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FORMATION OF THE WORLDVIEW AND DEVELOPMENT OF NATURAL SCIENCES IN THE KIEVAN RUS DURING THE X-XIII CENTURIES

Analysed here are the pre-history and development of natural sciences in the territory of Ukraine during the X–XIII centuries. The development of worldview of the eastern Slavs from the period of empirical amassment of knowledge to the period of its generalization is investigated. The significant role of natural sciences for the development of certain branches of economy of the Kievan Rus is highlighted. It has been clarified that the formation of knowledge occurred in a tense struggle between carriers of theological and rationalist views on the nature. The tight connection between the people of Rus and the nature, as well as their great knowledge about it, which is reflected in works of art and literature of that time, is shown. Particularly investigated are the sources of medical knowledge and highlighted the high level of “specialized” medical care in the Kievan Rus. Also considered here is the gradual development of farming methods, education, and science as factors of formation of knowledge on the nature and as basis for specialization and secularization of science.

Keywords: Development of natural knowledge, natural sciences, Kievan Rus.

Introduction.

Humanity had amassed some elements of knowledge about the environment they were surrounded by from the ancient times. The very first imaginings started to emerge in the ancient world and they were included into the complex process of different generalizations. Ancient Slavs had a permanent and logical interest to the surrounding environment because their contact with the nature during farming, husbandry, hunting, fishing and food gathering was continuous. Knowledge that was the treasure of the collective experience of many generations were transmitted in the pre-literary period by oral family-to-family translations and when used they required compliance with certain conditions, prohibitions, and recommendations. Also in the pre-literary period humans started to record their knowledge about the nature, as it is evidenced by so-called “agricultural calendars.” They are ceramic, wood, or stone tools with cryptograms and drawings recording information about environmental conditions, and recommendations for agricultural works¹.

With the advent of writing knowledge about the nature started to be recorded and transmitted in written form. From this time, especially in the Hellenistic period and early Middle Ages, elements of imaginings about the nature existed mainly in compiled collections, which united diverse material from practical advice to philosophical considerations.

Slavs of the Kievan Rus used the information about animals and plants, their medical and hunting specifics, acquired during earlier ages.

The subject of this research is the analysis of the world perception and knowledge in natural sciences in the Kievan Rus during the X-XIII centuries. The goal is to study the development of the worldview from the period of empiric amassment of knowledge about the nature to the period of their generalization, and also to study their value for the development of separate branches of economy in the Kievan Rus.

It should be mentioned that science was still under influence of the church in the Middle Ages in the territory of Ukraine and it was the period when the comprehension of the world was carried out in direct connection with the development of the entire cultural potential of the society. Biblical texts had the highest authority, which, however, did not give answers to certain questions about the universe and origin of natural phenomena. Modern views about the level of knowledge in natural sciences in the Kievan Rus could be composed due to archaeological data, written reports of medieval travellers, fragmented information of chronicles and other documents. To some extent, they allow some knowledge about natural

¹ Зубрицький, М. (1900). *Народний календар. Матеріали до української етнології*. Львів, 33–60.

conditions on these territories and the knowledge of humans in this period. It should be noticed that biological knowledge of this time could not be separated from the knowledge in medicine and agriculture. When compare the amount of biological knowledge (in this case zoological and botanical) of the people of the Kievan Rus with the world level of knowledge in these branches it should be considered that the culture of the Kievan Rus was part of the European culture just as, for instance, Byzantium¹. Achievements of ancient Slavs in different branches of knowledge and art, one way or another related to biological knowledge, in this period were on the same level as in countries of Western Europe. It is evidenced, for example, by Slavonic recipes of medication of the XI-XII centuries, recipes of paints, drying oils, kvass, honey, and hops².

Natural and philosophical knowledge in literary monuments. Geographically the Kievan Rus was situated at the junction of boundaries of cultural zones. The translation into Slavonic languages of books of ancient writers such as Aristotle, Theophrastus, Democritus and Plato had a major influence on distribution of biological knowledge about the wild nature and practical use of animals and plants. During this time, such books as “A Book of the Era” [Kniga Epokha], “The Physiologist” [Fiziolog] and “Interpreter Paleia” [Tolkovaya Paleia] and many other anthologies and collections were written, in which the authors aimed to include all of the information they considered valuable. After the acceptance of Christianity, to Rus came mostly canonical literature, while natural and philosophical knowledge were fragmented or modified, this often distorted the truth.

The teaching of Aristotle (I century BC), the great systematiser of knowledge, had a major impact on the next period of development of science and became basic both in Eastern and Western Europe. It became known due to its interpretation by the Byzantine philosopher John of Damascus [Ioan Damaskin] (VIII century AD). He put to the forefront the work “The fount of knowledge” which consisted of three parts such as “Dialectics”, “On heresies” and “Exposition of the Orthodox faith”³. In these works, the main attention is paid to theology and natural history information can be found only in the theoretical part (physiology).

In the XI-XII centuries, in Ukrainian chronicles descriptions of the structure of the world appear. The polymorphism of the concept of biology as a system of knowledge in the Middle Ages does not allow its using in a form of science. However, compared to other scientific branches, it has a special place in the system of knowledge. Biological, geographical and astronomical knowledge made up the system of “Christian Topography” by Cosmas Indicopleustes (VI century AD) which was distributed in the territory of Rus in the pre-Mongolian period. Details of the descriptions of the elephant and camel had no theological sense but the identification of a biological fact was already a progress. It is well illustrated in summae “The Physiologist” (symbolical parables about animals) and “Lucidarius” that contained descriptions of natural phenomena, animals, and plants.

“Hexameron” [Shestodnev] and “Lectures on the Hexameron” [Besed na shestodnev] translated by John [Ioan] Exarch of Bulgaria contain a considerable amount of useful information about the world of animals and plants, cattle-breeding, farming, structure of the human body, as well as Aristotle’s classification of animals. In treaties of those times, the classification of animals contained many errors, for instance, bats and birds were united into a single image of “birds”, and in a monument of the XII century crayfishes were classified as fishes⁴. In addition, in “Hexameron” astronomical issues were elucidated considering the ancient legacy – the spherical Earth is situated in the centre of the spherical sky with which moving circles are connected. The Moon, the Sun, and “floating and fixed stars” are connected to those circles. All stars, the Moon, and the Sun have spherical form. In the treatise, the ideas about the structure of universe of both Ptolemy and Cosmas Indicopleustes are presented⁵.

¹ Старостин, Б.А. (1978). Биологические знания. *Естественнонаучные представления Древней Руси*. Москва: изд-во Наука, 82–97.

² Гвоздецкий, В.Л., Будрейко, Е.Н. Естественнонаучные представления Древней Руси (XI-XV вв.). <http://www.portal-slovo.ru/impressionism/39140.php>.

³ Кузаков, В.К. (1978). Особенности истории науки и техники средневековой Руси. *Естественнонаучные представления Древней Руси*. Москва: изд-во Наука, 11–27.

⁴ Кузаков, В.К., Коханова, Л.Л., Лихварь, А.П., Маркевич, А.П. (1978). Биологические знания в Киевской Руси. *Естественнонаучные представления Древней Руси*. Москва, 30–41.

⁵ Колтачихина, О.Ю. (2014). Уявлення про світобудову в Україні до XVII ст. *Українське небо. Студії над історією астрономії України*. Львів: Вид-во Інститут прикладних проблем механіки і математики ім. Я.С. Підстригача НАН України, 23–26.

“The Physiologist” was translated into Slavonic in Bulgaria in the X-XI century and it was known in the Kievan Rus and contained, for example, descriptions of the beaver, crocodile, elephant, lion and also such mythical animals as the phoenix and unicorn. To the list of sources containing interesting for us information can be also added the Kievan and Halich-Volynian chronicles, Laurentian Codex (covers the period from 852 to 1305), “Pouchenie” of Volodymyr Monomakh, “Slovo” of Kirill of Turov, and “Tolkovaya Paleia” (compiled in the XI-XII centuries). In “Izbornik” of Sviatoslav of Kiev (1073) astronomical, astrological, and calendar information are presented. The monk Nestor’s “Tale of Past Years” or “Primary Chronicles” written in the Kiev Pechersk Lavra reflects the sense of inviolability of the perception of the world and the proximity of man to the nature¹. It also contains realistic images of animals and plants.

The disadvantages of Slavic translations of the above treatises are the presence and descriptions of fantastic creatures, their exoticism, which were a condition for recognition the “scientific nature” of the writing. Later a new system of knowledge emerged which existed simultaneously with the former one and had practical knowledge about hunting and farming, specifics of life cycles of plants and animals, other knowledge that was used by ancient Slavs.

The role of farming and cattle breeding in accumulation of knowledge about the nature.

The association in the X century of the ancient tribes up to Novgorod the Great gave the Kyiv State an opportunity to dispose of enormous natural resources. According to evidence of the actual materials, the Slavs had a highly developed agriculture, they cultivated many sorts of grains and legumes, and the species composition of plants cultivated in the Kievan Rus was much larger than in the Scythian-Sarmatian times. With the development of agriculture the process of exploration of new lands began, mainly forests under arable lands. This contributed to a close acquaintance with the fauna and flora of the forest strip. Cattle breeding in the Kievan Rus was mostly shepherd. The horse in written sources is mentioned more often than any other animal and, according to archaeological finds, was used both as a work animal and as for riding. In addition to the horse, remains of dogs, cats, chickens, ducks, geese, sheep, pigs, and oxen are found in excavations of ancient settlements and villages of Rus².

Hunting, fishing and beekeeping as sources of knowledge about the nature.

Among sources of biological knowledge in the Kievan Rus, hunting, fishing, beekeeping, and food collecting (mushrooms, berries, nuts) occupy a significant place. The development of these areas of human activity contributed to closer acquaintance with the nature, induced to study the specifics of animal behaviour and conditions of cultivation of crops.

The role of hunting for the people of Rus is evidenced by the facts of tax payments to princes and Khazar conquerors by skins of wild animals such as martens (kun), squirrels (belei), minks (black kun), and foxes. Such skins were the equivalent of goods also in exchange instead of money; even some of their parts were used: “mordki” (snout), “nogati” (leg), “rezani” (skin segment). It is mentioned in the writings of eastern travellers who travelled in Rus, e.g. Al-Masudi, Al-Istarh, Ibn Rustah, and Ibn Hawqal³. Pelt was one of the main trade objects of the Principality of Kiev – beavers, otters, foxes, minks, stoats, and martens were exported to foreign countries in large amounts. Volodymyr Monomakh in his “Pouchenyia” gave the list of other game animals – horse,

aurochs, deer, wild boar, and bear. In “The Tale of Igor’s Campaign” 22 animal species hunted in those times are named – aurochs, wolf, fox, mink, beaver, eagles, falcons, swans, ducks, nightingales, jackdaws, eagle-owls, pigeons, geese, gulls, etc.⁴

In the book “To the History of Hunting and Stock Breeding in the Kievan Rus,” the author gives a list of wild and domestic animals of those times with brief descriptions to most of them. Based on this book we know that according to medieval written monuments in the Middle Dnipro area 24 species of wild and 10 species of domestic mammals can be identified⁵.

The importance of hunting in the economy of the Kievan Rus is evidenced by the frescoes of St Sophia Cathedral in Kiev, which was built by Prince Yaroslav the Wise in 1037. On the frescoes game mammals and birds can be depicted, also scenes of hunting on wild boars, squirrels, wild horses, and

¹ Повесть временных лет. <<http://lib.ru/HISTORY/RUSSIA/povest.txt>>.

² Кузаков, В.К., Коханова, Л.Л., Лихварь, А.П., Маркевич, А.П. (1978). Биологические знания в Киевской Руси. *Естественнонаучные представления Древней руси*. Москва: изд-во Наука, 30-41.

³ Гудзий, Н.К. (1946). *Хрестоматия по древней русской литературе XI-XVIII веков*. Москва: изд-во Учпедгиз.

⁴ Мазурмович, Б.М. (1972). *Розвиток зоології на Україні*. Київ: Видавництво Київського університету.

⁵ Тимченко, Н.Г. (1972). *К истории охоты и животноводства в Киевской Руси*. Киев: Изд.-во Наукова думка.

bears – animals common for this land¹. The moose was especially valued and its skin was used for dress making, while its antlers were used for domestic needs.

The important role of hunting for the society influenced the development of conservation practices on hunting grounds. Different types of punishment were used against those who violated the rules depending on the depth and seriousness of the guilt. Paragraphs of the “*Russkaya Pravda*” impose large fines for the theft of birds and guns. In the chapter “About the beaver” for the illegal shot of this valuable beast the following fine was imposed: “If one steals a beaver 12 grivna should be paid” (for comparison, a horse cost 2 grivna)¹.

In the Kievan Rus, areas similar to modern reserves were created. For example, in Kiev one district has still preserved the name “Zvirinets” [a former hunting ground]. It is believed that a protected forest inhabited by a large number of wild animals was here in the XI century and it was a hunting ground of Kievan princes. However, the owners did not care about the restoration of the abundance of game animals. For instance, during hunting on bison organized by Yaroslav Osmomysl, Prince of Halych, in 1154 in honour of the arrival of the successor of the Byzantine throne, hundreds of animals were killed².

Later on, the uncontrolled and predatory killing of animals and other factors of anthropogenic pressure affected the abundance of animals. The animals retreated to the woods and hardly accessible habitats not inhabited by men. The bison in the end of the XIII century retreated to the north, while deer from the forest-steppe to the west, into the Carpathians woods³.

Fishing also played a major role in the economy of the Kievan Rus. Fish were caught by fishing rods, nets, and trophies and they are found in almost all the villages of the ancient Slavs located on river banks. The Russian scientist Aristov wrote: “Fishing sites of Princess Olga (X century) were situated on the Dnipro and Desna rivers and over all inhabited in those time lands of Rus.”

Later fishing becomes of industrial importance and the duty of permanent special workers in princely reservoirs. Interestingly, monasteries and private persons were exempted from tax on catch if the water was given to them by the rule.

Beekeeping was also well developed in Rus. As a system based on compulsory knowledge of the biology of bees it developed in the X century and later transformed into a highly developed branch of economy. “*Russkaya Pravda*” appoints punishment and fine for robbery and ruining the beehives. Spiritual certificates of princes of Rus convey to the descendants the beekeeping fields and the beehives as an inheritance. Village people also paid taxes to Princess Olga on honey. Almost in all settlements of the Kievan Rus special thorns are found that were used as instruments by beekeepers.

Besides bees, other insects are also mentioned in old manuscripts. The invasion of locusts that destroyed crops planted over large areas were fairly well known and are described in various treatises of the time, particularly in 1008, 1094, 1095, 1103, 1196⁴.

Medical knowledge.

The great experience of treatment of many generations of ancient Slavs was personified by pagan wizards or “volkhvs.” From ancient times “volkhvs,” “veduns,” and “znakhars” (different types of witch doctors) were familiar with the medical properties of plants and had some skills of giving medical aid at injuries or bone breaks. For a long time, even after accepting the Christian faith, volkhvs remained the most acclaimed “doctors” in Rus.

In the times of Prince Volodymyr, the Kievan Rus becomes one of the leading countries of Europe. In those times the “specialized” medical aid appeared in the towns, there were doctors who treated the eyes and teeth, also midwives, “cutters,” “masters of iron tricks” – surgeons who were able to deal with wounds, breaks and beats. Doctors of those times already were able to amputate the limbs and make implants, which is evidenced by Nestor’s manuscript “The Life of Boris and Gleb”.

¹ Кузаков, В.К., Коханова, Л.Л., Лихварь, А.П., Маркевич, А.П. (1978). Биологические знания в Киевской Руси. *Естественнонаучные представления Древней Руси*. Москва: изд-во Наука, 30-41.

² Кузаков, В.К., Коханова, Л.Л., Лихварь, А.П., Маркевич, А.П. (1978). Биологические знания в Киевской Руси. *Естественнонаучные представления Древней Руси*. Москва: изд-во Наука, 30-41.

³ Старостин, Б.А. (1978). Биологические знания. *Естественнонаучные представления Древней Руси*. Москва: изд-во Наука, 82-97.

⁴ Кузаков, В.К., Коханова, Л.Л., Лихварь, А.П., Маркевич, А.П. (1978). Биологические знания в Киевской Руси. *Естественнонаучные представления Древней Руси*. Москва: изд-во Наука, 30-41.

Later the needs of the society led to the selection of people engaged with medical care to a separate profession. Doctors enjoyed the trust of the people and received payment for the treatment. Simultaneously with the local medics, in the towns foreign doctors started to practice who brought new knowledge and also took over the experience of the local doctors. Slavonic translations of Hippocrates, Galen, and their commentators appeared. Galen's "On Hippocrates' On the Nature of Man" and other books became widespread. These sources, obviously, contained many false and mystical information, which is due to insufficient volume of knowledge of that time.

The most basic medical information is presented in Sviatoslav's "Izbornik" which considered medicine as a skill of the highest quality¹. In that contribution doctors are proposed to be acquainted with the patient's living conditions, there is a general description of the senescence of the organism, a list of exact reasons of diseases such as falling, bite, etc. Illnesses were divided into mental and bodily disorders. A medical terminology is used. The book also proposed treatment methods – imposition of patches and bandages, making of tisanes. Many kinds of local plant species such as henbane, mugwort, sage, as well as vinegar and bile were used in treatment. There is also advice on nutrition and hygiene guidelines given.

From the XI century in the Rus at monasteries and large churches shelters for sick and disabled people were opened. One of the first shelters was opened at the Kiev Pechersk Lavra by Theodosius of Kiev. Monks were engaged to the medical care in such shelters having high authority among the people and using mainly traditional treatment methods.

The quick increase in number of medical establishments in the Kievan Rus could be explained by social needs, on the one hand, and by Christianity, the new religion, which aimed to convert to faith and to tear off pagan volkhvs, on the other. For this, all of the experiences of the Christian world were involved.

Reflection of natural subjects in works of art and literature.

The tight connection between man and nature and, largely, its worldview are reflected by images of animals, plants, and natural themes in manuscripts and works of art. People of the Kievan Rus also attempted to reflect their view of the world through art. The nature of the Kievan Rus very often is the theme of frescoes and wall paintings (graffiti) of ancient cathedrals and churches. For instance, a graffiti on the wall of St Sophia Cathedral in Kiev depicts a cow with a note "moo." In Sviatoslav's "Izbornik," there are paintings of the lion, hare, snow leopard, and peafowl. Paintings of different animals decorate the walls of the XII century Boris and Gleb Cathedral and Cathedral of Annunciation of Our Lady in Chernigov.

An example of remarkable knowledge of nature is the description of animals in "The Tale of Igor's Campaign"². According to the behaviour of animals and birds, the researchers of "The Tale..." established the exact period of year and period of day when the described events happened.

The pagan imagination about the world was inherited by Christianity using pagan symbolism – gems, constellations, plants, and animals. The whole world was encoded in the "Book of Genesis" wherein things, events, and images were symbolized. One of the most acclaimed philosophers of the XII century Kirill of Turov widely used symbolism when describing nature or comparing events. The "Tale of Past Years" compiled by the monk Nestor in the Kiev Pechersk Lavra is illustrated with realistic paintings of plants and animals written with a great skill³.

Imaginations about the world structure.

Especially significant for the Slavs of the Kievan Rus were the "signs" [znamennya] – different natural phenomena, mainly eclipses, optical illusions, etc. An anonymous writer in 1064 described in detail in the "Tale of Past Years" what kind of "signs" occur. In the same work, other natural phenomena are described as well, considered unusual or causing fear – the birth of animals-monsters, conjoined twins, "in Africa two children was born, one with four legs and another one with two heads"⁴.

From the XI century, the times of Michael Psellos who had the honorary title of Hypatos of Philosophy, Christian dogmas were considered more critically. M. Psellos did not share the views of Aristotle and tended to Neo-Platonism. He supported the geocentric concept, according to which

¹ Изборник великого князя Святослава Ярославовича. <<http://litopys.org.ua/zapas/izbornik.htm>>. (2017, September, 25).

² Слово о полку Игореве. <[https://ru.wikisource.org/wiki/ слово_о_полку_игореве_жуковский](https://ru.wikisource.org/wiki/слово_о_полку_игореве_жуковский)>. (2017, September, 25).

³ Повесть временных лет. <<http://lib.ru/HISTORY/RUSSIA/povest.txt>>. (2017, September, 25).

⁴ Павленко, Ю.В., Руда, С.П., Хорошева, С.А., Храмов, Ю.О. (2001). *Природознавство в Україні до початку ХХ ст. в історичному, культурному та освітньому контекстах*. Київ: Вид.Академперіодика.

the Universe is an assembly of spheres that circle Earth^{1,2}. Simeon Seth was also close to the views of M. Psellos and he wrote in his work “On the things of nature” about the rotation of the celestial spheres around spherical Earth³.

Among original sources, “Trips of Hegumen Daniel” [Khozhdenie igumena Daniila] (early XII century), where descriptions of the nature of southern countries are given, should be mentioned, as well as the translated into Slavonic “Book of Enoch,” where a model of world structure is presented, according to which the Universe is composed of seven skies situated one upon another³.

The use of knowledge about the nature for the development of chemistry.

One of the most important branches of economy in the Kievan Rus and simultaneously the beginnings of the formation of chemical technology was the production of various paints for fabrics and paintings. To the paints of plant origin belonged the red “cherven” obtained from larvae of insects called cochineal, which live on the roots of some plants. In addition to the red, green, blue, yellow, and other paints of plant origin were also used. They were obtained from tree barks, remains of wheat and rye, and flowers. The most widely used paint was black – ink of plant origin containing tannins⁴. Ancient Slavs were familiar also with the use of mineral or earth paints. Their common name “vapy” can be found in ancient sources. “Vapy” represented pastes or water solutions of mineral or organic products. Ochre, cinnabar, yar (green paint), carmine, and ink were also used. Along with natural mineral paints, artificially manufactured ones became also popular in use, for example, cupric acetate and cinnabar. In painting icons gold and silver were widely used.

Conclusions. Presented here materials show the high level and originality of material and spiritual culture of the Eastern Slavs of the period of the Kievan Rus.

Development of the worldview of ancient Slavs in the Kievan Rus in the X-XIII centuries occurred in a tense struggle between carriers of theological and rationalist views on the nature and it happened in two directions – in a form of primitive interpretation of the Holy Bible and due to obtaining knowledge from the treatises of philosophers of ancient Greece. However, in the first case fantastic and far from reality images were drawn out, while in the second empirical experience was used, wider views on the origin and structure of the world were allowed. The new system of interpretation of knowledge existed simultaneously with the former one and contained practical data on homekeeping, included elements of scientific classification of plants and animals, as well as results of chemical experiments and astronomical calculations. It became the basis for formation of natural sciences. Later, the experience and practical skills gradually ousted the mystical worldview, while amassed knowledge became the basis of secularization of separate sciences and their own development.

Favourable conditions for the rapid development of culture, economy, and science of the Kievan Rus were destroyed by the Mongol invasion in the XIII century which inflicted a devastating blow on all branches of social activity. At the same time, from the XIII century the feudal system strengthened in Ukraine, the economic basis of which was the agriculture. The restoration of destroyed and building of new cities contributed to the spread and development of new knowledge, including natural sciences.

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