Vladimir Vernadsky vs. the origin of life

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Abstract. Having started to study biogeochemistry in 1916, V.I. Vernadsky discovered that the generally accepted opinion about the origin of life from inert matter has no scientific sources. But all the data of biology and paleontology indicate the origin of living things only from living things (Redi principle). Vernadsky found convincing evidence of biogenesis in the state of biological space-time, which allowed him to describe the biosphere as a planetary shell, which actually forms the planet. Vernadsky’s concept of the planetary role of living matter is currently gaining overriding and fundamental importance for all sciences about the Earth and space.

1. Introduction
In modern science, the hypothesis of the origin or origin of life has a very vague status. From religious and philosophical sources it came to science and remains an extremely stable tradition. This phrase is constantly used itself in scientific texts, since the authors learned it in some form at school, including higher institutions. However, not a single fact has yet been found that would indicate the origin of organisms chemically on Earth or in space.

Vernadsky questioned abiogenesis as soon as he began to create his own concept of the biosphere. He accepted the opposite idea of not coincidental nature of life in the system of material and energy relations in the biosphere. If we keep in mind the fundamental level, living matter is necessary for the transformation of energy into terrestrial chemical compounds. Thus, Vernadsky connected geological and biological phenomena and processes together with causal relationships. This approach brings the laws of the biosphere to the planet, and even cosmological level.

However, in modern science, Vernadsky’s concept of eternity and the cosmic status of living matter is practically unknown. It still stands apart not affecting the development of earth sciences. There are several historical, scientific and philosophical reasons for this.

Due to the strict rejection of the biogenesis idea by the Soviet ideological authorities from the very beginning of its publication (1922) to the end of Vernadsky’s life, it was considered to be dangerous and did not receive any development as a scientific school. The theory of abiogenesis created by academician A.I. Oparina was considered to be relevant. This theory was adopted by the group of scientists of T.D. Lyssenko. And only in 1965 the main works of Vernadsky on this subject begun to be published. The concept of the biosphere is widely known in the West. The fundamental book “Biosphere” was published in French by Vernadsky in 1929. But when people faced environmental problems, it turned out that the book serves as the most adequate fundamental scientific basis for them [1]. In 1968, the UNESCO conference dedicated to Vernadsky took place. After the famous Stockholm International Conference on Environmental Protection in 1972, the book became popular.
and was republished 24 times in all the major languages of the world. It shapes our attitude towards wildlife.

The American publication of the Biosphere is of particular importance [2]. It was initiated by the English biologist, ecologist and chemist James Lovelock, who discovered that his idea of the Earth as a living organism ("Gaia theory") coincides with many of Vernadsky’s ideas. The preface to this book is signed by 13 scientists from 12 countries. It contains a biographical chronicle of Vernadsky and his most complete bibliography and works about him. The text is provided with detailed annotations. We present some of them below.

However, we most often discuss the biological rather than the geological aspect of the concept of living matter. The idea of the eternity of life lying in the foundation of the biosphere did not receive any noticeable development in science, since it does not combine with the generally accepted physical image of the Universe and radically contradicts the materialistic basis of the scientific worldview. The fundamental basis of Vernadsky’s concept is still at the familiarization level.

There is a tendency in Russian-language literature to refer to Vernadsky’s works on the problem of eternity, the geological and cosmic nature of life as to a kind of author’s “philosophy of natural science”. It is placed in the tradition of the noosphere or the well-known “Russian cosmism”, which cultivate the universal status of human thought and activity. Some researchers of Vernadsky qualify him as a thinker inclined towards a general “cosmization” of knowledge [3]. This is how they relate to it in Western science. For example, in an almost only article on the problem of time and space by Vernadsky, the authors say:

“First, it seems to be extremely abstract and speculative. During his work with this topic, Vernadsky constantly went beyond the so-called method of ‘empirical generalization’ he declared as a basic principle of scientific work” [4].

The reason for this paradoxical situation lies in a simple fact: the main final works of Vernadsky, scientifically revealing the cosmic status of life, are unknown in the West. The book “The chemical structure of the Earth’s biosphere and its environment” has not yet been translated, which significantly deepens knowledge about the planetary nature of living matter. The collection "Problems of Biogeochemistry", which includes the most important theoretical treatise "On the states of space in the geological phenomena of the Earth. Against the backdrop of the growth of science of the twentieth century” has not been translated or published. Here the foundations of natural science are laid, where the status of living matter has the same rank with the principles of conservation of mass and energy. The principal article “The Beginning and Eternity of Life”, in which the problem of biogenesis was first announced, is also unknown.

Thus, the problem of eternity of life is not discussed in Russian-language scientific literature, but is classified as a problem of philosophy. In the western scientific literature scientists are not aware of it.

The purpose of this article is to present a brief history of the creation of Vernadsky's concept of the cosmic status of living matter and the biosphere. This topic is described in more detail in my last book [5]. The novelty of Vernadsky’s idea lies not only in the idea itself, but in those unexpected events that are happening in science nowadays. In biogeochemistry, in other Earth sciences, in planetary astronomy, the facts that are directly predicted by Vernadsky's concept are studied thoroughly. It explains the facts and can serve as a methodological basis. The article presents some trends in modern sciences arising from the concept of the biosphere as a cosmic phenomenon.

2. Results
Vernadsky came up with the idea of biogenesis and eternity of living matter in a lecture at the House of Writers in Petrograd in 1921. He began with the main and most important questions:

“Was the beginning of life or the life and living beings ever somewhere the same eternal foundations of cosmos, which are matter and energy? Are life and living beings a characteristic only of Earth, or is this a common manifestation of cosmos? Did it have a beginning on Earth, did it originate in it? Or did it, as a finished product, penetrate into it from other celestial bodies? <...> We know – and we know scientifically – that space cannot exist without matter and energy. But is there
enough matter and energy – without manifestations of life – to build cosmos, Universe, which can be understood by humans, i.e. scientifically built?"[6, p. 262].

In 1668, the Florentine doctor and natural scientist Francesco Redi, summarizing the observations of scientists of that era, formulated an aphorism: “Living – only from living!” Vernadsky called this principle the principle of biogenesis and considered all subsequent attempts to refute it. Without exception, all of them were unsuccessful. But since the dogma of the indispensable beginning of the world and life remained a biased attitude of consciousness, it always revived during biological discoveries, for example, with the discovery of microscopic life. However, Louis Pasteur experimentally convincingly proved the fallacy of the bacterial spontaneous hypothesis. Moreover, they turned out to be not a primitive life, but, as Vernadsky repeatedly emphasized, the most important and powerful geological force on Earth.

Equally futile were numerous attempts by biochemists to create a living cell or part of it in a laboratory. According to Vernadsky, the idea of spontaneous generation was still relevant in geology, since those layers of the earth's crust that did not contain the remains of organisms were studied. But Archean sedimentary rocks, in which there are no obvious traces of life, were also formed in the biosphere:

“There is no indication of the absence of life in the reconstruction of these physical and geographical conditions. On the contrary, we see indirect evidence of its presence everywhere,” writes Vernadsky [6, p. 275].

There was also a hypothesis of the so-called panspermia, whence the abiogenetic thought concluded that in the history of Earth there were special cosmic periods of planet formation, and only then organisms got on the planet. But, according to Vernadsky, we don’t find any primary pre-geological layers on Earth. All rocks and minerals studied in geological disciplines were formed in the biosphere.

The final conclusion of Vernadsky is:

“Recognizing biogenesis, according to scientific observation, as the only form of the origin of living things, we inevitably have to admit that there was no beginning of life in the cosmos that we observe, since there was no beginning of this cosmos. Life is eternal insofar as cosmos is eternal and has always been transmitted by biogenesis. What is true for tens and hundreds of millions of years that have passed from the Archean era to the present day is also true for the whole countless passage of time in the cosmic periods of the history of the Earth. It is true for the whole Universe ”[6, p. 278].

Based on the logic of biogenesis, Vernadsky's book Biosphere (1926) was built. The author suggests not considering three common and biased ideas: the opinion of geological phenomena as consequences of coincidence of random causes; an indispensable beginning of life in a particular geological era in the history of Earth; and the presence of certain pre-logical stages of its formation. According to this triple negation, he writes:

«Let us consider all empirical facts the point of view of a holistic mechanism that combines all parts of the planet in an indivisible whole. Only then will we able to perceive the perfect correspondence between this idea and geological effect of life. I will not speculate here about the existence of the mechanism, but rather will observe that it corresponds to all the empirical facts and follows from scientific analysis. Included in the mechanism as integrating member is the biosphere, the domain of manifestation of life» [2, p. 40].

Vernadsky bases the concept of the biosphere on initial empirical generalizations. They do not require evidence, because they stem from all the centuries-old scientific experience. We give them in summary:

1) there was never a beginning of life, it was always transmitted by biogenesis;
2) there have never been lifeless geological eras on Earth;
3) all life is unified in its basic properties;
4) living matter has always determined the chemical environment of the planet's surface;
5) the number of atoms captured by living matter in the biosphere at any given moment never went beyond the average values, i.e. constantly;
6) in which life would not manifest itself, the energy released by living organisms is mainly solar [2, pp. 54–55].

In the American edition, in the annotations to the 1st, 2nd, and 4th postulates, Mark A.S. McMenamin very eloquently refers to Russian authors who call biogenesis problematic, as to limited authors, from which Vernadsky later supposedly refuses. But these arguments are not true. It was precisely in the above-mentioned final books that Vernadsky believed that the laws of nature are unchanged. If living matter stimulates the movement of chemical compounds on the surface of the planet, then this has been the case throughout its geological history. Already in an article in 1922, Vernadsky implicitly deduced an absolute scientific ban on the origin of life, based on the geological movement:

“Abiogenesis, according to these notions (evolutionary – G.A.), is one of the stages of the evolutionary process, associated with those unique and unreplaceable earth conditions that are not repeated and not restored for any evolutionary change in the body. First of all, we cannot restore the necessary and inevitable for this – time” [6, p. 277].

The main contradiction of abiogenesis lies in the concept of time. His supporters think of time as an indefinite quantity, which it appears in the physical picture of the world [7]. But now, Vernadsky pointed out, already 9/10 scientists are working in biological and social disciplines, where time looms brighter, it becomes much clearer than in physics. First of all, it has the main quality – irreversibility, as well as the evolution of life. This means that the irreversibility of geological events is created by the living matter of the biosphere.

In understanding of the time, Vernadsky was guided by the ideas of the French philosopher Henri Bergson, who as early as 1889 in the dissertation “Immediate data of consciousness” and in his other works asserted: time is life. Developing the concept of living matter, Vernadsky now understood these words no longer abstractly and not philosophically, but at the level of empirical facts. He began to consider Bergson not a philosopher, but a theorist of biology, who found a fundamental difference between a living cell and inert matter: it remembers and continues its past state for the synthesis of its new molecules. In his main, "Nobel" book, the French theorist wrote:

«Evolution implies a real persistence of the past in the present, a duration which is, as it were, a hyphen, a connecting link. In other words, to know a living being or natural system is to get at the very interval of duration, while the knowledge of an artificial or mathematical system applies only to the extremity.

Continuity of change, preservation of the past in the present, real duration—the living being seems to share these attributes with consciousness» [8, p. 23].

The continuity of the biological movement is especially clear in heredity, adds Bergson. In this process, the very prolongation of time or its flow is constantly renewed and never stops.

Vernadsky deeply appreciated thoughts about the continuity of life by preserving the past, when in 1925 he began to reproduce organisms. Based on many facts, he derived an empirical formula for reproduction common to bacteria, plants, and animals. It turned out that the rate of transmission of life does not depend on environmental conditions. Reproduction may well stop from a lack of nutrition, for example, and from many other accidents. But there is, as we would say today, a breeding program determined by a purely genetic cause. Thus, Vernadsky found the world constants, having an objective and absolute character. Reproduction constants, like limiting cases in mechanics, give a common dimensionless unit of time – generation:

“The natural [breeding] process is an intermittent process; it develops with pauses and leads to drastic changes. The formula corresponds to a continuous process, it expresses the phenomenon – the origin of individuals – as a function of time ”[9, p. 582].

Thus, biogeochemistry filled Bergson’s theoretical thought with specific empirical content [10]. In other words, in addition to the long-described mechanical movement, the true and main process in the world is the internal life of the body's cells. In 1930, Vernadsky introduced a new concept and term biological time, which has the same eternal character as living matter:
"This biological time corresponds to one and a half to two billion years, during whom we know on Earth the existence of life, starting with the Archeozoic. It is very possible that these years are connected only with the existence of our planet, and not with the reality of life in space. We now clearly come to the conclusion that the duration of the existence of cosmic bodies is ultimate, i.e. and here we are dealing with an irreversible process. How extreme is life in its manifestation in the Cosmos, we do not know, since our knowledge of life in the Cosmos is insignificant. It is possible that billions of years correspond to Earth planetary time and make up only a small part of biological time. 

From the point of view of time, apparently, the manifestation of the Redi principle is the main phenomenon, i.e. generational change" [11, pp. 274-5].

In this article, Vernadsky points out that along with the extension of living organisms, their fundamental property is no less important, namely molecular dissymmetry (today called chirality). It was discovered by Louis Pasteur and then mathematically framed by Pierre Curie as a "state of space." Proteins of any organisms are always left in their molecular structure, while sugars are right. Such a spatial structure has no exceptions, while all mixtures of inorganic compounds contain an equal number of left and right isomers and are called racemic. Pasteur also discovered a more mysterious phenomenon: when eating mushrooms, yeast and bacteria, which means that all other organisms prefer only left-handed proteins and right-handed sugars and completely ignore the opposite isomers, although they do not differ in chemical properties in their set of atoms, but only mirror each other. With artificial synthesis in the laboratory, any substance is always synthesized only in the racemic state.

Thus, both duration and dissymmetry are peculiar only to living bodies, says Vernadsky. Therefore, both biological time and biological space are formed only with birth and are transmitted from organism to organism according to the Redi principle. That is why all attempts to synthesize a living organism from chemical compounds, even from organics, have always been absolutely unsuccessful. And since any living organism has integrity, it is impossible to synthesize any part of it. Moreover, an asymmetric substance cannot be formed "by itself", by chance during purely geochemical natural processes.

Thus, no secret of the origin of life exists. Vernadsky decided it in the most radical way. Biogenesis is consistent with the entire body of scientific empirical evidence.

But if life is not accidental, the biosphere formed by it in the planetary system is also not accidental. And, therefore, the planetary function of living matter is to build its habitat. Among the masses of bodies with the most diverse composition and structure in outer space, only planets are organized by life, says Vernadsky.

On January 18, 1942, he made a report in which he substantiated such an idea. In the light of the concept of the biosphere, the Earth should not be considered unique, as taught in school science, it is also typical at the same time:

"The Earth is one of the natural bodies close to it – the planets of the solar system. It is logically inevitable that among the phenomena occurring on it, the main ones will be those that are common to the planets "[12, p. 476].

In other words, while studying the Earth, we are obliged to extend the main features of its structure to astronomical bodies of the same class. In the solar system, these include internal "earth planets". The general and most important features of their structure will be as follows, the author says:

a) they are solid, cold bodies of revolution, all have geological shells, primarily the atmosphere;

b) they are all individually different and their planetary shells are physically and chemically diverse;

c) for two planets – Venus and Mars – we can assume the presence of the biosphere;

d) atmospheric gases of all planets are of biogenic origin [12, p. 478].

It follows that the giant planets of the solar system are not planets, emphasizes Vernadsky. They have a different composition and structure.
3. Discussion
The scientist’s cardinal biogeochemical conclusion about the typicality of the Earth is most directly proved by the development of modern planetary astronomy. According to space probes, all the major satellites of the giant planets are the bodies of the class that Vernadsky attributed to the planets. In the solar system, 29 satellites with a radius of 200 km and above turned out to be bodies of perfect spherical shape, cold, with a solid surface, some have an atmosphere. Many have found traces of violent tectonics and volcanism, there are mountains, gorges, plains and other surface structures that are well known to us on Earth. But with the general features of planetary nature, all these bodies are truly individual. They are all not alike in size, density, surface structure, or dominant color. Sulfurous volcanoes act on Io, in Europe they suggest the underground ocean; on Enceladus there are powerful water-gas emissions, methane geysers are seen on Triton. Each planet is unique. So the conclusions of Vernadsky came true in 1942.

From the biosphere or biogeochemical point of view, the solar system looks very different than from the traditional heliocentric. This is indicated by the sensational discovery in 1995 of the first exoplanets. With the improvement of technology and methods, starting in 2009, their number is growing rapidly and today there are 4135 planets combined in 3067 systems [13]. But while most of the discovered bodies are not related to planets, they are called “Jupiters” and “Saturn”. Their distinction from real planets will become clear when the James Webb orbiting telescope, which is about to be launched in 2021, begins to work.

Confirmation of the accuracy of axiom No. 2 from the Biosphere book is also very significant, namely the absence of lifeless eras in the history of the Earth, or the synchronism of biological time and geological history. For a long time after Vernadsky there was only a clear tendency: geochemists always found isotopes of elements in any layers of the Earth, some of which turned out to be biogenic. But now the fact of discoveries of zircon from rocks about 4.4 billion years old has already become well-known, and this mineral is formed only in wet and cool surfaces, i.e. in the biosphere. Now it’s not worth talking about a dry or red-hot lifeless planet. The outstanding microbiologist Academician Georgy Zavarzin reconstructed in detail the bacterial biosphere of the Archean, which is correctly called the Archeozoic [14].

Nowadays there is a solid array of facts of finding traces of life in outer space. No one is surprised by the finds of amino acids and other complex organic compounds, both in the near and deep space, in meteorites that arrived from other planets. Here is a striking example. In June 2016, a group of radio astronomers discovered in space the substance propylene oxide, which is part of the amino acids of organisms:

«The work raises the prospect of measuring the enantiomer excess in various astronomical objects, including regions where planets are being formed, to discover how and why the excess first appeared» [15].

A large number of scientific and popular science sites reported this finding of the left substance in space as a sensation, because it raised the question of the "origin of life" in space again.

4. Conclusion
Thus, modern science, not taking into account the developed by Vernadsky in 1921–1944 concepts of eternity of life, is successfully moving along the path indicated by him. The most important result of the development of knowledge about the Earth and about space is that not a single fact has been found that would refute the concept of biogenesis. There are no discoveries that would doubt on the cosmic role of living matter.

The controversy is growing, and the story with the book "Biosphere" repeats. Created almost a hundred years ago, the theory of the biogenesis and cosmic nature of living matter does not go down in the history of science. On the contrary, it is modern and has a future, because it foresees and explains the latest discoveries. All of them fit into his empirical generalizations, which indicate:

- the equality of biological division and geological history, which is provided by the fundamental bacterial biosphere, which existed for 6/7 of its canonical age before the appearance of multicellular organisms;
• the unity of the whole "monolith of life", its basic fundamental properties, including the most important ones – asymmetric space and biological time;
• the need for the biosphere as a geological shell to build all other shells and the planet itself from the physical side (the shape of its body), the geochemical situation and the conditions of thermodynamics.

There is no doubt that resolving the contradiction and accepting these generalizations is a matter of time.

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