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DARWIN'S GEMMULES AND ADAPTATION

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Abstract

Currently the origin of new adaptive forms, new body plans or species is associated with mutation of the gene (genes). The idea of biological variation is usually associated with the existence of the gene and the generation of form in biology is the result of the differential regulation of developmental genes. Without challenging the merits of such an approach, we offer, to revise the old hypothesis of Darwin's gemmules, based in his theory of pangenesis. The fact is that the possibility of origination of complex adaptive forms only on the basis of random mutations at the genelevel is not proved yet. Darwin supposed that gemmules are the material sources of biological variation and they appear in response to the external environment. In recent years the data of new sources of biological variability were received (except for random mutations), based on which the new adaptive forms can appear. It is considered that evolution is a very slow process and therefore it cannot be observed directly in Nature. However, it's turned out that sometimes under the effect of external factors evolutionary processes can dramatically accelerate, as has happened in the case of *Anoliscarolinens* living on Islands off the Florida coast. We suppose that the case of anoles provides scientists with a rare opportunity to test experimentally the hypothesis of Darwin's gemmules.

Keywords: Darwin's gemmules; adaptation; Anoliscarolinens; developmental biology; origin of adaptive forms.

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INTRODUCTION

The fact that the evolution of biological life on Earth has taken place is no doubt. However, the mechanism(s) of evolution itself is still the subject of intensive debates. The mechanisms of evolution proposed by Ch. Darwin and Modern synthesis, under all their undoubted merits, do not answer many questions, including about the origin of new adaptive forms to the new living environment. Currently the beginning of new adaptive forms, body plans or new species is associated with mutation of the gene (genes) that is the"gene-centric"approach is based in all hypotheses. Without challenging the merits of such an approach, we offer to revise the old hypothesis on the Darwin's gemmules, based in his theory of pangenesis.

Backgrounds

According to Darwin and Modern Synthesis the material sources of variations are random mutation at the level of DNA and chromosomes (duplications, polyploidy, structural rearrangementssuch as deletion, insertion, substitution etc.), a part of which may be useful at adaptation to the new environment. In other words, the adaptation idea is perceived mainly in the context of changes in the sequences of nucleotides in DNA. However, it is still a controversial question about the possibility to beginnings of new adaptive forms, body plans and new species only on the basis of random mutations of genes and chromosomes.

Currently it is considered that the generation of form in biology is the result of the differential regulation of developmental genes. In recent years the evolution of form has become a major focus of evolutionary developmental biologists. It is supposed that the developmental gene regulatory networks have played a major role. However, is it possible to be completely sure that such sophisticated shapes, like a trunk of an elephant or a long neck of a giraffe, may be the result of coordinated favorable mutations?

We suppose that, possibly, Darwin's gemmules (DG) are additional sources of biological variability (except for random mutations), based on which new adaptive forms, new body plans or species appear. However, their impacts on individual development are implemented through epigenetic changes in the genome. If such epigenetic changes contribute to the survival of individuals in the new environment, then over time they may result to 'persistent' developmental changes in gene.

As it is known Darwin proposed that cells not only are able to grow by means of cell division but are also capable of 'throwing off' gemmules—minute informative molecules—that are self-replicating and circulating. These gemmules circulate throughout the organism, penetrate other nascent cells and modify their subsequent development. The cells gave off minute hereditary particles (gemmules) that congregated in the sperm and ova to be transferred to offspring. There they aggregated to recreate the same structures from which they were derived in the parent. They could lie dormant across the life cycle and across multiple generations, and the quantity and composition of gemmules with specific properties determined the qualities of the trait that they generated (Darwin, 1868).

Unfortunately, our knowledge about gemmules since Darwin's time is not changed significantly. In fact, the idea of Darwin about gemmules was simple: all parts of an organism issue small particles throughout the individual's life. Consequently, the entire life history of an individual, from conception until death, is recorded in a trial of gemmules. Individually unique events such that those that result from use or desuse would be recorded in the gemmules of the affected part or parts and thus affect the pool of potential variation. Travelling by way of some unspecified bodily fluid, gemmules accumulate in an individual's sex organ. Upon mating, parental gemmules blend, thereby producing additional sources of variation. Gemmules could also become latent and not expressed over a series of generation. But at some later time, they could become active again, which would account for atavism. In other words, Darwin invoked forces external to the organism as the primary provocateurs of change (e.g. as in gradual environmental change, use-desuse).

As DG are the products of life activity of cells, tissues or organs of the individual, some of which are formed under the influence of a new environment, may be biologically active substances that can effecton growth, development or differentiation of cells of the offspring. If such phenomena occur in Nature, then we have right to expect from DG the same, that the author of the theory of pangenesis has expected – gemmules are the material sources of biological variability in the population with all the ensuing consequences for heredity, individual development and evolution.

Facts that prove possibility of DG existence.

As it is known, Jean-Baptiste Lamarck proposed the idea that is now called the Inheritance of Acquired Traits in which he suggested that maybe the experience of an organism in one generation could somehow lead to changes in the progeny that would benefit them in the next generation. He famously thought that the giraffe's neck had been extended by reaching higher and higher into trees for nutrition.

Darwin himself had noted that "the existence of free gemmules is a gratuitous assumption"; by some accounts in modern interpretation, gemmules may be considered a prescient mix of DNAs, RNAs, proteins, prions, and other mobile elements that are heritable in a non-Mendelian manner at the molecular level (Liu, Li, 2012; Anker, Stroun, 2012).

Over the past several decades, the presence of free-circulating nucleic acids in plasma and serum of healthy and diseased human beings has been a well-established phenomenon (Fleischhacker et al, 2007). Recently, Garcia-Olmo et al, (2000) presented a 'genometastasis hypothesis', which indicates that metastasis might occur via transfection of susceptible cells located in distant target organs with dominant oncogenes that derived from the primary tumor and are circulating in the plasma. This hypothesis is consistent with Darwin's Pangenesis (Liu, 2010).

Fortunately, we do not have to search for more data on that adverse environmental exposure upon the fetus early life. On

this subject a review was recently published, where all data on this issue known in biomedical science were published (El Hajj et al, 2014). In this review, there is no mention of DG that increases its value more in the context of the problem we are discussing. In this review authors are focused on the epigenetics of an adverse intrauterine environment, in particular gestational diabetes and its implications for the prevention of complex disease. It is occurred that epigenetic changes due to maternal diabetes/obesity may predispose the offspring to develop metabolic disease later in life and, thus, transmit the adverse environmental exposure to the next generation. This vicious cycle could contribute significantly to the worldwide metabolic disease epidemics.

Most of our current knowledge on fetal programming comes from animal models and epidemiological studies in humans, in particular the Dutch famine birth cohort. In industrialized countries there is more concern about adverse long-term consequences of fetal over nutrition, i.e. by exposure to gestational diabetes mellitus and/or maternal obesity which affect 10-20% of pregnancies (El Hajj et al, 2014).

As one well-documented example of the latter, a fetus born to an obese mother who is diabetic during pregnancy is exposed to high levels of glucose and insulin, and is born large and prone to developing diabetes and obesity later in life. Among female offspring, this increases the chances that the grand offspring will experience a similarly over-nourished gestational environment, perpetuating the phenotype into the future. Siblings born to mothers after they have lost weight by gastric bypass surgery have much lower risks of disease development than their siblings born before their mother's weight loss, showing that these effects are not primarily due to shared genes, but are phenotypic and epigenetic in origin (Kral et al, 2006).

Analyzing the results of these studies El Hajj et al. (2014) conclude that "Fetal overnutrition and undernutrition have similar long-lasting effects on setting of the neuroendocrine control systems, energy homeostasis and metabolism, leading to life-long increased morbidity. There are sensitive time windows during early development where environmental cues can program persistent epigenetic modifications, which are generally assumed to mediate these gene-environment interactions".

In retrospect, aspects of pangenesis were closer to the mark than Darwin is often given credit for. In particular, there is a growing consensus that changes in behavior or activity may be the initial catalyst for the development of new phenotypes, and that this plasticity-induced change can precede the more gradual process of genetic adaptation (West-Eberhard, 2003).

However, not everybody share this point of view. For example, Kuzawa (2012) argues: "We now know that cells do indeed harbor hereditary material – DNA – which they obtain from the gametes, but rarely do the gametes obtain extra-nuclear DNA. Interacting with the environment can induce phenotypic change in structures, but there is no evidence that this changes the genome in those cells or that somatic mutations are transferred to sperm or egg. For they primarily purport to show that certain superficial traits, such as feather or coat color, may in some instances be influenced by circulating DNA. This is interesting, but not likely evolutionarily important, given that the development of these particular traits is not likely influenced by changes in functional demand or activity (the 'conditions of life'), as Darwin's model required to establish new and better-adapted variants. And, there is similarly no evidence that the phenotypic modifications induced by the experiments are incorporated into the germ line".

In whole, the bulk of the existing data on the possibility of the environment effect upon the phenotype of the individual and his generationalready cause no doubt. Another case that we don't yet know whether these changes may be the material sources of biological variability in the understanding of Darwin.

DG and adaptation.

Scientific theory of adaptation: evolution by natural selection. Darwin supposed that gemmules are the material sources of biological variation and they appear in response to the external environment. Currently the idea of biological variation is usually associated with the existence of the gene. Nothing seriously challenged the possibility of evolution depending upon the existence of genetically determined variation. While a tremendous amount of variation has been revealed, a satisfactory explanation of the origin and maintenance of such variation is still lacking. It is not at all clear whether adaptive evolution makes use of the kind of genetic diversity that is now known to be so common. Population genetic theory leads to conflicting conclusions about the forces operating on the variation, and it appears that current theory is inadequate to cope with the data (Lewontin, 1974).

Our long-term studies of human populations permanently living in extreme climatic conditions show that *Homo sapiens* can adapt even without the involvement of the gene parts of genome. Thus, for example, the human populations can adapt to cold and high-altitude hypoxia by changing the amount of chromosomal Q-heterochromatinregions (Q-HRs), which consist mainly of highly repeated sequences of DNA, not capable to encode proteins and enzymes known in the science. In particular it is turned out that chromosomal Q-HRs is distributed in human genome not accidentally. Specifically: a) The amount of chromosomal Q-HRs in human population genome depends on climate and geographical conditions of permanent residence and not their ethnic and racial peculiarities. The largest amount of chromosomal Q-HRs is found in the genome of populations living in low altitude subequatorial Africa and India, and the least - in Northern Siberia aborigines, as well as indigenous people of Tien-Shan, Pamir and Ethiopian high altitudes (Ibraimov, Mirrakhimov, 1982a,b,c; Ibraimov et al, 1982; 1986; 1997; Kalz et al, 2005); b) Individuals capable of successfully adapting themselves to the extreme high-altitude climate (e.g. mountaineers) and newcomers of the Far North (e.g. oil industry workers of the Jamal peninsula of polar Eastern Siberia) are characterized by extremely low amounts of chromosomal Q-HRs in their genome (Ibraimov et al, 1990; 1991).These data show that there is connection between the amount of chromosomal Q-heterochromatin in human genome and his adaptability to some physical environmental conditions (Ibraimov et al, 2014).

This example is notable for the fact that all this happened for very short period of time (several millennia) and *H. sapiens* remained a single tropical biological species.

By the aforementioned we want to argue that the acquisition of new forms is not sufficient and necessary condition of successful adaptation. However, at appearanceof new animal and plant species the shape of the body or parts thereof often undergo changes. Hence it questions, what the material sources of adaptation are: genes (random mutations), the non-gene part of the genome (in the case of a humanchromosomal Q-heterochromatin regions or DG?

Mutations of genes may really result in changes to the existing forms. But it's hard to imagine that complex adaptive forms and organs may occur due to mutations in many genes simultaneously. In any case, this possibility is not proved in the experiment. As for the non-gene part of the genome (chromosomal heterochromatin regions), that by their nature they are incapable to encode proteins and enzymes, that excludes their possible involvement into the origin of new adaptive forms. If things in Nature are that way, then why don't we return to the hypothesis of Darwin on gemmules that are born in response to direct exposure to the biological, physical and chemical environmental factors and may make upnew forms?

We trend to suppose that there are much more adaptation ways than are known to science. Thus animals and plants use the most different ways which are possible, including non-gene parts of the genome. In this sense, DG are one of the material sources of biological variability, which are formed by cells, tissues or organs of an individual in response to exposure of external environment.

Organisms react to changes in the external environment so that to minimize their impact. This phenomenon is called homeostasis. The existence of complex organisms itself depends on homeostasis. The lack or absence of food perhaps is the most important factor that disturbs homeostasis. Let us imagine such hypothetical situation in the example of a giraffe. The climate of the African Savannah began to change rapidly, trees became less and less, and for giraffes became harder and harder to get the leaves, most of which were located on the upper levels of plants. Since to hunt for food is a vital need, then animals mobilize all the possibilities of their organisms. As it is known in response to stress a variety of chemically active substances, intended to maintain constant internal environment are formed in the organisms. When such condition of existence becomes constant due to a new factor appearance in the environment and the internal resources of the organism already are at the limit of their capacity, then for the individual "gaining" a new adaptive form may be the only way out of this situation.

Where and how to search DG?

If really DG exist in the Nature, then where and how to look for them?Whether to look DG in the circulating blood, lymph or juice? If yes, then the question can be considered resolved positively, since traces of free circulating DNA, RNA and other substances are really found (see above). But how to be sure that they have the properties we attribute to DG? For the beginning, we should identify those of them that originated in cells, tissues or organs of an individual in response to exposure of biological, physical or chemical environment factors. Then to get data about their epigenetic effects on the growth, development or differentiation of the individual's cells and his generation. Most important we still poorly understand what properties DG must have.

Thus, for example, the possible number (types) of DG in the body of the individual in normal conditions of development is not known. If DG is produced in all types of organism cells, then their number, for example, in a human must be about 250, in accordance with the number of types of cells present in his organism. It is possible that the number of DG is somehow limited. In any case, the DG number increase cannot be considered useful because they can bring more "noise" to the already complicated process, which is the individual development.

During his life Darwin attempted to experimentally verify the existence of gemmules in Nature. As it is known his cousin Francis Galton conducted blood transfusion experiments in rabbits of different colors without any observable effects on their phenotypes, though many years later this verdict has been questioned (see more in Liu, 2010; Liu, Li, 2012). Now, it seems that it is the time to test the theory of pangenesis using the methods of modern biology and biochemistry. This problem is not technical, it is rather creative, in the sense that it is difficult to create an experiment that allows you to judge correct verdict: whether DG exists or not in the Nature.

It seems to us highly probable that the place of search of DG, in addition to circulating fluid in the body of the individual, should be exactly the cytoplasm of oocytes. Here we want to make one basic clarification; in spite of the fact that DG is produced throughout the body and is accumulated in the germ cells of the individual, regardless of gender, the biological values are only those contained in the cytoplasm of oocytes. The fact is that, as it is known, the contents of cytoplasm of the sperm do not enter the fertilized egg.

If hypothetically places to search DG can be considered more or less definite, the question to reveal the material sources of organismic variability remains even less certain. As in this case, the object of the search includes chemicals that are able to cause any morphological changes in cells, tissues or organs at different stages of development of the individual.

It is considered that evolution is a very slow process and therefore it cannot be observed directly in Nature for one generation of researchers. However, it is turned out that sometimes under the influence of external factors, the evolutionary processes can dramatically accelerate, as happened in the case of green anoles *(Anoliscarolinens),* lizards-dart anoles living on islands off the Florida coast. Recently, scientists have witnessed record quick evolutionary changes among American lizards (Stuart et al, 2014). Literally within a few years the habits and structure of these reptiles has undergone significant restructuring. Thus, in the 1950s, from Cuba to Florida was brought other species of lizards- brown anoles *(Anolissagrei).*Then the anoles-aliens began to settle in the islands and squeeze lizards-aboriginal. Scientists observed this process for about 15 years, during which managed to turn about 20 generations of lizards. It is turned out

that during the observation period pads on the toe pads of green anoles began larger and sticky, and they began to dwell in the upper part of the trees. According to the researchers, if the human height was changed with the same speed, then after 20 generations of American men (average height is 175 cm) would be similar to the NBA basketball players (average height is193 cm). We suppose that the case of anoles provides scientists with a rare opportunity to test the hypothesis of Darwin of gemmules.

Our idea of DG search paths is based in addition to the aforementioned, on the following considerations. During cell division, tissues and organs assume different shapes and functions. The patterns that they produce depend on their position within the organism and on the physic-chemical environment. They constitute what has been called the phenotype (Lima-de-Faria, 1988). As it is known in the body of the embryos of higher vertebrates the head, eyeballs and ears occupy disproportionately large place, compared with an adult body. The reason for this phenomenon is not known and is not specifically discussed, perhaps implying that these body parts are very important for the future of the organism and therefore they are laid early in embryogenesis. It seems to us highly probable that the cause of their early formation in embryogenesis and occupation by them disproportionately the most part (compared to an adult organism) in the body of the embryo is related to larger concentration of DG in the cytoplasm of the egg that determine the development of cell types that make up these organs, compared to the rest. In other words, we suppose that the concentration of DG, determining the development of different types of cells, depending on the number of this cell type in the body of an adult organism, where gemmules are formed. If things in Nature are that way, then it is easy to imagine why the head, eyes and ears in the embryogenesis in higher vertebrates are formed early and occupy much more space in the body of the embryo than in the adult. This is, apparently, because of the number of types of cells in the tissue of the head, eyes and ears exceed all other organs of the body of higher organisms. Though the muscles, for example, in the adult body, occupy 43% of its entire mass, however, according to a variety of cell types the muscle tissue is inferior to the bodies of the head. If the concentration of DG depends on the weight and not the number of cell types in the body of an adult organism, then in embryogenesis the muscle tissue would be formed prior the other and would occupy 43% of the embryo body, as in adult organism.

By definition, any scientific hypothesis must be able to prediction. If our hypothesis is correct, then we can expect that: a) for example, in higher vertebrates, in normal conditions of development, the highest concentration should show DG, which are associated with the development of cells of the brain, eyeballs and a hearing organs; b) the concentration of gemmules related to the development of cells, tissues or organs, where the natural selection pressure must change in the direction of increasing or decreasing.

The essence of suggested experiments with the anolis lizards, aimed to DG identification are as follows. At the first stage it is necessary to compare the chemical composition of the blood and cytoplasm of oocytes of sampling of green (*Anoliscarolinens*) and brown anoles (*Anolissagrei*) from populations living in places of their permanent residence. In the second stage to compare the chemical composition of the blood and cytoplasm of the eggs sampling of *Anoliscarolinens*, adapted to a new natural environment of Florida with the lizards-natives who live in Cuba. At the third stage is to use methods of artificial insemination because, we suppose that DG in the cytoplasm of the sperm cannot be the sources of biological variability. Therefore, it is necessary to take the fertilized egg of adapted *Anoliscarolinens*, remove the nucleus out and on its place to enter the nucleus from the fertilized eggs of native lizards of the same species. If in the result of such experiments in the offspring of lizards the toe pads become larger and sticky, then you can try to isolate and identify the desired substance, using the power of analytical methods of modern science, ranging from two-dimensional electrophoresis, fluorescence molecular to nanotechnology.

In the long-term perspective, it could possible to try to “reproduce” in the laboratory the adaptive evolution of shapes of Darwin's finches. Thus, for example, to propose to eat to a sample of chicks of the domestic chicken only grain enclosed in a hard shell so that to extract grains the animals must exert all the power of its beak. Before another sampling of chickens to pose a different problem: to eat, they should be able to pull the grain from the bottom of a deep narrow dish (or other devices) and at this those individuals who have relatively long beaks will have benefits. If in the result of this experiment with the passage of time the individuals who have changed the form of beak to obtain food (more powerful or long beaks) appears as in the case of in the natural environment of the Galapagos Islands with finches, then you could say that it’s time for experimental verification of the existing theories of biological evolution.

Place of DG in the adaptive evolution

In the times of Darwin two types of variability were distinguished: modification and hereditary variability. With the passage of time it became clear, that hereditary variability can be divided into three types: gene, chromosome, and organismic. Usually the first two types of hereditary variability unite under one common name – the genetic variability.

At adaptation, all three types of hereditary variation are used. Thus, for example the prokaryotes will adapt to the new environment mainlyat the expense of gene mutations. Apparently, eukaryotes use all kinds of variability. If you take a human, a classic example of adaptation (to tropical malaria) at the gene level is mutation of the hemoglobin gene. It was revealed that a human became adapted to northern and high altitude climate using a wide quantitative variability of chromosomal Q-HRs in human populations (see above). The color of skin, eye shape, body constitution, height and other physical peculiarities innate human may be considered as an example of human adaptation to different climatic and geographical conditions of the Earth by organismic variability.

However, among the three types of hereditary variation there is similarity in the sense that they all, one way or another, appear under the effect of the environment. It is known much about the nature of gene and chromosomal variability, which

cannot be said about organismic variability. Most important that we do not know exactly what is a material basis of organismic variability, their location, mode of transmission among the generations and how they are realized in the phenotype. Just this circumstance makes some scientists to look at DG as one of the possible source of organismic variability.

It is known how new genes or chromosome rearrangements are formed. It is supposed that all new adaptive forms, whatever they were in form and complexity appear based on already existing forms. Lima-de-Faria (1988) thinks that "Form can only arise from form, no form can arise *de novo*; it can only emerge as a result of a previous form". Thus, example, the tusks of an elephant is the transformed giant incisors of the upper jaw, and the trunk is the product of adaptive evolution of the upper lip and nose. Despite the fact that some adaptive forms affect our imagination, however, they all have their predecessors. The matter is in the ratio of different types of cells and tissues; predominance of muscle tissue and nervous receptors in the elephant's trunk provides it with some flexibility and versatility, and the predominance of bone tissue gives hardness of the bone. Thus, we suppose that, apparently, the material bases of some form of organismic variability are DG, which affect upon the phenotype of an individual through epigenetic changes of its genome.

Concluding remarks.

We already had to refer to DG (Ibraimov, 2009). For these years a number of publications on this topic have appeared (Liu, 2010; Deichmann, 2010; Kuzawa ,2012; Bateson, Gluckman, 2012; Schneider et al, 2014), which convinced us to come back to this problem. Thus, we have seen that the genetic and organismic evolutions are disproportionate. Really, a human and chimpanzees are identical in 99% of their genes (King, Wilson, 1975), but belong to different families. The striking phenotypic differences between chimpanzees and present-day humans cannot be fully explained by an approximately 5% DNA sequence divergence (counting indels) (Chimpanzee Sequencing and Analysis Consortium, 2005), in particular considering that mice and rats exhibit relatively small phenotypic differences and yet are much more diverged in their sequence (Schneider et al, 2014).

According to our point of view, the main material basis of organismic variability that occur in response to environment are DG, not DNA mutation. The mechanisms of impact of DG on biological variability are through epigenetic changes at different stages of ontogenesis. With the lapse of time, these changes may proceed in the form of the genetic variability. In other words DG, mainly responsible for plasticity, and the DNA and chromosomes are responsible for robustness in development and evolution.

The fact that the DG accumulated only in oocytes is transmitted to the offspring, apparently, is a deep biological sense. In fact, if in a fertilized oocyte met DG from both parents, there would be a serious failure in the development of a fetus. It is not difficult to imagine that to the quantitative and qualitative composition of DG in germ cells will undoubtedly have effect by gender, age, weight, height, food composition, environment features and the history of the individual development of parents. Therefore, the collision of biological parents past through DG can create chaos in the already complicated process, which is the individual development. Thus, we suppose that only the maternal organismsDG, as a source of organismic variability, participates in biological evolution.

According to Darwin , the allegedly lasting effects of changed conditions of life were no contradiction to natural selection. Darwin's emphasis on ''Lamarckian'' mechanisms as causes of variation and adaptation was particularly strong in his later publications. The accumulative action of natural selection in the Origin was thus replaced by accumulative actions of the environment. Central to Darwin's thoughts about heredity was the idea of blending inheritance, i.e. the merging of parental differences in the offspring of bisexual reproduction; according to Robert Olby this was the most unfortunate of the assumptions underlying Darwin's mechanism of evolution (Olby, 1966).

It's still unclear how new adaptive forms are gained and transmitted to descendants? Let's imagine that such a "Hopeful Monster" has appeared in Nature, as, for example, Goldschmidt (1940) has admitted in his time. Then why do not admit that the new adaptive form, when crossing such a "monster" with other individuals in the population can be transmitted from generation to generation through DG? The value hypothesis of Goldschmidt about "Hopeful Monster" is interesting with the fact that he was the first evolutionist to integrate genetics, development, and evolution.

To the question why the experience and knowledge of a human gained in the course of his life do not transmitted to theoffspring, we would answer that perhaps in the process of memory formation in the brain the compounds that are accumulated in the body and germ cells of the individual are not formed. Memory is not recorded in the "language" of molecules, as in the genes as sequences of nucleotides in DNA, but is supported by, apparently, more stable changes in neuronal connections.

We talked more about the role of DG in the emergence of new adaptive forms in animals and plants. However, this does not mean that DG relates only to morphogenesis, that is, organismic variability. Emphasizing the possible morphogenetic role of DG, we have meant, mainly, the methodological side of the question, in the sense that the studyorigin of new adaptive forms perhaps is the most convincing way to prove the existence of DG in the Nature.

There is an opinion that "The central problem of evolution is not the 'Origin of Species' but the origin of form and function" (Lima-de-Faria, 1988). He argues, «The gene does not create form and function". We are of the opinion that with the appearance of the sexual mode of reproduction the role of genes in the evolution of multicellular organisms has decreased (Ibraimov, 2010; 2011; 2015). In any case, none has been able to prove that new adaptive forms, body plans or new species have appeared due to random mutations of the gene(s). In other words genes for complex organisms did not show themselves as bridges between the outer and internal environments. DG would suit for this role, if they really exist in Nature.

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