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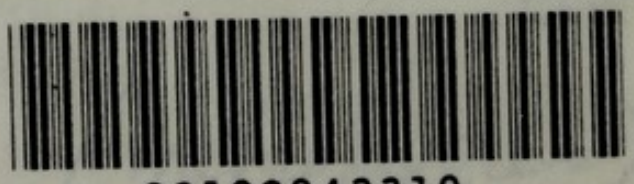

BIOLOGY AND THE NEW PHYSICS

A PLEA FOR A CONSISTENT PHILOSOPHY OF LIFE

BY

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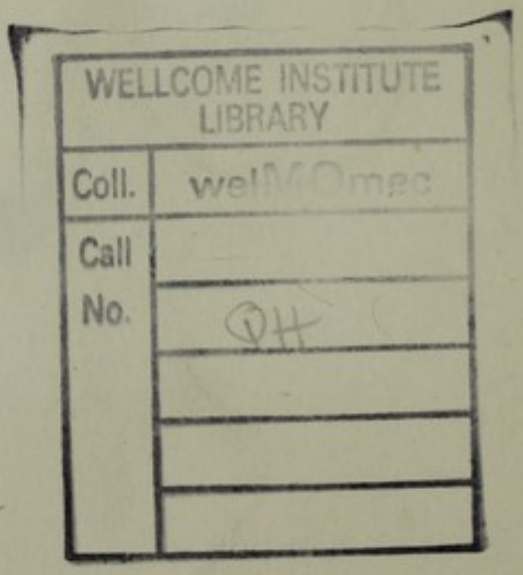

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PREFACE

THE following address formed part of the Presidential Lecture given at the Centenary Meeting of the Leicester Literary and Philosophical Society on 7th October, 1935.

In it I have tried to bring the newer scientific thought, and the traditional or common-sense view of the Universe into closer harmony.

From this common standpoint I have also tried to reach a consistent philosophy of Life, a philosophy which can satisfy the intelligence and also serve as a guide to conduct.

A somewhat extensive search has been made into the recorded opinions of eminent physicists, biologists and psychologists, on this fundamental problem of cosmic evolution, and in presenting this address to a wider public, I hope that, in spite of many shortcomings, it may be helpful to other enquirers in the same field.

INTRODUCTION

IN the following remarks I shall endeavour to describe, in simple language, some of the more recent changes in scientific thought concerning the material universe, and the influence which these new views are exerting on our ideas about Life and Mind.

I shall try to find an answer to the question, whether and if so, to what extent the "scientific" and the "common sense" views of the universe and Man's place in it can be brought into closer harmony.

I make no apology for inviting attention to this difficult subject, for it is well that we should take stock of the furniture of our minds from time to time, and find out how we stand in regard to these fundamental questions. History tells us that it is by the attitude of men's minds to such problems that the standard of intellectual achievement of any culture or civilisation can be judged. Further, civilised man is to-day being called upon to exercise increasing control over human evolution, and he must be equipped with scientific knowledge, and a sound Philosophy of Life if he is to carry out this great task successfully. Moreover, although such problems may seem to be remote from the affairs of daily life, they inevitably influence thought and conduct in every sphere.

Now it is in the atomic world, the realm of the inconceivably small, and in the astronomic sphere, the realm of the inconceivably vast, that the changes in scientific thought have been most marked in recent years. Moreover, this change in the scientific outlook has influenced our views about Life and Mind, and it is leading to a deeper analysis of the factors concerned in evolution.

A short description, from the lay point of view, of the more important changes in the Physical outlook is however first necessary, before we enter on the Biological and Psychological aspects of our subject.

CHAPTER I.

THE ATOMIC WORLD. THE INCONCEIVABLY SMALL.

The older conception of the atom as the indestructible and indivisible unit of matter, has given place to a more dynamic view.

Physicists to-day regard the atom as a complex system of electrical forces. As a miniature solar system in which the electrons, like planets, revolve round a proton sun, though it is true that Niels Bohr's (1) original conception of atomic structure has recently undergone considerable modification. But while knowledge about the behaviour of the atom has greatly increased in recent years, we are still very much in the dark as regards the nature of the electron, the proton, and the other unitary systems which represent the ultimate constituents of matter.

Here, as Sir J. Jeans (2) has said—"Science presents us with a double picture, a particle and a wave picture, each differing from, and independent of the other". But since both pictures only represent our mental concepts, our interpretation of events, neither can claim fully to represent Reality.

Von Planck's Quantum Theory.

The energy which radiates from an atom when it is bombarded or is undergoing change, is liberated, according to Von Planck's (3) Quantum Theory, in unitary packets or quanta; that is to say, the atom when giving out radiation, changes from a defined level of higher to one of lower energy, while between these defined levels, intermediate values (of energy) are not liberated. Energy like Matter is thus particulate.

In fact, matter is now regarded by physicists in terms of energy. Lord Rutherford (4) has recently said that, at any rate as regards massive particles—"Mass (matter) and Energy are

equivalent and mutually convertible". "Though in the case of lighter particles, such as electrons, either the theory does not hold, or some part of the energy is carried off in some, at present, unknown form".

On this subject Professor Dirac (5) has an important article on the question "Does conservation of energy hold in atomic processes?"

Indeterminacy.

Planck's (3) Quantum Theory and Heisenberg's (6) Uncertainty Principle have re-opened the old problem of Indeterminacy.*

The Quantum Theory has played the same revolutionary part in the realm of the inconceivably small, that Einstein's (7) Relativity Theory has played in the realm of the inconceivably vast.

Now indeterminacy in the atomic sphere, means that the movements of the electrons, or other ultimate constituents of matter, though predictable in the agggregate or statistical sense, are not predictable in the case of the individual electron.

Here, however, it must be said that some eminent physicists, including Von Planck and Einstein, still remain Determinists. They hold that if all preceding events were fully known, as by an infinite mind, then all succeeding events could be accurately predicted.

But the absence of scientific proof of the existence of Indeterminacy applies apparently with equal force to the existence of Determinism. Thus Professor Dingle (8) says—"The sum and substance of the matter is, that we have found that the data by which we thought we could forecast the future are unattainable".

Professor Jeffreys (9) also says—"The principle of causality has no scientific status.....the notion of a universal principle of causality is by nature incapable of verification.

* Prof. Schrödinger (6A) describes the orthodox view of Indeterminacy held by Physicists to-day, as follows :—"The momentary state of a physical system does not determine its movement, or development, or behaviour to follow".

Moreover, as Sir J. Jeans has pointed out, neither the particle picture nor the wave picture of the ultimate constituents of matter help us in solving the problem of the existence of Determinacy or Indeterminacy as factors in cosmic events. For while the apparent indeterminacy in the particle picture is meaningless (in the sense that, although any single particle does not appear to obey a determinate law, the motion of a large number of such particles can be predicted statistically), the apparent determinacy of the wave picture on the other hand, has nothing to do with the course of objective nature. It only represents a subjective process, or the way in which we interpret events in our own minds.

But there is a further point. The apparent uniformity of Nature arises from the observation that the motion of material particles, in the aggregate, appears to obey a statistical law. Does this mean that the unpredictable movements of those particles which do *not* conform to this law in the organic world, represent, or are the precursors of those more noticeable departures from uniformity which appear to be the basis of choice and volition in the world of Life and Mind? To this point, however, we shall return later.

I have given the opinions of certain distinguished physicists in regard to the existence of Determinism and Indeterminism. Other expressions of views might be added, thus:—

Dr. Dunne (11) considers that the evidence as to the existence of both principles is incomplete and unreliable, owing to the repeated transference from the object under observation, through a regressive series of instruments (of observation), up to the ego of the observer. Thus on page 19 of "The Serial Universe", he states—"The uncertainty pertains to the last instrument in the picture, but never to the world or object studied".

This means that the subjection to observation (or experiment) of any object causes changes in the object observed and thus vitiates the observation.

Professor Schrödinger (12) writing on this subject says—"There is scarcely any possibility of deciding this issue, by experiment"....."for the methods of pure reasoning

evidently allow us either to derive chance from law, or law from chance".

No doubt the assessment of the value of the evidence in favour of Determinism or Indeterminism in the atomic world must rest with the Physicist and the Mathematician, but even if scientific proof in both instances should be, from the nature of the case, unattainable, this need not prevent us from trying to bring the scientific view, and the common-sense view into closer harmony, in that strictly limited part of the universe with which, up to the present, man has established relationship. Now the common-sense view is that causality and freedom both have a place in cosmic events.

We human beings assume, and we act on the assumption that strict Determinism rules in the physical environment, in the ordinary happenings of daily life.

But we also act on the assumption that, in the affairs of the mind, as in so-called voluntary action, a considerable degree of choice of alternative modes of response is available.

But choice presupposes Indeterminacy. We believe that water will boil when raised to a certain temperature, but we also believe that we can, within limits, choose to act in a certain way, and experience, speaking in the name of common sense. apparently tells us that we are right in both assumptions.

But if we are right in thinking that the movements of the water atoms are mainly determined by environmental conditions, while the actions of an organism like Man are, within limits, less completely governed by such influences, then the difference becomes one of degree only. Determinism is present in both cases, but to a lesser extent in the case of human behaviour.

But such questions open up other important problems, such as the freedom of the will, and we shall consider these in a later chapter on "Life and Mind".

The Origin of Restricted Movement or Determinism.

Most physicists will, I think, agree that free, that is unrestricted movement, was a feature of the activity of the "world stuff" out of which matter has been evolved.

At a later stage of cosmic evolution condensation centres arose, and heterogeneity began to appear as the earlier free movement came under the influence of an unequally operating, or non-uniform environment.

Thus in a *Continuum,* Space, or "Void", in which the movement of the contained particles is random or chaotic, the distribution of the aggregates must necessarily be uneven in different areas. Moreover, energy will tend to flow from the more densely, to the less densely populated regions.

Although this irregular distribution would at first be reversible, *i.e.* the aggregation and dispersal (of the particles) would go on alternating in any limited area of space; yet in vastly larger areas, the second law of Thermo Dynamics, or Entropy, would bring about a more persistent unidirectional flow of energy which would stabilise the heterogeneous condition, and would prepare the way for those cosmic changes which constitute Evolution.

Heterogeneity and random movement (chaos) were thus initially, inseparably associated. They represent two aspects of one event.

Moreover, the establishment of Heterogeneity, which in turn restricts disorderly or random movement, not only coincides with the passage from chaos to order, it also registers the first tick of the unidirectional Time clock. Before this stage Time was non-existent or stood still.

It was then in some such way as this that Determinism appeared in certain parts of the original *Space Time Continuum*, while in other portions free movement persisted.

The Relation Between Indeterminacy in the Atomic Sphere, and Volition.

At a much later evolutionary period, and notably in association with the evolution of mental activity or thought, choice and volition became manifest.

At this point the question arises whether Indeterminacy, or free movement in the atomic sphere is, in any way, associated with choice and voluntary action as shown by sentient, reasoning beings like Man. While we are not justified in attri-

buting conscious choice to the movements of electrons or atoms, we may, I think, legitimately conclude that Indeterminacy, or free movement in the atomic sphere, has been the foundation on which conscious control has been built up during the course of cosmic evolution.

Professor Whitehead (13) would seem to have some such idea in mind when he says—"The energetic activity considered in Physics is the emotional intensity entertained in Life".

Professor Schrödinger (48A) has recently expressed the opinion that any attempt to trace a relationship between Indeterminacy in the Atomic Sphere and Indeterminacy as represented in Choice and Volition, will prove to be illusory. This objection will be considered in Chapter III. Life and Mind. Meanwhile I will add here that there is only one kind of Indeterminacy, namely the Indeterminacy which represents the power of removal, or circumvention, or avoidance, of those environmental restrictions to free movement which bring about Determinism.

Moreover, the view now put forward—namely that Determinism has arisen out of Indeterminism—does not involve the importation of any outside principle or agency into the scheme of creation beyond that originally present at the beginning of things.

In other words the vital and psychical characters which we attribute to living and thinking matter, represent the development and the manifestation of potentialities originally present in a more primitive form in the primeval cosmos.

Thus one main difference between the movements of an atom and the movements of a conscious organism like Man is this. While the former are random and indeterminate, the latter are, to some extent, definitely directed. They have some reference to the future, and are what McDougall (14) has called purposive.

As heterogeneity advances the movements of the atoms in the inorganic world are increasingly controlled by environmental influence, while, in the case of Man, the environment itself comes, within certain limits, under the control of the individual.

THE PRIMEVAL CONDITIONS.

The choice between Indeterminacy and Determinacy must depend, of course, on the nature of the primeval conditions under which the universe originated, or was created.

If cosmic evolution started on its course on a predetermined plan, then it is difficult to understand how Indeterminacy or voluntary movement could ever have arisen. If, on the other hand, Indeterminacy was the original condition, then the subsequent appearance of Determinism, in areas affected by environmental restrictions, can be more readily imagined.

However this may be, the fact that free atomic movement is to-day constantly being restricted and controlled by environmental conditions rests on a sound, incontrovertible basis of experiment and observation.

Further, if Determinism has succeeded, and partly superseded, Indeterminism in certain areas, and at certain stages of cosmic evolution, then the settlement of the dispute between the Determinist and the Indeterminist schools of thought must come about, as Von Planck (15) has said—"not by the rejection of causality, but in a greater enlargement of the formula (of causality) and in a refinement of it so as to meet modern discoveries".

It is with this object in view that I venture to suggest that primary Indeterminism and its derived Determinism coexist, and both play a part in cosmic events.

Moreover, even if the "common-sense" view of the nature of Determinism and Choice, which I have indicated, does not fully represent Reality, and even if reliable evidence on the matter may be unattainable at this stage, this need not mean the end of the enquiry, for as knowledge grows, Man's insight into this fundamental problem will grow likewise.

It is, however, necessary to remember that as Haslett (16) has said—"There will always remain something which neither Science nor Philosophy can analyse or explain, because there is no longer anything else in terms of which it is possible to explain it. When Science has reached this stage, it makes use of mathematical equations. But mathematical symbols, though

extremely valuable, can only tell us how things behave, and not what they really are".

Meanwhile, I repeat, that such evidence as we have, suggests that Determinism and Indeterminism, *i.e.* Causality and Freedom, both operate side by side in different areas of the cosmos, in different degrees, and at different stages of cosmic evolution.

Moreover, until evidence to the contrary becomes available, Man will continue to act on this assumption.

He will confidently expect that water will boil when raised to a certain temperature, and he will continue to believe that he can, though within narrow limits, exercise choice and control over his actions, and, as we shall see later, to a lesser degree over his thoughts and his wishes.

Indeterminacy and Determinacy in Space and Time.

Perhaps a word may be added here concerning the relationship between Indeterminacy and Determinacy in Space and Time.

If we assume that Indeterminacy represents a primary or antecedent condition, out of which Determinacy has arisen at a later stage of cosmic evolution, how, it may be asked, does the re-appearance of Indeterminacy in the shape of volition, fit in with the passage from homo to heterogeneity, or from random movement to organisation, or from activity to quiescence, which the Law of Entropy tells us, is the direction along which cosmic events are, on the whole, moving?

Freedom or choice, as we see it in operation in the human mind, is associated on the neural side with matter of very complex molecular constitution. This brain matter, with its associated psychical manifestations, represents the high water mark of terrestrial evolution. But in association with these psychical manifestations, and at the expense of falling cosmic energy, some of the environmental restrictions which cause Determinism can apparently be overcome. If this be true then the recovery of a degree of Indeterminacy necessary for the exercise of volition means the active circumvention or control

of restricting influences. It does not mean a mere passive retention of some part of the primeval Indeterminacy.

But a further point deserves notice.

If the properties of Matter depend on the environment as well as on the material aggregate, and both observation and experiment show that this is true, then the behaviour of Matter should be more predictable where the environment is stable, than where it is unstable.

Now it is well recognised that the environment is relatively much more stable in the inorganic than in the organic sphere. As a consequence of this difference in stability, the movements and behaviour of inorganic bodies are far more predictable than the behaviour of organic aggregates such as living cells, or organisms.

This dependence of behaviour on environmental influence, which differs so widely in the two spheres, explains why Indeterminacy and Determinacy operate apparently so unequally in the inorganic and the organic world. It also explains why the so-called Laws of Nature, which appear to us to be so inflexible in the material universe, are less rigid in the world of Life and Mind.

Schrödinger (17) in discussing the widespread belief that the behaviour of molecules is determined by absolute causality, attributes this belief to the custom, inherited through thousands of years of thinking "causally". He also expresses the opinion that such a duality (as between Determinism and Indeterminism) in the Laws of Nature is improbable.

But does not this mean that it would be better to discard the notion of the existence of two opposing principles, and regard cosmic evolution as a process of "becoming". (See John McMurray) (18).

This "becoming" is, moreover, a cyclical, a rhythmical process. At an early stage of cosmic evolution, environmental restrictions limit freedom of movement, and bring about Determinism. While at a later stage, certain living aggregates of high complexity of molecular constitution are able, to some degree, to control their response to the environment.

CHAPTER II.

THE ASTRONOMIC SPHERE.

THE INCONCEIVABLY VAST.

HERE, too, in the astronomic sphere, equally great changes have taken places in scientific thought.

To-day physicists regard the Material Universe as consisting of material aggregates, or centres of energy scattered, though not indiscriminately scattered, in a *Space Time Continuum* which, though finite, is yet unbounded, and different from the "nothingness" which surrounds it.

To the older conception of Space with its three dimensions, Einstein's (19) Relativity Theory has now added Time as a fourth dimension, thus making, in modern scientific thought, a *Space Time Continuum,* in which, with its contained matter, events take place.

It would, however, seem, from a recent statement by Sir J. Jeans (20) that, according to Einstein's latest conjecture, Space may, after all, be of literally infinite dimensions. This latter conception is not, however, in harmony with Professor Milne's (21) view which is that, from the point of view of Physics, Space must be regarded as finite in extent. Physicists liken this *Space Time Continuum* to the film which envelops an air bubble. The surface of such a soap bubble film, though finite, is yet unbounded in the sense that a traveller might conceivably pass over it continuously and yet return to the spot from which he started. The Universe, like such a film, might thus be circumnavigated as Man circumnavigates the Earth.

HUMAN CONCEPTIONS OF SPACE AND TIME.

It will be of interest here to ask, how the ideas of Space and Time have originated in the human mind, for, as Jeans

(22) and Haldane, J. B. S. (23) have pointed out, Space and Time are creations of our own minds.

Now the idea of Space may have arisen along with the perception of motion among external objects when these change their relative positions. The idea of movement on the part of any object like an atom or a star, necessitates the existence of some area, or space, in which such movement can take place. In like manner, the idea of Time, though intimately associated with the succession of states of consciousness, may also have arisen as a concomitant of the perception of varying speed of movement among external objects.

Thus the motion of celestial objects, the rapid movements of birds or animals, and the slower growth of plants, all probably contributed to the notion of a time interval which varied in degree.

Space thus came to be regarded as an area or portion separated off from "nothingness", and Time as an isolated part of "Eternity".

"Nothingness" and "Eternity" came later to represent unchanging conditions, in which no events take place.

The mental separation of the ideas of Space and Time, which is characteristic of the early stages of human thought, probably arose from a failure to recognise the fact that movement inevitably involves both Space and Time.

This misconception is illustrated in Genesis, Chap. I, where the creation of the cosmos (the world) out of chaos is described as taking place through the fiat of the Deity on a predetermined plan. The modern conception of the cosmos as a gradually evolving process, requires the mental unification of the ideas of Space and Time, though it does not preclude the idea of a Creator.

Jowett (24), quoted by Jeans (25), in the introduction to the Theætetus states that "Space is the element which surrounds objects".

"It is the vacuum or void which they leave, or occupy, when passing from one position in Space to another". So also in regard to Time, Jowett says "We cannot think of successions

of sensations without Time. Time is the vacancy of thoughts or sensations", that is the void they occupy when succeeding each other. Both conceptions (Space and Time) are thus, in Jowett's view, associated with movement.

It is also of interest to consider how the ideas of Space and Time arise and develop in the child's mind, and in the mental experience of Mankind.

As Jeans (26) says, "Space and Time form the framework for the sense impressions which the child's mind receives from the external world".

Now it is by co-ordinating the impressions received through touch and sight* aided by impressions derived from the movements of external objects, that the child learns to distinguish the self from the non-self, and to consolidate his early conceptions of Space and Time.

The same is also true in the racial experience of Mankind.

This misinterpretation of Space and Time as separate objective realities was acquired very gradually, and at a comparatively late stage in human evolution. The Homeric poems contain no words for Space or Time.

It has only been with the latter-day growth of scientific knowledge, and more recently with the advent and acceptance of Einstein's Relativity Theory, that Space and Time have come to be regarded as subjective and relative, and not as objective realities.

O. L. Reiser (27) has some interesting remarks on the development of our conceptions of Time and Space.

He quotes the Russian Physiologist, E. Cyon's suggestion, that just as the system of semicircular canals represents the physical basis underlying the perception of Space, so the organ of Corti is the special organ for the appreciation of Time.

This is probably a too limited, a too simple explanation. Any theory which attempts to explain the perceptions of Space and Time must include the functional activity of the brain

* The fact that tactile precedes visual experience both in ontogeny and in phylogeny, is of interest in this connection.

as a whole, that is the physical mechanism through which the interaction between the organism and the environment is carried out.

As Reiser points out, "There must be some complexity of structure to produce a Time sense". In the case of Man this complexity of structure involves the existence of intero-receptors and extero-receptors, and the Time sense emerges as a result of the interaction between them.

As Hogben (28) has said, "The concepts of Space and Time owe their peculiar permanence to the circumstance that we can never get away from our labyrinthine organs, or from the rhythms of our own bodies".

It is at any rate an interesting fact that, as Reiser (29) observes, "The 'Arts of Space' should in the main be associated with vision, and the'Arts of Time' (*e.g.* Music) with hearing".

Bergson (30) also makes some interesting observations on "Time" and its perception. Bergson's Philosophy would seem to imply that the only real Time is the present. Time past, Time present, and Time future, cannot be compared together as we compare portions of Space.*

May it be legitimately inferred from this, that Actuality itself only exists in the immediate present, and is being continually created. If so, does this also mean that Matter, like Time, is constantly being formed out of and converted back into energy?

Bergson disputes the conclusion that the sussessful prediction of astronomical events, *e.g* eclipses, by astronomers, supports the theory of Determinism. He points out that, if the velocities of all the material aggregates in the Universe were doubled, including of course those of the observer, no one would recognise that any change had taken place, and accurate prediction would still be possible.

The Time factor, therefore, can have no bearing on Prediction or Determinism. Such is Bergson's argument.

Bergson and Mental Concepts.

Bergson, as quoted by William James (31) has also taken a leading part in emphasising the inadequacy of concepts to

* See also Plato in The Timæus.

represent Actuality. The very process of mental abstraction by which they are formed, robs concepts of the essential element of completeness. When we remember that concepts are the symbols with which Philosophers have built up their different systems, we find an explanation of the fact that philosophic systems have varied so greatly in the degree to which they have represented Reality.

Moreover, and this is of especial importance to us now, the soundness of our Philosophy of Life will also depend on the degree to which our concepts represent Reality. It is for this reason that we have given so much attention to criticism of the doctrine of the universal validity of Causality. Causality and Freedom represent fundamental problems on which a sound philosophy of Life must ultimately rest.

I have also dwelt in some detail with the question of Space and Time appreciation, because, although philosophers, psychologists, and physicists are by no means agreed as to the right solution, yet the problem, when regarded from the evolutionary standpoint, does, both ontologically, and phylogenetically, serve to illustrate the interaction which goes on between the organism or the person, and the environment in a fundamental field of neuro-psychical activity.

Starting vaguely in the differentiating process, which distinguishes the self from the non-self, our perceptions of Space and Time pass through a stage in which both, though in different degrees, are projected outwards, and are regarded as objective realities until at such a much later period of human development, and only with the growth of scientific knowledge about the Universe, they come to be recognised as subjective in character, and as representing human interpretations of cosmic events.

The history of the evolution of the ideas of Space and Time, both ontogenetically and phylogenetically, exhibits a to and fro swing from subjectivism to objectivism, which indicates that the point of stable equilibrium, the "truth" lies somewhere between the the two phases, and will only be reached when the synthesis of subject and object is complete. (See Bishop Berkeley) (32).

The Emptiness of Space.

A feature of this finite but unbounded Space is its extreme emptiness. In this vast comparatively empty region, physicists tell us that, as a rare event, planets have been born from the near approach of two parent stars.

But comparative emptiness is also a characteristic feature of the atomic world.

Here in the atom, the electrons pursue their widely separated paths without much risk of collision.

The Expanding Universe.

Further, according to Einstein's (33) view, this universe, this *Space Time Continuum* is undergoing a rapid expansion of volume.

The material aggregates, the nebulæ or island universes, are becoming more widely separated and with greater rapidity in proportion as their distance, from us, increases. Whether, as seems probable, this phase of expansion will be followed by a phase of contraction, physicists cannot tell us. Meanwhile, the material aggregates are themselves apparently becoming denser, and the intervening Space still more empty.

Now the curvature of Space is intimately associated with its material content. On this point Sullivan (34) says—"A piece of matter on Eddington's Theory is a place where the *Space Time Continuum* is curved in a certain way. It is not that the piece of matter produces the curvature, the curvature is the piece of matter".

But here physicists are not wholly in agreement. Thus Professor Milne (35) says—"The phrase 'the curvature of Space' is meaningless from the point of view of Physics—so also is the phrase 'bodies are accellerated because Space is curved' ".

But other questions of great interest arise when we conceive of the Universe as expanding in volume. According to de Sitter's (36) theory of Cosmogeny, Space expands most where matter is relatively-speaking absent. Thus within the confines of an island universe where matter is abundant, expansion

is relatively slight. Jeans (37) has calculated that while Space as a whole (the Cosmos) doubles its volume in two thousand million years, a Galactic system only doubles its size in thirty million, million, years, that is fifteen thousand times more slowly.

Further, according to de Sitter (38), whatever may have been the condition of the universe in the past, it is to-day in a condition of unstable equilibrium.

But whether it be true or not that the universe is oscillating between phases of expansion and contraction, "Rhythm", *i.e.* alternation of phase, is a marked feature of many events both in the inorganic and the organic world. In other words oscillation is characteristic of cosmic happenings.

Gravitation.

But Einstein's (39) Relativity Theory has also altered our views about Gravitation.

Gravitation in the older Newtonian sense can no longer be regarded as dependent on some force acting at a distance. It must to-day (in Einstein's view) be regarded as a property of the curvature of Space.

According to Einstein's (39) Relativity Theory, bodies move along a curved path, not because they are deflected from a straight path by some external Force, but because the *Space Time Continuum,* of which matter is a part, is itself curved.

Moreover, in Einstein's (39) view, this *Space Time Continuum* represents the primordial form of the Universe. It is the source of all energy, and the medium in which matter first appeared, and in which events take place.

The Law of Increasing Entropy.

But whether the Universe be expanding or contracting in volume, the so-called Law of Entropy, or the second Law of Thermo-Dynamics, tells us that the energy of the Universe is falling from a higher to a lower intensity, that is from a condition of greater to one of less availability for doing work.

Now the law of Entropy implies that if cosmic energy is running down like an unwinding clock spring, the Universe will, so physicists tell us, eventually reach a condition of energy or heat equilibrium, *i.e.* stagnation, though even on this point Professor Milne (40) takes a different view. He writes "The Universe is an ever continuing system, knowing Birth, but not Death"....."At the confines of the visible Universe creation is for ever going on".

But if it be true that this running down of energy is taking place in a Universe which is believed to be expanding in volume, *i.e.* one in which the material aggregates are becoming denser, and more widely separated, and in which the *Space Time Continuum,* is becoming less curved, will this fall in energy continue, if the phase be reversed and the Universe should begin to contract in volume?

Aristotle (41) was at any rate on the side of Professor Milne, when he wrote "The sun and stars are born not, neither do they die, but are eternal and divine".

At this point we may refer to the late Professor J. S. Haldane's (42) view about the Law of Entropy as applied to the Universe. Haldane says that "from the newer standpoint (of Physics) co-ordinated activity is inherent in matter", and "with fall in temperature this inherent activity is not lost to it", *i.e.* to matter; and further, "even if the temperature (in the cosmos) fell to absolute zero, everything would still be full of co-ordinated activity".

Now the essential idea underlying Haldane's conception is, that the Universe is tending, not to a state of rest, but to a state in which co-ordinated activity will prevail over what was, or seemed to be, originally a state of chaotic activity, and that this conversion of chaotic into co-ordinated activity is associated with the cooling-down process, which, under the older view, was taken to indicate a state of energy equilibrium or stagnation.

J. S. Haldane apparently did not regard the Law of Entropy as applying to cosmic energy when locked up in organised aggregates. A piece of coal left to itself does not lose its potential energy until it is subjected to some external influence, such as heat.

But this problem of the ultimate future of energy raises other questions, for instance—the nature of organisation, and the relationship of the entity to the environment, or the Part to the Whole.

Moreover, when the last free electron, or free atom, has become part of some larger aggregate, when the Cosmos has been wholely organised, when co-ordinated has completely replaced chaotic energy—from what source will the Cosmos obtain the stimulus required to liberate the energy locked up in organised structures? Will not the answer to this question be found, in what now seems to be an established fact, namely the mutual convertibility of Mass and Energy. (See Rutherford (4)).

The discrepancy between the old and the newer view, if I rightly understand Haldane's explanation, is due to the fact that the former did not include the phenomena of Life and conscious behaviour in its interpretation of the cosmos. It is only when the biological, and the psychological interpretations are added to the physical, that the Universe can be viewed in a true light. For as daily observation shows, there is another side to this running down process.

While it may be true that, in the physical sense, the Universe is tending to a state of stagnation, and that cosmic energy is becoming less and less available for doing work, yet this diminishing fund of available energy is meanwhile being used in association with what we know as Life to build up complex organic substances and living matter.

It is in this way that the green leaf makes use of the sun's radiation to build up the living organism, the plant or the tree.

At a still higher evolutionary level, in combination with matter of still greater molecular complexity, and in association with what we know as Mind, directional control of movement and events begins to make its appearance, and to become increasingly manifest. Meanwhile, the psychical activities with which this directional control is associated, also undergo increasing development, and apparently an increasing power of control.

But surely this building up of living organisms in association with Life, and this directional control of movement in

association with Mind, suggests that the Universe is working out some general scheme; not necessarily a wholly predetermined scheme, but a scheme, subject to re-adjustment, a scheme which is itself in the making, and one which is capable of realisation along experimental lines.

On the other hand a wholly Deterministic scheme of creation, must presumably exclude many possibilities which may be favourable to evolutionary progress. Whereas, under an Indeterminate scheme, given unlimited Time, and every kind of environment, then under the method of experiment based on Indeterminacy, every event that can happen will happen and the best result will become possible of achievement.*

In fact the experimental method of evolution represents a self-regulating process, and one which necessarily contains fuller possibilities than a rigidly-planned scheme of creation, which excludes some possibilities.

J. B. S. Haldane (43) writing about the theory that "Mind takes advantage of the uncertainty principle to make certain events more probable", states that "the essence of the uncertainty principle is that certain events are equally liable to occur".

But does not this liability to occurrence vary with the degree and the kind of environmental restriction of movement, and would it not be equal only where the possibilities of occurrence are limited to two in number?

If we apply the uncertainty principle to the Universe as a whole, then the possibilities are not limited to two. All possible events may occur. It is true that cosmic events seem, on the whole, to have a unidirectional tendency, that is from homogeneity to heterogeneity,† but since this unidirectional change occurs in a limitless number of ways, Indeterminacy is not a mere *accidental,* but an *essential* factor in cosmic evolution. In other words, Creation is not finished. It is continually going on, and it is going on by way of the experimental method.

* The relationship between Order, Purpose and Design in Creation will be referred to later (see Chapter on Conclusions).

† The possibility of a reversal of this process, *i.e.* from Cosmos back to Chaos, cannot be ignored.

CHAPTER III.

LIFE AND MIND.

Such in brief and in very imperfect outline is the picture of the Material Universe as it is drawn by Physical Science to-day. But if such a picture of the Cosmos is to be complete, if it is to include, not only the material world, but the Universe as a whole, it must represent all forms of cosmic activity, including Life and Mind.

Now the mechanistic, 19th century view of the Universe left little room for Life or Mind. Both were regarded as by-products or epiphenomena, and as negligible factors in cosmic events.

To-day Life and Mind are regarded by an increasing number of biologists and physicists as playing an important part in the direction and control of energy. Both have acquired a new significance in cosmic evolution, since the recognition by some physicists of the existence of the principle of Indeterminacy in the atomic world.

In a former chapter I have indicated certain directions in which the new conceptions of modern physics have thrown further light on Biology and Psychology. I shall now try to apply the knowledge so gained to the closer study of Life and Mind.

Modern Physiology tells us that Man's apparent ability to exercise choice and volition, has grown *pari passu* with the evolution of that very complex mechanism, the human brain.

There are, so neurologists tell us, some 10,000,000,000 separate nerve cells, or neurones in a normal human brain. Has this marvellous complexity of constitution of the organ of

Volition any bearing on the problem of Indeterminacy in the organic world.

On this point Eddington (44) has some suggestive remarks. He writes—"The conscious unit (of volition) differs from an inorganic system (*i.e.* an atomic field) in having a much higher indeterminacy of behaviour", and again—"In the case of the conscious cell, its behaviour symbolises a single volition, and not a conflict of billions of independent impulses, as in the atomic system".

Professor Schrödinger ((48A) in a recent article previously alluded to, has expressed the opinion that "the hope of extracting a model of free will from the theoretical Indeterminacy of Modern Physics is illusory". But he also says that when free will is regarded subjectively, it stands on a different plane to that which it occupies when examined objectively in other individuals. The factors concerned (in the subjective case) are (1) Prediction or Prescience, *i.e.* a knowledge of what is going to happen, and (2) a feeling of responsibility. It is these two factors which, together, entail the idea of Choice.

Professor Schrödinger goes on to suggest that such a state of things would mean, either that the Laws of Nature are at the mercy of the Individual, or that no explanation is afforded of the feeling of responsibility, since the frequency of the interferences with those laws is determined by Heisenberg's Uncertainty Principle. But, we ask, why should not the Laws of Nature be at the mercy of the Individual, within the narrow limits set by Individual Capacity in interaction with environmental conditions, that is if Indeterminacy and Determinacy both play a part in cosmic events? Does not Indeterminacy in both spheres imply interference with the Laws of Nature as we regard them?

J. B. S. Haldane (45) has recently said that "an atom is a complex system which automatically repairs itself after the loss of one or more electrons", and further, that "the most essential feature of 'wholeness' as applied to an atom or molecule is, that which, in physical terms, is called 'degeneracy', or loss of degrees of freedom (of movement)".

Now this capacity of repair by inorganic material entities, is an even more marked characteristic feature of the living organism. Moreover 'wholeness'—*i.e.* integration and organisation, in the organic sphere, also entails some loss of freedom on the part of the component units.

Von Planck's (46) view concerning Indeterminacy in connection with human volition is, I think, somewhat difficult to grasp in its entirety. Planck accepts Determinism as operative in the material universe but, while he apparently includes the human will as coming under the same principle, he makes a reservation, on the ground of what he calls the "spiritual nature of the will", and also because the will lies outside scientific enquiry, since in any enquiry about the nature of the will, the observer must of necessity act as the subject and object of the enquiry at the same time. In an earlier book Planck (47) has also stated that "Human free will is perfectly compatible with the universal rule of Causality"; but he also states "No person can derive the decisions and motives of his own conscious actions from the Causal Law alone, he requires another Law, the Ethical Law".

In a more recent book, Max Planck (48) deals more fully with the problem of the freedom of the will. He says, p. 32, that "looked at from inside, *i.e.* subjectively, the will (in so far as it looks to the future) is not causally determined, but when 'looked at from outside', *i.e.* objectively, it is causally determined", and he attempts to reconcile these two views by reference to the existence of an "Ideal Spirit" having "a full knowledge of the action of the natural forces, as well as of the events in the intellectual life of men". Meanwhile the common-sense view of the will is, that Man possesses some power to change the course of events, or to control (within certain narrow limits) his environment, and further, that this capacity of control has its roots in his own mind.

Now it is useful to consider the subjective and the objective aspects of the human will not only in relation to an ideal mind, but also from the neural and the mental standpoint, for it is these two aspects which together make up the body-mind, the Personality of the individual.

We study the will from the physiological aspect when we enquire into the activities in the cerebral cells which serve as the physical basis of thought and conduct, and we study it psychologically, when, by introspection, we consider among other questions the motives which actuate conduct, inhibition, and so on.

But we cannot suppose that the will is causally determined on the neural side, and undetermined or free on the physical side or *vice versa*. The two aspects together make up the Personality. The Personality as a whole may be predetermined, or free, or as we have already given reasons for thinking, mainly determined, but partly free. Now this conclusion, that Indeterminacy and Determinacy both play a part in cosmic events, including volition, is I think in agreement with Von Planck's statement in his recent book, to which I have already referred. After describing the Determinist and the Indeterminist schools of thought, Planck (48), says—"There might also be room for a third party, which might take up a kind of mediating position, treating certain concepts, like those of electrical attraction, or gravitation, as possessing an immediate significance, and as being subject to strict laws, while assuming others, like those of the light wave, or the material wave, to have a merely statistical meaning for the world of the senses.

Perhaps this difficulty in harmonising Determinism in the atomic sphere with Freedom in the case of the human will might be, at any rate partly, overcome if it were more fully recognised that it is, for the most part, the environment which restricts free movement and brings about Determinism.

The first step in Volition consists in the assessment of values as between alternative modes of behaviour or response in the attempt to secure the satisfaction of desires. The large store of potential (neural) energy possessed by the human organism makes possible the expenditure of some of this energy in combating, or circumventing those environmental restrictions on movement which would otherwise prevent the attainment of satisfaction.

Although the atom has no comparable store of available energy, although it cannot assess values, and though its move-

ments, in the statistical sense, are the resultant of environmental restrictions, yet it is surely from the inherent capacity of the atom for free movement that, the ability of the human organism to control and circumvent, within limits, those environmental limitations which would otherwise rigidly predetermine conduct, has been gradually evolved. In this, however, human volition resembles other emergent characters.

The Entity and the Environment.

The misconception that Determinism is inherent in the aggregate or entity, while the environment plays a passive part, has, I think, been responsible for some of the obscurity, and diversity of view which still surrounds the problem of Causality.

Moreover, we realise to-day that the contact or interaction between the individual and the environment is far more extensive in Space and Time than has been formerly supposed.

O. L. Reiser (50) has pointed out that, since the field of an electron may be regarded as extending to infinity, *i.e.* to the confines of the Universe, two electrons may therefore occupy the same space at the same time.

J .B. S. Haldane (51) says that if mind be regarded as a wave system or resonance phenomenon, mind can extend out into Space, although it cannot be definitely located in Space.

Moreover if, as Jeans, Einstein, Max Planck, Schrödinger, Eddington and others (52) seem to think, consciousness is fundamental, and the energy of the Universe is Thought Energy or Mind, then it become less difficult to undertsand how the energy of the world without can be related to or interact with the energy of the mental world within, for both are in essence one.

Although, as Sherrington (53) has said, "It is not yet possible to bridge the gap between the physical and the psychical, yet in the case of Man, the neuro-psychical has become conscious of itself and its own activity. The bridge, when it is built, will be a psychological or mental structure, resting on physiological or neural foundations.

I have said that the interaction, or the field of influence between the entity and the environment extends throughout Space and Time.

Now it is a suggestive fact that Man's growing power to control his environment to his own ends, depends on his increasing ability to circumvent those environmental restrictions to free movement, which, as we have seen, bring about Determinism.

But failure to exercise this power of control on ethical lines* may originate in the inner environment of the Personality. It may be due to some defect, hereditary or acquired, in the brain, the physical organ, with which mental activity and volitional control are associated.

In such cases the higher brain centres fail to inhibit or control the activity of the lower centres, those which are the seat of the more primitive instincts and desires, with the result that the conduct of such individuals is largely predetermined.

These and other facts suggest that what is known as Inhibition, in the neural and in the psychological sense, plays an important part in Volition and Choice. It removes restrictions in one direction and imposes them in another. It is an active and not merely a passive process.

Further, if the personality of the individual represents the combination of two sets of influences—inherited racial experience, and experience acquired during the lifetime of the individual—then we must look to the latter as the chief seat of those departures from predetermined or routine conduct which constitute Choice and Volition.

The Behaviour of Identical Twins.

A study of the mental equipment and the mode of behaviour of so-called identical, or monovular twins, which has proved so useful in the science of Heredity, also throws light on the problem of the freedom of the will.

* That is on lines calculated to promote Social and Individual Welfare.

Identical twins possess the same, or nearly the same, kind of cerebral mechanism, and respond in much, though not quite, the same way to their environment, even when this varies as between each member of the pair of twins. In other words their attitude and mode of response to their surroundings depends mainly on their personality, rather than on outside influences. Such differences in behaviour as do exist seem to reside in the temperamental, rather than in the intellectual sphere of their mentality.

What then is the significance of this biological fact from the point of view of the freedom of the will? This close similarity of behaviour by identical twins, even when exposed to diverse surroundings, is true in the average or statistical sense. There are slight but important differences as between each member of a pair when regarded individually which recall the Indeterminacy which characterises the movements of electrons when these are considered individually.

The fact that two minds, associated with two physical mechanisms or brains of the same or nearly the same hereditary constitution, behave in the same or nearly the same way, suggests that such differences in their mode of response as do exist, must be sought in the minds and the brains of the individuals rather than in the environment.

In view, moreover, of the known intimacy of association between Psychosis and Neurosis, we may, I think, safely assume that any mode of response that is established as a habit in the Personality of the individual by the exercise of Choice and Volition, will have its counterpart in the neural or brain mechanism which subserves thought and action. Though this of course does not mean that it will be handed on to Posterity.

The Electrical Rhythm of the Brain.

A word may be added here about Berger's and Adrian's observations on the electrical rhythm of the brain.

According to Adrian's (54) view, the electrical rhythm (of about 10 to 20 a second) is only obtained when the cerebral neurons are *not* being stimulated by concentrated thought or

by mental effort, or by sense impressions entering the brain mainly through the visual channels.

Lennox (54A), as the outcome of observations on epileptic patients has suggested, that in normal brain activity many clusters of neurones are discharging, not in unison but in harmony, while in abnormal conditions of activity, as in the disease *Petit Mal,* the harmony is obliterated and many waves become one.

It seems probable that further study of the conditions under which the electric rhythm is, or is not obtainable, may throw light on the nature and significance of Inhibition on both its neural and its psychological aspect.

To what extent, if at all, further research in this direction will support the view that Indeterminacy, or Determinacy, predominate as factors in cerebral and psychical activity, remains to be seen.

R. S. Lillie (55) after quoting Whitehead on the influence which the general unity of the organism exerts on the behaviour of the single electrons composing it says—"We may predict that Evolution will continue to give rise to new forms of Life, and in the human sphere we must acknowledge the very real sense in which individual men and women are free agents within the restrictions set by their biological organisation, and the conditions of life".

Control over Thought Compared with Control over Conduct.

It may be of interest here to point out that the normally constituted person seems to have more power of control over his actions than over his thoughts.

Schopenhaur (56) has said—"A man can do as he wills but he cannot will as he wishes". What is the significance of this observation? To wish represents a preparatory stage in willing. Moreover, thought is more varied, that is less standardised than voluntary (as opposed to instinctive) conduct. Voluntary conduct represents the motor response we make to

certain influences *after* these have been co-ordinated and adjusted by passage through the higher brain centres, those which represent the association of ideas. The reason why thought is less standardised than conduct is that thought has been less subject than conduct to social, religious, and other environmental restrictions in the course of human evolution. Moreover, control over thought has less survival value than control over conduct.

This comparative feebleness of control over the flow of our thoughts is well shown when any break or interruption occurs in the train of thought.

Experience tells us that, though we may, to a certain extent, hasten the recovery of the missing link in the chain, by recalling the thoughts which occupied the mind just before the interruption occurred, yet it is useless to try to recover it by any concentration of mental effort. It is better to wait, and it then often happens that the necessary neural contacts will be established across the synaptic fields, and the missing link in the chain of thought will re-appear in focal consciousness without further effort, and apparently automatically.

But this surely is what we might expect. For conduct, though it is moulded by social influences, religious ideals, conceptions of duty, and other social sanctions or taboos, yet it depends for its driving power on more primitive, instinctive desires, and the physical or neural mechanism which subserves these earlier impulses run more continuously and autonomously than the more complex, later evolved mechanism, which underlies the association of ideas, the forming of concepts, and the weighing of motives.

But to arrive at the conclusion, that Determinacy and Indeterminacy both play a part in cosmic events, while it may help to explain the relationship in which freedom of the will stands to freedom in other spheres of cosmic activity, does not of course solve the problem of Causality.

What we have done is to formulate the problem in a rather different way in the hope that a study of it from the combined standpoint of Science and Common-Sense may throw further light upon it.

The late J. S. Haldane (57) in discussing the relative degree of adequacy and completeness with which Physics, Biology, and Psychology, enable us to interpret the Universe, including the problem of Casuality, says—"It is always the same Universe that we are interpreting, though we are interpreting it more fundamentally in Biology than in Physical Science, and more fundamentally in Psychology than in Biological Science".

"Psychology helps us to a more adequate interpretation of Reality because it is the Science which deals with Personality. Our experience is an experience of Personality, and the Universe of our experience is a Universe of Personality, hence the fundamental importance of Personality, individual and collective, in any interpretation of the Universe".

CHAPTER IV.

THE METHOD OF EVOLUTION.

A study of the way in which evolution works supports the notion that the primary structure of the Universe was Indeterminate. Speaking generally, the method of evolution has been the method of experiment, of "Trial and Error".

We may illustrate this point by examples from the inorganic and the organic world.

The Birth of Atoms.

The number and the constitution of the 92 different kinds of atoms which form the components of terrestrial matter suggests the use of the experimental method.

The fact that these 92 elements fall into a series of family groups showing some community of constitution, and the further fact that change is going on in the constitution of some of these atoms, and that one kind may, under certain conditions, give rise to another kind, suggest that they were not separately created on a predetermined plan.

Then there is the problem of the existence of Isotopes. Why, for instance, should there be two kinds, or Isotopes, of the chlorine atom in approximately equal numbers, or ten or more Isotopes of the tin atom, if the lines on which the chlorine and the tin atom were created were predetermined from the beginning? If, on the other hand, different kinds of atoms have sprung from a common origin through an evolutionary process akin to that by which different types of organisms have arisen, then the existence of Isotopes can be more easily understood. Sir A. Eddington (58) writing about the beginning of things, says—"Thus, at the earliest stage, the void was sparsely broken by tiny electric particles, positive and negative, which wandered aimlessly in solitude"....."aggregates occurring

casually in one place and another, drew to themselves more and more particles"; and later he writes—"Nature made nearly every possible mistake before she reached her greatest achievement, Man".

This conception of a very early period when the "void" was sparsely broken by electrically-charged particles carries us back to a point at which the human imagination falters, though we might still go on to ask the question, who or what agency created these electric particles, or the *Space Time Continuum,* or the "void" in which they appeared. On the other hand, we may start by assuming the existence of the electrically-charged particles and regard Creation as the assembling of such particles together. But on either assumption the problem of Indeterminacy and the use of the experimental method is unaffected.

The Origin of Life.

At a much later stage in our own world's history, although we know nothing for certain about the conditions under which Life appeared on this earth, it seems highly probable that the passage from non-living to living matter first occurred in a salt water, or marine environment. It is a significant fact that the watery secretion of the mammalian oviduct, which to-day forms the early environment of the mammalian (and the human) egg cell during fertilisation, is a saline fluid approximating in chemical constitution to that of the less concentrated sea water of earlier geological times. C. J. Bond (59).

But the problem of the nature and origin of the earliest forms of life carries us back, as J. B. S. Haldane (60) has pointed out, to a still more primitive stage, to a time when the earliest living aggregates were probably naked bodies without any cell wall or pellicle, and of a comparatively simple molecular constitution, resembling that of the bacteriophage or virus. They were probably colloidal aggregates capable of living in an environment or atmosphere, containing carbon dioxide, ammonia, and water, but very little free oxygen. The claim recently made by Stanley to have obtained, from the infected juice of Tobacco plants (61), a crystalline protein having some

of the properties of a virus, if confirmed, is an important achievement, from our present point of view. Sumner, Northrop (61A) and others also think that they have isolated enzymes in a crystalline form.

Now it is an interesting fact that anærobic organisms, such as the Tetanus and other pathogenic bacilli exist and flourish to-day. Moreover, a large part of the muscular activity of mammals, fishes, and birds is carried on by muscle cells which can function under anærobic conditions. The fact that the tissues of our bodies live, for the most part, under conditions of oxygen debt, throws further light on our anærobic ancestry, though this mode of life has now been supplemented and largely superseded by the respiratory method, which requires an environment rich in free oxygen.

Such then in all probability were the simple, naked, organisms in which life first appeared. They were molecular aggregates capable of maintaining their own existence and of producing duplicates of themselves in an environment poor in atmospheric oxygen.

These duplicate aggregates were not only chemically identical, but they were also physically identical, except that they were either dextro or lævo-rotatory. Now it is again a significant fact that, while both these forms can be produced in the laboratory, and while one form can be converted into the other, yet, speaking generally, only one of the two forms, *viz.* the lævo-rotory form is found in Nature. The amino acids, for instance, are lævo-rotory in all types of organisms.

The next stage in the evolution of Life was reached when one or more of these naked molecular aggregates succeeded in surrounding itself with an envelope, or cell membrane. This stage marked the advent of a more complete individuality. These cell entities or organisms were of sufficient molecular complexity and contained an organic substance, chlorophyl, which enabled them to utilise the sun's energy in the assimilation of carbon from the carbon dioxide present in the primitive atmosphere.

This necessary molecular complexity was apparently best achieved by compounds made up of comparatively few ele-

ments, such as Carbon, Nitrogen, Hydrogen, and perhaps Silicon, all of which are atomic elements capable of self-linkage together with Hydrogen and Oxygen. For instance, Carbon and Nitrogen are both middle members of their family, neither very acid nor very basic, which, on the addition of other elements, like Hydrogen, and Oxygen, can form chain and ring compounds, by linking atom to atom of the same kind. It is not, of course, claimed that either the types of aggregates or the evolutionary events which we have associated with the beginnings of Life on the Earth, prove or disprove the influence of Determinacy or Indeterminacy in evolution. We do, however, suggest that the creation of varied and numerous types, the success of some and the failure of others, and especially the continued persistence, even to the present day, of vestigial remains of discarded organs and tissues, and of superseded modes of metabolism, does support the idea that the method by which different types of organisms have been evolved and some have perished, has been the method of trial and error. But the method of trial and error is inconsistent with rigid Determinism.

Life a Rythmic Process.

But Life is also a rythmical process. It consists both in the absorption and in the liberation of energy.

A living molecular aggregate or organism requires a changing or oscillatory environment, in order that it may exhibit vital activity, that is anabolism and katabolism, to the best advantage.

Now such an oscillatory environment is provided by the rotation of the earth on its axis. This brings about the alternation of light and darkness, while the tilting of the earth's axis in relation to the sun, is responsible for the alternation of the seasons, and the establishment of an annual rhythm.

But there are other reasons why our earth should be the home of Life, as we know it.

The earth is the most dense of all the planets in our solar system. It has been able to collect and retain an atmosphere,

an atmosphere, moreover, which contains the elements Carbon, Nitrogen, Hydrogen, and Oxygen, all of which are essential for Life as we know it on our earth, though there may, of course, be other forms of Life on other planets, of which we have no knowledge.

Another favourable circumstance has been that our earth has cooled and settled down in a way which has provided a solid rock crust, superimposed on a metallic core. On this rock crust living organisms can find support, while above this crust, liquid and gaseous envelopes are present in which organisms can move, and find their food, and also materials necessary for respiration.

Thus, what we know, or what we may legitimately infer, about the conditions under which Life appeared on our earth, suggests the use of the experimental method. We also find the same sort of evidence when we come to study the later evolution of the various types of living organisms (both plants and animals), which have peopled the earth at succeeding stages in its history.

Mutations and Variations.

The fact that organic evolution has not been a continuously graded process, but has occurred in steps or stages, is associated with, or depends on, the discontinuity, due to mutational change, which is characteristic of the life of the genes, the bodies which represent the physical basis of Heredity. Both processes again suggest the existence of Indeterminacy.

We know, for instance, that innumerable variations, large and small, have appeared in numerous directions during the course of organic evolution, but only those types have survived which were best equipped in the struggle for existence. The misfits and failures have largely died out.

It is true that biologists are not in complete agreement as to the origin or the significance, from the evolutionary point of view, of the specific differences which distinguish different types of organisms. Professor R. A. Fisher (62) has recently criticised the mutation theory. But it still remains substan-

tially true, that evolution by means of the struggle for existence, *i.e.* the method of trial and error, has played a main part in the development of the various forms of Life on the Earth.

The Palæontological Record.

Then we have the Palæontological Record. The story of the rocks presents us with the fossilised remains of organisms, like the Dinosaurs, in which loss of plasticity and adaptability, the result of over-specialisation and the excessive development of abnormal structures, has led to extinction.

Sex Determination.

The facts concerning sex determination and sex reversal in certain individual organisms, also point in the same direction. Although sex is for the most part determined at the time of fertilisation, yet both the stage and the degree of the development of the primary sex organs, and also the secondary sex characters, are largely influenced by nutrition, by the internal secretions, and by other environmental conditions. There is, in fact, an element of Indeterminacy at work in bringing about the end result.

The Embryological Evidence.

So also in the ontological field. The mode of development of the embryo from the fertilised egg cell is not apparently rigidly and absolutely predetermined. Some latitude is present in the interaction between innate potentiality and environmental influence, which constitutes the basis of individual development.

In short the development of the embryo is regarded by embryologists to-day as *epigenetic* and not *preformative* in character.

Spemann's (63) experiments on the influence of the so-called "organisers" in embryonic development are of fundamental interest in this connection.

Learning Through Experience.

The same latitude is even more clearly seen at work in the development of the human individual after birth.

Man, and to a lesser degree the animal, learns through experience. He tries many methods, he makes effort in many directions, many of these end in failure and only a few succeed.

But what do we mean by "learning through experience"? James Ward (64) has described "learning through experience" as "becoming expert through experiment", and experiment means "trial and error".

On this question of "learning through experience", as a factor in organic evolution, I may perhaps refer to the Withering Lecture, II, "On the Making of Use Acquirements", C. J. Bond (65).

Two partners are concerned in the process, one, the individual organism. This provides the capacity of response, the aptitude which varies so much in different individuals. The other partner, or the environment, decides as to the kind of behaviour which is best calculated to promote survival under the existing environmental conditions.

But whatever may have been the method by which evolution has proceeded in the past—whether, that is, organic evolution has been dependent on natural selection acting on so-called "spontaneous" variations as Darwin (66) thought, or on mutations of purely genetic origin as de Vries (67), Bateson (68) and other geneticists have thought, or whether it has depended on the inheritance of acquired characters as Lamarck (69) supposed—in any case, trial and error, and the use of experiment, have been important factors in the result.

Dame Nature's remark about her method of working in C. Kingsley's (70) "Water Babies", is significant here—"You see", she said in answer to Tom's enquiry, "I make things make themselves".

Orthogenesis.

One theory of evolution, however, still remains for consideration, which does not depend wholly on the experimental method.

The theory of "Orthogenesis" regards evolution as dependent on an "orthogenetic" principle inherent in the organism, a principle which directs the course of evolution along definite predetermined lines. It also largely ignores the influence of the environment as one of the two partners concerned in the making of use acquirements. But there is a further difficulty.

If the principle of Orthogenesis be invoked to explain progressive evolution, that is, successful adaptation to a wider environment in Space and Time, then the same directing principle must also be regarded as responsible for the evolution of those excessive and monstrous characters which brought about the extinction of certain types of organisms, of which examples occur in the Palæontological Record. Haslett (71).

It may be, however, that the theory of Orthogenesis is not without some foundation in fact. It may be that it is a somewhat extreme way of indicating the limits within which organic evolution is confined. It is the existence of these limiting conditions which prevents evolution from, so to speak, running off the rails. It explains why, in T. H. Huxley's (72) words "Whales never produce feathers, nor birds whalebone". The physical basis on which these limitations rest, must be sought in the potentialities of the genes, and the extent to which they can vary or undergo mutational change.

Thus while the theory of Orthogenesis emphasises the Deterministic side of evolution, it ignores or fails to give due importance to the part played by Indeterminacy or plasticity, and it takes no account of the use of the experimental method in the evolutionary process.

But if it be true as we suggest that Indeterminism and Causality both play a part in evolution, though in different degrees, and at various stages, then we must endeavour to ascertain the relative influence exerted by each factor in evolution regarded as a whole.

The Entity and the Environment.

I have already emphasised the fact that we must look upon evolution as an interaction between two partners, the entity or organism, and the environment. We can trace this interaction

back through cosmic evolution to the time when material aggregates began to be formed.

Moreover, the role of the two partners, *Part* and *Whole*, is, in a sense, mutually convertible. The Whole functions as the environment of the Part, and the Part as the environment of the rest of the Universe, or the Whole.

Thus if we imagine two atoms, or two primary constituents of matter, as existing alone in Space, each limiting or influencing the movements of the other, then each atom will function as an entity as regards itself, and as an environment as regards its neighbouring atom.

Moreover, as I have previously pointed out, it is in such limited circumstances that certain events are equally liable to occur on the "Uncertainty Principle". But if we apply the same uncertainty principle to the Universe as a whole, then all possible events may occur, and the frequency with which they do occur will depend on the environmental influence. It will be the outcome of the interaction between the two partners concerned.

Emergent Evolution.

The problem of so-called emergent evolution as put forward by Lloyd Morgan (73) and others requires a short consideration from our present point of view. We want, in fact, to know how far emergent evolution in Lloyd Morgan's sense comes within the sphere of the combined scientific and common-sense view of the Universe which we are here considering. That is to say, is it universal in character? Does it apply to the inorganic, as well as to the organic world, to the world of the atom as well as to the world of Life and Mind?

Is it based on the recognition of the fact that Indeterminacy and Determinacy both play a part in cosmic events?

Is it consistent with the use of the experimental method in evolution? Certain passages in Lloyd Morgan's (73) latest book—"The Emergence of Novelty" suggest that we may regard Emergent Evolution as fulfiilling the requirements here mentioned.

The same applies to some extent to General Smut's (74) theory of Holism as set out in his book "Holism and Evolution".

The theory of Holism has many points of contact with that of emergent evolution. Determinism and Indeterminism, and the use of the experimental method in evolution are intimately associated with both theories.

In both theories the capacity of the living entity or organism, to maintain its individuality and to reproduce itself, is of fundamental significance. This capacity for organisation and maintenance is also intimately associated with "wholeness" in General Smut's sense. Some non-living material aggregates seem to possess this capacity to a certain degree. Thus the atom can restore the loss of an electron.

The theory of emergent evolution rests on the observation that the entity, or the organism, possesses capacities or characters which its constituent parts taken separately do not possess, or at any rate do not reveal. But everything depends on the nature of the arrangement, and the way in which the constituent units are assembled. Thus one molecule of water, H_2O, cannot by itself become an ice crystal. It requires a number of molecules arranged in a certain orderly manner to form ice.

In like manner a random assemblage of chalk crystals has no polarising effect on Light. The crystals of chalk must be all similarly orientated if the new polarising property is to emerge or be fully exhibited.

As Claude Bernard (75) said long ago—"The properties of Matter depend on the arrangement as well as on the nature of its units".

Even aggregates in which the arrangement of the constituent parts is the outcome of human thought and effort also possess potentialities which do not belong to the separated parts. A motor car may be said, when supplied with the necessary motive power, to possess a capacity for transport. When taken to bits this capacity is lost. On the other hand such a manufactured machine cannot maintain, or repair, or reproduce itself.

This capacity for organisation or arrangement of units which is associated with an entity or organism when functioning as a whole, seems to depend on a basis of Indeterminacy and, as we have already seen from embryological, ontological, and other evidence, the organising process itself seems to employ the experimental method.

Moreover that which is true of the organising capacity of individual unitary systems, seems also to be true of the Universe as a whole.

In regard to the theory of Orthogenesis see also :—

Eimer (86) Orthogenesis der Schmetterlinge.
Robson and Richards (87) The Variation of Animals in Nature.
Berg, L. S. (88) Nomogenesis or Evolution determined by Law.

CHAPTER V.

THE PROBLEM OF CAUSALITY AND HUMAN LIFE.

But the problem of Causality is not one of mere academic interest. It is intimately concerned with daily life.

In the Biological Sphere.

As we have already seen, experiment acting through survival and selection (natural or artificial or both) decides which type of organism, and what kind of behaviour, shall survive and function as the parent of the next generation, or the precursor of the next series of events.

In the Sociological Sphere.

In the sociological sphere, much of our social legislation, our educational theory and practice, and our treatment of crime and criminals is meaningless, if all human conduct is rigidly predetermined.

In the Religious Sphere.

In the sphere of Religion the question of Determinism or Freedom has been, and still is, an important factor. Some oriental religions, Mohammedanism, for instance, are fatalistic in character. Mohammed, and to a certain extent Buddha were Determinists. The founder of the Christian religion, on the other hand, was an Indeterminist. Christ's attitude to the question of individual responsibility is clearly set forth in many passages in the New Testament.

The Roman Catholic form of Christianity, in so far as the thought and conduct of its adherents is concerned, is to a large extent ruled by Ecclesiastical authority, and is thus more Deterministic in character.

Speaking generally, the history of the evolution of Religion from Animism, through Polytheism and Monotheism, to its more modern form, has been the story of the passage from a more to a less Deterministic basis; or, in other words, to the removal of the fear of the unseen and the unknown, with its consequent effect on conduct.

In the Political Sphere.

It is not without significance that while the governments of civilised western communities, have, until the War, been based on a certain amount of individual freedom of thought and action, the marked restriction of individual liberty which has been a noteworthy characteristic of modern dictatorships, represents a reversion to a more Deterministic form of government. Dictatorship, in its effort to secure unification, suppresses the exercise of choice in thought and action on the part of the citizen. Here again the wave of human progress shows a rhythmic character. A cycle of liberal Indeterminism has been succeeded by a more restricted phase of Determinism and *vice versa*. We hear much to-day about freedom, and the absence of freedom, in both individual and national life, and it becomes a matter of great interest to enquire, to what extent, if at all, we can relate political and social freedom in human affairs to Indeterminacy and freedom of movement in the scientific sense, or in other words, how far back we can trace the rudiments of human freedom to an early stage of cosmic evolution.

It has indeed been this search for the early beginnings of freedom which has formed the connecting thread running through this address.

As I said at the beginning of my remarks, a combined study of the common-sense view, and the scientific view, *i.e.* an outlook which embraces the biological and psychological, as well as the physical aspect of cosmic events, is essential if we are to reach a sound Philosophy of Life.

CHAPTER VI.

THE EXISTENCE OF EVIL, SUFFERING AND DEATH.

Any conclusion we may reach as to the influence of Causality on human life naturally leads to a consideration of the existence of Evil and Suffering in the world, and it will moreover profoundly affect our attitude to both.

Association Between Suffering and Experimental Evolution.

I will commence by stating that the question of what we call Evil and Suffering is intimately associated with the use of the experimental method in evolution. I will also express my own conviction, which is—that the belief that the government of the Universe, or in other words, cosmic evolution, is being carried on along experimental lines is in no way derogatory to the dignity or the character of the Creator.

Surely the possibility of choice in the employment of adaptational methods provides a better, a more elastic method of control than a rigidly predetermined scheme, or one which does not allow of any adjustment to changing conditions. Moreover, the experimental method is more in harmony with our limited human experience of what is happening in our own world.

We human beings have no direct knowledge of any existence in which all is good, or all bad, from the human point of view. The world, as we know it, is full of contrasts and opposites. Light and Darkness, Cold and Heat, Motion and Rest, Right and Wrong. Why should these contrasts exist if all proceeds on a strictly predetermined plan? Does not the fact of their existence suggest the experimental method?

In human experience, failure and success exist side by side, though we hope and believe that the journey will lead after many windings and setbacks, to ultimate victory.

Moreover, if we believe that the Creator is one with, and immanent in Creation, and that the Personality of the Deity represents the synthesis of all the activities of the Universe, then surely we must also believe that the Creator co-operates with man, and the rest of Creation, in the carrying out of this vast experimental scheme, and that He shares with man and the rest of Creation in what we, with our partial knowledge and limited experience, call the existence of Failure, Evil and Suffering.

Religion itself speaks plainly on this point. Is not the doctrine of Redemption through suffering on the part of the Deity an essential element of Christian Doctrine?

The Idea of Progress.

No one has insisted more strongly than Dean Inge on the fact that there is no absolute law of progress in human affairs. But, if Progress does not occur of necessity, but depends, among other things, on human conduct, then surely progress rests on experiment. It means "Testing all things and holding fast to that which is good".

But progress in the evolutionary sense means much more than mere survival. It means a survival which is dependent on fuller adaptation to an environment which is constantly widening in space and time.

The Universality of Failure and Suffering.

Further, as has been previously indicated, failure and suffering are not confined to human life. They are present throughout Creation. The problem is an evolutionary one, a question of adaptation to the environment, and of the relationship of Parts to each other, and to the Whole.

But failure in adaptation may be due to a too great, or a too sudden change in the environment, that is, a change to which the organism is unable to respond sufficiently rapidly, or sufficiently completely.

To what extent, if at all, failure in the adaptational sense occurs in the inorganic sphere is a difficult problem. Senescence and eventual death do seem, however, to be necessary accompaniments of the process of Individualisation, that is,

the formation of entities or parts out of the whole, even in the inorganic sphere.

The stars, in spite of Aristotle's dictum, apparently grow old and die, that is, if death means the total cessation of all activity. It would be misleading to speak of suffering as the accompaniment of senescence in the inorganic world. In the organic sphere, however, failure of adaptation, involving suffering and death, plays a very important part.

Evolution itself depends, speaking generally, on the inherent tendency of matter to pass from a condition of less to one of greater complexity. But like other universal processes, this passage from the homogeneous to the heterogeneous takes place in steps or stages. This means that the appropriate response on the part of the organism may fail to correspond with the environmental change in time, or in direction, or in both, and imperfection in the adaptive response means, as we know, failure, suffering, and eventual death.

In thus describing physical suffering, failure and defeat as dependent on lack of adaptation between the individual and the environment, I also include the mental suffering and the sense of failure which are associated with the transgression of the moral law, and the perennial conflict between individual and social interests. I mean the suffering and failure which different religions include under the term "the wages of sin". Here, in the ethical, as in the biological sphere, the evolutionary point of view throws light on the problem.

Failure, Suffering and Death thus seem to be necessary accompaniments of an evolutionary process which is experimental in character.

But, as I have said, the problem of the nature and significance of evil, also assumes, in my opinion, a more hopeful aspect when it is viewed from the evolutionary standpoint, for as Evolution advances Evil should diminish.

I fully realise, of course, that this suggestion that an intimate association exists between the existence of evil and failure of adaptation to environmental conditions, does not fully explain the origin of evil. The problem is a very old one. Many attempts have been made by thinkers in all ages to solve

it. Spinoza (76) apparently denied the existence of evil, at any rate in the form in which we think of it.

At different periods of human thought, evil has been attributed to the influence of a malevolent Power or Devil, and since light and warmth have been closely associated at all times with prosperity welfare and beneficent rule, this hostile influence or Devil, responsible for evil has been associated with darkness. He has been called "The Prince of Darkness".

On the other hand, the theory which seeks to explain the Universe as originating in a predetermined plan, and as evolving on rigidly predetermined lines, throws the responsibility for the existence of what we call evil and suffering on the Designer of the plan, or in other words, on the Architect of the Universe.

The Tragedy of Human Life.

But much of the tragedy, the pathos of human life lies surely, not in the inevitability of death. Death for the individual is apparently an essential factor in the evolutionary scheme of things. What does seem to us to be mysterious and unexplainable, because apparently unnecessary, is that, for mankind, death should so often be preceded by a "growing old" of mind and body, by decline in mental vigour, and by a partial disintegration of the personality.

Moreover, this process of senescence and decay is characteristic more especially of civilised human life. It does not exist to nearly the same extent among wild animals, or among human beings living under more primitive, *i.e.* more natural, surroundings. For such beings, living under such conditions, death, for the most part, follows swiftly on loss of health and vigour.

But mankind is passing through a transitional stage in the march of civilisation, and it may happen that, as Metchnikoff (77) thought and hoped, further development in the world within, with fuller adaptation to the world without, will in time bring about the elimination of many of the troubles which at present, in so many cases, accompany old age.

Thus, while criticism of the meaning of, or of the part played by, death of the individual in the scheme of Creation may be out of place, we may yet reasonably ask whether the decline in mental vigour and the partial disintegration of the Personality, which so often accompanies old age, does perform any useful function or is inevitable?

We are, moreover, justified in asking this, because experience has shown that some part at any rate of the degenerative process can be prevented by the application of growing scientific knowledge to human life.

It is at this point that the question of Euthanasia assumes not only theoretical but practical importance.

There remains also the fact that the well-being, the happiness of the individual does not, under present conditions of life, by any means always coincide with the welfare of the species or the society, of which the individual is a member. Nor is the welfare of society in all cases in harmony with the well-being of the individual.

It is this lack of harmony between conflicting social and individual interests that is responsible for much of the disharmony which we call suffering and evil.

But even if the growth of scientific knowledge should enable civilised mankind in the future to harmonise these conflicting interests, and even if a wise application of scientific knowledge should enable us to eliminate the stage of senescence and decay in the life of the individual, death will still be with us, and the old question, what becomes of the personality of the individual after death, will still remain unanswered, and this in spite of Plato's (78) teaching that the soul is one and is not made up of parts, and cannot therefore undergo disintegration.

How far then, we now ask, can a philosophy of Life based on a combination of the scientific and the common-sense views of the Universe, help us at this point?

The Limitations Associated with Individualisation.

While the emergence of individuality and personality no doubt are essential elements in the scheme of Creation under the

present conditions of terrestrial life, the continued persistence of personality in the form in which we know it might, under different conditions of existence, imply some hindrance to the progress of a more universal scheme.

We know, for instance, that differentiation and integration, *i.e.* breaking down and building up, go on side by side in organic evolution. They probably represent two aspects of one great principle at work in cosmic evolution. But the process of integration involves the loss of some degree of autonomy by the individual units, the cells, the organisms, or the individuals which undergo the unifying process.

In like manner, personality, though an all important stage under certain conditions of existence, may involve some degree of separation and isolation of the "part" within the "whole". Personality may be only a stage in a larger synthesis. To be made capable of functioning as constituent parts in a universal synthesis, this may itself involve some loss of individual autonomy, some degree of preliminary disintegration, preparatory to reconstruction of the personality on a wider basis.*

When we pass on, however, to consider the Universe as a whole, the objection may perhaps be raised that the conception here put forward of evolution as an experimental process is inconsistent with the idea of creation as proceeding on a purposive basis.

In trying to answer this objection, we can only fall back on our human conception of purpose, and the method we employ in order to obtain our ends.

Purposive Behaviour.

Now, whatever may have been its evolutionary origin, we know that human behaviour is frequently purposive in character. We form a mental image of the object to be attained, and we employ the experimental method in order to attain it. In short we act both purposively, and experimentally.

No doubt organisms lower down in the scale of evolution also appear at times to act purposively, and with reference to

* Compare also the Buddhist doctrine that the attainment of happiness is possible in the absence of Personality.

the future, though in many cases such behaviour is the outcome of instinctive racially acquired inpulse.

We do not know to what extent, if at all, animals below a certain evolutionary level form any mental picture of the end to be achieved, though we do know that they make use of the experimental method, though to a limited extent, in their effort to attain it.

Thus preconception or preawareness of the end in view, and the use of the trial and error method in the effort to attain it, are not mutually inconsistent factors, at any rate in the case of human behaviour, and we may legitimately conclude that they also play an important part in the scheme of cosmic evolution.

While the suggestions which have been put forward cannot, of course, be regarded as giving a full or wholly satisfying explanation of the origin or the nature of Evil, I believe that a study of the problem from the evolutionary and the adaptational point of view, and from that of the Part to the Whole, will be helpful in throwing further light on the question.

Attention has already been drawn to the significance of contrasts in Nature. In the same way the problem of failure and suffering must be considered in relation to the existence of Joy in Life and successful adaptation to a widening environment in Space and Time, that is to progressive Evolution.

The fact that Happiness exists points to a beneficent Scheme of Creation, and we may regard Evil and Suffering, which are diminishing on the whole, as representing transitory experiences which Progressive Evolution will in time eliminate.

CHAPTER VII.

CONCLUSIONS.

We must now gather up the threads of our argument, and try to indicate the conclusions to which a combined study of the scientific and the common-sense views of the Universe has led us.

In the first place we find that the changes which have taken place in recent years in scientific thought are tending in a direction away from the mechanistic interpretation of the Universe current in the 19th century. They point to a fuller recognition by Physicists of the important part played by Life and Mind in the universal framework.

Among the problems of universal significance to which we have endeavoured to find some solution, that of Causality is perhaps the most important, because our philosophy of Life largely depends on our answer to the question—whether the Universe is governed on deterministic or indeterministic lines, or, as I have tried to show, on both? Indeterminism and Determinism in fact represent different degrees of freedom.

Unfortunately, as Sir J. Jeans (79) has pointed out, neither the "particle" nor the "wave" picture of the ultimate constituents of matter help us in coming to a decision on this point. The picture which we obtain from a combined study of the scientific and the common-sense views of the Universe does however suggest:—

1. That Indeterminacy and Determinacy represent two aspects of one principle. Both operate as factors in the universal framework.

2. That both factors influence events, though in different degrees, at different stages of cosmic evolution.

3. That Indeterminacy, *i.e.* free or random movement, was the original condition under which material aggregates

(electrically charged particles—Eddington) (80) began to form in the "void", or in the world stuff, or the *Space Time Continuum,* in which, or from which, matter originated.

4. That, as a consequence of the unidirectional flow of cosmic energy, and as homogeneity gave place to heterogeneity, restrictions of environmental origin began to limit free or random movement. Thus Determinacy succeeded and eventually superseded Indeterminacy in many part of the *Space Time Continuum.*

5. Indeterminacy, however, still persisted in other parts, where the environmental restrictions were less numerous and less powerful.

6. This persistence of Indeterminacy in a Universe which appears to be governed on deterministic lines, must be explained by supposing either that Indeterminacy has never been entirely lost or superseded, or that, if temporarily lost, it has been recovered.

This latter supposition, however, implies a reversal of the method of evolution, or the unidirectional flow of cosmic energy.

If, however, we accept the picture drawn by some Physicists of the Universe as oscillating between a phase of expansion and a phase of contraction, then such a condition may perhaps illustrate what is meant when we speak of the method of evolution as being a "reversible" process. Repulsion and attraction in the electrical sphere may also be regarded, from the same point of view, as an alternation of phase.

7. Bearing in mind, however, that Indeterminacy can never arise out of Determinacy, we have still to account for the re-appearance of the former (at a later evolutionary stage) in the form of choice and volition, both of which depend for their manifestation on free movement, *i.e.* movement which has not been predetermined.

A study of the combined scientific and common-sense views suggests that this basis of Indeterminacy must be sought at a very early stage of cosmic evolution, when freedom of

movement preceded or accompanied the formation of material aggregates, electrons and atoms.

THE INFLUENCE OF LIFE AND MIND.

8. Under the influence of, or in association with, what we know as Life, free movement became controlled and directed movement, but controlled to a certain extent by the organism rather than, as previously, by the environment.

9. At a still later evolutionary stage, and in association with, or under the influence of, what we know as Mind, this controlled and directed movement became "purposive" in character. This purposive character, however, only becomes clearly manifest when mental activity is associated with living material of great molecular complexity, and a high degree of organisation, such as we find in the human brain.

Purposive behaviour differs, however, only in degree from the instinctive behaviour of animals.

Purposive behaviour is associated with the formation of a mental image of the end in view, and with the use of the experimental method in attaining it. It is, in fact, largely concerned with the Future, though dependent on past experience or memory.

10. If the basis of Indeterminacy, which is essential for the manifestation of volition and purposive behaviour, is derived from the freedom which formed the early condition of atomic or pre-atomic movement, then there is no need for the introduction of any outside influence, or power, in order to over-ride or supersede Determinism.

It is true that Indeterminacy cannot arise directly out of Determinacy, but this difficulty does not occur if some measure of Indeterminacy has persisted alongside of Determinism from the beginning of Creation.

We must also explain that, when we speak of movement as free, or not causally determined, we do not mean that it is independent of all causation on the one hand, or that it is under the arbitrary influence of some supernatural power on the other.

What we do mean by free movement is movement which was originally free from, or has been freed from, the direct influence of those environmental restrictions which make for Determinism.

The kind of causality which underlies volition and choice resides in the constitution and potentiality of the organism or personality. It is this which counterbalances or over-rides the environmental restrictions.

This state of relative independence of environmental influence was present at the beginning when material aggregates began to form at a time when the environment was homogeneous. It reappeared in a more marked form at a later stage of cosmic evolution when the entity or the organism began to control the environment, instead of being wholly controlled by it.

On the old mechanistic theory of the Universe, any suggestion that Indeterminacy and Determinacy might both exist and both operate as factors in cosmic events, would have been inadmissible. Now, however, when the existence of Indeterminacy in the atomic sphere has been accepted by some eminent Physicists, the problem has entered on a new phase. The question has become one of the nature of the relationship between free movement in the atomic sphere, and the free movement which underlies choice and volition.

Now the difference between these two aspects of Indeterminacy is mainly a question of the kind of reaction which takes place between the aggregate or organism, and the environment. The inorganic aggregate is losing energy and is subject to the law of Entropy. The living organism makes use of falling energy to build up an entity of greater complexity, and potentiality. The law of Entropy is temporarily, but only temporarily, arrested.

In the conscious thinking organism, the building-up process goes further. The individual entity acquires a wider sphere of influence in Space and Time. The environment comes, within somewhat narrow but ever widening limits, under the control of the personality. But this only occurs, as far as we know, in association with, or under the influence of, Mind.

THE METHOD OF EVOLUTION.

Having now stated our conclusions about the problem of Causality when viewed from the scientific and the common-sense standpoint, we may go on to enquire what light this combined point of view throws on the method of cosmic evolution.

Here the evidence is more definite. It points to the conclusion that the evolution of the Cosmos is proceeding along experimental lines, that is, by the method of "Trial and Error".

The grounds on which this conclusion rests have already been stated. They include illustrative examples drawn from the inorganic and the organic world.

The facts of Palæontology, Phylogeny, Ontogeny, and especially the way in which the human individual learns form experience, and makes "use acquirements" all support the conclusion, that, whatever may have been the scheme or plan of Creation, the realisation of that plan or scheme is being carried out along experimental lines. But the use of the method of "Trial and Error" pre-supposes a basis of Indeterminacy, *i.e.* freedom from rigid pre-determinism.

Other questions, besides those of Causality and the method of evolution have also arisen, such for instance as the real nature of Actuality; the origin of our conceptions of Space and Time; the freedom of the Will; and the nature and significance of evil, failure and individual death.

These problems, however, have been in part considered, and the conclusions arrived at have been stated, as far as has been possible, in the appropriate sections of this address.

A CONSISTENT PHILOSOPHY OF LIFE.

We have also tried to ascertain to what extent a combination of the scientific and the common-sense views can help us in framing a sound and consistent Philosophy of Life.

Such a Philosophy, if it is to be in any degree adequate as an explanation of cosmic events, if it is to satisfy the mind, must be based on sound scientific knowledge, not only of the mode of government of the material universe, but also of the world

of Life and Mind. It must, in fact, include a study of all those forms of cosmic activity with which man has established any relationship.

But this means that, as a Philosophy, it must be capable of revision and change, as the scientific knowledge on which it rests itself grows and develops. For as T. H. Huxley (81) has said "Science commits suicide when it adopts a creed".

The same can also be said of Philosophy and Religion.

The introduction of dogma in Religion limits man's outlook on the unseen world, and it is man's mental attitude to the unseen, or that portion of the universe with which he cannot, or has not as yet, established direct contact, that constitutes the real spirit of Religion.

Thus, when traced back far enough, all questions of universal significance seem to find their ultimate source in the fundamental problem of Causality, and, as I have tried to show in this address, the problem of Causality is a dual and not a single one.

Our Philosophy of Life must then, be deeply influenced by the view we take of the two fundamental and inter-related problems, Causality, and the mode of government of the Universe.

Philosophy as a Guide to Conduct.

Moreover, the Philosophy of Life which we have tried to reach from the study of the evidence afforded by the scientific and common-sense views of the Universe, must be a Philosophy which can serve as a guide to conduct. Let us see to what extent our Philosophy fulfils this requirement. In so far as it is based on the existence of Indeterminacy, it will recognise some degree of choice, and individual responsibility, in human affairs.

Being founded on the assumption that the Universe is controlled and governed on experimental lines, it will also realise that human progress can only be achieved by the "Trial and Error" method, that is, by "Testing all things and holding fast to that which is good".

But such a Philosophy of Life will also include the recognition of the fact that increased control over the environment includes the internal as well as the external environment. For it is only as man secures greater control over himself and his own development, that he will be able to overcome those restrictions to freedom of action which originate in the external world.

Hence such a Philosophy will recognise that mutual aid and co-operation are necessary for the achievement of fuller control over the human, as well as the material environment on any large scale, and it will, therefore, welcome the replacement of crude and wasteful competition by mutual co-operation in the social evolution of Mankind.

While, for the improvement of human nature itself, which is essential to progress, the wise application of sociological, as well as biological and genetic knowledge, will also be necessary. In an address on "Individualism and Socialism from the biological standpoint" (83), given in 1911, attention was drawn to the need for approaching the eugenic problem from the environmental, as well as from the genetic side. In the last Galton Lecture, Professor J. S. Huxley (84) has insisted on the need for levelling up "opportunity" all round, if we are to secure the right kind of selection. Professor H. J. Muller (85) has also emphasised the same point.

Thus we are led to our ultimate conclusion which is, that cosmic evolution is not fortuitous or haphazard, but orderly. The process of development has reference to the future and is therefore purposive in character. It depends on the existence of Indeterminacy as well as Determinacy, and is capable of change and re-adjustment, in short, the evolutionary process is proceeding along experimental lines.

Of alternative theories of the Universe, all we can say is that this one seems to be the most probable when judged by the test of our human experience of what has happened, and is happening, in that limited portion of the Universe with which man has, up to the present, established any relationship. It seems also the most probable when viewed from the combined standpoint of science and common-sense.

Moreover, it gives us a Philosophy of Life which is consistent in itself, and can also serve as a guide for conduct.

In a recent paper, M. Hadden Moore (82) has suggested that it is not necessary to associate order or design with the teleological concept of Purpose, that is to say, there is no need to go beyond design or orderly development to a Purpose or a Designer. Thus, Moore says that "the order or design which is found in any system is a function of the system itself taken as a whole". He recognises, however, "that much of human behaviour *is* purposive in character, since it is directed towards ends", but he explains this purposive character as a function of the "total situation" or as, perhaps we might say, of the interaction between the individual and the environment, the Part and the Whole.

But much depends on what we include in the words "the whole situation". If we mean, the orderly, purposive activity of a human individual, exercising some degree of choice and freedom of action in response to, and in interaction with the environment, then no doubt such is a fair description of what takes place. The individual and the environment both share in the result and it is not necessary to invoke any other outside agency to prepare the plan which is thus carried out.

In the same way, if we agree that the thought of the Universe, the Creator, is one with and immanent in Creation, then we can legitimately speak of the order and purpose of the Universe as the outcome of the synthesis of all its activities, including the control exercised by the "whole" over the parts.

We have spoken of the possibility of a Plan or Scheme of Creation in relation to purpose. We may perhaps regard a Plan as a way of directing events in one direction only, to the exclusion of all other directions. While a Scheme may be looked upon as a method which includes all possible happenings and is self-regulatory.

But both a Plan and a Scheme, and indeed every conception or theory of the origin of the Universe, starts with the assumption that matter possesses certain inherent qualities and

such an assumption pre-supposes the idea of a Creator. The ultimate question is therefore whether the Creator is outside and apart from, or immanent in, and one with Creation. The belief that the Creator is immanent in Creation, that Nature and God are one, seems to be more in harmony with the existence of Indeterminacy, and with our experience of the experimental character of Cosmic Evolution.

Sir James Jeans (89) has expressed the opinion that "Modern scientific theory compels us to think of the Creator as working outside Time and Space, which are part of Creation, just as the artist is outside his canvas", and he also describes "Creation as an act of Thought". But may not the Creator be outside his creation in the sense that his Thought originated its framework, and yet be immanent in, and one with Creation in the sense that its evolution represents the "Materialisation of the same creative thought".

Moreover in comparing the work of the human artist with that of the Creator, we must remember that the former first draws a mental picture on the canvas of his mind, through the medium of his personality, from which he cannot free himself or get outside. To what extent this mental picture is faithfully reproduced in the drawing on the easel, will depend on the technical skill of the artist and on limitations imposed by the environment. The two pictures represent the material and the mental side of one and the same event.

The same is also surely true of Creation in its physical and psychical aspects, which are manifestations of one and the same Reality. It is the old story of the self and the non-self, the Part and the Whole. But while our human selves are only Parts, the self of the Creator embraces the Whole.

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