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FROM SPONTANEOUS GENERATION TO COSMIC ABIOGENESIS. AN ATTEMPT AT SYSTEMATIZATION OF BIOGENESIS THEORIES*

Abstract. The question of the origin of life interested people for centuries. All existing views on this subject can be classified into different areas of our knowledge of the world: natural sciences, philosophy, and theology. Some theories (perhaps the majority) contain more or less explicit elements from all of these areas. Thus, it is helpful to take a closer look at them and to classify all the typical groups of theories about the origins of life. We can in this way stress their mutual connections and clarify their own nature. Nowadays, driving forces of pre-biological chemical evolution and the explanation of the transition from "non-life into life" present a great variety of solutions. The differences between the theories, however, as well as the current controversies in the scientific community (e.g., what was "in the beginning"?; where did prebiotic evolution take place? etc.), will be shown to be of secondary importance in comparison with several much more profound philosophical assumptions underlying the origin-of-life-studies. The attempt to organize and classify different types of theories on the genesis of life allows to take into account different kinds of perspectives (theistic, philosophical and scientific), and to compare them to each other. The most general division between theories is based on a distinction between metaphysical conceptions and scientific ones. Some theories answer the question of the emergence of life in general, whereas others tackle the question of the origin of life on Earth only. Interestingly, two traditional ideas concerning the problem of the origin of life (i.e., spontaneous generation and panspermia) are still at play in contemporary scientific research, albeit in a modified form. In the perspective of contemporary scientific research on the origin of life it seems interesting that two main ideas concerning the problem of the origin of life, spontaneous generation and panspermia, are still present as presuppositions of certain theories but have been modified. Moreover, it is evident that the theistic view of the origin of life (creation) does not have to fall into conflict with contemporary scientific theories. Rather, they are complementary. This article is an extension, explanation and refinement of the proposed scheme of the main types of theories on the origin of life. An attempt to classify various biogenesis theories is also proposed. One of the most important questions that will be addressed concerns the philosophical presumptions of biogenetics still informing current research as well as scientific explanations of the origin of life.

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1. INTRODUCTION

Traces of the oldest attempts to solve the problem of the origin of life can be found in various myths and beliefs. They have also been the subject of reflection in various philosophical and theological systems. The development of pre-scientific and scientific knowledge has led to a huge number of hypotheses and theories, complementary or contradictory, partly confirmed or completely refuted by new facts. Some of them are therefore only of historical value. The development of a strictly scientific search for the origin of life dates back to the early 20th century.

Generally speaking, the beginning of life on Earth can be interpreted and explained as (1) the result of the divine creative act (the concept of creation); (2) the effect of the spontaneous and sudden transformation of non-living matter into living matter (so-called "naive" spontaneous generation); (3) the result of the process of physico-chemical evolution occurring on Earth and/or in space (natural abiogenesis); (4) the transfer to Earth of life previously created in/on other celestial bodies (panspermia). When answering the question about the beginning of life in general, one can also offer a solution referring to the eternal existence of life. This, however, does not really answer the question about biogenesis, but merely states that such a question is pointless, as life has no beginning.

Nowadays, the problem of the origin of life can be considered in both naturalistic and philosophical terms. The naturalistic approach is the basis for a philosophical analysis of the issue. However, the conclusions on this issue can also be dictated by philosophical presuppositions and solutions that are prior to the naturalistic ones.

Contemporary naturalistic theories of the origin of life are created based on the results of specialized research in the field of biology,

chemistry, physics, astrophysics and others. Previous attempts to explain the origin of life have referred to superficial ordinary observation and can only be classified as scientific explanations because of the empirical method applied therein. However, they usually led to false findings and nowadays they remain only a historical testimony to the development of natural sciences and the search for the origin of life[1].

When referring to the history of research on the origin of life, it is worth mentioning that in 1897 Richard Krzymowski (1875-1960)[2], son of a Polish immigrant, who lived in the Swiss town of Winterthur at the time, published an article entitled The essence of *spontaneous generation* (*Das Wesen der Urzeugung*) in the "Die Natur" magazine[3]. In this article, he presented the concept of biogenesis based, among other things, on the idea of prebiological selection of natural and early heterotrophy. Unfortunately, his article has fallen into oblivion. Perhaps, however, in his golden years, Krzymowski enjoyed the satisfaction of witnessing the birth of a scientific discipline dealing with the issue of the origin of life (protobiology), since the first international conference on this topic was held in Moscow in 1957[4]. From then on, a wave of scientific publications on biogenesis began to grow gradually and increasingly. Between 1957 and 2000, more than 150 theories of biogenesis were announced (to date, this number has increased even further)[5].

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1 See: *Wypisy z ewolucjonizmu*, vol. 1: *Powstanie i właściwości żywej materii (Zeszyt 1: Powstanie życia na Ziemi. Część pierwsza: Okres wiary w samorództwo)*, eds. J. Kreiner, S. Skowron, PWN, Warszawa 1957.

2 See: *Neue deutsche Biographie*, vol. 13, Duncker and Humblot, Berlin 1982, 154.

3 R. Krzymowski, *Das Wesen der Urzeugung*, Die Natur 46(1897)19, 221–222 and Die Natur 46(1897)20, 229–232.

4 See: *The Origin of Life on the Earth: Reports on the International Symposium*, ed. A. Oparin, Academy of Sciences of the USSR, Moscow 1957.

5 See: W. Ługowski, *Ile jest teorii powstania życia?*, in: *W poszukiwaniu istoty życia*, eds. G. Bugajak, A. Latawiec, Wydawnictwo UKSW, Warszawa 2005, 111–124; Idem, *Progress or Crisis in the Origin-of-Life Studies? A Philosophical Perspective*, Dialogue and Universalism 18(2008)11–12, 207–218; Idem, *Filozoficzne podstawy teorii biogenezy: kontrowersje rzeczywiste i pozorne*, in: *Filozoficzne i naukowo-przyrodnicze elementy obrazu świata*, vol. 8, eds. A. Lemańska, A. Świeżyński, Wydawnictwo UKSW, Warszawa 2010, 170–190.

This multitude of theories of biogenesis is leading us to attempt to systematise them in some way. The proposal to be presented herein is based on the assumption that philosophical premises (and philosophical implications) play an important role in the construction of the theory of biogenesis[6], and their adequate recognition and characterisation may prove to be important for putting in order and evaluating the multitude of natural theories of the origin of life. In my opinion, each of these theories is also based on one of the two main ideas that have shaped the panorama of past and present views on the origin of life. These ideas include the idea of spontaneous generation and the idea of panspermia. Both of these ideas have evolved over many centuries and have undergone various transformations, however, traces of their presence can also be seen in contemporary, naturalistic proposals for solving the mystery of the origin of life.

2. CLASSIFICATION OF THE TYPES OF CONCEPTS RELATING TO THE ORIGIN OF LIFE

The proposed classification of all concepts concerning the origin of life is primarily historically conditioned, by the chronology of their origins and the relationship to scientific findings on the origin of life. Concepts that were proposed before the emergence of the scientific method in its contemporary understanding or that completely disregard scientific findings can be described as metaphysical concepts (M). And concepts developed based on modern and contemporary natural sciences can be defined as natural (N). At the same time, I assume that none of them is completely free from certain presuppositions and pre-presuppositions

6 Scientists quite often deny any philosophical significance to the scientific research they undertake. However, there can be no doubt as to the importance of the philosophical presuppositions and arguments involved in the examination of the issue of the origin of life. In this case, the philosophy goes back to the very core, the very "raison d'être" of this scientific endeavour. See: I. Fry, *Are the Different Hypotheses on the Emergence of Life as Different as they Seem?*, Biology and Philosophy 10(1995)4, 414. Cf. M. Ruse, *The origin of life: philosophical perspectives*, Journal of Theoretical Biology (1997)187, 473–482.

of a philosophical nature and the philosophical implications that result therefrom. In other words, they contain the natural layer, which is usually the core of the concept, and the philosophical layer, which contains consciously or unconsciously accepted claims of a philosophical nature[7]. The antecedence of metaphysical solutions does not mean that they are not being proposed nowadays as well, for example by supporters of a creationist or *quasi*-creationist vision of the origin of life[8].

From another perspective, the classification of all concepts of the origin of life may occur between the theories that attempt to answer the question of the origin of life on Earth (E) and those that address the issue of the beginning of life in general (U). For these two issues can be treated separately, or it can be considered that the beginning of life on Earth is also the beginning of life in the Universe (in the latter case, we are dealing with another philosophical presupposition).

Once they are superimposed, the two aforementioned fundamental classifications concerning the concept of the origin of life determine the main areas in which the different types of biogenesis concepts can be situated. Thus we have: (1) the area of metaphysical concepts that explain the emergence of life on Earth (M-E); (2) the area of metaphysical concepts explaining the origin of life in the Universe (M-U); (3) the area of naturalistic theories explaining the emergence of life on Earth (N-E); (4) the area of naturalistic theories explaining the origin of life in the Universe (N-U).

7 The most basic pre-presuppositions include an ontological presupposition about the existence of order in nature and an epistemological presupposition about the possibility and ability of the mind to get to know this order. On the other hand, presuppositions adopted by the authors of contemporary theories of the origin of life include, i.a.: a presupposition about the existence of a causal link, in particular the physical and dynamic interdependence of phenomena through which matter reveals its development potential and the pursuit of higher levels of complexity; recognition of the existence of an abiotic period in the history of the Earth; presuppositions on the chemical similarity of the first life forms to the organisms living today; the reductionist presupposition that biological phenomena are an expression of chemical processes and therefore a physico-chemical explanation is sufficient. (See: W. Ługowski, *Philosophical foundations of the theories on the origin of life*, Origins of Life and Evolution of the Biosphere 32(2002)5–6, 517–518).

8 See for example "Rational Design Hypothesis" (B. M. Shiller, *Origin of Life: The 5th Option*, Trafford Publ., Victoria – Crewe 2004).

This classification is not a separable division and allows for the identification of the links that exist between the separated areas and the types of theories of the origin of life located within them. Their detailed discussion should begin with metaphysical concepts, which are the earliest in the history of human thought. This group of views includes the following, respectively: (1) the concept of the pre-existence of life combined with the idea of panspermia (in the so-called "old" version of panspermia); (2) the concept of the creation of life on Earth; (3) earthly spontaneous generation. These concepts fall within the area of concepts relating to the explanation of the origin of life on Earth. And the area of concepts relating to the origin of life, in general, includes: (1) the concept of the eternity of life; (2) concepts on the creation of life (in the Universe); (3) cosmic spontaneous generation[9]. It should be noted here that the concept of the creation of life can explain its existence both in the Universe and only on the Earth itself, depending on where the act of creation is assigned to. Besides, creation must be differentiated into direct creation and indirect creation, according to the traditional theo-

9 The supporters of the concept of pre-existence of life included, among others: C. Flammarion (1842–1925); H. Richter (1808–1876); H. von Helmholtz (1821–1894); W. Thomson (1824–1907) – litopanspermia; S. Arrhenius (1856–1927) – radiopanspermia. The concept of creation was considered and elaborated on by: Saint Basil the Great; Augustine of Hippo; Thomas Aquinas. The concept of the eternity of life was proposed by, among others: Ionian natural philosophers; Anaxagoras; W. Preyer (1841–1897) – theory of potentiality of life; G. Fechner (1801–1887) – space-organic movement; E. Le Roy (1870–1954) – biosphere hypothesis; V. I. Wiernadski (1863–1945) – biosphere and noosphere. Whereas spontaneous generation was supported, among others, by: Aristotle; Titus Lucretius Carus; J. B. van Helmont (1579–1644); A. Kircher (1602–1680); L. Oken (1779–1851); J. C. Ross (1800–1862); F. A. Pouchet (1800–1872); H. Ch. Bastian (1837–1915). We have to distinguish between the primary and secondary spontaneous generation; the secondary spontaneous generation is the 18th-century view according to which living organisms (microorganisms) emerge out of the organic matter that remained from the disintegration of the previously existing living organisms (in accordance with the principle: „corruptio unius est generatio alterius"; see the famous dispute between J. T. Needham and G.-L. de Buffon with L. Spallanzani – J. Farley, *The Spontaneous Generation Controversy from Descartes to Oparin*, Johns Hopkins University Press, Baltimore – London 1977; J. E. Strick, *Sparks of Life. Darwinism and the Victorian Debates over Spontaneous Generation*, Harvard University Press, Cambridge 2002).

logical approach to creation. This distinction is important in order to determine the possibility of reconciling the basic statements of the metaphysical concept of creation with the philosophical layer of contemporary naturalistic concepts, which will be discussed further. It is also worth noting that the views on the pre-existence and/or eternity of life have been the backbone of the authors of some modern and contemporary concepts on the origin of life that clearly indicate certain metaphysical preferences of their authors.

In contrast, naturalistic theories originating in modern and contemporary times in the history of scientific development can be divided, by analogy with the division of metaphysical concepts, into those relating to the problem of the appearance of life on Earth and those relating to the origin of life in general. Chronologically speaking, the first group of concepts can be identified as follows: (1) natural earthly abiogenesis[10]; (2) natural bilinear abiogenesis[11]; (3) pre-existence of life combined with neopanspermia[12]. In the area concerning the origins of life in general, we can place cosmic abiogenesis, similarly to the area mentioned earlier, in the group of naturalistic theories.

10 Examples of such theories include the following: A. Oparin (the theory of coacervates); S. Fox (the theory of microspheres); H. Quastler (the theory of the emergence of biological organisation); C. R. Woese (the theory of atmospheric protocells); A. G. Cairns-Smith (the theory of mineral origins of life); S. Kauffman (the theory of self-organisation of proteins); J. B. Corliss (theory of submarine hot springs); J. Bada (the theory of the frozen ocean); C. de Duve (the theory of thioesters); C. Dobson, V. Vaida, A. Tuck et al. (the theory of atmospheric aerosols). It is worth noting how diverse is the natural layer of these theories.

11 In this case, biogenesis is understood as a process of cosmic-earthly fusion of physical and chemical changes that lead to the creation of life. Selected theories: A. Lazcano, J. Oró (comets as the source of life on Earth); A. Brack, F. Raulin (meteorite theory); B. C. Clark (theory of the comet pond); F. R. Krueger, J. Kissel (cometary-earthly scenario of the origin of life); G. W. Wojtkiewicz (the theory of geological eternity of life). Theories of this group also contain a multitude of detailed naturalistic solutions. They are sometimes referred to as pseudo-panspermia or "soft" panspermia or molecular panspermia.

12 Examples of the theory of neopanspermia are: interstellar or interplanetary panspermia; cometary panspermia; directed panspermia. See *The Biological Big Bang. Panspermia and the Origins of Life*, ed. N. C. Wickramasinghe, Cosmology Science Publ., Cambridge 2010.

Primary spontaneous generation (also referred to as "naive") originates from antiquity (mainly from the views of Aristotle) and includes the belief that in favourable environmental conditions certain (sometimes even quite complex) living organisms can arise suddenly, unprompted and spontaneously. This view has lasted for a relatively long time, as microorganisms were believed to be formed in this way until the 19th century. Depending on the place to which the spontaneous generation is attributed, it can be divided into a spontaneous generation that took place on Earth and cosmic (extraterrestrial) spontaneous generation.

Natural abiogenesis, on the other hand, is a collection of many detailed protobiological theories[13], which share a claim that life in the Universe is created through gradual and complex physical and chemical transformations. Depending on where the various stages of this process take place, we can speak of earthly, cosmic or bilinear abiogenesis (in the case of the latter, it is believed that its initial stages also took place in outer space, but ultimately, life reached the Earth). Therefore, in the natural layer, they differ primarily in the place where the process of the creation of life occurs, while they can all include the same philosophical component. Therefore, taking into account the content of the various theories of the origin of life, three basic types of philosophical layer underlying the natural views can be distinguished, and it is thus possible to propose three varieties of the abiogenesis theory: (1) meta-information abiogenesis – the group of theories, which refer to some form of universal integration principle or some kind of the law governing the course of all the processes within the Universe,[14] or the theo-

13 Protobiology is a science created in the 1950s that deals with the origin of life (biogenesis). It is based primarily on the idea of chemical evolution, although not all of the theories proposed by protobiology respect all the philosophical and naturalistic premises of this idea. See: K. Dose, *Molecular Evolution and Protobiology: An Overview*, in: *Molecular Evolution and Protobiology*, eds. K. Matsuno, K. Dose, K. Harada, D. L. Rohlfing, Plenum Press, New York – London 1984, 1–10.

14 For example: G. Wald (theory of the designed Universe); H. D. Kenyon (biochemical predestination).

ries assuming the eternal existence of biological information[15]; (2) mechanistic-chance abiogenesis – the group of theories based on the assumption of the chance emergence of the first living molecule, because of the "lucky" coincidence of natural circumstances and physico-chemical regularities favorable for the origin of life[16]; (3) abiogenesis as a self-organisation of matter – the group of theories which adopt the evolutional way of understanding the emergence of qualitatively new systems and which point to regularities governing the process of their development, among which the crucial element is the natural tendency of matter to organize itself into more and more complex structures[17]. All three groups of the theories of abiogenesis can be subdivided in even more detail, distinguishing their varieties, in which the aforementioned theses of a philosophical nature are accepted with different intensity and expressed with different force[18]. Historically, however, natural abiogenesis can be understood as the development and transformation of the idea of naive spontaneous generation, which will be discussed further.

The latter group of theories of the origin of life, the pre-existence of life combined with neopanspermia, is a view that also derives from antiquity. However, in the versions developed today, it not only assumes that life can move through the Universe and thus, at a certain historical moment (once or many times), it has also reached our planet in a very simple form, where it has found conditions fa-

15 For example: C. Portelli (theory of metainformation sources); P. Fong (static-dynamic theory).

16 This group of theories of abiogenesis includes, among others: H. J. Muller (theory of random gene formation); G. Schramm (theory of random self-replication); A. C. Elitzur (theory of the first living particle).

17 This group of theories of abiogenesis includes, among others, the following: A. Rudenko (theory of self-development of open catalytic systems); H. Kuhn (theory of self-organization of protobiological systems); M. Eigen (theory of the self-organization of matter); B.-O. Küppers (theory of the origin of biological information); S. A. Kauffman (theory of molecular systems self-replication); C. de Duve (theory of the thioester world).

18 See more: W. Ługowski, *Philosophy and Biogenesis*, Wydawnictwo Arboretum, Wrocław 2008; Origins of Life and Evolution of Biosphere (*Special Issue: Abstracts form The 2008 ISSOL Meeting*), 39(2009)3–4, 179–392.

vourable to its development, but it also specifies the conditions and mechanisms responsible for the aforementioned journey of life[19].

3. LINKS BETWEEN THE DIFFERENT TYPES OF CONCEPTS OF THE ORIGINS OF LIFE

The scheme defined by the proposed division of the types of concepts of the origin of life takes on additional significance when the links existing between the different types of concepts are revealed. They exist both between groups of concepts located in one of the designated areas (metaphysical or naturalistic), and between types of concepts relating respectively to the problem of the origin of life on Earth and the origin of life in general (M↔N, E↔U), and between concepts from different areas (M↔E, M↔U, N↔E, N↔U). All these links make it possible to see both the historical development of ideas about the origin of life and the relations existing between different ways (levels) of thinking about the genesis of life (metaphysical, naturalistic, philosophical-naturalistic).

When examining these links, it can be seen that:

(1) The adoption of the concept of the pre-existence of life leads to the recognition of either its eternity, or the creation of life by God (outside the Earth), or the creation of life through cosmic spontaneous generation. Such solutions, on the other hand, force the introduction of the concept of panspermia (currently neopanspermia) as an explanation of how existing/created/generated life reached the Earth;

(2) The adoption of the concept of creation in the matter of the origin of life on Earth is tantamount to the adoption of the concept of creation in general, with the act of creation being direct or indirect. The second version of creation is possible to be reconciled with the theory of natural abiogenesis, as the act of creation can be

19 For example: *Life in the Universe. From the Miller Experiment to the Search for Life on other Worlds*, ed. J. Seckbach, J. Chela-Flores, T. Owen, F. Raulin, Kluwer, Dordrecht – Boston – London 2004; *Life in the Universe. Expectations and Constraints*, eds. D. Schulze-Makuch, L. N. Irwin, Springer, Berlin – Heidelberg 2006; *Comets and the Origin and Evolution of Life*, eds. P. J. Thomas, R. D. Hicks, C. F. Chyba, C. P. McKay, Springer, Berlin – Heidelberg 2006.

understood as a hidden creative action manifesting itself in the processes of transformation of matter;

(3) The pre-existence of life combined with neopanspermia requires referring to the cosmic version of abiogenesis; however, one can also refer to explanations of a strictly metaphysical nature: the creation of life, the eternity of life, spontaneous generation in an extraterrestrial version;

(4) The idea of panspermia is nowadays continued in the form of modern, scientific neopanspermia and it is possible to be reconciled with both abiogenesis and with metaphysical concepts (eternity, creation, spontaneous generation). Therefore, the transformed idea of panspermia is still useful for the supporters of cosmic abiogenesis;

(5) The idea of spontaneous generation is now being pursued in the theories of natural abiogenesis in the form of earthly, cosmic and bilinear abiogenesis. This relationship is evidenced by the presence of the basic claim of the transformation of inanimate matter into the living matter in the abiogenesis theories; the difference is in how the mechanism of this transformation is explained[20];

(6) The direct creation of life can be reconciled with the idea of spontaneous generation as a sudden and spontaneous transformation of inanimate matter into the living matter – this transformation can be a result of the direct creative intervention of God, who brings the inanimate matter to life;

(7) Indirect creation of life can be reconciled with the concept of abiogenesis, as the latter discusses a complex physico-chemical process leading to the creation of life, which, from the point of view of understanding creation, can be seen as an indirect creative act (the intermediary are the physico-chemical transformations which take place in accordance with the Creator's will and with his effective involvement);

(8) All three versions of natural abiogenesis (meta-information abiogenesis, mechanistic-chance abiogenesis and abiogenesis understood as a self-organisation of matter) can function within each of the types of abiogenesis: earthly, cosmic and bilinear, and, in

20 See: A. Świeżyński, *Nowożytne przemiany idei samorództwa*, Roczniki Filozoficzne 57(2009)1, 195–229.

the case of cosmic abiogenesis, can be combined with the idea of panspermia (in the neopanspermia version).

4. RELATIONSHIPS BETWEEN THE VIEWS ON THE ORIGINS OF LIFE – A HISTORICAL AND CAUSAL APPROACH

When we examine contemporary theories of the origins of life, we can notice their structure, which includes three levels[21]: (1) conceptual level; (2) theoretical level; (3) empirical level. The conceptual level can also be called the metaphysical (strictly philosophical) layer of the theory. In historical terms, it distinguishes between two main ideas – the idea of panspermia and the idea of spontaneous generation (in the earthly version of spontaneous generation) – which guided detailed solutions to the issue of the origin of life on Earth from the beginning. The third identifiable idea – the idea of the eternity of life – should be considered a "backdrop" for the idea of panspermia, since it does not provide a solution to the question of the genesis of life on its own but it removes the problem by recognising that life does not have a beginning – it has always existed (whatever this "always" means). These ideas were modified during the period of crystallization of the modern scientific method and empirical research, becoming theoretical elements of naturalistic theories of origin of life. Their modification was influenced by empirical findings (mainly physico-chemical and astronomical-cosmological), through the theory of physico-chemical evolution and the contemporary version of the theory of the "plurality of worlds" that may harbour life[22]. As a result of this modification, various versions of the theoretical

21 See: W. Ługowski, *Kategoria zmiany jakościowej a biogeneza*, IFiS PAN – Ossolineum, Wrocław – Warszawa – Kraków – Gdańsk – Łódź 1985, 10.

22 The contemporary version of the theory of the "plurality of worlds" that may harbour life, which was previously mentioned by, among others, Nicholas of Cusa (1401–1464), Giordano Bruno (1548–1600), Bernard Le Bovier de Fontenelle (1657–1757), Christiaan Huygens (1629–1695), Immanuel Kant (1724–1804), expresses the belief that there are other planetary systems apart from the Solar System with conditions conducive to the creation and development of life. Nowadays, the empirical basis for this belief is the discovery of many planetary systems in the observed Universe, which include planets that meet the basic natural conditions necessary for life to appear and exist. See:

approach to the natural process of abiogenesis and the mechanisms of the phenomenon of panspermia (neopanspermia) appear in the theoretical layer of contemporary theories of the origin of life. It should be noted that the proposal of earthly abiogenesis was made possible by the adoption of the theory of physico-chemical evolution, inspired by Darwin's theory of evolution, and the emergence of the proposal of cosmic abiogenesis as a theoretical construct for certain contemporary theories of biogenesis was made by the extension of natural abiogenesis beyond the Earth under the influence of the theory of the "plurality of worlds" that harbour life. The fusion of these two versions of abiogenesis gave birth to bilinear abiogenesis, which is the third way of formulating the origin of life on a theoretical basis and is currently preferred by a large group of researchers[23].

An important observation relates to the way in which the idea of panspermia has been transformed into the theory of neopanspermia. This was done not directly but through the prior proposal of the theory of earthly abiogenesis and then of cosmic abiogenesis. The latter has facilitated the modification of the idea of panspermia in such a way that it is possible to justify, from a theoretical point of view, the origin of life on Earth by referring to some kind of natural mechanism for delivering life to Earth from the outside. The liter-

A. Bednarczyk, *Z dziejów idei życia we wszechświecie: epoka Oświecenia (Fontenelle, Huygens, Kant). W trzechsetną rocznicę śmierci Christiana Huygensa (1629-1695)*, Kwartalnik Historii Nauki i Techniki 40(1995)3, 7–48; C. B. Pilcher, J. J. Lissauer, *The quest for habitable worlds and life beyond the solar system*, in: *Exploring the Origin, Extent, and Future of Life. Philosophical, Ethical, and Theological Perspectives*, ed. C. M. Bertka, Cambridge Universty Press, Cambridge 2009, 143–166. In contrast to the physical or cosmological theory of the plurality of worlds, in this case we should be talking about the theory of the plurality of bio-worlds.

23 See for example: J. P. Dworkin, D. W. Deamer, S. A. Sandford, L. J. Allamandola, *Self-assembling amphiphilic molecules: Synthesis in simulated interstellar/precometary ices*, Proceedings of the National Academy of Sciences of the United States of America (2001)98, 815–819; G. Cooper, N. Kimmich, W. Belisle, J. Sarinana, K. Brabham, L. Garrel, *Carbonaceous meteorites as a source of sugar-related organic compounds for the early Earth*, Nature (2001)414, 879–883; M. Bernstein, *Prebiotic materials from on and off the early Earth*, Philosophical Transactions of The Royal Society B (Biological Sciences) (2006)361, 1689–1702.

ature on the subject relatively often overlooks this dependence and a direct historical connection between the ("old") idea of panspermia and neopanspermia is made, as if the latter was only a simple continuation of the former[24].

In the context of the above correlations, it is puzzling why a clearly formulated idea of cosmic spontaneous generation did not emerge when the search for an answer to the question

of the origin of life begun as a fourth idea and, at the same time, as an alternative to earthly spontaneous generation. Perhaps this was related to the old concept of the Earth as the only environment that is favourable to the creation of life, and of the cosmos as a sphere where life can only exist as eternal. It seems that the "missing" idea of cosmic spontaneous generation is now being revealed, as it were, in a secondary way, in some contemporary theories of biogenesis, of course as the cosmic abiogenesis theory.

5. CONCLUSIONS

In the proposed systematisation of views on the origin of life, the philosophical criterion used is associated with the presence of specific ideas in the existing concepts of biogenesis. Apparently, such a solution gives a universal and holistic character to the said systematisation. This is because it avoids being entangled in a diversity of contemporary concepts of biogenesis in their natural layer connected with a multitude of detailed solutions of the problem of biogenesis (biogenesis scenarios), a diversity which is difficult to put in an unambiguous order. Moreover, the proposed solution allows to include in the outlined scheme both older and contemporary concepts of biogenesis, as well as those which will be put forward in the future, which is highly probable – judging on the basis of the dynamic advancements in protobiology. It therefore should be expected that,

24 Cf. F. Raulin-Cerceau, *Historical Review of the Origin of Life and Astrobiology*, in: *Origins. Genesis, Evolution and Diversity of Life*, ed. J. Seckbach, Kluwer Academic Press, New York – Boston – Dordrecht – London – Moscow 2004, 17–33.

regardless of the scientific content of new natural scenarios of biogenesis, they will be founded on one of the aforementioned essential ideas of the origin of life, albeit, perhaps, again adequately modified.

The following general conclusions can be drawn from the proposed systematisation of the types of concepts of biogenesis and links that are revealed between them in a historical and typological approach:

(1) Contemporary concepts of the origin of life, regardless of the detailed empirical solutions that they propose to the essential problem, include in their non-natural layer a continuation of one of the two essential ideas of the origin of life: spontaneous generation (currently in the form of the theory of natural abiogenesis) or/and panspermia (currently in the form of the theory of neopanspermia);

(2) The metaphysical concept of creation can be reconciled with the natural layer of each of the three contemporary varieties on the concept of abiogenesis, and with neopanspermia; which cannot be said about the concept of eternity of life;

(3) The philosophical layer (foundation) is irreducibly present in every theory of the origin of life, as long as it is a theory and not a wide set of findings of a natural character;

(4) The presence of the natural (empirical) and the philosophical layer in contemporary natural theories of the origin of life requires, on the one hand, their clear distinction from each other (due to their methodological difference), on the other hand – the awareness of their interdependence and mutual determinants that are important for proposed final and holistic solutions to the issue of the origin of life;

(5) The philosophical foundation which is irreducibly present and identifiable in the natural theories of the origin of life proves that the problem of the origin of life is not just a strictly scientific, but also a philosophical problem; and therefore it cannot be fully solved by referring only to the empirical aspect of the issue.

The issue of the philosophical foundations of the theory of the origin of life, highlighted above, is often addressed in the light of the conviction that "mature science" should be free of philosoph-

ical determinants. Meanwhile, the very initiation of scientific research on biogenesis has already represented a significant philosophical breakthrough in two fundamental aspects. From an ontological perspective, it required a break with the perception of matter as a passive substance and recognition of its active character. From an epistemological and methodological perspective, it meant moving away from the scientific models of classical physics and turning to the ones proposed by evolutionary biology[25]. Consequently, the fundamental presuppositions in contemporary biogenesis research include: (1) the autodynamics of matter; (2) a holistic view of nature as a system composed of interrelated and interacting elements; (3) a historical view of the evolutionary process that takes into account the diversity and variability of evolutionary factors and mechanisms. It can therefore be argued that in the mainstream of contemporary research into the origin of life there is a conviction, consciously or sometimes unconsciously accepted by researchers, that life is the natural emergent property of matter. Consistent development of this formula is important from the perspective of the science of protobiology (and also from the perspective of its most modern and dynamically developing strain – astrobiology), as it constitutes a fundamental premise for research on biogenesis, the presence of which contradicts the claim of protobiology as a science that is without any philosophy.

The "continuity thesis"[26], which is a consequence of the adoption of the idea of self-organisation of matter, is an ontological presupposition that is necessary for the scientific investigation of the origin of life. This can be used to derive a methodological principle of continuity. However, the methodological principle of continuity can be applied without recognising the ontological continuity thesis. It is then recognised that the creation of life is admittedly within the framework of the regularity of nature, but is a "peculiarity", i.e. something

25 See: W. Ługowski, *Filozoficzne podstawy teorii biogenezy: kontrowersje rzeczywiste i pozorne*, op. cit., 187.

26 See: I. Fry, *Are the Different Hypotheses on the Emergence of Life as Different as they Seem*, op. cit., 389ff.

exceptional, one-off and in this sense accidental. However, scientific data (and arguments) on favourable/non favourable conditions for the creation of life, used as an argument in favour of the thesis on the chance creation of life, are different from a philosophical presupposition, e.g. on the self-organisation of matter, which is in line with the contemporary methodology of natural research. Philosophical theses (e.g. chance origin of life) should not be formulated and justified on the (sole) basis of natural findings (e.g. specific conditions of the original Earth). From this perspective, statements and publications whose authors seem to claim that the creation of life was a "lucky coincidence" must be of concern. As a result, by reducing the problem of the origin of life only to empirical and naturalistic solutions, and at the same time introducing "through the back door" approaches that are foreign to the consistent application of a fully evolutionary view of matter as active and capable of subsequent transformations, the followers of the views of J. Monod, F. Crick or E. Mayr[27] consider it to be impossible to produce scientific answers (as science searches and studies regularities, not one-off, unique occurrences). In this way, the search for a solution to the mystery of the origin of life is transferred from the sphere of what is scientifically "miraculous", because it reveals the fascinating properties and regularities of matter, to the sphere of what is almost "miraculous", because it is so unlikely.

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27 See J. Monod, *Chance and Necessity*, Collins, Fontana Books, Glasgow 1974; F. Crick, *Life Itself*, Simon and Schuster, New York 1981; E. Mayr, *The Growth of Biological Thought*, Harvard University Press, Cambridge MA 1982.

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