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# Scenarios for the Development of the Material World

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**ABSTRACT**

Various scenarios of matter development are the subject of extensive works by naturalists and social thinkers. Many works on the evolutionary development of the biochemical world have been published in this journal in recent years. This paper presents an overview of all the main scenarios of material world development, supported by examples. This material can be used in educational institutions of any level, from elementary to higher, since it is presented in a generally accessible language.

**Keywords:** Material World; Development; Dying; Stagnation; Evolution; Revolution

## Purpose of the Work

Even the ancient Romans knew it well: Times change, and we change with them = Tempora mutantur et nos mutamur in ills (Ovid). And we, in the present, notice that the world around us is changing. This change of the world in time we call its development. Another thing is how we treat the results of development. Most often, neutrally. Approvingly, when we become more comfortable. Negatively, when it becomes uncomfortable. Those of us who consider and are called ourselves naturalists, naturalists, notice and highlight a few characteristic scenarios of development in the complex systems of our super-complex world. We will briefly describe several scenarios known to us to highlight a special, evolutionary scenario against their background, which was analyzed in detail at the molecular level earlier in this journal [1-5]. Knowledge of the background is necessary, since all development scenarios in the world relate to each other, and tearing one scenario out of the general context is dangerous for understanding.

In describing the scenarios, we will try to refer to well-known natural phenomena, to facts that we directly observe. But we cannot do without explanations of these facts, and these are already interpretations. Let us recall the warning from Friedrich Nietzsche: There are no facts at all. There are only interpretations. We, physicists and a school methodologist, fight this ironic warning of a philosopher, citing interpretations not from ourselves, but from major specialists in the relevant fields of knowledge. Such interpretations also become Verified Facts.

## Universal Scenario – Chaos

Any material object consists of atoms and molecules. We do not directly see this internal structure. Therefore, the firmly established fact of the existence of atoms and molecules is precisely the reliable interpretation of numerous observed facts. This is so that Friedrich Nietzsche would not dare to laugh at us, researchers of facts.

In any collective of atoms and molecules, there is continuous thermal chaotic motion. Sooner or later, it inevitably leads to chaos, to the destruction of the external form that presents the given object to an external observer. This is a natural tendency that cannot be cancelled. Various efforts and tricks can only slow down the destructive process

in a specific natural object. And Nature tricks itself, opposing the tendency to destroy objects with the tendency to create new objects. But about the tendency to create will be later. And now is a specific example of the manifestation of the scenario of chaos, the destruction of a valuable object. For me, an individual from the genus Homo Sapiens, the most valuable is the external form of existence of a huge collective of simple and complex molecules is my own organism. In essence, it is me. In this natural object dear to me, cells and entire tissues are constantly being destroyed by themselves. And by themselves, continuous repairs are taking place, new cells appear, and damaged tissues are being replaced with new ones. This is done on the basis of the genetic code contained in the nuclei of cells in the form of very long DNA molecules. These giant molecules are very resistant to the destructive action of thermal chaotic motion. Forensic scientists cleverly use this property of DNA when they need to identify someone's long-destroyed organism.

Everything would be fine, but we, specialists in the field of molecular physics, figured out what exactly happens in long and super-long biopolymer molecules, in this basis of Life. It turned out that the thermal chaotic motion in any long molecule sooner or later leads to the breakage of the external link of the polymer chain. The long DNA molecule shortens. Not so much as to confuse forensic experts if something happens. But so much that not all proteins encoded in DNA would continue to be properly synthesized in the body. As a result, the repair of cells and tissues becomes less qualitative than in youth. I am getting old. And sooner or later I can't cope with the repairs at all, I die. That's how it goes, as one of Kurt Vonnegut's characters said. These are complex processes, this is how indirectly chaos takes its toll, but it takes it. Nothing can be done – it is the law of Nature (Dura lex, sed lex).

Let us pay attention to our complete disregard for the external physical conditions in which the chaos scenario is realized. The fact is that chaos occurs under any external conditions. In some conditions it occurs faster, in others slower. The only physical parameter for characterizing different conditions is temperature. The higher the temperature of the system, the faster the system moves toward chaos. The lower the temperature, the slower the Chaotization. It stops only at a temperature of -273º Celsius. But it has been proven in thermodynamics that absolute zero temperature (-273º Celsius) is unattainable.

## Stagnation or A Stationary State

This is the calmest development scenario for a complex natural or technical object. And the safest one, the least destructive to the environment. Because in its stationary state, the object accumulates garbage in the external environment at the lowest rate. By garbage, we mean high-entropy products that the object generates as a result of internal processes of destruction, chaos. And these processes, as was said, no one can cancel. Let's give a brief reference from technical thermodynamics, what and how happens with a specific natural object. Any such object is called an open non equilibrium system. It is open because flows of matter and energy enter the system through the outer shell. And flows of matter and energy are also discharged through the same shell. Such a system is nonequilibrium because the temperature in different parts of the system is different and differs from the external temperature. The pressure is also not the same in different parts of the system, which makes the object like a pump that draws something from the outside and throws something out.

Let's consider, for example, the object that is dearest to me, an individual - my body. If you observe me, an adult, over a not very long period of my life, you will notice that my weight, height, and volume do not change. My temperature is a stable 36.6º C my blood pressure is stable at 120 to 80. My appearance has not changed either. At least for border guards, when they compare my appearance with my photograph when I cross the border. Let's see how my organism interacts with the outside world. And it cannot help but interact, because my internal processes of chaos will quickly lead to death if I am hermetically sealed. Cells and tissues are constantly being destroyed. The decay products cannot be left inside the body. They are harmful, poisonous, and must be removed. The body applies excess pressure to them and expels them out into the environment. Instead of destroyed cells and tissues, the body must build new ones, the same in quantity and quality. To do this, the body feeds on valuable products. It disassembles them into component parts and reassembles them according to a plan contained in my proteins-enzymes. When assembling new molecules, the body always releases thermal energy, the temperature tends to rise, but the body releases excess thermal energy outside, and thus maintains its average temperature at the same level.

As a result of all these complex processes of nutrition, digestion and breathing, my body remains for a long time the way I like it. Unchanged. This is my stationary state. I am in a state of stagnation. Until a certain time, when I will start to dislike some things. Disease and aging. In addition to this example, we could give others, no less interesting. For example, our country was in a stationary state for some time. Many liked it. But the leaders rightly noted that this was stagnation. And they became worried. Quite rightly worried. They were concerned about the further development of the country, even the Acceleration of Development. They took hold of the levers of Glasnost and Perestroika, but they pulled these levers not quite successfully, not in accordance with the natural development scenarios. As a result, the country fell ill and moved into another state, an unstable one. Let's return to the reference from technical thermodynamics. An open nonequilibrium system, to maintain its life, absorbs valuable products with their low entropy and high internal energy from the outside world. And it returns products with high entropy to the outside. As a result, the outside world spoils. Garbage accumulates in the outside world, which is more difficult to use for something useful than the valuable products spoiled by the open system. And here it is high time

to recall Prigogine's comforting theorem: An open nonequilibrium system in a stationary state exerts the least possible entropic load on the outside world compared to the load in a state of growth or destruction of this system.

Now let's consider the conditions for implementing this scenario. Despite the apparent simplicity of this scenario, the conditions for its implementation are not at all simple for any complex object. First, the object must be created and developed to its stationary state. And this requires resources, special initial conditions and significantly greater efforts from nature and the object itself than maintaining the object in a stationary state. And the entropy load on nature is significantly greater during the period of birth and upbringing of such an object. And there is nothing to say about the period of illness and destruction of the object. The object itself turns into garbage. The entropy of the surrounding world increases sharply during this period. That's how it goes. The conditions for maintaining an object in a stationary state are also difficult. Resources are needed to feed the object. Mechanisms are needed to remove waste. If the products obtained in the internal processes of destruction are not removed from the vicinity of the object, the object will be isolated from the power resources. And in isolation, any object develops according to the scenario of chaos, dies.

## Linear Quantitative Development

This is the simplest scenario. So simple that it can be described and analyzed mathematically. Other natural development scenarios are very difficult to describe and analyze. And some scenarios cannot be described quantitatively at all. However, at the physical level, this scenario is not simple either. Let's say something grows in nature. For example, a snowflake grows, a forest grows or shrinks, a human baby grows. The number of babies born per year and surviving the first days of life grows. Why does it grow? Why at such a speed? This is because suitable conditions have been created. And in these conditions, with the availability of resources, the process has begun. And only then can differential equations be drawn up and solved to forecast and correct the process. There is no point in describing this scenario in detail, since it is part of the scenario of preparing the system for the transition to its stationary state. For no quantitative change in nature can develop infinitely. Quantitative changes encounter qualitative leaps, as Hegel claimed. Nothing can be done about it. One feature of this scenario should be noted for further discussion. on specific examples of its implementation. Let a forest massif grow. New members of this massif appear. But nothing NEW appears on a qualitative level. Let a glacier grow, on which snowflakes fall. From snowfall to snowfall, from year to year, new layers of ice or compacted snow build up, but nothing NEW appears. For something NEW to appear, a completely different scenario is needed, an evolutionary one.

## Evolutionary Development

The mechanisms of the evolutionary scenario and the conditions of evolutionary development are described in detail in the links provided. In this section, we will limit ourselves to one example, one specific scenario, in which the features of evolution are clearly manifested. The proposed example will show that evolution according to Galimov [6] and evolution according to Darwin are not antagonists, but possible collaborators in a natural laboratory. In the warm seas there lived an archipelago with its own flora and fauna. The islands of the archipelago are located at distances that are quite accessible for bird migrations between the islands. The birds helped to transfer plant seeds between the islands. Therefore, each island was completely covered with greenery. The greenery consisted of trees and grass. At the beginning of time, the birds were of one species, with short beaks and small claws. This allowed the birds to feed bugs on tree branches. Bark beetles rarely appeared on the surface of the branches. Small worms and larvae rarely appeared from the soil. The birds ate poorly and did not reproduce very vigorously. But in general, the entire ecosystem of the archipelago lived in a pleasant stationary state for centuries.

And a disaster happened in the depths of the sea, a catastrophe. As a result of the epizootic, a lot of deep-sea fish died. The swollen fish floated to the surface and were thrown onto the beach of one of the islands. It was a feast for the birds. With one side effect that led to serious consequences. The bird that had eaten the fish picked up not only valuable proteins from the tissues of the dead fish, but also those pathogenic microorganisms that caused the fish to be epizootic. Whether it was bacteria or viruses is not so important. What is important is the fact that it is now well known to us, that the genetic material of living cells is transmitted from the past to the present and to the future not only vertically (along the trunks and branches of the genealogical tree of a given species), but also horizontally - from one species to another. Approximately like it follows. The fish meat cells are pleasant and useful for birds. These cells will be disassembled by enzymes into parts, from which other enzymes will build bird cells and tissues. But the fish pathogens are foreign. They are not pathogenic to the birds. They just need to be destroyed. Special bird cells, phages, absorb the foreigner, disassemble it into parts. The details of this process are not important. What is important is that fragments of the bird's DNA molecule and fragments of the foreigner's DNA or RNA molecule can end up next to each other in the same cellular broth. And then attractive-repulsive forces arise between the individual parts of the molecular fragments of two different genomes. And an exchange of parts of the genomes, a mutation, can occur (mutatio = exchange, change). The bird develops a new genome, which can get into its reproductive system.

Please note - a NEW microscopic object, a DNA molecule of a new structure, has emerged by chance, suitable and even favorable for birds. Previously, during the linear process of reproduction, the transfer of genetic information into the future in birds, such an object did not emerge. The same structure was boringly repeated in new copies of DNA molecules. But the emergence of a NEW object due to the random interaction of fragments of old objects, this is evolution according to Galimov. And there are old mechanisms that will transmit information about a completely NEW object into the future. A NEW object is fixed in world history, if natural conditions allow it to survive. What does this lead to in this example of an ecosystem? Most likely, not every bird that has eaten dead fish will exchange genetic material. In those birds where it does occur, it will not necessarily happen in the same way. Let's assume that only two new types of bird genomes have emerged. One genome, through the new proteins encoded in it, will lead to the emergence of a population of birds of the "beak" subspecies with long strong beaks. The other genome will lead to the emergence of a population of birds of the "claw" subspecies with powerful claws. Then macroscopic processes occur, following the Darwinian scenario of evolution.

Let the birds of the new subspecies of this species fly evenly across the different islands of the archipelago. Let Beak Island has a large part of the territory occupied by forest, and Claw Island has a large part occupied by meadows. These are significantly different natural conditions for the two subspecies of birds. On Beak Island, the Claw subspecies can only feed on the bugs that have appeared on tree trunks. But bark beetles prefer to be in the depths of the bark. From there, the Beak subspecies easily gets them. As a result, on Beak Island, the Beak subspecies feed and reproduce better than the Claw subspecies. For similar reasons, on Claw Island, the Claw subspecies, which can dig up the soil with its powerful claws and extract soil worms from under the ground, feeds and reproduces better than the Beak subspecies. After several hundred years, a ship will pass by the islands of Beak and Claw, and a young Charles Darwin will be on board, having met the captain. And he will notice that on Beak Island the feeding and breeding conditions are favorable for the Beak subspecies of birds. And on Claw Island the conditions are favorable for the Claw subspecies of birds. And he made a brilliant conclusion:

- The origin of the species is caused by natural conditions to which the surviving ones adapt well and survive, and against this background the dying ones adapt poorly and die out.

We are not being ironic. The mechanisms of survival and extinction according to Darwin's evolutionary scenario work perfectly. And not only in warm seas. But they have nothing to do with the origin of new species and subspecies. NEW natural objects appear on their own under the influence of special conditions, under the action of special mechanisms and according to Galimov's evolutionary scenario. Let's follow the example we have analyzed, how some special features of Galimov's evolutionary scenario manifested themselves. According to Galimov, evolution does not destroy anything. On the contrary, it carefully preserves everything. In this example, the genetic material of the original bird species has not disappeared. The genetic material of pathogenic microorganisms within fish has not disappeared without a trace either. These materials have only exchanged small sections of their material carriers, DNA molecules. NEW, previously non-existent objects (two subspecies of birds) are quite suitable for further evolution according to Galimov. Nothing prevents them from getting infected with something from bugs or worms. Then new mutations await them. With this, corresponding consequences for the environment, if the environment allows this benefit or catastrophes to happen.

## Catastrophe

We have already looked at two examples of small, quiet disasters in the ecosystems of two quite prosperous islands. If the reader is interested in analyzing larger disasters in more serious ecosystems, we recommend a link to an analysis of possible events with one of the complex ecosystems [7]. It remains to explain the term itself. The Greek word καταστροφή, if broken down into its components, can mean not only "disaster", but also "from a new line", which is much more optimistic. Indeed, in nature, healing of a system that has suffered a catastrophe often occurs. On an island where the entire forest has perished, the winds can carry the seeds of trees that are good at resisting voracious bark beetles. And a new forest will grow, from a new line. Learn Greek. You don't necessarily have to learn this difficult language. But you will be more fluent in scientific terms, which are all from Latin. And they came to Latium from the more enlightened Greeks.

## Revolution

This scenario usually starts working after the evolutionary and linear development of a large complex natural system. Under certain external and internal conditions, NEW objects start producing so many of their new copies that the populations of these NEW ones become crowded in the struggle for resources, for dominance. NEW ones start to dominate, take power into their own hands (in Old Church Slavonic, Polish and Ukrainian "powerful" = "own"). The interfering copies of OLD ones are destroyed or vigorously thrown out into the environment, into the outside world, into emigration. Thus, the characteristic feature of revolution is the destruction of material unnecessary for the further development of the system. In this way, revolutionary development, in its wastefulness, differs significantly from evolutionary development. It is comforting that after a revolution, after the accompanying catastrophes, after the self-healing of wounds, the stage of evolutionary development can begin again. The work was carried out within the state assignment of the Vernadsky Institute of Geochemistry and Analytical Chemistry of the Russian Academy of Sciences (GEOHI RAS).

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