SearchLites

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The Quarterly Newsletter of The SETI League, Inc.

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Refining our Focus

by H. Paul Shuch, Ph.D., Executive Director

When The SETI League was born, now nearly eight years ago, founder Richard Factor envisioned it as a ham radio club for advanced microwave experimenters, and I prepared its Vision and Mission Statements accordingly. *Project Argus*, our first major scientific effort, contemplated thousands of amateur radio telescopes, built and operated by dedicated ham radio operators, coordinated in a global search for radio emissions from distant civilizations. We've achieved modest success in inching toward that lofty goal, and in fact a microwave search for ETI still seems like a pretty good idea. But, as the sailor says, time and technology wait for no man.

That the focus of SETI is shifting is demonstrated by the diversity of papers to be found in the Proceedings of our first two SETI League Technical Symposia. The expected papers on microwave receivers, amplifiers, and antennas are there, to be sure. But they have been joined by excellent treatises on Optical SETI, Gamma ray bursters, interstellar probes, Lunar radio astronomy, space archaeology, panspermia, and a host of related and not-so-related topics. SETI is no longer solely the domain of ham microwave geeks; today we embrace new approaches, fresh challenges, and unprecedented opportunity.

The SETI League's Strategic Planning Committee, composed of seven members (including three volunteer Regional Coordinators, our President, Secretary, Executive Director, and a member of our Advisory Board), is tasked with keeping us on course through social, political, and technological change. In recent months they took a look at our published goals, and decided it was time to tweak them into alignment with our current reality. On that Committee's recommendation our Trustees approved, at the 2002 Board meeting, the first ever revision to our stated Vision and Mission.

The changes just approved are subtle, and symbolic. They do not change our prime focus (pun very much intended). Rather, they broaden it, in recognition of recent developments. Gone from our Vision Statement is its original, restrictive wording about microwave experimenters. Now, it merely states:

> *Recognizing that confirmed evidence of extraterrestrial intelligence will change forever our view of humanity's place in the cosmos, The SETI League, Inc. envisions a worldwide network of amateur and professional scientists working together to hasten our entry into the galactic community.*

Similarly, a few points in our Mission Statement have been made somewhat less restrictive. For example, where previously Point 5 called for providing a medium of communication "through journals, meetings, conferences, and electronic means," now it has us "providing a variety of forums and media for wide-ranging communication among SETI experimenters, enthusiasts, and organizations." Exactly what those forums and media might turn out to be in the future, we cannot (and ought not) specify today. Similarly, to Point 8, which previously called for "raising public consciousness as to the importance and significance of a broad-based Search for Extra-Terrestrial Intelligence," we've now added "that encompasses a variety of strategies."

You can read the entire Vision and Mission statements, as amended, on our website at <http://www.setileague.org/general/mission.htm>. The original version will still be kicking around for a while, on the thousands of membership brochures that were printed before the changes were made. The differences are not worth wasting trees over, but they may become important in the months and years ahead. For what is SETI but a glimpse into humanity's future?

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Guest Editorial:

SETI and God

by Robert J. Sawyer

Okay, here's a thought: what if an *Encyclopedia Galactica* is radioed to us by aliens, and it contains proof of the existence of God?

I'm not talking about the God of the Bible or the Torah or the Qur'an. But I am talking about an intelligent designer — a creator of the universe.

I'm a science-fiction writer, and, despite our antithetical worldviews, I like to quip that SF writers and creationists have a lot in common: we both try to twist the evidence science has uncovered into the most dramatically interesting interpretation.

For instance, a few years ago, astronomers announced that some stars seemed to be billions of years older than the universe.

Well, that was a perfect SF conundrum, and I wrote a novel about it (the Hugo Award-nominated *Starplex*), in which beings in the far future were sending stars back in time to increase the mass of the early universe so as to slow its expansion.

But young-earth creationists had already had a go at a similar problem. They think the world was created around 4000 B.C., which makes it hard to account for the starlight from the Andromeda galaxy seeming to be two million years old. "Ah hah!" they crow. "A clever intelligence must have created the universe with that starlight already en route to us!"

Both my SF solution and the creationist spin are fantastic. But the difference between SF writers and creationists is that we writers usually aren't as likely to believe the stories we make up.

Still, what if, through SETI, we do receive that long hoped for repository of all the knowledge of an infinitely more advanced race?

And what if, as I suggested above, it includes proof that we live in a created universe?

A ridiculous premise for a science-fiction writer to be discussing, you say? Not at all. SF has long been full of created universes, from Theodore Sturgeon's "Microscopic God" through Gregory Benford's *Cosm*. True, those were sub-universes within our own, made by humans.

But remember the woman who didn't believe that Earth revolved around the sun, but rather asserted that it sat on the back of a giant turtle? When asked what the turtle was sitting on, she replied, "It's turtles all the way down." If we can conceive, in our best speculations today, of creating a universe, why couldn't this universe, the one we call home, be the product of someone else's science experiment?

After all, there is a real movement among some scientists called "intelligent design" that argues that our universe shows deliberate fine-tuning in its fundamental parameters, such as the ratio of respective strengths of the four fundamental forces (electromagnetism, gravity, and the weak and strong nuclear interactions). If the ratios were only slightly different, our universe either would never have developed any elements beyond helium, or would have almost immediately collapsed back down in a big crunch. Either way, no intelligent life would ever have existed.

Now, yes, there is an excellent argument against intelligent design. Sure, the parameters of this universe seem carefully tweaked — but what if there are countless other parallel universes, or there were countless other big-bang/big-crunch cycles before the current one, and each of those universes had different physical constants? If you have enough rolls of the dice, the winning combination is bound to come up eventually by pure chance — no need for any sort of God.

Right now, we don't know if such parallel universes existed or do now exist. But someday we will know. Maybe not in a decade, maybe not in a century, maybe not in a millennium. Eventually, though, our science will answer that question.

But perhaps we won't have to wait. If the "L" in Drake's famous equation — the lifetime of a technological civilization — isn't capped by a tendency for all thinking beings to destroy themselves, SETI may give us access to knowledge that we wouldn't otherwise obtain for millions of years. And that knowledge might include the revelation that we exist inside a supracosmic petri dish, that our universe is somebody else's science project.

And at that point, even though we might have only begun to communicate with extraterrestrials, we'll have another quest ahead of us, for a new level of contact — with our own creator. SETI, you see, will never end, so long as it's turtles all the way down ...

Editor's Note*: Nebula Award winning science fiction author Robert J. Sawyer specializes in first-contact scenarios, in books such as* Starplex, Illegal Alien, Factoring Humanity, *and his latest novel,* Hominids, *just out from Tor. His 2000 novel* Calculating God *was edged out for the Hugo Award by* Harry Potter. *Rob lives in Ontario, Canada, and writes knowledgeably about SETI. For more information, see his web site at: sfwriter.com.* ❖

Announcing:

SETICon03

The SETI League's Third Annual Technical Symposium, Awards Banquet and Membership Meeting

Mark your calendar now for the best SETICon ever, scheduled for the weekend of 25 – 27 April 2003. Help us celebrate the tenth anniversary of Congress canceling the NASA SETI program, by showcasing a decade of progress in privatized SETI.

New for 2003 will be a Microwave Construction Workshop, conducted by Steve Kostro, N2CEI, of Down East Microwave Inc. Participants will have the opportunity to construct a SETI Low Noise Amplifier, Downconverter, or Weak Signal Source, under Steve's watchful eye, and test it in The College of New Jersey's microwave laboratory. Further details may be found online, at www.setileague.org/seticon.

WHY ALIEN INTELLIGENCE MAY NOT BE SO ALIEN

By Prof. N. Chandra Wickramasinghe

SETICon02 Banquet Presentation

Viewed from space our planet Earth is an insignificant planet orbiting a quite ordinary star, the Sun. The sun in turn is one of some hundred billion similar stars that make up our Milky Way galaxy, and similar galaxies are to be found as far as our most powerful telescopes can penetrate. Recent discoveries in astronomy using the Hubble and Keck telescopes have revealed a remarkable fact. The most distant galaxies, closest in time to a presumed big-bang event, are not too different in many ways from nearby galaxies. And most significantly, the element on which life depends, carbon, has been discovered in great abundance in these old and distant objects. Stellar processes creating these elements were clearly at work at the very dawn of the Big Bang Universe, 15 billion years ago. The antiquity of the entire cosmos, and whether all the galaxies we see in the expanding Universe were spawned by a single Big-Bang event, are still matters of dispute. More likely in my view is that other similar "Big Bang" events preceded the one we observe at 15 billion years ago, and the Universe is therefore timeless and eternal. On this view, as I shall show, life and intelligence are also ever present cosmic attributes.

Returning home to Earth, we see that it is populated by many billions of species of microbes, plants, and animals, and at the top of the evolutionary pile is a species we call *homo sapiens sapiens*, humans, wiser than the wisest. There are at the present time six thousand two hundred million individual members of this species grouped into 221 separate nation states, with exceedingly diverse fortunes, and with 80% of the population living on the verge of starvation.

In the year 2002 there are several divergent worldviews, called religions, in existence that divide our species even further. Different nations, different religions, are often seen to be at loggerheads, engaging in war, expressing what appears to be a primal instinct of gaining control over this planet. Despite all these distractions and tribulations we cannot deny that we have made huge technological advances and progress over the past few hundred years. Our noblest intellectual aspirations are directed towards pushing forward the frontiers of knowledge, and to exploring the Universe to our fullest capabilities. This must of course includes our desire to communicate with intelligent life forms in other parts of the Universe.

The search for extraterrestrial intelligence is based on three assumptions.

1. Such intelligence, that is ET, exists
2. It is worth our while to attempt contact with such intelligence
3. The relevant technology for communication exists.

All of us, believers in SETI, take these three caveats for granted. But of course, as expected, there are people who still would assert with absolute confidence that we are alone. Either that habitable planets are extremely rare, or that the emergence of intelligence is a unique event in the Universe, necessarily confined to the Earth. Let me touch briefly on these three aspects in the reverse order.

First, technical feasibility. This has been taken for granted for at least four decades. The first strategy to be explored was the use of Radio Telescopes such as the Arecibo dish to search the sky for intelligent signals, as proposed by Cocconi and Morrison in the 1950s. The first serious attempts at radio detections were launched by Frank Drake in 1960 when he turned the Green Bank Radio telescope to two sun-like stars tau-Ceti and epsilon Eridani. Searches started over narrow wavebands around 21 cm, the famous neutral hydrogen line, but subsequently other wavelengths and multi-channel detections have been attempted. Nowadays, there is a growing trend to turn to the optical waveband, in the belief that laser signaling may have been used by some of our intelligent neighbors. The idea of optical SETI was in fact also suggested quite early by Schwartz and Townes.

Well, we can ask where are they? Leaving aside a few false alarms that you all know of, so far no clear signals have been detected by any of these methods, and indeed ET seems to have kept stubbornly silent thus far. Some of the SETI opponents have argued that it may be time to give up. But that is surely not justified. My own view is that it would be greedy of us to expect a clear positive result so soon. We are at the start of perhaps the greatest adventure of the human race and to turn our backs to it after a measly 40 years would be foolish to say the least. The process of searching for ET and communication with it is surely an integral part of the unceasing search to understand the world in which we live, and to see how we, on Earth, fit in to this grand scheme of things.

That deals with feasibility and motivation as far as we can deal with them at the present time. Let's see what the negative case might possibly be against SETI.

Some would assert that ET capable of communication does not exist.

A superficial defense of this position could go as follows. Intelligence and technology capable of SETI has arisen in only a span of a few thousand years out of a total history of terrestrial life that spans 4000 million years. Superficially, at least, the probability of intelligence comes out at 1 in 10 million, and that would at best give only a meager 1000 stars with inhabited planets throughout the galaxy. That is bad enough, but some of our critics would go even further. They would say that intelligence on the Earth has arisen at the very end of a long series of multiple contingencies, a succession of random events, each with a vanishingly small probability. If you multiply a few thousand such small probabilities you end up with a chance of ET arising to be impossibly small. On that argument, using the famous Drake Equation, Earth is the only planet with intelligence in the entire Universe!

Some people may be comfortable with such a geocentric position, but I surely am not. I even begin to despair so much at this point that I would question the integrity and motivation of our critics. Throughout history we know that every attempt to place the Earth in a special place or privileged position in the Universe has turned out to be wrong. Four thousand years ago in ancient China, Beijing was regarded as the center of the world. In the middle ages, in Europe, the Earth itself was the center of our local universe, the solar system. It was next the turn of the Sun, then the Galaxy, the local group of galaxies, and so on. Each time we turned out to be woefully wrong in our assessment of our self importance. Why should this time be any different?

If we are to worry about improbabilities associated with evolution, lets us turn directly to the facts and see what they reveal, particularly in relation to the origin of life on the Earth. The Earth today is surely teeming with life, and organic molecules exist in great abundance. But this, clearly, was not always so. Four and a half billion years ago the material of the Earth was in the form of a cloud of fine dust particles that was in the process of contracting to become the primitive Earth. And for a while after the Earth had itself condensed into a solid body, its molten crust would have been too hot for life to persist. We now know that comets from the outer regions of the solar system impacted the Earth for the first half billion years of its life, and such comet impact brought the Earth's oceans and atmosphere. Quite remarkably, life in the form of simple microorganisms also makes its very first appearance at a time when comet impacts were still taking place.

The usual picture of a primordial soup developing in the oceans as a result of volcanic eruptions and lightning flashes in clouds is now beginning to wear thin. This picture maintained that organic molecules generated in this way somehow combined through a succession of chemical reactions to form life.

To back up this point of view, Harold Urey and their collaborators in the mid-1950s were able to show that trace quantities of life's building blocks can be formed through the action of electric discharges and ultraviolet light in a laboratory flask containing a mixture of water, methane, and ammonia. The synthesized products in these experiments included amino acids, which are the building blocks of proteins, and nucleotide bases and sugars which are the components of DNA and RNA. The results were hailed as a major breakthrough in our understanding of life's origins. It was optimistically thought that it would be only a matter of time before the spontaneous generation of life from inorganic matter would finally be achieved. Despite a sustained effort on the part of many scientists that final goal has become ever more remote.

Before discussing the probability or improbability of intelligence, it would be prudent to examine the old argument that life itself arose through random processes in a warm terrestrial pond. The one problem is, I believe, inextricably linked with the other. The most difficult problem of all in the origin of life is to explain the transition from building blocks to edifice, from relatively simple chemicals to the incomparably magnificent edifice of life. That requires the invention of a genetic blueprint embodying a catalogue of building instructions, information that is specific in kind and unimaginably vast in quantity. We can attempt to quantify this information in various ways, and in whatever manner we look at the problem the honest answer remains the same. Honest is of course the key word.

Let's imagine a warm pond on our planet supplied with vast quantities of the 20 amino acids of life and unlimited amounts of energy, and let's ask the question whether these amino acids would ever combine to form a set of some 2000 enzymes, which are an absolute prerequisite for life. The answer is of course an emphatic NO. To have 20 crucial sites per enzyme occupied by the correct amino acid in a set of 2000 enzymes is like giving 60,000 people in a small village a pair of six-faced dice and expecting them all to throw a double six! That just would not happen. Counting the number of trials that are needed to get the correct arrangements of building blocks into some crucial life molecules always gives rise to numbers that can only be described as super-astronomical.

Fred Hoyle and I have used a variety of metaphors to emphasize the improbability of life's origins. One of our more graphic metaphors is that of a tornado blowing through a junk yard leading to the assembly of a fully working Boeing 747.

There is clearly no logic whatsoever that constrains the origin of life to a warm little pond on the Earth. Panspermia, which I shall describe shortly, offers a totally different landscape on which the logic of SETI can be restored. As far as life's first origin is concerned, it stands to common sense that one would be better off to extend the boundaries of Darwin's warm little pond vastly beyond the confines of our tiny planet, to encompass the largest possible amount of carbonaceous matter in the cosmos.

The best condition of all would be for a spatially infinite universe, a universe that ranges far beyond the largest telescopes. Then the very small chance of obtaining a replicative primitive cell will bear fruit somewhere and, when it does, replication in a suitable astronomical setting will cause an enormous number of copies of the first cells to be produced. It is here that the immense replicative power of biology shows to great advantage.

Taking the same replicative power as that of a typical bacterium, a single cell in a warm watery culture medium would double, producing two cells in two or three hours. The two cells then produce four, four produce eight, and so on in a cascade of exponential growth. We obtain 2^{40} cells in about four days, giving a culture the size of a cube of sugar. With a continuing supply of nutrients, the initial cell yields 2^{80} similar cells in a further four days, with the culture reaching the size of a village pond. Then 2^{120} cells with the size of a comet or asteroid in four days more, only 12 days from the beginning.

Taking this process further, with instant propagation of replicated material the mass of a molecular cloud like the Orion Nebula would be enveloped in 16 days from the beginning, rising to the mass of a cluster of galaxies in only 20 days. Of course a concentrated supply of nutrients would not be maintained indefinitely at the same place, and there are also delays in the dispersal of biological material amplified in comets across galactic distances. But what the calculation shows is the crucial importance of replication, even for the first primitive proto-cell. It generates enough copies of itself for a second highly improbable event to occur in one of the profusion of offspring from the first cell. And so by an extension of the argument to the third improbable event, thence to the fourth, fifth, and so on. Indeed to a whole chain of interconnected improbable events, events that could be separated by vast galactic or intergalactic distances. It is end result of such a cumulative evolutionary process that leads to the cells we have today, the cells that were already present with the fullest range of evolutionary possibilities at the formation of the Earth.

According to this model no great innovation in biology ever happened on the Earth. The Earth is merely a receiving station where cosmically determined genes were assembled. On this view of the origin of life there would be little variation in the forms to which the process gives rise, at least so far as basic genes are concerned, over the whole of our galaxy. Or, indeed, over all nearby galaxies. If intelligence is seen as an inevitable consequence of gene expression, the emergence of intelligence would also seem assured.

The evidence for microbial life and its end-products occurring cosmically came in small installments from the 1970s. First there was the evidence for organic molecules in space, and recently these have included a sugar glycolaldehyde and an amino acid glycene. In the 1980s organic particles with sizes and spectra indistinguishable from bacteria were discovered, and then finally similar particles were found in comets after the 1986 explorations of Comet Halley. Arguments still rage whether these particles could look like bacteria and yet not be bacteria, but that is surely being perverse. There is an old English saying that if something looks like a duck, walks like a duck and quacks like a duck then most probably it *is* a duck. That is the situation we have in relation to the astronomical data.

The data from many different viewpoints are converging towards a validation of an ancient idea - panspermia - which I have already introduced but not defined. Panspermia is a coined word with Greek roots - *pans*=everywhere + *spermia*=seeds, meaning life-seeds everywhere. In the Western world this idea can be traced back to Aristarchus of Samos in the 3rd Century BC. A strong hint that this is indeed the correct explanation of the origin of terrestrial life came as early as 1870 with the work of Louis Pasteur. His work on the souring of milk and the fermentation of wine led to the concept of life being derived only from pre-existing life, in contradiction with the then fashionable idea of spontaneous generation, of which the primordial soup theory was an offshoot. The life from life connection extends all the way down the fossil record, to the time when the first life shows up at four billion years BP. We saw earlier that this was the time of intense cometary impacts. Quite apart from the difficulties of improbability discussed before, the conditions on Earth were distinctly unfavourable for any primordial soup to persist. Panspermia is then a much more reasonable option.

On this point of view it is clear that bacteria should be space hardy, and so they are found to be. On the Earth bacteria are known to survive under the most adverse conditions imaginable. Spores of *Bacillus subtlis* survived in space after spending 6 years aboard NASA's Long Duration Exposure facility and reproduced readily after being incubated in a laboratory. Certain types of heat-loving bacteria or hyperthermophiles are able to replicate at temperatures above 100C in oceanic thermal vents and in the extreme condition in Black Smokers. Physcrophillic or cold-loving microorganisms are plentiful in the frozen wastes of Antarctica. Certain bacterial types thrive in highly concentrated salt solutions, as in the Dead Sea, whilst others exist in highly radioactive environments even in the interiors of working nuclear reactors. A culture of *Deinococcus radiodurans* after exposure to 1.7 megarads of gamma radiation was shown to divide and replicate after repairing extensive areas of damage to their DNA. A 250 million-year old microorganism was recently revived from its dormant state from a salt crystal in a New Mexico salt pan.

Perhaps the most recent finding with a direct relevance to panspermia is the discovery of organic structures (arguably biogenic, but certainly organic) within the Martian meteorite, ALH84001. This piece of the Martian regolith was blasted off the surface of Mars 1.5 million years ago. It has been shown that the interior of this meteorite remained cool enough throughout the processes of impact ejection from Mars, transit, and subsequent re-entry and landing on Earth for any organic structures, or even biomolecules to survive. These facts are beginning to convince many scientists that the origin of life must have been external to the Earth. How far external to the Earth is all that now remains to be resolved.

Once life had originated on a cosmic scale according to the logic I have described earlier, possibly as a one-off, near miraculous event, its dispersal on a galactic or extragalactic scale would be assured by virtue of the survival properties of microorganisms we have just discussed. Any improbability factors associated with surviving the hazards of space would pale into insignificance when compared with the improbability of starting life in the first place.

Only a survival fraction of as little as one in a trillion is needed to ensure the continuation of panspermia through recurrent cycles of star planet and comet formation. As an ongoing astronomical process, biological regeneration would seem to take place most readily within the warm, radioactively heated interiors of comets. This would have happened in our own solar system in its early history when the planets Uranus and Neptune were being pieced together from cometary bodies. Within such comets, bacterial dust from the parent protoplanetary cloud from which the solar system formed would find environments in which they become vastly amplified on a very short timescale. When the radioactive heat sources became exhausted and the comets refroze, cometary microorganisms would have deep-frozen and become dormant, remaining so for billions of years.

In March 1986 Comet Halley as it approached perihelion expelled small particles that matched the infrared spectral properties of bacteria. When this spectrum was measured Comet Halley was producing organic dust at the prolific rate of several million tonnes per day. Other comets, notably comets Hyakutake and Hale-Bopp, were later found to behave in a similar way. All the available data on comets are consistent with the view that they are indeed the most likely places where cosmic bacteria are amplified. And cometary activity leads to the release of bacterial grains into interplanetary space, some of which could of course land on the surfaces of planets. A fraction of the biological material generated in comets would inevitably escape from the entire planetary system, thus providing a feedback source of biological dust back into interstellar clouds, clouds from which new stars, planets, and comets can subsequently form.

Throughout the entire Universe, over a cosmological timescale, the potential for biological evolution offered by this cosmic replication cycle would be of a truly astronomical order.

In our model of panspermia the oldest evidence of terrestrial life dated now at some four billion years is identified with the first moment when fully-fledged bacteria from comets arrived at the Earth and were able to survive. The process of natural selection can prevent the deterioration of an already-established genetic structure, and it can also favor adaptive improvements provided these are confined to single-point mutations on DNA. That is to say, to one point mutation at a time. What natural selection cannot do is to produce the basic genetic structures themselves. (For reasons that should be clear from the probability calculation that we have already given.) To explain the development of life from microbe to Man, genetic structures must therefore have been more or less continuously supplied to the Earth in cometary material, which serves to relate life here on the Earth to its cosmic origin. Biological evolution on the Earth through natural selection only serves to fine-tune systems of cosmic origin once they become established here on the Earth.

If comets brought the first life onto the Earth, and possibly onto other planets as well, that process could not have stopped at some distant time in the past. Comets are with us all the time, and the Earth is entwined in the debris shed by comets. We know that at the present time some 100 tons of cometary material reaches our planet on a daily basis. One might then ask: What evidence is there of living particles, microbes, coming in with this influx of debris? Much of the infalling cometary debris would of course be in the form of millimeter-sized or larger particles that burn up as meteors on entry.

But a significant fraction of infalling cometary material will be of sizes that will enable them to travel safely through the atmosphere, and this, according to what I have said tonight, must include clumps of bacteria freshly released from cometary surfaces.

The best prospect of testing this proposition would be to collect samples of air in the very high stratosphere. Above the tropopause, which is 18 km in the tropics and 10 km in temperate latitudes, aerosols of 1-10 micrometers in size, including bacterial clumps, could not persist for more than a very short timescale, weeks or less. They would quickly fall under gravity. If small amounts of bacteria from the Earth's surface get lofted on rare occasions to great heights, for example after a volcanic eruption, they would quickly fall. Above 40 km you would not expect to find any terrestrial bacteria at all in normal times, so if significant quantities of stratospheric bacteria are discovered, this would provide *prima facie* evidence of panspermia.

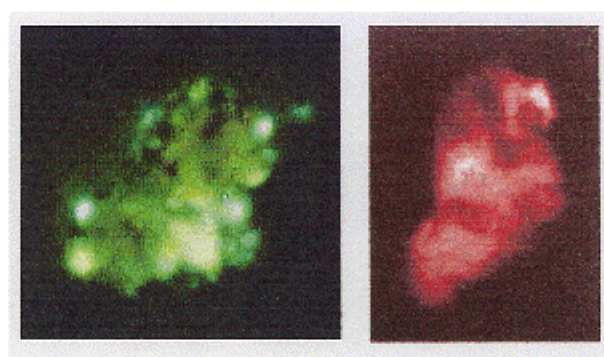
When one thinks about it, it must surely seem remarkable that such a crucial experiment as this was not carried out until January in the present year, and then not by NASA or ESA but by an equally competent space agency of a much poorer nation – India Space Research Organisation (ISRO). Part of the reason for this was that the relevant technology for collecting stratospheric air samples under perfectly aseptic conditions was not available until relatively recently. But more I think to blame was the firm conviction of scientists that the Hoyle Wickramasinghe theory of panspermia just had to be wrong.

Well, as events are turning out, it is our critics that were wrong. A group of Indian scientists from several reputed research institutions collaborated with a group of us at Cardiff to conduct an experiment that was long overdue. The plan was to collect stratospheric air aseptically, and to examine it in the laboratory for signs of life. The collection part of the project was as follows. A number of specially manufactured sterilized stainless steel cylinders were evacuated to almost zero pressures and fitted with valves that could be open and shut on ground telecommand. An assembly of such cylinders was suspended in a liquid Ne environment to keep them at cryogenic temperatures, and the entire payload was launched from the TATA Institute Balloon launching facility in Hyderabad, India on 20 January, 2001. As the valves of the cylinders are opened at predetermined heights, ambient air rushes in to fill the vacuum, building up very high pressures within the cylinders. The valves were shut after a prescribed length of time and the cylinders hermetically sealed to be parachuted back to the ground.

Back on the ground the cylinders were carefully opened and the collected air made to flow through sterile membrane filters in a contaminant free environment. Any bacteria or clumps of bacteria present in the stratosphere would then be collected on these filters. The analysis in Cardiff was conducted by a team at Cardiff University led by microbiologist Professor David Lloyd.

The first phase of our investigation has been completed and in August last year we reported unambiguous evidence for the presence of clumps of living cells in air samples from as high as 41 kilometers, well above the local tropopause (16 km), above which no aerosols from lower down would normally be transported. The detection was made using a fluorescent dye known as Cyanine which is only taken up by the membranes of living cells. When the isolate treated with the dye is examined under a special kind of microscope the picture on the left of the slide is obtained.

The picture on the right is an image obtained using a stain that can only be taken up by nucleic acid. The variation with height of the distribution of such cells indicates strongly that the clumps of bacterial cells are falling from space. In recent weeks some of these organisms have been cultured in the laboratory by Dr. Milton Wainwright of the University of Sheffield. The result is not some weird and wonderful new microbes but microbes very similar to Earth microbes. That is what the theory predicted.



The daily input of such biological material is provisionally estimated to be in the range one-third to one ton over the entire planet. If this amount of organic material was in the form of bacteria, the annual transfer of bacteria is 10^{23} and if they are viruses, the number would be nearer 10^{25}. This exceeds the number of viruses exhaled by humans over a whole year, so it is exceedingly difficult to maintain that such an input has no effect on terrestrial biology. On the contrary the biological and even medical implications are likely to be profound.

The situation in our view is now absolutely decisive. With another balloon flight of this kind planned for next year, and several space missions planned in the decades that lie ahead it would seem inevitable that we soon be overwhelmed with further confirmation of this startling result. This would surely constitute absolute and unequivocal proof of panspermia, in other words, proof that life is a truly cosmic phenomenon. If that were so it also follows that intelligence must be a truly cosmic phenomenon. To maintain otherwise is to cling to a pre-Copernican worldview, and to fly in the face of all the available evidence.

On other planets around other stars the same processes of assembly of cosmic genes would also operate. Life would inevitably develop on every habitable planet, descended from the same all-pervasive cosmic genes. Now, intelligence, if it is part and parcel of the package of cosmic evolution as I indicated, should show up inevitably in the evolutionary history of life on any planet. It may come sooner rather than later depending on particular circumstances, and it could last a short time or a very long time, again depending on local contingencies. A crucial datum for SETI is the average duration of an advanced technological civilization. There may be a case for saying that those civilizations that have overcome their tendencies of conflict, and developed enlightened pacifist philosophies, dominate the scene through a process of natural selection. If so there would be a great deal to learn from a future moment of contact. They may tell us how to avoid conflict. They may tell us the nature of God if such exists, and thereby eliminate a major cause of strife and dissention on our planet. We may be thinking of a world or cosmic religion in which petty squabbles such as the Arab-Israel conflict will have no place.

An enlightened civilization on a planet like Earth could easily survive and develop for say 2 billion years, before any stellar or planetary catastrophe intervenes. If so, then their numbers within the galaxy may well run into billions.

Should we fear contact? The answer is of course NO. In my view our moment of first contact would be the most important moment in the entire history of Mankind. We would instantly become enlightened to a degree that could scarcely be imagined. It would be like a Neanderthal man coming suddenly into contact with modern Man - our horizons would expand immeasurably.

Our genetic links to ET would of course be similar to our links with past life forms on the Earth, for example to Neanderthal man. ET would also be made of the same cosmic genes. It is no wonder then that all depictions of ET in fiction and on the screen have not departed greatly from the body plans of creatures we know, and love or hate, on this planet. Such connections implying a unity of cosmic life were hinted by poets down the ages.

For instance in his famous poem *Gitanjali*, Rabindranath Tagore wrote:

The same stream of life that runs through my veins

Night and day pervades the universe and dances in rhythmic measures

It is the same life that shoots in joy through the dust of the Earth in numberless blades of grass and breaks into tumultuous waves of leaves and flowers

It is the same life that is rocked in the ocean-cradle of birth and death, in ebb and flow. ❖

Event Horizon

August 16 - 18, 2002: *10th International Amateur Radio Moonbounce Conference*, Prague Czech Republic.
August 29 - September 2, 2002: *ConJose* World Science Fiction Convention, San Jose CA.
September 7 - 8, 2002: UK*W-Tagung* 47th VHF Convention, Weinheim Germany.
October 10 - 19, 2002: *World Space Congress*, Houston TX.
October 24 - 26, 2002: *Microwave Update*, Enfield CT.
October 26 - 27, 2002: *ARRL International EME Competition*, first weekend.
November 7 - 10, 2002: *AMSAT Space Symposium*, Ft. Worth TX.
November 22, 2002: *Radio Club of America Annual Banquet*, New York NY.
November 23 - 24, 2002: *ARRL International EME Competition*, second weekend.
April 19, 2003: *Fifth Annual SETI League Ham Radio QSO Party*; 14.204, 21.306, and 28.408 MHz.
April 25 - 27, 2003: *SETICon03 Technical Symposium* and *Annual Membership Meeting* , Ewing NJ.
May 3 - 4, 2003: *Trenton Computer Festival*, Edison NJ.
May 16 - 18, 2003: *Dayton Hamvention*, Dayton OH.
May 17, 2003, 0700 hours: *SETI Breakfast*, Marriott Hotel, Dayton OH.
May 23 – 26, 2003: *Balticon 37*, Baltimore MD.
June 20 - 22, 2003: *ARRL National Convention and HamCom 2003*, Arlington TX.
July 13 - 16, 2003: *SARA Conference*, NRAO Green Bank WV.
July 24 - 27, 2003: *Central States VHF Conference*, Tulsa OK.
August 28 - September 1, 2003: *Torcon 3* World Science Fiction Convention, Toronto ON Canada. ❖

Book Review:

The Universe Next Door

by Marcus Chown, Oxford University Press, $26

One of the characteristics that makes Marcus Chown such a good science reporter is his ability to convey the most complex ideas in understandable terms. After reading this book, I felt I had a handle on some very complicated ideas indeed. Divided into three parts: The Nature of Reality, The Nature of the Universe, and Life and the Universe, many of the most fascinating theories of our time are laid out in a lucid, thoughtful, and thought-provoking fashion.

Does time run backwards? Are there multiple realities? Was our universe created as an experiment by superior beings? And, of most interest to our members, Are we alone in the universe? All these and many more questions are asked, and some interesting answers are propounded.

Chown devotes some pages to the Panspermia theory that Chandra Wickramasinghe so ably presented at SETICon02. He also writes about the theory of another SETI League member, Alexey Arkhipov, that alien "garbage" may be falling on our world. The suggested "Further Reading" includes both science and science fiction (and a book by SETI League member Cliff Pickover). Highly recommended as a comprehensive sampler of Where Science is At. -- A. Heather Wood ❖

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