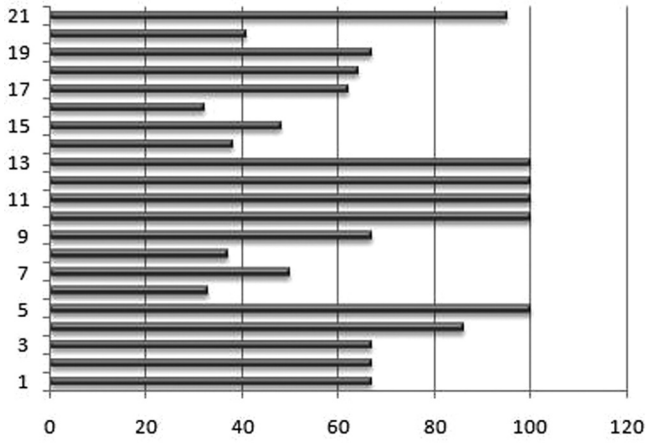

FIGURE 5. Distribution of dental cavities in various ethnoterritorial groups: 1. Lanjik (Kura-Araks culture), 2. Black fortress (epoch of Late Bronze), 3. Gonyr Depe, 4. Tell-Hazna, 5. Chograj-9 (Yamnaya culture), 6. Chograj-9 (North Caucasian culture), 7. Chograj-9 (East Manichskaja culture), 8. Dneprovsky thresholds (Mesolith), 9. Dneprovsky thresholds (Neolith), 10. Kuban (Early Bronze), 11. Kuban (Bronze Epoch), 12. Kuban (Catacomb culture), 13. Kuban (Srubnaya culture), 14. Elovkskij-2 (Andronovo culture), 15. Elovkski-1 (Andronovo culture), 16. Elovkski-2 (Elovskaya culture), 17. Zhuravlevo-4 (Irmenskaya culture), 18. Tanaj-7 (Irmenskaya culture), 19. Zarechnoe-1 (Irmenskaya culture), 20. Old Garden, 21. Western Siberia (Afanasevo culture).

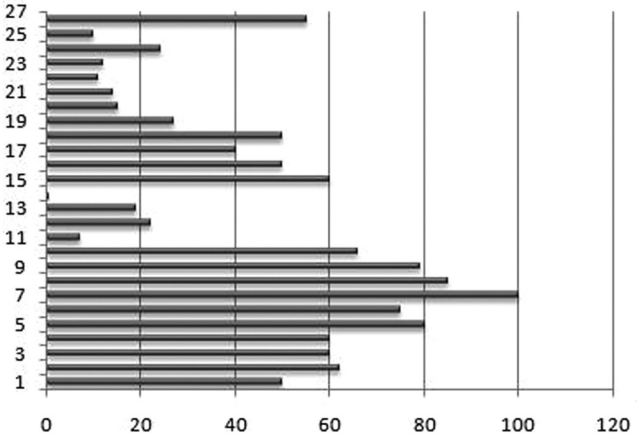

FIGURE 6. Distribution hypoplasia enamels in various ethnoterritorial groups: 1. Lanjik (Kura-Araks culture), 2. Black fortress (epoch of Late Bronze), 3. Jericho, 4. Chograj (Yamnaya culture), 5. Chograj-9 (North Caucasian culture), 6. Chograj-9 (East Manichskaja culture), 7. Saxtish IIa (Ljalovskaya culture), 8. Saxtish IIa (Early Volosovskaya culture), 9. Saxtish IIa (Volosovskaya culture), 10. Saxtish IIa (stage of the developed culture), 11. Wasilewka II, 12. Wasilewka III, 13. Iasinowka, 14. Osipovka, 15. Kuban (Early bronze), 16. Kuban (Bronze epoch), 17. Kuban (Catacomb culture), 18. Kuban (Srubnaya culture), 19. Locomotive (Kitoiskaya culture), 20. Elovkski-2 (Andronovo culture), 21. Black lake-1 (Andronovo culture), 22. Elovkski-2 (Elovskaya culture), 23. Zhuravlevo-4 (Irmenskaya culture), 24. Tanaj-7 (Irmenskaya culture), 25. Zarechnoe-1 (Irmenskaya culture), 26. Old Garden, 27. Western Siberia (Afanasevo culture).

characteristic high percent of occurrence of lifetime loss of teeth. High frequency of the marker is observed in the representatives of Northern Mesopotamia (Tell-Hazna), the Armenian highlands (Lanjik, Black fortress), Turkmenistan (Gonyr Depe), Kalmykias (Chograj-9, Yamnaya and North Caucasian cultures) and Western Siberia [Zhuravlevo-4 (Irmenskaya culture)]. Low frequency of the marker is found in some populations localised in the territory of Western Siberia [Elovkski-2 and Black lake-1 (Andronovo culture), Elovkski-2 (Elovskaya culture), Zarechnoe-1 (Irmenskaya culture) and the Old Garden (epoch of late bronze)]. In groups Chograj-9 (East Manichskaya culture) and Tanaj-7 (Irmenskaya culture) the marker does not appear (*Figure 4*).

Another indicator of food stress is the presence of *tooth stones*. According to some information, tooth stones are visible in subjects who eat albuminous food less often, and it is marked mainly in those who use soaked grains – a soft, viscous food. However, on the example of the Eskimos, whose food is considered albuminous, tooth stones are not a rarity (Merbs 1983, etc.) though the food is considered sufficiently soft and viscous.

It is known that predisposition to tooth stones can occur for several reasons including features of microflora in the mouth, chemical factors connected with food, and hypovitaminosis. In *Figure 5* the picture of distribution of tooth stones in various territorial groups is shown. The highest frequencies are noted in representatives of cultures of early bronze, Catacomb and Srubnaya of Kuban, Yamnaya of Kalmykia (Chograj-9) and Afanasevo Western Siberia. High frequencies of tooth stone are found in inhabitants of Northern Mesopotamia (Tell-Hazna), the Armenian highlands (Lanjik, Black fortress), of Turkmenistan (Gonyr Depe), of Western Siberia [Zarechnoe-1, Tanaj-7, Zhuravlevo-4 (Irmenskaya culture)] and of Dnieper (neolith). From the groups compared it is visible, that tribes of Western Siberia [Old Garden (epoch of late bronze), Elovkski-2 (Elovskaya culture), Elovkski-2, Black lake-1 (Andronovo culture)] had low frequencies of tooth stone. Low frequencies of this marker also are noted in tribes of Kalmykia (Chograj-9, North Caucasian and East Manichskaya cultures) and of Dnieper (Mesolithic).

Hypoplasia enamel. This is a developmental anomaly, characterised by an infringement of the structure and growing of insufficient or slowed down adamantoblast function. The change of their function occurs as a result of the infringement of activity by the parathyroid glands that take place in such illnesses as measles, scarlet fever, syphilis, rickets, etc. Underrating, diseases, avitaminosises, and an imbalance of food availability – are all part of a large body of literature that is devoted to the specification of age stresses and the discovery of the concrete reasons

causing hypoplasia (Hutchinson, Larsen 1988, Lanpear 1990, Van Gerven *et al.* 1990, Goodman *et al.* 1990). In some teeth, calculosa in the same time, are amassed in this case. The reason may be hypoplastic and distribution of the inflammatory process from a root of a baby tooth on a rudiment constant. Enamel hypoplasia testifies to a sharp stressful experience in childhood (as a rule, in the range from 6 months till 7 years) (Alekseeva, Buzhilova 1996). Drawing 6 illustrates intergroup variability of enamel hypoplasia in various groups of Eurasia. Here extreme variants of distribution of hypoplasia enamels (from 0 to 100% for 27 groups), probably, adequate to an extreme inhabitancy of populations are found out. In subject from burial ground In Osipovka, the marker is not found. Authentically lowered level of the marker is found in some populations in the territory of Western Siberia and Ukraine. Among them: people from burial ground Wasilewka II, Old Garden (an epoch of late bronze), Zarechnoe-1 and Zhuravlevo-4 (Irmenskaya culture), Elovkski-2 (Elovskaya culture), Elovkski-2 and Black lake-1 (Andronovo culture). Authentically high levels of markers are noted in inhabitants of the Russian plain (Saxtish IIa) and Kalmykias (Chograj-9) (*Figure 6*). At the same time in representatives of cultures of Jericho, the Armenian highlands, of Kuban and Western Siberia (Afanasevo culture) – is marked increase in frequency of damage to the tooth enamel.

As a whole, the genetic mechanisms reflecting the biological history of the formation of actual populations lies at the heart of the interethnic distinctions of indicators of physiological stress in the ancient population of Armenian highlands and Eurasia. Most likely, the key to understanding the received data is related to certain ethnosocial, cultural demographic features of the groups analyzed.

A connection of the separate stress indicators with territory where the population lived has been shown. Each of factors – ecological and ethnic – brings a contribution to the character of the adaptive reaction of an organism. The results of this research represent new essential information on biological individuality of the person and the defining factors that allow us to specify the borders of norm and pathology in ancient human populations. The results of analysis of indicators of physiological stress in Eurasia demonstrate that people had adequate reactions to their living conditions. The quantity and the character of these indicators are known for the Bronze Age population. The overestimated frequency of occurrence of such markers as anaemia, vascular reaction to bones of the skull, enamel hypoplasia, dental caries, lifetime loss of teeth due to inflammatory processes etc., testify that that the organism here experienced a variety of forces and durations – internal and external – of stressful influences. Each of the physiological and medical markers gives an original picture; however, for all the markers high frequencies of occurrence are characteristic. Most likely, the key to understanding the received data is covered in certain ethnosocial, cultural-demographic features of the analyzed groups. All the above-stated data can throw light on certain aspects of conditions of life of people during the Bronze Age.

REFERENCES

ALEKSEEVA T. I., BUZHILOVA A. P., 1996: Population of old Russian cities according to anthropology: an origin, paleodemography, paleoecology. *Russian archaeology* 3: 58–72.

BUZHILOVA A. P., 1995: *Ancient the population (paleopathologic aspects of research)*. RGNF, Moscow. 189 pp.

BALANOVSKAYA E. V., RICHKOV Y. G., 1990: Ethnic genetics: adaptive structure of a genepool of nations of the world by data about polymorphic genetic markers of the person. *Genetics* 4: 739–747.

DOBROVOLSKAYA M. V., MEDNIKOVA M. B., 2008: New data about the population of Northern Mesopotamia in an early bronze age (on anthropological materials from excavation on Tell-Hazne). In: A. P. Derevyanko, N. A. Makarov (Eds.): *Works of II (XVIII) All-Russia archaeological congress in Suzdal*. Pp. 301–304. Vol. I. Institute of archeology of the Russian Academy of Sciences, Moscow.

DUBOVA N. A., KUFTERIN V. V., 2008: The adaptation factor in formation of physical type of the ancient population of the south of Central Asia: example Gonur-Depe, Turkmenistan. In: A. P. Buzhilova, M. V. Dobrovolskaya, M. B. Mednikova (Eds.): *Actual directions of anthropology*. Pp. 113–116. Institute of archeology of the Russian Academy of Sciences, Moscow.

GOODMAN A. H., ROSE J. C., 1990: Assessment of systemic physiological pertrubation from dental enamel hypoplasias and associated histological structures. *Yearbook of Phys. Anthrop.* 33: 59–110.

KHUDAVERDYAN A. Y., 2005: *Atlas the paleopathological finds in territory of Armenia*. Van Arian,Yerevan. 286 pp.

KHUDAVERDYAN A. Y., 2009: *Population of the Armenian highlands during a bronze epoch*. Ethnogenesis and ethnic history. Van Arian, Yerevan. 440 pp.

VAN GERVEN D. P., BESK R., HUMERT J. R., 1990: Patterns of enamel hypoplasias in two Medieval population from Nubia Bath El Hajar. *Amer. J. of Phys. Anthrop.* 82: 413–420.

HUTCHINSON D. L., LARSEN C. S., 1988: Determination Episode Duration from Linear Hypoplasics. A case study from St. Catherines Island, Georgia. *Hum. biology* 60: 93–110.

LANPEAR K. M., 1990: Frequency and distribution of enamel hypoplasias in a historic skeletal sample. *Amer. J. of Phys. Anthrop.* 81: 35–43.

KOZLOVSKAYA M. G., 2002: Power supply systems and a way of life of primitive and historical communities of hunters-fishers-collectors. *Archaeology, Ethnology & Anthropology of Eurasia* 3 (11): 141–159.

LILLE M. C., RICHARDS M., 2000: Stable isotope analysis and dental evidence of diet ar the mesolithic-neolithic transition in Ukraine. *Journal of Archaeological Science* 27: 965–972.

MERBS C. F., 1983: *Patterns of activity- included pathology in a Canadian Inuit population*. Archaeological Survey of Canada. Mercury Series, N 119. National Museum of Man, Ottawa. 206 pp.

SMITH P., BAR-YOSEF O., SILLEN A., 1984: Archaeological and skeletal evidence for dietary change during the late Pleistocene/ early Holocene in the Levant. In: M. N. Cohen, G. J. Armelagos

(Eds.): *Paleopathology at the origins of agriculture*. Pp. 104–136. Academic Press, Oriando.

ZUBOVA A. V., 2008. To an adaptation question y the ancient population of Western Siberia (Andronovo time and an epoch of late bronze). In: A. P. Buzhilova, M. V. Dobrovolskaya, M. B. Mednikova (Eds.): *Actual directions of anthropology.* Pp. 117–122. Institute of archeology of the Russian Academy of Sciences, Moscow.

Anahit Khudaverdyan
Institute of Archaeology and Ethnography
National Academy of Science
Yerevan 0025
Charents st.15
Republic of Armenia
E-mail: akhudaverdyan@mail.ru
akhudaverdyan@gmail.com