

ALTERNATIVE BIOCHEMISTRY AND EVOLUTION OF HYPOTHETICAL EXTRATERRESTRIAL ECOSYSTEMS

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New data obtained during investigations of the Solar system and discovery of exoplanets (especially Earth-like planets) dramatically increased scientific interest to the existence of extraterrestrial life. This subject is tightly connected with the problem of origin and evolution of the Earth biosphere. One of questions is: how 'arterial' is the variant of metabolism dominated on the Earth and are other ways of biosphere evolution possible? At different conditions (chemical composition, temperature, pressure, spectrum and intensity of electromagnetic radiation etc.) biosphere variants based on metabolism typical for the Earth extremophiles could appear. Thus we can discuss hypothetical life with alternative biochemistry using diversity of metabolic processes among Earth organisms. For the origin of such life the following connected biochemical systems are necessary to arise:

1. systems of self-replicating molecules;
2. systems of energy metabolism with participation of red-ox reactive compounds;
3. protective systems against environmental physical-chemical factors and reactive metabolites (i.e. free radicals) causing destruction of biopolymers.

At some physical-chemical conditions alternate replicators (not based on DNA and RNA) can be preferable. In these systems analogues of nucleic acids containing non-canonical base pairs or other sugars (instead of ribose or desoxyribose) can be used.

Energy metabolism of the majority of modern Earth organisms is based on oxidation of organic compounds with oxygen (aerobic respiration). However existence of extraterrestrial biospheres with domination of anaerobic ecosystems is possible. Compounds containing hexavalent sulphur (S^{6+}) and pentavalent nitrogen (N^{5+}) can be effective substitution for molecular oxygen. It is important that products of reduction of these compounds can be reoxidised at anoxygenic photosynthesis or hemosynthesis.

Biospheres of alternative biochemistry can significantly extend the zone of the planet inhabitance. In the Solar system potentially inhabitant can be Mars, Jupiter's satellite Europa and Saturn's satellites Titan and Enceladus. It is interesting that even evolution of the Earth life resulted in appearance of ecosystems surviving without Solar light and at low oxygen concentration. They are biocenoses of 'Black smokers' and methane seeps.

Preference of aerobic or anaerobic metabolism in biosphere can affect evolution of protective systems, especially antioxidant ones. In fact oxygenic photosynthesis and aerobic respiration are the sources of toxic reactive oxygen species. Accessibility of microelements necessary for regulative, protective and energy transforming systems can be an additional factor influencing the mainstream of extraterrestrial biocenoses. Co-evolution of these systems is the general condition for existence of the both terrestrial and extraterrestrial life, and living organisms can not only be adapted to the environment but also can change it.