FOR PRIVATE CIRCULATION ONLY

The Emergence of Man

by Michael Polanyi

(As delivered on March 2, 1964 at Duke University)

At the end of my first lecture I said that the Copernican revolution, completed by Newton, has placed on the same level the ultimate components of all things, including those of man and of the thoughts of man. Everything in the world would be explicable then by the laws governing these uniform ultimate components. No additional higher principle would be at work in them; there would, in fact, be only one level of existence in the world. But I opposed this world view and promised that once we credit ourselves with genuine powers of integration, we shall see the structure of our comprehension re-appear in the structure of that which we comprehend. We shall be able to uphold the existence of genuinely higher entities, not altogether determined by the laws to which their ultimate components are subject.

*

I have shown how we participate in the world by understanding it. We know all the complex things we see around us, whether inanimate or living, dumb or intelligent, by relying on our awareness of their parts for attending to them as wholes, and this process is logically equivalent to using their parts as we use our own body for attending to things outside it. Thus we form an interpreted universe populated by entities, the particulars of which we have interiorised for the sake of comprehending their meaning in the shape of coherent entities.

Consider now the situation when <u>two</u> persons share the knowledge of the same comprehensive entity--of an entity which one of them

produces and the other apprehends. Such is the case when one person has made a communication and the other has received it. But the characteristic features of the situation are seen more clearly if we consider the way one man gets to understand a skilful performance of another man. He must try mentally to combine the movements of the performer to the same pattern to which the performer combines them practically. Two kinds of indwelling meet here. The performer coordinates his moves by dwelling in them as parts of his body, while the person who watches him tries to correlate these moves by seeking to dwell in them from outside. He dwells in these moves by interiorising them. By such exploratory indwelling the pupil gets the feel of a master's skill and may learn to rival him.

Nor is this structural kinship between subject and object, and the indwelling of one in the other, present only in the study of a bodily performance. Chess players enter into a master's spirit by rehearsing the games he played, to discover what he had in mind.

When entering and dwelling in comprehensive entities of this kind, we meet something that accounts for the coherence of the entity. In one case we meet a person skilfully using his body and, in the other, a person cleverly using his mind.

The recognition of a person in the performance of a skill or in the conduct of a game of chess is intrinsic to the understanding of these achievements. We must surmise that we are faced with some coordinated performance, before we can even try to understand it, and must go on to pick out the features that are essential to the performance, with a view to the action felt to be at work in it. Hence, the question, much discussed by philosophers, how we

can infer--explicitly infer--the existence of other minds, from observing their external workings, does not arise, for we never do observe these workings in themselves. Indeed, many of them we could not identify, even after we have successfully integrated them to our knowledge of a personal performance, any more than its performer could tell us, except quite vaguely, what the particulars are that his performance coordinates.

This is not to say that we gain an understanding of the mind without a process of enquiry. But the enquiry consists, like a scientific enquiry, in picking out clues as such, that is, with a presumed bearing on the presence of something they appear to indicate. And as in a scientific enquiry, many of the clues used will remain unidentifiable and may indeed be subliminal. Such is the effort by which we enter into the intimate structure of a skill or of a game of chess and get to know the powers of the person behind it. The method by which a historian explores a historic personality, is an expansion of this way of knowing.

The structural kinship between knowing a mind and pursuing a scientific enquiry throws light on some further points obscured by the false assumption that we start acquiring the knowledge of a mind by observing the workings of the mind in themselves. It tells us that the mind is unsubstantial only in the sense in which a good problem is unsubstantial. Indeed, a great mind is an inexhaustible and rewarding problem to the historian and literary scholar, and every human person is of infinite concern to one who cares for him. But neither problems nor minds should on this account be set far apart from other things. For an inanimate solid object, too, is

known by understanding its particulars, from which we attend to it as an object.

This brings up a question similar to that I have just spoken of in respect of our knowledge of other minds. The question is now how we infer the existence of a permanent object, from observing its sensible qualities. Analytic philosophers would dispose of this problem by denying that we ever see anything but objects. But this is not true. We do see the several parts of a camouflaged object as mere patches, and can break down this deception then by an effort to see these fragments meaningfully as an object. These philosophers are right in pointing out that no process of explicit inference takes place either in getting to know a mind, or in seeing a cobblestone, and that it is fruitless, therefore, to enquire in the way such an inference is conducted; they overlook the fact that we do get to know solid objects only by a tacit integration of their parts, which may require a difficult intellectual effort.

The examples which I have quoted point at a new aspect of this problem of philosophy. The structural kinship between knowing a person and discovering a problem, and the alignment of both with our knowing of a cobblestone, call attention to the greater depth of a person and a problem, as compared with the lesser profundity of a cobblestone. Persons and problems are felt to be more profound, because we expect them to reveal themselves more richly and unexpectedly in the future. Since I have attributed the capacity of things to reveal themselves inexhaustibly in the future, to the fact that they are an aspect of reality, I shall say that minds and problems possess a deeper reality than cobblestones, even though

cobblestones are more tangible. And since the significance of a thing is more important than its tangibility, I shall say that minds and problems are more real than cobblestones.

With this settled, we can say now also that man's skilful exercise of his body is a real entity that another person can know, and know only, by comprehending it, and that the comprehension of this real entity has the same structure as the entity which is its object. And we may likewise say--to drive the point home--that the skilful conduct of a game of chess by another person is a real entity, knowable by our tacit comprehension of it, and that this comprehension is similar in structure to that which it comprehends.

You may feel that I have been slow in drawing this conclusion. But I had to make quite sure of it, for it carries far-reaching implications. I said in my second lecture that the question, what it is that we know by understanding a comprehensive entity, makes an ontological reference to it. We have now given a more definite content to this ontology. We have shown that the kind of comprehensive entities exemplified by skilful human performances are real things; as real as cobblestones and, in view of their far greater independence and power, much more real than cobblestones. It seems plausible then to generalise to all other instances of tacit knowing that the structure of comprehension re-appears in the structure of that which it comprehends and to go further and expect to find the structure of tacit knowing duplicated in the principles which account for the stability and effectiveness of all real comprehensive entities. I shall show now that this is in fact the case.

Tacit knowing can be destroyed by switching our attention from

its comprehensive distal term, back to its proximal terms. Language offers a good example. Language has a meaning only when we tacitly rely on it for attending to that which it means. Switch your attention back on a word you have spoken; repeat it several times, attending carefully to the motion of your tongue and lips, and soon it will sound hollow and lose its meaning. The same is true of a skilful performance. By concentrating attention on his fingers, a pianist can paralyse himself; the motions of his fingers, having lost their meaning, no longer bear on that which they had meant, which was the music performed by them.

This destruction of tacit knowing is reversible. The word uttered again in its proper context; the pianist's fingers used again with his mind on the music; they come to life and recover their meaning within their once more comprehended relationship.

We can anticipate then the ontological characteristics of a comprehensive entity on the following lines.

1) Tacit knowing relies on our awareness of the particulars of an entity for attending to it.
2) If we switch our attention to the particulars, this function of the particulars is cancelled and we lose sight of the entity to which we had attended.

The ontological counterpart of this would be

1) The principles controlling a comprehensive entity would be found to rely for their operations on laws governing their particulars in themselves.
2) At the same time the laws governing the particulars in themselves would never account for the organising principles of a higher entity which they form.

Take our knowledge of a game of chess and the game itself. The playing of a game of chess is an entity controlled by principles which <u>rely</u> on the observance of the rules of chess; but the principles controlling the <u>game</u> cannot be derived from the rules of chess.

The two terms of tacit knowing, the proximal, which includes the particulars and the distal, which is their comprehensive meaning, would be seen then as two levels of reality, controlled by distinctive principles, so that the upper one relies for its operations on the laws governing the elements of the lower one in themselves; but that the operations of the higher level are not accountable by the laws of the lower level. In this sense, a logical relation holds between two such levels, a logical relation that corresponds to the fact that the two levels are the two terms of a tacit knowing, which jointly apprehends them.

I have spoken before of the way we interiorise bits of the universe, and thus populate it with comprehensive entities. The program which I have set out now would change this panorama into a picture of the universe filled with strata of realities, joined logically together in pairs of a higher and a lower one.

I could exemplify this by analysing in these terms the various cases of tacit knowing that I have spoken of before, but this would bring tedious repetitions. I shall rather give some new examples, which will take us a step further, by showing pairs of levels which tend to link up into a series forming a hierarchy.

Take the art of making bricks. It relies on its raw materials placed on a level below it. But above the brick-maker there operates the architect, relying on the brickmaker's work, and the architect in his turn has to serve the town-planner. To these four successive levels there correspond four successive sets of rules that govern them. The laws of physics and chemistry govern the raw materials of brick-making; technology prescribes the art of brick-

making; architecture teaches the builders and the rules of town planning control the town planners.

My next example, which is the uttering of a set speech, will prove more suited for the detailed examination of a hierarchic structure. It includes five levels; namely the production 1) of voice, 2) of words, 3) of sentences, 4) of style, and 5) of literary composition. Each of these levels is subject to its own laws: 1) of phonetics, 2) of lexicrography, 3) of grammar, 4) of stylistics, and 5) of literary criticism. The principles of each level operate under the control of the next higher level. The voice you produce is shaped into words by a vocabulary; a given vocabulary is shaped into sentences in accordance with grammar; and the sentences can be made to fit into a style, which in its turn is made to convey the ideas of a literary composition. Thus, each level is subject to dual control; first, by the laws that apply to its elements in themselves and, second, by the laws that control the comprehensive entity formed by them. Such is the structure of a hierarchy of comprehensive entities.

In such a hierarchy, the operations of a higher level cannot be accounted for by the laws governing its particulars forming the lower level. You cannot derive a vocabulary from phonetics; you cannot derive the grammar of a language from its vocabulary; a correct use of grammar does not account for good style; and a good style does not provide the content of a piece of prose. We find confirmed then throughout such a hierarchy what I said when I identified the two terms of tacit knowing with two joint levels of reality. It is impossible to represent the principles operating

on a higher level by the laws governing its isolated particulars.

This may seem too obvious to merit such emphasis, but it will prove highly controversial, when I pass from hierarchies of human skills to the hierarchy of levels found in living beings. The sequence of these levels is built up by the rise of higher forms of life from lower ones. We can see all the levels of evolution at a glance in an individual human being. The most primitive form of life is represented by the growth of the typical human shape, through the process of morphogenesis, studied by embryology. Next we have the vegetative functioning of the organism, studied by physiology; and above it there is sentience, rising to perception and to a centrally controlled motoric activity, both of which still belong to physiology. We rise beyond this at the level of conscious behaviour and intellectual action, studied by ethology and psychology; and, uppermost, we meet with man's moral sense, guided by the firmament of his moral standards.

I shall set aside, for the moment, the question, how far these consecutive levels form a hierarchy in our sense, and concentrate on the fact that all these levels are situated above that of the inanimate, and that hence they all rely for their operations--directly or indirectly--on the laws of physics and chemistry that govern the inanimate. If we apply then the principle, that the operations of a higher level can never be derived from the laws governing its isolated particulars, it follows that none of these biotic operations can be accounted for by the laws of physics and chemistry.

Yet it is today taken for granted among biologists that all manifestations of life can ultimately be explained from the laws

governing inanimate matter. K. S. Lashley declared this at the Hixon Symposium of 1948, as the common belief of all the participants, without even consulting his distinguished colleagues. It was taken for granted. Yet this is patent nonsense. The most striking feature of our own lives is our sentience. The laws of physics and chemistry include no conception of sentience, and any system wholly determined by these laws, must be insentient. It may be in the interest of science to turn a blind eye on this central fact of the universe (I shall yet come to this), but it is certainly not in the interest of truth. I shall prefer to follow up, on the contrary, the fact, that the study of life must ultimately reveal some principles additional to those manifested by inanimate matter, and to prefigure the general outline of such, yet unknown, principles.

I shall start by a scrutiny of the prevailing procedure of modern biologists. While the declared aim of current biology is to explain all the phenomena of life by the laws of physics and chemistry, its actual practice is to attempt an explanation in terms of a machinery, based on the laws of physics and chemistry. Biologists think that the substitution of this task for their declared aim is justified, for they assume that a machine based on the laws of physics is explicable by the laws of physics. My first point is that biologists are mistaken in assuming this.

Some authors have pointed out that machines have a purposive character which cannot be derived from the laws of physics and chemistry. This is true. But, to obtain the actual relationship between the principles of a machine and the laws governing its

parts, we must consider the nature of a machine as a comprehensive entity. This will serve also to consolidate and deepen our conception of the logical structure governing such entities, for in this case it is possible to define with a fair degree of precision the relation by which the parts are integrated to the entity they form. I have presented this analysis often elsewhere, and shall therefore state only its main points here.

Machines are defined by their operational principles, which tell us how the machine works. These operational principles describe the parts composing the machine, and define their several functions, by showing how they are made jointly to achieve the purpose which the machine is to serve. The machine relies for its functions on certain physical and chemical properties of its parts and on certain physical-chemical processes involved in their joint operation. But little more may be required in this respect, than that the machine be solid and its material subject to the laws of mechanics.

Hence, engineering and physics are two different sciences. Engineering includes the operational principles of machines, and such knowledge of physics as bears on its operation. On the other hand, physics and chemistry include no knowledge of the operational principles of machines and hence a complete physical and chemical topography of a machine would not tell us whether it <u>is</u> a machine, and if so, how it works, and for what purpose. Physical and chemical investigations of a machine are in fact meaningless, unless undertaken with a bearing on the previously established operational principles of the machine.

But there is an important feature of machines, which its operational principles do not reveal: they never account for the failure and ultimate breakdown of machines. And here physics and chemistry effectively come in. Only the physical-chemical structure of a machine can explain its failures. Liability to failure is, as it were, the price paid for embodying operational principles in a material subject to laws which ignore these principles. The material in its blindness will eventually go its own ways and break the framework of intelligent design that forms it into a machine.

We may ask how a machine which, as an inanimate body, obeys the laws of physics and chemistry, can fail to be determined by these laws? How can it follow both the laws of nature and its operational principles as a machine? How does the shaping of inanimate matter in a machine make it capable of success or failure?

The answer lies in the word: shaping. Natural laws may mould inanimate matter into distinctive shapes, such as the spheres of the sun and the moon and into such patterns as that of the solar system. Other shapes are imposed on matter artificially, and yet without infringing the laws of physics and chemistry. The operational principles of machines are embodied in matter by such artificial shaping. These principles may be said to govern the borderline conditions of an inanimate system: the conditions that are explicitly left undetermined by the laws of physics and chemistry. Engineering provides a determination of such borderline conditions. And this is how an inanimate system can be subject to a dual control on two levels: the operations of the upper level are artificially embodied in the lower level which is relied on to obey the laws of

inanimate nature, i.e., physics and chemistry.

I shall call the control exercised by the organisational principle of a higher level on its particulars forming its lower level, the principle of marginal control.

This marginal principle could be recognised already in the way I described some hierarchies of human performances. You can see, for example, how, in the hierarchy constituting speechmaking, successive working principles control the borderline left indeterminate on the next lower level. Voice production, which is the lowest level of speech, leaves largely open the combination of sounds to words, which is controlled by a vocabulary. Next, a vocabulary leaves largely open the combination of words to form sentences, which is controlled by grammar. And so it goes on. Each lower level imposes restrictions on the one above it, even as the laws of inanimate nature restrict the practicability of conceivable machines. And again, as in machines, we may observe that a higher operation may fail, when the next lower operations escape its control.

In a broad way we can see this principle of marginal control operating also in the hierarchy of biotic levels. The vegetative system, sustaining life at rest, leaves open the possibilities of bodily motion by muscular action, and the principles of muscular action leave open their integration to innate patterns of behaviour. Such patterns are open, in their turn, to be shaped by intelligence, the working of which offers, once again, wide-ranging possibilities for the exercise of still higher principles in man's responsible choices.

These illustrations of the principle of marginal control should make it clear that it is equally present in artefacts, like machines; in human performances, like speech; and in living functions at all levels. It underlies the functions of all comprehensive entities having a fixed structure. We may confidently rely, therefore, on our analysis of machines, to declare that the predominant view of biologists, that a mechanical explanation of living functions amounts to their explanation in terms of physics and chemistry, is false. Moreover, the conclusion that machines are defined by the fact that borderline conditions, expressly left open by physics and chemistry, are fixed according to principles foreign to physics and chemistry, makes it clear that what remains inexplicable by physics and chemistry in a mechanically functioning part of life are its characteristic borderline conditions.

This is not to deny that there is a great deal of truth in the mechanical explanation of life. The organs of the body work much like machines, and they are subject to a hierarchy of controls, exercised by an ascending series of mechanical principles. Biologists, pursuing the aim of explaining living functions in terms of machines have achieved astounding success. But this must not obscure the fact, that these advances only add to the features of life which cannot be represented in terms of laws noticeably manifested in the realm of inanimate nature.

There is an important minority of biologists, who deny the possibility of representing all living functions by mechanisms of the kind known to engineering and technology. The non-machine-like processes of life which they postulate, they call <u>organismic</u>. Such

organismic processes are found at work in regeneration, and are most strikingly demonstrated by the embryonic regeneration of the sea urchin discovered by Hans Driesch. Driesch found that throughout the gastrula stage any cell or combination of cells detached from the embryo will develop into a normal sea urchin. He described an embryo having such regenerative powers as a 'harmonious equipotential' system. Such regeneration of the embryo from a fragment is known also as 'morphogenetic regulation'.

In the process of embryonic development, we find a progressive limitation of equipotentiality due to the fixation of the prospects of the several areas of the embryo. This lends the embryo a mosaic character. Two principles are henceforth combined in the development of the embryo. 1) Its division into a mosaic of areas having a fixed determination lends it a machine-like structure. 2) The regulative powers which mutually adjust the several areas of fixed potentiality and which preserve equipotentiality within each area, represent, on the other hand, an organismic principle. As maturation progresses, it leads to increasingly differentiated mechanical structures, and in each of these the scope of regulation is correspondingly reduced. Biologists who acknowledge a basic distinction between mechanismic and organismic processes, consider living functions to be determined at all stages by a combination of mechanism and organismic regulation.

Gestalt psychologists have often suggested that the processes of regulation are akin to the shaping of perception, but their insistence that both perceptual shaping and biological regulation are but the result of physical equilibriation, brought this suggestion

to a dead end. I agree with gestalt psychologists that the regulative powers of living beings and their mental powers of comprehension are akin to each other, but I believe that they both embody principles that are not noticeable in the realm of inanimate nature.

As the organismic processes observed by biologists bring about the emergence of novel structures operated by principles not present before, I shall identify first the occasions on which such emergence takes place, and identify morphegenetic regulation among them.

Inanimate nature is self contained, achieving nothing, relying on nothing and hence, unerring. This fact defines the innovation achieved by the emergence of life from the inanimate. All living things function, and a function necessarily has a result which it may achieve or fail to achieve. Thus processes that are expected to achieve something have a value and such value is inexplicable in terms of processes having no value. The logical impossibility of such an explanation may be affiliated to Hume's dictum that nothing that <u>ought</u> to be, can be determined by knowing what <u>is</u>. We may conclude that a principle not noticeably present in the inanimate must come into operation when the inanimate brings forth living things.

But the hierarchic structure of the higher forms of life necessitates the assumption of further processes of emergence. If each higher level is to control the borderline left open by the operations of the next lower level, this implies that these borderline conditions are in fact left open by the operations going on at the lower level. In other words, no level can gain control over its own borderline conditions and hence cannot bring into existence a higher

level, the operations of which consist precisely in controlling these borderline conditions. The logical structure of the hierarchy implies that a higher level can come into existence only by a process not manifest in the lower level, a process which thus qualifies as an emergence.

Our understanding of this relationship can be deepened by considering its mental counterpart. To the combination of organismic and mechanical principles there corresponds in the mental field the combination of tacit comprehension with a set of fixed logical operations. A child starts off with a scanty repertoire of innate mental connections and enriches them rapidly by using his powers of comprehension for establishing further fixed relations of experience. Piaget has described how a child's powers of reasoning are improved by developing increasingly stable rules of logical procedure. This development is stimulated by the interiorisation of language and of its verbal culture. In this process the growing mind re-creates for itself the conceptual framework and the rules of reasoning bequeathed to it by its culture. Each of these fixations reduces the conceivable range of creative innovations, but at the same time increases their power, by placing new tools at their disposal. This works like the anatomical differentiation of a developing organism, which narrows down its areas of equipotentiality, while offering in exchange the use of a more powerful biotic machinery.

We must have then two kinds of principles present in living beings that are not observable in inanimate nature. We have the principles currently running the hierarchic machinery of life, by controlling the margin left open by a principle below them, and

controlling ultimately the margin of physics and chemistry. And we must have a principle that supplies the innovating power for bringing these controlling principles into existence. They must be present in the growth of the germ cell into a mature organism, where they are recognised here as morphogenetic regulation, and they must be present also in the process of organic evolution by which higher forms of life have been brought forth from specks of protoplasm, as they were present before, in the event, which first brought life into existence.

Having drawn an analogy, amounting to kinship, between embryonic maturation and the intellectual development of the child, I clearly intend to claim now a kinship between the innovating powers of evolution and the powers of discovery in science and technology. I shall indeed do so, as Henri Bergson has done before. I had this in mind already in my last lecture, when I spoke of supreme originality in science as a self transformation, achieving new levels of existence. By this definition, originality coincides with emergence, as I defined it today.

In order to re-consider the process of organic evolution in this sense, we must start by restoring the problem from its misrepresentation by the current theory of evolution. In my view, which I shall vindicate as I go along, the principal problem of evolution lies in the rise of higher beings from lower ones and, principally, in the rise of man. A theory which recognises only evolutionary changes due to the selective advantage of random mutations cannot acknowledge this problem. For the capacity to survive is no criterion of evolutionary achievement in my sense. There exist today

animals and plants on every evolutionary level. The lower species have of course survived up to date much longer than the higher ones and so their proven powers of survival are the greater. But even if it could be shown that, for some reason, life at a higher level succeeds better in surviving than at a lower level, this would not explain how higher forms of life have come into existence, any more than the fact that living things emerging from the inanimate have continued to live, explains the origin of life. The current theory of evolution could explain as easily--indeed more easily--the descent of the amoeba from man, as the actual rise of man from creatures like the amoeba. Hence it is not dealing with evolution at all. It is the height of intellectual perversion to renounce, in the name of scientific objectivity, our position as the highest form of life, which makes our own advent here by a process of evolution the central problem of evolution.

The representation of evolution, as due to differential selective advantage, has been assisted by shifting attention from evolution to the origin of species. A preoccupation with the way populations of a new kind come into existence has made us lose sight of the more fundamental question, how any single individual of a higher species ever came into existence. I shall bring this problem into focus by surveying the historical antecedents of any single individual of a higher form.

The origins of one man can be envisaged by tracing the man's family tree all the way back to the primeval specks of protoplasm in which his first origins have lain. The history of this family tree includes everything that has contributed to the making of this

human being. This segment of evolution is precisely on a par with the history of a fertilized egg developing into a mature man, or the history of a single plant growing from seed, which includes everything that caused that man, or that plant, to come into existence. Natural selection plays no part in the evolution of a single human being. We do not include in the mechanism of growth the possible adversities which did not befall it and hence did not prevent it. The same holds for the evolution of a single human being; nothing is gained for understanding this evolution, by considering the adverse chances which might have prevented it.

The distinction between the origin of species and the evolutionary origin of a single individual, is logically sharp. To represent changes in population as equivalent to the coming into existence of their members, is like saying that you catch a tiger by catching two and letting one go. It might help to keep the two conceptions apart if we coin a new name for the process by which we may call it an ideogenesis as distinct from a phylogenesis.

The study of ideogenesis does not disregard the occurrence of accidental mutations which may prove adaptive. It merely assumes that these can be distinguished from changes of type achieving new levels of existence. Most palaeozoists would agree that, though this distinction is often difficult, it is none the less valid. And once this obvious distinction is allowed for, the thrust of evolutionary rise is as clearly manifest, as the growth of an individual from a germ cell.

It is widely accepted today that philosophy must leave the study of nature strictly to science. I must explain why I am offend-

ing against this injunction. I am doing this simply in the interest of truth, and I expect that scientists will see my point. For I do not think that they believe that what they say in these matters is true. For example, when the great Lashley (1948) made the absurd statement that all mental processes must be ultimately explained by physics and chemistry, his purpose was merely to exclude any suggestions that we should explain mental processes by an infringement of the laws of inanimate matter in the nervous system. Other such statements, even more obviously absurd, made by O. Hebb, (1954) clearly show this pragmatic intention. Since he surely did not want neurophysiologists to assume that all their subjects are unconscious, he can have meant this admonition only as a guide to the theoretical interpretation of neurological findings. This is apparent from an account of the situation given by the psychiatrist L. S. Kubie on the very occasion when Hebb spoke in the terms I have quoted. Kubie said he regarded consciousness as an indispensable 'working concept' for psychology and went on to say "Sometimes we are explicit and frank about this. Sometimes we fool ourselves about it. Many workers have attempted to avoid using the word because of its traditional connotations . . . ".

The practice of such deliberate ambiguities is freely admitted in biology. Everyone knows that you cannot enquire into the functions of living organisms without referring to the purpose served by them and by the organs and processes that belong to them. Yet we must pretend that all such teleological explanations are merely provisional. The story goes round among biologists everywhere that teleology is a woman of easy virtue, whom the biologist disowns in

public, but lives with in private.

The steady rise of higher organisms from lower ones, from which this digression started, is also a case in point. In an article on Teilhard de Chardin P. B. Medawar reproved him for suggesting that "evolution has a main track and privileged axis", yet in the same article Medawar offers his own explanation for this very fact.

Scientists may be right in recommending, and indeed enforcing, certain basic assumptions that are obviously false. The assumption that man is an insentient automation, which no one can believe to be true, has kept neurophysiology on the track of many beautiful discoveries, which perhaps could not have been made otherwise. But these technical fictions are not binding on the outsider. However widely the working assumptions of science may lead to ever new discoveries, we must not allow them to falsify the image of man and the universe and depriving it of all meaning.

And if science, for very good reasons, cannot undertake the task of giving us a reasonable view of the universe, we must take the matter into our own hands, in which scientists should help us, as ordinary people, outside the laboratory. Ordinary people have anticipated in many fundamental respects the knowledge on which biology is based. Animals and plants were recognised before zoology and botany; health and sickness before pathology; the contrast between sentience and insentience, between intelligence and its absence, were known before they were studied by science. These were common knowledge, and so were many details of living functions, like hunger for food, need for breath, the processes of digestion, elimination and secretion, the functions of our senses, the process of procrea-

tion, of embryological development, of growth and maturation, of senescence. One could go on without end enumerating the subjects which biologists took over from popular knowledge.

I want us, ordinary men, to exercise once more our basic interpretative powers, for establishing a basic understanding of the evolution by which man has come into existence.

The principle we must apply is the same as that by which we see the fingers of our hand and by which Copernicus saw the earth circling the sun. It is the principle underlying the mental life of both animals and men, which tells us that things that hang together are real and significant and that all such coherence presents a problem, for what hangs together in one way is likely to hang together also in other ways, yet to be discovered in the future.

The rise of man, of any single human being from inanimate beginnings is such a massively coherent fact, unrivalled in the number and distinctiveness of the relations composing it. To see this image, free of the false clues of selectionism, is to recognise that we are facing a constructive power of the universe that has culminated, so far, in bringing ourselves into existence.

The Copernican image of celestial motions evoked the theory of universal gravitation which accounted for the central position of the sun. Evolution, conceived as ideogenesis, recognises man as the peak of creation, as the Bible had done in the language of religion. Of the universal principles under which this achievement has taken place, we can discern some already in outline.

One is the stratified structure of living things, which makes ideogenesis a process of radical innovation; another is the principle

which identifies the emergence of new levels of existence with the heuristic powers of tacit knowing. A further principle, which will link emergence with the responsible choices made in an act of creative thought, will be outlined in my next lecture.

I have not hesitated to value the more comprehensive levels of life as the higher forms of existence, for the absence of value judgments in science is but a pretence, which, if followed strictly, would render biology blind not only to evolution, but to life itself. For the value of life comes into existence with life itself.

But while there is a gradual intensification of value throughout the evolution of man, the emergence of these values is accompanied at every step by an additional liability to miscarry. The capacity for growth, by which living things acquire their typical shapes, may produce malformations; physiological functions are subject to disabling and eventually mortal diseases; perception, drive satisfaction, and learning, bring with them new failings by falling into error; and finally, man is found not only liable to a far greater range of errors than animals are, but by virtue of his moral sense, becomes capable also of evil.

This parallel development of capabilities and liabilities is accompanied by a consolidation of the center to which these are attributable. Life exists predominantly in the form of individuals. But at the vegetative level, as we have in plants, individuality is still weak. The center of the individual becomes more pronounced with the rise of animal activities, and it grows more marked still in the exercise of intelligence. It rises to the level of personhood in man. And again, every additional function with which the

center is credited, exposes it to new reproaches, in respect of new failures.

Thus, each new branch of biology that was developed to cover the increasingly complex function of higher animals sets up additional standards, to which the observer expects the animal to come up. And this intensification of criticism coincides with an increasing enrichment of relations between the critic and his object. We know an animal, as we know a person, by entering into its performance and we appreciate it as an individual, in the interests of which these performances have their meaning. Even at the lowest, purely vegetative, level, we accept the interests of the animal as the standard by which our own interest in the animal is justified. All biology is, in this sense, convivial. But this conviviality rises to emotional concern as the animal approaches the human level. We then become aware of its sentience, of its intelligence, and above all of its emotional relations to ourselves.

Yet, however greatly we may love an animal, there is a feeling, which no animal can deserve, yet is commonly given to our fellowmen. I have said that at the highest level of manhood, we meet man's moral sense, guided by the firmament of his standards. Even when this appears absent, its mere possibility is sufficient to evoke our respect.

We have here a fact that casts a new major task on the process of evolution; a task which appears the more formidable as we realise that both this moral sense and our respect for it, presuppose an obedience to commands accepted in defiance to the immemorial scheme of self-preservation, dominating the evolutionary process up to this point.

Yet evolution must make sense also of this afterthought to five hundred million years of pure self-seeking. And in a way this problem can be put in biological terms. For this potentiality for obedience to higher demands is largely involved in man's capacity for another peculiarly human relation to other men, namely, the capacity to feel reverence for men greater than himself. If evolution is to include the rise of man, with all his sense of higher obligations, it must include also the rise of human greatness.

In my last lecture I shall expand the panorama of a universe that I have sketched out so far, to include man's cultural equipment and this should offer us a framework within which we can define responsible human action, of which man's moral decisions form but a particular instance.