International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-7, Issue-6, June 2021
ISSN: 2395-3470
www.ijseas.com

Definition of "Life" A multidisciplinary approach

Igor Krichtafovich

Abstract

For many centuries people have tried to define the most complex concept: LIFE. The generally accepted definition still does not exist. In this article, an attempt is undertaken basing on the new hypothesis.
The main statement claims that the Biosphere is a single Organism, all parts of which are interconnected by continuous information flows. Due to information exchange, the Organism has formed a memory, the ability to generate, process, transmit and modify the accumulated information. The Biosphere, consisting of relatively simple chemical formations, has acquired intellectual and creative potential over time.
As an analogy, the article considers a digital computer consisting of binary cells, i.e., transistor switches. When the number of such switches reaches a certain level, the computer achieves the ability to perform many mental tasks at a higher level than the human brain. Our Biosphere, containing an immeasurably larger number of self-replicating molecules, also performs logical operations. It does it with an efficiency that is many times greater than the capabilities of both a supercomputer and the brain.
The proposed hypothesis gives reason to believe that the evolution of a living world is not a blind process based on trials and errors, but is a directed, creative action performed over billions of years.
The proposed life definition: LIFE IS THE CO-EXISTENCE OF A MULTITUDE OF TANGIBLE SELF-REPLICATING FORMATIONS, UNITED BY INFORMATION FIELD.

Multidisciplinary Approach

Erwin Schrödinger in the preface to his book “What is Life from the Point of View of Physics”, wrote: “A scientist is supposed to have a complete and thorough knowledge, at first hand, of some subjects and, therefore, is usually expected not to write on any topic of which he is not a life, master. This is regarded as a matter of noblesse oblige. For the present purpose, I beg to renounce the noblesse, if any, and to be the freed of the ensuing obligation. My excuse is as follows: We have inherited from our forefathers the keen longing for unified, all-embracing knowledge. The very name given to the highest institutions of learning reminds us, that from antiquity to and throughout many centuries the universal aspect has been the only one to be given full credit. But the spread, both in and width and depth, of the multifarious branches of knowledge by during the last hundred odd years has confronted us with a queer dilemma. We feel clearly that we are only now beginning to acquire reliable material for welding together the sum total of all that is known into a whole; but, on the other hand, it has become next to impossible for a single mind fully to command more than a small specialized portion of it. I can see no other escape from this dilemma (lest our true who aim be lost forever) than that some of us should venture to embark on a synthesis of facts and theories, albeit with second-hand and incomplete knowledge of some of them -and at the risk of making fools of ourselves. So much for my apology” [1].

The person who realized that the structure of the basic building blocks of a cell, consisting of 20 basic amino acids, can be encoded in a sequence of four possible nucleotides, was not a biologist. It happened to be a famous physicist Georgy Gamov.
Alan Turing, being a pure mathematician, wrote an article "The Chemical Bases of Morphogenesis", where he described the patterns of the formation of patterns on animal skins in the language of formulas. Turing's contributions to this area are considered fundamental.
Needless to say, Charles Darwin also received no biological education.
To understand the processes occurring in living organisms, a multidisciplinary approach is required with the involvement of specialists in such areas as: physics, including quantum physics; computer science; information theory; telemechanics (remote control); radio engineering; electrodynamics; electrostatics, theory of probability; theory of cellular automata; semiotics, etc.

Attempts to define the concept of "life"

Let us mention only the most notable attempts, starting with Friedrich Engels ("Life is the mode of action of proteins") and ending with the definition of Gerard Joyce (and NASA): "Life is a self-sustaining chemical system capable of Darwinian evolution" [2].
We have learned since then life is not limited to proteins. NASA arbitrarily limited all life processes in the Universe to Darwin's concept.
Erwin Schrödinger defined life as the ordered and regular behavior of matter, based not only on its tendency from order to disorder but partly on the maintained existing order derived from the environment. But in this case, crystals that take energy from the environment and form ordered structures could also be considered life.
The Big Encyclopedic Dictionary "Biology" indicates that "in the most general sense, life can be defined as an active maintenance and self-reproduction of a specific structure, proceeding with the expenditure of energy received from outside."
Biologist E. Koonin [3] postulated that "any replicator stable in time is a form of life." This view was shared by N. Timofeev Resovsky: "The basis of life is a convariant reduplication." These definitions do not cover non-fertile species such as mules or F1 lutea hybrids. It is unlikely that these organisms can be recognized as inanimate, although they do not take part either in the reproduction of offspring or in the process of evolution.
Encyclopædia Britannica summarizes: "Although the scientists, technicians, and others who participate in studies of life easily distinguish living matter from inert or dead matter, none can give a completely inclusive, concise definition of life itself." [4].

Information approach

It seems to us that the barrier separating the living from the nonliving matter is information. Bernd-Olaf Kuppers wrote: "The problem of the origin of life is clearly basically equivalent to the problem of the origin of biological information." [5]. Danish biologist and philosopher Claus Emmeche formulates: "life is the functional interpretation of signs in self-organizing material 'code-systems' that construct their own 'umwelts' [6]. M. Vitas and A. Dobovišek believe that "Life is a far from equilibrium self-maintaining chemical system capable of processing, transforming and accumulating information acquired from the environment." [7].

Indeed, life is the only entity in the Universe that operates with information. The last always includes three components: Source, Receiver, Code. The information is not the same as data. In any physical body, a huge amount of data is stored: mass, structure, shape, chemical composition, charges, etc. But these data would become the information only when they are perceived and deciphered by someone. Let's take two sequences of numbers: 1836337829011 and 0000000000000. Which of them carries information, and which is worthless? To answer this question a coding agreement should be established between the Source and the Receiver. Both of these sequences can be informative or empty.
Meanwhile, ALL living organisms exchange information.
In non-living matter no such exchange takes place.

The analogy with a digital computer

Computers can perform calculations, store vast amounts of information, play chess better than world champions, and so on.
But what are these intelligent machines made of? All their intellectual power is based on the simplest silicon switches - transistors. A single switch cannot perform any intelligent activity. All they can do is switch from the “on” to the “off” position and vice versa, and hold one of these positions for a long time. But if we take 16 transistors and arrange them in a certain way, we would be surprised to find out that they can play tic-tac-toe and never lose to the most advanced player. Should we increase the number of transistors to 500, the ability to play chess occurs. Deep Blue II, containing 720 million transistors, beat then world champion Garry Kasparov with a score of 3 ½: 2 ½.
For each mental task, there is a certain "critical mass", which we define as the minimum number of switches capable of performing this task.
In 2015, English scientists from the University of Edinburgh assessed the potential of the Biosphere as a giant parallel supercomputer with DNA as memory storage. According to their calculations, the amount of information stored by the Biosphere exceeded the total memory of the four most powerful supercomputers by 10^{21} times.
Can the Biosphere process this information? The same scientists assessed the Biosphere computing capability. The best supercomputer, the Chinese Tianhe-2, had a capacity of about 10 thousand teraflops in 2014. The Biosphere surpasses this number by about 10^{22} times.
The objection is routinely put forward that a computer is a piece of hardware that is good for nothing until a certain creative entity (a programmer) steps on the scene. The latter creates instructions that direct the processes of coordinated transition of transistors from the "on" state to the "off" state and back.
With the advent of "cellular automata", this objection is no longer valid.
British mathematician John Conway invented in the 70s a computer game, which he called "Life".
This game does not need a programmer and requires no external intervention. For its functioning it needs just several randomly located "cells", that is, switching binary formations, and the simplest rules that determine whether a cell "dies" or is "born". Then the initial set of several cells often grows into structures that take on forms familiar to engineers. By themselves, logical functions are formed and multiply: "and", "or", "not", memory cells - what is necessary and sufficient to build a digital computer according to the theoretical constructions of Alan Turing.

International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-7, Issue-6, June 2021
ISSN: 2395-3470
www.ijseas.com

Communication in the Biosphere

A computer cannot function without the exchange of information between its parts. The presence of accumulated information and information exchange in the living world is an indisputable fact. It is limited to just DNA storage and exchange. Cognitive processes in nerve cells or the exchange of chemical signals in the plant kingdom are an integral part of living existence.
Communication processes in the Biosphere can be divided into:

- Intracellular.
- Intercellular.
- Interorganism.

The first two categories have been explored in great detail. Their presence and material basis are beyond doubt.
The processes of information transfer are diverse. They historically evolve along with the development of the Biosphere. Horizontal gene transfer appeared, most likely, at the very beginning of evolutionary processes and is, according to a massive, universal, and all-encompassing phenomenon. It is estimated that the amount of DNA transferred horizontally at hundreds gigatons per year. This is about 2,500 times greater than the mass of all people on our planet.
Microbes and viruses are important means of transmitting information between organisms. The water of the oceans contains about 10^{30} viruses. Every day, about 800 million virus particles are dropped on every square meter of the Earth's surface. In addition to transporting functions, viruses perform another task to provide information flows. They destroy the cell membrane and ensure the flow of genetic material into its genetic pool.
The renowned scientist professor Lynn Margulis believed that "on an evolutionary scale of time, the entire gene pool of the biosphere is available to all organisms."
The transmission of information over a distance, including long distances, is also an established fact. Electromagnetic interorganism communication cannot be questioned. Indeed, visual images are transmitted by electromagnetic waves. The same applies to acoustic waves and the transport of chemicals such as pheromones.
Less worked out is the question of the rapid transfer of information between organisms at distances beyond the line of sight. There is a lot of speculation in this area and information that has not been sufficiently verified by rigorous and repeatable experiments. Advents of telepathy and other paranormal believes often discredit scientific research. Meanwhile, there is nothing mystical or unusual in such transfer of information.
Possible means of fast transmission of information over long distances include:

- Electromagnetic waves.
- Radio relay, i.e. transmission of signals between remote subjects using intermediate entities, i.e., living beings.
- Long-distance (over-the-horizon) transmission of FM waves based on the. Kabanov effect, with the waves' reflection from the Earth's ionosphere.
- Principle of a Phased Antenna Array. It has been experimentally proven that the sweat glands of humans and higher primates contain spiral structures capable of information transmission.
- Schumann resonance, i.e. formation of standing electromagnetic waves at frequencies below 100 Hz. These frequencies are compatible to the brain's rhythms.
- Transmission of information using magnetic fields. These fields are responsible for the accurate, global orientation of fish, birds and migratory insects.

·Quantum communication. The presence of quantum processes in living cells has recently received solid confirmation.

The transmission of information in the process of biological evolution has also been evolving and developing. From slow and uncertain processes that existed billions of years ago, it grows into instant, long-range and reliable means of accumulating and exchanging information flows, forming a global, all-encompassing network.

Definition of life

To define life, we need to accept two postulates:

1. Life is a collective, global phenomenon. Neither unicellular nor multicellular organisms may form or exist on their own.
2. Living organisms are linked by information channels. These channels cover all living things with a single information network.

The Biosphere, in our view, is not a collection of separate living organisms, but a single indissoluble Essence possessing intelligence and creativity. Since the inception of the first chemical compounds capable of replication, many of them have exchanged information during the multiplication process, forming a single communication network. The transmission of information over this network was slow and primitive. The exchange processes did not last for moments, but millions of years. The accumulated information was saved. It was used to create more complex self-replicating structures, such as RNA, DNA, and proteins, not by trial and error, but immediately and "cleanly". Evolutionary leaps, speciation, and cephalization became possible with the transition of the number of elementary formations to a new qualitative level upon reaching a really large number of them (critical mass).

The above reasoning logically leads to a simple and complete definition, which, I hope, will become generally accepted:

LIFE IS THE CO-EXISTENCE OF A MULTITUDE OF TANGIBLE SELF-REPLICATING FORMATIONS, UNITED BY INFORMATION FIELD.

The "formations" are all forms of the living world, animals and plants, multicellular and unicellular organisms. Viruses and organelles are also included here. Life in the light of this concept can neither arise nor exist in a solitude, no matter how complex and developed is the formation. Life is the coexistence of a very large number of relatively simple formations. The Biosphere did not evolve spontaneously or by a chance, but is a result of a creative directed process, as the outcome of its "elements" interaction, representing a single global Organism [8].

Our formulation does not exclude the interaction of the Biosphere with artificial life forms, including non-biological ones. In the case of the creation of a self-replicating AI and its inclusion in the communication system of the Biosphere, the concept of the Noosphere, proposed by V.Vernadsky, will be expanded.

Literature

1. E. Schrödinger. What is life from the point of view of physics. M. Rimis. 2015.
2. G.Joyce. The RNA World: Life Before DNA and Protein, in Extraterrestrials – Where Are they? II, ed. B. Zuckerman, M. Hart. Cambridge: Cambridge U. Press. 1994.
3. E. Koonin. Logic of Chance, The: Nature and Origin of Biological Evolution. FT Press Science. 2012.516 pp.
five.

4. Encyclopædia Britannica, Available at https://www.britannica.com/science/life. (assessed on March 19, 2021).
5. B.O.Kuppers. Information and the origin of life. MIT Press. 1992. pp. 170-172.
6. C. Emmeche. Defining life as a semiotic phenomenon. Cybernetics and Human Knowing, Vol. 5, no. 1, 1998, pp. 3-17.
7. M.Vitas & A.Dobovišek. Towards a General Definition of Life Received: 9 February 2019 / Accepted: 4 June 2019. Published online: 20 June 2019 # Springer Nature BV 2019.
8. I.Krichtafovich. The Biosphere as a Supercomputer: Self-directed Evolution.
Amazon edition. 2018.