The Origin of Biosphere

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Abstract
The problem of origin of the life is broadly being discussed during very long time. The majority of the theories are founded on different hypotheses which describe origin of primary primitive organisms by some non-biological ways, for example, by self-organization of non-living substances. The origin of the biosphere (Gaia) is considered within a framework of such approaches as one of consequences of the origin and subsequent expansion of different species. At that the biosphere is described as simple sum of all organisms but not as united functional system. On the other hand, it is known that any terrestrial organisms are not able to survive and to reproduce outside the biosphere as well as without interactions with other organisms (this is possible sometimes but during only restricted time). Therefore the hypothesis about simultaneous origin of organisms and biosphere is looked quite probable. But such approach leads to several assumptions, in particular about inclusion of earliest forms of pre-life into planetary circulations.
Keywords: evolution, origin of life, biosphere

1 Introduction. Traditional Approaches

The most of theoretical approaches to the problem of appearance of the life in our planet concern out some abiotic mechanisms of the origin of primary organisms. In order to explain these mechanisms different chemical and (or) physical processes are being described. There are, for example, suggestions about origin of cell membrane, hypothesis concerning of so called coacervates (Oparin, 1966), assumptions concerning mechanisms of genetic memory, energy processes etc (Ponnamperuma, 1972, Rutten, 1971). All they consider various hypothetical ways of abiotic creation of different systems of known organisms. The first principal defect of all these theoretical constructions is that, the biosphere is described as some mechanical sum of all organisms but not as united functional system which provides for the existence of own components.

The above conceptions, of course, are interesting in particular because they use sometimes to explain the origin of the life very exotic mechanisms. But all they have also several other unremovable defects because they imply usually quite unlikely assumptions in order to be well grounded. There are:

1) very peculiar conditions in the localities where the life could arise and, thus, very low probability of origin of initial organisms;

2) very peculiar but relatively stable conditions for development of primary life;
3) very long period (at least one billion years) when such conditions have to exist.
Moreover, it is not clear:
4) what is the food for primary organisms during all period when initial life evolved;
5) how to explain the appearance of several trophic levels in primary biosphere.
But one can investigate the problems of origin of the life using another approach.

2 The Biosphere Approach

There is also another point of view concerning the origin of the life and its evolution on the Earth. It is based on the assumption that all living organisms on the planet depend on one another i.e. any life, at least known its forms, outside biosphere are impossible (Capra, 1995; Lovelock, 1991; L. von Bertalanffy, 1962; Maturana, Varela, 1980; Vernadsky, 1980). At that, the biosphere (or – in western tradition – Gaia) is considered as separate system of the highest structurally-functional level of the life organization. This system controls and directs evolution of all living organisms and all earth ecosystems. Such assertion is named **pan-biospheric paradigm** (Starobogatov, Levchenko, 1993). The problems of both biological evolution as well as the origin of the life can be described within framework of this paradigm.

The above assumption leads us to several conclusions. At the first, the biological evolution has to be described in context of the ecosystems evolution. This is named the **ecocentric conception of evolution;** according to it, the relationships between the evolutionary processes on different levels of biological organization are inter-coordinated. In other words, the evolution on the species level and above (genus, family etc) can't take place without evolutionary changes of correspondent ecosystems and biosphere. Some exceptions with micro-evolutionary processes are connected with ecologically-neutral drift (Levchenko, 2004; Eigen, 1971). Only the biosphere is relatively independent "whole" alive system, although it is dependent, of course, on geological and cosmic processes, in particular, in interplanetary conditions (Starobogatov, Levchenko, 1990).

The second conclusion from the pan-biospheric paradigm concerns the origin of life. In order to explain the development of pre-biosphere, it was proposed **embryoshere hypothesis** (Levchenko, 1990, 1993a, 1993b, 2002). According to it the appearance of different sub-systems of primary organisms could happen independently from each other within united functional system – so called embryosphere. This is a system with self-regulated processes of the substances interchange between different its parts under influence of external energy flows. Note that embryosphere is not another name for either hypothetic pre-biospheres, because it has some functional properties of living systems. Among various substantiations concerning of its appearance and existence in the past, one can point out, for example, such ones, which concern analogies between processes of evolution and development.

It was revealed, several evolutionary principles can be applied to organisms, to ecosystems and to the biosphere. In particular, there are:

a) principle of evolution of functions; it can be formulated as the intensification of processes supporting important functions of biosystem along evolution (see in details Orbeli, 1979);

b) principle of increasing of multi-functionality of separate sub-systems for organisms or ecosystems along the evolution;

c) principle of so called superstructure (or over-basis): new functions do not replace previous ones but they subordinate old functions, are "superimposed" on them (Orbeli, 1979).

These principles can be applied also to the development of embryos. Comparing all these features of evolution and development, one can suppose that the pre-biosphere is the system, which is being self-preserved, and which is similar to primitive organism without generative organs. In other words, the pre-biosphere in this view is weakly differentiated system, which develops as embryo by means of successive differentiations. The pre-biosphere with above particularities was named embryosphere (Levchenko, 1990, 1993a, 1993b, 2002). Consecutive differentiation leads to complication of the embryosphere system. Known in paleontology the microfossils could be non independent separate primary organisms but they are like functionally the cell organelles.

The embryosphere hypothesis is based also on the following assumptions:

1) the interchange of substances between the embryosphere parts occurs under influence of external energy flows;

2) embryosphere is united system with closed circulation of substances;

3) the origin of different known vital processes could happen independently in different regions of embryosphere;

4) embryosphere is the system which is being self-preserved and self-instructed (Eigen, 1971); in particular, this means, the system is able to switch some branches of processes depending on external conditions in order to maintain important vital functions. In other words, the embryosphere is able to change “reasonably” interaction with surroundings in order to survive.

This approach, which explains the origin of living organisms within embryosphere by means of successive coordinated differentiations, implies also that Earth had initially sufficient quantity of mobile substances (liquids, gases) in order that the embryosphere is functioning. The organic substances must be also enough in order that primary life could be evolving long time, at least, hundreds of millions of years or more.

One of traditional points of view to the problem of biological evolution is latent assumption that evolution is going from some simple forms to more complicated ones. This supposition can be easy explained within framework of the biosphere approach. The above phenomenon is connected with "biosphere memory", in other words with irreversible results of previous evolutionary changes. At the first, they create different evolutionary restrictions on the organism level, for example, morphogenetic ones. At the second, changes of the biosphere surroundings modify factors which control directions of global evolutionary process (or canalize it – in biological terminology). At last, the flow of energy, which is used by the biosphere, grows gradually along the biosphere evolution (the causes and consequences of that see Levchenko, 1999, 2002).

Not difficultly to come from above to the idea of auto- or self-canalization of the life evolution (Levchenko, 1992, 1993a, 1997). This idea conforms to the general systems theory of L. von Bertalanffy (1962) as well as approaches of Lovelock (1991) and Capra (1995).

What could be the embryosphere system in this point of view? How could the life arise in the Solar system just in our planet? In order to come near to the answers to these questions, one can consider the conditions in some other planets of the Solar system.

3 Hydrocarbons in Small Planets of the Solar System

It is possible to avoid many difficulties of explanation of the origin of primary life if to suppose that surface of early Earth contains big quantity of hydrocarbons. This assumption isn't too fantastic if to remember results of investigations of other bodies of the Solar system.

It is known, many satellites of Jupiter and Saturn have much hydrocarbons on their surfaces and in atmospheres. For example, Titan – the satellite of Saturn - has even oceans and seas of liquid hydrocarbon – methane – see Fig. 1. There are also other, high-molecular hydrocarbons which are dissolved in these seas. The diameter of Titan is about 5150 Km; it is more than diameter of Mercury (about 4880 Km) and less than one in the case of Mars (about 6800 Km). The investigations of Cassini orbiter in 2005 have demonstrated, that Titan has dense atmosphere (up to 1.6 Kg/sm^2), which consists of nitrogen mainly (about 95%), methane, other gaseous hydrocarbons and ammonia. The temperature of the planet is quite low: it is approximately minus 160 degree by Celsius. Therefore, the water on Titan (the water quantity is also big there) is only in "stone" solid form (Woolfson, 2000).

Is it possible that water and hydrocarbons are present simultaneously in considerable quantities on other, not great planets? It is quite probable for at least earliest phases of planetary evolution in the case of planets of Earth's group and satellites of large planets. This point of view is prevailing in planetology (Kenyon, Steinman, 1969; Rauchfuss, 2008; Woolfson, 2000). Moreover, we know one contemporary planet of the Solar system with oceans and seas of liquid water on its surface. This is, of course, our Earth, which has appropriate temperature of its surface for that. As water and hydrocarbons can be found on ancient planets together, then the evident question arises: could liquid water and liquid medley of hydrocarbons exist on the Earth surface somewhere jointly? If to remember that fossilized precambrian oils (the origin of which are not explained obviously by biological processes) are present in Earth then one can suppose the ancient Earth had on its surface somewhere medleys or emulsions of some heavy hydrocarbons and liquid water. The temperatures of ancient Earth was apparently suitable in order that some of these hydrocarbons can be in liquid form (may be, even resembling the most ancient oil). Later, planetary evolution went to modern situation when ancient hydrocarbons have decomposed and much carbon exists in other forms on the Earth's surface (e.g. as living substance)

Figure 1. The reconstructions of Titan landscape by M.Zawistowski (Canada) on the basis of the Cassini mission data – see http://www.astrogalaxy.ru/271.html. The seas in the pictures consist of liquid methane mainly . The color of the sky is yellow-orange.

If so, then water-“oil” emulsion could be fine surroundings for the origin and long evolution of the initial forms of the life on our planet. Such emulsion could be appropriated for forming of liquid structures – coacervates (Oparin, 1966; Rutten, 1971) and, moreover, it could be suitable food for initial forms of the life.

4 The Joint Origin of the Biosphere and the Life on the Earth

If to summarize the above considerations then one can come to the following hypothetical statements:

1. The origin of the embryosphere was necessary stage of the origin of the life on the Earth. This approach conflicts with so called panspermic hypothesis as we assume any biological organism isn't able to successfully exist outside surroundings of embryosphere or biosphere. In our opinion (Starobogatov, Levchenko, 1993) the conception of the biosphere has to be included to any definition of contemporary life. Vice versa, panspermic hypothesis of Arrenius (Ponnamperuma, 1972) supposes the early lifeless Earth is appropriate in order that "cosmic sperm" can there settle down.
2. The embryoshere hypothesis tries to explain how conditions, which are necessary for the life, could be created without contribution of the life on early stages of Earth history. It is supposed that origin of embryosphere is connected with organization and evolution of the substances circulations in pristine "bouillon" under influence of external energy. The large-scale circulations can contain “micro-circulations”; autocatalytic reactions of some circulations can use sometimes chemical factors from other circulations – see Fig. 2. The competition between different circulations results in the origin of such of them which are able to be self-preserved. This tendency is conjugate with the organization of complicated nets of autocatalytic reactions; in cybernetic context these nets are the controlling mechanisms which support the existence of embryosphere.

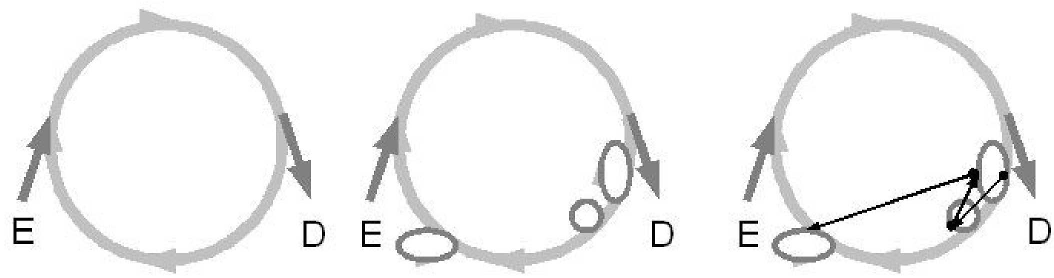

Figure 2. Stages of evolution of circulations in the embryosphere. On the left: the simplest natural circulation: the external energy (E) supports circulation of substances and dissipates as thermal energy (D). In the middle: the appearance of the micro-circulation cycles on the energy gradients of main circulation; this is possible when micro-circulation processes accelerate some parts of main circulation. On the right: the appearance of immediate interactions (for example, by way of chemical catalysis) between different cycles of micro-circulations; the development of the controlling net of embryosphere.

3. Self-preserving of embryosphere is connected with development of compensative, adaptive reactions, which are being switched on when conditions change. This mechanism probably could be the same as described for physical evolution of the biosphere: when external "interruptions" of the energy flow weaken some of existing processes, then new compensative processes may happen (Levchenko, 2002). This can be described also in the terminology for mechanisms of auto-canalization and self-instruction (Eigen, 1971) for the chemical evolution of the planet (Kenyon, Steinman, 1969; Rutten, 1971; Fox, Dose, 1977). Self-instruction mechanism implies anticipatory behavior of system (Dubois, 1997; Rosen, 1991); in fact this is the possibility to change the functioning using internal mechanisms (instructions of functioning – in cybernetic context) when circumstances of existence vary.

4. Every substance circulation, which is being self-preserved, supports own dynamic structure. New circulations, which arise along evolution of the embryosphere, create new dynamic structures. These processes lead to gradual formation of such relatively stable environment, which is more suitable for the origin of the pre-life. If the energy flow through embryosphere grows along time (see above), then preconditions of origin of different trophic levels of embryosphere appear.

5. The origin of primary organisms was a result of several continuous evolutionary processes, At that, the power of inter-coordination between these processes was gradually being increased: a) complexification and self-organization of chemical complexes (proteins, nuclein acids, lipid membranes); b) successive structural differentiation of embryosphere; c) the intensification of interchange of substances

between different parts of embryosphere, d) origin and further use of mechanisms of molecular memory (RNA, DNA) by pre-life.

Many of self-supporting processes in contemporary biological cells (for example, the processes of the energy transformation connected with ADP <–> ATP conversions) could arise in some fragments of the embryosphere before the origin of independent organisms. In other words, such processes in existent organisms can in general traits repeat some ancient processes.

The water-“oil” emulsion which very probably existed in large quantity on the surface of early Earth, was fine surroundings for the development of different physical and chemical processes in embryosphere and later – in primitive biosphere. When hydrocarbons on the surface of the planet was mainly exhausted, then the life has found the mechanism of photosynthesis.

And, at last, about functional basis of the life: it is ability to foreknow the future using previous successful “experience” ,that gives possibility of anticipatory behavior. This faculty allows to avoid the destroying situations and to use accessible means which help to survive. The ability of anticipatory functioning has been perfected by natural selection along biological evolution and is not possible without biological receptors and memory mechanisms (Levchenko, 1999, 2001; Levchenko, Khartsiev, 2000).

5 Conclusions

It is asserted in this hypothesis that Earth’ life has arisen in the pre-biosphere – embryoshere, as result of mixing of great quantities of liquid hydrocarbons and water on the surface of ancient planet. Such supposition doesn't contradict the planetology data.

The question "what is the origin of the life: either origin of organisms or origin of biosphere?" isn't correct because only whole biosphere is independent unit of the life among all known living forms (Lovelock, 1991). There are two important regularities of the evolution of the life on Earth. The first one demonstrates the autocanalization of physical evolution of the biosphere (increase of the energy flow which is used by the Earth life) and correspondingly the texture evolution of biosphere; this approach leads to the hypothesis of embryosphere, which was developed from primitive chemical processes up to biosphere. The second regularity shows to non predetermination of the phenotypical realizations of biological evolution, what is demonstrated by ecologically neutral changes of some biological forms. It is reasonable in this relation to suppose non predetermination of origin of concrete life forms on Earth but to assume there is some predetermination of evolution of embryosphere and biosphere. Proposed general approach may give new insights concerning of the problem of origin of life in Solar system and in the Universe.

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