CHAPTER VI

The Nineteenth Century

My previous lecture was occupied with the comparison of the nature-poetry of the romantic movement in England with the materialistic scientific philosophy inherited from the eighteenth century. It noted the entire disagreement of the two movements of thought. The lecture also continued the endeavour to outline an objectivist philosophy, capable of bridging the gap between science and that fundamental intuition of mankind which finds its expression in poetry and its practical exemplification in the presuppositions of daily life. As the nineteenth century passed on, the romantic movement died down. It did not die away, but it lost its clear unity of tidal stream, and dispersed itself into many estuaries as it coalesced with other human interests. The faith of the century was derived from three sources: one source was the romantic movement, showing itself in religious revival, in art, and in political aspiration: another source was the gathering advance of science which opened avenues of thought: the third source was the advance in technology which completely changed the conditions of human life.

Each of these springs of faith had its origin in the previous period. The French Revolution itself was the first child of romanticism in the form in which it tinged Rousseau. James Watt obtained his patent for his steam-engine in 1769. The scientific advance was the glory of France and of French influence, throughout the same century.

Also even during this earlier period, the streams interacted, coalesced, and antagonised each other. But it was not until the nineteenth century that the three-fold movement came to that full development and peculiar balance characteristic of the sixty years following the battle of Waterloo.

What is peculiar and new to the century, differentiating it from all its predecessors, is its technology. It was not merely the introduction of some great isolated inventions. It is impossible not to feel that something more than that was involved. For example, writing was a greater invention than the steam-engine. But in tracing the continuous history of the growth of writing we find an immense difference from that of the steam-engine. We must, of course, put aside minor and sporadic anticipations of both; and confine attention to the periods of their effective elaboration. For scale of time is so absolutely disparate. For the steam-engine, we may give about a hundred years; for writing, the time period is of the order of a thousand years. Further, when writing was finally popularised, the world was not then expecting the next step in technology. The process of change was slow, unconscious, and unexpected.

In the nineteenth century, the process became quick, conscious, and expected. The earlier half of the century was the period in which this new attitude to change was first established and enjoyed. It was a peculiar period of hope, in the sense in which, sixty or seventy years later, we can now detect a note of disillusionment, or at least of anxiety.

The greatest invention of the nineteenth century was the invention of the method of invention. A new method entered into life. In order to understand our epoch, we can neglect all the details of change, such as railways, telegraphs, radios, spinning machines, synthetic dyes. We must concentrate on the method in itself; that is the real novelty, which has broken up the foundations of the old civilisation. The prophecy of Francis Bacon has now been fulfilled; and man, who at times dreamt of himself as a little lower than the angels, has submitted to become the servant and the minister of nature. It still remains to be seen whether the same actor can play both parts.

The whole change has arisen from the new scientific information. Science, conceived not so much in its principles as in its results, is an obvious storehouse of ideas for utilisation. But, if we are to understand what happened during the century, the analogy of a mine is better than that of a storehouse. Also, it is a great mistake to think that the bare scientific idea is the required invention, so that it has only to be picked up and used. An intense period of imaginative design lies between. One element in the new method is just the discovery of how to set about bridging the gap between the scientific ideas, and the ultimate product. It is a process of disciplined attack upon one difficulty after another.

The possibilities of modern technology were first in practice realised in England, by the energy of a prosperous middle class. Accordingly, the industrial revolution started there. But the Germans explicitly realised the methods by which the deeper veins in the mine of science could be reached. They abolished haphazard methods of scholarship. In their technological schools and universities progress did not have to wait for the occasional genius, or the occasional lucky thought. Their feats of scholarship during the nineteenth century were the admiration of the world. This discipline of knowledge applies beyond technology to pure science, and beyond science to general scholarship. It represents the change from amateurs to professionals.

There have always been people who devoted their lives to definite regions of thought. In particular, lawyers and the clergy of the Christian churches form obvious examples of such specialism. But the full self-conscious realisation of the power of professionalism in knowledge in all its departments, and of the way to produce the professionals, and of the importance of knowledge to the advance of technology, and of the methods by which abstract knowledge can be connected with technology, and of the boundless possibilities of technological advance,—the realisation of all these things was first completely attained in the nineteenth century; and among the various countries, chiefly in Germany.

In the past human life was lived in a bullock cart; in the future it will be lived in an aeroplane; and the change of speed amounts to a difference in quality.

The transformation of the field of knowledge, which has been thus effected, has not been wholly a gain. At least, there are dangers implicit in it, although the increase of efficiency is undeniable. The discussion of various effects on social life arising from the new situation is reserved for my last lecture. For the present it is sufficient to note that this novel situation of disciplined progress is the setting within which the thought of the century developed.

In the period considered four great novel ideas were introduced into theoretical science. Of course, it is possible to show good cause for increasing my list far beyond the number *four*. But I am keeping to ideas which, if taken in their broadest signification, are vital to modern attempts at reconstructing the foundations of physical science.

Two of these ideas are antithetical, and I will consider them together. We are not concerned with details, but with ultimate influences on thought. One of the ideas is that of a field of physical activity pervading all space, even where there is an apparent vacuum. This notion had occurred to many people, under many forms. We remember the medieval axiom, nature abhors a vacuum. Also, Descartes' vortices at one time, in the seventeenth century, seemed as if established among scientific assumptions. Newton believed that gravitation was caused by something happening in a medium. But, on the whole, in the eighteenth century nothing was made of any of these ideas. The passage of light was explained in Newton's fashion by the flight of minute corpuscles, which of course left room for a vacuum. Mathematical physicists were far too busy deducing the consequences of the theory of gravitation to bother much about the causes; nor did they know where to look, if they had troubled themselves over the question. There were speculations, but their importance was not great. Accordingly, when the nineteenth century opened, the notion of physical occurrences pervading all space held no effective place in science. It was revived from two sources. The undulatory theory of light triumphed, thanks to Thomas Young and Fresnel. This demands that there shall be something throughout space which can undulate. Accordingly, the ether was produced, as a sort of all-pervading subtle material. Again the theory of electromagnetism finally, in Clerk Maxwell's hands, assumed a shape in which it demanded that there should be electromagnetic occurrences throughout all space. Maxwell's complete theory was not shaped until the eighteen-seventies. But it had been prepared for by many great men, Ampère, Oersted, Faraday. In accordance with the current materialistic outlook, these electromagnetic occurrences also required a material in which to happen. So again the ether was requisitioned. Then Maxwell, as the immediate first-fruits of his theory, demonstrated that the waves of light were merely waves of his electromagnetic occurrences. Accordingly, the theory of electromagnetism swallowed up the theory of light. It was a great simplification, and no one doubts its truth. But it had one unfortunate effect so far as materialism was concerned. For, whereas quite a simple sort of elastic ether sufficed for light when taken by itself, the electromagnetic ether has to be endowed with just those properties necessary for the production of the electromagnetic occurrences. In fact, it becomes a mere name for the material which is postulated to underlie these occurrences. If you do not happen to hold the metaphysical theory which makes you postulate such an ether, you can discard it. For it has no independent vitality.

Thus in the seventies of the last century, some main physical sciences were established on a basis which presupposed the idea of *continuity*. On the other hand, the idea of *atomicity* had been introduced by John Dalton, to complete Lavoisier's work on the foundation of chemistry. This is the second great notion. Ordinary matter was conceived as atomic: electromagnetic effects were conceived as arising from a continuous field.

There was no contradiction. In the first place, the notions are antithetical; but, apart from special embodiments, are not logically contradictory. Secondly, they were applied to different regions of science, one to chemistry, and the other to electromagnetism. And, as yet, there were but faint signs of coalescence between the two.

The notion of matter as atomic has a long history. Democritus and Lucretius will at once occur to your minds. In speaking of these ideas as novel, I merely mean *relatively novel*, having regard to the settlement of ideas which formed the efficient basis of science throughout the eighteenth century. In considering the history of thought, it is necessary to distinguish the real stream, determining a period, from ineffectual thoughts casually entertained. In the eighteenth century every well-educated man read Lucretius, and entertained ideas about atoms. But John Dalton made them efficient in the stream of science; and in this function of efficiency atomicity was a new idea.

The influence of atomicity was not limited to chemistry. The living cell is to biology what the electron and the proton are to physics.

Apart from cells and from aggregates of cells there are no biological phenomena. The cell theory was introduced into biology contemporaneously with, and independently of, Dalton's atomic theory. The two theories are independent exemplifications of the same idea of 'atomism.' The biological cell theory was a gradual growth, and a mere list of dates and names illustrates the fact that the biological sciences, as effective schemes of thought, are barely one hundred years old. Bichât in 1801 elaborated a tissue theory: Johannes Müller in 1835 described 'cells' and demonstrated facts concerning their nature and relations: Schleiden in 1838 and Schwann in 1839 finally established their fundamental character. Thus by 1840 both biology and chemistry were established on an atomic basis. The final triumph of atomism had to wait for the arrival of electrons at the end of the century. The importance of the imaginative background is illustrated by the fact that nearly half a century after Dalton had done his work, another chemist, Louis Pasteur, carried over these same ideas of atomicity still further into the region of biology. The cell theory and Pasteur's work were in some respects more revolutionary than that of Dalton. For they introduced the notion of *organism* into the world of minute beings. There had been a tendency to treat the atom as an ultimate entity, capable only of external relations. This attitude of mind was breaking down under the influence of Mendeleef's periodic law. But Pasteur showed the decisive importance of the idea of organism at the stage of infinitesimal magnitude. The astronomers had shown us how big is the universe. The chemists and biologists teach us how small it is. There is in modern scientific practice a famous standard of length. It is rather small: to obtain it, you must divide a centimetre into one hundred million parts, and take one of them. Pasteur's organisms are a good deal bigger than this length. In connection with atoms, we now know that there are organisms for which such distances are uncomfortably great.

The remaining pair of new ideas to be ascribed to this epoch are both of them connected with the notion of transition or change. They are the doctrine of the conservation of energy, and the doctrine of evolution.

The doctrine of energy has to do with the notion of quantitative permanence underlying change. The doctrine of evolution has to do with the emergence of novel organisms as the outcome of chance. The theory of energy lies in the province of physics. The theory of evolution lies mainly in the province of biology, although it had previously been touched upon by Kant and Laplace in connection with the formation of suns and planets.

The convergent effect of the new power for scientific advance, which resulted from these four ideas, transformed the middle period of the century into an orgy of scientific triumph. Clear-sighted men, of the sort who are so clearly wrong, now proclaimed that the secrets of the physical universe were finally disclosed. If only you ignored everything which refused to come into line, your powers of explanation were unlimited. On the other side, muddle-headed men muddled themselves into the most indefensible positions. Learned dogmatism, conjoined with ignorance of the crucial facts, suffered a heavy defeat from the scientific advocates of new ways. Thus to the excitement derived from technological revolution, there was now added the excitement arising from the vistas disclosed by scientific theory. Both the material and the spiritual bases of social life were in process of transformation. When the century entered upon its last quarter, its three sources of inspiration, the romantic, the technological, and the scientific had done their work.

Then, almost suddenly, a pause occurred; and in its last twenty years the century closed with one of the dullest stages of thought since the time of the First Crusade. It was an echo of the eighteenth century, lacking Voltaire and the reckless grace of the French aristocrats. The period was efficient, dull, and half-hearted. It celebrated the triumph of the professional man.

But looking backwards upon this time of pause, we can now discern signs of change. In the first place, the modern conditions of systematic research prevent absolute stagnation. In every branch of science, there was effective progress, indeed rapid progress, although it was confined somewhat strictly within the accepted ideas of each branch. It was an age of successful scientific orthodoxy, undisturbed by much thought beyond the conventions.

In the second place, we can now see that the adequacy of scientific materialism as a scheme of thought for the use of science was endangered. The conservation of energy provided a new type of quantitative permanence. It is true that energy could be construed as something subsidiary to matter. But, anythow, the notion of *mass* was losing its unique preëminence as being the one final permanent quantity. Later on, we find the relations of mass and energy inverted; so that mass now becomes the name for a quantity of energy considered in relation to some of its dynamical effects. This train of thought leads to the notion of energy being fundamental, thus displacing matter from that position. But energy is merely the name for the quantitative aspect of a structure of happenings; in short, it depends on the notion of the functioning of an organism. The question is, can we define an organism without recurrence to the concept of matter in simple location? We must, later on, consider this point in more detail.

The same relegation of matter to the background occurs in connection with the electromagnetic fields. The modern theory presupposes happenings in that field which are divorced from immediate dependence upon matter. It is usual to provide an ether as a substratum. But the ether does not really enter into the theory. Thus again the notion of material loses its fundamental position. Also, the atom is transforming itself into an organism; and finally the evolution theory is nothing else than the analysis of the conditions for the formation and survival of various types of organisms. In truth, one most significant fact of this later period is the advance in biological sciences. These sciences are essentially sciences concerning organisms. During the epoch in question, and indeed also at the present moment, the prestige of the more perfect scientific form belongs to the physical sciences. Accordingly, biology apes the manners of physics. It is orthodox to hold, that there is nothing in biology but what is physical mechanism under somewhat complex circumstances.

One difficulty in this position is the present confusion as to the foundational concepts of physical science. This same difficulty also attaches to the opposed doctrine of vitalism. For, in this later theory, the fact of mechanism is accepted—I mean, mechanism based upon materialism—and an additional vital control is introduced to explain the actions of living bodies. It cannot be too clearly understood that the various physical laws which appear to apply to the behaviour of atoms are not mutually consistent as at present formulated. The appeal to mechanism on behalf of biology was in its origin an appeal to the well-attested self-consistent physical concepts as expressing the basis of all natural phenomena. But at present there is no such system of concepts.

Science is taking on a new aspect which is neither purely physical, nor purely biological. It is becoming the study of organisms. Biology is the study of the larger organisms; whereas physics is the study of the smaller organisms. There is another difference between the two divisions of science. The organisms of biology include as ingredients the smaller organisms of physics; but there is at present no evidence that the smaller of the physical organisms can be analysed into component organisms. It may be so. But anyhow we are faced with the question as to whether there are not primary organisms which are incapable of further analysis. It seems very unlikely that there should be any infinite regress in nature. Accordingly, a theory of science which discards materialism must answer the question as to the character of these primary entities. There can be only one answer on this basis. We must start with the event as the ultimate unit of natural occurrence. An event has to do with all that there is, and in particular with all other events. This interfusion of events is effected by the aspects of those eternal objects, such as colours, sounds, scents, geometrical characters, which are required for nature and are not emergent from it. Such an eternal object will be an ingredient of one event under the guise, or aspect, of qualifying another event. There is a reciprocity of aspects, and there are patterns of aspects. Each event corresponds to two such patterns; namely, the pattern of aspects of other events which it grasps into its own unity, and the pattern of its aspects which other events severally grasp into their unities. Accordingly, a non-materialistic philosophy of nature will identify a primary organism as being the emergence of some particular pattern as grasped in the unity of a real event. Such a pattern will also include the aspects of the event in question as grasped in other events, whereby those other events receive a modification, or partial determination. There is thus an intrinsic and an extrinsic reality of an event, namely, the event as in its own prehension, and the event as in the prehension of other events. The concept of an organism includes, therefore, the concept of the interaction of organisms. The ordinary scientific ideas of transmission and continuity are, relatively speaking, details concerning the empirically observed characters of these patterns throughout space and time. The position here maintained is that the relationships of an event are internal, so far as concerns the event itself; that is to say, that they are constitutive of what the event is in itself.

Also in the previous lecture, we arrived at the notion that an actual event is an achievement for its own sake, a grasping of diverse entities into a value by reason of their real togetherness in that pattern, to the exclusion of other entities. It is not the mere logical togetherness of merely diverse things. For in that case, to modify Bacon's words, "all eternal objects would be alike one to another." This reality means that each intrinsic essence, that is to say, what each eternal object is in itself, becomes relevant to the one limited value emergent in the guise of the event. But values differ in importtance. Thus though each event is necessary for the community of events, the weight of its contribution is determined by something intrinsic in itself. We have now to discuss what that property is. Empirical observation shows that it is the property which we may call indifferently *retention, endurance* or *reiteration*. This property amounts to the recovery, on behalf of value amid the transitoriness of reality, of the self-identity which is also enjoyed by the primary eternal objects. The reiteration of a particular shape (or formation) of value within an event occurs when the event as a whole repeats some shape which is also exhibited by each one of a succession of its parts. Thus however you analyse the event according to the flux of its parts through time, there is the same thing-for-its-own-sake standing before you. Thus the event, in its own intrinsic reality, mirrors in itself, as derived from its own parts, aspects of the same patterned value as it realises in its complete self. It thus realises itself under the guise of an enduring individual entity, with a life history contained within itself. Furthermore, the extrinsic reality of such an event, as mirrored in other events, takes this same form of an enduring individuality; only in this case, the individuality is implanted as a reiteration of aspects of itself in the alien events composing the environment.

The total temporal duration of such an event bearing an enduring pattern, constitutes its specious present. Within this specious present the event realises itself as a totality, and also in so doing realises itself as grouping together a number of aspects of its own temporal parts. One and the same pattern is realised in the total event, and is exhibited by each of these various parts through an aspect of each part grasped into the togetherness of the total event. Also, the earlier life-history of the same pattern is exhibited by its aspects in this total event. There is, thus, in this event a memory of the antecedent life-history of its own dominant pattern, as having formed an element of value in its own antecedent environment. This concrete prehension, from within, of the life-history of an enduring fact is analysable into two abstractions, of which one is the enduring entity which has emerged as a real matter of fact to be taken account of by other things, and the other is the individualised embodiment of the underlying energy of realisation.

The consideration of the general flux of events leads to this analysis into an underlying eternal energy in whose nature there stands an envisagement of the realm of all eternal objects. Such an envisagement is the ground of the individualised thoughts which emerge as thought-aspects grasped within the life-history of the subtler and more complex enduring patterns. Also in the nature of the eternal activity there must stand an envisagement of all values to be obtained by a real togetherness of eternal objects, as envisaged in ideal situations. Such ideal situations, apart from any reality, are devoid of intrinsic value, but are valuable as elements in purpose. The individualised prehension into individual events of aspects of these ideal situations takes the form of individualised thoughts, and as such has intrinsic value. Thus value arises because there is now a real togetherness of the ideal aspects, as in thought, with the actual aspects, as in process of occurrence. Accordingly no value is to be ascribed to the underlying activity as divorced from the matter-of-fact events of the real world.

Finally, to sum up this train of thought, the underlying activity, as conceived apart from the fact of realisation, has three types of envisagement. These are: first, the envisagement of eternal objects; secondly, the envisagement of possibilities of value in respect to the synthesis of eternal objects; and lastly, the envisagement of the actual matter of fact which must enter into the total situation which is achieveable by the addition of the future. But in abstraction from actuality, the eternal activity is divorced from value. For the actuality is the value. The individual perception arising from enduring objects will vary in its individual depth and width according to the way in which the pattern dominates its own route. It may represent the faintest ripple differentiating the general substrate energy; or, in the other extreme, it may rise to conscious thought, which includes poising before self-conscious judgment the abstract possibilities of value inherent in various situations of ideal togetherness. The intermediate cases will group round the individual perception as envisaging (without self-consciousness) that one immediate possibility of attainment which represents the closest analogy to its own immediate past, having regard to the actual aspects which are there for prehension. The laws of physics represent the harmonised adjustment of development which results from this unique principle of determination. Thus dynamics is dominated by a principle of least action, whose detailed character has to be learnt from observation.

The atomic material entities which are considered in physical science are merely these individual enduring entities, conceived in abstraction from everything except what concerns their mutual interplay in determining each other's historical routes of life-history. Such entities are partially formed by the inheritance of aspects from their own past. But they are also partially formed by the aspects of other events forming their environments. The laws of physics are the laws declaring how the entities mutually react among themselves. For physics these laws are arbitrary, because that science has abstracted from what the entities are in themselves. We have seen that this fact of what the entities are in themselves is liable to modification by their environments. Accordingly, the assumption that no modification of these laws is to be looked for in environments, which have any striking difference from the environments for which the laws have been observed to hold, is very unsafe. The physical entities may be modified in very essential ways, so far as these laws are concerned. It is even possible that they may be developed into individualities of more fundamental types, with wider embodiment of envisagement. Such envisagement might reach to the attainment of the poising of alternative values with exercise of choice lying outside the physical laws, and expressible only in terms of purpose. Apart from such remote possibilities, it remains an immediate deduction that an individual entity, whose own life-history is a part within the life-history of some larger, deeper, more complete pattern, is liable to have aspects of that larger pattern dominating its own being, and to experience modifications of that larger pattern reflected in itself as modifications of its own being. This is the theory of organic mechanism.

According to this theory the evolution of laws of nature is concurrent with the evolution of enduring pattern. For the general state of the universe, as it now is, partly determines the very essences of the entities whose modes of functioning these laws express. The general principle is that in a new environment there is an evolution of the old entities into new forms.

This rapid outline of a thoroughgoing organic theory of nature enables us to understand the chief requisites of the doctrine of evolution. The main work, proceeding during this pause at the end of the nineteenth century, was the absorption of this doctrine as guiding the methodology of all branches of science. By a blindness which is almost judicial as being a penalty affixed to hasty, superficial thinking, many religious thinkers opposed the new doctrine; although, in truth, a thoroughgoing evolutionary philosophy is inconsistent with materialism. The aboriginal stuff, or material, from which a materialistic philosophy starts is incapable of evolution. This material is in itself the ultimate substance. Evolution, on the materialistic theory, is reduced to the rôle of being another word for the description of the changes of the external relations between portions of matter. There is nothing to evolve, because one set of external relations is as good as any other set of external relations. There can merely be change, purposeless and unprogressive. But the whole point of the modern doctrine is the evolution of the complex organisms from antecedent states of less complex organisms. The doctrine thus cries aloud for a conception of organism as fundamental for nature. It also requires an underlying activity—a substantial activity—expressing itself in individual embodiments, and evolving in achievements of organism. The organism is a unit of emergent value, a real fusion of the characters of eternal objects, emerging for its own sake.

Thus in the process of analysing the character of nature in itself, we find that the emergence of organisms depends on a selective activity which is akin to purpose. The point is that the enduring organisms are now the outcome of evolution; and that, beyond these organisms, there is nothing else that endures. On the materialistic theory, there is material—such as matter or electricity—which endures. On the organic theory, the only endurances are structures of activity, and the structures are evolved.

Enduring things are thus the outcome of a temporal process; whereas eternal things are the elements required for the very being of the process. We can give a precise definition of endurance in this way: Let an event *A* be pervaded by an enduring structural pattern. Then *A* can be exhaustively subdivided into a temporal succession of events. Let *B* be any part of *A*, which is obtained by picking out any one of the events belonging to a series which thus subdivides *A*. Then the enduring pattern is a pattern of aspects within the complete pattern prehended into the unity of *A*, and it is also a pattern within the complete pattern prehended into the unity of any temporal slice of *A*, such as *B*. For example, a molecule is a pattern exhibited in an event of one minute, and of any second of that minute. It is obvious that such an enduring pattern may be of more, or of less, importance. It may express some slight fact connecting the underlying activities thus individualised; or it may express some very close connection. If the pattern which endures is merely derived from the direct aspects of the external environment, mirrored in the standpoints of the various parts, then the endurance is an extrinsic fact of slight importance. But if the enduring pattern is wholly derived from the direct aspects of the various temporal sections of the event in question, then the endurance is an important intrinsic fact. It expresses a certain unity of character uniting the underlying individualised activities. There is then an enduring object with a certain unity for itself and for the rest of nature. Let us use the term physical endurance to express endurance of this type. Then physical endurance is the process of continuously inheriting a certain identity of character transmitted throughout a historical route of events. This character belongs to the whole route, and to every event of the route. This is the exact property of material. If it has existed for ten minutes, it has existed during every minute of the ten minutes, and during every second of every minute. Only if you take *material* to be fundamental, this property of endurance is an arbitrary fact at the base of the order of nature; but if you take *organism* to be fundamental, this property is the result of evolution.

It looks at first sight, as if a physical object, with its process of inheritance from itself, were independent of the environment. But such a conclusion is not justified. For let *B* and *C* be two successive slices in the life of such an object, such that *C* succeeds *B*. Then the enduring pattern in *C* is inherited from *B*, and from other analogous antecedent parts of its life. It is transmitted through *B* to *C*. But what is transmitted to *C* is the complete pattern of aspects derived from such events as *B*. These complete patterns include the influence of the environment on *B*, and on the other antecedent parts of the life of the object. Thus the complete aspects of the antecedent life are inherited as the partial pattern which endures throughout all the various periods of the life. Thus a favourable environment is essential to the maintenance of a physical object.

Nature, as we know it, comprises enormous permanences. There are the permanences of ordinary matter. The molecules within the oldest rocks known to geologists may have existed unchanged for over a thousand million years, not only unchanged in themselves, but unchanged in their relative dispositions to each other. In that length of time the number of pulsations of a molecule vibrating with the frequency of yellow sodium light would be about $16.3 \times 10^{22} = 163{,}000 \times (10^{6})^{3}$. Until recently, an atom was apparently indestructible. We know better now. But the indestructible atom has been succeeded by the apparently indestructible electron and the indestructible proton.

Another fact to be explained is the great similarity of these practically indestructible objects. All electrons are very similar to each other. We need not outrun the evidence, and say that they are identical; but our powers of observation cannot detect any differences. Analogously, all hydrogen nuclei are alike. Also we note the great numbers of these analogous objects. There are throngs of them. It seems as though a certain similarity were a favourable condition for endurance. Common sense also suggests this conclusion. If organisms are to survive, they must work together.

Accordingly, the key to the mechanism of evolution is the necessity for the evolution of a favourable environment, conjointly with the evolution of any specific type of enduring organisms of great permanence. Any physical object which by its influence deteriorates its environment, commits suicide.

One of the simplest ways of evolving a favourable environment concurrently with the development of the individual organism, is that the influence of each organism on the environment should be favourable to the *endurance* of other organisms of the same type. Further, if the organism also favours the *development* of other organisms of the same type, you have then obtained a mechanism of evolution adapted to produce the observed state of large multitudes of analogous entities, with high powers of endurance. For the environment automatically develops with the species, and the species with the environment.

The first question to ask is, whether there is any direct evidence for such a mechanism for the evolution of enduring organisms. In surveying nature, we must remember that there are not only basic organisms whose ingredients are merely aspects of eternal objects. There are also organisms of organisms. Suppose for the moment and for the sake of simplicity, we assume, without any evidence, that electrons and hydrogen nuclei are such basic organisms. Then the atoms, and the molecules, are organisms of a higher type, which also represent a compact definite organic unity. But when we come to the larger aggregations of matter, the organic unity fades into the background. It appears to be but faint and elementary. It is there; but the pattern is vague and indecisive. It is a mere aggregation of effects. When we come to living beings, the definiteness of pattern is recovered, and the organic character again rises into prominence. Accordingly, the characteristic laws of inorganic matter are mainly the statistical averages resulting from confused aggregates. So far are they from throwing light on the ultimate nature of things, that they blur and obliterate the individual characters of the individual organisms. If we wish to throw light upon the facts relating to organisms, we must study either the individual molecules and electrons, or the individual living beings. In between we find comparative confusion. Now the difficulty of studying the individual molecule is that we know so little about its life history. We cannot keep an individual under continuous observation. In general, we deal with them in large aggregates. So far as individuals are concerned, sometimes with difficulty a great experimenter throws, so to speak, a flash light on one of them, and just observes one type of instantaneous effect. Accordingly, the history of the functioning of individual molecules, or electrons, is largely hidden from us.

But in the case of living beings, we can trace the history of individuals. We now find exactly the mechanism which is here demanded. In the first place, there is the propagation of the species from members of the same species. There is also the careful provision of the favourable environment for the endurance of the family, the race, or the seed in the fruit.

It is evident, however, that I have explained the evolutionary mechanism in terms which are far too simple. We find associated species of living things, providing for each other a favourable environment. Thus just as the members of the same species mutually favour each other, so do members of associated species. We find the rudimentary fact of association in the existence of the two species, electrons and hydrogen nuclei. The simplicity of the dual association, and the apparent absence of competition from other antagonistic species accounts for the massive endurance which we find among them.

There are thus two sides to the machinery involved in the development of nature. On one side, there is a given environment with organisms adapting thmselves to it. The scientific materialism of the epoch in question emphasised this aspect. From this point of view, there is a given amount of material, and only a limited number of organisms can take advantage of it. The givenness of the environment dominates everything. Accordingly, the last words of science appeared to be the Struggle for Existence, and Natural Selection. Darwin's own writings are for all time a model of refusal to go beyond the direct evidence, and of careful retention of every possible hypothesis. But those virtues were not so conspicuous in his followers, and still less in his camp-followers. The imagination of European sociologists and publicists was stained by exclusive attention to this aspect of conflicting interests. The idea prevailed that there was a peculiar strong-minded realism in discarding ethical considerations in the determination of the conduct of commercial and national interests.

The other side of the evolutionary machinery, the neglected side, is expressed by the word *creativeness*. The organisms can create their own environment. For this purpose, the single organism is almost helpless. The adequate forces require societies of coöperating organisms. But with such coöperation and in proportion to the effort put forward, the environment has a plasticity which alters the whole ethical aspect of evolution.

In the immediate past, and at present, a muddled state of mind is prevalent. The increased plasticity of the environment for mankind, resulting from the advances in sicentific technology, is being construed in terms of habits of thought which find their justification in the theory of a fixed environment.

The riddle of the universe is not so simple. There is the aspect of permanence in which a given type of attainment is endlessly repeated for its own sake; and there is the aspect of transition to other things —it may be of higher worth, and it may be of lower worth. Also there are its aspects of struggle and of friendly help. But romantic ruthlessness is no nearer to real politics, than is romantic self-abnegation.