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Introduction

Universality and Inexhaustibility of Evolution

Leonid E. Grinin and Andrey V. Korotayev

From the very beginning, our Yearbook 'Evolution' has been devoted to searching for the common ground at different levels of development, to gradual elaboration of a mega-evolutionary paradigm (see Grinin *et al.* 2009), as well as to considering features of various evolutionary phenomena. As a matter of fact, in speaking of similarities, one should take into account the most important characteristics of phenomena and systems – their uniqueness. At the same time the common and unique sustain complex interaction. In particular, the uniqueness is never overall, it is always realized only in several aspects important in evolutionary terms. At the same time, the deeper we comprehend the balance between general development and general evolutionary trends, on the one hand, and breakthroughs to new levels of organization, on the other, the more clearly we perceive that an evolutionary breakthrough which occurred as a result of emerging unique conditions is never an element of randomness but always occurs due to a huge and consistent evolutionary advance in a certain direction. Thus, the new emerges far from inevitably. For the emergence of something new a number of peculiarities and coincidences of complicated conditions is required; at that, it is always difficult to conceive whether all these conditions were necessary or some were contingencies of minor importance. Therefore, the transition to a new evolutionary level is such a rare and important event. And still the gap between the levels is not as obvious as it sometimes seems.

Thus, the uniqueness and regularity, the general and the particular in evolution, are opposed to each other and at the same time unified as they make up an evolutionary unity. This can be seen even from the issues proposed in this Yearbook. For example, the Big Bang phenomenon (in the article by **Leonid E. Grinin** 'Was There a Big Bang?') is associated with unique events which generate numerous patterns of our Universe and its diverse features that have become its regularities. Thus, life on the Earth is a unique phenomenon as yet but one can search for the regularities of its origin even in our Galaxy (as in **Dmitry A. Novoseltsev's** paper 'The Catalysis Project: On the Possibility of

Purposeful Expansion of Intelligent Life in the Galaxy'); singularity is a peculiar phase which still can be revealed in an increasing number of processes (about singularity see the paper by **Sergey V. Dobrolyubov** 'Global Society as Singularity and Point of Transition to the New Phase of Social Evolution').

We particularly encourage the strive to search and analyze the common in functioning and development of various forms of organization of inanimate, living and thinking matter, the common in both historical and non-historical aspects of evolution; to formulate the evolutionary laws, principles and mechanisms that can be applied at different levels and stages of evolution (as well as to study various phases and levels of Big History and Evolution and analyze the problems of the origin of certain phenomena and institutions (see the articles by **David J. LePoire** 'Expansion and Integration Phases in the Major Stages of Big History' and **Ryszard Skarzynski *et al.*** 'Mind and Vision: Social Evolution and the Origins of the Political'). Indeed, despite the diverse manifestations, the comparison of different processes and subjects, their appearance, development and evolution, *etc.* at the same time demonstrate considerable similarity in forms, methods, mechanisms, patterns, on the basis of which there will be derived rules and even laws that will be applicable at various phases of evolution and in its various manifestations (see, *e.g.,* about rules and patterns in articles by **Leonid E. Grinin** 'Evolution of the Early Solar System in Terms of Big History and Global Evolution'; and **Anton L. Grinin** 'Technological Dimension of Big History and the Cybernetic Revolution'; Grinin *et al.* 2009; Grinin 2013b, 2017; Grinin, Markov, and Korotayev 2013; Grinin, Korotayev, and Markov 2012a, 2013b; Grinin, Korotayev, and Markov 2011, 2017). Sometimes one should speak not about rules, but rather about regularities, and often only about analogies, but not at all random ones. This approach has repeatedly given a new vision for science. Cybernetics was created just under such conditions. The predecessor of the science of cybernetics, the Russian scientist Alexander Bogdanov in his work about the fundamentals of organization science (in which he was ahead of his time) paid much attention to such analogies that allow us to see the common in a wide variety of phenomena belonging to different realms, and he also gave a detailed information on the scientists working in this direction.[1]

Following Bogdanov, one may ask: with the infinite abundance of the matter in the Universe and infinite variety of forms, where do these systematically reproduced and extended by cognition analogues come from? And one can agree that recognizing them as simple 'random coincidences' means the introduction of an element of arbitrariness into the worldview and even coming into a clear

[1] The particular attention was paid to the Serbist-French scientist M. Petrovic who since 1906 tried to explain 'the theory about analogues' by developing the formulas of 'general mechanisms of heterogeneous phenomena' (eponymously-named book was published in 1922).

contradiction with the theory of probability. And modifying his answer, one can argue that there is only one scientific conclusion: there really exists a unity of evolutionary laws and patterns, their unity is manifested everywhere – in animate and inanimate nature, in elemental forces and human conscious actions (Bogdanov 1989).

Elsewhere we have already pointed that comprehension of the idea that many principles, mechanisms, characteristics, features, patterns, laws and rules of evolution, which we used to attribute only to its highest levels and mainstreams, can be found at all its levels and in different lines, and this fact clarifies a lot in understanding of evolution (see, *e.g.,* Grinin 2013a, 2014; Grinin, Korotayev, and Markov 2012a, 2012b; Grinin, Korotayev, and Ilyin 2012; Grinin and Korotayev 2014; Grinin 2015). It also contributes to the understanding of its driving forces, vectors, trends, and reveals new aspects of evolutionary studies and creates a common field for interdisciplinary research. Our world is amazingly multifaceted, diverse and inexhaustible in its manifestations. And still, many of its foundations are universal. Of course, it is very difficult to find even some of these foundations. A number of contributions in previous issues of our Yearbook as well as in this volume are devoted to the search for this unity and the forms of its manifestation in the historical path of our Universe.

The contributions to our Yearbook demonstrate that the number of similarities and common features in the evolutionary trend at various stages and levels is extremely large and they are peculiar to the seemingly most different processes and phenomena.

This is one of the reasons why the word 'patterns' is added to the subtitle of this volume. Speaking of patterns (*i.e.*, some examples, models, and evolutionary changes), we certainly understand that in addition to the patterns one can observe a wider range of evolutionary regularities: evolutionary cases, principles, rules, or just evolutionary analogies and ideas.[2] Anyway, each finding enriches our vision. In general, the studies of these aspects allow us to see, on the one hand, what a wide toolkit evolution has, and on the other hand, that it is rather rational in its transformations, and it does not search for new ways where it is possible to use proven methods. To some extent it explains the similar processes of change at its different levels.

[2] These are some examples of universal evolutionary patterns: the pattern of cyclical alternation of order and chaos; moreover, the order from chaos is one of the major evolutionary patterns; the alternation of order and disorder, when the transformation of the latter into order with subsequent breakdown of order for the sake of the transition to a new level appears an inevitable sequence of many processes; the catastrophe pattern as one of the main selection mechanisms at all levels of evolution. One can also conclude that any history of nature and society is always associated primarily with the redistribution of resources and struggle for them. But of no less importance is the fact that this redistribution leads to a peculiar concentration of rare resources or conditions which gives rise to their new quality.

The present volume is the sixth issue of the 'Evolution' Yearbook. It consists of four sections. As before, we strive to arrange every issue in such a way that the line from cosmic evolution to the human future is evident. Megahistory and global evolution still are the main subjects of our Yearbook.

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Section I. Big History's Phases and Long-Term Trends contains two contributions.

David J. LePoire ('Expansion and Integration Phases in the Major Stages of Big History') points out that the three major stages in extended evolution towards increasing complexity: life, humans, and civilization, can be viewed as separate logistic developments (or learning curves). Each stage has an initial rapid expansion into a new niche followed by a slower integration and synthesis in preparing for the next growth stage. These expansion and integration stages are summarized as: 1) life extending around the Earth then integrating towards primates; 2) the expansion of the primate branch from forests leading to adaptive humans with an integration of tools and language in agricultural villages; and 3) expansion of civilizations towards an integrated technological-based system. This is also seen in the earlier physical development of the Universe from the expansion after the Big Bang towards planet formation through gravitational collapse. There are also indications of substructure and geometric temporal patterns in each major stage. The duration of each subsequent stage is reduced by about a factor of 1,000 (*i.e.*, life beginning about 5 billion years ago, human evolution about 5 million years ago, and civilization about 5 thousand years ago). Each stage seems to be formed by about 6 nested sequential transitions (steps) with the duration of each subsequent transition being reduced by about a factor of 3 (note the 6 factors of 3 between steps give the factor of 1,000 between stages). Some possible explanations for these factors are reviewed.

Cadell Last ('Symbolic Orders and the Structure of Universal Internalization') shows that Big History is a theoretical field attempting to ground a historical evolutionary view of the physical universe. However, in this paper the author argues that such a view by necessity can only remain on the first order of discourse. In the first order of discourse the observer remains external to the system objectively under reflective observation. This approach has proven effective and useful but remains limited in terms of understanding the evolution of the symbolic order. Internal to the symbolic order networks of observers produce and maintain their identities via mechanics of reflection that are independent of any external systemic objectivity. Consequently, in this work the author explores the potential for Big History to approach the problematics of a higher order framework inclusive of observers. The main goal of this ap-

proach is to understand the ways in which symbolic orders evolve across time reflectively transforming visions of past and future.

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Section II. ***Cosmic Evolution*** covers issues related to the Big History and especially its cosmic phase. It opens up with the article by **Leonid E. Grinin** 'Was there a Big Bang?'

The idea that our Universe emerged as a result of the extraordinary power of the Big Bang from singularity (*i.e.*, a state of an infinitely small quantity and infinitely high concentration of matter) is still very popular today. It was one of the main postulates of the Big Bang theory that completely formed in the 1960s–1970s. However, at present this idea as well as the Big Bang theory is outdated, although it is still shared by many scientists. Being widespread since the end of the 1970s the Inflation theory appears more modern. The main reason for the emergence of the Inflation theory was that the Big Bang theory could not satisfactorily explain a number of the contemporary parameters of the Universe.

The Inflation theory makes still widespread views of the Big Bang theory archaic as regards the following points: 1) the history of the Universe started with the Big Bang; 2) it started with the singularity. According to the Inflation theory, the Big Bang was not the beginning and the moment of the origin of the Universe, but it was preceded by at least two epochs: inflation and post-inflationary heating. That is, the Big Bang or precisely the hot Big Bang is just a phase transition from the state of cold inflation to the hot phase. Since the Inflation theory does not consider the Big Bang as the initial phase there emerges an intricate problem of the role of the Big Bang in the process of the formation of the Universe as a whole. The paper considers the confusion with the Big Bang notion, a number and sequence of 'bangs' and why the theory can dispense easily without the notion 'the Big Bang'. Some advantages and disadvantages of the Inflation theory will be also discussed.

In his contribution 'The Catalysis Project: On the Possibility of Purposeful Expansion of Intelligent Life in the Galaxy' **Dmitry A. Novoseltsev** considers the possibility of expansion of biological life, intelligence and modern culture in the Galaxy in the autocatalytic mode using modern and promising technical means. The author proposes to accelerate biogenesis in protoplanetary disks by introducing biocatalysts into them by means of the groups of simple probes with solar sails. The subsequent placement of the groups of simple probes with solar sails, used as information carriers is proposed on the periphery of the formed exoplanet systems.

The contribution by **Leonid E. Grinin** 'Evolution of the Early Solar System in Terms of Big History and Global Evolution' provides an opportunity to briefly conceive the evolution of the Solar system in the first billion years of its

existence when the most considerable changes took place. The article has two dimensions. First, the paper gives a brief history of the early solar system, while the author pays great attention to debatable aspects and shows different approaches and points of view, along with more or less confirmed hypotheses. Second, it demonstrates the opportunities for the formulation of evolutionary rules and ideas using the examples from the history of the early Solar System.

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Section III. The Aspects of Socio-Cultural and Political Evolution consists of five articles. It opens up with the contribution by **Ryszard Skarzynski, Mateusz Wajzer, and Tymoteusz Staniucha** 'Mind and Vision: Social Evolution and the Origins of the Political'.

During the transition from family to state organizations, that is from structures built upon the cooperation of a few relatives to organizations controlling the behaviour of thousands and millions of genetically distant individuals, the unification of people around ideas processed by the mind became increasingly more important. A large part of the mechanisms that control these processes has been beyond scientists' interests. Meanwhile, the results that are available from archaeological research show that political control of the masses by specialized organization began to develop around 6,000 years ago in Mesopotamia and Egypt, and not only because of the increasing complexity of Neolithic agricultural societies. It was incredibly important that cooperating individuals shared visions of universal order. The results of modern neuroscientific research show that, ultimately, the emergence of political phenomena and their development were determined by the specific mental abilities of *Homo sapiens*, which were unprecedented at such a level of development or even absent in other species. In this text the authors analyze the most significant of them, explain how political mobilization was initiated and how many other political phenomena evolved to define the functioning of the human species today.

The paper by **Leonid E. Grinin and Andrey V. Korotayev** 'Chiefdoms: From Archaic Polities to Modern Terrorist Organizations' demonstrates that the chiefdom concept is one of the most productive in social anthropology and political evolution. It helps to deeply understand the process of complication of society's structure and the development path from stateless society to early states. However, even when states spread everywhere, chiefdoms still remained political and administrative actors. At present one can find some features of chiefdoms in developing countries (*e.g.*, in some regions of Africa) and in different kinds of organizations especially in illegal and terrorist ones. Thus, using chiefdom theories one can clarify a few basics of such kind of organization as well. Therefore, it makes sense to show how such chiefdom-like structures preserve and develop the features of ancient polities within them.

Thus, in the modern world, along with states, one can find numerous alternative social and political organizations, which, to a greater or lesser extent, have some features that are similar to certain ancient polities. How and why is this possible? The authors hope this paper will shed some light on this question. However, it requires and deserves further study.

Brian Spooner in his paper 'What does Big History Do for the Study of Religion?' indicates that religion, historically, has provided the understanding we need for everything beyond our immediate experience in the absence of science, ideology, philosophy. Big History provides a more comprehensive and valid understanding, at a time when religion is losing its appeal and social change is making it less socially workable. It enables us to see not only the significance of literacy and various social and demographic factors, but also what we may learn about the human propensity for religion from other academic disciplines outside the humanities and the social sciences.

Ken Baskin in his contribution 'Religion as the Ultimate Human Evolutionary Survival Strategy' begins exploring an alternative model for thinking about religion. In this alternative view, religion emerged as our evolutionary ancestors faced a challenge common to members of all species: evolving body structures that enabled them to know exactly what they needed to survive in a highly complex, continually shifting environment. In this way, bats rely mostly on sound to model the world, and dogs depend mostly on smell. For our evolutionary ancestors, natural selection chose the genes that would create a brain that transformed the world around them into story-like constructions. Religion emerges in myth as those ancestors faced the powerful forces that often overwhelmed them, driving events such as birth and death, abundance and famine. Moreover, as our ancestors moved out from the rainforests of East Africa to the savannah, natural selection further chose for the ability to cooperate, first through brain developments and then rituals. The stories and rituals that developed as these two developments intertwined enabled hunter-gatherers not only to survive, but to spread across Eurasia. In fact, these myths and rituals proved so powerful that they would enable human beings to create societies of increasing social complexity, as their communities skyrocketed from bands of 20 to cities of 20 million.

Antonio Gelis-Filho in his contribution 'Geoculture: Missing in Action' indicates that Wallerstein defined geoculture as 'a set of ideas, values, and norms widely accepted throughout the world-system and that constrained social action thereafter'. Its importance in the full development of the capitalist world-system was made clear many times. Nevertheless, geoculture is missing in literature. A new approach to the concept, aiming to set the basis for further discussion is presented in this paper. The author sustains that world-systems are in fact the assembly of two subsystems of unequal exchanges: the material and the symbolic ones. While material goods are traded, 'symbolic goods', of a psycho-

logical nature are also traded. The result of the first subsystem workings is a world-systemic structure consisting of core, semiperiphery and periphery, with wealth accumulated in the first division. The result of the second subsystem workings is the acceptance of unequal exchanges as something normal, as 'the way things work'. Thus, geoculture is the structure of such subsystem of symbolic exchanges at any specific moment. The author emphasizes the role of unconscious processes to the creation and stability of any world-system and discusses some implications of that framework: bounded complexity, radical freedom and the asynchronous evolution of the two subsystems.

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Section IV. Looking from the Past into the Future contains four contributions which provide different forecasts.

Leonid E. Grinin and Anton L. Grinin in their paper 'Technological Dimension of Big History and the Cybernetic Revolution' analyze the evolution of technology from the beginning of the human history. A new paradigm to analyze the causes and trends of the global evolution is introduced. They also describe the direction of technological transformations, discuss and explain the present and forthcoming technological changes. Their analysis of technological evolution mainly focuses on the second half of the 20th century. The authors present a detailed analysis of the latest technological revolution which we denote as 'Cybernetic', and give some forecasts about its development up to the end of the 21st century. It is shown that the development of various self-regulating systems will be the main trend of this revolution. They argue that the technological transition of the final phase of the Cybernetic Revolution will start in medicine, which is to be the keystone of technological convergence forming the system of MANBRIC-technologies (based on medicine, additive, nano-, bio-, robotic, IT and cognitive technologies). Today we are at the threshold of post-human revolution, the era of an intensive impact on the human body. The authors consider the directions of this revolution such as considerable life extension, organ replacement, BCIs, robotics, genome editing, *etc.* It is very important to understand the mechanisms of technological development and to measure the possible risks arising from them.

In the paper 'Global Society as Singularity and Point of Transition to the New Phase of Social Evolution' **Sergey V. Dobrolyubov** considers social evolution as a process consisting of three phases: adaptive, structural and cognitive, which are separated by two phase transitions or by two singularities – the neolithic and the global. The mechanism of social evolution at these phases is different and is based on different institutional means of cognition and competition. At the current structural phase, competition of individuals leads to inequality, and competition of societies leads to extension of societies. Social inequality and exploitation of the periphery become institutional tools for the

development. The expansion of societies and evolutionary limitations of its growth lead to life cycles of societies. The maximum size of society increases in the process of evolution and tends to cover all humankind. The Global Society is a final point of structural evolution, and transition to it is singularity. It will be a metamorphosis of the society's nature. The mechanism of further social evolution at the cognitive phase will rely directly on individual's need for cognition and self-realization, and not on the special social institutions. Mathematical model of the primary transformations dynamics at the structural phase is described by the equation $T(n) = -11214 + 1893\,n$, where $T(n)$ is the moment of evolutionary transformation, and n is the ordinal number of transformation. Global singularity is predicted by this model in AD 3930.

In the paper 'The Need for the Second Solar-Digital Revolution: Advice and Warning from a Friendly, Alien Civilisation' **David Hookes** notes that in order to survive as a species on this planet, to prevent the possibility of the Earth becoming a dead planet through run-away global warming, then we need to have a second solar-digital revolution. The first solar-digital revolution was the beginning of the evolution of complex life itself. It was only possible for life to evolve beyond a very primitive level of bacteria and archaea when it had developed a solar energy source that could be linked to an existing quaternary digital system (qDS), *i.e.*, the genetic code. The latter was necessary to control the release of this energy and to pass on adaptation to environmental changes to the next generation. Once the cyanobacteria developed photosynthesis to capture solar energy, with the concomitant creation of an oxygen-rich atmosphere, evolution could 'take-off'. Oxygen from photosynthesis then provided an immediate rich source of energy for respiration. For evolution of life on the planet to continue we must replace fossil energy by renewable largely solar energy – a return to our evolutionary origins as it were. Binary digital systems (bDS) technologies will enable the integration of the different intermittent sources of solar energy, store it, possibly, as hydrogen, and then control its release. Thus, bDS technology will also allow the development and integration of a new socio-economic system driven by this new energy source, and create the possibility of a global cultural enlightenment.

The paper by **Johanna Butler-Hookes** 'Agroecology vs Agribusiness in the Solar-Digital Age' addresses the following question: can the world's nutritional needs be met from a sustainable food system, *i.e.*, one that simultaneously protects the environment from pollution, prevents loss of bio-diversity and reduces carbon emissions, so as to stabilize the climate? The present agribusiness food production is highly dependent on external inputs of fossil fuel, artificial herbicides, pesticides, fertilizers and genetically modified seeds (GMS) to keep yields maintained. Environmental scientists, social scientists and development agencies consider them as big polluters and major contributors to loss of biodiversity and destabilization of climate. The paper considers agroecology,

working with nature, agroecologists and local knowledge, practiced by millions of smaller farm units, presently providing 70 % of the world food needs. This approach is analyzed and compared with the commercial system through the use of various case studies. Conclusions are drawn on which system is the most likely to succeed in meeting the urgent need for a sane (S), humane (H) and ecologically (E) (SHE) sustaining food system that will both care for the planet and contain the increase in temperature to within the 2 % above pre-industrial levels with the assistance of solar renewable energy.

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