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THE PROBLEM OF CAUSALITY IN THE BIOGENESIS RESEARCH: TOWARDS A QUANTUM LOGIC OF LIFE*

MARIAN WNUK

INTRODUCTORY REMARKS

In the 20th century the dynamic view of the world was consolidated in science. The Universe is no longer perceived as a static creation as it was thought before, but as one that is subject to development. The crucial points in this evolution are an object of intensive studies that comprise the questions of the origin of the Universe, life and consciousness. The aim of the article is a review of the present state of the issue of causality in the research concerning the origin of life. This problem is an object of studies of both natural sciences and philosophy. In these two categories of knowledge, however, the range and the cognitive status of the problem of causality is different[1]. Generally speaking, the principle of causality

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* Translated from: *Zagadnienie przyczynowości w badaniach biogenezy. W kierunku kwantowej logiki życia*, "Roczniki Filozoficzne", LVI (2008), No. 1, pp. 329-353.

Prof. Marian Wnuk – Department of the Philosophy of Biology at the John Paul II Catholic University of Lublin; address for correspondence: Al. Racławickie 14, PL 20-950 Lublin; e-mail: marian.wnuk@kul.pl

[1] The bibliography of the problem of causality includes thousands of items, and there are at least hundreds of items that deal with e.g. the logic of quantum mechanics, that is with the so-called quantum logic. In the present article I only note the most important and most representative – in my opinion – works, selected because of their close or direct connection with its subject. They are: S. Mazierski, *Zasada przyczynowości w aspekcie fizykalnym i metafizycznym* [The principle of causality in the physical and metaphysical aspect], "Zeszyty Naukowe KUL", 1 (1958), No. 4, pp. 27-42; Z. Hajduk, *Filozoficzny i fizykalny aspect przyczynowości w ujęciu Dawida Bohma* [The philosophical and physical aspect of causality in Dawid Bohm's formulation], "Roczniki Filozoficzne", 23 (1975), fasc. 3, pp. 49-74; T. Rutowski, *Przyczynowość na terenie fizyki, filozofii przyrody, metafizyki i teorii informacji* [Causality in the field of physics, philosophy of nature, metaphysics and theory of information], "Roczniki Filozoficzne", 32 (1984), fasc. 3, pp. 49-71; J. Henson, *Comparing causality principles*, "Studies in History and Philosophy of Modern Physics", 36 (2005), No. 3, pp. 519-543; M. Dorato, *Becoming and the arrow of causation*, "Philosophy of Science". Proceedings, 67 (2000), pp. S523-S534; N. Cartwright, *Causation: one word, many things*, "Philosophy of Science", 71 (2004), No. 5, pp. 805-819; G. Tarozzi, *Logical positivism, quantum mechanics and the meaning of philosophical principles*, in: G. Au-

states that in nature such a connection between phenomena, or such a mutual interaction between them occurs, that there is a constant order in it. However, before this order can be expressed in the form of a system of causal laws, an order has to be introduced in the given domain. It is logic that supplies the paradigm for the method of putting it in order. Contemporary natural sciences use two categories of languages: a mathematical and an "imaginational" one. The former is connected with the classical logical calculus, whereas for the latter systems of the so-called non-classical logics are construed. It is in them that the laws ruling the correct usage of non-extensional operators connected with such terms as "change", "time" or "cause", are formulated[2]. In the context of the issue of causation attempts will be discussed of the use of nonequilibrium thermodynamics and quantum mechanics for explaining the origin of life. However, attempts at formalizing causality will be omitted. The review will be directed at the question of the need of creating a quantum logic of life.

1. THE PROBLEM OF CAUSALITY IN THE PHILOSOPHY OF BIOGENESIS

In the context of pluralism of various types of theoretical knowledge the problem of causality or causation is formulated and understood in various ways. In the broadest formulation it is considered that causality (causation) is a two-argument relation connecting beings, events, states of affairs, states of the world or facts. In its formal aspect the causal relation is most often characterized as anti-symmetric and transitive. The anti-symmetricalness is a consequence of the fact that the cause is always prior to the effect. Fundamental questions concerning the origin of life, like "why did life emerge?", "when, where and how did it emerge?", "why does its existence still last?", etc., in fact turn out to be exactly questions about causal relations.

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letta (ed.), *The Controversial Relationships between Science and Philosophy: A Critical Assessment*, Rome, Vatican City 2006, pp. 129-166; P. Kawalec, *Przyczyna i wyjaśnianie. Studium z filozofii i metodologii nauk* [Cause and explaining. A study in philosophy and methodology of sciences], Lublin 2006.

[2] S. Kiczuk, *Logicy i logika a poznanie przyrody* [Logicians and logic versus cognition of nature], "Roczniki Filozoficzne", 49 (2001), fasc. 1 pp. 127-150; id., *Problematyka wartości poznawczej systemów logiki zmiany* [The issue of cognitive value of systems of the logic of change], Lublin 1984; id., *Prawa nauk przyrodniczych a tezy logiki formalnej i metafizyki* [Laws of natural sciences versus theses of formal logic and metaphysics], "Roczniki Filozoficzne", 50 (2002), fasc. 1, pp. 303-331.

Epistemological realism dominating in classical philosophy considered the existence of beings-causes and beings-effects resulting from them as obvious[3]. However, the concept of causation also gave rise to intriguing questions, like e.g. "How is it possible that the existing present owes its existence to the past, if the past does not exist any more?" "What does the invariance of the causal order consist in?", "Is backward causality, that is causes later than their effects, possible?" In the case of this last question the obviousness of the fact that the causal order is intertwined with the temporal order is questioned. It is exactly the "backward causality" that not so much philosophers, as physicists referred to, when they explained some of the phenomena belonging to quantum mechanics. I will return to the problem of causation in physics in a further part of the article concerning the quantum mechanics of biosystems and quantum biology.

The question concerning the cause of the origin of life was not asked in the oldest view of life in human culture, that is in panvitalism, as it used to be thought that the whole world is alive, that it is an organism. The world was perceived as a vital environment similar to a womb, in which everybody lives: people, animals, etc. In a mysterious and inexplicable way they emerge from this environment borrowing some vital power, and when they die they merge again with it into one thing. Similarly, there is no need to explain the appearance of life on the Earth in the hypothesis of the eternality of life[4], since life is something more primeval than inanimate matter – and it is the origin of the latter that should be explained.

Nevertheless, questions about the cause of the origin of life did appear, and it was in many philosophical doctrines, like hylozoism, vitalism, neovitalism, panpsychism, panprotopsychism, materialism, etc. In modern times first of all dialectical materialism and neo-Thomism discussed the question.

In the metaphysical aspect dialectical materialism identifies matter with being. It states that life of its nature has a material character, but it is not a property of the whole matter in general. Life is only a special form of the motion of matter, qualitatively different[5] from the non-organic world. Defining the qualitative separateness of life in relation to other forms of the motion of

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[3] M.A. Krąpiec, *Przyczyny bytu* [Causes of being] [in:] *Powszechna Encyklopedia Filozofii* [Universal Encyclopedia of Philosophy], vol. 8, Lublin 2007, pp. 527-545.

[4] The authors of this hypothesis were, among others, W. Preyer (1841-1897) and G.T. Fechner (1801-1887).

[5] W. Ługowski, *Kategoria zmiany jakościowej a biogeneza* (*The category of qualitative change versus biogenesis*), Wrocław–Warszawa–Kraków–Gdańsk–Łódź 1985.

matter is the cognitive priority for this philosophy, because of the fact that "a fierce ideological struggle between science and religion, materialism and idealism, has been still going on", and the problem is "inseparably connected with the issue of the emergence of life on the Earth"[6]. Hence, life emerged from matter itself, without any participation of outward causes. A.I. Oparin's conception of the essence of life, and his biochemical theory of abiogenesis that is closely connected with it, are typical of this philosophical current. Natural causes of the origin of life on the Earth are accepted by many naturalists with the so-called naturalist orientation, like e.g. the geologist M.G. Rutten[7].

In turn, neo-Thomism propagates the thesis about the absolute impossibility of abiogenesis, as according to the principle of causation – stating the proportionality of the effect to its cause – inanimate matter was not able to create life as something essentially superior and more perfect than matter itself. Thomistic metaphysics gives the so-called ultimate and adequate explanation of the emergence of life as a qualitatively new being, indicating the participation of the First Cause that is a necessary and sufficient reason for the existence and action of the so-called contingent beings. It may cause the emergence of a living being owing to the existence it has of its essence.

Putting forward the evolution theory that was next universally accepted by most naturalists, was followed by debates concerning several philosophical problems, among them the problem of causality[8], especially of the causes of transitions: from matter to life, from life to consciousness, from consciousness to reflection. Scientists (e.g. paleontologists) not so much looked for the causes,

[6] This kind of priorities in the policy of science were determined by followers of Marxism-Leninism, like e.g. in a certain resolution of the Central Committee of the Communist Party of the Soviet Union and the Council of Ministers of the USSR, *On the means towards the further development of biology and towards consolidating its connections with the practice* [the quotation after: *On the essence of life*, translated from Russian into Polish by A. Bednarczyk, ed. G.M. Frank, A.M. Kuzin, I. W. Kuzniecow, N.N. Liwszyc, M.F. Wiedienow, Warszawa 1967, pp. 5-6.

[7] M.G. Rutten, *The Origin of Life by Natural Causes*, Amsterdam 1971.

[8] J. Donceel, *Causality and evolution: a survey of some neo-scholastic theories*, "New Scholasticism", 39 (1965), pp. 295-315; D.A. Recker, *Causal efficacy: the structure of Darwin's argument strategy in the "Origin of Species"*, "Philosophy of Science", 54 (1987), No. 2, pp. 147-175; J. Gayon, *Chance, explanation, and causation in evolutionary theory*, "History and Philosophy of the Life Sciences", 27 (2005), No. 3-4, pp. 395-405; C. Hillinger, *A generalization of the principle of causality, which makes it applicable to evolutionary systems*, "Synthese", 18 (1968), pp. 68-74; A. Stoltzfus, *Mutationism and the dual causation of evolutionary change*, "Evolution and Development", 8 (2006), No. 3, pp. 304-317; L. Calabi, *On Darwin's 'metaphysical notebooks'. II: "Metaphysics" and final cause*, "Rivista di biologia – Biology Forum", 94 (2001), No. 2, pp. 277-291.

as for the temporal predecessors. It was not obvious for them that what was called "higher" stages of evolution contains more perfection than "lower" stages. And even if they admitted it, they tried to explain this progress in the "mechanical" way, that is by referring to energetic factors, effects of the environment, etc., without resorting to such factors as purpose, entelechy or project. In other words, they explained evolution using only the laws of physics, chemistry or biology. Hence, at first sight it seemed that causality in evolution involves transitions from one species to another. The main source of misunderstandings was the concept of "species" understood by scientists in a different way than by philosophers, but also the concepts of "becoming", "development", etc.

The controversies between evolutionism and creationism that began about one hundred and fifty years ago, in various forms have lasted till today[9]. Deeper levels of causality are indicated, instrumental causes are distinguished from efficient ones, downward causation is distinguished from upward causation[10], immanent from evolutionary causation[11], etc.

The problem of the origin of life is considered as tantamount to the problem of the origin of biological information[12]. Contemporary philosophy of biogenesis[13] tries to "reconcile" the doctrine of creation with the theory of evolution.

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[9] K. Jodkowski, *Spór ewolucjonizmu z kreacjonizmem. Podstawowe pojęcia i poglądy* [The dispute between evolutionism and creationism. The fundamental concepts and views], Warszawa 2007; id., *Metodologiczne aspekty kontrowersji ewolucjonizm – kreacjonizm* [Methodological aspects of the controversy between evolutionism and creationism], Lublin 1998.

[10] W.S. Robinson, *Zooming in on downward causation*, "Biology and Philosophy", 20 (2005), No. 1, pp. 117-136; M. Hulswit, *How causal is downward causation?*, "Journal for General Philosophy of Science", 36 (2005), No. 2, pp. 261-287; C.N. El-Hani, C. Emmeche, *On some theoretical grounds for an organism-centered biology: Property emergence, supervenience, and downward causation*, "Theory in Biosciences", 119 (2000), No. 3-4, pp. 234-275; M.A. Bedau, *Downward causation and the autonomy of weak emergence*, "Principia", 6 (2002), pp. 5-50; C.F. Craver, W. Bechtel, *Top-down causation without top-down causes*, "Biology and Philosophy", 22 (2007), No. 4, pp. 547-563.

[11] R. Amundson, G.V. Lauder, *Function without purpose: The uses of causal role function in evolutionary biology*, "Biology and Philosophy", 9 (1994), No. 4, pp. 443-469; H.J. Barr, *The epistemology of causality from the point of view of evolutionary biology*, "Philosophy of Science", 31 (1964), No. 3, pp. 286-288.

[12] B.-O. Küppers, *Geneza informacji biologicznej. Filozoficzne problemy powstania życia* [The origin of biological information. Philosophical problems of the origin of life], trans. from German into Polish by W. Ługowski, Warszawa 1991.

[13] I mean here the Christian current in philosophy: K. Kłósak, *W poszukiwaniu pierwszej przyczyny* [In the search the first cause], vol. I, Warszawa 1955; T. Kucia, *Filozofia biogenezy* [Philosophy of biogenesis], London 1981; K. Kloskowski, *Filozofia ewolucji i filo-*

The philosophy is based on the natural image of the world and on the theory of immediate creationism, showing biological life as the effect of action of the Transcendental Cause and at the same time as a result of action of secondary causes, i.e. of the whole evolving material cosmos. For example, for P. Teilhard de Chardin spiritualistically interpreted principle of evolution is the supreme principle in treating biogenesis; in turn, K. Rahner approaches biogenesis as a manifestation of spontaneous transcendence of material beings; whereas C. Tresmontant argues that the only philosophically correct interpretation of biogenesis may be made within philosophy of the spiritualist type, and naturalist approaches to biogenesis are the point of departure for its ultimate explanation.

2. THE QUESTION OF CAUSALITY IN NATURAL THEORIES OF THE ORIGIN OF LIFE

Historically, the most influential doctrine of causality in biological sciences was Aristotle's conception of four kinds of causes (material, formal, moving, final). In contemporary science, however, the term "cause" is most often used in the meaning of "final cause", but still the "moving cause" has survived[14], even in such conceptions as teleonomy[15] or genetic program.

Protobiology[16], exobiology[17], astrobiology[18], bioastronomy[19], biocosmology[20]

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zofia stwarzania [Philosophy of evolution and philosophy of creation], vol. I: *Między ewolucją a stwarzaniem* [Between evolution and creation], Warszawa 1999.

[14] L.A. Page, *Teleology in biology: who could ask for anything more?*, "Zygon: Journal of Religion and Science", 41 (2006), No. 2, pp. 427-433; J. Wattles, *Teleology past and present*, "Zygon: Journal of Religion and Science", 41 (2006), No. 2, pp. 445-464; F.J. Ayala, *Teleological explanations in evolutionary biology*, "Philosophy of Science", 37 (1970), No. 1, pp. 1-15; S.S. Meyer, *Aristotle, teleology, and reduction*, "Philosophical Review" 101 (1992), No. 4, pp. 791-825; J.L. Esposito, *Teleological causation*, "Philosophical Forum", 12 (1980-1981), No. 2, pp. 116-127; J. Wysocki, *Problem wyjaśniania teleologicznego w biologii* [The problem of teleological explanation in biology], in: *Z zagadnień filozofii przyrodoznawstwa i filozofii przyrody* [Problems in the philosophy of natural sciences and the philosophy of nature], ed. M. Lubański, S.W. Ślaga, vol. 13, Warszawa 1991, pp. 33-90.

[15] A. Pross, *Causation and the origin of life. Metabolism or replication first?*, "Origins of Life and Evolution of the Biosphere", 34 (2004), No. 3, pp. 307-321; id., *On the chemical nature and origin of teleonomy*, "Origins of Life and Evolution of Biosphere", 35 (2005), No. 4, pp. 383-394; S.W. Ślaga, *Teleonomia organizacji biosystemów* [Teleonomy of the organization of biosystems], "Studia Philosophiae Christianae", 27 (1991), No. 2, pp. 65-81.

[16] K. Matsuno, K. Dose, K. Harada, D.L. Rohlfing(ed.), *Molecular Evolution and Protobiology*, New York–London 1984; W. Ługowski, *Filozoficzne podstawy protobiologii* [Philosophical foundations of protobiology], Warszawa 1995.

– these are the names of the most important natural sciences studying the same problem, that is the origin of life, and more precisely – abiogenesis. These sciences try to reconstruct the possible ways of abiogenesis. The first of them focuses on the origin of life on the Earth, and the remaining ones search for its beginnings in extraterrestrial environments, studying natural causal factors[21]. Hence they accept silently that metaphysics has not been able to prove that biological life could not emerge by way of abiogenesis, that is, it has not shown that inanimate matter does not have the so-called vital potentialities at its disposal. These potentialities are such properties of matter, owing to which, on a certain level of organization it is enlivened. And what these properties are like will turn out only when science finds them. The issue of the origin of life is extraordinarily complex, and since it involves the necessity to reconstruct events from the pre-biotic epoch, it requires interdisciplinary astronomical, cosmo-chemical, geological, physico-chemical, paleo-geophysical and other studies.

Abiogenesis understood in this way, studied by natural sciences, may be useful for different philosophical options. On the one hand, it is not contrary to pantheistic philosophy, according to which matter is the first cause of the emergence of life, as it stems from necessities that are immanent for inanimate matter. In such a case we may talk about e.g. materialistic emergentism. On the other hand, it may agree with theistic philosophy, as inanimate matter

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[17] J.E. Strick, *Creating a cosmic discipline: The crystallization and consolidation of exobiology, 1957-1973*, "Journal of the History of Biology", 37 (2004), No. 1, pp. 131-180; R. Sullivan, *Exobiology*, "Perspectives in Biology and Medicine", 43 (2000), No. 2, pp. 277-285; W. Dyk (ed.), *Egzobiologia czyli poszukiwanie życia w kosmosie* [Exobiology or looking for life in the cosmos], Szczecin 2002; C. Ponnamperuma (ed.), *Exobiology*, Amsterdam 1972.

[18] F. Ferrari, E. Szuszkiewicz (ed.), *Astrobiologia: poprzez pył kosmiczny do DNA* [Astrobiology: through cosmic dust to DNA], Szczecin 2006; M. Gargaud, B. Barbier, H. Martin, J. Reisse (ed.), *Lectures in Astrobiology*, vol. 1, Berlin–Heidelberg 2005; M. Gargaud, B. Barbier, P. Clayes (ed.), *Lectures in Astrobiology*, vol. 2, Berlin–Heidelberg–New York 2007.

[19] F. Raulin-Cerceau, M.-C. Maurel, J. Schneider, *From panspermia to bioastronomy, the evolution of the hypothesis of universal life*, "Origins of Life and Evolution of the Biosphere", 28 (1998), No. 4-6, pp. 597-612; J. Heidmann, M.J. Klein (ed.), *Bioastronomy: The Search for Extraterrestrial Life – The Exploration Broadens*, Berlin 1991; G. Marx (ed.), *Bioastronomy – The Next Steps*, Dordrecht 1988.

[20] C.C. King, *Biocosmology*. 2003, http://www.dhushara.com/book/biocos/biocos.pdf (2004-12-15).

[21] J.K. Kavanau, *A theory on causal factors in the origin of life*. "Philosophy of Science", 12 (1945), no. 3, pp. 190-193.

could have received from God (transcendent in relation to nature) the ability to form life in certain conditions of its evolution. In this case emergentism of creationist theism[22] may be an example. From the methodological point of view natural sciences dealing with biogenesis are not of their nature competent in the issue of the First Cause, but they only may state their views in the question of secondary causes that can be found on the level of empirical cognition.

For a long time such methods dominated in the studies of abiogenesis as the structural-functional or systemic-structural ones. However, they have proven to be insufficient when quantum mechanics or nonequilibrium thermodynamics began to be used. Owing to non-linear thermodynamics of nonequilibrium processes such properties of matter were discovered as e.g. coherence, wholeness, continuity and dynamism of processes and gradual autonomization and increasing stability of the emerging prebiotic systems. In connection with this the necessity was pointed to of reinterpretation of causal relations[23] showing just these properties, and perhaps even – of correcting causality as it had been understood until then, even because of the categories of causal relations unknown until then. This is why global-systemic, historical-systemic and genetic-historical methods are suggested. Instead of the concepts of "structure", "form", "system" such ones as "temporal organization", "functional system" or "dynamic system" are introduced; and instead of the concepts of time and causality understood linearly, the existence is postulated of the so-called network causal conditions. The new conceptual structures allow grasping and describing: (1) the interdependence of all phenomena and processes occurring in an evolving system, which results in the possibility to reveal the specific relations of their consequences, (2) the far-reaching special-temporal correlations between elements of a system, (3) the processes of creation and processing information[24] in the given system and its surroundings, and their interactions[25].

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[22] The choice of one or another philosophical option does not depend, as it seems, on the results of natural research, although probably it does have some connection with it. The question of causes of such a choice is outside the scope of the present article.

[23] W. Dyk, *Termodynamiczne aspekty genezy życia* [Thermodynamic aspects of the origin of life], in: M. Lubański, S.W. Ślaga (ed.), *Z zagadnień filozofii przyrodoznawstwa i filozofii przyrody* [Problems in the philosophy of natural sciences and the philosophy of nature], vol. 15, Warszawa 1996, pp. 13-179; H. Pattee, *Causation, control, and the evolution of complexity*, in: P.B. Andersen, C. Emmeche, N.O. Finnemann, P.V. Christiansen (ed.), *Downward Causation. Minds, Bodies and Matter*, Aarchus, Denmark 2000, pp. 63-77; A. Moreno, *Closure, identity, and the emergence of formal causation*, "Annals of the New York Academy of Sciences" 901 (2000), pp. 112-121.

[24] H.P. Yockey, *Information Theory, Evolution and the Origin of Life*, Cambridge-New York 2005.

It is suggested that quantum-relativistic processes on the micro-evolution level may prove the key to understanding the nature of self-development of matter towards creating life[26]. Therefore the processes of self-organization of matter are studied[27], that occur under the conditions of thermodynamic imbalance, i.e. the processes of forming new structures and functions. Irreversible emergence of dissipative structures that self-organize matter and energy into constant patterns, is necessary for understanding the beginnings of life as emergence of order from disorder. The processes of proto-biological evolution may result from the cyclical flow of information through a system. It has turned out that the processes have a continuous character owing to the fact that nonequilibrium systems show the ability to store, save and use information from previous developmental cycles, and also owing to formation of hypercycles in new physicochemical conditions. As result of generating information in the given system, joining two tendencies in it occurred: "self-sustenance" and "self-transcendence". The former one meant that dissipative structures prolong their existence by exchanging mass and energy with the environment; and the latter is the tendency of dynamic structures to exceed their own possibilities and to perfect their inner environment. It was also found that the rules of the types of causality described until then failed, and this is why the so-called network causality, also called functional causality, has been recognized as the most adequate[28]. Its basic properties are systemicity and feedback, as it expresses the dynamic, reflexive and multidirectional character of relations between the cause and the effect. Within its frames that are considered to be broader, Aristotle's four kinds of causes, mentioned above, are contained.

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[25] W. Dyk, *Termodynamiczne aspekty genezy życia* [Thermodynamic aspects of the origin of life], p. 112.

[26] *Ibid.*, p. 162; W. Sedlak, *Zarys biologii relatywistycznej* [An outline of the relativistic biology] "Roczniki Filozoficzne", 29 (1981), fasc. 3, pp. 43-64; F.J. Tipler, *The Physics of Immortality: Modern Cosmology, God and the Resurrection of the Dead*, New York–London–Toronto–Sydney–Auckland 1995.

[27] J. Skar, *Introduction: self-organization as an actual theme*, "Philosophical Transactions of the Royal Society of London Series A", 361 (2003), No. 1807, pp. 1049-1056; M. Nussinov, V. Maron, S. Santoli, *Self-Organization in the Universe and Life: The Pathways to Quantum Life*, Jerusalem 1999; G.P. Gladyshev, *Thermodynamic self-organization as a mechanism of hierarchical structure formation of biological matter*, "Progress in Reaction Kinetics and Mechanism", 28 (2003), No. 2, pp. 157-188.

[28] R. Sattler, *Biophilosophy. Analytic and Holistic Perspectives*, Berlin 1986, p. 129; D. Gillies, *Causality, propensity, and Bayesian networks*, "Synthese", 132 (2002), No. 1-2, pp. 63-88.

Apart of the nonequilibrium thermodynamics that was mentioned above, also quantum mechanics together with Heisenberg's uncertainty principle effected a revision of views concerning causality[29]. First of all the difference between causality and determinism that had been a little blurred in classical physics, became more distinct. Causality, earlier considered deterministic or unambiguous, became ambiguous, since the same cause may have different effects with different probabilities. Such causality concerns processes in the "world of quanta" that has been shown to be quite different from the so-called macro-world. In the former one phenomena were encountered that cannot be defined with any required precision and unambiguously predicted, and, which follows from it, the question arose, if the phenomena are causally related. On the basis of quantum mechanics the conclusion was drawn that at the foundations of physical reality lies the so-called indeterminism[30] and that the accepted formulation of the physical principle of causality with which continuity of processes and equivalence of the cause-effect relation was connected, does not have the empirical application. This is not to mean that the concept of causality is completely crossed out, for the regularities in the "quantum world" are subject to the probabilistic laws and to "indeterministic causality" (that is, unequivalent, and not equivalent causality). In connection with this it was postulated that the term "indeterminism" should be used in these sciences that concern actions and products conditioned by man's free and reasonable activity, and the term "causality" should be generalized[31].

Following the origin of quantum mechanics, from the very beginning[32]

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[29] B.J. Gawecki, *Zagadnienie przyczynowości w fizyce* [The issue of causality in physics], Warszawa 1969; D. Bohm, *Przyczynowość i przypadek w fizyce współczesnej* [*Causality and incident in contemporary physics*], trans. from English into Polish by S. Rouppert, Warszawa 1961; J. Anandan, *Causality, symmetries and quantum mechanics*, "Foundations of Physics Letters", 15 (2002), No. 5, pp. 415-438; V.P. Belavkin, *Quantum causality, stochastics, trajectories and information*, "Reports on Progress in Physics", 65 (2002), No. 3, pp. 353-420; R.F. Blute, I.T. Ivanov, P. Panangaden, *Discrete quantum causal dynamics*, "International Journal of Theoretical Physics", 42 (2003), No. 9, pp. 2025-2041; D.T. Pegg, *Causality in quantum mechanics*, "Physics Letters A" 349 (2006), No. 6, pp. 411-414.

[30] It is indeterminism in three versions: indeterminism in time, indeterminism of measurement and indeterminism connected with the uncertainty principle.

[31] S. Mazierski, *Uogólnienie pojęcia rzeczywistości* [Generalization of the concept of reality], "Roczniki Filozoficzne", 5 (1955-1957), fasc. 4, pp. 153-171; P. Clayton, *Natural law and divine action: the search for an expanded theory of causation*, "Zygon: Journal of Religion and Science" 39 (2004), No. 3, pp. 615-636.

[32] J.B.S. Haldane, *Quantum mechanics as a basis for philosophy*, "Philosophy of Science" 1 (1934), No. 1, pp. 79-98.

a debate was conducted about the possibility of a new approach to the elementary components of biosystems and mechanisms of life processes, and especially to the organization principles and the way of functioning of living systems[33].

Two typical categories may be distinguished of application of quantum mechanics in biological sciences. The first of them assumes that the biochemical level is the lowest level of organization; there regulation of processes in organisms occurs by means of transporting ions and particles. In this case quantum mechanics is used as a theory explaining properties of biomolecules (and other chemical individuals) treated as an accumulation of the so-called distinguishable particles, as it is assumed here that the uncertainty of the position and the length of coherence for the particles, of which these molecules consist, does not exceed their sizes. In other words, it is assumed that all the interactions between them have a classical, and not quantum nature.

The second category tries to describe the phenomena by taking into consideration quantum interactions in the scale of the whole organism, using the quantum theory of numerous bodies to describe the organism as a whole. In this case it is assumed that in such systems as organisms (i.e. in systems consisting of a great number of atomic cores and electrons) negentropy is formed (i.e. a specific shape of system organization), which results from the interaction of the quantum nature of component elements with the rest of the environment. The specific organization of the biosystem results from various connections, that is by way of atrophy of local ties between the components to the advantage of collective ties. As result the biosystem has the ability of self-

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[33] M. Costato, M. Milani, L. Spinoglio, *Quantum mechanics: A breakthrough into biological system dynamics*, "Bioelectrochemistry and Bioenergetics", 41 (1996), No. 1, pp. 27-30; M. Pitkänen, *Biosystems as macroscopic quantum systems*, "Journal of Non-Locality and Remote Mental Interactions", 1 (2003), No. 1 (preprint); C.W. Smith, *Is a living system a macroscopic quantum system?*, "Frontier Perspectives", 7 (1998), No. 1, pp. 9-15; R. Rosen, *The role of quantum theory in biology*, "International Journal of Quantum Chemistry: Quantum Biology Symposium", 1974, No. 1, pp. 229-232; F.A. Wolf, *The Body Quantum. The New Physics of Body, Mind, and Health*, New York 1986; K. Matsuno, *Forming and maintaining a heat engine for quantum biology*, "BioSystems", 85 (2006), No. 1, 23-29; A. Patel, *Why genetic information processing could have a quantum basis*, "Journal of Biosciences", 26 (2001), No. 2, pp. 145-151; R.H. Beyler, *Targeting the organism. The scientific and cultural context of Pascual Jordan's quantum biology, 1932-1947*, "ISIS: Journal of the History of Science in Society", 87 (1996), No. 42, pp. 248-273; F. H. Thaheld, *An interdisciplinary approach to certain fundamental issues in the fields of physics and biology: towards a unified theory*, "BioSystems", 80 (2005), No. 1, pp. 41-56.

control that occurs at the cost of the limitation of distinguishability of the quantum states of atoms entering into its composition, and the mutual effect of the quantum states of the biomolecules forms "information channels" between them. It has turned out that collective quantum phenomena described as the so-called Bose's condensation[34], are connected exactly with indistinguishability of particles and uncertainty of their position as well as with the correlation of undulatory functions and the length of coherence comparable with the sizes of macroscopic objects. What is more, it has been found[35] that such significant characteristics of biosystems as stability and ordering in states distant from thermodynamic balance indicate a deep analogy with collective properties.

Quantum-mechanical aspects of studying biological systems also comprised the problems of the origin of life[36] and its evolution[37]. However, attempts at

[34] D.D. Georgiev, *Bose-Einstein condensation of tunnelling photons in the brain cortex as a mechanism of conscious action*, 2004, http://cogprints.ecs.soton.ac.uk/archive/ 00003539/ 01/tunnelling.pdf (2004-11-12); M.V. Mesquita, Á.R. Vasconcellos, R. Luzzi, *Considerations on undistorted-progressive X-waves and Davydov solitons, Fröhlich-Bose-Einstein condensation, and Cheronkov-like effect in biosystems.* "Brazilian Journal of Physics", 34 (2004), No. 2A, pp. 489-503; E.E. Müller, *Bose-Einstein-Kondensation von Photonen: Spielt sie eine vitale Rolle für das Verständnis von Leben?*, in: H.-P. Dürr, F.-A. Popp, W. Schommers (ed.), *Elemente des Lebens. Naturwissenschaftliche Zugänge – philosophische Positionen*, (Die Graue Reihe 28), Kusterdingen, Germany 2000, pp. 355-370; G. Vitiello, E. Del Giudice, S. Doglia, M. Milani, *Boson condensation in biological systems*, in: W.R. Adey, A.F. Lawrence (ed.), *Nonlinear Electrodynamics in Biological Systems*, New York 1984, pp. 469-475.

[35] M. Urbański, *Kwantowe wzbudzenia kolektywne w układach żywych* [Quantum collective excitations in living systems], in: W. Sedlak, J. Zon, M. Wnuk (ed.), *Bioplazma. Materiały II Konferencji nt. bioplazmy* [Bioplasma. Proceedings of II Conference on bioplasma], Lublin 1988, pp. 21-39; M. Urbański, *Kwantowa teoria struktur makroskopowych (układy żywe)* The quantum theory of macroscopic structures (living systems)], in: W. Sedlak, J. Zon, M. Wnuk, (ed.), *Bioelektronika. Materiały VI Sympozjum* [Bioelectronics. Proceedings of VI Symposium], Lublin 1990, pp. 65-73.

[36] H.H. Pattee, *Quantum mechanics, heredity and the origin of life*, "Journal of Theoretical Biology", 17 (1967), No. 3, pp. 410-420; P.C.W. Davies, *Does quantum mechanics play a non-trivial role in life?*, "BioSystems", 78 (2004), No. 1-3, pp. 69-79; A. Balázs, *On the physics of the symbol-matter problem in biological systems and the origin of life: affine Hilbert spaces model of the robustness of the internal quantum dynamics of biological systems*, "BioSystems", 70 (2003), No. 1, pp. 43-54; J. Matsuno, A. Nemoto, *Quantum as a heat engine – the physics of intensities unique to the origins of life*, "Physics of Life Reviews". 2 (2005), No. 4, pp. 227-250; M. Wnuk, *Życie ze światła: biosystemogeneza w świetle koncepcji elektromagnetycznej natury życia* [Life from light: biosystemogenesis in the light of the concept of the electromagnetic nature of life], "Studia Philosophiae Christianae", 32 (1996), No. 1, pp. 101-123.

[37] J. Chela-Flores, *Evolution as a collective phenomenon*, "Journal of Theoretical Biology", 117 (1985), No. 1, pp. 107-118; D.N. Stamos, *Quantum indeterminism and evolutionary biology*, "Philosohy of Science", 68 (2001), No. 2, pp. 164-184; W. Sedlak, *A possibility*

reconstruction of the possible scenarios of biogenesis are still insufficient and rather have the character of postulates. The issue of causality taking into consideration such aspects is very rarely taken up[38]. For example, bioelectronics that stresses the significance of the quantum theory in explaining living processes, postulates the existence in living organisms of the "quantum seam of life" ("chemical-electronic connection"). This is a thermodynamically optimal quantum open system of chemical and electronic processes coexisting thanks to electromagnetic information, i.e. on an electromagnetic carrier. It manifests self-synchronization, meta-stable energetic status, and properties that are constant and independent of the evolution[39]. In this approach the death of an organism is a process of the disconnection of the quantum seam of life, whereas the origin of life would consist in "electromagnetic sewing up" the chemical reactions with electronic processes. If this tailor's metaphor proves heuristically fertile for studies in biophotonics, bioinfonics or infodynamics (as an analogon of electrodynamics and thermodynamics), cognition of conditions that are necessary and sufficient for this "sewing up" could explain the origin of life, and also make the possibility of synthesis of life *in vitro* more conceivable.

3. IS QUANTUM LOGIC OF LIFE NECESSARY?

Theses expressing the cause and effect relations may be defined by logic of causal sentences. Such logic of causality has been built for a long time for natural sciences, and especially for physics. However, with respect to the ori-

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of quantum evolution of language, in: S. Puppel (ed.), *The Biology of Language*, Amsterdam-Philadelphia 1995, pp. 257-263; J. McFadden, *Quantum Evolution. Life in the Multiverse*, London 2000; J. McFadden, J. Al-Khalill, *A quantum mechanical model of adaptive mutation.* "BioSystems", 50 (1999), No. 3, pp. 203-211; F.-A. Popp, *Evolution as expansion of coherent states*, in: B. Rubik (ed.), *The Interrelationship Between Mind and Matter*, Philadelphia, PA 1992, pp. 249-281; E. Baake, M. Baakee, H. Wagner, *Quantum mechanics versus classical probability in biological evolution*, "Physical Review E" 57 (1998), no. 1, pp. 1191-1192; A. Goswami, *Consciousness and biological order: toward a quantum theory of life and its evolution*, "Integrative Physiological and Behavioral Science" 32 (1997), no. 1, pp. 86-100.

[38] K. Matsuno, *The uncertainty principle and the origins of life: An odd couple*, in: W. Ługowski, K. Matsuno (ed.), *Uroboros, or Biology between Mythology and Philosophy*, Wrocław 1998, pp. 107-120; K. Matsuno, *Molecular semantics and the origin of life*, "BioSystems" 42 (1997), no. 2-3, pp. 129-139.

[39] M. Wnuk, *Istota procesów życiowych w świetle koncepcji elektromagnetycznej natury życia* [The essence of living processes in the light of the concept of the electromagnetic nature of life], Lublin 1996, p. 195.

gin of life the question of defining causality in a logic system is probably very difficult, since such a system does not exist yet. And perhaps it is still premature, for there is even no satisfactory form of logic of life. According to e.g. W. Elsasser[40] this is caused by the fact that organisms and phenomena of life, especially the uniqueness of biological objects and the increasing amount of information in a developing organism cannot be reduced to purely physical objects and fully explained in the language of physics.

From the metaphysical point of view only the Absolute is the main efficient cause, and the remaining ones are instrumental efficient causes, or exclusively efficient. These latter ones are only so-called secondary causes, having various forms. After all, there are differences between the efficient action of reasonable and unreasonable causes, or animate and inanimate causes. Both in philosophy and in natural sciences the concepts of cause and effect are treated as ontological categories (e.g. thing, feature, status, event). E.g. "time" and "change" are very important terms. The causality principle expressing the conviction that in the world constant order rules, is the most general assumption accepted in any research, also research concerning biogenesis, as in this research causal laws are ultimately formulated. In such laws logic distinguishes three different classes: causes, effects and conditions. Systems of logic of causality are developed[41]. They are systems of non-classical logic superstructured on the classical calculus of sentences. Such systems belong here as logic of quantum mechanics, that is quantum logic[42]. The significance of quantum physics in explaining living processes was shown above[43].

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[40] W.M. Elsasser, *A form of logic suited for biology*, in: R. Rosen (ed.), *Progress in Theoretical Biology*, vol. 6, Academic Press 1981, pp. 23-62.

[41] S. Kiczuk, *Dwie próby konstruowania logiki przyczynowości* [Two attempts at constructing a logic of causality], in: K. Kłósak (ed.), *Z zagadnień filozofii przyrodoznawstwa i filozofii przyrody* (*Of the issues of philosophy of natural sciences and of philosophy of nature*), vol. 3, Warszawa 1979, pp. 17-47; S. Kiczuk, *Związek przyczynowy a logika przyczynowości* [*The cause and effect relation and logic of causality*], Lublin 1995; M. Scriven, *The logic of cause*, "Theory and Decision" 2 (1971), pp. 49-66.

[42] A. Baltag, S. Smets, *Complete axiomatization for quantum actions*, "International Journal of Theoretical Physics", 44 (2005), No. 12, pp. 2267-2282; H. Barnum, *Quantum information processing, operational quantum logic, convexity, and the foundations of physics*, "Studies in History and Philosophy of Modern Physics" 34 (2003), no. 3, pp. 343-379; J. Hintikka, *Quantum logic as a fragment of independence-friendly logic*, "Journal of Philosophical Logic", 31 (2002), no. 3, pp. 197-209; P. Mittelstaedt, *Quantum physics and classical physics – In the light of quantum logic*, "International Journal of Theoretical Physics", 44 (2005), No. 7, pp. 771-781; K. Tokuo, *Extended quantum logic*, "Journal of Philosophical Logic", 32 (2003), No. 5, pp. 549-563.

[43] Nevertheless, in the light of recent studies it shows that organisms should be treated

Logic of the language of biological sciences is one of the important branches of philosophy of biology. The different character of this language has its foundations in the variety and complexity of the structures, forms and of the organization of living systems. The character is expressed in logical peculiarity of the concepts that is not vested in extra-biological concepts. These peculiar logical features are historicity, functionality, poly-typicality and relationality[44]. In scientific writings many related terms function that are used in a variety of contexts connected with studies of life, like e.g. logic of biology[45], logic of evolution[46], logic of life[47], logic of biosystems[48], logic of the genetic code[49], logic of genomes[50], logic of biological processes[51], biological logic[52], logic

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as a new, special class of physical systems, different from both classical and quantum systems. See G. Auletta, *Organisms as a new class of physical systems*, in: P. Ramellini (ed.), *The Organism in Interdisciplinary Context*, Vatican City 2006, pp. 87-97.

[44] S.W. Ślaga, *Czym jest i czym powinna być filozofia biologii?* [What the philosophy of biology is and should be?], in: M. Lubański, S.W. Ślaga (ed.), *Z zagadnień filozofii przyrodoznawstwa i filozofii przyrody* [Problems in the philosophy of natural sciences and the philosophy of nature], vol. 13, Warszawa 1991, pp. 15-32. The same in English: S.W. Ślaga, *What the philosophy of biology is and should be?*, "Studia Philosophiae Christianae" 25 (1989), No. 2, pp.155-175.

[45] M. Greene, *The logic of biology*, in: id. (ed.), *Logic and Personal Knowledge. Essays by various Contributors presented to Michael Polanyi on his seventieth Birthday*, London 1961, pp. 191-205.

[46] J.F. Miller, *The logic of evolution*, "Southwestern Journal of Philosophy", 3 (1972), No. 1, p. 147-168; L. van der Hammen, *Structure, appearance and knowledge: the logic of evolution*, "Rivista di biologia – Biology Forum", 91 (1998), No. 1, pp. 119-124; T.F. Hansen, *Genetics and the Logic of Evolution. By Kenneth M. Weiss and Anne V. Buchanan*, "Quarterly Review of Biology", 79 (2004), no. 4, p. 420.

[47] G. Cullmann, J.-M. Labouygues, *The mathematical logic of life*, "Origins of Life", 14 (1984), No. 1-4, pp. 747-756; C.A.R. Boyd, *Reflections on The Logic of Life*, "Interdisciplinary Science Reviews", 28 (2003), No. 1, pp. 2-6; D. Buican, *Hasard, nécessité et logique du vivant*, "La nouvelle revue française", 38 (1971), n° 225, pp. 77-85; K.M. Weiss, *The phenogenetic logic of life*, "Nature Reviews Genetics", 6 (2005), No. 1. pp. 36-46.

[48] Z.H. Duan, M. Holcombe, A. Bell, *A logic for biological systems*, "BioSystems", 55 (2000), No. 1-3, pp. 93-105; M.A. Arbib, *Warren McCulloch's search for the logic of the nervous system*, "Perspectives in Biology and Medicine", 43 (2000), No. 2, pp. 193-216.

[49] J.M. Labouygues, A. Figureau, *The logic of the genetic code: synonyms and optimality against effects of mutations*, "Origins of Life", 14 (1984), No. 1-4, pp. 685-692; G. Cullmann, J.-M. Labouygues, *The logic of the genetic code*, "Mathematical Modelling", 8 (1987), pp. 643-646.

[50] A. Herbert, A. Rich, *RNA processing in evolution. The logic of soft-wired genomes*, "Annals of the New York Academy of Sciences", 1999, pp. 119-132.

[51] R.G. Matthews, C.T. Walsh, *Mechanisms – The logic of biological process*, "Current Opinion in Chemical Biology", 9 (2005), No. 5, pp. 421-423; E.M. Meyerowitz, *Plants, animals and the logic of development*, "Trends in Cell Biology", 9 (1999), no. 12, pp. M65-M68.

of chance[53], molecular logic[54], Darwinian logic[55], logic of a minimum protocell[56]. Logic may be even treated as a branch of biology[57]. So a form of logic that would be proper for the whole of biology does not exist yet.

It was indicated above that living organisms may be treated as macroscopic quantum systems. If they are such, they are also quantum information processors[58]. Even the biology of quantum information is already being built[59]. As it is well known, for quantum physics various systems of quantum logic and metalogic are worked out[60]. Can we then, by analogy, talk about quan-

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[52] G.C. Huth, J.D. Bond, P.A. Tove, *Nonlinear tunneling barriers at high frequencies and their possible logic processing function in biological membrane*, in: W.R. Adey, A.F. Lawrence (ed.), *Nonlinear Electrodynamics in Biological Systems*, New York–London 1984, pp. 227-241.

[53] B.E. Kiliç, *John Venn's evolutionary logic of chance*, "Studies in History and Philosophy of Science", 30 (1999), no. 4, pp. 559-585.

[54] R. Axel, *The molecular logic of smell*, "Scientific American" 273 (1995), no. 4, pp. 154-159; I.K. Cheah, S.J. Langford, M.J. Latter, *Concept transfer – From genetic instruction to molecular logic*, "Supramolecular Chemistry", 17 (2005), No. 1-2, pp. 121-128.

[55] J.B.S. Haldane, *A logical basis for the genetics?*, "British Journal for the Philosophy of Science", 6 (1955), no. 23, pp. 245-248.

[56] H.J. Morowitz, B. Heintz, D.W. Deamer, *The chemical logic of a minimum protocell*, "Origins of Life and Evolution of the Biosphere", 18 (1988), No. 3, pp. 281-287. (See the reprint in: D.W. Deamer, G.R. Fleischaker (ed.), *Origins of Life: The Central Concepts*, Boston–London 1994, pp. 263-269).

[57] R.W. Barnard, *The Evolution of Reason: Logic as a Branch of Biology, by William S. Cooper*, "Philosophical Psychology", 17 (2004), No. 1, pp. 128-131; K.R. Benson, *The Evolution of Reason: Logic as a Branch of Biology. By William S. Cooper*, "Quarterly Review of Biology", 77 (2002), no. 3, pp. 309-310.

[58] S. Hameroff, J. Tuszynski, *Search for quantum and classical modes of information processing in microtubules: Implications for "the living state"*, in: F. Musumeci, M.-W. Ho (ed.), *Bioenergetic Organization in Living Systems*. Proceedings of the Conference: Energy and Information Transfer in Biological Systems. Acireale, Italy, Singappore 2003, pp. 31-62; J.A. Tuszyński, J.A. Brown, P. Hawrylak, *Dielectric polarization, electrical conduction, information processing and quantum computation in microtubules. Are they plausible?*, "Philosophical Transactions of the Royal Society of London Series A" 356 (1998), No. 1743, pp. 1897-1926; S. Hameroff, A.Nip, M. Porter, J. Tuszynski, *Conduction pathways in microtubules, biological quantum computation, and consciousness*, "BioSystems", 64 (2002), No. 1-3, pp. 149-168.

[59] K. Matsuno, R.C. Paton, *Is there a biology of quantum information?*, "BioSystems", 55 (2000), No. 1-3, pp. 39-46; K. Matsuno, R.C. Paton, *Quantum mechanics in the present progressive mode and its significance in biological information processing*, "BioSystems", 49 (1999), No. 3, pp. 229-237; E.A. Liberman, S.V. Minina, N.E. Shklovski-Kordi, *Biological information and laws of nature*, "BioSystems", 46 (1998), no. 1-2, pp. 103-106; E.A. Liberman, S.V. Minina, *Cell molecular computers and biological information as the foundation of nature's laws*, "BioSystems", 38 (1996), No. 2-3, pp. 173-177; E.A. Liberman, S.V. Minina, *Molecular quantum computer of neuron*, "BioSystems" 35 (1995), no. 2-3, pp. 203-207.

[60] P. Mittelstaedt, *The metalogic of quantum logic*, "PSA: Proceedings of the Biennial

tum logic of life? After all, it is suggested that there exists quantum logic that some organisms use to process biological information[61]. F.A. Popp argues[62] straightforwardly that "living matter has at its disposal «quantum logic», which makes it possible for it to optimally use «information» impulses from the environment for its own stabilization and to escape the chaos of the heat bath", and that it may be characterized as a peculiar "imprint of the information from the environment, as a system that absorbs electromagnetic impulses, stores them and uses them for formation of permanent structures". Information is considered to be the basic property not only of life, but also generally of the Universe[63]. Information plays the fundamental role in all physical systems and processes. Processing information in biosystems happens already on the level of nano-sized dissipative structures, which has been called "bio-logic"[64]. Hence emergence of life has connections with physical limits of the computational processes. The lowest limit is determined by the set of Planck values, whereas elementary units realizing those processes are called, after Leibniz, "monads"[65].

FINAL REMARKS

Scientific research aims at determining both ever broader and ever more credible causal patterns. Whatever comes into life, does so owing to the final cause. The physical world, in which life once emerged (i.e. the first organism, or a system with locally small entropy and a great content of information) consists in fact of information, whereas matter (mass) and energy have a sec-

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Meeting of the Philosophy of Science Association", 1 (1978), pp. 249-256; J. Stachel, *The 'logic' of 'quantum logic'*, "PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association", 1974, pp. 515-526.

[61] T. Oi, *Biological information processing requires quantum logic*, "Zeitschrift für Naturforschung C" 43 (1988), No. 9-10, p. 777; G. McCollum, *Systems of logical systems: neuroscience and quantum logic*, "Foundations of Science", 7 (2002), No. 1-2, pp. 49-72; G. McCollum, *Mutual causality and the generation of biological control systems*, "International Journal of Theoretical Physics" 38 (1999), no. 12, pp. 3253-3267.

[62] F.A. Popp, *Biologia światła* [Biology of light], trans. from German into Polish by J. Kuryłowicz, Warszawa 1992, pp. 147-148.

[63] T. Stonier, *Information as a basic property of the universe*, "BioSystems", 38 (1996), no. 2-3, pp. 135-140; id., *Information and the Internal Structure of the Universe: An Exploration into Information Physics*, London–Berlin–Heidelberg–New York 1990.

[64] S. Santoli, *Nanobiological principles and the origin of life*, "Nanobiology", 2 (1993), pp. 201-214.

[65] A.U. Igamberdiev, *Physical limits of computation and emergence of life*, „BioSystems", 90 (2007), No. 2, pp. 340-349.

ondary character[66]. As far as the question of emergence of life is concerned, at least two options are considered: (1) emergence of something from elements that previously did not exist, (2) emergence of something from elements that already did exist. It seems that both these options have their philosophical (metaphysical) conditionings. However, the latter option is closer to natural theories and hypotheses of the origin of life that refer to closer causes. In other words, where emergence, or beginning of something that did not exist before, happens, the causal relation appears. Logic of causality should take into consideration both these options. The question arises, if the causal relation may be characterized as an information route between the cause and the effect. If so, then quantum logic of life suggested above should take into consideration not only creating structures and spreading them, but first of all the origin of information.

Translated from Polish
by Lech Karłowicz and Tadeusz Karłowicz

[66] T. Stonier, *Information and the Internal Structure of the Universe: An Exploration into Information Physics*, London–Berlin–Heidelberg–New York 1990; H. Lyre, *Quantum theory of ur-objects as a theory of information*, "International Journal of Theoretical Physics", 35 (1996), No. 11, pp. 2263-2269.