# ORIGINS

*A Symposium*

Pontifical Athenaeum
Poona

# ORIGINS

*A symposium on*
*the birth of the universe, the dawn of life*
*and the appearance of diverse living things*


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# PONTIFICAL ATHENAEUM STUDIES

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*Anthropological Quarterly*, Washington : J. F. Ewing, S. J., " Human Evolution-1956" ( for fig. 13 and 15 )

Yale University, New Haven : G. G. Simpson, *The Meaning of Evolution* ( for fig. 14 )

Methuen and Co., London : P. Bergsoe, *The Universe and Man* ( for fig. 1 an 2 )

The New American Library, New York : R. Thiel, *And there was Light* ( for fig. 3 )

Letouzey et Ane, Paris : M. Grison, *Problemes d'origins* ( for fig. 4, 6 and 7 )

The Viking Press, New York : G. Gamow, *One, Two, Three ... Infinity* (for fig. 5 ) — and G. Gamow, *Biography of the Earth* ( for fig. 7 ).

Biblical quotations are always from the *Confraternity Edition*, except in Chs. 8 and 9 where they are from the *Revised Standard Version.*

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# ILLUSTRATIONS

# Editor's Preface

Man, that proud spirit caught in the web of space-time and decay, has long been curious about origins. And curious he remains. Today, with an indulgent smile, he disposes of the myths and legends of his primitive ancestors. His modern science has much to say about the origin of the world and its various living things that is both exciting and factual. There simply is no room any more for mythic moonshine. In fact, there is perhaps no room even for the myths of that hoary tome which so many devout Christians revere as *the* book, the Bible.

The contributors to this symposium on origins belong not to the "*either–or*" but to the "*both–and*" school. They are genuinely fond of *both* science *and* the Bible. They all happen to have collected at least graduate degrees in various branches of science, and two of them actually teach science at the university level. They also happen to have acquired a love for the Bible and for their Christian faith from the long years that go into a priest's training. And, upon the more rabid gentlemen of the "*either–or*" school they are sorely tempted to bestow the indulgent smile reserved for primitive ancestors. Ah ! a polemical jibe ? Not precisely.

The point we are really trying to make is that *today* the supposedly clear contradiction between the scientific and biblical approaches to the problem of origins has rightly to be considered an amusing simplification from the past. If one really takes the trouble to make a comparison *in depth* between what science is actually asserting and what the Bible is really talking about, knotty points do remain but the frightful oppositions vanish. Now that is precisely the sort of trouble which *has* been taken, on the reader's behalf, by the contributors to this book.

They have tried to uncover, beneath the welter of facts and new discoveries, the hidden currents and grooves along which scientific thought keeps running. Similarly, they have endeavoured to lay bare the essential message of the early books of the Bible. And, whenever convenient, an attempt has been made to indicate where Catholic theology and the philosophical ideas of Aristotle and Aquinas might perhaps throw additional light.

In brief, they have ventured upon a calmly reasoned, non-polemical examination of the problems connected with the origin of the universe, of life and of diverse living things (including man) from the scientific, biblical, philosophical and theological points of view. It was their aim not to shirk the difficulties, and to be fair enough to admit that in certain cases our present state of knowledge does not as yet offer a satisfactory solution. And all this they have attempted to convey in a summarised and popularised form which might render even the more involved issues palatable to the serious university student or cleric in training.

Surely, a bold venture. Surely, a minor miracle if this book manages to attain all its objectives. However, as Chesterton once remarked, "whatever is worth doing, is worth doing badly." Some good, we hope, will result from our little literary adventure–especially since, to our knowledge, nothing of the kind exists in English under the covers of a single book.

The present work is a "symposium" in the sense that each contributor was originally given full freedom to develop his chosen topic as he thought fit. However, by mutual discussion and arrangement, each was aware of the views of the others and of the plan of the book as a whole. To achieve the desired unity, the editing has been somewhat heavy in Part I ("What Science Says"). This must be mentioned in fairness to the original contributors : any deficiencies in Part I are more likely than not the editor's fault. On the other hand, in the biblical portion (i. e. Part II), the unification was provided much more easily by the contributors themselves, leaving the editor little to do.

This is not the type of book which is likely to appeal to persons who will read nothing but Agatha Christie. Nor will it fascinate those dear people for whom the growing dialogue between Church and modern world is something of a nuisance. It is a book to be grappled with. Its contributors do not expect the reader to swallow all that they say. They will be satisfied if they have managed to stimulate accurate reflection on topics which do have a significance for our educated contemporaries. Above all, they would like to share with their readers that intellectual calm which arises from the recognition that science, philosophy and religion do not operate on the same level of explanation. Each has its peculiar scope, advantages and limitations.

And talking about limitations, this book is surely not free of them—which reminds us to say that we will gratefully acknowledge any comments or suggestions.

It is a pleasure to record the generous assistance without which works of this kind are clearly impossible. The Pontifical Athenaeum took the book under its wing thanks to magnanimous support from the Rector, *Fr. John Cyril Pereira, S. J.* The staffs of both the Papal Seminary and De Nobili College were a source of constant encouragement–and, of wisdom when consulted on the more intricate points.

In particular we are grateful to *Fr. Richard de Smet, S. J.*, for first setting our tottering steps on the path.

Our deepest debt, however, is to *Fr. Stephen Gak, S. J.*, who despite poor health and his normal professorial duties literally spent himself on the "dirty work" connected with printing and publication. In a true sense this is his book as much as anybody else's. Then there is *Fr. Paul Kehres, S., J.*, who spent many precious hours poring over manuscripts and galley proofs for reasons which will ever remain mysterious. In particular he saved Chapters 4 and 5 from a number of loose statements. *Fr. René Van de Walle, S. J.* rendered similar service for Chapters 6 and 7. And among the principal benefactors one cannot forget *Fr. Aloysius Schlegel, S. J.*, who never seemed to notice the constant nuisance we were in his vast and orderly library.

We also stand greatly obliged to : Frs. Hilario Fernandes, Rufino Coutinho and C. Alphonse (of the Pontifical Athenaeum), and Miss Lorna Rodrigues (of St. Xavier's College) for preparing the illustrations; Richard Lambert (of the Pontifical Athenaeum), Clarence Fernandes, Edgar da Silva and Zakir Hussein Bengali (of St. Xavier's College) for helping to type and correct the manuscript; and Fr. Joachim Pastor (of the Pontifical Athenaeum) for the dust-jacket design.

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# PART ONE

# WHAT SCIENCE SAYS

## A

## ORIGIN OF THE UNIVERSE

# Chapter 1

# What the Universe is Like

## 1.1 AN IMMENSE UNIVERSE

The most impressive thing about the universe as it appears to the eyes of twentieth century man is its overwhelming size. It is an immense universe whose vastness numbs our minds, accustomed as they are to the Lilliputian measures of the tiny world in which we live. That world, the earth, is a little globe somewhat less than 8,000 miles in diameter, so that a fast jet plane can circle it in 12 hours, an artificial satellite in less than 90 minutes, a ray of light (if you could induce it to speed round curves) seven times in a second.

**The Solar System**

The *earth* is one of 9 major and about 2,000 minor planets which dance attendance on a star we call the sun. Apart from the vastly important fact that it is our home, the earth is a pretty middling sort of planet—about 20 times as big as the stripling Mercury but a thousand times smaller than giant Jupiter. It circles the sun at a safe distance of 93 million miles and so escapes both the fierce heat which scorches the surface of Mercury a mere 36 million miles away, and the awful desolation of Pluto (the outermost planet) freezing in the feeble rays which reach it from a sun nearly 4,000 million miles off.

Nothing in the solar system can compare in splendour with the *sun*. It is truly immense—a huge globe of glowing gas (mostly hydrogen, a little helium, and traces of most of the other elements) measuring 864,000 miles across.

It is so large that if it were placed centre to centre on the earth, its surface would reach twice as far away as the moon. You could put a million earths into the sun, and leave room to spare.

Each second the sun pours out about ten million billion billion* ($10^{25}$) calories of radiant energy from its surface glowing at 6,000 degrees centigrade. Only about half a billionth of this falls on the earth, but it is this which supports all the life there is–and it is this which was, until Hiroshima, the ultimate source of all the energy used by man. This enormous amount of energy is produced by spectacular nuclear reactions taking place deep in the sun's interior where at temperatures of about 20 million degrees and pressures of more than a billion tons per square inch, hydrogen nuclei (protons) fuse together to form nuclei of helium. Each helium nucleus weighs a little less than the four hydrogen nuclei which went to make it. The difference (about 0·07%) shows the mass which has been changed into energy according to Einstein's well-known equation : $E = m \times c^2$, where "E" is the energy obtained, "m" the mass changed into energy, and "c" the velocity of light. In the sun about 4 tons of matter are changed into energy each second, or 564 tons of hydrogen are changed into 560 tons of helium. But this is only one billionth of one per cent of the sun's total mass, so that the sun will go on burning for millions of years without appreciably losing weight.

**The Stars**

Yet the sun does not cut a particularly impressive figure among its fellow *stars*. On a clear night we can count about 3,000 stars in our half of the sky, but a large

*"Billion" in this book stands for one thousand million, i. e. $10^9$ —and not for a million million, i. e. $10^{12}$.

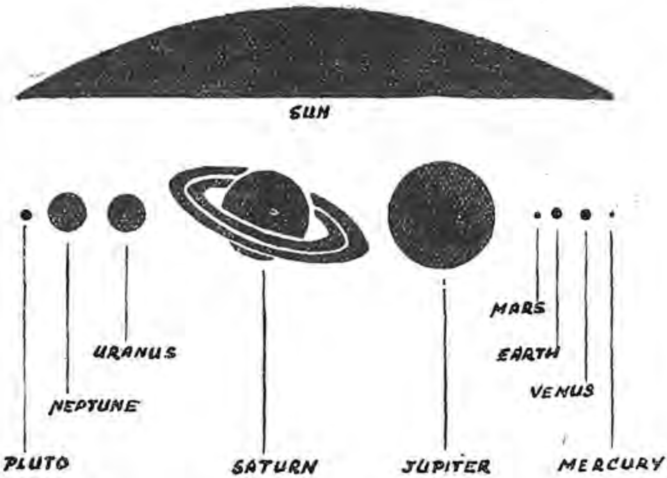


FIG. 1
The proportions of the planets

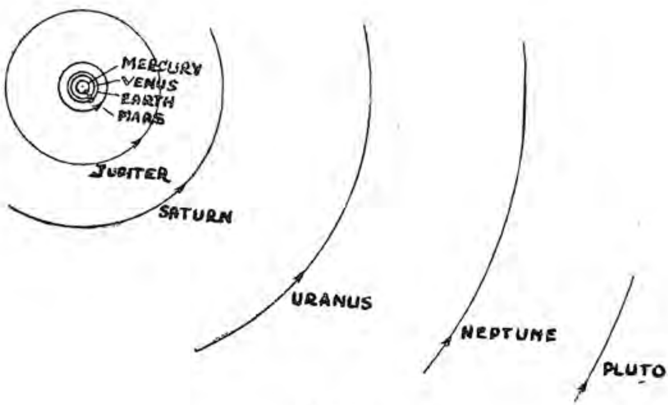


FIG. 2
The planetary orbits

telescope will reveal millions. Star differs from star in glory. Differences in mass are slight, since stars range only from 1/20th to 10 times the mass of the sun. But differences in size and brightness are very great. The Dog Star, Sirius, which is the brightest star we see, has a companion which is only as large as the planet Uranus (diameter = 29,000 miles), while Antares, the bright red star in the constellation of the Bull, is 100 million times as large as the sun. Van Maanen's star is so faint that it is barely visible even to the telescope; but the star Y-Cygni, in the constellation of the Swan, burns with the dazzling brilliance of 30,000 suns.

Ordinarily, the brightness of a star increases with its size. Large stars are brighter than small ones not only because they have a larger emitting surface, but because, as a rule, the larger a star the higher its temperature. Large stars are hot and brilliant stars, so that the ordinary stars include both small, relatively cool "yellow dwarfs" like our sun, and huge brilliant "blue giants" like Sirius. These ordinary stars are also called "main-sequence stars", because they fall on the main sequence or curve of the Russell-Hertzsprung diagram, a graph made by plotting the surface temperature of the stars against their brightness.

But there are two kinds of abnormality. There are stars which though very large are comparatively cool. They are bright because their large surfaces emit a great deal of light, but they burn with a dull red glow. These are the "red giants" like Antares (which, as we have seen, is 100 million times as large as the sun), and E-Aurigae, the bright star in the constellation of the Charioteer, which is 8 billion times as large. The opposite kind of abnormality is shown by the "white dwarfs", tiny but intensely hot stars which shine faintly but brilliantly white.

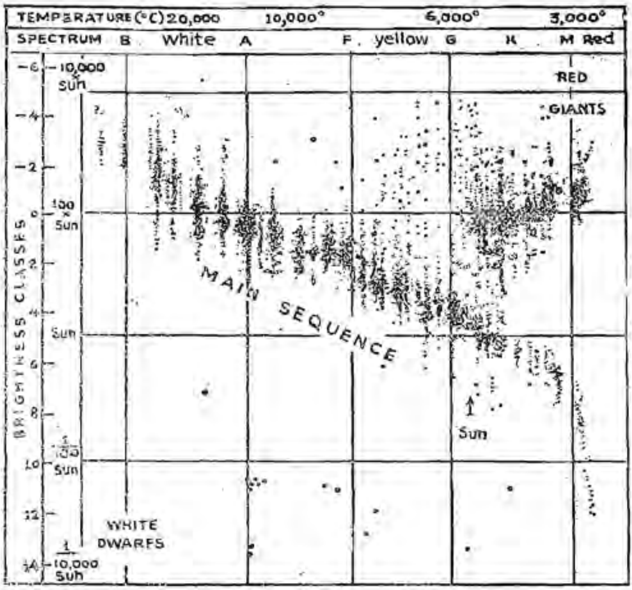


Fig. 3

Russell-Hertzsprung diagram of some of the nearer stars. Each dot correlates the temperature, spectra class and colour of the star (horizontal line) with its brightness and size (vertical line). Note the position of the sun amongst the main-sequence stars and how the red giants and the white dwarfs stand out from the ordinary track.

**A Star's Life-history**

The main-sequence stars, red giants and white dwarfs are regarded not as distinct species, but rather as stages in the life-history of every star. A star is thought to begin life by condensing out of a huge cloud of gas (mainly hydrogen) and dust. Due to the gravitational attraction of its component particles, the cloud contracts and its temperature rises. At about 20 million degrees the hydrogen "ignites" and begins to fuse into helium. Contraction now ceases and we have a hydrogen burning main-s quence star which will be a yellow dwarf or a blue giant depending on the size of the parent cloud. The main-sequence star will go on burning hydrogen for several millions or even billions of years (the larger a star, the more quickly it burns out), till the helium formed accumulates to about a tenth of its total weight.

The star now begins to expand rapidly while its surface temperature falls. It becomes an immensely bloated red giant. Complicated nuclear reactions take place in the red giant–the helium core "ignites" and burns into higher elements like neon and oxygen while the burning of hydrogen goes on along the "skin" of the core. But eventually all nuclear reactions are exhausted and the star (or what remains of it) collapses. It shrinks rapidly into a tiny, incredibly dense white dwarf. The white dwarf continues to burn brilliantly : not now by nuclear reactions, but by its own steady contraction. Eventually even contraction fails and the star cools into a cold, dark lump of crushed matter.

A formless cloud, a vigorously burning main-sequence star, a spluttering red giant showing signs of age, a white dwarf desperately squeezing out the last few drops of life only to peter out into a crushed and barren stone–such is the life-history of a star. In some cases a star presents the spectacular appearance of a "nova" or "supernova", suddenly emitting light and heat up to several million times greater than before. This flare-up helps to get rid of excess matter before transition to the white dwarf stage.

**Our Galaxy, the Milky Way System**

The stars we see are not scattered uniformly in space but are massed into island universes or *galaxies*. Our galaxy, the *Milky Way system* to which the sun belongs, is typical. It is a disc-shaped collection of about 100,000 million stars with a diameter of 100,000 light-years.* Situated apart from the plane of the Milky Way are over a hundred masses called the "globular clusters", each containing stars up to hundreds of thousands in number. Looked at from above, our galaxy would show a distinctly spiral structure with a central nucleus giving off concentric spirally coiled arms. And if we looked long enough, we would see that the spiral is slowly turning, not as a wheel turns, faster at the rim than at the axle, but as a system of planets turns, the outer planets moving more slowly than the inner ones. The sun lies in the Orion arm within the central plane of the galaxy but somewhat towards the edge (about 30,000 light-years away from the centre). Though it moves around the galactic centre at a speed of about 150 miles per second, the sun takes 200 to 250 million years to complete a single round of its long journey.

If our description has suggested that the galaxy is a fearfully crowded place with stars jostling each other for

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*A light-year is one of the convenient units for measuring the tremendous distances encountered in space. It is the distance covered in a year by rays of light–and these happen to travel at 186,000 miles per second. One light-year is approximately 6 million million miles or $6 \times 10^{12}$ miles.

elbow room, it is time to correct that impression. Our galaxy is in fact almost frighteningly empty. It has, it is

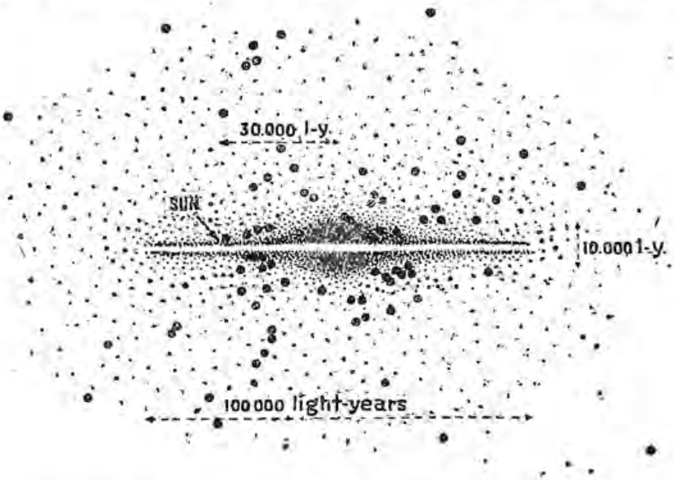


FIG. 4
Our galaxy, the Milky Way system, viewed sideways. The tiny dots represent the stars, and among them (about 30,000 light-years away from the centre) is our sun. The bigger dots are stellar clusters. The interstellar dust is thickest where the white band appears to split the galaxy into two halves.

true, its 100,000 million stars. But these stars are spread out in so vast a space that the average distance between two stars is 4 light-years. Proxima Centauri, the star nearest the sun, is 4·3 light-years away – and this is like the distance between two table-tennis balls 750 miles apart.

All the vast space between the stars is filled with a very tenuous (a few atoms per cubic centimetre) *interstellar gas*. Here and there, specially in the spiral arms, occur large opaque *cosmic dust-clouds* which (with gas) are the raw material from which stars are formed. Spectacular *gaseous nebulae* shine like luminous veils of gauze where (as in the Orion nebula) the ultra-violet radiations from particularly bright blue stars light up the interstellar gas around. Other nebulae still smoulder menacingly as flaming debris from the fierce fires which once shattered a star. Thus the Crab nebula, a rapidly expanding cloud of glowing gas, was ejected by the explosion of a supernova in prehistoric times. Light from this event finally reached the earth in July 1054 A. D., the fact being recorded by Chinese astronomers. And, all over, streams of *radiation* criss-cross the universe from end to end : rays of light, short wave ultra-violet and X-rays, heat rays, swiftly moving streams of high-energy atomic particles (cosmic rays), and even radio waves. These last are emitted by powerful sources (radio stars, radio galaxies) within and without our galaxy. Atoms of free hydrogen in "empty" space emit characteristic 21 centimetre radio waves ("the song of hydrogen") which have much to tell radio astronomers about the shape and movement of the immense galaxy to which we belong.

**Planetary Systems in our Galaxy**

Of the 100,000 million stars which make up our galaxy, one we know is attended by 9 large planets–among which one planet is for us "*home*" and the most important place in all the universe. But is the sun unique in possessing planets ? There is no reason to think so. True, no other planetary systems have so far been seen–but that is simply because stars are too far away. And from irregularities in the movements of stars nearer by, we have been able to infer the presence of large, presumably planetary bodies. The star 61-Cygni, about eleven light-years away, has an invisible companion of about 1/60th the mass of the sun. 70-Ophiuci has another of only 1/100th the sun's mass. Both of these are much larger than any planet of the solar system (Jupiter, the largest, is only 1/1000th of the sun), but they are well within planetary size and it seems preferable to regard them as large planets rather than as companion stars.

These observations however are inconclusive, and ultimately our views on the existence of planetary systems other than our own will depend on what we feel about the mode of emergence of a planetary system—and particularly of the solar system, which is the only one we know anything about. Till recently the "near collision theory" or "tidal theory" popularised by Sir James Jeans was all the rage. It supposed that the planets of the solar system had condensed out of a gaseous filament drawn out of the sun by the tidal action of a large star which happened to pass very close to it. If this is the way in which planets are formed, planetary systems must be few indeed since a near collision between two stars can only be a rare event in our empty galaxy.

But the near collision theory is no longer in favour. It has yielded place to the "condensation theory" of von Weizsaecker, which is an elaboration of Laplace's "nebular hypothesis" proposed 200 years ago. This supposes that the young sun was surrounded by a rotating gaseous envelope. The envelope because of its rotation slowly flattened out into a disc and began to recede from the central core. Planets were formed by the aggregation of the solid and liquid particles in the disc round certain centres of aggregation provided by the stable eddies in the rotating disc. This theory which explains a great many apparently arbitrary facts about the size, position and composition of the planetary bodies is very satisfactory, and it suggests that planetary systems are not quite as rare as they were once thought to be. Any star of sufficient size should normally put out a ring from which planets should form. Planetary systems are not the exception but the rule. Hoyle estimates that there should be 10,000,000 planets in our galaxy of which 1,000,000 should be capable of supporting life. These figures (like so many of Hoyle's suggestions) are very conjectural. But that many stars other than our own sun have planets, is likely.

**The Universe, a "Gas of Galaxies"**

For a long time our galaxy was believed to contain the whole of the *universe*, and it is certainly large enough to support that illusion. The great 200-inch telescope on Mount Palomar which peers out at least 2,000 million light-years into space has spotted more than two billion galaxies like ours. They are of different sizes, but fall into three broad groups on the basis of shape : *elliptical* galaxies without spiral arms, *spiral* galaxies with arms coiled tightly or loosely round a central disc, and *irregular* galaxies of no particular form. The *barred spiral* galaxies are a special sub-group of the spirals in which the arms are attached to a bar across the central disc. Astronomers believe that these different kinds of galaxies (like the different kinds of stars) are parts of an evolutionary sequence, though they are not at all sure just where the different types fit in. One acceptable view is that galaxies evolve from irregular to barred spiral, to spiral, to elliptical. The spiral galaxies would then be young galaxies; the elliptical, old ones. But all this is very conjectural, and there are quite a few astronomers who believe that galaxies evolve in precisely the reverse order.

What is more certain is that galaxies tend to form clusters most of which are small, like our own "Local Group" of at least 17 members. But clusters with as many as a thousand galaxies are not unknown. Are these clusters grouped, as some have suggested, into larger aggregations called "supergalaxies" ? It would appear not

Clusters of galaxies seem to be distributed more or less uniformly through the universe. Since galaxies are so immense, the universe is somewhat more crowded with galaxies than a galaxy is with stars. But "crowded" is scarcely an appropriate word. The average distance between two galaxies (2,000,000 light years) is like that between two tennis balls 50 feet apart. Like the galaxy, the universe is a very empty place. It has been very aptly described as a "gas of galaxies".

A glowing, rapidly expanding gas of more than two billion galaxies–each of which is itself a swirling gas of about 100,000 million stars–that is what the visible universe is like. "Think of the sun," writes Sir James Jeans, "as a speck of dust in a large city, and the earth as a millionth part of the speck of dust, and we begin to have perhaps as vivid a picture as the mind can really grasp of the relation of our home in space to the rest of the universe." The universe is truly immense.

## 1.2 AN EXPANDING UNIVERSE

As if it were not already large enough, the universe, we are told, is rapidly *expanding*. Clusters of galaxies are running away from each other at speeds proportional to their distances apart. When this distance is 500 million light-years the speed of recession is an astonishing 9,300 miles per second, but it increases to 38,000 miles per second when the distance is 2,000 million light-years. This introduces the possibility that we will never be able to see the galaxies which are really far out (assuming that such galaxies exist). They will be running away from us with the speed of light. Their light will therefore never have a chance to reach us. Such light will be–to use Eddington's comparison–"like a runner on an expanding track with the winning post receding faster than he can run."

We can picture this strange flight of the galaxies by imagining a balloon with large dots on its surface being slowly inflated. As it fills up, an observer on any dot will see the other dots receding from him at speeds proportional to their distances. So the recession of the galaxies means that the universe is expanding, just as the recession of the dots on the surface of the balloon means that the balloon is being inflated. Galaxies are running away from each other because the universe of "curved space-time" in which they are embedded is steadily growing larger.

**The Red Shift**

But we must be careful. The astronomer does not actually *see* the galaxies running away from each other; they are too far away for that. He *infers* their flight from the curious fact that the light they give out is redder than it should be. More accurately, certain characteristic dark lines in the spectra of these galaxies (notably the absorption lines of the elements potassium and hydrogen) are displaced towards the red end of the spectrum, the displacement being proportionately greater for more distant galaxies than for nearer ones. This red shift is interpreted as a "*Doppler effect*"–an effect we are familiar enough with in our age of screeching jets and loudly honking cars. When a sleek Cadillac flashes past a harassed pedestrian with all its horns blaring, he notices that the pitch of the sound *rises* sharply as the car *approaches* him, but that it *falls* off as the car *moves away*. Sound, we know, is a wave movement in the air. And we find the same effect in other kinds of wave emission too. In every case the pitch of the emission is affected by the movement of the source: it rises (i. e., the wavelength becomes *shorter*) as the source approaches the observer, and falls (i. e., the wavelength becomes *longer*) as it moves away from him. Now light is an electromagnetic wave, and so the light from an extremely rapid, moving object should look *bluer* (shorter waves) as the object approaches us, and *redder* (longer waves) as it moves away. And since light from the distant galaxies does in fact look redder than it should, we infer that they are moving away from us.

Other explanations are of course possible. But astronomers are so unanimous in holding on to the Doppler interpretation that the expansion of the universe has become almost an axiom of modern cosmology. There are several reasons for this :

1. Alternative explanations of the reddening–such as the scattering of light in intergalactic space, or the slowing down of light waves due to a "fatigue effect"–have all proved unsatisfactory.

2. An exactly identical shift towards longer wavelengths is observed in the radio waves which come to us from certain powerful extragalactic sources. This is understandable if the shift is due to a Doppler effect, since the movement of the source will affect all types of radiation (light waves or radio waves) in the same way. But it is not intelligible if the shift is due to some other sort of "space effect", since it is hard to see why anything in the space they cross should affect both light and radio waves in exactly the same way.

3. Most important of all, a Doppler interpretation implying the expansion of the universe is completely in line with what mathematical cosmology expects. The mathematical cosmologist builds *models of the universe* not out of wood and plaster, of course, but out of equations which attempt to deduce from the laws of terrestrial physics the structure and properties of the universe as a whole. Now

it is a fact that the laws of physics as we know them today (and their best expression is found in the general relativity equations of Einstein) do not allow us to construct a *static* model of the universe. On purely theoretical grounds, mathematical cosmology expects the universe to be either expanding or contracting. And the red shift, if interpreted as a Doppler effect, both confirms this expectation and is confirmed by it.

**Models of the Universe**

Building models of the universe is no new game: man has been busy at it for as long as he has lived on earth. Only, his pictures have gone on becoming more and more abstract until they are now almost as difficult to interpret as the latest surrealist creation from the studios of Montparnasse. The ancient Babylonians, plain practical people, pictured the world as a solid disc (the earth) resting on the waters of the ocean and covered with a solid bowl (the sky) to which the sun, the moon and the stars were fixed like so many lamps. The Greeks were a little more elaborate. They thought out an ingenious arrangement of crystalline concentric spheres (with the earth at the centre of the lot), carrying the sun, the moon, the various planets and the stars, and turning round the earth at appropriate speeds so as to reproduce the movements of the heavenly bodies in the sky. But as the vagaries of the planets came to be better known, it became more and more difficult to picture their movements accurately. By the end of the Middle Ages Ptolemy's system of concentric spheres had become fearfully complex in a desperate attempt to accommodate the newly discovered facts. Copernicus, we know, greatly simplified things by putting the sun instead of the earth at the centre of the system.

This was an enormous psychological revolution but it left the spheres untouched.

It was Kepler who dealt the first blow when he suggested that the planets moved round the sun not in circles but in ellipses. And when Newton discovered the law of gravity, the whole of this complex system which had dominated the imaginations of men for nearly two thousand years crumbled to pieces. Instead of crystalline spheres we now had the tension of intangible forces (gravity and inertia) holding the universe together. And the universe became an infinitely large container called *space* (which in the 19th century was for a time filled with a mysterious "ether" through which light waves were supposed to be propagated). The various heavenly bodies contained in space moved round each other in orderly patterns strictly determined by Newton's law of gravity and three laws of motion. Everything was precise, orderly, predictable. As the poet Pope put it:

> Nature and nature's works lay hid in night,
> God said: "Let Newton be"—and all was light.

But this happy state of things was not to last long. Soon Einstein was to appear and send Newton's universe the way of the others, so that a wit could appropriately cap Pope's couplet with:

> The Devil rising up in wrath said: "Ho!
> Let Einstein be," restored the *status quo*.

Still it would be wrong to think of Einstein's theory as just another attempt at mystification on a grand scale. Rather it is, in one sense, an enormous simplification. Einstein gives us a *universal physics* whose laws will be valid in all possible systems of reference. The principle of restricted relativity states: "The laws of physics are the same in all *inertial systems*, i. e., in all systems at rest or in uniform motion (moving with uniform speed in a straight line) with respect to each other." And the principle of general relativity says the same of *non-inertial systems*, i. e., systems moving with a non-uniform or accelerated velocity with respect to each other. That substantially is what the celebrated "theory of relativity" states.

But then not everything is quite as simple as that, and behind these apparently innocent affirmations there lurk all the familiar paradoxes of Einstein—lengths which contract and clocks which slow down in moving systems; rays of light which always appear to be moving at the same speed no matter in what direction we approach them; mass which changes into energy; gravity which turns out to be inertia; and of course space which is curved. An exploration into this unfamiliar idea of "curved space" and its peculiar geometrics in relation to the Euclidean geometry and curved surfaces (cylindrical or spherical) with which we are more at home, should be rewarding.

**Curved Space** Curved space tantalises us because we always seem to be on the verge of picturing it without ever being able to do so. And there is nothing we can do about it. We shall never be able to picture curved space because our imaginations can only work in three-dimensional images, and no amount of straining will get them to add that fourth dimension needed to represent curved space pictorially. But that does not mean that there is anything vague or absurd about curved space. If we cannot *imagine* it, we can certainly *understand* it. We cannot draw a picture, but we can at least form an idea. And our idea of curved space need be no more imprecise than our more familiar idea of a curved surface.

A sheet of paper stretched out before me is a *flat surface*, a *two-dimensional continuum* on which the geometry we learnt at school (Euclidean geometry) is valid. If I draw a triangle on this flat sheet of paper, I know that the sum of its interior angles will be two right angles. If I draw a pair of parallel lines, I know that they will never meet. If I draw a right-angled triangle, I know that the square on the hypotenuse will be equal to the sum of the squares on the other two sides. But if that piece of paper could be bent into a sphere, queer things would begin to happen. The sum of the angles of a triangle turn out to be greater than two right angles, and lines parallel at the equator meet at the poles. The geometry of the curved surface is no longer the geometry we know. A *curved surface* is non-Euclidean; it is a *two-dimensional non-Euclidean continuum.*

In the present scheme of physics, two kinds of curved non-Euclidean space are the only alternatives to flat Euclidean space as the space of the universe. These are *spherical space* corresponding to a *spherical surface* with its closed (or positive) curvature, and *hyperbolic space* corresponding to a *saddle-shaped* surface with its open (or negative) curvature.

The geometry of a *saddle-shaped* surface is that of *Lobatchevsky*, in which the sum of the angles of a triangle is less than two right angles and parallel lines approach each other asymptotically without ever meeting. On the other hand, the geometry of a *spherical* surface is that of *Riemann*. Here, as we have noted, the sum of the angles of a triangle is greater than two right angles and parallel lines meet. Such a spherical surface has other interesting properties. It is perfectly *symmetrical*. There is no privileged central point on the surface of a sphere (we are not talking here of the sphere as a three-dimensional solid, but only of its two-dimensional surface). Each point is the centre of all the others. Also, unlike a flat

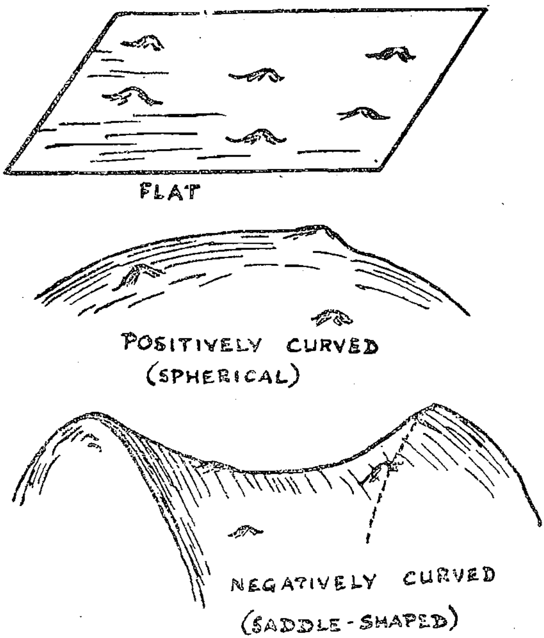


FIG. 5.

The flat ( Euclidean ) surface and the two curved (non-Euclidean) surfaces.

or open surface, a spherical surface is *finite but unbounded.* If an ant were to take a walk on a flat sheet of paper, it would (if it went on marching straight ahead) either fall off the paper when it got to the edge, or keep on going for ever if the paper happened to be infinitely long. But on the surface of a globe neither of these things would happen. The ant would neither fall off, nor would it go on endlessly. It would, like Magellan, come back to its starting point.

Curved space is the three-dimensional analogue of a curved surface: it is in three dimensions what a curved surface is in two. And so, unlike ordinary flat space, *curved space* is non-Euclidean : it is a *three-dimensional non-Euclidean continuum.* Its geometry will be that of Lobatchevsky if the space is hyperbolic space with an open curvature; it will be that of Riemann if the space is spherical space with a closed curvature. Spherical space will be *symmetrically disposed* with reference to all its constituent points : each point will be (and in three dimensions, not just in two) the centre of all the others. It will also be *finite but unbounded.* A ray of light in a spherical universe will not keep on going for ever but will come back on itself, and a patient observer who waits long enough, will be able to see the back of his head. Finally, just as we get a curved surface by bending a flat two-dimensional surface through a third dimension, we should presumably get curved space by bending flat three-dimensional space through a fourth spatial dimension. But that is a mental experiment it is not advisable to try.

Einstein's theory of general relativity implies that space is curved by matter. Large concentrations of matter like the stars and the galaxies appreciably curve space around them, and it is this deformation of space which, in Einstein's theory, is responsible for the effects of gravitation. Gravity ceases to be a mysterious pull exerted at a distance and becomes instead a property of space. But all this does not tell us anything about the shape of the universe as a whole. The question is : Apart from these *local* deformations produced by concentrations of matter, is space *as a whole* curved ? In other words, is our universe a flat (Euclidean) universe with a wrinkle here and there, or is it a curved (non-Euclidean) universe ? We are reminded of a similar question that was posed to the contemporaries of Columbus. Is the surface of the earth in spite of its local irregularities like hills and valleys ultimately flat, or does it—as some mad visionaries dared to assert—bend back upon itself? Einstein believed that the two questions had the same answer. Like the surface of the earth, the space of the universe too (but in three dimensions, not just in two) is curved.

**Einstein's Model for the Universe**

To obtain a model for this curved universe, Einstein made some simplifying assumptions without which calculations would have been impossibly complicated. He assumed that the universe was "homogeneous" (i. e., with the same large-scale features everywhere) and "isotropic" (i. e., with the same properties in all directions). But in working out the equations based on his new ideas about the gravitational curvature of space-time as applied to the universe as a whole, Einstein could find no solution which described a *static* universe. Now static the universe had to be, because the recession of the galaxies had not yet been discovered.

In 1917 Einstein realized that the problem could be surmounted by the introduction of an arbitrary new term in his equations. This is the celebrated cosmical constant "λ" (*lambda*) which is the exact opposite of the gravitational constant "*g*" because it stands for a feeble force of *repulsion* between bodies. The repulsion increases with distance and becomes significant only at galactic distances. Matter, in effect, attracts at short range and repels at great distances.

Einstein's model allows for a spherical universe (closed, symmetrical, finite but unbounded) whose radius of curvature depends only on the amount of matter it contains. Using the then accepted estimate for the mean density of the universe (a quantity whose true value is still very uncertain), Einstein obtained the figure $10^9$ light-years for the radius of his spherical universe.

The only trouble about the spherical, static universe of Einstein is that it is *unstable*. If such a universe is static, it is only because of the exact balance between cosmological repulsion and gravitational attraction. But this balance is precarious. If due to internal changes of density either $\lambda$ or $g$ should even for a moment prevail, the universe would at once start expanding or contracting—and nothing would be able to stop its expansion or contraction. In an *expanding* universe, $\lambda$, the force of expansion (which increases with distance), would become from moment to moment stronger, and $g$, the force of contraction (which decreases with distance), steadily weaker. In a *contracting* universe, of course, just the opposite would happen. The Einstein universe is a universe on a tightrope. The least fluctuation of density is enough to send it crashing into a process of irreversible expansion or contraction according as $\lambda$ or $g$ should happen to get the upper hand.

**The Universe of De Sitter**

An alternative model for a static universe was derived from the general relativity equations by De Sitter. It describes a spherical universe whose radius of curvature depends not on the amount of matter it contains, but solely on the cosmical constant. But neither is this a very satisfactory model. The universe it describes turns out to be a peculiar sort of place—not only is it totally empty (the density of matter is taken as zero, i. e., matter is supposed to be so thinly spread out as to have no cosmological singnificance whatever), but it is also a fantastic Alice-in-Wonderland world of continual illusion. Time is completely relative in the De Sitter universe, so that events slow down as they recede from an observer and eventually come to a stop. Even a ray of light cannot cross this "time barrier" : as it wings its way through space, it too slows down and stops. And so the universe which is in fact finite will (because it cannot be crossed) *appear to be infinite*. Then too, light from distant objects will be reddened because of the slowing down of the atoms which emit it. And because this reddening will be interpreted as a Doppler effect, the universe which is in fact static will *appear to be expanding*. Finally, De Sitter's equations of motion tell us that particles introduced into his empty universe will really recede from each other as if repelled by a force proportional to the distance. So that the De Sitter universe while not exactly a universe of expanding space, is in fact a universe of *really expanding matter* in an *apparently expanding* (and infinite) *space*. It is not really a static universe : it is *pseudo-static*.

The universe of Einstein and the universe of De Sitter are the only two "static" models which can be derived from the general relativity equations. And neither turns out to be really static. Einstein's universe of "matter-without-motion" is *unstable*. De Sitter's universe of "motion-without-matter" is *pseudo-static*. The present scheme of physics would not seem to favour a static universe. On the other hand, once the postulate of a static universe is given up (and the red shift suggests that there is good reason for abandoning it), several satisfactory models for a *dynamic* universe of "matter-in-motion" can be derived from Einstein's equations. And it is these dynamic models representing an expanding universe which are the mathematical basis for modern theories of cosmology. Later on, in chapter two, we will come back on the models of Einstein and De Sitter which find a place within the dynamic framework of Lemaître's "primeval atom theory".

## 1.3 A DYING UNIVERSE

The expansion of the universe is not, as one might think, a sign of growth but of decline. The expanding universe is a universe which is dissipating itself away and its expansion is part of a general process of decay which will lead inexorably to its death. So at least says the second law of thermodynamics which was first formulated a hundred years ago and still remains one of the unshaken pillars of modern physics.

**The Second Law of Thermodynamics**

For all its awesome name, the second law is a simple one. It states with commendable brevity: the "entropy" of a closed system always increases whenever an energy change takes place in the system. Such energy changes are of course continually taking place in the universe whenever there is movement or activity of any sort. The *quantity* of energy changed cannot be affected because energy can neither be created nor destroyed. But the *quality* of the energy can be altered. Some at least of the energy is degraded: it becomes less available for work, less usable, less organized. Now *entropy* is precisely a measure of what Eddington has called "the random element". What the second law says is that the *entropy* always *increases*, i. e., whenever energy changes from one form to another, it becomes more disorganized.

Falling water for instance has energy in a highly organized state. Its energy is the energy of movement ("kinetic energy"), the energy of millions of particles all moving in the same direction with the same speed. When the falling water strikes a rock, some of the energy of movement is changed into heat energy. Heat too is a form of kinetic energy: it is the energy a body has because of the random agitation of its molecules. So what has happened is that one form of energy of movement has been changed into another—the *random* movement of the molecules of the rock and the water has increased, at the expense of the *orderly* movement of the particles of the falling water. There is of course as much movement after impact as there was before. But whereas before, in the falling water, the movement was that of particles moving in an organized way like the disciplined march of an army, it has now become the movement of molecules moving at random like the frenzied rioting of a mob. The energy has not been lessened but it has been disorganized. Its entropy has increased. And this, the second law tells us, is what happens in *all* energy changes.

**The End of the Universe**

Heat, the random movement of molecules, is about the most disorganized form of energy we know. But as long as heat is concentrated in a given body which is at a higher temperature than its surroundings, the energy is not wholly disorganized. There is some difference between the faster molecules of the hotter body and the slower molecules of the bodies around. Such a concentration of heat can be made to do work (as in a steam engine) though not very efficiently, since the work obtained is always very much less than the energy put in. But once the heat has diffused out evenly over its surroundings (as heat invariably tends to do), the little organization it has is wholly lost. There is now no more distinction between fast and slow molecules, but through mutual collisions the speeds of all the molecules have more or less averaged out to a dead level. The molecules are now in what is called "dynamical equilibrium". Their energy is wholly unusable. No more energy changes are possible.

So what the second law comes to mean is that all the energy in the universe will eventually be degraded into heat energy and the heat will tend to diffuse out evenly. Nothing can reverse the direction of this change. Once organization has been lost, the random movement of molecules will not restore it again—no more than random shuffling will restore the original order of a pack of cards. This implies that the world is heading inexorably towards a "heat death", towards a state of maximum entropy, of total undifferentiation where all energy has been reduced to the energy of molecules moving at random in a state of dynamical equilibrium. No further energy changes will then be possible. Time will have come to a stop. The universe will be dead.

**The Beginning of the Universe**

To this end of the universe there must correspond a dramatic *beginning*. If the entropy of the universe increases steadily as we look towards the future, it diminishes steadily as we look towards its past. There was less entropy in the universe yesterday than there is today. And as we look at the past of the universe down vistas of steadily diminishing entropy, we must inevitably come to a point beyond which we cannot go, because the entropy here is zero and the organization of energy a maximum. This Eddington tells us is the beginning of the world :

> There is no doubt that the scheme of physics as it has stood for the last three quarters of a century postulates a date at which either the entities of the universe were created in a state of high organization, or previously existing entities were endowed with that organization which they have been squandering ever since. Moreover this organization is the very antithesis of chance. It could not have occurred fortuitously.

But not all scientists are quite so enthusiastic about this "entropological argument" for what Sir James Jeans has described as "creation at a time not infinitely remote". The second law, they point out, does not define the *rate* at which entropy increases and so we can push back the beginning it implies as far as we please. Besides, there is no guarantee that the second law is valid *all over* the universe and over *indefinite periods* of time. Finally, this is a statistical law (like the laws used by Insurance Companies to calculate their premiums) describing the *probable* behaviour of a large crowd of molecules. It is true that with very large numbers the probability approximates almost to a certainty. All the same, states of equilibrium or even of diminishing entropy, though extremely unlikely, cannot be absolutely ruled out.

When all is said and done, entropy continues to pose a challenge to the cosmologist. Modern theories about the origin of the universe have not been able to by-pass it without admitting " creation " in some form or other. According to one powerful school of evolutionary cosmologists, the universe (or at least this present phase of the universe) was *created at a given moment*, the first in its history as a low entropy "Cosmic Atom" whose explosion set the universe on its dizzy path of expansion. Supporters of the rival steady state theory talk of the *continuous creation* of low entropy hydrogen atoms, which, they say, keep popping out of nothingness. Whatever the theory or school, it must take into account both the expansion of the whole universe, and the apparent increase of entropy in our corner of the universe. The one big bang at the beginning seems to pass both tests admirably. But the succession of small bangs from continuously created matter, while providing the driving force for the expansion of the universe, would merely neutralise the increase of entropy—to leave the total entropy in the universe constant.

**The Age of the Universe**

When we come to the related question of the age of the universe, i. e., of how long it is since the universe began, we encounter another significant difference between the two rival theories just mentioned. The age of the universe is sometimes given as 10 billion (10,000 million) years. On the assumption that the rates of recession of the galaxies are now what they always were in the past, it can be calculated that some 10 billion years ago all these galaxies were packed together in the same place.* Here then we have what is, in some sense, a beginning for the universe. But, apart from dubious validity of the assumption made for constant galactic recession rates, there is a fundamental difficulty. A meaningful age for the universe cannot be assigned without making a choice between the evolutionary and steady state theories. Those who hold the steady state view will say that the galaxies 10 billion years ago were not packed together at all, but that the universe by and large then looked much the same as now.

The evolutionary theories must suppose a *changing* universe which has ultimately disintegrated from a superdense, low entropy initial state to its present diffuse and disorganized condition. In such theories, the term "age of the universe" stands for the *real duration* either of the

*Rough ages can also be assigned to the solar system and to our galaxy. From the analysis of the decay products of meteorites, the solar system is taken to be approximately 5 billion years old. Other methods based on the disintegration of star clusters and on the chemical composition of the stars provide an age of about 7 billion years for our galaxy.

universe itself (if we believe that the universe is finitely old and came into being at a precise instant a few billion years ago), or of the *present expanding phase* of the universe. In this latter possibility we could, for instance, conceive the universe itself as being infinitely old with phases of alternate expansion and contraction succeeding each other endlessly. The present expanding phase would however have begun a few billion years ago, so that the "age of the universe" refers to the duration of this present phase.

However, as we have suggested already, the steady state theory assumes that the universe in its large-scale features does not change but *remains always the same.* The thinning out of matter due to its expansion is made good by the appearance of new matter which is being continually created in the depths of space. Here, evidently, the "age of the universe" has no real meaning. It does not stand for any real duration. It is interpreted as the average age of the galaxies which are being continually born into a universe infinitely old.

And so, although we started by saying that the increase of entropy suggests an eventual *end* for the universe to which there would seem to correspond an inevitable *beginning*, we finally discover from rival theories that this beginning is not so inevitable. Hence speculations about the *age* of the universe are secondary to and dependent upon the solutions offered to that more fundamental problem which concerns the very origin of the universe. In the next chapter we shall discuss in detail what solutions are in fact offered by the steady state view-points of Bondi, Gold and Hoyle in comparison with the Lemaître form of evolutionary theory. There are of course other forms of evolutionary approach (less significant perhaps—at least for our scope), but these for the most part we will have to leave aside.

# Chapter 2

# How the Universe Came to Be

Cosmologists today would all admit that the universe is *immense* and *expanding*. They would also agree that it is *growing old*—at least our little corner of it, because not all would be prepared to admit this of the universe as a whole. But when it comes to the "*history*" of the universe, general agreement ceases. At present there are a number of different views, but it is true to say that in reality opinions centre around two main camps. The basic clash—other divergences are relatively minor—is between the evolutionary cosmologists and the steady state cosmologists. The former hold that the universe has changed and evolved with time, so that we can trace within its past a condition of origin, some unique and singular state. The latter feel that the state of the universe has steadily remained constant : past, present and future has nothing to do with it.

Could we today choose between these two camps on the basis of strict scientific evidence ? And, supposing we could, will science have provided the ultimate explanation ? Could perhaps philosophy and theology throw some light on how the universe came to be ? These are the problems to be explored in the present chapter.

## 2.1 THE PRIMEVAL ATOM THEORY OF LEMAITRE

There are many possible ways of picturing an evolving universe. The best, because the most complete and convincing, is that sketched out for us by the Belgian priest-astronomer, the Abbé Georges Lemaître of Louvain, in a brilliantly original and comprehensive theory about the origin of the world which he proposed in 1927.

The red shift had just been discovered by the Americans Humason and Hubble, though no one was as yet very sure of what exactly it meant. Friedman, a Russian mathematician (and Lemaître himself independently of him) had shown that satisfactory models for an expanding universe could be derived from Einstein's general relativity equations. Radioactivity discovered half a century earlier by Becquerel and the Curies in France had revealed an astonishing world of atoms that exploded spontaneously. The mysterious cosmic rays turned out to be streams of powerful radiation and high energy atomic particles raining down on the earth from outer space. And, for Lemaître, all this added up to his "*Hypothesis of the Primeval Atom*"—an apocalyptic picture of an expanding universe which started off with a bang. The universe, as Lemaître sees it, derives from a primeval cosmic atom which exploded violently. Its history is the history of this "radioactive disintegration" whose traces are still with us, and in it Lemaître distinguishes three stages.

**The Initial Explosion (first stage)**

Billions of years ago (20,000 million to 60,000 million years according to present estimates), all the matter that exists in today's expanding universe was packed together as tightly as possible into a single cosmic atom which completely filled up all the space then available. Here was matter (or rather, "prematter") at its densest squeezed together so tightly that every trace of structure—molecular, atomic, nuclear—was crushed out of existence. A mass equivalent to $10^{21}$ tons was gathered in a volume of space no bigger than the solar system is today. The density of this primeval lump must have been colossal, each cubic inch weighing millions of tons.

The superdense, cosmic atom was highly unstable and at once exploded mightily. Its fragments kept on fissioning over and over again until they could fission no more, and the resulting debris contained the atomic nuclei we know. If, for the sake of simplicity, we assume that the fragmentation always resulted in pieces of equal size, about 260 generations would be needed, Lemaître tells us, to reach " the present pulverization of matter into pieces almost too small to be broken again." Almost too small —but not quite ! Some of the largest of these pieces are still breaking up. These are the atoms of the radioactive elements—of radium, uranium and thorium. *Radioactivity* represents the last feeble splutterings of the big bang. At the same time, a great deal of powerful radiation and streams of high energy particles were emitted by the exploding mass and these continue to circle the world as the *cosmic rays.*

**Equilibrium the Universe of Einstein (second stage)**

The explosion of the primeval atom meant a rapid expansion of the elliptical space*, always filled uniformly with the increasingly dispersed flying fragments of the shattered atom. Little by little the original impetus of the expansion began to weaken, and when the density of matter reached the critical value of $10^{-27}$ grams per cubic centimetre, gravitational attraction ($g$) and cosmical repulsion ($\lambda$) just balanced each other. Conditions were now suitable for the static universe of Einstein,

*The elliptical space visualised by Lemaitre is like the spherical space described earlier, except that each point has two antipodes instead of only one.

a universe of radius $10^9$ light-years, uniformly filled with a thin gas at a low temperature, and teetering uncertainly on the edge of expansion or contraction.*

Such a large mass of cool gas is gravitationally unstable. It will tend to form condensations. The interplay of local condensations on the one hand and of the large-scale expansion caused by these local condensations on the other, would then produce a complex dynamical situation :

—over *small regions* of the universe (in the concentrations of matter formed by local condensations) where the density is greater than the equilibrium value ($10^{-27}$ grams cc.), $g$ would be stronger than $\lambda$ and these concentrations would condense out into galaxies. There is a formula in physics which tells us the average size of the clouds that should condense out of a large mass of gas at any given temperature and pressure. It suggests a diameter of 40,000 light-years and a mass of about 200 million suns for the clouds that should form in the Einstein universe. These then should be the average dimensions of the galaxies, if Lemaître's account of their formation is true. And, as far as we can tell, galaxies are in fact more or less this size.

—over *larger regions* in which the average density approaches the equilibrium value, $g$ and $\lambda$ would balance each other, so that the clouds which condense out would be held in a sort of frozen equilibrium and clusters of galaxies would be formed. The average density of galac-

*How long did the whole phase of equilibrium last ? Lemaître did not specify. Current estimates would indicate that it stretched over the enormous period of 10,000 million to 50,000 million years, but that it began only after about 1,000 million years from the initial explosion. The end of the equilibrium could be traced to the beginnings of galactic recession some 10,000 million years from our own day.

tic clusters is in fact found to tally with Lemaître's calculations.

—finally, over the *universe as a whole*, $\lambda$ would become stronger than *g*. The galactic clusters would recede from each other with ever increasing speed, and the univers would be launched onits career of expansion.

**Expansion towards the Universe of De Sitter (third stage)**

At present we are in the third and final phase of the expanding universe. Already the density of the universe has diminished a thousand times and its radius increased tenfold since the equilibrium period. Soon the velocity of the flying galaxies receding faster and faster from each other will approach the velocity of light, and no communication between them will be possible. Each will inhabit in splendid isolation the empty universe of De Sitter.

"The evolution of the world," writes Lemaître, "can be compared to a display of fireworks that has just ended : some few red wisps, ashes and smoke. Standing on a well cooled cinder, we see the slow fading of the suns and we try to recall the vanished brilliance of the origin of the worlds."

**Beyond the Primeval Atom**

After thirty years of the most prodigious progress in theoretical and observational astronomy, Lemaître's theory remains "the best that relativistic cosmology can offer." No other theory gives so simple and convincing an explanation of so large an array of facts. Nor, perhaps has any other theory been so thoroughly studied. As a result, the original framework has been enriched by subsequent contributions which have filled in many details and furnished carefully worked out mechanisms for processes which

Lemaître had merely suggested. The present day picture of the evolving universe is a much more sophisticated affair than Lemaître's somewhat naïve description of the "super-radioactive disintegration" of a primeval atom. Still it is not the final answer to our questions about the universe. It takes us back to the primeval atom, but the primeval atom itself poses a problem. It is not a full stop but a question mark. Even if the universe has in fact come from the primeval atom, we have still to ask where the primeval atom itself comes from.

For Lemaître this is a question which science cannot answer, simply because the primeval atom (scientifically speaking) does not come from anywhere at all. It is the true beginning of the material universe. It has no material antecedent for science to investigate, and the methods of science can, of course, reach only the material antecedents of an event. *Science* stops dead at the primeval atom. If we are to go further, *philosophy* must take over with its category of "creation" through which the Absolute Being who IS existence can call into being a world of contingent things which HAVE existence because they receive it from another. But that is a different story, and we shall talk about it later.

**Other Evolutionary Models**

In the *Lemaître model*, the history of the universe can be traced back to a primeval atom which exploded 20,000 million to 60,000 million years ago. Moreover, the expansion which we notice today is a result of the forces of cosmic repulsion which developed when the galaxies began to form in an equilibrium phase. But in the *Gamow* evolutionary *model*, which has had considerable vogue, the very force of the initial explosion (only about 10,000 million years ago) was great enough to account for the present expansion. Hence there is no need to postulate forces of cosmic repulsion and an equilibrium phase. A striking feature of the Gamow model is the idea that all the chemical elements were built up within half an hour of the big bang.

The Lemaître and Gamow models are examples of the many evolutionary models derivable from Einstein's equations. These equations of general relativity have three unknowns, whereas observationally there are only two sets of data. Hence, far from defining an unique universe, the equations allow for three major categories of non-static universe—and within these major categories a number of variants still remain possible. All the same, it is not for nothing that the Lemaître model is a favourite among the various evolutionary types. It is also very representative for purposes of contrast with the recent steady state cosmology proposed by the so-called "Cambridge astronomers"—Bondi, Hoyle and Gold.

## 2.2 THE STEADY STATE THEORY OF BONDI, GOLD AND HOYLE

The steady state theory is a theory of a peculiar sort. Scientific theories ordinarily start from facts and try to give a reasonable explanation of the facts observed. We observe for instance that apples always fall at a constant rate of 32 ft./sec.$^2$—*Observation of Facts.* We generalise this into a *law* : "all bodies on the surface of the earth fall freely at the rate of 32 ft./sec.$^2$"—*The Law of Gravity.* We then try to give some sort of explanation for this law by formulating a *theory* : "a body falls at a constant rate (we say), because it is pulled down by the earth with a force which is proportional to the product of their masses and inversely proportional to the square of the distance between them"—*The Theory of Gravity.* This is how science normally goes about things. *Facts are generalized into laws and laws are explained by theories.* But the steady state theory starts the wrong way round. It starts off by enunciating a principle—the "perfect cosmological principle"—and this principle is not derived from facts but is what they call a "methodological postulate", that is, it is an assumption we must make if we are going to have a science at all. Of course, once the principle has been laid down, one must show that its consequences do not contradict the facts. But what is central are not the facts themselves but the principle.

**The Perfect Cosmological Principle**

No science is possible without an act of faith in the uniformity of nature. A scientist can, after all, make only a limited number of observations. He studies an apple falling here, a stone falling there. If he can generalize his observations into a law (*all* bodies fall......), it is only because he believes that his observations have revealed some property of nature, and that nature is the same everywhere from Tennessee to Timbuctoo. Such an assumption is of course specially important in cosmology which tries to draw a picture of the universe from observations made in a very small corner of it. This obviously is only possible if the universe is pretty much the same everywhere. Otherwise our picture of the universe would be like the blind man's picture of an elephant: he might conclude that the elephant is very like a rope because his groping hands happen to fall on the animal's tail.

So in order to have a cosmology at all we must assume that the universe is in fact *homogeneous.* At every instant it must present the same large-scale features to all observers no matter what their position. It must be *everywhere* basically the same. This is the cosmological principle which all cosmologists accept.

But the steady state cosmologists go further. They argue that if cosmology is to be truly a science, the universe must look the same to all observers not only in all places but at all times. It must not only be *homogeneous*, it must also be *unchanging* with respect to time. No cosmology is possible in a universe which changes from day to day—because we there find ourselves in the absurd position of having to study its past using laws which are valid now but which (because the universe has radically changed) were not valid in the past. And so, if we are going to have a scientific cosmology at all, we must assume that, apart from local irregularities, the universe presents the same aspects from any place and at any time. It is *everywhere and always* the same. This is the *perfect cosmological principle* of the steady state cosmologists.

The principle is, we repeat, strictly "*a priori*". It is not derived from experience. Nothing in our experience suggests that the universe is unchanging. Rather, from what we see, it always appears to be in the throes of violent change. But steady state cosmology rules out change from the start. The universe cannot possibly be evolving—not because there is anything physically impossible about such evolution, but because it is methodologically inconvenient to admit it. We simply cannot have a truly scientific cosmology at all unless we agree to assume that the universe does not change. Once we have made this assumption, we can go ahead and make deductions about the nature of the universe—and these can then be checked with the facts.

We can first deduce, for instance, that the universe must be expanding—and this is checked by the observed fact of the red shift. A further deduction indicates that matter has to be created continuously—and this cannot at present be checked by facts, but it simply has to be so (because it follows logically from the perfect cosmological principle). Let us inquire a bit further into these two deductions.

**The Universe Must be Expanding**

From the perfect cosmological principle it is clear that the universe (always and everywhere the same) is *infinitely old*. If such a universe were not also *expanding*, we cannot explain how the matter in it still exceeds radiation despite the continual transformation of stellar matter into radiation (e. g., in the sun, four tons of matter are converted into radiation each second). But an explanation would be possible if the radiation were being dissipated into *expanding* space : radiant energy would then be trickling down the "cosmic sink." We deduce therefore that the universe must be expanding, and our deduction is triumphantly vindicated by the red shift of the galactic spectra.

**The Continuous Creation of Matter**

But the expansion of the universe naturally involves the "dilution" or steady thinning out of the matter it contains. Now according to the perfect cosmological principle this cannot happen. The universe cannot change: its density must always remain the same. So the thinning out of matter by expansion must somehow or other be compensated for. We must bring in new matter to take the place of the matter which is being dispersed.

And so the steady state theory arrives at the startling idea of the continuous creation of matter. Matter, it says, is being continually created (really created, we are assured—not formed from radiation, but produced out of *nothing*) all over the universe. But we must not ask just how this matter manages to appear, or by whom it is created. Such questions, says Hoyle, are meaningless. The fact that matter keeps appearing out of nothingness simply happens to be one of the basic properties of the universe. We must just accept it because it happens to be so. The continuous creation of matter is "an ultimate given" : it can be described but not causally analysed. Steady state cosmology assumes as a "simplicity postulate" that matter is created in the form of hydrogen atoms. The hydrogen formed in intergalactic space accumulates over billions of years and eventually condenses into galaxies.

The creation of matter is not affected by pressure, temperature or the presence of older matter. Matter is being created not only near the stars but equally in the depths of intergalactic space. The rate of creation is everywhere the same : it depends only on the mean density of the universe and on Hubble's constant (which is the constant ratio of the velocity of recession of a galaxy to its distance away). This creation rate works out to something like $10^{-48}$ gms./cc./sec.—which means that the mass of one atom of hydrogen is created per litre of space every billion years*. Obviously this is well beyond the reach of any present scientific observation, no matter how refined. The continuous creation of matter cannot in any way be directly demonstrated by science. And even if we conjure up a future scientific device so perfect that it would record the sudden appearance of a single hydrogen atom within the depths of space and time, we can still legitimately ask : where did *this* hydrogen atom come from ? Science finds this question as impossible to answer as in the case of the primeval atom.

*This seems to be a trifling amount, but the total quantity for the universe as a whole is enormous. One calculation gives 50,000 solar masses per second!

**Some Features of the Steady State Theory**

In a steady state universe neither the first nor the second law of thermodynamics is universally valid. The first law, the so-called *principle of the conservation of matter* ("matter can neither be created nor destroyed") is obviously violated by the continual appearance of newly created matter. True, as Bondi points out, the amount of matter in any *proper volume* of the universe (i. e. in any volume accessible to a telescope of any given power) remains constant. But in the universe as a whole, or in any *co-ordinate volume* the amount of matter increases. A universe which evolves with a definite amount of matter is of course in a very different position.

The second law too, *the law of entropy* ("the entropy of a closed system always increases") is valid only locally, and does not hold good for the universe as a whole. In the universe as a whole entropy does not increase : it remains always the same. While high entropy energy in the form of radiation is being lost in the expanding universe, low entropy energy is being continually supplied in the form of continually created matter. The total entropy of the universe therefore remains constant.

We said earlier that the steady state universe as a whole has no definite age : it is changeless and eternal. We can now add that individual galaxies must have definite and proper ages ranging from plus one to infinity. Hence, while the age we may be able to assign to a given galaxy is arbitrary, the *average age of the galaxies* can be calculated as a purely statistical quantity—which may then be considered as the "age of the universe". This "age" therefore expresses no real duration but only a statistical average.

And so the steady state universe presents a statistical uniformity like the population of a large city. Individual galaxies grow old and die (i. e. swim out of the observer's sight), but as they recede new galaxies are formed in their wake from the continually created hydrogen, so that the average distance between galaxies remains always the same. The steady state universe keeps on expanding—and remains the same for ever.

## 2.3 TESTING THE TWO COSMOLOGIES

Which of these two cosmologies gives us a true picture of the universe ? In theory it should be easy enough to decide. The crucial question is whether the universe has changed with time, whether it is different now from what it was a long time ago. And this should not be too difficult to answer because the past of the universe is in a sense present to us. *The astronomer who peers out into space is looking backward into time.* When he looks at the star Proxima Centauri which is 4·3 light-years away, he sees it just as it was 4·3 years ago because it has taken 4·3 years for the light he sees it by to reach him. So too he sees the great spiral galaxy in Andromeda, 1,500,000 light-years away as it was one and a half million years ago. In a word, he sees distant galaxies not as they are now but as they were when the rays of light he sees them by left them—it may be a thousand, a million, a billion years ago. In the distance he sees the universe as it was in the past, nearer by the universe as it is at present. And so to find out whether the universe has changed (whether the past is different from the present), all he has to do is to compare the more distant galaxies with the nearer ones. If he finds a difference, the universe has evolved. Otherwise it is a steady state universe.

**The Decisive Test in Practice**

In practice, of course, any such decisive test is enormously difficult, because it is not easy to make accurate observation of galaxies which are far away enough for such "age effects" to show. All the same, attempts are being made along two main lines of approach, both of which at first gave results which seemed to rule out the steady state universe. But we now know that those earlier results cannot be considered altogether conclusive. One line is to study the *spectra* of different galaxies to find out whether or not the light emitted by distant (younger) galaxies is intrinsically different from the light emitted by nearer (older) ones.

A second line, more fruitful apparently, is an investigation into the *distribution of galaxies* in various parts of space to find out whether or not the more distant galaxies are more crowded together than the nearer ones. Here, when optical telescopes alone are used as tools, the hindrances introduced by the earth's atmosphere limit their penetration into the really significant depths of space. Prospects should improve when telescopes come to be carried in earth satellites or come to be set up on the moon. But we may not have to wait for such spectacular feats, because present developments with radio telescopes are proving most valuable.

**Contributions from Radio Astronomy**

Invisible radio waves like visible light waves are electromagnetic vibrations but the former are about a million times longer. Now just as one can construct a telescope to get a brighter image by collecting rays of light from a distant luminous object, so one can erect a radio telescope to collect radio waves with the help of a directional aerial and thus get an amplification. One of the most famous of these radio telescopes is the instrument at Jodrell Bank in Cheshire, England.

Radio telescopes today are capable of detecting radio sources which are apparently some 7,000 million light-years away. Once these radio telescopes can fix the position of an unidentified radio source in space, the optical telescopes can subject that region to a more thorough study and a more prolonged exposure. The results of such collaboration are quite exciting. In 1960, a strange radio source in the constellation of Boötes was identified subsequently by the Palomar optical telescope as a cluster of galaxies 5,000 million light-years away, with a recession velocity of 86,000 miles per second. It thus became evident that the Palomar telescope could be useful at distances much further than was originally suspected. It also became evident that there are objects very far out in space which can be powerful radio sources but weak light sources.

Though we cannot be quite sure yet, recent results tend to support the view that *extremely far away in space and time* there are numbers of strong radio sources which appear to be *colliding galaxies*. The chances therefore are that at distances and times which are really significant for a choice between the evolutionary and steady state theories (i. e., the regions more than 5,000 million light-years distant), the galaxies do seem to be more crowded together.

**Cosmology an Infant Science**

But cosmology of course has not spoken its last word. A universe of more than a billion galaxies each with perhaps a hundred billion starts is not an easy subject to exhaust, and modern cosmology has not been working at it very long. As sciences go, it is still an infant, and for all its impressive record of progress, it has not been able to gather more than a few hints and guesses about the structure of the universe and its history. And so it is not likely that what it says today is going to be the final answer of science to the vexing problem of how the world began. All the same, there is much excitement among today's astronomers over the possibility that soon we will at least be able to make a decisive choice between the evolutionary and steady state theories.

## 2.4 THE LIMITATIONS OF SCIENCE*

In any case, even the most perfect cosmological theory (should it ever exist) is not going to tell us *all* that we would like to know about the origin of the universe. It may tell us what exactly the universe is like, and just how it has been evolving, but it will not answer the really important and ultimate questions : whether the universe is created and whether it has begun to be.

**Physical Sciences are purely Quantitative Disciplines**

The reason is that scientific cosmology, like all physical science, is a strictly *quantitative* discipline. It is concerned with the *measurable* aspects of *material* things—things which are extended in space and which endure in time. All its categories are therefore spatio-temporal categories : science can only think in terms of space, time, matter, movement and the like. Talk to a scientist of "colour" and he starts thinking of wave-lengths. Speak to him about "heat" and he thinks at once of a thermometer reading, or (if he happens to be in a more imaginative mood) of the random movement of

*The origin of the universe is tackled on the scientific level principally by a group of quantitative disciplines included under the so-called "physical sciences". This must be remembered when the term "science" or "scientist" is used in the present chapter. Other problems like the origin of living things are studied principally by more descriptive and less quantitative disciplines : the "biological sciences". Yet even these do manifest a tendency to express their findings by "pointer-readings" as far as possible.

molecules. Mention "force" and he will have at the back of his mind some physical action which changes the movement of a body, while "work" will be done only when "the point of action of a force moves through a distance". He would lift his eyebrows if you came to him babbling about soul-force, or the force of public opinion (even when this has just toppled a throne). He might even vigorously deny—only as a scientist of course—that the strenuous mental contortions he can manage for the solution of particularly knotty mathematical problems are actually "work" in any real sense of the word.

It is important to remember this—and not always easy. We are dazzled by all the marvellous discoveries of science and by the vast new vistas it keeps opening up for us. We are naturally impressed by the precision of scientific observation and we admire the vigour of scientific thought. And all the while we forget that the world of science is, for all its rapidly expanding horizons, a strictly limited world marked off by sharply defined, self-imposed limits. Science is interested in *material* things (and so the whole world of spiritual realities and values is a world science knows nothing about), and only in the *measurable* aspect of material things (and so the whole world of art, for instance, is a world into which science dares not intrude.)

As Sir Arthur Eddington has pointed out, of all the senses with which man is endowed the scientist needs only one. It is enough that he sees—and that too with one eye. Nothing more is necessary, because all science is ultimately a matter of "pointer-readings", and to read a pointer one eye is quite as good as two. For all its intricate complexity the world-view of science is like that of a man with just one eye. *It may be strictly accurate but it is not likely to be complete.* There are surely many things in heaven and on earth which are not dreamt of in the philosophy of a purely "one-eyed observer".

**Science and Creation**

And so we must not imagine that science is ever going to *prove* creation no matter how enthusiastically some simple souls may have hailed the apologetic possibilities of entropy or the primeval atom. Much less of course can science *disprove* creation even though Hoyle seems to think that all theology trembles each time it hears the terrible words "continuous creation". Science is not interested in such things—and they are beyond its competence.

Scientific cosmology can, at most, take us back to what it believes is the first observable moment of the universe, to the universe in some sort of germinal state, to the primeval atom. But beyond this it cannot go. It cannot tell us where the primeval atom comes from. Such a question will be meaningless, because the primeval atom is by hypothesis primeval. It is the first appearance of the universe; there is absolutely nothing before it—that is, nothing material, nothing which science can grasp. As far as science is concerned the primeval atom (should it ever be discovered) would be a first datum. The task of science would begin with the primeval atom, and all questions of how the atom got there would be outside its scope.*

**Science and the Absolute Beginning**

All this is on the supposition that science does manage to reach an indubitably primal atom. Actually even this is something science cannot do. Even when cosmology posits a primeval atom it has no way of

*What science is incompetent to say about the primeval atom, it cannot say about the individual hydrogen atoms of continuous creation either.

showing that this atom is *absolutely* primal : really the *first* appearance of matter *with nothing before it*, really the *absolute beginning* of the universe. True, all the evidence it has at any given moment may suggest that we are here at the real beginning of the universe—that is, that we have reached a point of time ("*t*") at which the universe exists, whereas immediately before (at time "*t—1*") nothing existed. But can we be really sure that nothing existed before time "*t*" ? Theory and observation appear to tell us so today, but who is to say that better theories and more refined techniques of observation may not reveal *tomorrow a whole series of undiscovered anterior states of the universe ?* Science, after all, is not omniscience.

The scientist, like the pilgrims in Flecker's poem, "must go always a little further." He never knows exactly what lies ahead. He cannot stop at any arbitrary point and say : beyond this there is *nothing*. Perhaps there really is nothing—but he, as scientist, can never be sure that there isn't. And so while the cosmologist can say categorically (and we shall believe him) that the universe existed at time "*t*", he has no right to state categorically that nothing existed at time "*t—1*". He *sees* nothing *today*, but that does not necessarily mean that there is in fact nothing at all. No, his conclusion about a primeval atom must be much more tentative. All he can strictly say is that the processes now going on in the universe appear to have begun at a definite time "*t*" a few billion years ago. This is, if you like, the beginning of *our phase* of the universe constituted as it is by these processes. But he has no means of telling whether or not it is the *absolute beginning* of the universe. As a matter of fact there are scientists who actually think that the primeval atom is only a state of maximum contraction in an oscillating universe—a universe with an indefinite series of expansions and contractions.

Now there is another reason why the absolute beginning of the universe must escape science : the fact that such a beginning cannot be a *temporal event.* If the universe began it certainly did not begin IN time but WITH time : *time began when the universe began.* So the absolute beginning of the universe must be OUTSIDE time. It is a limit like the term of an infinite mathematical series, or like zero in the series of natural numbers. One can (from within) approach it indefinitely without ever fully reaching it. The only way to reach the absolute beginning of the universe is to place oneself outside the series, outside time. But this is just what science, which is a spatio-temporal discipline, cannot do.

**Two Questions Scientifically Meaningless**

Science must therefore be silent on the two connected but not identical questions of the creation and the beginning of the universe. Because science is interested only in *material things*, it cannot tell us anything about the *creation* of the universe—creation is a supramaterial reality, a transcendental relation of cause and effect which cannot be fitted into the kinds of physical causality we know. And because science is interested only in *temporal events*, it cannot tell us anything very definite about the *beginning* of the universe, because the beginning of the universe is outside time. For answers to these two questions (different questions, we repeat, though connected ones), we must turn to other sources of knowledge : to *philosophy* which is human reason's unaided quest for the ultimate meaning of things, and to *theology* which is our attempt to understand the Word of God. As we shall soon see, a solution to the second question (i. e., whether the universe had a beginning instead of "an–existence–without–beginning–from–all-eternity") cannot be given even by philosophy. But the first of these questions (the problem of the creation of the universe) philosophy answers with a resounding YES.

## 2.5 BEYOND SCIENCE : WHAT PHILOSOPHY SAYS

Unaided human reason (the chief tool of the philosopher) can show conclusively that the world is created. It depends totally for its origin and its existence on a transcendent cause outside itself.

**The Universe as Dependent**

The universe is not self-sufficient : it cannot explain its own existence any more than the watch I pick up in a shop. Because it is a world of *blind, un hinking matter,* the universe cannot explain its own *inner harmony* nor the striking purposefulness of so many of its mechanisms. No "fortuitous concourse of atoms" will satisfy a man who has pondered celestial regularities, or watched a bee at work or looked at the shining patterns on a butterfly's wing.

Moreover, this is a mobile and unstable universe. Plato called our world "a world of shadows", and the Upaniṣads spoke of it as "a world of unreality, darkness and death". A universe of *imperfect, changing* and *transitory* things ("change and decay in all around I see") cannot explain its own *existence.* Nothing in the universe nor the sum total of all the things in it carries a complete explanation of its existence. They are all "contingent" —they do not *necessarily* exist, they need not have existed. Their existence is, as it were, an "accident". If they exist at all, it is only because they have received their existence from a Being which necessarily exists, which cannot not exist : a Being whose very essence is to be, because IT IS BEING ITSELF. And so philosophy drives us inexorably to the conclusion that all of this changing, transitory world comes from and depends wholly upon a transcendent cause : the unchanging *Absolute*, the undivided *One*, the all-powerful *God*.

**Dependent Not Distinct ( Emanation )**

Now, as a matter of fact, the dependence of the world has been conceived of in various ways. Some think of it as an emanation. *The world*, they say, *flows out of God** : matter is a sort of degradation, a watering down of the divine substance. And so the world which totally depends on God is not wholly distinct from Him. Emanationism is a very widely held doctrine. Plotinus taught it among the Greeks, and we find it in many of those systems of Indian philosophy which would admit that the world is at least partially distinct from God —and not (as Śaṁkara would have it) simply an "illusion" superimposed on the Absolute, as the image of a serpent is superimposed on a rope by a man who mistakes it for a snake.

Emanationism has its points, but it simply will not square with an adequate notion of God. If God is truly God, He cannot possibly emanate, because emanation means change and God cannot change. As Subsistent Being, God is all-perfect : He has all that there is of being, and therefore of reality, of perfection. But where there is absolute perfection, there can be no change. Change always means imperfection : a being which changes either loses something it had, or gets something it did not have

*More exactly, the world of spirit flows out of God, and the world of matter in turn flows out of the world of spirit.

before. In either case something is lacking—either after the change, or before it. But God cannot lack anything, and so He cannot emanate.

**Distinct Not Dependent (Dualism)**

Others therefore imagine that *God shapes the world* (as an artist shapes a statue) from matter which has been existing all the time independently of Him. These are the "Dualists", so called because they admit two ultimate and coeternal principles of reality—God and matter (from which God shapes the world). A world made in this way will evidently be quite distinct from God but not totally dependent on Him. It gets its shape from God (as the statue gets its shape from the artist) but not its existence : as matter it has been existing from all eternity independently of God.

The basic weakness of Dualism is revealed in the last words of the preceding statement. Because, if God is truly God, He is infinitely perfect, He is the all-perfect Being, who cannot grow in perfection; this we have seen already. Now, if something like shapeless matter existed independently of God, it would be a source of change for Him. For such so-called shapeless matter existing by itself would necessarily impose some limitations on the divine shaping influence. This so-called shapeless matter *existing by itself* would have its own nature. God would have to respect this, in other words, His shaping activity would in some way be dependent on the possibilities of that independent shapeless matter. God therefore would be—to whatever minimal limit we reduce it—*passive* with regard to it, and thus change would be introduced in God.

Besides, if this shapeless matter were independent of God, His knowledge of it would be in addition to God's self-knowledge. This increase in knowledge would make

God somehow more perfect, more fully being. So the absolute Being itself would undergo some becoming : the all-perfect Being would become more all-perfect. This is a contradiction. And under the supposition that God did not know this so-called shapeless matter which would exist by itself, then, besides being incapable of shaping it, His not-knowing-it is by itself a lack of perfection : God would not be the all-perfect Being......Such a God is not true God.—Hence, nothing can exist independently of God. God alone is the source of all being, and whatever exists has to receive its being from God.

**Perfectly Distinct and Totally Dependent (Creation)**

*Emanationism* founders on the rock of God's unchangeableness; *Dualism* fails to satisfy the demands of God's infinity. So Christian philosophy chalks out a third path with its doctrine of *Creation* through which *God wills the world into existence out of nothing.* The world neither comes from God's own substance nor from an eternally existing matter, but from God's word spoken over nothingness. God speaks, and where there was nothing, there now is the world. This is a world which must be *perfectly distinct* from Him, because it has not been emanated from His substance but evoked from nothingness. And yet it is a world *totally dependent* on Him, because it has not been moulded from pre-existent matter but has been called into being solely by the power of His creative word.

Creation is therefore very different from any of the kinds of production we are familiar with. When an artist moulds a statue or a carpenter makes a chair, they merely give a new shape to an already existing something (a lump of clay, a block of wood). But when God creates the world, nothing at all exists : God creates totally. Everything the world has, each atom of its reality is from Him. And so while a statue or a chair once made will go on existing quite independently of the man who made it (because he has given it its shape only, and not its being), the world once created can go on existing only if *God keeps on "creating" it*, keeps on sustaining it in existence. That is because God is the sole source of the world's total reality. The world exists only by participating in the being of God. It is real only because it is related to God as the term of God's creative act. Were this relation to cease, the world would at once cease to be. God creates the world not as a potter makes a pot, but as a man thinks a thought.* Creation did not end the day the world appeared : it continues as long as the world will last.

**The Universe Created yet Eternal ?**

But the fact that the world is created does not necessarily mean that it has had a beginning. God could have created the world from all eternity, and philosophy finds nothing particularly absurd in the idea of a world which has been existing for ever—coeternal with God, but always of course wholly dependent on Him. It is this idea of *absolute dependence* which is central to the idea of creation, and not (as we imagine) the idea of a beginning. The world would be truly created even if it had never begun. And as a matter of fact Christian philosophy, which has no doubt whatever that the world wholly depends on God, does not find it very easy to show that the world has in fact begun. It can prove conclusively that the world is created, but it offers no adequate grounds for preferring a "creation in time" (to use the traditional

* Or as a source of light sustains the brightness.

if somewhat inaccurate expression* to a "creation from all eternity". But if philosophy throws no light on the problem of the beginning of the universe, theology does.

## 2.6 BEYOND SCIENCE : THEOLOGY OF CREATION IN TIME

Theology can see deeper into the reality of creation than philosophy because it does not depend on the limited resources of the human intelligence alone. It can draw on the infinite knowledge of God Himself, for theology is the study of and reflection upon God's word :

—as revealed to us through *Jesus Christ*,

—as handed down to us in *scripture* (the inspired and inerrant writings of the Old and New Testament) and *tradition* (the living teaching of the Church down the ages),

—and as interpreted for us by the Church's *teaching authority* through which Christ continues to teach and to sanctify the world.

When the Church solemnly defines a truth of faith, it is in fact interpreting scripture and tradition, telling us that the truth defined is really part of God's word spoken to us through Christ. As such it must of course be accepted by us without question.

**Creation in Time and Vatican I (A. D. 1869–70)**

The creation of the world by God is one such truth defined by the Church. "The Holy, Catholic, Apostolic, Roman Church believes and professes," reads the definition of the First Vatican Council, "that there

* "Creation in time" cannot and does not signify that the creation of the universe is a *temporal event*. (From that point of view, "creation with time" is more accurate). This traditional phrase, however, suffices to indicate that the universe has had a beginning, that it is not eternal.

is one true and living God, the Creator and Lord of heaven and earth...... This one and only true God, by his goodness and almighty power......from the very beginning of time has created both orders of creatures in the same way out of nothing, the spiritual or angelic world and the corporeal or visible universe. And afterwards he formed the creature man, who in a way belongs to both orders, as he is composed of spirit and body."

The Council quite evidently defines that God has in fact created all that exists other than Himself, and that He has created them in the strictest sense of the word, out of nothing. Apparently it also defines that God created the world "*in time*", because it speaks of a "beginning of time". Time apparently has had a beginning : the duration of the world has not been infinite; the world has not been created from all eternity but has begun to be.

Now there are theologians (admittedly a minority) who do not take these words so seriously. They believe that by this "passing reference" (part, in fact, of a citation from a previous Council, the Fourth Lateran Council of 1215 A. D.) the Fathers of the First Vatican Council did not intend to settle the question of the world's beginning at all. But the discussion is in any case somewhat academic, because, defined or not, the creation of the world "in time" has always been taught in the Church and would seem to be an authentic part of Christian doctrine.

Theology then teaches us not only that God created the world out of nothing, but that He created it "in time". The world has not existed from all eternity—it has begun to be. And it is impossible to exaggerate the part played by this idea of creation in time in shaping the Christian vision of the world.

## 2.7 BEYOND SCIENCE : CHRISTIAN VISION OF MAN IN THE UNIVERSE

The emanationist who believes that the world has emerged physically from God, naturally thinks of it as a degradation of the divine substance. *Matter* is the term of a downward movement from infinity to nothingness, and as such it is inevitably *evil.* And so the *human body*, a piece of *matter*, cannot really be a part of man. No, man is a spirit, a spark of the divine flame, which has somehow (perhaps for a sin committed in some previous state of existence) been imprisoned in the material body as a bird might be locked up in a cage. Plato calls the body a "tomb" in which the soul repines. The Gītā describes it as a "suit of clothes" which the soul casts off when they are worn out. The Upaniṣads (and Plato again) call it a "chariot" which the soul drives. It is always the same: the soul uses the body, controls the body, lives in the body, but is never united to the body. Man is soul *in* body, never soul *and* body, never *body-soul.*

Indeed to achieve himself fully a man must throw off the body and get rid of every tie that binds him to the world. *Salvation* means escaping from the contamination of matter. It is, says Plotinus, a flight—"the flight of the alone to the Alone." It is, say the Hindu Śāstras, a *liberation* ("*mokṣa*")—a liberation from the cycle of rebirths. And so every emanationistic religion becomes a religion of withdrawal, seeking self-realization through perfect detachment from all earthly things. Its goal is not action but inaction. Its ideal is the totally inert, introverted, self-sufficient personality of the "yogi" or "sage".

**The Christian Vision (1) The World and Evil**

But that is not how a Christian can look at *the world*. For him the world cannot possibly be evil. Because it is created out of nothing, it is not the result of a movement of degradation or decadence, but the term of an "upward movement" from non-being to being. And because it is created by God, it reflects ("as in a glass, darkly") His goodness and power just as any piece of work reflects the skill of the craftsman who made it. "For since the creation of the world," says St. Paul, "His invisible attributes are clearly seen.........being understood through the things that are made." (Rom. 1, 20) We cannot call the world evil without calling God evil too. No, the world and everything in it is good—as the Bible repeatedly assures us. Evil is not a metaphysical reality, some *thing* embedded in the tissue of the world. It is a moral reality, or *attitude* of a will fixed in wilful opposition to the will of God. *The seat of evil is not matter but the heart of man.*

True, the world can be a distraction and a danger for man in his present state of alienation from God. Instead of leading him to God as it should, it can lead him away. But that is only because, partially blinded as we are by sin, we are so dazzled by the beauty of created things that we forget the infinitely greater Beauty of which they are only the reflections. We stop at the shadow instead of going on to seek the Substance. We are so enamoured of the image that we fail to look for the Object it so crudely mirrors. The world is a danger to fallen man *precisely because it is good and beautiful*, not because it is evil.

**The Christian Vision (2) Man's Body**

And if the world is good so also is *man's body*. The body is not something to be ashamed of, and in any case it is not something we can disown.

It is an integral part of man, as truly his (or rather him) as the soul. Man is a composite being of matter and spirit in whom body and soul do not just lie side by side but are united substantially into one strictly unified being. Man is properly "spirit-matter" or "body-soul". The soul does not just use the body, or live in the body. It does not merely give life to the body—rather, it "informs" the body. That is, it is the body's principle of being, it makes the body be. Body and soul have one existence—which is why they are one thing.

And so soul and body cannot really exist without each other. The body cannot exist *at all* without the soul: separated from the soul it is no longer a body but a heap of chemicals which may (for a time) keep the outward shape of a body but has none of the internal unity and organization which makes a body what it is. And the soul cannot exist *properly* without the body: separated from the body it continues to exist, but in a state of incompleteness and indigence. It needs the body and will be reunited to it on the Last Day.*

**The Christian Vision (3) Salvation as Cosmic Redemption**

Thus the Christian cannot possibly think of saving himself by escaping from the body. We do not save just our souls, we save ourslvees, soul and body. And we do not save just ourselves, but in saving ourselves we "save the world." *Salvation for the Christian has always a cosmic dimension.*

The world, created for man and wounded (in some sense) by his fall from grace must be redeemed through man. "For the eager longing of creation", writes St. Paul, "awaits the revelation of the sons of God. For creation

* This Christian vision of the human body is viewed within the framework of the Thomistic system.

was made subject to vanity.........in hope, because creation itself also will be delivered from its slavery to corruption into the freedom of the glory of the sons of God." (Rom. 8, 19–21). And both St. Peter in his second letter (2 Pet. 3, 13) and St. John in the Apocalypse (Apoc. 21, 1) look forward to "new heavens and a new earth" at the end of time.

Material reality is to share in man's glorification, though just how this will be we do not know—certainly through the transfiguration of the human body, but perhaps also (as many theologians believe) through a renewal of the non-human world. Salvation for the Christian then is *not a "flight" nor a "liberation", but a "redemption"*. It is the bringing back to God of man (soul and body), and of the whole world through man.

This imposes on the Christian an altogether new attitude towards the world. He confronts it not with an uneasy feeling of suspicion, fear or contempt, but with a profound sense of respect and commitment. The world is his responsibility. "Heaven is the heaven of the Lord, but the earth He has given to the children of men," says Psalm 115.16. 113 (114). As the one being in the universe, for all we know, in whom matter meets spirit and nature encounters grace, *man is the high priest of nature* (dare we say, "the Christ of nature", for does not the incarnation of spirit in matter image faintly the incarnation of the divine in the human?). Through man God's transfiguring action comes down to nature; and in man nature's silent paean of praise bursts into a song that rises up to the throne of God. "The heavens declare the glory of God, and the firmament proclaims His handiwork," sings the Psalmist in Ps. 18 (19), 1.

Man, if the Bible is to be believed, is also *entrusted with the material development of the world*. "Be fruitful and multiply and fill the earth, and subdue it," says God to our first parents (Gen. 1, 28). Surely we have here a divine sanction for that long and arduous task of humanizing nature which has been the burden of man's efforts all through his long sojourn on earth. Man's material task thus takes on a spiritual significance, and so a man need not renounce the world in order to save his soul. He can reach God through his very involvement in earthly things, because the God who redeems man is the same as the God who has created the world. Because he believes in creation, the Christian can sanctify himself by his commitment to the humdrum tasks of his everyday life. He can take the world seriously.

**The Christian Vision (4) Time, Freedom, History**

And he *can take time seriously too.* Time has no meaning for the emanationist. Emanation goes on for ever: it is a divine and therefore eternal process. An emanating world can have no beginning and no end. It can have any number of apparent beginnings—that is, it can undergo repeated cycles of alternate "creation" and "destruction". Such are the cycles of the oscillating universe described by science, as also the immense *kalpas* of Hindu mythology (vast and endlessly successive epochs of emanation from and reintegration into the Absolute). Most emanationist systems do actually conceive time as cyclic : it goes round and round, but it does not go on. Events do not progress towards a goal : they go on repeating themselves endlessly.

There can be no *freedom,* of course, in such a cyclic world where events have to repeat themselves with mathematical precision. In fact, any kind of *emanationist* world is a world *without direction, without freedom and without history.* Proceeding inexorably from the Absolute, it is predetermined down to its smallest details. It is a world which cannot be otherwise. A created world, on the contrary, is not predetermined. It need not have been created at all, and other types of world could have been created instead.

*History* in the sense of temporal events with a supra-temporal meaning, purpose and destination, *has sense only in a world created in time.* The world has begun, the world will end—and in between time speeds along straight as an arrow, never turning back upon itself but heading straight for a goal. The world has a purpose, it goes somewhere, it has a *direction.* And it has *drama.* Because there are no infinite stretches of time ahead, time takes on a sense of urgency. And because time does not repeat itself in cycles, time becomes unique. Each moment stands out in sharply defined individuality. It is unrepeatable: once gone it is gone for ever. And when *freedom* enters, into this world of swiftly moving, unrepeatable events, then *each unique moment becomes truly a moment of decision.* Time is immensely important to the Christian because it is the field in which his freedom operates. He knows with T. S. Eliot that "only through time is time overcome."

**Science Supposes a World Freely Created by God**

And just as history finds its justification in the idea of creation, so does science. Professor A. N. Whitehead has pointed out the debt which modern science owes to Christian theology and its doctrine of the creation of the world by a free and rational God. Modern science, he shows us, rests on two suppositions: that the world is *orderly* and that it is *contingent.* Without the first supposition (that the world is orderly) *any* science would of course be impossible, because all that science does is to seek out and explain ordered patterns of behaviour. Without the second (that the world is contingent) *experimental* science would be unnecessary, because we would then be able to know all we wanted to know about the absolutely predetermined universe without even taking a look at it.

The emanationist has really no need to look at the world. This is why Emanationism has produced great philosophies (we have only to recall the system of Plotinus), but has not been able to make any notable contribution to science. The world is, after all, an inferior sort of reality which no serious person should bother about. And, in case if somebody does really want to know something about it, he can best find out by enquiring deeply into the nature of that Absolute from which the world emanates according to strictly determined laws. *Science is, for the emanationist,* not only unworthy of the attention of a wise man, but totally *unnecessary for knowing about the world.*

It is only in a world freely created by a rational God that those suppositions are verified on which the whole edifice of science rests. Such a world because it has been created by a *rational* God is *orderly*, and because it has been *freely* created by God is *contingent.* God has created this particular world out of an infinite number of possible worlds He could have created, and we can give no compelling reason for His choice. That will always remain the secret of His freedom. And so we have no way of predetermining which of the infinite number of possible worlds (which creation, unlike emanation, allows for) has actually been chosen for creation by God. *The only way* of finding out what a freely created world is like *is to take a good look at it.*

So the Christian confronts the world with wonder and respect, and his own body with reverence. He is conscious of the meaning and the urgency of time : he has a profound sense of history. He is aware that the world is contingent and realizes the need of science. And all because he believes that the world has been freely created by God out of nothing and "in time."

# Suggestions for Further Reading

James A. Coleman, *Modern Theories of the Universe*—a pocket book in the Signet Science Series, The New American Library, New York 1963.

Apart from the author's disastrous incursions into theology at the very beginning of this book (where he treats us to his distressingly inaccurate views on the evolution of religion) and at the very end (where he brings in a fearfully confused though not otherwise particularly objectionable allusion to the 'role of the Deity'), this makes excellent supplementary reading on our subject. It covers much of the ground we have done, but in much greater detail and with exemplary lucidity. It tells us nothing about the structure of the universe but there is much on world-models, on methods of dating the universe, and on the two cosmologies. All, very clearly told with the help of some unusually intelligent and intelligible diagrams. A fine example of what the French call '*vulgarisation*''.

G. J. Whitrow, *The Structure and Evolution of the Universe*—Hutchinson, London 1959; also as a paper-back in the Harper Torchbooks, New York 1959

Much less "popular" than Coleman without being technical. Most of the book is about the "structure" of the universe. Its "evolution" is disposed of in a single, perhaps not quite adequate, chapter. But there are excellent historically orientated chapters on the shape and size of the universe as a whole, on the structure of the galaxies and on world-models. On this last especially Whitrow is superb. This is the best serious all round layman's introduction to cosmology we know.

George Gamow, *The Creation of the Universe*—The Viking Press, New York 1952; also as a paper-back in the Mentor Books, The New American Library, New York.

Gamow is the prince of scientific popularizers, a highly competent scientist who writes with the verve of P. G. Wodehouse. This is good vintage Gamow, as one would expect, since Gamow is a professional cosmologist of repute and has his own particular brand of evolutionary cosmology. Most of the book is, naturally, about this. But the steady-state theory is given a fair place.

Fred Hoyle, *Frontiers of Astronomy*–Heinemann, London 1955; also as a pocket book in the Signet Science Series, The New American Library, New York 1963.

A fascinating book. Hoyle is the Eddington of today, a very able scientist gifted with a brilliant pen, but with a weakness for philosophical asides of an often astonishing *naïveté*. Here we have Hoyle at his best : a sparkling mixture of sound astronomical fact and almost outrageously wild (but always plausibly argued) conjecture. It is strong on stellar evolution (on which Hoyle has done a lot of original work) and, naturally on the steady-state theory. The hard cover edition has some of the most magnificent plates we have seen. If these have been adequately reproduced in the pocket book (which claims to be fully illustrated), these alone will be worth the price of the book.

*The Universe* : a symposium in the *SCIENTIFIC AMERICAN*, September 1956.

A fine collection of articles by top-ranking scientists on nearly every aspect of modern cosmology. We meet Gamow on the evolutionary cosmology and Hoyle on the steady-state theory. Fowler is excellent on the origin of the elements. So is Sandage on the red-shift and Ryle on radio-galaxies. And Neymann and Scott give the clearest account imaginable of the distribution of galaxies, and of its significance for the competing theories of the universe. Although written nearly ten years ago, most of the articles are far from depassé and offer a pleasant introduction to the exciting universe of modern science.

E. A. Mascall, *Christian Theology and Natural Science*—Longmans Green and Co., London 1956.

We couldn't recommend this book highly enough. It is a theologian's look at some of the theories of modern science. Mascall is an Anglican theologian devoted to St. Thomas, who has had a very good scientific education, so that his criticisms are perceptive and sane. Naturally most of his book is about things other than origins. But there is a valuable chapter, which, by contrasting the scientist's idea of creation with the theologian's, throws much light on both. Quite apart from this, the book is invaluable for any theologian interested in science, or for any scientist interested in Christian theology.

B

# THE ORIGIN OF LIFE

# Chapter 3

# How Life Came to Be

Of all the gaps in evolution history there is none so profound as that which stretches from the most complex forms of lifeless matter to the most rudimentary living organism. There are just a few factual clues to indicate how this abyss might have been bridged, if at all it was bridged. Small wonder then that this chasm in our knowledge of the universe should be packed with speculations, some of them among the more fantastic products of the human brain.

## 3.1 LIFE FROM NONLIFE—OR OTHER WORLDS?

**Spontaneous Generation**

Till the last century, many people did not see anything strange in the view that living things should arise spontaneously from lifeless matter. Among those who accepted without question the production of eels from mud and maggots from rotten meat were not a few respected scientists. These crude views advocating the theory of "spontaneous generation" were somewhat shaken by the work of Redi (17th century) and Spallanzani (18th century), but it was Pasteur who really upset the theory as propounded in those times. In a series of brilliant experiments begun in 1858, Pasteur showed that the claims being made for the production of living things from lifeless matter were actually based on badly controlled experimental conditions. He demonstrated, for instance, that it was impossible for any living beings, including even microscopic ones, to be produced in an extract containing meat broth and sugar, if this was somehow prevented from being contaminated by micro-organisms in the air. In one of these experiments the extract was sterilised by boiling in a round-bottomed flask whose neck had been softened in a flame, drawn out and bent into the shape of the letter "S".

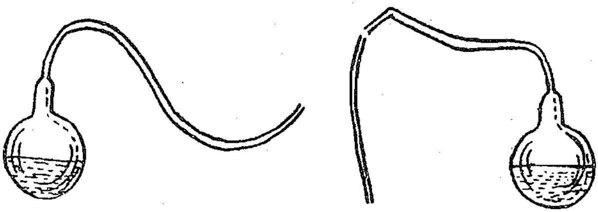

Fig. 6.
Flasks of the type used by Louis Pasteur in his experiments on "Spontaneous Generation"

When on boiling the liquid a strong current of steam issued from the extended neck of the flask, the boiling was stopped and the flask allowed to cool and stand. No micro-organisms developed in the liquid. But when the S-shaped neck was cut off, the liquid was soon colonised by micro-organisms. This shows that, if previously such a thing did not happen, it was because the organisms floating in the air were denied access to the solution, being retained together with all particles of dust on the curved surfaces of the S-shaped tube. This and other similar experiments shattered what was called the theory of spontaneous generation. This discovery, so simple to us, was deemed of such importance that Pasteur was awarded a prize by the French Academy of Sciences.

**Astronaut Germs ?**

Pasteur's experiments led many to believe that the abyss between the living and the nonliving was unbridgeable. Possibly, then, living things were transferred to the earth from other worlds. But a serious difficulty against this hypothesis is that life would almost certainly have been destroyed by ultraviolet light from the sun. The reason why we on earth are safe from these death rays is because our planet is surrounded by a screen of ozone. But no such screen would have protected our astronaut germ.

Apart from these difficulties, is there any evidence on the earth to prove without doubt (which means, to the satisfaction of at least a majority of scientists) that germs "from Mars" actually landed here ? Among those who have recently studied this point are Nagy and Claus. They examined some samples of the meteorites known as Orgueil and Ivuna, and found what they call "organized elements", which, so they say, may be microfossils of living matter that came to earth aboard the meteorites. This interpretation has been received by scientists with mixed reactions. Geophysicist Harold Urey thinks it is evidence enough that organisms were transmitted from outer space on board the meteorites. But physicist Edward Fireman has pointed out that the particular type of meteorites examined are porous and notoriously eager to absorb moisture, including organism-bearing sweat from the hands of people who touch them. He suspects that during the long years the two meteorites have been on earth (Orgueil fell in 1864, and Ivuna in 1938), they have had ample opportunities to take earthly life into their crevices. He refuses to believe that the Nagy-Claus "organized elements" really came from outer space until he sees inside one of them a mineral that is found only in meteorites.

So, for the time being at least, we shall have to stop thinking about the brave germ who dared to take a trip through space. And, in any case, even if it were proved some day that life on earth came originally from elsewhere, the problem of the origin of life would still not be solved but only transferred to another setting.

## 3.2 VITALISM, MECHANISM AND TEILHARD

**The Vitalistic View**

Pasteur's experiments, disproving spontaneous generation as it was understood at that time, led to a revival of what is called the vitalistic theory of life. This theory had been elaborated a century before by John Needham, who thought that there was inherent in every microscopic particle of organic matter a so-called vital force which was responsible for all the activity of the particle. The vitalists believed that no organic compound could be synthesized except by the vital force in a living organism. But when, in 1828, Friedrich Wohler prepared urea in the laboratory, the vitalistic theory received a severe jolt. The situation worsened when the synthesis of urea was followed by the synthesis of numerous other organic compounds which made vitalism an outdated theory. Now, however, Pasteur's experiments brought the vitalists back to life by pointing to an insurmountable barrier between the animate and the inanimate, a deep-seated difference which (according to the vitalists) could only be explained by the vital force.

Then came apparently additional evidence from the work of Hans Driesch on sea-urchins (1893). Embryonic development in sea-urchins begins of course with the cleavage or segmentation of the egg : the egg divides into 2, 4, 8, 16 cells, etc. Now when the cleavage cells were separated from each other at the two-cell or four-cell stage, a complete organism developed from each of the separated cells. Moreover, a quite normal larva appeared even when, in the 8-cell stage, Driesch altered the position of the cells with respect to each other. Finally, one single organism developed even when two separate eggs were forced into combination. Such wonders, argued Driesch, are possible only if there is some mysterious factor directing the organism to a definite goal in spite of disturbances. Although such a "goblin pilot" (which Driesch called *entelechy*) was too elusive to be observed however minutely one examined the organism, it had to be postulated for an adequate explanation of the behaviour of living things.

This conception would discard *a priori* all hypotheses of the evolution of life from nonliving matter, since no amount of the most ingenious combinations and constructions built with organic and inorganic molecules will ever give a living cell, if there is no *entelechy* to run the system. Besides, such a theory would lead science into a blind alley. Rather than explaining, it would explain away and put a stop to all further scientific investigation.

**The Mechanistic View**

In the opposite camp are mechanistic theories. These look upon living beings as mere complex automatons which behave as they do because of a perfectly self-regulating and elaborate system of physico-chemical reactions. Though these theories offer ample scope for scientific investigation, they are nonetheless unsatisfactory, because basically they put the living on the same footing as the nonliving, making them only more complex Besides, in the case of man, to be labelled an automation is not merely insulting, it is unrealistic. Man, or any other living creature, is far too different from the automaton we can imagine.

Moreover, when the mechanists tell you that these complex living automatons evolved through billions of years by a continuous process of trying out different possibilities till the most suitable were hit upon, you cannot help feeling that you are in the realm of fancy. A blind hit-or-miss evolution of such complex systems becomes so little probable that one finds it difficult to understand how it can be conceived as at all possible. Thus vitalism and mechanism tend, each in its own way, to disprove an evolution of life from the nonliving. Vitalism declares it *a priori* impossible, whereas mechanism propounds such improbable speculations that it makes it most fanciful.

**The Teilhardian Approach**

Recently a new vision of the nature of life has been conjured up by Teilhard de Chardin in his thought-provoking book, *The Phenomenon of Man*. He starts with the postulate that there is a fundamental unity and continuity in the whole universe, a postulate that is basic in every scientific theory and in knowledge itself, since these are continually striving to acquire a greater unification and correlation of apparently diverse elements. According to this postulate there is no property which exists exclusively in a few objects of the universe. Even life is supposed to exist in an extremely rudimentary and attenuated form in those objects which we call nonliving. At a certain period in the development of the earth, matter reached a stage of complexity such as to make this prelife undergo a radical change and burst out into that activity which goes by the name of life. This change is something in the line of, but much more radical than the critical point in physics, when a substance changes its state of solid, liquid or gas. Nothing absolutely new comes into existence, only a deep radical change in something that already existed in a latent form.

Teilhard thus appears to insert Driesch's *entelechy* into all the objects of the universe. But unlike Driesch, Teilhard does not think of a fairy technician inside a physico-chemical machine. For him there is a single unified reality with a double aspect, the outer and the inner, or to use Teilhard's terminology, the "*without*" and the "*within*". The *without* is what is observable and is studied by the physicist, chemist and biologist. Theories of the evolution of life concern themselves exclusively with the development of the *without*. The *within* becomes the subject of direct intuition only in man. But the unity and continuity of the universe demand that the *within* be coextensive with the *without*. The *within* can exist at different levels of development depending on the complexity of the *without*. The evolution of nonliving matter towards life is not, therefore, a blind grouping at the mercy of chance, as the mechanists would have it, nor is the chasm between life and nonlife insurmountable, as the vitalists say. But the interplay of *within* and *without* directs the gradual increase in the complexity of the *without* to a point where it triggers off a metamorphosis which raises the *within* to a level proper of a living thing.

Whatever one may feel about the vitalistic, mechanistic or Teilhardian interpretation of the nature of life, the impossibility of life arising from nonlife *under any conditions whatever* cannot be proved. Pasteur's experiments showed that spontaneous generation (even of micro-organisms) had never been proved; but his experiments did *not* prove that spontaneous generation was absolutely impossible. The speculations of scientists today are in fact centred on the notion that life might have been generated from nonlife spontaneously, i. e. through the ordinary workings of nature (cf. "chemical evolution" below). Scientifically speaking, we may never be able to prove that life did actually evolve from nonlife in the distant past when no human observer existed. But neither can we prove that the appearance of life required some special intervention* of God. Both positions are equally hypothetical, with the only difference

* This does not imply that living things are only more perfect machines than the nonliving. What exactly is meant by "special intervention" will be made clear in Chapter 5·4.

that evolution is scientifically (and theologically) more appealing and stimulating.

## 3.3 CHEMICAL EVOLUTION

The term "chemical evolution" is used for the postulated evolution of living from nonliving, as distinguished from the "organic evolution" of life, which is the further development of the first living beings into the *phyla*, *genera*, *species*, etc., that we see today. The theory of the chemical evolution of life has proved scientifically very fertile. It has opened up a vast scope for studying and reproducing the supposed stages in the long course of development of matter which led up to the first appearance of living things.

Evidence of this are the countless books and articles written on various aspects of the subject by scientists of different specializations. There is no branch of natural science that is not involved in this study. Astronomers, geophysicists and geochemists have studied the formation of our planet, its early development and the primary formation of organic substances in it. Physicists and physical chemists have approached the problem from their own point of view. The application of the laws of open system and chemical kinetics to the development of living beings has provided biophysicists and biomathematicians with matter for investigation. It is the biochemists, however, that are most directly concerned in the problem of the origin of life, of whom Haldane, Pirie and Oparin are the ones who have the most significant contributions.

J. B. S. Haldane in 1929 gave a strong impetus to the theory of a chemical evolution of life by propounding the view that organic compounds developed *even before the formation of the first living beings*. This view became generally accepted when it was found in 1934 that the atmospheres of the large planets (Jupiter, Saturn, Uranus and Neptune) contain hydrocarbon methane. This hydrocarbon could only have been formed there abiogenetically, i. e. without the help of living beings, since the temperatures in this group of planets are too low to make life possible.

According to current hypotheses, the planets of the solar system were formed from a cloud of cold gas and dust which at one time encircled the sun. The cloud first condensed into numerous planetesimals which then united to form the planets. This cloud must have certainly contained methane, which, being a gas, might have drifted away from where the earth was being formed to the outer colder parts of the cloud, and finally settled on the surfaces of the larger planets, where we actually discover it.

**Formation of Hydrocarbons**

Some of this methane, however, might have remained entrapped inside the group of planetesimals which formed the earth. More of methane and other hydrocarbons could be formed on the earth through the decomposition by water vapour of metal carbides. These carbides are compounds of metals with carbon, which must have certainly existed in the primitive planetesimals just as they are observed to exist today in meteorites. A familiar example of a carbide decomposition is calcium carbide which gives acetylene.

$$\underset{\text{calcium carbide}}{CaC_2} + \underset{\text{water}}{2H_2O} \longrightarrow \underset{\text{calcium hydroxide}}{Ca(OH)_2} + \underset{\text{acetylene}}{C_2H_2}$$

Another possible way in which hydrocarbons might have been formed is the reduction of graphite by hydrogen produced in the *lithosphere* (the stony crust of the earth) through the splitting up of water by radioactive substances.

**Derivatives from Hydro carbons**

Regarding the atmosphere of the primitive earth most geophysicists admit that it must have been virtually free of oxygen, nitrogen and carbon dioxide. It was reducing in character, made up largely of hydrogen, hydrogen sulphide, methane, ammonia and water vapour. These atmospheric gases could have undergone various spontaneous chemical reactions with hydrocarbons to give oxygen derivatives (such as alcohols, aldehydes and ketones), nitrogen derivatives (such as amines and cyanides) and sulphur derivatives (such as sulphides and mercaptans). For example :

| | | | | | | |
|---|---|---|---|---|---|---|
| $CH_4$ | + | $H_2O$ | $\longrightarrow$ | $CH_3OH$ | + | $H_2$ |
| methane | | water | | methyl alcohol | | hydrogen |
| $CH_4$ | + | $NH_3$ | $\longrightarrow$ | $CH_3NH_2$ | + | $H_2$ |
| methane | | ammonia | | methyl amine | | hydrogen |
| $C_2H_4$ | + | $H_2S$ | $\longrightarrow$ | $C_2H_5SH$ | | |
| ethylene | | hydrogen sulphide | | ethyl mercaptan | | |

**Amino Acids**

Hydrocarbons, even methane, polymerise* easily under the influence of an electric discharge, to form a countless variety of large organic molecules. In the presence of water and ammonia they could give even porphyrins** and amino acids. These latter are of special interest since they are the building blocks of proteins, which are very important for the structure and activity of living things.

In this connection, an interesting experiment was

*A "polymer" is a long chain molecule (straight or branched) made up of smaller sub-units. It is formed by the process of "polymerisation". Thus glucose is polymerised in plants to starch.

**"Porphyrins" are of special interest because the chlorophyll of plants is a magnesium-porphyrin, and "heme" (which gives animal blood its red colour) an iron-porphyrin.

carried out by S. L. Miller in 1955. In an apparatus, specially designed for the purpose, was placed a mixture of methane, ammonia hydrogen and water vapour, simulating the supposed composition of the primitive atmosphere. The mixture was subjected to silent electric discharges. A number of amino acids, e. g. glycine and alanine, were isolated from the mixture, as also some carboxylic acids, e. g. lactic and formic acids.

Some scientists, believing that carbon dioxide was present in the atmosphere of the primitive earth, have studied its possible reactions to give organic compounds. The chief reaction investigated thus far is the formation of formaldehyde ($CH_2O$) when carbon dioxide is reduced by hydrogen.

$$2H_2 + CO_2 \longrightarrow CH_2O + H_2O$$

Paraformaldehyde (a polymer of formaldehyde) can react with potassium nitrate in the presence of iron chloride to give amino acids.

**Fox's "Proteinoids"**

Another interesting discovery is that of Sidney Fox, who heated a mixture of amino acids at 170°C. under a blanket of carbon dioxide for 3 hours. He obtained some substances which were found to have properties similar to those of natural proteins, such as being digested by enzymes and eaten by bacteria. He called them "proteinoids". Though the above points of similarity do not mean much, yet it would be interesting to investigate these substances further to find out their exact structure.

**Primitive Conditions**

The reactions mentioned above are not observed in nature today. But this may be because they are obscured and complicated by the presence of carbon compounds of biogenic origin. Another reason why these reactions could have abounded in very early times is that the primeval earth must have possessed extraordinary sources of energy which made such reactions possible. For besides electric discharges and ultraviolet radiation from the sun, the primitive planet contained a relatively larger concentration of radioactive substances in the *lithosphere*, which released a large amount of energy on disintegration.

Hence, we can safely assume that both in the *lithosphere* as well as in the *atmosphere* many diverse and complicated organic compounds were formed from comparatively simple ones, namely, methane, ammonia, water vapour and hydrogen sulphide. With rain these complicated substances fell into the primitive *hydrosphere*. Compounds in the *lithosphere* partly escaped into the *atmosphere* if volatile (like the natural gas which we now observe), and were partly extracted by the *hydrosphere* itself.

Regarding the concentration of organic substances in the waters of this "primitive soup", Urey has calculated that, if only half the carbon now existing on the surface of the earth was present in the form of an aqueous solution of organic substances, then the primeval ocean would have consisted of a ten per cent solution. At that time the amount of water in the oceans was probably only one-tenth of what it is today. Evaporation of water in land-locked basins might have led to even higher concentrations of organic substances. Bernal believes that a good deal of organic substances must have been held on the surface of clays on the shores and at the bottom of the waters, leading to further concentration. The stage was now set for the further combination and evolution of these organic substances to produce the first living organisms.

## 3.4 THEORIES FOR CHEMICAL EVOLUTION

Were there chemicals that acted as building blocks for the first organisms ? Many assume that there were, and that these first building blocks were proteins, since proteins are so abundantly contained in today's living organisms. But there is no compelling reason to think that proteins were the original materials of life. They could have been merely the most successful. The same could be said of the other basic constituents of the living materials today, viz. the so-called "nucleic acids" and "polysaccharides". Another fact that has to be taken into account is that today's organisms are extremely complex and co-ordinated laboratories where every substance plays a role in the synthesis of the others. It is therefore difficult to see how these substances could be formed *independently and then later linked* together to constitute the first living cell.

**Calvin vs. Oparin**

A theory proposed by the Nobel-laureate Melvin Calvin suggests that what was probably first formed was a *nucleic acid** molecule, whose molecular structure then *behaved as a template*** to put together simple molecules and weld them into more complex ones of nucleic acid itself and of protein. As we shall see later, such a conception of the evolution of life is the result of current theories of reproduction which emphasise the template principle.

To Oparin, on the contrary, it seems much more probable that at first it was only the simpler organic substances that came together to form elementary systems. These

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*Nucleic acids ("DNA" and "RNA"), as will be explained below have important roles in heredity and protein synthesis.

**A template is like a mould. The pattern of the mould dictates the pattern of the material formed on it.

*systems then developed further* and became more complex, both in their constituent chemicals and their inner reactions, till they reached a stage which possessed all the characteristics that we normally ascribe to a living being. Instead of being the products of isolated reactions, proteins and nucleic acids would appear as the end result of the formation and development of whole systems.

**Characteristics of Living Things**

In working out any theory for the chemical evolution of life, a scientist must keep clearly before him the main characteristics of the goal of evolution (here, a living being) and then work systematically towards it. Those characteristics are individuality, open system and reproducibility. The *first* quality of a living organism is its individuality. It is sharply delimited from the surroundings. It is a unit by itself, distinguished from its environment and physically separated from it by some sort of membrane. This separation, however, is not such as to cut off all communication. In fact, and this is the *second* characteristic, the existence of an organism depends on interaction with the environment. The organism is an open system. Since it is becoming more and more popular in biological circles to describe living beings as open systems, it will be worth discussing this concept a little more in detail.

## 3.5 LIVING THINGS AS OPEN SYSTEMS

An ordinary bucket containing water is a *closed* system. It has no relation with the outside in the sense that no water flows into it or out of it. The water is in a *static* equilibrium because its level is maintained without any flow of water. On the other hand, a tank of running water in which the water flows in through one pipe and out through another is an *open* system, since it is connected to an external source of water and an external sink. By adjusting the rates of inflow and outflow the water can be maintained at a constant level. The equilibrium is no longer static but *dynamic*. Similarly we can also have chemical reactions which are open systems in dynamic equilibrium.

**Dynamic but Closed**

If a mixture of nitrogen and hydrogen is enclosed in a vessel containing a catalyst, ammonia is formed. Only a small proportion of the nitrogen and hydrogen combine to form ammonia. But the reaction does not actually stop. It is balanced by the opposite reaction, viz. the decomposition of ammonia to give back nitrogen and hydrogen. We say the reaction is in a dynamic equilibrium. It is represented by the following diagram.

$$\boxed{3H_2 + N_2 \rightleftharpoons 2NH_3}$$

The dotted line indicates the boundary between the system and the environment. The double arrow shows that both the forward as well as the reverse reactions are going on at the same time. But, although the reaction is in *dynamic* equilibrium, it is a *closed* system.

**Dynamic and Open**

Suppose now that molecules of ammonia are removed from the system at one end and hydrogen and nitrogen are added at another. At first the above equilibrium will be disturbed. But by adjusting the rate at which ammonia is removed and the rate at which the mixture of hydrogen and nitrogen is supplied, it is possible to set up a new equilibrium in which the quantities of the three gases remain constant, balanced by the inflow and outflow of gases and the internal reversible reaction. We have here an *open* system in *dynamic* equilibrium. The former reaction was also dynamic but closed. The new system, unlike the former, is, on the whole, forward-moving because it keeps continually taking in nitrogen with hydrogen and yielding ammonia.

**Application to Living Cells**

In the living cell matters are incomparably more complicated. In the first place there are not just one or two reactions but a whole chain of strictly coordinated chemical transformations. The sugar entering a yeast cell from the wort surrounding it, is transformed into the final products of fermentation, namely, alcohol and carbon dioxide not directly as the result of a single chemical reaction but as the result of a complicated series of reactions which are co-ordinated with one another. The system within a living organism may be represented as follows :

$$
\begin{array}{cccccccccccccc}
S & \longrightarrow & A & \rightleftharpoons & B & \rightleftharpoons & C & \rightleftharpoons & D & \ldots\ldots & \rightleftharpoons & N & \longrightarrow & Z \\
 & & & & & & \upharpoonleft\downharpoonright & & & & & \upharpoonleft\downharpoonright & & \\
 & & & & & & X & \rightleftharpoons & & \ldots\ldots\ldots & \rightleftharpoons & Y & &
\end{array}
$$

"A" stands for the group of reacting substances which is transformed into another group of substances, "B", which react further to give "C", etc. At "C" there is branching of the chain, i. e. part of the substances "C" are changed into "D", and another part into "X". Through a series of transformations, "X" is made to give "N." "N" is also formed by another route from "C". "S" represents the environment from which materials are taken into the system, and "Z" the environment into which the products are discharged.

In the much more complex system that a living organism is, two or more open systems within it may constitute a new open system superimposed upon them. It is not necessary that every reaction in the living organism be an open system, provided it forms such a system with other reactions. Ludwig von Bertalanffy, the foremost exponent of the open system theory of life, makes almost fantastic claims for the open system as an explanation for the whole behaviour of a living organism. An open system makes for great stability precisely because it is flexible, i. e. adjustable to a changing external environment. If its equilibrium is disturbed it reacts to restore it or to set up a new equilibrium. This explains the responsiveness to an external stimulus and the instinct of self-preservation innate in every living organism. It is claimed by von Bertalanffy that all the phenomena which Driesch ascribed to the vital force are explained by the laws of an open system. The structure itself of the organism is an open system. Though it appears fixed and immutable, it is actually being slowly but steadily renewed in its constituent material.

## 3.6 OPARIN'S COACERVATE APPROACH

The original contribution of Oparin to the speculation on the origin of life is that he explains the formation and evolution of a stable system of chemical substances, by exploiting a little studied phenomenon called "coacervation".

**Solution, Suspension, Colloid**

There are different ways in which one substance may exist within another. Thus, in a *true solution*, e. g. when sugar is dissolved in water, the solid molecules are so finely dispersed among the water molecules that no solid is seen but only a clear liquid. On the other hand, if we have a *suspension* of sand in water, the solid can be clearly distinguished from the liquid. A *colloid* or colloidal solution is midway between the condition of a true solution (sugar in water) and a suspension (sand in water). In a colloid, e. g. milk, the particles of the solid are dispersed within the liquid, but the particle size is bigger than in the case of sugar in water, and so what results is not a clear solution but a turbid liquid. A solution, colloid and suspension differ in the degree of particle size.

**The Coacervate Condition**

Now, in between a colloid and a suspension comes the condition of a coacervate. Coacervates are formed under certain conditions by colloids containing organic substances. In coacervation the solid particles of a colloid join up into numerous minute aggregates which look like droplets. The liquid outside the droplet is clear, and contains no solid. But inside each droplet the solid particles are mixed up with liquid particles and form a sort of a minute colloid. There is a *clear surface of demarcation* between each droplet and the surrounding liquid. This surface, so it is thought, consists of *concentric layers of liquid molecules* as indicated in the Fig 7.

The molecules of the liquid forming the first layer are firmly attached to the surface of the particles, whereas the successive outer layers are bound more and more loosely. This surface of demarcation prevents the drops from fusing with one another and from mixing with the surrounding liquid.

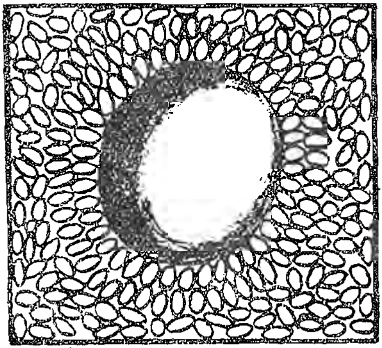

Fig. 7

Diagram showing how concentric layers of liquid molecules could form the surface of demarcation around a coacervate droplet

**Coacervation vs. Coagulation**

Coacervation is quite different from coagulation. When a colloid coagulates (e.g. when milk curdles), the solid also joins up into aggregates. But these contain no liquid. They all settle to the bottom like a sediment or float on the surface like a scum. A coagulate is like a suspension. It is not clear how a coacervate droplet differs in its physical nature from a miniature colloid, except that it is thicker than the colloid from which it is formed. But a coacervate has certain physico-chemical properties not found in any ordinary colloid. The very form in which it exists, viz. as minute droplets scattered all over the liquid, is something very unusual in a colloid. It has other peculiar properties, to be mentioned later, which make it (according to Oparin) apt to evolve into a living organism.

We have spoken so far of a *simple* coacervate. But more important for our purpose is *complex* coacervate, in which every coacervate droplet contains many types of substances. Such coacervates can be prepared in various ways, but one easy way is to mix under certain conditions two or more colloidal solutions having particles with opposite electrical charges. Forces of electrostatic attraction bring the particles together into a coacervate. It has been possible to obtain complex coacervates in which one type of coacervate droplet composed mainly, for instance, or gelatin and gum arabic, contains within itself another type of coacervate droplet composed of gelatin and nucleic acid.

**Resemblances to Protoplasm**

Oparin shows the striking similarities between the physico-chemical properties of complex coacervates and those of the protoplasm in living things. One of these resemblances is the phenomenon of *vacuolisation*–the formation of bubbles within the coacervate drop. Another property of coacervates that is relevant here is their tendency to form *structures*. Structure, fundamentally, is any regular arrangement of molecules. The interface between a coacervate droplet and the surrounding liquid is made up of a regular arrangement of liquid molecules round the droplet. Within a complex coacervate droplet, there would be similar interfaces consisting of arranged molecules between the droplet, say, of gelatin and nucleic acid and the surrounding bigger droplet of gelatin and gum arabic. Besides this, coacervate droplets have been observed under certain conditions to arrange themselves into some sort of regular pattern. This pattern, however, is not rigid and disappears with a change of conditions. Nevertheless such tendencies of forming structures could have played a part in the evolution of the structure of the first living organism.

Another relevant property of coacervates is the *permeability* of the water membranes separating the droplets. Liquid and even solid particles can pass in and out of them. This enables the droplets to absorb various substances which may be introduced into the surrounding liquid. Many organic substances are extracted almost completely by coacervates from the liquid. Even when the concentration is as low as 0.001 per cent, a coacervate may absorb some substances from the liquid in which they are dissolved. The molecules which are absorbed by the coacervate may remain as such or may react chemically with other substances present inside the droplet and thus bring about quite substantial chemical alterations in the coacervate. The absorption has a *selective* character. Coacervates may accumulate large amounts of one substance, collecting it from dilute solutions, while on the other hand they may take up only very limited amounts of another, although this may be present in high concentration.

**Coacervates as Open Systems**

After this long excursion into the domain of coacervate chemistry, let us come back to those organic substances which were dissolved in the ocean of the primitive earth. According to the reactions previously described, a complex mixture of different high-molecular organic compounds must have been present in the ocean. Complex coacervates must surely have been formed, because the conditions for their formation are not difficult to obtain. High dilution would be no obstacle. Coacervation in water containing merely traces of organic substance has been frequently observed under experimental conditions. Coacervation itself would bring about concentration of organic matter and its separation from the surrounding medium. Selective absorption of substances from outside ("food material") into the coacervate drop, chemical reactions within it, and the expulsion of other substances ("wastes") from it would set up a co-ordination that would give the drop the dynamic stability of an open system. Further, nothing prevents such a system from growing in mass and yet maintaining a constant stability.

**The Evolution of Coacervates**

Oparin uses the Darwinian principle of evolution by natural selection to explain the development of the coacervate drop to a stable and growing open system. It must be stated at the outset that this "selection" in pre-life evolution could only have been of a very primitive type. It can hardly be compared with fully developed natural selection in the strictly biological sense of the term. The selection, or rather, the preservation of certain drops and the elimination of others can be visualized as being the result of three factors.

The first is *individual stability.* Drops which remained closed systems would soon be eliminated. Among the incipient open systems the degree of stability would vary depending on the co-ordination of reactions within the drop, communication with the external medium and a host of other factors. There would be an elimination of less stable drops.

Another factor, *growth,* would cause one type of system to predominate over another. Rates of growth would certainly vary from drop to drop. In some drops the presence of catalysing substances would speed up the reactions taking place within. The systems could become larger in the form of uniform layers of coacervated mass, or they might divide into separate drops. Whatever it be, the variety in the rates of growth would make certain types of systems predominate over others.

A third factor of elimination would be the quantity of *food material available* in the external medium. The drops would not all feed on the same type of substance. Hence, when the food of certain drops ran out of supply, those drops would be starved out of existence. What would happen when all the food of all the systems started showing signs of exhaustion? Here Oparin in the course of his book suggests an ingenious explanation based on the data of comparative biochemistry. There would be systems which contained photosensitizing chemicals (e.g. porphyrins), which, by absorbing light energy could utilize the organic wastes now present in abundance, in particular carbon dioxide, for building up fresh food material. Such systems would eventually start proliferating and replenishing the world with a welcome supply of nutritive broth for other well-nigh famished systems. This is the beginning of photosynthesis which would now start releasing free oxygen into the atmosphere. At this stage, however, we have long passed the critical point and are well within the confines of life. Our systems have come so far away from coacervates that no right-minded hypothetical observer would have much hesitation in calling them living organisms.

**Evaluation of Oparin's Theory**

We have seen so far how the coacervate theory could account for two important characteristics of living organisms, viz. *individuality* and *open system*. The final characteristic which has to be looked for in the evolving coacervate drop is the *ability to reproduce*, i. e. to produce another drop of the same kind. This is the point where Oparin is least satisfactory. On reading his lengthy disquisition on reproduction, one gets the impression that he is tacitly assuming that as a result of change over a vast extent of time and of selection from a vast number of coacervate units, those that still persevered developed a capacity of producing not just catabolic wastes but new units which were of the same type as the parent units. Oparin's theory apparently fails completely to show how regular reproduction developed. Instead he is preoccupied with counteracting an idea of reproduction, which is current today and is based on the so-called template principle. This principle we have to discuss in order to see that it must necessarily be incorporated into Oparin's open system hypothesis if we are to get a more satisfactory view of the evolution of life.

## 3.7 DNA AS TEMPLATE

From various experiments on viruses and chromosomes it has become clear that the principal factor concerned with the transmission of hereditary characteristics (a central feature of the total process of "reproduction") is a substance called desoxyribonucleic acid, usually referred to as DNA. This DNA is found in the chromosomes which are intimately linked with the processes of cell division. If a gorilla produces another gorilla and not a chimpanzee, it is because of its DNA. Gorilla DNA is not the same as chimpanzee DNA.

**Chemical Constitution of DNA**

Chemically, DNA is a long-chain polymer with a backbone made up of alternate sugar and phosphate groups. The sugar is always the same sugar, i. e. desoxyribose.

It is always joined to the phosphate in the same way, so that the long chain is perfectly regular, repeating the same phosphate-sugar sequence over and over again. But while the phosphate-sugar chain is perfectly regular, the molecule as a whole is not, because each sugar has a base attached to it and the base is not always the same. Four different bases are commonly found : adenine, guanine, thymine and cytosine. The order in which they follow one another along the chain is irregular, and probably varies from one piece of the chain to another. The *sequence* of bases is believed to make the DNA specific to the particular species of organism since the relative amounts of the four bases is found to be fixed for the given species.

**Structure of DNA**

The DNA chains in the chromosomes are paired. The two chains in each pair run in opposite directions and are coiled round each other to form a double helix. It looks like a spiral staircase in which the bases form the steps and the phosphate-sugar chain provides the banisters. Each step consists of two bases, one from each of the chains. The bases are linked by hydrogen bonds. Such a model, proposed on the basis of x-ray analysis, predicts that only specific bases can be paired to form a step : adenine-thymine and guanine-cytosine. This implies that the sequence of the bases in the two chains is complementary, so that the sequence on one chain determines that on the other. (Cf. Fig. 8, p. 99)

**Chain Replication**

According to current theory when a parent cell has to divide, the two strands of the double helix unwind themselves from each other. Each chain then acts as a mould on which a new complementary chain can be synthesised. This is done by the assembly on the DNA matrix of building blocks (called precursors) present in the cell. The right order among the blocks is assured by the specific pairing of the bases. We thus have two pairs of chains where before there was only one—the chromosome has reproduced itself.

**DNA Controls Specific Features**

How does DNA control the development of the rest of the cell in a specific way ? The sequence of the bases acts probably as a genetic code. Such an arrangement can carry an enormous amount of information. If we imagine that the pairs of bases correspond to the dots and dashes of the Morse code, there is enough DNA in a single cell of the human body to encode about a thousand large textbooks. Now, the characteristic hereditary traits of an organism are based on numerous chemical reactions which in their turn are determined by specific enzymes. Enzymes are proteins. They consist of amino acids built into a structure whose fundamental pattern is the same as that of DNA, viz. a regular backbone and a varying sequence of side groups. This suggests that the DNA chain is in some way responsible for assembling the protein precursors in a sequence determined by its own.

## 3.8 FINAL CONSIDERATIONS

All that has been said above shows how closely related is the phenomenon of life to a molecular structure capable of precursor-assembly. A theory of the chemical evolution of life will have to explain the development of such a molecular template.

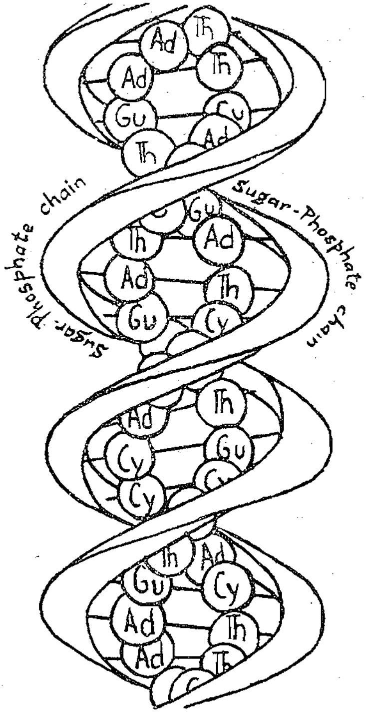


Fig. 8.

Doble helix structure of DNA with the paired bases : Ad = adenine; Gu = guanine; Th = thymine; Cy = cytosine

**Evaluation of Calvin's Theory**

This is just what Melvin Calvin tries to do. His theory is based on two postulates. First, certain kinds of molecules would have to predominate over others in the primeval ocean because of autocatalysis, i. e. they would catalyse their own formation. Secondly, such molecules now present in abundance would have to come together to form large polymers which would acquire a certain molecular structure capable of acting as matrix for assembling other large molecules of various types. Finally, these different molecules would then get together and make up the first cell.

The template theory of the evolution of life as propounded by Calvin would explain replication marvelously, but it fails to account for the individuality and flexibility of the open system. Also, the total process of reproduction is not merely the result of the sameness of a template but depends as well on the constancy of a reaction network in an open system. No template phenomenon in today's organisms occurs except inside the open system of a living cell. Viruses, though they contain nucleic acid, apparently "come to life" only within the open system of the host cell. That is why scientists are doubtful whether to call viruses alive or not. In reproduction, sexual or otherwise, it is not naked, isolated DNA chains that are involved but whole cells. So much against Calvin.

**Ideals for the Future**

But against Oparin we have to assert that though an open system may explain the evolution of an individual, it cannot tell us how this individual develops the power of not merely producing another individual but of providing it with a complete set of instructions which preserve the lessons learnt through millions of years of evolution. In the ideal future hypothesis for the nature of life as also for its evolution from nonliving matter, some sort of synthetic theory incorporating the *conservatism* of template together with the *dynamism* of open system would be highly desirable.

Of all the theories proposed on the origin of life from nonliving matter, that of Oparin is at present the most systematically and scientifically worked out. Yet Oparin himself in an introductory address at the first international symposium on the origin of life (Moscow, 1957) stated: "We have, as yet, *no single satisfactory account* of the phenomena which occurred at some time on our planet. *We want to verify our assumptions*, either by observations of natural phenomena which are taking place at present, or by experimental reproduction of the separate stages of the development of matter which we have *postulated*". (Italics ours). One wishes that certain scientists and popularisers were as careful in their statements as Oparin.

The problem is indeed one of extreme difficulty and complexity. This is why we cannot but marvel at the tenacity and inventive genius of men who continue to worry nature for progressively better answers to the great riddle of life's origin. History shows that to such men nature finally yields her secrets.

# Chapter 3
## ( Continued )

# Viruses and Life

## A Supplementary Enquiry

Nowadays keen discussion is devoted to the problem of whether or not viruses are alive. This is, moreover, a topic involving biological and philosophical considerations closely connected with the body of the chapter. Hence, there is some point in taking it up here.

"*Are viruses alive ?*" The very statement of our problem requires that we know what viruses are and also what life is. These two points will, therefore, be looked into before tackling the problem directly.

### 3.9 WHAT ARE VIRUSES ?

The viruses are a class of objects *very small, very deadly* and *extremely interesting.*

**Incredibly Tiny**

They are so *small* that their sizes are expressed in a special unit called the "millimicron" which is one millionth of a millimetre (one can try to visualise what that means with the help of an ordinary footrule! ). The size range for viruses is usually between 10 and 200 millimicrons. Hence, most of them will be "submicroscopic", i. e., invisible even under an excellent modern microscope using ordinary light. But the electron microscope, being far more powerful, can give us "pictures" full of information on the shape, structure and behaviour of viruses.

**Dangerous Guests**

Viruses are *deadly* too : the very name derives from the Latin for "venom" or "poisonous fluid". They cannot multiply except within living host cells, which are consequently destroyed with ruthless efficiency and often in an amazingly short time. Plants, animals and men are all attacked. Among the important viral diseases of man are smallpox, rabies, poliomyelitis and yellow fever. There are, of course, numerous other human ills caused by the tiny bacteria (the "germs" of ordinary conversation, which we *can* see in the usual microscopes). It is some slight consolation to know that even these bacteria are plagued by viruses all their own called "bacteriophages"—or just "phages" for short. Since bacteria are easy to handle and grow in the laboratory, no other group of viruses, with the exception, perhaps, of some plant viruses, has so far been studied as thoroughly as the phages. Much has thereby been learnt (especially about the decidedly peculiar mode of virus multiplication) which, with caution, may be extrapolated to understand other types of virus also.

**Current Interest in Viruses**

So small and so deadly. Yet these are not the only reasons why viruses are today considered so extremely *interesting*. Though small (the smallest viruses are only about as big as the larger protein molecules), they have characteristic shapes built up in an organised fashion, with protein coats enclosing cores of nucleic acid.* Though deadly, they may at times lie low, multiplying quietly in step with the host's own chromosomes at the time of cell division. Then, suddenly, they seem to wake up, so to say, becoming dangerous once more through rapid multiplication.

* Some viruses have been found to contain small portions of other types of organic material as well.

It is significant that chromosomes are themselves composed (to a large extent) of protein and nucleic acid. Some experts, therefore, think that viruses are fragments of chromosome-like material which originally broke free from the cell's control system, and that their menace consists precisely in multiplying faster than the rest of the cell. This hypothesis for the origin of viruses is, perhaps, more likely than the others which have been proposed.

The viruses will continue to remain curiously mysterious for a long time to come. They lurk in the shadowy region between the giant molecules of lifeless protein (or nucleic acid) and those dwarf organisms like bacteria which all consider to be alive. A number of viruses can be crystallised like nonliving matter without losing the ability to invade and multiply in living cells. "Animated crystals" what an enigma !

## 3.10 WHAT IS LIFE ?

In its intimate nature and distinctive features "life" is at least as enigmatic as "viruses". The discussion on the nature of life (cf. A. below) is going to be difficult because we shall be obliged to grapple with the comparative philosophical merits of mechanicism, vitalism and hylomorphism. Things will be somewhat more pleasant when, after that (cf. B. below), we examine the characteristics that help to distinguish life from nonlife.

### A. THE NATURE OF LIFE

**Mechanicism as Method and as Theory**

We were already introduced to *mechanicism* in the previous pages. This is the view which regards living things simply as complicated machines, *totally* explicable by the laws of physics and chemistry *alone*. Now there are sufficient proofs for rejecting this view as a faulty philosophical theory, uncritically built up from a correct scientific method of work. The scientist correctly limits himself to assigning physico-chemical explanations for various activities in living things.* For him mechanicism *as a method of work* is entirely justified. He searches for the physico-chemical factors which will tell us how a particular vital activity is brought about, and how the various activities come to influence each other.

But even when all these physico-chemical factors are added together, no convincing explanation emerges for the patent fact that the living being is an "organism" in which we find an amazing unity—a unity apparent in the unification of all the various vital activities to secure the good of the living being as a whole. And that is why mechanicism *as a philosophical theory* must be rejected. A living thing acts primarily as a single coordinated unit. It is a whole which is more than the sum of its parts; its activity as a whole is more than the sum of its partial (particular) activities. Physics and chemistry can and should be effective in explaining the partial activities, but they do not explain the vital activity as a whole.

**Vitalism and Hylomorphism**

The contrary philosophical theory of *vitalism* was supported precisely by those scientists who felt that physics and chemistry could not explain everything. They were so deeply conscious of the organic unity and unification of activity in living things that they postulated the presence of a special "vital principle" as guiding influence.

* Of course, when he is merely concerned with the accurate recording of his observations, he does not bother much about explanations at all. Exact observation is a first step in the scientific method.

Without this principle, the living thing would not "go"— it would be like a car without its driver. This theory is also to be rejected because it needlessly postulates too much. It must yield before another philosophical theory, *hylomorphism,** which lifts the explanation for the unity and unification found in living things off the plane of "efficient causes", i. e., away from (in our case) those physico-chemical factors which scientists can detect and study in order to explain particular vital activities.

The mysterious "driver" of vitalism remains an "efficient cause", whereas hylomorphism attributes the directed unification of vital activities to a "formal cause", to what it calls the "substantial form" of the living thing. Now a "formal cause" is necessarily beyond detection by scientists, because it is *not some material thing* but the *principle which explains the specific nature of all material things whether living or nonliving.*

**Prime Matter and Substantial Form**

If living things are characterised by a unity and unification not found in lifeless things, if physico-chemical factors explain living things far less satisfactorily than they do lifeless things, it is because living things have a superior "substantial form". In the hylomorphist view all material things are made up of two co-principles called "prime matter" and "substantial form", which do not exist separately but *which together constitute one material thing.*** "Substantial form", the principle of perfection and unity, explains the specific nature of a thing, whereas "prime

*Derived from two Greek words which united mean "matter-form".

**This statement needs qualification before it can be applied to that most complex of material things : man–whose soul is **both** "substantial form" **and** capable of separate existence. But we will leave him out to avoid complicating further a sufficiently complicated issue.

matter" explains individuals within that nature. A common "substantial form" makes all cows precisely *cows*, whereas *many* cows are possible only because of "prime matter".

These two coexistent principles make up not only the *living*, organised matter of biology (bacteria, plants, animals), but also the *lifeless* matter of physics and chemistry (water, oxygen, iron, etc. ). If iron is different from copper it is because it has its own specific "substantial form" different from that of copper. If the plant manifests a unity and unification which make it different from iron, it is because plants have a type of "substantial form" superior to any of those found in lifeless matter. We may consider the "substantial form" in lifeless matter as being completely immersed in "prime matter". As we mount the scale of being from lifeless matter to plants and on to animals, the "substantial form" progressively emerges from the restricting influence of "prime matter", so that progressively superior activities become possible to the material being.

**Life from Dead Matter ?**

It is to be hoped that this condensed treatment has at least served to indicate how scientist and philosopher need each other if the explanations offered on the nature of life are to be really adequate and satisfying. But, in addition, hylomorphism has a bearing on two other important problems : *did life originate "spontaneously" from (lifeless) matter in the past ?* and, *will scientists "create" life from (lifeless) matter in the future ?* Hylomorphism cannot give a "*yes*" or a "*no*" to these two questions. However, when hylomorphism is aided by the principle of contingency, it can answer to both questions : "*quite possibly*".

The principle of contingency means that at every instant all creation is receiving its existence, nature and powers from God. Now it is *quite possible* that the material world has been endowed by God with that power by which the higher "substantial form" proper to a living thing should appear as soon as lifeless matter becomes possessed of a certain type and level of organization. And IF this actually did happen in the past under certain circumstances, there seems to be no inherent reason why scientists should not be able to duplicate those circumstances in the future.

## B. Features Distinctive of Living Things

Philosophical views on the nature of life will not be much of a help in deciding whether or not viruses are alive. The hylomorphist will merely say that viruses are, like all material things, made up of "prime matter" and "substantial form". He cannot say that the viral "substantial form" is of the superior type proper to living things unless he is given proofs that viruses show those characteristic features which living things alone possess.

Now, in practice, what are these *characteristic features* that distinguish life from nonlife ? Once we know that, it should be possible to frame a *definition* of life, i. e., a carefully worded statement which will apply to all living things and exclude all nonliving things. We can then return to the viruses, check them against the list of characteristic features and the life-definition, and so finally decide whether or not viruses are alive.

**Scientists and the Definition of Life**

When scientists today are asked for a general *definition* of life they usually have no ready answer. They can easily pick holes in those definitions which a few of their more courageous colleagues have offered. In fact, the common tendency is to consider the framing of such a definition rather a waste of time. And when tackled about the viruses in particular, scientists are inclined to say : "What does it matter really whether we label them living or not ? Viruses are fascinating objects for laboratory research. Let's get down to investigating them by more thorough experiments. The rest can be discussed on a quiet evening get-together*."

**Distinctive Features Listed by Scientisits**

However, when scientists today are asked to list the *characteristic features* distinctive of living things, they talk with more confidence and freedom. And the features most commonly mentioned are *nutrition, growth* and *reproduction* together with the more basic underlying characteristics such as *organic unity, cellular constitution, metabolism, unstable equilibrium* and *reaction to changes in the environment.* Some at least of these terms will mean little to the uninitiated reader. Instead of explaining each of them in detail, it might be better to watch a cell at work so that a concrete picture emerges not only of the distinctive features but also of the manner in which they fit into the pattern of cell activity as a whole. But let us first examine the implications of cellular constitution and organic unity.

"Organism" and "living thing" are used practically as synonymous terms. All organisms have a *cellular constitution,* being composed of one or more cells. In the higher forms of life (e. g. dog) there are many cells, but these are so organized into tissue and organ systems that we rightly speak of a single individual (e. g. the dog "Brownie"). But even in a unicellular organism there is within the cell an

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*Occasionally, one does find a scientist or a populariser saying : "Obviously viruses are alive." It is difficult to see how it is so obvious, especially since they are usually careful not to explain what they mean by "alive."

*organic unity* with all the structures and activities coordinated and subordinated for the good of the whole. Moreover, despite the differences in shape, size and function, all cells throughout the world of life are basically similar. Hence, the characteristic features of living things can be illustrated from the simplest of them. So let us look at a unicellular bacterium.

**The Structure and Activity of a Bacterium**

Like all cells, the bacterium has a nucleus, or at least nuclear material, distinct from the surrounding cytoplasm in which it lies. Both nucleus and cytoplasm are enclosed in a porous cytoplasmic membrane (through which, selectively, nutrients are introduced and waste products excreted). Protection and support come from an outer cell wall, whose function is perhaps merely mechanical.* There are, of course, other structural features, but we need not delay on them.

*Nutrition* and *growth* result from a bewildering number and variety of chemical reactions (*metabolism*) by which large food molecules are broken down into the smaller units necessary for the cell to build up its own substance. The energy required for the building-up processes (anabolism or synthesis) comes from the breaking-down processes (catabolism), and the extra energy released is stored for use in certain high-energy compounds, e. g., Adenosine Tri-Phosphate, or, ATP. The vast series of metabolic reactions, whether catabolic or anabolic, is controlled by "enzymes". These truly amazing molecules are proteins (predominantly or totally) which function as "catalysts", i. e., they effect with speed and efficiency chemical conversions otherwise rather difficult. To sum up : metabolism, through which the cell feeds itself and grows, is the sum

*Not all cells among living things have a cell wall.

total of the reactions catalysed by enzymes. Metabolism involves both catabolism and anabolism.

**Catabolic Processes ( breaking down ) Yielding Energy** A practical illustration should help. Suppose there is some starch in the environment which the cell needs. Well, starch, being made up of chains of glucose molecules, is too large to be passed as such through the cytoplasmic membrane. So the bacterium secretes extracellular enzymes which will break up the starch into smaller units. Inside the cell each glucose molecule from the starch can be made to travel, according to the needs of the cell, down what is called "the glycolysis pathway" : a series of reactions by which glucose ($C_6H_{12}O_6$) is broken down to pyruvic acid ($CH_3 \cdot CO \cdot COOH$). In this series of reactions each step is controlled by a different, specific enzyme. The energy released is stored in ATP. If necessary, pyruvic acid can in turn be broken down to carbon dioxide ($CO_2$) and water ($H_2O$), with a much greater release of energy, when passed through another enzyme-controlled series called "the Tri-Carboxylic Acid, or TCA, cycle".

**Anabolic Processes ( building up ) Requiring Energy** On the other hand, according to the needs of the cell, the energy obtained or stored from the catabolic processes can be used to build up cell substance or reserve food material. The catabolic processes supply the building blocks too. For example, inside the cell, glucose molecules can be linked together to re-form starch and similar *polysaccharides*. Pyruvic acid can be passed up "the fatty acid spiral" to eventually form *fats*. Compounds can be withdrawn from "the TCA cycle" and then changed into amino acids which are the building blocks for the cell's *proteins*. In all these synthetic processes (anabolism), as we might have expected, each of the steps is also controlled by an enzyme.

Even in the simplest of living things, therefore, we have ceaseless activity with complicated interconnections and delicately balanced reaction series which will shift now one way, now another, according as the cell needs more food or energy or building blocks for growth. This is the situation described as *unstable equilibrium*—which is simply another way of expressing the *organic unity* and unification which makes each living thing an "organism". And, necessarily, there will be *reaction to changes in the environment*, that world lying just outside the cell membrane, and these reactions are strikingly adaptive for the good of the organism. Some bacteria, when the environment is unfavourable, simply close shop, so to say, and retire into tough structures called "spores". When conditions become more helpful, the spores develop into normal organisms.

**The Nucleus as Control Centre**

Attention has been drawn to the importance and central role of the enzymes. They dominate the quality, quantity and course of cell activities. In a real sense, the cell is what its enzymes are, and organisms differ from each other according to the enzymes they possess.

But how do the cells of one type of organism come to have a particular set of enzymes and the cells of another type a different set ? Clues to this puzzle have appeared only in recent years. Enzymes are proteins, and the sites of protein synthesis are tiny structures called "ribosomes" scattered through the cytoplasm. Now proteins differ from each other according to the sequence of their constituent amino acids—just as nucleic acids (DNA and RNA) differ according to the sequence of the nitrogenous bases of their constituent nucleotides. The sequence in proteins

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and nucleic acids will be specific for each type of organism; i. e., each type of living thing has its specific enzymes (proteins) and nucleic acids (DNA and RNA).

The modern hypothesis is simply that *the sequence in the proteins is patterned according to the sequence in the RNA which is, in turn, patterned after the sequence in the DNA.* Now the DNA is found in the nucleus, while the RNA occurs mostly in the cytoplasm and its ribosomes (sites of protein synthesis) but partly also in the nucleus. *This means that the nucleus becomes the real control centre for all the activities of the cell.* The pattern of the DNA of the nucleus is carried (by RNA molecules) over into the cytoplasm so as to determine the pattern of the RNA of the ribosomes, and so finally the pattern of the proteins (enzymes) formed in the ribosomes. Hence, it is ultimately the specific DNA of the nucleus which is responsible for the specific set of enzymes, and therefore for the quality, quantity and course of all cell activities. *DNA is the genetic material : it carries "the genetic code".* All this is still hypothesis, of course, but an impressive body of evidence continues to accumulate in support of it.

**Reproduction and the Genetic Material**

If we refer back to the scientist's list of distinctive features, it will be noticed that there is just one feature about which we have said nothing as yet : *reproduction.* It was worth waiting, because now it should be clear that, whatever else happens in reproduction, it is essential that all newly produced units get their proper share of the specific DNA. Otherwise, reproduction would result in new units of a quite different nature and activity.

What happens is roughly as follows. Continued metabolism brings about growth, i. e., an increase in amount of all the constituent parts of the cell with their polysaccharides, fats, proteins, etc. Growth is eventually accompanied by a division of the nucleus involving (among other things) the accurate and precise duplication of the DNA. Hence, a double set of the genetic material (DNA) forms before the cell finally divides into two, so that each of the two new cells has its own set of DNA identically coded to control specific cell activity*. Of course, each of the two cells also gets its share of the other cell constituents whose quantity had increased with growth. That basically is what *asexual* reproduction involves, and, as a result, we get an increased number either of individuals (in unicellular organisms) or of cells (in multicellular organisms).

In *sexual* reproduction, however, a new individual arises from the fusion of two sex cells,** one male and the other female, called "gametes". The gametes are prepared by a special process of cell division (called "meiosis") which ensures that *each gamete has only half a set of the genetic material*. Fusion of the gametes will, therefore, give rise to a single cell with a complete set of the genetic material, and this cell can further reproduce, if necessary, by the ordinary asexual method.

**The Philosopher and a Definition of Life**

We said earlier that scientists in general fight shy of a *definition* of life. A number of philosophers are somewhat bolder. Reflecting on life's characteristic

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* The partition of the genetic material is most evident in the cells of higher organisms where, during cell division, the material of the nucleus gathers into chromosomes carrying the DNA. The chromosomes are duplicated before cell division is complete.

** The case of *parthenogenesis* is an exception where the new individual arises from the unfertilised female sex cell alone.

features as explained by the scientist, a philosopher might come up with a definition like this one of J. F. Donceel: "Life is that which makes a being naturally capable of self-perfective immanent activities." *

To paraphrase briefly Donceel's own comments on the definition. An *immanent* activity is one whose effects remain within the subject which acts**, e. g., thinking, seeing, growth, nutrition and the like. The word *naturally* is introduced to exclude machines which may appear to have immanent activities of a sort; but then, machines are not real subjects acting from within, since their unity is artificial and introduced from outside by their manufacturers. Similarly, the word *self-perfective* serves to exclude the immanent activities of intra-atomic particles which maintain the atom's energy without being self-perfective as growth and nutrition (for example) are.

## 3.11 ARE VIRUSES ALIVE?

We have, in some detail, examined the distinctively characteristic features of living things as manifested in even the simplest organisms—those unicellular creatures which everybody will admit are alive. The definitions of life offered by philosophers and scientists are based on those distinctive features. Hence, if (by and large) the viruses do not possess those features, it is obvious that they will not fall under the definitions either.

Now, from what follows, it will soon be evident that

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* Perhaps not every philosopher will frame the definition in exactly these words. But those of the Thomistic school should find it substantially acceptable.

** This is opposed to *transitive* activity, e. g. kicking a ball, where the effects pass into the ball even though I do the kicking. Some philosophers like to insist that there is no activity which is purely transitive.

viruses differ very markedly from organisms in structure, composition and reproduction. If, then, anyone says that viruses are "alive", it can only be in some sense quite different indeed from what "alive" means when applied to organisms.

### A. The Structure and Composition of Viruses

Viruses show some variation in shape. Thus, bacteriophages are tadpole-shaped. Animal and plant viruses, on the other hand, are typically either cylinders or spheres. On closer examination the "spheres" are seen to be polyhedrons with a fixed number of faces, while down the length of the "cylinders" appear grooves and ridges.

Whatever its shape, a given virus has only one kind of nucleic acid : *either* DNA *or* RNA—not both. Protein is also present, enclosing the nucleic acid like a coat.

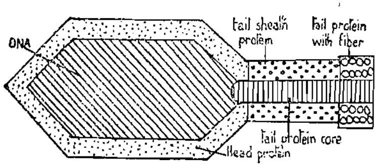


Fig. 9

Diagrammatic representation of a bacteriophage. See text for explanation

The structure and composition of a bacteriophage is represented diagrammatically in Fig. 9. Most phages contain DNA, but a few have RNA. The head region of the phage appears to be polyhedral as in the "spherical" viruses. Peculiar to phages, however, is a tail (with its special protein) by which the phage becomes attached to the wall of its bacterial host. With the help of an enzyme the phage makes a small perforation in the wall, and through this the nucleic acid (DNA or RNA) in the head region is injected into the bacterial cell. Fig. 9 may be misleading about the nature of the area marked "tail protein core". The core is really hollow, allowing for easy injection of the DNA from the head region.

The marked differences in composition and structure between viruses and organisms are therefore evident. In the former there is no trace of nucleus, cytoplasm, ribosomes and the like. Organisms always have both DNA and RNA, whereas most viruses have either one or the other, not both. Organisms possess not only proteins (present in viruses) but also fats and polysaccharides (for the most part absent in viruses). Most significant of all : even the simplest organisms have hundreds of enzymes for a vastly complicated and connected series of metabolic reactions involving ATP as an energy storehouse; but viruses have no ATP, and enzymes are either few or absent.

### B. The Replication of Viruses

"Replication" is the term which scientists preferr, because the process by which new viruses are formed is so peculiar that the word "reproduction" would only create misunderstanding.

The sequence of events for the replication of phages is outlined in Fig. 10. The diagrams are based on "pictures" obtained with the electron microscope.

Step 1 shows the infecting phage particle in position : already attached to the bacterial cell wall and injecting its nucleic acid. The rough diagrams for steps 2 and 3 attempt to indicate the fact that phage protein is formed *separately* from nucleic acid, and that the actual assembly of these subunits takes place only later in time. Finally, in step 4, the bacterium is "lysed" : it breaks open to release large numbers of new phage particles (150 is not uncommon). The clocks in the background are a reminder that about half an hour might easily suffice for the whole process. It should also be noticed that the protein coat of the original infecting particle usually remains attached

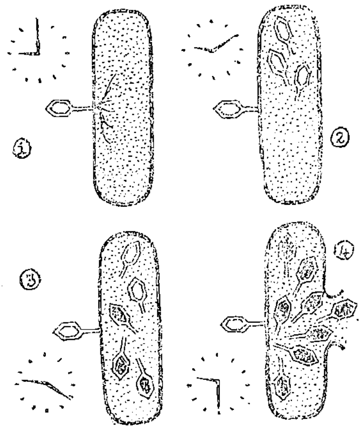


Fig. 10
A very rough diagrammatic representation of virus "reproduction" as it occurs in bacteriophages. See text for explanation.

to the bacterial wall—uselessly. It has no further function once the nucleic acid has been injected.

Isn't it now clear why the process is prudently termed "replication"? How different this is from the reproduction observed in the cells of organisms. The cell is reproduced not merely from its genetic material (DNA) but from all its constituent parts. The phage does not need even its protein coat. It is replicated solely from its genetic material (DNA or RNA) and put together like a pair of scissors or a fountain pen : the parts are manufactured separately and then assembled.

Theoretically, phage replication is not difficult to explain. Earlier, we saw how in organisms the specific amino acid sequence in the cell's RNA provides a code (copied from the DNA of the nucleus) which acts like a set of instructions for the production of the cell's specific enzymes. Hence, it is quite likely that the phage DNA (or RNA) provides contrary instructions once inside the host cell. The very metabolic machinery of the cell is captured and now obliged to turn out phage sub-units (subsequently assembled) according to the new instructions from the genetic code of the invader. *The phage does not reproduce itself;* rather, it has the ability to order its replication— in quantites !

**Fraenkel-Conrat and "TMV"**

The experiments of H. L. Fraenkel-Conrat and others strongly suggest that the sequence of events in phage replication are basically the same for other types of virus also. Unlike phages, plant and animal viruses have no tail, and so there is probably no *injection* of nucleic acid. Apparently, the whole virus particle (protein and nucleic acid) enters the cell. Still, the nucleic acid alone would seem to be responsible for initiating replication. In fact, the RNA of the tobacco mosaic virus ("TMV" for short) which attacks tobacco leaves is infective even when its protein is removed— and infection implies replication of the virus.

Working with TMV, Fraenkel-Conrat obtained other amazing results. He chose two types of TMV distinguishable by the kind of damage caused to tobacco leaves. Suppose we call one type ($N_1$ $P_1$) and the other ($N_2$ $P_2$), where $N_1$ and $N_2$ are the differing nucleic acid portions, and $P_1$ and $P_2$ the differing protein portions. Fraenkel-Conrat was actually able to separate the protein from the nucleic acid in each type, and to recombine them to form a new virus ($N_1P_2$). Now, when this newly created virus ($N_1P_2$) was allowed to infect tobacco leaves, he found that the leaves became damaged exactly as if

($N_1P_1$) were the infecting agent. Moreover, the replicated virus recovered from the infected leaves was not of the ($N_1 P_2$) type but of the ($N_1 P_1$) type. This could only mean that even when the $N_1$ type of nucleic acid is carried to the leaves in a $P_2$ type of protein coat, the host cells are induced to manufacture coats of the $P_1$ type.

In brief : the evidence suggests that replication depends solely on the nucleic acid not only in bacteriophages, but also in the tobacco mosaic virus, which may be considered a representative plant virus. The chances, therefore, are that the same can be said for all types of virus.

### C. Conclusion

Viruses, therefore, cannot be considered "alive" in the sense in which even the simplest genuine organisms are alive—there are too many fundamental differences. On the other hand, the viruses cannot be lumped with those molecules and molecular combinations which all consider "dead". The structurally organised protein-nucleic acid combination which we call "virus" has that strange ability to get itself replicated (quickly and in quantities) which is quite unmatched in the world of "dead" molecules. If that much is to be considered sufficient to characterise "life", then viruses are indeed "alive".

No doubt this is a peculiar state of affairs, which may irritate those who like neat categories. But the world of reality is always richer than our concepts.

# Suggestions for Further Reading

Perhaps the best introduction to most of the problems and opinions is : Philip G. Fothergill, *Life and its Origin* (Newman Philosophy of Science Series, No. 2; London, Sheed and Ward, 1958). This has the added advantage of being brief and fairly non-technical.

Oparin's views are extensively developed in : A. I. Oparin, *Life: its Nature, Origin and Development* (Edinburgh, Oliver and Boyd, 1961). Simpler and more condensed is the same author's earlier booklet : *The Origin of Life* (Moscow, Foreign Languages Publication House, 1955).

A better insight into the ideas of Melvin Calvin can be gained from his article in *American Scientist*, Vol. 44 (1956), pp. 248–263.

The advanced thinking of the top experts is collected from the proceedings of the first international symposium in : A. I. Oparin et al. (ed.), *The Origin of Life on Earth* (Oxford, Pergamon Press, 1959)

A most useful article is that of William J. Schmitt, "Spontaneous Generation and Creation," *Thought*, Vol. 37 (1962), pp. 269-287. There is a neat summary of the modern theory of spontaneous generation ("chemical evolution") with the suggestion that this theory only enhances the dogma of creation.

A brief exposé of the scientific data with some interesting philosophical reflections on the artificial synthesis of life can be found in the article, "Towards the Synthesis of Life" by Norman Fuller, S. J., in *The Clergy Monthly*, Vol. 25 (1961), pp. 211-219.

Non-technical but interesting discussions on how biochemistry and virus research have helped towards the elucidation of the mystery of life can be read in two articles by Nobel Prize Winner Professor Adolf Butenandt, "The Problem of Life and Biological Chemistry", *Universitas*, Vol. 1 (1957), pp. 47–54, and "Life as a Subject of Chemical Research", *Ibid.*, Vol. 4 (1961), pp. 17–34.

Another useful article to read is that of Sr. Adrian Marie, O. P., "Viruses : Are They Alive?", *The New Scholasticism*, Vol. 31 (1957), pp. 297–316.

Still about viruses : "The Structure of Viruses", by R. W. Horne, *Scientific American*, Vol. 208 (1963), pp. 48-56, and "The Ultimate Parasite", in *Time Magazine*, Nov. 17, 1961, pp. 40-44.

For the philosophical aspects a valuable treatment is to be found in the first three chapters of J. F. Donceel, S. J., *Philosophical Psychology*, ( New York, Sheed and Ward, 2nd ed. 1961).

C

# THE ORIGIN OF MAN

# Chapter 4

# How Life Came to Be Diverse

Has the universe evolved? Did life arise from complex, nonliving molecules? Fascinating questions. The preceding chapters have indicated the large amount of imaginative effort expended on those questions. But we are still far from an answer that would be based on real scientific evidence.

There is less of mere speculation and more of sheer fascination in what faces us next, the problem of *organic* evolution. Let us say at once that when the word "evolution" or "evolutionary theory" is used in the present chapter, it must be understood as limited to the particular scope of the question in hand : have all the *living* things of our experience evolved from a simple form of *life ?* Man is included too, but he is important enough to have the whole of the next chapter to himself.

## 4.1 THE PANORAMA OF LIFE

Cats, dogs, roses, worms, pumpkins, foxes, wolves, oranges, ants, men : each so different, so unexpected, so deserving of infinite observation. A lovely chaos that almost refuses to be put in order. Somehow though, we cannot live with utter disorder. One solution with great appeal to tidy minds is that refined form of the pigeon-holing called biological classification.

**The Pigeon-hole Approach**

All cats for instance are conveniently pigeon-holed into a *genus* named "Felis", which happens to be the Latin for cat. The various *species* of cat could be regarded as smaller compartments in that pigeon-hole. Thus the domestic cat is "Felis domestica", the tiger is "Felis tigris", the lion is "Felis leo". One species, in turn, may embrace several *varieties* or *races*. "Felis domestica", for example, includes the Persian, Siamese and other varieties.

Just as the relationship between several *species* allows them to be grouped under one large *genus* (plural : genera), so the similarities between several genera bring them under one huge *family*. Thus the "Canidae" family of dog-like creatures includes "Canis" (dog), "Vulpes" (red fox), "Urocyon" (grey fox) and other genera. Related families are allotted to a single *order*, related orders to a *class*, related classes to a *phylum*, and related phyla to a *kingdom*.

We thus have the so-called "taxonomic categories", which, working down from the biggest units, are : kingdom, phylum, class, order, family, genus, species, race and variety.

Two kingdoms, plant and animal, are generally recognised— though some would like a third kingdom for the small living things that are neither obviously plant nor obviously animal. The animal kingdom has about twenty phyla. What interests us most, as mammals, is the *Chordate* phylum, or more accurately, its sub-phylum the *Vertebrates*, to which (as classes) are assigned the mammals, birds, reptiles, amphibia and fishes. Further division of the *Mammalia* class, the *Carnivora* order, the *Canidae* family and the *Canis* genus are indicated in the table on p. 129.

Within this framework, we humans are members of the phylum *Chordata*, sub-phylum *Vertebrata*, class *Mammalia*, sub-class *Eutheria* (placental mammals), order *Primates*, family *Hominidae*, genus *Homo*, species *sapiens*.

SUB-PHYLUM: **Vertebrates,** Hemichordates, etc.

CLASS : Fishes, Reptiles, **Mammals,** Amphibia, Birds

ORDER : Primates, **Carnivores,** etc.

FAMILY : Felidae, **Canidae,** etc.

GENUS : Vulpes, **Canis** etc.

SPECIES : Canis lupus, Canis familiaris, etc.

**The Dynamic Approach (Evolution)**

To classify with the help of the taxonomic categories is a static approach to ordering life's richness. We take things as they are, look at them closely, and then put them into the right pigeon-hole. The effort, obviously, is not useless. But there is a dynamic approach possible. Suppose everything that lives has evolved from one or a few simple forms of life. Suppose all the living things we know have actually descended from one or a few primitive ancestors. Suppose the interplay of purely natural forces has juggled, moulded, squeezed, and drawn out an endless succession of marvellously varied living things.

That would be evolution—and on the conceptual level it is magnificent. To postulate for all that has lived a genetic descent from one or a few simple primitive forms by the action of natural forces is a vision whose grandeur and sweep is overwhelming. Man has kinship with the sparrow—all living things are linked together. Life becomes a mighty river which from tiny beginnings sweeps out eagerly in every direction. A motley array of new water-patterns continually develops through active struggle with the land. Flow, novelty, dynamism. Phyla branch into classes which flow into orders and families and genera. The taxonomic categories come alive.

Is this just a poet's dream? However magnificent the evolutionary idea, we can rightly demand evidence for accepting it. And evidence there certainly is, even if it is not as abundant and compelling as the evolutionist would desire.

## 4.2 DIGGING UP THE PAST

One obvious method of checking on the dream is to uncover the past and find out whether living things have, by and large, really become more diversified and structurally more complicated with the passage of time.

**Earth-layers, Fossils and Dating**

Untended tables need dusting. This is one of the irritating facts of existence, but it draws attention to the phenomenon that layers are constantly, if imperceptibly, being added to the land. The deeper the layer in a given land mass, the more ancient it should be.

An animal skeleton resting on the soil may, in the course of time, be partially covered and at last completely buried. Millions of years later it may lie under several hundred feet of layered earth. The differing composition and structure of each layer will reflect climatic and other changes over the centuries. And one fine day, a geological disturbance, or the hand of a digger, or a river's cutting action may expose those forgotten fossilized bones.

Ancient skeletons are not the only type of fossil. The word has a more general sense, for "fossil" designates any trace or impression left by a living thing. Shells, teeth, hardened footprints, petrified tissues and the like also qualify as fossils. At times, an entire organism is found beautifully preserved—like the 38-million years old insects embedded in amber, or the mastodons refrigerated in Siberian ice.

Some bones can be dated directly by the method of "fluorine analysis"*. In general, however, fossils are dated from the layer of earth in which they are found. The age of a layer may appear from its position below the surface and from comparison with other layers, but there are also delicate methods (e. g. those based on residual radioactivity) which give more direct estimates. Dating methods are not absolutely accurate of course, and the margin of error increases the further back we go in time. But they are not wholly unreliable either. Approximations must serve when nothing better is available.

A knowledge of the past, as revealed in the composition, structure, position and age of various earth-layers, allows us to reconstruct the story of the earth. We shall turn our attention to that at once, leaving for later what the fossils in the layers tell us about the story of life.

**The Story of the Earth**

The earth's crust, according to current thinking, became solid and subject to the processes of erosion and sedimentation about 3,500 million years ago—so long back that if we added together a million stretches of time, each of a length equal to the twenty centuries from the birth of Jesus Christ, we would merely have travelled a

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*This method depends on the estimation of the amount of fluorine attracted into bones lying in water-bearing soils.

little more than half-way towards the point where our story of the earth begins.

There are five parts to the story each called an "era". Working upwards from more distant times to the present, these eras are : the Archaeozoic (2000), Proterozoic (1000), Palaeozoic (360), Mesozoic (150) and Cainozoic* (75). The figures in brackets indicate approximately for how many millions of years each era lasted.

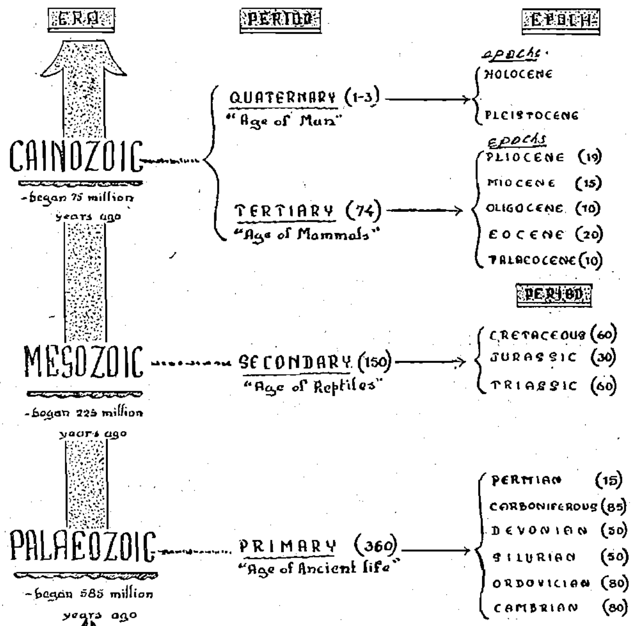
During each era changing patterns of erosion, sedimentation, glaciation and volcanic activity had their influence on climate and the look of the land. But between the eras occurred mighty upheavals that made mere playthings of mountains, seas and land masses. The Appalachian mountains of North America were pushed up between the Palaeozoic and Mesozoic; the Alps of Europe, the Andes of South America and our own Himalayas were raised between the Mesozoic and Cainozoic. Living things and their fossils certainly did not escape the effects of all these changes, mighty or mild.

But did living things exist way back in the Archaeozoic? Perhaps; but the evidence is meagre. In the Proterozoic, however, fossils of living things clearly appear—primitive aquatic plants, marine protozoa and invertebrates. From the Palaeozoic onwards the traces are rich and abundantly diverse.

The Palaeozoic is therefore called the *Primary* period or the Age of Ancient Life. The Mesozoic then becomes the *Secondary* period, or (from the creatures that dominated the scene) the Age of Reptiles. The reptiles of that period could not have found domination much of a problem. Their fossil-skeletons reveal some of them to have been monstrous brutes. "Diplodocus" was 87 feet long,

*This era is often spelt "Cenozoic"—a legitimate form but less true to the Greek roots of the word.

Fig. 11. THE EARTH'S TIME-TABLE




Proterozoic

NOTES:

1. Figures in brackets represent approximate duration in millions of years.
2. Still earlier eras were, of course, the Proterozoic (1000) and the Archaeozoic (2000), which began, respectively, 1,500 million and 3,500 million years ago.
3. The Carboniferous Period is often subdivided into the Pennsylvanian (35) and Mississipian periods (50).

Archeozoic

"Tyrannosaurus" soared to a height of 19 feet, while "Brachiosaurus" tipped the scales at around 50 tons.

Within the Cainozoic, the final era still in progress, are placed the *Tertiary* period (the Age of Mammals) and the *Quaternary* period (the Age of Man), beginning respectively about 75 million and 1 to 3 million years ago.

The very names given to these eras and periods of the earth's history reveal their correspondence with the story of life in its barest outline. The outline could be filled in with many details provided by the fossils. Our purpose, however, will not allow us to do this more than sketchily, but even a summary treatment demands some awareness of the subdivisions (also called "periods"—or "epochs") of the three final eras. The Table in Fig. 11 will be handy for reference.

## 4.3 THE STORY OF LIFE

One basic feature of the fossil record is the richness, variety and complexity of the life revealed in rocks from the dawn of the Palaeozoic, i. e. from the Cambrian period. Every phylum of the animal kingdom, except the Chordates (backboned creatures), is already represented in at least some primitive way. All organisms at that time seem to have lived in the sea. How this Palaeozoic animal abundance arose is not so evident. From the earlier era (Proterozoic) only brachiopods, arthropods, jellyfish, worm tubes and the like have been recovered, and no incontrovertible fossils seem to have been found in the earliest of the eras (Archaeozoic).

It is not illegitimate to surmise that all life, both plant and animal, began in the sea and that each of the Palaeozoic aquatic forms descended from earlier ancestors in the Proterozoic and even Archaeozoic. The absence of fossils is not an insuperable argument against the conjecture. The earliest living things need not have had bodies hard enough to form fossils. And if fossils were in fact formed they would not be easy to find—even assuming that they survived all the geological upheavals of the 3,000 million years which precede the Palaeozoic.

**Plants**

The 360 million years of the Palaeozoic saw marvellous developments among both plants and animals. Some are tempted to wax lyric over these marvels and cover the gaps in the fossil evidence with clever guesses eloquently expressed. However, at the risk of being colourless one must stick to the evidence. Our scope demands moreover that we be selectively brief. To take the plants first.

Marine algae are all that the Cambrian has to offer. The first definite evidence of land plants is provided only in the Silurian, and of forests in the subsequent Devonian. Incidentally, the ancient forests (especially of the Carboniferous) have helped to form our present coal deposits.

The first seed plants also appear in the Devonian—in the form of the gymnosperms, which have no flowers and produce naked seeds, e. g. the conifers of today. The angiosperms or true flowering plants (whose seeds form inside a fruit) come only later. In fact that branch of the angiosperms in which there is a single seed-leaf (monocotyledon) in the embryo,* makes its appearance only during the final period of the next era, i. e. the Cretaceous of the Mesozoic.

*Some familiar examples are the lilies, grasses and palms.

**Animals**

At the beginning of the Palaeozoic there were no animals with backbones, no insects or spiders, and nothing that dared to venture onto land. By the end of the Palaeozoic, however, fossils indicate an advance on each of these points, but birds and mammals had apparently to wait for the next era, the Mesozoic. The first toothed birds, for instance, appeared in the Jurassic, and the first birds of a modern type only in the Cretaceous.

Now since it is the postulated line (fish-amphibian-reptile-mammal) leading to man which concerns us most, the following first appearances are of particular interest. To start with the Palaeozoic era. Jawless *fishes* do not make their debut before the Ordovician (about 500 million years ago); then come the now extinct Placoderms (Silurian) and the bony fishes (early Devonian). The first creature that tried to make the best of both worlds, an *amphibian*, has left its footprint in late Devonian strata, but by the Pennsylvanian the first *reptiles* had arrived and some of these became quite mammal-like in the Permian

The Mesozoic era (which began roughly 225 million years ago) records the first advent of *mammals* in the shape of egg-laying forms. A survivor is today's duck-billed platypus. The pouched marsupial mammals (e. g. the kangaroo) were to come only later. Mammals had a better time of it when, at the close of the era, the giant Mesozoic reptiles became extinct.

Some 65 million years from our day (in the Eocene of the Cainozoic era), we find a notable diversification and specialization of the *placental mammals*, technically the "Eutheria". This higher type of mammal, to which man belongs, is characterised by the fact that its embryo is nurtured in the womb through a placenta.* The first

*This is an organ formed by maternal and embryonic tissues in close union.

*manlike apes* are traced to the Miocene of about 30 million years ago. And finally there arrives on the scene man—a last-minute arrival geologically speaking, but no strange intruder structurally. So much for the facts.

**The Meaning behind the Facts**

The fossils so far uncovered are a mere sampling of what lies hidden and great gaps between groups of organisms do exist. Some species have remained quiescent for millions of years, others have degenerated. Nevertheless if we consider the totality of living things, present and past, it is true to say that there is a gradual diminution of divergences between today's forms the further back we go in time. In general, too, the earlier the fossil, the simpler its form; the more complicated types appear only progressively. Backboneless animals precede those with backbones, jawless fishes those with jaws. Reptiles do not antedate the amphibians; birds and mammals are missing from the Palaeozoic.

There are also some striking fossil-series. For instance, an ordered sequence of progressively more complicated species of the "Paludina" genus (fresh water molluscs) has been demonstrated in a single 300 foot deposit. The horse series of fossils is the most classic of such examples. Our familiar modern horse "Equus" can be traced back through 12 to 15 other genera of the "Equidae" family to a dog-sized creature with four toes called "Eohippus" (which lived in the Eocene, about 55 million years ago).

Against this background it seems rather unfair to deny the reasonableness of the evolutionary hypothesis. On the scientific level there is no better explanation for the fossil-facts than to suppose a genetic link between the forms.

It is natural to postulate that fishes gave rise to amphibians, and these to reptiles which in turn produced the mammals. And, generally speaking, the basic assumption is confirmed by discoveries in which new forms are found not just anywhere, but precisely in those strata where on structural grounds evolutionists predict they ought to be. If a man-like ape were to be found in the Jurassic, i. e. before the differentiation of the placental mammals, the evolutionists would be really shaken.

**Time's Vast Backdrop**

Evolution seems the more impossible, the less we can imaginatively visualise the moulding influence on living things of unfamiliar geological conditions—especially when these are permitted to operate over vast stretches of time. The very conditions escape us. It is difficult for us to really grasp the fluctuations of climate and the frequent invasions of sea and glacier onto our continents. For example, can we really believe that Canada's Laurentian hills were once proud and majestic mountains which the centuries have quietly rubbed away?

A sense of the vast backdrop of time is particularly essential—and we must fix it somehow. Suppose a movie were made of the events which began 3,500 million years ago so that the whole story should be proportionately compressed into a film that ran non-stop for 20 days and 20 nights. Then all the events from the birth of Christ till today would have to be squeezed into the final second.

But we moderns have no time for such thoroughgoing full-length features, so let us rather suppose that the same film were speeded up to finish the whole story in two hours. On this scale the first hour would present an exciting narrative of crazy volcanoes and nervous glaciers, but probably

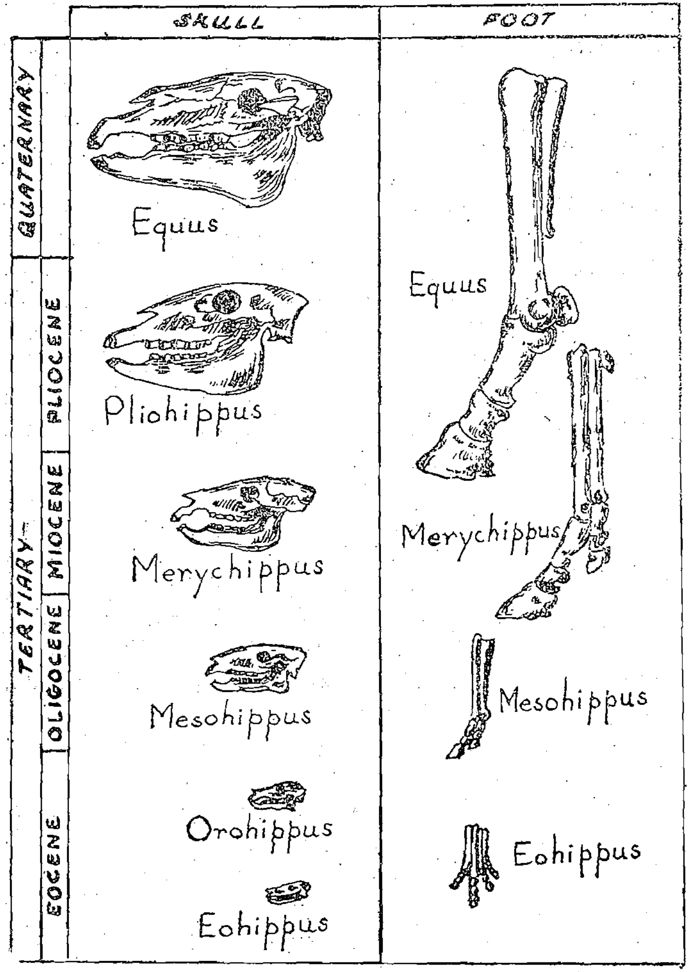



Fig. 12

The famous horse series. Note especially the transition from toes to present hoof.

there would be no living things around. Then life would gradually begin to appear and an hour and a half from the start worms, molluscs and other marine invertebrates would dot the waters on the screen. The last twenty minutes would be worth the price of any ticket. Sixteen minutes from the end some rapidly evolving creatures would be seen to be fish; twelve minutes from the close and there are quaint amphibians venturing onto land; nine minutes and we have reptiles, bewildering in the variety of their shape, size and menace; seven minutes and milk-suckled mammals would come on. These last would spread, develop and diversify until a minute from the end we would recognise the first manlike apes. And man himself ? The final three or four seconds is the most our hero would get—and that is a generous estimate.

**Curious Convergences**

The fossil record provides the backbone of the evidence for evolution. But there is, in addition, a striking convergence of evidence in favour of the theory coming from many diverse branches of knowledge. Whatever be the force or weakness of the evidence from each branch, the very convergence is significant.

First there is the fact that on occasion, even in our times, new species do appear *spontaneously*—like the Spartina grass, which first appeared suddenly on the English coast at the end of the last century through the accidental crossing of two existing species. At times close observation will bring to light two types within a given species which are beginning to lose inter-fertility, i. e., the types seem to be evolving towards a distinction and separation of species. What nature effects spontaneously, man has achieved through planned *breeding experiments.* New varieties of food grain, dog, fruit, etc., are common examples. On comparing Brussels sprouts, cauliflower and kohlrabi one would not easily recognise them as descendants of Europe's wild cliff cabbage. Man has even succeeded in crossing two different genera (radish with cabbage, or sugarcane with bamboo) to produce fertile new species which normally will not hybridise with either parent.

Then there is the interesting evidence which comes from the *geographical distribution* of organisms. It was precisely this biogeographical data which so impressed Darwin. He wondered why the plants and animals of the Galàpagos Islands should be similar and yet different from those of the mainland coast of Ecuador, a few hundred miles off. The islands contained only forms which could have swum or flown across from the mainland, and these have developed differently because of the isolation. Again, how explain Australia's peculiar array of egg-laying and pouched mammals ? Not only the kangaroos have pouches, there are even pouched cats and bears. The most plausible explanation is that all these had a chance to develop without competition from the placental mammals when Australia became isolated from the rest of the world during the Mesozoic.

The study of *physiology* indicates that the processes of respiration, digestion, circulation, excretion and nervous response function very similarly among all mammals. Drugs and vaccines are first tested out on mice, guinea-pigs and rabbits because their reactions are analogous to ours. Dogs and monkeys preceded man into space.

As *embryology* indicates, various mammalian embryos are rather alike and difficult to distinguish in their earliest stages. In fact the over-all pattern of embryonic development among the vertebrates is similar, though significant differences are undoubtedly present. Also common descent with modification renders more explicable that delicate hierarchical relationship which provides the basis for biological classification and the field of *taxonomy*.

Reflecting on fossil data, structural similarities and other clues, evolutionists had concluded long ago that the great apes were closer to man than the Old World monkeys, and that the birds were more closely related to the turtle-crocodile line of reptiles than to the snake-lizard line. That these were not mere fanciful speculations has been confirmed in more recent times by the tests of comparative *blood chemistry*.

The riddle of the so-called *vestigial organs* detected in many living things has in evolution its most reasonable solution. How explain otherwise, for instance, the vestigial hind legs found embedded in the abdominal flesh of whales and pythons? It does seem likely that these were once organs in use which gradually degenerated through non-use.

Besides vestigial organs, anatomical studies have revealed *structural similarities* between organs which superficially look quite dissimilar. For instance, all mammals (except the sea-cow) have seven neck vertebrae—each 12 to 20 inches long in the giraffe, but mere flattened discs in the whale. The seal's front flipper, the bat's wing, the cat's paw and the human hand are obviously adapted to quite different functions. And yet a common source is suggested by the fact that they have similar embryologic origins, the same basic pattern of arrangement, and almost exactly the same number of bones, muscles, nerves and blood vessels.

The series of curious convergences of evidence pointing towards evolution is really remarkable. One important distinction, however, becomes necessary when all the evidence is put together and weighed : the case for *micro-evolution*, i. e. evolution of varieties, species and genera, is clearly stronger than that for *macro-evolution* embracing families and the higher taxonomic categories.

## 4.4 BALANCING THE SCALES

The evolutionary theory continues to provide fuel for controversy. It might be useful therefore to look critically at some of the statements that are bandied about in current debate.

*"Where are the missing links?"*

This is an important question when fossils are admittedly the backbone of the evidence. Fossils of transitional types between the species are numerous, between genera many, but between classes few. The fish-amphibian, amphibian-reptile, reptile-mammal and reptile-bird transitional types are of particular interest to us since they involve classes of the vertebrate sub-phylum, to which we as mammals belong. The showcase specimen for a transitional type between classes is "Archaeopteryx", a curious reptile-bird from the Jurassic, with feeble wings, teeth and a long feathered tail. Such a specimen indicates that missing links between classes are at least biologically possible.

The absence of intermediate fossils for a postulated line of development clearly weakens the evidence for that line. Yet one must be fair in considering the reasons why the fossil record will necessarily be always more or less incomplete—even though new transitional types do continue to be found.

First of all, fossilization needs quite special conditions to occur, and, once formed, fossils may be easily destroyed by pressure, erosion and geological disturbances. Secondly, fossils that have survived are difficult to find.

Digging must proceed slowly and with great care, and one can always hit the wrong spot or run out of money. The more important older layers, presumed to carry the transitional types between classes and phyla, are less accessible and have been more subject to destructive forces. Thirdly, on theoretical grounds which cannot be discussed here, many evolutionists would themselves demand that intermediate types be few and somewhat unstable, quickly evolving into numerous stable forms, better adapted to the particular environmental possibilities.

One fact of considerable importance remains. Between phyla no transitional types have so far been discovered. Now since there are about 20 animal phyla, the consequence is that there is a lack of fossil evidence to show that all living things have proceeded from *one* form precisely. Ancient fossils bear some analogy to historical documents. They are nature's record of events no man could have observed. The passage from the postulated single ancestor to all the known phyla is, in the absence of fossils, no more than a working hypothesis.

On the other hand, when fossils are present we can no longer speak of mere working hypothesis. In the absence of human eyewitnesses a fossil can provide valid "historical" evidence for the existence of a particular intermediate type at a particular period of time. No better proof is necessary, because no better proof is possible.

*"As scientific theory evolution is excellent."*

Anybody would admit this statement—so readily in fact that its force is often all too vaguely grasped. The evolutionary theory is consistent with the known facts, co-ordinates phenomena into an intelligible pattern, suggests interesting lines for research, and makes predictions which may subsequently be verified. A vast amount of data from fields such as genetics, anatomy, physiology and geology is made intelligible by this one fruitful concept. Take away evolution, and the biologist is confronted with much chaos and confusion.

Besides, on the *scientific* level, no other positive theory is offered. As we shall see in a later section ("Evolution vs. God"), both the alternative theories proposed transcend the *scientific* sphere by postulating some special divine action.

*"Prof. X, the renowned scientist is no evolutionist."*

"Prof. X" is a courageous man. He stands bravely among a minority who reject evolution on scientific grounds. He and his friends are justly irritated by the cheery optimism of some enthusiastic evolutionists and the haughty manner with which they ignore the many unsolved difficulties and problems which remain. In fact, men like "Prof. X" have rendered a great service to science in helping to induce that critical climate which now happily prevails among the better evolutionists.

Still, most biologists support evolution in the absence (from "Prof. X" and Co.) of any alternative scientific theory which would make the facts positively intelligible. As pointed out earlier, the scientific advantages of the evolutionary theory are enormous. Unsolved problems are matter not for discouragement but for research—they do not seem entirely insuperable to competent scientists.

Incidentally, the common man is often deluded into thinking that an opponent of Darwinism is necessarily against evolution. This is regrettable confusion. The two things are different, because Darwinism deals with one of the possible "mechanisms" to explain *how* evolution may have operated. *

*This is a point of capital importance. We will return to it later.

*"Evolution is a fact."*

Here is one of the irritating statements from the evolutionist. His use of the word "fact" is unfortunate and misleading. Surely he cannot mean that the evidence generates real certainty all along the line, and that no further proof is needed.

What he should rather say is : "evolution is convincing." It is not absolutely certain, but the present evidence already generates a probability so high that it ought to carry real conviction to the mind of a trained, unbiased observer. The anti-evolutionist should remember that the events in question took place over long stretches of time, under irreproducible geological conditions and before man appeared. Given the peculiar nature of the events, the evidence that can be offered must be equally peculiar. The fossil documents and the other convergent indications do seem sufficient to produce genuine conviction. There is, in this matter, a form of scepticism which would remain unconvinced even if there were relatively complete sets of fossils for all the series. The sceptic could still say that *genetic* descent precisely remains undemonstrated—and who could demonstrate it for him?

On the other hand, what the theory does lack just now is an acceptable "mechanism" to explain how macro-evolution could have taken place. Moreover, if intermediate types between phyla were to be discovered, the single ancestor view would benefit considerably. But, of course, one can remain an evolutionist while holding to a *few* simple forms as starting point.

## 4.5 DARWINISM AND ALL THAT

Charles Darwin (1809—1882) did not invent the idea that the present forms of life arose from earlier, simpler forms. That idea, in germ at least, seems as old as certain Greek thinkers who lived centuries before Christ. And it was undoubtedly known and discussed by some of Darwin's predecessors, including his own grandfather, Erasmus Darwin. Notable among these predecessors was Lamarck (1744—1829).

But Darwin did invent Darwinism, i. e. the theory of *natural selection,** through which wide acceptance for the idea of evolution was first gained. Nobody before him had hit on a plausible explanation for the way in which evolution could have operated.[1] This "mechanism" Darwin supplied. It is sometimes forgotten, though, that Alfred Russel Wallace (1823—1913) discovered the idea of natural selection independently, and that he and Darwin agreed to have their papers read jointly before the Linnean Society in 1858.

**Darwinism not the only "Mechanism"**

In popular thinking evolution and *Darwinism* are often identified. Yet most evolutionists today are not really Darwinians. They choose the "mechanism" suggested by the so-called *modern synthetic theory*, also known as *neo-Darwinism* even though this theory has refined Darwin's original ideas to a point almost beyond recognition. And since even this synthetic theory is vulnerable, there are some influential evolutionists who prefer "*macro-mutationism*" (to be explained below), and a few who defend a revised version of Lamarck's standpoint called *neo-Lamarckism.*

Lamarck's own views have not been so successful because he held to the experimentally unsound notion

*The core of Darwin's theory is the concept of the struggle for existence, the survival of the fittest and the passing of advantageous qualities on to the offspring.

that acquired characteristics could be inherited. It is a strange fact that Darwin himself did accept this notion to some extent, but assigned the major role in evolution to natural selection, backing up his views with a wealth of carefully collected observational data. In the struggle for life, said Darwin, nature selected those fittest to survive from among the existing varieties of a given species. Darwin's success was indeed phenomenal. But the weakness of his approach lay in failing to explain how the useful characteristics of the fittest were passed on to their descendants. On this point, in fact, Darwin held a quite erroneous view of the "blending of parental pangenes" in the offspring.

**Mendel and the Synthetic Theory**

This is where Abbot Gregor Mendel (1822—1884) was of such service. His ideas were rediscovered by Tschermak, Correns and de Vries around 1900, and finally led to the concept of *genes** as bearers of hereditary characteristics. It is the genes (present in the germ cells of the parents) which are passed on to the offspring. *Mutations* in the genes furnish the raw material for Darwin's natural selection to work on.

A major break-through was thus achieved. The "mechanism" of evolutionary change became demonstrable from the study of large interbreeding populations both in nature and in the laboratory. And so there developed the *modern synthetic theory* which explains evolution as *natural selection acting on the small mutations observable in the study of large popula-*

*"Genes" are the units of heredity. They are located in the "chromosomes", which are rod-shaped bodies formed from nuclear material during cell division. A "mutation" is a sudden and relatively permanent chromosomal change. The majority of mutations are gene-mutations.

*tions*—a phenomenon which is open to laboratory investigation and to the statistical analysis of mathematicians.

The defenders of the synthetic theory (neo-Darwinists), especially G. G. Simpson, J. S. Huxley and T. Dobzhansky, are very influential in the English-speaking world today—and that world does not seem sufficiently aware of the opposition provided by R. Goldschmidt, A. Dalcq and O. H. Schindewolf. These latter rightly insist that the neo-Darwinian concept of evolution progressing *smoothly* through the gradual accumulation of micro-mutations is credible and experimentally verifiable only for micro-evolution. To really explain the big changes beyond genera and species, they postulate a *large* and *abrupt* change in the genetic material, i. e. a "systemic mutation" or a "macro-mutation" in early embryological development. For want of a better name we have called this view "macro-mutationism". Its obvious weakness for the scientist is that it is not open, in its present form, to factual observation and laboratory check. Its strength is neo-Darwinism's failure to provide a truly satisfactory macro-evolutionary "mechanism".

## 4.6 EVOLUTION VS. GOD

For any inquiring mind the fossil-facts demand an explanation. The evolutionary hypothesis, i. e. descent with modification through time, appears to be more useful than the two other alternatives that are proposed.

**The Other Alternatives**

One alternative theory is "special creation" : God created each species or genus or family separately at the times indicated by the fossils. The second alternative holds that there were key points in evolutionary development (e. g. the passage from merely vegetative to truly sentient life), where God would have to supply by some special action what nature's forces could not of themselves achieve. This is the theory of "miraculous intervention at key points".

These alternative explanations are not unreasonable, but they are of little use to the scientist because God's special actions fall outside the scope of his science. Even if the scientist is a believer, he is justified in holding to the evolutionary theory which is scientifically fruitful and, to a point, verifiable. There is no reason why he should surrender in his search for natural explanations until it is quite clear that no natural explanation is possible. Even the extraordinary cures at Lourdes are not certified as miracles until the Church is sure that any merely natural explanation is inadequate.

**Being Created, not just Created**

Besides, where do nature's forces get their powers, and in fact their very existence from? Whatever need not exist provides no explanation of its own existence.* Now it is clear that the whole universe and each thing in it, men included, need not exist. Yet actually they do exist—even if they themselves, single or together, provide no explanation for their own existence. Hence they have this existence from something that must exist necessarily: God. Further, this existence cannot be given to them once and for all. It cannot but come as a new gift at each moment. In other words, things are not just created, they are continuously *being created*. The carpenter can give existence to a chair and a chair it will remain,

*A simpler and less condensed treatment of the matter in this paragraph has already been provided in Ch. 2·5 ("Beyond Science : What Philosophy Says.")

because the wood already exists. But the carpenter must first *be* before he can be a carpenter; the wood must first *be* before it can be wood. Both he and his chair are being created at every second. One need not be a Christian to admit all this. It is the product of accurate reasoning —and yet the consequences are enormous. "Purely natural forces" and "chance" come to be seen in a quite different light.

Suppose one fine morning it became entirely certain that one tiny blob of protoplasm under the influence of *purely natural forces* has successively given rise to every living thing. Our wonder at the amazing capacities of protoplasm and of nature's forces would be tremendous. But these amazing capacities need not have existed. They do not explain themselves. And should we not wonder far more over a God who from the start gave and continues to give existence to them—an existence of such a sort that no additional special action of His becomes necessary thereafter?

**The God of Chance**

Again, laboratory experiments can show that certain variations of evolutionary significance are regulated by mere mathematical laws of probability. This indicates the place of *chance* in evolution. In fact it can even be argued that the supposed straight-line development of the famous horse series from "Eohippus" to "Equus" is a chance occurrence : all along the line we find many other fossils of horsy forms which chanced to become extinct....

Well, once more, for the sake of argument, let us suppose that it were proved one day that the whole course of evolutionary development must necessarily be attributed to chance and that the development was solely regulated by the mathematical laws of probability. Would not God be automatically excluded? Where would God come in, for example, when natural forces just happened to act in a particular way upon the chance variation of one type of fish so that it evolves into another?

God does not have to come in. He is there all the time. He must be present to give existence to the natural forces, the "happening to act", the fish and the "chance variation." God will have used chance to bring about evolution. For the paradoxical truth is that chance, while having some meaning for us, has no meaning for God. What *we* legitimately call "chance" does not escape *God's* control.

A stone falling from a roof kills a woman walking on the street below. This for us is an accident, a chance event. It is not in the nature of stones to fall on women, nor in the nature of women to walk under falling stones. So the death, we say, is due to chance. But both woman and stone were at every split second in the tragic sequence being kept in existence by God. There is no such thing as chance for God. A scientist may work for years to demonstrate the chance nature of evolutionary events and yet remain a convinced believer.*

**Pointless Quarrels**

Both theists and atheists can be good evolutionists. Had this been admitted earlier much passion and undignified squabbling would have been avoided. A number of nineteenth century champions of evolution

*From all this it should be clear that "chance" is not itself a cause, although we often speak of something as resulting from chance. No event can really be *caused* by chance. Rather, a chance event is an event which presupposes the interference or concurrence of real causes. But the actual occurrence of the chance event itself falls outside the goal of any of the contributing causes taken singly.

threw their weight behind the theory at least partly because it appeared to make God superfluous. This turned a number of nineteenth century churchmen into vigorous opponents of evolution. Both groups were off the track, and unfortunately, they have left twentieth century descendants who are blissfully unaware of the distinction which better thinkers today acknowledge between the scientific, philosophical and theological levels of explanation.

As one complete thoughtful being, a brilliant biologist is surely entitled to considered views on the U. N. O., politics, religion and God. But when he dilates on extra-scientific topics he is not entitled to the respect he can command when he is talking biology. If he says that his experiments point to natural causes and to chance, he should be heard respectfully. If he goes on to assert that God is thereby excluded and that materialism is the only philosophy that is scientifically sound, he deserves no more than one raised eyebrow. He is off his ground, because such views can be proved by no experiment and require, rather, a *philosophical* competence which *qua scientist*, he cannot claim to have.

So too, the churchman who has had no adequate training in science deserves the same polite scepticism when he uses scientific arguments to reject the evolutionary theory. Often he is shrewd enough to take cover behind the views of one of the few anti-evolutionary scientists. Yet he is scarcely in a position to judge the force and validity of either the majority or the minority arguments. Those arguments may be useful for deflating the rabid evolutionist, but, however pointed they be, what is really pointless is the churchman's defensive stance.

# Chapter 5

# How Life Came To Be Human

All the popular interest and excitement about evolution has arisen chiefly from bringing man into the picture. The average person might listen with curiosity and even amusement to the case for fishes evolving into amphibians. But talk of "monkeys becoming men" and immediately strong feelings are likely to be aroused. Religious people are offended by the very suggestion; materialists exult over dim animal origins where God seems a stranger. Cartoons are remembered, lampoons are quoted, and in the vitiated atmosphere the whole problem of human origins is prejudged and accordingly dismissed. Still, if calm objectivity is anywhere needed, it is here.

## 5.1 CLEARING THE GROUND

In the first place, trained evolutionists do not say that men came from *monkeys*. They rather insist that men and monkeys are terminal products of evolutionary lines that started to diverge very, very long ago. Where they see a closer relationship is between men and the *anthropoid apes*, but again as terminal products of a divergence that began more recently (in the Miocene perhaps).

**The Distinction of Levels**

Secondly, as in the previous chapter, it is important to maintain a clear distinction of levels. The scientific level of explanation must be separated from the philosophical. When each is given its place, a number of what are really pseudo-problems vanish. To bring out the distinction of levels the following mythical example, crude though it seems, should help. Suppose a scientist were present at the birth from a female chimpanzee of some ugly creature which later learnt to speak several languages and ended up becoming a famous spaceship designer. That creature, whose activities manifest intelligence in an animal frame, is a man.

The scientist's job would then be to record the event carefully, study the biological, physico-chemical, environmental and other conditions which could perhaps explain the phenomenon, devise experiments to deepen these studies and form hypotheses for further check. He would, of course, be very much tempted to say, "Ha! here at last is conclusive proof that man can be produced by the chimpanzee." But if he does yield to that temptation he has not only exceeded his own scientific level but is talking nonsense. The later activity of the "chimpanzee child" points to its possession of a spiritual principle—so absolutely non-material in fact, that it could not have its origin from anything merely material. The child possesses something which its chimpanzee "mother" could not give it, and that something is precisely what makes a man a man. In other words, despite all appearances, the chimpanzee does not completely account for the man. Because the child has *issued from* the chimpanzee, it does not follow that it has been *generated by* the chimpanzee.

The criteria which characterise man not merely as *animal structurally related to the monkey*, but precisely as "*rational animal*" are developed not by science but by philosophy. It is philosophical analysis which concludes to man's nature by reflecting on man's activities. The human ability to say meaningfully, "I am myself" reflects that utter self-lucidity which is possible only to a spiritual principle. Another clue to his nature is man's capacity to form abstract ideas, e. g. the idea "horse" is a notion applicable to all the material (flesh and blood) horses one meets. The genuine abstract idea is the basis for the word-symbol used to express it in language.* Animals also use definite sounds to communicate with each other. This so-called "animal language" cannot be shown to require, as basis, anything above the level of "*sense*" (e. g. impressions and images). But man's words are freely chosen, conventional symbols. The idea expressed in the word "horse" is given different words in other languages. And if tomorrow all English speakers decided to call horses "houses", we would happily feed "houses" as before. All this demands something above "*sense*". It demands spirit.

We turn to the philosopher for information about the rational-not-merely-animal nature of man. But science can test experimentally the criteria which philosophy has developed. The extended work on apes carried out in Florida's Yerkes Laboratory has underlined the absence, in these highly developed creatures, of any activity explicable only by the presence of a spiritual principle. An ape recollects and associates images; but it does not really understand. It has no ideas, and therefore no genuine language or "culture". It may use tools, but it won't produce whole collections of a given type of tool, for this would imply the abstract idea of a specific tool-type, and that the ape is found to be incapable of.

**The "GM", Hominid and Pongid**

For clarity's sake let us agree to call a "GM" (short for Genuine Man) any creature that manifests the behaviour of philosophy's "rational animal".

*Creatures which genuinely speak a language will be capable of what the anthropologist calls "culture", i.e. a set of historically conditioned, learned ways of group behaviour as manifested in dress, dances, art, food preferences, religious beliefs etc.

Then, if the scientist should find buried in the earth the fossils of some creature together with large collections of a certain type of tool *used by that creature* (a point not easy to establish), then he can rightly use the philosophical criteria to conclude that he has found a "GM", even if structurally the bones show many "monkey features." A similar conclusion would seem justified if it could be shown that the creature has used fire habitually.

Further, the anatomical structure, arrangement, and correlations of the bones will allow the scientist to make a statement which the philosopher, as such, is incapable of. Only the scientist can say whether the creature was a "hominid" or a "pongid" i. e. whether it belonged to the biological family "Hominidae" or "Pongidae". The gibbon, orang-utan, chimpanzee and gorilla are living types of pongid. They have, for instance, a "U-shaped" dental arch, and their canines are long fangs—as against the parabolic arch and progressively reduced canines of the hominids. Pongids, strictly speaking (cf. classification below), are not monkeys. Anthropoid apes is a better term, but even that we will avoid here to prevent confusion.

A great deal of muddled thinking would disappear, if, instead of words like "ape-men", "near-men", "man-apes" and the like authors would stick to some such term as "GM" (admittedly clumsy) for the philosophical level, and "hominid" or "pongid" for the strictly scientific level. The present position for living and fossilized forms would then read : *no pongid is a "GM"; every "GM" is a hominid, but every hominid is not necessarily a "GM"*. This reading of the matter need not be accepted uncritically. The evidence for it will be provided below.

**Hominid vs. Pongid**

The evolutionist claim is that pongids are most closely related to the hominids and that both have branched out from a common ancestral stock. The progressive adaptation of limbs for *erect posture* is that primary feature which distinguishes the hominid line of development from the pongid.

There are certain reliable clues which help to determine whether a creature walked erect and to what extent. First, the shape of the bones in the *pelvis*. When a creature continually holds itself upright, the muscle which makes that posture possible needs for anchorage a pelvis which is wide at the top. The greater that width, the more upright the habitual position. This is seen easily when the pelvis of a four-footed animal is compared with that of a man or the semi-erect gorilla.

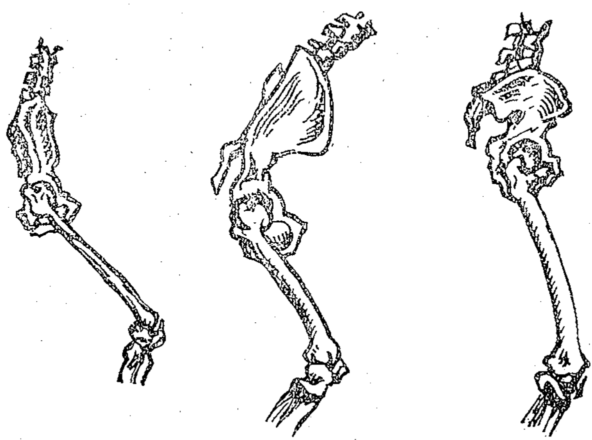


Fig. 13

Comparison of the pelvic regions of (from left to right) gibbon, gorilla and man—animals which are, respectively, four-footed, semi-erect and fully erect

Secondly, the angle at which the spinal column is held becomes manifest from the actual location in the skull of the hole (*foramen magnum*) through which the spinal cord reaches the brain. The pongid skull will have this opening towards the back and pointing backwards. The hominids, however, tend progressively towards the location as found in modern man : a more central, downward-pointing position underneath the skull. Thirdly, the more bent the body, the more powerful the supporting neck muscles, and therefore the more prominent the shelf (*nuchal crest*) high up at the back of the skull for those muscles to hang on to.

Erect posture leaves the hands free for obtaining food or warding off attack. Massive, *protruding jaws* and canines that are real *fangs* become unnecessary, and their gradual disappearance from the hominid line may be linked, quite plausibly, to the attainment of an upright position.

**Classification** A rough classification of some sort is convenient whenever related animals are being discussed. Primate classification is not a topic on which all biologists agree, but the following is perhaps one of the more acceptable of the schemes proposed :

ORDER : **Primates**

SUB-ORDER : **Anthropoidea,** Prosimii

SUPER-FAMILY : Ceboidea, **Hominoidea,** Cercopithecoidea

FAMILY : **Hominidae,** Pongidae

Our chief concern is, of course, with the Hominoidea super-family, for this gives us our Hominidae (the hominids) and Pongidae (the pongids). But let us start at the beginning.

The primates are divided into two sub-orders. It will be noticed that the Prosimii (which include the lemurs and tarsiers) are left without further division, like some other groups in the scheme. Our scope will not allow us to say much about such groups.

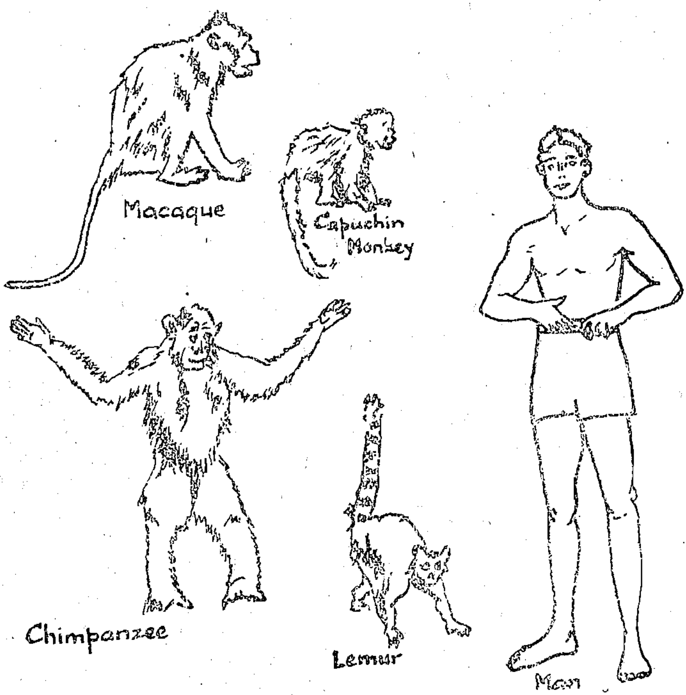



Fig. 14

Examples of the Prosimii (lemur), Cercopithecoidea (macaque), Ceboidea (capuchin monkey), Pongidae (chimpanzee) and Hominidae (man).

11

Among the super-families of the sub-order Anthropoidea are the Old World catarrhine monkeys (Cercopithecoidea) with narrow noses and nostrils directed downward. Living examples are the mandrill, macaque, baboon, langur, etc. The broad-nosed platyrrhine monkeys (Ceboidea) of South and Central America, such as the spider monkey and capuchin monkey, have often a "fifth hand" in the form of a prehensile tail.

Although the genera and species of the Hominidae family are soon to be discussed further, it will be useful to see at once how they fit into the whole scheme.

| FAMILY | GENUS | SPECIES |
|---|---|---|
| | **Homo** . . . . . . | H. sapiens |
| | | H. neanderthalensis |
| **Hominidae** | **Pithecanthropus** | P. erectus |
| | | P. pekinensis |
| **Pongidae** | **Australopithecus** | |

## 5.2 HOMINID FOSSILS

When in 1871 Darwin published his "Descent of Man", the fossil evidence for hominid evolution was practically nonexistent. It may therefore be argued that in his time the reasons for postulating relationship between hominid and pongid were flimsy, and that his opponents on the problem of human origins were justified in remaining unconvinced. The picture is different today. Hominid fossils discovered over the last twenty-five years exceed the total number of such discoveries ever made before. They are relatively easy to find, since they rest in the upper earth-layers and in more habitable spots like caves.

An important facet of evolutionary theory—and the fossils appear to confirm it—is that the common ancestor of two lines will have been less specialized than the present products of these lines. The ancestor had to be "*generalized*" enough to give rise to specialized forms in either direction. If, on the other hand, one were to work backwards in time, the divergences between two present lines would become less marked until they merged in a plastic common ancestor.

A likely candidate as ancestor for both hominids and pongids is the large ape *Proconsul major* from the Miocene deposits of Africa. This creature resembles modern man more closely than the pongids of today. *Proconsul* was one product of the great expansion and diversification of apes in Africa during the Miocene. These apes seem to have emerged in the preceding epoch, the Oligocene, in the form of representatives like *Parapithecus* and *Propliopithecus*.

The Pliocene epoch is of absorbing interest precisely because it lies between the Miocene, with its various types of generalized ape, and the Pleistocene which began roughly a mere 1 to 3 million years ago. Now in the Pleistocene the hominids and pongids were clearly quite specialized, and some of the hominids were, as clearly, genuine men("GMs"). The point therefore is : what happened during the intervening 19 million years of the Pliocene ? We know very little. The number of pongid and hominid fossils from the Pliocene is small enough to be irritating. Among those which have been found are the gibbon-like *Pliopithecus* of Europe, the recently discovered *Kenyapithecus* of Africa, and the much too poorly studied fossils from India's Siwalik hills (e. g. *Ramapithecus* and *Bramapithecus*). The Pliocene is an epoch of more darkness than light for hominid and pongid evolution.

**Choosing our View-point**

An enormous mass of scientific literature on hominid evolution is available. The thorough description of past finds does not keep pace with the new fossils which continue to turn up. Among the more significant and startling current discoveries are those being made by L. S. B. Leakey's team in Tanganyika's Olduvai Gorge.

Still, the unsolved problems, however stimulating, do really exist. A large number of people deluded by the scientific popularisers may see no problems. But the serious, dedicated evolutionist admits they are there—to be solved. He does not abandon his evolutionary standpoint, but he is aware that his professional colleagues do offer divergent *interpretations* even after the fossil material has been subjected to careful scrutiny.

Moreover, science progresses precisely through these clashes of opinion. Weak points are made manifest, defective reasoning is brought to light, new evidence is looked for. One such clash of opinion led finally to the exposure of the "Piltdown man" as a skilfully executed hoax. It must not be forgotten that the deception was uncovered precisely by the efforts of *evolutionists* who realized that this "fossil" simply didn't fit into their pattern for hominid development.

The patent fact that there are conflicting interpretations should encourage the general public not to take a given scientist's views too seriously—especially when they are aired in newspapers and popular magazines. If the average person were to read widely and deeply about evolution he would soon be confronted by a lack of agreement. The same fossil may be called by two or three different names. Its discoverer will often claim for it the status of a new genus or species, while others will say : "Come now, it isn't so very different after all from that other fossil we know so well." And when tools are found in the same layer, there will be questions like : "How can we be certain that this hominid actually used these tools ?" "Isn't it possible that our fossil represents not hunter but hunted ?" And so on, endlessly. There will also be discussions on the date to be assigned to the fossil, on the probable structure of its missing parts, and especially on its significance and place within the whole scheme of hominid evolution. Yet, when all is said and done, the discussions have only made the value of the evolutionary approach more clear.

As far as this little book is concerned, the abundance of the hominid fossil material and the interpretations put on it raises the question of what to treat and what to leave out. We must choose some particular line of approach. And so, at the risk of seeming high-handed, we are going to concentrate on what we think really central and crucial. First, we will briefly describe the four hominid groups which are admitted landmarks for everybody. Then we will indicate some of the areas where the disagreements are of more significance.

We limit ourselves to the fossils, resisting all temptations to follow man's cultural development through the perfecting of his stone tools up to the times when he tamed bronze and iron to his service. This cultural development, however, suggests a theological problem—as we will see later.

**The Four Landmarks**

The four groups commonly accepted as reference points when the status of hominid fossils is under discussion are the following :

(1) Our own species, *Homo sapiens*, which is at least 30,000 years old. We are familiar enough with specimens of this group : cranial capacity averaging around 1,350 cc.;

the skull high and spherical, with a vertical convex forehead; a good chin; third molars being gradually lost.

(2) The *Neanderthal group*, which became extinct about 25,000 years ago and whose stone tools belong to that particular culture called "Mousterian". These were definitely "GMs". Besides tools, they used fire. There is even evidence for reverent burying of the dead. The corpse was placed in an East-West position and provided with food and ornaments. Despite all these endearing characteristics, the Neanderthaler looked ugly by modern standards. The brain, at times larger than ours (cranial capacity 1,300 to 1,600 cc.), was held in a skull which had thick walls and a low vault flat at the top. Other features were heavy jaws, the absence of a chin, an uninterrupted shelf of bone overhanging the eyes and a forehead sloping backwards. The body was short with the long bones (in arms and legs) thick, clumsy and bent. This is an oversimplified physical picture, but it will have to serve for the present.

(3) The more ancient (200,000 to 500,000 years old) *Pithecanthropus group*, with which the cranial capacity drops to a mean value of 1,000 cc. This group is further distinguished from both the Neanderthalers and our own species by possessing a characteristic combination of modern limb bones with primitive cranial and dental characters. Huge brow ridges, a thick flattened skull, a projecting chinless face with massive jaws and huge teeth are some of the primitive features. Within the group the Javanese representatives of Pithecanthropus (*P. erectus*) seem to have been more primitive than the Chinese types (*P. pekinensis*). The former had, for instance, a smaller cranial capacity, a heavier jaw and a less pronounced curvature of the dental arcade. Also, whether *P. erectus* ("the Java ape-man") was a "GM" remains doubtful since there is no clear evidence for the

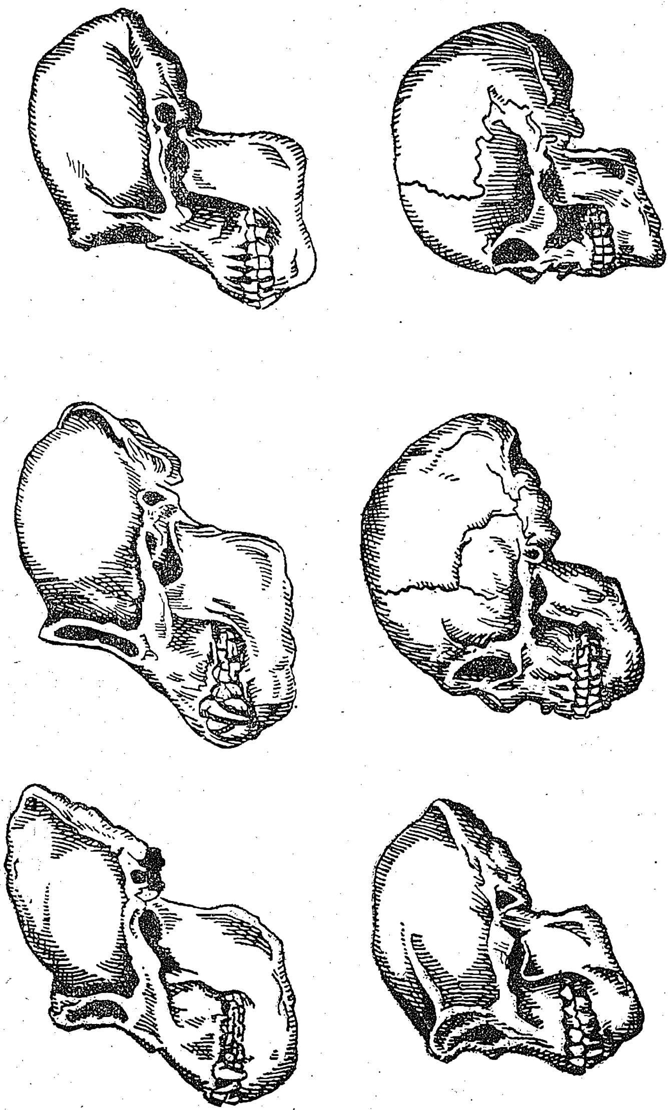


Fig. 15.

Comparison of various skulls ( not drawn to the same scale ). From left to right we have :
Top row : gorilla, chimpanzee, an Australopithecine ( " Paranthropus " )
Bottom row : *P. pekinensis*, *H. neanderthalensis*, *H. sapiens* ( modern White )

use of tools. But the evidence for *P. pekinensis* ("Sinanthropus", "the Peking man") being a "GM" is impressive, because the use of both tools and fire is fairly clear.

(4) The earliest and most primitive of all the hominid groups, the South African *Australopithecines*, which lived 500,000 to 1,000,000 years ago. Their average cranial capacity was only 600 cc., but then these were much smaller creatures than those of the three other groups. Each individual could have weighed only about 50 pounds. Despite pongid features like the low forehead, prominent brows and protruding muzzle, the dental arch was parabolic (as among the hominids). Pelvic evidence for erect posture is another strong argument for the group's hominid status. The specimens from Kromdraai and Swartkrans generally possessed larger jaws, teeth and skull than those found in Taung, Sterkfontein and Makapansgat.

Needless to say, the many hominid fossils discovered cannot all be fitted neatly into one of these four groups, but the groups *do* serve as landmarks and centres of reference for discussions about relationships.

## 5.3 DISAGREEMENTS OF SIGNIFICANCE

With the four hominid groups as background, we can get some idea of the problems which occasion argument among the experts on hominid evolution.

**How Many Species ?**

There are first taxonomic problems. For example, how many different species should one recognise within the *Pithecanthropus* group or the *Australopithecines* ? At first sight this may seem to be merely a battle of words. But it *is* important to decide whether the differences between two or more forms are sufficiently large to merit division into two or more species. The moment one admits two separate but related species, there arises the evolutionary problem of how and when the two separated.

Though there is no absolute agreement on the number of species and genera to be admitted within our four landmark-groups, we can say that the majority of experts would recognise two species in the genus *Homo*, namely *H. sapiens* and *H. neanderthalensis*. It is also common opinion to recognise two species in the genus *Pithecanthropus*, namely *P. erectus* and *P. pekinensis*. As for the Australopithecines there is much less agreement. It is best perhaps to recognise the genus *Australopithecus* and let interested parties quarrel over the species.*

**Relationships between the Landmark-groups**

Secondly, there is a big question mark over the precise nature of the *genetic* relationships between our four commonly accepted landmark-groups. Are they perhaps ancestral to each other ? If so, how ? Can we at least say that *Pithecanthropus* gave rise to a type of *Homo* which then split into two species, i.e. the Neanderthalers and us ? Would it not be better to conceive hominid evolution as a sort of vast advancing front which threw out the Australopithecines, Neanderthalers and Pithecanthropi as unsuccessful secondary branches ? We are still far from common agreement on these questions—and they are not the only ones that can be asked. Must we, for instance, regard hominid evolution after the Australopithecines as split decisively between two trends : the *Neanthropic* leading to modern man, and the *Palaeanthropic*

*A good, though technical, work to consult on taxonomic problems is W. E. Le Gros Clark's *The Fossil Evidence for Human Evolution*. This work is, in fact, a safe guide to the whole field of hominid evolution, a model for objectivity, rigorous reasoning and cautious statement.

(thick-walled braincases, heavy jaws, bony shelves over the eyes, no chins) dying out with the Neanderthalers ?

**The Progressive Neanderthaloids**

The status of the so-called "progressive Neanderthaloids" is another problem of significance. They are different from our landmark-group the Neanderthalers, who for the sake of contrast are sometimes called the "classic Neanderthaloids". The progressives seem to have appeared before the classics and are more Neanthropic (higher braincases, a chin, less bone over the eyes) than the latter. Their fossils have been found in places like Ehringsdorf, Steinheim and Mount Carmel. Are they perhaps an early form of *H. Sapiens*, ancestral to both modern man and the extinct classic Neanderthalers? No definite answer can yet be given.

**Leakey's Recent Discoveries**

Among other problems, that of the species of *Australopithecus* was accentuated recently by a discovery of the Leakey expedition in the Olduvai Gorge (East Africa). In 1959 a skull was found with many Australopithecine features but with certain differences such as a long face, a greater cranial capacity and the lack of a heavy brow ridge. To Leakey, the use of tools by this creature seemed quite likely. Moreover, a modern dating method (the "potassium-argon process") indicated the age of the deposit as about 1,750,000 years. There seemed therefore to be some case for recognizing here the oldest discovered "GM" (to use our own terminology). Leakey called the find *Zinjanthropus boisei*—an entirely new species in a new genus. But other authorities at the time considered the fossil merely a new form of Australopithecine and denied to the creature any toolmaking capacities. And, on both these points, Leakey is now (1964) reported to agree with his former critics.

In addition, from 1960 onwards, the Leakey expedition has been finding fossils of an entirely different type of hominid from *Zinjanthropus*. The new fossils belong to what is described as "a race of upright but small-brained pygmies who lived in East Africa about 1,820,000 years ago". Leakey thinks this new type much closer (and probably ancestral) to modern man, and has accordingly named it "*Homo habilis*". It will take time before Leakey's new claims are checked and substantiated by the scientific world. But if he is right, much rethinking will have to be done. And many of Olduvai's secrets still lie buried....

**The Roots of Disagreement**

A lot of clever guesswork must go into the interpretation of hominid fossils. Complete skeletons are scarcely ever found. The skull of one individual should hardly be looked upon as furnishing an accurate picture of the average characteristics of the whole race or species. And if the fossil is, say, a million years old, it does not follow that members of its race or species did not exist before or after. All this makes for the fun and fascination of the subject. But, surely, we are far from knowing enough to make categorical statements on the *actual* lines of hominid evolution in general, or on the evolution of *H. sapiens* in particular. Hence, it is always useful to read the views of more than one expert on hominid evolution before rushing to conclusions. The crying need of the moment is less guesswork and more fossils.

**Some General Conclusions**

Just in case all these subtle disagreements have left the reader dizzy, it might be useful at this point to set down a few conclusions derivable from a sympathetic but careful examination of the present position in hominid evolution.

1. There is, in general, clear evidence for evolution among the hominids and the evidence continues to grow. It is most natural for the scientist to be especially curious about the very problem which concerns us most : the origin of our own species, *Homo sapiens*.

2. The precise paths along which hominid evolution flowed and, therefore, the central question of ancestral relationships between the various hominids (including *H. sapiens*) is far from clear. The fossil evidence is too scanty just now for definite conclusions on this point.

3. There are a sufficient number of fossils to permit fruitful attempts to trace the lines of hominid evolution back from our own day to, say, about one million (*Australopithecus*) or even two million (*Zinjanthropus* and *Homo habilis*) years ago. But beyond that there are huge gaps in the series which should link the Australopithecines with that common ancestor from which hominids and pongids presumably diverged. It is conjectured that certain fossil ape-like forms discovered in the Miocene and Pliocene (i.e., 20 to 30 million years ago) *may* represent this ancestor.

## 5.4 PROBLEMS FROM SCIENCE BEYOND SCIENCE

There are some delicate problems which arise from the evolutionary interpretation quite reasonably given to the hominid fossil record by scientists operating on their own level of explanation. These are problems of a philosophical and theological nature, and the methods of science cannot be employed for their solution—which is why we consider them "problems from science beyond science". We intend to look into three of these problems now. Unavoidably, our treatment will involve simplifications and, at times, we will be able to do no more than indicate the line of solution. The restricted scope of this work does not include the instruction of the philosopher or theologian in his own speciality.

The *first* problem concerns God's part in the particular transition from hominid to "GM". But that problem must be tackled within the larger framework of God's action in the general evolutionary process.*

**God's Action in the General Evolutionary Process**

As we have seen in the previous chapter, the scientist might rightly talk about "purely natural forces" and the role of "chance" in the whole process of evolution from the simplest living things to man. But on a deeper (philosophical) level of explanation one must admit that *everything which is not God* is kept in existence and directed in its activity *by God* at every instant. This all-sustaining divine action cannot be detected by scientific methods, and that is why the scientist is justified in talking of "purely natural forces" and of "chance."

In addition, the scientist is wont to reject considerations of "finality" and "purpose" in evolution. This sort of talk he not uncommonly regards as mystical and cowardly and proper to those who have not the vigour to search for what he calls "really scientific explanations". Faced, for example, with the problem : "how/why do birds fly ?",

*From here on, especially towards the end of this chapter, we shall sometimes have to deal with the evolutionary process even outside the sphere of living things. Hence terms such as "evolution" and the like will signify more than "*organic* evolution"—but that should be clear from the context also.

the scientist will come up with the answer : "because of their wings." By this answer the scientist has shown *how flight is possible*; the wings are for him the agents which bring about flight; the wings are "efficient causes". But then, this same solidly concrete reality of the flying, winged bird can be questioned from another angle. It is surely not mystical to ask : "why do birds have wings ?" And it is quite reasonable to accept as satisfactory the answer :"because birds are *meant to* fly." The answer tells us *why wings exist at all.* The *purpose* of wings might not interest the scientist whose usual business is to search for *efficient causes.* But purpose is not an extra : it is simply branded into the very activity of the flying, winged bird. Efficient causes and purpose (or *finality*) presuppose each other and cannot exist without each other. They are complementary, even if many scientists concentrate on efficient causes and reject purpose. But it may take a philosopher to detect that.

Hence, the scientist who is ready to grant that both science and philosophy have something valid to say, will be able to search for *efficient causes* among the purely natural forces, and yet regard the whole evolutionary process from lifeless matter to man as *purposefully* sustained and directed by God. Such a scientist will look on "finality" not as something unscientifically superimposed, but rather as something written into the very nature of those same efficient causes which provide his cherished "scientific explanation".

**God's "Ordinary" Action Suffices Up to the "GM"**

Now up to (but excluding) the "GM", the philosopher sees *no absolute necessity* for any "extraordinary" intervention of God. In other words, with regard to the passage from lifeless matter to the non-human hominids, all that is strictly necessary is a divine sustaining and directive influence which we may term "ordinary". It cannot, however, be overstressed that in such a view matter must be regarded as divinely endowed with much more marvellous powers, capacities and virtualities than if God had to assist its inadequacy by intervening even at a few points in the evolutionary process. Nevertheless, absolutely speaking, one cannot deny that God *could* have enriched matter with just such extraordinary capacities.

Now it is not the *philosopher's* business to find out whether, as a matter of *fact*, natural forces have *actually* been able to effect the tremendous, if gradual, transformation from the first living things (and even from lifeless matter) to the hominid (excluding the "GM"). That is really the *scientist's* job, and it is as yet far from being completed. But on the *theoretical* level of *possibility*, the philosopher can state : this tremendous transformation is conceivable under God's "ordinary" control over the action, interaction and concurrence of natural forces operating on matter gifted with marvellous potentialities. Not every philosopher will be ready to admit such a statement, but there seems little doubt that the statement is philosophically defensible.

Objections of the type: "the greater cannot come from the less," or "the effect cannot be greater than the cause," or "a species is immutable," all seem to neglect the hidden (but all-pervasive) role of God among the causes and the extent of the capacities He can give to matter.* After all, right through the transformation we are considering, there is no trace of the appearance of anything *truly spiritual*. We can rightly regard the whole process as a gradual unfolding of the potentialities of matter (even though we are justified logically in distinguishing life from

*Incidentally, having brought in the term "species", one might point out that it is not easy to decide what a "species" is—either scientifically or philosophically.

nonlife and vegetative life from sensitive life). When all is said and done, even the highly developed apes of today show no activities which demand the existence of a truly spiritual principle.

**"Extraordinary" Action for Transition to the "GM"**

However, by definition, in the "GM" (as rational animal) such a truly spiritual principle exists. His intellect *can know itself, can know that it knows*; it is capable of coming back upon and possessing itself completely because it is spiritual and without parts. By contrast, one end of a table cannot possess the other end, nor can the eye see itself : these realities have extended parts and are material.

Again, *man's mind is open to a knowledge of everything*, without limits—even though in practice, a man's knowledge is limited by various factors (including laziness). Mere *sense knowledge*, however, such as that of sight, *is limited* to colours, shapes, sounds, etc. Not so our intellectual knowledge. And finally, as explained earlier, the fact that man has *abstract ideas* and a *genuine language* also points to the presence of a truly spiritual principle.

Now if the "GM" possesses something truly spiritual it could not have come from anything material—and that excludes all natural forces however marvellous. This is precisely why the philosopher demands an "extraordinary" action of God for the transition from mere hominid to "GM". In other words, because the soul of a "GM" could not come from anywhere else, we must recognise the need for a special intervention of God.

Suppose we admit, then, that God infused a newly created human soul into a body derived from animal (hominid) parents or into an embryo borne by an animal mother. Could we go on to say that this body or embryo was *human* before the soul was infused ? No; because the human body and soul are not separate things loosely joined together. We experience ourselves as a composite of spirit-in-matter. Man is a single unified reality : "spirit-matter" or "body-soul".* Without a human soul there is no human body. Hence, the "extraordinary" divine action for the transition to "GM" involves not only the creation and infusion of a human soul, but also the humanizing of the animal body (adult, young or embryonic) by the very infusion of that soul.** Here again the action of God is not detectable by scientific methods. The scientist will record the appearance of the "GM" after the mere hominids and say that evolution has resulted in man.

One final point. Does not what we have said about God's action conflict with the biblical teaching on the creation of Adam and Eve as recorded in the first chapters of Genesis ? That depends on what Genesis *really* says on the subject : a question to be examined in the biblical part of this book.

**Science and Primitive Man**

We shall now turn to our *second* problem which arises from the apparent conflict between the picture of primitive man presented by science and the Catholic teaching about the status of Adam and Eve. Science suggests that primitive man was hardly distinguishable from the more developed hominids. On anatomical grounds the transition from mere hominid to man appears to have been

*The unity of man is also suggested by the teaching of the Council of Vienne ( 1311–1312 A.D. ) on the soul as the "form" of the body.

**Some philosophers would require something *more* on God's part : some *extra* preparation of the body before it is fit for the infusion of the human soul. However, we have set down the minimum, i. e., what we consider necessary and sufficient.

normal and gradual. Moreover, it seems possible to trace various stages of perfection in the fashioning of the first crude stone tools. The actual polishing of stone, and eventually the use of metals came quite late. For the cultural anthropologists, the "social evolution" of man is the subject of learned investigation : they will discuss, for example, the tremendous revolution introduced into man's way of life by the passage from the food-gathering stage to the food-producing stage with the concomitant domestication of plants, animals and even man himself. One can understand, therefore, why the earliest men are almost invariably portrayed in the popular magazines as growling, naked, two-legged beasts. How really savage they look, hunting their prey in little bands and cutting up red carcasses with sharp stones !*

**Church Teaching on Adam and Eve**

Contrast this with the Church's picture of Adam and Eve raised to the supernatural order, possessed of sanctifying grace and blessed with immortality and freedom from concupiscence. The Catholic cannot doubt the certainty of this official teaching. However, if he shuts off his imagination (deluded as it is by the primitive men of popular literature), he will realise that there is nothing ridiculous or contradictory in God choosing to raise to the supernatural level human beings who were, by modern standards, physically, intellectually and culturally primitive. For the might and wonder of our God surpasses human understanding. The galaxies and the expanding universe are the playthings of His fingers. If He decided to raise an insignificant speck in this universe

*Needless to say, the details in these pictures often owe more to the imagination of the artist than to the findings of science.

to a share *in His own life*, does it matter whether that speck used skins and stone tools instead of trousers and rockets?*

**Less Certain Conclusions of Some Theologians**

It is important not to confuse the certain teachings of the Church on Adam and Eve with the less certain conclusions of some of her theologians who hold that our first parents were the most happy and wise of creatures, perfect specimens even of physical beauty.** At face value, these conclusions of the theologians do seem to conflict with the picture of primitive man presented by science. But our theologians are not outwitted so easily. They have fashioned a number of theories which allow them to keep both the scientific data and their conclusions. Here are two for instance :

1. The fall of Adam and Eve (original sin) could have produced the very physical and cultural degradation which scientists discover.

2. The degenerate types are *not really our ancestors*, because they died out before Adam and Eve. Incidentally, this so-called "Pre-Adamite theory" is not excluded by what Pius XII has to say in "Humani Generis".

To sum up then on our second problem. The de-

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*It may be objected that each of these specks is not insignificant. It is a SPIRIT-matter composite and therefore more valuable than the whole material universe. This is, of course, true. But matter for matter we are as nothing in comparison with the immensely vast, expanding *universe*. And spirit for Spirit we are as nothing before *God*. And to share in the very life of the *God of the universe*, spirit-matter composites are not rendered much more worthy by social, cultural or technological developments.

**The influence of these theologians is clear in those pretty pictures of lovely Adam and Eve in some of our "Bible-History" books. We cannot forget that the seeds of confusion that could thereby be sown in tiny minds may bear disastrous fruits later.

scription of primitive man given by science does not conflict with the certain teaching of the Church. As for the apparent conflict with the not so certain teaching of some theologians, the difficulties may be removed by various theories.

**The Problem of Monogenism**

The *final* problem has to do with "monogenism". To the theologian this term stands for the doctrine that all men are derived from a *single original pair*, the biblical "Adam and Eve".* In consequence, Adam's original sin has affected all men so that all need Christ's redemption.

"Monogenism" in the *theological* sense could hardly interest the scientist as such. He does use the term "monogenism" at times, but on examination it will be found that the term indicates for him the origin of all the races of men from *one stock*. He is therefore concerned rather with "monophyletism".

Now there were scientists in the past who used to maintain that our various modern races are derived from separate stocks ("polyphyletism"). Today, on structural and morphological grounds, this view is discarded. It is generally agreed that all modern races of mankind, despite their external differences, are simply variants of one species, *H. sapiens*. One species suggests a single stock and so monophyletism is in high favour among present scientists.

The trouble, however, arises because one stock (monophyletism) does not necessarily mean one pair (theological monogenism). It leaves room for many pairs. And so we ought to investigate the state of the *scientific* evidence for or against *theological* monogenism. As we shall see, science is neither "for" nor "against" theological monoge-

*How far the Bible really teaches that mankind arose from a single pair is a separate problem which will not be avoided in the biblical part of this book.

nism; it is, instead, "open". But this conclusion must not be accepted without a closer examination.

**Science Neither "FOR" Nor "AGAINST"**

Science has no argument "*for*" theological monogenism. Why ? Because a single stock need not mean one unique pair. On what purely scientific grounds can we say of two ancient skeletons : from this pair alone have all modern races arisen ?

On the other hand, science has no argument "*against*" theological monogenism. A single stock need not exclude one unique pair. Certain neo-Darwinists may feel otherwise, accustomed as they are to thinking statistically of all evolutionary changes as involving whole populations over a period of time. Well, even within this statistical frame of thinking there is the possibility of mutations being fixed in "bottleneck populations" (which may be reduced to a single pair) as indicated in the mathematical work of Sewall Wright of Chicago University. Besides, the neo-Darwinist would betray both pride and prejudice in refusing to acknowledge two points : that every good evolutionist is not necessarily a neo-Darwinist; and that valid knowledge is possible even when it is not based on that form of proof and reasoning which science is accustomed to. There *are* such things as philosophy and theology, and it does not show much intelligence to shrug them away.

**The "OPENNESS" of Science**

In brief, science is "*open*" to theological monogenism. A scientist who can survey the present situation with calm and unprejudiced enlightenment should be able to say: As a scientist, I cannot show that all modern races come from a single pair. It is true, moreover, that the most fruitful of today's scientific approaches is inclined to deal not with pairs but with populations. But even this approach cannot absolutely exclude the pair. Furthermore, I am ready to admit that man does not live mentally by science alone. I am therefore prepared to examine the evidence of the philosopher and the theologian according to *their* criteria and tools—not precisely as a scientist, but as a *man* who can also reach truth on the philosophical and theological levels. In particular, I can see that scientific experiments lend some support to the philosopher's assertion that there is something different in man, something by which he transcends the whole sphere of the merely material, something he could not have received from any mere animal. If then the theologian would add that this something comes from God and was first given to a unique pair, I cannot really raise objections as a scientist. My objections, if any, would come from another, extra-scientific source.

## 5.5 A CHRISTIAN VISION: MATTER-IN-EVOLUTION

The wheel has turned considerably within the last hundred years. In Darwin's life-time, evolution was to some people an almost irreverent word, the banner around which vociferous materialists and atheists gathered gladly. Today, a Christian reading *The Phenomenon of Man*, that powerful best seller of Jesuit priest-scientist Teilhard de Chardin, might almost welcome evolution as an integral part of his faith. And it is not difficult to understand either of these quite contrary attitudes.

One can understand, for instance, the enthusiasm felt for evolution by the earlier materialists among whose successors one could number our modern Communists. After all, an explanation of origins which involves "chance mutations" and "purely natural forces" operating on evolving matter fits effortlessly into a materialistic philosophy of life. However, it is possible for the theistic philosopher to show (though the arguments are too refined for the average Communist) that this very explanation enhances the status not only of matter but even of God. Actually, as we have already suggested, things have moved round to the point where one must attempt to understand a relatively new phenomenon : the enthusiasm of a number of modern religious thinkers who find at hand the materials for constructing a Christian vision of matter-in-evolution.

We would like to sketch here the outlines of such a vision. Even apart from its apologetic advantages, this sort of vision has a fascination and a charm all its own. In fact, it may easily beguile one into forgetting that evolution has its scientific difficulties and is far from being "the curve through which all thinking must necessarily pass." Hence, to avoid needless misunderstandings, a few preliminary clarifications are in order. And after that, before we come eventually to the vision itself, it should not be unprofitable to explain the sense in which thinkers today talk of "evolution" within the very plan of redemption.

**Some Necessary Clarifications**

Let us begin by recognizing that the evolutionistic outlook is an accepted and valuable dimension of contemporary thought. In general, one can only commend the tendency of people nowadays to look upon facts, trends and events as having evolved from earlier beginnings under the influence of various natural factors. For one thing, we have gained thereby a true sense of history and of human development in historical time. But warm appreciation should not blind us to the tacit assumptions which a number of moderns make. There is, for instance, the assumption that evolution is scientifically proved for certain and that it will never be disproved. There is also the assumption that no real line need be drawn between "evolution" and "evolutionism". However, the former is a reliable *scientific* theory (especially when applied to living things), while the latter is a much less reliable *philosophical* approach which regards the principle of evolution as the norm of true progress and the *one key* to an understanding of almost anything at all. When, for example, "evolutionism" is applied to morality, sound principles as stable norms for sane behaviour just disappear.

But even within the purely scientific sphere, important clarifications are called for, because, caught in its total sweep, the evolutionary scheme stands revealed as a vast drama in four connected Acts. In this drama, Act I shows us the *various chemical elements* evolving from the simplest of them, i.e., from hydrogen atoms. Act II then deals with the formation (from those elements) of increasingly complex and organised *compounds* till finally we have the first living things. Act III goes on to portray the progressive development of *various living things* up to man. Finally, Act IV presents the story of the gradual evolution of *human culture and society*—and many elements in this story escape science (in the strict sense).

It would be useful to summarise here what this book has said about each of the Acts. About *Act IV* there were only a few passing remarks—in connection with the theological problem raised by the scientific evidence on the first men. But we did make a serious attempt to show that substantial scientific evidence is available for the "organic evolution" of *Act III*, even though the evidence is not absolutely compelling. An earlier chapter (ch. 3) pointed out the quite fragmentary nature of the evidence for *Act II*, i.e., for "chemical evolution".

As for *Act I*, our book has said practically nothing, because, at present, little is known about this area. The main emphasis in the first two chapters was rather on that key topic of current interest : the rival theories for the origin of the universe as a whole. Within the larger theoretical framework, scientists have devoted a certain amount of thinking to the problem of deriving the various chemical elements from simple hydrogen atoms, but nobody has hit on a truly satisfactory solution. There is, of course, the Gamow view of all the elements being built up within a short time of "the big bang". But not everybody accepts this. Recent observations suggest that the synthesis of higher elements is still going on in the hotter stars, and that newer stars have a larger proportion of the higher elements. Besides, in no current view is there a properly worked out explanation of how *our primitive earth* (whose actual mode of origin remains still somewhat uncertain) got that full quota of chemical elements necessary for the developments in *Act II* to proceed.

**Redemption as an Evolutionary Drama**

Having made clear where we stand with respect to the evidence for the various stages of the evolutionary drama as conceived by the *scientist*, we must next clarify the sense in which redemption too may be viewed as an evolutionary drama by the *theologian*. This insight has been made possible by the progress of biblical studies and a stronger stress on the Church as a living, organic reality. Let us insist that there is no question here of idle or dangerous speculation, but rather of a *deeper awareness of development* within God's own redemptive plan.

"We Jews are God's chosen people" : this was the element dominant in the consciousness of the men responsible for the first portions of the Bible. They were less concerned with Adam and Eve and the origins of the human race than with the call of Abraham and the origins of the Jewish people. In this people would the whole human race be blessed; from this people would spring the Messiah. In the later books of the Bible the story of God's special dealings with His chosen people is the central theme. We are told of His active interventions in their history, of how He spoke through prophets, judges and kings, of how He used natural factors (such as political conflicts) to chastise, instruct and educate them.

It is the story of "the divine pedagogy". Scholars today can point to an "evolution", to the gradual emergence of a more purified people, or at least of a faithful remnant. It is interesting to note that a certain development can be traced even for an idea as basic as monotheism. In a true sense then, the Jewish people "evolved" towards conditions which set the stage for Christ.

Christ the God-man would be the Redeemer, the "Second Adam", the new starting-point and principle of return to the Father, the One who would restore to mankind in a more wondrous manner what the first Adam had lost.

Now Christ redeemed mankind by the events of His death-resurrection-ascension. This redemption involves the grafting of human beings into Christ, and all who thereby share His risen life must form one body. The chosen people are now a Church, the extension of Christ through space, time and history. Vivified by one Life and one Spirit, Christ's Church is a living, organic reality. Newly defined doctrines such as the Immaculate Conception or the Assumption of Our Lady are seen to be not arbitrary innovations but merely flowerings from seed-beginnings which were always actively present. Struggling through the centuries the Church grows and develops unto "the fulness of Christ". In a certain true sense then, the Christian people are "evolving" towards a definitive stage in the universe's history, towards that final consummation pictured in the burning symbols of the Apocalypse and characterized by St. Paul as the condition in which God will be "all in all." (I Cor. 15, 28).

We are by no means suggesting that "*redemptive evolution*" is of the same nature as "*biological*( organic ) *evolution*", or that "*supernatural election*" works on the same lines as "*natural selection*". But it is precisely the continuity and analogy between the two evolutionary dramas which furnishes the ground for a Christian vision of matter-in-evolution.

**A Christian Vision of Matter-in-Evolution**

Having already made the clarifications necessary to avoid misunderstanding, we may now indulge in a bold assumption. Let us suppose a state of things in which the four Acts of the scientist's evolutionary drama stand linked with the drama of redemption so as to present a single connected sequence in time. What are we then faced with ? Nothing less than an indescribably magnificent scheme of ordered development stretching over millions of years from the "Alpha" of the simple hydrogen atoms to the "Omega" of the consummation-point where God is all in all. In terms of unity, perspective and sheer poetry this vision is surely one of overwhelming grandeur. It is true that in reality the "evolution" all through the scheme is not always of the same type, nor on the same level, nor blessed with the same degree of certainty or importance.*

*For instance, once true human beings appear on the scene, further "evolution" must allow for human freedom and control. There must now be room not only for the survival of the fittest but also for the care of the unfit. Moreover, the whole sphere of redemption and the supernatural hangs on God's entirely free decision to speak to man and to

( Contd. on page 188 )

But let us forget all that for the moment. We have made an assumption boldly, and must now allow the resulting vision to sink in and exercise its charm.

And if we ponder the vision intently, then, gradually, we should become possessed by a sense of the wonder and mystery of *MATTER*, by a sort of "Christian materialism" in the best sense of the word. For the vision brings before us a vast picture of matter-in-evolution, of matter steadily moving (despite apparent detours, blind alleys, and setbacks) towards progressively higher levels by its own God-given and God-sustained powers until we come to man. At that point matter had to bow and expectantly await the gift of human spirit. The appearance of man made possible that dramatic dialogue which would henceforth dominate future developments in this world of space-time and matter: God's free offer of the gift of divine life, mankind's sorry response in Adam, and the unbelievable generosity of the divine redemptive "retort" which continues to restore all things in Christ.

Normally, we are too inclined to think of matter as something low, dirty and second-rate, and of ourselves as marvellous solely because of our immortal souls. We are far too prone to forget that we are *material beings* ("spirit-matter", not spirit *and* matter), that Jesus Christ took on the nature of a *material being*, and that He employs *matter* (such as water and oil and bread) in conveying to us through the sacraments the riches of His own divine life.

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enter into a life-sharing, personal relationship with him. And an abiding personal relationship involves frequent interventions offered and accepted in freedom. All of that is presupposed in any talk about "evolution" within the sphere of the supernatural. On the other hand, there is no need to demand an absolute separation between the natural and the supernatural. One may allow, for example, a *natural* desire in man for the *supernatural* vision of God—a desire which God would not be obliged to fulfil.

Though seemingly the lowest thing in God's creation, the vision portrays matter as charged with the most remarkable of properties, powers and potentialities. Now we must realise that even on the purely scientific level we are only just beginning to come to grips with matter intellectually. Who, for instance, really understands even a single atom ? All too often we have learnt to make use of the properties of matter : its radiations and energy and electrical charges. We have learnt to make bits of matter send us messages from the depths of space; we can pulverize huge cities with small nuclear bombs. But who has really penetrated to the heart of the mysterious mass-energy relationship ? Who has truly comprehended the precise nature of electricity or of electromagnetic radiations ? And these the basic, fundamental things lie unexplained while we explore the secret properties of the massive material combinations, such as proteins and nucleic acids.

Matter, however, is not its own explanation. Further pondering should deepen our sense of the wonder and mystery of *GOD*, this God whose redemptive love is now carried back over and into millions of years of preparation, the God who all through the vision of matter-in-evolution remains consistently the hidden Master of natural factors, time and history.

So powerful is His underlying action that He can afford to give other agents (secondary causes and natural factors) full scope. Chance in biological evolution, cultural factors in the authors of the Bible, political power in the persecutors of the Jewish race, malice in the enemies of Christ, human failings in Popes—all are given a free hand. Ample opportunity is provided for secondary causes to play the roles which scientists and scholars can dissect and study. As a result, the unbeliever has also ample opportunity to see nothing but secondary causes. But in both biological and redemptive evolution the presence of a master-plan becomes detectable—even if it is the plan of a hidden Master.

This God is consequently the Lord of time and of history. He is in no hurry whatever. Over millions of years He could brood with patient love while natural selection and the struggle for existence assured for Him the dominance of the mammals by way of the favoured reptiles and amphibians and fish. Meanwhile the world of sky and ocean, of minerals and coal and oil deposits was being prepared as home for man, the crown of His creation, whose nature He would one day take to Himself.* Undeterred by Adam's sin, He spent centuries preparing His chosen people. Much active intervention was now necessary to ensure the permanence of the Jewish race—within the wider setting of a world that would receive the Redeemer. In the process of supernatural election He choses Abraham and not Lot, Isaac and not Ishmael, Jacob and not Esau, the remnant and not all the Israelites, and finally the new Adam and Eve in whom all creation finds a more wondrous meaning. Today we live in the last times, we observe and fashion the final dramatic phases of the universe's history. Converging upon themselves under the abiding guidance of the Holy Spirit, members of the new Adam move as One Body towards the ultimate goal.

Matter-in-evolution : that is the vision—at least in sketchy outline. A Christian is certainly not obliged to accept it. And yet, if he does catch something of its grandeur, will he fear or fight evolution again ?

Modern man approaches reality with a mind that is deeply coloured by evolutionary thinking. Can the Christian today remain unmoved by the prospect of integrating this approach into the homage he owes to the Trinity ?

*A respected school of Catholic theologians, the "*Scotists*", have always preferred to hold that the Incarnation and recapitulation of all things in Christ would have taken place even if Adam had never sinned.

# Suggestions for Further Reading

(1) For the OVERALL VIEW (embracing scientific, philosophical and theological aspects), two recent symposia stand out for excellence :

—*Symposium on Evolution* (Pittsburgh : Duquesne University, 1959)

—W. J. Ong (ed.), *Darwin's Vision and Christian Perspectives* (New York : Macmillan, 1960)

(2) Brilliant SHORT TREATMENTS are :

—J. F. Ewing, "Human Evolution—1956", *Anthropological Quarterly*, Vol. 29 (Oct. 1956), pp. 91–139. Specially good on techniques of investigation, hominid fossils and cultural evolution.

—J. L. Russel, "The Theory of Evolution", *The Month*, Vol. 15 (1956), pp. 33–45. A brief but thorough presentation of the scientific data is crowned by a penetrating evaluation.

—B. de Solages, "Christianity and Evolution", *Cross Currents*, Vol. 1, no. 4 (Summer 1951), pp. 26–37

(3) The purely SCIENTIFIC aspects are competently dealt with in many a text. The following may be recommended, but the last two may prove too technical for most :

—C. A. Villee, *Biology* (Philadelphia : Saunders, 1957)

—E. O. Dodson, *A Textbook of Evolution* (Philadelphia : Saunders, 1952)

—G. G. Simpson, *The Meaning of Evolution* (London : Oxford University Press, 1950; first published : New Haven, Yale University Press, 1949). One must regretfully note the unfortunate tendency in Simpson to derive ethical conclusions from evolutionary data.

—R. S. Lull, *Organic Evolution* (New York : Macmillan, 1948). Valuable details and diagrams on fossils rarely found elsewhere.
—W. E. Le Gros Clark, *The Fossil Evidence for Human Evolution* (Chicago : University of Chicago Press, 1955)

(4) The PHILOSOPHICAL angle is handled with skill by :
—A. G. van Melsen—cf. his contribution to *Symposium on Evolution* (cited above)
—L. Bright, "Two Difficulties about Evolution", *Blackfriars*, Vol. 40 (1959), pp. 119–125
—R. J. Nogar, "From the Fact of Evolution to the Philosophy of Evolution", *The Thomist*, Vol. 24 (1961), pp. 463–501
—J. F. Donceel, *Philosophical Psychology* (New Yoık : Sheed and Ward, 1961)

(5) For the sort of THEOLOGICAL problems touched upon in Chps. 4 and 5, we would recommend :
—C. Vollert, "The Evolution of the Human Body", *Proceedings of the Catholic Theological Society of America*, 6th Convention (1951), pp. 122–145
—R. Gleason—cf. his contribution to *Darwin's Vision and Christian Perspectives* (cited above).

(6) Finally it is only just to indicate where the views of strong though fair CRITICS of evolution may be found:
—D. Dewar and H. S. Shelton, *Is Evolution Proved* ? (London: Hollis and Carter, 1947)
—R. Collin, *Evolution : Hypotheses and Problems* ("Faith and Fact Books", No. 30; London : Burns and Oates, 1959)

# PART TWO

# WHAT THE BIBLE SAYS

## A

## BACKGROUND TO GENESIS

# Chapter 6

# How to Read the Bible

Nuclear and atomic physics are not the only sciences that have made rapid progress today. Biology too has advanced by leaps and bounds. The biologist is no longer satisfied with seeking and classifying new specimens. Now he tries to understand what life is and even to produce it himself. He does not stop at noting the characteristics of various species; he tries to change and improve them with the aid of his research. All this progress must needs give a rude shock to one who thought that the Bible, thousands of years ago, had said the very last word on how the world and life came to be. Geology, biology and other positive sciences give us a very different picture. And yet today, as for centuries past, the Bible continues to be the world's best-seller. Not that learned men approach it as a sort of infallible encyclopedia on sundry topics—but when one wants an ideal and an inspiration for life, when one wants to realize life's deeper meaning and purpose it is still the Bible to which millions the world over will turn.

Whence then does this power of the Bible come ? Surely not merely because it is a book thousands of years old. There are numerous musty old documents which only specialists will study. Nor does the Bible attract because of its story content. There is too much of fiction and truth-stranger-than-fiction material on the market for the Bible to stand a chance on that score. The Bible remains *the book* of all time because it is the inspired Word of God.

## 6.1 THE DOCTRINE ON INSPIRATION

**Old View Too Simplified**

There was a time when the doctrine of inspiration presented no problem. It was thought that God's authorship of the Bible was as incontestable as Tagore's authorship of the *Gitanjali*, and that every word and sentence of the Bible could stand unchallenged in its literal meaning for all ages to come, precisely because the eternal God was the Author of the Bible. But the advance of science, the study of ancient history and archaeology and the critical study of the text of the Bible itself showed that such a simplified theory could never hold water.

Yet inspiration is a dogma of the Church and theologians who know well all the difficulties brought against the Bible, continue to believe in its divine authorship. Not of course in the simplified way of earlier centuries, but in a deeper and more intelligible way which helps bring out more fully the true message of God contained in the Bible. If we too are to understand the true meaning of the descriptions of the origin of the world in Genesis, we must study in what sense the Bible is God's book.

**Official Doctrine versus Rationalism**

The classical Catholic doctrine on inspiration stems from the 1890's, a time when the theological atmosphere was quite different from the 1960's. Outside the Church, the exaggerated glorification of human reason as the highest form of knowledge had turned into a boomerang and philosophers began to believe that all truth is relative, and that nothing permanent and objectively true existed. The same liberal and rationalistic tendency manifested itself in attacks on Holy Scripture. The Bible was alleged to contain not only factual and scientific errors, but even forgeries and falsehoods; divine revelation and inspiration free from error were openly denied. In general, revealed and organized religion was decried as the refuge of the weak and of superficial minds. Instead, a "religion of the spirit" was advocated. It would be free from authority and the human spirit would thereby attain perfect development.

Evidently the Church had to meet this challenge, but the generality of faithful theologians were carrying on a tradition of abstract speculation on religious topics that failed to impress men of their day. Several Catholics, therefore, in order to speak to their contemporaries in a language they could understand, began to speak in terms of an inner, subjective religious sense in man, which in Christ and in the Church evolved to a high religious experience of God.

This trend of thought caught on very fast and claimed many followers who were later called the "Modernists". As any one can see, the doctrine was fraught with danger, and unwary exponents could easily exaggerate the truth contained in it with great detriment to the eternal, objective and absolute value of the Christian Faith. In such a doctrine, errors in the Bible could be admitted without affecting the religious experience which was the goal. It was to safeguard the Bible from being watered down by such subjective, though well-meaning, interpretations, that the Catholic authorities laid down strict directives and clear ideas that had to be followed and accepted by Catholic theologians.

**Classical Teaching Stresses God's Influence**

The classical Catholic doctrine on inspiration bears the stamp of the Church's vigilant defence, at that time, of the Bible as the Word of God. It emphasizes very much God's influence in the composition of Scripture and the absence of any error whatsoever in whatever the Bible asserts. Leo XIII in his encyclical *Providentissimus Deus*, describes inspiration as a supernatural power by which the Holy Spirit "so moved and impelled them [the human authors] to write—he assisted them while writing—that the things which He ordered, and those only, they, first rightly understood, then willed faithfully to write them down, and finally exposed in apt words and with infallible truth."

In order to stress as strongly as possible that God is really the Author of Scripture, the Pope used the metaphor of an "*instrument*" to describe the activity of the human author. His intention was to prevent compromising theologians from facilely admitting errors in Holy Scripture by supposing that these could be attributed to the human author's independent activity. The point of the metaphor was not to minimize the personal activity of the human author.

**Personal Role of Human Author**

Consequently, we ought never to think that the human author does not count at all, that he is like a reed shaken this way and that by the wind of God's breath, or a tape-recorder endlessly parroting words which God has dictated. He may not be compared to a dead instrument like a piece of chalk; he is a living, thinking, freely-willing human person whom God uses in his free, human, creative activity. Nor may he be compared to a mere stenographer or scribe, for God does not use merely the penmanship of the author, but the author as author.

So the human author does not just sit around waiting for a great light to dawn upon him, but he goes about his job of writing in the ordinary, laborious way. He gathers the material by meticulously examining first hand sources (as we read in the Gospel according to St. Luke : "I have traced the course of these happenings closely from the beginning,"—Lk. 1,3) or by carefully editing existing documents on the subject (as the author of Macchabees II did, and found that it was no easy task, but rather a business involving much sweat and the labour of long night watches—2 Mac. 2,26) or he may use existing local traditions, folklore and even polytheistic myths (as archaeologists seem to have proved) if in that way he can make his message clear to his audience.

We shall see later what this all-important message was, but we who are accustomed to read straightforward reports of actual happenings and abstract, technical expositions of religious truths, should never make the mistake of imagining that in biblical times the same styles existed. The people of primitive times preferred stories to moral principles, and did not narrate an incident unless it had a lesson they were interested in giving.

But to come back to the role of the human author, his individuality is to be seen sometimes only in the general plan of a book and in the mutual arrangement of its parts. The human author would at times correspond very closely to what we would call today a compiler, except that even if his personal contribution was very small in bulk, he did give to the book as a whole the purpose and orientation which he had set himself, whether that was the meaning of the individual parts he incorporated or not. At other times, however, we can recognise an author's own inimitable style, in keeping with the literary canons of his day, with the particular turn of phrase and personal idiom which mark a man's style as his very own. Yet all the while, God's action is at work, secretly, silently, giving to the writing the meaning *He* intends and conveying the message He wants to proclaim.

**Infallible Formulae Not Explained**

It is not easy to say how exactly God's inspiring action works. The sure dogmatic and infallible teaching of the Church is very sparse indeed. The first Vatican Council has infallibly defined that the sacred books have God as author, but it does not say how the word "author" is to be precisely understood. Earlier Ecumenical Councils, speaking of the books which had to be admitted as constituting Holy Scriptures, mention that they had been written "*Spiritu Sancto inspirante*" and "*Spiritu Sancto dictante*", but of course the content of these formulae is not expounded. The official teaching of the Church gives some negative hints about the nature of inspiration when it says that the absence of error or the approbation of the Church, taken alone, do not constitute the precise nature of inspiration.

This official teaching carefully avoids specifying the psychological process in the mind of the sacred writer receiving inspiration. He may or may not be aware of it, he may or may not learn new truths—we do not always know. But we do know that God sees to it that the human author writes what God wants him to write in the way that God wants him to write it.

Theologians have tried to give a more concrete content to this highly abstract teaching. In past years, to avoid any trace of liberal Rationalism or Modernism, they emphasized the "instrumental" nature of the human author's activity. They tried to describe the "intellectual illuminations" and "impulses of the will"—traditional terms in Scholastic theology since the Middle Ages—which God gave the writer so that God's Book was produced by true human authors.

**Inspiration in its Total Context**

Today we have understood better the numerous human and even pagan and mythological influences that were at work in the making of the Bible, and the highly personal imprint of the author which each book carries. We also understand that it is not meaningful to consider inspiration as a miracle apart, producing a work which has its roots directly in Heaven, and upsetting the ordinary course of human activity. Many of the books of Scripture, especially Genesis and the Pentateuch took centuries to attain their present form. It is true that the time of final redaction which culminated in the form which the Church has approved of, is a supreme moment at which God's influence must have been specially powerful. But the mystery of inspiration did not come to be only at that moment. It is part of the far more basic mystery of God's intervention in human affairs, and, in particular, biblical inspiration in Genesis is part of the saving intervention of Jahweh in Israel's history. The sacred character of the Bible is intimately linked to the whole design of God for man's salvation.

## 6.2 GOD'S MESSAGE OF FAITH

**The Faith of Israel**

Every one has heard of how Moses led a crowd of Hebrews out of Egypt and slavery (probably there were several such migrations), and how God manifested Himself to the Hebrews in a specially forceful way, and how the people pledged themselves to worship Him alone as their God, believing that in return He would protect them and give them peace and prosperity. This manifestation of God was so soul-stirring that the incident gave a distinctive character to the people. It was a supreme experience of faith for those early Hebrews. Externally, however, they remained very much the same as any other tribe of the Near East, with basically the same knowledge, manners and customs. Not only did they lack the religious knowledge with the delicate nuances and profound depths of meaning which the Church has developed during well-nigh 2000 years, but they did not even have the details of Judaism as it was taught by the rabbis.

What then was the effect of the faith of the nation ? It was a supernatural judgment on the mysteries of God, man and the world.

**Faith in Yahweh Pervades National Tradition**

The Hebrews were enabled to see Yahweh and His design in their tribal heritage of religious traditions and in all the future vicissitudes of their nomadic life as well as in the later history of the Israelite nation. Yahweh who delivered them from slavery in Egypt was their God, who would guide them in their wanderings, lead them to victory in their battles and finally give them the land where they would enjoy sufficient material comfort to worship Him as He desired. In a word, national tradition was also a tradition of faith in Yahweh, and the material details of this tradition would remain very much the same as before. Faith gave unity and character to all the facts and stories that one generation transmitted to the next.

Most of us are familiar with the great upsurge of national consciousness that occurred throughout India when, in 1962, the Chinese invaded her north-eastern territory. This event was a crisis for the unity and integrity of the young, democratic republic, and the nation as a whole rallied to the cause. This was a test of the loyalty and dedication of the Indian people to the cause of political freedom and national unity. Similarly when the atom bomb was dropped on Hiroshima in 1946 with its prolonged ill-effects on the survivors, the event was a test of the people's dedication to their metropolis, and of their faith in the inviolability of the Japanese will to live. By their determination in the face of recurring disasters they vindicated themselves before the national ideal.

The Hebrew tribes, too, had their crises and trials. But in their case these events did not have merely a national or political dimension. These events were seen in the framework of their faith in Yahweh who was their Shepherd, King and God. These events became occasions for a special contact with Him and resulted either in a strengthening or a denial of their faith in Him. One who elsewhere would have been just a national hero became for Israel a leader or prophet who caused a new development of her faith in Yahweh, her Saviour. Israel's national literature, her prophetic and religious movements and her history were born of her faith and served to preserve it. Thus throughout the long evolution of the Hebrew community God's influence was at work, keeping the faith alive and pure.

**Literary Expression Under Divine Influence**

It is in this context of God's continuous action on Israel by which He revealed to her His Word—whether it be through a national crisis like war, or the preaching of an enraptured prophet, or the theological reflection of a learned scribe, or the production of a sacred book—that we must understand *Biblical Inspiration.* When finally the sociological evolution of the Hebrew community had reached the stage at which national traditions had to be preserved in literary form, once more God's watchful care over His chosen people was at work. What for another people would have been just the national evolution to literary forms was—in Israel's case—influenced by God's supernatural intervention. The unique *Book* which Israel would so produce would contain the résumé of what God had been teaching man through the centuries. In that Book man would find *the Truth of Love*, which *God is Himself* and which He revealed to men in actions and in words.

**Vision of Faith, the Purpose of the Biblical Message**

If we understand inspiration in this way we shall soon realize that what matters in Holy Scripture is not the content of human knowledge (e. g. the details of the creation story) but the vision of faith on history. This vision is the outcome of that supernatural impulse from God which inspired the composition of the sacred Book. We shall then understand that each sentence of the Bible is not an absolute truth that can be universally valid in its literal content, even out of its context, but that the Bible must be studied as a whole with a view to learn the message God wants to communicate, which is that He is their Lord, Shepherd and Saviour who, in various ways, leads them relentlessly to salvation.

The present tendency among theologians is to understand biblical inspiration in a way that is meaningful for contemporary man. This question, however, is far from settled, and the Fathers of the Second Vatican Council, in 1963, decided to postpone discussion on it until theological thought had matured sufficiently for them to define the faith of the whole Church on this point.

**Word of God in Words of Men**

So the Bible is not the word of God dictated to men (because inspiration is not verbal dictation), neither is it the word of men—a purely human book subsequently approved by the Church (because inspiration is not merely official approval); it is not even the thought of God put into the words of men—because God uses not only the words, but the very *thought* of the human author. Rather, it is the Word, the intention or purpose of God, expressed in the words (and by word here we mean not just the sound or symbol, but the *thought* behind the symbol) of men.

As Christ was God the Son, come into the world as man to take us back to the Father, and not just a wonderful divine prodigy bursting through the hum-drum of human existence for its own sake, so too Scripture is not just a literary prodigy to be wondered at for all time but is the message of salvation, the Good News of our return to the Father, expressed in ordinary human language and idiom. This message is the same as Christ's message : a proclamation of God's saving will and a challenge to men to respond in faith to His Word. It is our perennial task to try to understand that message by interpreting the language of the Bible in forms of thought and speech which we know and use today.

## 6.3 INTERPRETATION OF SCRIPTURE

The encyclical of Leo XIII of 1893 devoted many paragraphs to establish that the Bible cannot err because God Himself is ultimately responsible for what the Bible teaches. The defects of the human author are seen in the presentation of God's message (e.g., the awkward style, inaccurate references, etc.), yet God sees to it that the content of His message is rendered with infallible truth. But inspiration does not guarantee what the Bible only *appears* to say, nor what its human authors privately believe even when these personal opinions of theirs are reflected in the expressions they use. Only what the Bible actually *asserts* and *teaches* is the infallible word of God. This is a truth which helps to understand the real message of Scripture behind what the words sometimes seem to say.

**Emphasis Shifts from Inerrancy**

Pius XII writing in 1943 fully endorsed the teaching of Leo XIII on the inerrancy of Scripture, but it is noteworthy that he does not dwell on it in detail himself. This is not surprising, for with the gradual decline of liberal Rationalism in intellectual circles, and with a better understanding of the distinction between the respective points of view of the sciences and history on the one hand, and of the religious point of view of the Bible on the other, the attacks on the Bible on the score of its scientific and historical "errors", have very nearly spent their force. Now the emphasis is on trying to understand what it is that the human author did assert in his own characteristic way and how that message may be intelligibly rendered to men of today. Thus we find that Pius XII emphasized interpretation of Scripture and the study of textual criticism and biblical antiquities.

Though the Bible cannot err, yet it can easily be misunderstood, like all human sayings. But the danger of our misunderstanding the Bible is all the greater because it is a very ancient book, written in languages largely obsolete and by a people whose ways of thought and expression were very different from the Graeco-Latin culture of the past and of today. The literature to which the Bible is most akin, at least as far as literary form is concerned, is the ancient literature of the Near East. As a matter of fact the ancient Sanskrit literature of India is, in many respects, similar to the scriptural writings : thus the Psalms and the Vedic Hymns, the prophetic writings and the Upanishads, the patriarchal narratives together with the so-called historical books of the Bible and the Indian Epics, the Mahabharata and Ramayana, the liturgical books (e.g. Leviticus) and the Brahmanas, etc., are comparable in their literary qualities. But the modern forms of literature with which we are familiar today are quite different from biblical forms.

**Difficulty of Interpretation**

The Bible is a book which took shape slowly over more than a thousand years and has come down to us as a vast collection of different styles and literary forms which have to be interpreted in their own way. There is poetry in the Bible and parable, often tediously elaborate allegories, pithy proverbs and dry codes of law, exhortations, prayers, liturgical chants, much history too (not the modern scientific history we are accustomed to, but a type of deeply meaningful saga) and many other kinds of writing which are quite unlike anything we know, or worse, just sufficiently similar to confuse.

The Bible demands very careful interpretation because it is written in a foreign language and reflects a very different mentality. It is a Hebrew book, written by hard-headed Semites, who preferred a story to a neat syllogism and were more at home with colourful images than with abstract ideas. It is a primitive book, written by men who did not know that the world is round and who would have been quite surprised to learn that a man thinks with his head and not with his heart. No plain, blunt approach which goes straight for the "obvious meaning" of the text, brushing aside the "useless subtleties" of scholars, is going to get us very far. Rather the only sound way to approach the Bible is to heed the warning of Pius XII who tells us :

It is absolutely necessary to go back in spirit to those remote centuries of the East and, making proper use of the aids offered by history, archaeology and the other sciences, to discover what literary forms the writers of that earlier age intended to use and did in fact use. For, to express what they had in mind the writers of the ancient East did not always use the same forms and expressions as we use today; they used those which were current among the people of their time and place; and what these were the exegetes cannot determine in advance but only from a careful study of ancient oriental literature.

## 6.4 THE BIBLE AND THE CHURCH

For the Christian, the last word on what the Bible really teaches must be spoken by the Church, for the Bible is the book of the Church. The relation between the official, infallible teaching authority in the Church (*the Magisterium*, as it is called) and Holy Scripture has not been conclusively determined. But we should consider briefly how it is that the Church is empowered to make authoritative statements about the meaning of scriptural passages, as she has done in the past, in times of theological crises. Such pronouncements, however, are comparatively rare and only made when the Church is unanimously conscious of her faith on the passage in question. Even in such cases the infallible *Magisterium* usually restricts itself to excluding erroneous interpretations and leaves theologians full scope to carry on their investigations on the positive meaning of the passage.

**The Problem of the "Two Sources"**

If *the Magisterium* of the Church claims the right to propound infallibly what Scripture really says, does not the Church put her teaching above the inspired Word of God Himself? Is there not a rupture in the Mystical Body of Christ when some members, the teaching Church, try to lord it over the Head? On the other hand, if there is no authority to state definitively the meaning of Scripture we might as well give up hope of ever knowing what Scripture really teaches. We seem really to be caught on the horns of a dilemma : either Christians will never know what to believe as scriptural doctrine or they will subordinate God's Book to their authority which means ultimately they will not hear God's Word but their own. And in any case, why should God give us two sources to hear His message from, the infallible *Magisterium* and inerrant Scripture ? If He was to bestow the grace of infallibility on the Church would not that alone suffice ?

The answer is that the Bible and the Church are not two independent realities. The Bible is the book of the Church. Even though the Church does not need the support of Scripture to back up her teaching, yet the Bible is *the source* for the teaching authority to draw from. God gives the Church for her teaching function not only the ever-living grace of infallibility but also the permanent, objective presentation of revealed truth in the Bible, because this double arrangement seems best adapted to human nature which is both personal and social. Thus as faith is not just pure religious experience but has its foundation in objective fact and in reason, and as the Church herself is not a purely spiritual community of love but has a visible organization and authority, so too God willed that her teaching authority should enjoy not only infallibility but should have an inerrant permanent objective norm, Holy Scripture, to which she would always necessarily refer.

**Scriptural Inspiration, a Part of Special Providence**

We saw earlier that the Old Testament was not a miracle apart, a literary prodigy all on its own, but had to be seen in the total context of

God's saving intervention in the history of Israel. The inspiration of the New Testament too is not a separate miracle in the Church's history but is part of the special providence God exercised over the Church when her permanent foundation was being laid by the Apostles.

We all believe that God exercises a special care over His Church and will continue to do so to the end of time. But perhaps we do not always remember that the generation of the Apostles and their immediate disciples was an altogether unique period in the history of the Church. During this Apostolic Age, as it is called, God exercised an altogether special providence over the Church so that her foundations might be firm and strong. Christ Himself had of course established the Church and determined her nature as the people of God on earth, but the more detailed organization and widespread establishment throughout the known world was the work of the Apostles, and this organization was to be valid for all time, unlike later organizational decrees of the Church.

But the special providence during the Apostolic Age was not confined to organization and authority. The Apostles were not only rulers—whose government would be a service of love, after the example of the Master—but also ministers of the Word and of the Spirit. They were to teach the Truth and impart the Life which Christ had brought for all men of all times. In this function too, the Apostolic Church had a unique role, irreplaceable even by the infallibility of the Pope or the Ecumenical Councils. The faith of the Apostolic Church was like the seed or embryo which contains all the essential qualities of the organism in such a way that only what is potentially present in the seed will ever be organically one with the whole organism.

Now we know that in God's providence the faith of the Church was to be permanently expressed in a fixed, objective way in a book which would be valid for all future generations. This book, the Bible, would be written and accepted under divine inspiration which itself is an aspect of God's special providence in establishing the Church. Furthermore, under that special providence, the various local churches would recognise certain books as truly and inerrantly reflecting their faith, until slowly the whole Church would finally agree on *the* "*Canon*" (the list of officially recognised books) of Sacred Scripture.

**Bible, An Essential Part of the True Church**

Now this *Canon of Sacred Scripture* is not separate from the Church but is as much a constitutive element of the Church as is her living teaching or governing authority. Just as we cannot accept a Church without an infallible teaching authority, so too we cannot accept a Church without her Sacred Scripture, containing in embryo the full faith of the Church which later generations would unfold, and which would be the objective norm to which later teaching acts would refer.

The infallible teaching authority is the inerrant interpretation of Scripture because the living Church of history is organically identical with the Apostolic Church which produced Scripture. In apostolic times the Church accepted the Old Testament as her preparation and pre-figuring and formed the New Testament as the permanent, objective expression of her faith for future generations. Today she retains this as her own book and preaches the same faith to men of the changing world. She can interpret it infallibly because she herself had produced it under the influence of the same Spirit who continues to abide in her and guide her in her teaching.

But the Church's teaching power is never a substitute for study. Catholic biblical scholars may not just sit waiting for the Church to tell them what to say. We shall consider for a moment how the Church comes to define a dogma infallibly and we shall understand that the gift of infallibility far from replacing or eliminating theological study rather always supposes it and can hardly be exercised in practice unless theological discussion has cleared the field and enabled the belief of the Church to mature sufficiently to be defined solemnly and infallibly.

**Scripture and Dogma**

When the infallible teaching authority of the Church teaches a new dogma, this truth has actually always been present in the living faith of the Church and can become explicit even independently of scriptural studies. There are innumerable factors which bring into focus a particular aspect of revealed truth and make the Church as a whole explicitly conscious of it, even to the extent of defining it as an infallible dogma. These factors may be as heterogeneous as political conditions, secular philosophies, technological progress or an advance in scriptural studies. But as theologians or ecclesiastical authorities begin to teach this new aspect of revelation, naturally they look back on Scripture, the inerrant, objective norm with which the teaching authority of the Church always compares her developing doctrine and from which she always hopes to draw her profoundest inspirations. Now this comparison with Scripture is necessarily dependent on the contemporary state of Scripture studies.

Rarely would the official teaching authority undertake to give infallible interpretations of particular passages in Scripture. What the Church teaches infallibly is certainly scriptural doctrine, but the particular passages which are adduced as supporting or suggesting that doctrine, are not given a final infallible interpretation by their being so used.

Scripture scholars must always keep up their studies basing themselves firmly on the truths ennunciated clearly by infallible dogmas and abiding by the directives of Church authorities, as these are issued according to the particular needs of the time.

**Magisterium and Exegesis**

For the exposition of the meaning of Scripture, text by text, or "*exegesis*" as it is called, the Church may lay down some guiding, corrective or restraining principles in order to help her frail and fallible sons to remain on the difficult path of sound doctrine, and to safeguard the good of the faithful in general, but she leaves the actual work of interpreting the Bible largely to her exegetes, who with patient scholarship, strengthened by deep faith pursue the exact shade of meaning of these ancient texts, persuaded that it is only when they have through much painful study unravelled the meaning of these words of men, that they will be face to face with the Word of God.

## 6.5 CONCLUSION

A balanced doctrine of inspiration teaches us, therefore, that the Bible is the result of an indescribable union of divine and human activity. The human author is author in the full sense of the word according to the literary norms of the time when the book was composed. There are, of course, many things in the Bible which the author could not have known except by divine revelation (direct or indirect), yet *biblical inspiration* as such would not demand that we should expect to find a single sentence in the whole Bible to which we could point and say, "That sentence could never have been written by a mere man." Though man is not the *only* cause of the Bible, yet a *full human activity* has gone into the writing of the *whole* of the Bible. For this reason it is absolutely necessary to study the cultural background of the human author in all its relevant aspects, in order to get at a true understanding of the Bible. Many past exaggerations in biblical and theological studies may be traced to an insufficient appreciation of this truth.

**Divine Power in Scripture**

But this should not blind us to the other vital truth of a real divine impulse in the revelation and writing of Holy Scripture. The most detailed and accurate study of the human background will never give us adequately the effect proper to the reading of God's Word. There is a quasi-sacramental virtue in the reading of Scripture, specially if done in a liturgical gathering of the faithful. Scripture was written and inspired not just to make available so many propositions about the Christian religion, but to proclaim the work of redemption and man's spiritual regeneration. Contact with the written word of God makes available to our conscious life of faith, what the visible presence of the Incarnate Word did for His contemporaries. As St. John says in his first Epistle (1, 3–4) : "This message about what we have seen and heard we pass on to you, so that you too may share in our fellowhip....Fellowship with the Father, and with His Son Jesus Christ....so that joy may be yours in full measure."

The unique character of Holy Scripture as the Word of God in the words of men requires painstaking study to understand the idiom and meaning of the human author, and faithful, reverent hearing to experience the power of God's word and to grow in supernatural union or fellowship with Him. An arrogant questioning of the Bible to discover what *we* want to know, as for example, Where was

Paradise ? Who was Cain's wife ? and so on, will never permit the building up in us of the mystery of Christ which the proclamation of the Gospel ought to effect according to the plan of God.

# Chapter 7

# How To Read Genesis

If we are to understand what the Bible really tells us about the origin of man and the world in Genesis 1-3, we must keep in mind the principles of biblical inspiration that we have seen above. These archaic and picturesque narratives whose origin goes back thousands of years were surely not meant to be read like the pages of "Popular Science"; so, if we are going to understand the true meaning of the elaborate story of the six days of creation or the colourful description of God making man from the dust of the earth, we must read these accounts in their total human context, reconstructing the mentality, outlook and literary traditions of the people who wrote them. And this brings us to the question, Who did write Genesis?

## 7.1 THE WRITING OF THE PENTATEUCH

**Authorship of the Pentateuch**

For ages past, when men did not have the precise notions we have about authorship, originality, plagiarism and copyright, Christian and Jewish tradition never hesitated to say that the first five books of the Bible (Genesis, Exodus, Numbers, Leviticus and Deuteronomy) known collectively as the *Pentateuch*, had Moses for their "author". However, we must not imagine that the whole of this vast collection was personally penned by Moses himself in the leisure moments of his busy life. There are too many divergencies of language and style between its different parts, too many repetitions and variant accounts of the same events, for the Pentateuch to be anything but a compilation—a compilation built up by a series of editors, who collected and put together the religious traditions of their people.

Still, it is commonly accepted even today that the Pentateuch is substantially Mosaic in origin. Moses was the tribal leader who had formulated *the Law* for the clan formed by the twelve tribes of Israel. He had had a surpassing religious experience, a veritable encounter with God, and in the light of that encounter he had drawn up the Law which his own and the other tribes accepted as the rule of their pact with Yahweh. This formulation of their obligations towards God in return for His election and promise was, for the Hebrews, the nucleus of their whole national tradition and spirit. It was to preserve and elucidate this faith that later additions to the Law were made. They all preserved the spirit of the unique experience undergone by Moses, so we may rightly say that the books of the Pentateuch are "substantially" of Mosaic origin.

**The Four Sources of the Pentateuch**

Scholars believe that the Pentateuch attained its present form about the *fifth century B. C.*, when a redactor belonging to the Jewish priesthood collected the traditions, both literary and oral, which had matured in the course of centuries into the literary form we have today. There seem to have been four "sources" or groups of traditions which were used to compile the Pentateuch and the book of Joshua. If we may give a very schematic and incomplete account of the theory, necessarily omitting all nuances and details, the four sources are :

THE JAHWIST SOURCE (J) which uses the name Yahweh for God. This is a group of primitive traditions coming from the kingdom of Judah in South Palestine, and written before the eighth century B. C. It is picturesque and forceful in style and uses bold anthropomorphisms (i.e., human ways of speaking about God) instead of technical theological terms; but no scholar would dare call this helpless naïveté. It is concerned with the fundamental problems of human existence, sin and salvation.

THE ELOHIST SOURCE (E) uses Elohim as the divine name. It originated in the north of Palestine, but does not contain the primeval history of the world.

THE PRIESTLY SOURCE (P) reflects the spirit and preoccupations of the Jewish priesthood. We are perhaps somewhat familiar with a similar mentality from the encounters, which we read of in the Gospels, of Our Lord with the priestly class of his time. This source is abstract and juridical in character. Most of the liturgical and ritual parts of the Pentateuch, including the whole book of Leviticus, belong to this source. It has also non-ritual narratives of a distinctly "priestly" flavour. In its final form, "P" belongs to the period after the Babylonian exile (538 B.C.) but much of it goes back to a far earlier date.

THE DEUTERONOMIST SOURCE (D) is characterised by its eloquent preaching style. It was probably formed during the seventh century B. C. in levitical circles in the North. This source does not occur in Genesis.

## 7.2 THE NATURE AND PURPOSE OF GENESIS

Scholars today dispute whether our present version of Genesis is the work of an anonymous "redactor" (more or less mechanically harmonizing different traditions) or of a true author and artist who creatively (within the limits of the literary norms of his time) composed the work according to a definite idea and plan. However, one thing is certain, he did not set to work on the traditions in order to find out the most accurate report of the "events" described, after the manner of a modern chronicler. Therefore he did not compare and correct differing traditions but either gave them both as two independent traditions, at the most externally related to each other (as the two descriptions of man's origin in Genesis, the P account of Ch. 1 and the J account of Ch. 2), or else, he skilfully combined the two to read as a continuous narrative (the Flood story of Gen., Chs. 6-9). This method of work makes it difficult for us to understand Genesis since we seek only the "objective" happening, which the author, evidently, did not intend to relate primarily. We must therefore try to see what his purpose was in forming the book of Genesis.

**Religious Purpose of Genesis**

Though the final form of Genesis is due to a member of the priestly school, yet the general framework is usually attributed to J.

This was the earliest source of Genesis and its basic conception was more or less definitive for later amplifications by E and P. We should therefore try to understand the atmosphere in which J wrote his narration, and his purpose in doing so. The Davidic State with its political legislation and administration had replaced the original religious union of the twelve tribes. Hitherto the Hebrews realised the divine presence only in specifically religious events: a vision, the call to a holy war, the miraculous destruction of the enemy, etc. These experiences and the religious and cultic regulations resulting therefrom determined the daily life of the nation. But in the organized political state these regulations were in danger of losing their hold on the people once confronted with secular legislation. The Jahwist therefore set about showing the people that God's presence is seen not only in extraordinary and religious events, but even in profane political developments and in the private life of individuals.

We may say that the various authors of the scriptural books have achieved this religious purpose. The Jahwist first, and subsequent authors later, did succeed in producing a "Sacred History", a religious book, showing the march of human events as the fulfilment of the divine plan, and the Davidic expansion of the Jewish State in particular, as the fulfilment of the promised land made by God to Israel's first ancestors. Historical events interest the authors only in as much as they help to understand the story of God's dealing with His people.

**Method Used by the Authors**

In the actual working out of his plan, Jahwist integrated various local traditions: relating to cult (e.g. Gen. 15, 7, Yahweh's promise to Abraham), to sanctuaries (Gen. 16, 13-14; 31, 43-54); songs (e. g. Gen. 4, 23-24, the *Song of Lamech*); early codifications (Gen. 17, 11-14); some explicit references to earlier written works such as the *Book of the Wars of Yahweh* or the *Book of the Just* (Num. 21, 14; Jos. 10, 13; II Sam. 1, 18); traditional explanations relating to usages and customs (Gen. 32, 33), etc. The individual traditions were well known. Some of them had already been integrated into "cycles", i.e., series of anecdotes centred round a particular person or topic (e.g. the Laban narratives). The Jahwist therefore did not arbitrarily reconstruct the past according to his subjective views. His liberty in handling these traditions was rather limited, but even the small material changes made by him in any one of the traditions could considerably change the tone of the narrative and give it the new dimension of faith in Yahweh. The same would apply to the final redactor when he made use of the various sources.

## 7·3 HISTORY IN GENESIS

**Biblical History Not "Critical History"**

Since the intervention of God in human history is objectively real and historical even in the modern sense of "objectively valid history", it is important that we understand in what sense the Pentateuch is *historical.** The problem arises when, in an attempt to determine what exactly happened, we try today to correlate the different narratives about a given person and to reconstruct the story in a critical, "historical" sequence. As we have seen, the redactors of Genesis did not have this purpose primarily in mind, and we find "historical" inconsistencies in the various narratives. Obviously two differing accounts of one incident cannot both be true in the sense of being objectively "historical", nor does the author assert them to be so. But both could have a very true and real *meaning* and it is this meaning we have to try to unravel when we set about interpreting Sacred Scripture.

We have just seen, the authors of Genesis had a religious purpose in composing the book, not an "historical" one. Although we today speak of Genesis as one of the "Historical Books of the Old Testament", the ancient Jews never spoke in this way. For them there were three types of writings: *the Law* ( the Pentateuch ), *the Prophets*, and *the Writings*

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*In the following paragraphs the words "history" and "historical" occur frequently and it would be well to distinguish at the outset the two meanings which the word "history" may be given in English : (a) critical historical writing (cf. *Historie,* in German)—an exact, documentated account of facts as they occured objectively; ( b ) real history ( cf. *Geschichte,* in German)—it refers to a multi-dimensional reality which includes events of the past but goes beyond those major happenings of which alone critical historical writing usually takes cognizance. It includes such intangible, but nonetheless real, values as "the spirit of the nation", ancient experiences with subtle and pervasive after-effects, etc.

(Psalms, Job, etc.). The division into historical, prophetic and didactic writings is a logical one, due to Graeco-Latin influence. Due to this division we are led to expect that historical books of divine origin should meet the requirements of objectivity better than other writings, and we become more interested in knowing, whether the story presented actually happened, than in its meaning.

It has gradually been realized that this approach does not correspond to the mentality of the authors of the Bible and does not help to understand its message. The ancient Israelite did not think that a fact or event was worth recording for its own sake. A fact was the expression of a design or plan; it was a spur to action and suggested a line of conduct. When an Israelite related history he moralized and when he moralized, he told a story. What interested him was the meaning of the event related; the question of "exactly" what happened was of secondary importance for him.

**Historical Value of Saga Narratives**

Objective historical writing was over estimated in the nineteenth century, and the literary form of *saga* was looked down upon as myth and fable or just poetic fancy. It is true that saga as a cultural and literary form is characteristic of the more primitive communities when ways of thought are still more on the imaginative and concrete side. It is only in the later stages of the evolution of the community that abstract thought comes into play. Before this stage is reached, the concept of "critical" history does not exist in a community. Men may retain memories of past events that are accurate enough. But as a cultural form no one would dream of producing a work which "merely" reproduces accurately, to the last detail, a past event.

The ancients were only interested in a past event which had a present significance and for this purpose the form of saga is eminently suited. It is richer than modern "objective" historical writing since it not only interprets a past event, but carries with it an *historical experience* of the people which is secretly present at the time of narration and is decisive for the spirit of the nation. In the course of ages this story could be amplified with the aid of even fictional material, so long as that helped to elucidate and preserve the real and vital past experience. In this sense the saga, once its inner meaning is appreciated, is eminently *historical,* since this inner meaning is that intangible something which truly exists and which characterises the spirit of this nation or community as distinguished from all other groups.

**Nature and Meaning of the "Biblical Saga"**

The spirit which characterized Izrael was, as we have seen, *faith in Yahweh.* This faith is the inner meaning of the Old Testament sagas; and the sagas themselves are meant to preserve and transmit that faith to future generations. These sagas therefore were a precious heritage of Israel and were to be taken earnestly. We would be mistaken if we imagined that the narratives of the Old Testament were just popular stories narrated to while away the idle hours as we might today with a detective novel or a thriller.

Neither are they fictional renderings of universal religious truths after the manner of the fables, as we have in the *Panĉatantra* or in the collection of *Aesop*. Likewise they are not just creative projections into the primitive past of contemporary popular faith. This may have been done in certain cases to gain dignity and authority for new legislation as, e.g., by attributing the legislation contained in *Deuteronomy* to Moses.

These narratives (as regards the human part in their creation) might be compared with the stories of "little

Jesus" through which Catholic parents introduce their children to the tradition of faith which it is their proud privilege to hand over to the new generation. These stories have a factual foundation and a religious meaning, and it is this which is communicated in imaginative garb adapted to the mentality of children.

**Single Past Events Become Valid for the Nation**

Sagas are not mere objective renderings of past events, but neither is the communal theological element the sole content. The ancient meaning (whether it be of a cult centre, a miraculous escape from danger or any other event formative of the faith of the nation) is preserved, but the inner meaning is enlarged from the unique experience of an individual to a kind of typical occurrence, valid for the nation as a whole. Thus, for example, the meaning behind the narrative of the jeopardizing of Sara's purity at the Egyptian court or of the selling of Joseph, is that God miraculously brings the promise to fulfilment in spite of human failure; and this was an eminently real and *historical* experience for the whole community. Therefore we should be missing very much of the rich depths of the biblical narratives if we merely looked upon the details recounted as the factual description of an actual event and neglected going behind the story to the *meaning* which the author intended to convey by it, and which the audience contemporary with him was eminently qualified to grasp.

## 7.4 THE CREATION ACCOUNTS

Genesis describes the beginnings of Sacred History in two great acts, the Primeval History of Chs. 1-11, and the Patriarchal History of Chs. 12-50. We have just dealt with the type of history contained in Genesis as a whole and specially with the sagas which are characteristic of the Patriarchal narratives; but since in the past the first two chapters of Genesis have evoked bitter controversies, we shall dwell on these in particular.

**Literary Form of Primeval History**

If we were to try to classify the literary form of most of what is contained in the first eleven chapters of Genesis, and especially in the two accounts of creation, the first word which comes to our minds, is the word "myth". But this word is popularly associated with polytheism, superstition, imaginative tales where natural phenomena are explained by naïve personifications and stories of gods.—The History of Religion considers the myth as a "sacred story of origins, providing an account of the beginning of the world and of human beings and containing the mysterious meaning of existence." It gives a popular—not naïve—philosophy. In a rough and ready way it reflects the idea, the vision which a particular community or people has of man in the world. But even this latter meaning has to be modified if this word is applied to Genesis. As a result of all this, it is *not* common among Christian scholars to speak of "creation-myths" in Genesis.

We have seen in the previous chapter that biblical inspiration must be understood in the total context of God's intervention in the fully human life of the Hebrew community. The usual psychological channels which led to the formation of the myths of other peoples—observation of nature within man and outside him, and its explanation on the basis of a religious belief—had their share in the formation of the creation accounts in Genesis. But here the religious belief, the vision on the basis of which human existence was explained, was supernatural faith in Yahweh. The sages and seers of the Israelite community judged and reconstructed their observations of nature in the light of their faith.

Because of her knowledge of the true God and owing to His historical intervention in her life Israel was able to produce a *Primeval History*, while other nations, by the same mental processes, only produced myths. Here the word "history", however, is not to be taken in its modern, "critical" sense but refers to the inner, real truth behind the symbolic and figurative language of these chapters of the Bible.

**Universality of Salvation**

It is only after relating the dispersal of the nations, following upon the incident of the Tower of Babel, that the Jahwist narrates the election of Abraham, father of Israel. The *primeval history* (the first eleven chapters), however, was not primarily inserted, to teach popular tenets about the ancestors of the human race or their creation, but to bring out the *universal* intent of salvation. Scripture is the history of God's plan of *salvation* and everything else is subordinated to that aim. Through Abraham and the Saviour to be born from him, Yahweh would re-establish His relationship and fellowship with human kind.

The whole of primeval history, as it is built up in the Jahwist narratives, shows the increasing estrangement between man and God as man sinks deeper and deeper into sin. The sins of Cain, of Lamech, the union between the sons of God and the daughters of man, the sins of all humaniy before the Flood and finally the Tower of Babel,—these are the strokes with which the Jahwist graphically sketches how man steeps himself deeper and deeper in sin and misery.

**Paradise in J Shows Meaning of Sin**

The very description of the Garden of Eden or Paradise in Gen. 2, 4-26, is an image conceived by him of the desirable and pleasant state of the world prior to sin. It was a garden with flowing water, luxuriant vegetation and man dominating the animals—a cumulation of all that was most desirable to the Hebrew nomads before they became sedentary. It was described in this way to show that the struggle and suffering which are the lot of man in this world, were not the original intention of Yahweh for His creature, but the result of man's own misdeeds. The description of Paradise was not therefore any divine revelation, but just a storyteller's device to bring out the point of the story, the effect of sin as the cause of suffering.

**Creation in P Shows Power of Yahweh**

Chapter 1 and the first four verses of Ch. 2 of Genesis belong to the Priestly source. In its literary form it constitutes the latest part of Genesis, but the unwritten tradition is much older than many other parts of the book. It is arranged as a ritual hymn, and was regarded with the greatest reverence by the Jews. It was placed at the head of the book of Genesis to show that Yahweh who had singled out Israel as His special people was the highest God and Creator of the earth and of the heavens. This creation was His first and most fundamental work of salvation. We must not think that it was included for its own sake, to inculcate faith in creation, much less to describe that process, but rather to instill confidence in the fulfilment of Yahweh's promise to Israel. This chapter contains the essence of the priestly doctrine that had been perfected over the centuries. Each element is chosen after mature reflection, carefully, deliberately and precisely. The meaning of each element will be exposed in a later chapter.

Evidently the accounts of creation do not derive from a primitive tradition handed down by word of mouth from the time of the first man, who came to be, not in the year

4004 B. C. as a computation of biblical dates might lead one to believe, but somewhere in the vicinity of at least 30,000 years ago. Must we then say that it was directly revealed? Did God reveal to Moses all He wanted to tell us about the origin of the world?

**Creation Doctrine not Directly Revealed**

There certainly was a divine revelation made to Moses of the election, promise and covenant with the Hebrew people. God made Moses realize that Yahweh who had made a covenant with Israel was the only God whom they might recognise and whom they had to worship. This faith, characteristic and constitutive of the Hebrew people, had to be preserved for posterity. Succeeding generations, after much discussion and controversy developed the implications of this revelation in various aspects. The creation hymn of Gen. 1, was one of these developments. In it the uniqueness of Yahweh, God of Israel and God of the Universe was set forth. The revelation to Moses was preserved for and conveyed to a theologically developed community in a way suited to its religious and liturgical needs. The development surely took place under divine guidance and was included in Genesis under divine inspiration.

The elements of the creation hymn could naturally be only the world-view, the current religious ideas in rival religions and the "scientific" jargon of the period. Since his contemporaries believed in an abyss, a solid firmament and sea-monsters; since they were always in danger of falling into the worship of light or the stars, the author of Genesis made use of these notions to inculcate the truth that everything in the universe, even those things that were adored as divinities in other places or were considered to have an independent anti-God power of thier own, were all the work of Yahweh, were brought into being by Him and were completely subordinate to His will. Had he lived a few thousand years later, he would have spoken of the celestial spheres. If he had been a man of our own times, he would no doubt make use of terms like the "space-time continuum", "evolving matter" or "Absolute Mind" or anything that would have helped us realize the transcendence of Yahweh. His real message would have remained the same. That would not be affected by the pseudo-scientific trappings with which he had clothed it, because it was not this outer garb that he wanted to teach.

It is likely of course that, being a man of his times, the author took his scientific jargon seriously. But the personal opinions of the author, we have said, must not be confused with his message. It is quite clear from the Bible as a whole (which is, we repeat, a *religious* book) and from the structure of the creation story itself, that what the author wanted to tell us was not *how* God made the world, but simply that "in the beginning God *did* create the heavens and the earth," and therefore was powerful enough to fulfil His promise to Israel.

**Creation Stories are Religious History**

So the first chapters of Genesis are history in the sense that they teach genuine (religious) truths, and are not mere fiction or fantasy. But they are not meant to be accurate descriptions of the way in which the world came to be—this would never have interested the ancient Israelite. They form part of a popular *religious prehistory* which teaches religious truths about the origin of the world and man by means of colourful, easily remembered symbols and popular stories. In reading them today we must sift the "doctrinal substance" of the narrative from its "symbolic garb."

## 7.5 VARIOUS POINTS OF VIEW

All this will show that any attempt to reconcile what the Bible says on a religious plane with what science says on a purely scientific plane will not take us very far. To try and make out that the Bible has always been saying in popular language what modern science has only now begun to teach in more technical terms; to talk glibly of the six days of creation as six epochs whose sequence fits in well with what science teaches about the successive appearence of plants and animals; to figure out tortuous explanations of how light could have appeared before the sun, moon and stars—all such "Concordism" as it is called, is so much wasted effort.

**Scientific Concordism is False and Useless**

Fortunately, Concordism is a fast-disappearing phase in the history of biblical interpretation. Actually, even if successful at any moment, Concordism would hardly ever be lastingly useful, for even if one has, convincingly or otherwise, shown that the Bible speaks with the accents of Einstein, very soon Einstein may become as obsolete as Newton is today. In any case, it is not merely ill-advised, but hopelessly wrong, starting as it does from the false supposition that the Bible is meant to be an encyclopedia of human knowledge. It is already 1500 years since St. Augustine had warned: "It is not written in the Gospels that Our Lord said, 'I will send you the Holy Spirit to teach you the movements of the sun and moon.' It is Christians he wanted to make us, not mathematicians."

The true way of reconciling the Bible with science is not by exaggerating their apparent similarities (which only makes the Bible a puerile and rather childish text-book of science which a school-boy today would find inadequate) but by pointing out the difference in the respective fields of human experience of which each one treats.

**Archaeology and Bible Study**

Although scientific concordism is fast disappearing, a somewhat similar trend has arisen, specially among Catholic biblical scholars, with respect to Archaeology. Every new archaeological discovery that seems to confirm a biblical statement is eagerly seized upon as a confirmation of the historical accuracy of the Bible—as though the Bible were meant to give us details of wars or manners of life o the ancient inhabitants of the Near East. An eminent scholar J. Bright, after studying the question dispassionately feels that Catholics make a selective use of archaeological research and turn it into a tool for the apologetic purpose of defending the historical accuracy of the Bible.

Rather, as with science, so too in the case of the details of critical history, we must realize the different scope of the Bible, not stress apparent similarities. As the Bible is not a text-book of science, so it is not a text-book of critical history either. The Bible is a book of religious history, and it is this distinction that must be appreciated. If the problem to be tackled is the writing of a modern-type, well-documentated History of Israel, the tools proper to this science, not the Bible, should be used. If we may adapt the words of St. Augustine, the Holy Spirit inspired the writings of the Bible not to make us historians, but Christians.

**Unique View-point of Holy Scripture**

When comparing the data of the Bible with that of science or history, we must be careful to show that even when the Bible treats of material common to these fields of knowledge, it considers them from an entirely different point of view. It is this point of view which we have, faithfully and laboriously, with stern intellectual discipline, to make our own.

Science tries to find out the "HOW" of the world. It is interested in mechanisms. How did the world begin? How do the stars move? . . . . . . History tries to find out and interpret the sequence of man's free actions. Which nation was foremost at a particular period? What were the causes of its rise and subsequent decline ?. . . . But when all is said and done these ingenious constructions by themselves remain in the ultimate analysis "inadequate", because they miss the meaning behind it all. Why has the world come to be? Whither is it going? What is the purpose of man's life on earth? This science and history cannot tell us, and it is to the Bible that we must turn. Only the Bible can tell us of the ultimate WHENCE, WHITHER and WHY—the origin, the destiny and the meaning of the wonderful mechanisms and the impressive interplay of liberties in an evolving, marching world.

# Suggestions for Further Reading

(I) PONTIFICAL DOCUMENTS :

* *Rome and the Study of Scripture* (St. Meinard, Indiana : Grail Publications, 1946) is a collection of important documents from 1893-1943.

(II) BOOKS OF FUNDAMENTAL INTEREST :

* Jean Levie, S. J., *The Bible, Word of God in Words of Men* (London : Geoffrey Chapman, 1961)—The first part which treats of the History of Biblical studies gives a rather full understanding of the scientific and theological background to the official teaching on inspiration. In the second part, Inspiration and Catholic Exegesis, the author brings out the various human characteristics of Scripture and their implications for a theological interpretation of the sacred text.

* P. Synave, O. P., and P. Benoit, O. P., *Prophecy and Inspiration* (transl. by Avery R. Dulles, S. J., and Thomas L. Sheridan, S. J.) (New York: Desclée, 1961)—The second part of the book (pp. 84-168) contains a technical exposition of the traditional scholastic teaching on inspiration according to the principles of St. Thomas.

* A shorter exposition on the same lines appeared in A. Robert and A. Tricot (Eds.), *Guide to the Bible*, Vol. I, ch. 1: "Inspiration", by P. Benoit, O. P. (Paris : Desclée Co., 1960)—However in a recent article in *Revue Biblique* (1963) Fr. Benoit develops the same subject in a new light, considering inspiration in its total context.

* Georges Auzou, *The Word of God* (transl. by Josefa Thornton) (St. Louis : B. Herder Book Co., 1960)—This book contains a brief historical development of the doctrine on inspiration (pp. 73-82). Although in the theological

exposition (pp. 82-88) the author uses the metaphor of "instrument" for the human author a bit too freely, yet he develops in a couple of pages the importance of viewing the Bible in the total context of the evolving situation in which it was formed.

* Georges Auzou, *The Formation of the Bible* (transl. by Josefa Thornton) (London : B. Herder Book Co., 1963)—Treating of the history of the composition of the biblical writings, the author considers specially the relation of the various books to their original and living environment. It contains useful chapters on myths and other forms of ancient thought (pp. 22-28), on the faith of Isreal (pp. 57-65) and on the formation of the Pentateuch from the four sources (pp. 98-107 ; 172-78).

(III) SPECIALIZED STUDIES :

* Karl Rahner, S. J., *Inspiration in the Bible* (transl. by Charles H. Henkey) (New York : Herder and Herder, 1961)—A difficult but penetrating analysis of some problems of inspiration. Unfortunately the language is tortuous! He shows the serious difficulties arising out of the traditional view and proposes that the whole question be rather considered in the framework of the Church.—A summary of it appeared in Karl Rahner, S. J., "Inspiration of Scripture", *Theology Digest*, Vol. 8 (1960), pp. 8-12—A review easier to understand appeared in *The Clergy Monthly*, Vol. 26 (1962) pp. 141-44, entitled : "Divine Authorship of the Scriptures", by C. M. Cherian, S. J.

* D. J. McCarthy, S. J., "Personality, Society and Inspiration", *Theological Studies*, Vol. 24 (1964), pp. 553-76—Considering inspiration in the Old Testament, the author strives to maintain a balance between the personal expression of the sacred author and the influence of society on his writings. Though the relations between the author and his

community which are considered are impressive, the precise conclusions on the nature of inspiration are not clear.

* D. M. Stanley, S. J., "The Concept of Biblical Inspiration", *Proceedings of the Thirteenth Annual Convention of the Catholic Theological Society of America* (Yonkers, New York : St. Joseph's Seminary, 1958), pp. 65-89— In this paper, Fr. Stanley exposes the views of four eminent theologians, Frs. Benoit, Coppens, Rahner and Brinkmann. He then suggests new ground for investigation on the total purpose of God in inspiring the sacred writers.

* W. M. Valk, S. C. J., "Moses and the Pentateuch : A new Approach to an Old Problem", *Scripture*, Vol. 5 (1952), pp. 60-67— The author considers the history of the problem since the beginnings of literary criticism in the last century. He mentions the theory of oral tradition and, towards the end, affirms the preservation of the spirit of Moses throughout the later enlargements of the Pentateuch.

* A. M. Dubarle, O. P., "History and Myth in Genesis", *Theological Digest*, Vol. 6 (1958), pp. 95-99— Discussing the nature of the story of the fall in Genesis, the author shows that it should be called neither plain history nor just myth, but a special kind of history in traditional images.

B

# GENESIS AND ORIGINS

# Chapter 8

# Genesis and the Origin of the World

## 8.1 THE CREATION STORIES OF GENESIS

The Bible is a book that really begins at the beginning. "In the beginning," it starts off, taking us back to the dim and distant origins of all that we see, "God created the heavens and the earth." With that we plunge right into the familiar story of the six days of creation. This is really the first of two adjacent stories in the Bible, both of which speak about creation, even though both are not (as we shall see), strictly speaking creation stories. It is first, that is, in *position*. Since it belongs to the P tradition, it was probably written much later than the J story of Genesis 2, 4-25.

**P**

**Gen. 1, —2, 3**

In the beginning God created the heavens and the earth. The earth was without form and void, and darkness was upon the face of the deep; and the Spirit of God was moving over the face of the waters.

And God said, "Let there be light;" and there was light. And God saw that the light was good; and God separated the light from the darkness. God called the light Day, and the darkness He called Night. And there was evening and there was morning, one day.

And God said, "Let there be a

**J**

**Gen. 2, 4—2, 25**

These are the generations of the heavens and the earth when they were created.

In the day that the Lord God made the earth and the heavens, when no plant of the field was yet on the earth and no herb of the field had yet sprung up—for the Lord God had not caused it to rain upon the earth, and there was no man to till the ground; but a mist went up from the earth and watered the whole face of the ground—then the Lord God formed man of dust from the ground and breathed into his

P

**Gen.** 1,—2. 3 (contd.)

rmament in the midst of the waters, and let it separate the waters from the waters." And God made the firmament and separated the waters which were under the firmament from the waters which were above the firmament. And it was so. And God called the firmament Heaven. And there was evening and there was morning, a second day.

And God said, "Let the waters under the heavens be gathered together into one place, and let the dry land appear." And it was so. God called the dry land Earth, and the waters that were gathered together He called Seas. And God saw that it was good. And God said, "Let the earth put forth vegetation, plants yielding seed, and fruit trees bearing fruit in which is their seed, each according to its kind, upon the earth." And it was so. The earth brought forth vegetation, plants yielding seed according to their kinds and trees bearing fruit in which is their seed, each according to its kind. And God saw that it was good. And there was evening and there was morning, a third day.

And God said, " Let there be lights in the firmament of the heavens to separate the day from the night; and let them be for signs and for seasons and for days and years, and let them be lights in

J

**Gen.** 2, 4—2, 25-(contd.)

nostrils the breath of life; and man became a living being...

Then the Lord God said, "It is not good that the man should be alone; I will make him a helper fit for him." So out of the ground the Lord God formed every beast of the field and every bird of the air, and brought them to the man to see what he would call them; and whatever the man called every living creature, that was its name. The man gave names to all cattle, and to the birds of the air, and to every beast of the field; but for the man there was not found a helper fit for him.

So the Lord God caused a deep sleep to fall upon the man, and while he slept took one of his ribs and closed up its place with flesh; and the rib which the Lord God had taken from the man He made into a woman and brought her to the man. Then the man said, "This at last is bone of my bones and flesh of my flesh, she shall be called Woman, because she was taken out of Man."

Therefore a man leaves his father and his mother and cleaves to his wife, and they become one flesh.

*

P (Contd.)
**Gen.**1.—2, 3

the firmament of the heavens to give light upon the earth." And it was so. And God made the two great lights, the greater light to rule the day, and the lesser light to rule the night; He made the stars also. And God set them in the firmament of the heavens to give light upon the earth, to rule over the day and over the night, and to separate the light from the darkness. And God saw that it was good. And there was evening and there was morning, a fourth day.

And God said, "Let the waters bring forth swarms of living creatures, and let birds fly above the earth across the firmament of the heavens." So God created the great sea monsters and every living creature that moves, with which the waters swarm, according to their kinds, and every winged bird according to its kind. And God saw that it was good. And God blessed them saying, "Be fruitful and multiply and fill the waters in the seas, and let the birds multiply on the earth." And there was evening and there was morning, a fifth day.

And God said, "Let the earth bring forth living creatures according to their kinds : cattle and creeping things and beasts of the earth according to their kinds." And it was so. And God made the beasts of the earth according to their kinds, and the cattle according to their kinds, and everything that creeps upon the ground according to its kind. And God saw that it was good.

Then God said, "Let us make man in our image, after our likeness; and let them have dominion over the fish of the sea, and over the birds of the air, and over the cattle, and over all the earth, and over every creeping thing that creeps upon the earth." So God created man in His own image, in the image of God He created him; male and female He created them. And God blessed them, and God said to them, "Be fruitful and multiply, and fill the earth and subdue it; and have dominion over the fish of the sea and over the birds of the air and over every living thing that moves upon the earth." And God said, " Behold I have given you every plant yielding seed which is upon the face of all the earth, and every tree with seed in its fruit; you shall have them for food. And to every beast of the earth, and to every bird of the air, and to everything that creeps upon the earth, everything that has the breath of life, I have given every green plant for food." And it was so. And God saw everything that He had made, and behold, it was very good. And there was evening and there was morning, a sixth day.

Thus the heavens and the earth

were finished, and all the host of them. And on the seventh day God finished His work which He had done, and He rested on the seventh day from all His work which He had done. So God blessed the seventh day and hallowed it, because on it God rested from all His work which He had done in creation.

**The P Story**

The two stories are, obviously, not at all alike. P is a systematic and stylised description of the *origin of the world*. It starts off from a primordial chaos, which it pictures as a dark, unruly ocean, and leads up through a series of eight successive creations spread out over a period of six days, to the ringing words that announce like a fanfare of trumpets the making of man : "So God created man in His own image, in the image of God He created him, male and female He created them" (Gen. 1, 27). Man appears *last*. He comes as a king, comes to take possession of the palace that has just been built for him. And all through its building we have been aware of the immense *power* of God whose naked word brings light and life leaping out of the dark and empty abyss.

**The J Story**

The J story is very different. It describes and not in the sober cadences of P, but in colourful images, full of picturesque detail—the origin of man as the *first* of the inhabitants of the primeval world, here pictured as a barren desert waste. The other living things (and last of all woman) are then made for man. There is no trace here of any six-day time-table, but the story is given a precise location : it takes place in Eden which the author places at the (imaginary) common source of the four great rivers (the Euphrates, the Tigris and probably the Ganges and the Nile) which watered the world he knew. (Gen. 2, 10-14).

J is evidently more interested in the origin of man than of the world he lives in, and it is God's *providence* rather than His power which shows up clearly in his story. The reason is that J is not really a creation story at all, but rather a sort of prelude to the story of the Fall. What it wants to teach is not the origin of the world, but the origin of evil; and if it speaks about the making of man at all, it is only to set the stage for the tragic drama of his disobedience and fall. If the first chapter of Genesis is (as we shall soon see) a liturgical hymn to the Creator praising His work as very good, the second explains how evil has come to deface His once unsullied masterpiece. The purpose of the redactor in adding the J story to P is, partly at least, to exonerate the Creator.

Thus the J story will not help us appreciably in finding out what the Bible has to say about the origin of the world and we can for the moment put it aside. We shall have to return to it when we come to the vexing problem of the origin of man, about which J (like Hebrews on Melchisedech) has "much to say which is difficult to explain." In the meantime let us take a closer look at the P creation story of the six days.

## 8.2 THE STORY OF THE SIX DAYS

The Genesis story of creation begins by solemnly announcing : "In the beginning God created the heavens and the earth." "*The heavens and the earth*", is the sort of (1)
antithetical expression the Hebrews liked to use to describe any sort of totality. When for instance Psalm 138 (139) cries out to Yahweh : "Thou knowest when I sit down and when I rise up," it is saying that God knows all that I do; and when it says, "Thou dost beset me behind and before," it means that God is all around me. So too when Genesis says that God made the "heavens and the earth", it means

that God made *all that there is*. The "heavens and the earth" of the Bible is the orderly *Cosmos* of the Greeks, or the immense *Universe* of modern science.

**Its Setting**

How did our author picture this universe? Certainly not as a "gas of galaxies". Like any other Semite of his time he took the universe at its face-value. He imagined that it really was just what it appeared to be. And so he thought of the earth as a flat disc resting on some sort of earthy *pillars* (Ps. 103 (104), 5; Job 9, 6), in the *world-ocean* or abyss out of which it had come (Ps. 23 (24), 2); and whose waters seeped through hidden *channels* in the earth (Gen. 7, 11; Job 38, 16) to form its rivers, lakes, springs and seas. Within the earth lay a gloomy cavern called *sheol* in which the dead eked out a shadowy existence (Num. 16, 30; Is. 14, 9). Along the edges of the earth were high mountains, the *pillars of the sky* (Ps. 103 (104), 5; Job 9, 6) which supported a great solid vault, the *firmament* or sky (Job 37, 18). This rested on the earth like a great inverted bowl, and carried the sun, the moon and the stars. Above the firmament there was more water which rained down on the earth when the *floodgates* (Gen. 7, 11) in the solid vault were opened. The firmament thus divided the "waters above" from the "waters below" (Gen. 1,7) by putting an abyss of air between them. And far above these *upper chambers* (Amos 9, 6) of the firmament was the *highest heaven*, the dwelling place of the angels and of God.

The "heavens and the earth" of the Hebrews was evidently a tidy little world : a orderly series of concentric regions or zones, each peopled (it was believed) by its own army or "host" of appropriate inhabitants (Gen. 2,1). A journey through this compact and carefully structured

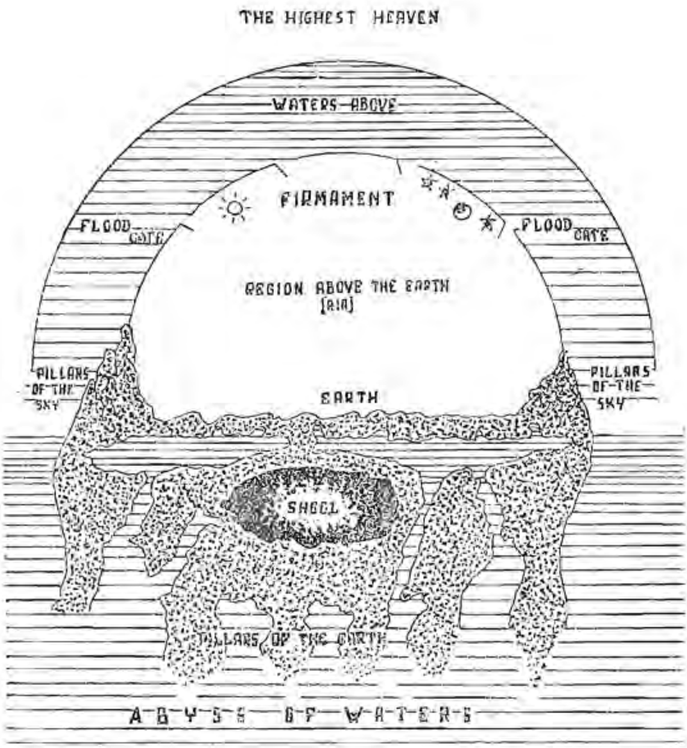


Fig. 16

The Hebrew Universe ( " the heavens and the earth " ) universe, from below upwards, would take us successively through :

—the *abyss* or world-ocean inhabited by the "monsters of the deep,"

—*Sheol*, the abode of the dead,

—the *face of the earth* alive with "the beasts of the earth, the cattle of the field and every creeping thing,"

—the *region above the earth* or the abyss of air the home of "every winged bird,"

—the *firmament* filled with the "hosts of heaven"—the sun, the moon and the stars,

—the *waters above* the firmament,

—the *highest heaven* which is the dwelling place of God.

**Its Structure**

Such was the "heavens and the earth" which God made in the beginning. How did He go about making it ? "The earth," says the author, "was without form and void." That is, it was a chaotic emptiness—not the organized series of orderly inhabited zones we have just looked at,— a formless mass, with the earth covered with water and the water covered with darkness ("and darkness covered the abyss"), in which no living thing stirred. And into this dark, formless and empty waste the voice of God rang out bringing *order* into the chaos and *life* into the emptiness. God creates by FORMING a formless waste and by FILLING an empty void.

All this must take place (for reasons we shall soon see) within six days. So on the first three days God FORMS : He organizes the universe. As His creative word penetrates into the chaos of darkness-water-earth, it brings order by successively dividing each element of chaos into its pair of opposites. On the FIRST DAY God's action reaches the
(1) darkness, and God creates the *Day* and the *Night* by separating light from darkness. On the SECOND DAY, God's (2)

action reaches the water, and God creates the *Sky* and the *Sea* by separating the waters above the firmament from the waters below. And on the THIRD DAY, God's action reaches the earth, and God creates the *Dry Land* by pushing off the waters of the sea from the earth which they envelope.

Thus at the end of three days of creation the primordial chaos has been "formed" into three dichotomous regions: Night-Day, Sky-Sea, Dry Land-Water; and these God now proceeds to FILL with their appropriate "armies". Already on the third day God has made the plants, or rather, the earth has emerged from the covering waters of the ocean already clothed with vegetation. The plants, in fact, are not part of the armies of the world, because in Hebrew thought plants are not alive : they do not move. The stars on the other hand which do move are thought of as alive and are part of the "hosts of the heavens".

Then on the FOURTH DAY, God fills the heavens by creating the sun for the Day and the moon and stars for the Night. On the FIFTH DAY He fills the Sky and the Sea by creating the birds of the air and the fish in the ocean. On the SIXTH DAY God peoples the Dry Land by creating the animals, and, last of all, man. And on the SEVENTH DAY, God rests. And so with plan and method God forms and fills the "heavens and the earth", fitting His *eight works* of creation with a remarkable though somewhat forced symmetry into *six* crowded *days*. (Cf. fig. p. 248)

As we read the creation story more carefully, we notice other, even subtler symmetrical patterns in its style. Each of the eight works of creation is described in a set formula which, when complete, has *seven* different elements: (a) an introduction : "And God said;" (b) the divine command : "Let there be light ;" (c) the effect : "and there was light;" (d) a description of God's action : "and God separated the light from the darkness;" (e) the blessing or naming of the

GOD

FORMS ↙ ↘ FILLS

CHAOS

| DAY | WORK | (by separating) | | (with armies) | WORK | DAY |
|---|---|---|---|---|---|---|
| I | 1 | Day/Night (creates light) | DARK-NESS | Sun/Moon & Stars | 5 | IV |
| II | 2 | Sea/Sky (creates firmament) | WATER | Fish/Birds | 6 | V |
| III | 3 | Dry Land | EARTH | Animals | 7 | VI |
| | 4 | (Plants) | | MAN | 8 | |

thing made : "calling the light Day;" (f) God's approval : "And God saw that it was good;" (g) a conclusion : "And there was evening and there was morning, the first day." All the seven elements are not found in every one of the eight works; but if we count the elements occuring in each, we get a surprisingly symmetrical result :

| DAY | WORK | FORMING | FILLING | WORK | DAY |
|---|---|---|---|---|---|
| I | 1 | abcfdeg (7) | (6) abcd-fg | 5 | IV |
| II | 2 | abdce-g (6) | (6) ab-dfeg | 6 | V |
| III | 3 | abc-ef- (5) | (5) abcd-f- | 7 | VI |
| | 4 | abcd-fg (6) | (7) abcdefg | 8 | |

**Its Literary Form**

Such symmetrical arrangements can scarcely be accidental. The story of the six days is obviously a highly artistic and artificial construction which reads more like a poem, a hymn to creation, than like a factual report of how the world began. And that, according to many commentators, is in fact what it more or less is. The creation story of Genesis, they say, has its "Sitz im Leben" in the cult : meaning that long before it was written or incorporated into the book of Genesis as we know it now, the story was elaborated over the years as part of a service of worship. It is this cultic background which explains its nicely balanced symmetry and its stereotyped repetitions of phrase, since this is just the sort of thing that liturgical recitation requires. It explains also why the story adheres so closely to its six-day schedule (even though eight works have to be fitted in) and then tags on a seventh day of rest at the end. If God is said to rest on the seventh day, it surely is not to tell us that God, who has effortlessly willed the heavens and the earth into being needs to rest. But it is to provide us with a divine model for the observance of the Sabbath rest.

Like any good liturgical narrative the Genesis story was supposed to *teach*, and that meant that it had to be closely adapted to the concrete mentality of the ancient people for whom it was narrated. It had to hold their attention — and so it vividly dramatizes the action of God. It had to be intelligible — and so it speaks in a language familiar to them about a world (the multi-zoned "heavens and the earth") they knew. It had to be easily remembered (an important thing at a time when books were few, and those who could read them not so very many more)— and so it is told in a sort of regularly recurring chant. The literary form of the creation story evidently owes a great deal to the liturgical and pedagogical purposes the story was meant to serve.

And because no literature develops in a cultural vacuum, the Genesis story was also influenced by the literary traditions of neighbouring peoples (the great civilizations of Babylon and Assyria and Phoenicia and Egypt), whose creation myths were current all over the ancient Middle-East when Genesis was being composed and written. It may have derived some of its imagery from these myths : it certainly reacted strongly to their content. That is why many elements in it have *polemical* overtones. The six-day scheme may be one of these, because besides its obvious cultic moral (the observance of the Sabbath) it teaches an important cosmogonic lesson too. It dissociates the Genesis story from the cyclic conception of time in which the creation myths (with their continually recurring cosmogonies) move. The Genesis story does not move in cyclic time. By limiting the events of creation to a fixed number of days, it presents creation as something which happened once and for all in a unique and never to be repeated interval of time. The time of Genesis is the linear time of salvation history.

**Its Interpretation**

All this again reminds us how different the story of the "Six Days" is from the simple factual report it might at first sight appear to be, and how important it is, if we are going to understand it correctly, to separate its ever valid *doctrinal content* from the historically conditioned *concepts* and *images* used to express it, as well from the *literary form* in which it has been clothed for liturgical, pedagogical and polemical reasons.

All those interesting little details of time and place in which the story moves — the primeval abyss wrapped round with darkness, the exact order of the successive creations, the six-day scheme—all these belong to the author's conceptual frame and to the literary conventions he uses. To express his burning conviction that the saving God does indeed stand at the origin of all things he draws upon the cosmological ideas of his time, and upon the literary forms available to him. He elaborates a ritual narrative which contains the truth he wishes to teach, but contains it, not as a bald statement of fact, but as a skilfully constructed story which is liturgically satisfying and pedagogically effective. His particular historical situation determined, we might say, the imagery of his story, whereas his liturgical and pedagogical preoccupations determined its style. But the *content* of what it teaches is independent of both style and imagery.

What this content is will emerge in the course of our study. As a first step to bringing it into some sort of focus we shall compare the Genesis story with one of the best known of the creation myths of the ancient Middle-East. Such a comparison confronts the Genesis story with a non-biblical creation narrative from its own cultural milieu, and thus throws light on those elements of its *literary form*, common to other creation stories of its time. This comparison will also help to pin-point its *content*, which, because it ultimately derives not from human speculation but from revelation, is all its own.

The confrontation of Genesis with these creation myths resolves itself to a confrontation of two kinds of religious experience : the experience of a people who had encountered their personal saving God in history and viewed nature as the field and instrument of His saving action ; and the very different religious experience which starts from an awed contemplation of nature and arrives at God as the more or less personal Power behind the violent clash of the personified forces of nature. Ultimately it is a confrontation of Revelation with Myth. And it is against the colourful shifting patterns of myth that the hard lines of revelation show up most revealingly.

## 8.3 GENESIS AND MYTHOLOGY

The myth to which we shall compare the Genesis story is the creation epic called from its opening words *Enuma Elish* which is one of the oldest, and certainly the best known of the creation stories of the ancient Middle-East. It probably dates back to the Babylon of Hammurabi (c.2000 B.C.), though the versions we actually possess are more recent. The best is the one that was found inscribed on seven clay tablets in the great library of Ashurbanipal, who ruled over Niniveh round about the seventh century B.C. So Enuma Elish was very well known throughout the ancient Middle-East during the time that Genesis was being written. It is quite unlikely that the author of the Genesis story would have been unacquainted with it.

**The Babylonian Myth**

Enuma Elish takes the story of creation back to two primordial cosmic principles which stand at the beginning of all things. There is the god *Apsu* who personifies a fresh-water chaos, and the terrible goddess *Tiamat* who is the primordial salt-water ocean :

> When above the heavens had not as yet been named (= did not exist),
> When below the earth had as yet no name,
> When Apsu, the first one, the father of the gods and Mumu Tiamat the mother of them all had not as yet mingled their waters,
> When there were no bushes, nor were there any reeds,
> When no gods existed and neither the name nor the destiny of any was yet decreed
> Then it was that the gods were formed in their midst. (I, 1–9)

So do Apsu and Tiamat give birth to gods, who in turn beget other gods, until we have *Anshar* and *Kishu* and *Anu* and *Ea* the god of earth and water, and *Marduk* the god of light — all the great figures of Babylonian mythology. But soon Apsu and Tiamat weary of their progeny. She is troubled by their "hilarity in the abode of heaven"; he is unable to "lessen their clamour". So Apsu decides to destroy them, but he is forestalled by the wise Ea who casts a spell on him, takes him captive and slays him :

Ea the all wise saw through their scheme...
Having fettered Apsu he slew him. ( I,60,69 )

The death of Apsu rouses Tiamat to fury. She spawns eleven horrible monsters ("The Viper, the Dragon, the Sphinx, the Great-Lion, the Mad-Dog, and the Scorpion-Man, Mighty Lion-Demons, the Dragon-Fly the Centaur.... withal eleven of this kind she has brought forth," so Speiser's translation in *Ancient Near East Texts*) who are to attack the badly frightened gods. But Marduk the hero-god of Babylon joins combat with Tiamat, and with the help of an evil wind the gods have given him, he slays the terrible goddess and captures her entourage :

The Tiamat and Marduk the wisest of the gods joined issue,
They swayed in single combat locked in battle;
The lord spread out his net to catch her,
The evil wind which followed behind he let loose in her face.
When Tiamat opened her mouth to devour him
He drove the evil wind so that she could not close her lips.
As the fierce winds rushed through her belly
Her body was blown up and her mouth was wide open,
And when he released his arrow it tore her belly
It cut through her insides and split open her heart....
After he had slain Tiamat, the leader,
He scattered her band and broke up her followers
And the gods her helpers who marched at her side....
He made them captives and smashed their weapons (IV, 93–111).

The victorious Marduk then makes the heavens and the earth by splitting up the dead body of Tiamat :

He split her like a shell-fish into two parts
Half of her he set up and made it the sky
He pulled down the bar and posted guards
And bade them not to allow her waters to escape
He crossed the heavens and surveyed its regions. (IV, 135–141).

**The Myth and Genesis**

It seems a far cry from the rather grotesque details of this dramatic but obviously primitive story to the solemn and sober cadences of Genesis. But there are resemblances. The *Tiamat* of Enuma Elish is evidently related to the "*tehom*" (—the abyss) of Genesis so that both the Babylonian epic and the Bible derive the earth from a primordial ocean-chaos. Both also picture the world in the same simple way : a saucer floating on water under a solid dish-cover; and both describe creation as a ordering of the primordial chaos by a series of bipartite divisions. In a word, because they belong to the same cultural milieu, both stories have the same "scientific" ideas about the world and use (the Bible with much more sophistication and sobriety) the same popular images. And that is all. Here the similarity ends. In content and meaning the two stories are poles apart and the surface similarity of the images only highlights the profound differences in doctrine.

The world of Enuma Elish is unashamedly *dualistic*. The myth symbolizes the never-ending struggle between the opposing and equal forces of chaos and order, in which now one now the other gets the upper hand, but neither is ever completely supreme. And so history becomes an endless cycle of successive creations and destructions. The world stands always in a precarious equilibrium, threatened continually by the dark forces of chaos which are always there, subdued but undefeated, awaiting their chance of revenge. Even the gods cannot escape the cosmic cycle. They are parts of it, mere personifications of the forces of order and disorder which determine its cyclic rhythm.

Very different is the *strictly monotheistic* world of Genesis. The Lord God of the Bible is not one of the many gods spawned by a primordial chaos : He is the only God who always IS. He is no personification of impersonal cosmic forces but a person, the Covenant-God, who stands completely outside and wholly above the cosmic order. He does not have to struggle against the strong forces of chaos to bring the world into a precarious state of existence. No, He speaks— and the world is. He is the absolute master of all that there is. He is the only Lord. And so the sun, the moon and the stars are not the gods the Babylonians made them out to be, but are things made by God "for signs and for seasons and for days and years" (Gen. 1, 14). The monsters of the deep are not creations of chaos sent to wage war against God, but are His docile creatures. The world is not ringed round with forces of evil and disorder, which the slightly stronger forces of order barely manage to keep at bay; it comes wholly from God (and so it is all good), and rests secure in the hands of Him on Whom it wholly depends.

## 8.4 GENESIS AND THEOLOGY

Christian theology, we have seen, expresses this dependence in its doctrine of creation. Everything that is not God has been "created" by God — that is, it has been willed into being by God out of nothingness. God did not make the world the way a carpenter makes a table out of wood, but the way (though the comparison, naturally, is not perfect) a man thinks a thought. Thus He does not give shape to some substance which is already there and then leave it to fend for itself (this is what the carpenter does); rather, He gives both shape and substance to something which did not exist at all before He called it into being, and which would fall back into nothingness (like the thought of a thinker) the moment He stopped willing its existence. God does not "produce" or "make", He "creates". That is what theology teaches. Does Genesis?

**Does Genesis Teach "Creation"?**

Yes, think some. They point out that the Hebrew word "*bara*" which Genesis uses to describe the action of God is an unusual sort of word. Not that the dictionary meaning of "bara" is "to make out of nothing". No, the original root probably means something like : "cutting and separating to put into order", "shaping", "organizing"; and the word itself is occasionally used in the Bible for ordinary kinds of production (Num. 16, 30; Is. 4,5). But neither does "bara" positively exclude the idea of true creation : in fact its normal biblical usage rather suggests it. "Bara" is used 48 times in the Bible and always to describe an action of God in which His power shows itself in some extraordinary way. One could scarcely find a more suitable word than this to stand for true creation; and the fact that Genesis uses it here rather than the more usual words for making, like "asah" or "yatsar", is surely significant.

In any case (they say), the context leaves us in no doubt whatever that Genesis is really speaking about creation proper. "In the beginning," the story begins, "God made the heavens and the earth," and then immediately adds "and the earth [presumably the one just made] was waste and void" — that is, it was the primordial chaos. God begins by making the primordial chaos. But He could make this only by creating it out of nothing. He could not have formed it from something else since the primordial chaos is the last word in utter formlessness, absolutely the most disorganized state of things we can imagine. And so by showing us God making the primordial chaos, Genesis is in effect describing the creation of the world from nothingness.

To clinch matters, we notice that while Enuma Elish tells us that Marduk made the world out of the dead body of Tiamat, Genesis says nothing at all about the stuff from which God made the heavens and the earth. And its silence is surely significant. If no stuff is mentioned, isn't it because there *was no* such stuff, because the world was in fact created out of nothing?

**What Genesis really Teaches**

There may be something in all this but it isn't completely convincing. The trouble is that the resounding first verse of Genesis isn't about the creation of the primordial chaos at all : it can't be. The "heavens and the earth" could not possibly have meant the chaos for the ancient Israelite : it was always the structured universe he knew. And so when Genesis tells us : "In the beginning God created the heavens and the earth," it is not saying that God made the primordial chaos. What then is it saying? That will depend on how we understand the grammatical structure of this first verse of the creation story — and about this commentators unfortunately do not agree.

Those who hold that Genesis does in fact teach true creation naturally take Gen. 1, 1 to be *straight narration*, the first affirmation of the creation story. Gen. 1, 1 would then be all about the creation of the primordial chaos. But this is a minority opinion. The tendency today is to read Gen. 1, 1 as a *subordinate clause* whose meaning would be something like : "At the beginning of God's creating the heavens and the earth, the earth was waste and void...;"

or, as the Anchor Bible (a joint venture of Catholic, Protestant and Jewish scholars) puts it : "When God set out to create heaven and earth, the earth being then a formless waste,... God said 'Let there be light'."

This is one way of reading the first verse of Genesis. Another is to take it as a *title* which announces the theme of the story that follows, but is not really a part of it. The story itself would then begin at v. 2 with its description of the primordial chaos; and the beginning of the creation story could (with a little licence) be rendered as : "We are going to speak about how God in the beginning made the heavens and the earth. At that time the earth was waste and void.."

If read like this, with its first verse taken as a title or a subordinate clause (and that is how most commentators are reading it today) the Genesis story obviously tells us nothing at all about the creation of the primordial chaos. It takes the chaos for granted. The chaos is already there when creation starts, and what God does is to put it into order. Creation in Genesis is simply the forming and filling of a primordial waste.

Where this primordial waste comes from the author does not tell us, and it probably did not even occur to him to ask. He preferred concrete images to abstract ideas, and the dark formless "waste and void" was the nearest he could get to picturing nothingness; whereas the image of God forming and filling this empty waste was the best he had to express the world's total dependence on God. The highly abstract idea of creation out of nothingness would have meant nothing to him or to the hard-headed Semites for whom he wrote. Nor need God have specially revealed it to him. God's self revelation is, after all, progressive; and at these first stages it was enough that His people understood the total dependence of all things on the universal Lord of all, even if they did not yet grasp, in all its metaphysical subtlety, the exact modality of this dependence. That would come later.

**Genesis Implies "Creation"**

But though Genesis does not (we think), explicitly teach the creation of the world out of nothingness, it does, in a sense, imply it. To a mind more metaphysically inclined the Genesis story would inevitably pose the problem of ultimate origins; that is, of the origin of the chaos from which God structures the world. And the story, with its insistence on the absolute oneness of God, on His overwhelming power, on the utter docility of all things even the primordial chaos to His creative word, would suggest the inevitable answer : the chaos too can only have come from God. Devout Israelites reading the book of Genesis down the ages penetrated deeper and deeper into its meaning, until, by the time of the exile, they had come to understand the Genesis story as the story of a creation in the strictest sense of the word. So, in the book of the Machabees, the mother of the seven young martyrs butchered by Antiochus bids her sons : "Look upon heaven and earth and all that is in them and consider that God *made them out of nothing* and mankind also." (II Macc. 7, 28).

## 8.5 THE MEANING OF CREATION

**A Salvific Event**

It is important to remember that the Bible is interested in creation not because it is the beginning of the world and of time but because it is the beginning of salvation history. Creation in the Bible is not so much a cosmic as a salvific event. And the reason is that Israel had come to know God not by discovering Him in nature as the first cause and ultimate explanation of its unexplained mysteries, but by meeting Him in history as the saviour God who had delivered His people from captivity, and led them through the desert into the land flowing with milk and honey.

This shattering encounter with Yahweh through which they had become His chosen people was for the Israelites the dominant fact of their religious history, an experience they were never to forget. Yahweh would always be first and foremost the *Saviour* who had led them out of Egypt, the *Covenant-God* who had made them His people and the *Lord of history* who controlled the destiny of nations and would lead Israel to a final triumph over them all. It was only by reflecting on the marvels that Yahweh had wrought in bringing them out of Egypt that Israel began to realise the extent to which the Lord of history was also the *God of nature*. Yahweh, the saviour God who had mightily redeemed His people, now stood revealed as God the creator who had wonderfully fashioned the heavens and the earth out of nothing. "Thus says the Lord, your Redeemer, who formed you from the womb," cries out Isaias, "I am the Lord who made all things, who stretched out the heavens alone, who spread out the earth—who was with me?" (Is. 44, 24).

But even while He was stretching out the heavens and making firm the earth Yahweh remained in the eyes of Israel primarily the God who saves. Creation itself was part of His salvific plan. It was the *prelude to salvation*, the setting of the stage on which the drama of salvation would be enacted, the first of those great interventions of God through which He would build a people to whom He could give Himself in the total self-gift of a love freely given and freely returned between persons who are free. And because God is always the same this His first salvific act becomes the type of all the others. Each time God will intervene in history to achieve some new phase of His plan of salvation, we shall have a "creation", and there is a striking similarity in the biblical imagery describing these successive interventions of God. Creation is, in fact, a *biblical theme*, one of those constants of God's action which run all through the Bible (like the theme of a symphony) and give salvation history its profound and organic unity. And it is the subtle and sometimes elusive pattern of this developing theme that we shall try (at least in broad outline) to trace, by reflecting on salvation history from our vantage point in time.

**A Type of Salvation**

God creates the world as the *Prelude* to salvation history by pushing back the waters of the primeval ocean which cover it. "Thou didst set a bound which they [the waters] should not pass, so that they might not again cover the earth," is the triumphant cry of the great creation hymn, Psalm 103 (104); while the Book of Job describes Yahweh the creator as the one who "shuts in the sea with doors when it burst forth from the womb" (Job 38, 8). In both Job and the Psalms the stilling of the ocean is connected with the slaying of *Rahab*, a mythical monster who appears occasionally in the more purple patches of biblical poetry. "By His power He stilled the sea, by His understanding He smote Rahab," we read in Job (26,12), and in Psalm 88 (89): "Thou dost rule the raging of the sea, when its waves rise Thou stillest them. Thou didst crush Rahab like a carcass, Thou didst scatter Thy enemies with Thy mighty arm." The parallelism of Hebrew poetry would suggest that Rahab here stands for the unruly ocean, and given the creation context of both Job 26, 12 and Psalm 88 (89), 9-10 it seems likely (exegetes generally agree), that Rahab is in fact a personification of the primordial ocean chaos, a creation monster of the kind we find in nearly all the cosmogonies of the ancient Middle-

East. And that means that to express its idea of creation the Bible uses not only the concrete image of God pushing back the waters from the face of the earth, but the even more concrete and colourful image of Yahweh smiting a dragon.

When, much later, God delivers Israel and sets afoot the *First Act* of salvation history, the *time of Preparation,* He again pushes back the sea—this time the Red Sea, or more correctly, the REED Sea—to make a dry land for His people to pass over : "And the Lord drove the sea back by a strong east wind all night (compare this with the "ruah elohim" the "spirit of God" in Gen. 1, 3 which can be, and sometimes is translated as "a strong wind"), and made the sea dry land" (Ex. 14, 21). So once again creation is repeated and Isaias can remind Yahweh of this His mighty work of deliverance in images which evoke at once that other mighty work of His, creation :

> Awake, awake, put on strength
> O arm of the Lord!
> Awake as in the days of old
> The generations of long ago!
> Was it not Thou that didst cut Rahab in pieces,
> That didst pierce the dragon?
> Was it not Thou that didst dry up the sea
> The waters of the great deep?
> That didst make the depths of the sea a way
> For the redeemed to pass over ?
>
> (Is. 51, 9-10 .

"Rahab" the primordial monster has now become a symbol for the power of Egypt and "tehom" the deep now describes the Reed Sea. The ideas of creation and exodus interpenetrate in this magnificent verse whose subtle allusions sing the praises of God as at once Creator and Redeemer.

The New Testament sealed in the blood of Christ is the decisive event of salvation history, and with it we begin its *Second Act, the time of Redemption.* Once again there is "creation", and we are back among the images and allusions of Genesis and Exodus. To be redeemed, to enter effectively into this time of redemption, "neither circumcision counts for anything nor uncircumcision," says St. Paul, "but *a new creation*" (Gal. 6, 15); and "if anyone is in Christ he *is* a new creation" (2 Cor. 5, 17). So, the new creation means, to "be conformed to the image of His [God's] Son" (Rom. 8, 29); that is, to "put on Christ" (Gal. 3, 27) who is the Second Adam (Rom. 5, 14) and to "be changed into His likeness from one degree of glory to another" (2 Cor. 3, 18), until even in this corruptible body we will "bear the image of the man of heaven" (1 Cor. 15, 49). And all this, by being "baptized into Christ" (Gal. 3, 27) through the "washing of regeneration and renewal in the Holy Spirit" (Tit. 3, 5), just as the Israelites were "baptised into Moses" by passing through the waters of the Reed Sea (1 Cor. 10, 29).

St. John too has much the same creation symbolism. His Gospel begins "in the beginning", echoing the familiar first words of Genesis, and it packs the events which inaugurate the new order (so some exegetes believe) into one momentous week, ending with a marriage feast (Jo. 2, 1), a symbol of the New Covenant. It tells us also that to be saved a man must be born anew and from above of "water and the Spirit" (Jo. 3, 5), as the world, we might say, was "born" on that stirring first day of creation of the "spirit" brooding over the waters of the deep (Gen. 1, 2).

And that is not all. This is not the last of the "creations" of salvation history, because the time of salvation though truly begun has not yet ended. The world has been reconciled to God in Christ, the people of God truly exists on earth, and each of us has really entered into God's loving kindness; but we have not, individually or collectively, reached our goal. We are still on the way—like the Israelites in the desert, who had been saved from Egypt but had yet to reach the promised land. And so we too, though we are no longer in the time of preparation, of types and shadows, have not yet reached the time of consummation, of perfect possession. We are in between: in the time of grace but not of glory, in the time of faith but not of vision, in the time of hope but not of possession. We are saved but not yet fully saved. We have Christ but we have still to grow (each of us and the world as a whole) into the fullness of Christ. And when God by a final intervention into history will bring history to an end by bringing it to this fullness, then that too will be a "creation". There will be, St. Peter tells us, echoing the Apocalypse, "new heavens and a new earth" (2 Pet. 3, 13); and there not man only but "the creation itself will be set free from its bondage to decay and obtain the glorious liberty of the children of God." (Rom. 8, 21) Once again God will push back the sea (the perpetual symbol of the demonic forces of destruction), this time forever : "And the sea was no more" (Apoc. 21, 1). Instead: "Behold the dwelling of God is with men. He will dwell with them and they shall be His people, and God Himself will be with them; He will wipe away every tear from their eyes and death shall be no more, neither shall there be mourning nor crying nor pain any more, for the former things have passed away." (Apoc. 21, 3-4). Because creation in the Bible is a salvific event the whole of salvation history becomes a recurring creation.

## 8.6 CONCLUSION—GENESIS AND COSMIC ORIGINS

**Genesis Teaches**

And so, for all its primitive setting and sometimes naïve imagery, the Genesis story of creation has many profound lessons even for twentieth-century man, whose telescopes peer two billion light-years into space and whose giant reactors hum with the crackling power that pulses in the heart of the atom. It teaches him :

—*that the world and everything in it has come from God* and depends on Him completely, since it has been "created" by Him.

—*that God is therefore the ONLY God.* There are no quasi-divine or demonic forces that exist independently of Him. A man's fate is not determined by the stars; nor need he fear the spirits of the dead nor attach much importance to the number "13" or to broken pieces of glass. Everything that is not God has been made by God. Our lives rest secure in His all-controlling hands.

—*that the world which God has made is throughout good.* Six times during the creation story God is said to look at what He has made and to find it good. And a seventh time at the end of it all — "and God saw everything that He had made, and behold, it was very good"(Gen. 1, 31). Of course, the author of Genesis was quite aware that there is evil in the world, and He will add the J story of the fall to the story of creation, precisely to explain the origin of this evil. But the point he insistently makes (against the accepted ideas of his time) is that evil is not an original quality of the world. It is not something ingrained in the very nature of material things. Matter is not a malignant force to be feared nor a taint to be avoided : ultimately, because it comes from God, it is good. It is not matter which is evil, it is man. Because all evil, as the story of the fall will show, comes from sin; and sin is not a contamination but disobedience. Perhaps alone of all the great religions of antiquity the Bible has been able to exorcise evil from the world and put it where it really belongs—in the heart of man.

**Genesis Does not Teach**

But Genesis has nothing at all to say about HOW or WHEN the world was made or HOW LONG it took to make it. It is not (we insist) a text-book of science, of even the most elementary kind, and so it is a sheer waste of time to start comparing the order of the successive creations described in it with whatever evolutionary sequence science claims to have discovered, in the hope of finding similarities. Resemblances, if any, will be coincidental because the order of Genesis is not determined by the real order in which things appeared but by the demands of a purely artificial scheme.

And it is quite as useless to think of interpreting the six days of creation as six more or less extended epochs in order to bring Genesis in line with science which requires vast stretches of time for the evolution of the world. "Yom" the Hebrew word meaning "day", can sometimes (in the plural) stand for an extended period of time—but not here in Genesis 1, where it is used in the singular and is further specified by the uncompromising formula : "and there was evening and there was morning, one day" (Gen. 1, 5). No, "yom" means a day of twenty-four hours. The Genesis story of creation is enacted (for excellent liturgical, pedagogical and polemical reasons, we have seen), in six ordinary days. But this is a detail of its symbolic garb. It certainly is not intended to teach that the world was in fact created by God in one short week. The lessons of Genesis lie elsewhere. "O Lord, how manifold are thy works!", sings Psalm 103 (104), "in wisdom hast Thou made them all; the earth is full of Thy creatures." This is as good a commentary as any on the stirring first chapter of Genesis.

# Suggestions for Further Reading

Charles E. P. Hauret, O. P., *Beginnings : Genesis and Modern Science*— Dubuque : Priory Press, 1955.

Till Renkens entered the lists this year this was unquestionably the best popular book we knew on the first three chapters of Genesis. In many ways it still is. It is the most readable, up–to–date account of what Genesis teaches about origins : popular without being jejune, accurate and in touch with the best modern scholarship without the least trace of any theological jargon. All in all a near perfect initiation into the teachings of Genesis I–III.

Henricus Renkens, S. J., *Israel's Concept of the Beginning* —New York: Herder & Herder, 1964.

This covers much the same ground as Hauret but in more detail and in greater depth. Rather than a commentary it is a biblical theology of Genesis I–III. Bruce Vawter (who has himself written a successful commentary on Genesis ) calls it "the best treatment I know of by a Catholic author on the subject." It is. The author's easy familiarity with biblical thought-forms allows him to show up all sorts of new shades of meaning in passages which long familiarity had (we thought) long since drained dry. The text of Genesis I–III comes to life in this truly fascinating book of sudden and surprising revelations.

J. De Fraine, S. J., *The Bible and the Origin of Man* —New York : Desclée, 1962

The outstanding merit of this little book is its theological precision. It sets out to give what exactly the Bible and Catholic theology teach about the origin of man and does it with the professional theologian's passion for exactitude. Inevitably the book is a little dry.

# Chapter 9

# Genesis and The Origin Of Man

## 9.1 THE P STORY—GEN. 1, 26-31

Both the P story of creation and the J story of the fall describe the origin of man, and each does it in its own particular way. In the P story man is the last of the creatures made by God in the ascending series of His eight stupendous works of creation. He appears on the sixth day, the day on which God has already made "all kinds of wild beasts, every kind of cattle and every kind of creature crawling on the ground." But man is not just one more addition to the list : he is something quite different from everything that has gone before. And to make sure that we realize this the author now adds a new detail to his story—he shows us God deliberating: "Let us," muses God, "make man in our image and likeness" (Gen. 1, 26).

**God Deliberates**

So much has been written about this "let us" that it seems almost a pity to dismiss it as a mere *deliberative plural* — a grammatical trick the author uses to suggest that God deliberates with Himself *as if* He were two different persons. But it is, very likely, just that and no more.

It certainly isn't (as has been suggested) *a vestige of polytheism.* No one of course seriously imagines that the creation story itself is in any way polytheistic. Like the whole of the P tradition to which it belongs it is almost violently aggressive in its allegiance to the one true God. But it may have used old sources coloured with polytheism, and the "let us" would then be a vestige of these. This is possible but not likely. It is difficult to believe that the author, a careful craftsman if ever there was one, would have allowed so telltale a vestige to remain. He may have used polytheistic sources (though it is not at all certain that he did), but he would surely have adapted them better to his more advanced theology. No, the "let us" is not a vestige of polytheism.

Neither is it (as is sometimes piously believed) a *reference to the Trinity.* The mystery of the Trinity, say theologians, and St. Thomas among them, was not revealed until New Testament times. So it is unlikely that we should come across a casual allusion to it in the first chapter of Genesis. All in all, the deliberative plural seems to be the safest bet.

God decides to make man in His "image and likeness". It is tempting to read into this pleasing little phrase a whole Christian theology of man — that strangest of all God's creatures, in whom matter joins spirit and nature meets grace. Man, we would say, is the *image of God* by nature, because like God (but in an infinitely poorer way) he is a spirit : a centre of self-consciousness and self-possession and freedom; able to know and to love and to choose. He becomes the *likeness of God* by grace, because grace makes him truly a child of God. Grace gives him God's own life and the powers that go with it : the power to know and love, not just as men know and love, but in the infinitely more wonderful way in which God knows and loves Himself. This is how many Fathers of the Church understood "image and likeness" and thus thought that Genesis is here talking about the elevation of man to the supernatural life of grace. In fact, it is not.

In the original Hebrew, "image and likeness" simply means 'an image which is a likeness'; that is, 'a good image' —something which looks like, but is not exactly the same as, the object it images. So, all that Genesis says is that man is meant to be a "good image" of God. He is to be nearer to God than the rest of creation, and this nearness will appear in the erect stature of his body and most of all in his intellect and will, which make him like the wise and powerful God we met at the very beginning of the creation story. Being a good image of God in what he is, man is also to be a good image of God in what he does. He is to be God's representative and rule over creation in the name of the divine King : "Let them have dominion over the fish of the sea, and over the birds of the air, and over the cattle, and over all the earth, and over every crawling thing that crawls upon the earth."

**God Creates**

Deliberation is followed by action, and God now creates ("bara") man:

"And God (elohim) created man in His own image,
In the image of God ( elohim ) He created him,
Male and female He created them." (Gen. 1.27 ).

So sings the author in moving rhythmic phrases, carried away by the grandeur of his theme. In his book *Beginnings*, an excellent popular commentary on the first three chapters of Genesis, Charles Hauret suggests that we have here a description of man as a sort of comprehensive microcosm mirroring at once :

*—the divine world —* "And God created man in His own image"
*—the angelic world—* "in the image of the angels — this is a possible alternative translation for 'elohim' — He created him."
*—the animal world—*"male and female He created them."

This may strike us as a little fanciful. But what we certainly do have here is the emphatic assertion that man (and woman equally with man) has been created by God, and has been created as a peculiarly privileged creature who both transcends the animal world ("in the image of God He created him"), and is yet a part of it ("male and female He created them").

And that is all. There is no word here about HOW God created man on that stirring sixth day of creation, nor any hint about HOW MANY men He created. The Hebrew "*adam*" is really a collective noun (that is why God can say of 'man', "Let *them* have dominion over the fish of the sea. . . "), and is perhaps better translated as 'mankind' : "God made *mankind* in His image." Did He make one pair of human beings or several? Did He make man and woman together or at different times? Did He conjure them out of nothing or mould their bodies out of the dust of the earth? . . . . About all such questions the P story is discreetly silent.

## 9.2 THE J STORY (GEN. 2, 5-25)

No such inhibition appears to trouble the author of the colourful J story who gives us in two vividly dramatic scenes a detailed and circumstantial account of how God made the first man and the first woman.

**God Makes Man**

The curtain goes up on a bleak and empty stage. We are in a barren desert : "No plant of the field was yet in the earth and no herb of the field had yet sprung up, for the Lord God had not caused it to rain upon the earth and there was no man to till the ground." (Gen. 2, 5) So God proceeds to make man : "Then the Lord God formed ("yatsar") man out of dust from the ground and breathed into his nostrils the breath of life; and man became a living being." (Gen. 2, 7)

God *forms* man. The word used is no longer the "bara" (= to create) of the P story but the more concrete "yatsar" (= to make, to shape, to form), a word used technically to describe the action of the potter moulding his clay. So Yahweh appears as a potter deftly modelling a lump of damp earth ("dust from the ground", watered by the "mist" which "went up from the land") into a life-like statuette, and then bringing it to life by breathing into it His own breath.

**God Makes Woman**

But man so made is alone. God brings him "every beast of the field and every bird of the air" which He has also made "out of the ground". Man names the animals, showing that he has authority over them; but in all that varied host he fails to find a "helper fit for him". The Potter then becomes the Surgeon. Yahweh puts man to sleep, pulls out one of his ribs replacing it with flesh, and shapes the rib into a woman: "So the Lord God caused a deep sleep to fall upon the man, and while he slept took one of his ribs and closed up its place with flesh; and the rib which the Lord God had taken from the man He made into a woman and brought her to the man." (Gen. 2, 21-22) Delighted with his companion, man breaks out into a cry of wondering joy and imposes on her too a name:

> "This at last is bone of my bones and flesh of my flesh; she shall be called Woman because she was taken out of man." (Gen. 2, 23)

## 9.3 THE INTERPRETATION OF THE STORY

How are we to understand this colourful, attractive and obviously primitive little tale? It used to be understood quite literally. Not that anyone took the potter-image or the surgeon-image seriously. These were evident anthropomorphisms—human ways of speaking about the ineffable action of God. But people did believe quite literally in the "dust from the ground" and in the "rib of Adam". That is, they believed that the Bible taught that the body of the first man had been made directly from dust (or at least from some inorganic substance), and the body of the first woman from the rib of the first man (or at least from some material taken from his body).

Such a literal interpretation was never questioned from the earliest times to nearly our own, simply because there was never any good reason to question it. "In the interpretation of Holy Scripture," says St. Augustine, "it is not lawful to depart from the obvious literal sense unless some good reason compels us to reject it." This is a safe rule. And so as long as science knew nothing about the origin of man, it seemed reasonable to stick to the Bible story, in what appeared to be its obvious meaning. But then came Darwin and the fun began.

**The Biblical Commission**

In 1909 at the height of all this "monkey-business", and at a time when Modernism was dangerously watering down Catholic teaching on revelation and the inspiration of the Bible, the Biblical Commission gave some directives on the interpretation of the first three chapters of Genesis. The Biblical Commission had been founded by Leo XIII some seven years earlier (on the 30th October 1902) to protect the integrity of the Catholic faith in biblical matters and to revitalize Catholic biblical scholarship which was then in rather a bad way. It was meant to be a supreme directive and consultative body for biblical studies — a sort of biblical Holy Office in fact. And so its decisions (like those of the other Roman Congregations), while certainly not infallible, are authoritative for the Catholic.

Of course the authority of the Biblical Commission (like that of the Church itself) extends directly only to questions of faith and morals, and more specifically, to questions of faith and morals about the Bible. Ultimately, its directives are all exegetical. They are "in the last resort always concerned," says H. Renkens, S. J., in his recent and remarkable work on Genesis I-III (*Israel's Concept of the Beginning*), "with the meaning of the biblical text itself." Often too, these directives are disciplinary rather than doctrinal, and will exclude this or that opinion, not necessarily as false, but as one which cannot at least for the moment be safely taught—perhaps because it is based on evidence which is as yet insufficient or because its doctrinal implications are not as yet clear. Such prohibitions are not definitive; neither do they rule out further investigation of the disputed point. All they wish to prevent is the irresponsible dissemination of inadequately founded and insufficiently examined ideas.

Because they deal with a living science which has grown prodigiously in the last fifty years, the Commission's decrees of long ago must be interpreted flexibly if they are not to stifle progress in biblical exegesis altogether. And that in fact is just what the Commission invites us to do. In a much publicized review of the new edition of the *Enchiridion Biblicum* (a collection of Church documents on the Bible), which appeared in 1955, A. Miller, O. S. B., the Secretary of the Biblical Commission, explained that these decrees must be read in their historical context. Issued at a time when "the tide of liberal and rationalist criticism threatened to sweep away the wall of all the traditions hitherto held as sacred," they are evidences of the Church's great and continuing care to preserve intact "the truth and purity of the word of God." But they are not meant to be an obstacle to biblical study and "in so far as they proscribe opinions which are not connected, directly or indirectly, with the truths of faith and morals, the exegete is naturally completely free to pursue his investigations and to prove his point, always of course in submission to the teaching authority of the Church."

This is specially true of the directives of 1909 on the historical character of the first chapters of Genesis. The Biblical Commission admitted as much in its letter of 1948 to Cardinal Suhard, the then Archbishop of Paris. The letter explained that these directives were to be understood in the light of the liberal recommendations of *Divino Afflante Spiritu,* the great biblical encyclical of Pius XII, written five years earlier in 1943. In that document Piuus XII had strongly encouraged a truly scientific study of the Bible by all those latest methods of biblical research, which pay such great attention to the language, mentality and literary forms of its ancient narratives. Looked at in this way these directives were, the Commission felt, "in no way opposed to a further truly scientific examination of the problems in the light of the results acquired in the last forty years."

**The Special Creation of Man**

Actually, even in 1909 the Biblical Commission did not expect everything in Genesis to be interpreted literally. But it did insist on a literal interpretation of all those parts which spoke of things connected with the "foundations of the Christian religion." And among these the Commission mentioned :

— the creation of all things by God
— the special creation of man
— the formation of the first woman from the first man
— the unity of the human race.

Even as it stands this decree is not as restrictive as it appears at first sight. Since it speaks of the "*special creation of man*", rather than of the "*immediate formation of the human body*", it does not, theologians like to point out, impose any very literal interpretation of the Genesis story. The "special creation" it talks about need mean no more than that God created the SOUL of Adam and infused it into a BODY in the making of which He played some special part. And this special part may have been quite an indirect one. We are not bound to suppose that God created the body of the first man out of nothing, nor that He moulded it out of dust, nor even ( as Catholic evolutionists once felt obliged to believe), that He directly modified the body of an evolving near-human organism to make it fit for a human soul. He could have made it indirectly by guiding a natural process of evolution to its predetermined term through the normal operation of His laws of nature.

In a word, God could have "specially created" man simply by *creating his soul* directly out of nothing and *forming his body* indirectly through a natural process of evolution. So the Biblical Commission, even in 1909, did not rule out the possible origin of the human body through evolution. Evidently we need not take the "dust from the ground" too seriously.

**The Formation of Woman**

And we need not take the "rib of Adam" too seriously either. True, the decree of 1909 described the formation of the first woman from the first man as a point connected with the foundations of the Christian religion, and this was for a long time something of a stumbling block to Catholic exegetes. It was, says Renkens, " unanimously (and gratuitously) concluded without further investigation or reflection, that the rib must ' therefore ' be held to be a part of the symbolic clothing of the narrative, but that the physical origination of the woman from the man is taught by Scripture as a fact." Actually the exegetes were taking the decree far more literally than it warranted. What the Biblical Commission intended here was to lay down a valid *exegetical principle :* the text of Genesis is to be interpreted literally whenever it speaks about things connected with the doctrinal foundations of the faith. It certainly did not intend to give an exhaustive or definitive list of the dogmatic truths which do in fact belong to these foundations. The propositions it does give are provisional : a list of points which may possibly belong to the substance of the faith, and did in fact appear to belong to it at that time. And that is why the relevant passages of Genesis had, pending further investigation, to be interpreted literally. But further investigation was certainly not forbidden. That much at least the letter of 1948 makes quite clear.

Such further investigation, the " truly scientific examination of these problems " recommended by the letter of 1948, has led many Catholic exegetes to conclude that Genesis does not teach the physical origin of the first woman from the first man. And it is quite commonly held today that the " rib of Adam " need not be interpreted any more literally than the " dust from the ground ".

## 9.4 THE MEANING OF THE J STORY

If most exegetes today have given up the literal interpretation of the Genesis story of the origin of man, it is not because of what the Biblical Commission has said (the Commission after all merely permits an allegorical interpretation; it does not impose or even encourage it), nor because they are in a frightful hurry to reconcile the Bible with the very latest findings of science. True, new theories in science may have sparked the new trends in the interpretation of Genesis, but science was never anything more than a catalyst : it was never really a determining cause. Science posed the *problem* which drove the exegetes back to the Bible for a fresh look, but the *answer* had to come from the Bible itself. The first loyalty of an exegete is to his text, and the current less–than–literal interpretation of the first chapters of Genesis would never have been proposed if the text of Genesis itself did not require it. But there are many indications that, in fact, it does.

For one thing the fact that Genesis makes no attempt to harmonize J's account of the origin of man with P's, even though the two differ considerably in the details of their setting and imagery, suggests that it does not take these details too seriously. Then, too P, which is more recent than J, and so has a more developed theology, presumably gives us the doctrinal content underlying the colourful anthropomorphisms of J. And so it is likely that all those fascinating little details about how man was made, which find no echo in P, belong to literary embellishments of the J story rather than to its doctrinal substance. A closer look at the J story itself confirms this.

**Dust from the Ground**

Much in the story is obviously symbolic. We surely are not expected to believe that God really moulded clay or breathed in the breath of life. We know that God has no hands to mould with nor has He lungs to breathe. But if the action of moulding is symbolic, why not the dust? Surely both are of a piece. Both together form one picture : they are parts of a single symbolic story suggested to the author by the popular science of his time. From the universally known fact that dead bodies crumble into dust and that all living things need to breathe he had jumped to the obvious conclusion : man = dust + breath. Such a view was also suggested, perhaps, by the popular (and erroneous) etymology which derived the word " adam " (= man) from " adamah " ( =earth). In any case the image of a potter–god (or goddess) making man from clay is common enough in the creation stories of the ancient Middle–East and elsewhere. The Egyptians had their potter–god *Khnum*, the Sumerians their *Ea*, the Babylonians *Marduk*, the Akkadians a goddess *Mami*, and even the distant Maoris of New Zealand a god *Tiki*, all of whom in one way or another are said to have made men by moulding them from clay.

So in this story of God making man of " dust from the ground " Genesis is using a universally popular, almost archetypal image, to drive home an important lesson. What is this lesson? Obviously the frailty and impermanence of man and *his utter dependence on God;* man depends on God for his origin and existence as completely as the pot depends on the potter.

And the image he uses is a good one. Any one who has seen an oriental potter at work, says G. Lambert, S. J., in an article in the *Nouvelle Revue Théologique* of March 1951, will realise how suitable this potter–image is to suggest " the sovereign liberty of God, His marvellous power, His absolute dominion over the work that has issued from His hands, and also man's total dependence on his Creator, and God's goodness and mercy towards the frailty of His creature."

**The Breath of Life**

This lesson is reinforced by a second image : God breathing into man the breath of life. To us this at once suggests the infusion of a spiritual and immortal soul. But this is not the meaning of the " breath of life ". Animals too are said to have the

" breath of life " (Gen. 7, 22), which they receive from God (Ps. 103/104/,30); and so " vital principle" would probably come closer to the meaning of the " neshamah hayyah " (= breath of life) than "spiritual soul". In any case, the ideas of Genesis about body and soul are not quite those we have today. Genesis thinks of man not so much as an embodied spirit made up of a material body and a spiritual soul distinct (though interdependent) and even separable, but as *living dust*, which is at once " nephesh " (= soul) in its vital activity and " basar " (= flesh) in its concrete reality. In its still pre-philosophical anthropology, body and soul are two aspects of one individual living thing rather than two distinct co–principles of a composite being.

But what Genesis does teach is that man depends on God not only for his body but equally for his life. " No less than the image of the potter, " says Father Soubigou, " this conception of the breath of life given, maintained and withdrawn by God....strongly emphasises the state of total dependence in which man finds himself with regard to his Creator." Thus, with its powerful imagery of God moulding man of " dust from the ground " and breathing into him the " breath of life", the story is telling us what P had, with more restraint, said in a single resonant phrase : " God created man."

It is also telling us that man is a creature of a very special sort. That is why he receives the breath of life in so immediate and personal a way, and that is why his creation is described with such a wealth of detail when the creation of the animals is dismissed with the bald assertion: "The Lord God formed out of the ground every beast of the field and every bird of the air. " (Gen. 2,19) Besides, the animals are obviously made for man. God brings them to Adam who gives them their names. A name meant a lot in the ancient world : it stood for the inner reality of a thing; and to know its name meant not only to know something intimately but to have a hold on it. So by naming the animals man shows that he has authority over them. And if the whole animal world cannot provide man with a suitable companion—" but for the man there was not found a helper fit for him " (Gen. 2, 20),—it is because man is a being of an altogether different kind. In a world teeming with gods in the shape of beasts ( like *Dagon* the fish-god of the Phoenicians, and *Hathor* the divine cow of Egypt) the Jahwist story vehemently asserts that no animal whatever is the equal of man, much less his superior. No less than the P story, J proudly announces of man : " In the image of God He created him."

**The Rib of Adam**

With P it also announces " male and female He created them." But it does this, naturally, in its own colourful and concrete way, spinning out an elaborate story about the making of woman which moves solemnly forward in four articulate steps :

1. There is *Yahweh's deliberation* (Gen. 2,18) : " It is not good," says Yahweh, " that the man should be alone; I will make him a helper fit for him." And this draws attention to the importance of the work God is about to undertake.

2. There is the *animal parade* (Gen. 2,19–21) : the animals, also made by God from the earth, are brought to man but are unable to provide him with a suitable companion.

3. There is the *making of woman* (Gen. 2, 21–22) : Yahweh puts man into a deep sleep (not so much to anesthetize him as to keep inviolate the mystery of the divine action which is to be the origin of the profoundly mysterious enigma of sex), and then, playing the surgeon, pulls out one of his ribs and builds it up into a woman.

4. There is the *conjugal hymn* (Gen. 2,23–24) : in which man sings his delight at finding her who is " flesh of my flesh ", and sums up in one tremendous phrase " the answer which the man of every age gives to the miracle of woman." (Renkens.)

The whole of this carefully constructed story is obviously of a piece with the J account of the making of man. There are the same familiar anthropomorphisms—Yahweh deliberating, Yahweh taking the animals to man, Yahweh removing and shaping the rib....And there is also a quite unexpected parallelism of structure :

| **The Making of Man** | **The Making of Woman** |
|---|---|
| The *earth* is barren without man : | *Man* is alone without woman : |
| So man is made from the *earth*, | So woman is made from *man*, |
| by Yahweh playing the Potter. | by Yahweh playing the Surgeon. |
| "Adam" (= man) is from "adamah" (= earth). | " Ishshah" ( = woman) is from "ish" ( = man). |

If we do not hesitate to interpret the " *dust from the ground* " symbolically there seems to be no reason why we should not take the "*rib of Adam*" symbolically also, the more so as " tsela'", the Hebrew word we translate as " rib ", is an obscure word whose real meaning is not certain.

In fact, recent exegetes see in the rib story a symbolic statement, not of HOW woman came to be, but of WHAT woman really is. The story, they say, sets out to explore the origin and meaning (physical, moral and social) of the mystery of sex—a mystery which awed the ancients quite as much as it fascinates us today. Consequently it attempts to interpret the mysterious attraction of married love which is so much stronger than any other human love we know, and also to explain how man and woman are related to each other, not as master and slave but as equal companions before God. How did the sexes originate?

Why are they attracted to each other? How is woman related to man? What does marriage mean? These are some of the questions which Genesis tries to answer.

And it answers them in good Hebrew fashion by telling a story. Perhaps the story was inspired by the popular etymology which derived the word " ishshah " (=woman) from " ish " (=man), or by the proverbial Hebrew expression which described close ties of kinship as : " You are my flesh and bone." Perhaps it was remotely influenced by the many ancient myths which tell of the origin of the first woman from half of the first man. In any case it was not the story that was important but its *meaning*.

Genesis asserts that it is God who stands at the origin of the sexes. Woman, no less than man, has been made by God. She is of the same nature as man (taken from his "rib" she is "flesh of his flesh"), subordinate to him in the social institution of the family (it is for man she is made, it is man who gives her a name), but certainly not inferior. Rather she is man's complement filling an emptiness which no other creature can fill, so that without her man is truly "alone". That is why man is drawn to woman ("for this reason a man leaves his father and mother and clings to his wife"), and he is to be united to her in the indissoluble bonds of a union so intimate, that the two become "one flesh", that is, one being. This is what the Genesis story teaches. In an age of fertility cults which divinised sex while degrading woman, it was a timely lesson.

## 9.5 CONCLUSION—GENESIS AND HUMAN ORIGINS

**Genesis Teaches**

About the origin of man, then, Genesis has something to say that is worth listening to. It tells us :

—that man has been created by God. It is unlikely that the biblical author made our clear-cut distinction between a spiritual soul created out of nothing, and a material body made, perhaps indirectly, from dead matter or from a living organism through evolution. But what he did know was that man, and the whole of man, comes ultimately from God and depends utterly on Him. Man is God's creature and his destiny rests wholly in God's hands. "O house of Israel, can I not do with you as this potter has done," says the Lord in the Book of Jeremias, "Behold like clay in the potter's hand so are you in My hand, O house of Israel." (Jer.18, 6) And what God says of the historical destiny of His people He could say of the individual destiny of each man : "In His hand is the life of every living thing and the breath of all mankind." (Job 12,10)

—that man has been created in the image of God. Man is a peculiarly privileged creature, unique in this world of ours in that he is a thinking animal with an intellect and a will. Through them man images God's wisdom and power and rules over the world as God's representative. God has given him dominion over the beasts and the birds and has entrusted him with the task of "subduing" the earth. "What is man," asks Psalm 8, "that Thou art mindful of him?" and then goes on in a great shout of grateful joy :

Yet Thou hast made him little less than God,
    and dost crown him with glory and honour.
Thou hast given him dominion over the works of Thy hands;
    Thou hast put all things under his feet,
all sheep and oxen,
    and also the beasts of the field,
the birds of the air, and the fish of the sea,
    whatever passes along the paths of the sea.
O Lord, our Lord,
    how majestic is Thy name in all the earth ! (Ps. 8, 5-9).

But what Genesis teaches about man as the image of God is only a preparation for, and a foreshadowing of, the great revelation of man's assimilation to God through a sharing in His own divine life. The Genesis theme of the image of God points, in fact, to the New Testament theme of man as the *son of God*. Because, as St. Paul shows us, the "new man" recreated in Christ is "conformed to the image of His [God's] Son" (Rom. 8, 29), who is Himself "the image of the invisible God" (Col. 1,15), one who "reflects the glory of God and bears the very stamp of His nature" (Heb. 1,3).

—that man has been created male and female. God stands at the origin of sex as He does of the world and of man. So woman too has been made in the image of God. She is man's equal, the same kind of being that he is, his companion not his slave. She is in fact man's complement, through whom he must find himself, and to whom he is to be joined in the intimate and indissoluble union of marriage in order to "fill the earth and subdue it".

And once again it is only in the New Testament that the full meaning of this union will be revealed. There we shall see it transfigured into the image of the ineffable union of Christ and His Church. "For this reason a man shall leave his father and mother and be joined to his wife and the two shall become one," quotes St. Paul and then comments : "This is a great mystery and I take it to mean Christ and the Church." (Eph. 5,31–32)

It is only in the light of the New Testament that the lessons of Genesis can be fully understood. And this is as it should be. We have spoken of creation as a salvific event, as the prelude to salvation history. Concretely, in the present order of things, this means that creation is the prelude to the Incarnation. God's salvific plan is " the purpose which He set forth in Christ as a plan for the fulness of time to unite all things in Him, things in heaven and things on earth" (Eph. 1,10). So it is only in Christ that things find their true meaning : they reveal their unsuspected depths and disclose new perspectives opening on to eternity. Man created in the image of God becomes God's son conformed to the image of Christ. Marriage, the union of man and woman, turns out to be the symbol of the union of Christ and His Church. Bread, the food of the body, becomes the sacramental sign of the food of the soul. Water, the source of natural life, is made the vehicle for the life from above. So all creation is fulfilled in Christ. It is, in Teilhard de Chardin's fine phrase " filled with the virtue of Christ." And it can no more be truly understood without Christ than a symmetrical pattern can be understood without the point round which it is centred.

**Genesis Does not Teach**

But Genesis has no lessons for us about HOW and WHEN the human race came into being. It leaves open the whole tangled question of the origin of the human body. The "dust from the ground" and the "rib of Adam" are not scientific or even popular descriptions of the way in which the first man and woman were made, but are symbolic affirmations of *religious truths* about the relation of man to God and of man and woman to each other. So Genesis is neither in favour of evolution nor against it : all such questions are completely beyond its horizon. "The Spirit," as St. Augustine warns us, "had no intention of teaching things useless for salvation."

Neither does Genesis tell us HOW MANY men were created as the progenitors of the human race. Did mankind originate from a single pair (monogenism) or from several human couples (polygenism)? Genesis gives us no answer. The P story we have seen speaks of the origin of "mankind" and not of "a man" and so it remains ambiguous. J obviously is describing the creation of one man and one woman. But there is nothing to show that this is anything more than one of the many symbolic elements of the story, just a detail of the elaborate symbolic frame, with no particular doctrinal significance. Genesis is as discretely silent about polygenism as it is about evolution.

## 9.6 THEOLOGICAL DEVELOPMENTS

Christian theology has always taught that the human race has descended from a single human couple and it is to this that the Biblical Commission refers when it puts the "unity of the human race" among the biblical truths which it feels are connected with the "foundations of the Christian religion." But the Church bases her teaching not so much on the narratives of Genesis as on her dogma of *Original Sin.* All men inherit the sin of Adam, which, says the Council of Trent, "is one in origin, is communicated to all men by propagation and not by imitation, and is in all men and proper to each." Even without entering into the fearful complexities of this highly technical question, it is easy to see that a sin which is "one in origin," and which is "communicated to all men by propagation and not by imitation," can scarcely be "in all men and proper to each," unless all men have in fact descended from Adam as the sole progenitor of the human race. So monogenism seems to be an immediate consequence of the Catholic teaching on original sin.

**Humani Generis**

This is what Pius XII teaches in his encyclical letter of 1950, *Humani Generis.* And we shall round off our study of Genesis and human origins with the appropriate quotation from this remarkable document, because it gives us an admirable summary of what the Catholic must think about the origin of man, after he has heard the competing (or rather complementary) voices of science and the Bible on the subject.

> Thus, the teaching of the Church leaves the doctrine of evolution *an open question*, as long as it confines its speculations to the development, from other living matter already in existence, of the human body. (That souls are immediately created by God is a view that the Catholic Faith imposes on us.) In the present state of scientific and theological opinion, this question may be legitimately canvassed by research, and discussion between experts on both sides. At the same time, the reasons for and against either view must be weighed and adjudged with all seriousness, fairness and restraint; and there must be readiness on all sides to accept the arbitration of the Church, as being entrusted by Christ with the task of interpreting the Scriptures aright, and the duty of safeguarding the doctrines of the faith. There are some who take a rash advantage of this liberty of debate, by treating the subject as if the whole matter were closed—as if the discoveries hitherto made, and the arguments based on them, were sufficiently certain to prove, beyond doubt the development of the human body from other living matter already in existence. They forget, too, that there are certain references to the subject in the sources of divine revelation, which call for the greatest caution and prudence in discussing it.
>
> There are other conjectures, about polygenism (as it is called), which leave the faithful *no such freedom of choice*. Christians cannot lend support to a theory which involves the existence, after Adam's time, of some earthly race of men, truly so called, who were not descended ultimately from him, or else suppose that Adam was the name given to some group of our primordial ancestors. It does not appear how such views can be reconciled with the doctrine of original sin, as this is guaranteed to us by Scripture and tradition, and proposed to us by the Church. Original sin is the result of a sin committed, in actual historical fact, by an individual man named Adam, and it is a



*

> quality native to all of us, only because it has been handed down by descent from him....(Italics ours)

The encyclical makes four important points :

1. *We may not admit evolution as an explanation for the origin of the human soul.* A theory of total evolution which derives the whole of man, body and soul, from an evolving animal and talks glibly of intelligence emerging from instinct must be rejected by the Catholic. Faith and reason alike teach him that a spiritual soul can come into existence only if created by God out of nothing.

2. *We may admit evolution as an explanation for the origin of the human body.* This the encyclical calls an open question. It is presumed that ours will be a theistic theory of evolution, one which supposes the existence of God, who guides the course of evolution to its appointed end through His providence (the normal operation of the "laws of nature"). But the encyclical does not (and this is significant) require any direct action of God on the evolving animal body. Nor does it speak of the formation of the first woman from the first man.

3. *We must advocate the theory of human evolution with prudence.* The encyclical gives us two reasons. The first is that it is an hypothesis (however well-founded) and not a proven fact. The other is that it has theological repercussions. Since man is not simply a natural being but belongs to the supernatural order of grace, questions about his origin cannot be purely scientific questions. Theology too must have its say. And as long as theology has not spoken clearly, caution is advisable.

These reasons are still valid. But the findings of the past fifteen years in both science and theology would probably have merited a somewhat more favourable attitude towards human evolution if the encyclical had been written today. Scientifically, the theory is much better founded today than it was when *Humani Generis* appeared. In any case, one must not make too much of its hypothetical character. As Bruce Vawter puts it in his *A Path through Genesis*, while we can "by no means assert that it has been proved beyond all doubt," we cannot "simply dismiss it as an 'unproved hypothesis', as though the evidence in its favour and the apparently unanimous consent of the scientific world counted for nothing." And theology too, while it has certainly not spoken its last word, is far more open to the theory of evolution than it was a decade ago. It is much clearer now that our theological sources do not really tell us anything about just how the human body originated, and that there is nothing particularly objectionable in a theory of evolution, provided of course it is kept in a properly theistic context.

4. *We may not hold polygenism.* The reason given is its opposition to Catholic teaching on original sin. But the encyclical affirms this opposition guardedly. It does not say plainly that polygenism definitely cannot be reconciled with the dogma of original sin, but says in a rather involved way (whose laboured awkwardness is more evident in the original Latin), that "it does not appear how such views can be reconciled with the doctrine of original sin." The inference is that should some one find a way of reconciling the two (a prospect at present admittedly dim), the whole question might be reconsidered. Hence the prohibition of polygenism does not seem to be absolutely irrevocable.

## Summary

* Genesis has two narratives about origins : the P story of creation which tells of the origin of the world and of everything in it; and the prelude to the J story of the fall which speaks about the origin of man. Each bears the distinctive traits of the tradition to which it belongs.

* The P story is a stylised 'hymn to creation' which describes the creation of the world from a primordial ocean-chaos in six dramatic

days. God speaks, and by the naked power of His word creates and peoples the different regions of the universe, as the ancient Hebrews imagined them to be. The story originally developed as part of a service of worship and was a way of teaching unsophisticated people living in a strongly polytheistic milieu the basic affirmations of Israel's strictly monotheistic faith. This it did naturally in the cosmological language of its time. But it did not intend to teach any cosmological lesson. All its cosmological details (the order of the successive creations and the six day scheme among them) are parts of the artificial framework in which the author puts his doctrinal affirmation—Israel's faith in one God who is the Lord of all that there is.

* The J prelude to the story of the fall is a colourful description of the origin of man from "dust" into which God has breathed the "breath of life", and of woman from the "rib" of the first man. Neither the "dust from the ground" nor the "rib of Adam" belongs to the doctrinal substance of the story, but are parts of the elaborate, anthropomorphic imagery through which the story conveys its profound religious lessons about the relation of man to God and of man and woman towards each other.

* So Genesis has nothing to tell us about the mechanisms of the origin of the world or of man. It is interested only in the ultimate question of how man and the world depend upon God and not in how and when they appeared. There can be no conflict between Genesis and any scientific theory of cosmic or human origins— provided that the theory does not transgress the limits of science and make affirmations about the part played (or not played) by the Creator.

* Even about polygenism, the one scientific theory at present theologically unacceptable, Genesis is silent. The theological opposition to polygenism comes from the teaching of Scripture, tradition and the Church on original sin which seems to require the origin of the whole human race from a single human couple. Yet even here the question has not been definitely closed.

# Suggestions for Futher Reading

( *Contd. from p. 267* )

Bruce Vawter, *A Path through Genesis* — London : Sheed and Ward, 1957.

An admirable and adequate layman's commentary on the whole book of Genesis. Naturally the chapters on origins deal with them more summarily than Hauret or Renkens. But soundly.

John L. Mckenzie, S. J., *The Two-Edged Sword* — Milwaukee : The Bruce Publ. Co., 1957.

A sort of theological running commentary on the Old Testament. Good but not always easy to understand. The chapters on 'Cosmic Origins' and 'Human Origins' are valuable for putting biblical doctrine in its historical setting. The confrontation of the teachings of Genesis on origins with the religious thinking of the Ancient Middle-East is remarkably good.

J. O'Neill, "The Bible and Evolution", in *Scripture*, Vol. II (1959), pp. 6—22, 42—51.

This is the best article we know on the subject. The part on evolution is a little meagre though the author does manage to give us an intelligent assessment of the theory (or theories) of evolution. The part on the Bible is magnificent. It gives a fine historical aperçu of the Church's directives on the interpretation of Genesis I--III during the past fifty years, and the light of this sets out an admirably clear and concise explanation of the Genesis narratives on the creation of man and woman, with abundant allusions to what contemporary exegetes have to say. Our own chapter on "Genesis and the Origin of Man" owes much to the clear exposition of this very competent article.

*Donald Dias*, S. J., "Genesis and Modern Science", in *Indian Ecclesiastical studies*, Vol. I (1962), pp. 205–220: 257–276.

Somewhat on the lines of O'Neill except that it limits itself to the theological aspect of the question. It is particularly good for its detailed examination of the Church's documents on the interpretation of Genesis.