Considerations Regarding the Probability of Life Appearance on Earth by Chance

Dan CHICEA

Universitatea „Lucian Blaga” din Sibiu, Facultatea de Științe, Centrul de Cercetări Pediatrice și Respiratorice
“Lucian Blaga” University of Sibiu, Faculty of Sciences, Pediatric Respiratory Medicine Research Center
Personal e-mail: dan.chicea@ulbsibiu.ro

The evolution theory states that a primitive life form appeared by chance and that by successive genetic mutations, speciation and evolution, complex and superior forms of life gradually came in existence. A simple combinatorial model was used to assess the probability that the genes that form chromosomes come in the right sequence by chance, in the primitive form of life. A possible conclusion, based on this simplified model, is that the hypothesis that the primitive form of life came in existence by chance is considerably less probable than the hypothesis that life, even the most primitive form, was created.

Keywords: evolution, creation, combinatorial model, last universal common ancestor, essential genes

1. Introduction

How did life appear on Earth? This is one of the questions most of the people ask at lest once in their life after looking around them and meditating on what they saw. Some of them were eager to share the conclusion of their meditation with others and elaborated certain theories to explain how life appeared.

One of the theories states that all life forms on Earth are descended from a Last Universal Common Ancestor (hereafter LUCA) that lived approximately 3.5 - 3.8 billion years ago[1]. The existence of species and the overwhelming variety of life forms is attributed to the variety existing in the DNA sequences[2]. The evolution theory explains the variety of life forms by natural evolution[3]. Some features of the theory are considered to be the facts that lead to the variety of the life forms, as we see today. They features are: there are more offspring which are produced than can survive, particular characters vary among individuals and individuals have therefore different rates of survival; moreover, particular characters are heritable[4].

It was stated that “life was born complex”[1]. It is also stated[1] that “abundant indications suggest reductive evolution of this complex and heterogeneous entity towards the prokaryotic Domains Archaea and Bacteria”. Reference 5 suggests a number of gene families between 1144 and 1529; they also expresses distrust in the existence of LUCA in the form of a bacteria.

Opposed to the theory of evolution is the one that states that God created the Earth, plants, animals and finally the first human being and it is called the theory of creation, as stated in Genesis 2:7, of the Holly Bible, regardless the version or translation[6,7,8,9].

The next section presents the results of a simple combinatorial model used in assessing the time required for the genes forming the LUCA genome to come in the right order by chance, hence an estimation of the probability that LUCA appeared by chance on Earth, in the time that passes since Earth started to exist till the estimated date that LUCA was alive on Earth.

2. The combinatorial model

A very simple model can be established to asses the probability that the protein encoding genes sequence came in the right order, in LUCA, by chances. We can consider only the protein encoding genes, not al the genes, to be ready made entities that can combine in a randomly combining experiment that is repeated continuously. We can consider the expected event to be achieved when the protein encoding gene sequence is the sequence that could be found in LUCA, hereafter the right sequence.

If we have a small number n=2 of entities and if the entities can combine in a simple manner and if the order is the only thing that matters, the total number of combinations is 2 and can be computed as factorial of 2, which is currently written as 2!. If we move further to three entities that can form a linear chain, the total number of possible combinations is 1*2*3=3!=6.

As the purpose of this simple model is to assess the magnitude of certain probabilities not the exact values, we can simply ignore the symmetry; with this assumption the combination 1-2-3 is different from 3-2-1. Moreover, we can consider that during the early stage of existence of the Earth, this was a huge laboratory where this combinatorial experiment was carried on constantly. We can assume that one combinatorial experiment was completed every second. The number of experiments that was completed in one year was 365 days times 24 hours a day times 3600 seconds per hour makes 31536000. And more, we can consider that in this huge laboratory called Earth in its early stages, the experiment was carried on not in one place but in $1000000=10^6$ places of the lab in parallel, each one trying different combinations from one to another. Thus in one year the total number of combinations that were tried is $31536000000000=3.1536*10^{13}$. And more, if we consider that the combinatorial experiment took place in parallel not in 10^6 places but in one trillion, which is 10^{12}, places, in one year the total number of combinations that were tried is $3.1536*10^{19}$.

With these simple considerations in mind, we can assess the total number of possible combinations of entities linked one to another to form a chain, for a different number of entities, listed in the first column of Table 1 and place them in the second column in Table 1. The factorial is increasing very fast with the number, soon exceeding the range that a computer can use in calculus. In order to overcome this inconvenient, we can estimate the logarithm of the factorial, using the Stirling approximation, in (1):

$$\ln(n!) \approx n \cdot \ln(n) - n + \ln\sqrt{2\pi n}$$

(1)

Afterwards we can estimate the factorial, as in eq. (2) and this is the third column in Table 1.

$$n! \approx \exp(\ln(n!))$$

(2)

Continuing the basics of the model, we can estimate the time required for all the combinations to have been tried, in the above mentioned circumstances, of performing one experiment per second, 1 million experiments in parallel (10^6), without repeating the combinations from one experiment to the other. This time, in years, is presented in the third column of Table 1. The time, in years, required for all the combinations to have been tried, in the above mentioned circumstanced, but with the experiment repeated in one trillion places rather than in one million, is presented in the fourth column of Table 1. We estimate the total number of possible combinations for a number of entities starting with 1 and up to a ridiculously small number of 51.

The age of the Earth is estimated to be around $4.5\bullet 10^9$ years[10,11], and the estimation is based on radiometric minerals age dating. Examining the results presented in Table 1 we notice that, in the circumstances presumed and presented above, the age of the Earth enables the completion of the combinatorial experiment for a number of about 24 entities, if the combinatorial experiment is carried on in one million places and for 28 entities, if we have one trillion experiments in parallel.

The LUCA lived around 3.5 to 3.8 billion years ago[1] and ever since the species and the variety inside the species of the living organisms is attributed to the evolution process[3]. This leaves a time span of about 1 billion years for the combinatorial experiment to produce the sequence of genes of LUCA, or the right combination. Reference 5 states that the LUCA sequence of gene comprised a number of family genes around 1000. The term family of genes involves more genes in a family; we can consider this number to be at least three, which makes the total number of genes to be bigger than 3000.

It is also stated[12] that there does exist a number of genes that are essential for an organism like a bacteria to maintain life and that the number is about 10% of the total number of genes, which makes the number to be around 300. The last line of Table 1 presents the number of possible combinations and the time required in the hypothetical experiment described above to try all the possible combinations for 300 hundred elements. We notice that the time required for all the possible combinations to be tried is about 10^{594} years for one million of experiments in parallel and 10^{588} years for one trillion experiments in parallel. Now we can compare this time with 10^9 years or even with $4.5\cdot 10^9$ years, which is the estimated age of the Earth. The probability that the essential genes came in the right sequence can be assessed as the ratio of this time ($4.5\cdot 10^9$ years) to the time of the combinatorial experiment to be fulfilled (10^{594} or 10^{588} years). Thus we find that the hypothesis that the LUCA gene sequence appeared by chance is 10^{585} or 10^{579} times less probable than the hypothesis that it appeared by a different procedures, creation being tremendously more probable than other imaginable procedures.

No. components	No. of possible combinations	Time in years, 10^{6} experiments in parallel	Time in years, 10^{12} experiments in parallel
1	$1.000\bullet10^{00}$	$3.171\bullet10^{-14}$	$3.171\bullet10^{-20}$
3	$6.000\bullet10^{00}$	$1.903\bullet10^{-13}$	$1.903\bullet10^{-19}$
6	$7.200\bullet10^{02}$	$2.283\bullet10^{-11}$	$2.283\bullet10^{-17}$
9	$3.629\bullet10^{05}$	$1.151\bullet10^{-08}$	$1.151\bullet10^{-14}$
12	$4.790\bullet10^{08}$	$1.519\bullet10^{-05}$	$1.519\bullet10^{-11}$
15	$1.308\bullet10^{12}$	$4.147\bullet10^{-02}$	$4.147\bullet10^{-08}$
18	$6.402\bullet10^{15}$	$2.030\bullet10^{02}$	$2.030\bullet10^{-04}$
21	$5.109\bullet10^{19}$	$1.620\bullet10^{06}$	$1.620\bullet10^{+00}$
24	$6.204\bullet10^{23}$	$1.967\bullet10^{10}$	$1.967\bullet10^{+04}$
27	$1.089\bullet10^{28}$	$3.453\bullet10^{14}$	$3.453\bullet10^{+08}$
30	$2.653\bullet10^{32}$	$8.411\bullet10^{18}$	$8.411\bullet10^{+12}$
33	$8.683\bullet10^{36}$	$2.753\bullet10^{23}$	$2.753\bullet10^{+17}$
36	$3.720\bullet10^{41}$	$1.180\bullet10^{28}$	$1.180\bullet10^{+22}$
39	$2.040\bullet10^{46}$	$6.468\bullet10^{32}$	$6.468\bullet10^{+26}$
42	$1.405\bullet10^{51}$	$4.455\bullet10^{37}$	$4.455\bullet10^{+31}$
45	$1.196\bullet10^{56}$	$3.793\bullet10^{42}$	$3.793\bullet10^{+36}$
48	$1.241\bullet10^{61}$	$3.936\bullet10^{47}$	$3.936\bullet10^{+41}$
51	$1.551\bullet10^{66}$	$4.919\bullet10^{52}$	$4.919\bullet10^{+46}$
300	$\sim10^{614}$	$\sim10^{594}$	$\sim10^{588}$

Table 1 – An approximation of the number of possible combinations of a certain number of entities, in column two, the time required for trying all the possible combinations, with one attempt per second and one million attempts in parallel, in column three and 1 trillion attempts in parallel, without repeating the combinations in the parallel experiments, in column four.

3. Discussions

A comprehensive attempt to describe different aspects of evolution using the quantum mechanics predictions was made[13], as well. A speculation is made regarding the quantum mechanics tunneling process and a possible acceleration the evolution process. The quantum effects make themselves manifest in systems that are small enough, or, more precisely, in systems where the physical variable named action is comparable with Plank's constant, of the order of 10^{-34} J·s. The quantum effects are manifest in physical processes like atoms ore molecules ionization and in chemical reactions, among other phenomena. The quantum effects are not influenced at all by the fact that the molecules that are interacting are part of an inorganic structure, organic structure or biological structure, but are simply dictated by the size of the physical variable named action or by the size of the product of the standard deviations of the physical variables, as compared to the value of the Plank's constant, in the Heisenberg's relations of uncertainty[14]. The values of the chemical reactions rates were measured experimentally way before the quantum mechanics principles were stated; once that the principles were established, this did not change the chemical reactions rates, whether they were inorganic, organic, or biochemical reactions, therefore quantum mechanics does not speed up evolution. This conclusion, and the conclusion of this computational model presented in this article is in good agreement with the qualitative statement made by the famous astronomer Fred Hoyle[13]. He considered the probability of assembling a structure like a bacterium from the random thermodynamic processes to be comparable with the chances that a tornado in a junkyard could spontaneously assemble a Boeing 747 airplane.

Another statement in favor of evolution is that it does not throw dies and resets the combination each

Fred Hoyle

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time, but preserves the new structure and adds new parts. This statement raises another question. If the structure is a form of life, it replicates itself, evolving or not and this is not directly related the subject of this article, which is the appearance of life by chance. If the structure is not alive, another question raises: what mechanism in nature selects and preserves the right combination reached up to that moment, to continue adding parts and to keep preserving the improved structures till it reaches the first primitive form of life, that will self replicate further on? The answer of this question, should this be the process that led to the appearance of the primitive form of life, as LUCA, suggests the existence of a superior intelligence that supervised the process of assembling the complex structure from parts in the right order till the first organism was able to replicate, therefore becoming the first living organism. The simple question of how simple is a life form is answered[13] that is not simple at all and states the number of gene basis. Considering the number of gene basis and not the number of genes and repeating the combinatorial model stated in this section we would find numbers for the time required for completion to be astronomical, even compared with the numbers stated above.

Another interesting analogy of evolution to superior forms of life is made[13] with the possible evolution of self replicating programs like Tierra[15] towards digital life. In spite of the overwhelming volume and variety of internet data traffic and of the computers linked to the internet, no such evolution that suggest digital life has been found so far.

Another possible source of life on Earth is considered to be panspermia[16]. That hypothesis does not explain how life appeared in general, but just hypothesizes on how life "arrived" on Earth. Even considering the age of universe, overestimated to be 10 time bigger than the age of Earth and considering the number of laboratories where the imaginary combinatorial experiment took place in parallel much bigger than 1 trillion, the probability that a structure of the complexity mentioned above came in existence by chance remains at the magnitude of $10^{-(\text{seveal hundreds})}$. This leaves creation as the most probable hypothesis that explains how life came in existence.

4. Conclusion

In this short article a combinatorial model was used to assess the probability that the sequence of the essential genes of the LUCA organism appeared by chance. We found that this alternative is 10^{585} or 10^{579} (considering the alternative of one trillion experiments in parallel) times less probable than the hypothesis that sequence of the essential genes of the LUCA appeared by other possible mechanism, creation being the alternative.

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