A REVIEW OF EXOBIOGENESIS THEORIES

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Abstract

Many evolutionists have concluded that all existing naturalistic origin of life hypotheses are highly untenable. Consequently, some prominent evolutionists have hypothesized an alternate origin of life theory called exobiogenesis, or the theory that life evolved elsewhere in the universe and was carried to earth. Those who reject both the theistic world view and the possibility of abiogenesis on the ancient earth must assume a set of conditions existed elsewhere in the solar system or the universe which were more favorable for the origin of life or biological molecules. Recognizing that conditions on earth historically precluded the spontaneous origin of life forces exploring exobiogenesis to maintain the naturalistic world view. This view has also motivated the reintroduction of an intelligent design theory called directed panspermia. Nowhere does the literature reveal as vividly the impossibility of a naturalistic origin of life on the earth than in this field. The fact that an entirely hypothetical scenario has been proposed in a theory which is supported by virtually no empirical evidence forces a review of the major exobiogenesis theories.

Introduction

Exobiogenesis, the study of the role of organic molecules from outer space in causing the origin of life on earth, is receiving increased discussion in both scientific and popular media. The term exobiology was coined by Joshua Lederberg and refers to the study and distribution of life in the universe. The three basic types of exobiogenesis are, the delivery to earth of *complete* organisms such as bacteria, the delivery of *complex organic* molecules, and the delivery of *simple organic* molecules which synthesize on their way to earth from energy sources such as ultraviolet light or electrical discharges, or as a result of impact shocks (Chyba and Sagan, 1992, p. 125). One theory speculates that during a past heavy bombardment of the earth, which is postulated to have resulted from the collision of the earth with planetesimals left over from our solar system's planetary formation 3.5 billion years ago, may "have had important consequences for the origin of life" on earth (Chyba and Sagan, 1992, p. 125). Modern researchers are also exploring ideas such as the seeds of life came from dust clouds which the earth had at one time passed through during its orbit around the sun:

> Earth in orbit sweeps up some 16,000 tons of interplanetary matter each year, much of it the remnants of decaying comets. Are new life forms present in this stellar gift? Did viruses evolved in comets or interstellar dust bring novel genes to influence earthly evolution? Did earth's life itself evolve from these cosmic seedings? (Cowen 1978, p. 6).

Specifically, it is theorized that during the bombardment of earth, volatile-rich impactors may have delivered essential 'biogenic' elements to our terrestrial surface. Moreover, since comets, carbonaceous asteroids, and interplanetary dust particles (IDPs) are rich in organic molecules, some speculate these sources may also have contributed directly to terrestrial prebiotic inventories. The force of the impact of these compounds with the earth may have shock synthesized some organics in the atmosphere (Chyba and Sagan, 1992, p. 125). Some simple organic molecules can remain intact if caught in dust particles small enough to decelerate them sufficiently to prevent significant pyrolysis (chemical break down by heat). Many have taken this as evidence that complex organic molecules, or even bacteria could likewise have survived an eons long trip from outer space. This paper reviews exobiogenesis theory involving the delivery of both simple and complex organic molecules to the earth, and the motivation behind current speculations in this field.

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The Types of Exobiogenesis

The two basic classes of exobiogenesis are the theories that life arrived on earth from outer space either from extraterrestrial molecules which later evolved on earth, or as developed life in the form of seeds, bacteria or of other organisms, the latter idea called panspermia. The two main types of panspermia (which is from the Greek, and means "seeds everywhere") are: *Deliberate* or *Directed Panspermia* — the conclusion that the seeds of life deliberately were brought to earth by beings from other planets, and *Accidental Panspermia* — the position that simple forms of life accidentally were carried here by comets, meteorites or even from garbage left by past space visitors (Gold, 1960, p. 65).

The History of Exobiogenesis Theories

The theory of exobiogenesis has a long history, dating back to the ancient Romans and Greeks. The modern panspermia theory was probably originated by the nineteenth century Swedish chemist Svante Arrhenius (1859-1927), a Nobel laureate who concluded that life must have come from outer space because it could not have begun on earth by naturalistic means (Arrhenius, 1908). He speculated that the earth was seeded by spores that came from another planetary system and which adhered to specks of dust propelled by light waves from stars. As a consequence, life was diffused throughout the universe and took hold where it could exist, including possibly Mars (Asimov, 1972). Scottish physicist Lord Kelvin (1824-1907) argued that, "seed-bearing meteoric stone from another world started life on earth" (Brush, 1982, p. 12). Other past panspermia advocates include Enrico Fermi, the Nobel laureate who designed and constructed the first atomic pile that ushered in the atomic age, and the Hungarian Nobel laureate Leo Szilard who eventually became professor of biophysics at the University or Chicago. Even the first great defender of evolution, Thomas Henry Huxley (1825-1895), speculated that some type of panspermia could have been the source of all life on earth.

Jules Verne's novel, *From the Earth to the Moon* (1865) and H. G. Wells: *The War of the Worlds* (1898), both served as catalysts to encourage exploring the possibility of life in outer space in our century. More recently, the popular 1950s *Flash Gordon* television show, and now *Star Trek, Star Wars,* Carl Sagan's highly acclaimed *Cosmos* series and Sir Fred Hoyle's novel *Black Cloud,* all have made the life-from-other-worlds idea feasible in the minds of much of the public. Much science fiction has eventually become science fact—journeying to the moon, for example—and this should not surprise us. Science fiction writers are often scientists by profession, or at least trained in a science field at the graduate level. The best known examples are Isaac Asimov, a biochemistry Ph.D., and H. G. Wells, a biologist. Writing good science fiction requires both a grasp of science and a vivid imagination. Exobiogenesis is one of the latest science fictions which is fast becoming respectable science theory (Lawren, 1989).

Christian (1986, p. 364) observes that hundreds of thousands of comets exist and, if life exists throughout the universe, it could have been carried here by this means. Many scientists are currently actively testing this theory in the lab and on computers (Lawren, 1986, p.32). Hoyle hypothesizes that life originated in space and migrated by chance to earth by comets, meteorites, or even dust clouds. Some speculate that a meteorite trade between earth and Mars may have seeded the later planet, and these spores may have flourished on Mars when water freely flowed there (Lawren, 1986, p. 37). This conclusion is unlikely though, because, in Phinny's words, "the conditions on Mars are sufficiently extreme that any microbes that survived the trip in space would probably be killed on its desolate surface (quoted in Eberhart, 1989, p. 191).

The Reasons for the Exobiogenesis Theory

Some scientists, after noting the level of evidence against the theory of the spontaneous generation of living molecules on earth, have concluded that life must have come from outside our solar system. For example:

> Miller, who after almost four decades is still in hard pursuit of life's biggest secret, agrees that the field needs a dramatic finding to constrain the rampant speculation. . . . "I come up with a dozen ideas a day, and I usually discard"—he reflects for a moment—"the whole dozen." . . . Unlike some origin-of-life theorists, Cairns-Smith cheerfully admits the failings of his pet hypothesis: no one has been able to coax clay into something resembling evolution in a laboratory; nor has anyone found anything resembling a clay-based organism in nature. Yet he argues that no theory requiring organic compounds to organize and replicate without assistance is likely to fare any better. . . . There is one other way out of this frustrating theoretical impasse. If neither the atmosphere nor vents provide a likely locale for the synthesis of complex organic compounds, maybe they were imported from somewhere else: outer space. Joan Urò of the University of Houston raised this possibility as early as the 1960s (Horgan, 1991, p. 125-126).

It is only one step farther to assume that organic molecules or even "simple" life came to earth in this way. Likewise it has "long been speculated that earth accreted prebiotic organic molecules important for the origins of life from impacts of carbonaceous asteroids and comets" during past major comet-asteroid showers (Chyba et al. 1990, p. 366). Since some eminent scientists have championed this theory, it has now achieved surprising credibility among respected scientists.

> . . . Drs. Hoyle and Wickramasinghe in developing the concept of the cosmic cradle [have based] . . . their theory partly on their own interpretation of the infrared signatures of some space chemicals [and because] they reject Darwin's warm shallow pond or Stanley Miller's and Harold Urey's lightning-created chemical mixtures as birthplaces or organic life. "The concept of primeval soup," Dr. Wickramasinghe remarked in an interview, "is just a confidence trick which people have bought without much critical analysis. It would be too dilute for anything to happen" (Cowen, 1978, p. 6).

Astronomers Chandra Wickramasinghe and Sir Fred Hoyle have written more about this topic than any other researchers. Their books on the subject include *Lifecloud, Diseases From Space, Evolution From Space,* and *From Grains to Bacteria.* Adler's summary of Hoyle's view that:

> . . . primitive living cells originated in comets and were "seeded" on earth early in its history. In Lifecloud he also pointed out that earthly organisms are strangely out of tune with conditions in the rest of our solar system; the wavelengths of light that chlorophyll uses most efficiently, for example, are not these in which the sun's spectrum is concentrated. Such speculation . . . has led Hoyle to exactly the view that seemed self-evident in the Middle Ages: that life did not arise spontaneously on earth (1982, p. 55).

Other mainline scientists who advocate the theory that the origin of life is from outer space via rocket ships, comets, or similar vehicles, or at least conclude that the theory has merit, include Francis Crick. In 1962 he shared the Nobel Prize with James D. Watson for his deoxyribonucleic acid (DNA) research, a substance that had previously been identified as the master molecule of heredity (Lear, 1978; Watson, 1968). In 1953 he and his co-workers demonstrated the now famous *double helix molecular structure* carries the four base code that forms the blueprint which directs the cell's polypeptide construction. Their discovery spawned the now famous genetic revolution, including gene mapping technology, recombinant DNA, and gene therapy (Crick, 1981).

Yet other prominent scientists who have publicly stated Panspermia has merit include *Salk Institute for Biological Studies* researcher Leslie Orgel, University of Toledo astrophysicist Armand Delsemme; Joan Orò, professor of biochemical and biophysical sciences at the University of Houston, and Harvard astrophysicist Brian Marsden (Cowen 1978). University of California's Gustav Arrhenius and Richard Gammon of the National Radio Astronomy Observatory "suggested that solar nebula seeded earth with life-forming chemicals" (Cowen, 1978, p. 6). Flindt and Binder (1974) advocated a similar theory as did Von Daniken (1969) and Cohane (1977). NASA expert Maurice Chatelain (1978) even concludes that the only way to understand earth history is to postulate some visitation from outer space which started the events that he concludes caused "the sudden evolution" which eventually produced humans.

Ginsburgh (1975) theorizes that the first humans arrived on earth via a spacecraft that landed about 6,000 years ago. The evidence he uses to support his theory includes the well documented knowledge that many of the earliest known civilizations were highly advanced and have enjoyed from their very beginning highly developed religion, culture and language, both written and spoken. He notes the time before these advanced civilizations existed, about 6,000 years ago, is called "pre-history" because virtually nothing is known today about this period. Creationists view this as an inadequate attempt to interpret the facts of history without a creator.

According to Jaroff, Crick and most other proponents concluded that existing abiogenesis evolution theories are untenable, partly because the primeval soup was far too dilute for significant biological activity to occur.

> A decade ago the restless Crick . . . began stalking the greatest secret of all: the origin of life itself. Along with other biologists, Crick was troubled by the prevailing explanations of how life began on earth. In 1973, he and Leslie Orgel. . . published an article in the journal *Icarus* theorizing that life on earth originated with micro-organisms sent by rockets from another planet in our galaxy. They call this act of deliberate seeding "Directed Panspermia" (1981, p. 62).

Their research also caused them to "dismiss" neo-Darwinism especially Darwin's "warm shallow pond" theory and Stanley Miller's and Harold Urey's lightning-created chemical mixtures in the earth's oceans as the birth place of organic life (Cowen, 1978, p. 6) and to conclude:

> that evolution has been guided not by natural selection but by repeated invasions of 'cosmic genes,' [and] insects in particular . . . are such successful predators and so resistant to human attack that they must be alien invaders, perhaps carrying out the plan of a higher intelligence (Kunzig, 1988, p. 68).

Atmospheric research and other developments also caused a major shift from abiogenesis on earth to exobiogenesis as explained by NASA researcher Chyba:

> . . . the production of organics on earth depends on the details of earth's primitive atmosphere. Once again, scientists are hindered by a lack of data. About forty years ago, when the first key experiments on organic production in early terrestrial atmospheres were performed, scientists thought earth's earliest atmosphere consisted of methane and ammonia. . . But most geochemists no longer think that earth's early atmosphere consisted of methane and ammonia. The composition of the atmosphere of early earth was governed by the chemistry of earth's mantle and crust, and the clues we have about this chemistry now point toward an early atmosphere rich in carbon dioxide and molecular nitrogen, not methane and ammonia. In this case, laboratory experiments have shown that it is vastly more difficult to synthesize organics in earth's atmosphere. So it is exactly in this case where the extraterrestrial sources loom in importance. In this less hospitable kind of atmosphere, IDPs could have been the dominant source of organics on early earth (Chyba, 1992, pp. 34-35).

Among the many reasons for the new theory, Johnson suggests the following:

> Assuming away the difficult points is one way to solve an intractable problem; another is to send the problem off into space. That was the strategy of one of the worlds most famous scientists, Francis Crick, codiscoverer of the structure of DNA. Crick is thoroughly aware of the awesome complexity of cellular life and the extreme difficulty of explaining how such life could have evolved in the time available on earth. So he speculated that conditions might have been more favorable on some distant planet (1991, p. 108).

Many other researchers have also expressed much dissatisfaction with the prevailing theories about how life originated on planet earth. They have concluded that, given what we know about the environment necessary for life, it could *never* have spontaneously generated here (Yockey, 1992; Thaxton, Bradley and Olsen, 1984). Both Aleksandr Oparin's theory of **Coacervates,** microstructures of water surrounded by a few proteins, and Sidney W. Fox's **proteinoid microspheres** theory have totally failed to bridge the stupendous gap between life and nonlife (Bergbauer, 1993, p. 8). Milner summarizes the exobiogenesis argument as follows:

> The conditions for the origin of life may have been better among the vast amount of organic matter he believes floats through interstellar space. Unimaginably immense quantities of chemical molecules colliding in space might make the rare and improbable combinations more likely, almost inevitable (1990, p. 354).

Consequently, researchers are looking elsewhere in search of a viable explanation for life's origin. And in so doing, Adler concluded:

> Probing the origins of life on earth, a biologist and an astronomer have performed the improbable feat of reinventing religion. Conventional science has invoked the workings of chemistry over almost limitless time to bring the order of life out of the planet's primitive chaos. But life seems to have begun rather quickly: the more scientists have looked, the further back they have found signs of life; the earliest fossil cells, . . . are almost as old as the solar system itself. Pondering such mysteries, Nobel Prize winning biologist Francis Crick and Sir Fred Hoyle, the distinguished astronomer, have independently supposed a *deus ex galaxia* to explain the sudden appearance of life on earth: the "seeding" of space by intelligent beings from distant corners of the universe (1982, p. 55).

Crick's book, the best seller *Life Itself*, has received mixed reviews—many scientists were extremely favorable; others, such as Niles Eldredge, were very critical. Eldredge (1981, p. 94) called Crick's book "nothing short of a disaster," partly because, as Eldredge concluded "Crick develops his notion of 'Directed Panspermia' unhampered by such pedestrian considerations of testability." Ironically, one of Eldredge's main criticisms of Crick's work was his tendency to see

> . . . science as an alternative to religion and [his lashing] out at "antiscientific fanatics" who fail to hearken to the clarion call of the twentieth century gurus of the West, the enlightened scientists. . . . Crick's characterization of religion as an amalgam of arcane, outmoded beliefs is intemperate in light of his own views on how life came to exist on the planet earth (1981, p. 94).

The fact that some of the greatest of the world's foremost scientists disagree to this extent on this topic illustrates how much we have yet to learn about life's origin.

> Coming from a lesser man, Directed Panspermia might well be written off as science fiction. But Crick is a giant among scientists, and his ideas are not taken lightly. While he concedes the weaknesses in his theory and does not hesitate to expound the strengths of others, he insists that Directed Panspermia is built on a foundation of scientific detail . . . Crick allows that he has several times sworn off further writing on the origin of life "because there is too much speculation running after two few facts:' but he confesses that "the subject is so fascinating that I never seem to stick to my resolve" (Jaroff, 1981, p. 62).

Recent Discoveries Relate to Exobiogenesis

A century of unprecedented scientific advancements finds scientists still arguing over the views that Jules Verne and H. G. Wells outlined in their science fiction, and scientists today do not seem to be any closer in arriving at a reasonably well supported theory of abiogenesis. As Adler observed, we are still "running after too few facts," and:

> Crick and Hoyle may have the most far-out hypothesis, but they are not alone in asking whether life on earth was made possible—or at least influenced—by objects from the far reaches of the solar system. Astrophysicist Armand Delsemme . . . believes that the stuff of living things—including hydrogen, carbon and oxygen—came from comets, which brought gas and organic material to lifeless, airless earth . . . (1982, p. 55).

This situation motivated Delbruck to state about existing abiogenesis and exobiogenesis theories:

> While all these theories seem quite plausible and very intelligent, in my opinion they tell us very little about the origin of life. I have made it my rule not to read this literature on prebiotic evolution until someone comes up with the recipe that says "Do this and do that, and in three months things will crawl in there." When someone is able to create life in a shorter time than was originally taken by nature, I will once more start reading that literature (1986, p. 31).

Frank and Huyghe (1990) have discovered evidence that each minute about 2,100 small comets consisting primarily of water and ice dump tons of water on the earth. If the evidence proves valid, our lakes and oceans must have been formed relatively recently, which poses serious problems for most existing naturalistic theories of life's origin. The implications for the current naturalistic origin of life scenario is obvious; without enormous quantities of water, most existing theories break down. Frank realizes that for this reason some type of exobiogenesis is the only savior of atheistic abiogenesis. An exogenesis is also argued for on the grounds that many of the biochemicals necessary for life could not have formed here, and thus must have had heir origin elsewhere. Consequently, in Frank's words many scientists "now believe that much of the organic molecules needed to create the first forms of life on earth could well have been brought in by comets that bombarded the planet early in its history" (1990, p. 56). He cites the work of a number of researchers who conclude that "a cometary bombardment could have brought in a hundred to a thousand times as much organic material as the earth itself would have produced photochemically during the same period" (1990, p. 56). And, the oxygen problem is likewise solved by this hypothesis,

> . . . it may be that these small comets provided not only the chemical seeds for life on earth, but the oxygen to protect it from the sun, as well as the marine incubator—the ocean—in which it could grow and thrive. That, in essence, would make us all the children of comets (1990, p. 57).

The tentative terminology used here is appropriate because no evidence yet exists that small comets were historically the source of large amounts of either complex organic molecules or oxygen, and we now have only controversial evidence that small comets today are bringing vast quantities of water and some simple organic compounds from outer space to earth (Marcus, 1991).

In an intriguing interview with William D. Hamilton of Oxford University by the senior editor of *New Republic*, science author Robert Wright reveals another reason for the attraction of exobiogenic theories. A theory of the universe "that I rather like," Hamilton says, is the idea that our planet is a "zoo for extraterrestrial beings" who planted the seeds for life, hoping to create interesting intelligent creatures. And these creatures watching the zoo here "every now and then . . . see something that doesn't look quite right . . . the zoo is going to kill itself off if we let you do this or that. So they insert a finger and just change some little thing. And maybe these are the miracles which the religious people like to so emphasize" (1992, p. 44). He recognizes that this view is fully speculation, yet states, "It is a kind of hypothesis that is very, very hard to dismiss . . . if I were setting up an aquarium. . . this is virtually the way I would do it. I would try to make as interesting an aquarium as I could. And I would try to make sure that this big fish didn't molest little fish too much. And I would occasionally insert a finger and try to stop him." The anthropomorphic projection here, and the parallels with a theological world view of a caring God who takes an active role in his creation, is obvious. The theory also answers the evidence that this intervention occasionally must have happened—there are too many disasters which were highly likely, but have never happened, and the fine tuning of the natural world often seems too precise to be natural. Hamilton, Wright claims, is "considered by some to be the most important evolutionary biologist of the second half of this century" (p. 44). In the words of Crick and Orgel, one of the strongest arguments for the exobiological origin of life is:

> The chemical composition of living organisms must reflect to some extent the composition of the environment in which they evolved. Thus the presence in living organisms of elements that are extremely rare on the earth might indicate that life is extraterrestrial in origin. Molybdenum is an essential trace element that plays an important role in many enzymatic reactions, while chromium and nickel are relatively unimportant in biochemistry. The abundance of chromium, nickel, and molybdenum on the earth are 0.20, 3.16, and 0.02%, respectively. We cannot conclude anything from this single example, since molybdenum may be irreplaceable in some essential reaction—nitrogen fixation, for example. However, if it could be shown that the elements represented in terrestrial living organisms correlate closely with those that are abundant in some class of star—molybdenum stars, for example—we might look more sympathetically at "infective" theories.
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> Our second example is the genetic code. Several orthodox explanations of the universality of the genetic code can be suggested, but none is generally accepted to be completely convincing. It is a little surprising that organisms with somewhat different codes do not coexist. The universality of the code follows naturally from an "infective" theory of the origins of life. Life on earth would represent a clone derived from a single extraterrestrial organism. Even if many codes were represented at the primary site where life began, only a single one might have operated in the organisms used to infect the earth 1973, pp. 344-345).

Another concern is the uncritical speculation that exobiogenesis has produced. North even concludes that exobiogenesis has influenced the speculation of persons such as Von Daniken:

> People who are not skilled scientists but who have come to believe in the doctrines of evolution are therefore easy targets for the Von Danikens of the world. Von Daniken seems to be able to answer questions that standard scientists cannot answer. How is it that mankind could have evolved so rapidly both technologically and philosophically? How is it that his intellect is so advanced compared to changes in his body? How is it that the mind of man seems to have evolved much more rapidly than changes in man's environment would have accounted for? Questions such as these baffled Alfred Russell Wallace, the cofounder of the doctrine of evolution through natural selection and led him into occultism and spiritism in the late nineteenth century. Similarly, modern readers are baffled by these obvious questions or variants of these obvious questions, and when they find that modern science has no answers, they easily pick up on pseudoscientific answers. Von Daniken's answer sold millions of copies (1986, p. 307).

Von Daniken has been a prolific and influential popular writer (1969, 1970, 1973, 1973a, 1974, 1982) his works having sold millions of copies and resulted in several films. Most scientists classify his works as unscholarly, often containing unfounded and unsupported speculation.

The Major Problems with Exobiogenesis

The most common objection to exobiogenesis is the fact that we simply *have no direct evidence* that any form of natural exobiogenesis has ever actually occurred. Panspermia is more speculative because it presumes both that life exists on other planets and that, given the right conditions, life is able spontaneously to generate itself there. The whole theory, as many of its critics point out, is almost purely speculation. Although several kinds of amino acids have evidently been found in meteorites, we have not detected evidence even for the simplest amino acid, glycine, in outer space, though astronomers "have looked like mad for glycine" (Kunzig, 1988, p. 7). The Murchison meteorite found in Murchison, Australia, "is rich in simple amino acids" and an estimated 300 tons of organic molecules annually fall to the earth, But no complex polypeptides or similar "organic" molecules have yet been found (Chyba, 1992, p. 30; Pendleton and Cruikshank, 1994).

Of the about one-hundred molecules identified by astrochemists in outer space, as is also true on earth, most are simple organic having up to only thirteen atoms (Pendleton and Cruikshank, 1994). The most complex example found so far is simple ethanol C_2H_6O) discovered in some outer space clouds—a finding which Kunzig states, "is not surprising [because] after hydrogen, helium and oxygen, carbon is the most abundant element in space" (1988, p. 70). Because of the major gaps in our knowledge of early earth conditions, the confidence of scientists in the exobiogenesis theory is mixed, as explained by NASA Ames Research Center scientist Chyba:

> The debate about the composition of earth's early atmosphere is far from settled. Remarkably, though, it appears that whatever the primitive atmosphere's exact nature, the heavy bombardment played an important role in stocking the primordial soup of organics available for the origin of life. If the atmosphere was methane and ammonia-rich, the heavy bombardment produced organics copiously by shock chemistry in the atmosphere. If the atmosphere was far less hospitable for organic chemistry, composed of carbon dioxide and nitrogen, say, then the asteroids and comets responsible for the heavy bombardment, and the ever-present interplanetary dust particles, may have played a key role by providing organic-rich dust to seed earth's ancient surface. Either way, the case for an important extraterrestrial connection for the origin of terrestrial life is too intriguing to ignore (Chyba, 1992, p. 35).

Although amino acids are the building blocks of protein, they are "rather simple substances" and a long way from most proteins. The amino acid leucine consists of only 22 atoms, whereas most proteins contain many thousands. Further Hoyle estimates that it requires 200,000 types of protein assembled in an incredibly complex way to make up a cell (1983, p. 12). The compounds found in outer space and in meteorites, while organic, are a long way from life, actually about as far as a bucket of bolts is from a Ferrari (Sandilands 1986,1986a). Labeling something an organic compound implies to the uninformed that it is a "living organism," or something close to it, when it is actually only *any compound that contains carbon and hydrogen* (Dorin, 1984). Carbon readily combines with most other elements—actually almost all known types of compounds are carbon based; over 10,000,000 are "organic' compared to only about 1,000,000 nonorganic. Iron is a necessary transport molecule for many forms of higher life; yet the discovery of iron on a planet would hardly prove that life was close to formation there. Crick and Orgel conclude:

> It now seems unlikely that extraterrestrial living organisms could have reached the earth either as spores driven by the radiation pressure from another star or as living organisms embedded in a meteorite. As an alternative to these nineteenth-century mechanisms, we have considered Directed Panspermia, the theory that organisms were deliberately transmitted to the earth by intelligent beings on another planet . . . [and] that it is possible that life reached the earth in this way, but . . . the scientific evidence is inadequate at the present . . . (1973, p. 341).

A major problem with explaining the origin of life by exobiogenesis is that it only moves the origin-of-life problem to another location, relocating elsewhere all unanswered questions to a place where they are almost impossible to answer (Wysong, 1976). As Christian (1986, p. 364) notes, pushing "the problem light-years away to some unknown location" does not solve the question of how naturalistic origins can occur. This speculation results from the assumption that there may be other types of planets "on which the origin of life *ab initio* is greatly more probable than on our own" (Crick and Orgel, 1973, p. 341). From what we know about the conditions in outer space, though, it seems that it is far more hostile to the formation of organic molecules than the earth ever was. Heat or other forms of energy are critical to form most compounds, and interstellar space gas is at most only about 25 to 30 above absolute zero and stars are far too torrid (Kunzig, 1988, p. 71). Some simple compounds that exist there may have been formed by cosmic ray energy, but this is also a major means by which many compounds are destroyed (Friedlander, 1989).

Other problems include the low likelihood that extraterrestrial life would be compatible with earth's environment, or even survive traveling for millions and millions of years in a space environment which is extremely hostile to life and still be viable. We know of no possible source of life within fewer than about five light years away from the earth. Consequently, any possible origins are at the minimum many centuries travel away, depending on how fast the carrier can travel. The transport problem was summarized by Angelo as follows:

> The greatest difficulty most scientists today have with Arrhenius's original panspermia concept is simply the question of how these "life-seeds" can wander through interstellar space for up to several billion years, receive extremely severe radiation doses from cosmic rays and still be "vital" when they eventually encounter a solar system that contains suitable planets. Even on a solar system scale, the survival of such microorganisms, spore or bacterial would be difficult. For example, "life seeds" wandering from vicinity of the Earth to Mars would be exposed to both ultraviolet radiation from our Sun and ionizing radiation in the form of solar-flare particles and cosmic rays. This interplanetary spore migration might take several hundred thousand years in airless, hostile environmental conditions of outer space (1991, p. 127).

Shklovskii and Sagan (1966, p. 209) estimated if the earth were seeded by a planetary system, it would have to have occurred "several billions of years ago" to fit current evolutionary theory, and thus must have been from a star no more than about 6,000 light years away. This limits enormously the potential sources.

Another concern is that ultraviolet x-rays and other radiation, and the high vacuum (1 atom per cm^{-3} conditions and the lack of oxygen in space would likely destroy life or life's seeds during its long journey. Crick and Orgel argue "any known type of radiation-resistant spore would receive so large a dose of radiation during its journey to the earth from another solar system that it would be extremely unlikely to remain viable" (1973, p. 341). A further hazard is the large regions of hot, ionized, interstellar gas pockets that evidently existed in early space (Shklovskii and Sagan, 1966). One objection is answered by assuming that the seeds of life were shielded from space radiation by a meteorite's outer shell (Lawren, 1986). How life got inside of a meteorite without being destroyed by the heat that formed the meteorite rock originally, or how it survived the heat generated in its travel through space dust or the earths atmosphere, is not clear. Shklovskii and Sagan note that if a life bearing meteorite was ejected from a planet that is near a star, which probably includes most planets,

> the radiation hazards cannot be avoided by providing a protective shielding for the bug. With a shielding thick enough to be useful for radiation protection, the bug would be too large to be ejected by solar radiation pressure. Similarly, we cannot save the panspermia hypothesis by imagining interstitial spores locked within the fissures of some interplanetary dust particles or meteors and thereby shielded from the harmful radiation (1966, pp. 209-210).

Some have tried to deal with these problems by speculating that

> Because much of the kinetic energy of a comet with a density of 1 g cm^{-3} will be partitioned not into heating the impactor but into kinetic energy of ejecta and target heating, it is possible that aerobraking (slowing by atmospheric drag) and uneven distribution of shock energy throughout

> the impacting projectile will conspire to yield some region of the comet for which temperatures remain low enough to allow at least the hardier organics to survive (Chyba et al., 1990, p. 367).

The ability of a spore surviving during a trip from outer space to earth has been researched by many scientists, and the most optimistic are Leiden and Greenberg who speculated that: "While 'naked' spores had a life expectancy of only 150 years in space, at least 10 percent of those with molecular shields could last up to 45 million years—more than long enough to survive an interstellar journey" (Lawren, 1986). The spores used in this research, though, were those of the highly developed *Bacillus subtilis,* a hardy bacterium which in contrast to most except a few of its cousins, is very difficult to kill. Further, to be able to produce a set of events in controlled laboratory conditions says only what may be possible, not what actually has occurred historically. The 45-million year survival time is pure speculation which assumes a set of ideal conditions and ignores the extremely destructive effect of cosmic rays. No one is denying the potential contributions of this experiment, but it argues far more for *over design* of bacteria than for *atheistic evolution* of them, illustrating the extent to which some researchers will go to deny a designer to explain design.

Another question of concern is how the spores could break away from their home base gravity and travel into space. This is no easy task, as our space program engineers are keenly aware (Lawren, 1986, p. 32). In the words of Crick and Orgel "The probability that sufficiently massive objects escape from a solar system and arrive on the planet of another one is considered to be so small that it is unlikely that a single meteorite of extrasolar origin has ever reached the surface of the earth" (1973, p. 341). Crick does an admirable job attempting to explain many of these difficulties, but falls far short, leaving most of the major objections unanswered. Many of these objections were recognized long ago. Wells, Huxley and Wells summarized the problem a full half-century ago as follows:

> The actual origin of life must always remain a secret: even if man succeeds in artificially making life, he can never be sure that Nature did not employ some other means. Some thinkers have supposed that life was carried to this earth in a dormant state within meteorites. But this is to think timorously and to balk the issue; it only removes the problem of life's origin one step farther back. It does not absolve us from asking how and when life originated, but merely introduces an extra difficulty (1935, p. 8).

Many researchers have recognized these problems with the theory that accidental exobiogenesis was the source of life on earth, so they have proposed the intelligent design theory called directed panspermia. Crick and Orgel attempted to resolve the above fatal problems of evolution.

> . . . by proposing the directed-panspermia hypothesis. . . . in the early 1970s they suggested that an ancient, intelligent alien race could have constructed suitable interstellar robot spacecraft; loaded these vehicles with an appropriate cargo of microorganisms, spores or bacteria; and then proceeded to "seed the Galaxy" with life, or at least precursors of life (Angelo, 1991, p. 127).

In their words, they reason that life could have begun on earth

> as a result of infection by microorganisms sent here deliberately by a technological society on another planet, by means of a special long-range unmanned spaceship? . . . If we are capable of infecting an as yet lifeless extrasolar planet, then, given that the time was available, another technological society might well have infected our planet when it was still lifeless. The spaceship would carry large samples of a number of microorganisms, each having different but simple nutritional requirements, for example blue-green algae, which could grow on CO_2 and water in "sunlight." A payload of 1000 kg might be made up of 10 samples each containing 10^{16} microorganisms, or 100 samples each of 10^{15} microorganisms (Crick and Orgel, 1973, p. 343).

The purpose of this effort by these aliens to spread life, according to Crick and Orgel, was "missionary zeal" (1973, p. 344). In Johnson's words, the exobiogenesis theory of Crick and Orgel includes

> the basic idea. . . that an advanced extraterrestrial civilization, possibly facing extinction, sent primitive life forms to earth in a spaceship. The spaceship builders couldn't come themselves because of the enormous time required for interstellar travel; so they sent bacteria capable of surviving the voyage and the severe conditions that would have greeted them upon arrival on the early earth (1991, p. 108).

The motivations of these spacemen were discussed in more detail by Angelo:

> Why would an extraterrestrial civilization undertake this type of project? Well, it might first have tried to communicate with other races across the interstellar void; then, when this failed, it could have convinced itself that it was alone! At this point in its civilization, driven by some form of "missionary zeal" to "green" for perhaps "blue") the Galaxy with life as it knew it, the alien race might have initiated a sophisticated directed-panspermia program. Smart robot spacecraft containing well-protected spores, microorganisms or bacteria were launched into the interstellar void to seek new "life sites" in neighboring star systems. This effort might have been part of an advanced-technology demonstration program, a form of planetary engineering on an interstellar scale. These life-seeding robot spacecraft may also have been the precursors of an ambitious colonization wave that never came—or is just now on its way! (1991, p. 127).

Not only the origin of life, but also its extinction has been postulated by scientists as occurring by extraterrestrial events. The best example is the Chicxulab impact Crater, now estimated to be 185 miles wide and 15 miles deep, the largest crater in the universe, even surpassing the 175 mile wide Mead Basin on Venus (Sharpton et al., 1993). It is speculated to have wiped out 60 to 80 percent of all animal species then, allowing the evolutionary diversification of mammals.

The Empirical Evidence for the Theory

One method exists to test the theory that the first living cells which gave rise to life on earth formed in space about 4.6 billion years ago. Since, Hoyle and Wickramasinghe (1978, 1984) concluded that this influx of life from outer space (mainly via comets) may be occurring today, it is feasible to determine empirically whether or not the recent visit of other comets brought germs or complex organic matter *of any kind* aside from amino acids to earth. For a control population, satellites or high flying airplanes could be used to accurately evaluate the contents in a certain area of space. Then, when a comet makes a close enough appearance (as Halley's tail does occasionally) a germ or organic molecule count of the same area can again be taken. If it increases significantly, and if this increase cannot be accounted for by other causes, the result would indicate that the comet was carrying germs or some type of complex organic molecules.

One piece of evidence Hoyle uses to support his view is that smallpox and other diseases tend to appear and disappear at "mysterious intervals" throughout history. Some scientists have even speculated that each return of some comet could herald disaster because of the germs and other life that they believe it carries, a theory not supported by the research completed on the 1986 return of Halley's comet. A space craft sent to Halley's comet to determine, among other things, if it contained complex organic molecules or germs, found no evidence of such.

So far, only simple "organic" compounds have been identified in Halley's comet from infrared detectors in telescopes on earth (Cowan, 1993). Wickramasinghe and Allen used this equipment to measure waves emitted by the comet beyond the visible light spectrum. They found a 3.4 micron wavelength, which indicates that some hydrogen-carbon molecules are present in the comet. Only about 100 compounds so far have been identified in outer space out of over ten million known. Most were found in the thousands of giant molecular clouds that are from 30 to 180 light years across and about 700 times the density of outer space. The density is such that 700 molecules exist in the cloud compared to each one existing in outer space (Cowen, 1978, p. 6). The study of the chemistry in these clouds, called astrochemistry, has grown to the extent that

> the fact that Drs. Hoyle and Wickramasinghe are willing to stake their professional reputations on these audacious theories shows how fast the young science of astrochemistry is developing. (Cowen, 1978, p. 6)

The Theory's Implications for Abiogenesis

The theory clearly emphasizes the fact that serious difficulties exist with the assumption that life could have originated spontaneously eons ago in a primordial soup of speculated composition somewhere on the earth's surface. The literature on the various theories of how the spontaneous generation of life on earth could have occurred eons ago is based on the *a priori* assumption that, since life is clearly here and it is not "scientific" to resort to a creator to guide the process, we therefore must speculate on *how life* could have *generated spontaneously*. That scientists of the stature of Hoyle, Crick, Ginsburgh and Wickramasinghe seriously question the assumption that life could have originated on earth without outside direction clearly portends that serious difficulties exist in *all* of the current origin of life theories (Thaxton, et al., 1984; Johnson, 1991). In the words of Chang, "the primeval soup theory scientists were once confident was valid is, because of much more knowledge, no longer viable and the consensus that once prevailed, the conviction that the basic ingredients of the 'primeval soup' have been worked out, is gone" (Kunzig, 1988, p. 68). In the end, we do not know, in spite of a score of theories, how life *could* have evolved on earth, a far easier question than knowing how it *did* evolve here:

> How important were the organics brought in from out there for the origin of life down here? Because scientists don't really understand the origin of life, this question can't be answered with confidence. One way to approach the issue, though, is to compare the extraterrestrial sources with likely sources of organics made on earth. Since the early 1950s scientists have worked out a number of ways for making organics via chemical reactions in earth's atmosphere (Chyba, 1992, p. 34).

And as Chyba elegantly shows, the subject is far more complex today than the 1950s. Consequently, researchers have appealed to exobiogenesis to explain the many existing abiogenesis problems and thus to develop plausible abiogenesis theories. Many researchers also recognize that at least directed panspermia has clear similarities to the intelligent design view of creationists. Hoyle recognizes its similarity to the religious world view, but stresses that many scientists endeavor to deny this because, in his words, "orthodox scientists are more concerned with preventing a return to the religious excesses of the past than in looking forward to the truth" (1983, p. 9). The view of directed panspermia also argues against the "purposeless outlook of orthodox opinion" and argues against the nihilistic outlook which "has dominated scientific thought through the past century" (p. 9). He goes further than this, stressing that publication of the *Origin of Species* "committed mankind to a course of automatic self-destruction" and that many people sense something is "fundamentally amiss with society." It is not only the implications of atheistic evolution that has motivated Hoyle to develop his theory, but his conclusion that the accidental origin of life is more unlikely than solving the Rubik's cube at random, an activity which he concludes mathematically approaches the impossible. If one could make one random move a second, Hoyle concluded that it would take an average of 300 times the estimated age of the earth, or 1,350-billion years, "of just one of our body's proteins having evolved randomly by chance." Since about 200,000 types of proteins exist in each cell, the odds against random creation, Hoyle concludes, are "unimaginably vast" (1983, p. 12).

The motivations for both earth abiogenesis and exobiogenesis involve philosophical presuppositions. A good example is the work of one of the pioneering researchers whose theories have influenced the field for several decades, Soviet scientist A. I. Oparin. In his classic work on evolutionary theory, he reviews the history of atheistic theories of the origin of life. He appropriately mentions that in the 1870s Frederick Engels, the co-founder of communism with Karl Marx, believed that atheistic evolutionary development of matter was the only path by which life could have arisen. According to Engels, life arises by a process of matter evolution whenever conditions are favorable (Oparin, 1957, p. 92). Oparin explained the difficulty in synthesizing life in the lab by quoting the "distinguished Russian botanist and cytologist," V. Velyave who stated in 1893, "in the great laboratory of nature . . . we are hardly likely to succeed in obtaining quickly that on which nature as spent thousands of years." in our efforts to create life (Oparin, 1957). Engels is important in the history of communism because "it is with Engels, the former fundamentalist Christian, rather than Marx, the formerly Jewish child who loved his father and his father-in law, that the atheistic syndrome first enters the history of communism" (Koster, 1989, p. 164). Koster argues that atheism often develops from a hatred of one's father, producing what he calls the atheist syndrome. Marx, however, is a striking exception to the many examples that Koster documented. Koster therefore concludes the incorporation of atheism, and importantly Darwinism, into communism was primarily through Engels, not Marx. Marx, though, did have "a greater intellectual admiration" for Darwin "than for any other" of his contemporaries because of Darwin's "theory of evolution and natural selection" (Berlin, 1963, p. 204). The relationship between Darwinism and communism is complex, but essentially

> once Darwin's ideas started to percolate through Europe, the Marxists seized on them eagerly as a sort of antidote to organized religion. . . . the Marxist. . . adopted Darwin as a fixture of the new world view because he was an atheist and because his theory of evolution by natural selection, taken at face value, helped to undermine the Judeo-Christian view of man" (Kosler, 1989, p. 164).

Koster relates that both Lenin and Stalin had come to accept, first, Darwin's theory of evolution and the belief that "man was a mere animal and not a being created by God" (1989, p. 164). Darwinism also influenced Stalin to abandon his faith in God and to accept the view that "people were descended from apes and not from Adam." Koster also argues that atheism is a necessary plank for communist philosophy, at least that which developed in the Soviet Union. Theistic evolution would not suffice because it was imperative to totally remove the idea of God, especially the Judeo-Christian God, in order to fully embrace the communist party line. It was, consequently, especially necessary to show that the origin of life itself can occur by natural means. Even many theists accepted evolution from primitive animals to the more advanced creatures including humans. Consequently, the final plank, that of the origin of life itself, had to be dealt with, and this was the challenge Oparin assumed.

Oparin recognized that the origin of life theories accepted in his time were not viable, and therefore devoted his life work to making the ancient spontaneous generation of life views plausible. The view common then was, in Oparin's words, "H. J. Muller . . . affirms his earlier hypothesis . . . as to the random emergence of one successful gene among myriads of types of molecules" (Oparin, 1957, p. 99, my emphasis). Recognizing the many problems with this view, Oparin noted one was that it was difficult to accept the idea of one unique past event "because it completely shuts the door on the scientific study of the most important event in the history of our planet, which was the first emergence of organisms. How can one study a phenomenon which, at best, can only have occurred once in the whole lifetime of the earth?" He then hypothesizes that the conditions must have been such that the origin of life was once common and indeed inevitable—and in his classic work he discussed what he felt these conditions were. The research reviewed above, though, has shown that many of the early earth conditions he postulated are not tenable, and the modern recognition that the spontaneous generation of life on earth is highly improbable has led to the exobiogenesis hypothesis in order to maintain the philosophical assumption that life generated spontaneously. If this could not occur on earth, then it occurred somewhere else.

ReMine (1993) argues that life was designed both to look like the product of a single designer, and secondly to resist all other interpretations of its origin. That idea, called **message theory,** asserts that life's designer would *not* create extraterrestrial life, because to do so would violate one or both of these goals. For example, while all earthly life possesses common designs to intentionally convey that they are the work of one designer, the existence of extraterrestrial life like ours would violate the second goal. If extraterrestrial life existed, it would lend credence to the view that our creator did not create us, but that we are the product of, evolved from, or that extraterrestrial life is in other ways responsible for our existence. Naturalistic evolutionists then could use evidence of extraterrestrial life to argue in favor of naturalistic interpretations. Thus, studying the creation allows us to learn about the traits of the creator, and within the creation is a message. The creator deliberately precluded evidence of exobiology, ReMine argues, because this would confuse the message he intended to convey, namely that we are the product of the creator only, not extraterrestrial life. The lack of evidence for extraterrestrial life, he concludes, supports the message theory hypothesis (1993, p. 441). Although this lack is so far supported by science, many speculate that evidence for extraterrestrial life will be found with continued searching, but at this point this conclusion is based on belief, not empirical evidence.

And in Conclusion

The whole exobiogenesis theory and the speculation it is based upon vividly illustrate how a century of research has revealed many difficulties with all naturalistic theories of life's origin. The evidence indicates both outer space and the early earth were extremely hostile to life. In Kunzig's words, "The profusion of hypotheses about the origin of life . . . is a symptom of the fundamental problem in the field: the lack of hard evidence" (1988, p. 76). Outsiders should be cautious and not uncritically accept the many speculations put forth by contemporary scientists and their students. It is recognized by many that even the exobiological theories developed to explain abiogenesis cannot be "a random process, but one carried out under the influence of a greater cosmic intelligence" (Angelo, 1991, p. 128). The panspermia theory is an intelligent design argument which is acceptable to the scientific community because it assumes the creator of life itself evolved by natural means. Would a God created by natural forces as opposed to an eternal existing God be acceptable to secular scientists and the public schools? Shklovskii and Sagan have concluded this view is an acceptable theory because it "is not inconsistent with materialistic philosophy" (1966, p. 11). The exobiogenesis theory also illustrates the extent that some scientists will go to try to account for the complex reality around us without a creator. We can do no better than conclude with the words of Javor:

> Thus there is a crisis in the field of chemical evolution. The best efforts of brilliant scientists over the past 40 years have stalled in logical dead ends. Increasing numbers of evolutionary scientists are accepting now the concept of "panspermia," that life evolved elsewhere in space and was imported accidentally or purposefully to the earth. First proposed at the end of the past century, after Pasteur disproved the spontaneous generation of life, this theory is an admission of failure to find a convincing naturalistic account for the origin of life on earth. It pushes the problem out of the realm of experimentation and gives up on suggesting how life could have come about. But it is also a stubborn clinging to the notion that somehow matter can self-organize into living matter—if not on this earth, then elsewhere in the universe. What we know about living matter makes it clear that this cannot happen (1993, p. 11).

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