

## Aliens Depend on Time to Grow Brains

By: Leslie Mullen

**Spock:** To hunt a species to extinction is not logical.

**Gillian:** Whoever said the human race was logical?

*Star Trek, The Voyage Home*

We expect aliens to be a whole lot smarter than us. Not only will they possess the wisdom of the ages, but they will travel at warp speed, have the ability to transform (or destroy) entire planets, and their civilizations will span across galaxies.

Until we find alien life, however, we can only guess at how many intelligent civilizations may be out there. Frank Drake made a stab at guessing the number in 1961, when he formulated the "Drake Equation." According to this equation, there could be a million intelligent civilizations in the Milky Way galaxy, and probably billions of such civilizations throughout the universe.

The Drake Equation is based, in part, on an estimate of the number of planets in the galaxy that might harbor life. Such planets would have to exist in "habitable zones" - those regions around stars that would best support life as we know it. These planets would be the most likely places where life capable of achieving intelligence is fostered and sustained.

To understand how intelligence develops, we have only one example to study: the development of human intelligence on Earth. The first life on our planet probably arose about 3.8 billion years ago, less than a billion years after the Earth itself formed. But multi-cellular life didn't appear until nearly 3 billion years after that, and the first animal life didn't form until the Cambrian Explosion 600 million years ago. Intelligent life - which we broadly define as human civilization - didn't develop until a few tens of thousands of years ago. Christopher McKay, a planetary scientist with the NASA Ames Research Center, has defined intelligence as "the ability to build a radio telescope." If we go by McKay's definition, then truly intelligent life on Earth didn't show up until the twentieth century.

Since intelligent life took a long time to develop on Earth, some believe it will take just as long on other worlds. The paleontologist Peter Ward and the astronomer Donald Brownlee expressed this belief in their book, "Rare Earth: Why Complex Life is Uncommon in the Universe." Intelligent life on Earth, they say, is due to a long chain of events that greatly relied on happenstance. The odds of such a chain of events occurring on other worlds seem to be impossible. Thus, as the title of their book indicates, they believe that simple, microbial life may be common in the universe, but complex life will be rare. They certainly don't expect to find very many advanced alien civilizations out there.

Other scientists disagree with this conclusion. They suggest that animal life - or something resembling it - may have developed more rapidly on other worlds. One proponent of this theory is McKay, who wrote the essay, "Time for Intelligence on Other Planets," in order to determine the shortest possible time it would take for intelligence to develop after the origin of life.

### Crunching the Numbers

Although the traditional view of evolution is as a constant push toward greater complexity, the fossil record on Earth shows instead that there were periods of rapid changes followed by long periods where nothing much happened at all. McKay says such a drawn-out style of evolution need not be universal. By removing what he calls evolution's "spurious" time periods, he says that intelligent life could take as little as 100 million years to develop.

"Nothing in our understanding of evolution suggests that these periods of stasis are required," says McKay. "We believe they represent mere historical happenstance."

Another limiting factor for evolution on Earth was a lack of oxygen. The early Earth had very little free oxygen until cyanobacteria and other photosynthetic life forms began producing it about 2 billion years ago. Oxygen may be the key to tissue multi-cellularity, and thus the formation of large, multi-celled organisms capable of developing a brain. The build-up of oxygen also led to the development of an ozone layer, shielding life on Earth from the Sun's harmful UV rays.

But this need not be the case on other worlds. Perhaps some planets begin with substantial amounts of atmospheric oxygen. Slower tectonic activity would make more oxygen available, as would a less iron-rich geography. A planet with early access to oxygen might see life, and intelligence, evolve much faster than on Earth.

Other factors affecting Earth's evolution were cataclysmic events such as asteroid impacts. Such events would kill off complex life, but these events could also clear the way for the development of more advanced forms of intelligence. The creatures with superior brains may have been better able to save themselves from the sudden changes in their environment caused by these events.

Many of the factors that went into the development of life on Earth remain a puzzle to us, so there may be many other characteristics of a planet, or even a solar system, that affect the development of intelligence. For instance, some scientists have noted that intelligence did not arise on Earth until the Sun hit middle age. Perhaps, they suggest, intelligence cannot evolve until the planet's star reaches a certain stage in its own evolution.

Chris McKay, however, says he has not heard a compelling argument as to why human level intelligence needed the Sun to be middle aged.

"I would say that the build-up of oxygen is the only good environmental requirement," says McKay.

### **Why Only One?**

The Earth's fossil record indicates that, despite periods of stasis or of setbacks like asteroid impacts, most organisms evolve toward greater complexity. Some of Earth's life forms have gone extinct, while others became cornered in evolutionary dead ends. But as a whole, evolution has moved toward increasing the complexity of the central nervous system, culminating in the development of the brain. (The "brain" as an organ within the skull did not develop until the emergence of the first vertebrate animal.)

Since evolution seems aimed towards the development of intelligence, a planet should be able to evolve not just one, but many intelligent species over time. Yet on Earth, humans were the only species who developed "radio telescope-building" intelligence.

"It might be argued that among mammals, humans developed intelligence first and are thereby effectively precluding the development of intelligence in any other species," says McKay. "It follows from this argument that intelligence evolves once and only once on a planet, because once evolved it changes the rules of the interaction between species and effectively dominates the planet from then on."

Human intelligence may never have developed if the dinosaurs had not gone extinct. During the age of the dinosaurs, our ancestors were small, rodent-like creatures scavenging for food in the low grass. Perhaps we had to wait for the dinosaurs to disappear before we could evolve beyond a certain point. However, says McKay, this theory still does not explain why the dinosaurs didn't become the Earth's first telescope-builders. They dominated the planet for over 150 million years, occupying all the niches mammals currently occupy.

"That is more than twice the time between the end of the Cretaceous and the construction of the first radio telescope," says McKay. "One might speculate that perhaps *Stenonychosaurus* (also known as *Troodon*) or her progeny did build radio telescopes but their civilization was destroyed by some internal or external catastrophe. Perhaps the lifetime of their civilization was so short, compared to the resolution of the geologic record, that it is simply lost without trace in the depths of time. It is difficult to say what evidence would survive of human civilization - if it was terminated now - after 65 million years of tectonic activity, erosion, and sea level change."

Since it seems that intelligence only evolved once on Earth, despite other opportunities to do so, perhaps not many forms of intelligence could evolve on other planets. McKay says that, considering the Earth's evolutionary history, the odds for developing intelligence elsewhere may be less than one in three (65/215). Still, given the potential number of habitable planets in our Galaxy alone, that could mean there are many millions of intelligent species out there.

"The odds I computed are just a rough upper limit based on the history of Earth as we now know it," says McKay. "For us to be the ONLY intelligent radio builders in the galaxy, the odds would have much lower -- about 1 in a million."

### **What's Next**

Despite all the rationale behind one viewpoint or another, the question of how many intelligent civilizations are out there can only be answered if we discover alien life. NASA is planning to launch the Terrestrial Planet Finder in 2012. This satellite will operate for 6 years, searching for Earth-sized planets around distant stars.

In the meantime, scientists with the Search for Extra Terrestrial Intelligence (SETI) continue to explore the electromagnetic spectrum for alien transmissions. The SETI Institute recently published "SETI 2020," a book detailing the focus of SETI strategies between now and the year 2020.