Panspermia Theory for Life's Origins Gets Boost from Top Scientists

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By NewsWax

> *"Life is all about information – its replication and processing."* — Professor Paul Davies

A team of scientists from the United States, United Kingdom and the Netherlands have determined that chemicals in a meteorite that form the building blocks of DNA and RNA had formed before the meteorite fell to Earth. In a paper published in Earth and Planetary Science Letters on June 15, the team documents an examination of molecules found in the Murchison meteorite, fragments of which landed near the village of Murchison, Victoria in Australia in 1969.

Previous studies had identified amino acids and sugars in the meteorite that were believed to have formed in space. The samples the current study examined included molecules of uracil and xanthine, which belong to the class of nucleobases – chemicals which, when combined with sugars, form a crucial part of DNA and RNA. These molecules contained a form of carbon, known as carbon 13, in much higher concentrations than would be expected if they had come from contamination through exposure from Earth sources. The study, using nuclear magnetic resonance (NMR) imaging, had not been undertaken before due to its laborious and time-consuming nature – the low concentration of nucleobases in the meteorite meant that 15 grams of space rock had to be processed to get a large enough sample, compared to the milligrams required for previous studies.

Co-author Dr Zita Martins, a chemist and astrobiologist from Imperial College London, believes their findings suggest that some of the chemicals that generated life on Earth came from meteorite bombardments. “We are not saying that only meteorites contributed to the building blocks of life,” she said, “but it’s a very great contribution.” Other scientists, however, do not believe that meteoritic chemicals played such a significant role. According to Emeritus Professor Robert Shapiro of New York University, “They’re a subunit of a subunit of DNA. My opinion is that their amounts were utterly unimportant and insignificant.”

Wikinews contacted Professor Paul Davies, a physicist and astrobiologist presently at Arizona State University, about the recent findings. While he agreed with the findings, he said that he thinks such discoveries are “a red herring in the origin of life story – a hangover from the Miller-Urey experiment. Life is all about information – its replication and processing.”

<u>Backgrounder on Panspermia</u>

Panspermia (Gk. ÃƒÂÃ¢â€šÂ¬ÃƒÅ½Ã‚Â¬ÃƒÂÃ¢â‚¬Å¡/ÃƒÂÃ¢â€šÂ¬ÃƒÅ½Ã‚Â¬ÃƒÅ½Ã‚Â½ (pas/pan, all) ÃƒÂÃ†â€™ÃƒÂÃ¢â€šÂ¬ÃƒÅ½Ã‚ÂÃƒÂÃ‚ÂÃƒÅ½Ã‚Â¼ÃƒÅ½Ã‚Â± (sperma, seed)) is the hypothesis that “seeds” of life exist already all over the Universe, that life on Earth may have originated through these “seeds”, and that they may deliver or have delivered life to other habitable bodies.

Hypothesis

The first known mention of the idea was in the writings of the 5th century BC Greek philosopher Anaxagoras. The panspermia hypothesis was dormant until 1743 when it appeared posthumously in the writings of BenoÃƒÆ’Ã‚Â®t de Maillet, who suggested that germs from space had fallen into the oceans and grown into fish and later amphibians, reptiles and then mammals. In the nineteenth century it was again revived in modern form by several scientists, including JÃƒÆ'Ã‚Â¶ns Jacob Berzelius (1834), Kelvin (1871),Ãƒâ€šÃ‚Â Hermann von Helmholtz (1879) and, somewhat later, by Svante Arrhenius (1903). Panspermia can be said to be either interstellar (between star systems) or interplanetary (between planets in the same star system). Mechanisms for panspermia include radiation pressure (Arrhenius) and lithopanspermia (microorganisms in rocks) (Kelvin). Directed panspermia from space to seed Earth (Orgel and Crick, 1973) or sent from Earth to seed other solar systems (Mautner 1979, 1997) has also been proposed.

There is as yet no compelling evidence to support or contradict it, although the majority view holds that panspermia ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Â especially in its interstellar form ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Â is unlikely given the challenges of survival and transport in space. One new twist to the theory by engineer Thomas Dehel (2006) proposes that plasmoids ejected from the magnetosphere may move the few spores lifted from the Earth's atmosphere with sufficient speed to cross interstellar space to other systems before the spores can be destroyed.

Sir Fred Hoyle (1915ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Å"2001) and Chandra Wickramasinghe (born 1939) were important proponents of the hypothesis who further contended that lifeforms continue to enter the Earth's atmosphere, and may be responsible for epidemic outbreaks, new diseases, and the genetic novelty necessary for macroevolution. This extension has also been adopted by proponents of Cosmic ancestry.

Panspermia per se does not remove the need for life to originate somewhere, but does extend the time frame and environments available. Similarly, it does not necessarily suggest that life originated only once and subsequently spread through the entire Universe, but instead that once started it may be able to spread to other environments suitable for replication. (In the strongest version of panspermia, life never originated, but always existed ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Â this axiom would require amending the big bang theory.) The mechanisms proposed for interstellar panspermia are hypothetical and currently unproven. Interplanetary transfer of material is well documented, as evidenced by meteorites of Martian origin found on Earth. However, claims that these carry evidence of extraterrestrial lifeforms ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Â let alone viable dormant lifeforms ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Â have either been proven unfounded as a result of terrestrial contamination, misinterpretation, or hoaxing; or are currently hotly disputed.

Interestingly, space probes may also be a viable transport mechanism for interplanetary cross-pollination in our solar system (or even beyond). However, NASA has implemented strict abiotic procedures to avoid planetary contamination.

Evidence

Until a large portion of the galaxy is surveyed for signs of life or contact is made with other civilizations, the panspermia hypothesis in its fullest meaning will remain difficult to test. There is, however, circumstantial evidence for exogenesis:

The Precambrian fossil record indicates that life appeared soon after the Earth was formed. This would imply that life appears within several hundred million years when conditions are favorable.

* Generally accepted scientific estimates of the age of the Earth place its formation (along with the rest of the Solar system) at about 4.55 Ga.
* The oldest known sedimentary rocks are somewhat altered Hadean formations from the southern tip of Akilia island, West Greenland. These rocks have been dated as no younger than 3.85 Ga. The

Greenland sediments include banded iron beds, thought to be the result of oxygen released by photosynthetic organisms combining with dissolved iron to form insoluble iron oxides. Carbon deposits in the rock show low levels of carbon-13. Kerogen deposits (derived from organic matter) are isotopically light (i.e. more negative ÃƒÅ½Ã‚Â´13C values) which is indicative of photosynthesis (see Schidlowski, 1988). However, this interpretation is under doubt as the Akilia rocks have undergone high-temperature metamorphosis which is known to be fractionating itself (Gilmour & Wright, 1997). There is also a lack of corroborating sulphur isotope fractionation (Nisbet, 2000). Both the sedimentary origin and the carbon content of the rocks have been questioned (Lepland et al, 2005).
* Fossilized stromatolites or bacterial aggregates, the oldest of which are dated at 3.5 billion years old, suggest that photosynthesis might be exogenic. The bacteria that form stromatolites, cyanobacteria, are photosynthetic. Most models of the origin of life have the earliest organisms obtaining energy from reduced chemicals, with the more complex mechanisms of photosynthesis evolving later.
* During the Late Heavy Bombardment of the Earth’s Moon about 3.9 Ga (as evidenced by Apollo lunar samples) impact intensities may have been up to 100x those immediately before or after (Cohen et al., 2000). From analysis of lunar melts and observations of similar cratering on Mars’ highlands, Kring and Cohen (2002) suggest that the LHB was caused by asteroid impacts that affected the entire inner solar system. This is likely to have effectively sterilised Earth’s entire planetary surface, including submarine hydrothermal systems that would be otherwise protected (Cohen et al., 2000).
* The best estimate of the origin of the Universe, from the Wilkinson Microwave Anisotropy Probe, is 13700 million years ago (13.7 Ga). However, at least one subsequent cycle of star birth/death is required for nucleosynthesis of the C, N and O essential to life, and this

process may have taken up to several Ga to produce sufficient quantities (Gilmour et al., 1997). This puts the earliest possible emergence of life in the Universe at ~12.7 Ga, although there is large uncertainty in the length of the necessary time period.

If life originated on Earth it did so in a window of at most 1 Ga (4.55 Ga to 3.5 Ga), most plausibly 400 Ma (3.9 Ga to 3.5 Ga), and possibly <100 Ma (3.9 Ga to 3.85 Ga) if the Greenland (3.85 Ga) isotope signal is correct. If life originated elsewhere, the window expands to ~9 Ga. That full length of time might not be available on a single planet, but the Earth has provided a life-friendly environment for at least 3.5 Ga.

Extremophiles

Evidence has accumulated that some bacteria and archaea are more resistant to extreme conditions than previously recognized, and may be able to survive for very long periods of time even in deep space. These extremophiles could possibly travel in a dormant state between environments suitable for ongoing life such as planetary surfaces.

* Bacteria and more complex organisms have been found in more extreme environments than thought possible, such as black smokers or oceanic volcanic vents. Some extremophile bacteria have been found living at temperatures above 100 Ãƒâ€šÃ‚Â°C; A study revealed that a fraction of bacteria survive heating pulses up to 250 degrees C in vacuum, while similar heating at normal atmospheric pressure leads to the total sterilization of samples. Other bacteria can thrive in strongly caustic environments, and others at extreme pressures 11 km under the ocean.
* Semi-dormant bacteria found in ice cores over a mile beneath the Antarctic lends credibility to the idea that the components of life might survive on the surface of icy comets.
* There are bacteria that do not rely on photosynthesis for energy. In

particular, endolithic bacteria using chemosynthesis have been found inside rocks and in subterranean lakes.
* Deinococcus radiodurans is a radioresistant bacterium that can survive high radiation levels.
* Dormant bacteria have been isolated from insects in amber 10s Ma old.
* Recent experiments suggest that if bacteria were somehow sheltered from the radiation of space, perhaps inside a thick meteoroid, they could survive dormant for millions of years.
* Duplicating the harsh conditions of cold interstellar space in their laboratory, NASA scientists have created primitive cells that mimic the membranous structures found in all living things. These chemical compounds may have played a part in the origin of life.

Spores

Spores are another potential vector for transporting life through inhospitable and inimical environments, such as the depths of interstellar space. Spores are produced as part of the normal life cycle of many plants, algae, fungi and some protozoans, and some bacteria produce endospores or cysts during times of stress. These structures may be highly resilient while metabolically inactive, and some can function when favorable conditions are restored after exposure to radiation, temperature extremes, desiccation, or other conditions fatal to the parent organism.

Wider range of potential habitats for life

Another line of evidence comes from research that shows there are many more potential habitats for life than Earth-like planets.

* The presence of past liquid water on Mars, suggested by river-like formations on the red planet, was confirmed by the Mars Exploration Rover missions. In December of 2006, Michael C. Malin of Malin Space Science Systems published a paper in the journal Science which argued that his camera (the Mars Observer Camera) had found

evidence suggesting water was occasionally flowing on the surface of Mars within the last five years.
* Water oceans might exist on Europa, Enceladus, Triton and perhaps other moons in the Solar system. Even moons that are now frozen ice balls might earlier have been melted internally by heat from radioactive rocky cores. Bodies like this may be extremely common throughout the Universe. Lake Vostok in Antarctica, which has been sealed for millions of years, and which may contain unusual life or be sterile, is a possible testing ground for ways to explore these moons.
* Bacteria have been discovered living within warm rock deep in the Earth's crust.

Evidence of extraterrestrial life

Although clearly speculative, the majority view in the scientific community seems to be an acceptance that the existence of life elsewhere in the Universe is highly probable due to the sheer number of potential sites where life could take hold. Today's estimates of values for the Drake Equation suggest the probability of intelligent life in a single galaxy like our own Milky Way may be much smaller than once was thought while the sheer numbers of galaxies in our Universe make it seem inevitable somewhere nevertheless. Space travel over such vast distances would be limited to below the speed of light by the theory of relativity alone, taking such an incredibly long time to the outside observer, with vast amounts of energy required. Nevertheless small groups of researchers like the Search for Extra-Terrestrial Intelligence (SETI) continue to monitor the skies for transmissions from within our own galaxy at least.

Moreover, the expanded Drake equation of astrobiological proponents like the Rare Earth hypothesists reduces this probability further still. They argue that the conditions required for the evolution of complex multicellular life here on Earth ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Å“

and therefore by extension intelligent life ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Å“ may be exceedingly rare in the universe whilst simultaneously conceding that simple single-celled microorganisms might well be abundant.

Still under investigation/undetermined

* The Red Rain of Kerala. In 2003, Satyanarayana et al. proposed that the rain was coloured red by a dust cloud from the Persian Gulf.Ãƒâ€šÃ‚Â Their paper was then published in Aerosol Science and Technology. Dr. Godfrey Louis has analyzed the dust and reported finding spores that he has hypothesised are of extraterrestrial origin. In April 2006, Louis published his findings in Astrophysics and Space Science. Louis claimed that the red particles "reproduce plentifully", and that they did so even in "water superheated to nearly 300 Ãƒâ€šÃ‚Â°C".

* A meteorite originating from Mars known as ALH84001 was shown in 1996 to contain microscopic structures resembling small terrestrial nanobacteria. When the discovery was announced, many immediately conjectured that the fossils were the first true evidence of extraterrestrial life ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Â making headlines around the world, and even prompting U.S. President Bill Clinton to make a formal televised announcement to mark the event. As of 2003 however, most experts agree that these are not indicative of life, but may instead be formed abiotically from organic molecules. It has not yet conclusively been shown how they formed and recent advances in nanobe research has made the find interesting again.

* An Indian and British team of researchers led by Chandra Wickramasinghe reported evidence at the 46th annual meeting of the International Society for Optical Engineering (SPIE) in San Diego, California on April 29, 2001 that air samples gathered from the stratosphere by the Indian Space Research Organization contained clumps of living cells. Wickramsinghe calls this "unambiguous

evidence for the presence of clumps of living cells in air samples from as high as 41 kilometers, well above the local tropopause, above which no air from lower down would normally be transported". A reaction report at NASA Ames indicated skepticism towards the premise that Earth life cannot travel to and reside at such altitudes, but noted that some microbes can remain dormant for millions of years, possibly long enough for an interplanetary voyage. Max Bernstein, a space scientist associated with SETI and Ames, argues the results should be interpreted with caution, noting that "it would strain one's credulity less to believe that terrestrial organisms had somehow been transported upwards than to assume that extraterrestrial organisms are falling inward".

* On May, 2001, two researchers from the University of Naples claimed to have found live extraterrestrial bacteria inside a meteorite. Geologist Bruno D'Argenio and molecular biologist Giuseppe Geraci claim the bacteria were wedged inside the crystal structure of minerals, but were resurrected when a sample of the rock was placed in a culture medium. They believe that the bacteria were not terrestrial because they survived when the sample was sterilized at very high temperature and washed with alcohol. They also claim that the bacteria's DNA is unlike any on Earth. They presented a report on May 11, 2001, concluding that this is the first evidence of extraterrestrial life, documented in its genetic and morphological properties. Some of the bacteria they discovered were found inside meteorites that have been estimated to be over 4.5 billion years old, and were determined to be related to modern day Bacillus subtilis and Bacillus pumilus bacteria on Earth but appears to be a different strain.

* Narlikar et al. (2003) took air samples at 41 km over Hyderabad, India ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Â above the tropopause where mixing from the lower atmosphere is unexpected ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Â from which rod and coccoid bacteria were isolated. Two bacterial

and one fungal species were later independently isolated from these filters which were identified as Bacillus simplex, Staphylococcus pasteuri and Engyodontium album respectively (Wainwright, 2003).

The experimental procedure suggested that these were not the result of laboratory contamination, although similar isolation experiments at separate laboratories were unsuccessful. That these are common terrestrial organisms is not necessarily contraindicative of panspermia, since a prediction of the hypothesis is that life throughout the Universe is derived from the same ancestral stock. Assuming they are not contaminants, did the micro-organisms come from the Earth or space? That there were no volcanic eruptions ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Â the only known way for terrestrial particles to mix up beyond the tropopause ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Â prior to sampling suggests against a terrestrial source. In either case, Wainright (2003) points out that some part of the panspermia hypothesis is validated: either terrestrial micro-organisms are indeed derived from space, or they are capable of contaminating our local space in a viable form. Measuring the isotope ratios of carbon and nitrogen in the micro-organisms from the stratosphere could reveal whether they come from Earth or space.

* Of three biological experiments on the Mars lander Viking, two gave results that were initially indicative of life. However, the similar results from heated controls, how the release of indicative gas tapered off, and the lack of organic molecules in soil samples all suggest that the results were the result of an abiotic chemical reaction rather than biological metabolism. Later experiments showed that terrestrial clays could reproduce the results of the two positive Viking experiments. Despite this, some of the Viking experiments' designers remain convinced that they are diagnostic for life.

Widely discounted

* A NASA research group found a small number of Streptococcus mitis bacteria living inside the camera of the Surveyor 3 spacecraft when it was brought back to Earth by Apollo 12. They believed that the bacteria survived since the time of the craft's launch to the moon. However, these reports are no longer tenable: see Reports of Streptococcus mitis on the moon.

* Over the past century thousands of people have reported UFO sightings in countries all over the world. Nevertheless, these reports have caused disagreements among experts as to their validity, and no widely accepted evidence has yet been published in mainstream scientific writings to suggest that intelligent alien species have ever visited the Earth.

Falsified

* In 1962, Claus et al. announced the discovery of 'organised elements' embedded in the Orgueil meteorite. These elements were subsequently shown to be either pollens (including that of ragwort) and fungal spores (Fitch & Anders, 1963) that had contaminated the sample, or crystals of the mineral olivine.

* In 2002, the discovery of glycine (the simplest amino acid) in interstellar clouds was reported. Subsequent investigation has refuted these claims.

Hoaxes

* A separate fragment of the Orgueil meteorite (kept in a sealed glass jar since its discovery) was found in 1965 to have a seed capsule embedded in it, whilst the original glassy layer on the outside remained undisturbed. Despite great initial excitement, the seed was found to be that of a European Juncaceae or Rush plant that had been glued into the fragment and camouflaged using coal dust. The outer 'fusion layer' was in fact glue. Whilst the perpetrator of this hoax is unknown, it is thought he sought to influence the 19th century debate on spontaneous generation ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Â rather

than panspermia Ãƒâ¢Ã¢â€šÂ¬Ã¢â,¬Â by demonstrating the transformation of inorganic to biological matter.

Objections to panspermia and exogenesis

* Life as we know it requires heavy elements carbon, nitrogen and oxygen (C, N and O, respectively) to exist at sufficient densities and temperatures for the chemical reactions between them to occur. These conditions are not widespread in the Universe, so this limits the distribution of life as an ongoing process. First, the elements C, N and O are only created after at least one cycle of star birth/death: this is a limit to the earliest time life could have arisen. Second, densities of elements sufficient for the formation of more complex molecules necessary to life (such as amino acids) only occur in molecular dust clouds (109Ãƒâ¢Ã¢â€šÂ¬Ã¢â,¬Å"1012 particles/mÃƒâ€šÃ,Â³), and (following their collapse) in solar systems. Third, temperatures must be lower than those in stars (elements are stripped of electrons: a plasma state) but higher than in interstellar space (reaction rates are too low). This restricts ongoing life to planetary environments where heavy elements are present at high densities, so long as temperatures are sufficient for plausible reaction rates. Note this does not restrict dormant forms of life to these environments, so this argument only contradicts the widest interpretation of panspermia Ãƒâ¢Ã¢â€šÂ¬Ã¢â,¬Â that life is ongoing and is spread across many different environments throughout the Universe Ãƒâ¢Ã¢â€šÂ¬Ã¢â,¬Â and presupposes that any life needs those elements, which the proponents of alternative biochemistries do not consider certain.

* Space is a damaging environment for life, as it would be exposed to radiation, cosmic rays and stellar winds. Studies of bacteria frozen in Antarctic glaciers have shown that DNA has a half-life of 1.1 million years under such conditions, suggesting that while life may have potentially moved around within the Solar System it is unlikely

that it could have arrived from an interstellar source. Environments may exist within meteors or comets that are somewhat shielded from these hazards.

* Bacteria would not survive the immense heat and forces of an impact on Earth ÃƒÂ¢Ã¢â€šÂ¬Ã¢â‚¬Â no conclusions (whether positive or negative) have yet been reached on this point. However most of the heat generated when a meteor enters the Earth's atmosphere is carried away by ablation and the interiors of freshly landed meteorites are rarely heated much and are often cold. For example, a sample of hundreds of nematode worms on the space shuttle Columbia survived its crash landing from 63 km inside a 4 kg locker, and samples of already dead moss were not damaged. Though this is not a very good example, being protected by the man-made locker and possibly pieces of the shuttle, it lends some support to the idea that life could survive a trip through the atmosphere. The existence of Martian meteorites and Lunar meteorites on Earth suggests that transfer of material from other planets to Earth happens regularly.

* Occam's Razor implies that when developing a hypothesis, we should avoid making evidentially unsupported presumptions about things if at all possible. See heuristic arguments. From this perspective, geogenesis appears to be the default assumption when compared with panspermia or exogenesis. The former assumes a single step: that life originated on Earth, where it is now commonly observed, excluding the presumption that life formed elsewhere, in places where it has never been observed before. Geogenesis eliminates the unsupported presumption of life existing beyond the Earth, but requires a lot to happen in a relatively short time frame in order for life to arise. Exogenesis allows for a longer period of time than could be offered on Earth. Given that an understanding of life's emergence remains speculative, however, the perception of which presumption (life beyond Earth or life emerging rapidly) is

preferable can be less than clear.

* Supporters of exogenesis also argue that on a larger scale, for life to emerge in one place in the Universe and subsequently spread to other planets would be simpler than similar life emerging separately on different planets. Thus, finding any evidence of extraterrestrial life similar to ours would lend credibility to exogenesis. However, this again assumes that the emergence of life in the entire Universe is rare enough as to limit it to one or few events or origination sites. Exogenesis still requires life to have originated from somewhere, most probably some form of geogenesis. Given the immense expanse of the entire Universe, there is a higher probability that there exists (or has existed) another Earth-like planet that has yielded life (geogenesis) than not. This explanation is more preferred under Occam's Razor than exogenesis since it theorizes that the creation of life is a matter of probability and can occur when the correct conditions are met rather than in exogenesis that assumes it is a singular event or that Earth did not meet those conditions on its own. In other words, exogenesis theorizes only one or few origins of life in the Universe, whereas geogenesis theorizes that it is a matter of probability depending on the conditions of the celestial body. Consider that even the most rare events on Earth can happen multiple times and independent of one another. However, since to date no extraterrestrial life has been confirmed, both theories still suffer from lack of information and too many unidentified variables.

Directed Panspermia

A second prominent proponent of panspermia was the late Nobel prize winner Professor Francis Crick, OM FRS, who along with Leslie Orgel proposed the theory of directed panspermia in 1973. This suggests that the seeds of life may have been purposely spread by an advanced extraterrestrial civilization. Crick argues that small grains containing DNA, or the building blocks of life, fired randomly in all directions is the best, most cost effective strategy for seeding life on a compatible planet at some time in the future. The strategy might have been pursued by a civilization facing catastrophic annihilation, or hoping to terraform planets for later colonization. Later, after biologists had proposed that an "RNA world" might be involved in the origin of life, Crick noted that he had been overly pessimistic about the chances of life originating on Earth.

Directed panspermia in reverse, from Earth to new solar systems, has been proposed to expand life in space. For example, microbial payloads launched by solar sails at speeds up to 0.0001 c (30,000 m/s) would reach targets at 10 to 100 light-years in 0.1 million to 1 million years. Fleets of microbial capsules can be aimed at clusters of new stars in star-forming clouds where they may land on planets, or captured by asteroids and comets and later delivered to planets. Payloads may contain extremophiles for diverse environments and cyanobacteria similar to early microorganisms. Hardy multicellular organisms (rotifer cysts) may be included to induce higher evolution.

The probability of hitting the target zone can be calculated from $P(target) = \frac{A(target)}{\pi (dy)^2} = \frac{a r(target)^2 v^2}{(tp)d^4}$ where A(target) is the cross-section of the target area, dy is the positional uncertainty at arrival; a – constant (depending on units), r(target) is the radius of the target area; v the velocity of the probe; (tp) the targeting precision (arcsec/yr); and d the distance to the target (all units in SIU). Guided by high-resolution astrometry of 1ÃƒÆ'Ã¢â‚¬â€10ÃƒÂ¢Ã‹â€ Ã¢â‚¬â„¢5 arcsec/yr, almost nearby target stars (Alpha PsA, Beta Pictoris) can be seeded by milligrams of launched microbes; while seeding the Rho Ophiochus star-forming cloud requires hundreds of kilograms of dispersed capsules. The figure shows the launching of solar sail ships with effective thicknesses that will achieve final velocities as shown. The figure also shows the dispersion and capture of the microbial payload at the target solar system.

Directed panspermia is altruistic and may be motivated by life-centered ÃƒÂ¢Ã¢â€šÂ¬Ã…â€œpanbiotic ethicsÃƒÂ¢Ã¢â€šÂ¬Ã‚Â that aims to secure and propagate our form of gene/protein organic life, and to establish life as a controlling force in nature.

Theoretically, by humans traveling to other celestial bodies such as the moon, there is a chance that they carry with them microorganisms or other organic materials ubiquitous on Earth, thus raising the curious possibility that we can seed life on other planetary bodies. The same can be said for unmanned probes manufactured on Earth. This is a concern among space researchers who try to prevent Earth contamination from distorting data, especially in regards to finding possible extraterrestrial life. Even the best sterilization techniques can not guarantee that potentially invasive biologic or organic materials will not be unintentionally carried along. So far, however, in the limited amount of space exploration conducted by humans, “terrestrial pollution” does not appear to be a problem although no concrete studies have investigated this. The harsh environments encountered throughout the rest of the solar system so far do not seem to support complex terrestrial life. However, it should be noted that matter exchange in form of meteor impacts has existed and will exist in the solar system even without human intervention. As evidence, some argue that anomalies found within Martian meteorite ALH 84001 indicate that bacteria could travel from planet to planet without intelligent help.

Deliberate directed panspermia would seed space objects. The securing of future life would need to balance against interference with science. This interference can be minimized by targeting remote solar systems where life would not have evolved yet. Seeding a few hundred young solar systems would secure future life while leaving billions of stars pristine for exploration.

There exists speculation on a connection to the Titius-Bode Law, arguing that Earth may have received seeds of life by directed panspermia, because the extraterrestrial senders knew that Earth belonged to a solar system with stable Titius-Bode structure. See: External Link “Directed Panspermia and Titius-Bode”

Recent Experiment

After enduring a 12-day orbital mission and a fiery reentry, an unmanned spacecraft, Foton-M3, awaits retrieval in a field in Kazakhstan. The 5,500-pound capsule, seven-feet in diameter, housed experiments testing the lithopanspermia theory. The capsule contained, among other things, lichen that were exposed to the radiation of space. Scientists also strapped basalt and granite disks riddled with cyanobacteria to the capsule’s heat shield to see if the microorganisms could survive the brutal conditions of reentry. Alas, this batch didn’t arrive alive but the scientists believe that it was at a disadvantage.

“When compared to a real meteorite,” says Rene Demets, the European Space Agency’s coordinator for space biological experiments for this mission, “the heat penetrates quite deeply into our test samples”.

Panspermia References

http://mensnewsdaily.com/2008/06/20/panspermia-theory-for-lifes-origins-gets-boost-from-top-scientists/