Introduction.
From the Past to the Future

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Our Yearbook will soon celebrate its 15th anniversary. We have long extended the scope of its research field. And the articles on various topics are presented in this issue: those related to the ability to formalize historical topics, as well as modeling aspects of a relatively distant (singularity) and rather distant future. We will not remind the reader of the various aspects touched upon in previous issues, as we did it in the previous issue. However, we will cite these issues in Reference list.

The present Yearbook (which is the eighth in the series) is subtitled *Investigating Past and Future*. It is devoted to three problems: the analysis of the aspects of past and present in the light of formal methods; singularity, *i.e.* forthcoming abrupt shift in development, the approach (or even presence) of which we already feel; the aspects of the cosmic future of human race.

Evolutionistics that we develop in our works and Yearbooks ('Эволюция' [Evolutsia] and 'Evolution') is considered as an interdisciplinary common field (as well as intended combination of history and mathematics), which shows the unity of the world in its diversity. And what is better than mathematics at all times proved this unity of the world? Thus, we believe that the integration of evolutionary studies and mathematical dimensions in our Yearbook is fully justified and reasonable.

The issue consists of four sections: (I) History, Technologies, Politics, and Mathematics; (II) Singularity; (III) Beyond the Earth; (IV) Reviews and Notes.

Section I includes five articles on different directions of factual or theoretical content: history (**Antony Harper**. 'A Quantitative Analysis of Reign Lengths of Pre- and Post-Taifa Periods and Taifa Kingdom Durations during the Existence of Al Andalus'), (**Leonid E. Grinin**. 'Kondratieff Waves, Technological Modes, and the Theory of Production Revolutions'), technology (**Claude Diebolt and Karine Pellier**. 'Patents in the Long Run: Theory, History, and Statistics'), politics (**Mateusz Wajzer**. 'Political Violence and Evolutionary Game Theory: A Methodological Introduction'), and studies covering past, present, and future (**Svetlana V. Kobzeva**. 'Digitalization of Global Governance in NBIC-Convergence Era').

The article by **Antony Harper** ('A Quantitative Analysis of Reign Lengths of Pre- and Post-Taifa Periods and Taifa Kingdom Durations during the Existence of Al Andalus') explores the disparity in the distribution of Umayyad Caliphate reign lengths with respect to the Nasrid Sultanate reign lengths. Further resolution is given to this disparity by showing that the same disparity exists between the Taifa 1 period and the Taifa 2 period. In response to the demonstration of this disparity, a hypothetical position is put forward according to which Malthusian limits on resources did not exist until at least the Taifa 2 period. A preliminary computer model is constructed to show the potential for such a non-intuitive relationship between populations of entities and their upper (Malthusian) limits.

In the article by **Leonid E. Grinin** ('Kondratieff Waves, Technological Modes, and the Theory of Production Revolutions') Kondratieff waves theory is considered in comparison with the theory of production revolutions which analyzes the regularities of the major technological breakthroughs in history. Both theories analyze the processes of cyclic nature related to the innovative technological development of the World-System. The mutual comparison of both theories allows the author to make important clarifications in understanding of the long-wave dynamics as a whole, as well as to give relevant explanations of the peculiarities of the unfolding of each of the five waves and their phases, to make forecasts about the sixth wave and the development of technologies of the sixth technological mode. The special attention is paid to the analysis of aspects and limitations of the theory of technological modes, as it is used by many researchers to explain the causes of the long-wave dynamics.

The article by **Claude Diebolt and Karine Pellier** ('Patents in the Long Run: Theory, History, and Statistics') examines the structural and spatial dynamics of patents in France, Germany, Japan, the United Kingdom and the United States. The time series are extracted from international, comparative and historical databases on the long-term evolution of patents in 40 countries from the 17th century to 1945 and in more than 150 countries from 1945 to present. The authors have found strong evidence of infrequent large shocks resulting essentially from the major economic and political events formed by the two World Wars in the 20th century. Their results question the autonomous process, *i.e.* the internal dynamic of the patent systems. Wars seem to drive innovation and, finally, the very process of economic growth. The authors investigated the role of innovation in economic growth through a causality analysis between patents and GDP per capita. Their major findings support the assumption that the accumulation of innovations was a driving force only for France, the United Kingdom and the United States during the post-World War II period.

The contribution by **Mateusz Wajzer** ('Political Violence and Evolutionary Game Theory: A Methodological Introduction') is focused on evolutionary game theory. Classical game theory is one of the basic methods of scientific analysis of political phenomena. The models developed on this basis are used in the studies of electoral and legislative behaviour, in the analysis of processes of forming political coalitions, and in the analysis of issues related to democratization, national security and armed conflicts. Evolutionary game theory has developed from classical game theory. This theory is referred to in this article, which presents selected possibilities of using single-population evolutionary models in studies of political violence transmission. On the basis of the analysis of two population variants, the article describes the changes in the prevalence of selected behavioural traits and answers the questions regarding the asymptotic states of evolutionary processes and their stability. The study uses Hawk-Dove and Hawk-Dove-Retaliator type games. The calculations were carried out using the R program.

According to **Svetlana V. Kobzeva** ('Digitalization of Global Governance in NBIC-Convergence Era') the rise of globalization processes at the turn of the 20th – 21st centuries led to the growth of interdependence in the international arena – the development of transnational business networks, emergence of new supranational political structures, increasing flows of people, capital, goods and information at intercontinental distances. Modern processes are named by researchers as the Fourth Industrial Revolution which is characterized by convergence of digital, physical and biotechnologies. Globalization of ICT leads to the formation of new frameworks of cross-cultural interactions, expands control over conflict situations and strengthens international cooperation in ensuring global and regional security, accelerates social politics (education and health care) and human capital by increasing employment, inclusion in active life of socially isolated groups of people, overcoming deprivation, poverty and various forms of discrimination, eliminating territorial, administrative, civilization and cultural barriers. The risks and threats of globalization processes are created by the actors of subnational and transnational levels using both legitimate and criminal activities. Modern world development is focused on enhancing of e-government technologies in public administration by increasing the qualitative level of qualification and technological effectiveness of public service and reducing their cost.

Section II 'Singularity' includes two contributions and is devoted to a rather interesting phenomenon of singularity. The rapid change leading to 'some essential singularity' was articulated early by John von Neumann in the 1950s. According to Ulam (1958: 5), von Neumann maintained, 'the ever-accelerating progress of technology and changes in the mode of human life… gives the ap-

pearance of approaching some essential singularity in the history of the race beyond which human affairs, as we know them, could not continue'. In 1960 the study of Heinz von Foerster and his colleagues of the global population dynamics indicated 2026 as a possible date of the singularity (Foerster *et al.* 1960). By now a number of mathematical models describing the global hyperbolic trend leading to the singularity have been developed (Grinin *et al.* 2020; Korotayev 2018, 2020; LePoire 2013, 2015, 2016, 2020; Nazaretyan 2018; Panov 2005, 2011, 2020). They suggest that indeed the hyperbolic planetary evolutionary trend observed since the origins of life on the Earth cannot continue beyond the forthcoming singularity, whereas the post-singular evolutionary trend should be qualitatively different from what has been observed before. The articles of the second section discuss this thrilling phenomenon.

This section opens with the article by **David J. LePoire** ('A Potential Simple Analogous Heat Flow System to Explore Big History's Singularity Trend') according to which many historical systems (*e.g.*, civilizations) demonstrate trends towards acceleration of knowledge, energy flow, and complexity. These systems are far from thermal equilibrium as they depend on great flows of energy through them to maintain their structure, similar to Dissipative Dynamics Systems (DDS). This dissipation causes entropy, but while entropy is often associated with disorder, often ordered patterns can spontaneously develop in them to facilitate entropy generation. That is, entropy gradients (and the second law of thermodynamics) might be the driver to higher complexity. In addition, optimized engineered systems that are far from equilibrium, such as removing heat from electronic chips, also follows fractal pattern formation. A major trend in Big History is the singularity trend of complexity, which has substructure where the complexity tends to increase by a factor of about 3 for every shortening (by a factor of ⅓) period. At the same time, the energy flow tends to increase at a slightly faster rate of about 4–5 within each period. This paper develops a simple analogous energy flow system that may help gain insight into this Big History trend, however, it is incomplete. Research areas are identified to tighten this approach.

In the contribution by **Sergei V. Tsirel** ('Technological Achievements of the Future as the Path of Destruction of Habitual Human Society?') the author assumes that extensive experiments on the correction of the human genome will fall on the 2030s and 2040s. Therefore the real problems associated with the emergence of new subspecies of *Homo sapiens* will arise already in the 2070–2080s or even in the 2060s. Although such prospects are usually considered in an apocalyptic manner, the tragic course of events is not necessary. But, in any case, there will appear new unprecedented problems, primarily inequality prob-

lems, not only socio-economic but legal and political ones, as well as generally the possibilities of democracy in a society of genetically different people, *etc.*

Section III 'Beyond the Earth' consists of two very different articles, but they are united by their interest in the future of human race in terms of their interaction with the space.

In the paper by **Marc Widdowson** ('Can Humanity Escape the Earth?') the main question is whether space colonisation lies within the limit which the Earth can support in the future under the growing pressure of the human population – so that humanity can escape the earth's boundaries – or whether it is beyond the limit, so that humanity will converge to a stagnant, earth-bound equilibrium. For more than one hundred and twenty years meeting with extra-terrestrial civilizations is one of the most disturbing topics for fantasts and futurologists.

The article of **Dmitry A. Novoseltsev** ('The Catalysis Project: On the Possibility of Purposeful Expansion of Intelligent Life in the Galaxy') deals with the possibility of expansion of biological life, intelligence and modern culture in the Galaxy in the autocatalytic mode using modern and promising technical means.

Section IV 'Reviews and Notes' includes a review by **Antony Harper** of a recent book 'Islamism, Arab Spring, and the Future of Democracy' by Leonid E. Grinin, Andrey V. Korotayev, and Arno Tausch (Springer, 2019).

References

von Foerster H., Mora P. M., and Amiot L. W. 1960. Doomsday: Friday, 13 November, AD 2026. *Science* 132(3436): 1291–1295.

Goldstone J. A., Grinin L. E., and Korotayev A. V. (Eds.) 2015. *History & Mathematics: Political Demography & Global Ageing.* Volgograd: 'Uchitel' Publishing House.

Grinin L., Grinin A., and Korotayev A. 2020. A Quantitative Analysis of Worldwide Long-Term Technology Growth: From 40,000 BCE to the Early 22nd Century. *Technological Forecasting and Social Change* 155: 1–15. DOI: https://doi.org/ 10.1016/j.techfore.2020.119955.

Grinin L. E., Herrmann P., Korotayev A. V., and Tausch A. (Eds.) 2010. *History & Mathematics: Processes and Models of Global Dynamics.* Volgograd: 'Uchitel' Publishing House.

Grinin L. E., and Korotayev A. V. (Eds.) 2014. *History & Mathematics: Trends and Cycles.* Volgograd: 'Uchitel' Publishing House.

Grinin L. E., and Korotayev A. V. (Eds.) 2017. *History & Mathematics: Economy, Demography, Culture, and Cosmic Civilizations.* Volgograd: 'Uchitel' Publishing House.

Grinin L. E., and Korotayev A. V. (Eds.) 2019. *History & Mathematics: Big History Aspects.* Volgograd: 'Uchitel' Publishing House.

Grinin L. E., de Munck V. C., and Korotayev A. V. (Eds.) 2006. *History & Mathematics: Analyzing and Modeling Global Development.* Moscow: KomKniga/URSS.

Korotayev A. 2018. The 21st Century Singularity and Its Big History Implications: A Re-analysis. *Journal of Big History* II(3): 71–118. DOI: http://dx.doi.org/10.22339/jbh.v2i3.2320.

Korotayev A. 2020. The 21st Century Singularity in the Big History Perspective: A Re-Analysis. *The 21st Century Singularity and Global Futures. A Big History Perspective* / Ed. by A. Korotayev, and D. LePoire, pp. 19–75. Springer. DOI: https://doi.org/10.1007/978-3-030-33730-8_2.

LePoire D. 2013. Potential Economic and Energy Indicators of Inflection in Complexity. *Evolution: Development within Big History, Evolutionary and World-System Paradigms* / Ed. by L. E. Grinin, and A. V. Korotayev, pp. 108–118. Volgograd: 'Uchitel'.

LePoire D. 2015. Interpreting 'Big History' as Complex Adaptive System Dynamics with Nested Logistic Transitions in Energy Flow and Organization. *Emergence: Complexity and Organization* 17(1): 1E.

LePoire D. J. 2016. Exploring Temporal Patterns in Big History Dynamics. *KronoScope* 16(2): 229–249.

LePoire D. J. 2020. Exploring the Singularity Concept within Big History. *The 21st Century Singularity and Global Futures. A Big History Perspective* / Ed. by A. Korotayev, and D. LePoire, pp. 77–97. Springer. DOI: https://doi.org/10.1007/978-3-030-33730-8_3.

Nazaretyan A. 2018. The Polyfurcation Century: Does the Evolution on Earth Have a Cosmological Relevance? *Journal of Big History* 2(1): 27–41. DOI: http://dx.doi.org/10.22339/jbh.v2i1.2253.

Panov A. D. 2005. Scaling Law of the Biological Evolution and the Hypothesis of the Self-Consistent Galaxy Origin of Life. *Advances in Space Research* 36(2): 220–225.

Panov A. D. 2011. Post-singular Evolution and Post-singular Civilizations. *Evolution: A Big History Perspective* / Ed. by L. E. Grinin, A. V. Korotayev, and B. H. Rodrigue, pp. 212–231. Volgograd: 'Uchitel'.

Panov A. 2020. Singularity of Evolution and Post-Singular Development in the Big History Perspective. *The 21st Century Singularity and Global Futures. A Big History Perspective* / Ed. by A. Korotayev, and D. LePoire, pp. 439–465. Springer. DOI: https://doi.org/10.1007/978-3-030-33730-8_20.

Turchin P., Grinin L. E., de Munck V. C., and Korotayev A. V. (Eds.) 2007. *History & Mathematics: Historical Dynamics and Development of Complex Societies.* Moscow: KomKniga/URSS.

Ulam S. 1958. Tribute to John von Neumann. *Bulletin of the American Mathematical Society* 64(3): 5.