Introduction

At the Junction of Theories and Paradigms

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The present volume is the third issue of the Almanac series titled 'Evolution'. The first volume came out with the sub-heading 'Cosmic, Biological, and Social' (Grinin *et al.* 2011), the second was entitled 'Evolution: A Big History Perspective' (Grinin, Korotayev, and Rodrigue 2011).

When we started the publication of the *Evolution* Almanac, we proceeded from the idea that we need epistemological key terms in order to understand the changes occurring in nature and society in their entirety and similarity of patterns and laws of development *etc*. There are quite a few scientific notions that can be employed as such key terms. We think that *evolution* is one of them. In our opinion, the concept of evolution remains important for the unification of knowledge. At present we also need a higher level of co-operation that could provide a large-scale analysis of the evolutionary processes through interdisciplinary approaches. Our research in this direction as well as our interaction with those who work in this field representing various sciences and approaches (including the Big History one) have convinced us that this idea is really fruitful. The application of the evolutionary approach to the history of nature and society has remained one of the most effective ways to conceptualize and integrate our growing knowledge of the Universe, society and human thought. Moreover, we believe that without using mega-paradigmatic, theoretical instruments such as the evolutionary approach, the scientists working in different fields may run the risk of losing sight of each other's contributions (Grinin, Korotayev, Carneiro, and Spier 2011: 7).

What is more, we have become convinced that the evolutionary megaparadigm is not only capable of uniting representatives of different branches of science; it is capable of finding such research directions where representatives of different sciences can work together. The present volume (subtitled *Development within Big History, Evolutionary and World-System Paradigms*) demonstrates this in a rather convincing way. In addition to the straightforward evolutionary approach, it also reflects such adjacent approaches as Big History,

the world-system analysis, as well as globalization paradigm and long wave theory. The Big History issue was discussed in much detail in the previous issue of the Almanac (Grinin, Korotayev, and Rodrigue 2011). *Big History* or Universal evolutionism considers the process of evolution as a continuous and integral process – from the Big Bang all the way to the current state of human affairs and beyond. It implies that cosmic, chemical, geological, biological, and social types of macroevolution exhibit forms of structural continuity. The great importance of this approach (that has both the widest possible scope and a sound scientific basis) is evident. It strives to encompass within a single theoretical framework all the major phases of the history of the Universe, from the Big Bang to forecasts for the entire foreseeable future, while showing that the present state of humankind is a result of the self-organization of matter. However, the evolution field is much wider than the single Big History's line of changes (though it is very important).

On the other hand, many readers of our Almanac may be less familiar with the world-system approach. That is why further we will discuss it in some detail. We also find it appropriate to say a few words about the notions of 'world-system' and 'the World System'.

The notion of 'world-system' (as it is used in the present Almanac) can be defined as *a maximum set of human societies that has systemic characteristics, a maximum set of societies that are significantly connected among themselves in direct and indirect ways. It is important that there are no significant contacts and interactions beyond this set, there are no significant contacts and interactions between societies belonging to the given world-system and societies belonging to other world-systems.* If still there are some contacts beyond those borders, then those contacts are insignificant, that is, even after a long period of time they do not lead to any significant changes within the world-system – for example, the Norse voyages to the New World and even their settlement there did not result in any significant change either in the New World, or in Europe (see, *e.g.*, Slezkin 1983: 16).

Within this framework, the 'world-system' can be characterized as a supersystem that unites many systems of lower orders, such as states, stateless societies, various social, spatial-cultural, and political entities – civilizations, alliances, confederations, *etc.* Thus, the evolutionary field with respect to a world-system has the maximum wideness in comparison with other social systems. The very process of social evolution is modified within a world-system, because contacts become denser, whereas the role of macroevolution becomes more and more salient. In a certain sense it appears even possible to say that independent evolution of separate societies tends to cease, because the evolution of particular societies becomes more and more influenced by macroevolutionary aromorphoses that diffuse within the world-system framework. That is

why we observe different rates of development in societies belonging to world-systems and isolates, in the main ('central', Afroeuroasian) world-system (= the World System) and peripheral (*e.g.*, American) world-systems (prior to their incorporation into the World System). In general, the larger the size and internal diversity of a social system, the more internal links it has, the more complex those links are, and, *ceterum paribus,* the higher is the rate of its development.

A formal criterion that allows us to regard (with Andre Gunder Frank) the Afroeurasian world-system as the World System is the point that during its entire history this world-system encompassed more territory and population than any other contemporary world-system. What is more, for the last few millennia it encompassed more than a half of the world population and this appears to be a sufficient criterion permitting to denote this world-system as the World System. Another point of no less importance is that the modern World System that actually encompasses the whole world was formed as a result of the expansion of that very system which, after A. Gunder Frank (1990, 1993; Frank and Gills 1993), is denoted in the present article as the World System (and which up to the late 15th century was identical with the Afroeurasian world-system).

The world-system approach originated in the late 1960s and 1970s due to the works by Braudel, Frank, Wallerstein, Amin, and Arrighi, and was substantially developed afterwards (see, *e.g.*, Braudel 1973; Frank 1990; 1993; Frank and Gills 1993; Wallerstein 1974, 1987, 2004; Chase-Dunn and Hall 1994, 1997; Arrighi and Silver 1999; Amin *et al.* 2006; Grinin and Korotayev 2009). Its formation was connected up to a considerable degree with the search for the actual socially evolving units that are larger than particular societies, states, and even civilizations, but which, on the other hand, have real system qualities.

The Almanac consists of four sections.

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Section I. Globalization as an Evolutionary Process: Yesterday and Today contains three articles demonstrating that Evolutionistics[1] is capable of creating a common platform for the world-system approach, globalization studies, and the economic long-wave theory. It is worth saying a few words about this theory (see also Korotayev and Tsirel 2010; Grinin, Devezas, and Korotayev 2012).

The Russian economist writing in the 1920s, Nikolai Kondratieff observed that the historical record of some economic indicators then available to him

[1] Evolutionistics is an interdisciplinary field of research focusing on studying similarities and differences in evolutionary laws, principles, patterns and mechanisms at all or some levels and stages of evolution. Therefore, Evolutionistics is a common field for carrying out special evolutionary research.

appeared to indicate a cyclic regularity of phases of gradual increases in values of respective indicators followed by phases of decline (Kondratieff 1922: ch. 5; 1925, 1926, 1935, 2002); the period of these apparent oscillations seemed to him to be around 50 years. He discovered this pattern with respect to such indicators as prices, interest rates, foreign trade, coal and pig iron production (as well as some other production indicators) for some major Western economies (first of all England, France and the United States), whereas the long waves in pig iron and coal production were claimed to be detected since the 1870s for the world level as well (note that as regards the production indices during decline/downswing phases we are dealing with the slowdown of production growth rather than with actual production declines that rarely last longer than one or two years, whereas during the upswing phase we are dealing with a general acceleration of the production growth rates in comparison with the preceding downswing/slowdown period [see, *e.g.*, Modelski 2001, 2006 who prefers quite logically to designate 'decline/downswing' phases as 'phases of take-off', whereas the upswing phases are denoted by him as 'high growth phases']). Many social scientists consider Kondratieff waves as a very important component of the modern world-system dynamics. As has been phrased by one of the most important K-wave students (who is also among the contributors to this volume), 'long waves of economic growth possess a very strong claim to major significance in the social processes of the world system… Long waves of technological change, roughly 40–60 years in duration, help shape many important processes… They have become increasingly influential over the past thousand years. K-waves have become especially critical to an understanding of economic growth, wars, and systemic leadership... But they also appear to be important to other processes such as domestic political change, culture, and generational change. This list may not exhaust the significance of Kondratieff waves but it should help establishing an argument for the importance of long waves to the world's set of social processes' (Thompson 2007).

There are three articles in the section.

George Modelski ('Kondratieff Waves, Evolution and Globalization') considers that contemporary Kondratieff wave (K-wave) studies show two tendencies: first, a macroeconomic analysis that maps long trends of prosperity and depression with GDP data, and second, a sectoral approach that traces the influence of K-waves of basic innovations, and the rise of a succession of leading industrial and/or commercial sectors on the emergence of a global economy. They stand in a close relationship with world politics, democratization, and globalization. An evolutionary explanation of K-waves is one that gives a reasoned account of the emergence of the modern global economy over the past millennium, and one that may project equally far into the future.

Leonid E. Grinin and Andrey V. Korotayev ('Globalization and the World System Evolution') proceed from the point that the formation of the Afroeurasian world-system was one of the crucial points of social evolution after which the social evolution rate and effectiveness increased dramatically. The authors analyze processes and scales of global integration in historical perspective, starting with the Agrarian Revolution. They connect the main phases of historical globalization with the processes of development of the Afroeurasian world-system, in which the integration began a few thousand years before the Common Era. Grinin and Korotayev analyze some versions of periodization of history of globalization and propose their own periodization of globalization using as its basis the growing scale of intersocietal links as an indicator of the level of globalization development.

Andrey V. Korotayev ('Globalization and Mathematical Modeling of Global Evolution') points out that the variation in demographic, economic and cultural macrodynamics of the world over the last ten millennia can be accounted for in a very accurate way by very simple mathematical models. It is shown that up to the 1970s the hyperbolic growth of the world population was accompanied by the quadratic-hyperbolic growth of the world GDP and these are very tightly connected processes, actually two dimensions of one process propelled by the nonlinear second order positive feedback loops between the technological development and demographic growth. The suggested approach throws a new light on our understanding of globalization processes. The author discusses that the most of the world population got 'globalized' many millennia before 'the century of globalization', though the World System had only encompassed the whole of the Earth landmass in the 2nd millennium CE.

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Section II. Society, Energy, and Future. The evolution of human society (as well as the evolution of the Universe in general) is connected rather tightly with the development of the capacity to capture and transform energy. The future of humanity depends rather heavily on the solving of energy problems. This direction of the evolutionary studies is developed in all the three contributions to this section that on the basis of Evolutionistics unite the long wave theory, the Big History, and globalization studies. There are three articles in the section.

William R. Thompson ('Energy, Kondratieff Waves, Lead Economies, and Their Evolutionary Implications') affirms that one way to look at the evolution of technological innovation is to develop ways to convert various types of matter into successively greater amounts of energy to fill sails, to spin cotton or to drive automobiles and air conditioners. One approach to interpreting Kondratieff waves (K-waves), associated with the leadership long cycle re-

search program, emphasizes the role of intermittent but clustered technological innovations primarily pioneered by a lead economy, with various significant impacts on world politics. This approach is further distinguished by asserting that the K-wave pattern is discernible back to the tenth century and the economic breakthrough of Sung Dynasty China. While K-wave behavior has many widespread manifestations, the question raised in this essay is whether explanatory power is improved by giving a greater role to energy and energy transitions in the K-wave process(es). Eight specific implications are traced, ranging from the interaction of technological innovations and energy to cosmological interpretations.

David LePoire ('Potential Economic and Energy Indicators of Inflection in Complexity') proceeds from the idea that energy and environmental factors have often driven transitions in natural evolution and human history to more complex states which are far from equilibrium. He points out that recent studies have indicated: 1) the importance of energy along with labor and capital in determining economic productivity; 2) the potential slow-down of growth in economies and sciences; and 3) the relatively increased pace of global technology diffusion compared with concentrated technology breakthroughs. His paper identifies indicators in energy, economic growth, and global economic disparities to connect historical trends with potential scenarios of the transition to an expanded sustainable non-equilibrium society. By transitioning back to a sustainable non-equilibrium pattern, the required complexity changes may also slow down as suggested by interpretations of Big History major events. Similar transitions have been observed and modeled in natural dynamic ecological systems.

Joseph Voros ('Profiling 'Threshold 9': Using Big History as a framework for Thinking about the Contours of the Coming Global Future') makes use of the '8-threshold' formulation of Big History due to David Christian. Voros examines some of the conceptual possibilities that arise when one consciously and systematically takes a 'Big History perspective' on the future of humanity at the global scale. Specifically, he considers the question of what the next major threshold in Big History – what he calls 'Threshold 9' – may look like in broad outlines.

He finds that the most probable global future currently in prospect is a slowly-unfolding collapse or 'descent' over a time-scale of decades-to-centuries towards a human society characterized by ever-declining access to sources of fossil-fuel-based energy. In his opinion such a future trajectory clearly has major implications for the level of human societal complexity possible. This suggests undertaking an anticipatory program of continuing research and exploration into both the underlying nature and the emergent characteristics of the coming transition to 'Threshold 9'.

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Section III. Aspects of Social Development. The themes of contributions to this Almanac cover all the areas of Evolutionary studies; however, most articles deal with social evolution. This section touches upon four aspects of social evolution – technological, environmental, cultural, and political.

There are four articles in the section.

In their article 'Macroevolution of Technology' **Leonid E. Grinin and Anton L. Grinin,** basing their research on abundant data, demonstrate that global technological transformations is one of the most fundamental causes of human evolution. Among all the major technological breakthroughs in history, they consider the most important the three production revolutions: 1) the Agrarian Revolution; 2) the Industrial Revolution; and 3) the Scientific-Information Revolution which will transform into the Cybernetic one. In the article the authors introduce their original Theory of Production Revolutions. This is a new explanatory paradigm which is of value when analyzing causes and trends of global shifts in historical process. The article describes the course of technological transformations in history and demonstrates a possible application of the theory to explain the present and forthcoming technological changes. The authors argue that the third production revolution that started in the 1950s and which they call the Cybernetic one, in the coming decades, that is in the 2030s and 2040s, will get a new impetus and enter its final stage – the epoch of (self)controllable systems. They give certain forecasts concerning the development in such spheres as medicine, biotechnologies and nanotechnologies in the coming decades (the 2010s–2060s).

In his paper 'Volcanism as It Impacts the Integrity of the World System', **Tony Harper** investigated a very interesting aspect of interconnection between society and environment, notably the relationship between the occurrence of global volcanic events (GVEs) and the integrity of the world system. Tree-ring data recording GVEs is used as a context for comparing the response of the world system through four centuries after any given GVE. It is found that the GVEs have no significant effect in the century after them, but two, three, and four centuries afterwards. Besides, this effect is counterintuitive, as the world system became more but not less urbanized. The rank size-frequencies were analyzed for each data set to show that all changes effectively fit a linear series characteristic of the systems exhibiting self-organized criticality. Finally, it is shown that a threshold effect with respect to the number of year equivalents of GVEs exists; whereby the reduction in world system urbanization occurs in the century right after such threshold events. These results are then put in the context of both physically and endemically induced societal collapses.

Within Big History framework, **Christopher J. Corbally and Margaret Boone Rappaport** ('Crossing the Latest Line: The Evolution of Religious

Thought as a Component of Human Sentience') explore the emergence of religious thought as a major foundation of sentience and some aspects of the subject of Human Sentience in Big History retrospective. They put following questions: Do religious and scientific thought have common roots and ongoing connections? Is scientific thinking enhanced by a capacity for religious and artistic thought? The authors also explore religious thought as an evolutionary adaptation with cognitive, emotional, and perceptual features that were acted upon by natural selection.

Neil Robinson ('"Natural" States and the Development of Democracy') points out that such scholars as Douglass C. North, John Joseph Wallis, and Barry R. Weingast have developed a parsimonious theory of the relationship between political order and economic development. They argue that most states in human history have been 'limited access orders' (LAO) or 'natural states', rather than 'open access orders' (OAO). They also state that this framework can be used to analyze constraints on economic development and the development of political order across recorded human history. The author considers how cases from the former Soviet bloc can be integrated into their theory. The paper reviews North *et al.*'s ideas and maintains that the LAO schema can be adapted to describe Soviet-type systems. It argues that some of the variance between Soviet-type systems and their ability to move from LAO to OAO can be accounted for by the way that the logic of being a LAO led them to engage with the global economy.

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Section IV. The Driving Forces and Patterns of Evolution. This section deals with various phases of megaevolution.

There are the following articles.

In his article '10^{500}. Darwinian Algorithm and a Possible Candidate for a "Unifying Theme" of Big History' **David Baker** postulates another aspect of the long-sought after 'unifying theme' of Big History, in addition to the rise of complexity and energy flows. He looks briefly at the manifestation of the 'Darwinian algorithm', that is to say an algorithm of random variation and non-random selection, in many physical processes in the Universe: cosmology, geology, biology, culture, and even the occurrence of universes themselves. This algorithm also seems to gradually open more forms of variation and more selection paths over time, leading to a higher level of free energy rate density, or what we know as 'complexity'. In fact the complexity of the object under discussion seems to correspond to the available number of selection paths. The article also reflects on what the Darwinian algorithm and the rise of complexity could possibly mean for the humanity and the future of the cosmos.

It is worth making some editorial comments on David Baker's paper. This is an interesting and audacious article trying to find a common evolutionary mechanism not only within, but beyond Big History as well. Baker starts his article with analyzing the selection of universes within which there could appear some physical laws and parameters allowing the universes to evolve. Baker explores the selection mechanism among an enormous number (potentially 10^{500} – a fabulous number even for modern cosmology) of universes in the 'multiverse'. Of course, the idea that there exist other universes besides ours is still an absolutely unconfirmed, though outstanding, hypothesis. But consideration of hypotheses is one of the main activities in science. In our opinion, the algorithm, which Baker analyzes, could hardly be called Darwinian in proper sense with respect to cosmic evolution and *a fortiori* with respect to the selection of universes and physical laws. He rather speaks about the evolutionary selection in general – that is not the selection of the fittest, but rather the selection of those capable to evolve – which is much wider than the Darwinian selection. The matter is that in biology we always have limited resources (even in the absence of direct competition) and constantly changing conditions. If the resources were not limited and if conditions did not change constantly, there would be no selection. The Darwinian selection means the survival of the fittest. How could this be applicable to universes? Would not it be more correct to speak about a random cosmic selection which later in the course of evolution could evolve into non-random (though not directed) Darwinian selection? Or at least would not it be more appropriate to call the cosmic selection proto-Darwinian? No matter how one interprets such cosmic selection, we cannot but appreciate the author's endeavor to point out selection as one of the most important evolutionary mechanisms at all stages of Big History.

Dmitry A. Skladnev, Sergey P. Klykov and Vladimir V. Kurakov explore the important subject of biological evolution in the paper titled 'Complication of Animal Genomes in the Course of the Evolution Slowed Down after the Cambrian Explosion'. They also propose an original mathematical model which takes into account a multiphase character of development and importance of multidirectional trends in evolution. The authors argue that for the first time the growth rate of minimal animal genome size is shown to have slowed down in the course of the evolution from prokaryotic forms to mammals after the Cambrian explosion. From the biological viewpoint, the authors explain the exponential change of minimal genome size which occurred in the beginning of the evolutionary process and slowed down after the period of the Cambrian explosion; they also present certain parameters of evolutionary processes resulting from their model application. According to the proposed model, the S-shaped curve with distinct inflexion point adequately describes the increase of minimal genome size.

Arthur Saniotis, Maciej Henneberg and Jaliya Kumaratilake present the article 'An Evolutionary and Anthropological Examination of Brain/Mind and Novelty'. This article provides an overview on how the brain/mind works in relation to novelty from evolutionary and anthropological perspectives. They maintain that the human brain functions evolved to support the survival of our ancestors as omnivores in natural environments that were of complex and varied nature. This evolution, of necessity, had to support the development of extensive memory systems and of an ability to imitate behaviors of others. Novelty as an expression of creative thought probably evolved along with the increasingly complex social processes of earlier human ancestors. Novel thought was especially expedited by the evolution of complex societies, which allowed for increasing of the individual specialization. The paper locates brain/mind novelty in terms of evolution, pattern and evolutionary learning. The authors conclude that novelty is contingent on social systems, and that current human societies need to challenge habituatal ways of thinking in order to reduce social and ecological problems.

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The final section **(*Discussion. Evolution: Pro et Contra*)** is devoted to a discussion. As we declared in the first issue of our Almanac, we want to encourage as much an open discussion as possible about evolutionary studies, in hope that sometime in the future a new diversity of approaches may lead to the emergence of a new unifying approach. In the present volume the subject of the discussion has turned out to be the very essence of evolutionism rather than particular aspects of the evolutionary theory (whatever important they could be). The discussion is opened with **Gregory Sandstrom's** article ('Peace for Evolution's Puzzle: The Arrival of Human Extension') that can be regarded as generally antievolutionist.

One of the initial reviewers of this article, Edmundas Lekevičius notes that Sandstrom tries to present (as he claims) a positive alternative to evolutionism as a universal ideology that can be applied to social sciences and humanities (as Sandstrom believes) without sufficient justification. He is inclined to leave Darwinian evolution to biologists only, and he is strongly against its application to social studies, for example, in the form of Sociobiology. His position is based on the following points.

He believes that both Darwinism and neo-Darwinism consider struggle and competition as the primary cause of evolution and as its driving force (note that this critique is rather obsolete dating to the late 19^{th} – early 20^{th} century), whereas in social systems cooperation turns out to be more important (here Sandstrom relies on Kropotkin's article that must be regarded as very one-sided and besides rather out-dated by present). It is just cooperation that secures

socioeconomic progress. The society develops, but does not evolve in the sense in which evolution is understood by the biologists. The development of society is reversible, whereas the development in nature is irreversible. Sandstrom also believes (without serious reasons) that the notion of 'natural selection' is not applicable to the social/human realm.

Though the author claims to offer a theory that could serve as an alternative to evolutionism, he has actually failed to produce such an alternative. He insists rather persistently on the substitution of the term 'human evolution' with the notion of 'human extension'. In this respect, Edmundas Lekevičius notes the following: 'I am not ready to call such a substitution "a new methodology" or a new paradigm. The author pays too much attention to this purely linguistic aspect of the issue under discussion'. Together with Lekevičius, we can also draw the readers' attention to the fact that the author did not even try to give at least a couple of examples of inadequate application of the Darwinian approach in Sociology and Economics. As a result, in his article he had to fight an entirely imaginary enemy.

It might have looked natural for the *Evolution* Almanac to reject such an article. However, we believe that at present the Evolutionary Studies are sufficiently strong not to avoid the participation in discussions on the relevance of classical evolutionary approaches for modern social sciences. We will not go in detail in the critique of Sandstrom's approach, as the famous evolutionist **Henri J. M. Claessen** has expressed not only his position, but also the position of the editors and many our authors in his reply to Sandstrom that is published in the final part of the present Almanac.

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