Comets may solve the puzzle of life’s origin

Robert B. Sheldon

By carrying chemical and biological information throughout the galaxy, comets vastly increase the computing power of the cosmos and may even solve the origin-of-life problem.

The origin-of-life (OOL) event necessarily precedes any evolutionary theory, yet it is the single most implausible step of Darwin’s 1861 theory of natural selection. Since evolutionary theory assumes reproducing life, OOL falls into the domain of prebiotic chemistry. Even with two centuries of progress, a great chasm separates what chemistry can be accomplished in the lab from what chemistry even the most primitive cell needs to grow and replicate. Just as the incremental development of life through evolution was more probable than earlier theories on spontaneous generation, OOL would be rendered more probable if prebiotic chemistry could be made geologically incremental rather than sudden.

Panspermia, which proposes that life was transported to Earth as a spore and subsequently evolved, is a century-old theory that has received some recent experimental support. However, many biologists say it merely moves OOL from a place we know a lot about (Earth) to a place we know very little about (extra-terrestrial), without solving any of the prebiotic chemistry. We propose a modified theory, panzooia, that does not locate OOL on an unknown distant planet, but rather on a recognized interstellar transport: a comet. We argue that the biosphere of comets is at least a billion times greater than that of rocky planets, and the probability of OOL on cold comets is vastly superior to warm ponds (see Figure 1).

This transforms OOL theory from a focus on change at Earth to a focus on transport by comets. Therefore, fossil record development is not so much caused by genome innovation as by transport to the genome of extraterrestrial genes inserted the way a herpes virus causes a cold sore (a process known as horizontal gene transfer). Both prebiotic chemistry and panzooia assume that complexity arose from simpler non-living systems that somehow acquired an extra function. Panzooia focuses on the process of gradually adding information rather than the more difficult process of suddenly creating it.

If biological systems are treated as an extended body of information that can be quantified, then a crystal, bacterium, or elephant can be characterized with a single number representing its information density. Unlike inanimate matter, living things have such high concentration of information that we assume there is a ‘life threshold’ of minimum information density. Converting OOL into an information-theoretic problem changes the question from “How did the first cell get created?” to “How can enough information be concentrated in a small volume to cross the life threshold for the first time?” The OOL problem is then concentrating preexisting but diffuse information.

Panzooia’s focus on transport answers the question “Where did all the information come from?” by pre-distributing information at low density across the galaxy. Initially, the network of cometary connections contains more information than the cometary nodes. We model this as a conservation of Shannon...
information in spacetime (comets) and its Fourier transform (connections), building a time-evolving distribution that may cross the information density threshold of life: OOL.  

The great enemy of prebiotic chemistry is entropy, the tendency for information to diffuse away. In an ideal laboratory, the reactions are separated and products are purified before being transported to a new reaction vessel. Comets keep their chemistry frozen while traveling to the next reaction site, providing a low-entropy environment for holding unstable intermediate products. Reactions proceed enormously faster in liquid than in solid phase. Comets also melt during the brief time they interact with other cometary debris at their orbital perihelion. In such a manner, comets approximate laboratory best procedures worked out by trial and error over the past four centuries.

In summary, we are not yet providing a detailed mechanism for OOL. But in demonstrating a way to make incremental improvements by concentrating diffuse information, we are making progress in increasing the OOL probability. Panzooia also predicts that subsequent evolution of information on Earth will demonstrate features of ‘bootstrapping’ or positive feedback, and that recently discovered microfossils on comets will be optimized for information storage.

We will continue our work on comets as information carriers, analyzing mysterious cometary framoids (10-micron spheres made of magnetite plates) as potential bacterial navigation aids adapted to a low-g, low-gauss (very weak magnetic field) environment. If they are, then comets have indeed been bi-engineered for maximum information transfer.

The author is grateful to the University of Alabama, Huntsville, for supporting this research.

Author Information

Robert B. Sheldon
Consultant
Huntsville, AL

For the past 25 years, physicist Rob Sheldon has designed and built satellite mass spectrometers for NASA and European Space Agency missions. He consults for NASA in the areas of astrobiology, planetary, heliophysics, and nuclear propulsion.

References