Living Systems are "Cooperons"

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Abstract
Living systems (for instance, organisms, ecosystems) are traditionally being discussed in the context of structural-morphological approach. We suppose that such approach, although is illustrative, but distracts from the circumstance that any living system is to be considered an integrated structural-functional complex. The maintenance of existence of this system is being impossible without the processes aimed at preserving this complex. This leads to the concept of cooperons – the self-preserving dynamic structures existing only as a result of specifically organized cooperative various processes. From this point of view, all living systems are cooperons of different hierarchy levels. Some other systems, for example the symbiotic ones, also are cooperons. Within a framework of this concept, it is possible to discuss the functioning of living systems of different types of organization in a new context.

Keywords: organism, regularities of functioning, cooperative systems.

1. Introduction

Traditionally, living organisms are discussed within a framework of structural-morphological approach. This is quite convenient way, which has allowed to classify almost all known organisms. Nevertheless, not all systems, which demonstrate some functional properties of living systems, for example ecosystems and symbiotic ones, can be included in the such classifications. Therefore, some philosophers propose more broad classifications of living systems.

If summarize different points of view, there are the following structural levels of the life organization, which are mentioned in almost all approaches (Levchenko, 1993):

1. The unicellular organisms, in which cellular organelles serve as individual structural-functional blocks – subsystems.
2. The multicellular organisms, for which the subsystems are cells and organs.
3. The ecosystems, in which the subsystems are single organisms and the species populations, or else also other ecosystems of the lower scale and range (Levchenko, 2004; 2011; Levchenko, and Starobogatov, 1999).
4. The biosphere, for which the subsystems are large ecosystems (as a rule, – so-called biogeocenoses).

Sometimes, cells of multicellular organisms are also identified as an individual structural level. However, this is accepted by not everyone, as these cells usually cannot exist and/or be reproduced outside the whole organism (Platonov, 1978; Ptitsyna and Muzalevskii, 2002; Volkenshtein, 1980).

It is also known that any living system exchanges with environment with substance, as well as uses the energy and information obtained from external medium. The functioning of the system is organized in such way that at each moment of time it "strives" to provide **subsequent existence** for itself (Levchenko, 2004; 2011; Shredinger, 1972). At that, there takes place a phenomenon that can be called preventive or **anticipatory behavior** (of course, on the basis of prognosis of development of situation (Levchenko, 2001; Rosen, 1985, 1991)). Obviously, it is necessary to investigate this problem more, but it seems, the level of anticipatory activity is higher for such biological systems as organism, where it is strong, and weaker for ecosystems.

On one hand, each of the living systems of above levels of organization is relatively autonomous. On the other hand, it depends on external different living systems. The entirely open system is factually dissolved in environment and does not exist as the separate unit of life. The degree of autonomy decreases if diversity of factors simultaneously necessary for the maintenance of integrity of such system grows.

However, apart from the above-mentioned division to structural levels of organization, it is also possible to examine the problem of classification and interactions of living systems from another position by using some ideas of functional approach, in particular, the concept of cooperative systems (Savost'yanov, 2005; Ugolev, 1987, 1990; Volkenshtein, 1981).

2. Functional organization. Cooperative systems

The **cooperative system** is such a relatively autonomous system whose properties are determined by the entire complex of its composing elements. Nevertheless, it is important to note that simple summation of properties of composing elements without taking into consideration of peculiarities of their interactions with each other does not allow to explain all features of cooperative system as a whole.

Such organization of the system is impossible without specific interactions between its parts. More exactly, it is impossible in the case of the absence of exchange between the parts by not only different substances, but also just informational and controlling messages, in response to that, properties of the parts and of the whole regularly change in either direction. In other words, the "secret" of any cooperative system consists in peculiarities of interactions between parts, i.e., in peculiarities of its internal organization. In other words, individual properties of any part of any cooperative system are important, but still this is not all determining its properties as a whole.

The concepts on cooperation in physical systems seemed to have been first proposed by Fowler at considering the flip-flop changes occurring sometimes during phase transitions (Volkenshtein, 1981). For example, the transition gas -> liquid at gas compression under conditions when the temperature is lower than critical, occurs spasmodically due to involvement of the positive feedback mechanisms: a decrease of volume increases the mutual attraction of molecules, which results in a further decrease of volume. Since in the process of such transition the elements of system act as if in coordination, their behavior is considered cooperative. As a measure of change of degree of cooperation, it is proposed to use some value, which is proportional to the energy extracted from the medium during the phase transition (Volkenshtein, 1981).

The systems, in which the products of reactions are catalysts of these reactions, are called autocatalytic, sometimes allosteric (Volkenshtein, 1981). Such systems, of course, are also cooperative. A fine example of autocatalytic cooperative system with positive feedback connections extremely sensitive to conditions of the course of reactions, is provided by the so-called model hypercycles of Eigen: RNA → protein → RNA, etc (Eigen, 1973).

3. Cooperons

We will further be interested in not any cooperative systems, but in self-preserving ones, i.e. the such, whose functioning is directed to the maintenance of their own integrity by means of adaptation to environment. The self-preserving cooperative system represents a relatively stable structural-functional complex and exists as the whole in some diapason of external conditions. To avoid further use of complicated word-combinations, we will call such complexes the **cooperons**. The structure of cooperon is a specific substrate for the maintenance of processes providing its preservation. Conceptually, this approach uses ideas not only of physics, chemistry, and cybernetics, but also of general theory of systems, in particular of the concept of self-organization.

The example of cooperon in inanimate nature is mentioned model of auto-catalytic self-instructing Eigen's hypercycles (Eigen, 1973). In living nature, there are also the self-preserving systems adapting to environmental variations, for instance, organisms. They are valid "candidates" for the role of cooperons. In some cases, cooperons can appear as a result of spontaneous self-organization, for example, during formation of new ecosystem.

It is important that all parts of above relatively autonomous system – cooperons – are combined by close causal-investigatory relations, i.e., the consequences of individual activity of any of the parts "return" back to it ultimately in the form of changes of other parts and/or the whole, but do not disappear entirely. Hence, although specific individual peculiarities of the parts (for instance, the internal morphological structure) are essential but their activity within of the entire system has also great significance. In biological language the above-mentioned interactions of parts can be also interpreted as symbiotic ones by the type of mutuality (Ptitsyna and Muzalevskii, 2002; Ugolev, 1990).

In several cases some structural levels of organization coincide with obvious levels of cooperation. For example, cells of a multicellular organism undoubtedly are relatively autonomous cooperons. In other cases the such coincidence is absence, as, for instance, it happens in local ecosystems around the individually spread environment-forming trees or in the situation concerning individual organs and some specialized cellular populations (for example, populations of the adrenal cortex cells or the anterior pituitary cells participating in synthesis of hormones – Leibson, 1983).

All this leads to conviction of that the traditional ways of separation of parts of living systems on the basis of only morphological peculiarities are happen to be insufficient. The morphological method perfectly manages description of structure of corps, but cannot provide an adequate consideration of the living organism "filled" also with numerous inter-coordinated cooperative processes.

Within a framework of the cooperon conception, it seems also reasonable to add to cooperons various symbiotic constructions. The issue of separation of some of them (not all) as individual units of life is usually tried to be avoided. An illustrative example can be lichens consisting of organisms of different, rather distant taxonomic groups – algae and fungi. For lichens the special taxonomic system is created, but even lichenologists not always risk to use an organism approach upon discussion of life activity of these biological objects. Another interesting example of symbiotic constructions is demonstrated by some algae from the *Volvocaceae* family combined in the self-preserved, organism-resembling colonies that consist of genetically uniform, but structurally and functionally differentiated cells (Desnitskii, 1991). Another peculiar example of the organism-like cooperative system is provided by an anthill (Dolnik, 1994).

The established specifically organized interrelations between the cooperon components provide long existence of the cooperon in some diapason of conditions. For the purpose of self-preservation this system is able to change interaction with environment, by means of control of internal processes, for example, switching their branches. This means the system is the cybernetic one with all attributes typical in this context – acceptors (receptors), memory, effectors, etc.

By summarizing the above-said about cooperon, it is to be noted, that

1) interactions between components have symbiotic character (by the type of mutualism),

2) at that, adaptive behavior of the whole system, which consists from separated relatively autonomous components, prove to be possible.

Thus, we come to the following, although not completely precise description of cooperon: this is the autonomous, functional, cybernetic, mutualistic system self-maintaining own integrity.

It is known that the changes that occur in biological system in the respond of the appearance of any circumstances are determined by the necessity of survival. We called this the "principle of the priority activity" that represents factually the capacity to self-preservation (Kotolupov and Levchenko, 2009). If some situation happened earlier, usually there are already existed instructions of the functioning, which were kept by in the memory of the system; these instructions are used by it in this case. In the case of unknown situations, the system turns out to be necessary to search for new ways of the functioning, for which living systems use either mechanisms of prognosis (if it is possible for them) or the random, heuristic search. Both cases of the known and unknown situations are generalized within a framework of concepts on cybernetic aspects of functioning of the living systems (Levchenko, 1993, 2004). In this connection it would be useful to mention the so-called, always awaked "Daemon of life" – the major instruction based on the functional imperative of any living system subordinating all its specific instructions of the functioning. The essence of this instruction consists in preservation of the system and maintenance of continuity of the life processes under any circumstances (Levchenko and Khartsiev, 2000; Levchenko, 2011). Simplifying a little, it follows from all these considerations that cooperon is a material realization of processes or, more widely, of the closed-loop causal-investigatory relations organized by a specific way (in this case, under control of "Daemon of life"). Of course, this can look to certain degree unaccustomed in the context of the every day logic, but "cooperon of living system is a material realization of functioning of Daemon of life" is quite adequate description.

In conclusion of this section it is important to note that cooperons, being relatively autonomous functional systems, can include other cooperons, i.e., they have own levels of organization and hierarchy. In the scale of the planet, all are joined by cooperons of the highest level – biosphere; on the lower levels there are large ecosystems, as well as, sometimes, socio- and technocenoses (Krichevskii, 2007; Oleskin, 2001). It is necessary also to select an important large group of independently existing organisms including unicellular and multicellular organisms. The latter consists of differentiated cells of various types, which also are restrictedly autonomous, self-preserving cooperative systems. One can suppose, moreover, the presence of intracellular level, where, the specific cooperons also exist.

4. Conclusion

Thus, life on Earth is a complex of interacting cooperons, which are cooperative self-preserving constructions; all they compose cooperon of the highest level - biosphere, or in other words, support the "web of life" (Kapra, 2002). Traditionally, the parts of biosphere are considered in the structural-morphological context, i.e., as living systems that have different sizes, organization, and ways of existence. All they are taking part in creation of local and global environments of existence, as they are involved in the substance circulation of biosphere and participate in processes of informational exchange (i.e., can sometimes be for each other a source of information important for survival - Kotolupov and Levchenko, 2009; Dolnik, 1994). This approach also allows the natural inclusion in the number of systems revealing some properties of living, the such that usually are not discussed in biology and medicine as independent ones, for example, various symbiotic systems, ecosystems, socio- and technocenoses (Rautian, 1988; Levchenko, 2004; 2011; Krichevskii, 2007; Krichevskii, 2007; Menchutkin, Natochin and Chernigovskaya, 1992; Kotolupov and Yakovenko, 2006). In frames of the proposed ideas, one can discuss not only functioning of living systems of different levels of structural organization in the conditions ordinary for them, but also such changes in these systems that are associated with the disturbances of cooperative interactions inside them.

The cooperon is the self-preserving dynamic structure existing only as a result of occurring and acting of the specifically organized processes, which are maintaining the existence of the structure and its components. Cooperon can be considered as a specific unit of life, but in another, not traditional morphological context. The idea of cooperons allows to connect within a framework of one conception the structural and functional approaches, as well as to discuss the common properties of cooperons for very different levels of organization of the living systems.

Some ideas concerning of the cooperon evolution are presented in the article (Levchenko, Kotolupov, 2010) and chapter of new book "Biosphere" (Levchenko at all, 2012).

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