ON THE THEORY OF SPECIES EVOLUTION THROUGH NATURAL SELECTION

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ABSTRACT
Modern science still did not give us a satisfactory empirical explanation of increasing complexity in living beings through the evolutionary history. This question poses itself when comparing simple prokaryotic cells with more complex eukaryotic cells or comparing these with animals or plants or the most complex phenomena, *e.g.* consciousness and human language. The proposed thesis defends the hypothesis that at the beginning in the origins of life the evolution had to first involve autocatalytic systems, which only subsequently acquired the capacity of genetic heredity.

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INTRODUCTION

We live in an age that is characterized by personal individualism. This age could as well be called the age of individualism. Is this not exactly the period that was predicted by philosopher Friedrich Nietzsche in his famous work Will to Power more than a hundred years ago? His thoughts in this work reach as far as the basic principles that dictate the behaviour of particles or bodies in the animate as well as inanimate world. According to Nietzsche, each specific organic, and in a wider sense inorganic body as well, strives to dominate the whole space with its power and repulse anything that defies such expansion. It, of course, also resists the similar tendencies of other bodies. In the final phase, the process changes in harmonization with those "bodies" that resemble it or are related to it (Nietzsche F.). In this same work, F. Nietzsche also quantizes the will to power so that a question can be posed at this point: "Is not this the very claim that is described by the so called "Modern synthesis" of Darwin's theory of evolution by natural selection and Mendelian genetics or neo-Darwinism, whose foundation was proven at the level of DNA molecules?" Of course, one can ask, whether all of our actions and volitions in life can really simply be reduced to spreading of our genes? This was also brought to the attention of Nietzsche, who said that the will to power is by no means related to the self-preservation instinct but in fact just the opposite. Nietzsche, despite a stunningly good understanding of Darwin's work and its implications, thus assumed a somewhat different perspective to Darwinism. But the discussion on this topic exceeds the framework of presented essay. In any case, biological laws apply to humans just as they to any other living being. The last period of Nietzsche's creative work was marked by biologism. Some authors from the field of the philosophy of science are of the opinion that his philosophy is deeply rooted in Darwinism (Dennett D.C., 1995).

Nietzsche in his understanding of Darwin's and Wallace's evolution theory exposes two key problems, that were thus far not yet suitably explained by the paradigm of reductionism or neo-Darwinism.

1 – The problem of increasing complexity of living being throughout the evolutionary history (Maynard Smith J. in Szathmary E., 1995a; Szathmary E., in Maynard Smith J., 1995; Olson M.V., 1999),
2 – creation, significance, explanation and preservation of sexual reproduction still represents a substantial problem for modern science of biology that is based on reductionism (Dawkins R., 1978a; Barton N. H. in Charlesworth B., 1998).

DISCUSSION
Modern science still did not offer a satisfactory empirical explanation of increasing complexity of living beings throughout the evolutionary history. This question poses itself when comparing simple prokaryotic cells with more complex eukaryotic cells or comparing these with animals or plants or the most complex phenomena, *e.g.* consciousness and human language (Maynard Smith J. and Szathmáry E., 1995a). The question of how the life actually came into existence is definitely important in this respect. In 1924, Russian biochemist Aleksander Oparin introduced his thesis that the development of living creatures in its initial phase should have been the subject of purely chemical evolution. Under the influence of various natural circumstances, such as for example electrical discharges in the presence of various inorganic substances, synthesized more complex organic substances, which lead to the creation of the so called "primeval soup" that was composed of substances, which represented basic building blocks for creation of first living cells (Dixon B., 1994; Luisi P. L., 2006a). It would be meaningful to mention panspermia hypothesis which includes creation of life in the universe from where it was transferred to the Earth. Advocates of panspermia hypothesis are of the opinion that the history of earth is not long enough to give life, which appeared in its cellular form 3.7 billions of years ago, the opportunity of development, because impacts of asteroids and comets prevented development of favourable conditions for inception of life up to 3.8 billions of years ago (Horgan J., 1997). Despite the latter argument, the remainder of this essay will be limited to the hypothesis that presumes the development of life on Earth.

The essential characteristic of present as well as primordial living beings is metabolism. This is an interconnected series of chemical reactions that are powered from an external source of energy. The characteristics of heredity of all living beings depend on specific replication of the DNA or RNA polymers that contain genetic information. And what is the connection between heredity and metabolism? Both processes are interconnected in the living organisms in two ways:

- Metabolism supplies the monomers that constitute replicators, which contain recorded hereditary information,
- replicators alter the kinds of chemical reactions occurring in metabolism. With other words: Replicators contain all of the information for construction and implementation of metabolism. Natural selection can exert influence over evolution of metabolism only via replicating units.

The term "replicator" in this text is understood in its broadest sense, as everything in the universe that can be copied. Replicating units in the above example would be sequences that are written within DNA or RNA homopolymers. The question is, how was such a bidirectional interaction established? It would be the easiest to adopt that the first "metabolism" was only composed of abiotic chemical reactions, as was demonstrated by Miller and Urey with their famous experiment in 1953. The experiment simulated atmosphere of Earth as was present a couple of billions of years ago. They presumed that this atmosphere was reductive and composed of CH_4, NH_3 in H_2O. They also simulated electric discharges. The result was astonishing: Several of the proteinogenic amino acids and other organic compounds were formed, which supposedly composed the "primordial soup", as it existed a couple of billions of years ago. Such abiotic chemical mechanism supplied monomers that could be synthesized or replicated into first replicators. Natural selection acted and chose the replicating units that were best replicated in the chemical environment, over which they had no influence. Later in the evolution history, replicators acquired the capacity of changing their chemical environment – metabolism. Such reductionistic approach therefore presumes replicators or genes as the first, later followed by the metabolism. As alternative to the scenario that supposes the replicating units were first to develop, one may presume that there was metabolism before creation of replicators, which them in time acquired the capacity of heredity, *i.e.* DNA or RNA homopolymers. If we summarize the aforementioned, the key question is therefore what was the first thing to develop in the evolutionary history: nucleic acids that are carriers of hereditary information or proteins that read and express contained information with their specific enzyme activity, *i.e.* generate phenotype and metabolism. This classic question of "chicken and the egg problem" therefore has the following possible answers: (1) nucleic acids were first, (2) proteins were first, (3) none of them, which presumes co-evolution of both (Maynard Smith J. in Szathmáry E., 1995a,b).

General opinion is that the DNA and RNA nucleic acids appeared before the proteins did in the process of the evolution of life. RNA molecules are the most popular candidates for the evolution of life before proteins due to their capacity of enzymatic catalysis and due to their replicability ("RNA world hypothesis"). Even Richard Dawkins in his famous popular scientific work "The selfish gene" relies on the thesis that the primate in the development of life is held by replicators, *i.e.* nucleic acids. The first molecule that had an extraordinary property of being able to make copies of itself, *i.e.* self-replication, was supposedly created under the influence of certain fortunate coincidences. Further evolution through natural selection and competition between molecules that were capable of self-duplication led to formation of enzymes and first cells.

In contrast to that, there are a growing number of authors that emphasize the hypothesis that promotes metabolism as the primordial process in evolution history. Such organism ("a metabolist") supposedly later acquired genetic control and cellular organisation. Besides that, all the attempts of laboratory synthesis of DNA and RNA polynucleotids under prebiotic conditions up to date ended up with negative result. Thus the alternative option of the first RNA molecule creation, which was supposed to reproduce due to its capability of self-replication "under special circumstances" is chemically unrealistic. This is why today the theories that give primary role to prebiotic evolution of autokatalytic systems of proteins or metabolic systems, which presumably later acquired the competence of genetic information storage, are in the forefront (De Duve C., 1998; Wächtershäuser G., 1998; Shapiro R., 2000).

There were thus several authors that proposed their theories, according to which life did not come to existence with the appearance of structured polymer replicating units but they rather put a series of catalytic reactions that are mutually supported and include smaller molecules on the place of proposed beginning of life (Shapiro R., 2000 and given references). We can suppose that the autocatalytic system is more stable than the system, which is not supported by autocatalysis. With this, we can view life as an interconnection of thermodynamic stabilization and kinetic factors that accelerate catalysis, with simultaneous understanding of life as a dynamic balance that is far distanced from thermodynamic equilibrium. The next developmental stage is represented by acquisition of information code for construction of a system in replicable elements (*e.g.* in homopolymer chains, such as RNA and DNA nucleic acids). Such code provides additional stabilization of the system against spontaneous disintegration and simultaneously represents the very beginning of heredity as known in modern organisms. Replication, transcription and translation that are used to transfer information from genes doubtlessly represent a special and very sophisticated type of catalysis or auto-catalysis. DNA and RNA molecules can also be viewed as catalysts. This particular viewpoint becomes clearer if they are not treated as separated from replication apparatus and from apparatus for transport of information that is stored within genes, *i.e.* transcription and translation. We would do well not to overlook the presence of RNA within ribosomes, where they serve as a part of translation apparatus. The system that contains the code for its own construction also definitely is capable of sophisticated regulation/self-regulation. This is why the system further had to develop mechanisms of suppression and epigenesys over "selfish interests" of replicable elements that compose the system and contain the information for construction, description and maintenance of the system itself. It is interesting that Nietzsche in his Will to Power treats division of cells as a consequence of lack of power to control the system. Can then the initially mentioned syntagm of Nietzsche be further broadened to include the system that struggles to use its power to dominate over the whole space and out-compete other systems or absorb them. If we consider the division of the system in its broadest sense so that the division does not necessarily include creation of equal parts, then we can, while considering the aforementioned syntagm, treat it as the basic generator of diversity. It would be necessary to also mention the so called *Gaia* concept, according to which the planetary organism is practicing "homeostasis". This concept gained no support in the wider scientific community (Williams G. C., 1992 and given references). It can be treated as a limit case for the framework of our discussion.

The system at a certain stage definitely had to develop recombination or reposition of hereditary elements to be able to respond to the constantly changing environment. When dealing with the sexual reproduction there are a couple of paradoxes encountered that are very hard to explain from the paradigm of neo-Darwinism. That would be, for example, that nature favours the precision of genetic information transmission. The sexual reproduction, however, demands recombination if a gamete is to be created (Wuethrich, B., 1998). The next paradox that must be mentioned is the fact that fertilization involves combination of genes from both parents, which then gives rise to new genetic combinations. This, however, also means a greater probability of good gene combination disappearing than being created. Sexual reproduction definitely has an indisputable role in prevention of transmission of harmful mutations to offspring. In the recent time, the Red Queen hypothesis that treats sexual reproduction as accumulation of favourable mutation in response to quickly changing environment, such as resistance against parasites and enlargement of genetic diversity in future generations (Wuethrich, B., 1998; Goldsmith, T. H. and Zimmerman, W. H., 2001). It must be emphasized that with taking into consideration the selection at the level of individual organisms, the adaptability of the population is also increased in long term as an answer to natural selection (Barton N. H. and Charlesworth B., 1998). It must be stressed out that the term population would be more appropriate than, for example, group. Many of the organisms that reproduce sexually are otherwise not living in social groups. This offers a tempting thought of group selection. We do not doubt today that selection exists at the level of groups and we treat it as a weak force of selection (Williams G. C., 1992; Blackmore S., 1999). The proposition, in accordance with which the natural selection operates on all levels, from genes to social groups (Wilson D. S. and Sober E., 1994) or even on the level of *species*, must also be mentioned. The reposition of hereditary elements in primordial period of living being development is still shrouded in mystery (Ridley M., 2002). We could propose at this point that the differentiation of plasma cells, *i.e.* those cells that produce antibodies, which involves translocation of genes with intracromosomal recombination as a response to the environmental stimulus (see Stryer L., 1988a), as well as "crossing over" in meiotic cell division, are relicts from the ancient evolutionary past.

The discussion about the level at which the natural selection occurs must include the so called Spiegelman's experiment that involved the research of RNA molecule evolution outside living cells. The experiment included incubation of RNA molecules of QB bacteriophage with QB replicase and ribonucleoside triphosphates. The duration of incubation was 20 minutes, *i.e.* the time that allowed for selection of mutant RNA molecules that replicate with high speed. After that, he diluted the aliquotes of this solution in the medium that contained equal mixture of QB replicase and ribonucleoside triphosphates. The procedure was repeated for 75 times with occasional reduction of the incubation period. The result showed that the molecules of QB RNA were only long 17 % of original QB RNA length after selecting them for 75 times, and that they replicated 15 times faster as the original QB RNA molecules. This experiment demonstrated the selection at the level of homopolymer molecules outside the cell (see Stryer

L., 1988b). But because the only criterion of the selection was the speed of replication, the above-mentioned experiment did not reveal anything about the rising complexity of living beings through natural selection. All RNA viruses have high rates of mutation, which is why their replication units are usually not longer than 10 kilobase pairs. This exposes another paradox, the so called "Eigen" paradox (Maynard Smith J and Szathmary E., 1995c; Eigen M., 1986). The quantity of information that can be transferred to the future generations and is preserved with the help of natural selection depends on the accuracy of replication. The accuracy of replication in existing organisms is a consequence of actions by genetically programmed enzymes, which is why sophisticated enzymes are necessary and that demands a large genome. The accuracy of replication without such enzymes would be low. The large genomes can therefore not exist without the precision of replication.

To be able to deal with the abovementioned paradoxes, we must return to the question on definition of life itself. It is definitely questionable to treat homopolymer molecules that carry hereditary material as life despite the proven evolution through natural selection because molecules are principally immortal and therefore lack an important attribute of life. The so called NASA definition of life is more interesting, as it proposes that the life is "self-sustained system, capable of undergoing Darwinian evolution" (according to Luisi P. L. 2006b). This definition is closer to the ideas of E. Schrödinger, proposing that organisms retain their ordered structures in the light of the second law of thermodynamics by creating disorder in their surroundings (Murpy M. P. and O'Niell A. J., 1997).

The proposition of the primordial role of metabolic system helps us avoid some of the difficult questions that are posed when considering the hypothesis that the primordial cells developed gradually around molecules of nucleic acids, capable of self-replication (*e.g.* "RNA world hypothesis") with the help of mechanisms of natural selection. The proposition of the primate of metabolism or autocatalytic networks offers trivial solution of the previously mentioned "chicken and egg problem”. The following paradoxical question that can be answered is the question of mutations or hereditary DNA and RNA material errors during copying as an essential condition of evolutionary development. The problem is in that natural selection gives priority to high fidelity of hereditary material copying. Or in simpler words, nothing tends to evolve by itself. The problem was also pointed out by Richard Dawkins in his work "The selfish gene" (1978b). This problem simultaneously leads to next two questions we will try to answer. These are the questions of the role of hereditary material recombination and sexual reproduction of the organisms and on growing complexity of living beings throughout the evolutionary history. The recombination of hereditary material doubtlessly represents the generator of diversity to adapt to the constantly changing environment. It must also be taken into consideration that the sexual reproduction represents a fairly ineffective manner of propagating genes from an individual organism, because only 50 percent is transferred to an individual descendant (Dawkins R., 1978a). The problem of precise copying is also related to the question of growing complexity throughout evolutionary history or the "Eigen paradox". Both problems can be seen in another light when considering the proposition that the replicable elements, *i.e.* homopolymer DNA and RNA chains were formed later in evolution history and that the natural selection does not only operates on the level of genes.

There is also the question of complexity and the size of the system when life was created. One can suppose that the system spread and grew in strength while also becoming progressively more complex. The more complex and elaborated system demanded the most precise and detailed code possible and, of course, also its reliable transcription. It would definitely be meaningful to ask what to define as the ultimate system and what is the boundary that delimits it. Research projects with the goal of acquiring artificial or semi-synthetic minimal cells that could be defined as life are very popular in the last period. The results of this kind of research work are still far from result that could be defined as minimal cells (Luisi P. L. *et all*., 2006). Interesting results can definitely be expected.

This article began with a bit more philosophical introduction that is not regular. I do, however, believe that this kind of approach is suitable, because philosophy can also be understood as the foundation of all sciences. One should also emphasize the inverse connection; the Darwin's theory of evolution has also a momentous significance for modern philosophy (Kupiec J. J., 2009). This is why the article is concluded with a quote from Thomas H. Huxley (1883): "Let us understand, once and for all, that the ethical progress of society depends, not on imitating the cosmic process, still less in running away from it, but in combating it." One can, of course, agree or disagree with the above-mentioned.

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