

Planetary Bootstrap: A Prelude to Biosphere Phenomenology

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Abstract. This paper deals with systemic status as well as with some phenomenological and evolutionary aspects of biosphere. Biosphere is represented as multilevel autopoietic system in which different organizational levels are nested into each other. The conceptual model of *punctuated epigenesis*, biosphere evolutionary process is suggested, in which endogenous planetary organizational crises play role of evolutionary mechanism, creating novelty. The hypothesis is proposed, that the biosphere reaction on the humankind destructive activity reminds the distributed immune response of biological organism, described by F.Varela in his “cognitive immunology”.

The biosphere evolution is interpreted as the hermeneutical spiral of “Process Being” self-uncovering thus illustrating the historical process of transformation of biosphere as the type of Being in the periods of crises. Some arguments are adduced in favor of biosphere phenomenology development and application of the methods of second-order cybernetics to actual problems of planetary scale.

Keywords: Autopoietic bootstrap, Gaia, biosphere evolution, punctuated epigenesis, Klein bottle, hermeneutic spiral.

1 INTRODUCTION

Though Eduard Seuss had coined the term *biosphere* more than hundred years ago, it is Vernadsky’s concept of the biosphere, formulated in 1926, that is accepted today as the basic one. Biosphere is a specific envelope of the Earth, comprising totality of all living organisms and that part of planet matter which is in constant material exchange with these organisms. Biosphere includes lower part of the atmosphere, hydrosphere and upper levels of lithosphere. Virtually, it is a spherical layer 6-12 km. thick. Life is the geological force. Virtually all geological features at Earth’s surface are bio-influenced. The planetary influence of living matter becomes more extensive with time. The number and rate of chemical elements transformed and the spectrum of chemical reactions engendered by living matter are increasing, so that more parts of Earth are incorporated into biosphere. Life, as Vernadsky viewed it, was a cosmic phenomenon which was to be understood by the same universal laws that applied to physical world. All his life Vernadsky was dreaming about creating the universal biosphere science, comprising not only biogeochemical processes, but also processes, peculiar to noosphere.

Whereas Vernadsky’s work emphasized life as a geological force, English scientist James Lovelock reflected about Earth “geophysiology”: the temperature, alkalinity, acidity, and reactive gases are modulated by life. According to his Gaia hypothesis, put forward in seventies, with the appearance of life, our planet had got self-regulatory, homeostatic properties, inherent to living biological organism. Particularly, aspects of surface temperature and chemistry are being self-supported at constant, comfortable for current life forms value for more than 3.6 billion years [1].

In many relations, latest version of Gaia system reminds latest version of biosphere concept. Conventionally “Gaia” can be used nowadays as a synonym of “biosphere”.

In his work “The Self-Organizing Universe”, E.Jantsch [2] suggested, that Lovelock’s “Gaia” is a multilevel *autopoiesis*, viz., a cyclically organized network of productions (syntheses, transformations, and destructions) of components, that recursively regenerate and support this very network. “Autopoiesis”, a neologism meaning “self-production” was coined by Chilean neurophysiologists and system theorists H.Maturana and F.Varela [3] in

seventies of the last century. It is the name of minimal formal model of life (biological cell), interacting with its environment holistically by adaptive change of structure (“structural coupling”) for the sake of conserving the autopoietic organization. Structurally determined reactions on reciprocal perturbations bring about the co-evolution of the system and its environment. Autopoiesis is now accepted as a theoretical basis of the contemporary cybernetics (the second – order cybernetics [4]), sociology, management and robotics.

E.Jantsch subordinated autopoiesis to the notion of specific self-organization, dissipative regenerative systems and virtually ignored phenomenological aspects of the theory. That gave him possible to classify living cells, organisms, populations, ecosystems as autopoietic systems. The philosophy of radical constructivism and phenomenology of included autopoietic observer are excluded from consideration under assumptions made.

The last two decades were marked by great progress in the development and critical analysis of Gaia theory – geophysiology as well as of the phenomenological aspects of autopoiesis. This work is a reflection on revisions to the autopoietic interpretation of Gaia. The objectives, pursued by these reflections – to pose and try to make more clear some questions concerning biosphere systemic and ontological status; to give conceptual model of biosphere evolution; to make some inferences, concerning human civilization – biosphere relationships and at last, to outline some perspectives of the *biosphere phenomenology*, new science, new interdisciplinary synthesis. This new science is developing beyond cartesian positivistic paradigm. Classical science and coming into being new science are not antagonists, they should complement each other. They have different methods and spheres of application.

2. BIOSPHERE AS AN AUTOPOIETIC – SYMPOIETIC NESTED SYSTEM

Applying the criteria of the autopoietic system, proposed by F.Varela [5], and perfected later by Fleischaker [6], some scientists [7] concluded that Gaia is a real autopoietic system. It should be noted here, that Francisco Varela denied that Gaia is an autopoietic system. He proposed that it is an autonomous system, a system from wider class without regeneration of elements and border.

But, there are problems with this interpretation of biosphere as well with the definition of autopoiesis itself. First, let me pose two questions, concerning interpretation of biosphere as an autopoietic system.

What can we say about biosphere environment? How can we explain Gaia development (epigenesis) as a result of Gaia and cosmos co-evolution through structural coupling?

It is clear, that in many relations biosphere is a self-determining system, and the internal environment, interior milieu is the main source of perturbations, responsible for its development and evolution. How can we coordinate this fact with the role of environment in autopoiesis?

Strictly speaking, autopoietic systems are not evolving in traditional sense. Is it possible to combine evolutionary and autopoietic mechanisms? Classical, pure autopoietic model looks non-productive, non-constructive when applied to biosphere. What to do? The idea of the “multilevel autopoiesis” first suggested by E. Jantsch looks promising, but it should be perfected and corrected. Biosphere can be represented as Russian matryoshka of encloses into each other autopoietic systems of different organizational levels (be it hierarchy or “holarchy”). “Space” between levels is filled by “metasystems” [11] or sympoietic systems [9]. Recently, the idea of “nested autopoietic systems” was proposed by Gunther and Carl Folke [8]. In biosphere we see alternation, interchange of system levels with rigid autonomy, autopoietic organization just as living cell, organism or some modular organisms and system levels with loose, population-like or community-like organizations. The latter are organizationally half-opened, “ajar”, sympoietic, as Beth Dempster names them [9]. These levels play role of buffer between rigid organizational levels, local environments. This flaky structure gives possible to realize multilevel evolutionary process.

In many respects, biosphere is a self-determining system, because the internal medium is the main source of perturbations, responsible for its development and evolution. But, if we accept the cosmological ‘bootstrap’ hypothesis, put forward by Geoffrey Chew [10], the internal and external processes are co-determined (non-locality). In many aspects Gaia is materially closed in contrast to ordinary biological organism. She is a local cosmos, necessary condition of life existence. As F.Varela surmised, the autopoietic organisation can be interpreted as a ‘bootstrap’, or an indefinite recursion. But really, bootstrap is an organisationally closed collective self-production, which cannot be reduced to mathematical recursion. Metaphorically, we can say, that bootstrap is the “structural recursion”.

The physicist Geoffrey Chew [10] developed a ‘bootstrap’ approach to sub-atomic particles in which no particle is to be considered as more fundamental than any other. They do not exist separately. This is not a traditional but instead a collective mode of elemental base. This theory has not been very successful in physics up to latest times, and Chew has tried to apply it at the cosmic scale. Nevertheless, the bootstrap idea in general seems to be applicable in planetary autopoiesis. Revival of some form of bootstrap model in physics is very likely as well.

3. PLANETARY BOOTSTRAP, KLEIN BOTTLE AND MODEL OF PUNCTUATED EPIGENESIS

F.Capra [7] evoked the topological image of the Klein bottle to illustrate bootstrap. In this manifold, which can be constructed in four-dimensional space by pasting together two Mobius bands, the interior and exterior are topologically connected. With the 'bootstrap' hypothesis, 'part' and 'whole', the future and the past are dynamically and reciprocally transmutable. Kent Palmer [11] named such system "holon" (the term, coined by Arthur Koestler). Phenomenologists Merleau – Ponty, Lacan and recently, Steven M. Rosen [12] operated with the same topological model to illustrate subject-object reversibility.

We, humanity are the participator of biosphere evolutionary processes and at the same time, we are the autopoietic, included and moreover, internal observer. So, we are in paradoxical situation, when in general, naive realism of traditional scientific objectivism is of limited applicability (see sections 5 and 6). That does not mean, that the objective models of autopoietic biosphere evolution are not of value at all. Some conceptual models of this sort are outlined in this and in the next two sections.

If we represent planetary autopoietic organization as bootstrap, then the planetary organisation crisis can be interpreted as a breaking of that topological structure in an autopoietic space, when the non-traditional, collective elementarity for a short period of time is changed by the traditional one. This interpretation became a basis of conceptual model of Gaia evolution as **the punctuated epigenesis** [13], [14], [15]. In this conceptual model, the periods of gradual development, occasionally interrupted by structural crises, inevitably lead to organisational crises, characterised by the perturbation of the autopoietic organisation, which brings to the self-construction of a new, superior structural level of the system. Traditionally, biological evolution is understood in darwinian sense as the historical development in succession of replications and reproductions. That is why, Lovelock spoke about "Gaia epigenesis" or individual development. Gaia is developing internally, without reproduction, through periodical organizational self-transformations ("transfigurations"). It looks as new form of open-ended organizational non-darwinian evolution of the autopoietic system with darwinian-like processes in its parts. The evolutionary process can be represented as transformation of closed topological manifold. It is not just a useful metaphor, but a prelude to the theory, based on topological interpretation of autopoiesis.

Just as E.Jantsch, we represent Gaia (or biosphere) as a multilevel autopoiesis. Every essential symbiogenesis not only adds new basic structural elements to her, but brings about new symmetric macro-level systems. So, every symbiogenesis (Jantsch extrapolates this concept on physical systems) brings to symmetry break which play role of ratchet, responsible for unidirectional character of biosphere evolution. This evolution can be represented as a gradual process of self-harmonization, bootstrap, organizational closeness perfection. This process reaches its peak, then eventually fails and brings to destabilization of biosphere organization and construction of a new, more complex one. Crisis begins with rising of promising basic element of new type. Then we observe expansion of this new structure, generation of new autopoietic levels with the accumulation of actual biogeodiversity. But all this ends with contradictions on microlevel, provoked by inevitable disbalance on micro-and macrolevel, followed by global crisis and transformation of autopoietic organization. Thus, the notorious Klein bottle of planetary bootstrap system is disturbed and then transformed into Klein multilevel hyper-bottle. Such global reconstruction took place only ones in the period of Cambrian explosion, about 550 million years ago.

All the previous levels and elements of biosphere system organization are not eliminated in the course of biosphere evolution. They now play role of genotype, distributed memory. Strictly speaking, biosphere (Gaia) does not evolve in traditional neo-darwinian sense of unidirectional "open-ended" process of linear progressive gradual development. This is a historical non – Markovian process of development with fortuitous bootstrapping, when a sort of dialogue, moreover, transmutation of whole and parts, observer and observed does occur. Vivid metaphor of this process – circular path in topologically closed manifold such as Klein bottle. The emergency of new biological species is always a result of "negotiations" of parts and whole. In periods between crises we can speak about unidirectional evolution or perfection of anticipatory properties of biosphere, of this multilevel autopoietic (or autonomous by F.Varela) system.

4. GAIA IMMUNITY AND HOMOSPHERE

With the appearance of Homo sapiens, biosphere has given rise to the "homosphere" (term coined by H.Maturana), including human society. Homosphere separated itself from biosphere and really became a parasitic and an autonomous reflexive self-determining episystem. Its developmental rate is fantastic. It manipulates the biosphere for the sake of short-sighted egoistic interests, thereby destroying the basis of its own biological existence. From the conventional point of view, the crisis in the relationships between human society and biosphere can be interpreted as lack of mutual understanding, host and the parasite co-adaptation failure. The contrasting hypothesis is

proposed [14], [15], that Gaia's answer on human activity is similar to the immune response of a biological organism on invasion, described by F.Varela in his "cognitive immunology" [5]. The first, pessimistic for us and most realistic scenario of this system evolution is the human population extinction or at least, its substantial reduction. If social consciousness will not radically change in this century, our thoughtless planetary activity can trigger global deregulation and cause a sort of autoimmune disease, self-amplified deregulation of Gaia system.

The second, optimistic scenario is the emergence of new macro-symbiosis of humanity and biosphere. This process will bring us to a new autopoietic or autogeneous [16] planetary system (new homosphere). The realization of this scenario will demand radical transformation of social and individual consciousness and global economy reorganization. There is a serious doubt that this symbiosis can be reached only by the development of manipulative abilities of humankind. Stephen J. Gould [17] is right, when he states, that we are living in the age of bacteria. J.E.Stewart [18] speculates about new mechanism of biosphere evolution through internal manipulation, bacteria and other organisms purposeful engineering. So, he imagines Humanity as the self - determining monster. The well-known picture "The Autumn Cannibalism" by Salvador Dali is only an insipid story of this nightmare. There are some serious arguments against this perspective. It is much more easy to change his mind and control egoistic interests, than to change the whole basis of our life, bio-cosmos, organized by bacteria and viruses. Physicist David Bohm [19] spoke about "proprioceptive thought", a meditative act in which consciousness becomes aware of its implicate activity. We should overcome this hard period of fragmentation in our history and attain wholeness.

Steven Rosen is inspired by old oriental wisdom, that wholeness is to be realized only through paradox, and what is more, this paradox should be embodied. He came to conclusion, that Klein Bottle in four-dimensional space is the best topological model of paradox embodiment [12]. Phenomenology of consciousness is in the center of attention of system theorists now.

5. THE HERMENEUTIC SPIRAL OF PROCESS BEING SELF - UNCOVERING

In terms of existential phenomenology of Heidegger, the ontological aspect of Earth evolution can be represented as the process of biosphere, this meta-ontic level of Being "the self-uncovering". There are attempts to interpret this uncovering as a hermeneutic spiral [20] thus illustrating the historical process of its transformation as the type of Being in the periods of crises. It is a sort of existential phenomenology applied to the biosphere along traditions in European philosophy of last century formed by Heidegger, Sartre, Merleau-Ponty et al. The 'non-locality' on this existential level comes as a result of the inadequacy of the ontical model (the level of concrete being) of meta-ontical.

'Self - revealing of Being' (the process of its transmutation from the state of concealment to the state of unconcealment or 'aletheia' in Heideggerian interpretation of ancient Greek term) is not a deterministic, Markov-like process. The autopoietic Gaian stage cannot be determined or produced by only the previous, allopoietic stage. It is the non-local process of "cosmic quantum" reduction as well. Humankind cannot produce *per se* the autopoietic planetary system, autopoietic homosphere by conscious planned activity. The robotosphere will never be autopoietic. But, humankind, producing artifacts and merging with them, is self-transforming to a new reality, new type of Being, called by K.Palmer [11] as "Hyper Being". The Being of his new type of artifacts are classified by K.Palmer as "in-hand" thus extending the heideggerian "present - at hand" of "Static Being" (non-live entity) and "ready - to hand" of "Process Being" (living systems and autopoietic systems, including Gaia).

Gaia, the 'planetary autopoiesis' or 'bootstrap' could only appear on the stage of the cosmic bootstrap. The cosmos as a whole is responsible for its emergence. So, the global crises, which are responsible for the evolution of our planet's autopoietic organisation, are the periods of structural coupling of Gaia with 'Cosmos'. In the period of a crisis, the "cognitive domain" of Gaia (in terms of autopoietic theory) extends to the cosmic scale. So, the internal, sub-atomic Gaian bootstrap, and the cosmic-scale bootstrap are related. Gaia can be viewed as a virtual particle, bootstrapping onto 'Cosmos'. She is a local cosmos, type of Being, background for all future emergent states and forms. But she can do nothing but to demonstrate the readiness of the universe or the multiverse to accept man such as he is. Thus, according to this hypothesis, the traditional scientific approach to the Gaia evolution is of limited applicability. This is true for the proposed "objective" model of Gaia immunology as well. The modelling of Gaian evolution (embodiment) in the cosmos can be based only on the non-local approach and needs a new technique and epistemology.

6. AUTOPOIETIC META -THEORY: GAIA AS HOLON

In its turn, true role of humankind in Gaia evolution and formation of harmonious homosphere cannot be understood only from the classical scientific position. We are now in a situation of included observer. The classical autopoietic theory in its phenomenological part (the autopoietic observer) is controversial and paradoxical, what makes it non-science in traditional sense. But, thirty years of discussions were conducive to development of new meta-systemic theory and rationalistic approach to ontological monism of neo-heideggerian sort.

Kent Palmer [11], trying to surmount contradictions of classical autopoietic theory is developing Autopoietic Metatheory and Reflexive Autopoietic Systems Theory. He had to operate with paradoxicality and suprarationality, applying Indian Vajra logic, apparatus of hypercomplex numbers, Spencer-Brown Logic of distinctions, modified by F.Varela and his colleagues for analysis of logically circular structures and processes. Gaia is classified as *holon*, special environment, in which whole is equal to the sum of its parts and which realizes autopoietic bootstrap. The topology of Klein bottle and hyper-bottle is constituent part of this meta-theory. He can only speculate about emerging of Reflexive Autopoietic System, autopoietic homosphere. Subject and object in the autopoietic homosphere are paradoxically dynamically related and form a wholeness on meta-systemic level. It is becoming clearer, that spiritual and mental aspects of our existence are becoming the main forces in the Earth evolution.

7. CONCLUSIONS

There are new vistas in development of “neo-autopoietic” view of biosphere. For example, biosphere can be represented as a multi-layer “nested” autopoietic – sympoietic system having structure of Russian matryoshka with alternating autopoietic and sympoietic organizational levels.

Conceptual model of biosphere evolution, “the punctuated epigenesis” is proposed. According to this model, biosphere multi-layer organization is transforming in the periods of organizational crises. Particularly, the evolution of biosphere anticipatory properties furnish the clue to understanding the mystery of biosphere permanent evolvability development.

As far as biosphere have features of autonomous system of biological type, it is quite possible, that our planet’s reaction on destructive activity of human civilization will be systemic, holistic and will remind immune response of biological system, described F.Varela in his cognitive immunology.

But new vistas concerns not only objective scientific models of biosphere as multi-level self-productive system, used for the forecasting of the ecological crises, and possibly, for manipulation with it. We should realize, that humanity is in position of internal, autopoietic, included observer. Classical science can give only fragmental pictures of the different aspects of this situation. We are only on the threshold of the biosphere existential phenomenology construction. The apparatus of second-order and perspectives of third-order cybernetics, self-closed manifolds topology, as well as the theory of hypercomplex numbers applied to solving problem of consciousness embodiment seems provide a promising start. These developments looks like non-scientific, metaphysical, because they use metaphora, but it is an inevitable phase. New metaphysics will inevitably form new physics.

The new approach could be a basis of the homosphere – biosphere relationship problem understanding and resolution. It is mainly a humanitarian problem, but there is gap between traditional humanitarian sciences and natural sciences. New science should fill this gap.

Traditional science still stay and will ever be an effective, absolutely necessary and useful instrument of our practice, modelling and theory. But there are spheres, where naive realism fails. Traditional and arising “non-cartesian” science are complementary.

Predominance of positivistic, so-called traditional scientific worldview now threaten our civilization, our existence on the Earth. We need in “naturalized phenomenology” [21] to form new worldview, to solve problem of fragmentation and alienation of nature in our consciousness. Model of consciousness, which is being developed in frameworks of the new phenomenology is just one more endeavour to overcome fragmentation, to form new science and to come to a new harmony on the Earth.

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