Cosmological Skepticism

...an argument for exclusivity

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The Search for Extraterrestrial Intelligence[1] has been operating since 1985, and was preceded by a NASA program with the same mission. We've been searching for a long, long time – with huge expenditures of resources. SETI is a massive project operating from a headquarters in Mountain View, California. The organization is staffed by about 130 of the best minds in astronomy, mathematics, communication, planetology, physics, public relations, and fundraising, and at various times during the past decades SETI has recruited help from every level of humankind by outsourcing research to universities, engaging non-SETI astronomers to assist with specialized searching, and to process the incredible volume of data generated by searches. Millions of people and organizations worldwide have participated in a program by which their personal or corporate computers can, when otherwise idle, process complex SETI data[2] in the search for anomalies that might guide SETI toward discovery. The goal of the project is best expressed in its mission[3]: to explore, understand and explain the origin and nature of life in the universe and the evolution of intelligence. Obviously, our goal is the discovery of life beyond the planet Earth, then to discover complex life, and finally to detect intelligence anywhere but here.

Most observers believe that SETI must eventually succeed, due to recent discoveries regarding the prevalence of planets, and convincing huge numbers defining the size of our galaxy and of the universe. It's now certain that most stars and star systems include planets[4], and it's probable that there are more planets than stars. Estimates regarding the number of star systems in a galaxy vary, but for the Milky Way the number ranges from 100 billion to one trillion stars. The detected number will grow as mankind gains experience with red dwarf stars[5], a star class that now appears to be the most common – though generally not visible – in the galaxy. Because the core reaction of a red dwarf is relatively slow and at a low level compared with other star forms, energy usage suggests that this type of star has a lifetime of trillions of years. Now that astronomers have begun applying infra-red detection methods to the search for red dwarfs, and finding planets on most of them, it appears that this galaxy's star population may exceed one trillion, with a planet population much larger than that number. That's one galaxy.

The innovative and exciting Kepler space telescope[6] was designed and deployed exclusively to search for planets[7]. It stares at a miniscule piece of the sky containing only about 150,000 stars, and looks for tiny variations in light output caused by a planet passing in front of its host star. So far, Kepler has detected over 3,600 exoplanet candidates[8] and generated persuasive evidence that there are… … trillions more.

The Milky Way is a disc that is 1,000,000,000,000,000,000 km (about 100,000 light years) across and three percent of that in thickness; it's a galaxy a bit above average in size[9]. Some galaxies are much larger – like IC1101, which is the largest detected so far. IC1101 is about a billion light years from Earth, and is believed to comprise approximately 100 trillion stars. That's 100,000,000,000,000 stars – and astronomers now believe that the majority of them have planets.

Compelling numbers? Most astronomers now agree that the universe is comprised of at least 200,000,000,000 galaxies, with an average of at least 200,000,000,000 stars each. If the average star has at least one planet, that's approximately four gazillion (a 1 followed by a bucketful of zeroes) places in the universe to search for life in general and intelligent life in particular. That number expands rapidly considering that many planets have moons, and many moons have been found to provide what we believe are the necessities of life: liquid water, energy, organic molecules, and time.

As an inquisitive species, we are systematically exploring those locations in the universe where life might (should?) exist. Over the decades we have deployed complex antenna arrays, trained and dedicated thousands of experts, and generally diverted a massive share of our species' productivity to the Search for Extraterrestrial Intelligence. We'll examine the skies with Kepler, focus upon a likely candidate, turn our huge radio telescope arrays to the identified point, tune to millions of possible frequencies, and wait to detect an alien form of *I Love Lucy*. So far, after decades of spending

[1] https://www.seti.org/
[2] https://seti.berkeley.edu/participate/
[3] https://www.seti.org/about-us/mission
[4] https://www.space.com/24894-exoplanets-habitable-zone-red-dwarfs.html
[5] https://en.wikipedia.org/wiki/Red_dwarf
[6] https://www.nasa.gov/mission_pages/kepler/main/index.html
[7] https://en.wikipedia.org/wiki/Kepler_space_telescope
[8] https://en.wikipedia.org/wiki/List_of_exoplanets_discovered_using_the_Kepler_space_telescope
[9] https://www.popsci.com/science/article/2013-04/cool-galaxy-size-comparison-chart

hundreds of billions of dollars and dedicating an important share of our intellectual resources to the search, science has discovered only one location in the universe that's ever harbored life – and that is our planet Earth.

Considering the needs of life, Earth is perfect. It's the right distance from the right sort of star, has the right amount of liquid water, has the right mass and gravity, is in the right orbit, is stabilized by the right-size moon, has the right amount of energy available, is protected from solar winds by a magnetic field, and contains all the chemical components of life.

Many scientists believe that in the presence of those ingredients, and given sufficient time, life must occur. It might take a while, but the universe has been around nearly 14 billion years and our planet has existed for a third of that, so there has been plenty of time – and the result proves it. Extinction events have killed off all, or virtually all, life on this planet – suggesting the possibility that life formed more than once. Earth's life, observed today and by fossil from antiquity – appears to have a common genetic connection to a fundamental chemical structure comprising the "message" by which each generation of a species communicates to the next. It's a system that works brilliantly, whether it developed spontaneously on Earth, or arrived here as a passenger on an inbound object from another location in space. It works, and once it's established the system grows and branches to exploit as many environmental opportunities as exist, as many functional niches that are possible, even into environments and circumstances that seem hostile to life.

8,700,000 different species operate on Earth[10], of which about 6.5M are on land and 2.2M are aquatic. Many species branch further into complex and extended subspecies. Scientists agree that there are still many species to be discovered – they're out there, but scientists are uncertain as to how many remain undiscovered except to estimate "many." All of those complex species on Earth, plant and animal, on land and in water, utilize the same basic mechanism[11] for transmitting genetic instructions regarding construction and behavior from one generation to the next. That instruction package is called DNA - deoxyribonucleic acid. The only known exception is in the family of viruses, some of which use RNA - ribonucleic acid, of which DNA is a derivative - to carry their genetic message. Whether a human whose every cell carries that critical DNA information, or a virus that uses RNA, the essence[12] of the genetic message, and the chemical components comprising that system for "construction" and "behavior" of life, are the same everywhere on Earth.

But there is at least one other chemical means[13] by which genetic messages can be encoded, stored, and transmitted: xeno nucleic acid (XNA)[14], and constructs like it, prove that RNA/DNA do not have exclusive dominance over this basic requirement for life. Though geneticists and biochemists agree that "life" could exist without RNA/DNA, we've simply never discovered such life on Earth. Oddly, we've never discovered evidence that non-DNA derivatives evolved. Despite incredible diversity of life on Earth comprising almost nine million species, we have never found complex lifeforms that are independent of DNA. Research shows that the DNA "message" points to a root that's common to all species; it appears that we all emerged from the same chemical cauldron in which life was first brewed.

Mars is smaller and cooled relatively quickly, so was once similar to the Earth of today. If life is easily generated in an Earthlike environment, then Mars should display evidence of life in its past. Our searches have found no evidence of life there, even at the microscopic level. There is nowhere on Earth's surface (except the poles) where a teaspoon of dirt or water will NOT contain detectable biological material. A typical cubic centimeter of coastal seawater contains about 1M bacteria and 100M virus particles - generally detectable, quantifiable, recognizable. Mars once had oceans, and if they teemed with at least micro-life we would have found its remains in the soil of that planet's dry ocean plains.

Considering all that, perhaps we should reconsider the Drake equation, which asserts that with so many stars/planets/moons that life "must" be out there, reallocate resources. Instead of searching for alien life on exoplanets, we could focus upon a search for non-DNA life on planet Earth. And if a heightened effort does not discover non-DNA life on Earth, a rare and demonstrably suitable place for the formation of life, we must accept the possibility that Earth – and the life on it – are unique in the universe.

And if life exists only on Earth, there's another issue: the competitive advantage of intelligence in light of Darwin's principle of Natural Selection. The 9M species on Earth today represent only a small share of our planet's lifeforms over the millennia (more than 99% of all known species are extinct[15]). If intelligence is a dominant factor in the scenarios defining survival in Darwin's world, why didn't mentality emerge among many other species? Why aren't we sharing this

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[10] https://www.sciencedaily.com/releases/2011/08/110823180459.htm
[11] https://www.sciencedaily.com/terms/dna.htm
[12] https://en.wikipedia.org/wiki/Introduction_to_genetics
[13] https://www.sciencedaily.com/releases/2012/04/120419143117.htm
[14] https://en.wikipedia.org/wiki/Xeno_nucleic_acid
[15] https://en.wikipedia.org/wiki/Extinction

planet with myriad other intelligent species? If intelligence is somehow unique, perhaps we should refocus SETI assets and funding on other issues and let intelligent species of the universe – if there are any – spend resources to find US.

Considering the best information available, we must accept the possibilities that life is unique on Earth, and that intelligence is unique to humankind. That's a painful hypothesis, but it's perfectly supported by our understanding and all available data. In a certain way, that viewpoint strongly supports religiosity – but that's another document entirely…

Note: references were selected for their readability by non-astronomers, non-mathematicians, non-physicists.