

The Biosphere as a Biogeomeride and Its Biotope

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Abstract—The concept of a geomeride proposed by V.N. Beklemishev in 1928 and subsequently mistakenly forgotten is of basic significance for the development of the biosphere doctrine, global ecology, and stratigraphy. In the article, notions “biosphere,” “living matter,” and “geomeride” are discussed. The specified term “biogeomeride” is proposed to emphasize the significance of the living constituent of the biosphere in its biodiversity.

Key words: biosphere, geomeride, living matter, biogeomeride, biocoenology, paleoecology, biospherology, biogeocoenology.

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In connection with the growing interest in biospheric problems in basic and applied studies, in this brief work, I would like to draw attention to the geomeride concept. This concept was first proposed by Vladimir Nikolaevich Beklemishev, an outstanding biologist (Beklemishev, 1928). I had touched on this concept in the article published in a little-known edition (Sokolov, 2006). Therefore, without worrying about repeating myself, I want to express my thoughts on the notion of “geomeride” and its relations with other notions such as “biosphere” and “living matter” to the wider scientific community.

(1) The doctrine of the biosphere is undoubtedly the greatest “empirical generalization” by Vernadsky (1923, 1926) and in its present-day form it is multidisciplinary. I have abandoned long ago attempts to connect the biosphere doctrine with any single science (Sokolov, 1981, 1986). It was difficult to share completely Vernadsky’s opinion that biogeochemistry is a science of the biosphere (Vernadsky, 1965, 1978), since the entire subsequent practice after the 1920s objectively demonstrated that only biospherology or biogeospherology (Guegamian, 1980; Sokolov, 2004) may be considered as a discipline of the biosphere or, essentially, metascience. Being an outstanding geologist and geochemist, who enriched these disciplines by the metaphorically bright concept of integral “living matter” (Sokolov, 1983), Vernadsky was, however, persistent in his belief that biogeochemistry should represent science of the biosphere, although he himself provided grounds to his adherents (Kovda and Tyuryukanov, 1970; and others) for well-known different views and the possibility to believe that “the biosphere includes both life (naturally functioning—B.S.) and other structures of the Earth genetically connected with living matter.”

At the same time, I have no scientific and moral right to “correct” Vernadsky and think that he moved away from biology, uniting all the inhabitants of the Earth into an indivisible “living matter.” This is not the case, if only for the reason that the idea of geological time was for Vernadsky biological time of the evolution of living matter. Galimov (2001) is undoubtedly right in citing his words (Vernadsky, 1988): “In studying living matter, we are studying a geochemical, not biological process...,” although “similar to the biosphere, living matter is characterized by a specific organization and may be considered as a regularly expressed function of the biosphere.”

(2) I found it reasonable to mention the above citation as a necessary preface to discussion of one half-forgotten, although important, concept in theoretical biology, paleontology, and geology. I mean the geomeride concept by Beklemishev (1928). In the 1920s, Beklemishev was a member of a group of bright young and older biologists at Perm University, the last university, which opened in Russia on the eve of the Revolution of 1917. This group included remarkable and widely educated researchers, such as the already well-known A.A. Lyubishchev, P.G. Svetlov, Yu.A. Orlov, A.A. Zavarzin, and A.G. Genkel. They became founders of many new scientific schools in zoology, botany, histology, physiology, morphology, theory of evolution, paleontology, biocoenology, virusology, taxonomy methodology, and, even, philosophy of science. Beklemishev contributed much to the development of biocoenology, the understanding of the principles of the organization of life, and the methodology of taxonomy (Beklemishev, 1928, 1964a, 1994, and others); however, he gained world recognition largely for his fundamental two-volume work “Basics of Comparative Invertebrate Anatomy”, published repeatedly in many languages. My personal acquaint-

tance with him in the 1950s was mainly connected with the discussion of problems, concerning the morphology and physiology of Paleozoic tabulatomorphic corals. Now, I regret that I did not have enough time for discussing similarly interesting problems of biocenology and paleoecology with him.

(3) In contrast to Vernadsky, who primarily saw living matter in the biosphere, which interacts in an organized manner with other geospheric shells of the Earth (lithosphere, hydrosphere, and atmosphere) via its biogeochemical function, Beklemishev viewed the living cover of the Earth as a similarly basic phenomenon, although in its direct core and integrity. For him, it was a “living crust prostrated over a stone sphere.” He wrote that “this is the primary single least abstract object of our science—a stirring immense living world, incredibly complex and integral, where we ourselves and the whole of mankind are only a part; at the same time, this is a most abstract construction limited to the search for relationships, which remain constant throughout life.” Further, he posed the question: “What should this Essence be called? I myself named it as the Biosphere. According to A.A. Lyubishchev, Starynkevich¹ calls it a Geomeride, which is probably a better choice.” “Of what elements does a Geomeride consist? Similar to the metazoan body or mankind, which is not composed immediately of cells and people, respectively, a Geomeride cannot be immediately composed of individual animals and plants. A lot of intermediate individualities occur between them and the general organization of a Geomeride... These are primarily various different-order biocoenoses, from mud microzones ... to geographic domains such as the Caspian Sea or Tethys.”

Already these thoughts clearly show that the geomeride concept accepted by Beklemishev is holistic and quite autonomous, being directly related to the concept of the biosphere. Unfortunately, in his works Vernadsky frequently formulated the notion of the biosphere in his concept of “living matter” ambiguously, which was probably responsible for the fact that Beklemishev, who initially defined the functioning living cover of the Earth as the Biosphere, soon replaced this term with the more exact geomeride notion. Nevertheless, as is shown in an interesting book by Galimov (2001), the phenomenon of life and living matter displays in these biochemical and bioenergetic aspects its evolutionary character, starting from the origination and early evolutionary stages of life.

(4) The geomeride concept by Beklemishev has had a very strange fate. This undoubtedly basic biological concept, clearly formulated in the 1920s and containing very substantial terms, was not included in the fundamental Biological Encyclopedic Glossary (1986). This is probably explained by two reasons:

¹ From the note to the book (Beklemishev, 1994, p. 61, 213): K.D. Starynkevich, from his report in the former Tavricheskii University in 1919.

first, Vladimir Nikolaevich, who always wanted to be correctly understood, most frequently formulated his geomeride concept as a “living cover of the Earth,” which was usually understood as a notion synonymous with the biosphere, although it did not correspond to the biosphere in Vernadsky’s terminology as a medium (sphere) embraced by life in the form of an integral “living matter,” and, second, the most important works by Beklemishev, where these aspects are discussed, were published only after his death in 1962.

(5) Mirzoyan (2001, 2006), a most prominent historian of biology, was first to subject the geomeride concept to a thorough analysis. He writes that the geomeride concept is “one of the first, if not the first theory of global ecology,” which received a powerful impulse ... from biochemistry and studies on the biosphere.” “The notion “Geomeride” emphasizes an element of integrity, inherent to this highest-order biocoenosis..., while the term “biosphere” designates the “highest-order biotope, not highest-order biocoenosis” (Beklemishev, 1928, p. 142). I consider this emphasis as extremely important, since it distinctly determines relations between the geomeride and general notions of the biosphere, and simultaneously demonstrates their indissolubility similar to the indivisibility of biocoenosis and biotope in their relationship and functioning, without which their construction would be impossible. This was excellently understood by Sukachev (1945, and others), who introduced the notions, biogeocoenosis and biogeocoenology, in natural sciences. In the western literature, the latter notions are usually designated as an “ecosystem,” which is characterized by the active interaction between living and inert constituents of biogeocoenosis. In his very logical reasoning about the organization level of all living systems, Lyubishchev (1982) pays particular attention to the “hierarchy of organisms beginning from a cell to a landscape and ... to an understanding of all the organisms of the Earth as a single organism,” i.e., geomeride. He understands this new term proposed by Starynkevich in the same manner as Beklemishev and emphasizes that the geomeride is a real organismic notion of the highest rank, which comprises “facts of biogeography” and “exists as a single specimen.”

(6) Abakumov (1975) dedicated a special article to the hierarchy of the biosphere’s organization. His reference to the thoughts of the outstanding theoretic physicist, V.A. Fok, on relations between a living organism and a medium in biology: “A living organism is not a medium, although no sharp boundary can be drawn between them.” From my viewpoint, Abakumov is right to note that the “geomeride, atmosphere, hydrosphere, and solid shell of the biosphere..., which mutually penetrate each other” should be attributed to the main components of the biosphere.” These four components exactly correspond in their biogeospheric sense to the basic geospheres according to Vernadsky, and the biosphere fitted into them in its entire geohis-

torical volume, from the “former biospheres” recorded in the stratisphere (the stratified shell of the Earth) to the present-day biosphere, which includes the entire planet. The latter is, however, important for Vernadsky as a biogeochemical function of living matter, which interacts with the medium of three other geospheres. In other words, there is no place for Beklemishev’s geomeride in Vernadsky’s biogeochemical concept. This is the main point of theoretical divergence for researchers, who accept the term “biosphere,” but interpret the latter differently: originating from living matter with its chemical properties on the one hand, and from matter reflected in the discrete physiologically active living structures of organisms and their conenoses of a different organization level, on the other hand. In the above-mentioned article by Abakumov (1975), “the biosphere is understood as the highest dialectic unity with the geomeride, not as a “highest-order biotope.” In the long run, both statements are valid. At the same time, it is important to understand that the “structure of the present-day biosphere appeared as a product of a long period of evolution, which lasted at least 4 Ga. All the subsystems and elements of the biosphere have resulted from the entire development history of the lithosphere; therefore, the most important task of biospherology is the study of the genesis of the biosphere’s structure” (Abakumov, 1975). Life’s origin and the onset of biospheric evolution in an ancient preaerobic medium (“anaerobic biotope”) mark the starting point of the biospheric structure’s formation.

(7) Kafanov (2005), a well-known Far Eastern biogeographer, relentlessly follows the Cartesian principle—“define your words correctly and you will exempt the world from half of its contradictions”—when he writes: “The understanding of “life” or “living matter” by Vernadsky sharply differs from their recent understanding by biologists.” He would undoubtedly be right if it is considered that only biogeochemistry still remains the science of the biosphere. At the same time, Vernadsky himself was not always strict in his wording, let alone his numerous followers, especially geologists in Russia and in the world. This is explained by the Life phenomenon itself: it is too grandiose in all its manifestations. It strikes the imagination primarily by its specific physical biodiversity, which has been subjected to a drastic reduction due to the recent uncontrollable technogenesis, rather than by its biogeochemical function. At the same time, it is hard to argue with Zavarzin (2000) that “the action of the biogeochemical machine started in the prokaryotic biosphere and continues on this basis until now.” A similar thought was formulated prior to Vernadsky in (Henderson, 1924). Henderson noted that life, as far as we know it, is a physicochemical mechanism and can hardly be imagined as something else. This idea was also close to the geologist and geochemist Vernadsky (1926), who perceived both living and bioinert phenomena as categories of chemistry, and

not as an organization of living structures of organisms and their communities. However, both these interpretations have been implanted in science; they only seemed autonomous in the biosphere, although were hardly divisible in a functioning ecosystem and in a common understanding of metabolism. Shimanskii (1987), an outstanding paleontologist, very clearly expressed this dualism: “The leading role in the [biospheric] system belongs to a living being. At the same time, one cannot limit the biosphere only to the totality of living beings, since they cannot provide a single system beyond their living conditions.” He justly also noted the insufficient attention of researchers to the historical development of the biosphere. As can be seen, here we are dealing with the impossibility of reducing ideas of the biosphere and geomeride to a common notion and the geomeride, in the paleontological sense, plays the role of a living world of the geological past.

(8) An extremely important question arises: are there grounds for discussing this paleontological phenomenon, such as the living world of the geological past, using actualistic terminology? Indeed the latter fell out of the functioning living system and is nowadays displayed in the form of dead bioinert and inert matter, i.e., various biolites (Samoilov, 1929, others), which are frequently practically devoid of features of the formerly living organism and represent just a physiological product of its life activity. Samoilov writes openly about “biochemical paleontology” and paleophysiology, which are separated from the morphology of organisms and any of their relations. From this it follows that we are dealing with the manifestation of properties of living matter in the biosphere, although this notion is not used by the last Samoilov. In fact, the trouble is that the boundary between the “field of life’s existence,” i.e., part of the active biosphere, and the part, which fell out into the inert medium of the Earth’s crust, appears to be very thin, in all its critical distinctness. Samoilov also expressed this thought clearly, emphasizing that the stratisphere is a product of “past biospheres.” Precisely for this reason it appeared to be preferable to reject the idea of dividing the biosphere into the apobiosphere, parabiosphere, biosphere, and metabiosphere (Vassoevich, 1976). Speaking about the biosphere, I mean, in fact, a single and continuous panbiospheric process, which lasts at least four billion years. The “past biospheres” considered in depth by A.V. Lapo (1979) automatically fit with this process and occupy a central position in an understanding of the biosphere’s evolution during the entire geological past. This process demonstrates convincingly that the present-day biosphere represents only a thin slice of the most important geological phenomenon, whose prognostic significance can hardly be overestimated (Sokolov, 1988). Thus, the use of actualistic terminology in the doctrine of the past biosphere appears to be quite logical and even necessary; when it is necessary, it may be accompanied by the pre-

fix “paleo” (for example, paleoecology, paleobiogeography, paleoclimatology), although this does not change the core process. The biosphere as a medium is inseparable from the appearance of life itself.

(9) The significance of the above-mentioned work by Kafanov (2005) consists in the fact that 40 years after Timofeev–Resovsky and Tyuryukanov (1966), he reverted to the problem of biochorological divisions of the biosphere and thoroughly considered the latter. He returned also to Beklemishev’s geomeride concept, although a comprehensive and deep consideration of the biospheric evolution and the functioning of the biosphere itself were beyond his interests. As was rightly noted by Mirzoyan (2001), the latter represents a basis of global ecology. Beklemishev (1964a, vol. 1) justly considered historical documents such as (1) taxonomic data (independent of any hypotheses), (2) biogeographic (i.e., chorologic) data, and (3) biochronologic data, i.e., data on the distribution of organisms through the geological history of the Earth as being of principal importance for understanding the diversity of organisms and their communities (i.e., the geomeride). The last point is important as the recent chorology of biocoenotic forms of life’s organization on continents and in the World Ocean. I repeat again that the biosphere’s evolution cannot be separated from the paleontological history of life, and the geological record of the latter is not as scarce as it is sometimes thought. This life is manifested in the high level of taxonomic diversity and it demonstrates its different-order paleobiospheric phased patterns, chorological changes in the environmental succession through geological epochs, past ecosystems’ reorganizations and crises, interaction with geospheres of the planet, and other phenomena. This life acts as a phenomenon of the physical life in its geomeride or, I would say, biogeomeride form, not only as the biogeochemical factor of living matter.

Without this paleobiospheric understanding of life on Earth, historical geology, which is based on the basic conception of biostratigraphy, would not have developed; also biochronology, or the concept of geological (biological), not abstract, time, lacking any autonomous scientific content in any standard calibration could not have occurred. Only specific biogeospheric events transfer the sense and course of geological time. Only they represent reference points of geological time. This does not belittle the significance of independent “isotopic time” in geological history. Moreover, only the latter yields the possibility to approach maximally the assessment of age and duration of geological processes. It should be kept in mind that our recent understanding of this metrical tool and its application do not replace stratigraphy as a geological science in the scale of “abstract” geological time. The mappable geological (physical) bodies, including the entire stratosphere with the recorded information in it, their structures, and constituent matter serve as operational notions of geology. Any dynamics of past

geological, geochemical, and biological processes and their formation time itself (chronology) may be reconstructed only on this basis.

(10) Recently, Mirzoyan, a historian of biology, published two new important works: a small book *The History of Global Ecology. Beklemishev’s Conception of a Geomeride* (Mirzoyan, 2007a) and an article *Biological Cognition and the Scientific Image of the World* (Mirzoyan, 2007b). In the first work, the author considers in detail Beklemishev’s studies run by the geomeride conception in its present-day state. In the second work, Mirzoyan addresses the biosphere and geomeride of the geological past justly considering, for example, the Vendian System with its biota as an important Precambrian evolutionary stage of the biosphere. This is, however, the Vendian stage in the evolution of the geomeride of the Earth’s biosphere! In defining the Vendian, the phase of this evolution became substantially more refined. The book “Flourishing of the Animal Kingdom” just published in English by M.A. Fedonkin with colleagues (Fendonkin et al., 2007) and dedicated to myself, Reg Sprigg, and Marie Weide presents for the first time excellent images of the Vendian ediacaran biota now traced through all the continents of the Earth. The Vendian stage separates (and connects) two different-duration periods of the evolution of the geomeride: a longer period (from the initiation of life itself to the Vendian onset) marked by the dominant role of prokaryotic ecosystems and a relatively brief period characterized by the incredible biodiversity of recent ecosystems with distinctly dominant eukaryotic organisms. The relatively brief transitional stage (Vendian System) represents a most topical paleontological problem.

In conclusion, I would like to repeat again that it is not a question of replacing the term “biosphere” by the term “biogeomeride.” These are two different notions and terms that designate two different approaches to the study of life and living matter (Vernadsky discriminated between living matter as the fourth state of substance and biosphere as a life medium). One approach starts from integral living matter, which is an element of the lithosphere, hydrosphere, and structure of the atmosphere; the method of studying it is biochemistry. The other approach starts from a study of the discrete biodiversity of life (taxonomic and biogeocoenotic) and the method of studying it is biological or globally ecological. Life and the biosphere appeared simultaneously. Life could not appear without water, energy from the Sun, and nuclear decay. Indeed, as noted above, we have no justification in correcting Vernadsky. It is only a question of looking at the other side of the coin, i.e., at the living discrete biodiversity in the Earth’s history or biogeomeride (from the Greek *meros*, which means part, share). Beklemishev proposed an excellent term “geomeride,” although the prefix *bio* should be added for clarity. In the paleontological and historical–geological respect, the biogeomeride is the integral biodi-

versity of the Earth within space and time, starting from origin of life, although this topic is outside the scope of this work.

Thoughts about the biogeomeride and the biosphere as a biotope of the highest order appeared to be of great interest to my colleagues, among whom I especially thank E.N. Mirzoyan and M.A. Fedonkin for their attention.

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