The Evolutionary System of the Biosphere and the Metameric Concept of Its Evolution: From the Past to the Future

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We offer a detailed description of our previously published new concept of the evolution of the biosphere as an integral system of its states over time, united by development trends. The structure of the biosphere is considered as a hierarchical fractal system, and the elementary unit of the biosphere is an ecosystem. The fractal structure of the biosphere corresponds to the emergent principle: each lower level is an element of a more complex system and has its own properties. The proposed concept of biosphere evolution is based on the general categories of dialectics: states and interstates, continuity and discreteness, reproducibility and uniqueness. The evolutionary history of the biosphere is a metameric picture of changing states and interstates. The most important feature of the biosphere organization in space–time is a complex system of continua. The development of an integral biospheric system occurs in a time continuum: in the biosphere, the differences between the early and subsequent states are quite significant and obvious. Moreover, these differences are associated with fundamental complications, development, which is, in fact, evolution. The states of the biosphere in certain periods are linked by trends that form an evolutionary system. Continuing states, when the system remains self-identical for a long period, are replaced by new states through interstates. Based on the principle of actualism, the problems of the biosphere's future and evolutionary trends of the biosphere under anthropogenic impact are considered.

evolution biosphere fractal structure development trends states interstates metameric model continuity

Many global processes (in particular, climate change) are considered primarily from the perspective of changes in human living conditions [1][2] even if the impacts of certain factors on ecosystems are considered [3]. This does not take into account the fundamental position expressed by V.I. Vernadsky: a human, like any other species of living beings, is a product of the biosphere, and they do not exist and cannot exist outside it [4]. Forecasting the future of humans and the biosphere is impossible without knowing the history and regularities of the biosphere's development. The fundamental principles of the biosphere system's structure and functioning, both before and with human participation, have been and remain unchanged.

Vladimir Vernadsky's concept is that the complex of living organisms (he calls it "living matter", Glossary) interacts with the inert elements of the Earth's geological system, actively influences them, and forms the biosphere as a united self-regulating and self-sustaining system. V. Vernadsky's concept of the connections and development of living matter in the changing conditions of the planet as a whole was like a Copernican revolution in understanding the world [5][6]. It allowed for the first time to look at life and the geological basis of life existence as a single whole,

a single system, although earlier, such great minds as J.B. Lamarck, A. Humboldt, and E Suess tried to move from particular knowledge to planetary generalizations.

Recently, the idea of the unity of evolutionary processes in nature has been actively discussed [7][8]. Self-development and irreversibility of the general progressive course of evolution are important. The evolution of the biosphere has repeatedly been the subject of scientific consideration and analyses, in general philosophical terms [9][10][11]. More specific issues related to both the evolution of biotic components of the biosphere and the evolution of bioinert systems have also been discussed [12][13][14][15][16]. Indeed, biological evolution in its most general form is transcendence of the struggle for life and natural selection by entropic forms of interaction through ascending levels of symbiosis from cell organelles to biotic communities and ecosystems [17], but such evolutionary processes as entropy reduction are peculiar not only to biotic systems, but also to the biosphere as a whole.

Therefore, history enters development as heredity and is projected into the future by means of the epigenetic renovation of the developmental program. This principle determines the relationships between ontogeny and phylogeny at the genomic, organismic, and ecosystem levels, converting complexity of developmental programs into the directedness and determinism of evolutionary developments [17][18].

In evolution, the irreversibility of general progressive self-development with the cyclic nature of individual processes is important [19]. Biotic evolution is an inevitable result of maintaining the stability of the system of the highest rank relative to the organism [20]; the population is regulated by the biogeocoenosis [21] in the hierarchical structure of biotic and biocosmic systems of the biosphere.

The authors' familiarity with the problem of biospheric evolution showed that Western scientists very rarely use the literature from eastern Europe, so we intentionally used predominantly this literature in our discussions to create and maintain some informational bridges.

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