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Biosphere as semiosphere: Variations on Lotman[1]

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Abstract. The analogy between semiosphere (world of cultures) and biosphere (world of life), coined by J. Lotman, is a courageous attempt to interconnect two seemingly incompatible worlds. In congruence with his view, I would like to convince the reader that the only possible general definition of life is "a system born, endowed with semiosis, with history". Such a view requires considering biosphere and semiosphere as coextensive, which requires merging the cultural, scientific, historical, and linguistic approaches into a coherent whole.[2]

Keywords: biosphere, semiosphere, texts and interpretation, lineages as cultures, ontogenesis

> In general terms we can say that the structure of symbols of a particular culture shapes the system which is isomorphic and isofunctional to the genetic memory of an individual. (Lotman 1990: 111)

> An intrinsic contrast of any living culture resides in a struggle to maximize the tendency towards its structuration, and an unavoidable consequence of such a trend – automatism. (Lotman, Uspenskij 2010[1971]: 485)[3]

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[2] Based on the presentation at the Tartu Summer Scool of Semiotics, Kääriku, Estonia, 18–23 August 2013.

[3] *Противоречие между постоянным стремлением довести системность до предела и постоянной же борьбой с порождаемыми в результате этого автоматизмом структуры внутренне, органически присуще всякой живой культуре*. Lotman, Uspenskij 2010[1971]: 485–503 (translation mine, A.M.).

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1. Two introductory remarks

It is an inevitable consequence of a life-long activity of great personalities that their favourite concepts often evolve considerably in the flow of decades. A reader of the collected works, then, notices many inconsistencies, even contradictions when reading through such a volume.

1.1. This is also the case of the concept of 'text' in Juri Lotman's oeuvres (he readily accepts the fact: see, e.g. the very first sentence in Lotman 2009). A naive reader will often and urgently ask the question: "Well, what is *not* a text, then"? Out of the eight meanings of the word, as contained in the comprehensive dictionary of Lotmanian terms (Levchenko, Salupere 1999), the entry "Text II" comes closest to my understanding. In this essay I will use the term exclusively in the sense of a linear string (sequence) of alphabetical (i.e. digital) characters that is accessible to extraction of meaning when read by a speaker of some natural language. It should be understood that a text is *not* a material entity, as absolute digitality cannot be attained in the material world; rather a text is an "avatar" embodied in an appearance of, e.g. book or CD.[4]

It follows also that I shall not consider scripts written in artificial languages as *sensu stricto* texts, neither do I comprehend spoken utterances as such. All multifarious Lotmanian usages of the word 'text' should be replaced by words like 'artefacts', 'appearance', 'self-presentation', 'likeness', etc. The distinction will help to expand my reception of Lotman to the sphere of living beings as dwellers and/or builders of the biosphere-which-is-semiosphere. (For a different approach to the concept of 'text' see Kull 2002; he is much closer to other Lotmanian usages than I am.)

1.2. My second comment concerns important "just so" remarks often made *en passant* in some marginal text. Such is – at least to my knowledge – Lotman's pansemiotic belief expressed in a letter to B. A. Uspenskij, dated March 19, 1982:

> [At one occasion] I dared to express my conviction that a text [in its broadest sense, see above] can exist only when preceded by some other text; that any developed culture should be preceded by an advanced culture. Now I learn from Vernadskij […] that life can be born only from life, i.e. if it is preceded by [some other form of] life. He concludes: science can be built only on facts that can be observed and/or reconstructed. Nowhere in the universe has the turn of non-life into life been observed; neither can it be reconstructed. […] Hence, all hypotheses

[4] In this respect, I disagree with Hoffmeyer and Emmeche 2005 who envisage both digital and cultural codes as situated in material world. For details, see, e.g. Markoš, Faltýnek 2009; 2015.

> concerning origins of life come out as mere speculations. […] A message becomes a message only if preceded by a semiotic sphere. Solely the existence of reason [*разум*] explains the existence of reason.[5] (Lotman 2010: 683–684, translation mine, A.M.)

I give this example in order to stress that similar pansemiotic statements can be found in works of many other authors working in semiotics or cosmology (e.g. Peirce, Hoffmeyer, Jantsch, Ruyer, etc.). Hence the idea of a universe endowed with meaning and giving birth to all its appearances is tempting. It will, however, blur the difference between life and non-life (and consequently, culture and non-culture as well[6]). I therefore prefer the distinction between life and non-life. In this treatise, however, I am not going to discuss the singularity of life's origin; for the sake of the argument I shall maintain with Lotman that life (which is culture, as I will argue) can be born exclusively from the living (for more details, see Markoš *forthcoming*, 2015).

2. Lineages as cultures

I espouse the notion of cultural properties of organismal lineages, species, and ecosystems, as opposed the genocentric[7] view of evolution. In 2002, I came up with the following analogy:

> How many cultures have arisen based on different interpretations of a single canonical text – the Bible? We will find no difficulties here, because, along with the text, people (or peoples) also transmit the way to interpret it. But who is the interpreter in a biological species? In addition to the canonical text – two

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[5] *[Я однажды] осмелился вслух высказать свое убеждение в том, что текст может существовать (т.е. быть социально осознан как текст), если ему предшествовал другой текст, и что любой развитой культуре должна была предшествовать развитая культура. И вот сейчас я обнаружил у Вернадского ... что жизнь может возникнуть только из живого, т.е. если ей предшествует жизнь. Он рассуждает так: наука может основываться лишь на фактах, наблюдаемых или реконструируемых. Момент превращения не-жизни в жизнь нигде во Вселенной не наблюдается и не реконструируется. [...] А все гипотезы о происхождении жизни – спекуляции. [...] Только предшествие семиотической сферы делает сообщение сообщением. Только существование разума объясняет существование разума.*

[6] This happens to Lotman who explains how a culture differentiates between 'inside' and 'outside', just to admit that as soon as an item is being recognized in the outer world, it becomes semiotized hence becomes internal.

[7] The "genocentric belief" takes for granted that genes are represented by linear strings of bases in DNA; whatever the appearance of a living being may be, it is a function of the DNA script – understood as programs controlling all, or almost all, traits.

> versions of genome inherited from our parents [containing inscriptions of genetic texts] – we also inherit a small but very important piece of body: the egg cell. […] The fertilized egg manipulates the genetic text according to rules inherited from countless generations of its predecessors. Driven by this tradition it builds the specific morphology.[8] I maintain that a species can be understood as a culture; it follows that the emergence of new species may equally be a matter of the mutation of the text (DNA) and/or changes in the rules for manipulating it. (Markoš 2002: 42)

Inspired by the Distributed Language Group (e.g., Cowley 2012) and by the work of Rappaport (2010), our group developed the view further and speculate that the interpretative capacity of species-cultures highly surpasses (as to their informational content) the genetic script stored in DNA (Markoš *et al.* 2013). This brings us closer to views of the Tartu School, as I hope to explain below. To proceed, I shall first give explanations on (1) how a newborn individual becomes coupled to the (pre)existing biosphere/semiosphere; and (2) how current views on evolution fit into the picture.

2.1. Two-phase development (ontogenesis)

For multicellular organisms (most living beings on our planet) we propose the "indoctrination" of newborn individual into the actual state of affairs in the population, ecosystem, biosphere – by parents and other dwellers of its surrounding, plus, of course, by the reigning physical conditions. Actually, the process is biphasic (see Pátková *et al*. 2012). In the first phase the mother organism goes into great pains to insulate its germs (zygotes, spores, and early embryo they give rise to) from the rest of biosphere (by developing sophisticated envelopes like, e.g. egg-shells). The newly-emerging organism, thus, can be considered to be a reader of its genetic text(s) according to hermeneutic instructions provided by its mother (in some lineages, e.g. mammals or seed plants, the mother organism retains its exclusive access even in this phase). As soon as the threshold of organogenesis has been attained, a drastic turn occurs: the "germ-free" and "solipsistic" individual becomes "contaminated", and it starts actively establishing multiple links to its kin as well as to the rest of biosphere/semiosphere, and with the world beyond its borders. From this point on, the individual becomes a member of its culture, learns (and is introduced to) its contexts.[9] Its unique genetic

[8] Instead of 'morphology', today I would use 'appearance', 'likeness', 'form'. I maintain that words like 'biology', 'psychology' 'morphology', etc., denote special sciences developed for modelling manifestations of life, but not appearances of life themselves. See Markoš *et al*. 2009.

[9] At the first sight the model resembles that developed by M. Barbieri 2003; here, the "solipsistic" phase regulated by *organic codes* is followed by reconstruction of *organic memory*, that is *not* explicitly written in the genome – it only provides the rules for such a reconstruction. Note, however, that the reconstruction as proposed by Barbieri draws on internal resources and does not presume community links.

endowment, and its unique bodily structure is confronted with, and interpreted according to, the actual contexts of the biosphere/semiosphere – it follows that the final appearance (the "phenotype") of a newcomer is not determined but negotiated by its "cultural" milieu.

Uniqueness of instructions for the proper (i.e. species-specific) reading of genetic script becomes apparent when one realizes that the script is quite universal; i.e. not its "wording" but interpretation (by the body of the cell and embryo) is crucial for early morphogenetic processes. The importance of linking to the world can be demonstrated on the sorry state of animals or plants artificially kept in a germ-free and/or gnotobiotic states.[10]

2.2. Plasticity and elasticity

After Darwin, most biologists accepted that evolution is a process not deterministic, but historical: as in human historiography, trends can be revealed only *ex post* (and may differ from the points of view of different historians, social groups, or nations), but cannot be predicted from our knowledge of past and present events. Darwin's view of evolution as a smooth, gradual change proceeding by infinitesimal steps in successive generations, however, received only minimal support from paleontology. Fossil records usually witness abrupt appearance of new life-forms that subsequently last for longer period, finally to get extinct. To reconcile theory with paleontological data, different versions of *punctuated evolution* were suggested, in the frames of the Darwinian paradigm.

Here I am outlining one version of such a theory, developed by J. Flegr and dubbed "frozen evolution" (Flegr 2008; 2010; 2013). Flegr argues that lineages of organisms (populations, species, and even higher taxons) go through two phases of evolution. The first, *plastic* phase is typical of the founder population in its beginnings; the population is apt to embark on a plethora of trajectories that meet the requirements of the environment. In the later phase (comprising 98% of the lifetime of the lineage), however, it becomes *frozen* and only "unwillingly" moves away from its equilibrium when forced by the environment. As soon as such a forcing ceases, the population returns to the norm. In other words, no trajectories into new morphospace appear in the frozen state any more. Natural selection is inefficient, and the population (species) thrives unchanged (often as marginal) under changing conditions, until it gets a last kick when conditions become incompatible with its survival. Only on rare occasions may parts of such a population re-enter the plastic phase and start a new round of evolution. The model is genocentric, and Flegr explains its working in frames of

[10] An organism is an ecosystem of hundreds of symbionts. Artificially, the newly developing animal fetus may be kept under absolutely sterile, i.e. germ-free conditions, or it can be grown in a state of gnotobiosis, in the presence of only one or a small number of symbionts.

neo-Darwinian paradigm. In the first phase, the population is small and its genetic heterogeneity is limited; any mutation has a chance to get amplified, to influence the body parametres (phenotype), and to get selected by natural selection. As the population grows in numbers (both of individuals and genetic heterogeneity), the web of gene interactions (epistasis, polygenic inheritance, etc.) becomes more and more complicated, any mutation and any effect from the environment would be probably buffered ("frozen"), without any effect on the overall appearance of its members.

The scenario, however, may hold even beyond the frames of genocentric explanation. For example, E. Danchin 2013 argues that "written", textual genetic information (i.e. that stored in DNA as a genetic script) may explain only several percent of trait variation in a species; the rest relying on other resources, like epigenetic recording, outlasting cellular structures, "ritualized" processes of development and/or behaviour, even fashion. In short, we are dealing with cultural processes isomorphic – and developing in similar ways – as described in cultural sciences.

In my opinion, the potential of the species' appearances goes far beyond what that appearance reveals at a given period. Evolution is dependent not only on random errancy of script transcription: most of its potential goes beyond it. This brings us to the Tartu School. "In the center there is situated a certain normal 'we', to which other peoples are opposed as a paradigmatic set of anomalies", we read in the 1973 *Theses* (Uspenskij *et al.* 1973a, Thesis 1.2.4; Russian original 1973b). To what extent could this statement be broadened from peoples and their cultures to the whole realm of the living: is it allowed to replace 'peoples' by concepts like 'species', 'lineage', 'community', 'ecosystem', even 'biosphere'? Do such formations exist in the world, or do they represent merely our abstractions? If they do exist, are they entitled to say "we"?

3. Stasis and turn

S. Kauffman in his *Investigations* devoted to the evolution of biospheres, coins a following conjecture: "Our, and any, biosphere, expands the dimensionality of its Adjacent Possible [i.e. immediate future], on average, as rapidly as it can" (Kauffman 2000: 175). His biospheres-econospheres develop according to self-organized criticality models: they proceed in time smoothly, but their evolution is punctuated by *complexity catastrophes* – avalanches of small or big disturbances generated from inside the system that cannot be predicted as to both their size and onset. The word "catastrophe" is used in its original meaning – a sudden turn in behaviour of the system, not necessarily destructive (a *felix culpa*). In whatever phase of its evolution, however, the biosphere-econosphere-semiosphere should be resilient enough to avoid a "bonfire", a magnificent, but *explosive* self-destruction. This brings us to Lotman and his views of cultural evolution in his book *Culture and Explosion* (Lotman 2009[1992])

and other treatises. He is, in my opinion, similar to Kauffman, but for the word "explosion" (*взрыв*); what he is describing are indeed rather catastrophes or turns. Otherwise I find many isomorphisms with the views presented above. Culture as its own "entry", a generator of knowledge "from inside" (e.g. Lotman 1989), building its semiosphere (an upgraded version of umwelt perhaps that *can* and *does* evolve).

4. Living?

Below, I am proposing three triads that will help understanding the nature of life and its contrast with the non-living:
(1) causality – code – semiosis;
(2) creation – emergence – birth;
(3) duration – deterministic evolution – history.
It has been notoriously known that none of the many definitions of life is satisfactory, and if a list of properties is provided instead, one may never be sure if it is complete. I suggest but a game with nine words: the first group defines "achievements" of complex systems, the second reflects their coming into being, and the third their behaviour in time.

4.1. Complex systems

4.1.1. The first – "metabolic" phase of the development of biology as a science was driven by the well-known slogan "nothing but physics and chemistry" and by the concept of "mechanism". This "nothing but" was, I suspect, a remnant of old encounters with vitalists; after all, nobody denied ultrastructural requirements that could not be created "from scratch" on the lab bench. ("Mechanism" is even older, a euphemism for Cartesian "machine", I suspect.)

"Deterministic and canalized set of chemical reactions explainable by physics and chemistry" may be the right formulation of the metabolic phase of biology. Chemical composition, structure and ultrastructure ("contraptions"), and metabolism were key topics of study. With the onset of cybernetics, biology absorbed also the notion of regulation and feedback flows. This phase ended with a Heracleitan view of life as a *steady state*: everything is in a flow, in a permanent change, just to remain the same. Note that cyclic processes remain in the centre of attention: to describe acyclic events like ontogenesis by means of equilibrium thermodynamics is not an easy task.

Most of contemporary biology, physiology, ethology, and medicine are the result of this phase that ended roughly in the 1970s.

4.1.2. The discovery of biological codes marked a new chapter. A code cannot be derived from physics – it is a product of a *convention* (a term coined by M. Barbieri; see, e.g. 2003), a (final) set of rules how to translate information from one set of inscription into another one. A paradigmatic example is, of course, the genetic code, but see Barbieri's book (plus many papers on the topic published by him especially in the journal *Biosemiotics*) for more examples. The code, then, is a necessary precondition for life. However, the same period (1950s–1970s) also marked the onset of the computer age; with programmable *machines* we were again left with a dilemma: either living beings are "nothing but" analogies of computers, or computers are alive as we are (later on, they will perhaps also think with their silicon minds and outcompete us in evolutionary struggle). In short, existence of code is not a satisfactory precondition for distinguishing life from non-life. Moreover, recent achievements in epigenetics show that codes may not be as "frozen" as was considered by the founders of molecular biology. The rules employed, e.g., in ontogenesis, may develop in the flow of generations, and display many "dialects" in different lineages (Markoš, Švorcová 2009; Švorcová 2012).

But biology succeeded to accomplish a very important trick: in spite of the fact that codes are not deducible from physics, it turned out that code-driven systems can easily be studied by procedures of natural sciences: as to methods, paragraph 4.1.1 and 4.1.2 can merge into one. The code biology, even if not a natural science, *can* be studied by methods of natural sciences (a similar example is, e.g., econophysics). Such an approach gave rise to molecular biology, neurophysiology, code biology, and many theories of mind and behaviour.

4.1.3. Semiosis, the ability of interpretation based in memory, history, experience and context resists reduction into a set of simple rules and code tables – therefore it cannot be subject of sciences. Biosemiotics, then, when and if stating that life and semiosis are coextensive, must draw inspiration from humanities, with three types of danger: (1) its exploration will leave the safe territory of biology, facing once again (2) allegations of vitalism from biologists. Moreover, (3) semiotics proper, as almost exclusively human-oriented activity, will become very suspicious against statements of semiotic achievements of plants or even bacteria. What is most important here, however, semiotic beings work with texts (both in their narrow definition as strings of characters, as well as texts in a Lotmanian sense); the text necessarily is code-based, but its message is not known: it should be deciphered, reconstructed,[11] or even created

[11] *Меняется соотношение текста и кода (языка). Осознавая некоторый объект как текст, мы тем самым предполагаем, что он каким-то образом закодирован, презумпция координованности входит в понятие текста. Однако сам этот код нам неизвестен – его еще предстоит реконструировать, основываясь на данном нам тексте.* (Lotman 2009: 312)

anew[12] in a new cultural, historical, religious, or language constellation, often with an open end...

Biologists should draw inspiration from modern semiotics (U. Eco, J. Deely, J. Lotman) and hermeneutics (M. Heidegger, H.-G. Gadamer) but, at the same time, avoid being driven into problems concerning exclusively (adult and literate) humans. It is, surprisingly, not a trivial task to define such exclusive areas having no (at least primitive) counterparts elsewhere.

4.2. Coming into existence

The problem has been discussed since the beginning of our culture – see, e.g. the *fysis* of ancient Greeks, or *creatio ex nihilo* in scholastic Christianity. For our purposes, I suggest three alternatives for how complex systems can arise:

4.2.1. Creation, i.e. bringing to existence by God or by a craftsman, be it a human engineer (e.g. computers) or some other living being (e.g. anthills). In any case, the forming agency, as well as the plan (recipe) comes from outside of the system; *the system is passive towards its designer*.

4.2.2. Emergence is a process creating complex systems spontaneously, "out of nothing", from a singularity in some unstructured homogeneous system, and repeatedly under specific conditions. Examples: growth of crystals, flames, stars, gyres, tornadoes, etc. The above-mentioned homogeneous primordium should be situated in a steep gradient of energy; the rules how such a *dissipative structure* develops are, however, internal, no external designer is necessary. The dissipative structure may have a very long lifespan (stars, galaxies) but they lack memory different from the structure itself; of course, as they emerge from a singularity, no memory of previous cases is available, either. As they come up in many exemplars, their structure and development can be studied and described scientifically.

4.2.3. For our investigation the most interesting is the third group of complex systems – let us call them *cultures* – that will not emerge from scratch but must be *born* from some pre-existing structure of similar complexity; such are human civilizations, languages, religions, cultures, fashions, and even living beings (see the Introductory remark). Thanks to the existence of codes (often preserved and copied as texts), as well as memory and trans-generational transmission of experience (Švorcová 2012), the systems are able to accumulate knowledge, absorb novelty, and develop new ways

[12] *В общей системе культуры тексты выполняют по крайней мере две основные функции: адекватную передачу значений и порождение новых смыслов.* (Lotman 2009: 313)

of existence. As also mentioned in the Introduction, origins of such systems are lost deep in the past and cannot be studied effectively – (historical) narrations are more appropriate here than scientific descriptions.

While dissipative structures *emerge* from singularities, cultures are *born* from pluralities.

4.3. Time-course

The third group of concepts concerns behaviour of our systems in time, along the arrow of time going from the past to future.

4.3.1. The simplest form is a simple standstill, duration while "doing nothing". The flow of time can be recorded only by the trend to higher entropy, i.e. wearing away; at maximum entropy attainable, in equilibrium, time disappears.

4.3.2. Systems with deterministic, predictable evolution (calculable or statistically decipherable). Such is the evolution of stars or, say, diseases, but also ontogenesis of many forms of life (with a predominant "solipsist" phase of development, see above, 2.1). If codes are involved, they remain constant, or elicit very slow changes in time.

4.3.3. Most interesting from our point of view will be systems capable of semiosis, i.e. systems which – besides memory, experience, and ways of handling things are endowed with the ability of re-interpreting their own past, i.e. "re-tell" their history according to present settings. Here belong systems which are born (4.2.3) and bear the memory of countless generations; in fact, living beings only, with their genuine history-which-is-evolution. Of course, language, culture, arts, etc. are also born from life, so they belong here too. Obviously, such systems cannot be studied in the frame of sciences.

4.4. What is life?

Our working definition may be "*a system born, endowed with semiosis, with history*", very similar, if not identical, with that suggested by Kull *et al.* (2009). Of course, such a definition is incomplete again and raising many questions. Why doesn't it encompass metabolism, ability of work, reproduction, why not questions of form, bodyness? Why not thermodynamic approaches? What about origins of life? All such doubts deserve attention and should be further elaborated. Yet I suggest the above working definition is the most general one, does not apply to the non-living world, and does include all living beings, including humans with their language and culture.

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Биосфера как семиосфера: вариации на тему Лотмана

Приведенная Юрием Лотманом аналогия между семиосферой («миром культуры») и биосферой («миром живого») является дерзкой попыткой связать между собой на первый взгляд несовместимое. На основе идей Лотмана автор предлагает единственно возможное общее определение жизни: «рожденная система, которая обладает семиозисом и историей». Такая точка зрения требует, чтобы семио- и биосферу считали существующими одновременно, это предполагает соединение культурологического, научного, исторического и лингвистического подходов в единое целое.

Biosfäär kui semiosfäär. Variatsioone Lotmani teemadel

Juri Lotmani poolt loodud analoogia semiosfääri (kultuuride maailma) ja biosfääri (elumaailma) vahel on vapper katse siduda omavahel kaht näiliselt kokkusobimatut maailma. Kooskõlas tema vaadetega tahaksin lugejat veenda, et elu ainuke võimalik ülddefinitsioon on „sündinud süsteem, mis omab semioosi ja ajalugu". See seisukoht nõuab, et biosfääri ja semiosfääri peetaks üheaegselt eksisteerivateks, mis nõuab kultuurilise, teadusliku, ajaloolise ja lingvistilise lähenemise liitmist koherentseks tervikuks.