J B S HALDANE

SCIENCE AND LIFE

ESSAYS OF A RATIONALIST

Introduction by
J Maynard Smith

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CONTENTS

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INTRODUCTION

I FIRST READ A BOOK of essays by Haldane, it was *The Inequality of Man*, when I was at Eton. I was led to read them because he was at that time regarded by at least some of the masters as a figure of immense wickedness. Although I did not know it at the time, this chance encounter with Haldane's writing had a big influence on my future career. My interest in genetics had already been aroused by that most imaginative of all science-fiction novels, Olaf Stapledon's *Last and First Men*. When, ten years later, I decided to chuck in engineering to take up biology, I went to University College, London, because I wanted to study under Haldane, and I remained at the College for almost twenty years.

My first experience of Haldane's writing I found most encouraging at a time when I needed encouragement. I had already reached the conclusion that the religious faith in which I had been brought up was untenable, but I was reluctant to accept the conclusion. Christianity may be untenable, but it is also comforting. Haldane's essays showed that a lack of religious faith is not merely negative; it brings with it an advantage for which I would gladly sacrifice any amount of comfort and reassurance. This advantage is the freedom to follow any train of thought to its conclusion without fearing that this conclusion may upset one's faith.

This point is worth emphasizing, because it is part of the justification a Rationalist has for saying what he thinks. After all, it might be argued, if a man is an atheist, why does he not keep it to himself? A religious man has grounds for proselytizing the heathen, since he believes conversion will benefit them. But an atheist does not believe that religious belief harms a man. Why, then, upset people who are happy in

their belief? As a rather sophisticated example of this argument, I remember deploring the current vogue for Teilhard de Chardin to a distinguished American evolutionist, who replied that it was pointless to criticize Teilhard, since most people need a religion, and it might just as well be an evolutionary one.

The answer to this argument, of course, is that religious belief, or indeed any belief held as an article of faith whether or not appeal is made to a personal God, can harm a man. Harm may result because of the large-scale application of a belief, as of the Aztec belief that their welfare depended on removing the hearts from living victims, or of the (now regretted) Christian insistence that the Jews had crucified their God, or of the (still unregretted) belief that birth control is wicked. But harm is also done to the individual if his faith makes him reluctant to use his mind. My remembered pleasure in reading *The Inequality of Man* arose, I think, because it was my first acquaintance with a man who felt free to question anything.

The essays collected in this book all appeared originally in the *Rationalist Annual*. It is therefore natural that many of them deal with problems of superstition and of ethics. I worked with Haldane long enough to know that he held strong if sometimes unorthodox ethical opinions. If anyone wanted from a single essay to get some idea of what kind of man Haldane was, they could do worse than read the essay 'A Passage to India' in this book. It is entirely characteristic of him that he should have singled out for approval from Hindu mythology the story of Yudhisthira's entry into heaven (you can read the story in his essay). It is characteristic first of all that he should, at an age of over sixty, have acquired an extensive knowledge of Hindu mythology. The myth which he selects has as its moral, to quote Haldane, 'a man must not do an action which he regards as dishonourable even if ordered to by the chief of the gods in person'; and he adds, 'If Abraham

had refused to kill Isaac at the divine command, I should have more respect for the Old Testament.'

But the essays in this book are not confined to narrowly 'Rationalist' topics. In particular, there is a series of essays on 'origins'—of life, of purpose, and of language. These contain important ideas; Haldane's ideas on the origin of life have played a crucial part in the history of this subject. But if you want to get an idea of how his mind worked, I recommend the essay on 'The Origin of Lactation', in which he puts forward a new and to me entirely convincing solution to the difficult problem of how the various adaptations—of the mother's anatomy, of the mother's behaviour, of the structure of the baby's mouth and digestive system, and of the baby's behaviour—could have arisen; the problem, of course, is that any one of these adaptations would be useless without the others. It is typical that he starts from an apparently irrelevant observation made by a colleague—in this case by his wife Helen Spurway. He was not himself a good observer—and he was a terrifyingly bad experimenter—but he read avidly and he listened to what people told him, and he had a knack of drawing conclusions which the observer himself had missed.

The fact that he wrote essays about superstition, and about biochemistry, genetics, and evolution, is not accidental. The connection between biochemistry and heterodox views about religion and politics may seem tenuous, but it exists. Recently an English biochemist wrote to *Science* complaining of the difficulty which he had experienced in obtaining a US visa, and of the fact that in explanation of the delay he had been told '. . . it was now the policy of the US Embassy, in dealing with visa applications, to regard all biochemists as likely to have left-wing tendencies, and therefore to investigate closely the political background of any biochemist who applied for a temporary visa to visit the States'. Of course it is very silly to exclude scientists from the US because one fears they may

hold heretical views. But if I did want to start a heresy hunt, I might well start on biochemists.

A story from my childhood may explain why this is so. My religious doubts must have started when I was at my preparatory school, because I remember the Headmaster, who needless to say was a parson, setting my mind at rest with the following argument. Chemists, he said, can now determine with great exactitude how much of each element—carbon, oxygen, nitrogen, and so on—is contained within a seed. But if you make an artificial seed containing just these elements in just these proportions, it will not grow. It lacks the breath of life, which only God can give. Today, to argue thus would be to give a hostage to fortune, but it must have seemed safe enough in those days.

The point of this anecdote is that fifty years ago, when Haldane started his scientific career, and to a significant extent even fifteen years ago, the difference between 'living' and 'dead' matter was an unsolved problem, and hence provided a refuge for religious faith. Biochemistry as a subject therefore acted as a magnet to a particular kind of mind—the kind of mind which likes asking awkward questions. It may have had a particular attraction for Haldane because his father, the physiologist J. S. Haldane, for whom he had a great respect and affection, had held some peculiarly woolly ideas about the nature of living matter.

Looking through what I have written, it seems that I have failed to emphasize the most important thing about Haldane's essays, which is that they are enormous fun to read.

J. MAYNARD SMITH

1929

THE ORIGIN OF LIFE

UNTIL 1668 it was generally believed that living beings were constantly arising out of dead matter. Maggots were supposed to be generated spontaneously in decaying meat. In that year Redi showed that this did not happen provided insects were carefully excluded. And in 1860 Pasteur extended the proof to the bacteria which he had shown were the cause of putrefaction. It seemed fairly clear that all the living beings known to us originate from other living beings. At the same time Darwin gave a new emotional interest to the problem. It had appeared unimportant that a few worms should originate from mud. But if man was descended from worms such spontaneous generation acquired a new significance. The origin of life on the earth would have been as casual an affair as the evolution of monkeys into man. Even if the latter stages of man's history were due to natural causes, pride clung to a supernatural, or at least surprising, mode of origin for his ultimate ancestors. So it was with a sigh of relief that a good many men, whom Darwin's arguments had convinced, accepted the conclusion of Pasteur that life can originate only from life. It was possible either to suppose that life had been supernaturally created on earth some millions of years ago, or that it had been brought to earth by a meteorite or by micro-organisms floating through interstellar space. But a large number, perhaps the majority, of biologists believed, in spite of Pasteur, that at some time in the remote past life had originated on earth from dead matter as the result of natural processes.

The more ardent materialists tried to fill in the details of

this process, but without complete success. Oddly enough, the few scientific men who professed idealism agreed with them. For if one can find evidence of mind (in religious terminology the finger of God) in the most ordinary events, even those which go on in the chemical laboratory, one can without too much difficulty believe in the origin of life from such processes. Pasteur's work therefore appealed most strongly to those who desired to stress the contrast between mind and matter. For a variety of obscure historical reasons, the Christian Churches have taken this latter point of view. But it should never be forgotten that the early Christians held many views which are now regarded as materialistic. They believed in the resurrection of the body, not the immortality of the soul. St Paul seems to have attributed consciousness and will to the body. He used a phrase translated in the revised version as 'the mind of the flesh', and credited the flesh with a capacity for hatred, wrath, and other mental functions. Many modern physiologists hold similar beliefs. But, perhaps fortunately for Christianity, the Church was captured by a group of very inferior Greek philosophers in the third and fourth centuries AD. Since that date views as to the relation between mind and body which St Paul, at least, did not hold have been regarded as part of Christianity, and have retarded the progress of science.

It is hard to believe that any lapse of time will dim the glory of Pasteur's positive achievements. He published singularly few experimental results. It has even been suggested by a cynic that his entire work would not gain a Doctorate of Philosophy today! But every experiment was final. I have never heard of anyone who has repeated any experiment of Pasteur's with a result different from that of the master. Yet his deductions from these experiments were sometimes too sweeping. It is perhaps not quite irrelevant that he worked in his later years with half a brain. His right cerebral hemisphere had been extensively wrecked when he was only forty-five

years old; and the united brain power of the microbiologists who succeeded him has barely compensated for that accident. Even during his lifetime some of the conclusions which he had drawn from his experimental work were disproved. He had said that alcoholic fermentation was impossible without life. Buchner obtained it with a cell-free and dead extract of yeast. And since his death the gap between life and matter has been greatly narrowed.

When Darwin deduced the animal origin of man a search began for a 'missing link' between ourselves and the apes. When Dubois found the bones of Pithecanthropus some comparative anatomists at once proclaimed that they were of animal origin, while others were equally convinced that they were parts of a human skeleton. It is now generally recognized that either party was right, according to the definition of humanity adopted. Pithecanthropus was a creature which might legitimately be described either as a man or an ape, and its existence showed that the distinction between the two was not absolute.

Now the recent study of ultramicroscopic beings has brought up at least one parallel case, that of the bacteriophage, discovered by d'Herelle, who had been to some extent anticipated by Twort. This is the cause of a disease or, at any rate, abnormality of bacteria. Before the size of the atom was known there was no reason to doubt that

> *Big fleas have little fleas*
> *Upon their backs to bite 'em;*
> *The little ones have lesser ones,*
> *And so* ad infinitum.

But we now know that this is impossible. Roughly speaking, from the point of view of size, the bacillus is the flea's flea, the bacteriophage the bacillus' flea; but the bacteriophage's flea would be of the dimensions of an atom, and atoms do not behave like fleas. In other words, there are only about as

many atoms in a cell as cells in a man. The link between living and dead matter is therefore somewhere between a cell and an atom.

D'Herelle found that certain cultures of bacteria began to swell up and burst until all had disappeared. If such cultures were passed through a filter fine enough to keep out all bacteria, the filtrate could infect fresh bacteria, and so on indefinitely. Though the infective agents cannot be seen with a microscope, they can be counted as follows. If an active filtrate containing bacteriophage be poured over a colony of bacteria on a jelly, the bacteria will all, or almost all, disappear. If it be diluted many thousand times, a few islands of living bacteria survive for some time. If it be diluted about ten million fold, the bacteria are destroyed round only a few isolated spots, each representing a single particle of bacteriophage.

Since the bacteriophage multiplies, d'Herelle believes it to be a living organism. Bordet and others have taken an opposite view. It will survive heating and other insults which kill the large majority of organisms, and will multiply only in presence of living bacteria, though it can break up dead ones. Except perhaps in presence of bacteria, it does not use oxygen or display any other signs of life. Bordet and his school therefore regard it as a ferment which breaks up bacteria as our own digestive ferments break up our food, at the same time inducing the disintegrating bacteria to produce more of the same ferment. This is not as fantastic as it sounds, for most cells while dying liberate or activate ferments which digest themselves. But these ferments are certainly feeble when compared with the bacteriophage.

Clearly we are in doubt as to the proper criterion of life. D'Herelle says that the bacteriophage is alive, because, like the flea or the tiger, it can multiply indefinitely at the cost of living beings. His opponents say that it can multiply only as long as its food is alive, whereas the tiger certainly, and the

flea probably, can live on dead products of life. They suggest that the bacteriophage is like a book or a work of art which is constantly being copied by living beings, and is therefore only metaphorically alive, its real life being in its copiers.

The American geneticist Müller has, however, suggested an intermediate view. He compares the bacteriophage to a gene—that is to say, one of the units concerned in heredity. A fully coloured and a spotted dog differ because the latter has in each of its cells one or two of a certain gene, which we know is too small for the microscope to see. Before a cell of a dog divides, this gene divides also, so that each of the daughter cells has one, two, or none according with the number in the parent cell. The ordinary spotted dog is healthy, but a gene common among German dogs causes a roan colour when one is present, while two make the dog nearly white, wall-eyed, and generally deaf, blind, or both. Most of such dogs die young, and the analogy to the bacteriophage is fairly close. The main difference between such a lethal gene, of which many are known, and the bacteriophage is that the one is only known inside the cell, the other outside. In the present state of our ignorance we may regard the gene either as a tiny organism which can divide in the environment provided by the rest of the cell, or as a bit of machinery which the 'living' cell copies at each division. The truth is probably somewhere in between these two hypotheses.

Unless a living creature is a piece of dead matter plus a soul (a view which finds little support in modern biology), something of the following kind must be true. A simple organism must consists of parts A, B, C, D, and so on, each of which can multiply only in presence of all, or almost all, of the others. Among these parts are genes, and the bacteriophage is such a part which has got loose. This hypothesis becomes more plausible if we believe in the work of Handuroy, who finds that the ultramicroscopic particles into which the bacteria have been broken up, and which pass

through filters that can stop the bacteria, occasionally grow up again into bacteria after a lapse of several months. He brings evidence to show that such fragments of bacteria may cause disease, and d'Herelle and Peyre claim to have found the ultramicroscopic form of a common staphylococcus, along with bacteriophage, in cancers, and suspects that this combination may be the cause of that disease.

On this view the bacteriophage is a cog, as it were, in the wheel of a life cycle of many bacteria. The same bacteriophage can act on different species, and is thus, so to say, a spare part which can be fitted into a number of different machines, just as a human diabetic can remain in health when provided with insulin manufactured by a pig. A great many kinds of molecule have been got from cells, and many of them are very efficient when removed from it. One can separate from yeast one of the many tools which it uses in alcoholic fermentation, an enzyme called invertase, and this will break up six times its weight of cane sugar per second for an indefinite time without wearing out. As it does not form alcohol from the sugar, but only a sticky mixture of other sugars, its use is permitted in the US in the manufacture of confectionery and cake-icing. But such fragments do not reproduce themselves, though they take part in the assimilation of food by the living cell. No one supposes that they are alive. The bacteriophage is a step beyond the enzyme on the road to life, but it is perhaps an exaggeration to call it fully alive. At about the same stage on the road are the viruses which cause such diseases as smallpox, herpes, and hydrophobia. They can multiply only in living tissue, and pass through filters which stop bacteria.

With these facts in mind we may, I think, legitimately speculate on the origin of life on this planet. Within a few thousand years from its origin it probably cooled down so far as to develop a fairly permanent solid crust. For a long time, however, this crust must have been above the boiling point of

water, which condensed only gradually. The primitive atmosphere probably contained little or no oxygen, for our present supply of that gas is only about enough to burn all the coal and other organic remains found below and on the earth's surface. On the other hand, almost all the carbon now combined in chalk, limestone, and dolomite were in the atmosphere as carbon dioxide. Probably a good deal of the nitrogen now in the air was combined with metals as nitride in the earth's crust, so that ammonia was constantly being formed by the action of water. The sun was perhaps slightly brighter than it is now, and as there was no oxygen in the atmosphere, the chemically active ultra-violet rays from the sun were not, as they now are, mainly stopped by ozone (a modified form of oxygen) in the upper atmosphere, and oxygen itself lower down. They penetrated to the surface of the land and sea, or at least to the clouds.

Now, when ultra-violet light acts on a mixture of water, carbon dioxide, and ammonia, a vast variety of organic substances are made, including sugars and apparently some of the materials from which proteins are built up. This fact has been demonstrated in the laboratory by Baly of Liverpool and his colleagues. In this present world such substances, if left about, decay—that is to say, they are destroyed by micro-organisms. But before the origin of life they must have accumulated till the primitive oceans reached the consistency of hot dilute soup. Today an organism must trust to luck, skill, or strength to obtain its food. The first precursors of life found food available in considerable quantities, and had no competitors in the struggle for existence. As the primitive atmosphere contained little or no oxygen, they must have obtained the energy which they needed for growth by some other process than oxidation—in fact, by fermentation. For, as Pasteur put it, fermentation is life without oxygen. If this was so, we should expect that high organisms like ourselves would start life as anaerobic beings, just as we start as single

cells. This is the case. Embryo chicks for the first two or three days after fertilization use very little oxygen, but obtain the energy which they need for growth by fermenting sugar into lactic acid, like the bacteria which turns milk sour. So do various embryo mammals, and in all probability you and I lived mainly by fermentation during the first week of our pre-natal life. The cancer cell behaves in the same way. Warburg has shown that with its embryonic habit of unrestricted growth there goes an embryonic habit of fermentation.

The first living or half-living things were probably large molecules synthesized under the influence of the sun's radiation, and only capable of reproduction in the particularly favourable medium in which they originated. Each presumably required a variety of highly specialized molecules before it could reproduce itself, and it depended on chance for a supply of them. This is the case today with most viruses, including the bacteriophage, which can grow only in presence of the complicated assortment of molecules found in a living cell.

The unicellular organisms, including bacteria, which were the simplest living things known a generation ago, are far more complicated. They are organisms—that is to say, systems whose parts co-operate. Each part is specialized to a particular chemical function, and prepares chemical molecules suitable for the growth of the other parts. In consequence, the cell as a whole can usually subsist on a few types of molecule, which are transformed within it into the more complex substances needed for the growth of the parts.

The cell consists of numerous half-living chemical molecules suspended in water and enclosed in an oily film. When the whole sea was a vast chemical laboratory the conditions for the formation of such films must have been relatively favourable; but for all that life may have remained in the virus stage for many millions of years before a suitable

assemblage of elementary units was brought together in the first cell. There must have been many failures, but the first successful cell had plenty of food, and an immense advantage over its competitors.

It is probable that all organisms now alive are descended from one ancestor, for the following reason. Most of our structural molecules are asymmetrical, as shown by the fact that they rotate the plane of polarized light, and often form asymmetrical crystals. But of the two possible types of any such molecule, related to one another like a right and left boot, only one is found throughout living nature. The apparent exceptions to this rule are all small molecules which are not used in the building of the large structures which display the phenomena of life. There is nothing, so far as we can see, in the nature of things to prevent the existence of looking-glass organisms built from molecules which are, so to say, the mirror images in our own bodies. Many of the requisite molecules have already been made in the laboratory. If life had originated independently on several occasions, such organisms would probably exist. As they do not, this event probably occurred only once or, more probably, the descendants of the first living organism rapidly evolved far enough to overwhelm any later competitors when these arrived on the scene.

As the primitive organisms used up the foodstuffs available in the sea, some of them began to perform in their own bodies the synthesis formerly performed at haphazard by the sunlight, thus ensuring a liberal supply of food. The first plants thus came into existence, living near the surface of the ocean, and making food with the aid of sunlight as do their descendants today. It is thought by many biologists that we animals are descended from them. Among the molecules in our own bodies are a number whose structure resembles that of chlorophyll, the green pigment with which the plants have harnessed the sunlight to their needs. We use them for other

purposes than the plants—for example, for carrying oxygen—and we do not, of course, know whether they are, so to speak, descendants of chlorophyll or merely cousins. But since the oxygen liberated by the first plants must have killed off most of the other organisms, the former view is the more plausible.

The above conclusions are speculative. They will remain so until living creatures have been synthesized in the biochemical laboratory. We are a long way from that goal. It was in 1928 that Pictel for the first time made cane sugar artificially. It is doubtful whether any enzyme has been obtained quite pure. Nevertheless I hope to live to see one made artificially. I do not think I shall behold the synthesis of anything so nearly alive as a bacteriophage or a virus, and I do not suppose that a self-contained organism will be made for centuries. Until that is done the origin of life will remain a subject for speculation. But such speculation is not idle, because it is susceptible of experimental proof or disproof.

Some people will consider it a sufficient refutation of the above theories to say that they are materialistic, and that materialism can be refuted on philosophical grounds. They are no doubt compatible with materialism, but also with other philosophical tenets. The facts are, after all, fairly plain. Just as we know of sight only in connection with a particular kind of material system called the eye, so we know only of life in connection with certain arrangements of matter, of which the biochemist can give a good, but far from complete, account. The question at issue is: 'How did the first such system on this planet originate?' This is a historical problem to which I have given a very tentative answer on the not unreasonable hypothesis that a thousand million years ago matter obeyed the same laws that it does today.

This answer is compatible with, for example, the view that pre-existent mind or spirit can associate itself with certain kinds of matter. If so, we are left with the mystery as to why mind has so marked a preference for a particular type of

colloidal organic substances. Personally I regard all attempts to describe the relation of mind to matter as rather clumsy metaphors. The biochemist knows no more, and no less, about this question than anyone else. His ignorance disqualifies him no more than the historian or the geologist from attempting to solve a historical problem.

1934

IF . . .

IN A SCIENTIFIC PAPER one can almost gauge the intellectual honesty of the author by the number of phenomena which he or she leaves unexplained. The historian, with rare exceptions, is expected to explain everything. This happened because King John was a bad man, that because God willed it, and the other because the feudal system had developed an internal contradiction. It is only a great historian who can dare to confess his complete ignorance. That eminent Rationalist, the late Professor Bury, devoted a learned and fascinating book to the collapse of the Roman Empire about AD 400. He raised the question of why the Western Empire fell when the Eastern survived, and after a very close analysis he put it down to bad luck—in other words, to causes outside the sphere of the historian. If at the critical moment Rome had produced a military leader, it would not have been compelled to rely on Stilicho the Goth, and Alaric might have been repulsed from Rome as he was from Constantinople.

This sort of history is encouraging to the lover of speculation like myself. If individuals count, if Cleopatra's nose and Elizabeth's sexual abnormality really diverted the course of history, then we may legitimately rewrite it as it might have been. And just because the details of religion depend so much on the ideas of individuals, even if its general lines are determined by economic and social conditions, religious history should be particularly easy to rewrite in this way. So it is not unprofitable to consider what would have happened if, instead of being murdered in his tent, Aurelian had reigned for as many years as Constantine, and founded a dynasty devoted

to the worship of the Unconquered Sun. We must allow for modifications of Mithraism similar to those which occurred in primitive Christianity, and try to put ourselves in the place of a liberal Churchman of today—worried, but not overwhelmed, by the advance of science, and eager to make the best of both worlds. Here is what, but for the dagger of Mucapor, we might today be reading, or hearing on the radio:

'Mithraism and its Critics'

Twenty, nay even ten, years ago the intellectual basis of our faith seemed insecure to many honest thinkers. Old Testament critics had carried with them a large body of opinion, even among the clergy, in favour of the theory that the books usually attributed to Zoroaster contained many later interpolations. And the evidence that even the New Testament writings had not always come down to us in their completely written form had shaken the faith of many. But these things did not touch the core of our religion. The writings of Drews in Germany and Robertson in England, which actually cast doubt upon the historicity of Mithras, were a more serious matter. Fortunately this preposterous theory has been completely discredited by such works as the Bishop of Cambridge's *Mithras the Man*, just as the recent excavations in Persia have done so much to verify the miraculous element in Zoroaster's writings.

But it was the advance of science, rather than the criticism of Scripture, which had done most to shake the faith of those who did not realize that there can be no contradiction between science and religion. For every advance of science has served to confirm the truths handed down to us by our Lord and his Apostles. To take a well-known example, every child asks its mother: 'Why does the Sun let the clouds hide His face?', and one of the dualistic heresies of the primitive Church was, of course, based on the idea that the clouds represented

an evil power hostile to the Sun. Thanks to science, we know today that the Sun Himself draws them up from the ocean by His own power.

The Church of England is based on science, as embodied in the Copernican Reformation. The discovery that the Sun is the centre of our system gives us a far truer idea of His greatness than the Ptolemaic system still taught by the Roman Church. And the Anglican Church has always welcomed the advance of science, provided that it was true science and not idle speculation. Rationalists (so-called) have regarded the execution of Bruno as a blot on our Church, and have claimed him as a martyr of science because he regarded the fixed stars as suns. They forget that Bruno conceived these bodies as each surrounded by planets like the earth—a doctrine clearly destructive of true religion. His execution was not, of course, in keeping with modern views; however, he was a martyr not of science but of error.

Now, when the sizes of the fixed stars were ascertained and their spectra observed, it became clear that in certain respects they did resemble the Sun. For many this seemed the beginning of the end. The champions of religion were not always discreet. We must admit that in Norman Lockyer's famous encounter with the Professor of Dogmatic Heliology at the British Association's meeting at Oxford the Professor had the worst of it. Yet men of faith went on in the quiet certainty that with the further progress of knowledge the wise old heliologians would be vindicated. And it was so. We already know that the vast majority of these so-called suns are utterly unfitted to be luminaries surrounded by planets with living, let alone rational, inhabitants. Some are too hot, others too cold. Many are double, many more are variable. A hundred years of careful search has not produced a tittle of evidence that any planetary system save our own exists. The beautiful researches of Sir Jacob Janes, popularized in *The Intelligible Universe*, have shown that another such system

could have come into being only by a miracle. And a Rationalism which can defend itself only by postulating miracles is not a very redoubtable foe.

It may well be that many of the fixed stars resemble the Sun as a statue, or even a corpse, resembles a man. But they are not the fathers of living systems, and they are not themselves alive. It is one of the most elementary facts of religious experience that the Sun is full of an intense life, and no one who opens his eyes without bias on a bright summer's day can well escape awareness of it. No fact of religion has been more abundantly confirmed by science than that the Sun is 'the Lord and Giver of Life'. Not only has a study of photosynthesis shown that the energy for the lives of plants and animals is all derived from the Sun but opinion is becoming stronger and stronger that life on our earth originated in organic matter formed by solar radiation in the primitive atmosphere. Finally, every year makes it more probable that our whole earth *is only* a detached fragment of His body. Zoroaster has been fully vindicated.

The fantastic cosmogony of Laplace, according to which the Sun and His planets were evolved out of a spinning nebula, has gone the way of other such follies. A little elementary philosophy would have shown its deluded adherents that order cannot arise out of chaos. But during the late nineteenth century certain oriental religions became temporarily fashionable in 'advanced' circles. Hinduism, disguised as Theosophy, obtained a certain hold. Still more fantastic was the attempt to bring Christianity into Europe. This religion had a certain vogue among the poorer classes of the Roman Empire in the first centuries of our era, but vanished, with other dark things, before the rising Sun of Mithraism. Its extraordinary doctrine that the material world had an immaterial creator, who yet begot a material son, could have appealed only to lovers of paradox, and its moral consequences are sufficiently demonstrated by the fact that it is the

official religion of Abyssinia, the only State where not merely slavery but slave-raiding is still in vogue.

True religion can be built only on the impregnable rock of Materialism, and we need not be surprised that one of the most daring of recent attacks on the divinity of the Sun is to be found, thinly veiled under a cloud of mathematical formulae, in *The International Constitution of the Stars*, by the well-known idealist Professor Addington. Throughout the tacit assumption, based on a possibly fortuitous numerical agreement, is made that the Sun is only a star. And a star, according to this author, is a mere ball of gas, a chaos of atoms and electrons flying at random.

Not for the first time the learning of Oxford has overthrown the speculation of Cambridge. There are many who feel that any attempt to probe the internal constitution of the Sun, even in a spirit of the deepest reverence, has a flavour of blasphemy. We cannot share this view. Religion, we repeat, has nothing to fear from science. So firmly is this principle established by history that we can afford to neglect pronouncements contrary to religion, made in the name of science, in the certainty that further research will disprove them. Professor Mill of Oxford re-examined Addington's assumption. The Sun, it now seems, has a gaseous envelope, but a core of incredible density, in which the matter is organized in a manner to which our earthly experience furnishes no analogy. Here, and not in the solar atmosphere, we find the material conditions for a Divine Life; and here, by processes beyond the reach of human understanding, is generated the energy which we later see as Light.

If the Sun's atmosphere is gaseous, His core is eminently solid and material. And the same is true of Light. The hideous hypothesis of Young and Fresnel reduced the Holy Light Itself to vibrations in an hypothetical ether. No more than the particle theory of Newton could it be reconciled with the truths of religion. After being bandied about for a cen-

tury by scientific dogmatists the wave theory is now being withdrawn with as little noise as practicable. Light has properties like those of waves, others like those of particles; and matter also has properties of both kinds. By faith we have accepted the doctrine that the Sun, Mithras, and the Holy Light are one. In every century there have been scoffers who asked how this was possible. In the nineteenth century, with the progress of astronomy and physics, the number of the scoffers increased. 'The Sun', they said, 'consists of atoms, His Light of vibrations—how can they be one?' Today, if still only incompletely, we see how.

Just as the Solar Life is not, and could not be, divorced from matter, human life is inseparably bound up with matter of a different kind. Heretical sects have continually toyed with the idea of an immaterial spirit, and during the nineteenth century several eminent scientists had adopted this theory. Their numbers are diminishing, and Sir Oliphant Ledge, who, till recently at any rate, was a champion of the undulatory theory of Light, is perhaps their last survivor. It cannot be too strongly emphasized that our creeds teach the resurrection of the body by the same Solar power which causes the germination of seeds in the spring. They contain no reference to an immaterial soul.

Such is the position today. There is not one of the central doctrines of our faith that has not been completely confirmed by science. It is a question whether we should not give this fact a practical application. A constant flood of anti-religious teaching is poured out upon our youth in the name of science. Has not the time come when this poisonous propaganda should be taken in hand? We do not wish to discourage honest investigation, even of the most basal doctrines of our religion. We must protest, however, when the half-baked theories of the lecture room are given to the world as firmly established truths. The theory that the resemblance between the Sun and the stars is more than superficial is hinted at in

many school text-books. The time is come when such books should be withdrawn. Thank the Sun, ours is still at bottom a Mithraistic country, and public opinion is ripe for recognition that, in its own interests, science should be protected against the dissemination of such errors in its name.

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And so on. We may be quite sure that this sort of stuff would find a very wide audience, in spite of the fact that, according to all the evidence, the Sun is a rather ordinary star, with no more claim to be alive than has a kettle. One can always find certain details of a religious myth or doctrine which are supported by contemporary discovery. The flood seems to have been a historical event. It is true that it did not drown everyone in Mesopotamia, let alone all mankind, except one family. But any widespread flood was good enough for Christian apologists. The walls of Jericho had fallen down (at least in some places). So they must have been brought down by Joshua's ram's horn band. Our present astronomical equations do not work for more than about 2,000 million years back. So the universe must have been created at about that date. We cannot yet predict rainstorms as accurately as eclipses. So it is legitimate to pray for rain, though superstitious to hang the crockery when the sun is eclipsed. But all these amusing details are negligible compared with the solid fact that centuries of science have produced no evidence for Divine intervention in the order of nature, or the existence of a soul detachable from the human body.

Religion is still parasitic in the interstices of our knowledge which have not yet been filled. Like bed-bugs in the cracks of walls and furniture, miracles lurk in the lacunae of science. The scientist plasters up these cracks in our knowledge; the more militant Rationalist swats the bugs in the open. Both have their proper sphere, and they should realize that they are allies.

1939

WHAT IS RELIGIOUS LIBERTY?

ALL RATIONALISTS, and most religionists in Britain, claim to believe in religious liberty. And I suppose they would all agree that no one should be killed, imprisoned, or even fined for his or her religious opinions. But how much farther are they willing to go? Thomas Paine said that 'liberty consists in the right to do whatever is not contrary to the rights of others'.

Yes; but what are other people's rights? Do they include a right to beat one's child if he does not go to church? Or have children a right to choose their own religion? Do they include a right to wake up one's neighbour in the morning because one is about to hold a religious ceremony? Or would I be right to climb the church steeple and cut the bell-ropes? Do they include a right to use endowments to propagate a doctrine when the property was originally intended for the support of a very different doctrine? Do they include a right to use the streets for processions? Or should streets be reserved for traffic?

Perhaps we shall get a clearer view on these questions if we consider the conditions which prevail in the Republic of Krassnia, whose people mostly claim that they enjoy very full religious freedom, though others take the contrary view. The official doctrine of Krassnia is Dialectical Materialism. In the past it was Mechanistic Materialism, and some traces of this survive. Thus when a new President is installed, as occurred last year, he is formally oiled by the Chief Materialist. This was originally intended to signify that he was a machine, but the meaning is now often forgotten, and it is

generally admitted that the interest of the ceremony is mainly archaeological.

However that may be, Dialectical Materialism is closely connected with the State. The President and the Minister of Justice must be Dialectical Materialists, though the Chief Commissar need not be. But he would not hold his position for long if he were so rash as to attack the theory openly; and, whatever his views may be, he usually finds it expedient to attend from time to time one of the rather tedious lectures on that topic which are given every sixth day in special lecture halls.

Again, twenty-five men chosen from the ranks of the lecturers are appointed by the government to the Upper House to represent Dialectical Materialism. They serve a valuable purpose in persuading the people that the government's measures conform to that doctrine on the whole, and they do this all the more effectually because they frequently criticize the government in matters of detail, and lament that the country is falling away from materialism.

The huge endowments of Dialectical Materialism do not come directly out of the national revenue; and this gives the government an excellent excuse for claiming religious impartiality. During the last seventy years the State has drawn little distinction between different more or less materialistic doctrines. There are methodistic materialists, dogmatic atheists, sceptical atheists, and many more sects. The present Chief Commissar is a Nullitarian atheist, and because of this many Krassnians honestly believe that they enjoy complete toleration.

Actually all forms of atheism and materialism are indirectly subsidized by the State, since buildings used for the propagation of these doctrines enjoy immunity from various forms of taxation. Buildings used for religious purposes are no more highly taxed than any others, but any tenant who holds a religious service may be ejected without notice. It is only fair to say that this law is rarely enforced.

Education is often stated to be impartial; most elementary schools are paid for by the State. In these a certain amount of formal instruction in materialism is given weekly. Children whose parents object are not compelled to attend. However, a large number of schools are subsidized by the State, but owned by various irreligious organizations. Here the anti-religious propaganda is a good deal more systematic, and the teachers must at least pretend to be good materialists. There are no specifically religious schools, though occasionally religious propaganda is put over at special classes on the sixth day in State schools, but this always leads to trouble, and sometimes to the dismissal of teachers.

Many of the secondary schools and universities are specifically materialistic. Indeed, in the 'best' of the schools the children are compelled to attend lectures on materialism twice daily. A Christian friend in Krassnia has told me that, after six years of this propaganda, materialism has become absolutely meaningless to the children, and they are often converted to Christianity without difficulty. This may be true; but there is another side to the question. Even the converts to Christianity are so saturated with materialistic principles that they still follow them unconsciously even when they have rejected them consciously.

And here literary tradition plays a considerable part. There is no doubt that the translations of Lucretius, Diderot, and Engels are among the finest literature in the Krassnian language—some say they are better than the originals. They are so assiduously taught that their ideas are part of the common stock. Indeed, it is not uncommon to hear a prominent Christian quoting these works in a public speech.

Just as materialism is bound up with their ideas on all topics, so it is inextricably mingled with their public life. To take a simple example, the National Anthem begins—

'*There is no God in Krassnia*'.

This song is sung, or its tune played, not merely at official ceremonies but at the close of stage plays and film shows. On these occasions the whole audience is accustomed to sit down, and the men to put their hats on as a token of reverence. Christians who objected to this form of blasphemy have often been assaulted, though of late years on the ground that their action was unpatriotic rather than anti-materialistic. Judges have held that such assaults were justified, as a failure to sit down was insulting behaviour.

The radio is, of course, controlled by materialists, and brief discourses on materialism are given twice daily, while much longer and duller lectures occupy much of the programme on the sixth day. A few Christians have in the past been allowed to give a rather diluted account of their religious tenets, but this led to so many protests from materialistic listeners that such propaganda has now ceased. At no time have the most important religious bodies, the Religious Press Association and the National Salvation Society, been permitted to use the radio, and there was a storm of protest when the former rented a foreign radio station for an hour, though the discourse was of a most moderate character, and care was taken not to hurt the feelings of materialists.

Unofficial Christian propaganda is not forbidden, but it is discouraged in every possible way. Only one daily newspaper, the *Daily Warner*, has a fundamentally Christian outlook, but even this is kept in the background owing to the fear of offending materialists who sympathize with its opinions on political and economic matters. It is a remarkable fact that the vast majority of Christians in Krassnia prefer to buy a materialist newspaper which agrees with their political views rather than a Christian newspaper which does not do so. The result is not only that the *Daily Warner* is run at a loss but that it is far less openly Christian than would otherwise be the case.

An International Christian Congress is to be held in

Krassnia this year. A number of deputies attempted to stop it. They claimed that it would lead to violence by the indignant proletariat, and that it would be used as a vehicle for Fascist propaganda. However, this Congress, though officially discouraged, has not been forbidden. It will be interesting to see whether it will lead to any acts of violence, but the odds are at present against this.

The only sphere in Krassnia where religion is actually persecuted is in the armed forces. On joining the army every recruit is asked his irreligious opinions. The majority register as Dialectical or Mechanistic Materialists, except in North Krassnia, where Hylozoism is in favour. However, Positivism, Agnosticism, and several other opinions have lately been legalized. But no soldier may register as a member of any religious organization. And if he is killed in battle a wooden O, to symbolize annihilation after death, is always placed over his grave. On the sixth day every soldier is compelled to attend a lecture on the tenets of his particular brand of irreligion; refusal to do so is punished as a breach of discipline by imprisonment. It is only fair to say that no Christian soldier in Krassnia has so far, like St George, been martyred for refusal to obey such an order; but many have been punished in minor ways. And, although the State does not formally subsidize materialism, it pays some hundreds of materialistic lecturers to bore its soldiers, sailors, and airmen.

The perspicacious reader will by now have noticed that the conditions described in Krassnia are exactly those in Britain today, substituting 'Dialectical Materialism' for 'Anglicanism', 'Mechanistic Materialism' for 'Catholicism', the *Daily Warner* for the *Daily Worker*, and so on. If he compares the conditions prevailing in Krassnia with those which prevail in the Soviet Union today he will find that religion is freer in the Soviet Union than in Krassnia in some respects, and less free in others. Thus in the Red Army it was recently found that a large fraction of the soldiers were theists, whereas in the army

of Krassnia atheism is compulsory, and in the British army every soldier is compelled to be a Christian or a Jew. On the other hand, few religious books are published in the Soviet Union, though some are. For example, a translation of Cardinal Newman's *Apologia pro vita sua* was recently printed. They are permitted in Krassnia provided their style is not of such an honest and straightforward character as to come under the blasphemy law. As against this, although atheism and materialism are associated with the State in the Soviet Union, they are not rammed down the throats of the public as is materialism in Krassnia or religion in England. The worthy Comrade Yaroslavski, President of the League of Militant Atheists, enjoys a position very inferior to that of the Chief Materialist in Krassnia, or the Archbishop of Canterbury in England. If formal religious instruction of children is forbidden, I have yet to learn that there is any compulsory instruction in irreligion. And certainly they are not compelled to assent to any philosophical doctrines, as many British children are forced to recite the Catechism and the Creeds.

To sum up, there is about as much religious freedom in the Soviet Union as in Great Britain. I should like to see a little more in each. I do not know of any legislative step in that direction taken during the last ten years in Britain which is comparable with the enfranchisement of priests in the Soviet Union in 1937. Of course, in so far as they are followers of Engels, Communists are definitely enjoined not to use the police 'to attack religion and thereby help it to martyrdom and a prolonged lease of life', to quote from the last chapter of *Anti-Dühring*. This does not mean that they should not argue against religion, or suppress organizations which use religious forms for political ends.

It seems to me that most discussions by Rationalists concerning religious liberty have been far too abstract. In a laudable but futile attempt to be impartial they have neglected the fact that many forms of religion are absolutely opposed to

liberty. If a priest terrorizes parents by threats of hellfire into forcing their children to go through the motions of religious observance, this is a strange sort of freedom. On the other hand, it is right and reasonable that children should be taught something in school about the prevailing forms of religious belief or unbelief in their own country, and any attempt by their parents to prevent this is, I think, short-sighted, and likely to have an effect opposite to that intended—at least, in the case of intelligent children.

Our notions of freedom are apt to be dominated by two ideas, neither of which is up to date—the idea that the patriarchal family is natural and normal, and that large sums of money can be left for the propagation of opinions without harm to freedom. Actually the patriarchal family is only one out of many types. To many primitive people it seems natural and inevitable that a man should adopt the totem and magico-religious practices of his mother rather than his father.

And it is bad enough that my opinions should be formed according to those of Lord Beaverbrook or Lord Southwood, but even worse that that they should be formed by the late Sir Henry X, a food adulterator who left large sums to the Wesleyans out of a very natural and justifiable fear of hellfire; or Mme Y, an opera singer with a whale of a past, who endowed a Catholic church for a similar reason. One of the great benefits of Socialism is that churches, like cinemas, are paid for by their audiences and not subsidized out of legacies. The living generations are not subject to the 'dead hand' of the past. The churches therefore cease to function when nobody wants them.

We should strive to establish in this country the legal position laid down in Article 124 of the new Soviet Constitution, by which every citizen is guaranteed freedom of religious worship and anti-religious propaganda. It may be that this constitutional right is not always fully enjoyed in Russia, but it does not even exist in England.

We should realize that religious beliefs persist for economic and political reasons in the face of valid intellectual arguments, and that it is futile to expect that rationalism will triumph if it uses only intellectual weapons. We cannot neglect these weapons. On the contrary, we must use them as fully as we are allowed to. For, if we do not, the decay of religion will lead not to Rationalism but to mere indifference, and will furnish a soil for doctrines quite as irrational as any religious creeds, as has been the case in Germany.

But I question whether most Rationalists inquire with sufficient care and thoroughness into the social and economic basis of religion in their own countries. This is just as important a question as the date of St John's Gospel, and one on which it is almost equally difficult to arrive at the facts, because we take so much in our social environment for granted. I hope that this article may be of some value in helping its readers towards an objective point of view.

1940

WHY I AM A MATERIALIST

WHEN I SAY that I am a materialist I mean that I believe in the following statements:

1. Events occur which are not perceived by any mind.
2. There were unperceived events before there were any minds.

And I also believe, though this is not a necessary logical deduction from the former two, that:

3. When a man has died he is dead.

Further, I think that it is desirable that other people should believe these statements. I do not mean that I believe that the universe is a machine, or that I am a machine; nor yet that consciousness does not exist, or has a lesser reality (whatever that means) than matter. When I say 'I believe' I do not mean the word in the sense in which a fervent Christian uses it concerning the Virgin Mary, Pontius Pilate, and others who figure in the creeds. I mean it in the ordinary sense, in which, for example, I believe that dinner will be waiting when I go home, though, of course, the cook may go on strike or the chimney may catch fire. That is to say, I act, and propose to act, on the basis that materialism is true. But I am prepared to consider evidence to the contrary. And I certainly don't get shocked or angry if someone criticizes or doubts the truth of materialism.

Now the word 'materialism' is used, particularly in controversy, to imply a belief that a good dinner is better than a good deed. In fact, a materialist is supposed to be a man who

has, or does his best to have, large meals, a large mistress, a large bank balance, a large motor-car, and so on. It is not obvious why this should be so. Other peoples' meals are as material as mine, and a bank balance is not something tangible, like a cellar full of gold and jewels.

In practice I have found that professed materialists are generally less selfish than professed idealists. For idealism is a remarkably useful device to enable us to bear other peoples' ills, and particularly their poverty. It is easy to persuade ourselves that the poor have various spiritual blessings. But it is not so easy, when one's own affairs are concerned, to avoid the attitude of the idealist of whom it was written:

There was a faith-healer of Deal
Who said: 'Although pain isn't real,
When I sit on a pin and it punctures my skin
I dislike what I fancy I feel.'

I do not of course deny that some idealists are excellent people, and some materialists coarse and selfish. But on the whole I think the contrary is true, for reasons which will appear later.

Fifteen years ago I was a materialist in practice, but not in theory. I treated myself as a material system. We all do this to some extent. When we want to go somewhere we get into a train or bus, confident that on the one hand we shall not be able to propel ourselves so rapidly through space by the mere exercise of our wills, nor on the other that the vehicle will find any more difficulty in moving us than if we were a sack of potatoes. However, though we all have considerable faith in the applicability to ourselves of the laws of physics, our faith does not apply to chemistry. We should be willing to trust our weight to a rope which has been tested to stand double our weight, but we should mostly hesitate to drink half the fatal dose of a poison. Rightly too in some cases, for poisons in sub-lethal doses may do a good deal of harm. But not by any means always. Some poisons,

such as carbon monoxide, are completely harmless in half the lethal quantity.

I applied the laws of chemistry to myself. For example, I said: 'If a dog is given hydrochloric acid to drink (diluted, of course, so as not to injure its stomach), it excretes part of the acid combined with ammonia as ammonium chloride. Now men work in a similar way to dogs, and both are systems of partially reversible chemical reactions. So if I eat ammonium chloride I shall become more acid.' This did in fact happen. I was quite correct in my reasoning, or at any rate it led to a correct result.

However, although I was a materialist in the laboratory, I was a rather vague sort of idealist outside, for the following reason. I had learned that matter had certain properties. It consisted of atoms which united in particular patterns. They moved in definite paths under given forces, and so on. My belief in these theories was not a matter of mere docility either. I had tested them and risked my life on their substantial accuracy. Clearly, if matter had the properties attributed to it by physicists and chemists, something more was needed to account for living organisms. And it was far harder to account for mind. As a believer in evolution I had to reject such theories as T. H. Huxley's epi-phenomenalism, according to which mind is a secondary consequence of a small class of material events (namely, those which go on inside our heads), but does not influence them. Apart from my very strong belief that I can act, the evolution of something as complicated as my mind, yet absolutely functionless, seemed most unlikely. Not that functionless organs are never evolved. On the contrary, it is probable that most organs are evolved in a rudimentary form before they develop a function. And I have not enough faith in the theories of Paley and his like to believe that every organ—for example, a cock's comb, a pigeon's cere, or a cassowary's wattle—has a function. However, I cannot believe that a system so complicated, and

within its limitations so efficient, as the human mind could have evolved if it were functionless.

Nor did I see how, on a materialist basis, knowledge or thought was possible. The light which reaches my eyes causes nervous impulses in about half-a-million fibres running to my brain, and there gives rise to sensation. But how can the sensation be anything like a reality composed of atoms? And, even if it is so, what guarantee have I that my thoughts are logical? They depend on physical and chemical processes going on in my brain, and doubtless obey physical and chemical laws, if materialism is true. So I was compelled, rather reluctantly, to fall back on some kind of idealistic explanation, according to which mind (or something like mind) was prior to matter, and what we call matter was really of the nature of mind, or at least of sensation. I was, however, too painfully conscious of the weakness in every idealistic philosophy to embrace any of them, and I was quite aware that in practice I often acted as a materialist.

The books which solved my difficulties were Frederick Engels's *Feuerbach* and *Anti-Dühring*, and later on V. I. Lenin's *Materialism and Empirio-Criticism*. But the actual progress of scientific research in the last fifteen years also helped me enormously. None of the books which I have mentioned is easy if one has been brought up in the academic tradition which goes back to Plato and Aristotle. This is partly because they apply scientific method not only to philosophy but to philosophers. They are not merely concerned with showing that their authors are right and their opponents wrong but with explaining why, under particular social conditions, such and such theories are likely to gain wide acceptance. Hence, unless one accepts their political and economic theory, one is not likely to agree with their views concerning nature and knowledge, though it is only with the latter that I am concerned in these pages.

Engels and Lenin were firm materialists—that is to say, they

believed that matter existed before mind, and that our minds reflect nature, and reflect it truly up to a point. But they absolutely rejected the current scientific theories of their day as complete or even satisfactory accounts of nature. 'The sole property of matter', wrote Lenin, 'with whose recognition materialism is vitally connected, is the property of being objective reality, of existing outside of our cognition . . . The recognition of immutable elements, the immutable substance of things, is not materialism, but metaphysical, anti-dialectical materialism . . . It is of course totally absurd that materialism should . . . adhere to a mechanistic world-picture of matter and not an electro-magnetic or some immeasurably more complicated one.' Writing of the physics of his own day, he said: 'Dialectical materialism insists on the temporary, relative, approximate character of all these milestones on the road of knowledge of nature.'

Nature is in a state of perpetual flux—in fact, it consists of processes, not things. Even an electron is inexhaustible—that is to say, we can never give a complete description of it. We professors are always trying to give such a complete description, so that we can deduce all natural happenings from a few general principles. These attempts are successful up to a point, but we always find that nature is richer than we had thought. And the newly discovered properties of things appear to us as contradictions. Thus at the present moment both light and matter are found to have two sets of properties —one set resembling those of particles, and another set resembling those of waves. According to Engels and Lenin, things really embody a union of opposites, whose struggle makes them unstable and results in their development into something else. When we find 'internal contradictions' in our conceptions about things our minds are mirroring nature.

But these internal contradictions do not mean that nature is irrational. They mean that it is unstable. Our brains are finite. Nature is probably infinite, certainly too large for us to

take in. So our account of any material phenomenon is a simplification. We naturally think of things as neatly rounded off, and therefore tend to exaggerate their stability. However, the more we study nature, the more we find that what is apparently stable turns out to be the battlefield of opposing tendencies. The continents are the field of a struggle between erosion, which tends to flatten them, and folding and vulcanizing, which build mountains. For this reason they have a history. Animals and plants are never completely adapted to their environment, as Paley thought, and as they presumably would have been had they been made by an all-wise and all-powerful creator. On the contrary, they evolve just because they are imperfect. The same principle holds for human societies.

One of the materialist's greatest difficulties used to be perception. If the world consists of self-contained objects isolated from one another in space, how can any sort of image of it be formed in our brains? There is no hollow space in our heads where a puppet representation of the external world could be set up. Sound is the only feature of the external world about whose representation in our brain we know much. If we place an electrode on the auditory part of a cat's cerebral cortex and another somewhere else on its body, then in favourable circumstances if we amplify the current between them and pass it through a loudspeaker we actually hear sounds which the cat is hearing, or would hear if it were fully conscious. The same experiment is quite possible with a conscious human brain, though I don't think it has yet been done.

This means that the ear and the auditory nerve serve to set up electrical disturbances in air which we perceive as sound. In this case, then, there is an actual imaging of the external reality. But how can anything of this kind take place with a solid object seen or felt? The physical discoveries of the last decade have shown that ordinary material objects, from

electrons upwards, can be regarded as periodic disturbances. Certainly the rhythm is very much faster than that of sound, and could not possibly be copied in the brain. But some kind of rhythmical changes in the brain, though very much slower than those which they mirror, would be copies of at least one aspect of matter.

The physicists tell us that the frequency of the vibrations associated with a particle are proportional to its mass, and the physiologists, in studying the impulses in a nerve fibre from an end organ responsible for our touch or pressure sense, find that the frequency of the impulses increases with the stimulus, though not in exact proportion. We do not yet know in any detail what happens in the brain when we feel pressure, but it is likely that a similar law holds good.

We are only on the very fringe of the necessary investigations, but it is becoming daily more plausible that our minds are physical realities acted on by the rest of the world and reacting on it. Our minds are processes which occur in our brains. Until recently it was quite impossible to see how the processes going on in thousands of millions of cells could possibly form a unity such as we find in our consciousness. We are now, however, discovering both in atoms and molecules properties of a system as a whole which cannot be located at any particular place in it. There is nothing in any way mystical about these properties. They can be very precisely measured and calculated. They are expressions of the fact that the various constituents of nature are much less isolated than was at one time thought.

The difficulties about truth are complicated by the fact that we use the word for at least three very different relations. We may mean that a perception or idea in a mind is true if it corresponds to an external reality. If the relation between the two is one of likeness it can never be complete, but it may be true enough for a particular purpose. We may mean that a physical copy or image is like its original. Or we may mean

that a statement is true. This statement may be in words or other symbols, and logic is largely concerned with the truth of statements. Their truth or otherwise depends on the meaning of the symbols. This is a social matter. A statement is true only as long as someone understands it. After that it is meaningless. 'Iron is heavier than water' will be true only as long as someone understands English, even if he is only an antiquarian. After that it will be gibberish like 'Pung twet maboroohoo', which for all I know meant something to the men who built Stonehenge, but is neither true nor untrue today.

Of course the philosophers say that a symbolic statement stands for a mental reality called a judgment, which is independent of language. I think this is extremely doubtful. On the contrary, it seems much more likely that language began with words or phrases whose English equivalents would be 'Come here', 'Wolf!', 'Heave-ho', 'Darling', and so on, which are not statements, and neither true nor false. And one can certainly think without making statements or judgments, as when one remembers the plan of a town and picks out the quickest route, or imagines what an acquaintance will do in given circumstances.

The great advantage of the theory that judgments are anything but sentences repeated in our heads is that it gives philosophers a chance to theorize about thought without investigating the physiology of the brain. This enables them to tell us a lot about truth, but very little about how we get to know it or how we act on it. If we take the view that a statement is true in so far as it calls up mental images which correspond to reality, and useful in so far as it incites actions appropriate to the real situation, we have got away from metaphysics, and are up against problems concerning the action of the brain, the history of language, and how we learn language as children, which cannot be solved by pure thought, but only by studying the real world.

For such reasons as these I find materialism intellectually satisfactory. I also think it is useful because it leads to actions of which I approve. Mankind is up against a very difficult situation. We have dealt with a great mass of problems in the past by scientific thinking—that is to say, materialistic thinking. We try to solve our political problems by appeal to eternal values. But if we start thinking materialistically about these 'eternal values' we find that they are social phenomena which have come into being in the last few thousand years, because men gave up hunting and took to husbandry, agriculture, and handicraft. So society became a great deal more complicated, and 'eternal values' are part of the apparatus by which it has been kept going. In particular they are very useful to those who are in comfortable situations at present, and would like the present state of things, with a few minor modifications, to be eternal.

Materialistic thinking in the past has been revolutionary in its effects. It has built up natural science and undermined religion. The same process is going on today. We have to realize that our current ideas about society are mostly very like our ancestors' ideas about the universe four hundred years ago—irrational traditions which stifle progress in the interests of a small minority. These ideas are being transformed by materialistic thinking about history as our ancestors' ideas were transformed by materialistic thinking about nature. The consequence will no doubt be revolutionary, as it was in the past. This would perhaps be deplorable if our society were working well. But it is working very badly. So we are probably going to have an uncomfortable time in the immediate future, whatever happens. And as I want a rational society to come out of our present troubles I am not only a materialist myself, but I do what I can to make other people materialists.

1941

THE LAWS OF NATURE

THE PHRASE 'A law of Nature' is probably rarer in modern scientific writing than was the case some generations ago. This is partly due to a very natural objection to the use of the word 'law' in two different senses. Human societies have laws. In primitive societies there is no distinction between law and custom. Some things are done, others are not. This is regarded as part of the nature of things, and generally as an unalterable fact. If customs change, the change is too slow to be observed. Later on kings and prophets could promulgate new laws, but there was no way of revoking old ones. Thus the unfortunate Jews, if orthodox, stagger under a burden of law which was increased over thousands of years by ingenious rabbis. The Greek democracies made the great and revolutionary discovery that a community could consciously make new laws and repeal old ones. So for us a human law is something which is valid only over a certain number of people for a certain period of time.

Some people also believe in Divine laws which hold for all men everywhere. The curious can consult a report, *Kindred and Affinity as Impediments to Marriage* (SPCK), by Anglican bishops and others who have tried to solve the fascinating problem of where human law ends and Divine law begins as regards marriage with relatives. God forbids you to marry your sister, it appears, but it is not so sure whether it is God or man who says you may not marry your niece. So many gods have issued so many different laws in the past that a study of history makes the theory of Divine law a little ridiculous. Just the same applies to the Stoic conception of a natural law

incumbent on all men as men. Even if such laws existed they would not be eternal, for man has evolved and will evolve. Actually they turn out merely to hold for a particular stage of social and economic development.

Laws of Nature, however, are not commands but statements of fact. The use of the same word is unfortunate. It would be better to speak of uniformities of Nature. This would do away with the elementary fallacy that a law implies a law-giver. Incidentally, it might just as well imply a parliament or soviet of atoms. But the difference between the two uses of the word is fundamental. If a piece of matter does not obey a law of Nature it is not punished. On the contrary, we say that the law has been incorrectly stated. It is quite probable that every law of Nature so far stated has been stated incorrectly. Certainly many of them have. Nevertheless, these inaccurately stated laws are of immense practical and theoretical value.

They fall into two classes—qualitative laws such as 'All animals with feathers have beaks', and quantitative laws such as 'Mercury has 13·596 times the density of water' (at 0° C and 1 atmosphere's pressure). The first of these is a very good guide. But it was probably not true in the past. For many birds which were certainly feathered had teeth and may not have had beaks. And it is quite possibly not true today. There are about a hundred thousand million birds on our planet, and it may well be that two or three of them are freaks which have not developed a beak, but have lived long enough to grow feathers. It was thought to be a law of Nature that female mammals (defined as warm-blooded vertebrates with hair) had mammary glands, until Professor Crew of Edinburgh found that many congenitally hairless female mice lacked these organs, though they could bear young which other females could then foster.

And quantitative laws generally turn out to be inexact. Thus water is nothing definite. It is a mixture of at least six

different substances. For in the molecule H_2O one or both of the hydrogen atoms may be either light or heavy, and so may the oxygen atom. Similarly, mercury consists of several different types of atom. Thus the ratio of the densities of mercury and water is not fixed, though in the case of ordinary samples the variation is too small to be detected. But it can be detected if the water happens to have been taken from an accumulator which has been used for some time.

We have, I believe, gained a somewhat deeper knowledge of the meaning of natural laws from the work of two living English physicists—Jeffreys and Milne. In his *Theory of Probability* (Oxford, 1939) Jeffreys has something new to say about induction. Two contradictory theories are in vogue as to the laws of Nature. The older view is that they are absolute, though of course they may have been inaccurately formulated. The extreme positivistic view, enunciated by Vaihinger, is that we can only say that phenomena occur as if certain laws held. There is no sense in making any definite statements, though it is convenient to do so.

Now Jeffreys points out that, if a number of observations have been found to conform to a law, it is highly probable that the next one will do so whether the law is true or not. In Jeffrey's words: 'A well-verified hypothesis will probably continue to lead to correct inferences even if it is wrong.' This can be proved in detail if it is stated with sufficient exactitude, on the basis of some highly plausible assumptions. Thus we can use the 'as if' principle without denying the existence of natural laws. What is more remarkable, laws which ultimately turn out to be inexact are often far more exact than the data on which they are based. Thus Jeffreys remarks, speaking of gravitation, that 'when Einstein's modification was adopted the agreement of observation with Newton's law was three hundred times as good as Newton ever knew'.

Positivists and idealists have made great play with the fact

that many laws of Nature, *as formulated by scientists*, have turned out to be inexact, and all may do so. But that is absolutely no reason for saying that there are no regularities in Nature to which our statements of natural law correspond. One might as well say that because no maps of England give its shape exactly it has no shape.

What is remarkable about the laws of Nature is the accuracy of simple approximations. One might see a hundred thousand men before finding an exception to the rule that all men have two ears, and the same is true for many of the laws of physics. In some cases we can see why. The universe is organized in aggregates with, in many cases, pretty wide gaps between them. Boyle's law that the density of a gas is proportional to its pressure, and Charles's law that the volume is proportional to the temperature, would be exact if gas molecules were points which had no volume and did not attract one another. These laws are very nearly true for gases at ordinary temperatures and pressures, because the molecules occupy only a small part of the space containing the gas, and are close enough to attract one another only during a very small part of any interval of time. Similarly, most of the stars are far enough apart to be treated as points without much error when we are considering their movements.

And most men manage to protect themselves from injury so far as is needed to keep both ears. Whereas trees cannot protect themselves from the loss of branches. It is very rare to see a completely unmutilated, and therefore completely regular, tree. Mendel's laws, according to which two types occur in a ratio of 1:1 in some cases and 3:1 in others, are theoretically true if the processes of division of cell nuclei are quite regular, and if neither type is unfit so as to die off before counts are made. The first condition never holds, and the second probably never does. But the exceptions to the first condition are very rare. In one particular case a critical division goes wrong about once in ten thousand times. The

effect of this on a 1:1 ratio or 3:1 ratio could be detected only by counting several hundred million plants or animals. Differences in relative fitness are more important. But even so the Mendelian ratios are sometimes fulfilled with extreme accuracy, and are generally a good rough guide.

Jeffreys points out that in such cases it is often much better to stick to the theoretical law rather than the observed data. For example, if you are breeding silver foxes and a new colour variety occurs which, if crossed to the normal, gives 13 normal and 10 of the new colour, you are much more likely to get a ratio of about 1:1 than 13:10 if you go on with such matings, even though if you breed many thousands the 1:1 ratio will not hold exactly. The mathematical theory which Jeffreys has developed concerning such cases is particularly beautiful, but can hardly be summarized here.

Milne's theories are extremely revolutionary. He starts off with very simple postulates. He assumes some geometrical axioms—for example, that space has three dimensions—but does not assume Euclidean geometry. He also assumes what he calls the principle of cosmological relativity—namely, that observers anywhere in the universe would see much the same things. There is no favoured point or centre, no limit beyond which there is no more matter, and no direction in which matter progressively thins out. This is an assumption, but it is only the natural extension of Copernicus's theory that the earth is not the centre of the universe but just one star among others.

He then imagines observers on different stars communicating by light signals. This is, of course, unrealistic. But I have little doubt that, if his cosmological views prove valuable, later workers will be able to replace it by a more realistic hypothesis. Given this possibility of signalling, and clocks, he shows how the observers can graduate their clocks and establish a geometry. There is nothing very surprising in this. What is remarkable is that Milne claims that he can deduce

some physical laws as necessary consequences of his basic assumptions. In particular, he deduces a law of gravitation which reduces to Newton's at 'small' distances measurable in units less than light-years.

This does not seem impossible. The law that the angle in a semicircle is a right angle was first observed as being at least very nearly true. Then twenty-five centuries ago Thales opened a new era in human thought by proving that it must be true. Milne may be a new Thales. Of course, later mathematicians showed that Thales, and Euclid too, had made a number of concealed assumptions. The proof was not as simple as they thought. And even if Milne's theories meet with no stronger criticism, they will doubtless meet with this one.

Milne claims that some, and perhaps all, physical laws are inevitably and rationally linked. He accuses those who say that laws might be otherwise of using 'magical', not rational, thinking. Dirac goes even further, and suggests that there is nothing chancy about the distribution of the matter in the universe, and that an all-wise mathematician could deduce this too from a few postulates. I must say I find this much harder to swallow. Laplace's theory, that given a full knowledge of the universe at one time one could deduce its state at all times past and future, was difficult enough to believe. This is worse. But in so far as any elements in these theories are accepted, this will be a signal triumph for Rationalism as against theories which recognize an irrational element in the universe.

However, if Milne simplifies natural laws with one hand, he complicates them with the other. Lengths may be defined in two ways. They may be referred to a material object, such as the standard metre, or to a wave-length of light which has the merit that it can be reproduced anywhere. If all the standard metres were lost, they could be reproduced with an accuracy of about one in thirty million by reference to known

wave-lengths such as that of the red cadmium line derived from spectroscopic observations. One result of Milne's calculations is that the length of the metre, measured in standard wave-lengths, is increasing by about one part in twenty million per year. If you like, you may say that the universe, including the standard metre, is expanding. But it is simpler for most purposes to say that atoms are vibrating quicker. It makes not the slightest difference to any observable phenomenon which of these statements you choose. In fact, on this theory, and indeed on several others which have been worked out in less detail, many of the laws of Nature are changing. There is nothing arbitrary or haphazard about this change, but simply an increase in certain physical constants with the time.

This has important philosophical consequences. If true, it rules out any theories of a cyclical or recurrent universe. At a sufficiently early date the properties of matter were so different, and in particular chemical processes so sluggish, that life must have been impossible, or, to be accurate, material systems similar to any existing organisms could not have lived. Thus we can see why, even if the universe had no beginning, life has not got very far yet. And in the far future life will also be impossible for beings constituted like ourselves, though it may be that our descendants could keep up with changes in the laws of Nature by natural or artificial evolution.

Once again, I am sure that Milne's theories, even if they are partially correct, will turn out to be too simple for the immense complexity of the real world. But they give us at least an inkling of how posterity will think of natural laws. So far from being laid down by the arbitrary word of a creator, they may prove to be a system as intimately and rationally knit together as the propositions of geometry, and yet changing and evolving with time like the forms of plants and animals.

1944

THE ARGUMENT FROM DESIGN

I HAVE RECENTLY been reading Paley's *Evidences of Christianity*, as every good Rationalist should. Paley attempts, with very great skill, to prove the existence of a creator from the design of living organisms. Of course a good many of his arguments were met by Darwin. It is clear that, given the facts of heredity and variation, organisms tend to adapt themselves to their environment without any conscious planning by themselves or anyone else. But it is by no means proved that the whole course of evolution from single-celled organisms to oaks, daisies, ants, and men can be explained on these lines.

There are real difficulties in the evolution of such an organ as the eye, where many parts must vary together to produce an improvement. I have tried to meet them from a neo-Darwinian standpoint, but my argument is not so strong as the general argument for Natural Selection. Again, the evolution of instincts presents great difficulties. They cannot be inherited memories in the most interesting case—that of social insects. For since the ancestors of worker bees and ants were not workers, they have instincts quite different from any of their ancestors. The chemical organization of a cell is immensely complicated, and it is hard to see how an organism could work at all unless it were of extreme chemical complexity. If so, the very first steps in evolution are the hardest to explain. I think, therefore, that a reasonable man should be prepared to examine arguments which assume a measure of design in living creatures, even though I do not personally think that they are cogent.

Now Paley imagined an intelligent savage picking up a

watch and concluding that it had been designed. He then argued that animals show far more evidence of design than watches. And he next argued that the designer had many of the characteristics of the God whom he worshipped.

To my mind his argument leads to a radically different conclusion. Let us suppose an intelligent savage to come upon one of the battlefields of World War II, and to examine tanks, artillery, rifles, land mines, and other weapons left behind in the desert. He might well conclude that these weapons had been designed, but a slight further exercise of intelligence would convince him that they had not all been designed by the same person or group of persons. He would conclude that the British weapons had been designed to destroy the German ones, and conversely. He might have a little difficulty if he got evidence that the Germans and Italians had had a scrap on their own, but we may omit this complication.

Now, the most conspicuous features of animal organization are those which are designed (if they are designed) for competition with other living creatures, and often for their destruction. All animals live by eating other animals or plants. They may kill them, as we kill rabbits and potatoes, or merely eat parts of them, as we eat parts of the apple tree and the flea drinks part of us. A few, such as the blowflies, beetles, and 'worms', actually mostly insect larvae, which eat our bodies if they get the chance, eat only dead food, apart from bacteria. And these exceptional pacifists are not the noblest of animals. The plants generally compete by pushing, rather than biting. Look at a plantain spreading its leaves over the grass of your lawn, or a tree cutting off the sun from the plants below it till they die. Though only a few higher plants, like the sundew and the mistletoe, actually eat other living things, they are all engaged in a merciless struggle for life.

Of course biologists have devoted much of their time to

the internal co-ordination of organisms. If this is attributed to a designer it shows very great ingenuity and no malice. However, a tank resembles a motor-car or a tractor in many of its features, but its essential function is to carry a gun for the purpose of destruction. And when we consider animals, not in terms of the relations of their parts but of their relations to other animals, the same is true of them.

If, then, animals were designed, they were designed for mutual destruction. If there was one designer, he is or was a being with a passion for slaughter, like that of the ancient Romans, and the world is his Colosseum. A much more reasonable consequence of the hypothesis of design is Polytheism. If each one of the million or so animal species were the product of a different god, their mutual struggle would be intelligible. One must particularly admire the ingenuity of the creators of some of the parasites, particularly those with several hosts. For example, the digenetic trematode worms, such as *bilharzia*, which pass one generation in a water snail and another in human beings, causing an extremely painful chronic disease often terminating in cancer, are an amazing piece of work. So are the malaria parasites, which live alternately in mosquitoes and human blood.

A seaman dying of thirst on a raft may well curse Whitehead, who invented the torpedo. Trematode larvae surrounding a water snail and ramming their front ends into it look remarkably like little torpedoes when seen through a microscope. And, unlike the human creation, they multiply inside their victims and produce another generation which kills men or sheep. In fact, Whitehead was a mere amateur compared with the creator of *bilharzia*.

Wherever Paley's argument leads, it does not lead to Christianity. If pushed to its logical conclusion it forces us to believe in a malignant creator or, more probably, in a number of malignant creators. Certainly this creator or these creators are not wholly malignant. The world of life contains a great

deal of beauty and pleasure, but one can admire the beauty only by closing one's consciousness to the pain and injustice which are bound up with it. A biologist who has spent his life in the study of parasitic animals must inevitably smother his feeling of pity to some extent and tend to take human misery and injustice for granted.

But the moral effect of the belief that the world was made by a benevolent and almighty creator is vastly worse. C. S. Lewis's book, *The Screwtape Letters*, is a good example of its effects on an intelligent man. The book is supposed to be written by a devil. The devil is strongly in favour of modern medical practice, which in many cases has robbed death of its pain and terror. He is by no means enthusiastic about war, which gives many people the experiences of suffering needed to turn their minds to God.

If the world of Nature is God's plan, then attempts to banish pain are contrary to this plan. So are attempts to perfect human society by eliminating the various evils which men inflict on one another. The religionist can point out the impossibility of eliminating cruelty and injustice completely. Nor can one eliminate pain completely, but it is possible to reduce it to such a level that for years one may have no pain which interferes with normal action and thought. And Marxists, among others, believe that by applying scientific method to human affairs it will be possible to cut down injustice and cruelty to a similar extent. All Buddhists, most if not all Hindus, and most Christians believe this to be impossible, and further, that it is a dangerous illusion to think it possible. Conversely, those who think that the establishment of 'heaven on earth' is something worth trying must regard the religions as dangerous illusions, whatever services they have rendered to men in the past.

Darwin made it reasonable to reject the argument from design, and the evil god or gods to which it leads if carried to its logical conclusion. We have not yet realized what an im-

mense advance in our moral ideas this has rendered possible. Naturally enough, many of the early Darwinists retained the veneration for Nature which is justifiable if it is God's handiwork. They therefore used Darwinism to justify various forms of human struggle, including war and unrestricted economic competition. T. H. Huxley, by contrasting the ethical process and the cosmic process, did his best to combat this tendency. But, as he took so much of the structure of the society in which he lived for granted, he underestimated the power of the ethical process.

Today we see that cut-throat competition, both between species and to a lesser extent within them, was a necessary condition of evolution. We also see that it is so no longer. We can control the evolution of animals and make unprecedented creatures, such as the Jersey cow and the Angora rabbit, for our needs. We shall be able to control our own, though very fortunately we do not yet know how to do so. My own most important scientific work has been to accumulate some of the preliminary knowledge; for example, to map some of the genes on a section of one of the twenty-four pairs of human chromosomes. It is abundantly clear that the amount of such preliminary work needed is so great that we shall not have the necessary knowledge for some centuries. By this time a Marxist may reasonably hope that human society will be so far improved that there will be agreement on the innate characters desirable in man, and willingness to alter our breeding habits accordingly.

We can look ahead to this. If human society is brought near to what we should now regard as perfection in the next few thousand years, our descendants will find Nature pretty revolting. The scream of a rabbit caught by a weasel will be as horrible as that of a rabbit in a trap to sensitive ears today. If we abolished weasels, sportsmen, and other enemies of rabbits today, they would increase till they did vast damage to crops and trees and were finally kept down by disease and

starvation. Over-production, as Darwin saw, is a universal character of living things, and a necessary condition for Natural Selection. To abolish the needless pain of Nature we should need to check this over-production, as we already do to some extent with our domestic animals. The lion and the lamb will be able to lie down together when we can provide the lion with a diet high in proteins not derived from lambs but from vegetable or synthetic sources.

Speculations of this kind may seem ridiculous in the middle of a war. I believe that they are justified because we are apt to think that because widespread misery is part of nature it is therefore unavoidable. Those who are opposed to a radical reconstruction of human society naturally take this view.

It is also important that Rationalists should examine the arguments brought forward in favour of various religious dogmas and see where they really lead. Defenders of religion invariably stop in the middle. Thus the argument from design leads on to Polytheism; most of the arguments for the immortality of the soul also prove that it is not trammelled by space and therefore omnipresent. The argument, which is an essential part of Catholic theology, that God must have founded an institution to proclaim his will to mankind leads directly to atheism. For if there is such an institution it must be the Catholic or the orthodox Church, and their records prove that they are far from divine. Similarly an Idealist cannot logically stop short of Solipsism.

It is essential that we should study the economic and social origins of religious beliefs, and the irrational but profound psychological needs which they partially satisfy. But as long as these beliefs are alleged to be capable of rational proof it is our interesting, and sometimes amusing, duty to study these alleged proofs, and to see what, if anything, they really prove.

1946

TIME AND ETERNITY

IN THE AFFAIRS of ordinary life we are not concerned with eternity and very much concerned with time. We have to catch trains, clock in, boil eggs, light cycle lamps, remember Auntie's birthday, and so on. The only people who are professionally concerned with eternity are clergymen and astronomers. I shall suggest that astronomers have something to tell us. But first let us see what the clergy have to say. They do not all tell the same story.

The orthodox Christian version appears to be that time had a beginning, but will have no end. There was a first event, but there will not be a last one. God is said to be unchanging; so there could have been no change, and therefore no time, before matter or finite spirits were created. On the other hand, human souls will last for ever in heaven, or more usually in hell. Among the more or less heretical views are that the world has lasted for ever, though one or many creative acts have occurred, and that time will end with the last judgment, the future state of human souls being an unchanging pain or bliss. Still another view is that heaven and hell are somehow 'out of time', like the fact that $2 + 3 = 5$. I am far from clear what, if anything, this means. Those who hold this last view may leave open the question whether material changes will go on indefinitely.

What does a scientist mean by infinity or eternity? An infinite set, say, of numbers or points, is not a difficult idea. If you say that any particular number—for example, 10,000—is the largest, I can answer that you can make a larger one by adding one to it. If you say that you have specified all the

points on a finite stretch of a line, I can answer that you can always find another between any pair of them. Infinity is merely a name for such possibilities as these.

If we say that space extends infinitely in every direction we generally mean something like this. If you had a line (say, a rope) stretching in any direction, however far, and a foot rule, you could always extend this line a foot farther. Now such a statement is untrue, at least of human beings at the present time. You can't measure things with a foot rule even twenty miles up in the air. You have to use optical methods, employing light or short radio waves, and when you get a long way off these optical methods become very indirect, so that the statement that space is infinite has no meaning in terms of possible operations.

It is important to note that the infinity of space does not simply mean that there is always a point on a line in a given direction beyond any particular point. This is true for sets of points in a finite length; for example, the points half-an-inch, three-quarters-of-an-inch, seven-eights-of-an-inch, and so on, to the east of a given point. There is always another of them. But they all fit into half-an-inch. You must have something corresponding to a measure if your statement is to have any meaning. In other words, in the absence of matter one cannot measure space, or even say whether it is finite or endless.

The eternity of time means even less unless it is defined in terms of possible operations or perceptions. We say that two times are equal if they contain the same number of standard events, such as days or ticks of a clock. But one day is not identical with another, as the foot rule remains (in ordinary language) identical if we move it from one place to another. If days are progressively getting shorter in terms of swings of a standard pendulum, there is no obvious way of telling whether the day or the swing is more reliable. In fact, every clock has its own time scale, and one can imagine one in which the movement of the hands gradually slowed down so

that it was always approaching twelve but never got there. Such a clock would only register a finite time however long, by other standards, it went on.

There is a way in which we can attach a meaning to the finitude or infinity of space and time. It is a reasonable postulate that no finite volume of space contains an infinite amount of matter—that is to say, an infinite number of atoms. It is equally reasonable to postulate that in a finite volume and a finite time only a finite number of events can occur. We must be rather careful in our definition of events. We should be safe if we restricted them to cyclical events, such as the rotation of the earth or the swing of a pendulum, or to atomic transactions, such as the emission or absorption of a quantum of radiation. If we do not make such restrictions we get involved in such difficulties as the paradox of Achilles and the tortoise.

Until recently the remote past and future presented serious difficulties to physicists. These are very clearly seen in connection with heat. Most of the heat radiated by the sun goes off into space. Even if it ultimately reaches some material object, most of the energy which it has radiated in the past is probably still travelling through the void, and in the sufficiently far future, most of the energy now associated with matter will be in this state. We can see how the sun and other stars may shine and may have shone for a very long time, but unless certain at present rather unplausible suggestions are true, we cannot see how they can have shone for ever, or will shine for ever. Again, the spectral lines from the distant spiral nebulae are shifted towards the red. This is explicable if they are moving away from our own Milky Way and from one another. But if they are, then the relation between their speeds and distances strongly suggests that they were all packed together in an indefinitely small volume about 2,000 million years ago.

At first sight it appears that the universe was created at this

time, and that it has been expanding and cooling ever since. But this raises a number of difficulties apart from those inherent in the idea of creation. Either the amount of matter is infinite, and in particular the number of stars and atoms is infinite, or it is not. If this number is finite, then either space is finite, in the sense that a straight line in any direction comes back to its source, or all the matter is in a finite portion of infinite space. On the former hypothesis it seems to follow that space must be expanding, as Eddington thought, and this leads to the startling deduction that if we had better telescopes we should see the distant stars suddenly disappearing for ever. On the latter we are in a privileged position in the universe. And what is worse, most of space contains no matter, so there is no way of measuring it, and it is meaningless to talk about its infinity.

Milne built up a cosmology starting from the postulate that the universe would appear much the same to an observer anywhere in it. This is an extension of the view of Copernicus, that our earth is not the centre of the universe. Milne's other postulates are equally simple. I described some of the features of his theory in the 1938 issue of the *Rationalist Annual*, and have also used it to put forward a new theory of the evolution of stars, including our own solar system.[1] In this article I shall examine its bearing on the question of time and eternity.

For many purposes it is convenient to suppose that time has lasted for only 2,000 million years, and that no matter is farther off than 2,000 million light-years. This supposition leads to the simplest possible geometry, and to a fairly simple, but rather unfamiliar, dynamics. But as the amount of matter is infinite, this way of looking at things implies, among other things, that at the beginning of time it was all concentrated in a very small volume. This disagrees with the postulate which I put forward earlier.

[1] *Nature*, 153, 555, 1944; *American Scientist*, July 1945.

One can also choose a time-scale stretching back infinitely into the past and forwards into the future. This implies an infinite space also, though its geometry is not Euclidean. It is genuinely infinite, since no large stretches of it are without matter. It makes not the slightest difference to any observable prediction which scale is chosen, any more than it makes any difference whether you measure space in metres or feet. But one scale is more convenient for some calculations; the other for others. And the infinite scale does not violate the postulates which I made above. One can also use a time-scale with a definite future, or with a finite past and a finite future.

What conceivable value, it may be asked, can there be in this fantastic monkeying about with time? The answer is simple. On Milne's cosmology the laws of nature change gradually, so that, in any finite material system, events of a particular class can only occur a finite number of times. In the very remote past all matter was very hot, and unable to lose its heat by radiation. In the very remote future it will be very cold, and there will be no more high-temperature radiation such as we get from the sun. In fact, the sort of radiation which we call light occurs over only a finite stretch of time. Similarly, at the present time matter exists in the solid, liquid, and gaseous states. In the remote past it was all, or almost all, solid. Thus, processes involving the interaction of solids and gases, such as burning and breathing, are restricted to a finite stretch of time, measured in thousands of millions of years. There is therefore a sense in which time is finite. Any particular method of measuring it which we may choose, such as by pendulum swings, or planetary rotations, or the decay of uranium, can only be possible for a finite stretch of time. Before and after this, however, there were or will be events of other kinds by which time is measurable.

If this point of view is adopted, some of the past opinions of theologians appear in a different light. There was the good old description of eternity which ran somewhat as follows:

'Imagine a mountain of steel. Every century a bird comes and drops a feather on it. When the mountain is worn away, a soul in torment asks what is the date, and is told "eternity has just begun".' To which we can answer that birds and mountains are features of the present stretch of time, and long before the mountain could be appreciably affected by the process imagined, there will be no more birds or mountains.

St Thomas Aquinas based one of his main arguments for Theism on the impossibility of an infinite regress of causes and the necessity of a first cause. We can agree with him that an infinite chain of events of the same type—for example, collisions of solid bodies, each causing the next—appears to be physically impossible. But the first events in such a chain may have been caused by a process of a different type, which itself had a chain of causes behind it. For example, if my theory of the origin of planets is correct, their motion is not derived from that of another star which hit the sun or came near it but from the energy of radiation of a frequency which existed in the past but no longer occurs now.

The argument that the universe is running down, and must have been 'wound up' at a finite time in the past, completely loses its cogency. For on the infinite time-scale the 'running-down' process which we observe in connection with the loss of heat by the stars began only at a certain time in the past, when conditions permitted it. Of course it began slowly, since the laws of Nature which express the relations between matter and radiation alter slowly. And the idea that the universe will become too cold for life loses much of its cogency also. In the far future it will probably be too cold for life as it exists at present, but there is no obvious reason why, if our descendants become intelligent enough to direct their own evolution, some kind of life associated with mind should not last for ever.

We can also dispose of the old difficulty, which may be formulated as follows: 'If the universe has lasted for ever,

why has it not attained perfection in the course of eternity? If it was created why was it not created better?' The usual answer to the first question has been that planets suitable for life come into being and end, and that we are perhaps at a rather unhappy stage in the development of our own. The answers to the second have been the series of ingenious excuses which theologians have made for the Creator. Leibniz proved to his own satisfaction that this is the best of all possible worlds. So did Pangloss, in Voltaire's *Candide*—a work which may be recommended to anyone who (like such modern authors as Mr Hadham) shares Leibniz's opinion. In practice, excuses for God work out as excuses for society; for its injustice, which causes poverty and oppression, and its ignorance which causes disease and premature death. All these evils can be, and are, attributed to the inscrutable decrees of the Creator; to the no small advantage of the rich, who have a vested interest in poverty, and the clergy, who have a vested interest in ignorance.

According to Milne's cosmology, life could not have started much before it did; or, at any rate, not such life as we know; for of course it is conceivable that there is life in the interiors of the denser stars, and perhaps in other material systems. But, if so, it has a physical basis wholly different from our own. Perhaps evolution might have reached a stage equivalent to humanity rather earlier, and it may have done so in other planetary systems. But we could hardly expect it to have gone immensely farther than it has. So we may legitimately expect paradise on earth, though not quite as soon as St John or Shelley hoped.

Finally, the argument for some sort of design from the fitness of the environment for life loses most of its force. The environment was unfit for life through half eternity. Life appeared when it could.

Perhaps I owe my readers an apology for returning so frequently to the study of Milne's cosmological ideas. I do not

think so. He may be quite wrong; but if he is right he is as important a contributor to human thought as Copernicus; perhaps more so, since Aristarchus anticipated Copernicus, and no one anticipated Milne. No doubt he is wrong in details, as Copernicus was wrong in thinking that the planets moved in circles; but he may be right in his general picture of the universe. He is developing his theory so rapidly—and others are beginning to assist him—that no full account of it is at present available. I therefore think it is my duty to try to interpret it, so far as my ability permits, to men and women who are interested in the great problems which it solves, or at least presents in a new light.

1947

THE LIMITATIONS OF RATIONALISM

RATIONALISTS should from time to time take stock of their own position. This includes a survey of its weakness as well as its strength. If we do not realize its weak points, our enemies will often do so. What is more, if at some stage in our thought we suddenly realize this weakness for the first time, we may very well come to believe that our whole position is untenable.

As I see it, the weakness arises in four rather distinct ways. Our reasons cannot act without premises—that is to say, facts of which we are fairly well assured. And we have not got anything like enough such facts at our disposal. Secondly, our reasoning powers are weak. We cannot draw correct conclusions from fairly simple premises—conclusions whose truth is often clear enough when someone else has discovered them. Thirdly, we are not critical enough of what we regard as rational arguments provided they lead to results of which we approve. Fourthly, it is only very recently that men have started reasoning about the nature of things—that is to say, putting forward theories to be tested both by their agreement with facts and their internal consistency, instead of telling one another stories which were valued for their emotional effect.

Our conclusions about the nature of the world are almost wholly based on the data of our senses. These are finite in number. We have only a million or so incoming nerve fibres. Each fibre can conduct only a hundred or so impulses per second. Moreover, we take notice of only a tiny fraction of

the information provided by our sense organs; but if we took notice of it all, and remembered it all, we could form a very inadequate picture of the world, however much apparatus, such as microscopes, telescopes, radar, galvanometers, and so on, we used to supplement our senses. In particular, we could never be sure that the universe was infinite either in space or time, though we could conceivably discover that it was finite.

We can overcome this limitation to some extent because knowledge is social. For example, having checked the accuracy of maps of London, Paris, and New York, I am prepared to believe in the accuracy of maps of Peiping, Sydney, and Rio de Janeiro, and I am willing to accept the results of sciences such as geology, of which I know little, with the same degree of belief as I accept those of biology, of which I know more. However, the number of human beings is finite, and the limitations remain.

More serious is my own and other people's limited reasoning power. I simply cannot grasp a sufficiently complicated argument. The limitations of different intellects vary. Every educated person can factorize 35 in his or her head. I can factorize such numbers as 11,009; a few people can factorize six-figure numbers, however large their factors. Nobody can factorize twenty-figure numbers with large factors. This kind of thing can be done with a specially designed machine, and machines can already vastly extend the scope of our reasoning power in the field of mathematics. I believe that we are only at the very beginning of the use of mechanical aids to reasoning, and that they will be as important as mechanical supplements to our senses, such as microscopes. But they will only take us a certain distance.

Finally, our reasoning powers are only one side of our mental activity, and are influenced by our emotions. We can do our best to allow for this, so as to achieve 'pure' reason, by laying down general rules beforehand, and by using sym-

bolical and mechanical devices, such as algebra and calculating machines. But we cannot fully overcome this tendency to bias. Fortunately different people have different biases, and we can approach truth dialectically, both by actual arguments and by noting how others are led astray by emotions, and discovering that we are subject to the same limitation. A particularly useful practice is to read really worthless arguments for opinions which we hold ourselves. For example, I am an atheist, but I am not greatly impressed by the logical Positivists' argument that the questions which theologians answer in the affirmative are meaningless—a mere abuse of language. Nor, perhaps, are they much impressed by mine. I am much more likely to learn to think clearly by detecting fallacies in the works of Joseph McCabe than in those of C. S. Lewis. For one thing, they are a lot fewer. For another, I think most of McCabe's general conclusions are true, and I want other people to think so. Therefore I should like all McCabe's arguments to be correct; and if I find a hole in one of them it will make it easier for me to find holes in my own.

There are, of course, other limitations of rationalism. We cannot be quite certain that our senses do not deceive us systematically. This possibility is greatly increased if we admit the possibility that there is an almighty Being. For the good Bishop Berkeley held that such a Being habitually provided the human race with sensations which led all of them but himself and a very few others to believe in the existence of material objects.

I doubt how far a Rationalist has a right to be completely certain about any important generalization. I am sure that a materialist has no such right. But this simply does not worry me as a scientist. If I get 1,104 coloured, and 352 white, mice from a series of matings, I call this a good approximation to one white in four. I am quite aware that if on an average there were equal numbers of white and coloured, I should get as bad a fit as this about once in 10^{85} trials—that is to say,

once in a number which would take 86 digits to express. If every star in every nebula in the telescopically photographable universe were crowded with intelligent beings who had been repeating this experiment every month since the time when the earliest known rock was formed, it still would be excessively unlikely that any of them would have got such a bad fit to equality. But if the universe is infinite, then, if there is only one planet per galaxy with minds on it, someone has already got a result as unexpected as this. For all that, I am not going to let this degree of uncertainty, or a very much greater one, worry me at all.

The type of argument which we have to meet is this. Some of our religious opponents say: 'On your own showing you can't reach certainty. Of course you can't if your minds are mere by-products of evolution from mindless organisms. We can reach certainty for two reasons. We know that our minds are images of the divine mind, and therefore have capacities which no mind can have on your theory. And some of us have direct knowledge of divine things, even more direct and cogent than your sensory perceptions.' Of course there are many other and mutually contradictory arguments, but it is worth nothing that it is a Catholic dogma that men can be certain of the existence of an almighty and benevolent Creator by unaided reason.

Now it is a curious fact that according to Christianity man is much more deeply sunk in sin and error than most Rationalists believe. At the present time the majority of Christian radio commentators are telling us that we are not wise enough and good enough to plan our own future. We can't possibly know what is best for one species on one planet, or even for one-fiftieth of that species on the island of Britain. But even a quite stupid person should be able to convince himself that the universe was created by a rational Being of infinite power, knowledge, and goodness! Frankly, it seems to me a lot easier to decide whether or not it is in the public

interest that British railways should be nationalized than whether it is in the interests of the human species that our planet should have one moon instead of two, like Mars; or none, like Venus.

I do not regard the theistic theory of creation as disproved either logically, like the theory that we can express the ratio of the circumference of a circle to its diameter as the ratio of two whole numbers, or empirically, like the theory that we can construct a perpetual-motion machine. I merely think that the increase of knowledge makes it progressively less plausible. In the *Rationalist Annual*, 1946, I gave reasons for doubting that the universe had a beginning, and, in the 1944 *Annual*, for doubting Paley's argument from design proved the existence of a benevolent Creator.

If any Rationalist told me he was as sure there was no God as that he had no tail, I should think he overrated his reasoning powers. But that does not mean that I should describe myself as an agnostic rather than an atheist. I disbelieve in the existence of an infinitely powerful and benevolent Creator as I disbelieve that Bacon wrote Shakespeare, or that Petain was an innocent dupe. I may be wrong, but my belief is strong enough to be a guide to action. I prefer not to call myself an agnostic, because I think our descendants should be ultimately able to arrive at the same sort of certainty on theological questions as we have today about the existence and distances of the stars, even if not the sort of certainty which we can reach as to the existence and size of Paddington Station.

The other set of arguments for religion is from religious experience. This, in certain cases, is said to produce complete intellectual certainty, but to be incommunicable, though a good many books have been written about it, and there is quite a terminology of it in the Sanskrit language. Since Christians, Muslims, Hindus, and even atheistic Buddhists give a similar account of the experience, but arrive at different certainties after experiencing it, the certainty seems a little

unreliable. And certainty does not impress me unduly. For twenty centuries wise men were certain of Aristotle's law of the excluded middle—namely, that anything either possessed a quality or did not possess it. Then came Bertrand Russell, who deflated this 'eternal truth'. I give the disproof in the form of a fable adapted from Professor E. T. Bell.

The librarian of the Aristotelian Society was a great maker of catalogues of the Society's Library, constructed on various principles. He catalogued his books by authors, subjects, dates, languages, lengths, philosophical systems, shelves, prices, bindings, radio-activity, and examinations for which they were needed. He divided the catalogues into two classes; Class A, which contained a reference to themselves, and Class B, which did not. As a good Aristotelian, he knew that all possible catalogues must fall into one class or the other. He then started to make a catalogue of all the catalogues in Class B, which was the smaller. At the appropriate moment he reached the reference to this super catalogue. Since as yet it contained no reference to itself, it belonged to Class B. But, as soon as he put the reference in, it became a member of Class A. He scratched the reference out again, and the catalogue returned to Class B. He consulted Aristotle, St Thomas, Hegel, and John Stuart Mill. He did not go home that night. Next morning his daughter Barbara and his son Camestres found him still writing and erasing. Unfortunately the paper control has terminated this work.

In fact, Aristotle and a hundred generations of logicians were wrong about what they thought was a certainty. I think that even were the mystics in agreement, they might be wrong too.

Nevertheless, a Rationalist cannot neglect the fact of religious experience. He may try to explain it away, as Leuba did in his well-known book. But if so, he may find that he has also explained away not only the moral consciousness but the preference for truth as against falsehood.

As a materialist I think the correct line of approach is as follows. Our information about matter is not wholly derived from perceiving it and acting on it. We also have information from inside, so to speak, about one particular bit of matter—namely, our own body, and in particular our brain. If one is not a materialist, this information is about the mind, somehow associated with the brain, which, even if it is only an appearance, is a fairly stable one.

We are only just beginning to state this information in the objective manner which has proved to be necessary for an adequate understanding of material systems. We know something about the relation between physically observable events, such as electrical changes in the brain, and mental events, such as sensations, acts of will, and emotions. But we certainly do not know enough for anything but the sketchiest and most provisional scientific theory. On the other hand, we do not know anything which renders it impossible, or even unlikely, that such a theory will be achieved.

Our opponents waver between telling us that the relation between mind and body is quite a simple affair, adequately treated by St Thomas or some other philosopher, and warning us off with talk of insoluble mysteries and the limitations of science. We cannot of course be sure that our descendants may not find such limitations. But when we consider how much we know today about human reproduction and the causes of disease, which were both completely mysterious three centuries ago, I see no reason to doubt that our descendants will know a great deal about these matters, and no reason to suppose that their account will be any more like that given by metaphysicians than is our contemporary account of matter.

In view of our ignorance I have little sympathy with those who try to explain moral consciousness away. By all means let us investigate its history, both in individuals and societies. But you haven't explained away a horse by showing that it

originated from a fertilized egg and was evolved from three-toed ancestors. You merely know more about it. Religious experience seems to point to the existence of some relations between men and other living, and perhaps non-living, beings other than those at present known to science. To a materialist, at any rate, this would not be surprising. If Wordsworth's idea of a mountain was something like the mountain, then the mountain is something like Wordsworth's idea of it, and some of what Wordsworth felt about mountains, though probably not very much, was a perception of truth. If Wordsworth was a function of a certain bit of matter, it is quite intelligible that he may have derived some knowledge, however vague, of other bits of matter from inside, so to speak, as well as through sensory channels. But to go on and postulate a personal deity, or a pantheon of them, responsible for the origin and behaviour of dead matter, seems no more rational than to postulate a dryad in an oak tree because you recognize that it is alive. A materialist can admit to fellow feeling not only with other men but with animals, and matter of all kinds, without abandoning his position.

A Rationalist may, and I think should, admit that there are plenty of facts to be accounted for, including some which religious people take very seriously. Such an admission does not imply agnosticism, in the sense that these things are in any way inaccessible to reason. Nor does it imply that there is even a corner of the universe, let alone its origin and destiny, which is explicable only in terms of the crude guesses made when men began to think of these matters thousands of years ago, and which are embodied in the creeds of the various religions.

1950

A RATIONALIST APPROACH TO THE PROBLEM OF SEXUAL RELATIONS

THE MORE VIOLENT the emotions generated by a topic, the harder it is to be rational about it. That is one of the reasons why it is so hard to think rationally about death. But it is probably still harder to think rationally about sexual relations. I do not suppose that I shall succeed, but I may inject a little reason into the discussion at some points.

It would be ridiculous to begin any discussion at the present time without citing Kinsey, Pomeroy, and Martin's *Sexual Behaviour in the Human Male* (more accurately the American male), which probably comes nearer to the truth on this topic than anything which has been written so far. The first thing which comes out of their observations is the extraordinary differences in sexual activity which exist between men of very similar upbringing. I am not thinking so much of the fact that, for example, some married men are faithful to their wives, while others have relations with other women, with men, and so on, as of the extreme quantitative differences. Thus the average frequency of sexual activity among married white males aged thirty is about three times a week, but the range is from twenty to less than once. These differences are much greater than are found for any other physiological activity, such as eating, sleeping, or breathing.

The second point is that over ninety-five per cent of the males interviewed admit to types of sexual activity which are condemned by Judaism and Christianity. Social class is much more important than religion in determining the types of activity. On the whole the orthodox Jews seem to make the

best attempt to keep to the precepts of their religion, but it is a pretty poor attempt.

What should be the Rationalist approach to this question? I think that we should regard marriage as the normal human adult condition. By marriage I mean a reasonably stable union between two persons of the opposite sex, whether or not it is recognized by the State or the Church. A failure to regularize such a union involves some social disadvantages, but some unions without a formal marriage prove remarkably stable, while a number of formal marriages do not. I think that in a society organized like our own, or with a variety of other types of social organization including that of the Soviet Union, we can reasonably expect that most people will marry and that most of the marriages will be fertile and stable. Further, I think that on the whole married people are happier and healthier than unmarried, besides performing the social service of reproduction.

Some people do not marry, and some who do would be better unmarried. Does this mean that an appreciable proportion of people are born with such a constitution that they are unfit for marriage? I doubt it very seriously. Some people are certainly handicapped by bad health, but not one per cent, in my belief, are still-born from a genetical point of view that they could not make a physiological success of marriage. In fact, a great many more are too ill to marry by the time they reach maturity; but I believe this to be an effect of bad conditions in the vast majority of cases, rather than bad heredity. One reason why I think so is that twenty years or so after the great drop in infant mortality a generation ago, which certainly spared many children from chronic disease as well as from death, people started marrying younger.

I think that a much larger fraction of people do not marry, or fail in marriage, on account of bad psychological conditioning. Most of us are still taught that certain parts of our bodies are shameful or disgusting, and all sorts of religious

notions such as sin and impurity are connected with them. This propaganda works on a substantial fraction of people. It haunts even those who think they have seen through it. Now there is certainly a need for restraint on too early sexual intercourse. Very few people want their daughters to become pregnant at fifteen, perhaps by an unknown father, and what is more to the point, very few women of thirty wish they had become pregnant at fifteen.

The problem is how to discourage premature and promiscuous intercourse without making children believe that there is anything wrong or shameful in sexual intercourse as such. The official efforts to do so are certainly humorous, but I suppose that the fact that they are being made at all is encouraging. One borough during the war had a rat week, a Spitfire week, and a VD week in rapid succession. An acquaintance of mine, now married, asked her mother what one of the posters on the latter topic meant, to which her mother replied, 'You'll find out soon enough.' In fact, this propaganda is probably little more effective than religious propaganda and, like it, tends to make sex appear shameful and disgusting. However, it can grow into something better.

We shall perhaps get somewhere if we consider the anti-marriage propaganda which goes on. Probably most of it has a religious origin. In the ancient religions a number of women were dedicated to the gods. They could not marry. Generally they served the god by cohabitation with a number of men who represented him and made gifts to his temple. More rarely they were condemned to perpetual virginity. The former type of holy woman is today represented by the prostitute; the latter by the nun. The prostitute, especially in Catholic countries, preserves a certain glamour value which is almost certainly religious. For the Devil is an ex-god, and sin is his service. The religious element in homosexuality is equally clear. Such practices were certainly part of many ancient religions, and in my opinion the repression of normal

sexual activity is the main cause of homosexuality today. 'Public' schoolboys are not allowed to consort with local girls, though there is no reason to think that the consequences would be more serious than they are in the vast majority of the population. Oxford and Cambridge students were locked in at nine o'clock, in my time. In consequence, there is a great deal of homosexuality in these places, and a good many people never recover from it. Whereas at Bedford College for Women in London, students can come in up to midnight, and men other than fiancés are supposed to be out of the girls' rooms after ten p.m.; a fiancé can stay till midnight. I have never heard of a case of pregnancy, venereal disease, or homosexuality at Bedford.

I think that celibacy, sodomy, and prostitution, the principal alternatives to marriage, are all undesirable and that propaganda in favour of all of them should be discouraged. How far it should be forbidden is another matter, which raises the whole question of tolerance, too large a question to be discussed here. But I do not think that Rationalists should hesitate to describe St Paul's views on sexual relations, and the enforcement of clerical celibacy, as obscene superstitions.

Certainly a Rationalist attitude to sexual relations will not solve our problems completely. They will not be solved till every couple who wish to live together, whether married or not, can be sure of finding accommodation and a job sufficiently well paid to keep them. At the present moment in Britain the jobs are generally available; the housing is not. Judging from the enormous rebuilding programme which is going on in eastern Europe, where there is certainly no unemployment, it looks as if the necessary economic background for a healthy sexual life would be secured there before it is available here.

Given such an economic background, what could we reasonably hope for if children were brought up to look forward to sexual experience as something very delightful—in

no way sinful, but involving dangers and obligations? I am perhaps rather well equipped to give a provisional answer to this question because a number of my younger colleagues have a biological education which enables them to take a moderately objective view of sex and have been less exposed to prescientific ideologies than I was myself.

We can certainly expect that many of them will begin sexual relations before marriage. In quite a large number of cases, to judge from my acquaintance, these relations will lead directly to marriage, and to happy and stable marriage. I think that a Rationalist, once he or she regards marriage as the normal and desirable human state, will be bound to take the view that such relations, though less commendable than marriage, are to be preferred to celibacy, sodomy, or prostitution. They often end in marriage. The question to be answered is whether, when they do not so end, they make a subsequent stable and happy marriage more or less likely. This is a question of fact, which can to some extent be decided by statistical investigation.

Kinsey and his colleagues have not yet published systematic results on this important question. They content themselves with stating that pre-marital experience with other partners does not necessarily prejudice the prospects of a later marriage, and may in some cases improve them. Unfortunately, however, statistics will not give a satisfactory answer to the question. If it were found that, on the whole, marriages were more successful if neither partner had had previous liaisons, this might merely prove that persons with a low intensity of sexual emotions were less likely to seek other partners after marriage. If it were found that pre-marital activity was associated with stable and happy marriage, this might merely mean that a strong sexual urge, while favouring pre-marital liaisons, also made for happiness in the marital state. The question certainly demands a causal as well as a statistical analysis. But this will be possible only when we know the

facts which demand a causal analysis; and I do not see any other method than Kinsey's which will give us the facts.

Unfortunately we have nothing resembling Kinsey's data for our own country. His method of obtaining data by personal interviews has been widely criticized. I can only give my strong impression, based on conversation with him as well as reading his book, that it is likely to come fairly near to the truth. He may well have got too low an estimate of the frequency of activities which are criminal. I doubt if it is grossly too low. And I also think that, in the majority of cases, he would have been able to detect people who admitted to actions which they had not actually done.

His first book deals only with males. The corresponding data on females will be of even greater interest. Given that the vast majority of American working-class males have premarital relations with women other than prostitutes, does this imply a similar figure for young women, or is there a relatively small proportion of highly promiscuous females?

Whatever the answer, we need similar data for Britain. A few people have been trying to collect them, but I am inclined to regard the results so far published as somewhat worse than useless. In fact, I think we shall learn more from the excellent observations on animals which are being made both in Britain and elsewhere. One result which comes out clearly is that monogamy is much commoner in animals than is often believed, though a union is often dissolved after a brood has grown up and left its parents. We have deliberately selected our domestic animals for ease of breeding—that is to say, sexual promiscuity—and if a wild duck could speak, it would probably refer in scathing terms to the 'farmyard' morality of tame ducks. We may get quite important hints for our own conduct by seeing what influences monogamy in animals. We can also learn the fundamental fact that monogamy is just as natural as promiscuity, and that plenty of animals achieve it without any supernatural aid.

I am quite aware that many Rationalists will object to my views from one point of view or another. Some will say that society should be completely neutral as to sexual relations; others that Rationalists should observe all the canons of Christian morality, if only to avoid the accusation that they are corrupting the youth. I may well be wrong on many or most points. But I believe that the time has come when Rationalists should discuss this topic seriously. There are, I think, two prerequisites to such a discussion. We must realize the immense variability of men and women, and not condemn those who are more or less active than ourselves as 'oversexed' or 'undersexed'. And we must take an historical point of view. It is no good trying to frame a code of morals for an ideal society. We do not live in an ideal society, and we have to discuss how we wish people to behave in our existing society, or in such modifications of it as we can hope for in our lifetime. We have to realize that our ideas on sexual morality have been profoundly influenced by religion, and that founders of religions have seldom been sexually normal. Some, like St Paul and St Augustine, objected to sex, at least in their old age; others, like Mohammed and Luther, were probably more sexually active than the average. We shall not reach a rational point of view in a hurry. But because such a goal is distant, there is all the more reason why we should start towards it now. I strongly suspect that one result of such an attempt will be the discovery that, from St Paul to Freud, people have attached greater importance to the subject than it deserves.

1952

THE ORIGIN OF LANGUAGE

IN THIS ESSAY I propose to discuss the consequences of a hypothesis—namely, that human language, as we know it, originated only in the last eighty thousand years, perhaps even in the last thirty thousand. I wish to emphasize that this is only a hypothesis. It seems to me more likely to be true than false, but I certainly do not regard it as almost certain, like the theory that men are descended from ape-like animals, or even as highly probable, like the theory that our ancestors passed through a stage resembling the Australopithecines of South Africa, even if these were not our actual ancestors.

But first I must make an acknowledgment. I had already formulated the hypothesis in conversation, and roughly planned a presentation of it, when Professor R. J. Pumphrey was kind enough to send me a copy of his inaugural lecture as Professor of Zoology in Liverpool University. I found that he had formulated just the same hypothesis, though largely on different grounds from my own. There is thus no question that if our views are accepted the priority belongs to him. Several of the theories suggested later on regarding ritual are due to my wife.

Human industry, as shown by stone tools, dates back for something like half-a-million years, and the first known tool-makers were considerably more ape-like than ourselves. It is possible that throughout this time human language, and the cerebral organization needed for speech and its understanding, were developing slowly side by side. However, the fact that the speech centres in our brains are near the centres which control the right hand (or the left hand in left-handed people)

suggests that manual dexterity developed before speech, and perhaps a long time before it. I have no doubt that these tool-makers had some form of vocal communication, as most mammals and probably all birds have, so that one man could call effectively to another, warn him of danger, threaten him or offer him friendship, tell him that food was available, and so on. I have also no doubt that vocalization played its part in love, but it is probably that on the whole these noises were expressions of emotion rather than statements of fact.

My reasons for thinking that descriptive language developed rather suddenly are as follows. Something immensely important happened to man in the Upper Palaeolithic. During the older palaeolithic periods there were changes in the technique of flint-chipping, but styles endured for enormously long periods without much change. The type of industry called Levalloisian lasted for 150,000 years, according to Zeuner. I do not mind if it turns out to have been only 60,000 years. The Abbevillian industry may have lasted even longer. Then a rather sudden break occurred, at least in Europe. In the Aurignacian culture a number of new types of tool, and what is more striking, pictorial art, appear for the first time. The tools were not always as well-shaped as the earlier types, but they were adapted for various different purposes, and their forms changed relatively rapidly. This culture probably lasted for a few thousand years, and was succeeded by the Solutrean and Magdalenian. Then followed the mesolithic and neolithic periods, and the age of metal tools in which we live. The date of these periods is in considerable doubt. Zeuner put the beginning of the Aurignacian about 100,000 years ago, and the Magdalenian from about 60,000 to 30,000 years ago. But Foster Flint, using the radiocarbon method, which works well enough for wood from dated Egyptian tombs, finds a date of only 10,500 BC for charcoal from the cavern of Lascaux, assigned to a middle Magdalenian date. If this is correct, Zeuner's figures are

about three times too long, and the Aurignacian epoch may have started only about 30,000 years ago. Zeuner bases his chronology largely on Milankovic's astronomical theory of ice ages, which is by no means universally accepted, but the radio-carbon method is not necessarily infallible either. Zeuner's figures for the duration of the older palaeolithic are, perhaps, more likely to be correct.

Before the origin of descriptive language a technique can be learned only by rigid imitation, if, indeed, it is not fixed by heredity like the spider's web-making technique. Once it is possible to describe and discuss what one is doing, innovation becomes far easier.

Existing languages are very different from one another, but a number of recent workers have found similarity between languages of quite different 'Families'. Rae and Paget in England and Johanesson in Iceland have attributed these to a tendency to move the lips and tongue in harmony with the arms and hands during gesture language, which is still highly developed among the Australian blacks, the most primitive people known to us today. Marr, in the Soviet Union, claimed to have traced the ancestors of many different languages to a common source. He may well have been much too dogmatic, as Stalin thinks. The gesture theory may be quite false. Nevertheless, these workers have found connections between quite dissimilar languages, such as the Aryan group, the Semitic group, Chinese, and Polynesian. Given the rates at which languages change—unless, like Sanskrit, Hebrew, and Latin, they are preserved for religious purposes—it would be very strange if any similarities whatever remained if language were half-a-million years old.

I think that the arguments of Professor Pumphrey, who is probably our most distinguished student of animal hearing and voice production, are quite as strong as my own, but we must await the publication of his work on the subject.

Let us now look at some consequences of our hypothesis.

Ritual is older than language. No doubt before true language existed ritual was often accompanied by some sort of vocalization. Let us take an example of animal ritual. Many mammals, from the badger to the hippopotamus, delimit a territory, usually occupied by a family, by various marks, such as scratches on trees, and by their own excretions, sometimes also by odorous secretions from special glands. They defend this territory with great vigour against strangers of their own species, and, what is more remarkable, strangers recognize these boundary marks, and show a hesitancy to fight, which looks almost like guilt, in a foreign territory. Birds seem to claim territory by singing rather than by odorous marks. We meet this ritual demarcation in our own species, where it is called taboo in Polynesia. I do not eat these yams, not because they are your property but because they are under a taboo, notified by bunches of leaves tied to trees, or some other simple symbol. If I break the taboo I may expect anything from a severe stomach ache to death, and if I escape these symptoms I must still dread the wrath of my fellow tribesmen.

Now, according to the Christian religion, the primal eldest curse is not, as Hamlet said, a brother's murder but the violation of a taboo on two trees. The same ritual underlies various forms of primitive thought. A wizard encloses himself in a pentacle, weaves a circle round him thrice, or in some other way produces a boundary between himself and evil spirits. 'Saint' is derived from *sanctus*, the past participle of the Latin verb *sancire* (to hallow), which means to perform a ritual to make a place, object, or promise holy, or inviolable. Modern etymologists derive it from the same root as *sacer* (holy), but the late Latin grammarian Servius derived it from *sangius* (blood) and said that it meant 'to sprinkle with blood from a sacrificial victim', so, perhaps, etymologically at least, the saints are bloody men. In fact, the sprinkling with blood, whether from a human or animal source, is a ritual quite

comparable with that which dogs perform with a different fluid on lamp posts. In all probability it was pre-linguistic. It is notable, however, that the Primates are particularly given to using signs to delimit their territory, as, of course, singing birds do. The howler monkeys, who howl rival gangs of their own species out of the confines of their area, are perhaps not too unlike certain human politicians who use vocal stimuli to reinforce national unity. Some rituals evoke emotion in animals. The best account of this in English is the Rev Edward A. Armstrong's *Display in Bird Life*, where he describes all kinds of rituals, including those of fighting, appeasement, and courtship, all of which arouse appropriate responses in other members of the species. Some rituals are individual, others communal. He quite rightly insists on the value of ritual for mankind, but he does not consider some of the obvious consequences of his theory for the interpretation of religion.

Now in animals, ritual performances often have an innate basis. That is to say, both the action and the response to it are unlearned activities, or instincts, of all normal members of a species, but learning generally plays a part in instinctive behaviour, and often an unexpected one. For example, the following situation occurs in some duck species. If a drake of species A is brought up as a duckling with species B, he will mate, or try to mate, with females of species B, but not with those of species A. On the other hand, he will fight males of species A, but not of species B. Thus the characteristics of a feather pattern of a rival act on a brain 'mechanism' which is there independently of learning, whereas the feather pattern of a potential mate has to be learned. In man there are, perhaps, rather few 'innate releasing mechanisms', as Lorenz calls them, but at least some activities arouse emotion more easily than others.

In so far as ritual evokes suitable behaviour, it is socially efficient; and doubtless early palaeolithic men had a number of

socially efficient rituals as other animals have. If they were of the kind which we now call religious or magical, then his religion and magic were, in a sense, true, but once descriptive language arises, some misguided genius is bound to start explaining why a rite is effective. The explanation that it has supernatural effects will reinforce the response to it; the explanation that it has no effects except through the emotions aroused will diminish this response. Hence, if the response is socially useful, the supernatural explanation will tend to be accepted.

This explanation is not wholly untrue. The kind of causation involved in the social efficiency of a rite is of a different character from that involved in building a house which will stand up, or planting seeds so that they will yield a crop. We are only just beginning to understand it, and a fuller understanding will involve a great deal of brain psychology. Psychologists are still giving names to capacities of the brain, as if they were things or people. The Id, the Super-Ego, the Censor, and so on are only a step nearer to truth than the Devil, Mars, Pallas, and other supernaturals. Blake's Four Zoas represent an intermediate step. We need not think that modern psychology has wholly banished the supernatural.

Theology (or mythology, which is the name we give to other people's theology) is very largely an attempt to explain ritual. This conclusion is in no way original. It was argued with great learning by Jane Harrison. What is, perhaps, original is the notion that ritual is not merely of prehistoric but of pre-linguistic origin. As language grew up, linguistic elements, such as prayers, spells, hymns, blessings, and curses, were incorporated into ritual. Their language is largely emotive, and so, of course, is the language of theology. The most primitive element in our religious ceremonies, apart from the movements of the priest during the mass, crossing, genuflection, and so on, is the music. Here we have sound with no descriptive meaning. For many people it is the most

impressive element in a religious service, and so it should be. You don't have to believe the mythology to make the music or to appreciate it. If this were necessary the same man could not have composed *The Ring* and *Parsifal*.

It appears probable that certain types of ritual have an emotive effect on most men, and there is fairly good evidence for a very widespread type of primitive ritual, including ritual killing of a human victim, ritual copulation, and so on. The capacity for responding to this ritual would seem to be a human characteristic, and not a very desirable one. This ritual is found least changed in the culture of primitive peoples, and in the European witch-cult; but very obvious traces of it remain in existing religions. They may be primitive features, as is the ritual eating of Christ's body in Christianity, or intrusive, like the cult of the victims Hassan and Hussein in the Shiah branch of Islam.

But I must leave this very fascinating topic to discuss some other effects of the invention of language. So long as the sounds made by human beings were mainly emotive, it was possible to communicate a fact about the present—for example, 'I am hungry', 'I want you for a mate', or 'There are wolves about'. But it was not possible to make generalizations—for example, 'Salmon come into fresh water, but herrings do not'—or to make plans for the future—for example, 'Get me some more skins; we shall need them to wrap up the baby when it is born.' Early palaeolithic man was no doubt familiar with human death and often realized that he might die shortly, but it is very doubtful if he made the generalization, 'I shall certainly die some day.' On the contrary, some primitives still seem to think that otherwise unexplained deaths are due to witchcraft and that there is no natural term to human life.

We ourselves have not yet fully accepted the fact that we shall die. On the contrary, most people believe that they will go on living after death, whether in another world or in

another body in this one. I suspect that this is a relic of the pre-linguistic stage of human development. The discovery of the inevitability of death must have been a great shock to our ancestors, as it still is to some children, and we are uncritical in accepting stories of partaking in rituals which deny this inevitability.

The biological fact of paternity was probably an almost equal shock. To judge from reports of primitive peoples, it was probably made quite recently. Indeed, its discovery may have played an important part in ending the matriarchal period through which most, if not all, human peoples passed. It has given rise to a vast amount of nonsensical thinking. Some of this is enshrined in religions, but a great deal is embodied in the curious kind of folklore which we call 'smut', 'dirty stories', and so on. This oral tradition has quite a marked influence on human conduct. No doubt something of the kind was needed to counteract the equally fantastic exigencies of Christianity and other religions, but two blacks do not make a white, and human reproduction is one of the subjects on which we have the strongest objection to rational thought.

We can now, perhaps, begin to discover the seed of truth in the psychology of Jung. This author believes, or believed, in a 'collective unconscious' stored with racial memories. He uses this hypothesis to account for the constant reappearance of certain ideas in religious mythology, in the fantasies of neurotics, and in the imagination of poets and novelists.

It is a fact that certain animals take part in and respond to ritual performances by other members of their species, and sometimes by members of other species. These rituals have been most intensively studied in birds. Both the tendency to perform the ritual, whether of courtship, threat, appeasement, demand for food, or other social relationship, and the tendency to respond to it, are largely innate. What is more remarkable, Lorenz has produced good evidence that the

courtship ritual is actually more stable, changing more slowly in the course of evolution than the structures—for example, brightly coloured feathers—which are used during it.

How these inborn tendencies first came into being in the history of a species is quite unknown. The most obvious explanation is that memories somehow became fixed by heredity. Unfortunately this will not work in one of the best studied cases, the ritual dancing of bees, by which they communicate to their fellow workers the direction and distance at which food has been found. As the drones never, and the queens probably never, perform these dances or respond to them, they cannot very well be inherited memories. For if it is hard to see how I could inherit my mother's memories, it is vastly harder to imagine how I could inherit my aunt's.

If, however, such inborn tendencies exist in the human species, a Rationalist must take account of them. They may be unfortunate, like the position of our windpipe in relation to our gullet which may lead to choking, or the fact that we are liable to hernia because our guts are so suspended that they would be much less liable to protrude if we walked on all fours instead of upright, but the tendencies are there, or so I think.

If we simply deny their existence the results may be serious. We do not kill a human victim annually at Stonehenge or Westminster Abbey, but we put our young men into peculiar clothes and subject them to rituals such as close-order drill, after which they become psychologically qualified to kill foreigners once or twice every generation, and members of more pigmented races within the British Empire rather more frequently. We also dress up certain old men in peculiar head-dresses and the skins of small carnivores. After a very impressive ritual they give commands for the killing of a number of psychopathic individuals who have themselves killed someone else, a proceeding which appears to relieve the feeling of guilt in other people.

Psychologists are beginning to state such facts publicly and I think that that is all to the good. It may lead some people to reflect on the unconscious motivation of war and other evils. But if these tendencies exist, the question arises whether they can be repressed altogether, or whether some relatively harmless outlet can be found for them. Possibly the problem may be slightly easier to solve if we cease to ask 'What is the moral equivalent of war?' and ask for the moral equivalent of ritual murder. I fear that several suggested answers will not work. 'The Mass,' say the Catholics, but Catholics have been and are as bellicose as anyone else. 'Sport,' say others, but sportsmen are not usually conspicuous as pacifists. I think, myself, that the most hopeful answer is 'an organized struggle against the natural forces which are adverse to men'. This would include hygiene, and the reclamation of deserts, for which the Soviet Union is reported to be using atomic energy. But that is only a personal opinion.

I have followed up one of the consequences which seem to follow if Pumphrey's hypothesis is accepted. There are many more, and probably more important ones. We are apt to think that we have condemned certain human activities if we call them irrational. Perhaps we should adopt a more rational attitude to them if we called them pre-linguistic. In fact, this essay is only intended to open the discussion of what may be a very vast field. It may be wrong all through; it is certainly wrong in parts. My discussion of ritual is very incomplete. One of its important functions, on which I have not touched, is to overcome our simpler desires—for example, to mate with persons other than our lawful spouses, to run away in battle, and so on—but anthropologists and psychologists are better qualified than I to discuss such questions. If this essay contains some elements of truth which may help us to behave a little more rationally, I shall be fully satisfied.

1954

A RATIONALIST WITH A HALO

WE ARE CONSTANTLY told that we enjoy a great deal of freedom, and must be prepared to submit to various unpleasantnesses to preserve it. In England I am absolutely free to say or write anything I please, provided it is not blasphemous, seditious, obscene, slanderous, libellous, a breach of the Official Secrets Act, insulting, liable to cause a breach of the peace, contempt of a Court of Law, a breach of the privileges of either House of Parliament, or a breach of some other law of which I am ignorant but the police are not. In fact, I can say or write what I think provided no one sufficiently powerful finds it too objectionable. If I complain, I am told, and told truthfully, that in many other countries I should have still less freedom.

This inevitably prompts me to ask the question 'Where, in the world as it is at present, should I find the greatest amount of freedom of this kind?' I am not sure of the answer, but I suspect that the answer is 'In India'. I do not say that the ordinary man or woman has more freedom in India than elsewhere. This is not the case. On the one hand, the average Indian is desperately poor, and often hungry. A hungry man will generally barter at least some of his freedom for food. On the other hand, he is enmeshed in Hinduism, which restricts his activities in many ways, particularly as regards diet and marriage. In spite of this, I think that a man who wishes to do so can communicate a wider variety of ideas to his fellows in India than in any other country. This was not so a generation ago, and may not be the case a generation hence. If India becomes a Communist State within the next thirty

years, which is quite possible, there will, I think, be more freedom for the average man, who does not feel any urge to communicate novel ideas; but there will, for a time at least, be less freedom for intellectuals.

Indians also enjoy one very important freedom which we do not. They are not subject to compulsory military service. It is often stated that this is no infringement of freedom, since anyone with a conscientious objection to military service can escape it. This statement is untrue. A conscientious objector rarely secures exemption unless he bases his objection on religious grounds. It is, however, quite possible to believe that war is wrong on purely humanistic grounds. I have no personal axe to grind here. I joined the army as a volunteer in August 1914. But I recognize that compulsion to join it involves a serious loss of freedom.

The reasons for this state of affairs are numerous. Hinduism has always preserved a great freedom of discussion. Within its framework many philosophies have arisen. The number of systems is sometimes given as twelve; and they are divided into six *astika* systems, according to each of which the existence of one or more divine beings can be proved by reason, and six *nastika* systems which deny this possibility. Others make the distinction according as the authority of the Vedas is or is not admitted. The important point for the lover of intellectual freedom is that the books embodying the principal *nastika* philosophies have been preserved, sometimes for over 2,000 years, though the works of the more extreme materialist school, the *lokayatika*, are only known from quotation. The work of Kanada, for example, is extant. He regarded atoms and souls as eternal, and made no reference to gods. Some of the early *nastika* philosophies show extraordinary penetration. To take two examples, in the Sankhya philosophy, founded by Kapila (*c.* 700 BC), it is recognized that light and sound are transmitted by different media. However, light is supposed to be transmitted by air, while sound is

carried by *akasha*, which is generally rendered as 'ether'. According to the Jain philosophy, due to Mahavira or Vardhamana (599–527 BC), matter consists of *nigodas*, which are aggregations of a number of elementary beings closely packed, and in a state of intense discomfort. Even in the course of millions of years very few of these succeed in escaping. The analogy with modern ideas concerning atomic nuclei is obvious.

Hinduism in its earlier, Vedic, form, gave rise to two other religions, Buddhism and Jainism. Their founders, Gautama and Mahavira, both lived in what is now Bihar in the sixth century BC. Each preached throughout his life, and neither was persecuted, though both opposed the worship of the gods, and taught that men could attain salvation by their own efforts.

Further, Hinduism has never been a proselytizing religion as Christianity, Islam, and Buddhism have been. A person born into one of the Hindu castes had a series of duties and rights. One born outside them had fewer duties and also fewer rights. He was maltreated, but he was not persecuted in order to make him become a Hindu. In fact, the descendants of such people gradually became Hindus, while preserving a good deal of their primitive religions, and found themselves within the Hindu system as members of castes so low as often to be untouchable by Hindus of high caste. This may have involved as much human suffering, or more, as the methods adopted by the Spaniards in Mexico or Peru, where the conquered people were violently persecuted, but their descendants are now under little disadvantage compared with those of their conquerors; but it meant that the practice of killing a man for his opinions was foreign to Hinduism.

One reaction to the treatment of the 'lower' castes was that, when opportunity offered, many of their members embraced Islam in northern India and Christianity in southern India.

The Christians include 'Syrian Christians' who follow the ancient heresy of Nestorius, long since extinguished by persecution in its native land, but preserved in the more tolerant climate of India; Catholics who are largely the descendants of converts made by the Portuguese; and Protestants of more recent origin. In the north many of the Muslims have become citizens of Pakistan. In the south the result has been more surprising. It is precisely in Travancore-Cochin, where the largest fraction of the people are Christians, that the Communist Party obtained the largest vote in the election held last winter. There is, of course, no certainty that it was the Christians who voted Communist, but a pious Hindu capitalist would have a good case for saying that Christianity had paved the way for Communism in his country.

British critics had maintained that if India were granted self-government the Hindus would proceed to persecute the Muslims and Christians, and to oppress the 'lower' castes. This might have happened had India gained its freedom a generation earlier, though I venture to doubt it. What actually happened was more remarkable. India achieved its independence under the leadership of two very great men, Gandhi and Nehru. Gandhi was a fervent Hindu, but an equally fervent opponent of many features of the caste system, not only in theory but in practice. To take a single example, during his last years, when he was the unquestioned leader in the struggle for independence, and probably believed by millions to be an incarnation of Vishnu, he refused to attend any marriage unless one, but not both, of the spouses was a Harijan, that is to say, a member of an 'untouchable caste'. Gandhi died for his attack on the caste system: he was murdered by a Hindu traditionalist.

Nehru is a Rationalist, in spite of which he is an object of definitely religious veneration. All over India one can buy prints of artistic merit comparable with those of the Sacred Heart in Europe, in which Gandhi is shown ascending into

heaven with a large halo and other paraphernalia, while Nehru, with a smaller halo, watches from the ground. But in spite of this halo (which I did not notice on meeting him, perhaps because he impressed me sufficiently without supernatural aid) Nehru has succeeded in making India, by its constitution, a secular State. This is a very great achievement. Most Hindus regard the killing of cows and the eating of beef as sins comparable with murder and much worse than theft; but neither is a legal offence. Those who would like it to become one, and who would probably try to start an irredentist religious war against Pakistan, are represented by such parties as the Jan Sangh, which, in an election carried out with conspicuous fairness, except to a minority of the Communist candidates, were soundly defeated. There were, of course, massacres of about equal numbers of Hindus and Muslims in the rural areas near the borders of India and Pakistan when these States were separated. These massacres are, however, over, though many refugees are still destitute. The proof that they are over is simple. Several thousand people cross the border between India and Eastern Pakistan daily. The numbers of Muslims entering and leaving India are about equal. So are the larger numbers of Hindus moving in each direction. These people are 'voting with their feet', as Lenin put it. About equal numbers are returning to their old homes and seeking new ones.

There is a large body of Rationalists among the educated classes in India. Others, notably the Brahmo Samaj, are monotheists while claiming to be Hindus. Among my academic colleagues who were obviously dissatisfied with Hinduism as it exists today, I noticed two distinct tendencies. One group either said that I could not possibly be interested in Hindu art and ceremonial, or, to take a concrete example, allotted me a period of just half an hour to visit the great temple at Rameshwaram, of which the cloisters alone are 1,200 metres in length, and decorated with sculptures as re-

markable as those of any European cathedral. At the end of three hours I had still a great deal to see. I cannot think that a European colleague, because he was an atheist, would have supposed that I should be contented with a glance at the Christian art treasures of Gand or Bruges. In fact, I find some Hindu religious art not merely interesting but moving, and consider that it is as worth while learning the mythological stories about Hanuman or Yudhisthira as those about a Christian saint in order to be able to appreciate it.

An entirely different point of view is taken by most of the Indian scientists whose work is recognized throughout the world. They no more believe in the Ramayana than I believe in the *Iliad* or the *Divina Commedia*. But they realize that a culture cannot deny its past. Let me take two examples among my colleagues. Professor Mahalanobis, the distinguished statistician, has interested himself in what seems to me to be the exaggerated euhemerism of Dr Girindrasekhar Bose. This author has made a profound study of ancient Sanskrit literature, in particular the *Puranas*, and attempted to give it a naturalistic interpretation. According to the documents, the god Indra lived in *Svarga*, where certain mortals visited him. For Dr Bose, *Svarga* is not heaven but Uzbekistan, the ancestral home of the Aryan invaders of India, ruled by a series of kings called Indra, and occasionally revisited, until one of these kings, or perhaps a climatic change, closed the original route. Another more dangerous route, probably through the Himalayas, was then opened up, and it was on this route that Arjuna and other heroes of the Mahabharata died about 1400 BC. I am afraid I am not convinced; but I remember that European scholars were beginning to regard the heroes of the Trojan war as solar myths or vegetation spirits till Schliemann dug up Troy and Mykenae. At any rate, the Indian euhemeristic school is trying to construct a chronology of ancient India including records of floods, earthquakes, building of dams and digging of canals, and other events which may have

left records which can be identified; and euhemerism is a sign both of intellectual vitality and of intellectual toleration.

Professor Saha, who worked out the method by which (of course with some subsequent modifications) the temperatures of stellar atmospheres are measured, is interesting himself in ancient Indian chronology. His studies show (to my mind conclusively) that the modern Indian astrologers (who are one of the plagues of the country comparable with mosquitoes and considerably worse than crocodiles) are about three weeks out in their calendar. They base their computations as to lucky and unlucky days on a document of respectable antiquity which unfortunately ignores the precession of the equinoxes. I hope that Professor Saha's researches will not lead to the rise of an astrological school which makes the necessary corrections; but even if it does, would-be bridegrooms, who must choose lucky days for their marriages to satisfy their pious aunts, will perhaps have a wider choice. Meanwhile, it has become possible to date some ancient Sanskrit documents with fair accuracy from astronomical data.

Of course these men are not alone in their humanistic interpretation of a literature which is even more riddled with mythology than the European literature of the same period. I am, perhaps, prejudiced because when last in India I saw too little of my university colleagues in such faculties as history and linguistics. As an example of humanism in action I would mention the learning and aesthetic sensibility of the custodian of the caves of Ajanta, which contain not only sculpture but paintings of the Buddhist period which are a great influence in modern Indian art: he happens to be a Muslim. I gave him some perhaps unorthodox advice on what to see in the religious art of Europe from Granada to Moscow, and believe that his comments on it would be of the greatest interest. A serious attempt to build an Indian humanism is being made in the small rural university of Santiniketan, founded by Rabin-

dranath Tagore. To my mind it is handicapped by its syncretistic religious background. At Santiniketan they try to reconcile all the religions, an effort which seems to me too difficult for any human mind, and unlikely to lead to any great result. But I may well be doing them an injustice; it is certainly compatible with an art school whose products compare very favourably with those of the Slade School in London.

In these few pages I have tried to show that the prospects of humanism in India are perhaps brighter than in some parts of Europe and America. These prospects will depend to a considerable extent on co-operation with European humanists. British scholars, and not only scholars, have contributed to Indian humanism. For example, while Jones in the late eighteenth century, by his study of Sanskrit, made one of the greatest steps ever made in comparative philology, the caves of Ajanta were discovered by a party of English soldiers. At the present time two French scholars, Bernier and Daniélou, one married to an Indian wife, are making most important studies on Indian sculpture and music, and find it easier than Englishmen to obtain access to shrines. In fact, it was only in their company that I was able to take part in any Hindu ceremonial. As a Rationalist I can conscientiously bow before the image of Sarasvati, the goddess of learning, for a very simple reason. If I state my opinion to the officiating Brahmin that Sarasvati has no real existence, he will probably reply, 'Of course not, nor have you or I, all three of us are illusory forms.' We can then proceed to discuss the nature of illusion. The fact that such an opinion is not only common but even orthodox implies that Hinduism will offer a different kind of resistance to humanism from the other great religions. It may, of course, go down before a frontal attack by Marxism, but it is so plastic and undogmatic that I believe that it may incorporate a great deal of humanism without succumbing.

It is of vital importance to the future of the world that Europeans should learn to appreciate both the new India and the old India. Naturally enough the most readily welcomed are Scandinavians, just because their countries have no record of imperialism, in the last few centuries at least. But scholars from all the world are welcomed and honoured. A sympathetic approach is particularly easy for a European Humanist who has some insight into the history of his own culture, but is no more a propagandist for Heaven than for Olympus or Valhalla. Such a man or woman can, I believe, be of real help to the intellectuals of India, struggling amid a sea of superstition, but refusing to cut themselves off from the mass of the people or from the great past of their culture. Americans, just because they have less emotional contact with the past, find it easy enough to make the first stages of *rapprochement* with the Indian mind, and extremely hard to get much further.

The Indian government today is refusing to associate itself either with the Soviet or the American bloc. There is no doubt in my mind that most Indians support this policy. It can, therefore, claim to represent the 'third force' for which many Europeans are hankering; and it is unfortunately not impossible to imagine a situation where many of the ethical and cultural values developed in Europe during the last three centuries will have a better chance of manifestation in India than anywhere else.

Unfortunately the propaganda in favour of India in Europe has not been of the kind which would be most fruitful today. Up till the achievement of Indian independence in 1947 Indian propagandists were largely engaged in denigrating the British, while British propagandists were equally busy in contending that Indians could not govern themselves. Today Indian government propaganda is unimportant, and such religious bodies as the Ramakrishna mission no more offer a real picture of the riches of Indian culture than Christian missions offer a real picture of European culture to the people of India.

Indians in Europe are mainly busy in acquiring technical knowledge or engaging in trade. A few very wealthy ones are spending money in a manner which reflects no great credit on their culture. Very few of them realize what are the facts about India which educated Europeans find most interesting, or what contributions India can make to European ethics. One such contribution is certainly a more ethical attitude towards animals. Another is religious toleration. Perhaps the most important at the present moment is a real love of peace.

Such must be my excuse for devoting this article to a plea for a wider appreciation of Indian culture in Europe, and particularly among European Humanists. As a scientist I am quite unqualified to make such a plea. I hope that I may encourage others to do it on a basis of wider knowledge. One useful source of such knowledge is *The Discovery of India*, which Nehru wrote while imprisoned by the British government. The special cheers, which, as several people have told me, greeted him in the coronation procession this year, show that he stands, in the minds of many British people, for something which the other Prime Ministers of the Commonwealth do not. He is a republican, and an atheist, or at least a *nastika*. It can be argued that these points of view are mere importations from Europe, quite foreign to Indian culture. This is not so. It is true that the people of India as a whole has been subject to kings and gods for thousands of years. But this subjection has never been unanimous. It was into the mouth of a Hindu ascetic that Sir Alfred Lyall put the words:

Is it a god or a king that comes?
Both are evil, and both are strong;
With women and worshipping, dancing and drums,
Carry your gods and your kings along.[1]

[1] It was perhaps the recollection of Diogenes which prompted Pollock's translation of the poem from which this is an extract into ancient Greek, from which I quote just one line:

ὃν θεός ἢ βασιλεύς, πάντως κακόν, ἡγεμονεύει.

In every generation in India there have been men who were prepared to ignore gods and kings alike. Because other Indians, however they might bow down before gods and kings themselves, have regarded such men as the noblest members of the human race, India has had, and still has, something very great concerning the dignity of man to teach the world.

1955

THE ORIGIN OF PURPOSE

ACCORDING TO theories of evolution, whether explained in terms of natural selection or otherwise, men are descended from much simpler organisms, and possess capacities which these simpler ancestors lacked. Critics of evolution have chosen one or other of these faculties and argued, or sometimes merely asserted, that it could not have arisen except by supernatural intervention. This intervention is often located so far back in the past that it is even less open to direct investigation than are the miracles which, we are told, were everyday events in the early Church. Even if physical evolution is accepted it is argued that a moral, or potentially moral, being could not evolve from one incapable of moral decisions. Clearly one prerequisite for moral responsibility is purpose.

I say that an action is purposive, or that an animal performing it has a purpose, if the performer imagines a future state of affairs which can be achieved or prevented by this action, and acts so as to bring this future state of affairs into being, or to prevent it. Thus human breathing is rarely purposive. It is usually a reflex action performed involuntarily. If there is a resistance to breathing we certainly want to breathe, and may struggle to remove the resistance. But while doing so we are generally much too obsessed by our feelings to think, 'If I do not breathe I shall die.' We may think of this later on. Breathing certainly can be purposive. Swimmers and singers learn breath control, which later becomes automatic, but this is exceptional. Eating is much more often purposive. We may think, 'I must have a good breakfast, for I may not get anything more till the evening,' and so on. Going into a restaurant is

generally purposive, though, like any other originally purposive act, it may become habitual if we do it sufficiently often and sufficiently regularly. I am quite aware that such words as 'purpose' and 'purposive' are more loosely used. I am however going to apply Humpty Dumpty's principle to 'purpose'. In this article it will mean what I meant it to mean—the meaning given above.

I do not think we can possibly attribute purpose to an animal as simple as a jellyfish or a sea anemone. If food touches its tentacles they are pulled into its mouth and the food is swallowed. This requires rather less co-ordination than the acts of breathing or swallowing in a man. Such an animal may have feelings, but it seems ridiculous to credit it with imagination of the future. I doubt if a frog has purpose. I have very little doubt that it has feelings, including desires. If it gets dry, it goes into water and absorbs it through its skin. I think it probable that it wants water, as a thirsty man does. The account given of its behaviour by many modern animal psychologists is roughly as follows: A change in the animal's internal condition produces a drive, that is to say, an activity of a particular part of its brain. This part can sometimes be located, and by stimulating it we can make the animal thirsty, hungry, sleepy, enraged, and so on. As the result of the drive the animal exhibits appetitive behaviour. This may be undirected wandering, which we can interpret as a search for water. It may be directed from the first by sensory stimuli, but this is not so for a frog which gets thirsty in an unaccustomed environment. If in its wanderings it encounters sensory stimuli of a kind appropriate to the drive in question, it performs a consummatory act. A thirsty frog sits in the water when it feels it, a thirsty dog drinks it. The consummatory act gives a further sensory stimulation which is pleasurable to men and probably to animals with a sufficiently developed nervous system, including, in my opinion, frogs.

Once the consummatory act has been performed, sensory

stimuli received shortly before it, which were previously neutral, come to alter the animal's activity when it meets them again. In actions where, in man, will would be involved, we say that an animal learns. Thus a rat learns to find the shortest way through a maze to food or water. Where, in a man, will would not be involved, we say that the animal is conditioned. Pavloff worked on the conditioning, in dogs, of the secretion of saliva, which is a preliminary to eating. He found that if a bell was repeatedly rung just before, or at the moment when, a dog was given food, it salivated when the bell was rung, even if no food was given. Similarly the thirsty frog, when it sees certain objects, will presumably perform the preliminary to sitting in the water, namely hopping in a particular direction. There is no reason against applying Pavloff's analysis of the situation, whether we call the process learning or conditioning.

Just the same applies to eating. A newly hatched chick pecks at any small spots which contrast visually with their background. It picks them up in its beak if it can, and eats some, while rejecting others. For example, as long ago as 1873 Spalding found that newly hatched chicks generally picked at their own dung two or three times, and then ceased to do so. The 'sign stimulus' for some stage in a chain of instinctive behaviour leading up to a consummatory act may be very specific. Thus young herring gulls are fed by their parents. They peck at a red spot near the top of the parent's yellow beak. Tinbergen found that a cardboard model with a yellow beak 'released' pecking best if it had a red spot. A black, green, blue, or white spot elicited less pecking; no spot at all still less. But the colour of the model's head was irrelevant. The parent has a white head, but the chicks pecked at a dummy beak on a black or green head just as eagerly. This behaviour seems strange to us. But our own might seem just as strange to a seagull. We generally like food or drink which is sweet, and reject it if it is bitter. This is instinctive and

irrational. Fruit juice flavoured with quinine is much more nutritious than a saccharine solution with a dash of phosphoric acid. But almost everyone will choose the latter. It is nonsense to say, 'The young seagull sees a yellow beak with a red spot, and knows that it means food.' On the contrary, if it has any feelings at all (which we do not know, but guess) it likes pecking an object held in a beak of this kind just as a child likes sucking a sweet-tasting object. There is no reason to think that its action is any more purposive than that of a child sucking a lollipop. Sexual and parental activities can and should be considered in just the same way. Such activities may have a purpose in some animals other than men, but they certainly do not always do so, and we shall see reason to think that they seldom do so.

Now when we discuss the origin of some human activities, for example, consciousness or vision, we have an answer to those who say that they cannot have arisen in beings which did not possess them. The answer is that they arise afresh in every human life. A human foetus at the end of its first week's life, nearly nine months before its birth, very certainly cannot see, and has less claim to consciousness than a hen's egg a week after laying, which has a much better rudiment of a brain. The origin of consciousness 'out of nothing' is not a miracle which happened once in the history of the world. It happens in each of our lives, not only in infancy but every time we awaken from deep sleep. But the answer to other questions, such as the origin of language, is not so straightforward. If I were one of a group brought up as children by deaf mutes or by wolves, I should not speak a language, though I might make a dozen or more different sounds in appropriate situations. It is therefore reasonable to inquire into the historical origin of language. I am going to suggest that purpose is to a large extent a human tradition. My mother told me, 'If you go straight to bed, father will come and say goodnight,' or, 'If you drop that again, I won't pick it up.' She asked me

'Why did you do that?' and so on. No child which understands human speech can escape the idea of purpose. I suggest that without human speech I should have had the merest vestige of purpose. On the whole, I should have 'done things because I wanted to' and not for ulterior motives. I shall try to make this conclusion plausible by a further consideration of animal communication.

When an animal is in a physiological (or, if you prefer that word, psychological) state which makes it ready for some action, it commonly makes what Spurway and I have called prelude movements. An angry cat snarls and switches its tail. A sleepy one turns round and rubs itself on things. A lecherous cat emits peculiar cries, a hungry cat quite different ones. The same is true of other animals. I have learned to discern when a newt is 'air-hungry', that is to say, ready to swim up to the surface for a breath of air, amorous, and so on. Some of these movements, which may or may not produce a sound, are intention movements, preparations for another movement. Some, particularly where there is a conflict of 'drives' or 'motives', are displacement activities appropriate to a different situation, such as scratching the head. In other cases their origin is not clear. In any case they indicate the animal's psychological state, or at least what it is likely to do next, to a sufficiently careful observer who has watched the species for some time. If a species has any sort of social life, even if it is only mating or a minimum of parental care, it is often advantageous that one member of the species should react appropriately before or simultaneously with an action of another member. I did not write 'should know what the other one is going to do', though that is what a human observer is apt to think. It is advantageous that a parent bird should feed a nestling if it gapes its beak, that a female grasshopper should approach a male making the sound which signifies that he is ready to mate, and so on. In so far as this is so, the prelude will be exaggerated and ritualized, so that other members of

the species will notice it, and react to it differently from their reaction to any other activity. These reactions may be learned but they are very often innate or instinctive. In this way a system of communication is built up.

Now we can distinguish communication from X to Y into two classes. In one of them X is about to do something, and induces Y to do something quite different. For example X is a baby gull, and induces its parent Y to regurgitate some fish, or X is a female about to lay some eggs, and induces a male Y to fertilize them. In other cases X induces Y to perform an activity very similar to its own. A good example is the alarm note of many bird species, which may induce a whole flock to crouch from a hawk or take some kind of evasive action. The most striking example is the 'language' of bees elucidated by von Frisch, and described in Ribbands' *The Behaviour and Social Life of Honey Bees*, a book which should be in every public library. By suitable 'dancing' one bee can indicate to another the direction and the distance at which food is to be found.

In these cases X makes a signal, and Y very often repeats it. This has a double function. It broadcasts the signal to more animals, so that a whole flock of birds can crouch together, mob an owl together, or alight for food together. But there is very little doubt that by repeating the signal, Y can bring itself into the appropriate mood for the coming action. We can only judge of animals' moods by their subsequent actions, but we have more certain knowledge about our own. If anyone thinks that movements of the human face have no effect on subsequent actions, I advise them to read Shakespeare's *Henry V*, Act 3, Scene 1, where the king bids his soldiers 'Now set the teeth and stretch the nostril wide', with a whole catalogue of other prelude movements, in order to get them into the mood to kill some Frenchmen. If this does not convince him, let him yawn ostentatiously at a friend about 11 p.m. If the friend yawns too, he may go on to say, 'Isn't it time we went to bed?'

An animal finds it hard to imitate most of the gestures of other members of its species. A cockatoo can hardly see itself lift its crest. If it can do so it looks no more like a neighbour's crest than my nose looks to me like your nose, unless I have a mirror. But it can hear its own voice, and know when it has produced a sound like its neighbour's. The other activity which is easily imitated is a dance. I have to do no more than follow a leader in a country dance to imitate his pattern of movement. This is what bees do. A bee follows another one which has been to a flower whose smell is associated with food in the brain of the follower. By doing so it makes little rushes in the direction of the food, or a direction symbolizing this, with an appropriate rhythm, and is thus prepared for flight in the right direction and for the right distance.

We see then the biological advantage of vocal imitation in social birds, and we can understand how some of them have developed a sort of rudimentary language. Promptoff and Lukina distinguish about twenty different cries made by the great tit as a preliminary to various actions. Birds reared by human beings only make three of them, the alarm call, the fighting call, and the long-distance call, in their correct contexts, and understand them. The others, notably the sexual calls and those made while flying through dense foliage, have to be learned, and the unfortunate Romulus, Mowgli, or Tarzan, brought up by an ornithologist, has great difficulty in adjusting itself to tit society.

I doubt if the cries and gestures of monkeys have got any further than this. At this stage language is the expression of an emotion or mood, and in so far as it is concerned with the external world, it points forward in time. A good deal of human language is at this level. 'I love you' is (or should be) the expression of an emotion, in the hope of evoking similar verbal signals and actions appropriate to the emotion. The

most effective evocations of action, expressed in such words as

Allons enfants de la patrie,

or

Groupons nous, et demain
L'internationale sera le genre humain,

are evocations of joint action in the future. However, such human evocations almost always include words such as *enfants*, which refer to objects known in the past. They are not evocations like the alarm note.

On the other hand, a great deal of human speech consists of descriptions of events or situations in the immediate past, commonly miscalled the present, such as 'I am writing', or in the more remote past, such as 'W. K. Clifford wrote'. We do not know how these originated, but we can make a plausible guess. As the number of signals used by a species increases, some come to portend a class of actions only appropriate to a limited class of objects, for example, food, or large and dangerous animals. They could thus be regarded as descriptive as well as evocative. A few of our words are in this category. 'Drink' can mean either 'Swallow a liquid', or 'A liquid suitable to be swallowed'. Clearly a descriptive word or phrase implies the existence of memory. 'Gurnard' or 'quoin' means nothing to a person who does not remember a gurnard or quoin, or at least a picture or verbal description of one.

Some of our forward-pointing words are hardly descriptive. 'Danger!' or 'Look out!' may refer to a cobra, a tiger, a lunatic, a motor-car, or an aeroplane. Others, like 'food', are more nearly descriptive, but less so than 'bread' or 'meat'. As these words became more precise, when, for example, a different sound was used to indicate danger from a snake and from a tiger, they must have begun to arouse visual or other memory images in those who heard them. I think that descriptive language and systematic memory grew together,

that our ancestors began to describe things because they remembered them, and simultaneously to remember them because they described them. This is what happens in our individual lives. We may remember a few incidents of infancy, but our coherent memory begins about the time when we first learned to tell our mothers what we had done during the day.

I suggest that purpose, in the sense in which I have defined it above, only began to influence conduct at all steadily at about the same time. Primitive men probably chipped stones and even made traps before they had words for stones and traps, though they probably had words for 'Let's make a trap'. Truly purposive action probably began in connection with communal activities like this, for a pitfall which could catch a deer, let alone a rhinoceros, demands the work of several people, particularly if they are digging with sticks. I expect they chipped stones largely because they had learned to do so, and enjoyed it, and with rather little thought of how they would be used. No doubt every hundred generations or so a prehistoric Newton or Stephenson would have enough purpose to invent a new type of trap or a new use for stone tools. If so, he was probably rarely imitated.

I do not say that higher animals never have purpose. I think an intelligent cat may perform a purposive action once a week. But I am also convinced that, if it were suddenly endowed with the gift of language, and asked why it had done something, its only truthful answer would almost always be 'Because I wanted to'. Purpose, as I have tried to define it, implies the recognition of causation, physical or biological, with a time sequence reversed in our thought. That is to say, if I think, 'I want to catch the 9 am train, so I must start in five minutes,' my action is purposive. If I merely start at the accustomed time, even if at some stage I think, ' I shall catch the train easily,' my action is not purposive; it is a repetition of an action which was purposive when I first performed it. In other

cases this action is not now and never was purposive. I do something which is of use to me or someone else because I was laboriously taught to do so as a child.

If I am right, then, man is a somewhat less purposive animal than he likes to think. When I am driving a car at 20 mph I can afford to drive purposively. I bore my wife with a running commentary of remarks such as 'Look at that old lady stepping off just as the light goes red against her. Shall we ram her? Not tonight, perhaps.' But when I am driving at 70 mph I drive by conditioned reflexes. I have no time to think about my relations with any object less than fifty yards away. Nevertheless man is far more purposive than any other animal. However, I think purpose is very largely a social artefact. That does not mean that it is any more unreal than clothes or houses, property or language.

Any description of a purpose demands careful examination. I can always invent a purpose for any of my actions, and I may invent a false or inadequate reason when asked, without deliberately lying. It may be that some of my readers usually act with a purpose. I am more 'impulsive'—that is to say, I do things without thinking out their consequences. This sometimes lands me in scrapes. But it also leads me to formulate novel ideas and even to make novel experiments. It is extremely difficult to check any statements by human beings as to their purposes, as one can check statements about physical causation, by experiments. And this has, of course, led psychologists of the behaviouristic school to state that purposes are inaccessible or even non-existent. This seems to me to be an exaggerated point of view. If a reliable person states his purpose before an action, he is probably at least partly correct.

However, human thought went through a phase where no human action was responsible without a purpose, and natural happenings were only made respectable by attributing purpose either to an animal or even a plant, or to a supernatural

being. We are gradually overcoming this tendency, to the immense annoyance of some worthy persons who seem to think that there is no alternative between purpose and 'blind chance', whatever that may mean. Some events have a purpose, but I think these are a very small minority indeed. It is a prerequisite of purpose that the purposer should have enough experience, and a sufficiently orderly experience, to imagine future events resembling past events, and to behave in a manner calculated to bring about, or to prevent, these future events.

An almighty being, if such exists, need not perform purposive actions, and presumably does not do so. If I could have this article complete and printed by a mere act of will, I should not write it or send it to the press. It is extremely doubtful if such a being could be said to have a purpose. For anything which he desired to happen would happen automatically. Purpose implies the recognition of causation by the purposer. When one reflects sufficiently, one sees that one's own purposes arise as the result of causation, like any other events, though one cannot analyse the chain of causation completely. This inability leads to the curious opinion that one is somehow acting on the world from outside it. But the historical reason for this illusion is fairly obvious. If we are even to survive, let alone to live happily, it is necessary to understand about the kinds of causation which are concerned in carrying out our everyday purposes, for example, how to open a door or buy a bus ticket. It is not necessary to understand how our purposes arise; why, for example, I want a meal when I do. Such a necessity only arises when people have purposes which conflict with one another, with physical possibility, or with the purposes of others. Children are taught, often rather cruelly, not to have such purposes, save for the moderate amount of conflict between individuals which is sanctioned in our society. An investigation of the origin of purposes is therefore largely confined to cases of mental abnormality, and

psychoanalysis has probably given a somewhat biased account of them.

I think that an investigation of animal behaviour, which is rarely purposive, is likely to yield a much better account of the origin of human purpose, and I think that this possibility alone is quite sufficient to justify all the research which is being done upon it.

1956

MIRACLES

AT A RECENT DEBATE at the Oxford Union Society I spoke on this subject, and my speech was broadcast. It is not easy to present a coherent argument in a speech, especially if one has to answer not only previous speakers but interrupters. I also had to deal with the general topic of religious mythology. This includes accounts of events which do not purport to have been witnessed by human beings, such as the creation of the world, or the theft of the food of immortality from the Hindu heaven by the Garuda bird, and that of the fire from the Greek heaven by Prometheus. Mythology also includes accounts of remarkable events which are alleged to have been witnessed by one or more people.

The first class of alleged events may just be good stories, or they may be pre-scientific hypotheses to account for known facts. Bernal[1] has pointed out that they were not only anthropomorphic but technomorphic. They are usually stated in terms of the human crafts which had only recently been invented at the time when these accounts were first given. The Garuda bird, after chasing the gods away, had to find its way through a rapidly rotating wheel with sharp blades which protected the ambrosia. I must apologize to European readers for references to Hindu mythology, of which a good deal may be found in the Mahabharata, but I know that this *Annual* is read in India, and I consider that Hinduism will present a more logically coherent resistance to Rationalism than Christianity has done, if only because no Hindu holds that a

[1] *Science in History* (Watts & Co, 1954).

belief in such tall stories is necessary for a religious life, though many think that it is useful for this purpose.

I shall only concern myself with miracles, that is to say, remarkable events which can be used as arguments in favour of a particular religion. I shall shock a number of readers by stating that in my opinion miracles, to which the above definition applies, do sometimes occur. I do not say that the events are inexplicable from the scientific point of view. I say that they have not yet been explained. Unexplained events, analogous to those used to support religious beliefs, happen in my laboratory. In 1951 my then technician, Miss Jean Clarke, called the attention of my wife, Dr Helen Spurway, to a remarkable fact. A female guppy (*Lebistes reticulatus*, a small fish whose young are born as little fish, not spawned as eggs) seven months old had been alone in a glass jar since infancy. Miss Clarke noticed a small baby guppy along with her. This fact could be explained in several ways. One of my junior colleagues might have introduced a baby fish; he or she might have put in a male and removed it again during my wife's absence. Or the mother might have been fertilized before she was adult. A collective hallucination might have occurred. Finally, it might have been a case of virgin birth. We were quite prepared to accept one of the first three hypotheses, but we thought the last was worth testing. Dr Spurway has been testing it ever since, and her conclusions are now in the press in the *Journal of Genetics*, after a preliminary account in *Nature*. Thirteen out of about one hundred and fifty female descendants of the original female which have been kept isolated for a year or so have had virgin births under much better controlled conditions, and some of the details make the practical-joke hypothesis exceedingly improbable. But we do not know why these particular fish behaved in this manner. Since Spurway's first publication, Olsen and Marsden, in the United States, have obtained a number of dead embryos and four live turkeys from unfertilized turkeys' eggs.

I do not, therefore, say that virgin birth in vertebrates (including our own species) is impossible. I say that I am quite prepared to investigate such alleged occurrences when I can do so in such a way as to exclude to my own satisfaction the possibility of fraud.

In the case of most alleged miracles the documentary evidence is very unsatisfactory. We are not told that the gospel 'according to Mark' was written by Mark. It might have been written by someone who did his or her best to remember what Mark told them. The writer never states that he saw a miracle. Nor does he state who told him about a given miracle. It may have been an eyewitness, or it may not. So the accounts of the miracles are at the best second-hand and quite probably fourth-hand or worse, the chain being X, who claimed to have seen it, Y who told it to Mark, Mark himself, and Z, who wrote down Mark's account. This is on the assumption that the gospel according to Mark, at least, is what it purports to be, and not, as many scholars think, a compilation from several written and perhaps oral sources.

Now recent work has shown what happens to retold stories. Bartlett, in his book *Remembering*, gives examples of the changes which take place when a passage is read by A to B, retold from memory by B to C, and so on in series. Completely novel characters may appear. Thus, in an account of a cricket match, after more than a dozen repetitions, the story centred round the fine batting of Robinson, who was not mentioned in the original. Even more significant was the repetition of a Red Indian story called 'TheWar of the Ghosts' containing supernatural elements. A series of English subjects gradually dropped these out, even though the title suggested their existence. This is quite intelligible. Englishmen do not think much about the supernatural on weekdays. It is almost certain that supernatural elements would be interpolated in a similar series of repetitions within a culture where the supernatural is more familiar.

However, it is claimed that some miracles, for example, the appearances of Jesus after his resurrection and his subsequent ascension, were witnessed by a number of people, whose conduct was in consequence immediately altered. The apostles had run away when Jesus was arrested, and Peter had denied knowledge of his master. But after the resurrection they preached the gospel boldly, and many of them died for it. Until recently I took the view that if the non-miraculous parts of this account were correctly reported, this was very strong evidence for the truth of the miraculous part. Like Mr Bickersteth Owen, the fictitious author of Samuel Butler's *The Fair Haven*,[1] I could not take Strauss's 'collective hallucination' hypothesis seriously. By the way, Charles Darwin's copy of the first edition of this book is preserved at Downe House and contains his pencilled notes. It would be of interest to have these copied and reprinted. I may do so myself, if no one else will do it first.

Let us put the question bluntly. Suppose someone tells me that several thousand people have seen a man ascending into the sky in broad daylight without mechanical aid, that some of them were sceptical of supernatural events beforehand, and it can be shown that the event was immediately reported with evidence from a number of witnesses, should I believe that this ascension has occurred? Until a few years ago I should have said 'Yes'. But now, thanks to the powerful arguments of the Catholic priesthood, I am obliged to say 'No'.

On October 13, 1917, a miracle occurred at Fatima, in Portugal. It has been described in various works, of which I shall quote from *More about Fatima and the Immaculate Heart of Mary*, by Rev P. da Cruz, translated into English and published in Dublin by Gill and Son. Or so we learn from the title page and that following it. On the other hand, the name of Rev Fr V. Montes de Oca appears immediately after the

[1] Reprint by Watts & Co, 1938.

title, so here too a sceptic might be in two minds about the authorship.

Three pious children had had a series of visions of the Virgin Mary. They stated that she promised them to work a great miracle on October 13. On that day a large crowd assembled. Its numbers have been estimated at seventy thousand; but allowing for pious exaggeration it must have numbered many thousands. There was heavy rain, during which the children saw visions and heard voices. According to the report, the clouds then cleared up, and the sun was seen bright but not dazzling. It made some abrupt movements and began to spin round and emit beams of light of various colours for four minutes or so. This was repeated three times. Then, to quote the reverend father, 'the sun leaves its place in the firmament, and falling from side to side, plunges zigzagging on the crowd below, sending out a heat increasingly intense'. The sun, however, stopped, climbed back in a zigzag path, and resumed its usual brilliance. Some people also saw St Joseph, holding the infant Jesus, in the centre of the sun.

Now allowing for a good deal of ecclesiastical 'writing up', it is difficult to doubt that a great many people, including some who were not Catholics, believed that they had seen the sun plunging about and falling towards them. This is a miracle, according to Bernard Shaw's definition: 'An event which creates faith.'

Nevertheless, the vast majority of human beings, including the majority of pious Catholics throughout the world, saw nothing unusual on this day, nor is it claimed that they did. I say, therefore, that the sun did not move violently towards Portugal on the date in question, and that if a number of Portuguese say that they saw it do so, they were deceived, and that, in spite of their agreement with one another, their testimony cannot be accepted.

But no other miracle of ancient or modern times was attested by even a thousand people, let alone seventy thousand.

If a crowd of even a thousand people sees the present Pope ascending into heaven in the course of next year, we shall undoubtedly be asked to believe that he did so, and with some justification. In such a case there will not be the countervailing evidence of millions of other people who saw him remaining on the ground.

Of course the Catholic Church includes a great many highly intelligent people trained in formal logic. They realize this difficulty as well as I do. Presumably for this reason P. da Cruz states in his preface that: 'It goes without saying that neither the fact of the apparitions of Fatima nor the messages which accompanied them belong to the deposit of revelation proper, and that they are not truths of Faith.' For if they were, the Faithful would be in an awkward dilemma. Either they would have to believe that the sun really did move towards Fatima, and that this was miraculously hidden from all but a favoured few of the human race so that the majority were deceived by a supernatural agency, or else that a great many people at Fatima were miraculously deceived.

I take the latter view. I think that there was a miracle, and that it was a miracle to end all other miracles. If thousands of people can see the sun falling on them when it did not do so, the fact that a few spiritualists see trumpets and tables moving about in nearly dark rooms becomes a very minor miracle. And every other recorded miracle sinks into insignificance.

The miracle of Fatima thus leads us to a new definition of miracles. A miracle is a consensus of opinion among witnesses that they have seen (or heard, or felt) an event which in fact did not occur. If this definition is correct, miracles are historical events which ought to be investigated.

Besides miracles as defined above, the miracles claimed by various religions include two other classes of events. One class is that of physiological prodigies, such as the control by Indian yogis of their heart function and other physiological processes, and the rapid healing of a number of diseases. Such

events, including even the cure of hereditary skin abnormalities, have also been recorded as the result of hypnotism and other psychological treatments.

The second class includes miracles of the traditional type, that is to say, physical events incompatible with the laws of nature as we understand them. Such events may have occurred. But if they did, I do not see how the evidence for one of them could be convincing to anyone who has considered the facts recorded about Fatima. As very similar miracles are claimed by different religions, the acceptance of their truth would not, of course, lead to the acceptance of any particular faith.

Provisionally, then, I am inclined to stick to my own definition, while admitting that it may need revision.

Under what conditions do miracles corresponding to my definition occur? There is not much doubt that religious emotion of certain kinds favours their occurrence. They seem to be much commoner in India than in modern Europe, and a number are associated with modern Hindu saints such as Ramakrishna. If, like many Hindus, you are an absolute idealist and believe that nothing but experience exists, that the sun, for example, has no existence apart from the various sentient beings who are aware of it, then of course you can say that an event happened 'for' some people and not for others. All religions appear to have their quota of miracles, even when their founders, like Buddha and Mohammed, did not claim miraculous powers. Religion seems to generate miracles. I think that it also generates other kinds of self-deception.

One can also say a little about the conditions which are antagonistic to miracles. I remember doing some 'table turning' at an amateur spiritualist seance. Several of us were touching a table with our finger-trips, and after a while it began to move (or so I say) and we tried to follow its movements without pushing it. I asked the others to cease

touching it, which they did. The table went on moving. I then assumed the mental attitude of rather intense and exact attention to my sensations to which I have accustomed myself during experiments on my own physiology. The table promptly stopped moving. If I had had a little more faith, and a little less determination to attend carefully to my sensations, I have little doubt that the table would have continued its dance. Had I had a lot more faith, it might have chased me upstairs, as a spiritualist lady of my acquaintance told me that a table once chased her.

There is, I think, little doubt that the intense concentration on accuracy which is common in scientific laboratories is unfavourable to the occurrence of miracles in the sense defined above. Nevertheless, enough facts which could not subsequently be verified have been reported from scientific laboratories to show that the miraculous has not been completely exorcised.

I think that the conditions for the scientific investigation of miracles are much better in India than in modern Europe. This is not only because they are more frequent but because Hinduism is more sophisticated, and less censorious of human psychological variation, than is Christianity or Naturalism, a word which I use for the world view common in scientific circles. Unfortunately many of my Indian colleagues have accepted this latter standpoint so completely that they are unwilling to investigate the claims of yogis to perform even such minor prodigies as slowing their hearts down. Seeing that yogis perform most remarkable feats with other muscles, it seems to me probable that some of them can control their hearts. And they can certainly control their breathing. Now in 1924 I wrote a paper in *Pyschologishe Forschung* whose title, translated into English, is 'Hallucinations Resulting from Changed Carbon Dioxide Pressure'. I showed that by overbreathing I could produce tactile hallucinations, and by breathing too much carbon dioxide, olfactory hallucinations.

I think it probable that the yogis, by their special methods of breathing achieve what they regard as an extension of consciousness, though I have used the word hallucination for comparable phenomena. The terminology used will vary with one's world view. The yogis may also perform miracles in the sense in which I have used the word in this article. And they may be able, as the children at Fatima apparently did, to impose their abnormal perceptions on others. It may be that in these abnormal physiological states the processes described by such words as telepathy are facilitated. If so I can only state my opinion that the scientific investigation of such phenomena will lead towards truth, but a reliance on information gained by them will lead, and has led, away from it. However, I emphasize the need to investigate these happenings. They are certainly not explained away by polysyllabic phrases such as 'collective hallucination'.

Meanwhile, the miracle of Fatima has done a great deal of harm. The visions of the children have helped to revive faith in hell, which is always a source of cruelty and intolerance on earth. Their statement 'the sins which lead most souls to hell are sins of the flesh' is used to enforce on sexually normal men and women a rule of conduct framed by celibate, that is to say, sexually abnormal, men and women. Above all, the emphasis in the revelations to the children on the future conversion of Russia to Catholicism is used to justify the manufacture of weapons for the indiscriminate massacre of civilians.

But this miracle can be a means for good. Let every Rationalist ask his Catholic acquaintances, 'Did the sun really fall out of the sky at Fatima on October 13, 1917?

'If it did, were not the hundreds of millions of people from the Pope downwards, who saw nothing abnormal on that day, deceived? If it did not, were not the thousands who saw the prodigy at Fatima deceived? Do not your priests attribute this deception, whether of thousands or of millions, to the

God whom they worship? And if so many people were deceived on this occasion, why should we believe the statements of witnesses to other miracles? Finally, when, if ever, will your Church dare say, either that the sun was moved on October 13, 1917, or that it was not moved?'

These are simple questions. No Catholic can answer them.

1957

AUNT JOBISCA, THE BELLMAN, AND THE HERMIT

WE ALL BELIEVE a number of things, and quite a lot of them are true, or true enough. The processes by which we reach these beliefs are diverse; and one may reach a true belief by a process which is by no means respectable, and false one by processes which satisfy the canons laid down by Aristotle, or even by Russell and Whitehead. I want to examine three theorems on which we do, in fact, rely.

The Pobble's[1] Aunt Jobisca said: 'It's a fact the whole world knows.' Earlier in the same poem she stated the theorem in other words as 'the world in general knows'.

> *And it's perfectly known that a Pobble's toes*
> *Are safe, so long as he minds his nose.*

The Bellman[2] said: 'What I tell you three times is true.' Finally, 'the old hermit of Prague,[3] that never saw pen and ink, very wittily said to a niece of King Gorboduc "That that is is"'.

Aunt Jobisca was on good terms with the world. She owned a park, and what was more unusual, a runcible cat with crimson whiskers. I think the Roman Catholic Church is much more like Aunt Jobisca than the Whore of Babylon, to which some Protestants compare it. Of course, the Church enunciates the theorem in Latin, and, like Aunt Jobisca, has several versions, such as *securus judicat orbis*

[1] Lear, E., *The Pobble Who Has No Toes.*
[2] Carroll, L., *The Hunting of the Snark.*
[3] Shakespeare, W., *Twelfth Night*, Act IV, Sc. II.

terrarum, which means 'the world judges safely', or 'you can rely on the world's judgment', and *quod semper, quod ubique, quod ab omnibus*, meaning '[believed] always, everywhere, and by all'. Aunt Jobisca got a slight shock when it turned out that in fact her eternal truths were believed only by a minority of the human race. But so long as Europeans had superior weapons and military technique, one could regard the majority with contempt. This is no longer the case, nor will it be so long as the American government continues its present policy of exporting arms to Asia while irritating Asiatics sufficiently to ensure that some of the arms, at least, will be used against them.

Aunt Jobisca is not necessarily a Christian. Indeed, the most perfect specimen of the species that I have studied at all closely is a Hindu. And in fact Hinduism depends even more than Christianity, and much less than Islam, on Aunt Jobisca. Everyone knows that a Brahmin must be a vegetarian (except that in Bengal, fish and prawns are vegetables), but this is not explicitly laid down in the scriptures. Nor does Hinduism suffer from a pope or ecumenical councils. So when my Hindu Aunt Jobisca is born next she will be equally certain of a somewhat different set of eternal truths.

The scientific aunts are of two kinds. The females are extremely certain on matters of hygiene. Everyone knows that bad smells are unhygienic. My mother got that far. My father, who had dropped bacteriology about 1890 for branches of biology which were then more exact, used to say, 'Germs don't jump.' He also pointed out that sewermen had a rather low death-rate. In fact, most bacteria don't hurt most men. No doubt human excretions should be disposed of, because they may carry the germs of various diseases, besides being aesthetically offensive. But those of animals smell just as bad, in spite of which farmers who live beside a dung-hill are on the whole healthier than city dwellers who live according to the dictates of Aunt Jobisca's hygiene.

The corresponding male version of Aunt Jobisca knows the principles of science. They were taught him at the university, and he has gone on teaching them ever since, whether to school children or to university students. Facts which do not agree with them are suspect; theories which do not do so are new-fangled. He may, since he was a student, have assimilated some facts and theories which accord with the principles which he learned, while rejecting a number which do not. This makes him even more of a menace in the long run. Probably every scientist would ultimately reach this condition. One cannot learn new principles every ten years. I try to keep up to date with changes in biological theory; but my chemistry is very archaic and my physics probably even worse. For this reason it is perhaps a good thing that I should retire in two years or so to make room for someone with a somewhat less dated set of beliefs.

The Bellman does not rely on the authority of others. He has had a bright idea, and stated it several times. He has come to believe both in its truth and its importance. All religious innovators have something of the Bellman in them. An idea has struck them with overwhelming force. They usually attribute it to some supernatural cause. I quite understand this. Bright scientific ideas occasionally strike me with a violence which causes physical signs noted by persons observing me. I suppose they arise from my 'unconscious' or 'subconscious', or as I prefer to put it, as the result of the function of parts of my brain of whose activity I am not conscious. But for all I know they might come from angels or devils. A good many of them turn out to be logically incoherent. A little calculation shows, for example, that an influence which at first sight might be expected to keep the number of a population steady would in fact cause it to oscillate. Of the ideas which survive this logical screening, the majority disagree with some fact either known already or found out in the course of research suggested by the bright idea. So I do not think that

my own ideas have a supernatural origin, though of course ten per cent may come from angels and ninety per cent from devils.

But if my ideas related to matters where neither logical nor experimental verification is possible — for example, transubstantiation or the relations between Vishnu and Lakshmi — I should very likely suppose that I was inspired. Alternatively, after repeating my opinion sufficiently often, I should conclude that no unbiased student of the Bible or the Vedas could possibly reach any different conclusion, and that a failure to accept this great truth was at best a proof of inconvincible ignorance, at worst, of deliberate bad faith.

In spite of this, I suspect myself of being a Bellman. I give annual or biennial lecture courses. I introduce an idea with some such words as: 'A possible explanation of these facts would be that phenyl-ketonurics cannot oxidize phenylalanine to tyrosine.' Next year this becomes 'the most probable explanation', and after I have said it three times it becomes 'the explanation'. What is worse, when I write a textbook I use this last phrase. I fear that a good many scientific theories originate in this way. They are put forward as tentative hypotheses. They explain some facts. Students learn them from people like myself and accept them. They become part of the structure of their minds. When some more facts turn up which do not fit these theories, which have now assumed the stature of 'laws of Nature', they either refuse to accept the new facts or state that they disprove materialism. A study of Indian philosophies would at least have convinced them that mental facts can be fitted into a materialistic framework. Many of these philosophies attribute consciousness to one or more secondary bodies composed of other forms of matter or, more accurately, of *prakriti*, and very little can be said about the immaterial principle which is alleged to animate them. Indeed, according to some of these philosophies the 'soul' of all individuals is the same.

A scientific theory is alive only if a series of new observations and experiments is constantly being made, any one of which would disprove it. And in fact all scientific theories, in the form in which they are originally stated, are ultimately disproved. To expect anything else is to hope that a finite number of human words can give an adequate account of an infinite number of objects or events. A scientific theory which is worth anything develops in the course of time.

The Hermit is a tougher customer. He has two weapons. Bertrand Russell has blunted one of them, but he has sharpened the other. The first weapon is a pun. The word 'is' means two quite different things. It can be used to state that a thing has an attribute, or is member of a class. And it can be used to state that the thing exists, that there is a thing of that sort. Now we can and do use the word 'is' in the first sense about many a thing which 'is not' in the second sense. For example, we say that a sphere is the set of all points in space at a given distance from a given point, and that it is a member of the class of surfaces which can be moved so that every point of it is transferred to another point of it with at most a finite number of exceptions. A plane and a cone are other members of this class. Nevertheless, I am prepared to contend that there are no spheres. One can make a very good approximation to a sphere, but a good microscope will always reveal some irregularities. And in any case our approximate spheres are made of atoms, so they cannot be perfectly spherical. Presumably we ought to say, 'If there were spheres, they would have such and such properties'. We could also make statements in terms of what mathematicians call inequalities. For example, we could say: 'If the largest distance of a surface from any part of a small volume called the centre does not exceed the smallest by one-thousandth, then if it is turned so that no part of the centre moves by more than a thousandth of this distance, no part of the surface will be more than a five-hundredth of this distance from the former position of some other

part of the surface.' Quite clearly this sort of formulation would be intolerably cumbrous.

But the alternative way of thinking is dangerous. Mathematicians talk and write as if spheres existed, of which balls, stars, and so on are imperfect copies. But Plato extended the principle to other things. He thought there was an ideal city of which existing cities were imperfect copies. And he went on to describe this city. In fact, his ideal city had the greatest of all possible imperfections in a real city. It could not be improved. Similarly, moralists and religionists have described the ideal man, and even said that he existed historically. To avoid offending European susceptibilities, I may remark that last year I read at least one article in an Indian journal on the historical Krishna. In fact, 'Time makes ancient good uncouth'.

With the complication of human society the possibilities both of good and evil action have expanded. Two thousand, even five hundred years ago my principal duties were duties to my neighbour. Now I believe that I am more likely to save my neighbour's life by influencing American policy in Asia than in any other way.

The best-known example of the Hermit's first fallacy is the ontological argument for the existence of God. It was used by St Anselm, Descartes, and others, but it does not seem to have carried much weight with St Thomas Aquinas. One form of it runs roughly as follows: 'We can conceive of a most perfect being. But existence is a part of perfection. Hence the most perfect being exists.' Like St Thomas, I find the argument unconvincing. But we can perhaps see how it acquires a certain cogency. If you argue about the most perfect being, you may convince yourself and your hearers that such a being is eternal, immutable, incorporeal, and so on. Finally, you think you know so much about this being that the statement that he or it exists seems an almost trivial addition. As, in my opinion, we cannot think consistently of a

most perfect being, any more than we can think consistently of a largest number, I am not prepared to take even the first step with St Anselm.

The Hermit's second weapon is traditional logic. One can say 'Socrates is a man', or 'Jumbo is not a man', and argue from this premise, and from some other general statement about men, such as 'All men are mortal', or 'No animals except men are rational'. Russell and Whitehead greatly improved logic by sharpening the definitions of inclusion in a class. And it is interesting that if you want to give unambiguous instructions to an electronic calculator it is advisable to use the terminology of their *Principia Mathematica*. Nevertheless, logic, whether Aristotle's or Russell's, is not elastic enough to deal with reality. Of course the facts discovered about evolution make it impossible to draw a sharp line between men and not-men. Was *Pithecanthropus* a man? Very likely. Was *Australopithecus* a man? I rather doubt it. But we need not go so far back into the past. Perhaps a human embryo shortly before birth is a man. But I am quite sure that a recently fertilized human egg is not. The scholastics were quite aware of this difficulty, and said that an embryo became a man when issued with a soul some time before birth. But as they were not clear when this event occurred, they were not quite sure at what stage abortion became murder.

The most durable objects known to us are atomic nuclei, but they can be changed by shooting neutrons into them, in which case they may split. At some stage in this process it is impossible to say with confidence either 'This is an oxygen nucleus', or 'These are a carbon nucleus and a helium nucleus moving rapidly apart'. In fact, with no exception known to me, all objects, at some stage, refuse to qualify for membership of any class which we can define.

Bhadrabahu, an Indian philosopher who was probably a contemporary of Aristotle, tried to allow for this fact by producing a set of seven possible answers to the question 'Is this

an A?' The vaguest of the seven answers (if my translation from the Sanskrit is correct) reads: 'Maybe it is, maybe it is not, and maybe the question is unanswerable.' This is not very constructive. But it becomes so if we quantify it, and state the answer in terms of probability. This is what mathematical physicists are doing. They calculate the probabilities that in any very short time interval, an object should be one or two atomic nuclei. And these calculations are at least sufficiently this-sided to be used in designing atomic bombs.

I think the Hermit's theorem should be restated somewhat as follows: 'That which is, when I begin my sentence, very probably is when I finish it, unless indeed it is something of very short duration,' as in the philosophically valuable slogan 'That's Shell, that was'. The Hermit has so far, perhaps, always been right about mountains. Perhaps he was always right about houses, as he never saw a V2 rocket hit one. But he was wrong about something very important—namely, constituents of the human mind, such as sensations and emotions, which can change in a fraction of a second. Since it is much easier to find out about mountains, houses, and even atoms than about what is going on in our own minds, let alone in other peoples', the Hermit can be particularly misleading about human psychology.

I fear that some rationalists are too prone to listen to one or another of these Three Impostors.[1] It seems to me that any statement whatever about real things, whether it is made in words or in algebraical or any other symbols, is bound to be inadequate. It may very seldom let us down. In innumerable cases we can bet our life on it with full confidence, as I am now betting my life that the floor of the room where I am writing will support my weight. I have no intention of qualifying as a Fourth Impostor by laying down a new set of principles on which to base our beliefs. On the contrary, I

[1] The Hohenstaufen Emperor Frederic II is alleged to have described Moses, Jesus, and Muhammad as the Three Impostors.

shall continue to believe Aunt Jobisca when she tells me that Athens and Peking exist, though I have never been there. I shall continue to believe the Bellman when he tells me that the Prime Number Theorem has been proved, though I have never gone over the proof. I shall also believe the Hermit when he talks about Beachy Head, though not when he talks about a lightning flash or the properties of spheres. But from time to time I shall disbelieve with old Bhadrabahu.

1958

A PASSAGE TO INDIA

IN JULY 1957 my wife and I hope to leave Britain to settle down in India for the rest of our lives. By the time this article is printed we shall probably be living there. Our decision strikes many of our colleagues and friends as peculiar; and writers of anonymous letters regard us as traitors, perverts, and lunatics. So it may be worth while giving some of the many reasons which brought me to take the step. My wife's are not dissimilar.

If I had accepted a post in the US, no one would have been surprised. They would not have called me a traitor because I was leaving a monarchy for a republic, as I am on migrating to India. They would presumably have guessed that I was in search of a higher salary. This is commonly regarded as an adequate excuse. On February 21, 1957, the Archbishop of Canterbury (whose salary is more than thrice my own) denounced the desire for economic betterment as materialism. I am a materialist, but am not particularly interested in making money. A bank balance is highly immaterial and idealistic. As a materialist I would sooner see ten people eating good dinners, which are material, than one with a good dinner and a large bank balance, and nine inadequately fed. But not being a materialist in the Archbishop's peculiar sense, I don't want to go to America. For one thing I prefer Indian food to American.

Perhaps my main reason for going to India is that I consider that the opportunities for scientific research of the kind in which I am interested are better in India than in Britain, and that my teaching will be at least as useful there as here. This

may seem surprising. It is, however, a fact that the facilities for research now available to me in the University of London are somewhat less than they were twenty years ago, and would in any case have been reduced to zero or near it when I was superannuated in 1960. No doubt if I had devoted half the time which I have spent on research to extracting money from various available sources such as the Nuffield Trustees, the Agricultural Research Council, I could have had the facilities for research instead of the time for it.

Of course, if my work required electron microscopes, cyclotrons, and the like, I should not get them in India. But the sort of facilities which Darwin and Bateson used for their researches—such as gardens, gardeners, pigeon lofts, and pigeons—are more easily obtained in India than in England. And as for teaching, the demand is vastly greater in India than here, and the attendance at my lectures is larger.

Economically I shall be better off in India than here. My pension will probably be about £1,000 a year, and this will buy a lot more in India than in England. This is not because I shall be employing cheap labour. I shall; but Indian labour is not very efficient. It is partly because taxation is lower. Petrol, for example, cost about 3s 4d a gallon in India last year, and one can get ten excellent cigarettes for three halfpence, or, if like myself, one has no longing to die of lung cancer, three cheroots for twopence. One does not need a fire, glass windows, or socks. The climate is delightful, though during six months of the year one is well advised to stay indoors from 9 am to 3 pm, or at least to wear a hat if one goes out on a sunny day. The climate indoors is excellent if one has an electric fan. And my experience of Indian-made electric fans is as follows. During five months of hot weather spent in India in 1954 and 1956 we had to deal with three fans in our bedroom, sitting-room, and bathroom, and two in our laboratory. None of these ever went wrong. Modern Indian technology is not contemptible.

But, I am told, I am going to a country riddled with superstition, a country where the Brahmins regard themselves as superior to everyone else, and are only waiting to fix their yoke again on the rest of the population. Before we deal with the question of superstition, let me try to explain why I have a sneaking sympathy with the Brahmins. Last year I went to a Brahmin village in Orissa called Narasinghapur. The name means Man-lion-bury, and it is named after one of the incarnations of Vishnu, a man-lion who destroyed a very troublesome demon called Hiranyakasipu. I think a Rationalist can live as well in Manlionbury as in St Pancras, where I live at present, or on the Boulevard St Michel, where some of my French colleagues live. We are apt to forget that St Michael, like Narasinha, is a chimera, a man-swan, or man-goose, and a conqueror of demons. And, as Professor Sahni, the distinguished Indian palaeontologist—who probably believes the legend of Narasinha as firmly as I believe that of St Michael—has pointed out, the avatars of Vishnu give a rough, though not very accurate, picture of vertebrate evolution. They are a fish, a tortoise, a boar, a man-lion, a dwarf (perhaps an Australopithecine), and then four men. I like to think of Narasinha as a rather generalized mammal, perhaps living in the Paleocene.

But to go back to Narasinghapur, it was founded some centuries ago, and is planned like an H. The central street is occupied by Brahmins and their families, the other two streets by their servants. There is a temple at each corner. The servants are of lower castes, and till fields for the Brahmins, play musical instruments in the temples, and so on. In return for these services they get the product of other fields. The Brahmins were supposed to devote themselves to religion and learning, but by now they have multiplied so that most of them earn their livings as clerks and the like in the neighbouring city of Cuttack. The Brahmin houses are supposed to be all alike, but the Head of the village explained that some

unprincipled members had had porticoes built in the last fifty years.

I saw the village school and library, the meeting-place of the Council on a platform under a tree, and the inside of a house. Then we had a small meal. The lower castes sat at a slight distance and provided some music. And then suddenly I thought of a College at Oxford, and everything became clear to me. A pious king had founded Man-lion College, as it might be St John's or Magdalen. He had endowed two chapels and provided for a number of learned Fellows and Scholars. He had also given the College lands and hereditary College servants. I reflected that at Oxford the College servants did not dine at the High Table. Nor do the tenants of the College estates, who provide it with money rather than services. Nor did the servants at Man-lion College. Had they done so at Oxford, they and the Fellows would have been equally embarrassed. True, the Fellows would not have had to take a formal bath after such an event. But until recently the Fellows of English colleges were the victims of an even more serious superstition about untouchability, enunciated by St Paul, namely that 'It is good for a man not to touch a woman'. Even now, married fellows must '*per noctate*', that is to say, pass a certain number of nights per term in college without contact with their wives. The Indian government has made it a crime to exclude 'untouchable' men and women from streets or temples. The British government regards bequests to religious foundations whose members must treat women as untouchable as charitable bequests. I regard the Indian government as more progressive, in this respect, than the British.

I have written in defence of Brahmins, but there is plenty to be said against them, and it is being said in India today. There is a very lively secularist movement in Southern India, centred in Madras, one of whose leaders, Mr Naicker, has a white beard which gives him a deceptively holy appearance.

Last year he led a demonstration of some five hundred people to the seashore near Madras, carrying pictures of Ram, one of Vishnu's incarnations, which they proposed to burn there. They were arrested under a law which forbids actions calculated to outrage the religious feelings of others. But they were all released after six hours, as the authorities did not wish to incur the charge of persecution. Mr Naicker called the demonstration off, remarking that he had got far more publicity than if the police had done nothing.

So far as I know, Mr Naicker does not wish to inculcate the worship of any other being in place of Ram, nor does he put forward an atheistic system, such as Hinayana Buddhism, or dialectical materialism, to fill the allegedly vacant place in the minds of his followers which Ram had occupied. He and his like may be a much greater danger to Hinduism than the Muslim and Christian persecutors and missionaries of the past.

However this may be, the Brahmins in Southern India are now complaining that they are unfairly treated. A fraction of the places in universities is now being kept for members of groups including the 'untouchables', whose ancestors were denied education when the Brahmins had a monopoly of it. In consequence, boys and girls of these castes are getting university education at the expense of Brahmin boys and girls who had got much higher marks in qualifying examinations. On the face of it this is unfair. But it may lead to a rough kind of justice. It certainly does not outweigh the huge injustices which the ancestors of the Brahmin inflicted on their fellow Indians in the past, especially in the south.

Now for the accusation of superstition. It is perhaps not quite fair to say that superstition means another man's religion. But there is something in this definition. Millions of English people would say that the belief that one should not walk round a church 'widdershins', or in the opposite direction to the sun, was a superstition, while the belief that one should go inside it every seventh day was not. Neither belief has scrip-

tural authority. There is, of course, scriptural authority for the belief that women should wear hats in churches and men should not. So these practices are not superstitious! Now in India a great many unnecessary things are done on religious grounds, and a great many harmless things are not done. There is rarely any authority in the Vedas (which are the only Hindu scriptures thought to have supernatural origin) for any of these injunctions or prohibitions. So many modern Hindus do not accept them; and I can, if I wish, attack them without attacking Hinduism as such.

If I have to live among adherents of a religion, I would quite as soon live among people whose religion only tells them what to do and what not to do, as among those whose religion also tells them what to believe and what not to believe. I certainly object to a religion like Islam which tells its adherents in great detail both what they must do and what they must believe. A Hindu must, I suppose, believe in some god or gods. But if he chooses, he has scriptural authority for the opinion that the gods only exist in human minds. Relevant passages are as follows:

> This is the highest creation of Brahma, namely, that he created the gods who are superior to him; he, although mortal himself, created the gods who are superior to him, therefore this is the highest creation. Verily he who knows this becomes (a creator) in the highest creation.
>
> So whoever worships another divinity (than himself) thinking that he is one and (Brahman) another, he knows not; he is like an animal to the gods; as many animals serve one man, so does each man serve the gods; even if one animal is taken away, it causes displeasure; what should one say of many (animals)? Therefore it is not pleasing to those (gods) that men should know this.

These passages occur in the Brihadaranyaka Upanishad. I have given the translation by Radhakrishnan, the

Vice-president of the Indian Republic, to avoid the possible accusation that non-Hindus have distorted their meaning. For the author of these texts Brahma clearly meant the human mind, or what is common to all individual minds. Being an idealist, he regarded the creations of this mind as having an existence of their own. The nearest equivalent to this attitude in European literature is perhaps to be found in William Blake's writings, particularly in the last Night of *Vala*.

I am quite aware that the vast majority of Hindus, and a considerable fraction of educated Hindus, think the gods exist outside the human mind; or else they are idealists and think the gods have the same sort of reality as material objects. Now I may be expelled from the Rationalist Press Association for saying so, but I do believe in the gods. They are social products, like tunes or customs. One can ask questions about them, such as 'Is the god of the Jews jealous?', 'Did Siva help the other gods to churn the ocean?', as one can ask 'Are the tunes of *God Save the King* and *My Country 'tis of Thee* the same?' But I am a materialist when it comes to belief in things, and an idealist as regards supernatural beings. I do not know how far this peculiar eclecticism will go down among my Indian acquaintances.

I am also going to India because I am a socialist. I think that socialism is not only juster but more efficient than capitalism, that is to say, that it increases the national income and the standard of living more rapidly. I am quite aware that there has been plenty of oppression and injustice in those countries where socialism has so far been established. It was only established after prolonged war against internal and external enemies, and war always generates oppression and injustice. Capitalism only replaced feudalism by violent means. Neither Cromwell nor Napoleon was particularly just or merciful. But they did a good job. So, in my opinion, did Stalin and Mao.

However, now that a good third of the human species is living under socialism, it becomes possible to make the transition with much less injustice. We may take it that, if the Soviet Union and China were not socialist States, any attempt at socialism in India would be met by foreign invasion to 'restore order'. In this way socialism was extinguished in Finland, Esthonia, Latvia, Lithuania, and Hungary in 1919 and in Spain in 1936–38. If the US were not in existence, the governments of the neighbouring socialist countries might attempt to impose socialism on India by drastic economic pressure, or even by force. As things are, the Indian government is taking the socialist path, though perhaps rather slowly, and can reasonably hope to do so without external interference. It may fail through internal opposition, or through inefficiency and corruption. If so, there will presumably be a civil war like those which occurred in Russia and China, and in such a war I may very well be killed. I might, however, also be killed if I remain in Britain, since both parties are agreed that there should be no systematic protection for civilians against modern weapons, such as exists in Sweden, where there are large underground shelters strong enough to give protection against thermonuclear bombs exploded a thousand feet above ground level. Finally, I am going to India because I consider that recent acts of the British government have been violations of international law.

Several people have told me that I ought not to go to India because the Indian government refuses to hold a plebiscite in Kashmir. I do not know what the result of such a plebiscite would be. But in view of the persecution (or shall we say the active discouragement) of Muslim 'heretics' such as the Ahmadiyyas in Pakistan, I think a good many Muslims might prefer to remain citizens of a secular State rather than an Islamic one. Christians were not persecuted in India until the arrival of the Portuguese. I also consider that those who think a plebiscite should be held in Kashmir might reasonably call

for a plebiscite in Britain on the question of whether American bases for bombers and rockets should be permitted. I dare say a majority would favour their retention. But there would be a very substantial minority in both the major parties against it. I hope to go to Kashmir in the next two years. If I get the impression that a large majority of its inhabitants wish to join Pakistan I shall change my views accordingly.

Others, including perhaps some readers of this article, will say that poor old Haldane has fallen for the glamorous Orient in his old age, and has become a Hindu, or as nearly so as the real Hindus will permit. I fell in love with India in 1917, but I saw no point in going there till it was independent, as I could not associate with Indians on a basis of equality. As for Hinduism, one cannot possibly understand Indian culture without some knowledge of Hinduism, Buddhism, and Islam, not to mention the very remarkable religion of the Jains. No more can one understand European culture without some knowledge of Christianity, Judaism, the Ancient Greco-Roman religion, and the witch-cult. And one will not understand much if one finds these religions utterly unsympathetic. In fact, an acquaintance with Hinduism is even more important in India than one with Christianity in Europe because a larger fraction of the surviving ancient literature is religious.

I may be optimistic, but I do not think that a Rationalist and Humanist need necessarily break with Hinduism. To begin with, a complete break means discarding ancient literature. Now ancient Indian literature includes some dirty superstition and some abominable propaganda for race and class superiority. So does the Old Testament. But along with this is a lot of good straightforward mythology, and a few really magnificent stories. My favourite one is about the end of the Pandavas. These five brothers, the heroes of the Mahabharata, had defeated their enemies, and the eldest, Yudhisthira, had reigned for many years. But they had killed their

kinsmen; and most of their friends, including their own sons, had been killed in the fighting. They and their wife (for they had one wife in common, besides some private ones) renounced the world and set off on a pilgrimage round India. A stray dog joined the party and could not be scared off. At the end of their pilgrimage they went up into the Himalayas to reach Svarga (Heaven, Valhalla, or what you will). As they climbed, the wife and four brothers successively fell down dead. Only the eldest brother, Yudhisthira, and the dog reached the door of Svarga. The chief god, Indra, welcomed Yudhisthira, told him that his wife and brothers were waiting, and gave good reasons why no dogs are allowed in Heaven. Yudhisthira, who, on the whole, had been rather a prig throughout the epic, redeemed his character at the last moment. He refused to enter Heaven without the dog, because a nobleman must not abandon any creature which has put its trust in him. The dog turned out to be his father, Dharma, the god of justice, and both were allowed in. The moral is the wholly admirable one that a man must not do an action which he regards as dishonourable even if ordered to by the chief of the gods in person. I know of no equivalent myth in the ancient or modern religions of Europe. If Abraham had refused to kill Isaac at the divine command, I should have more respect for the Old Testament.

I know that my attitude will annoy many members of the Indian Rationalist Association. But they annoy me. They are losing a great deal of support in India because they insist on filling their journal with attacks on the current five-year plan, which is a slow approach to socialism. I cannot see why it is more rational that a steel plant should be owned by shareholders than by the State. Nor do I think, as some of them do, that Mr Nehru betrayed Rationalism by going on a pilgrimage to Prayag with many of his fellow citizens. The pilgrimage in question involves no prostration before idols or recitation of creeds. I have been on it myself.

There are, of course, many aspects of Hinduism which every rationalist must condemn. And there are groups of Hindus who believe that these are a necessary part of Hinduism. They may be gaining ground. Some of my Hindu friends fear that they are. If they gain enough I may begin talking about 'The heathen in his blindness'. But meanwhile I would sooner teach Hindus what I believe to be the facts of science than try to demonstrate to them that these facts cannot be reconciled with Hinduism. I personally doubt if they can. But Hinduism is so flexible that it can certainly accommodate a lot more science than any other religion which I have encountered.

Of course I may start staring at the tip of my nose and renounce reason as a guide. If so, I shall lose my job in the Indian Statistical Institute and presumably resign from the Rationalist Press Association. But until I do this I hope to continue to write for the *Rationalist Annual* in spite of the numerous deities which are said to inhabit India.

1960

ON EXPECTING THE UNEXPECTED

THE GENERAL PUBLIC is rather suddenly beginning to realize that the present age differs from all others as the result of the application of science to human affairs. The stupider members of our species (who include most politicians) concentrate on the more destructive applications. This is partly because war is socialized even in non-socialist countries, so that the governments in capitalist States are directly concerned with the destructive applications of science, and less directly with its constructive applications. It is partly because, for reasons some of which I discussed in this *Annual* a year ago, there is a very real and widespread hatred of science.

Even if half the present members of the human race are going to be killed in a war with atomic missiles (the fraction is likely to be much over half in Britain and much below half in India), this must be balanced against the fact that, as the result of applications of science to medicine and agriculture, our expectations of life have been doubled in the last century if we are not killed in wars. The present expectation of life of an English baby in the absence of war is certainly over sixty years and probably over seventy. What is more important, it should be healthy during most of this time. Whereas in India in 1940 the expectation was about thirty years, largely unhealthy. I therefore do not think that even if science is misused for a third world war it can be regarded as, on the whole, harmful.

If science, for good or ill, dominates our lives however much we hate it, it seems worth while knowing something about how it grows. There are few subjects on which the public is more ignorant than the nature of scientific research.

This is partly because of salesmanship. Commercial firms embellish our newspapers with pictures of scientists looking down microscopes or up at test-tubes, and perhaps their public-relations officers genuinely believe that that is how science advances. Philosophers, and scientists who have not been successful in research, write books on scientific method. These seem to me singularly misleading, for reasons which I shall give later. Finally, scientific publications, even careful and conscientious accounts of research work, do not describe how discoveries were actually made. Text-books inevitably summarize. But even papers by first-rate researchers published in well-edited journals are mostly written with two ends in view. Firstly, they are intended to persuade their readers that certain facts are true. And secondly, they state what steps must be taken to repeat the observations on whose basis it is believed that the facts are true. They do not usually state how the author came to think that a fact was true with sufficient probability for him to take some trouble to convince himself of its truth.

I am compelled to think about this matter seriously because I have to train research workers in India. I have been directing the research of others since 1922, but no British student ever came to me without some idea of what research was like. For at least some of the teachers in his or her degree courses had done independent research, often of high quality. This is unfortunately not always the case in India. Inevitably at a time when university teaching is expanding rapidly, we must expect that teaching will take precedence over research. And a good deal of the research carried out in India is inevitably of a cataloguing type, for example, description of new species, and routine geological mapping, which though necessary do not call for great originality.

What, then, is scientific method? It is generally thought to be a research for statements of the type 'all A is B'—for example, 'all animals with vertebral columns have red blood',

which incidentally is untrue, or 'all specimens of distilled water freeze at about 0° C at atmospheric pressure'. It may be better to say that an event of class P is always followed by an event of class Q. We establish such generalizations partly by investigating a large number of examples and partly by explaining, if we can, why they are true, in terms of other generalizations. This is all very well as far as it goes, but it gives us no idea of what sort of questions we can fruitfully ask for the first time.

No doubt if I am investigating a crop plant it is well to find out what sort of animals eat it in competition with ourselves, and how their numbers can be kept down. It is well to find out whether it gives a higher yield if nitrates, potassium salts, lime, or phosphates are added to the soil, whether perhaps it is helped by adding rarer elements such as copper or boron, and so on. All these investigations were bright and original ideas when first carried out. But there is nothing original in asking such questions about one more species of crop plant in one more soil.

What, then, are the sources of original ideas? There are, I think, two principal sources. One is, of course, theoretical work. If Newton's theory of gravitation is true, the equator should be farther from the earth's centre than are its poles. This was found to be the case after Newton's death. If light consists of electromagnetic oscillations, radio communication should be possible. If infectious diseases are caused by small living beings, it should be possible to poison these beings with some of the substances already known to be poisonous to larger plants and animals. If some characters are inherited by members of one sex only from the parent of the opposite sex, it should be possible to produce broods of one sex only. So far the only economically important animal in which this has been done is the silkworm. Once a theory becomes mathematical, it is possible to suggest experiments and observations whose results are a very long way from those

which would be predicted on a basis of common sense and some imagination. This source of original ideas is fully recognized by writers on scientific method, who devote long chapters to the methods of recognizing effects predicted by theory. A well-known book with the rather misleading title of *The Design of Experiments* describes how to save a good deal of time and money by proper statistical methods, provided you know what you want to find out, for example, whether one breed of wheat gives a higher yield than another on a particular soil in a particular climate. It does not tell you how to design an experiment which will produce a stock of wheat giving a yield higher than either of the parent breeds.

The other source of original ideas is, in my opinion, much more important. Some original ideas come directly from noticing what is happening around one. In any science one learns to classify what one sees, hears, or even smells or feels. And the classification may work very well for a long time. If it has done so, when one comes across an object or event which does not fit into the classification, one too often either puts it into a class where it does not belong or fails to notice it altogether. It may be quite obvious, as soon as one's attention is drawn to it, that it requires a new class. But one's habits divert one's attention from exceptions, unless they are on a large scale, like earthquakes and hurricanes, in which case they are liable to be classified as acts of God.

A few people have the capacity for noticing the exceptional very highly developed. I think particularly of my late friend L. A. Lantz, who was secretary of the British Colour Council. This is not, as might be thought, concerned with the rights of immigrants from tropical countries but with textile dyes; and its secretary doubtless had a fine eye for colour differences. He also had a fine eye for lizards and newts. His most remarkable achievement in this respect was perhaps noticing that he could not tell the sex of a lizard which he saw running about, catching and killing it, and finding that it was an intersex.

But this capacity, by itself, may only lead to naming a new species of animal, vegetable, or mineral. It is occasionally combined with a capacity for experimental work. The experimenter alters a system in some way which he can repeat; for example, cools down a newly made alloy slowly from red heat to ordinary temperatures, or grows a plant in a medium from which zinc has been very thoroughly removed. He has some observations in view. He wonders whether the metal will be tougher or brittler than if it had been cooled down quickly. He thinks it likely that the plant will grow more slowly than a normal plant, or even die. If he had no such expectations, his experiments would be very unlikely to yield interesting results. His expectations may or may not be fulfilled. If they are not fulfilled, a theory will have been disproved. If they are fulfilled, it will have been proved to have at least some predictive value.

But an experiment may have an entirely unexpected result. Perhaps if the metal is cooled down slowly enough it will become a magnet, or become a much better conductor of heat than otherwise. Perhaps the plant kept short of zinc will develop normally except that its pollen grains are irregular, or it is liable to attack by some bacteria which do not normally harm it. Perhaps its fruits will contain less fibre than usual, and be easier to eat. In such cases there is a good chance that the unexpected result will not be noticed. For example, Wang and Lee recently discovered what is generally called the non-conservation of parity. In many chemical and radioactive transformations spinning particles are produced, and they are as likely to spin in one direction as the other relative to their direction of motion. But in some changes this is not the case. One particular kind of particle, the neutrino, only seems to be able to spin in one direction. This fact has many observable consequences. When Wang and Lee published their finding it was soon discovered that for some years other physicists had been recording results which not merely

confirmed it but would have led to its discovery if they had been noticed.

It is useless to blame the men who did this earlier work for not analysing their data from every possible point of view. To take a concrete example, it is entirely possible that deaths from lung cancer are twice as common among people born when the planet Mars is 'in' (or rather in front of) the zodiacal sign of the Scorpion as among other people. Four hundred years ago, when it was generally believed that men were

Servile to all the skyey influences,

it would have been reasonable to look for such effects. It would also be reasonable for those who believe in astrology today to look for them; but such people do not understand statistics.

Nevertheless, there is no doubt that some of the greatest scientists do notice such things. It is an essential part of scientific method to expect the unexpected. The capacity for doing so was one of the most striking characters of the emperor Napoleon I. Of course, in a military commander it must be combined with a capacity for instant decision, and for organizing an army so that instant decisions may be carried out. Napoleon was perhaps never taken by surprise by a human military action until the Russians burned Moscow. Even then his instant decision to retreat might have saved his army if it had not been attacked by two other enemies for which he was not prepared—lice and the virus of typhus fever.

Rutherford, in particular, had this Napoleonic quality. When he discovered that instead of alpha particles being scattered by thin films of matter most of them went straight through and a few flew almost straight back, he instantly exploited this discovery and established the modern view on the fine structure of matter within a few months. Darwin, on his own showing, possessed the same capacity, but as he never

acted in a hurry there was at first sight nothing Napoleonic about him. His own self-assessment, which is amply borne out by a study of his botanical and geological work, was 'I think that I am superior to the common run of men in noticing things, which easily escape attention, and in observing them carefully'.

Can this capacity be taught? I do not think so. But it can be encouraged or discouraged. In most university teaching of science it is, I fear, discouraged. The student who notices the unexpected has generally made a mistake in his technical work. After a few such mistakes have been pointed out to him he realizes that he had better keep them dark in future. In this respect the situation is worse in India than in Europe, largely because teachers have larger classes to look after. However, much to my surprise, I have already come across two junior Indian colleagues who possess the faculty of observing the unexpected. It may actually be commoner in Indians than in Europeans, though it is much more rarely manifested, because the biological sciences are badly taught.

At this point I must break off to express my disagreement with Professor Bernal, who on page 203 of his book *World Without War*, with nine-tenths of which I am in agreement, writes: 'The objects of education should be first to detect, secondly to bring out, and thirdly to train the capacities of creative thought.' I hate to have to accuse Bernal of idealism. But the person who notices a particular snail is coiled in the 'wrong' direction for its species, or in other words is a looking-glass snail, is a valuable contributor to science, even if he or she is quite incapable of a 'creative thought' about such snails, such as 'Can they mate with normal members of their species, and if so what are the children and grandchildren like?', 'Do they have looking-glass structures at the microscopical level?', and so on. I cannot train people in the capacity to make observations of this sort, but I can detect it in others and 'bring it out' by explaining to them that their

observations are interesting. Whereas India is lousy with creative thought, most of which unfortunately creates a good deal of nonsense. And much of the rest is rather abstract and unrelated to reality.

If it is admitted that expecting the unexpected is an essential part of scientific method, a good deal seems to follow. It is actually believed that the scientific world view is in some way less satisfying, or less worthy of a free man, than the view that the world is governed according to principles which may be found in the holy books of one or other of the religions. I do not think anyone would believe this if science were not so badly taught. One reason why it is so badly taught is that teaching has till recently, at least in Europe and India, been mainly in the hands of the clergy. They tried to impart to their pupils a certainty about the nature of things which perhaps one in a thousand of them really felt. Unfortunately, the teachers of science have taken over their methods.

In my opinion science ought to be taught something like this. 'I am now going to teach you Boyle's Law, which gives the relation between the pressure and volume of a bit of gas kept at a constant temperature. This law is not true. But it is very nearly true for most gases at pressures under a hundred atmospheres and temperatures between minus a hundred and plus a thousand degrees. It is so nearly true that I have often betted my life on calculations based on its absolute truth. I am not going to talk about the much more complicated alternatives to it which have been proposed, because I am sure they are not absolutely true either.'

This point of view makes life exciting for those who hold it. They are constantly waiting for surprises, and they get them. However, they do not take the laws of gods or men very seriously and are more or less incapable of the dull but for all I know, satisfying form of existence which is now called social adjustment or integration into the group, and used to be called doing one's duty to God and one's neighbour. There

may, of course, be 'laws of Nature'. But if so, I don't know what they are, and I also know that nobody else knows them. There are, of course, good approximations to them, and if somebody claims to have made a perpetual-motion machine or to have lifted himself off the ground by will power, I shall not believe him, because I think it vastly more likely that he is lying or deceived than that one of these approximate laws has been violated. Similarly, there may be general rules for right human conduct, but I have not come across any which, in my opinion, admit of no exceptions.

In the early days of science it seemed possible that men would be able to formulate laws of Nature to which no exceptions could be found. Newton probably believed this, and it is a reasonable deduction from the hypothesis that the world was created by an omniscient being. This, by the way, is a most interesting theory, and has never been seriously examined. For those who claimed to hold it proceeded to attribute to this being the motives of the human rulers whom they admired, and who were, like all rulers, corrupted by power. To me at least the prospect of finding such laws seems to become more remote every year. As an employee of the Indian Statistical Institute I try to think statistically. If so, the nearest I can get to a law of Nature is something like this: 'The probability that an event of class P will not be followed by an event of class Q is less than a millionth of a millionth, how much less I do not know.' This is good enough for all practical purposes. Such a formulation is, of course, a bit of propaganda for my profession. Newton may have believed that by research or revelation it was at least theoretically possible to arrive at a complete formulation of the laws of Nature. If they were once known, scientific research would come to an end, though there might still be scope for engineers who applied these laws. I suspect, with Lenin, that the properties even of a single electron are inexhaustible. If so, it follows that there will always be a need for scientific research.

This does not imply that there will always be a demand for it. Even today the high priests of some branches of science would be delighted if research in their own branch could cease, except for the details which their subordinates are studying under their direction. This would consolidate their position. For they mostly have a good knowledge of some branch of science as it existed thirty years ago, and are too busy making friends with the mammon of unrighteousness to keep up with more recent developments. At present there is no chance of stopping research, partly because several sciences, and especially physics, are in a state of violent flux, and partly because international competition is based on research in applied science.

However, a few centuries hence our descendants may be citizens of a world State, and all the sciences may have reached the state of physics about 1900, when some physicists honestly thought that the principles of the science were known, and all that remained for posterity was to fill in details, make applications, and work out intricate mathematical theories. There is, then, I think, quite a good chance that research will cease, and our species will go in for a few thousand or a few hundred thousand years of life according to moral and æsthetic canons, until the unexpected happens, and no one is expecting it. Perhaps whatever killed the dinosaurs eighty million years ago—and we know no more about the causes of their extinction than Shelley did when he wrote Panthea's speech in the last act of *Prometheus Unbound*—may kill our descendants.

Meanwhile I want to make the elementary point that almost everything which is spoken or written about scientific method is arrant nonsense. This article may very well be included. It is indeed presumptuous to attempt to analyse the principal growing point of the human spirit. I have perhaps left out the essential. But I think I have left out less than some of my predecessors.

1961

THE DARK RELIGIONS

THE *RATIONALIST ANNUAL* is largely concerned, and rightly so, with working out the consequences of Rationalism for Britain, and showing how religion is used to justify irrational conduct. Its contributors also, very properly, show that many people who are not religious nevertheless support practices and prohibitions whose justification is to be found in religion rather than reason. This means that they concentrate on Christianity. Judaism is the only other important religion in Britain, and it can be intolerant when it gets the chance. But even the most scrupulous Jews in Britain do not try to make it a crime for non-Jews to eat pork or work on Saturdays. Catholics, and many Protestants, try to impose traditional taboos, especially as regards sexual conduct and literary and artistic expression, on the rest of the community. Of course they claim a rational justification. St Thomas Aquinas was rash enough in his *Defensio fidei christianae* or *Summa contra gentiles*, which every serious Rationalist should read, to attempt to base not merely Christian faith but Christian morals, on reason. One has only to read his justification of monogamous marriage to see that many of his arguments for it no longer hold in a Welfare State. As for the prohibited degrees, one of my colleagues in the Indian Statistical Institute finds that something like ten per cent of all marriages in eastern Andhra Pradesh are between men and their sister's daughters. St Thomas tried to justify the prohibition of such marriages on the ground that they mixed up two incompatible kinds of love. The Andhras think that a bride who marries her uncle is much less likely to be frightened, disappointed, or homesick than if she married

someone whom she had only known for a short time. It may be, however, that such marriages produce more defective children than those between unrelated or more distantly related parents. There are about thirty million Andhras, so it should be possible to find out.

But just because British Rationalists or Humanists are mainly concerned with Christianity, they take a rather narrow view. Most people live in Asia, and I believe that they have rejected Christianity fairly decisively. This is not necessarily a good thing. I regard Christianity as an improvement on some of the local cults. But it has been rejected, first, because of its association with Portuguese, Dutch, British, and French imperialism; and perhaps more decisively, because of Hiroshima. I am not concerned with the ethical justification or otherwise of atomic bombs, but with their effect on Asian opinion. Of course if the Pope, the Archbishop of Canterbury, and similar highly placed Christians had instantly condemned the destruction of Hiroshima and Nagasaki the situation might be different. But they did not condemn it; and Asians doubt whether they would have been equally silent if the bomb had been dropped on Hamburg or Genoa, or from a Soviet aeroplane.

British Rationalists should therefore consider religions in general. We have just celebrated the centenary of William Blake's death. His poems were lavishly quoted. I do not think that his Prophetic Book called *Vala, or the Four Zoas* is the greatest poem in the English language; but if any one claimed that it was, I should not regard him as devoid of good sense or of good taste. Its last line is:

The dark religions are departed and sweet Science reigns.

So far as I know, nobody quoted it. I hope that it is a true prophecy. But those who hope to make it true should certainly study the religions.

The religion with the largest number of adherents is prob-

ably Islam. It differs from the other great religions in a very important respect. It is possible to be a good Muslim, and even possible for most members of a community to be good Muslims. Perhaps a few individuals, such as St Francis of Assisi and George Fox, have been good Christians. No community has been based on Jesus's teachings, nor can a State at the present time be based on non-resistance to evil. Of course a non-violent religious order can get on very nicely provided there are police to protect it. But Islam was intended to be practicable. There is a story that Allah commanded Muhammad: 'Tell the people to pray to me fifty times a day.' The prophet finally got it cut down to five, which many Muslims achieve. Without believing in the literal truth of this story, we may suppose that it records a conflict in Muhammad's mind between the courses which he considered desirable and practical. The latter usually won; so he was not given hemlock nor crucified.

But it is very hard for a Muslim to live according to the Koran and its interpreters except in a State organized to make this possible. Such States appear tyrannical to adherents of other religions or of none. For example, Malaya is alleged to be a member of the 'Free world'. When I was last there I read in a local newspaper that a young married woman had been arrested because, while her husband was in another house with his other wife, she had been seen conversing with a man. It was expected that she would be sentenced to six months' imprisonment. In Saudi Arabia, which is the heart of the Islamic world, not only is slavery practised but attempts are being made to force American women to wear veils. Malaya is kept going by British money, Arabia by American. Quite a lot of people in Asia take personal liberty, including liberty for women, seriously. The British and American support for Islamic totalitarianism (though the Americans at least prefer Christian totalitarianism as in South Korea and Vietnam) saves the Communists a lot of effort on propaganda.

Nevertheless, a few Muslims may be a valuable element in a State. The nonconformist conscience in Britain was rather a nuisance; but it played its part in making the British less alcoholic, and did something to curb gambling and prostitution. Provided that they are a minority, I think the Muslims are an asset to India. They set an example of decent behaviour in some respects, even though this is balanced by what I consider bad behaviour in others, for example, the practice of sacrificing animals. A million or so Muslims would probably do no harm to England.

No doubt there is a good deal to be said against Arab nationalism, as there is against all kinds of nationalism. But to me it seems vastly preferable to Islamic imperialism, which from AD 700 to 1650 or so was as great a menace to world peace as Christian imperialism has been from the time of the crusades. However, since about AD 1200 Islam has been anti-intellectual, and therefore Islamic States have been incapable of absorbing, let alone originating, science. They are therefore incapable of conquering States with even a modicum of modern technological development, though one of them might start a general war. Arabic nationalism, especially perhaps in Syria, is much less opposed to thought.

Christianity has the worst record for intolerance of any of the great religions. Islam always permitted Jews and Christians to follow their cults in Islamic States, even if they were heavily taxed and occasionally massacred. It was no more intolerant than Christianity to atheism. As a regulator of private lives Christianity is, at its best, better than Islam, at its worst, worse. And it has the very great merit of being impossible to practise, and therefore pointing beyond itself. But its Catholic form, like Buddhism, suffers from the immense evil of regarding celibacy as morally superior to marriage. There is a lot to be said against marriage, especially for intellectuals and reformers. But I believe none of the objections hold against all possible forms of marriage. With infantile hygiene and

birth control a wife can find time for public activities. It is surprising how many of the women fellows of the Royal Society are mothers. And an educated wife can be an asset to an intellectual husband. Whereas a man or woman who has no intimate acquaintance with the other sex is liable to be a menace to society, particularly if he or she is a member of a celibate order. Among other things, celibates generally oppose reforms to marriage, such as birth control, easier divorce, and above all sex equality. This is natural enough if they regard marriage as intrinsically evil.

Now that the Soviet Union has got atomic bombs, and is well ahead of the US on missiles, I think Christianity is digging its own grave, which unfortunately may be shared by a lot of non-Christians. Three predominantly Christian nations have now got atomic weapons, but are determined not to allow universal scientific education, which alone could give them superiority in their use. Of course such education would involve the rejection of Christian mythology. The danger may become particularly acute if a nation has as its President a Catholic who believes in miracles but controls atomic missiles. The plain fact is that Christianity, though of Asiatic origin, was pretty well confined to Europe until technology and science allowed it to spread. Scientific technology developed in the teeth of Christian opposition. Some dogmatic Marxists have done their best to impede its development in the Soviet Union. But they have not been successful. At the present time Christianity is not so inimical to science as are the other great religions. But it is inimical enough, in my opinion, to prevent it from spreading any further by violence, though it may still be capable of enough violence to wreck civilization.

Buddhism is a minority religion in many countries, but only a national cult in Ceylon, Burma, and three States of Indochina. No religion has degenerated more abjectly from the ideals and doctrine of its founder. Buddha did not

announce any doctrine (save for details) which was not held by some sect of Hinduism. He doubted many of its tenets and denounced many of its practices. He was far more philosophical than Jesus or Muhammad. But if he cast out some of the devils of Hinduism, other far worse devils entered in their place. His teaching that everyone must work out his or her own salvation was too hard for his successors; and most of them took to worshipping a new set of deities, including himself. This tendency was most pronounced in Tibet, which is now in a disturbed condition. Most people outside the communist States probably believe that the Tibetans as a whole are resisting the Chinese. I do not. For a thousand years Tibet has been ruled by monks. This rule was far more absolute than the rule of the Church in Europe during the Middle Ages. I have no doubt that a great many Tibetans, including some of the monks, resent it intensely. The Chinese may be brutal. Some of their reported actions are very similar to those of Cromwell in Ireland. But lamaism was not based on non-violence. Let me quote the late Mr Kipling (*Kim*, pp. 348, 371). The dear old lama remarks about some men who had actually struck him, 'And truly, in Tibet there would have been a heavy and slow death for them'. However, he described how two groups of monks had fought one another with iron pen-cases. We may remember that in Ceylon the former Prime Minister, Mr Bandaranaike, whose widow has now succeeded him, was murdered by a Hinayana Buddhist monk. It is possible that the Chinese will merely encourage Mahayana Buddhism in Tibet, as the British encouraged Catholicism in Ireland: it is possible that they will introduce Marxism as successfully as the British introduced Protestantism into Wales.

The central doctrine of Buddhism, which is also widely held by Hindus, is that my good or bad fortune in this life is the reward, or punishment, of my actions (or if personal identity is denied, the actions of one being) in a former life. I believe

this to be as fundamentally immoral a doctrine as that these fortunes or misfortunes are the will of God. In either case it is wrong to correct fate. In so far as either doctrine prevails, science, and particularly medical science, must be regarded as an interference with the moral order of the world. Of course both these doctrines arise from wishful thinking that the world is morally organized, whereas in fact it is our business to organize it.

There remains the last of the four great religions, Hinduism. It is not at all comparable with the others. It had no founder, and has no dogmas, nor a moral code binding on all its adherents. There is a wide choice of creeds and codes. And they include some of the best and some of the worst in the world. It is obviously like the pre-Christian religions of Europe. The various cults tolerate one another. One can perhaps distinguish four levels. At the bottom a lot of pretty nasty magic frightens its devotees into pretty nasty actions. There is a specially unpleasant group of female hobgoblins, such as Sitala who presides over smallpox and Manasa over poisonous snakes. On the third level we find a polytheism very like the saint worship of southern Europe. You may acknowledge the supremacy of Siva, but you turn to Ganesa for help in your financial transactions, to Annapurna to look after your crops, and so on. Moral lapses can be redeemed by ritual or by gifts to Brahmins or religious foundations. At its best it is very picturesque. The main support for the caste system, which is one of the great obstacles to Indian unity, comes from this level. The second level is a monotheistic religion, and at its best conducive to noble lives, as in the case of Gandhi. Monotheistic Hindus generally believe that certain beings, such as Ram Chandra, were avatars, or incarnations (literally descents), of the deity, and often admit Jesus to this list. In fact, for monotheists, they are remarkably tolerant. But, so far as I can judge, their doctrines are even less intellectually coherent than those of western (Christian and Islamic)

monotheists. In particular, they have not solved the so-called 'problem of evil', which of course is no problem at all unless one postulates the existence of a conscious almighty and all-knowing being. In particular, it is no problem if one thinks that the gods have finite power or knowledge, even though they may be vastly superior to those of men. Jupiter or Indra may be doing as good a job as he can with refractory material.

The highest level of Hinduism admits the existence of a being which in some sense is supreme. But it has no qualities. The common human belief that human beings are different from this being, and from other human beings, or animals, is said to be the product of ignorance. And according to the great philosopher Sankara, in this context ignorance is the false identification of subject and object. I translate (no doubt very inadequately) a sentence from the introduction to the Sankarabhasya: 'And yet the imposition upon one of the essence and properties of the other, failing to distinguish these two categories, and their properties, which are totally distinct, thus coupling together the true and the false when saying "I am this", or "This is mine", this is an inborn practice of ordinary life which rests on a false belief.' This statement is not mysticism. On the other hand, any attempt to describe the self, even by negation, is more or less misleading. Human individuals have had experiences which they interpreted as a perception that they were not different from the one self. The word 'mystic' is derived from the Greek *muo*, meaning 'I close', particularly the lips. I wish they would.

Some of the fathers of British free thought at least took Sankara's difficulty seriously, even if they did not agree with him. W. K. Clifford spent many pages in attempting to show that 'ejects', or other people's minds, could be treated with the same logic as 'objects', or things. Sankara was probably not an idealist. At least he argued against contemporary Buddhist idealism. Nor did he call himself a monist, but an

advaita, or non-dualist. Now modern physicists are up against a very similar problem to Sankara. If two electrons are far enough away in space there is no objection to calling them 'this' and 'that'. But if they are close enough together, for example, in the same metallic conductor, there is no way of distinguishing between them: and this makes a difference to their observable properties. As a materialist, I see it as at least possible that the distinction between different minds is equally incomplete.

Almost all Indian philosophers since Sankara have been engaged in watering down his philosophy, even if they claimed to accept it. But a good many Indians, especially some groups of south Indian Brahmins, have adhered to it. Sankara denied that the existence of God could be proved by reason. But he was a theist, stating, in the words of Vice-President Radhakrishnan, that the reality of God 'is not a self-evident axiom, is not a logical truth, but an empirical postulate which is practically useful'. He accepted Scriptural statements on this matter. But in my opinion it is easy to become an atheist without ceasing to be an *advaita*. Most atheists in India are probably communists who have not always understood dialectical materialism very fully, because it is historically a revolt against Christian and to a less extent Jewish doctrine; so some parts of the Marxist classics are irrelevant to India. Others think more or less like non-Marxist European free-thinkers. But I certainly know—and admire—men who can best be called Hindu atheists. They have preserved a good deal of Brahmin ethics, for example, will not eat meat, take learning more seriously than money, and so on. Further, their imagination has been moulded on Hindu mythology. I do not say that this is better than European mythology, but it is different. Some of its heroes led as questionable public and private lives as David or Theseus. But I at least find that they stimulate my imagination in somewhat new directions.

At its lowest level Hinduism is probably more anti-scientific

than Catholic Christianity at its lowest level. At its highest level Hinduism is certainly more compatible with science than is any other religion. This fact may be, and probably is, irrelevant to the future. In spite of the example of the Vice-President of India, the modern tendency in Hinduism is, I believe, towards idolatry and superstition together with a cult of celibacy which is Buddhistic or Catholic rather than in the spirit of the Vedas. In particular, rich men endow temples and go in for a religion of unctuous devotion after office hours. Many intellectuals abandon religion altogether. Unfortunately the world view which they wish to substitute for it is commonly based on very crude popularizations of science and has little in common with the outlook which, for example, most of my scientific colleagues in England took for granted. So I do not think that Hinduism has much future in a scientific world; though it may have.

I have passed over the religions with fewer than about ten million adherents, for example Jews, Sikhs, and Jains; the much more dangerous Shinto religion, and the Chinese cults, which include a lot of superstition and the noble philosophy of Taoism. It is possible that the African cults may become important as Africa is liberated. It is uncertain how far Christianity will survive Christian domination. Islam is spreading southward in West Africa, and religious wars are at least a possibility.

Everywhere religion seems to divide men, about as effectively as the economic differences between classes

The walls of gold entomb us,
The swords of scorn divide;

and in Asia I think religious differences generate even more scorn than economic. The reason for this is simple enough. If religion A states that if you disobey its dictates you will go to hell, where you may stay for ever, or (in the case of Hinduism or Buddhism) be reborn as a louse or a hyena, while B merely

states that you will probably displease God, who, however, will forgive you, the adherents of religion A will make more effort to preserve and extend their numbers than those of B. The latter will perhaps look after the sick, try to raise the status of the poor, and so on. They may even induce the adherents of A to say that it is sad to think that they will burn in hell, rather than that it serves them right. But A is likely to spread at the expense of B, until it meets an equally intolerant religion C. Of course as long as A is in a minority its adherents will probably support toleration, as Catholics do in England. But it is the nature of religion to evolve towards intolerance by natural selection.

Fortunately, in recent years, natural selection has begun to operate in a different way. The opportunities for scientific research are negatively correlated with the importance attached to religion, and thus the least religious States have the greatest economic and military success. This fact may lead to the emancipation of mankind from religion, which Epicurus and Lucretius foresaw two thousand years ago.

As I see it, from a convenient distance, it is the clear duty of patriotic Britons to join in the fight against religion, all the more so, perhaps, if they find many aspects of Soviet life distasteful or even abhorrent. One of the advantages which the Soviet Union possesses over the US, Britain, France, and so on, is a more scientific world view. In my own opinion its economic system is a still more important advantage. Rationalists who are not socialists, or who object to the type of socialism practised in the Soviet Union, will disagree with me. It is all the more important for those who do so to fight against the attempt of all Christians who take their religion seriously to prevent the adoption of a scientifically based world view in Britain, and the attempt of an important section to base hostility to the socialist States on differences of religion.

In India a number of pious old gentlemen at the same time urge a war against China in connection with the present

frontier disputes, the abandonment of modern science in favour of various ancient beliefs and practices, and the cessation of attempts to develop heavy industry. If the rulers of China are as imperialistic as their opponents claim, they must find this propaganda very gratifying. English readers of this article will no doubt find it easier to see the self-destructive character of this Indian traditionalism than will Indian readers. From India the policy of the 'West', based on Christian mythology with a background of Judaistic faith in 'The Lord of hosts', appears equally suicidal. It is difficult to doubt that the culture of western Europe, based on a precarious compromise lasting for nearly three centuries between science and religion, is about to come to an end. Onlookers can only hope that it will end

Not with a bang but a whimper.

1962

BEYOND AGNOSTICISM

A CENTURY AGO men like Thomas Henry Huxley, who were as brave as they were intelligent, described themselves as agnostics. They believed that some questions about the world could be answered but that others were unanswerable. If I disagree with these grand old free-thinkers, it is not that I do not respect the precision and integrity of their thought. On the contrary, I owe them a great debt. Their standpoint was probably a necessary stage on the path towards truth. My own is certainly no more; I should be happy to be assured that it was in fact on that path.

I can give four reasons why I disagree with the agnostic position. Firstly, I disagree about the nature of knowledge. Secondly, I think that modern logic has shown that some of the unanswerable questions are unanswerable because they are nonsense. Thirdly, I think the old agnostics took too narrow a view of the possibilities of scientific inquiry. Fourthly, their time-scale was wrong. If I say that the united efforts of humanity and its successors may not answer some questions in thirty million years, that does not mean that they are unanswerable.

Let us take these reasons one at a time. At Oxford University fifty years ago I was taught that knowledge, in the sense of certainty, was possible. It may be, but I do not believe it. I think I am sitting in a chair about a mile from the Ganges, writing on paper. But others have believed such things and been mistaken. I can only say that I am sure enough of such facts to bet my life, and whatever I value more than my life, on them. They are immensely probable, but

not, I think, quite certain. I am somewhat less certain that London exists. It may, for example, have been destroyed by a nuclear explosion in the last hour. I am a lot less certain that the virus of smallpox exists. I cannot see how the evidence for its existence could be explained away, but I know that for two thousand years able men believed in the existence of rigid transparent spheres in the sky carrying the planets.

I am even less certain of the reality of the cloud of electrons round an atomic nucleus, and less certain still that Themistocles sent a messenger to Xerxes before Salamis, or that Jesus was judged by Pontius Pilate, even though I think both stories more likely to be true than false. I think it highly improbable that there are giant sea serpents or that mediums are controlled by the spirits of the dead, and vastly less probable that the universe was created by a being who eternally tortures persons who do not believe in his existence.

But as I can draw no sharp line between certainty and uncertainty, I might be called an agnostic if I let my uncertainty affect my conduct in cases where I am very nearly certain. The opinion that certainty is possible is perhaps due to Plato, but has been encouraged by philsophers who thought that logical argument was impossible without it. It is, of course, entirely possible. I have to deal with human genetics, and I know that the parentage of a child is never quite certain. Maternity is more certain than paternity, but babies can be exchanged, and clandestine adoption is possible. However, such events are rare enough to allow quantitative work on human heredity.

I think, then, that if by knowledge is meant the certainty achieved by some Oxford philosophers of my youth, I am an agnostic about everything, but that if it means the degree of certainty which I possess that I am now writing, it may be possible to achieve it where T. H. Huxley thought it was impossible. I proceed to examine some evidence for this view.

There are three different reasons for saying that a statement

is meaningless. There is the trivial reason that it contains words or phrases with undefined meanings such as 'A Giffle is larger than two Wotchets', or 'The if several persons are when not indebted'. There is the very important reason that it is self-contradictory, like 'All the statements written on this blackboard are false', which becomes no truer if we add a few good lies such as 'No tigers are dangerous' and 'One can buy a dozen fresh hen's eggs for a penny'. I think, for example, that the statement 'God is truth' is self-contradictory, but 'God is truthful' is not. Truth is, as I see it, a relation between a symbol (for example, a verbal statement of a picture) and either reality or another symbol. God is certainly not such a relation. Similarly, 'God is love' seems to be self-contradictory, and 'God is loving' not to be, though it may not be true.

It may be possible to show that certain attributes are impossible and self-contradictory, for example omniscience. In terms of modern logic this amounts to the statement 'For every x, it is false that, for every y, x knows y', or some equivalent proposition. St Thomas Aquinas placed considerable value on arguments based on the impossibility of an 'infinite regress', and thought that there must, for example, be a first cause. Such arguments can be shown to be quite worthless by a consideration of elementary arithmetic. There is not, for example, a largest whole number. If there is a being more powerful than any given finite being, it does not follow that there is a most powerful being, still less a being who can do anything. I think that it may be possible to show that these latter notions are self-contradictory. But I don't think this has yet been done. Much simpler things have not been proved. Thus we do not know if there is or is not a largest pair of consecutive odd numbers both of which are prime, like 17 and 19 or 101 and 103. Either a proof or a disproof of this would be most interesting. I am not an agnostic in the sense that I think this will never be proved or disproved.

If it could be shown that the notion of omnipotence was devoid of self-contradiction, this would certainly be a point in favour of theism, even though nobody had succeeded in showing either that there was an omnipotent being, or how an omnipotent being could be perfectly good, given the existence of various kinds of evil.

The third reason for saying that a statement is meaningless is that no observation can be made which would disprove it. This principle is an attempt to apply scientific method universally. For example, if some piece of matter moves in a manner predictable by a set of rules, we cannot disprove that it is moved by a spirit which wills to obey these rules. A spirit which confines itself to moving a pointer in accordance with the speed of my car has no claim to existence, but I at least cannot prove that it does not exist. Whereas until a machine has been made whose behaviour is indistinguishable from that of a man, we have reason to doubt that man is a machine and must at least consider the possibility that he is a machine plus a spirit. By producing a completely man-like machine I could show that the hypothesis of a spirit in the machine was meaningless.

Now there may be things in the universe as much more intelligent than I, as I am more intelligent than an earthworm. If so, my guess is that they exist somewhere in the sky, a very long way off. But it is possible, in the present state of our knowledge, that such a being is managing the affairs of our world, or perhaps our solar system or even our galaxy, while only revealing its existence directly to a select few human beings. Monotheists claim that such a being exists and directs the entire universe. Jews, Christians, and Muslims further state that a being of immense power and knowledge has revealed that it has created the universe and all other conscious beings. If one is convinced by appropriate miracles, or otherwise, that a superhuman being exists, should one not believe its assertion that it created the rest of us?

The only man who has challenged the validity of such an assertion, so far as I know, was Gautama Buddha (or possibly an early Buddhist writer who attributed the argument to Buddha). According to Buddhist doctrine, there is no such thing as a soul. But just as the set of events called the consciousness and will of J. B. S. Haldane in the year 1930 played a large part in determining the similar events in 1960, so both will determine the conditions of existence of a being (human, divine, diabolic, ghostly, or animal) to be born some time after the death of J. B. S. Haldane, unless the said Haldane attains nirvana before or at his death. From time to time the universe comes to an end, all matter is resolved into primitive constituents, and all consciousness ceases.

However, karma, the kind of causation which determines the birth of new conscious beings, is not destroyed. And when the matter starts to aggregate again, one conscious being comes into existence before the others. It organizes some matter into suitable shapes, but feels lonely and longs for companionship. Later on other conscious beings come into existence, as the result of less intense karma. The first being believes that he has created them, and what is more they believe it also, and start worshipping him as Brahma, who has created the world out of formless void, and the conscious beings in it. As far as we can make out, Buddha neither affirmed nor denied the existence of superhuman beings. But he made the very striking statement that if a superhuman being exists, and believes itself to have created the world and humanity, its belief is not necessarily true. I do not regret visiting, as I recently did, a temple alleged to contain a tooth of the man who produced this statement, which seems to me one of the more notable products of the human intellect. The fact that, though most people around him believed in one or more gods, Buddha was not killed, or even punished, for this statement, is an argument for the thesis that, in some respects, India is more civilized than Europe or south-western Asia.

Perhaps some of Buddha's hearers thought that Brahma had sufficient sense of humour to be amused by the argument.

To go back to our starting-point, I think Buddha's argument shows that it is impossible to prove the existence of a being with the attributes which the monotheisms that originated in south-western Asia ascribe to the creator. Nor do I think that the non-existence of a being with some of these attributes can at present be conclusively proved. But as time goes on the failure to produce evidence for the existence of any kind of conscious superhuman being, almighty or otherwise, becomes impressive.

My strongest argument against agnosticism is that science has just begun. In T. H. Huxley's day scientists mostly believed that Newton was right in supposing that the world consisted of hard, massy, impenetrable, movable particles. This view had been so vastly more successful in explaining and predicting Nature than earlier views, such as those of St Thomas Aquinas, that among scientists only a few cranks like Schorlemmer, under the influence of the subversive Engels, doubted it. Euclid had given an account of space, and Newton of time, which seemed wholly satisfactory. We now know that these accounts work well enough for objects in the very large range of sizes between a bacillus and a galaxy, but that they are inapplicable to very small or large objects, or to any object moving even a few hundred times as fast as a rifle bullet relative to its surroundings.

We have a sketch of a new physics, based on quantum theory and general relativity. But new facts are being discovered so quickly that it would be silly to try to work out the full consequences of existing theories, as Laplace tried to do with Newtonian stellar mechanics. It is now clear that so-called dead matter has a good deal more organization than it could have if it consisted of particles each moving under the attraction or repulsion of all the others. And the kind of organization which explains the stability of a molecule may

very well explain the stability of a tree or a dog, which we call its life. A sensation in a human mind may or may not be a quantum transition, but it is a great deal more like a quantum transition than it is like a particle.

I think, therefore, that within a century or less we may hope to have the rudiments of a psychophysics, so that we can state roughly how events in some material systems, including our own brains, achieve the peculiar type of organization which we call consciousness. It may take several thousand more years to work out the details. But it should be possible to state definitively what happens to this organization at death. Does it come to an end? Does it partially persist in such a way that it can be associated with a new body? Or, as C. D. Broad has suggested, do some traces of it persist, perhaps without consciousness or will, which are still capable of action on the brains of mediums? It is more likely, I think, that our descendants' notions of time will be so unlike our own that these questions will be seen to be incorrectly put.

A bit later, perhaps, they will begin to investigate super-individual realities by thoroughly scientific methods. Are such phrases as 'volonté générale' or 'group mind' meaningful, or mere fictions designed to support certain political theories? If these phrases are meaningful, are the realities represented by them in any way related to the alleged occurrences denoted by such words as 'telepathy'? Can duties and rights be described in the language of psychophysics, and therefore calculated scientifically? Or can science do no more than account for the illusory belief that duties and rights exist? If they exist, do they constitute, or are they derived from, a being with some, at least, of the attributes of a deity?

An atom or a molecule has attributes unsuspected sixty years ago which keep it from collapsing or falling apart. Has the solar system got such attributes? Laplace told Napoléon that he had found no need of Newton's hypothesis of a super-human being who could and would, if need be, correct the

disturbances of planetary orbits due to the gravitational interaction of the planets. In fact, Laplace was only able to show that this system would not break up in the next hundred thousand years or so. Its short-period oscillations do not increase indefinitely. As Laplace's theological opponents thought that the solar system was only about six thousand years old, this time-scale answered the question before him. Laplace only knew of seven planets. The calculations for nine are more complicated, and we still can't push them beyond a few million years. But the system seems to have lasted for about four thousand million. If it could be trusted to do so under Newton-Einstein gravitation, Laplace was right. If not, it is necessary to postulate a stabilizing agency which, if it exists, may have the general character of life or mind. With the development of automatic computers this question may well be settled before the end of the present century.

Similar problems will later be soluble for the galaxy, and for systems of galaxies. Whether they will be soluble for the universe is much more doubtful. But I do not think that we have the right to say that they are necessarily insoluble. My own guess is that utterly unexpected regularities will be found in the structure and behaviour of matter at many different levels, but that when they are fully investigated they will disclose the existence of beings with very slight resemblance to any deities adored even in India, where a wide choice is available.

My last point of difference from my predecessors is my different time-scale. We can now console ourselves with the thought that various imperfections of human nature, which we take for granted, are not part of the unchanging pattern of reality, as the laws of chemistry may be. But it might take fifty million years of evolution by natural selection, or five million by humanly controlled processes, to overcome them. Again, our galaxy appears to contain about a hundred thousand million stars, and to turn round its axis about once in two

hundred and fifty million years. So we may require several million years to collect the information needed for a detailed history and forecast of its development. And this might be necessary to determine whether it showed any characteristics of a living organism, on the one hand, or an intelligently designed or controlled machine, on the other. So without being an agnostic, I don't think that all the Riddles of the Universe will be answered in any great hurry. If they were, scientists would have no more to do, and research is such fun that I hope this will never happen.

What, then, is a reasonable intellectual position? If a conclusion is sufficiently highly probable, we must bet our lives and souls on its truth, if necessary. I think it is easy to show that some theological statements are nonsense, and I think that this number can be extended in future. It can perhaps be shown by Buddha's argument that even if some are true, there is no way of proving this. But the usual argument will be something like this. 'For so many centuries we have gone on making predictions which ignore the dogmas of religion. These predictions have never been falsified in such a way as to make us suspect that these dogmas might be true.' This is why, for example, educated people believe in gravitation, in atoms, and in evolution, even though none of these are quite what they were thought to be a century ago.

Apart from scientific advances, the most powerful support for atheism in this century comes from the Miracle of Fatima, in Portugal, in 1917. If the accounts which you can buy at any Catholic bookshop are correct, over ten thousand people believed that they saw the sun coming down out of the sky, dancing about, and going back. Even allowing for some pious exaggeration, the evidence for this miracle is far better than for any recorded in the Bible. The only trouble is that it didn't happen. The sun did not leave its position.

I think that as times goes on more and more people will accept atheism and man's mortality as working hypotheses.

This will not necessarily mean the end of religion. It is, I think, true that there are facts about the universe, or if you like about human experience, which cannot be stated in words. At present I doubt if we can state in words what is known about the two protons and two electrons in a hydrogen molecule without contradicting ourselves, though we may be able to state it in algebra. I suggest that language will never be developed to describe all our experience precisely. Among the undescribables there will be some very important facts of which poetry gives a better inkling than prose, and for some hearers—though not for me—music gets still closer. Mythology, which is the science fiction of two or three thousand years ago, may be preserved for a long time after it is no more believed, because it hints at these facts. I may be wrong. Psychophysics may become so complete as to explain everything, including its own existence. But my own belief is that though the religions are all untrue they are concerned with something very important.

1963

SOME LIES ABOUT SCIENCE

AT THE PRESENT TIME Western Europe and North America are being subjected to very heavy propaganda against science. The corresponding propaganda in the socialist countries is also dangerous. It consists of attempts to make scientific theory conform to what Marx and Engels wrote in the nineteenth century. Fortunately these authors were well ahead of their contemporaries. But they inevitably wrote in terms of the science of their day, and too great a respect for the detail of their exposition has sometimes retarded the progress of science, even though their more general statements about science seem to me to be correct.

In Britain the following statements are frequently made: 'Science is becoming so vast that every scientist is inevitably a specialist, and his or her judgment is not to be trusted outside a narrow field. In order to work even in a narrow field of science one requires so long and intense an education that one cannot be expected to know the "humanities". Scientific research is inevitably very expensive. It also involves teamwork, and therefore planning on a national or even international scale. So it must be controlled by States (i.e. in practice by politicians and professional administrators).'

From these premisses various conclusions are drawn. The most important is perhaps that although scientists may be remarkable people in their way, their opinions on matters outside their narrow specialities are worth no more than those of professional footballers or pianists, and the scientific point of view must not be allowed to influence political, ethical, or aesthetical decisions. This flattery of the ignorant is all

the more effective when it is mixed with a suitable dose of religion. When politicians or wealthy men misuse science, it is useful to blame the scientists who produced the knowledge or technique which is being misused.

I believe that all the statements in the second paragraph are false. I shall try to prove their falsity from my own career. Whenever I do so I am told that I am exceptional, and incidentally that I am boasting. However, I shall also quote the the careers of others in what follows. I learned a great deal of science from my father, both from his conversation and from working as his assistant. I was a 'science specialist' for three years at school, which meant that I learned physics, chemistry, zoology, and botany up to the levels needed for a university scholarship fifty years ago. I took no scientific degree at a university, though I attended several scientific practical and lecture courses in my spare time.

I missed nearly five years from 1914 to 1919, but since that year I have earned my living by scientific teaching and research, and my colleagues have been pleased to recognize my work. Thus I have received one of the Royal Society's medals and given one of its annual lectures. In 1961 I received a Feltrinelli prize of about £11,000. This is one of three international prizes awarded annually by the Roman Accademia dei Lincei for a wider variety of subjects than the better-known but not much more valuable Nobel prizes. I was the second person to whom it was awarded for work in the biological sciences. In the same year I was awarded the Kimber prize for genetics by the National Academy of Sciences of Washington. My work has been mixed. Thus I was the first person to estimate the rate of 'spontaneous' mutation of a human gene, in 1932. But unfortunately I think Russell's estimate of the effect of atomic bomb tests in provoking mutations is too high, and that of British and American government spokesmen too low; so my opinions on this matter are of no interest. I was also the first person to taste

oxygen (at six atmospheres' pressure) or to calculate the first dozen cumulants of the binomial probability distribution.

What is more to the point, I can launch others on what may be similar careers. In 1961 I spent some of the Feltrinelli prize in taking two of my Indian pupils, each aged twenty-four, round some European countries. One of them, K. R. Dronamraju, took his degree in botany. He has since held a fellowship at Glagow University, studying human cells in culture. During our tour he was offered posts in several other countries to work on human genetics, which he began to study in November 1959. The other, S. D. Jayakar, has a degree in statistics. In three weeks' practical work in France he made discoveries about cockles which were sufficiently novel and definite to publish in a French scientific journal.

I consider it desirable that a man's or woman's major research work should be in a subject in which he or she has *not* taken a degree. To get a degree one has to learn a lot of facts and theories in a somewhat parrot-like manner. One may also learn something much more important, namely how a branch of knowledge has been organized. And a piece of research directed by a good scientist should leave one with high standards of accuracy and integrity which one can transfer to other fields of science. But it is rather hard to be highly original in a subject which one has learned with a view to obtaining first-class honours in an examination. Let me give a few examples.

P. B. Medawar took a degree in zoology, and has taught that subject with distinction. He tried grafting skin between different rabbits, and studied the difficulties arising with such effect that he was awarded a Nobel prize for medicine, and has been appointed Director of the National Institute for Medical Research. J. Z. Young also took a degree in zoology, and is now a professor of human anatomy in London. His predecessor in the same chair, Sir G. Elliot Smith, found time to spare from anatomy to launch anthropological theories

which probably went beyond the facts but some of which are now generally accepted. P. A. M. Dirac took his degree in engineering, and became one of the greatest applied mathematicians of his age. Homi Bhabha also took a degree in engineering, produced some extremely brilliant mathematical physics, but returned to engineering, thus perhaps missing a Nobel prize, in order to start atomic power in India. C. H. Waddington took his degree in geology, and is now in charge of the leading genetical laboratory in Britain, though he has also made major contributions to embryology. Norbert Wiener's first work was on mathematical logic; he has contributed to various branches of engineering, to pure mathematics, philosophy, and the study of the heart and brain. Most of these men could probably learn enough of a branch of science such as astronomy or meteorology in their spare time to make a serious contribution to it, though some do not possess the mathematical ability needed in one group of sciences.

It can even be argued that it is easier to learn a science now than it was sixty years ago. Principles are more important, and unconnected facts less so. Of course, however, if one is really interested in a subject one can learn a surprising quantity of facts with very little conscious effort. Most scientists probably stick to one subject because they lack confidence, some because they find enough to keep them busy. I think that for most of us an occasional change is desirable because we are apt to think that the topics which, very rightly, excited us in our twenties, are still the most important.

As for the accusation that scientists are ignorant of, or uninterested in, the humanities, it will not bear examination. I think it was in 1941 that the editor of *Horizon* accused me of apathy because I would not contribute to his journal. I was engaged in work on the physiological dangers of high pressures. I made some contributions, however small, to the underwater attack on the *Tirpitz*, the destruction of magnetic

mines, and the clearing of liberated ports by divers. As I took my share in experiments, I sustained some injuries quite as serious as wounds received in battle and was often rather tired. Perhaps I ought to have worked in a government office as befitted my age, in which case I could have written for *Horizon*. On the whole, scientists prefer to enjoy the arts and literature rather than to make second-rate contributions to them. But they take their enjoyment seriously. When I was at University College, London, the senior zoology students dispatched enough apparently independent postcards from different addresses to induce the BBC to broadcast a particular piece of classical music. I am at present engaged in reading that very great poet Pindar. My former colleague, Professor D. M. S. Watson, has a magnificent collection of vertebrate fossils, and another of Chinese grave furniture. Lord Adrian, a very distinguished physiologist who has been President of the Royal Society, is one of a group who about 1913 produced an exhibition of their own post-impressionist paintings well up to professional standards. And so I might go on.

Most literary and artistic work, like most scientific, is second-rate or worse. I believe that uninspired scientific work is much more valuable than uninspired literature or art. Somebody will have to describe all the beetle species of India, all the stars within range of a spectroscope, and so on. I believe that this is a more important contribution to civilization than writing second-rate verse, or painting second-rate pictures. I am sure that it is a more important one than discussing the work of second-rate poets and painters. I fully recognize the importance of the first-rate poets and artists. But when scientists are blamed for atom bombs, I permit myself to wonder whether we might be a little less bellicose if Homer, Valmiki, David, Virgil, Shakespeare, Schiller, and Hugo, to mention no others, had confined themselves to such subjects as love, agriculture, religion, and sport and never written a line

in favour of war or warriors. Pindar,[1] for example, refers to Asklepios as 'the craftsman of analgesia, the hero who conquered manifold diseases'. If we took our notion of heroism from him, we might think of Pasteur and Florey as heroes, rather than use this word about men no braver and less intelligent than they, who killed the human enemies of their countries. For bacteriology is not a safe occupation. If we did so we might be less likely to be killed by nuclear explosions.

Scientific research need not be expensive. Except when working for the British government on high pressures, I have never used a piece of apparatus more expensive than a chemical balance. There are whole branches of science which need little apparatus. Palaeontology has possibly taught us more important lessons than history. In the field a palaeontologist needs spades and pickaxes, hammers and chisels. He would destroy his material if he used high explosives and bulldozers. In the laboratory he needs dentists' drills, lenses, and photographic apparatus. Of course, it is expensive to set up skeletons of any of the few giant animal species which have lived in the past. But they are no more biologically interesting than the smaller species and quite irrelevant to man's ancestry. Another science which has profoundly changed the views of educated people on man's place in Nature is the study of animal behaviour, which seldom needs apparatus more expensive than a pair of field-glasses and a watch.

As for team-work, in my experience quite a lot is still being done by solitary workers, but probably the best team consists of two first-rate scientists and one or two technicians. I am quite aware that vast teams are employed, for example, in searching for new drugs. Hundreds of compounds resembling a known drug are made, and tested on bacteria, on mice, and finally on men, in the hope that one may be superior to anything yet known. In our present stage of ignorance this is perhaps the only way open to us. We have only the

[1] *Pyth.* III.

rudiments of a scientific pharmacology. If a properly qualified mathematician is given the specification of an aeroplane wing, he can calculate at least roughly how it will behave. We have not yet reached the stage when a mathematical pharmacologist, shown the structural formula of an organic compound, will be able to calculate that it will relieve toothaches but not headaches, and will lead to addiction in about ten per cent of users.

But I do not hesitate to say that in nine cases out of ten large teams and expensive apparatus are a substitute for really accurate observation and really deep thinking. One can't order a Faraday and a von Frisch, with a Laplace to do their mathematics for them. One can order a hundred graduates, a cyclotron, a computer, two electron microscopes, and so on. Such apparatus also impress visiting journalists; whereas great scientists are often shy or rude, and sometimes both. One reason why giant apparatus and giant teams are so beloved by those who have the control of funds for research is that these controllers do not share my possibly unjustified faith in the intelligibility of Nature. There are particles which only appear when other particles collide at enormous speeds, and then disappear in less than a millionth of a second. How can they be studied without very expensive apparatus requiring a team of highly skilled physicists? If you believe, as I do, in the unity of science and the capacity of men to understand Nature, it follows that the existence of these particles could have been deduced from observations made with much simpler apparatus, or even with the unaided human sense organs. In fact, the existence of one of the queerest kinds of particles, the neutrino, was deduced by Pauli from observations made with fairly cheap apparatus; but neutrinos were only detected some time after his death with very expensive apparatus placed near a fabulously expensive atomic pile.

My apparently reactionary views are due to the fact that I have to solve the following problem. India is a poor country.

How can Indians turn out research which is better, in its own field, than anything done outside India? One can do so by using one's senses. For example, last year my wife, Dr Spurway, with some help from K. R. Dronamraju and myself, watched a wasp building a mud nest for twelve hours a day on each of fifteen days, timing the visits to the nearest second. The result is the first adequate 'time and motion study' of an animal. No bird-watcher, for example, has watched and recorded the complete building of a nest. The wasp only made 955 visits, classified under nine different tasks carried out. A bird may make many more. But a team of two or three could find out how many during next spring in England. As an example of 'pure thought', S. D. Jayakar and I have just answered the following question, among others. 'How many different "blood" relationships are possible between two people, if the pedigree does not go back beyond a grandparent on any ancestral line, and there is no inbreeding (which would be incestuous by European or Indian standards): though we do consider marriages which are forbidden on other grounds, such as that of a man with a mother and her daughter?' If you count, for example, the relations of a nephew and niece to their maternal uncle as different, the answer is 516, which is a good deal more than I, at least, thought likely when we started. This list could have been made three thousand years ago, but people who thought of such matters were too busy being shocked to think systematically.

Much of the work of my colleagues involves both new observation and new thinking, and some of it is of much greater practical value. I have given these two examples because they are rather simple. I believe that if I can encourage a number of Indians to work on such lines, we can challenge the science of economically advanced countries with some success. I also think that people who have done such work have quite as much claim to state their opinions on

ethical or political questions as political orators or those who enunciate as eternal values the moral platitudes which were fairly adequate guides to action in the human societies of two thousand years ago, whose structure and function were very different from those of today. I agree with the critics of science that a man who has spent ten years in servicing, and perhaps slightly improving, a part of a giant machine designed by someone else has no particular qualifications to speak on human affairs. But then I think that such work is an unfortunate necessity, if it is a necessity at all.

It is perhaps useless to write such an article as this. It may be that the beliefs and emotions of the majority, or of the ruling group, concerning science, are part of an ideology which reflects the structure of the society, and that it is futile to argue against them. One should concentrate on changing the society. This, I suppose, is the orthodox Marxist point of view. But it was not the view of Marx, Engels, or Lenin, all of whom spent some energy in interpreting the science of their day and pointing out its strong and weak points. However that may be, there is no doubt that the social structure of the 'West' is based on applied science, and to an outsider like myself many of its troubles and dangers seem to arise from false beliefs about science. No doubt others, such as C. P. Snow, are combating these falsehoods more effectively than I can; but perhaps I may be of some value.

I doubt my value for this reason. The demand for scientifically educated men and women in Britain exceeds the supply, largely because of the poor facilities for science teaching in secondary schools. Hence rather few people with a scientific education go into professions such as politics, poetry, or painting. This results in a gap between practice and theory like that which, in individuals, we call hypocrisy. Of course British scientific teaching is pretty bad. But I think it is better than the teaching of history or literature. I consider that austenite, progesterone, gastrulation, and photosynthesis

are more important as facts and more stimulating as ideas than Eleanor of Aquitaine, the Act of Settlement, or the author of *Euphues*. The vested interests against this view will probably prevent it from prevailing in my lifetime. And if it does not, Britain may be a radioactive wilderness or an unimportant but overcrowded island off the coast of Europe by the time I die. I hope that I am wrong.

Curiously enough the propaganda against nuclear warfare is quite useful to the Establishment. Its religious lackeys, in particular, can say 'Look at what science has given you, the possibilities of mass destruction'. Certainly these possibilities exist. But over about a third of the world science has made infectious disease a rarity, and thus doubled the human lifespan. This is, of course, a mere fact, whereas nuclear bombs give fine opportunities for imaginative writing. For a sum far less than that spent on preparations for nuclear warfare, all infectious diseases could have been abolished over the entire planet. It is not scientists but politicians and capitalists who decide how public money is to be spent on the application of science.

It is characteristic of their utter contempt for science that the Royal Society, in spite of various pledges which were no doubt not firm promises, and Mr Macmillan's statement that 'We have never had it so good', has not even been granted a room of the size of a large parish church, in which all its members can be accommodated. Things are a little better than that in India, though not much better. This contempt is based on lies, some of which the members of the Establishment believe. It may be impossible to conquer these lies. But I think it worth trying.

1964

THE ORIGIN OF LACTATION

AN ATTEMPT to describe the course of evolution along Darwinian lines raises the following difficulty. We have to suppose that structures or functions which proved valuable in later generations were also valuable, or at least harmless, at every stage. And one of the criticisms of Darwinism has been that it failed to explain the evolution of an organ like the vertebrate eye, whose parts are nicely adapted. The fossil record cannot help us. The earliest vertebrates whose skulls are preserved had quite large eye-sockets, though their soft parts may not have been as efficient as modern eyes. But fortunately among the living molluscs we have a fairly complete series of eyes ranging from mere patches of light-sensitive pigment in scallops and other like species to the eyes of cephalopods such as cuttlefish, which are quite similar to our own. At each stage the eye is presumably useful. But because a snail cannot pounce, nor hide quickly from a bird, it would be no better off if its eyes were more efficient.

A structure has to be used, and the nervous mechanisms for its use may be more important than the structure itself. The human hand is certainly a marvellous structure adapted for skilled work. But the area of brain controlling it is much more essential. Any of a variety of brain lesions can make a human hand no more use for manipulation than the external ear, and less so than the foot. On the other hand, a gene mutation may replace the hand by a 'lobster claw' in which only two digits, a thumb and the fifth finger, remain. When one reads the works of anatomists rightly enthusiastic for the efficiency of the human hand, one might suppose that these

lobster-clawed people would be incapable of skilled work. The character is dominant, so a number of cases occur in a family through several generations. One such English family is highly intelligent. Not only can they perform such actions as lacing their boots, driving automobiles, and even developing photographic plates in a dark room; their handwriting is excellent, and one of them could play a passable game of cricket, though he was better at bowling than catching. A race all of whose members possessed this character would be capable of survival in many parts of the world.

There is no difficulty in imagining the gradual simultaneous evolution of hands adapted for grasping and manipulation, and brain regions to control the movements, by small steps, each one being advantageous. On the other hand, a new organ, even if it arose by one step in a potentially useful form, would often lack the cerebral mechanisms which could render it useful. For example, horns might arise by a single mutation, but if so the first possessor of horns lacked instincts to use them in combat. It might discover their use, but this discovery would have to be made afresh in each generation until further mutation or segregation evolved the physical basis of an appropriate instinct. The problem is much more serious when the organ or organs concerned can only be efficiently used by two members of a species in co-operation. Copulation is a case in point. A large fraction of human unhappiness arises from a failure of nervous co-ordination of the activities of men and women in this act. Some, but probably not most, animal species appear to experience similar difficulties. No animals have achieved a method of 'dry' sexual intercourse like the pollination of the flowering plants, though if this could be achieved it would have obvious advantages.

Lactation, as we see it in existing mammals, involves the following adaptations. The female has two or more mammary glands, usually with nipples and muscular structures to

control milk flow. Milk secretion starts when the baby or babies are born. She also experiences satisfaction from being suckled, and may have complicated instincts controlling suckling. The baby has a mouth capable of sucking—as, for example, most birds have not—an instinctive urge to suck, and a digestive system capable of using milk. All these are needed before babies can be successfully nourished on milk, and it is not obvious how they arose simultaneously. Mivart, in *The Genesis of Species*, an attempt to answer Darwin, gave the mammary glands as an example of organs which would have been useless in their early stages, and Mayr, in *Evolution after Darwin* (Vol 1), described them as organs 'a gradual origin of which is indeed not easily imagined'. I take up his challenge.

The speculations which follow arose from the observations of my colleagues Jayakar and Spurway on the Yellow-wattled Lapwing, *Vanellus malabaricus*. They watched a pair nesting in our garden at Bhubaneswar through the hours of daylight for several weeks and noticed many features of their behaviour, which will be published elsewhere. The eggs are laid on the ground in a shallow nest, in this case exposed to full sunlight, which can heat the ground up to at least 55° C. The birds' efforts during the daytime are largely concerned with keeping the eggs cool, as those of British birds are largely concerned with keeping them warm. Both parents may leave the nest for an hour or so soon after sunrise and before sunset. But during the hot hours one was always shading it. However, this was not all. When one parent relieved the other, the freed parent usually went at once to shade or water, then did some foraging, and finally went to the nearest water, in this case the drip from a neighbour's tap, for the lapwings were too shy to use our bird bath. The bird sat down in the water and wetted his or her feathers. On return to the nest, it sat down on the eggs and wetted them. Without this they would probably have been slowly roasted.

Others have described egg-wetting in terns nesting near Indian rivers, but here the water was splashed rather than carried on the feathers. Soon after the eggs hatched, the parents and chicks began to walk about, and my colleagues were unable to see whether they continued feather-wetting after the hatch. However, in the *Avicultural Magazine* for 1919 Meade-Waldo had described the behaviour of two Indian species of sand grouse, *Pterocles orientalis* and *Pterocles alchata*. He bred one in captivity and could watch it from near by. In both the male wets his breast feathers, and the young were seen to drink water from them.

I only discovered Meade-Waldo's work later, but my colleagues' observations set me thinking. If young animals are hatched or born in a nest, and cannot leave it for some days, the parents can easily bring them food, as most birds do. But they cannot carry water so easily. All existing birds, and most existing reptiles, need much less water to drink than mammals or amphibians because they produce an almost solid urine, whereas mammals and amphibians use much of the water which they drink to form urine. The difference arises as follows. Mammals and amphibians excrete most of the excess nitrogen in their food in the form of urea, which is soluble in water, and can only be got rid of in a large volume of water. Birds and most reptiles form uric acid, which is not very soluble in water, and is excreted as a paste. This is, however, rather wasteful of carbon, which could be used as an energy source, and requires a special outfit of enzymes to make uric acid in large amounts.

Needham, who is now known to a very wide public for his magnificent series of volumes on Science and Civilization in China, pointed out that an animal such as a reptile, bird, or insect, which develops in a nearly watertight egg, must get rid of its nitrogen in an insoluble form while in the egg. Whereas if the egg is laid in water, like a frog's, and is permeable to it, or if the embryo develops inside the mother,

there is no harm in its producing urea or some other soluble substance. Needham pointed out that most animals with cleidoic eggs, that is to say eggs shut in from the external world, not merely make uric acid in the egg but go on doing so after hatching. They thus need less drink, and this is one reason why lizards have an advantage over mammals in dry countries. It is also, I think, a reason why lizards and birds have not developed mammary glands. McCance and others have shown that infantile mammals cannot produce as concentrated urine as adults and therefore need more water. If this was so two hundred million years ago, the production of milk, with the associated instincts, gave a special advantage to those of our ancestors which lived in warm climates.

Let me now speculate. In the Mesozoic Era, from about 250 to 70 million years ago, there were mammal-like reptiles which gradually evolved into mammals. The line between the two classes is rather arbitrarily drawn on the basis of skeletal characters such as the hinging of the lower jaw to the skull. We do not know when vivipary, lactation, hair, and temperature control were evolved. However, it seems fairly easy to change over from laying a soft egg to bearing young without shells. Half the species of reptiles living in England, namely the viviparous lizard, the slow-worm, and the adder, have given up egg-laying, probably as a protection against frost. When a number of mummified bodies of mammal-like reptiles have been found, as mummified dinosaurs and ichthyosaurs have been found, we shall know when hair and mammary glands appeared, and whether one appeared long before the other. At present the only indication is that small pits have been found in the upper jaws of some South African mammal-like reptiles, which are like enough to those housing the muscles moving the vibrissae (whiskers) of living mammals to suggest that the theromorphs had hairs on their upper lips. If they had them there, they probably had them elsewhere too. Within a few years we shall probably know about

the evolution of temperature control. The relative frequencies of two oxygen isotopes in the shells of recent molluscs differ with different water temperatures. This fact has been used by Urey and others to detemine the temperatures at which fossil shells were formed in the remote past. It should be possible to apply this method, or a similar one, to bones.

I suppose that a group of mammal-like reptiles had developed hair, but still laid eggs and had no mammary glands. Very likely they were 'warm-blooded', that is to say kept a fairly steady temperature. Both hairy coats and warm blood were probably developed in a cool climate. Some members of this group migrated into hot dry areas in which, however, water was available in streams and pools. They found that they could keep cool by an occasional bathe. And if their fur got wet they could stay cool for some time, which perhaps gave them an advantage over their hairless reptilian competitors. They laid eggs exposed to the sun, and cooled these as our lapwings do. There is no need to postulate either a knowledge that eggs can be killed by heat or the development of a special egg-cooling instinct. When a domestic hen goes broody, she develops a bare and hot patch of skin on her belly, and cools it on her eggs. The eggs are warmed in consequence, and once they are warm the hen is more likely to leave them. She doubtless has other drives which make her sit on them. But she does so at least in part because they are cool. If the mammal-like reptiles were warm-blooded they probably evolved similar instincts. I have little doubt that the first ancestors of our lapwings to nest in a tropical sun found that they could cool the eggs down by sitting on them when wet. Later on this activity has probably become instinctive, but if so the instinct is reinforced by the reward of getting a nice cool object to sit on.

If the young of the mammal-like reptiles could not fend for themselves on hatching, their parents no doubt brought them food. Juicy insects, worms, snails, reptiles, and berries

probably gave them enough water in cool climates. But in hot dry climates they must often have been thirsty and sucked the damp parental fur. This again could become an instinctive activity in the course of a few hundred generations. Once the instinct was established, the conditions for the development of mammary glands were present. If, like many hairy animals in hot countries, these reptiles sweated, the young could lap their sweat as of course cows lick one another today. And if the sweat glands in one area developed to an unusual extent, the young could suck this area. I suggest that lactation began as a means of relieving the thirst of baby animals in hot countries, rather than their hunger. The value of the precursors of mammary glands was increased when they came under the control of the hormone prolactin, which is secreted by the anterior pituitary gland. This hormone, which causes not only development of mammary glands but broodiness in hens and various other maternal functions in different vertebrates, was presumably being formed by our egg-laying ancestors. The mutation of a single gene suffices to put a function under hormonal control, or at least to vary the level of hormone needed to evoke it. Thus cocks of some poultry breeds have henny feathers because a mutation has made their feathers responsive to the small amounts of female hormones produced by a cockerel. Once the structures and instincts were established, there would be a further advantage in secreting nutritious materials as well as water. Both sexes may very well have suckled the young. Darwin, in Chapter VI of *The Descent of Man,* believed this to have been the case, on account of the fact that the mammary glands and nipples of male mammals are quite like those of females up to puberty, though they do not then develop further. The example of the sand-grouse even makes it possible that mammary glands developed in males before females.

Some comments on the above speculations may not be out of place. I have written of the development of instincts.

Darwin, when he wrote Chapter VIII of *The Origin of Species*, believed that some instincts were inherited habits. However, he fully realized that this was not always so. 'For peculiar habits confined to the workers or sterile females [of bees and ants], however long they might be followed, could not possibly affect the males and fertile females, which alone leave descendants. I am surprised that no one has hitherto advanced this demonstrative case of neuter insects, against the well-known doctrine of inherited habit, as advanced by Lamarck.' In fact the case is stronger than Darwin realized. For if instincts can be formed by habitual action, they can be lost by habitual inaction. Yet worker bees and ants perform instinctive actions which their ancestors have not performed for millions of years. What is inherited is not the instinct but the capacity for producing sterile or nearly sterile individuals possessing the instinct.

Here a digression on the meaning of the word 'instinct' is necessary. Some biologists reject the word completely, largely because so many false connotations have accumulated round it. Among those who still employ the word, a majority adhere more or less closely to the following theory, due mainly to Lorenz and Tinbergen. Animals have inherited patterns of movement (*Erbkoordinationen*) which they perform with very little or no learning. Well-known examples are the flight of birds, and (in my opinion) the songs of some, but not all, bird species. The pattern of movement can be modified to some extent in response to sensory stimuli. The components which are not fixed but depend on details of the environment are called taxis components. However, the underlying pattern is often remarkably stable. Each such pattern is released by appropriate signals. The response may be fixed by 'innate releasing mechanisms', or by a rapid process called imprinting as when young birds come to follow any moving object which they see at a critical stage of development. This object is normally a parent, but a human being can be chosen. If an

instinctive activity has not been performed for some time, it may be performed in response to an inappropriate signal or apparently in response to no signal at all ('vacuum activity'). It seems that the movement patterns are much less easily changed, both in individual development and in evolution, than the conditions under which they are carried out. If this point of view is accepted, a good deal of past writing on instinct must be reworded, and in particular Macdougal's account of human instincts must be rejected in the form in which he stated it.

Darwin wrote that instincts were variable within a species. It would perhaps be more correct to say that the innate releasing mechanisms are variable and can often be changed quickly by natural or artificial selection.

Koopman bred two species of Drosophila together which seldom interbreed in Nature, though their ranges overlap. When the species are kept together in a large cage, they sometimes hybridize, but the hybrids are nearly sterile; and in each generation Koopman killed them. Hence a female which accepted a male from the other species left no descendants, or at any rate fewer than if she had only mated with a male of her own species. After a few generations in mixed culture, the frequency of hybridization became quite small. The flies had been selected for preference for their own species. Laboratory stocks of insects are often found to differ in their preferences for colours and odours, and these differences can be enhanced by selection. It is, however, difficult to devise an experiment designed to show the inheritance of a habitual action forced on members of a species without giving some advantage to those which carry it out most quickly and effectively. If so, there is, of course, selection in favour of those which are most efficient and may be supposed to have an inborn propensity for such action.

The late Professor MacDougal, in collaboration with Rhine, claimed to have produced an instinct (or more

accurately a great inherited acceleration of a learning process) in rats while carefully avoiding selection. Others failed to repeat his results. There is, however, another objection. In the same laboratory Rhine claims to have produced evidence for 'extra-sensory perception', telepathy, and the like. Now if Rhine can predict the pattern on the back of a card which he has not seen, he was very probably able to pick out rats whose progeny would quickly learn to avoid a lighted entry. If he could convey his thoughts, perceptions, or wishes to another human, why not to a rat? So if MacDougal and Rhine's experiments prove anything, they may prove the existence of supernormal human powers of choosing rats or transmitting wishes to them, powers which do not exist in the laboratories where their results could not be repeated. The fact that this point never occurred to Rhine seems to show that he thinks in water-tight compartments. If he rejects the fairly obvious super-natural (or shall we say supernormal) explanation of an allegedly natural phenomenon, may he not have rejected natural explanations of allegedly supernormal phenomena in a similar way?

It may be some years before we can correlate differences of instinctive behaviour with differences of brain structure. However, the brain is a very variable organ, and presumably some of the fine differences can be inherited, as some of the grosser ones certainly are. The more easily observable organs of animals are often very variable, but very few variations from the normal pattern are useful and most of them seem to be harmful. Natural selection is constantly weeding them out. However, environmental changes can render previously neutral or harmful characters useful, and natural selection may then increase their frequency. For example, Koopman's female flies which would not accept males of another species may have been a little slower than the average in accepting males of their own species. This might have lowered their

fertility in Nature, though it did not do so in crowded cages in a laboratory.

I have, I hope, shown that the complicated and beautiful structures and instincts concerned in lactation could have arisen by mutation and natural selection. None of the postlated mutations are unlikely in the sense that they involved large changes occurring simultaneously of which one would not be valuable without the others. Natural selection is 'blind' in the sense that no character is favoured because it may be useful a thousand generations hence. That is doubtless one reason why no animals or plants have evolved a wheel; and functional anatomy has been said to be an account of how animals manage to do things without wheels. Of course, the hypothetical account which I have given may be quite false. If it were incapable of disproof it would be bad science. But, to take one example of a possible disproof, mummified mammal-like reptiles may be found which possessed mammary glands but no hair.

The train of my ideas is very obvious. Darwin and his contemporaries made similar speculations, some, but not all, of which have been verified by later workers. I think that if Darwin or Wallace had ever watched an Indian sand-grouse they might very well have had the same ideas a century ago. It is, however, an historical fact that most of the great naturalists who spent some years in the tropics spent them in regions where there is constant rain, for the excellent reason that in the rainy regions the numbers of plant and animal species are very numerous. A few naturalists, like Buxton, have worked on plant and animal life in deserts, where the rare species which manage to survive have produced very remarkable adaptations. But over most of India there is an alternation of dry and wet seasons, and the hot weather in the plains is unattractive to most people. The British officers, civil and military, who started the modern study of birds in India (though one of them, Hume, also played a big part in founding

the National Congress) found it pleasanter to study the birds of Kashmir or the Nilgiri hills in our summer. This was partly because the British Raj compelled them to wear clothes unsuited to the climate, and they ate large amounts of meat, which increased their heat production. One of the less publicized aspects of Indian independence is this. Since independence India is a vastly pleasanter place for Europeans interested in science or culture than it was before. It is, of course, not so good for those whose idea of fun is bawling at subordinates. If any naturalists read this article, I can assure them that Jayakar and Spurway watched the lapwings from easy chairs on the veranda of our house, in a luxury which British ornithologists crouching in their hides might well envy. The best time for new observations on nesting birds is the hot weather from March to early June, when most tourists have left India.

I am publishing this article in the *Rationalist Annual* for several reasons. One is that in 1928 I published an article in the *Annual* on the Origin of Life, which was quite as speculative as the present one. With some minor corrections its main conclusions have been accepted, partly because Oparin arrived at them independently (and for all I know a little earlier) in the Soviet Union, and has spent much of his life in developing them. My views are now orthodox in the US as well as the USSR, which makes me a little suspicious of them. Another reason is that at the present time British scientific journals welcome speculative articles on physics and cosmology, but not on biology. Soviet journals seem to be a good deal more hospitable to speculative biology, as British journals were seventy years ago. Some of the wilder speculations published there, of which a few will survive criticism and be orthodox a generation hence, are reported in Indian and British newspapers. There is still another reason. I think that Rationalists should be familiar with scientific thought processes. They cannot be expected to follow the mental

processes which led to the postulation of muons, or the modern theory of stellar evolution, because these involve quite difficult mathematics. But I think I have put forward all the arguments which led me to the hypothesis of this article. As it was written within a month of my colleagues' observations, and I only read of Meade-Waldo's results after framing it, I think I have given a fair account of my own thought processes. If I had waited for five years, the theory might be neater but its origin less clear.

I have not, however, mentioned one habit of thought which has certainly influenced me. For just over forty years I have been developing a mathematical theory of natural selection, though of late, owing to senile decay, I have found that without Jayakar's help I make so many mistakes that I can no longer work on it alone. We have to consider such questions as this. If a gene is advantageous to females and harmful to males (in the sense of increasing or diminishing the numbers of offspring left by those which carry it), will it spread through the population, will it disappear, or will a balance be struck? This depends on the numerical values of the fitnesses. In all such questions we are thinking of the immediate effects of a hereditary change, not of its remote advantages. Thus a species of fish which does not eat its own young can presumably raise more progeny than one which does so, and may thus overcome it in competition. But if such a species occurs in large shoals an individual with a hereditary propensity for cannibalism will be better fed, and produce more young, only a few of which it will eat itself. So cannibalism is likely to spread within such a species. More generally the development of altruistic instincts demands special conditions. So if I am thinking about evolutionary changes, I automatically think of their immediate advantages somewhat more consistently than Darwin and his immediate followers did. I have the further advantage that my wife and colleague, Spurway, has not only observed animal

behaviour but thought about it seriously, distinguishing, for example, between activities which do not permanently alter the sign stimulus evoking them, such as basking in sunlight or rising to the surface of water, and those which do, such as eating food or suckling one's offspring.

Some readers may think that the origin of lactation is unimportant in comparison with those of music, law, poetry, or monogamy. This could be disputed indefinitely. But I think that we are less likely to be biased by our emotions in considering the origin of lactation than those of law, on the one hand, or life, on the other. In the last two cases it has been said, for example, that law is merely the codified interest of the stronger, and that life was imposed on matter by one or more supernatural beings. Both these theories rouse considerable emotions. I do not think that the question whether milk secretion started as a source of food and drink, or of drink alone, is likely to divide people on such lines as proletarian *versus* bourgeois, extrovert *versus* introvert, or even man *versus* woman. Hence its discussion may help us to objectivity in thinking about matters where a decision between two alternatives may influence our conduct. That is to say, it may help us to be rational.

Finally, I want to urge that watching animals is not merely great fun. It is a necessity if we are to understand ourselves. One of the first to state this fact was William Blake, in *Visions of the Daughters of Albion*, etched just a hundred and seventy years ago.

With what sense is it that the chicken shuns the ravenous hawk?
With what sense does the tame pigeon measure out the expanse?

Ask the blind worm the secrets of the grave, and why her spires
Love to curl round the bones of death; and ask the ravenous snake
Where she gets poison, & the wing'd eagle why he loves the sun,
And then tell me the thoughts of man, that have been hid of old.

Blake held that the study of animal behaviour had a bearing on contemporary social problems. Later in the same poem he asked:

With what sense does the parson claim the labour of the farmer?
What are his nets & gins & traps; & how does he surround him
With cold floods of abstraction, and with forests of solitude,
To build him castles and high spires, where kings and priests may dwell?

Once you begin thinking of a parson in the same way as you think of a spider, you will at least get a novel insight, and you may get very much more. You will realize, for example, how few of your own activities are rational. One can, by the way, watch animals in central London. I have seen small birds mobbing an owl in University College, and I think a statistical aproach to the construction of spiders' webs would throw much light on human constructive behaviour.

These must be some of my excuses for contributing a scientific article to an *Annual* which is mainly concerned with cosmological and human social questions. I must thank my colleagues for allowing me to describe some of their findings, and the Bombay Natural History Society for helping me to find the accounts of earlier work.

1965

ON BEING FINITE

I HAVE reached the age of seventy-one, and been operated for a cancer near the hind end of my intestine. These events lead me to attend rather more closely than I did twenty years ago to the fact that I shall die within a few years—perhaps one year if the cancer has sent a colony of cells to another part of my body, perhaps twenty-five if it has not, and the rest of my cells behave unusually well.

Death, as something unavoidable, is probably quite a recent human discovery. Primitive men saw plenty of others die, but to judge from the bones of palaeolithic men, they very rarely saw people over the age of sixty, still less did they see deaths which could only be ascribed to old age. Almost all deaths were accidental. In a very sparse population infectious disease was probably rarer than it was in my youth in England, or is in India today. Perhaps it was as rare as in modern Britain; and when it happened was attributed to black magic.

Birds are like that today. They have a heavy death rate as eggs and nestlings. But once they can fly, as almost all can at a year old, the death rate is independent of age. For example, about two-thirds of all adult robins will be dead a year hence. So only one in two thousand or so lives to be seven years old. But if it does, it is no more likely to die in the next year than a year-old robin. Perhaps one robin in a million dies of old age—that is to say because one of its organs is worn out. If so, we have as yet no idea at what age such deaths occur.

Some animal species, on the other hand, have a much more sharply limited life span than men. For example, may-flies live for a year, almost all under water. They die within a

day of emergence from water into air. Many moths, including most whose caterpillars make silk, cannot eat or drink, and live for only a week or two after emerging from their cocoons. Probably, however, most animals, even if they die of old age when protected by men, die of 'accident', usually by being eaten, or of disease, in their normal environment.

To arrive at the notion 'I may die' requires a certain amount of social consciousness. It is one thing to see other humans die and a different one to realize that one is also human, and may die; though it must have been fairly obvious, if a tiger or a falling rock killed one's neighbour, that this could happen to oneself. Probably this was understood, at least by some people, several million years ago, long before our ancestors were recognizably men. They were presumably frightened, as we still are, by large and fierce animals not confined behind bars or a ditch, by rapidly rising floods, and so on. But if they had any language it is unlikely that it included the abstract notion of death, though it may have included words for several methods of killing and dying.

I suspect that the notion 'I must die' was a very much later development. I doubt if it could have arisen without some oral tradition about the past of one's tribe. It must have been a distressing discovery made by many different people, but not a secure part of the human tradition until language had become both fairly precise and fairly abstract. It was extremely difficult to accept, because it is unimaginable. One can imagine oneself playing a golden harp in heaven, in a fire in hell, or reborn as a cockroach, but one cannot imagine nothing. Most humans now believe, and probably most have believed for many thousands of years, in some kind of life after death.

There seems to me to be very little evidence in favour of this belief. What there is comes from one of four sources. These are revelation, memory of past lives, interviews with ghosts, and metaphysics. Various men and a few women have

so impressed their contemporaries that their statements about a future life have been widely believed. Neither Jesus nor St Paul, who are the main sources of Christian revelation, have left clear accounts of how they were informed as to the future life. Muhammad said that he repeated the words of Jibril (Gabriel). According to the Hindu epic, the Mahabharata, Krishna, a man who subsequently died, claimed explicitly to be the supreme god, and taught Arjuna accordingly. The revelations are very different. According to almost, but not quite, all Hindu teachers, and to Buddhists, Jains, and members of related religions, almost everyone will be born again; and even the wickedest, after considerable punishment, will have another chance. Christianity and Islam offer no such consolation. Unfortunately, if one of these two religions is true, adherents of the other will be tormented eternally in hell. Of course some modern Christians and Muslims try to ignore passages in their sacred books where such torment is described and promised. If the books are true, they are themselves in danger of hell fire.

Many adherents of the Indian religions have claimed to remember former lives on earth. This doctrine has the unfortunate effect that when its believers see a man or woman suffering they may say that he or she must have been very wicked in a former life to deserve such pain. Of course, every religion or philosophy which teaches that the world is administered by a just god or in accordance with a just law of *karma* leads to a similar conclusion. Fortunately there have always been enough adherents of religion with decent human feelings to prevent the full consequences of this doctrine from being worked out and the unfortunate completely neglected.

I think that were I a believer in rebirth I could have come to think that I remembered at least incidents in some past lives. In December 1916 I arrived at a camp behind the British trench line in what is now Iraq, after a night journey up the

Tigris. When I got up next morning and looked at the Persian mountain on the eastern skyline I got the feeling that they were absolutely familiar, as if I had seen them thousands of times already. This may have been a by-product of my satisfaction in rejoining old friends in the Black Watch after a voyage of two months round the Cape via Bombay. It may of course have been a memory of a past life. I doubt this; but had I been subjected to one of the Indian equivalents of hypnosis I might well have come to believe that I remembered details of a life in ancient Mesopotamia or medieval Iraq. When such alleged memories have led to the decipherment of even one previously unknown ancient language or the excavation of a previously unknown ancient site, I shall be prepared to consider them more seriously.

I do not doubt that many people have seen and heard ghosts. In some cases a number of people saw the same ghost. Similarly in 1917 a large number of people saw the sun moving about in the sky and descending towards them at Fatima in Portugal. Detailed accounts may be bought at any Catholic bookshop. In fact, however, the vast majority of the human race saw nothing. And the miracle may be described as a collective hallucination, though of course this phrase does not explain it. Some day, I hope, such facts will be explained. Ghosts are reported particularly in places where people have been murdered, or have died after doing actions of which they were grossly ashamed. The paucity of ghosts on the Western Front of the First World War raises difficulties for those who believe in their existence, for many of the millions who died there resented their deaths as bitterly as the victims of civil murder. Ghosts are said sometimes to have communicated facts such as the identity of their murders and the location of hidden treasure; and of course ghosts at spiritualistic seances often purport to give quite lengthy communications about their past lives. But even if we accept these statements as true there is no evidence that ghosts are conscious.

The dead can influence the living; for example, someone will probably read this article after my death, and may agree with some of it. But that does not prove that I shall still be conscious. I think the correct conclusion from the facts before us is to keep an open mind on hauntings, messages through mediums, and so on, but to agree with what, according to the Brihadaranyaka Upanisad, the sage Yajnavalkya said two thousand five hundred or more years ago: 'Na pretya samjh n' asti' ('There is no consciousness for a ghost').

The metaphysical argument is roughly that the human mind is of a quite different nature to material objects and, unlike them, cannot be destroyed. Bertrand Russell has pointed out that this argument, if correct, proves that the human mind or soul is not merely unbounded in time but in space. Not only have I existed for ever, and will exist for ever, but I am aware of events at any distance, however great, and can influence them. This is contrary to the facts. But some Indian philosophers have accepted it. They have been left to explain the nature of the illusion which leads me to believe that I am not an almighty and omnipresent being. I can only say that any metaphysical theories produced by, or believed by, beings subject to so vast an illusion are highly suspect.

I do not regard the statement that all men desire a longer, or even an eternal life, as an adequate argument. To begin with, it is untrue. The Indian religions are largely concerned with escape from rebirth. Even if it were true of most people, we all of us, at one time or another, desire impossible things in this present life. I have no personal desire to be born again. If I am to be replaced, I would prefer to be replaced by someone without some of my congenital deficiencies, for example tone-deafness.

I think, then, that we must, at least provisionally, accept the notion that we are finite in time as we are in space, and act on this acceptance. This means that we must be, to some extent, Epicureans, simply because Epicurus was the first man who

did his best to work out the consequences of his finitude and act on them. Of course, nobody living today can accept all Epicurus's teaching and example, for two good reasons. A great deal more is known about external nature, and at least something more about human nature, than Epicurus knew. And human society is very different from that of his time, though some people think it is becoming more like that from which he did his best to withdraw. By the way, not all professed Epicureans withdrew from public affairs. The divine Julius Caesar and his principal murderer, Caius Cassius, both belonged to this sect.

Epicurus taught that we should not be afraid of our own death, which amounts to being afraid of nothing. It is, however, rational to be afraid of the deaths of our friends, which are events of which we are aware, as our own death is not. I doubt whether we have an instinctive fear of death: but we certainly seem to have untaught fears of some ways of dying, such as falling from heights, being crushed, being eaten by large animals, and various forms of human violence. These fears cannot perhaps be abolished, but they can be overcome. One of the least plausible statements which Shakespeare attributed to Julius Caesar is:

> *Cowards die many times before their death,*
> *The valiant never taste of death but once.*

I don't think death has a taste, but its accompaniments have, and one only becomes valiant by sipping this taste, which is bitter at first, but soon becomes pleasant. If it did not, very few people would indulge in rock climbing, motor cycle racing, and similar activities. The pioneers, and a few people who make new records today, do such things to gain fame, but most people do so because they enjoy it. I am told that they have an unconscious death wish. Why not, if they do not let it dominate them? They enjoy flirting with Death, whom I picture as a woman, without intending to go all the

way, though prepared to do so when the occasion arises. I disagree equally with Swinburne's line

Some gainless glimpse of Proserpine's veiled head.

I think such glimpses are gainful. They develop the virtue of courage.

It is commonly stated by Christians that the spirit yearns for immortality. Epicurus (or whoever wrote 'The principal doctrines') thought otherwise. 'The body', he wrote, 'perceives the limits of pleasure as infinite, and infinite time is required to supply it. But the mind, after attaining a reasoned understanding of the ultimate good of the body and its limits, and after dissipating fears as to the future, supplies us with the complete life, and we have no more need of infinite time: but neither does the mind shun pleasure, nor, when circumstances begin to bring about the departure from life, does it approach its end as though it fell short in any way of the best life.'

Epicurus believed in the existence of gods. He thought that people sometimes saw them, though the world carried on without them under the influence of natural forces. I believe in them a little less than he did. I believe, with the author of the relevant passage in the Brihadaranyaka Upanisad, that they are social products, or with Lenin that they are sterile but genuine flowers on the tree of human culture. So I try to be polite to the deities of the country in which I am living, except in so far as their reported conduct, like that of Sitala the Indian smallpox goddess, who is an anti-vaccinationist, is grossly anti-social.

Epicurus taught that we should eat well, but in moderation. His teaching on sexual activity was similar. He taught that marriage and parentage should be avoided, but that friendship (the word could also be translated as mutual love) is by far the greatest good. His disciples, who included women, lived together in a garden in Athens. He believed that the

good were happier than the bad, but the virtues which he stressed were prudence, justice, and temperance rather than the intellectual or the heroic virtues. He recommended complete withdrawal from public affairs, which, in his time, when public affairs were largely wars between absolute monarchs, was sound advice.

He and his disciples were probably happy because they were busy working out a set of rather over-simplified scientific principles which can be read in Lucretius's great poem. But only a few people in any generation have ever found happiness in this way. I doubt if happiness is possible unless one works fairly hard and enjoys one's work. Aristotle taught that happiness is good activity, and in India Krishna taught that we should work for the sake of the work, not of its reward. I am in full agreement. What precisions does the acceptance of finitude bring to this notion?

The most satisfying work for most people is probably that which brings obvious and immediate benefits to a number of other people whom the worker meets personally, and for which he or she does not have to extract money or gifts from them—for example, the work of a postman, or a doctor under the National Health Service. The latter is, however, still somewhat bedevilled by the fact that, on economic grounds, he generally takes on a few more patients than the number which he could treat most efficiently. So is that of a teacher by the fact that many of his or her pupils do not want to be taught. Scientific research and artistic and literary creation, are, at best, the most satisfying of all pursuits. But scientific research is being more and more debased by team work, in which a large number of workers do what they are told to do, not what they want to do, and the results are remote. Similarly, literary and artistic work usually involves, and probably always has involved, either conformity to the tastes of the rich or powerful or a constant struggle against poverty. In the past one painted a dishonest merchant praying to his

favourite saint, or wrote an ode to an unattractive but influential duchess. Nowadays one paints designs to promote the sale of food which one would not eat, or labels the villain of one's novel a communist or capitalist according to one's geographical location.

I am not arguing that the community should keep artists to do 'art for art's sake' or scientists to do 'science for science's sake'. I argue that it should be possible for artists and scientists whose work is not paid to earn their living in other ways, and have sufficient leisure and spare money for the job which seems to them to make life worth living. During my first three years at a British university I had between twenty and thirty hours' teaching and administration per week. I did enough research in my spare time to get a job with much less teaching.

Of course, I am told that one should devote one's life to a great cause. Many of my contemporaries devoted themselves to the maintenance, and even the expansion, of the British Empire. Except for a few troubled spots like Aden, the British Empire is dead, and its servants who survive it are disillusioned old men and women. Those who worked for the World Revolution, whether primarily against capitalism or colonialism, were farther sighted, and have been more fortunate, including, in my opinion, those who died fighting. But the world revolution, like a swift stream, has its eddies, including recrudescences of various kinds of tyranny.

The trouble about great causes is that they are apt, in practice, to be great quarrels, and human beings find quarrelling enjoyable. They also give scope for power addicts, that is to say people who enjoy ordering other people about, as opposed to influencing them by example or argument. I am not happy working under a power addict, however able, efficient, and even kindly he may be. Some people are; but a power addict is a very brittle idol compared with a great cause, which may at least outlast one's life.

There is no doubt, however, that in identifying oneself with a great cause one can achieve a partial escape from that aspect of finitude called death. One can do worse than read such a book as Gordon Childe's *What Happened in History* to learn which human achievements have been relatively permanent. The most permanent have, I suppose, been advances in technology. Curiously enough, some of the ancient ones may outlast the modern. The inventors of the lamp, the loom, and the saddle would recognize the descendants of their prototypes, even if the inventor of the first lamp might find it hard to believe that the lamp in his room was lit by coal burned a hundred miles away, and the saddle of a bicycle might seem rather small. Modern inventions are shorter lived. I doubt if there will be a gramophone outside a museum a century hence. But if men survive there will be far more compact means for reproducing music and speech. Edison will not have lived in vain. If Marx was right, and I happen to agree with him, inventors are doing more for world revolution than many politicians. Changes in productive 'forces' generate a social instability which brings about change in productive relations, and hence in social structure. Those inventors who are Marxists are quite aware of this.

I venture to think that some of my scientific discoveries will outlive me, not merely for a human lifetime, but for very much longer. My reason for this belief is curious. I get credit in scientific literature for the less important of them; for example, 'The ingestion of even a quarter mol of magnesium chloride causes a marked acidosis (Haldane 1925)'. But the more important—for example, that the rate of mutation of a human gene can be measured—are taken for granted. Few geneticists, and much fewer of the people who make public pronouncements on human mutation, know that I made this discovery, much less where I published it. No greater compliment can be paid to a scientist than to take his original ideas

for granted as part of the accepted framework of science during his lifetime.

Literature and the arts are more chancy. Consider Cinna. Catullus, one of his two great contemporary Latin poets, though Catullus's poems were only preserved by a stroke of luck, wrote of him

Smyrnam incana diu saecula pervoluent.

(The hoary centuries will long unroll 'Smyrna'.) I doubt if a line of this work survives, and its author is remembered for the Fourth Citizen's maniacal exclamation 'Tear him for his bad verses', in Act III, Scene III, of *Julius Caesar*. In fact he is not all dead, for his verses almost certainly influenced later Roman poets and hence those of recent centuries throughout the world. On the other hand, Cinna's younger contemporary Horace was right when he said that he had made a monument more lasting than brass and higher than the Pyramids. So, we may safely conjecture, was Shakespeare when he wrote:

Not marble, nor the gilded monuments
Of princes, shall outlive this powerful rhyme.

But I wonder how many of Shakespeare's forgotten contemporaries thought the same. In the past, sculpture and mosaics had some chance of surviving two thousand years, paintings a much smaller one, though the murals of a few palaeolithic and Indian caves have been preserved. Music beyond a few simple traditional tunes had none at all. Nowadays the opposite is true. Paintings deteriorate, and may be burned or slashed. Sculpture will not stand up to modern weapons. But music can be recorded both as heard and in symbols. So Stravinsky and Hindemith are perhaps more likely to be directly known two thousand years hence than Picasso and Epstein.

Whether such an attitude is rational or not, there is no reasonable doubt that the prospect of death is greatly alleviated by

the beliefs that one's work will be of use or ornament after that event, and that others will carry on with it.

I should find the prospect of death annoying if I had not had a very full experience mainly stemming from my work. I missed many possibilities because I got a severe wound in my right arm in 1915. However, adapting to this wound has been an experience denied to most people. One thing which I am really sorry to have missed is walking to France on the sea bottom, which incidentally would have involved some interesting physiological research beforehand. I only got the money needed for this purpose at the age of seventy. Most of my joyful experiences have been by-products. Thus I have enjoyed the embraces of two notoriously beautiful women. In neither case was there any wooing. After knowing one another for some time we felt like that, and no words or gifts were needed. I later married a colleague. We had known one another for some years, and our love was largely based on respect for each other's work. I have tried morphine, heroin, and *bhang* and *ganja* (hemp prepared for eating and smoking). The alterations of my consciousness due to these drugs were trivial compared with those produced in the course of my work. I once dreamed that I was reading a life of Christ written and illustrated by Edward Lear. But I can only remember Pontius Pilate's moustache. If you want a dream as original as that, don't take opium, but eat sixty grams of hexahydrated strontium chloride. I have had some of the standard adventurous experiences such as being pulled out of a crevasse in a glacier, and more which are unusual. For example, I was one of the first two people to pass forty-eight hours in a miniature submarine, and one of the first few to get out of one under water. I doubt whether, given my psychological make-up, I should have found many greater thrills in a hundred lives. So when the angel with the darker drink at last shall find me by the river's brink, and offering his cup, invite my soul forth to my lips to quaff, I shall not shrink.

INDEX

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