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ON NOMOGENESIS, PHYTOSPREADING AND BIOLOGICAL EVOLUTION

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Abstract. In the first half of the twentieth century, among anti-Darwinist biologists, a worldview was formed, called nomogenesis (development based on "laws"). Nomogenesis soon went beyond biology and became for a number of scientists the fundamental principle of the evolution of all things. In particular, biological evolution strictly follows the laws that were formed, perhaps, in the first moments of the existence of the Universe and which we still do not understand. However, now we can identify some certain mechanisms, which implement the principle of nomogenesis in the form of a process of gradual discrete complication of the morphophysiological structure of living organisms. The author describes in general terms the hypothesis of reversible and repeated phytospreading (biospreading) based on S.V. Meyen's ideas. Hybridization of closely related biological species that existed separately in different climatic zones for a long time was recognized as the main driving force of evolution. The process of discrete morphophysiological complication of organisms can be interpreted as an elementary act of the reversible or repeated biospreading. It is noted that under the specific conditions of the Earth, biological evolution is provided by the rhythmic character of climate of the planet. Evolution is inevitable and irreversible, although not every climatic rhythm or combination of rhythms is capable to give an evolutionary impetus. The origin of life on the Earth and the origin of intellect are events, which correspond to singularity, i.e., uniqueness of this phenomenon.

Keywords: *nomogenesis, reversible phytospreading, biospreading, biological evolution, climatic fluctuations and rhythm.*

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1. Introduction

The biological paradigm, which formed by the middle of the XX century and called the synthetic theory of evolution or neo-Darwinism, gave many worthy discoveries, primarily in genetics. By the end of the XX century, certain promising directions emerged within the framework of neo-Darwinism (for example, the theory of neutral mutations by M. Kimura and the theory of punctuated equilibrium by S. Gould and N. Eldredge, which is only formally opposed to Darwinism, but, in fact, are based on natural selection). However, none of these theories (rather, hypotheses) explains the mechanism of progressive evolution and, accordingly, does not have a predictive ability. At the same time, the interest of biologists in the mysteries that were previously the main engines of biology (the problems of the origin of life and biological evolution), begins to wane. Philosophers attribute this phenomenon to the onset of a new era, called Postmodernity, which declares the multivariance or even unattainability of scientific truth (Bauman, 1992).

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In the first half of the twentieth century, V.I. Vernadsky came to the conclusion that the question of the origin of life is not entirely correct, since life as a universal phenomenon is indestructible, and even in the Earth conditions, the "lifeless" period was a relatively short-term act (Vernadsky, 1988). At the time of V.I. Vernadsky and his contemporaries E. Le Roy and P. Teilhard de Chardin new worldview began to form. This worldview later received the name of the anthropic principle. The meaning of the evolution of all that exists is the emergence of intelligent life. Otherwise, we must admit that everything in the world is accidental, and the morphophysiological evolution of living beings, confirmed by the richest fossil material, is also an accident.

Indeed, from the point of view of modern science, the emergence of life on a planet formed from a gas-dust cloud-clot is extremely unlikely. The transition from an almost structureless system to a highly organized system requires some hypothetical external source of universal organization. But what source?

Life and, moreover, intelligent life are attributes of highly organized matter. Why does life evolve towards morphophysiological complication? Finally, what is a mechanism of progressive evolution of everything that exists? These questions are still open.

2. Material and methods

Nomogenesis: a retreat to theology or a path to a scientific breakthrough?

In biology, the most optimistic alternative to the current skepticism generated by neo-Darwinism and the dictates of genetics is the theory of nomogenesis (development based on laws). Strictly speaking, nomogenesis is not a theory, but a principle. One of its main authors is deservedly recognized by L.S. Berg (1922). Nomogenesis postulates that the process of development of all that exists is based on the general laws, which are "built" in the evolution processes. The most prominent representatives of this trend in biology after L.S. Berg were N.I. Vavilov, A. Vandel, S.V. Meyen, A. Lima-de-Faria, Yu.V. Tchaikovsky (the list, of course, incomplete). Some of them came to the conclusion that neo-Darwinism will not solve the main problem of biology and that it should be considered one of the aspects of the new theory.

Although nomogenesis owes its appearance to biologists, this principle, according to A. Lima-de-Faria (1988), should apply to nature as a whole. Biological evolution is an obligatory continuation of physical and chemical evolution, which began at the moment of the birth of the Universe. In other words, biological evolution is set already at the level of elementary particles. Of cause, this view can be called reductionism (Nazarov, 2007). But the thought of A. Lima-de-Faria that biological evolution was laid down at the moment of the birth of the Universe is not only reductionism, but, possibly, the "starting point" of nomogenesis.

Nomogenesis did not receive worthy recognition neither under L.S. Berg, nor after him. However, science at the end of the Modern epoch is clearly beginning to get tired of positivism and neo-positivism, which have been its organizing principle for almost two centuries. Nomogenesis may be in demand just by the Postmodernity, and not only in biology, but also in other natural sciences, because the scientific pluralism of the Postmodernity opens up new perspectives for it. Some researchers have reasonably noted that nomogenesis almost automatically leads to the recognition of God, but God and science seem to be incompatible. But for L.S. Berg, S.V. Meyen and other biologists mentioned above, the "hypothesis of God" at the level of their research was superfluous. It is interesting and indicative this fact: if neo-positivism drew a clear line between material Nature and God, now this line is beginning to blur. The most obvious, and probably the only successful way to a consistent coexistence (it is too early to speak about synthesis) of the “new” science and theology is nomogenesis.

Phytospreading as a mechanism for biological evolution and implementing the idea of nomogenesis

One of the examples illustrating the fruitfulness of the idea of nomogenesis is the S.V. Meyen’s phytospreading. This hypothesis has almost become a theory (Meyen, 1987). Each act of global phytospreading can be represented as a stage in the deployment of the “logic” of nomogenesis, when a phased (stepwise) and irreversible increase in the level of morphophysiological organization of certain groups of living organisms is carried out. It should be recalled that S.V. Meyen was, first of all, a paleobotanist, and he came to nomogenesis thanks to his research in the field of meronomy. It is meronomy that has become one of the most impressive indirect evidence of the reality of nomogenesis. If S.V. Meyen was able to abandon attempts to reconcile irreconcilable opponents (neo-Darwinism and nomogenesis), then he would come close to understanding the mechanism of evolution.

The starting point of the phytospreading theory was the fact-confirmed conclusion of S.V. Meyen that almost all high-ranked (above genus) taxa of higher plants appear in the equatorial zone at a lower stratigraphic level than outside it (Meyen, 1987). This means that they are of near-equatorial origin. During warming, representatives of these taxa migrate from the equatorial zone to higher latitudes. This process S.V. Meyen called phytospreading. To be fair, one has to note that A. Wallace, a contemporary and associate of Charles Darwin, was the discoverer of the idea. With distance from the equator, the evolutionary (correctly: macroevolutionary) activity of higher plants decreases; in the temperate zone, we fix new genera, as a rule, in the arctic – species. According to S.V. Meyen, just in the equatorial zone, natural selection plays a minor role, which contributes to a more successful macroevolution of higher plants. Selectively neutral saltations play a decisive role in evolution. (In this assumption, S.V. Meyen was, of course, also right.) With the next cold epoch in the middle and high latitudes, the settlers either disappear or remain, but at the same time they slightly change their general organization and give rise to new species, genera and, much more rarely, taxa of higher rank.

3. Theory

The author of this article proposed to supplement phytospreading with a reverse process, which is inevitable during global cooling (Nevsky, 2014, Nevsky, 2017).

With a cooling, the whole ecotope (a homogeneous environment with a corresponding biocenosis) shifts towards the low latitudes. The composition of such an ecotope will undoubtedly include representatives of the flora, whose ancestors, during the warming, were carried out by phytospreading to the middle (rarely high) latitudes. In the initial or maximum phase of cooling, the full period of this rhythmic process, which can be called reversible phytospreading, should be completed. The period of the process, i.e., an elementary act of reversible phytospreading is completed when the areas of the ancestral, unchanged species (near-equatorial) and “modified” in middle latitudes (migratory) come into contact in the “native” near-equatorial latitudes.

There is an alternative (or rather complementary) version of reversible phytospreading. After the species brought by the phytospreading of the “first wave”, will gain a foothold in a new place in subtropical or temperate latitudes and will be forced to undergo some phenotypic and genetic changes due to the subsequent cooling, a new warming will occur. The next wave of phytospreading will carry the ancestors of these species to the same latitudes, which, being in more favorable near-equatorial conditions, have retained their morphophysiological organization almost at the original level.

A likely, but not obligatory result of both versions of phytospreading is hybridization of closely related species in the contact zone. In this case, closely related species should be called those species that are capable of crossing and producing offspring. In the generally accepted classification, the level of their relationship, apparently, will not exceed genus rank.

It should be noted that for a long time, while these closely related species existed in parallel in different climatic zones and did not interact with each other in any way, they went through a certain stage of slow adaptive evolution. According to A.N. Severtsov (1939), such evolutionary changes should be called allomorphoses. The most significant changes, of course, have undergone the individuals of the species (subspecies) that migrated from equatorial to subtropical or temperate latitudes and then returned back. These changes are primarily due to the climate. The second factor is a forced “switch” from a predominantly diurnal rhythm of functioning (in near-equatorial latitudes) to a predominantly seasonal one (in the subtropics and the temperate zone) and, finally, back to diurnal. As a result, on the eve of the final phase of reversible phytospreading, i.e., convergence of ranges, individuals of these closely related species will function according to different chronological “programs”. In this case, we are already dealing with different rates of ontogenesis. There is no doubt that these two reasons will lead to heterochrony (Raff & Kaufman, 1991). Heterochronies manifest themselves in different ways. The most significant evolutionary role is played by neoteny and the accompanying progenesis. In this context, it is important to emphasize that heterochrony is also manifested in a certain increase or decrease in the duration of the reproductive process. Since we are talking about a slow process of the adaptive type, this heterochrony becomes the norm and is fixed in the genotype.

What will happen in the contact zone of closely related species which live according to mismatched chronological “programs” and whose “chronologies” have been fixed in genomes?

In the process of hybridization, males of one species and females of another species participate, or vice versa. The result is the emergence of a whole group of hybrids with fundamentally different morphological and functional characteristics (in our understanding, “progressive” in comparison with ancestral forms).

The “mechanism” of hybridization, unfortunately, at present can only be interpreted using speculative modeling (Nevsky, 2014, 2017). More “subject” modeling is extremely difficult. Mathematic modeling is impossible, because we can’t describe genetic allomorphoses of migrants for many thousands or millions of years. This mechanism will be better understood if we apply the well-known principle of genomic imprinting to it (an epigenetic process in which the expression of certain genes is carried out depending on which parent the alleles came from). For example, in mammals, the paternal genes are responsible for the formation of the placenta, while the female genes are responsible for the differentiation of embryonic cells (Haig and Westoby, 1989).

This effect is also observed in insects and, in the plant world, in flowering plants. Most likely, this phenomenon is more or less characteristic of all dioecious organisms, although much in it is not yet clear. With regard to placental mammals V.A. Geodakyan (2012) formulated this effect as follows: at the beginning of embryogenesis, only the mother's genes "act", then the paternal genes are switched on and gradually progress, and in the final phase of embryogenesis, only the father's genes "act".

If we apply the conception of V.A. Geodakyan to hybridization in the contact zone of a "sedentary" (almost unchanged) species and a migrant species and carry out a speculative modeling of this process, then we obtain the following formula for the ontogenesis of a new hybrid species: the rate of development of the vegetative part corresponds to the maternal individual/program, the rate of development of the genital organs is higher than the vegetative part, and the rate of maturation of carriers of hereditary information (spores, gametes), in turn, outstrips the rate of development of the genitals (Nevsky, 2014, Nevsky, 2017). If this, of course, hypothetical formula is successfully implemented, saltation changes will be observed in the entire morphophysiological organization of individuals of new species in comparison with both ancestral forms. These transformations are quite identical to R. Goldschmidt's and A. Vandel's macromutations, with the difference that R. Goldschmidt and A. Vandel suggested other reasons for their appearance. Natural selection can participate in this scenario, but at later stages. New species (hybrids) will get new ecological properties due to their "progressive" morphophysiological organization. They will be able to successfully compete with parental forms in case of some climatic or ecological changes. However, the contribution of this natural selection will not go beyond allomorphoses.

At the end of the description, one must note the sagacity of two outstanding biologists of the early 19th and early 20th centuries – E. Geoffroy Saint-Hilaire and J.P. Lotsy. E. Geoffroy Saint-Hilaire came to the conviction that progressive evolution is a result of a deceleration in development or, conversely, acceleration in the development of the organs of descendants in comparison with the parental state of the organization of the parents. Many embryos, thanks to neoteny, could take a form that corresponds to completely different organisms of the same class. J.P. Lotsy was convinced that hybridization of closely relayed species is not only important, but the only means of biological evolution. He rejected the realism of all other means, including those of Darwin. The reversible (repeated) phytospreading hypothesis suggests a mechanism for this embryonic deceleration or acceleration due to hybridization of closely relayed species.

How is nomogenesis manifested in this case?

It should be noted that we can never rigorously prove its effectiveness. Nomogenesis is a principle of an inductive nature, like a postulate that requires trust. In this case, the causal line is clearly traced, where each elementary act (cause – effect) can be evaluated in categories from highly probable to unlikely probable:

1. External (cosmic) causes and planetary factors imposed on them lead to alternation of global cold and warm climatic epochs. The likelihood of such a rhythmic process (more precisely, a system of rhythmic processes of different frequency and degree of impact on the biosphere) is not assessed. The system really exists.

2. The amplitudes of climatic characteristics and the rate of their changes may be sufficient or insufficient to "push" the migration of a number of biological populations from low latitudes to middle latitudes and back. However, the probability of choosing a

"necessary and sufficient" rhythm or a combination of rhythms under conditions of different climatic rhythms caused by different reasons is expected to be high.

3. Reversible or repeated phytospreading is a real mechanism. However, it is unlikely that it always leads to hybridization of closely related species. Will it be able to provide the optimal (no more, but no less) divergence of phenotypes and genotypes required for such a significant hybridization? The probability of achieving such optimality is, of course, not the highest, but not vanishingly low either.

So, the emergence of new species with a progressive morphophysiological organization as a result of one act of reversible or repeated phytospreading can be characterized as an event with a probability "not very high", or "low", but not with "vanishingly low". We can say that in the specific conditions of our planet, every next evolutionary act is inevitable. The question is when – sooner or later, and from what (first, third, tenth etc.) "attempt". Biological evolution is provided by the climate of our planet. It should be emphasized that the last major evolutionary breakthroughs (aromorphoses, according to A.N. Severtsov) took place as early as the Mesozoic. These are the appearance of flowering plants and the appearance of the first representatives of the mammals. We see that such epoch-making events are indeed very rare. The intervals between them are calculated in tens of millions of years.

4. Discussion

Historical examples in favor of reversible biospreading hypothesis

S.V. Meyen developed his theory based on paleobotanical data. However, later, evidence appeared in favor of zoospreading (Chernov, 1988). Apparently, the time has come to introduce the concept of biospreading, since this process is global and obligatory for the entire biosphere. Speculative modeling with separate representatives of the fauna (Nevsky, 2014, 2017) leads to the same result, namely: hybridization of closely related species in the near-equatorial contact zone can lead to the appearance of individuals with progressive (according to our estimate) morphophysiological properties. Similar speculative modeling can be carried out also for another fateful event – the appearance of vertebrates. T. Brunet, A. Lauri and D. Arendt (2015) did multi-level comparison of the chordate notochord to the axochord, a paired axial muscle spanning the ventral midline of annelid worms and other invertebrates and hypothesized that the notochord evolved by modification of a ventromedian muscle followed by the assembly of an axial complex supporting swimming in vertebrate ancestors. If so, we can conclude that axochord of some representatives of the arthropod group and notochord are homological organs. According to speculative modeling, after the completion of the process of reversible biospreading as a result of successful hybridization, the final phase of embryogenesis (the formation of a chitinous cover) should be significantly reduced. In this case, the axochord will take over the function of ensuring the physical integrity of the organism. Subsequently, it is transformed into a notochord and later spine through a series of allomorphoses. At the beginning of the twentieth century, the aforementioned J.P. Lotsy suggested that vertebrates appeared as a result of the hybridization of two species of invertebrates (Lotsy, 1916). Some of his assumptions regarding hybridization were not confirmed, however, his concept differed from the views of contemporary biologists in the completeness of the coverage of evolutionary problems. European biologists ignored Lotsy's achievements. Nevertheless, in the USSR this idea was successfully developed by M.G. Popov. For example, he came to the conclusion that the evolutionary efficiency of hybridization is the higher, the farther apart the interbreeding parental species are (Popov, 1956).

Can mankind be considered a product of such hybridization? The author thinks "not". Most likely, homo sapiens is a product of a series of allomorphoses. But this opinion may change, because it is difficult to recognize nomogenesis in a series of allomorphoses.

On the "progressiveness" of biological evolution

Why does the evolutionary process proceed with a discrete increase in the morphophysiological (structural-functional) complexity of organisms, and not with the preservation of complexity or degradation?

Biology will not answer this question, because it lies outside the boundaries of this science. This idea was expressed in the work of A. Lima-de-Faria (1988). It would be naive to look for a biological "beginning of beginnings" in elementary particles, as A. Lima-de-Faria thought. But his hypothesis is not absurd; rather, it is metaphorical.

The only science that can come close to answering this fundamental question can be physics. At the beginning of the XX century, it became clear that the "philosophy of physics" needed the entire theoretical arsenal of natural sciences. But is it possible to answer this question without relying on nomogenesis? Nomogenesis can be traced everywhere. It is present, for example, in inorganic chemistry. Chemical evolution is also the stage of universal evolution and, accordingly, the fulfillment of the principle of nomogenesis.

Another interesting and unexpected aspect should be noted. "Configuration" of the reversible biospreading process resembles, in the general terms, the development process of the famous Absolute Idea of G. Hegel. The "cycle" of the Absolute Idea begins with its "self-alienation" into the surrounding world. In the case of biospreading, we also see a peculiar "alienation" of populations of different species in the form of a significant distance apart from the equatorial "ancestral home" in higher and colder latitudes. If we distance ourselves from idealism (although this is problematic, because the idealism is the basis of Hegel's philosophy), that is, from the self-awareness of the Idea through thinking and human activity, then in a purely material aspect there remains a certain renewal of the previous content. By another words, the Idea is enriched with new content. This is exactly what we observe in the initial phase of global cooling, when migrant species acquire new properties (allomorphoses) and when their reverse movement begins. In the final phase, the Absolute Idea (enriched with new content) returns to itself. The similar process we see in biological evolution: the return of large groups of individuals of migrant species to the "ancestral home" leads to a qualitative saltation complication of the morphophysiological organization (aromorphoses), i.e., to an evolutionary breakthrough.

To understand why biological evolution proceeds with an increase in the structural and functional complexity of organisms, there is the quite realistic way: we have to look for the origins of biological evolution (following A. Lima-de-Faria) in the cosmological singularity. Rather, we intuitively realize that the so-called progressiveness of evolution is not a local phenomenon, but a universal one. This is the main attribute of nomogenesis.

5. Conclusion

Few notes on the forms of the "Earth's singularity"

In conclusion, one should answer one question, which inevitably follows from the meaning of the article. If biologists, in principle, cannot find the fundamental reason for the emergence of life and the direction of evolution, then is it not high time to put an end to these attempts?

The thesis of A. Lima-de-Faria is fatally unproductive for biologists. However, from the initial "push" (cosmological singularity, "act of creation") to the appearance of intellect, universal evolution goes through a number of stages. Each stage is the subject of study by a separate science, and each stage is distinguished by its own mechanism for the implementation of the general principle of nomogenesis. The reason for the appearance of mammals should be sought not in the singularity of the emerging Universe, but in a detailed analysis of all really acting factors, including climatic ones. As for the origin of life, it will not be an exaggeration to declare that this process also follows from the singularity – but from "own unique". The conditions of every planet where life once appears are, in fact, conditions corresponding to a singularity. One must recall that the original or philosophical definition of singularity is the uniqueness of a being, phenomenon, event. It is pertinent to give one example. The minerals of the apatite group are quite widespread on Earth. This fact allowed the Far Eastern biologist E.Ya. Kostetsky to offer a hypothesis according to which the first prokaryotes and eukaryotes were formed with the participation of an apatite matrix and minerals "co-crystallizing" with it (Kostetsky, 2010). The main advantages of the hypothesis are the determination of the source of phosphorus for the construction of ATP, RNA, DNA and a number of other organic macromolecules and the substantiation of a viable model for the emergence of the matrix mechanism of transcription and translation. But would life arise on Earth in the absence of a source of phosphorus? – Biology will not give an answer to this question, although the proponents of nomogenesis will say "yes, but later and in a different form".

If we go further, we will have to admit that the appearance of intellect is also an event following from the singularity; and the reason for this is the uniqueness and exclusivity of the "monkey" brain. However, in contrast to the cosmological singularity, the singularity of the appearance of life and intellect is a phenomenon of a planetary scale, albeit of universal significance.

It might seem that the singularity is contrary to the fundamental principle of nomogenesis. But such juxtaposition is meaningless. Singularity is the starting point of nomogenesis, which "programs" nomogenesis. At the same time, the singularity of subordinate level must somehow be built into the higher level. How exactly? – While we don't know.

Verification of theories of the appearance of life and biological evolution is not even a matter of modern philosophy of physics or philosophy of biology, but of some synthetic science of the future. Biologists, of course, have to propose hypotheses of the origin of life and biological evolution. However, they should also remember that experimental testing, at best, can confirm the workability of their hypotheses, but will not prove the truth and uniqueness of a particular scenario.

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