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General order of the origin of life in the Universe

V. N. Kompanichenko (1,2)

(1) Institute for Complex Analysis, Birobidzhan, Russia, (2) University of California, Santa Cruz, USA, (kompanv@yandex.ru / Phone +7-42622-24113)

The principal succession of transformations of organic matter leading to its transition into the primary living units is theoretically substantiated in the framework of the systemic approach to the origin of life (Kompanichenko, 2004). The succession is conditionally divided into three stages. For 1^{st} stage significant change of conditions in the host aquatic medium constrains an organic prebiotic microsystem to leave the current stable state with the following transition into a new stable state through the unstable critical (bifurcation) point. At the critical point the microsystem acquires the original properties without of which life cannot exist (self-maintaining heterogeneous structure, incessant fluctuations and rearrangement of molecules, exchange with the surroundings by matter and energy, etc.). During 2^{nd} stage its unstable (nonequilibrium) state relatively stabilizes by means of the balanced oscillations around the bifurcation point (there appears the paradoxical state “stabilized instability”). In this way the microsystem keeps the original critical properties and acquires biforked structure. This rare and unusual type of natural systems was called a bistate system. 3^{rd} stage is characterized with the radical turn in the network of chemical reactions (from in Vitro into in Vivo): the free energy contribution begins to prevail over entropy contribution. As a result, constructive transformations proceed faster than destructive ones. Just at this stage the key properties of biological organization appeared: the ability to concentrate free energy and information, ability for intensified counteraction to external influences, expedient behaviour, persistent self-renovating. In accordance with the conception, on the early Earth such successive transformation of organic matter occurred in the changeable conditions of hydrothermal medium.

Most of the scientific knowledge that was put in background of the elaborated systemic conception of the origin of life covers not only to Earth, but to processes in

the vast explored Universe too. The used key notions “free energy” and “entropy” are universal and characterize ability or disability of a natural system to carry out work elsewhere. For instance, outbreak of ash by active volcanoes on Earth and Jupiter’s satellite Io is the same kind of work that can be approximately evaluated in terms of the spent free energy. The opposite spontaneous and non-spontaneous processes are universal as well. They are described the transition of a natural system to more or less probable state correspondingly. Cooling of a lava flow on Earth and cooling of the entire Mars planet are similar processes related with the spontaneous process - heat conductivity. All stars, planets and other space bodies in the Universe are composed of about one hundred elements systematized in the Periodic Table. In this context behaviour of chemical systems elsewhere in the explored Universe should comply with the fundamental laws determined on Earth, in particular with the Le Chatelier principle, Onsager theorem and the theory of dissipative structures used in this work. For example, outflow of matter from a star occurs simultaneously with outflow of heat energy (i.e. they are interdependent processes) as it follows of the Onsager theorem. The organic microsystems, which are considered as prebiotic for the early Earth, composed of diverse organic compounds that were detected in the space and meteorites (from simple hydrocarbons up to amino acids). Taking these reasons into account, the distinguished three stages in principle can be considered in the context of a general scenario of the origin of life in the Universe.

Some new ways of the experimental research in the origin of life field are suggested. The first of them is laboratory experimental research of diverse prebiotic models at the state of bifurcate transition and under oscillating conditions in the experimental chamber. The goal of the experiments is to corroborate or demolish the thesis about real existence of the bistate type of natural systems, including its “prebiotic version” useful to evolve to life. One more way consists in natural experimental exploration of changeability of the thermodynamic and physic-chemical parameters (pressure, temperature, concentrations of compounds, pH, Eh) in submarine and terrestrial hydrothermal systems, including amplitudes, frequencies, and periods of the oscillations. Also it is important to determine how the hydrothermal oscillations depend on the close volcanic and tectonic (seismic) events. The events were much more intensive on the early Earth, and might significantly influence a scale of the fluctuations. These investigations are aimed to characterize the probable geological Cradle of life with the following using the obtained data to conduct laboratory experiments. This information can be important for evaluation of possible life arising on other Earth-like planets at the early stage of their geological evolution, including the extrasolar planet Gliese 581 C discovered just recently.

Reference. Kompanichenko V.N. (2004) Systemic approach to the origin of life. *Fron-*

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