A panspermic view of life
Interview with N. Chandra Wickramasinghe.

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Two recent experiments in the United States have once again drawn the attention of scientists to the theory of panspermia. (Panspermia, which literally means seeds everywhere, underlies the hypothesis that the (biological) stuff of life did not have its origins in terrestrial resources but in inter-stellar space. The theory maintains that life on the earth was seeded from space and that life's evolution to higher forms depends on complex genes (including those of viruses and diseases) that the earth rec eives from space from time to time.)

British astrophysicist Sir Fred Hoyle and (left) his Sri Lankan student N. Chandra Wickramasinghe.

In one experiment reported in October, environmental biologists Russell H. Vreeland and William D. Rosenzweig claimed that they discovered the longest surviving (250 million years) bacterial spores locked inside a salt crystal formation in Mexico that co uld be revived. This was considered as evidence that life - even one-celled micro-organisms - could survive in suspended animation for eons and float on comets to far away planets.

In another experiment reported on October 27, a team of scientists from the California Institute of Technology, Vanderbilt and McGill Universities discovered that small pieces of space rock could be transferred from Mars to earth without its interior get ting excessively heated up, thus enabling living organisms to ride in them.

The renewed interest in panspermia also comes in the wake of space-based discoveries that include recent findings of some simple amino acids and sugars in inter-stellar space; the announcement by the National Aeronautics and Space Administration (NASA) in August 1996 of evidence of fossilised ancient life in a meteorite from Mars; evidence in the same year by geneticists that many genes are much older than what the fossil record would indicate; the discovery by a Russian microbiologist in 1998 of a mic ro-fossil in a meteorite was a previously unknown bacterium; and the announcement by NASA in April this year of the detection of very large organic molecules in space in its Stardust Mission launched in February and that the non-biological origins of suc h large molecules are not known.

The earliest proponent of the panspermia concept is believed to be the Greek philosopher Anaxagoras, Socrates' teacher. However, for the next 2,000 years or so, Aristotle's view that life was generated spontaneously on the earth became the preferred para digm of the sciences. In 1864, on the basis of his experiments, Louis Pasteur revived the idea of extra-terrestrial origins of life. This found support from British physicist Lord Kelvin and German physicist Hermann von Helmholtz in the 1870s. And in the early 1900s, the Swedish chemist and Nobel laureate Svante Arrhenius postulated that bacterial spores propelled through space by light were the seeds of life on the earth. This panspermic view of life in the universe was revived in the context of moder n astrophysics and cosmology by British astrophysicist Fred Hoyle and his Sri Lankan student, and long-standing collaborator, N. Chandra Wickramasinghe, in the 1970s.

Clearly, this view is totally opposed to the neo-Darwinian concept of terrestrial evolution, the Oparin-Haldane concept (advanced in the 1920s) of spontaneous generation of life on the earth from the primordial chemical soup and the supporting laboratory experiments of Stanley Miller and Harold C. Urey in 1953 that amino acids can indeed be chemically made from ammonia and methane. Though the evidence or even a convincing theoretical argument for the spontaneous generation of life forms from amino acids is still lacking, the Oparin-Haldane paradigm, together with the Darwinian principles of random mutations in the genes and environmental selection of the genomes for survival, still prevails despite arguments of Hoyle and Wickramasinghe to the contrary.

The Milky Way. The huge clouds of cosmic dust are made up of myriads of bacterial cells.

The key argument of the duo is that, given the fact that the life of the earth is about 3.8 billion years, the time scales available are, probabilistically speaking, very small for the kind of chance mutations and selection by accumulation of mutational errors to occur and the consequent emergence of higher life forms (like humans) entirely based on terrestrial processes. They argue that the time scales in the universe as a whole, particularly unbounded time in the context of steady state cosmology as a gainst the big-bang cosmology, and the combined resources of all the comets around all the stars in all the galaxies would be more conducive for life to begin. Once started, the robustness of life, for which Hoyle and Wickramasinghe claim there is suffic ient experimental evidence, ensures its "essential immortality".

Comets and meteorites function as transporting vehicles for these across space, as space between stars is littered with cometary debris. Life forms survive and are repeatedly regenerated in the warm watery interiors of comets, the duo argue. Comets arriv ing on the earth from the 100 billion-strong Oort cometary cloud brought the first life on the earth. The evolution of the earth was directed by the continued arrival of cometary bacteria, which are probably still arriving. In the evolution into higher l ife forms, genes of viruses and viroid particles which have complex genes, would have played a crucial role, Hoyle and Wickramasinghe believe. While there may have been local transfer of microbes between some of the planets, like Mars and the earth, thes e would be minor aspects of panspermia. The main transfer, according to them, is through comets to inter-stellar and inter-planetary space, back to comets, amplification in comets, transfer from comets to all prospective habitats on planets and planetar y satellites.

Hoyle and Wickra-masinghe did not begin their investigations with the aim of disproving Darwinism. In the early 1960s, they were essentially interested in explaining the observed spectrum (in the infrared) of inter-planetary dust and understanding its na ture. This led them to postulate in 1972 the existence of a cellulose like polymer based on the molecule formaldehyde besides micrometre-sized graphite spheres in the dust. Continuing from here, they found that the absorption of starlight by the interven ing stardust could be best explained by postulating the presence of biological molecules, even living cells, some of which had become selectively degraded into graphite. Conventional models of inter-stellar dust had not been successful in explaining the data till then. Bacteria, they said, seem to be present on a galaxy-wide scale.

While they regard their investigations as conclusive, these views have not found acceptance in mainstream science. One of the reasons for the general scientific community being not in favour of panspermia is what is known as the Occam's Razor principle - that is, you do not invoke more entities than necessary in explaining physical (and biological) phenomena. They attribute the failure on the part of most of the scientists to recognise clear evidences for panspermia to the early indoctrination in Darwin ism on the one hand and the Christian beliefs in creationism on the other. Besides the general disagreement over the manner of interpretation of data, opponents to the Hoyle-Wickramasinghe view argue that panspermia only shifts the idea of spontaneous cr eation from the earth to a different realm with no answers as to how it might have happened out there. Indeed, some say that even the theory of panspermia would require "deliberate intervention" of some sort and in that respect it is no different from cr eationism.

Wickramasinghe, who is also director of the Cardiff Centre for Astrobiology in the United Kingdom, is currently involved in experiments to detect life processes in space. Excerpts from his e-mail responses from Cardiff to Walter Jayawardhana's que stions posted from Los Angeles:

Why is there a renewed interest in the panspermia theory today among the scientific community?

(a) There are many different lines of evidence to indicate that life may not have originated in a primordial soup generated entirely on the earth. The oldest evidence of life on the earth has been pushed back to before 3,900 million years at a time when the planet was being severely pounded by comet and asteroid impacts. Life thus shows up here under conditions when it is almost impossible to survive, let alone originate. This goes a long way towards showing that life in the form of microbes may have co me to the earth along with the impacting comets.

(b) From the late 1970s onwards Sir Fred Hoyle and I, along with a handful of colleagues, have shown that there is ample astronomical evidence for the widespread cosmic occurrence of life's building blocks. These building blocks, scattered in inter-stell ar and cometary dust, are not the molecules of life, they are intact freeze-dried micro-organisms. This evidence too has expanded as the years have rolled by. Only a few months ago NASA scientists analysed the remnants of five inter-stellar dust particle s as they impacted detectors on the Stardust satellite at high speed. What they found were structures that could hardly be anything else but the shattered fragments of the cell walls of bacteria.

(c) Micro-organisms have been discovered in recent years to have amazing abilities to survive the harshest of conditions. Recently, a quarter of billion year old bacterial spore was brought back to life from an ancient salt crystal. Then, there was a rep ort in a recent issue of Science to indicate that microbes may have survived within the cool interiors of a meteorite that came from Mars... And the catalogue of supportive facts grow by the day.

The late Dr. Cyril Ponnamperuma, the Sri Lankan scientist who was attached to the Ames Research Institute of NASA, had professed that life began on earth in a primordial soup. How is your theory different from his? (A Frontline interview with Dr. Pon namperuma app-eared in the issue dated March 25, 1994.)

Our theory is diametrically opposed to that point of view. We argue that life could not have started here on the earth, and there is evidence now to support this position. Life is the most highly informational, the most highly ordered system we know of i n the universe. To get life started from non-living matter involves super astronomical improbabilities. This is true, however we look at life. So... such a near-miraculous event happening on the earth is impossible. The earth is too small and too insigni ficant a venue to achieve this near-miracle.

If life did not start in a primordial soup on the earth where could it have started?

I think the origin of life must have taken place on a cosmological scale. It required all the resources of all the stars in the entire universe to get started. But once started the incredible survival properties of microbes makes it inevitable that it sp reads across the universe. The huge cloud of cosmic dust we see stretching across the Milky Way and beyond are made up of myriads of bacterial cells. It does not matter even if 99.9999999 per cent of these bacterial cells are killed. There could always b e enough survivors for the panspermia theory to be valid. The amazing replication capabilities of bacteria take care of that.

If life is not unique on the earth, what do you think about the possibilities of the existence of intelligent life in other parts of the universe?

If life on the earth came from space 4,000 million years ago, it continued to arrive even to the present day. I think that this continuing input of bacterial genes contributed immensely to the evolution of life on the earth. The emergence of intelligent creatures like ourselves has been the eventual outcome of these processes. I think the cosmic genes that led to life and eventually intelligence must rain down on every habitable planet in the cosmos. Recent astronomical studies have shown that planet fo rmation might be a commonplace occurrence. Several dozen extra-solar planets have been discovered to date, and this list is growing. Of the 100 billion sun-like stars in our galaxy it is likely now that one per cent or so may have planetary systems like ours. That makes for billions of earth-like planets in our Milky Way alone. The same assemblies of cosmic genes leading to intelligence must then have taken place on a fair fraction of these. So, I believe on this basis that the universe must be teeming with intelligent or super-intelligent life.

Until recently many scientists did not regard panspermia as a scientific hypothesis. How did it gain recognition since your guru, Fred Hoyle, started preaching it?

I have already indicated the reasons. First, there was the difficulty of starting life on the earth under conditions that seemed inappropriate. Then there was the detection of organic molecules in inter-stellar dust and comets. By the end of the 1980s it became clear that cosmic dust added properties that made them indistinguishable from freeze-dried bacteria and their degradation products. Then came the story about the Martian meteorite, and so

on.
BRIAN SMITH/GAMMA
Meteorites that came from Mars. Scientists have found evidence of fossilised ancient life in the space rocks.

If life travelled from another part of the universe to the earth, could it also have travelled from the earth to other planets?

Yes, I think that reverse panspermia is possible and must also be happening. The evolutionary heritage and history of the earth will not be destroyed entirely when our planet eventually becomes uninhabitable. Living cells are lofted to the high atmospher e and some can reach space. The Martian meteorite evidence shows certainly that within a piece of rock or meteorite, life can be transported between planets in the solar system.

How do you react to the recent claim by Russell Vreeland and his colleagues that they have discovered 250 million year old microbes and the claim of Caltech geobiologist Joseph Kirschvink and others that a Mars rock travelling to the earth did not he at up?

I think these are pieces of supportive evidence, as I have said before.

What is the significance to your panspermia theory of NASA's Stardust Mission to collect dust from Comet Wild-2 in 2004?

BOB YEN/ GAMMA LIAISON
Comet Hale-Bopp, as seen from California, a 1997 photograph.

At the time when Stardust was conceived of it was not thought sensible to look for living particles. So the collection methods were not optimised to ensure survival. However, the serendipitous discovery of tell-tale signs of life in the impacting dust gr ains has already been found. And similar confirmations may be forthcoming in the sample returns that are being planned.

Scientists at the Indian Space Research Organisation are scheduled to launch a balloon to collect samples of comet dust from the stratosphere and seek proof of the continuing arrival of life from space. Could you please comment on the experiment and your contention that contagious diseases are introduced to earth from space?

I think the ISRO experiment could be the most decisive experiment for proving panspermia... From the previous flight (in 1999) some tantalising evidence for the unusual bacterial strain in the stratosphere has come to light. If microbes are raining down on the earth at the present time, of course it is possible that on occasion they could be pathogenic to plants, animals and humans. I think we cannot ignore this possibility, although this is still the most highly contentious part of the theory of panspe rmia.

With inputs from R. Ramachandran for the introduction.