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Pathfinding: Macroecology as a Social Science

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Abstract

By the last socioeconomic crisis of 2009, it became clear that the present path of world development is not sustainable in the longer term, even if we recognize the enormous potentials of the market and technological innovation. New ideas and strategies will be needed to ensure that improved living conditions and opportunities for a growing population across the world can be reconciled with the preservation of viable living conditions for this species – or, in other words, with enlarging of the carrying capacity of the human biotope. An 'Ecosystem evolution' approach offers a vision and path for understanding human social world development and for finding new pathways for social development.

Keywords: *world development, ecology, natural selection.*

A Fundamental Law of Evolution

Pross *et al*. (2011) affirm that the laws of natural selection – the authors call them Darwinian natural selection laws – determine the development of the inanimate world as well. The authors reformulate Darwinian Theory in physico-chemical terms so that it can accommodate both animate and inanimate systems, thereby helping to bridge this scientific divide. This extended formulation is based on the recently proposed concept of dynamic kinetic stability and data from the newly emerging area of systems chemistry. The analysis leads one to the conclusion that *abiogenesis* and *evolution*, rather than manifesting *two* discrete stages in the emergence of complex life, actually constitute *one* single physical-chemical process. The authors conclude that one can therefore say that *biological natural selection* emulates *chemical kinetic selection.*

Further on the authors conclude that 'the process of complication' (this pattern is observed in both biological and chemical evolution), can also be understood as a kinetic phenomenon. It is at the chemical level, where the transformation of a simple molecular replicator to an autocatalytic network of minimal complexity can be examined directly, that the kinetic advantage of the network over the single replicator appears to manifest itself. As for the Darwinian concept, it lies in the system's stability, as *biological natural selection* emulates *chemical kinetic selection*, *i.e.* biology is reduced to chemistry for this most fundamental of biological phenomena.

As for what is the subject of this selection – it turns out that the answer can be found in the system's stability. This kind of stability is termed *dynamic kinetic stability* (*Ibid*.). Thus, the dynamic equilibrum of system in homeostasis is a property of a system in which variables are regulated so that internal conditions remain stable and relatively constant. Homeosthasis in the complex system is possible as a result of adjustment and regulation mechanisms via numerous feedback loops. This feedback maintains the system in a state of dynamic equilibrium.

The fundamental law of evolution, or the process of a system's complication, can be observed in any kind of evolution, both chemical and biological. If this main law of evolution is applied to human social evolution, *i.e*. at a new level of complexity of interacting individuals forming social agglomerations or organizations, we meet the Darwin selection laws again, but at the level of free energy or exergy production. Exergy is the energy which is available to be used for other work but self-sustaining. The examination of long-term changes in socio-economic indicators together with a comparative analysis of historical and contemporary events allows experimental evaluation of their influence.

In this paper the authors will define the process of sustaining system's dynamic kinetic stability as 'Darwinian selection'. This process leads to gradual increase of the level of system's complexity. Periodically it comes up in major transitions in evolution (Maynard Smith and Szathmary 1995) or so-called phase transformation (Kapitza 2006).

Biosphere of Interrelated Ecosystems: Biosphere as a Cybernetic System

Anything around us belongs to the material world. Hence everything is affected by axiomatic laws of the material words, *i.e.* the 1st and the 2nd laws of thermodynamics, laws of stoichiometry, the laws of natural selection and the so-called Darwinian selection laws, together with a set of other physical and chemistry laws that determine the energy and matter circulation within material multicomponent systems. Components of this material world are unanimated and animated. The animated components are living organisms. They are proliferating and consuming for their development energy and matter. Hence the system which contains such components inevitably is energy-consuming and developing. In order to adjust to these material conditions, and to enlarge the volume of energy accessible for that proliferation, living organisms cooperate and form systems of the next levels of complexity, starting from forming multicellular colonies with their further diversification and real multicellular organism formation. At the level of individual biological organisms, they interact and form communities. These communities, in conjunction with the nonliving components of their environment such as air, water and mineral soil, form ecosystems.

Big History can offer insights into these systems. It is an emerging academic discipline which examines history from the Big Bang to the present, studying the material laws of the Universe's development, *i.e.* the Flows of Energy organizing the various levels of complexity.

In this article, we advance an explanatory scheme for all of history from the beginning of the Universe until life on Earth today (Big History[1]). This scheme is based on the ways in which energy levels as well as matter and energy flows have made possible both the rise and demise of complexity in all its forms.[2]

Towards Holism: Considering the Biosphere as a Thermodynamic System

The total aggregate of the ecosystems that cover the Earth forms its biosphere. The direction and volume of interrelations within the biosphere, which determine the energy and matter flows, are more or less stable in time, at least in the absence of significant influence of human activity. That means that biosphere may be regarded to some extent as semi-closed thermodynamic system that corresponds to the classic thermodynamic patterns.

In a thermodynamic system, free energy is the amount of work that a thermodynamic system can perform. This *exergy* may be used to sustain the long term dynamic equilibrium of the auto-developing thermodynamic system. This increase of exergy volume not only sustains the dynamic equilibrium at some fixed level, but also ensures that the system complexity level is raised. The second law of thermodynamics stipulates that external energy is a prerequisite for increasing complexity. And with more inherent complexity within a social system, more pathways of interaction become possible, facilitating increased interaction and cooperation between system components.

The diversity of various living forms ensures the diversity of incoming energy and matter transformations within those systems of conjunct living forms, or species. Temporary systems of the species are also called 'consortiums'. If these consortiums arise at a constant basis, they make up ecosystems.

None of the ecosystems are completely isolated from the influence of other neighboring ecosystems, just the degree of these interrelations varies. In the hydrosphere they are more obvious. Perhaps, that was the reason that researchers from oceanology have realized that holistic aspect of marine systems much better (see, *e.g.*, Leveque 2003: 472).

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[1] For more details on the Big History approach see, for example, Christian 2004; Spier 2010; Grinin, Korotayev, and Rodrigue 2011; Grinin *et al.* 2014; Markov, Grinin, and Korotayev 2015; Rodrigue, Grinin, and Korotayev 2015.

[2] URL: http://elibrary.ru/item.asp?id=8822479.

In order to work out a comprehensive model that sustains the dynamic equilibrium state, it is important to understand how that system reacts to the outer environment changes and how it develops, *i.e*. how it is evolving. Not less important is appreciating the energy-costly process of sustaining equilibrium with the required energy. Thus, in order to understand the complex process of sociobiological evolution of *H. sapiens* we suggest to consider it as an integral part of the Earth's biosphere.

The Ambiguity of Human Evolution

Human evolution includes two components – the evolution of the peculiar, but nevertheless animal species of *H. sapiens*, and the evolution of social groups of *H. sapiens*, of ecological consortiums, *i.e.* human social evolution.

Taken together such consortiums can be described 'as social agglomerations' of multiple groups but able to sustain long-term stability in a given set of conditions. Each of these components follows its specific patterns. In human history these consortiums were highly intermixed, so that it has hardly been possible to determine decisive border, to divide these aggregations. But more critically, it is that these two basic components of human evolution are inseparably linked. That problem poses difficulties to apply social theories and direct the development of global, humanity-oriented policies. However, there are some starting points for attempting this exercise.

The first and the most fundamental component of human behavior is the biological one. Hence, *H. sapiens* is influenced by the same biological motives as other biological species. These are the basic instincts of life, sustenance and proliferation – in the modern context that translates to consumerism and sexual behavior. However, since *H. sapiens* is an 'ultrasocial' species, meeting these basic instincts in human evolutionary history strongly depended on hierarchical status of the specimen in social groups that they belong to. In other words, it depends on the status position of individuals in social group of other specimens, *i.e*. how the individual is treated by other members of social group. As a result of that long-term process another basic instinct has evolved – the drive to increase status and to gain recognition by other members of its group. While meeting these instincts, the hypophysis in the human brain produces the 'hormone of pleasure' – oxytocin. This hormone, on the one hand, is the 'hormone of happiness' that corresponds to the special receptor centers in the brain. On the other hand, this hormone also influences our attention to other peoples (Zak 2012). Another neurohormone that influences the animal behavior is dopamine. Certainly, the range of neurohormones is much wider, but these two ones play the main role in determining human emotions and via this human behavior motivation.

The human behavior is the result of the interaction of two motives: the drive to meet those basic instincts and the drive to be socially recognized which strongly depends on social environment. For most of human social evolution those two drives were combined in one, as they still are in most traditional cultures.

The authors of this essay assume that since *H. sapiens* is, first of all, a biological species, its evolution always followed the general evolution law. For any biological species the information on its structure is transmitted by biochemical means. Either it is genetic, or epigenetic, it still depends on biochemistry, related with some protein synthesis.

However, together with the development of *H. sapiens* social system the biological means of the system information transmittance extended to the social ones, *i.e*. from genetic inheritance to symbolic inheritance (Jablonka and Lamb 2005, 2008).

The ratio of these two types of heredity was gradually changing in the course of the development of historic civilizations. And the medium of natural selection was also gradually shifting from the biological to social factors, *i.e.* to political and economic mechanisms. The mechanisms of Free Market and Liberal Democracy arose to provide the system kinetic stability. These mechanisms are more flexible, they make the object respond to the demands of its environment faster, rather than imposing delays spanning generations.

In the case of the evolutionary subject not being the individual human species, but a social group of these individuals – or consortiums of *H. sapiens*, these social mechanisms co-developed jointly, and to some extent they met their evolutionary goals rather successfully. In fact, these social systems are emulating *dynamic kinetic stability* at the next social level of complexity. Social life is formed by many various factors, but principally they are the political and economic systems of a given consortium. These systems have their foundation in communication among individuals, which are attributes of the social relations making up consortiums.

A Social Mind

In the course of development of the social patterns described above, there develops a particular 'social mind' that unites their members. This new term 'social mind' means the network of social relations, that facilitates coordination of the social members' activity in order to meet the majority of a society's members demands. This social mind has nothing to do with the individual cognitive activity. It is the network of social relations that governs the group of individuals' behavior. The authors introduce this term to denote the network of intra-society relations and distinguish from terminology used in other classical social disciplines. It should be noted that with this definition, this mechanism can be understood to significantly increase the system's exergy producing. It also forms the social-cultural environment.

The increase of the system's complexity to the present level required both social and individual cognitive mind development. Since the social mind is not able to develop by itself, *i.e.* without participation of social members, the development of the cognitive mind cannot be neglected as well.

However, with the more effective development of the social mind comes a presumed reduction of the demand from the environment for individual mind development at least in terms of competitive survival. Of course, there is still the drive for social recognition, but today it may be easily achieved through commercial success. In fact, that may be one of the main reasons that caused the so-called Flynn effect reversal in the second half of the 20th century.

The Flynn effect is the substantial increase in average scores on intelligence tests recorded all over the world. It was measured in 1949, 1974 and 1991. However, the consequent investigations in some more economically developed countries (MEDC) showed unexpected reverses of this effect (Flynn 2009). An underdeveloped cognitive mind implies a more important part played by emotions in human behavior motivation. In consequence, this opens up the potential role of social psychological factors and deliberate emotional manipulation, because at this social level the success of social policies is ensured by providing individual's behavior with the motive to succeed with individual competition and to be socially recognized.

This new environment, organized by humans, both material and social, is highly unnatural, even alien for any species that developed in a natural environment and thus can be expected to impose stress. Such transformations thus cause everyday stress level increase (see Lorenz 1973). In this way the changing environment determines the specialization of neurons in the course of individual development and hence the most probable reaction of that individual to the stimulation by the outer challenges (more on neurons' specialization see below).

Niche Construction as Evolutionary Mechanism

Niche construction is the process in which organisms alter their own – and other species' – environments, often but not always in a manner that increase their chances of survival. Several biologists have argued that niche construction is as important to evolution as is natural selection (*i.e.* that not only environment causes changes in species through selection, but species also cause changes in their environment, namely through niche construction). This feedback relationship between natural selection and niche-construction: when organisms affect their environment, that change can then cause a shift in what traits are being naturally selected for (Levins and Lewontin 1985). And this evolutionary effect can have remarkable synergies. For instance, microbiota have not only enabled humans to expand their ecological niche, but humans have likewise provided evolutionary opportunities for our resident microbes (Yeoman 2011).

The effect of niche construction is especially pronounced in situations where environmental alterations persist for several generations, introducing the evolutionary role of ecological inheritance (Pienta 2014). Less drastic niche-constructing behaviors are also quite possible for living organism. This theory, in conjunction with natural selection, shows that organisms inherit two legacies from their ancestors: genes and a modified environment. Together, these two evolutionary mechanisms determine a population's fitness and what adaptations those organisms develop in the continuation for their survival. This phenomenon is called eco-evo feedback (Ezard, Côté and Pelletier 2009).

As stated above, for a long time the system information that is required for optimal functioning of some biological system – that is living organisms at that level of complexity – was transmitted mainly via genes. Since the development of human civilizations started approximately 5,000 years ago, the next stage of complexity has started, *i.e.* the social evolutionary stage.

In the course of economic development *H. sapiens* used its main evolutionary advantage – the ability to produce new objects and to transform them – to change the environment (both material and social) after cognitive decisions, in order to meet their requirements. *H. sapiens* achieved these deliberate changes of their environment via cooperative actions of several members of society. Due to the ability to cooperate, the principle way of natural resources consumption changed, while increasing efficiency amplified again with the adaptation of new technologies requiring cooperation. And the relevant social consortiums changed correspondingly. Thus, in the course of its regular activities, *H. sapiens* constructed new ecological niches for its existence.

Manufacturing of goods in order to meet human needs led to some primitive economic development and trade between different groups or parts of total human population. The trade relations ensured the development of contacts between these local fractions of general human population and most importantly the transmission of 'system structural information' via social contacts among their members.

For a long time the critical pathways in these exchanges were obstructed, constrained by the geographical conditions of that subpopulation's habitat. These differences in their environmental conditions resulted in differences of biochemical processes. Simultaneously the differences of all the surrounding factors – climate, resource abundance, *etc*. – caused these subpopulations gradually develop their own social structures to optimize resource-use and exergy production models.

The trade relations ensured contacts between these localized subpopulations. These trade contacts in turn ensured the exchange of 'structural information' via other subpopulations voluntarily accepting the shared information (Morris 2010). Morris shows how intensity of such contacts used to influence the level of development of local subpopulation.

These highly complex genes-culture-environment interrelations in the past lead to the flourishing of many quasi-racist theories – especially so, since the phenotype is usually closely related to the most common phenotype of some state or society's stratum-representatives due to long-term history of gene-culture coevolution.

However, at the social stage of evolution the effect of genes diminishes, which will be examined more closely below. The most important one sets the pattern of social behavior, which depends on neurophysiology.

Neurophysiological research on the influence of individual life experience on the specialization of neurons confirm that the genes-behavior-culture interrelations are not at all that rigid and irreversible as it seemed before (Borinskaya and Korotayev 2002; Laland, Odling-Smee, and Myles 2010). The anthropogenic environment, as artificial objects within the current social environment will form individual life experience and hence specialize the neurons. The pattern of this specialization may be obscured by later experiences, but the primal version remains life-long and affects all the subsequent individual behavioral reactions to the current environment challenges, even if being hidden.

The increase of the system's complexity to the current level presupposes both social and individual cognitive mind development. Since the social mind is not able to develop by itself, without participation of the members of society, the individual cognitive mind development can therefore not be neglected as well.

From Niche Construction to a Biogeocenosis

As described so far, the following sequence of evolutionary stages may be observed, leading to a stage that may be called the anthropocoenosis, an interactive community of living organisms centered on humans (Scott 1996):

1. The formation of the planet.
2. The origin of life.
3. The growth of Earth's biodiversity, inhabited by the majority of various forms of life existing today.
4. The development of the biosphere, *i.e.* the environment-related evolution of species populations.
5. The origin of humans with their unique ability of cognitive niche-construction, expanding the habitat carrying capacity. Gradual forming of the anthropocoenosis in the course of the human history and development of human civilizations.
6. The development of social consortiums that increased the productivity of the anthropocoenosis then makes possible the formation of the anthroposphere.

The 2009 crisis highlights the 6^{th} stage of the system's increasing complexity. The socioeconomic upheaval experienced globally in 2009 made it clear that the present path of world development is not sustainable in the long term, even if we recognize the enormous potentials of the market and technological innovation. It is self-evident that new ideas and strategies will be needed to ensure that improved living conditions and opportunities for a growing population across the world can be reconciled with the conservation of a viable climate and the fragile ecosystems on which all life depends. A new vision and path for world development must be conceived and adopted if humanity is to surmount the challenges ahead.

From this conclusion, in 2009 the Club of Rome started a three-year program to determine 'A New Path for World Development' in order to achieve a better understanding of the complex challenges which confront the modern world and to lay solid foundations for the action which must be taken to improve the prospects for peace and progress.

This 'New Path' addresses a set of issues which were considered by the experts of the Club of Rome, as being the most influential factors for further Global Development. They are the following:

1. Environment and Resources;
2. Globalization;
3. International Development;
4. Social transformation;
5. Peace and Security.

These five issues are also addressed by the Millennium Development Goals. Meeting those Millennium Development Goals is supposed to ensure the further gradual long-term sustainable development of human civilization within the still limited planetary borders.

As long as the planetary boundaries remain impassable to all living organisms on the planet, they enclose the biogeocenosis. Biocenosis is a sustainable system that includes a community of living organisms and biogeocenosis incorporates the abiotic environmental factors within their habitat they are associated with. Its sustainability is provided by cycle of matter and energy flow (*i.e.* natural ecosystems). The doctrine of biogeocenosis was developed by Vladimir Sukachev in 1940. English-language researchers seldom use this term. In English-language research the term 'ecosystem' is usually used instead of 'biocenosis'.

That implies that the main limit regulating the flow of the evolution of *H. sapiens* is the carrying capacity of the biogeocenosis. The same resource limits affect the evolution of any biological species. Exceeding this carrying capacity normally results in population collapse. There are three reasons which contribute to this collapse: 1) epidemics; 2) famine – or other life-providing resource shortages; and, most importantly 3) the significant increase of intra-population competition and population division into groups with different environmental requirements.

So as long as planetary boundaries are in effect, the problem then is how else the carrying capacity of the biogeocenosis can become enlarged – under the conditions of constantly growing population density or, in other words, the problem of sustainable development. And that, in our conception, requires both social and individual mind development.

There are four ways to solve the overexploitation of a biotope carrying capacity in nature. Three of them are catastrophic either for the resident population, or for the biotope itself, or for both. These are famine, epizootic and the dramatic increase of competitive struggle. As a result, population density falls, when ecological development restarts again. The way out of this situation is either migration to new areas, or evolutionary adaptation to the conditions of new ecological niches, *i.e.* evolutionary changes of the involved species' characteristic.

A peculiar case of migrations is the so-called Lemmings Effect or 'pseudo-mass suicide' of the largest part of population. These are methods to decrease the overuse of resources of the biocenosis in natural conditions. If part of population survives, it will colonize the restored environment again.

However, in this sense it is just a theoretical construction, regarding the situation with abstract single-species population in a biotope in the absence of natural enemies. The situation in real ecosystem is more complex. The interaction of two species, one of which is prey, and another predator is better reflected by the Lotka–Volterra equation. This equation describes dynamics of biological system, in which two species interact, one as a predator other as prey. It reflects the autocatalytic fluctuation of the population density of species that never comes to zero. However, in real biological ecosystem more than two species are interacting. Their interactions are more diverse than just prey-predator. This equation supposes that some dynamic balance may be achieved. The main condition for a system to achieve it is that the negative feedback in the community should be still active.

The fourth way of the population density self-regulation is less catastrophic. It can rarely be observed in natural conditions. But experiments under laboratory conditions show that the increase of individual stress levels leads to neuropsychological status changes. That results in falling fertility rates. Research on human reproductive medicine over the last 50 years confirms that fertility was falling among humans as well, however with different rates. That rate is in negative correlation with the level of socio-economic development of some states.

Labor and the Evolution of Humankind

The results of human labor activity are found in the development and diversification of commodities produced with labor. Economic activity arose from the exchange of commodities. It occurred to ensure that the involved people would meet their needs. Besides, that process would provide people with an intrinsic and constant interest for the further development of technologies. Simultaneously, this endless development is the main human evolutionary interest.

Three types of such activity – each of them with its own level of natural resources dependence may be distinguished in labor activities: agriculture, industry and construction and services. In the course of human evolution, the proportions of these three types of economic activity in a generic GDP calculation were shifting gradually from agriculture to service sectors.[3] It is assumed that the deep crisis of social restructuring can be attributed to each shift of that proportion. Since the type of economic activity of a certain society strongly affects its social environment and energy consumption, the effect of that transformation cannot be left aside while regarding the transformation of social structure.

There are many examples in biology where system complication occurs due to the formation of species consortiums via coevolution with the result that coevolved complexes could get access to new environmental resources. An extreme case of such coevolution that illustrates this pattern is symbiogenesis (see, *e.g.*, Margulis 2010).

The activity of the evolutionary new system can transform even the global environment. The most impressive example is that of Great Oxygen Event, which followed the autotrophic cell formation as a result of symbiogenesis of autotrophic eukaryote with heterotrophic prokaryotes. The newly generated heterotrophic eukaryote cells changed the very global environment on the planet. The rising concentrations of oxygen wiped out most of the Earth's anaerobic inhabitants at the time. It was a catastrophe for these organisms. However, simultaneously that event triggered further biosphere development. In this paper the authors suggest that the latter crisis had an evolutionary effect, similar to that of the Great Oxygen Event in its scale. It can be a trigger event for the formation of the anthroposphere.

Thus, one can conclude that due to the coevolution of modules from the previous organizational levels, new systems of increased complexity levels arose.

One can see that both of those evolutionary laws were in effect at that level as well, but the speed of that selection was much lower due to slower feedback mechanisms.

The Case of the Social Evolution of *H. Sapiens*

In the course of the human species' evolution, together with cognitive mind and speech development *H. sapiens* gradually moved to the next stage of complexity – the social evolution – or to cultural evolution in other words. Within this

[3] URL: http://unctadstat.unctad.org.

kind of evolution the main accent in system evolution passes from the biochemical means of heredity to the so-called signal heredity, when the system's structural information is transmitted via language and stable behavioral patterns (Jablonka and Lamb 2005, 2008).

That is confirmed by the significant role that the Baldwin effect played in the evolution of ancient hominids, since effect of learned behavior on evolution constantly increased (Baldwin *et al.* 1902; Weber and Depew 2003; Hinton and Nowlan 1987).

As long as the object's structural information was transmitted mainly by biochemical means, *i.e.* via inbreeding within some species' population, the main cause for one part of that population's diversification was the distance together with other obstacles that prevented reproductive contacts between individuals that belonged to the separated population. Hence at that time social populations of some geographical and social spaces were synonymous with the biological meaning of the word 'population'. Each of those isolated populations was developing its own set of genetic features that became visible in peoples' phenotype. It would be logical to suppose that these genetic features determine the behavioral reactions as well. So they really do to some extent, and in the course of history it leads to the formation of races and sub-races. But many studies that have been carried out by now prove that unlike the phenotype features, the genetic features of neurons may be well devalued to some extent as a result of the specialization of neurons in the course of individual development. The latter is strongly influenced by social-cultural environment (see below references to the works on neuron specialization).

Due to the gradually increasing human role in the transformation of the environment, the role of genetic changes gradually decreased. Some genetic differences still exist, just like the phenotype of the Chinese differs from the phenotype of the European, but it can be argued that these differences are gradually getting less and less significant for ensuring success in social life.

'Social evolution' follows the same macroevolution pattern as biological evolution of other biological species pushed by Darwinian selection at the level of the system's ability to sustain the state of dynamic equilibrium. Only in this case the structural information is transferred not by biochemical means only, *i.e.* by genes, but by behavior-determining information or by memes, *i.e.* symbolic inheritance. The key difference is that the social-cultural evolution leads to deep changes in the social-cultural or anthropogenous environment. The latter results in the changes of environmental conditions. Then in response to those changes, they are reflected back by some of the system's structural changes. Both these kinds of environment are alien for biological organism, hence adjusting to them requires deliberate effort and is somewhat stressful. This leads to the gradual increase of the stress levels accompanying the development of civilizations, that is the development of social mechanisms of stress management via social behavior framing, *i.e.* the development of relevant social institutions. That stress results in fluctuations in human behavior, and in order to mitigate those destructive fluctuations it is crucial to realize well the reason why they occur.

However, at that stage an intrinsic system's contradiction comes up. Social mind development cannot be achieved without human natural sciences-related cognitive activity. Implementation of this activity results in meeting the day-to-day human life needs. But simultaneously meeting those needs with technology removes the demand for this cognitive activity. As the social mind develops, the pressure from the environment for natural individual cognitive activity for the survival of the individuals, for maintaining its individual life, decreases radically. The individual's cognitive activity is a very stressful energy-cast process, therefore without vitally important requirements it is usually avoided by the majority of people.

Another powerful motive for human behavior is to become socially recognized, but now this can be easily achieved by using cultural technologies, such as social media.

The combination of those two phenomena destroys a critical part of the system's feedback, and the most powerful one, which is the interest to meet the individual living organism's vital requirements.

At the biological stage of complexity such feedback is realized mainly via various protein synthesis process inhibition. That determines the synthesis of neuro-hormones which in turn determines the behavior of individuals.

At the social stage that had coincided with the institution of the Internet post-1975, it is necessary that new relevant feedbacks are to be worked out in order to ensure the self-regulation of the system.

The diversity of various living forms ensures the diversity of incoming energy and matters' transformations within those complexes of coupled living forms, or species. These complexes are also called species consortiums. Hence these consortiums determine the ability of the ecosystem to sustain the dynamic equilibrium in case of some outer conditions changes. To continue its self-regulation, the system needs to keep reliable negative feedback loops, to manage the development of the self-regulating system.

The Denomination of the Genetically Determined Features in Social Behavior

The apparent difference in phenotypes was the reason for behavioral geneticists busily conducting studies and refining their techniques as they responded to discovering this relation. By 2000, Erik Turkheimer, a behavioral geneticist, felt able to declare that the nature-nurture debate was over. Turkheimer said that everything is inheritable. He stated three laws of behavior genetics:

1. All human behavioral traits are inheritable.

2. The effect of being raised in the same family is smaller than the effect of genes.

3. Substantial portions of the variation in complex human behavioral traits are not accounted for by the effects of genes or families (Turkheimer 2000: 160).

This research seemed to have categorically resolved the classic dispute of 'nature *vs.* nurture'.

However, more recent neuropsychological research shows that the manifestations of those genetic features strongly depend on outer factors of individual development. Thus, 'genetic devolution' does occur in the course of a person's nurture in certain postnatal environment conditions. It occurs as a result of neurons specialization in the course of individual nurture experience. Even the tiniest changes in the postnatal individual life experience contribute to differences in individual behavior of adults specimens.

That is confirmed by studies of the variations in behavior in genetically identical laboratory rat population in heterogeneous environment (Freund *et al.* 2013). The experiment confirmed the differences in the individual's search activity. In the analysis the authors put forward the idea that this variation may occur due to the difference in postnatal individual experience. If considering individual life experiences of humans in anthropogenous environment, one can conclude that due to the cumulative effect this variation could affect the adults' behavior much more. Besides, search activity is just one of many motives of human behavior. We assume that this variation occurs due to the differences in the specialization of neurons. The influence of this non-genetic-drive specialization on the behavior of various animals is shown by many neurophysiological studies (*e.g.*, Alexandrov, Grinchenko, and Jarvilehto 1990; Cousillas *et al.* 2004; Tian *et al.* 2001; Duncan 2001).

That means that the eternal dispute of 'nature *vs.* nurture' is brought back to life again.

Features of This Consortium are Ensured by the Information on the System Structure

In other biological species the spread of information among the individuals of one population is a result of reproduction. Each population developed in accordance to its own habitat, but the geographical distances and other physical obstacles obstructed the contact with populations in other habitats, and hence – the informational exchange between them.

Social development reduced the requirement for reproduction as information transmission that was required for genetic-based organisms. Instead economics, trading and other social development led to the erosion of boundaries between various geographical habitats.

This process grew especially intensely by the end of the 20th century. It enlarged the human habitat to the scope of the whole planet. The subpopulations that used to be clearly separated by distances and other physical obstacles for contacts, suddenly found themselves face to face.

Therefore, by the present time, the global human population has become one whole biological population – or more specifically, a 'superpopulation' further on. Simultaneously that means that this global superpopulation is affected by the laws of evolutionary ecology or macroecology as a whole. But these laws are affecting the population at a new level of complexity – at the level of social structures, which determines the way of resource use, *i.e.* the ecological niche constructing in a modern world. Depending on the long-term, initial conditions of specific societies, their development shows two main patterns of resource use: social structures that are oriented toward extensive resources exploitation, and those oriented toward intensive use of existing resources.

However, in spite of contrasting patterns of resource use, since humans are still biological beings, their basic requirements remain. That means that these two niches are and always will be partly overlapping.

In the evolutionary ecology of other species there is one more principle 'Complete competitors cannot coexist', or in its more positive expression: 'Ecological differentiation is the necessary condition for coexistence' (Hardin 1960: 1292–1297). Since the load on the global biogeocoenosis increases – the competition increases as well.

In fact, this difference between competitors is determined by the level of social mind development.

The authors of this paper introduce the term 'social mind'. In social science there is already an academically accepted term 'human capital' in use. Human Capital determines the competitive ability of a state in modern world. It is characterized by the level of social services development and the system of wide public education and enlightenment. Extensive research of fundamental economics confirms the assumption that human capital development, and public education first of all, is the source for a sustainable economic development and so the competitive success of the state (Sunde 2001; Cervelatti and Sunde 2002).

Human capital is characterized by the stock of competencies, knowledge, social and personality attributes, including creativity. All those qualities definitely influence the network of intersocial relations, *i.e.* the social mind. Human capital development results in the development of people's cognitive mind, and the latter, in turn, contributes to the development of the social mind. Both of these kinds of mind give an individual the ability to forecast the consequences of its actions. Since the crucial factor for social mind development is the structural information, the dissemination of this information through electronic communication means that development depends first of all on the deliberate efforts by humans.

Besides that it means that the widely discussed problem of overpopulation and 'Limits of Growth' could be resolved soon simply because the laws of evolutionary ecology are now affecting this global population at social organization level. As the social structure gets more complex, the total fertility reduces, repeating the evolutionary consequence of *K*- and *R*-reproductive strategy of living forms in the course of colonizing new biotopes.

This hypothesis is confirmed by laboratory data, obtained in the research of the genetics of behavior and the neurophysiological influence of stress on reproductive behavior and fertility rate among populations of laboratory rats. Research on human reproductive medicine confirms that fertility is falling among humans. That means that under natural conditions the Total Fertility Rate (TFR) in the MEDC in the 20^{th} century was falling until the state took part in active social stimulation by increasing people motivation to get child.

Since human fertility, mortality and longevity figures are badly affected by other factors of sociocultural environment, it is not easy to distinguish social and biological factors and to determine the main causes. However, experiments on rat populations allow the isolation of the reproductive behavior from the influence of social factors. These experiments prove the key role of increased maternal stress level in course of prenatal fetal development on their further reproductive behavior (see Holson *et al.* 1995; Ward 1984; Masterpasqua, Chapman, and Lore 1977).

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The research of Rhees and Fleming (1981) confirms the purely neuroendocrine nature of this effect. However, at that stage it is seriously affected by social factors, which depend in particular on some state social politics, *i.e.* on the anthropogenic factors.

Again the experiments on laboratory rats allow to estimate the degree of the influence of anthropogenous factors (Navarro *et al.* 1996; Popova, Morozova, and Amstislavskaya 2011; Amstislavskaya *et al*. 2011).

However, the birth rate depends not just on sexual behavior but also on the individual fertility rate, which itself depends most of all on the male sperm quality. An analytical review showed the consistent gradual decreasing of male sperm quality in recent decades (Carlsen *et al.* 1992; Auger *et al.* 1995; Andersen *et al.* 2000; Clarke *et al.* 1999).

Prenatal dexamethasone or stress but not ACTH or corticosterone alter sexual behavior in male rats (Holson *et al.* 1995). Female fertility is also falling under the influence of stress. The relation of stress and fertility is now widely discussed in many corresponding public sources (Braverman n.d.; Tatarchuk

2006; Carlsen *et al.* 1992). This data from reproductive medicine confirms that the intrinsic reason for reproduction falls under the influence of stress. The authors assume that those innate reasons are determined by ecological requirements of the environment sustaining its carrying capacity. It does not mean any deliberate activity of this complex subject-object system. It is not animated, *i.e.* this complex has no free will. That activity is just the result of the interaction of numerous components interrelated by the endless number of complex feedbacks, which follow the main evolutionary law of complexity increase. That complex cybernetic system makes it impossible to work out some definite forecast. However, it is possible to work out some general strategy, based on the probabilistic crysis analysis. The authors assume that in order to work it out, the motivation of people has to be considered closer, and that cannot be done without taking into accout the trends of evolutionary ecology – or macroecology.

The analysis of the correlation between total fertility rate (TFR), the average number of children that would be born to a woman over her lifetime, and the Gross Domestic Product (GDP) distribution within a state confirm the initial assumption of the authors that the social evolution of human beings is an integral part of the Earth biosphere evolution.

Since human behavior is the result of two components' interaction, *i.e.* the biological and the social, its social component may increase the motivation of people to reproduce. This motivation strongly depends on the support of the given state. The more that demand is supported by relevant social life conditions, the more effective it is met by the population. The role of this social motivation especially increased along with the development of reproductive health, along with the in-vitro fertilisation methods development.

The present paper confirms the purely innate nature of fertility falling along with the increasing complexity of social structures, which provides for the enlargement of the biocenosis carrying capacity. That increase of social complexity imposes ‘unnatural’, artificial requirements on individuals' social behavior. Together with the increase of the ‘abnormal population density’, which is especially high in urban areas, daily stress levels increase as well. That stress increase leads to numerous socio-psychological effects, related with changing of social roles of family partners and gender social status. All those factors decrease the female motivation for multiple child-bearing, and hence, their fertility potential decreases too. It results in TFR serious falling as well.

However, the most crucial moment that the drop in fertility rate due to population density increase can be observed is in experimental populations of animals that have almost no signal inheritance at all – the laboratory rats.

Unlike rats, in human society the fertility rate is determined by both intrinsic ability of conception and people's basic motivations. The latter depends on social environment and signal heredity as well.

All the above makes the authors come to the following conclusion: social evolution of human beings is an integral part in the evolution of the Earth Biosphere. It follows the same pattern of evolutionary ecology of certain habitats, in which the prevalence of *R*-strategy species changes to the *K*-strategy ones. It goes together with complexity increase of the system. And the latter is unavoidable for it provides for the increase of human habitat carrying capacity.

By the end of the 20th century a new epoch is beginning. At that point the activity of human society determines the energy flows in the Global biosphere complex. This epoch is now called Anthropocene.

In the present article the authors suggest to choose a macroecological approach to the cognitive development of social structures and policy. The macroecological approach allows to consider particularly evolutionary factors that influence motivation of social groups' behavior. In modern social conditions, changes of public moods, in other words, changes in individual motivation are manifested in powerful social trends and are realizing in international politics agenda.

Finally, it is critical to alert to the most dangerous moment in the current situation of the demographic and developmental imbalance caused by the rapid anthropocoenosis changes, in particuar increasing population densities, and the tensions between subpopulations that have differentially developed socially – that increase the risk of anti-social behavior (Calhoun 1962; Galle, Gove, and McPherson 1972).

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