

Human Life and Evolution in Biospheres on Earth and Outer Space: Problems and Prospects

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In an interdisciplinary setting in philosophical, methodological and futurological discourses, the problems and prospects of life and evolution of modern human beings belonging to the species of Homo sapiens in natural and artificial biospheres on Earth and in outer space are discussed. New definitions are provided. A general formulation of the problem of managing human evolution is suggested. An analysis of a number of important aspects of human life and evolution on Earth and in outer space is presented. Particular attention is paid to the transition from life on Earth to space expansion under conditions and boundaries, when a human being remains a human being. The main conclusions are formulated.

Keywords: biosphere, Earth, life, outer space, culture, technology, technosphere, management, human, evolution

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Introduction

The article is devoted to the problems and prospects of the evolution of modern human beings belonging to the species of *Homo sapiens* in connection with the growing global socio-ecological crisis on Earth and the potential of the space exploration process.¹

The global crisis escalated in 2020 due to the COVID-19 pandemic and once again posed the question “to be or not to be?” to people, all countries and humanity, showed the fragility of our life and civilization, the need for new approaches to solving the problems of security, survival, and development of human and society in a new reality with the use of new technologies and in balance with the environment on Earth and beyond.

In 2021, the world celebrates the 60th anniversary of the first space flight of a human — Yuri Gagarin (1961), which laid the foundation for the process of human expansion into outer space. The General Assembly of the UN, in its resolution A/RES/65/271 of 7 April 2011, declared April 12 as the International Day of Human Space Flight “to celebrate each year at the international level the beginning of the space era for mankind, reaffirming the important contribution of space science and technology in achieving sustainable development goals and increasing the well-being of States and peoples, as well as ensuring the realization of their aspiration to maintain outer space for peaceful purposes.”²

In the evolutionary paradigm and interdisciplinary setting in the philosophical, methodological and futurological discourses, we will consider a number of aspects of life and evolution of modern humans of the *Homo sapiens* species on Earth and in outer space in natural and artificial biospheres. We will pay special attention to the transition from earthly to cosmic expansion, in particular, under conditions and boundaries when a human being remains a human being.

The concept of “human,” its definition, description of the “core” and boundaries, a comprehensive classification of a human being is necessary to be corrected, taking into account the problems and prospects of human evolution on Earth and in outer space.

Modern human and society on Earth³ exist and develop in a hybrid natural-artificial biosphere — the global anthroposphere, which includes parts of the transformed natural biosphere of Earth and artificial systems of the technosphere created by human and society when applying knowledge and technologies in the environment and using its resources on Earth and beyond, including expansion.⁴

Beyond Earth, in outer space, since the first flight in 1961, a human can exist, used to live and lives in closed artificial ecosystems and biospheres — spaceships and stations within a time period strictly limited by flight factors, technology capabilities, and properties of the human body. In the 21st century, since 2000, people constantly stay in the near-Earth space on the International Space Station. In the future, it is possible and is planned to create new permanent bases — human settlements in the near-Earth space, on the Moon, Mars, etc.⁵

¹ The materials and research results published by the authors throughout 2017-2021, devoted to the life and evolution of human, the Earth's biosphere, technosphere and space exploration. The ideas and text fragments of new books by the authors are used (Krichevsky, 2021; Levchenko, 2020), which are published here for the first time in English.

² See (The beginning, 2011).

³ At the same time, there are places on Earth where isolated communities of people still exist outside the global civilization.

⁴ Exemplified by the projects “Bios-1,2,3” (USSR), “Biosphere-2” (USA), “Mars — 500” (Russia), “Yuegong-1” (China), implemented on Earth, as well as artificial space ecosystems and biospheres for people in outer space. See (Allen & Nelson, 1991; Krichevsky, 2017; Tkachenko & Morozov, 2017; World Manned Cosmonautics, 2005; Yazdovsky, 1976).

⁵ See (Allen & Nelson, 1991; Cosmonautics, 2010; Gizenko et al., 1987; Space biology, 1994–2009; Krichevsky, 2020; Musk, 2017; Website of NASA; Website SpaceX; World Manned Cosmonautics, 2005).

In the process of space exploration as a result of scientific, technical and social development, the human being is increasingly transforming from an object into a subject, an actor of evolution, influencing their (and not only there) present and future on Earth and in outer space. This influence is contradictory, risky, unstable, turbulent; it has colossal and, at its highest, infinite potential for the creation and destruction of humans, society, state, humanity and the environment on Earth and in outer space. There are two main methods and scenarios of human space exploration, which are interrelated and intercomplementary:

- 1) “virtual” (without real space activities) — modeling of the process of space exploration on Earth; “virtual reality”; change of consciousness and then, through the control of consciousness, “vital,” and not “technotronic” and “technogenic” transformation of the human body;⁶
- 2) “real” (practical) — physical moving into space, life beyond Earth on the basis of space technologies, technique, and activities.

The attitude of the scientific community and the entire society in Russia and the world to the problem of human space exploration was quite contradictory throughout the 19th-20th centuries. It remained the same in the 21st century, and it covers the entire spectrum between two extremes: “cosmophobia” and “cosmophilia” — from complete denial of the idea of human space exploration and its active counteraction to absolute support and striving for its full and speedy implementation.

Modern “cosmophobes” justify their views by prioritizing, preserving, and using the Earth’s ecosystems for the life of humanity in the paradigm of the “only planet” really suitable for our survival and development. It is called on, for example, by William E. Ress: “Forget about interstellar space travel or even colonizing dead-cold Mars. Humans should be focused on regenerating ecosystems and life-support functions on Earth, the planet on which we evolved, which continues to sustain us, and for which we are best adapted. Despite damage wrought by *H. sapiens*, Earth remains infinitely more hospitable than the red planet; why would anyone think that efforts to terraform Mars is more likely to pay off than restoring the Earth?”⁷

There is a complex internal dynamics of the social process reflecting the attitudes of specific people, space and other communities, society, countries, states, the world community, and humanity towards human space exploration, with waves of euphoria and pessimism caused by new space technologies and achievements, excessive costs, risks, accidents, failures in space exploration combined with socio-political, military, economic, environmental and other crises and acute problems on Earth. Moreover, it is the state and dynamics of earthly problems that determine and modulate the attitude of people and society (including the evolution of views, priorities and activities of individuals and organizations) to the human space exploration as a way to solve them for the survival and development of human and humanity within the scope “Earth + Cosmos” in the present and future.

The “cosmophiles” have two main approaches to the implementation of the process of human space exploration:

First approach. First, it is necessary to solve Earth’s problems, unite humanity and its resources, and then proceed with a massive expansion into space.

Second approach. To expand into space at the highest possible rate, without waiting for the conditions set forth in the first approach to arise.

⁶ The last (about changing consciousness). See (Ableev, 2020).

⁷ See (Rees, 2020: 26).

Konstantin Tsiolkovsky supported the first approach,⁸ and it prevails in the public consciousness in the world today. Moreover, new megaprojects are being actively developed for organizing the life of society on Earth in balance with the environment on the basis of new technologies, which should be implemented before the start of possible expansion in space. For example, the social Venus Project of an engineer, designer, futurologist Jacques Fresco, and his followers. It represents the integration of science and technology's best achievements into an overarching plan for a new society on Earth based on human and environmental concerns.⁹

In the 10s — 20s of the 21st century, a new wave of human space exploration was rising in the world. Entrepreneurs, public figures, new corporations and space communities, which actively compete with the “old” space communities, states and corporations, have become the new space leaders since 2016, acting in line with the second approach. Among them is Elon Musk, the creator of the SpaceX Corporation (USA), who has suggested and has been actively implementing the strategy of making human a multi-planetary species and humanity a multi-planetary civilization, Igor Ashurbeyli (Russia), who created the space community — the first digital space state of Asgardia as the basis of the future space civilization — space humanity (about 1 million people from ~ 200 countries participate in it).¹⁰

At the same time, there are growing risks of a global catastrophe on Earth due to “internal” and “external” factors. Therefore, in the context of the problems and prospects of the evolution of human and society on Earth and in the process of space exploration, a number of topical issues can be singled out:

1. Is human evolution possible on Earth, which will ensure survival and development without resettlement, expansion into space?
2. Is it necessary and possible to create a “reserve” humanity beyond Earth for the survival and development of humans and humanity, taking into account the possibility of an “absolute” global catastrophe on Earth due to internal and external factors?
3. Is it possible to control the process of human evolution on Earth and in outer space and how to organize it?

The authors of the article will attempt to provide answers to these questions.

Basic concepts and definitions

In the context of this article, the most important concept is that of “human.” In the philosophical literature, it is defined as follows:

Human is “a subject of the socio-historical process, the development of material and spiritual culture on Earth, a biosocial being, genetically related to other forms of life, but separated from them due to the ability to produce tools of labor, having articulate speech and consciousness, moral qualities.”¹¹

However, this definition needs to be supplemented with some details. Humans cannot only live in the Earth's biosphere using it, but also create and use new technologies, artificial biospheres for survival and development on Earth and beyond (in outer space) and constantly live in them. In this sense, human is a “bio-socio-technological” being.

⁸ See: (Tsiolkovsky, 1920).

⁹ See (Website The Venus Project).

¹⁰ See (Krichevsky, 2021; Musk, 2017; Website “Asgardia — The Space Nation”; Website SpaceX).

¹¹ See (Frolov & Borzenkov, 2010).

The biosphere is a sphere, a space of life. According to Vladimir Vernadsky, the biosphere is the area of distribution of living matter on Earth.¹²

At the same time, it is the world's superior global ecosystem.¹³ In addition to the natural biosphere of Earth, there are also artificial biospheres and artificial space biospheres as part of the technosphere¹⁴ (see below).

Humans and humanity have evolved, exist and develop to a large extent at the expense of the resources of the Earth's biosphere, using and transforming the natural environment, creating a new artificial environment — the technosphere for their survival and development.

The technosphere is the sphere of life and technical activity of humanity, covering all its artifacts, including technologies, techniques, as well as technogenic pollution of the environment. The technosphere as an artificial environment was created by humanity, society; the process of its evolution is accelerating and proceeds in the mode of expansion on Earth and in Outer Space. Unlike the natural biosphere, localized in the space of Earth, the technosphere also spreads beyond Earth, in outer space.¹⁵

An artificial biosphere is “an artificially created living space ... in which all the necessary conditions are maintained to ensure the life and activity of humans and other biological objects. An artificial biosphere is created and maintained by an artificial ecological system”¹⁶ or, more precisely, by technical means that replace certain links of natural ecosystem processes.

Modern human of the Homo sapiens species is a human of the 20th -21st centuries, that is, human of our civilization who lives at the present time.

Cosmic human is the next stage in the evolution of terrestrial human, intelligent Homo sapiens, who realizes their cosmic purpose, is motivated, strives and is ready to fly into space, live beyond Earth, flies and lives in outer space and periodically returns to Earth or was born in space, lives in space or on Earth, periodically returns to space or permanently lives in outer space¹⁷.

There are *basic traits* that make human beings unique and which must be preserved in the process of their further evolution on Earth and in outer space, moreover, in the logic of “how to become a cosmic human and remain a human,” i.e., the human self and not turn into a cyborg, a cyborg-robot or other hypothetical entity.

But is it possible? What does it mean to be and remain human in the process of evolution? Where are and what are the boundaries of humans separating them from “non-human” if we consider the process of evolution in both directions: from regression and degradation with transformation into “pre-human” to the progress and hyper development with transformation into post-human?

Humans as biosocial beings experience some boundaries and limits. They are complex, multidimensional and change in the process of human and social evolution. At the same time, the immanent universal “core” of humans is preserved in any case. It is difficult but necessary to present, describe, formalize and interpret, and it is discussed in philosophy and art.

In our understanding, the most important property of the human “core” is the ability to evolve biologically and socially and develop (at the individual level) using, inter alia, technologies and technique.

¹² See (Vernadsky, 1989).

¹³ See (Odum & Odum, 1972; Reimers, 1994).

¹⁴ See (Allen & Nelson, 1991; Reimers, 1994; Yazdovsky, 1976).

¹⁵ See (Krichevsky, 2017: 155-156).

¹⁶ See (Yazdovsky, 1976: 23).

¹⁷ See (Krichevsky, 2020: 34).

The concept of “human” and the complete classification of human embrace the entire spectrum of all options, types, qualities, properties, characteristics, etc.: from a completely incapacitated (physically and mentally) human to a superman in the phase of maximum activity (with superior qualities, abilities, and level of development). In different sciences (for example, in biology and sociology), the concepts of “human” do not necessarily coincide.

The basic human rights adopted and acting in the world community determine humans’ legal status, general requirements and guarantees for their safety, survival and development as a living being and personality in society and the environment. But human rights do not cover and do not reflect the whole essence, properties, characteristics of a human, all their “internal” and “external” characteristics and relationships. Human is not reduced to human rights and is not formalized by them. Moreover, human rights themselves need to be adjusted and expanded (first of all, the right to life), considering the new reality on Earth and, especially, for people in outer space.¹⁸

Space exploration by a human is a comprehensive process of cognition, research, development, colonization, and use of space by a human for gaining knowledge, survival, security and development in all types and forms of activity, using technologies and technique, from observations, periodic flights from Earth into outer space, to full permanent life of humanity beyond Earth in outer space (including reproduction, life from conception to death), and up to the complete mastery of outer space as a physical object, its resources and space, covering all human interactions with society, Earth and outer space, including further evolution and the transformation of human on Earth and in outer space.¹⁹

The main goal (mission) of the life of modern human: survival and development of human and humanity based on the use and preservation of the Earth’s biosphere, the creation and use of new technologies and artificial biospheres on Earth and in space exploration.

Human evolutionary mission. Through humans, in the process of their evolution, “maturation,” preservation, survival, and development of highly intelligent life on Earth and its spread and expansion in outer space are carried out.

Management of human evolution is targeted effects for the preservation, survival and development of humans.²⁰

A new paradigm of controlled human evolution at this historical stage: preservation of modern human *Homo sapiens* as the highest priority of activity of human and humanity on Earth and in outer space.²¹

2. Evolution of life and human on Earth

Before discussing human spacewalk, let us dwell on the phenomenon of human and life on a separate planet Earth.

2.1. Life on planet Earth is not separate organisms, and it is the biosphere

When we talk about the existence of life on the planet and somewhere in outer space, we implicitly mean not just the presence of separate organisms of some kind there, but the existence of the biosphere system. The biosphere is characterized by closed cycles of substances, and the

¹⁸ See (Krichevsky, 2020; Krichevsky & Bagrov, 2019; Website UN).

¹⁹ See (Krichevsky, 2021: 17).

²⁰ By analogy with the management of the evolution of the biosphere and technosphere. See (Krichevsky, 2017; Yablokov et al., 2017).

²¹ See (Krichevsky, 2021: 278-282).

chemical compounds arising at each of the links of the cycle are used by organisms of another link.²² The whole “wheel” (cycle) rotates due to the influx of external energy. In the case of the modern terrestrial biosphere, practically all the energy it uses is the energy of the Sun in the visible part of the spectrum. As a result of photosynthesis carried out by plants, complex organic substances are formed from carbon dioxide and water, which are further used by other organisms of the biosphere. In the end, complex organic compounds turn into simpler ones (primarily carbon dioxide and water), which are returned to the cycle through photosynthesis. At the same time, it is essential that the functioning of this complex system requires populations of organisms of at least several different species, which are usually classified as producers (producing organic matter), consumers (using the living matter of plants or animals for nutrition) and reducers (using dead matter). The emergence of the biosphere on the planet is a complex, lengthy and, apparently, multi-stage process, in which primary organisms evolve in different ways and in different directions, even if they originally originated from one common ancestor. It is also worth noting, so that no terminological ambiguities arise, that the biosphere is the ecosystem of the highest level, consisting of other ecosystems, each of which provides the cycle of substances in its characteristic spatial scale, but also participates in the global cycles of the biosphere.

2.2. Evolution of the biosphere is the evolution of the ability to use new resources

The imperative for the functioning of the biosphere is its preservation as an integral, cooperative system. In other words, the imperative here is the preservation of life on the planet as such. The organisms and their populations that do not contribute to this, sooner or later, are either discarded by the selection, or forced to evolve. In fact, the biosphere is a living system of the supraorganic level, which uses the energy sources and environmental resources available to it, and is also tuned to the search for new sources and resources. This search becomes especially important when they become insufficient due to the increase in the volume of populations participating in biospheric processes. The search is carried out through evolution, i.e., by selecting new species that are capable of exploiting previously unused resources. Simultaneously, the biosphere’s internal environment becomes more complicated, more and more complex forms and methods of behavior appear since this ensures the possibility of their survival in new environmental conditions. This leads to a completely logical conclusion that the appearance of primates, and then of human beings, is a natural stage in the biosphere’s evolution. The question here is since what point in the evolution of primates, a smart ape can be called a human being. Presently, there exist many points of view. However, in any case, a human being cannot be separated from human culture (in a broad sense, viz., as a complex of knowledge and technologies of survival) without interaction with which a human child does not become a human. Outside culture, human remains a Mowgli, despite the fact that his parents were people, and in biological terms, he belongs precisely to the species of *Homo sapiens*.

Various definitions of humans have already been given above. However, it is necessary to clearly understand that there is no human outside human culture and civilization. It is about such humans that we are talking about in this article. Their evolution is discussed below.

²² See (Odum & Odum, 1972; Reimers, 1994; Vernadsky, 1989; Yablokov et al., 2017; Levchenko, 2020).

2.3. There have already been periods in the evolution of the biosphere when it conquered new spaces

One of the brightest, albeit greatly extended in time, stages in the evolution of the biosphere was the transition of life from the ocean to land. According to geological standards, this happened relatively recently — in the first periods of the Paleozoic era, i.e., starting about 540–550 million years ago. In the early Cambrian period, in some apparently humid parts of the surface, the so-called mats already existed, which are a kind of ecosystem in which organic matter was produced by unicellular algae and then utilized by other organisms. Mosses appeared in the Ordovician period, and vascular plants, which include modern higher plants, with the exception of mosses, appeared in the Silurian era. Plant, and along with it, animal life began to actively spread on the land, which was definitely manifested in the next period — the Carboniferous. In the context of the topic of the article, it is important to note here that the ascent to land and its gradual conquest by life began precisely when the ocean's possibilities in terms of using the energy of the Sun were practically exhausted, and the competition for resources pushed to search for new ways of existence. Although later, some plants and animals returned to the aquatic environment, this did not lead to a fundamental increase in the entire ocean's productivity. This suggests that the emergence of life on land was in some respects similar to the conquest of space by it. This happened in connection with the exhaustion of the resources of the traditional environment. This conquest took place gradually through the organization of new ecosystems in a new living space— fragments of a new biosphere.

The emergence of life in a new space — transition from the sea to the land — would be impossible without the parallel appearance of new adaptations in living beings. In plants, this is primarily the rise of photosynthetic formations (including leaves) above the surface with the help of stems, and as a result, the emergence of vascular plants, which now dominate the biosphere. In the case of animals, there were more inventions for life on land, and among them, those should be noted that helped to use the oxygen of the atmosphere, as well as contributed to the preservation of water in the body and maintaining the water-salt balance inside it. One way or another, this “spacewalk,” i.e., access to land, was accompanied by intense speciation due to the emergence of new adaptations. Divergent evolution led to the creation of new ecosystems with closed cycles of matter and, accordingly, to the complication of the entire biosphere.

Consider applying the regularities briefly mentioned above to the evolution of a human being who is now striving to go beyond the planet Earth. It is important to note here that although the search reflex is characteristic of all species of animals even when they live in comfortable conditions, the intensive search for a new living space occurred primarily due to the exhaustion of the environment's habitual resources. Another feature of resettlement to new conditions was ultimately the creation of new ecosystems. It became possible either as a result of changes in ecosystems that already existed here, as is the case with an introduction (invasion), or, more radically, the resettlement of groups of different species into new conditions at once. The mechanisms of evolution at the species level contribute in this case to such a mutual adjustment of the functions of different organisms that results in the creation of substances circulation, which ultimately ensures the sovereignty of a new ecosystem. In the latter case, it is possible to talk about the ecosystem colonization of new living space. In Neolithic evolution, humans contributed a lot to such processes, destroying existing ecosystems and introducing species of plants and animals, useful from their point of view, into the wild.

Summarizing what has been said, it can be noted that the accidental entry of organisms of any species into new conditions is not yet the settlement of the territory. For settlement, it is

necessary to create new ecosystems in a new place. They are evolutionarily and genetically related to ecosystems that already exist in other places, but at the same time, they differ from maternal ones since they are forced to exist in different conditions. Therefore, speaking about human spacewalk, we must clearly distinguish between research flights and the settlement of other planets, which is usually ignored in popular publications. When creating new ecosystems and especially new biospheres on other planets, part of the ecosystem functions may at first be temporarily replaced by technical means, but there is no need to talk about a self-sufficient and sovereign living biosphere. The question is whether human who has moved to another planet will be able to do without an archetypically innate need for their “small homeland” — the Earth’s biosphere. For this purpose, it is worth figuring out how our planet was populated by a human.

2.4. How man inhabited the Earth

Without going into historical details, it is sometimes very controversial, especially considering that it is still not clear whether the origin of a human being was monophyletic (from one common ancestor) or polyphyletic. We will consider the settlement of our planet by people even later, but before the periods of mass relocations and migrations characteristic of the new era. At the same time, we will be interested in the history of human from the point of view of their performance of ecosystem functions on the planet.

It is possible to try to describe the features of this last stage of the evolution of life on the planet with the concepts of evolutionary ecology, proceeding from the fact that each species population in ecology is associated with the corresponding potential ecological niche and the realized ecological niche. This approach works well for almost all biological species, except for humans. In the case of humans, this rule of niches is violated since different subpopulations of people with different skills and, accordingly, methods of survival have, generally speaking, different realized niches. It turns out that if we are guided by environmental considerations, then different subpopulations of biologically the same species of *Homo sapiens* should be spoken of as different species or subspecies. At the same time, the difference between such “ecological subspecies” (for example, the difference in how their populations interact with the environment and with each other) is determined mainly by the differences in the cultures of the ethnic groups to which they belong, and not by differences at the biological level. This is noted in the Universal Declaration of Human Rights: all people are recognized as having initially equal abilities and rights.²³

Considering the various “ecological subspecies” of people, we will use the *terms ethno-species and ethno-population*.²⁴ *Culture*, as mentioned above, will be understood as a set of mental and material means contributing to the self-preservation of an ethno-population (similar approaches are used in ethnography and social anthropology²⁵).

Ethno-populations of different ethno-species use the environment and its resources in different ways. Two polar types can be distinguished among them: ethno-populations that *fit* into the environment and those that *transform* the environment. The first type includes, mainly, already established and a little changing in time ethno-populations of one or another ethno-species, existing due to traditions, limited interaction with other cultures, as well as the relative constancy of physical and geographical conditions in equilibrium with the

²³ See (Website UN).

²⁴ See (Levchenko, 2004; Taksami et al., 2003).

²⁵ See (Rindoš, 1985).

surrounding nature. In essence, for ecosystems, or, more correctly, *ethno-ecosystems*, such ethno-populations are not different from populations of other species since, like the latter, they are involved in the ecosystem cycle of matter and participate in the stable functioning of the entire system as a whole.²⁶ Nevertheless, it is impossible to say for sure that these are exactly those ethno-populations that are in the state of the so-called “sustainable development,” since no development may take place in this case, as, say, in the case of some archaic ethnos that preserves unchanged ideas about the outside world for many generations, as well as a traditional way of life.

Apparently, ethno-populations of technocratic cultures belong to the second type. Each step in the development of such cultures, in one way or another, is associated with the use of new resources of the planetary environment and its transformation both locally and globally, since the idea of progress, understood in the context of various, ultimately material goods lies at the heart of the worldview of these cultures. The possibility of sustainable development of these cultures in the general case is controversial anyway, if it actually exists, but the ideas about some kind of compromise path that does not lead to irreversible changes in the natural environment of the planet are constantly appearing and are very popular (the latter can be summarized as follows: “the traditional life image, plus the latest technology”). Unfortunately, it is forgotten that the development of new technologies and the production of many new technical means, as a rule, are associated with the exploitation of additional resources of the planet.

Knowledge exchange (including conquest and expansion) involves the transfer of useful information (e.g., about agricultural plants). At the same time, the ecological niches of ethno-populations can change extremely quickly.²⁷ It is obvious that the rate of change, in this case, is incommensurably higher than the rate of those processes at the genetic level that usually leads to a change in niches, and as a result of which biological evolution ultimately occurs. It is also interesting that during expansion, the conquest of one ethnic group by another is not always immediately accompanied by significant mixing of the gene pools of the indigenous population and conquerors. To be convinced of this, it is sufficient, e.g., to recall the history of Europe or Russia of the last millennium.

It is appropriate to recall the ethnogenesis theory of an outstanding Russian scientist Lev Gumilyov (1990). Using substantial historical material, various ways of formation, survival, and death of ethnic groups are considered. He believed that one of the reasons for the emergence of new ethnic groups is the emergence of the so-called “passionaries,” violating the existing temporary balance between the parent ethnic group and the environment, as well as neighboring ethnic groups. A wave of passionarity often goes beyond the boundaries of one ethnic group and can eventually cover large territories. Gumilyov did not specifically consider the reasons for the emergence of passionarity; he believed that some cosmic cycles could be involved here, in particular, changes in the radiation background on the planet. From our point of view, this explanation reverses cause and effect. After all, the destruction of traditional culture and habitat occurs not as a result of the unexpected appearance of passionaries in some fertile place, but is quite the opposite: the depletion of environmental resources leads to a violation of the traditional way of life, the disintegration of the culture of the parent ethnos and, as a consequence, to the emergence of a special passionate type of subculture, in which the number of moral and ethical restrictions are reduced. In other words, the disintegration of

²⁶ See (Levchenko, 2020; Taksami et al., 2003).

²⁷ See (Rindoš, 1985).

an ethno-ecosystem is the reason for the appearance of passionaries, and not vice versa.

From the above, it is evident that in the case of ethno-ecosystems (i.e., ecosystems in which ethno-populations are included), one can also talk about their evolutionary transformations. At the same time, as well as for ordinary ecosystems, one can consider various types of slow and fast evolution, as well as such characteristics as biodiversity and *ethno-diversity* of ethno-ecosystems. The history of Western Europe, especially medieval history, makes it possible, apparently, to talk about stable ethno-diversity and even auto-regulation of ethno-diversity.

Summing up, it is easy to conclude that the main features of human, as a super-successful, super-universal species that managed to penetrate almost all large natural ecosystems and biogeocenoses, are determined not so much by their special physiological data but by the ability to preserve and quickly accumulate experience and skills in the population that contribute to survival. This was the result of the emergence of the developed brain, consciousness and exceptional communication abilities. It is worth noting that these features cannot be explained if we discuss only the individual abilities of each person. A very important role in the development of human and civilization was played and is played by culture and, accordingly, by the society, which predetermines, through social rules and myths, certain forms of communication, and hence the forms and contexts of information exchange between people, including that at the linguistic level.

3. Life, settlement and evolution of human in space

For a general description of life, settlement and evolution of humanity in space, four main aspects are singled out and briefly considered: (1) general assessments, covering the spectrum of opinions of experts and society; (2) experience of space flights, life, and evolution of people beyond Earth; (3) possible results of human biological evolution; (4) new opportunities, limitations and prospects for the process of space exploration and human evolution.

3.1. General estimates

The important estimates can be exemplified from the full spectrum of attitudes to the problem of space exploration, to space flights and the life of people beyond Earth, to settlement and evolution in outer space, reflecting positions in the classical ternary logic ("yes — no — I do not know"): 6 quotes — viewpoints of 6 outstanding authors during the period of 100 years (1920-2020) in chronology, in which three positions are set out ("for," "against," "I do not know if yes, but..."): 1) cosmist, founder of cosmonautics Konstantin Tsiolkovsky (Russia / USSR); 2) physicist, Nobel Prize laureate Niels Bohr (Denmark); 3) environmental scientist Nikolai Reimers (USSR / Russia); 4) astronomer, astrophysicist, popularizer of science Carl Sagan (USA); 5) cosmologist Stephen Hawking (Great Britain); 6) astronaut, the first person to step on the Moon — Neil Armstrong (USA).

1. Konstantin Tsiolkovsky (from the book *Out of the Earth*, 1920): "Humanity will not remain forever on Earth, but, in pursuit of light and space, at first it timidly penetrates beyond the atmosphere, and then conquers the entire solar space."²⁸
2. Niels Bohr (from the statement about human space flights, ~ 1970): "the undoubted triumph of human intelligence and a sad mistake of common sense."²⁹
3. Nikolay Reimers (from the text of *Ecological Manifesto*, 1992): "Going into space is the feverish delirium of a technocrat. Happiness on Earth cannot be replaced by

²⁸ See (Tsiolkovsky, 1920: III).

²⁹ See (Salakhutdinov, 2000).

- space travel. Inevitable death awaits the apostates: there is only one Earth in the Universe, and only on it can a person live. The dream of conquering the Cosmos is akin to the dream of world domination. Reasonable principle: space for Earth, not Earth for space.”³⁰
4. Carl Sagan (from *Pale Blue Dot: A Vision of the Human Future in Space*, 1994): “The Earth is the only world known so far to harbor life. There is nowhere else, at least in the near future, to which our species could migrate. Visit? Yes. Settle? Not yet. Like it or not, for the moment, the Earth is where we make our stand.”³¹
 5. Stephen Hawking (from speeches and publications in 2006-2007, 2010): “The ultimate survival of humanity depends on the colonization of the Solar system and beyond. ... Life on Earth is under increasing danger of being destroyed by a natural disaster such as a sudden global nuclear war, a genetically modified virus, or other dangers that we have not yet thought about,”³² “... humanity does not need to “put all its eggs in one basket,” and the only chance to survive in the long term is to subjugate outer space.”³³
 6. Neil Armstrong (from the speech at the first Starinus Science Festival in June 2011, to commemorate the 50th anniversary of the first manned space flight): “Improving the human species is our greatest challenge. ... It is possible that in the future there will be a migration of people from the Earth both to natural planets and to artificial habitats. ... Based on our practice here on Earth, we are not yet fit to populate and control a larger part of the Universe than we do now. We may or may not have enough time to grow as a species in order to fully control our destiny. But there is still good reason for hope. And we have no other choice. Our instincts will undoubtedly propel us to action.”³⁴

This series of quotes and points of view can also be supplemented by the results of sociological research, which should be carried out systematically (using modern digital technologies) to analyze the dynamics of public opinion and organize effective management of the process of human space exploration.

3.2. Experience of space flights, life and evolution of humanity beyond Earth

The process of real life, resettlement, and evolution of humans in outer space has been limited to the present by the experience of selection, training and flights of astronauts, their life beyond Earth and post-flight rehabilitation on Earth. In 1959–2020, about 100 thousand people took part in the competitions of astronauts in the world, ~ 1000 were selected and trained for flights, of which 565 flew into space (from one to seven times), twelve people were on the Moon. The duration of all human flights into outer space, life in it in artificial space biospheres (ships, stations, spacesuits) is ~ 140 years. The record of continuous stay in space is ~ 438 days (Valery Polyakov, Russia, 1994–1995), and the total duration of flights is ~ 878 days (Gennady Padalka, Russia, five flights, 1998–2015). At present, crews of astronauts from Russia, the USA, the EU, and a number of other countries fly into space, live and work on the International Space Station (ISS) in expeditions, usually with a duration of ~ 0.5 years. Human

³⁰ See (Reimers, 1994: 360).

³¹ See (Sagan, 2016: 27).

³² See (Overbye, 2017).

³³ See (Hawking, 2010).

³⁴ See (Man in space, 2020: 139-143).

properties and characteristics, risks, technologies and experience of space flights still limit the time of safe continuous stay in outer space: up to ~ 1.5 years in zero gravity in orbits ~ 300-500 km above Earth and ~ 3 days (~ 75 hours) on the lunar surface.³⁵

The main factors, effects and changes in outer space, the consequences of flights, including the manifestations of aspects of adaptation and human evolution, have been investigated and published.³⁶ Of particular importance are the results of recent years: the project “NASA Twins Study” (2019)³⁷ and a comprehensive analysis (2020).³⁸

The study of twins is a multivariate analysis of a long-term manned space flight according to the unique project “NASA Twins Study”, in which two US astronauts participated — twin brothers Scott and Mark Kelly (the first stayed ~ 340 days in flight to the ISS in 2015–2016, the second stayed on Earth) gave new important information. Changes in the human body in space were recorded, incl. those at the genetic level: mutations — up to DNA breaks, in addition, the expression and work of some genes changed, there were atypical variations in telomerase length, etc. Scott Kelly’s genome did not change, but it began to work in a different way, according to estimates, these changes affected 7% of his genes. It is not yet clear how long and irreversible these changes are and how they will affect his subsequent life, but it can be unambiguously concluded that space changes a human, including genetically. It is even assumed that there was a process of adaptation to space conditions at the genetic level during the flight.³⁹

A comprehensive, in-depth analysis of 59 astronauts and hundreds of samples sent into space reveals that “mitochondrial stress is the biological node for the effects of space flights, provides the insight into the fundamental biological mechanisms that are influenced by space flights, and highlights mitochondrial dysregulation. ... Evidence of altered mitochondrial function and DNA damage was also found in the urine and blood metabolic data compiled from the astronaut cohort and the NASA Twin Study data, indicating mitochondrial stress as a consistent phenotype of spaceflight. ... Health effects from mitochondrial dysfunction should be considered with spaceflight health risk models when planning future human-crewed missions to the Moon and Mars.”⁴⁰

The flight experience and research results provide new knowledge about the risks, adverse consequences and restrictions, the possibilities of expansion, ensuring life and safety, including the context of the future evolution of people in artificial biospheres in outer space.

3.3 Possible results of human biological evolution

Many ideas and publications are devoted to these findings — science fiction works, scientific research, and prediction.

Among the scientific works, the monograph by Oleg Gazenko and his co-authors (1987), is one of the first in the world on this aspect that can be singled out. In this book, the possible results of human biological evolution in the process of space exploration are systematized and presented in the form of two main scenarios, three options and a number of conditions, as well as their brief analysis is made. According to the first scenario, “space settlements within the Solar system are possible ... three options. The first option states that if space

³⁵ As of January 1, 2020. (Krichevsky, 2020: 38).

³⁶ See (Gazenko et al., 1987; Space biology, 1994–2009; Website NASA).

³⁷ See (Garrett-Bakelman et al., 2019).

³⁸ See (Silveira et al., 2020).

³⁹ See (Garrett-Bakelman et al., 2019).

⁴⁰ See (Silveira et al., 2020).

structures allow creating the environment equivalent in terms of the main earthly ecological characteristics, and the population of people living there is not isolated and does not lose genetic contact with earthlings, then the evolution of the inhabitants of space settlements will not differ from the evolution of humanity on Earth. The second option suggests that the living conditions of a settlement in outer space are distinguished by an increased level of exposure to cosmic radiation. Due to the random nature of radiation mutations, the course of evolution is unpredictable. The third option considers such an ecological feature as weightlessness, which has selective properties. The course of natural selection within the normal range of genetic reactions can lead to the development of moderate morphophysiological characteristics of people. Apparently, they will lose what people on Earth have acquired in the course of phylogenetic adaptation to gravity.” According to the second scenario, “the resettlement of people in the Galaxy can be expected and the partially or completely colonized Galaxy will be inhabited by creatures with the status of *Homo sapiens*, but distinguished by high species diversity ... in the absence of regular genetic contacts, human groups carrying out colonization will be subjected to “disruptive selection” in many ways, which will inevitably lead after a certain time (hundreds of generations) to a pronounced species divergence.”⁴¹

In the 20s of the 21st century, the ideas about humans’ possible biological evolution in space basically correspond to those outlined above and remain essentially fantastic, mythological and futurological. But the “moment of truth” is the possibility of human settlement in outer space and the transition to real space expansion: will a human being be able to survive and live permanently in new cosmic biospheres beyond Earth, its biosphere and magnetosphere — in near-earth space and on other celestial bodies — the Moon, Mars and others in the Solar system? New research, practice and experience can provide the answer.⁴²

3.4. New Opportunities, Limitations and Prospects for the Process of Space Exploration and Human Evolution

Back in 1987, it was clear that we have to “learn to determine exactly what we are willing to pay, the amount of that minimum of effects, shifts that a human is ready to make for the sake of flight ... still today we cannot yet determine this precisely. The overall strategy comes to making the biological cost of space travel ever lower.”⁴³

But in the 21st century, the “price” of space exploration is not reduced to the flight’s biological cost, and the strategy is seen as completely different — in the paradigm “to be or not to be for human and humanity?”. In the context of the global pandemic and the risks of other global catastrophes on Earth, human settlement in outer space is becoming a scenario for civilization’s possible salvation and the creation of “backup” humanity.

However, even today, we are still at the beginning of the process of expansion into outer space: new long and ultra-long flights are needed based on new approaches, strategies and technologies. They must be developed and implemented in the theory and practice of space exploration.

To go beyond the reached boundaries and limitations, we have to create fundamentally new artificial space ecosystems and biospheres — spaceships, stations, bases, settlements in the near-earth space, on the Moon, Mars, etc., in which protection from the effects and

⁴¹ See (Gazenko et al., 1987: 103-105). Apparently, this refers to our Milky Way Galaxy, but this also applies to the possible resettlement in other galaxies of the Universe.

⁴² See (Gazenko et al., 1987; Dias & Maynard, 2020; Space biology, 1994–2009; Krichevsky, 2020; Website NASA).

⁴³ See (Gazenko et al., 1987: 116).

consequences of dangerous factors will be provided (radiation, weightlessness, etc.) for people in outer space, with artificial gravity and other systems to ensure life, safety and decent living standards for people.⁴⁴

However, all these are impossible without society, social systems, rules and restrictions. “Human can go beyond Earth only through the social system of civilization using a special space infrastructure and is forced to live in space only in an isolated artificial environment — in the artificial biospheres of manned space objects, promising extraterrestrial space settlements. Therefore, the individual life of a “cosmic” human, their safety, and activities in space are even more dependent on society and technology than on Earth.”⁴⁵

The future of human evolution in space only seems distant and hypothetical. A new wave of space exploration has begun in the world. On the agenda, there are already issues of organizing the managing the process of human space exploration, as well as the issues of possible management of human evolution — by analogy and in addition to the processes of managing the evolution of the biosphere and technosphere⁴⁶ — in the scope “Earth + Cosmos,” including ethical, legal, technological and other aspects. “Ethical issues also come into play — We would be selecting a population with specific characteristics to constitute a new species. Who would make those decisions, and which characteristics would be selected for — or against — while colonizing space? All of these possibilities must be considered as we ponder life beyond the Earth.”⁴⁷

4. Discussion

Studies of the problem of life and evolution of modern humans belonging to the species of *Homo sapiens* on Earth and in outer space are of great importance for science, education and practice. This problem is relevant in connection with the transformation of the biosphere and the entire environment of Earth, especially the technosphere, and has three interrelated aspects (levels): biological, social and technological. The modern human is forced to adapt to a new reality — the rapidly changing environment of Earth.

Consideration of biological laws leads to the conclusion that the search and then the use of an unconventional habitat is a completely natural process from a biological point of view. This clearly implies that human penetration into the conditions new for them and into outer space and their settlement there is also quite natural and possible. In the case of humans, a new environment can be created and maintained artificially with the help of technology and technique, and in this case, it applies to artificial biospheres. Such biospheres can be created not only in outer space, but also, for example, on the ocean floor. However, for the settlement of entire planets, such a way is impossible since these are objects of a huge scale. In the case of planets, the only possible way is to create small artificial biospheres for settlements or new biospheres of a planetary scale with all their characteristic biological components (producers, consumers, reducers). Gradually, only humans can create such biospheres using terrestrial organisms since they possess the necessary complex of knowledge.

However, one must not forget that the process of creating any new biosphere on a planetary scale is extremely long, taking millions of years. Especially if one tries to populate a completely dead planet with all geological cycles specific to it, and with its own, almost certainly oxygen-

⁴⁴ See (Allen & Nelson, 1991; Krichevsky, 2020; Tkachenko & Morozov, 2017).

⁴⁵ See (Krichevsky, 2020: 40–41).

⁴⁶ See (Krichevsky, 2017; Krichevsky, 2021; Yablokov et al., 2017; Levchenko, 2020).

⁴⁷ See (Dias & Maynard, 2020).

free atmosphere. If some even primitive life already exists on a new planet, then apparently no less time is needed for the process of mutual adaptation of the transferable and the native life, i.e., the one already existing, to take place there. Obviously, in this case, the divergent evolution of all components of a new, emerging biosphere is inevitable due to the fact that even under conditions similar to those on Earth, they will not be completely identical to those on Earth and the original ones on a new planet.

Another equally important aspect of human migration into space is the evolution of human beings themselves. New environmental conditions will certainly contribute to changes in the body. The functioning of organs and physiological systems will change and become different from the conditions of Earth. If such effects continue for many generations, they eventually result in changes at the genetic level⁴⁸ and a new subspecies of *Homo Sapiens*. Subsequently, a new species unable to give birth when crossed with the original one will appear. This topic is usually dealt with in science fiction novels, which describe, for instance, the changes in the human skeleton on planets with different gravity or the skull in a different social environment. But there is no certainty that any changes will occur only at the biological level. Not less probable, in our opinion, is the path of the symbiosis of the human body with certain technical adaptations that allow existing more successfully in a new environment. As a result, human-machine hybrids or cyborgs will appear, which are not able to live and reproduce without the use of special technical means. And this will lead to the birth of a new “human-like” space civilization.

We now turn from futuristic hypotheses concerning the distant future to modern humans. Humans have a very long and complex evolutionary history and carry the seeds and matrices of almost all emotions and state that our close and distant ancestors experienced. They are altruism, egoism, cosmic and earthly things. What will arouse and become actualized in the human of the future, especially when it comes to life beyond Earth? The entire course of the further evolution of life on the planet and individual subpopulations of cosmic humanity depends on this. We cannot fully answer this question, remaining only on natural-scientific positions, and must move into the sphere of culture and its evolution.

However, clues can be found in the field of physiology as well. His prenatal development plays a very important role in the formation of the human psyche. Suppose the early phases of development of the human embryo proceed quite calmly and successfully. In that case, mental matrices of behavior and the desire for a symbiotic life with the surrounding nature are laid. Disorders during intrauterine development before and during childbirth initiate the awakening of aggressive behavior matrices, which will play an essential role during adulthood (we must not forget about everything that is stored by evolution in the psyche, and is not constantly updated but is turned on only under certain, specific circumstances.⁴⁹ It follows from this that taking care of the women’s health during pregnancy is one of the most important ways of managing the psychological types of people in a developing society. Long-term selection (dozens of generations) can lead to genetic fixation of psychological characteristics in members of subpopulations,⁵⁰ which is extremely important in the case of small human communities in cosmic settlements.

Beyond society, a human child does not become a human being, because a human is a social being. But in the same way, human is a natural being. Although still insufficiently

⁴⁸ See (Spirov et al., 2021).

⁴⁹ See (Levchenko, 2002; Levchenko, 2020).

⁵⁰ See (Spirov et al., 2021).

understood and considered by politicians, one of the most important resources is intact living nature with its fathomless, meditative beauty, to which each of us is subconsciously attracted by the archetypes laid down in the process of evolution. It is impossible to become human by growing up outside the nature that gave birth to them. The destruction of nature around and within itself is the destruction of the foundations of human essence. The human path is to create. Not destroy, but ennoble.

Therefore, human and society on Earth and in outer space must and will have to solve a complex socio-techno-natural problem of managing the evolution of modern human of the species of *Homo sapiens*, in which we will single out three main aspects:

- 1) survival and development of human on Earth under the conditions of the degradation of the Earth's biosphere and the expansion of the technosphere, the global socio-ecological crisis, internal and external risks of a global catastrophe;
- 2) organization and implementation of the resettlement of human and humanity beyond Earth, safe reproduction of people in outer space (including aspects of psychological types, behavior matrices, subpopulations, etc.);
- 3) preservation of the status and properties of human on Earth and in outer space (how to remain a "natural" living person, and not turn into a "cybernetic" person, cyborg, etc. on a new "base" in the form of a "synthetic" body and artificial intelligence).⁵¹

Main conclusions

1. Several aspects of life and evolution of modern humans of the *Homo sapiens* species on Earth and outer space in natural and artificial biospheres are considered in an interdisciplinary setting in philosophical, methodological and futurological discourses. New definitions are given.

2. The analysis of a number of important aspects of human life and evolution on Earth and in outer space is presented. Particular attention is paid to the transition from terrestrial to cosmic expansion in conditions and boundaries when a human remains a human.

3. If Earth's conditions are generally preserved and its biosphere remains in a slightly changed form, then the biological evolution of humans on Earth will proceed slowly. In biological terms, humans will remain a species of *Homo sapiens*. Social and cultural evolution is apparently possible, but in the direction of symbiotic coexistence of people and the planet's wildlife. Otherwise, the planet will face a global ecological crisis and the death of modern civilization. It is impossible to predict whether a human will have time to move to other planets and create new biospheres there, but the risk of the death of civilization is great.

4. The exit of human and humanity beyond Earth, settling in outer space is part of the natural process of populating the entire Universe with life, one of the necessary links in this process, since only human possesses the knowledge and technologies necessary for this and is able to use them to create new biospheres in outer space.

5. For the organization of permanent safe, and dignified human life beyond Earth, human settlement and evolution in space, it is necessary to create fundamentally new social systems and artificial biospheres.

6. A general formulation of the problem of managing human evolution on Earth and in outer space is made. Its main aspects are highlighted.

7. Prospects for human evolution on Earth and in outer space depend on the ability of humanity to combine efforts and resources to solve global problems on Earth in a new reality

⁵¹ For example, according to the scenario of cybernetic evolution, the creation of a cybernetic human, cyberworld, etc. See (Sukhonos, 2019).

and to organize the management of the evolution of the biosphere, technosphere and human, including the use of new technologies and the potential of the process of space exploration, including resettlement of humanity beyond Earth.

8. It is advisable to continue research on the issues of the evolution of modern humans of the *Homo sapiens* species, including the analysis of the possibilities of managing the general process of human evolution on Earth and in outer space.

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