These creationists confuse the issue when they try to account for geological changes on the basis of more or less uniform action. They may recognize that the flood was responsible for some geological changes, but fail to grasp the enormous proportions or the violence that must have continued afterwards for many hundreds of years. These persons might be designated as "stretch-time" creationists or "uniformitarian creationists." Their main problem is that they are thinking too much in terms of present rate of change. They believe in creation, but confuse the whole question of time because they cannot conceive of processes much different from what they now observe.

The problem of radioactive dating is discussed by other authors in this *Annual.* Therefore I will simply submit that the claims put forth in that field are not very impressive since there are so many untested and untestable hypotheses at the basis of the methods involved.

In conclusion, what can we really know about the earth in space and time? As far as space is concerned, we know a great deal, for our knowledge of the universe has expanded tremendously within the last four hundred years. But with respect to time, we know absolutely nothing about the origin of the rest of the universe, since the Genesis record deals only with the creation of this earth, and scientists have offered nothing but vague and impossible hypotheses. We can therefore conclude that the Biblical record of creation of the earth only a few thousand years ago is still valid, for nothing that scientific investigation has brought to light can disprove that record.

IS THERE LIFE ON OTHER WORLDS? A CRITICAL REASSESSMENT OF THE EVIDENCE

FRANK W. COUSINS*

The case for life on other worlds is examined according to three hypotheses that are presently put forward, viz.

1. *That there are numerous planetary abodes for life in the Milky Way and in the extra-galactic nebulae.*
2. *That simple life came into being by a fortuitous assemblage of inorganic matter in the primeval oceans of the earth.*
3. *That life has evolved from a simple beginning on earth and that it will have proceeded in a similar fashion on the other hypothetical planets.*

Evidence on each of these three counts is shown to be unsatisfactory and the intellectual edifice one that is open to considerable doubt. The question of life on other worlds is seen to be an open one.

> "There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact." (Mark Twain, *Life on the Mississippi)*

Prejudice in scientific matters is deeply ingrained and never more so than in the answers which are given to the question, Is there life on other worlds? Evidence for and against is meager and the answer is always an opinion, or assertion, not a statement of scientific fact.

Landing of men on the Moon has engendered a surge of rash speculation, with dogmatic statements through the mass media to the effect that the achievement is the greatest thing to have happened since "the fish stood up and walked out of the sea," and that the answer to extra-terrestrial life is at hand. But no one is able to show, outside fiction, that the fish once stood up and walked or that the problem of extra-terrestrial life is near resolution.

The dogmatic approach to the question of life on other worlds, of which I complain, is best illustrated by two representative statements. Ian McDonald reported in *The Times* of London (8 August, 1969 from Washington) on the subject, "Mariner 7 Finds Clue to Life on Mars," as follows:

> By coincidence, the Mariner findings came only a day after other scientists had found evidence of organic material potentially suitable *for the spontaneous evolution of life,* in two separate samples of Moon dust. (Emphasis added) (p. 1)

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And John Maynard Smith, a populariser of science writing in *The Listener* (London, 7 August, 1969), wrote:

> There is a rather sick joke which has been going the rounds among scientists for some time now. *To understand it, you have to accept their assumption that since intelligent organisms have evolved on Earth, they have presumably evolved on thousands and perhaps millions of other planets in our galaxy*. Since many of the other planets must be much older than the Earth, one may suppose that many intelligent life forms have evolved long before man did. One then supposes that any intelligent organism, having reached intelligence, will start beaming out into the galaxy interesting messages about how they're getting on. If so, it is, of course, exceedingly puzzling that we have never yet picked up a message from any other planet. The suggested explanation is that as soon as some organism becomes intelligent, then, within a few hundred years, it manages to destroy itself. (Emphasis added) (p. 178)

The dogmatism of the popular approach is also found in more serious works. Firsoff[1] and Puccetti[2] for example attempt to clothe the case with some scientific covering. Puccetti analyzes three "candidates" for the role of persons other than human persons—the supercomputer, the organic artifact, and the extra-terrestrial being. The first of these he rejects since a true machine cannot have feelings, and is therefore not a moral agent. Organic artifacts he rules out for the reason that none exists as yet. The major part of his work is thus devoted to extra-terrestrial beings despite the fact that, as with organic artifacts, there is likewise no satisfactory evidence for this third alternative.

Puccetti takes the view from the start that evolution is the mode of animal genesis. On Mars for example he tells us, "the scarcity of oxygen and formidable temperature variations *limit evolution* to the simplest forms of life." (p. 59) In every case his appeal is to *evolution* of life. Four extracts will be sufficient to show the position:

> (a) About 5 percent of all visible stars are both single-hence capable of providing stable planetary orbits—and of the right size to create "habitable" temperature zones for the spontaneous generation and *evolution* of life.
>
> (b) The large early spectral types (O, B, A, and early F), with broad habitable zones, unfortunately evolve too quickly themselves for *biological evolution* to take place on whatever planets they might have.
>
> (c) Even without sunlight, this internally produced energy should be sufficient for chemical evolution and photosynthesis of a distinct sort. Thus life could be generated on such crusted stars and self-heating distant planets; and if so, why should not intelligent beings *evolve* there?
>
> (d) About 5 percent of all single stars are of the right size to have planetary systems in which one or more planets would fall in the "habitable" temperature zone for long periods of time; and life could generate spontaneously and *evolve* into intelligent forms during that period of time by the same means as obtained on the surface of the Earth. (Emphases added in each extract.)

Firsoff builds a less erudite case than Puccetti. He fails in my view to distinguish between organic and inorganic evolution. He sees death as an expedient for further evolution, and puts the virus (without evidence) as evolutionarily late. Further he fails completely to understand the nature of mutations in the problem of evolution and asserts, but does not prove, "If any planet has surface conditions suitable, or at least tolerable to any terrestrial organisms life may be assumed to have developed there." (p. 58)

The case for life on other planets rests on three clearly separated hypothetical assumptions: (1) the existence of billions of planetary systems in the cosmos similar to our own solar system, (2) evolution of primary organisms from inorganic matter contained in a primaeval ocean which once covered our planet Earth and other planets with similar oceans in which life could have evolved, and (3) these simple organisms then evolved into complex organisms. Such an assembling of hypothesis upon hypothesis is intellectually unobjectionable provided the tenuity of the nexus in the argument is not lost sight of. Let us examine the validity of these hypothetical assumptions.

HYPOTHESIS I

That there are numerous planetary abodes for life in the Milky Way and in the extra-galactic nebulae.

The first hypothesis is a statistical abstraction which Shapley[3] gives succinctly, on the basis of an initial guess in our own galaxy and then extrapolates to embrace the population of the extra-galactic nebulae out to the periphery of the known universe.

He asserts that there are more than 10^{20} stars, each one capable of maintaining photochemical reactions that are the basis of known terrestrial plant and animal life. He assumes at the very lowest that one star in a thousand possesses a planetary system. One in a thousand of these stars is assumed to possess a planet at the correct distance from the star to provide a suitable en-

vironment for terrestrial protoplasm. One in a thousand of the suitable planets is believed large enough to hold an atmosphere (undefined). Finally one in a thousand of these might have air and water which might allow naturally arising complex inorganic molecules to develop into organic molecules. He then summates these four separate one-in-a-thousand chances, each of which is an inspired guess, to obtain the answer that one star in 10^{12} meets his criteria.

Shapely then divides 10^{20} by 10^{12} and obtains the answer that there are 10^{8} suitable systems in which conditions of the first hypothesis might exist. This arithmetical exercise appears dogmatic in that some latitude should be given to the assumptions made, thus arriving at a numerical range for the number of lifebearing planets, rather than a single number: 10^{8}. This general weakness in scientific inference, exemplified in Shapley's reasoning, has been explored by A. W. F. Edwards[4] Shapley's solitary figure of 10^{8} is a guess and nothing more.

Another Estimate of Possible Planets

Professor Fred Hoyle engaged in this guessing game before Shapley. In 1949 he marshalled the supposed affirmative evidence for life elsewhere in the universe in a radio talk given over the British Broadcasting Third Programme network. He was keen to form the planetary systems from binary stellar systems in which one component is a supernova. (A supernova is a star which suddenly becomes very bright.) He imagined that this gave him an ingenious yardstick to work out the planetary systems in the cosmos. Hoyle stated that it is known from observation that supernovae occur in each galaxy of stars at the rate of one every 500 years. To our own galaxy he accords an age of 5×10^{9} years hence 10^{7} supernovae will have appeared and thus 10^{7} planetary systems will have developed in the galaxy. There are 10^{8} galaxies and thus $10^{8} \times 10^{7}$ planetary systems (i.e. 10^{15}).

Professor Hoyle estimates (in contradiction to Shapley's 10^{8}) that there are 10^{6} planetary systems suitable for life in our galaxy and hence 10^{14} planetary systems for life in the known cosmos. This unique planetary-forming idea of Hoyle has not been accepted, indeed the formation of our own solar system is still very much unresolved, and Hoyle[5,6] personally rejected his own supernovae hypothesis. The interested reader may be referred with confidence to the recent erudite survey of the problem of the origin of the solar system by Williams and Cremin.[7]

We have then two estimates for the number of possible planets in the cosmos available to life [10^{8} (Shapley), 10^{14} (Hoyle)]. Only one is based on evidence (the rate of supernovae formation—Hoyle) and that evidence is now rejected by its author. It will be seen that figures of this nature must be treated with the greatest of caution and are not to be enthroned in the mind as facts.

Some Direct Evidence Itemized

Consider now the so-called direct evidence on the question of planetary bodies in the galaxy. In 1963 Dr. Van de Kamp reported the discovery of a new planet after his assiduous search of the heavens for 20 years. The "new" planet was not observed but only postulated from the dynamic abberations of Barnard's Star B in its celestial path, which is out of the accepted uniform rectilinear motion.

Barnard's star had been photographed by Van de Kamp and his colleagues every year since 1938 to produce 2413 photographic plates from which it was possible to calculate the motion and distance of the star. On the assumption that Barnard's star has 15% of the Sun's mass, the companion is said to be one and a half times the mass of Jupiter. The broad question of the planetary companions of stars has been reviewed by Van de Kamp.[8] The method of detection is one of long focus photographic astrometry and the calculation of the lower limit of the mass of the postulated unseen companion.

Other evidence to date for the existence of planetary companions is sparse. The possibility of a companion to the star 70 Ophiuchi and Krüger 60 has not been confirmed. Another spurious result is that of the postulated companion to the star Lalande 21185 derived by Mannino in 1951. Investigations concerning the stars Cincinnati 1244 and η Cassiopia are not conclusive. An unseen companion of 0.016 solar mass is believed to exist about the well-known double star 61 Cygni.

The difficulties in labour, accuracy of observation and calculation are immense. Something of the difficulty is shown by Su Shu Huang.[9] He records that

> to detect the existence of a planet the size of Jupiter in a hypothetical Sun-Jupiter system at distance of ten parsecs* requires an ability to measure an astrometric angular deviation of 0.00005 seconds of arc or an ability to measure by spectroscopy a radial velocity correct to 0.01 Km/set or to measure by photometry a change in luminosity of 0.01 magnitude.

It should be kept clearly in mind that all variations in proper motions may not of necessity derive from an unseen companion of plane-

*Note: A parsec is approximately 19.8 million, million miles (19.8×10^{12} miles) or 3.26 light years.

tary mass, but that conversely all unseen companions whatever their nature will yield perturbations of some magnitude, though whether they will be observed or not is open to doubt. Firsoff[10] makes this elementary mistake in his *Life, Mind,* and *Galaxies* by dogmatically equating dynamical anomalies with superplanets. The perturbing mass is unseen and no one can be certain on the point. To say that a superplanet *is discovered,* by such evidence, is hardly factual.

The argument concerning possible planetary companions to "near" stars is only a statistical abstraction since it makes no appeal to experimental evidence. In any statistical argument worthy of consideration the link with reality is the sample which is taken for the ground on which the edifice is to stand. In this argument no sample has been taken and none is yet within our skill. The numbers of planetary systems in our galaxy is unknown and there is therefore no firm ground on which to extrapolate in order to obtain a figure for the cosmos.

The one planetary system of which we have considerable data is the solar system in which the individual planetary environments are reasonably established. **The concensus is that there is no clear indication of life in the solar system other than on the Earth.**

In any planetary system, it would seem that conditions for the existence of life, as found on Earth, are critically limited. If the planet is too near its parent sun it will be too hot for life to exist; if it is too far away it will be too cold. If it is too large, it will have retained the gas hydrogen, and the intermediate state of oxidation characteristic of living organisms, of which we are familiar, would be maintained only under great difficulty for then CH_4, NH_3, H_20 and H_2S would be abundant compounds.

Until recent observations with space probes one might have included Venus as a possible site for life within the solar system, but it is now established the Venus is a hot dielectic sphere with mean thermometric temperatures of about 700°K.[11,12] Even the polar regions are thought to be above the normal boiling point of water. The data from the successful Venus 4 spacecraft of the U.S.S.R. support these conclusions since the entry capsule recorded surface temperatures of 550°K near the equator on the night side. "The universe," says Eddington, "is antiseptic—either too hot or too cold." This dictum is not without support from our "local" environment in space.

HYPOTHESIS II

That simple life came into being by a fortuitous assemblage of inorganic matter in the primeval oceans of the earth.

The second hypothesis in the nexus of argument is expressed with erudition by Oparin.[13] During the first quarter of this century there was little or no discussion on the nature and origins of life—a profound point for anyone interested in the philosophy of science.

An article by Haldane aroused a flicker of interest in 1929, but is was Oparin's *Origin of Life* published in 1937 which triggered off the many speculations of recent decades. His book of 1937 is still the best source of his general ideas, which have been augmented by the release in 1953 of the Dover edition with an erudite introduction by Serguis Margolis, Professor of Biochemistry at the University of Nebraska. A translation by Eleanor Maass from the Russian of Oparin's *Genesis of Evolutionary Development of Life* appeared in 1969 (Academic Press 1969), which is the 1937 book brought up to date. (Some inaccuracies in this later work have been noted, see *Nature,* 223: 103, 104, July 5, 1969.)

Oparin's Account

Oparin presents the story in several distinct stages. He forms the Earth out of the Sun's atmosphere on the now discredited theory of Jeans. He then asserts that carbon appeared first on the Earths surface, not in the oxidized form of carbon dioxide but in the reduced state in the form of hydrocarbons, and asserts that nitrogen also appeared first in its reduced state in the form of ammonia. He next postulates coazervation* in the helter-skelter accumulation of moving particles to obtain varying concentrations at different points of the aqueous medium.

He finds difficulty in explaining the exceptional energetic activity of enzymes and pathways for the appearance of such a perfect apparatus in the living cell (p. 168).[14] To overcome this difficulty he appeals to natural selection but does not detail how the selective "intelligence" operates in inanimate structures (p. 175). In this manner (p. 195) he produces "the simplest primary organisms" and with their appearance the question of the origin of life on Earth is in his view closed since to use his own words "what follows now is a history of the *evolution* of living creatures." He admits, however, that "unfortunately the problem of the origin of the cell is perhaps the most obscure point in the whole study of the evolution of organisms."

More recently this question has been examined by Professor J. D. Bernal,[15] one of the world's most distinguished crystallographers. The unusual scientific nature of the case is expressed in his own words:

We are here trying to settle a question of a

*Coazervation is the separation of a lyophilic colloidal sol into two liquid phases. A lyophilic colloid is one which is readily dispersed in a suitable medium.

different character from those of the rest of science; it is not merely a description . . . . . but an attempt to carry out an intellectual reconstruction based on assumptions of inner logic themselves drawn from experimental science here and now.

The inner logic follows some curious pathways since Professor Bernal expresses his dislike of the philosophical emptiness of special creation yet accepts it as axiomatic that life arose on the surface of the Earth. He departs from Oparin's views decisively in thinking that cells are a late stage in the process, preceded by about 2,000 million years of chemical evolution of macromolecules in "sub-vital areas" not defined by membranous boundaries.

Bernal is unable to explain, except by chance, how the key phenomenon of molecular self-replication arose in the course of chemical evolution. As with Oparin, once the intellectual schema has produced the cell from molecules and the molecules from organelles his story is combined with the theory of transformism to be found elsewhere in the literature on natural history.

One is left with the feeling that, provided the *premises* are carefully laid in this field of assertion, opinion, and guesswork, the desired answer is not too difficult to reach.

Both Oparin and Bernal allow evolutionary concepts to enter their reasoning which then ceases to be exact. They both require unlimited time for the creation of organisms (the reader may reflect that the supposed reduction of the toe number in Eohippus—the alleged progenitor of the parade horse of today—is said to require 60×10^6 years), especially for their further evolution to occur, yet time *per se* achieves nothing, and they are compelled from the start to break the rapid synthesis of organic matter. Even chemical processes become evolutionary, in spite of the fact that at present they are repeated nearly instantaneously in any terrestrial laboratory.

Professor C. D. Darlington[16] has spoken of "Galactic Life." He is more qualified than most to indulge his imagination. Actually he does little more than invite us to follow what we now know to be completely unproven, namely the build-up of a widely diversified set of living things on chance mutations.*

*Emile Guyenot has said mutations are powerless to explain the general adaptation which is based on organization. It is impossible to produce the world of life where the dominant note is functional organization, correlated variation and progression, from a series of random events. Further it runs counter to Boltzmann's elegant formulation of the Second Law of Thermodynamics: "the logarithm of the probability of a state is proportional to the entropy of that state."

An Experiment and Critiques

More recently still we have news of what is called the Kornberg Experiment. Dr. Arthur Kornberg, a Nobel prize-man, has with complete success conducted in the laboratory one of the key replication processes to which Professor Bernal refers in his hypothesis. In the experiment "Natural" DNA (the multi-unit compound which forms the stuff of the chromosomes) and the appropriate enzymes were made to combine, in the right order, with a set of primary building blocks provided by Kornberg. In this way a DNA molecule was produced, identical with the parent.

It has been widely held that this is the creation of new life in the test tube. It is in fact, not the creation of new life, but a persuading of life to act as the template to produce outside the living cell a replication process. The experiment is one of considerable elegance, but it is clearly to be noted that it offers no help in the understanding of the *origin* of life since it is a cascade experiment in which life has to be present *ab initio* before the experiment is able to proceed.

There are immense difficulties involved. Professor Barry Commoner[17] (the Watson-Crick critic) offers the most erudite attack in his critical article which ends with this powerful and profound thought:

Biologists have confronted succesively—like a nest of Chinese boxes—levels of complexity ranging from the ecosystem to the internal chemistry of the cell. The last box has now been opened. According to the Watson-Crick theory, it should have contained the single source of all the inherited specificity of living organisms—DNA. It is my view that we now know that the last box is empty and that the inherited specificity of life is derived from nothing less than life itself.

The philosophical problems in these fields are most cogently expressed by Professor M. Polanyi in his "Life Transcending Physics & Chemistry," Chemical & Engineering News, Aug. 21, 1967, which shows *inter alia* that coded information is not open to chemical and physical methods of investigation. He offers as an illustration of this profound point the following analogy:

A book or any other object bearing a pattern that communicates information is essentially irreducible to physics and chemistry. It would follow that we must refuse to regard the pattern by which DNA spreads information as part of its chemical properties.

These matters are more fully investigated in his essays *Knowing and Being* (London, 1969).

Criticisms from Mathematicians

Let us turn from biologists to mathematicians since there seems little opportunity to get any direct evidence from the biologists. In this change of disciplines we may find with Arbuthnot, "that mathematics are friends in as much as they charm the passions, restrain the impetuosity of imagination and purge the mind from prejudice."

Charles Eugene Guye, a Swiss mathematician has calculated the chances of manufacturing a single molecule of some protein-like substance and also the quantity of material to be mixed in the experiment. The odds come out at 100^{160} to 1 against, with the quanity of material to produce one molecule larger than that in the known universe, sextillion sextillion sextillion times in excess.

The calculation for the time involved for the experiment to have taken place on Earth is 10^{243} years which is an interesting figure to compare with the present estimate of the Earth's age of 4 x 10^{9} years. Proteins are very individual substances and the long chains linked by the amino acids cannot be combined in any way one chooses, indeed the wrong order of assembly may cause them to be inimical to life. It has been calculated that links in the chain of a single protein may be put together in 10^{48} different ways. Even according to the usual uniformitarian assumptions, the Earth has been cool enough to accommodate life for only about 10^{15} seconds. We may marvel at the speed with which chance would have to operate to show even a small measure of success.

Now comes the most recent mathematical "boulder" to be cast into the evolutionist's pond, and the ripples are likely to be wide and persistent provided the event does not fall beneath the notice of astronomers and biologists. F. B. Salisbury[18] calculates that,

> A typical small protein might contain about 300 amino-acids, and its controlling gene about 1,000 nucleotides (three for each amino-acid). Because each nucleotide in a chain represents one of four possibilities, the number of different kinds of chains is equal to the number 4 to the power of the number of links in the chain; that is, $4^{1,000}$, or about 10^{600}.
>
> Imagine that the primeval ocean was uniformly 2km deep, covering the entire Earth, containing DNA at a concentration of 0.001 M (about 700 g of DNA/l. of solution), each double stranded molecule with 1,000 nucleotide pairs. Also imagine that each DNA molecule reproduces itself one million times per second, a single nucleotide substitution (a mutation) occurs each time a molecule reproduces, and no two DNA molecules are ever alike.
>
> In four billion years, 7.74 x 10^{64} different kinds of DNA molecules will be produced. On 10^{20} similar planets in the Universe, this would be 7.74 x 10^{84} (say 10^{85}) different molecules. If only one DNA molecule were suitable for our act of natural selection, the chances of producing it in these conditions are 10^{85} / 10^{600} or only 10^{-515}.
>
> If 10^{100} different kinds of molecules could each carry out the necessary precursor synthesis, this is equivalent to saying that 166 of the nucleotides might be changed without loss in ultimate activity of the enzyme. Still, only one molecule out of ever 10^{500} would be acceptable, and after four billion years on 10^{20} planets, 10^{415} of the first 10^{500} possibilities remain to be synthesized.
>
> The chances are, then, still unimaginably small (10^{-415}) that a proper DNA molecule would be produced in this time. And if the proper molecule did appear by that fantastic accident, the problem comes up again the next time a precursor becomes limiting.
>
> In the 2km deep oceans on the 10^{20} planets during the 4 x 10^{12} years, the DNA chain can have only 141 nucleotides if all 10^{85} possible kinds are to be produced. This would code a protein chain only forty-seven amino-acids long.
>
> The point of these numbers is that one DNA chain 1,000 nucleotides long can be a unique individual in a population of 10^{600} other unique individuals. Numbers of this size have no precedent in anything but the concepts of information theory. Assume, for example, a cubic universe with dimensions of 20 billion light years on each side. In Angstroms, this would be about 10^{39} Å on a side, with a volume of "only" 10^{117} $Å^{8}$. Imagine the number of universes required to contain 10^{600} tightly-packed DNA molecules!
>
> In spite of the wild assumptions, the problem should be apparent. In the evolution of life on Earth, we are dealing with millions of different life forms, each based on many genes. Yet the mutational mechanism as presently imagined could fall short by hundreds of orders of magnitude of producing, in a mere four billion years, even a single required gene.
>
> To compound the problem, consider the fantastic information content of a nucleus. The DNA in man contains about 10^{9} nucleotide pairs per nucleus (other organisms from 10^{7} to 10^{11} pairs[11,12]). Written in standard type, this would occupy about 1,000 volumes (10^{9} bits, 2,000 bits/page, 500 pages/volume). Britten and Kohne have shown that certain DNA

sequences of higher organisms recur any where from a thousand to a million times per cell. Hence much is redundant. Work on amino-acid sequences within a given protein also implies a high redundancy. Yet if only one tenth of the genome in man is relevant, that is still 10^8 bits of information (100 volumes). Could the mutation process account for it? . . . .

Special creation or a directed evolution would solve the problem of the complexity of the gene, but such an idea has little scientific value in the sense of suggesting experiments.

Finally, we do not know how life began but the concept that life evolved from non-life is widely believed as a logical extension of the theory of evolution. Oparin[19] must not be misunderstood here since he has stated with great clarity that

> The pecularity which distinguishes life qualitatively from all other forms of motion matter . . . is that, in the living body, the many tens and hundreds of thousands of individual chemical reactions which, in their sum, make up the metabolism, are not only strictly coordinated in time and space . . . but the whole of this sequence is directed in an orderly way towards the continual self-preservation and self-reproduction of the living body as a whole.

The problem has been extensively studied more recently in the scholarly work, *The Origins of Prebiological Systems and Their Molecular Matrices,* edited by S. W. Fox, (Academic Press, 1965) which has been subjected to a revealing criticism in a masterly "Essay Review" in *Chemistry & Industry,* 1966 by Dr. T. L. V. Ulbricht. He reported that:

> . . . at this Conference, Bernal posed a number of awkward questions. Here is one of them: "Which of the various synthetic studies that have been made of the formation of elementary molecular compounds is relevant to the question of the origin of life?" This can be considered in conjunction with Lipmann's comment: "That one finds such compounds (amino-acids, for example, in the experiments mentioned) doesn't tell us that this is a process really related to the origin of life. It means only that what the living organism does effectively in an organised way, can ineffectively be done in an unorganized way outside the living organism. . . .

He tells us,

> . . . it was in the discussion of Fox's paper on the thermal synthesis of amino-acids at 1000°C that the most heat was generated. Sagan criticised this work as irrelevant, because of the high temperature used and of the necessity of absorbing the products in water before they are decomposed at the same temperature. Fox believes that volcanic regions could have provided the high temperatures required and that rain would save the products from decomposition. When the critics were not convinced he said "the premise that it does not rain on volcanoes cannot be defended. . . .

Dr. Ulbricht goes on to explain that

> . . . any replicative system we can conceive would appear to require the existence of ordered polymers. The formation of such polymers and of primitive enzymes is usually ascribed to "prebiological natural selection," *i.e.,* an extension of the concepts of evolution to the world of molecules. This was strongly criticised at this conference by Dobzhansky, and by Mora, who regards "prebiological natural selection" as a contradiction in terms. "Molecules are supposed to have accurate and persistent self-copy ability, sufficient to resist randomisation and yet to have a moderate mutability rate, leading to the 'evolution' of the first self-reproductive system," which seems extraordinarily improbable because, as Mora says elsewhere, you cannot get more order out of a system than you put in. (pp. 43-45)

This brings me to the third hypothesis.

HYPOTHESIS III

That life has evolved from a simple beginning on earth and that it will have proceeded in a similar fashion on the other hypothetical planets.

We have seen that those persons who argue for life on other worlds always appeal to evolution as the *modus operandi:* let me repeat my extract from Professor Puccetti's writings:

> Remember that we have established only two things: (1) that about 5 per cent of all single stars are of the right size to have planetary systems in which one or more planets would fall in the "habitable" temperature zone for long periods of time; and (2) that life could generate spontaneously and *evolve* into intelligent forms during that period of time by the same means as obtained on the surface of the Earth. (Emphasis added)

How realistic is it to advance the case for extra-terrestrial life in this way? It would have some validity if it could be shown first that evolution has occurred on the planet Earth. Many biologists and the greater part of the informed lay public accept evolution as a fact. But we should not neglect to examine the matter carefully. Universal acceptance is no substitute for evidence. Anyone familiar with Schopen-

hauer's stratagems[20] will recall his eternally valid warning:

> But to speak seriously, the universality of an opinion is no proof, nay, it is not even a probability, that the opinion is right.

Professor Polanyi in his recent illuminating essays[21] invites us to consider the "impatience with which most biologists set aside today all the difficulties of the current selectionist theory of evolution because no other explanation than that accepted as scientific appears conceivable. This kind of argument based on the absence of any alternative that is accepted as scientific may be valid, but it seems to me the most dangerous application of scientific authority." Professor H. Nilsson in his vast work, *Synthetische Artbildung,* 1953 goes further and claims that a slavish acceptance of Darwinian evolution prevents development of a proper system of biology.

In his recent article referred to above Salisbury points out:

> Modern biology is faced with two ideas which seem to me to be quite incompatible with each other. One is the concept of evolution by natural selection of adaptive genes that are originally produced by random mutations. The other is the concept of the gene as part of a molecule of DNA, each gene being unique in the order of arrangement of its nucleotides. If life really depends on each gene being as unique as it appears to be, then it is too unique to come into being by chance mutations. There will be nothing for natural selection to act on.
>
> The problem was discussed at a symposium of mathematicians and biologists in 1966; but they failed to solve the difficulty. I feel that virtually no one present except Eden and Schutzenberger, who outlined the problem, really understood what the commotion was all about. Some years ago I also outlined the problem. My outline begins by overstating the case somewhat, but it provides a background for discussion of modern discoveries which may be pointing toward a solution. I believe that the solution remains to be found.

No Textbook Explains Diversity

Let no one be deluded on this point. There is no textbook to my knowledge which offers even a plausible explanation of the multitudinous diversification of the animal kingdom on the transformist (evolutionary) model. Two books at opposite poles of the intellectual axis offer a ready test. I refer to the classic, erudite, and expensive work of Professor E. Mayr, *Animal Species and Evolution* (Harvard University Press, 1963), and the cheap *haute vulgarization* by J. Maynard Smith, *The Theory of Evolution* (Penguin Book, Second Edition, 1966). The reader will search both books in vain for a satisfactory answer, yet they are widely read and quoted.

That the universal acceptance of the Darwinian position is open to challenge is found in Dr. Marjorie Greene's essay "The Faith of Darwinism":

> . . . great new inventions, new ideas of living, which arise with startling suddenness, proliferate in a variety of directions, yet persist with fundamental constancy—as in Darwinian terms they would have no reason in the world to do. Neither the origin and persistence of great new modes of life—photosynthesis, breathing, thinking—nor all the intricate and co-ordinated changes needed to support them, are explained or even made conceivable on the Darwinian view.
>
> And if one returns to read the *Origin* with these criticisms in mind, one finds, indeed, that for all the brilliance of its hypotheses piled on hypotheses, for all the splendid simplicity of the "mechanism" by which it "explains" so many and so varied phenomena, it simply is not about the origin of species, let alone of the great orders and classes and phyla, at all. Its argument moves in a different direction altogether, in the direction of minute specialised adaptations, which lead, unless to extinction, nowhere. And the same is true of the whole immense and infinitely ingenious mountain of work by present-day Darwinians: *c'est magnifique, mais ce n'est pas la guerre!*
>
> That the colour of moths or snails or the bloom on the castor bean stem are "explained" by mutation and natural selection is very likely; but how from single-celled (and for that matter from inanimate) ancestors there came to be castor beans and moths and snails, and how from these there emerged llamas and hedgehogs and lions and apes—and men—that is a question which neo-Darwinian theory simply leaves unasked. With infinite ingenuity it elaborates the microscopic conditions for such macroscopic occurrences; but it provides no conceptual framework in terms of which they can be admitted to exist, let alone an "explanation" of their descent from "lower" forms.
>
> Moreover, evolutionists sceptical of the neo-Darwinian synthesis have themselves empirical evidence to support their doubts. For despite the neo-Darwinians' claims, two great biological disciplines, paleontology and embryology, appear to lend their chief weight against the selectionist dogma.[22]

That the evidence from palaeontology was inimical to evolution was advanced as early as

1914 in Spenger's great philosophical work "The Decline of the West." In volume two he states,

> There is no more conclusive refutation of Darwinism than that furnished by palaeontology. Simple probability indicates that fossil hoards can only be test samples. Each sample, then, should represent a different stage of evolution, and there ought to be merely "transitional" types, no definition and no species. Instead of this we find perfectly stable and unaltered forms persevering through long ages, forms that have not developed themselves on the fitness principle, but *appear suddenly and at once in their definitive shape;* that do not thereafter evolve towards better adaptation, but become rarer and finally disappear, while quite different forms crop up again. What unfolds itself, is ever-increasing richness of form, is the great classes and kinds of living beings which *exist aboriginally and exist still, without transition types,* in the groupings of to-day.

Is There Extra-terrestrial Life?

The supposedly direct evidence available is that gathered from a study of 20 carbonaceous chrondrites that have fallen on the Earth. The main evidence comes from two of these meteoritic stones.[23] A review of the position has been given by Hutchinson *et al.*[24] The evidence is controversial and turns on the so-called "organised elements" which may be terrestrial contaminants. The research work leaves much to be desired and cannot be accepted as conclusive.[25]

Anyone who has followed me this far will see that we are faced not only with a scientific case but a philosophical one.

Conclusion

The question, Is there life on other worlds?, is an open one. We have no indubitable knowledge concerning it. The three hypotheses presently put forward for an affirmative answer are shown to have no firm foundations.

The evidence available incontrovertibly shows that there is life on Earth and that the solar system is mainly hostile to it. How life arrived and flourished on Earth is a question open to a considerable controversy.

The most frequently advanced answer today, in which evolutionary forces are appealed to, is one of scientific prejudice since the available evidence when viewed dispassionately shows a leavening element of mystery coupled with the arrival of complex life *per saltum* in a manner compatible with creation. In such a situation demanding the exercise of humility we may close with Melville's powerful lines from "Clarel:"

> But how if Nature vetoes all Her commentators: Disenchant Thy heart. Look round!

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