What are we searching for?

Glybovskaya Yulia, Supervisor - Grigorij Meerovich Beskin

Traektoria Astrophysical School

The definition of life

Life is a chemical system, capable of undergoing Darwinian evolution. (And Lamarckian as well, if we will find such system)
There are three necessary conditions for Darwinian evolution:

- Reproduction of organisms or programs
- Mutation
- Heredity
- Selection (the probability of passing on mutations)

Carbon chauvinism

Carbon chauvinism is an assumption that life in the Universe can only be carbon based. The requirement for thermodynamic disequilibrium is the only universal feature of terran life that we know. Other aspects of life on Earth might not be necessary for extra-terrestrial life forms.

- Instead of carbon life can be based on silicone or nitrogen. (Carbon and silicone have much in common in their chemical properties, but the C-C bond is twice as strong as Si-Si bond. Silicone forms strong bonds with oxygen but is unstable and very active with water, acids, and ammonia. Nitrogen-based molecules can exist under very high pressure. Under the pressure of 360 000 times the standard atmospheric pressure nitrogen forms stable sheets, rings, and chains. The diversity of nitrogen-hydrogen molecules in these conditions can be compared to the diversity of hydrocarbons under atmospheric pressure.)
- Possible solvents, instead of water, are liquid ammonia, sulphuric acid, liquid CO2. the latest dissolves many substances as well as water does.

Informational molecules - the very core of evolution.

Before the evolution of DNA and proteins life, on Earth was, what we call it, the RNA world. The movement of different types of RNA was restricted due to the mineral substrate they were on. So, they could cooperate with each other not losing themselves in a gigantic soup anymore.

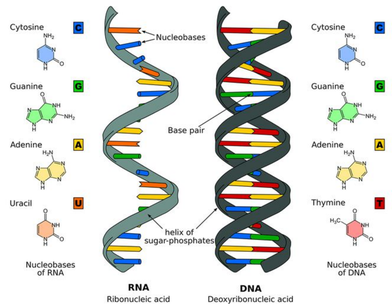

Figure 1: RNA and DNA molecules. (From Wikipedia))

Chemical conditions

- The Miller-Urey experiment showed that organic compounds can be formed from gases with the addition of energy. The gases used in the experiment were methane, ammonia, hydrogen and water vapor. And no oxygen that we have now.

Physical conditions

- Having a mineral surface is important for RNA and DNA formation. Too much water will only decompose these structures into amino acids and nucleotides through hydrolysis. Also mineral surface may be a catalyst for chemical reactions.
- Sun radiated way more energy when the life on Earth began than it does now. So, it is likely that certain nucleotides were selected because of their resistance to UV-radiation. Also, for the same reason nucleotides, capable of forming a pair had a higher chance of survival. The following figure demonstrates that the nucleotides we have in our DNA are a result of natural selection.

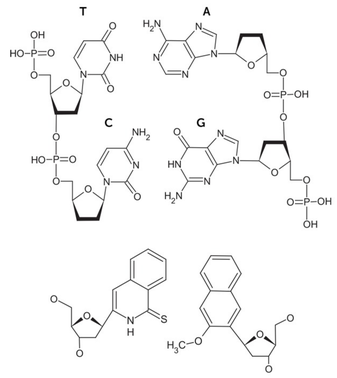

Figure 2: Upper part - a fragment of DNA with standard nucleotides A, T, G, C. Lower part - synthesized alternative nucleotides. (From "The origin of life" by M.Nikitin)

Taking a closer look at the Solar System

Not going far into space, we have interesting and possibly able to harbor life natural satellites of Solar System's planets. It is Jupiter's satellite Europe with an ice crust and, as was assumed, a water ocean beneath the surface. The predominant model suggests that the water ocean remains liquid from the energy of the tidal flexing.

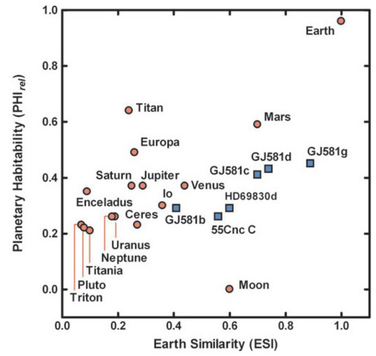

Figure 3: Earth Similarity Index (ESI) for 47 Solar System bodies with radius greater than 100 km (red circles) and 258 extrasolar planets (blue squares). The ESI scale makes a distinction between those rocky interior (light red area) and temperate surface (light blue area) planets. Only planets in these two categories can be considered Earth-like planets (light green area) The dotted lines represent constant ESI values. (from ASTROBIOLOGY, Vol.11, Num. 10, 2011, Mary Ann Libert, INC))

Conclusion and further research

- Life may not exist only in the ways we imagine. It can be diverse and thus hard to find. We should be very careful deciding which exoplanets are habitable.
- In the future I want to find out more about different ways living organisms can exist and try to imagine and model the environment they live in.

References

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- Dirk Schulze-Makuch, Abel Mendez, Alberto G. Fairen, Philip von Paris, Carol Turse, Grayson Boyer, Alfonso F. Davila, Marina Resendes de Sousa Antonio, David Catling, and Louis N. Irwin, "A Two-Tiered Approach to Assessing the Habitability of Exoplanets"