

Introduction

Evolutionary Megaparadigms: Potential, Problems, Perspectives

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The formulation of the first scientific theories of the evolution of nature began at least two centuries ago. However, the philosophical roots of evolutionary ideas are much older (see, e.g., Vorontsov 1999; Asmus 2001; Chanyshv 1976, 2001; Barg 1987; Ilyushechkin 1996; Losev 1977; Nisbet 1980). An incipient understanding of the historical dimension of natural processes can already be found among the ancient Greeks (e.g., Heraclitus, Anaximander, Empedocles, etc.). In the late Modern period these ideas strengthened in conjunction with the idea that historical changes in nature can be described with the aid of rigorous laws. This type of thinking created the evolutionary approach in science. However, these ideas penetrated rather slowly in various branches of science. Nevertheless, supported by a growing body of firm evidence, the evolutionary approach became gradually established during this period in geology, cosmology, biology and social sciences.

It is commonly believed that the concept of evolution was first formulated by Charles Darwin, but that was not the case. Although it is not generally known, Darwin did not even use the word ‘evolution’ in the first five editions of *The Origin of Species*. Not until the 6th edition, published in 1872, did he introduce the term into his text. Moreover, he used it only half a dozen times, and with no more of a definition than ‘descent with modification’.

It was Herbert Spencer who, in *First Principles* – a book published ten years before the 6th edition of *The Origin* – introduced the term into scientific discourse. Stone by stone, over the seven chapters that make up the heart of that book, Spencer carefully built up the concept of evolution, culminating in his classic definition: ‘Evolution is a change from an indefinite, incoherent homogeneity, to a definite, coherent heterogeneity, through continuous differentiations and integrations’ (1862: 216).¹

¹ *First Principles* represented only the final, full-blown formulation of Spencer’s concept of evolution. Previously, in a series of essays written during the 1850s, he had exhibited various aspects of the process as manifested in various domains of nature. Then in 1857, in the article entitled *Evolution: Cosmic, Biological, and Social* 2011 5–29

And – that is especially important for our subject – whereas Darwin applied evolution exclusively to the world of life, Spencer saw it as a process of universal application, characterizing all domains of nature.²

There followed a series of works – *The Principles of Biology* (1864–1867), *The Principles of Psychology* (1870–1872), and *The Principles of Sociology* (1876–1896) in which Spencer showed, in great detail, how evolution had manifested itself in each of these fields. Already in the 19th century it was possible to see Darwinian and Spencerian evolution as two contrasting – and indeed competing – interpretations of the kinds of change phenomena had undergone.³

Thus, after works of Darwin and especially Spencer in the final decades of the 19th century the idea of evolution in nature and society, together with the notion of progress, became a major component of not only science and philosophy, but also of social consciousness in general,⁴ leading to an overall picture of the world development. In the second half of the 20th century the related

‘Progress: Its Law and Cause’, he wrote: ‘The advance from the simple to the complex, through a process of successive differentiation, is seen alike in the earliest changes of the Universe to which we can reason our way back, and in the earliest changes which we can inductively establish; it is seen in the geologic and climatic evolution of the Earth; it is seen in the unfolding of every single organism on its surface, and in the multiplication of kinds of organisms; it is seen in the evolution of Humanity, whether contemplated in the civilized individual, or in the aggregate of races; it is seen in the evolution of Society in respect alike of its political, its religious, and its economical organization; and it is seen in the evolution of all those endless concrete and abstract products of human activity...’ (Spencer 1857: 465). Despite his use of ‘progress’ in the title of this article, Spencer came to realize that the word had normative overtones, and that he needed a word free of that. In ‘evolution’, he found a word – not often used in scientific writing up to that time – that proved to be the answer to his search.

² It is worth to point that Spencer first hit upon the idea of evolution while reading a description of Karl von Baer's discussion of embryological development. Von Baer described it as essentially a process of successive differentiations, from very rudimentary beginnings. Starting out as a single fertilized egg, the embryo underwent a series of divisions and subdivisions, its parts becoming progressively more varied and more specialized. Spencer was struck by the fact that the process that marked the development of a single organism was also the process that characterized the development of all orders of phenomena.

³ The contrast between them was not just that one concept was limited to the biological sphere while the other characterized change in the rest of nature as well. Rather, the contrast involved *different aspects* of the process itself. Both views saw natural selection providing the basic mechanism behind evolution, but while alike in this regard, the two conceptions of evolution differed in a number of respects. Darwinian evolution not only operated on a smaller scale, it also was more closely tied to individual events. It was more opportunistic, more contingent as to just what path it followed. In Darwinian evolution the form of an animal species could zigzag back and forth over the course of generations, seeking the most favorable adaptation to existing conditions. Only when it could be seen as having moved in the direction of increasing complexity could it be considered to have evolved in the Spencerian sense.

⁴ Morris R. Cohen (1958) maintains that the idea of universal evolution, starting with Spencer, has produced a very strong influence over people and has excited their imagination to such a degree that is only similar to a very limited number of major intellectual achievements since the Copernican revolution.

ideas of historicism and evolutionism had penetrated rather deeply into natural sciences such as physics and chemistry.

While this respectable scientific tradition has quite ancient roots, even today there is only a rather limited number of studies that analyze the evolution of abiotic, biological, and social systems as a single process. Even fewer studies seek to systematize the general characteristics, laws, and mechanisms of evolutionary dynamics in order to allow a comparative analysis of different evolving systems and evolutionary forms. Furthermore, the history of evolutionary approaches and methods is rarely represented in the literature. Encyclopedias, for instance, pay very little attention to the notion of evolution and the development of evolutionary approaches to history.⁵ This is remarkable, given the fact that the application of the evolutionary approach (in the widest possible meaning of the term) to the history of nature and society has remained one of the most important and effective ways for conceptualizing and integrating 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 scientists working in different fields may run the risk of losing sight of each other's contributions.

What could have caused the current insufficient attention to evolutionary studies? First of all, the crisis of evolutionism in the late 19th century and the first half of the 20th century in philosophy, biology, anthropology, sociology and some other fields (see, *e.g.*, Zavadsky 1973: 251–269; Zavadsky *et al.* 1983: 21–26; Cohen 1958; Carneiro 2003: 75–99) was caused by the fact that some classic evolutionists (but not all of them, including Darwin himself) based their ideas on a rather naïve belief in the idea of the unilinearity of development and the universality of general laws, as well as that nature and knowledge coincide entirely (see Bunzl 1997: 105). As a result, the positivistic philosophy of evolutionism could no longer accommodate the rapidly developing scientific knowledge and was rejected together with the idea of uninterrupted progress (Parsons 2000: 44).

However, the mistakes of the early evolutionists, who tried to encompass all the processes with a single and eternal evolutionary law, should not be regarded as the main cause for the current lack of attention to mega-evolutionary research. Such ‘excesses’ are rather common during the formative period of scientific schools. Since that time, the evolutionary approach has been purged from many of these excesses. This explains to a considerable extent why many scientists have returned to using evolutionary ideas at a new level of scientific understanding as well as why they are developing them actively, not only within biology, sociology, or anthropology, but also within physics, chemistry and astro-

⁵ We mean the approach to evolution as a general scientific interdisciplinary paradigm.

nomy. During the same period in the 20th century, the scientific understanding of timescales related to the evolution of the Universe, life and humanity improved dramatically. The better understanding of often enormously long periods of time during which certain systems and structures were formed stimulated (especially within natural sciences) studies into the emergence of everything. These studies proved to be more successful when they were based on evolutionary paradigms.

However, we believe that a major cause for the lack of attention to evolutionary paradigms is connected with the deepening contradiction between, on the one hand, the aspiration for levels of scientific precision and rigor that can only be achieved through narrow specialization, and, on the other hand, the limited human ability to absorb and process information. In addition, perhaps more than any other theory, macro-evolutionary theories have to deal with the acute contradiction between the world and its cognizing agents; this contradiction can be expressed in the following way: how can infinite reality be known with the aid of finite and imperfect means? The wider the scope of studied reality is within a given theoretical approach, the more acute this contradiction becomes.

In earlier eras of scientific studies one could hope to know reality interpreted as a ‘thing’ that is hidden from the human eyes by the armor of ‘phenomena’ (see Bachelard 1987: 17–18). The speculative philosophy dominant in the mid 19th century was based on the assumption that the search for universality implied the presence in the Universe of some form of essence that did not permit any relationships outside itself. It was the task of speculative philosophy to discover such an essence (Whitehead 1990: 273). Today, however, this type of approach has largely been abandoned.

If Popper (1974) and Rescher (1978) are right by maintaining that for any concrete scientific problem an infinite number of hypotheses is possible, and if it is correct that the number of scientific laws in any scientific field is an open system with an indefinite number of elements (see, *e.g.*, Grinin 1998: 35–37; Grinin and Korotayev 2009: 45), then what could be a possible total number of hypotheses in evolutionary theory? Furthermore, the need to master colossal amounts of information as well as complex scientific methods makes research into macroevolution rather difficult. However, if the human mind had always retreated while confronting problems of cognition that appeared overwhelming, we would have neither philosophy nor science today. The complexity of such tasks and the difficulties in reaching solutions both stimulate the search for new theoretical and experimental means (including bold hypotheses, theories, and methods). As we see it, evolutionism as an interface theory that analyzes historical changes in natural and social systems and as a method that is appropriate for the analysis of many directional large-scale processes

will occupy a most important place in the struggle for human understanding of the outside world.

In the past, philosophers and thinkers could try to embrace the whole universe with a single idea. Today, it seems as if the epoch of great universalists and polymaths, who could make great discoveries in very diverse fields of knowledge, will never return. However, the need for conceptual organization and unification of knowledge still exists and is felt as such by many scientists. As Erwin Schrödinger (1944) noted, even though it has become almost impossible for a single mind to master more than one small specialized field of science, some scientists should still try to synthesize facts and theories into large-scale overviews.

The fact that the need for modern analyses of a great variety of large-scale processes remains rather strongly felt and is even increasing today is not surprising. The currently globalizing world needs global knowledge. That is why we see the emergence of forecasts of the future of the Universe, of our planet and our World System; the development of gigantic data bases; the study of trends and cycles with enormous lengths and with very diverse characteristics. The trend toward multi-disciplinary approaches is also becoming ever more evident today.

However, we still need to develop effective meta- and mega-theories that allow us to study the development of nature, society, and, indeed, the entire universe on suitable scales of time and space. We need effective theories that provide good ways for linking universal and local levels as well as relatively objective instruments for comparing various systems using a range of parameters. Only this will make it possible to detect common features and trends in the endless flow of change and diversity observed in reality. This may also allow us to identify hierarchies of causes that influence the course of change and development.

We need epistemological key terms in order to understand change in nature and society in its entirety. There are not that many scientific notions that could play the role of such key terms. We think that *evolution* is one of them. As we see it, the idea of evolution remains important for the unification of knowledge. Yet one should not overestimate the importance of evolution in the way of Pierre Teilhard de Chardin (1987), who believed that the evolutionary theory is more than scientific theory. To be sure, no scientific method can claim to be the only one. There will always be alternative points of view. Any method or approach has its limitations. Today, the evolutionary approach seems especially valuable. Evolutionary studies constitute one of the most fruitful fields of interdisciplinary synthesis, where representatives of the natural and social sciences as well as the humanities find common ground for research and analysis.

We are entirely ready to acknowledge that evolutionism (as any other paradigm) has its limitations. That is why we want to discuss them here with

the aim to improve our understanding of it. This could raise evolutionary theories to a new qualitative level that is in agreement with current scientific knowledge. We believe that the present Almanac, which brings together scientists working in different areas of the vast evolutionary field, will hopefully make a contribution to this process.

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One of the clearest manifestations of the evolutionary approach is the form of universal evolutionism (*Big History*) that considers the process of evolution as a continuous and integral process – from the Big Bang all the way down to the current state of human affairs and beyond. Universal evolutionism implies that cosmic, chemical, geological, biological, and social types of macroevolution exhibit forms of structural continuity (for examples of this approach see, e.g., Chaisson 2001; Nazaretyan 2004; Panov 2008b; Fesenkova 1994; Christian 2004; Grinin *et al.* 2009; Jantsch 1983; Spier 2005, 2010).⁶ 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 universe, from the Big Bang down 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 conceptual efforts of a single scientist – even if he or she possesses exceptional erudition – have their limits. This situation does not change radically when a few such theorists become united in scientific schools. We now need a higher level of co-operation that can achieve a large-scale analysis of evolutionary processes through interdisciplinary approaches.

Which forms and directions could be especially promising in this respect? We believe that one of them could be *comparative evolutionary studies*, i.e. the approach followed in articles published in the second section of this Almanac.⁷ The search for a ‘common denominator’ for different evolutionary levels is very important, as it could show common fundamental characteristics of all forms of matter.⁸ Yet, there is some risk to exaggerate its potential for

⁶ Although the notions of *megaevolution* and *macroevolution* are very similar at the moment and can well be regarded as synonyms, it may still make sense to discriminate between them. For instance, the term *megaevolution* could be used for the whole process of evolution, all of its phases and qualitative levels from the Big Bang to the forecastable future, whereas *macroevolution* may be useful to characterize the full course of evolution within a particular realm – in such cases we would speak of cosmic, geological, chemical, biological, social macroevolution. In this book we will use those terms in this way.

⁷ Examples of comparative evolutionary studies include Carneiro (2005 and this volume), Grinin, Markov and Korotayev (Markov and Korotayev 2007; Grinin, Markov, and Korotayev 2008 and this volume); see also a number of articles in the special issue of the *Social Evolution & History* (Barry 2009).

⁸ Sometimes this is done using such ‘common denominators’ as energy or entropy (see, e.g., Chaisson 2001, 2005, 2006; on the analysis of such an approach see Spier 2005, 2010; see also his contribution to this Almanac).

the understanding of specific features of each type of macroevolution and its driving forces. Hence, any theoretical approach aiming to unite the methodological arsenal for analyzing different types of macroevolution cannot be mechanical in its nature. Thus, we need to develop and refine our common terminology, methodology, and conceptual contents.

This implies the necessity to create a *common field* for the study of evolutionary processes (among other things, through interdisciplinary research), within which we could clarify and refine the common and peculiar features in evolutionary approaches, terminology, principles, as well as conduct cross-evolutionary research. The wider the field will be and the more diverse the form of its integration, the more significant advances we may expect. We believe that this may well provide new productive opportunities leading to a better understanding of the course, trends, mechanisms, and peculiarities of each type of evolution.

In recent decades a number of researchers have tried to interconnect various forms of evolution. However, the study of evolutionary processes is mainly developing within each of its specific areas in rather isolated ways. In most cases, the scientists who study evolution often do not know that the problems they analyze may already have been solved in other fields of the evolutionary studies. The conclusions that they may have reached independently may be surprisingly similar for abiotic, biological and social systems. Some contributors to this volume experienced this firsthand when they discovered that solutions found in one field turned out to be applicable in another.⁹ The fullest consideration of this question is presented in the contribution by Leonid Grinin, Alexander Markov, and Andrey Korotayev 'Biological and Social Aromorphoses: A Comparison between Two Forms of Macroevolution' (in this Almanac); this article demonstrates how the application of ideas developed through the study of biological macroevolution can be very productive in the study of social macroevolution and *vice versa*. The authors trace contours of general analytic instruments, regularities and laws that are common for both types of macroevolution. This confirms once again the point that both a common field and significant theoretical elements that can shape a general paradigm of evolutionism are already available. However, they need to be developed further.

Thus, we first of all need to unite our efforts in order to see better what has already been done in this field. Those who are working with evolutionary *mega*-paradigms need to be enabled to know more about each other, in order to see

⁹ It is well known that, while developing the theory of natural selection (and, especially, the idea of struggle for survival) Darwin explicitly or implicitly relied on concepts of demography, political economy, and macrosociology, most notably the ones developed by Thomas Malthus, Adam Smith, and Herbert Spencer (see, e.g., Darwin 1991: 23; Mayr 1981: 18–19; Schweber 1977, 1980; Ingold 1986; see also Lekevičius' contribution to this Almanac, as well as the contribution by Grinin, Markov, and Korotayev). Note also that biologists have borrowed from economics such notions as 'invention' and 'innovation' (see, e.g., Erwin and Krakauer 2004).

and understand what has been done (and by whom), so that they can enrich themselves with the experience of scientists specializing in different fields of evolutionary studies. The best way to initiate such a process has often been to start a scientific publication. This approach formed the basis of the idea to start a multidisciplinary almanac with *Evolution* as its general title. We plan to publish here those articles that study multifarious forms of evolution. We suggest the widest possible range of topics in terms of both the scope of fields and the broadness of research designs: from approaches of the universal evolutionism to the analysis of particular evolutionary regularities in abiotic, biological, and social systems, culture, cognition, language, psychological phenomena, *etc.*

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The comparison between different types of macroevolution is an extremely important but, unfortunately, rarely studied subject, the analysis of which has convinced us that there are both fundamental differences and similarities. However, one may wonder on which common principles and aspects such a unified field, dealing with everything from galaxies to human societies, could be based. We believe that there are several important aspects to such an approach.

First of all, there are established fundamental notions such as ‘matter’, ‘energy’, ‘entropy’, ‘complexity’, ‘information’, ‘space’, and ‘time’, that provide a general framework for comparisons. In this issue of the Almanac several contributions deal with these issues, including Chaisson's ideas concerning the correspondence between increasing levels of complexity and the amount of energy flowing through them. This is expressed in terms of the amount of free energy that passes through a system during a certain period of time (Chaisson 2001, 2005, 2006). On this basis Chaisson seeks to detect a general mechanism of cosmological, biological, social, and even cultural evolution. In Spier's contribution to this Almanac, some of the merits and contradictions of this approach are discussed (see also Spier 2005, 2010).

In the second place, matter has some very general properties, which were perhaps already predetermined during the initial super dense phase of the universe. During the subsequent phases of universal evolution, matter acquires very specific forms, while new properties emerged at every new stage of the universal evolution.

In the third place, a few general system-dependent structural properties of matter¹⁰ appear to determine similarities between different types of macroevolution. Ashby (1958) noticed that while the range of systems is enormously wide, most systems consist of physical parts: atoms, stars, switches, springs,

¹⁰ If we take into account the concept of dark matter, it might be more appropriate to speak about ordinary matter as ‘matter that is capable of evolution’. Until now it has not been possible to say anything specific about ‘dark matter’, which supposedly forms the greatest portion of matter in the universe.

bones, neurons, muscles, gases, *etc.* (see also Hall and Fagen 1956). In many cases we are dealing with very complex systems that are found in many places (Haken 2005: 16). The emergence of forms of greater complexity results from the transition from one evolutionary level to another. The general principles related to the functioning and development of such objects can be described by general system theory. The concepts of self-organization and transition from equilibrium to a non-equilibrium state are also relevant in this respect. In addition, both biotic and abiotic systems show complex interactions with their environment that can be described in terms of general principles.

In the fourth place, mega-evolutionary trajectories can be considered as components of a single process, and their different phases can be regarded as different types of macroevolution that could be similar in terms of their main trends and directions as well as particular mechanisms. This will be discussed in more detail below.

In the fifth place, we can speak about common vectors of megaevolution as well as common causes and conditions during the transition from one level of organization to another.¹¹ There is a number of very important categories that are relevant for the analysis of all phases of megaevolution, most notably self-organization, stable and chaotic states, phase transition, bifurcation, *etc.*

Because of our rapidly growing knowledge of the universe, on the one hand, and, simultaneously, our lack of reliable information about many of its aspects, on the other hand, arguments regarding the issue of whether our world is 'strange', fortuitous (see, *e.g.*, Davies 1982, 1985, *etc.*), or 'regular' remain rather polarized (see, in particular, Kazyutinsky 1994). At present, we are dealing with conflicting paradigms that are hard to falsify, while even the very notion of what 'regular' means is not sufficiently rigorously defined (see Grinin and Korotayev 2009: ch. 1 for more detail). For this reason, modern cosmological theories and hypotheses sometimes exhibit directly opposing ideas. For example, according to Panov (2008a), the cosmological theory of 'chaotic inflation' implies that there is not just one universe, but in fact, an unlimited number of them, while all those universes can possess entirely different physics. As a result, life may be possible in some universes and impossible in others. Since we emerged in a universe where the life was possible, we observe the set of parameters that corresponds to the so-called 'anthropic principle'.¹² However, it may be that the cosmologies of inflation, the multiverse, and string theory do not have any relevance for reality as we observe it. The fundamental constants may

¹¹ The problem of evolutionary transitions from one level of megaevolution to another is discussed in a number of contributions to the present Almanac (Spier, Snooks, Grinin, Markov, Korotayev, Heylighen).

¹² The anthropic principle (that does not have any generally accepted wording yet) maintains the presence of a link between the large-scale properties of the expanding universe and the emergence of life, intelligence, and civilizations within it (see, *e.g.*, Kazyutinsky 1994).

simply have the observed values just because they cannot have any other values due to some yet unknown fundamental physical laws (Panov 2008a: 54–55).

At least five basic aspects can be identified that help us to recognize substantial similarities between different evolutionary forms and processes:¹³

1) the ‘starting’ level/aspect, consisting of a minimum number of general characteristics of matter and energy that are, apparently, determined at the very beginning of space and time. These fundamental characteristics allow us to identify the most basic common denominator for different evolutionary levels in terms of entropy/energy, self-organization potential, *etc.*;

2) ‘genetic-hierarchical’ levels/aspects, because any new form of evolution must be connected with the previous ones;

3) ‘interaction and adaptation’: emerging levels of organization may ‘tune up’ their parameters compared to preceding evolutionary forms, while at the same time all forms of evolution depend on each other; hence, there is a certain kind of ‘accommodation’ between them;

4) ‘behavioral’ aspects: different forms of matter can sometimes behave rather similarly in certain conditions. They can acquire similar structures, while it may also be possible to detect similar phases, cycles, rhythms and patterns. As a result, by concentrating on similarities instead of differences in details we may be able to formulate certain general principles concerning the ‘behavior’ of objects at various levels of evolution;

5) trends in, and possible direction of, evolution: this aspect has attracted the attention of especially those evolutionists who seek to define evolution in terms of transitions from less complex/developed systems to more complex/developed ones. Major issues include the following questions: Are these trends large-scale (for example of intergalactic level) or more localized, such as of the planetary scale and below? Is this dynamics cyclical or linear, like, for example, the rise and demise of certain societies? Do we need the anthropic principle to explain this? Currently, no consensus exists on these and many other issues of this kind. However, there can be no doubt that a great number of trends can be observed in megaevolution, which needs to be explained.

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We can now provide a fuller, yet still preliminary, characterization of evolutionary *megaparadigms*. First of all, this involves general evolutionary laws, characteristics, and principles; vectors, levels, and rhythms of mega- and macroevolution as well as similarities of ‘behavior’ of different forms of matter in

¹³ In particular, many processes that take place at different evolutionary levels are described by similar basic models; their phase portraits are also often very similar, which makes it possible to detect a number of important common traits in many different evolutionary processes (Chernavsky 2004: 83).

certain conditions.¹⁴ While discussing these aspects we need to answer the following questions: 1) What are the specific subjects of evolutionary studies? 2) Can we detect a certain unity in evolutionary *megaparadigms*? Tentative answers to those questions may include the following: within this approach we are dealing with specific processes of qualitative transformations of objects and structures, resulting in the emergence of new levels of organization of matter with new qualities, possibilities, and perspectives.¹⁵ We can identify at least three types of qualitative changes: a) changes leading to relatively small and localized qualitative changes; b) changes leading to more significant qualitative changes (for example, the emergence of a new level of integration); c) especially significant qualitative changes, whose emergence creates possibilities for evolutionary breakthroughs.¹⁶ In the words of Henri Claessen: ‘Evolutionism then becomes the scientific activity of finding nomothetic explanations for the occurrence of such structural changes’ (2000a: 2). Such qualitative transformations are described by a number of general evolutionary principles, laws, and rules, some of which are mentioned below.

In the second place, *megaparadigms* may include *mega-laws* that should be regarded as certain principles rather than as rigid and fixed relationships. However, the significance of each of those principles can be rather different, depending on the nature of the evolving systems (cosmic, biological, or social). It is not sufficient to formulate only very general principles and laws. It is also necessary to translate these more abstract principles into methodological models for specific case studies. The present issue of the Almanac considers such laws, rules, and regularities. We hope that this will lead to more detailed discussions in subsequent issues.

In the third place, the notion of *megaparadigms* implies the possibility to detect not only large-scale regularities and rules but it also opens up the possibility to analyze the degree of applicability of particular rules to the various types of macroevolution. Indeed, the appearance of certain similar traits, principles, and regularities in different types of macroevolution does not necessarily prove that they are the same type of process. Large underlying differences may convey the impression of similarities. Such a discovery can lead to a better understanding of such differences.¹⁷

¹⁴ These include, for example, patterns of evolutionary expansion and differentiation of forms, developmental crises, fluctuations around certain ‘attractors’, phase transitions, certain forms of self-organization, relationships of components as parts of internal structures, relations between the whole system and its environment, *etc.*

¹⁵ We generally follow the definition of Voget – Claessen who define evolution as ‘the process by which structural reorganization is affected through time, eventually producing a form or structure which is qualitatively different from the ancestral form’ (Voget 1975: 862; Claessen 1989: 234; 2000a, 2000b).

¹⁶ See Grinin and Korotayev 2007; 2009: ch. 1; Grinin, Markov, and Korotayev 2008 for more detail.

¹⁷ For example, the genomes of chimpanzees and of humans are very similar; the differences constitute only a few per cent (see, *e.g.*, Cohen 2007); however, there are enormous intellectual and so-

In the fourth place, we need to develop a common terminology. We have already mentioned a few such terms, *e.g.*, ‘energy’, ‘matter’, ‘information’, ‘system’, *etc.*

However, are there any terms that are specific for evolutionary studies? We think these terms should include, obviously, evolution and coevolution as well as micro-, macro-, and megaevolution; numerous notions labeled with the adjective *evolutionary*; various terms characterizing evolution, such as speed, directionality, levels, forms, types; terms that characterize spheres of evolution, most notably, perhaps, the biosphere, the noosphere, the technosphere, *etc.*; possibly, perhaps, notions of progress or the lack of it; processes of selection and resulting variation. However, for a further development of evolutionary *megaparadigms* these terms may not be sufficient, and examples of the use of new terms can be found in some contributions to this Almanac. It is noteworthy that all the existing mega-evolutionary terminology is interdisciplinary by nature. More likely than not, therefore, new terms will also have an interdisciplinary character.

In the fifth place, there is a potential for the development of cross-disciplinary and comparative research that can establish similarities as well as detect differences of both methodological and practical nature; this may allow us to find new heuristic evolutionary theories. While the issues studied within different branches of sciences may be very specific, through the prism of the evolutionary approach it is often possible to find opportunities for interdisciplinary comparisons, the creative borrowing of methodology, the identification of common mechanisms, of ‘vectors’ as well as systemic properties that are characteristic of different forms of organization of matter, energy, and information in abiotic, biological, and social systems (cf. Carneiro, Spier, Snooks, Grinchenko, Grinin, Markov, Korotayev, Reznikova, Lekevičius, Heylighen in this Almanac). In forthcoming issues of the Almanac we hope to present more discussions about these aspects.

In the sixth place, research in terms of evolutionary *megaparadigms* frequently requires considering issues such as directionality (vectors or trends), speed, reversibility, *etc.*¹⁸ In sum, the general nature of evolution requires attention to a great many fundamental aspects: ontological, epistemological, terminological and methodological.

In the seventh place, any serious scientific paradigm requires a study of its own history. We are planning to publish such overviews and discussions in future issues of the Almanac.¹⁹

cial differences between chimpanzees and humans that arise from the at first sight ‘insignificant’ difference between the two genomes.

¹⁸ In particular the speed of evolution has received considerable attention from a number of contributors to the Russian version of the Almanac (Tsirel 2009; Nazaretyan 2009; Iordansky 2009; Grinin, Markov, and Korotayev 2009a).

¹⁹ See also the issues of the Almanac in Russian: Grinin, Markov, and Korotayev 2009a, 2009b; Grinin, Ilyin *et al.* 2010; Grinin, Markov, and Korotayev 2010.

In the eighth place, we believe that there are common methodological principles and approaches to evolutionary studies, even though we are dealing with processes that never fully repeat themselves.

In contrast to the system approach that considers systems and structures as essentially static (or concentrates on their functioning), evolutionary approaches focus on those special conditions and factors that determine qualitative evolutionary transformations and reorganizations of such systems. These factors themselves become the subject of theoretical analysis. This may lead to the development of analytical instruments which are common for different branches of the evolutionary studies.

In evolutionary studies, the attention is usually focused on what is considered to be the most important, on qualitative changes and transformations (reorganizations). Leading questions include the direction of such changes: for example, if they lead to a decrease, or increase, in complexity; whether they constitute a transition to a new evolutionary level; or whether they are similar to, for instance, the mechanism of adaptive radiation in biology; whether it is possible to trace some genetic links.

The 'historical method' employed in evolutionary studies differs from the 'logical method' of traditional philosophy. Within such philosophical approaches 'the logical' was supposed to clean 'the historical' from various contingencies in order to detect its essence. However, in this 'cleansing' process the resulting logical constructions tended to lose their connection with reality entirely, which is unacceptable within evolutionary studies. This will be elaborated below.

Finally, a few epistemological aspects and principles are common to all evolutionary studies, because they stem from the peculiarities of self-organizing processes (see Grinin and Korotayev 2009: ch. 1 for more detail). As direct observations of complex large-scale objects and processes are impossible, our reflection about these things constitutes a multi-layered indirect process of cognition that is complicated greatly by linguistic ambiguities and other semiotic problems.

In conclusion, evolutionary *megaparadigms* must be based on empirical observations and plausible hypotheses, which allow the application of the standard scientific procedures of verification and falsification.²⁰ They must be able to accommodate most, if not all, of the existing evidence. We want to encourage as much open discussion as possible about evolutionary studies, in hope that from a new diversity of approaches a new unifying approach may emerge sometime in the future.

²⁰ For example, according to Popper (1974, 1984), Campbell (1974), and some other researchers.

The Almanac's Structure

The contributions to this volume are subdivided into three sections: Section I ('Universal Evolution', 2 articles); Section II ('Biological and Social Forms of Evolution: Connections and Comparisons', 4 articles); and Section III ('Aspects of Social Evolution', 3 articles).

Subjects and issues of the contributions to all three sections have a great deal in common and significantly supplement each other. As a result, the present issue may be regarded as a collective effort dedicated to the search for the contours and specifics of evolutionary *megaparadigms*. In addition, in this issue we have tried to present articles that study problems on various scales. Yet in general this issue deal with studies at very large temporal and spatial scales, in other words, the issues of mega- and macroevolution.

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The First Section of the Almanac (**Universal Evolution**) starts with *Fred Spier's* article 'How Big History Works: Energy Flows and the Rise and Demise of Complexity'. This article is written within the tradition of universal evolutionism, also known as the Big History. This research project aims at integrating the natural sciences and the humanities. In doing so it has become possible to detect a number of general vectors and trends in evolution as well as mechanisms and regularities, including their specific qualitative features at various evolutionary phases. The Big History emerged as a scientific discipline in the late 20th century. It offers an integrated model of the evolution of the Universe that connects the development of social, biological, and abiotic systems into a single consecutive process.²¹ Such Big History models lead to the following question: is the information component within the triad 'matter – energy – information' a significant factor of evolutionary processes, or are two basic categories (energy and matter) sufficient for their description? The changes in the Universe during 13.7 billion years reveal certain simple trends.

Fred Spier advances an explanatory scheme for all of history from the beginning of the Universe until life on Earth today (Big History). His 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.

According to Spier, the history of complexity in the Universe consists of a rather boring beginning, followed by a more exciting period of increasing local and regional complexity, which will subsequently peter out into total boredom. This is directly linked to the fact that, from the very beginning, the Big History has exhibited a trend towards lower energy levels as well as towards energy flows which first increased and then mostly began to decrease. As a re-

²¹ In 2005 the journal *Social Evolution & History* published a special issue (*Exploring the Horizons of Big History* [Snooks 2005]) dedicated to the problems of this direction of universal evolutionism; we have already made above some references to some contributions to that special issue.

sult, in most places the level of complexity has remained rather low. This is first of all due to the fact that most of the Universe is virtually empty. Wherever there was sufficient matter, complexity rose in the form of galaxies, which are made up of stars, planets, and clouds of gas and dust, possibly with black holes in their centers. The growing range of chemical elements needed for life was cooked by exploding stars. This signaled another rise in complexity.

In the beginning, the energy levels determined the level of complexity the Universe could attain. After about 400,000 years of expansion, however, the rise of complexity has come as a result of the interplay between energy levels and energy flows. The first level of material complexity would be reached as a result of the nuclear force. This complexity consisted of the smallest, subatomic and atomic particles. Electromagnetism would take care of the second, intermediate, stage, in which atoms, molecules and complexes of molecules would be formed. The effects of gravity would inaugurate the last stage and would bring about all the larger structures we know in the observable Universe.

Spier believes that greater forms of biological and cultural complexity are exceedingly rare in the Universe. During the past four billion years or so, the energy flows and levels on the surface of our home planet were suitable for the emergence of this type of complexity. The intricate energy flows on the Earth's surface first made possible forms of biological complexity. Life began to actively harness more and increasingly varied sources of matter and energy. A very similar process took place during the cultural evolution of humankind. This has led to the greatest levels of complexity known today.

Robert L. Carneiro ('Stellar Evolution and Social Evolution: A Study in Parallel Processes') suggests that the process of evolution can be seen at work in all domains of nature. Carneiro points out a number of parallels between the development of stars and the development of human societies. For example, the use of the comparative method has been prominent in the study of evolution in both fields. Also, there are parallels between the two, such as the use of stages to distinguish significant phases of the evolutionary process, the manifestation of both multilinear and unilinear evolution in both, and differential rates of evolution among stars and societies.

As has been already mentioned above, in his book *First Principles* (1862), published only three years after Darwin's *On the Origin of Species*, Herbert Spencer portrayed evolution as something far beyond 'descent with modification'. He saw it as a much broader process, which had manifested itself throughout the Universe, from the tiniest microorganisms to the largest galaxies. The evolution of the stars, then, was clearly within his purview.

As a field of astronomical research, stellar evolution has been pursued with increasing vigor and impressive results since Spencer's time. In fact, it may well be that the results astronomers and astrophysicists have been able to accomplish in reconstructing the process of cosmic evolution stand among the greatest intellectual triumphs of all time.

Carneiro points to some striking parallels between the evolution of stars and the evolution of human societies which anthropologists are barely aware of. And while recognition of these parallels may mean very little to the powerful and sophisticated science of astronomy, it just may be of some interest and value to the fragile and beleaguered field of cultural evolution.

* * *

The Second Section of the Almanac (Biological and Social Forms of Evolution: Connections and Comparisons) considers a number of important macro-evolutionary problems of biology and sociology. However, it will not be an exaggeration to say that it is primarily devoted to what may be denoted as *comparative evolutionary studies*. All the contributions to this section deal with comparisons between mechanisms, factors, laws, and trends in various fields of evolutionary studies as well as with terminology developed and applied in those fields, while the authors also consider the possibilities of their use in other fields. These articles also deal with issues of the development of general evolutionary methodologies and terminologies. This section mainly deals with comparisons between biological and social macroevolution, mostly since social evolution is substantially closer to biological evolution rather than to the evolution of abiotic systems. However, we have no doubts about the intrinsic possibility of comparative research with respect to any types of evolution (such as, for instance, shown in Carneiro's contribution to the First Section). In addition, relatively close types of macroevolution (physical and chemical, chemical and biological, geological and biological, *etc.*) may share evolutionary processes to some extent. In many cases it may even be better to speak of co-evolution between them – for example, with respect to geological and biological macroevolution, or biological and social macroevolution. Especially during the 20th century new scientific approaches emerged and developed quickly based on the analysis of such mutual links and parallels, including cybernetics and biogeochemistry, which studies, among other things, the relationship between the evolution of life and of inorganic matter on the Earth.

Contributions to the Second Section of the Almanac cover a wide range of topics, ranging from specific issues in biological and social sciences to the application of general systems theory to biological and social systems, including behavioral strategies. One of the main issues covered in this section is the problem of progressive change and its criteria in biology and history (this subject is discussed in the contribution by Leonid Grinin, Alexander Markov, and Andrey Korotayev). The notion of progress (together with the one of evolution) came to the evolutionary biology from philosophy. However, this term remains highly controversial and is rejected by many biologists and sociologists. While discussing the possibility of the use of this term in evolutionary biology, Grant (1991: ch. 34) poses the following questions:

1) Is it possible to transfer satisfactorily the notion of progress from the sphere of human activities to evolutionary biology?

2) If so, would it be possible to formulate scientific criteria that allow us to define the notion of progress in organic evolution?

Different scientists suggest diametrically opposite answers to those questions. There are even more problems with the application of the notion of progress to the study of social macroevolution (see, *e.g.*, Korotayev *et al.* 2000; Korotayev 2004; Grinin 2006 for more detail).

In all these cases, it appears necessary to take into account the fact that both in social and biological macroevolution the point of view of an observer and her or his value system plays a major role in defining the notion of progress (Grant 1985). Furthermore, the application of the notion of progress to the study of social evolution introduces a number of ethical problems. Although a great many attempts have been undertaken to apply the notion of progress more objectively in such studies, it has turned out to be impossible to avoid ethically charged positive connotations with this notion. In fact, the claim to be able to define the social progress with the aid of 'objective criteria' may imply the claim by some groups to know 'objectively' better than other people what these other people really need.

In his article 'Constructing a General Theory of Life: The Dynamics of Human and Non-Human Systems' *Graeme Donald Snooks* maintains that the ultimate objective of theorists studying living systems is to construct a general theory of life that can explain and predict the dynamics of both human and non-human systems. Yet little progress has been made in this endeavor. Why? The author suggests that this is because of the inappropriate methods adopted by complexity theorists. Snooks claims that by assuming that the *supply-side* physics model – in which local interactions are said to give rise to the emergence of order and complexity – could be transferred either entirely (social physics) or partially (agent-based models, or ABMs) from the physical to the life sciences, we have distorted reality and, thereby, delayed the construction of a general dynamic theory of living systems. According to Snooks, the solution can only be found if we abandon the deductive and analogical methods of complexity theorists and adopt the inductive method. With this approach it is possible to construct a *realist* and *demand-side* general dynamic theory, as in the case of the dynamic-strategy theory presented in this paper.

In his contribution 'Ecological Darwinism or Preliminary Answers to Some Crucial though Seldom Asked Questions' *Edmundas Lekevičius* asserts that evolutionary regularities might be deduced from basic principles describing how life functions, most notably part-whole relationships and control mechanisms. The author suggests adding the concept of functional hierarchy to the concept of the struggle for existence: no solitary individual or species is functionally autonomous. Life as we know it can exist only in the form of a nu-

trient cycle. Only two purely biotic forces – ‘biotic attraction’ and ‘biotic repulsion’ – act in the living world. The first one maintains and increases diversity and organizes solitary parts into systems integrated to a greater or lesser degree. The second one, in the form of competition, lessens biodiversity but at the same time provides life with necessary plasticity. On that ground, tentative answers to the following questions are given: (1) Why does life exhibit such a peculiar organization with strong integration at lower levels of organization and weak integration at higher ones? (2) Why did particular species and guilds appear on the evolutionary stage at that particular time and not at any other? (3) Why was the functional structure of ecosystems prone to convergence despite a multitude of stochastic factors?

In her article ‘Evolutionary and Behavioral Aspects of Altruism in Animal Communities: Is There Room for Intelligence?’ *Zhanna Reznikova* analyzes the phenomenon of the altruistic behavior by animals from an evolutionary perspective. The altruistic behavior of animals is still enigmatic for many evolutionary biologists, even though a great many data have been analyzed and several rational concepts have been developed, such as the theory of inclusive fitness and the theory of reciprocal altruism. Altruistic behavior in animal societies is based on the division of roles between individuals who are dependent on each other as a result of their behavioral, cognitive and social specialization. It is a challenging problem to explain intelligence within the framework of social specialization in such animal communities. In this review, the characteristics of different levels of sociality are considered and the role of flexibility of individual behavior within the functional structure of animal communities is analyzed. In some situations, behavioral, cognitive and social specialization can be congruent; maybe this is the formula for happiness in animal societies.

In their contribution ‘Biological and Social Anamorphoses: A Comparison between Two Forms of Macroevolution’ *Leonid Grinin, Alexander Markov, and Andrey Korotayev* emphasize the point that the comparison between biological and social macroevolution is a very important although insufficiently studied subject, whose analysis offers new significant possibilities to comprehend the processes, trends, mechanisms, and peculiarities of each of the two types of macroevolution. Even though there are a few important differences between them, it appears possible to identify a number of fundamental similarities. At least three fundamental sets of factors determining those similarities can be singled out. First of all, in both cases we are dealing with very complex non-equilibrium (but rather stable) systems whose principles of functioning and evolution are described by General Systems' Theory, as well as by a number of cybernetic principles and laws. Secondly, in both cases we do not deal with isolated systems but rather with complex interactions between both biological and

societal organisms and their external environment. The reaction of such systems to external challenges can be described in terms of certain general principles that are expressed, however, rather differently within biological and social reality. Thirdly, there is a direct 'genetic' link between the two types of macroevolution and their mutual influences.

The similarity of the principles and regularities of these two types of macroevolution does not imply that they produce the same results. Remarkable similarities are frequently accompanied by enormous differences (see, for example, the above mentioned case of the impressive similarity between genomes of chimpanzees and of humans).

According to the authors it appears reasonable to consider biological and social macroevolution as one single macro-evolutionary process to at least some extent, even though their concrete biological or social manifestations may display significant variations, depending on the specific properties of the evolving entities. This implies the necessity to comprehend general laws and regularities that describe this general process. An important notion that may contribute to our understanding of the differences and similarities of these two types of macroevolution is the term **social aromorphosis**. This term was developed as a counterpart to the notion of biological aromorphosis, which is well established within Russian evolutionary biology. Grinin, Markov, and Korotayev regard social aromorphosis as a rare qualitative macro-change that increases in a very significant way complexity, adaptability, and mutual influence of social systems, and thus opens up new possibilities for social macro-development. In their contribution, they discuss a number of regularities that describe biological and social macroevolution by employing the notions of social and biological aromorphosis, including such regularities as rules of 'module evolution' (or the evolutionary 'block assemblage'), 'payment for arogenic progress', *etc.*

* * *

The Third Section of the Almanac (Aspects of Social Evolution) starts with the contribution by *Dmitri Bondarenko, Leonid Grinin, and Andrey Korotayev* 'Social Evolution: Alternatives and Variations (Introduction)'. The article deals with important theoretical problems of social evolution. In the authors' opinion, a number of general evolutionary ideas, principles and conclusions formulated in the article may not only be significant for the study of social evolution but also for evolution as a whole. The authors' basic ideas and principles are as follows: Evolutionary alternatives can be found for any level of social complexity. Very often, different social and political forms have co-existed and competed with each other for a long time. Within specific ecological and social niches, some models and variants could be more competitive first, only to be taken over

by other forms later. As a result, many statements about certain ‘inevitable’ outcomes of evolution can be considered correct only in the most general sense and within certain conditions. The underlying reasoning is that evolutionary outcomes are usually the result of long-lasting competition between different forms, sometimes resulting in their destruction, or in transformations, social selection, adaptation to various ecological milieus, *etc.* This means that evolutionary outcomes are not inevitable for each and every particular society.

These ideas are illustrated at different levels, including pre-state societies, most notably chiefdoms. The notions of homoarchy and heterarchy as labels for ideal models of rigid (invariable) and non-rigid (variable) social structures respectively, are also discussed. The authors argue that it may be possible to postulate heterarchic and homoarchic evolutionary trajectories that embrace all cultures throughout all of human history. Special attention is paid to the analysis of models of politogenesis, in the course of which alternative models of transition to complex societies were realized. This idea is suggested as a replacement for the outdated theory that represents the transition from non-state to state societies as direct and unilinear. The authors show that this transition was multilinear. They introduce the notion of early state analogues and propose a classification of various types of early state formation. Furthermore, some societies resembling early states can, in fact be regarded as complex non-state societies that are similar to early states in terms of size, socio-cultural and/or political complexity, functional differentiation level, *etc.*, while they did not share some salient features that are typical of early states.

Christopher Chase-Dunn in his paper ‘Evolution of Nested Networks in the Prehistoric U.S. Southwest: A Comparative World-Systems Approach’ uses a nested interaction networks approach to interpret patterns of social evolution in the late prehistoric U.S. Southwest within a comparative and world historical perspective. Place-centric interaction networks are arguably the best way to bound human systemic processes, because approaches that attempt to define regions or areas based on attributes necessarily assume homogenous characteristics, whereas interaction itself often produces differences rather than similarities. The culture area approach that has become institutionalized in the study of the evolution of pre-Columbian social systems is impossible to avoid, but the point needs to be made that important interactions occur across the boundaries of the designated regions and interaction within regions produces differences as well as similarities. Networks are the best way to bound systems, but since all actors interact with their neighbors, a place-centric (or object-centric) approach that estimates the fall-off of interactional significance is also required. The comparative world-systems approach has adapted the concepts used to study the modern system for the purpose of using world-systems as the unit of analysis in the explanation of human social evolution. Nested networks are used

to bound systemic interaction because different kinds of interaction (exchange of bulk goods, fighting and allying, long-distance trade and information flows) have different spatial scales. Core/periphery relations are of great interest but the existence of core/periphery hierarchy is not presumed. Rather the question of exploitation and domination needs to be asked at each of the network levels. Some systems may be based primarily on equal interdependence or equal contests, while others will display hierarchy and power-dependence relations. It should not be assumed that earlier systems are similar to the modern global system in this regard. Rather it should be a question for research on each system.

This section ends with *Francis Heylighen's* article 'Conceptions of a Global Brain: An Historical Review'. The 'global brain' is a metaphor for the intelligent network formed by the people of this planet together with the knowledge and communication technologies that interconnect them. The different approaches leading up to this conception, by authors such as Spencer, Otlet, Wells, Teilhard de Chardin, Russell and Valentin Turchin, are reviewed in their historical order. The contributions are classified in three major approaches: organicism, which sees society or the planet as a living system; encyclopedism, which aims to develop a universal knowledge network; and emergentism, which anticipates the evolution of a suprahuman level of consciousness. The shortcomings of each perspective lead us to propose an integrated approach based on evolutionary cybernetics. Its selectionist logic allows us to analyze the process whereby initially selfish individuals self-organize into a synergetic system functioning at a higher level of intelligence, making use of an advanced version of the World Wide Web.

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