Pierre Auger

TOWARDS A MODERN ANTHROPOCENTRISM

Anthropocentrism was born with Man, and certain primitive tribes or ethnic groups considered themselves the center of the world. Their members assumed the generic name "the Men," and all the rest, including other tribes or ethnic groups, were part of a more or less hostile environment (to use the modern term).

The concept of the unity of the human species later led to a more general anthropocentrism in which the creation of the universe was believed to be directly related to the human race, if not indeed at its service. Ideological traditions codified this point of view, restricting its application to a single chosen people or extending it to all men, who in one form or another were considered as issuing from a divinity. Here we undoubtedly see the origin of the violent and obstinate resistance which was—and at times still is—opposed to Darwin's theory of evolution and its exasperated condemnation when it claimed to include man. We must keep in mind, however, that the rather simplistic formula stating that man descended from the

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monkey has in our day been replaced by the hypothesis that man and monkey have a common ancestor.

No doubt this anthropocentrism can be connected in some "natural" way to behavior found in all animals. In fact, the immediate actions of any living creature are directed toward its own survival, and although these actions have a purely physiological origin in the lower orders of animals, in the higher orders are added more elaborate instinctive reactions involving the central nervous system. Moreover, from the earliest stages of evolution other actions—always of a genetic type—working together for the continued existence of the species have been added to those of "individual interest," especially in reproduction and assistance to offspring. In addition, the survival of individuals among the social animals completes itself in the survival of the group which they compose: the anthill, the beehive, human tribes and societies. We may therefore say that three "centrisms" explaining individual action exist in animals: egocentrism, speciocentrism and sociocentrism.

In the case of man: here again, is it the justification of the survival of the species asserting itself through speciocentrism as a necessary stage in a future evolution? Almost all those who have pondered this question—with the exception of Nietzsche—have seen our justification not in the expectation of a Superman but in the building of a society and culture. Would we thus be led into a situation analogous to that of animals but in which the culture of a social group would be equivalent to the social instincts and conditioning of one species of the social animals? It is true that in the course of history such tendencies have existed and have survived for centuries, if not for millennia, almost without change. Solid traditions effectively complemented biologically hereditary instincts and tendencies. Men of philosophy and religion have not been lacking to uphold the doctrines of "survival" of such or such a collectivity, such or such an ideology or form of society, the individual's presence on earth being justified by his contribution to this survival.

A cultural evolution has also existed ever since the origin of man. "Inventions-mutations" appeared and became fixed whenever they brought an advantage for survival or in competition. Up to that point there is similarity: the individual still

found his justification as a member of a group and participant in a tradition. This justification had to re-establish itself each time an important change occurred, was integrated into a tradition and became the basis for a new cultural level.

The speed with which all kinds of "inventions" appear today, whether they be ideological, religious or partisan, has certainly rendered successive justifications more and more difficult to sustain. However, selection still plays a certain role, although it is becoming more and more ineffective because of the frequent transfer of traditions through influences from group to group.

In the last few decades we have witnessed the birth—and in a certain sense, the death—of strong sociocultural structures involving corresponding justifications. We have been able to verify the effect of selection in their struggle for survival, that is, the continuing existence of some of them and the disappearance of others, or in some cases the continuation of opposition under the new names of "cold war" or "peaceful coexistence." If we object that it is an opposition of social systems rather than of actual cultures, the response may be the quoting of expressions such as *Kulturkampf* or "cultural revolution," terms adopted as qualifiers by the oppositions themselves.

Some thinkers—among them Julian Huxley—clearly saw the parallel to be drawn between biological evolution of the animal species (an evolution ending in man) and the evolution of human sociocultural structure. They announced that human thought follows the course of organic life in an immense general evolution, that of species being followed by that of human cultures, an evolution marked at first by genetic mutations and later by the appearance of new ideologies. But they wanted to go further and asked themselves if this second evolution could escape the automatism which prevails for the animal species, that of the mechanism of mutation and Darwinian competition. They envisioned a fully conscious mankind finally taking its destiny into its own hands.

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It seems to me that we can in fact go further, but to do so we must try to achieve with respect to cultures the "exit" man

has achieved with respect to the series of species by recognizing his place in it and at the same time refusing it. No species before man had been conscious, in transcending itself, of its own nature as a "link" in the animal series; man has recognized his place in evolution even though he may be the present or even the definitive limit of it. And it may be that we cannot ask a traditional type of culture to be fully conscious of its place in the evolution of cultures and still remain itself. A culture will no doubt recognize the similarities and differences it has with regard to other cultures, present and past, but these will seem insufficient, often barbarous and at times ridiculous. In short, a perception and acceptance of the objective value of the total picture of evolution are difficult to integrate into the closed system of values, judgments, principles and even methods which make up a traditional culture.

Great historians such as Toynbee, and philosophers, have presented overall views of this evolution, but they have generally kept to the system of reference of their own cultures—their values, in particular—when they analyzed different cultural groups. To make an objective analysis they had to "exit" from their own cultural domain. And here should logically be located a step which can play a role, with respect to the linking up of traditional cultures, that the linking up of species and his place in this chain has played in man's thought.

To be conscious of his biological nature as a species and of his place in evolution, man has had to consider it from the "outside." This exit from his narrow nature as a link in the evolutionary chain permits what some philosophers might call an emerging from the ensemble of species by a consciousness of which he alone among all living creatures is capable. He may do this without denying his nature as an evolutionary link, his nature as a superior mammal of the hominid family, because his thought and his biological nature, being of different essences, can coexist in him without amalgamating. I propose the same sort of "exit" here, an exit from the cultural chain which permits a concept of evolution by an emergence, a view from above. I shall attempt to show that it is thanks to the appearance of scientific thought that this new step may be taken.

I shall begin by proposing to abandon the idea of "two"

cultures that places science on the same level and alongside or face to face with the classic culture called humanist and presents it as a new culture, a second culture. Now, in reality there are many more than two cultures: collectively they make up an evolutionary series whose terms are quite different from each other because of their individual natures but are also similar to each other because of their fundamental structure. Science has no place among these cultures and must resolutely be kept off the list: it is a system of thought in which certain very strict rules are different from those which govern systems of thought in traditional cultures. This fact determines a separation between scientific thought and the different cultures and ideologies, a separation of a different nature from those found within the latter. For a better understanding of this difference, let us try to analyze the mental processes which accompany the passage, or at least the attempt at passage, from the culture to another and compare them to those which exist in the passage from one of these cultures to scientific thought.

The complete passage from one culture to another requires first of all the abandoning of an entire series of thought processes, value and judgments before the plunge into a new system is possible. It is a sort of intellectual "stripping", a *dépaysement*, to use the term of Claude Lévi-Strauss. Descriptions of religious conversion are rich in details relative to this stripping of the "old" man, that is, the preceding ideology and culture, to put on the garments of the "new" man. This necessity explains the failure when attempts are made to create synchretisms, fusions and even deep mutual understanding between different cultures. This is the case with Occidental and Oriental cultures, for example, which men of thought, intellectual societies and international organizations have tried to bring together. The supporters of each of the confronted cultures will understand the words and the phrases, and often the ideas of the other, but in such cases it is a matter of restricted information, that is, a temporary disguise worn over the original clothing. However, clothes do not change the nature of man, and in order to become truly different we must have a vision on the road to Damascus.

Different cultures are not necessarily incompatible with each

other, and the expression "cultured man" is used to qualify one having broader knowledge of other cultures than that conferred on him by his own social group, family or education. In this case, though, it is essentially a matter of the ability to appreciate literary, artistic, philosophical, moral and poetic works created by men in different parts of the world and in the course of history. Now, these works are only the reflection of different cultural experiences, so that to "live" them thoroughly, to enter into the thought itself of the men of these cultures, a profound and difficult gymnastic of the mind is required: one cannot be content with intelligent reading, visits to museums and travel. Renan has described this possibility of exchange or even open struggle between two systems of ideas inside the same mind. However, if we suddenly ask such a connoisseur of two different cultures who he is, he will, if he is honest, indicate one and only one of them, however broad its definition.

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Where does sciences fit into all this? First of all, do several sciences exist, as several cultures exist based on ideologies, values, different principles representing different views of the world and capable of replacing each other by an interior revolution but also capable of coexisting as a pluralism and not as a synthesis? No. The different branches of science represent only conventionally defined domains of nature to which the same method is applied and which together make up a true unity. Let us recall that the scientific method begins with the observations made with the greatest possible precision and under well-defined conditions—in order to construct with them a model responding to the exigencies of reason. This model, still a hypothesis, is then tried out by being confronted with new experiments and observations, a confrontation which makes it a theory. Let us recall that these theories never claim to be "truths"; they are always submitted to the proof of new experiments that may require their modification or even their rejection in favor of new models. This absolute and direct reference to a nature in which man is submerged and of which he is a part, this always risky but always more precise and total agreement of the rational model and

the ensemble of objects and phenomena is the difference between science and all cultural systems of thought. It means that science is like a great river constantly moving toward the far-off ocean, but it is a movement which is not made up of a series of halts as is the case with the evolution of species and cultures having a principle of stability. It is rather a series of symbolic guideposts with fixed principles of a movement directed without rest and without turning back. We shall see that the reference to the external world also exists in the evolution of species and cultures, but it is an indirect reference that is in some way translated through the mediation of objects fixed in their nature, while the reference of science is direct, with no intermediary, and this gives it a guided drift in an implicit if not explicit direction.

Because of this profound difference in their natures science can coexist with such or such a culture, religion or philosophy, while they themselves are mutually exclusive. Thus we can more easily understand the possibility of the cohabitation of scientific and cultural thought in the same mind, especially thoughts connected with an ideology or religious faith, with esthetics or ethics. Historical examples abound. Pascal wrote, "The heart has its reasons which reason cannot understand." This coexistence is also seen in modern thinkers, and frankly, each of us may observe it in himself. It has been said that there are bulkheads in the brain. I think the image is too restrictive, because the two ways of thinking may influence each other without being amalgamated, much as large nations live in peaceful coexistence.

It seems to me that this point of view sheds new light on what has been called the crisis of scientism, that polemics which has led to the raising of voices proclaiming the "failure of science." In my opinion there was a misunderstanding. There was a desire that science enter—not re-enter—the category of cultures, a demand that it bend itself to modes of thought and use of concepts that are by nature foreign to it. Science was asked to define within its own framework the good and the bad, the beautiful and the ugly, and even absolute truth—what cultures generally provide in the form of religious "truths" or categorical imperative. The "failure" of scientism should from that moment have led to the exclusion of science from cultures: the attempt at parallels and the search for points

in common between the so-called two cultures would have been avoided. Modern theories relative to the distinct roles of the two hemispheres of our cerebral cortex are instructive in this regard: the left side would be devoted to abstract and logical thought and the language that expresses them, and the right side devoted to concrete thought, image and behavior directly related to the outside world.[1]

However it may be, we can only verify the constant interaction between the two types, or systems, of thought. Thus the present vogue for science, essentially due to the technical success resulting from its application, leads some prominent members of different cultural, philosophical or even religious systems to introduce science into their lectures and texts, at least nominally and through its vocabulary.

Conversely, the contribution of intuition, "*flair*" and especially free imagination to the creative process of scientific thought has been recognized by numerous scholars, including Jacques Hadamard and Henri Poincaré. It is perhaps through this intervention of ideas that may be called—not in a pejorative sense—vague and even irrational, not channeled into the narrow paths of the geometric spirit, that spiritual creation and new ideas are born. It may be a spontaneous bringing together, in some way unforeseeable to reason alone.

In addition to this cooperation as active partners, another kind of reciprocal influence between science and culture has long existed. In this case, each of the types of thought takes the other as "subject matter": a subject for study and scientific analysis on one hand and material for literary and artistic creation on the other. Many philosophers, writers, poets and artists have

[1] I think it should be added that instinctive impulse, as well as affective or emotional thought, are attributes of man deriving from the central part of the brain, that is inherited from our remote ancestors: the paleoencephalon. An entire issue of the *Courrier* of UNESCO was recently (January, 1976) devoted to studies on this subject. Completing the thought of a psychologist, we could add: We know we will die (left hemisphere); we do not believe it (paleoencephalon); and we cannot imagine it (right hemisphere). A ternary classification of thought would be the consequence of these experimental studies, justifying the hypothesis of a ternary division in ideas that I proposed in my work *l'Homme microscopique* (Flammarion, Ed., 1966); in an article in *Diogenes* (No. 22, Summer, 1958); and in an article in the journal *Leonardo* (Maxwell, Ed.).

used the material offered them by the man of science in his research, his behavior in success or failure and even at times his manias. *La soirée avec Monsier Teste* by Paul Valéry and Balzac's *La Recherche de l'absolu* are good examples in literature. Many of these theoretical or experimental results have also been more or less directly put to use in the literary genre of science fiction.

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We must now take a closer look at what happens in the dimension of time: we must make our study diachronic. Now, every culture, every animal species and every group or society of men or animals has a characteristic of permanence, of survival, in contrast to the fluctuation in the outside "unorganized" world: Heraclitus and Parmenides could thus each find a field which was proper to him. This is explained when we observe that cultures, like species, evolve and change by stages when mutations appear. These may be of greater or lesser importance, but they always represent a rapid passage from one stable (or at least meta-stable) situation to another. However, as with living creatures, stable cultural situations are not immutable and undergo slight variations characterizing individuals or small groups, whose ensemble forms a sort of population distributed around a middle state. When the stability is of long duration, the development of a culture over a period of time is filled with events resulting from actions and reactions with its surroundings, but it always stays within the structural framework of the values and principles that govern its functioning. Naturally, everything changes when the interactions are strong and rapid enough to bring about a mutation, whose establishment will then represent the advent of a new culture.

Here let us at once note the great difference between mutations in living organisms and those in sociocultures. The first are essentially changes in the genetic information characterizing the species. Appearing by chance, they depend for survival—by means of selection—on external and internal conditions; even more so if external conditions are able to increase or decrease the frequency and importance of fluctuations due to chance. The second on

the contrary show in their very nature, in the new information they contain, a strong direct influence of external and internal events. There, in contrast to the case of biological evolution, we find a sort of traditional heredity of acquired characteristics.

In order that establishment and communication (either oral or written) may assure the continued existence of ideas over a period of time in the course of an evolution, each transformation must bring an advantage, as is also true for living species. This may be an internal advantage such as a guarantee of duration, extension or, if such be the case, the rapidity of reproduction. It may be an external advantage of adaptation vis-à-vis other organisms, groups or cultures that may thus enter into more or less direct competition.

We are thus led to a broader formulation than would result from Darwinian competition alone, that is, the survival of the fittest in the struggle for existence. In the case of sociocultural groups, the internal conditions for continued existence are not as rigorously fixed as the physiological conditions for survival in the case of individual living organisms.

A special development is needed here to analyze the difference from this point of view between "monogenetic" groups whose members all come from the same egg (multicellular living creatures) or at least from the same parent couple (the royal couple of the social insects) and "plurigenetic" groups, such as human societies, and certain groups of social animals, such as mammals. In the first case there is no internal competition between the members, genetically identical (except for the pathological occurrence of competition leading to the development of tumors), while in the second case an internal struggle may occur to unbalance the structure and lead to its transformation by revolution or its ruin by favoring the lineage of a-social individuals. On the other hand, a sort of internal selection based upon a greater or lesser vitality may establish itself between different sociocultural groups when they readapt over a period of time to new external or internal circumstances. It is equally true that some of them avoid, or at least delay, the internal degeneration through stagnation that may result from a lack of stimulation caused by the absence of contact and exchange with other groups and *a fortiori* the absence of true competition.

There are many examples throughout history of the effect of stimulation by an external competition on a sociocultural group, a competition that ends in a reinforcement of the cultural unity and solidity of the group, at least for a time.

Thus the evolution of these cultures is conditioned by the external and internal success of the corresponding social groups. It may be achieved by stages of slow evolution and long duration separated by periods of rapid change: internal changes, whether slow or rapid, conditioned by technological innovations and bringing transformations in means of production. The Neolithic revolution, based on the invention of agriculture, is one example; lesser in importance are the invention of the water mill and the horse collar. What should be pointed out—since this will happen quite differently in science—is that the successes or failures are global. Coherent systems making up cultures may fragment under circumstances that test the coherence, for example internal or external conflict. The portions thus separated may be transferred to other cultural groupings. This construction of a myth with partial borrowings from other myths has been described by Lévi-Strauss, who calls it "*bricolage*," that is tinkering. A phenomenon of the same type may appear during the evolution of organized beings, and François Jacob has shown how this sort of bricolage has permitted the establishment of ensembles endowed with a harmonious global functioning in which portions—organs, for example—may be distinguished, deriving from preceding species in evolution and being put to other uses after varying degrees of modification. In cultures the analysis of traditional texts often permits the rediscovery of portions taken from pre-existing texts of other traditions and reutilized to form—by bricolage—new traditions. I think that in the two cases, genetic and traditional evolution, it is a matter of establishing a mechanism economizing the creative effort, a great consumer of free energy, or negative entropy. We will find acceptance of the facility offered by bricolage in the technical field and even in the field of scientific hypotheses, but there in a strictly provisory way, before confrontation with experiment.

As with organic evolution, it is thus a question of a confrontation with experiment, with the internal and external realities, including that of other groups and cultures. But this

confrontation leading to the success or extinction of cultural groups, leading to the selection and evolution of cultures, is made with the intermediation of the internal and external successes of the individual members of those cultures. The collection of realities through which selection is made—the referent by which success or failure is obtained—is thus essentially human here. On one hand, the structure itself of man, the living being, his physiology, his instincts, his predispositions, along with his natural needs and the technical means which allow him to satisfy them:[2] on the other hand, other sociocultural groups in possible competition. The referent is therefore relative only to man and is not absolute: it is not the same for different social creatures. In this connection we should point out that the individual members of a sociocultural group are as a rule unable to carry within them all the information corresponding to that culture and would not be able to reconstruct it if circumstance should force them out of the group. This is not the case for the cells of complex living beings nor for certain social animals, who carry within them all the information of the ensemble, even if they do not normally put it to effective use.

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A completely different type of evolution is found in the scientific realm. In science there are not, there must not be, "doctrines" such as are found in the cultural realm, and if such doctrines—there has even been talk of dogmas—have at times been formulated, it has been an inopportune manifestation of certain traits of human nature that normally figure in the referent of cultures. Science progresses through the reciprocal processes of theory and experiment, the latter at times being at the very origin of the former, as observation. Theory is essentially a coherent system with an internal logic,[3] but it is by its nature submitted to debate after its confrontation with experiment and may be rejected,

[2] What students of prehistory, in the absence of symbolic cultural signs, call culture: paleolithic culture, neolithic culture, etc.

[3] Here we do not pretend to judge the internal coherence of mathematical theories, a question best left to specialists in the field.

"*falsifié*," to use Karl Popper's term.[4] If the theoretician's construction is logically sound we cannot say that he has made a mistake, but we can say that the construction is not utilizeable in the measure in which it is contradicted by experiment. This latter, on the contrary, may present errors if it has defects in measurement or observation. However, a good experiment remains good indefinitely under the conditions in which it has been performed. A theory which has proved "good" for a certain time may suddenly become bad if it is no longer able to interpret new experiments completely. However, let us keep in mind that many theories remain "valid" in certain restricted areas of experiment and are thus very useful, even when they have been superseded by new theories covering the same area or a more general one.

In addition to particular theories, more general "principles" also exist in science. They have at times come close to being doctrines in the cultural sense of the word: there lies a danger that certain men of science have not escaped. However, principles are only the general framework within which theories are inscribed and which thus render great services. They may also be subject to revision.

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In what light, then, should we view the evolution of the sciences? I think we can say that in contrast to the evolution of cultures the selection of scientific ideas is direct with respect to an absolute referent, independent of man, and as a consequence it does not pass through the selection of any intermediary whatsoever, even of the men or groups of men who hold the ideas. A new experiment contradicts a theory, the latter is eliminated from all sources of information throughout the world. A new theory may lead to experiments superior in precision to the preceding, and the latter are then relegated to history along with the theory they verified.

[4] We recall the descriptive comment of Samuel Butler in his *Notebooks* mentioning the frightful occurrence of a superb theory, excellent in all respects, savagely assassinated by an ugly little fact.

This classic view of the evolution of science has been contested by the supporters of quite another epistomology, especially that described by Thomas S. Kuhn. It may be classified as "relativist," while the first, that of the Vienna school in particular, may be designated as realism or logical empiricism. This latter expression well shows the dual nature of scientific ideas, the logical formulation of conceptual models: hypotheses, then theories and even principles and their experimental proof. It is true that this classic view is too simple; it has the important defect of limiting the human aspect of science to the two characteristics of internal logic within thought and proof by experimentation. A pure rational thought is followed by a realistic or even empirical action. Actually, the construction of theories has not been an independent phenomenon but has been influenced, at times determined, by social or cultural circumstances. This explains the existence in history of periods of calm, if not stagnation, in thinking, during which men of science rested on a satisfying collection of premises and theories—which Kuhn calls paradigms—and were content to perfect them, at times in an exceedingly complex way, in order to interpret observations. Often the desire to interpret richer and more precise experiments through the *ad hoc* addition of imagined supplementary hypotheses in accord with the facts to be incorporated.

This impasse or blockage is then suddenly broken through when a new theory appears bringing elements capable of a much more direct and satisfying interpretation of former observations and inspiring new experiments. This is the case with Copernican, Newtonian and Darwinian revolutions of the past and the quantum and relativity revolutions, as well as the Mendelian genetics, of modern times. Supporters of Thomas Kuhn's thesis will recognize numerous paradigms here and predict a new period of stagnation: nothing in the present evolution of science seems to bear them out. The paradigms that scientists of *bon teint* sometimes stigmatize as "dogmas" do not hold up for long, except for certain principles of preservation.

In periods of stagnation we may see a tendency of researchers to put aside phenomena that are too aberrant with respect to the paradims in fashion at the moment. This reluctance to attack problems that are too obviously inaccessible to our conceptual

models is one of the useful characteristics of science, in contrast with the cultural processes which lead to the immediate construction of a system able to answer certain fundamental questions. To be able to declare his ignorance without weakening and not to delude himself as to the value of his theories is a major quality of the scientist and one of the conditions for the evolution of his science. The physicist who continued to improve his analysis of the luminous spectra of atoms was doing a normal scientific job—according to Kuhn—because he did not seek to explain the phenomenon and knew that he could not do so, but he was certain that in the future a new theory would. He who declared that we would never know the chemical composition of stars was a poor scientist: he should have said, "We do not know it yet"!

It seems to me that we can recognize some resemblance between the processes of scientific research and those of traditional cultures and ideologies, in a certain reluctance to abandon "paradigms" and a tendency to overburden them with commentary to support them in the face of reality. This is because "research" is a human activity of a technological and social nature. This is also why we must think of selection in this research as having men of science and even their groups—research teams and laboratories—as objectives, as is necessarily done in the case of cultures. And yet a strange but essential property of scientific knowledge is its rather anonymous nature, exterior to the individual. It is no doubt this property that makes it seem inhuman at times. But it is an essential characteristic of scientific knowledge that once established by the researcher it detaches itself from the particular contingencies of that man: it no longer belongs to him as an individual and far from being inhuman it becomes the inheritance of Man. This is why the scientist who presents his results does so, traditionally, by effacing himself before them. He does not say "I," and most often he lets the apparatus, the atoms, the organisms, the planets, speak. The artist or the engineer says, "I chose, I saw this, I did that," and he is right, because his personality is essential to his work. The scientist says, "Under these conditions, this happens," meaning, "if I had not been there to observe, it would have happened without me because it is a natural law. What is in my mind is only a

conceptual model of these laws." Scientific selection is concerned with the models, not with those who conceive them, neither directly nor through the human consequences they may have.

This is also why we cannot really speak of mutations in science. A mutation is the appearance of something new in a hereditary or traditional terrain that determines a transformation in the organism or social group and exposes it to selection. It is not the innovation which is put to the test but its acceptance by man and its consequences. In science it is the innovation itself—the new model—that is directly selected by experiment.

One of the consequences of this direct and universal method of selection is the universal nature of science. Because of its method of formation and selection it is the same for all men who apply its method, the only one that succeeds. The establishment of what is sometimes called the "world scientific community" of scholars, researchers and professors, users or merely amateurs and connoisseurs of science—a sort of fraternity without constitution and rules other than the complete acceptance of the method—has been the result since means of communication have become sure and rapid. We may ask ourselves if this community is necessarily limited to man and imagine what would happen if another type of thinking being, perhaps on a distant planet, began to consider the problem of natural laws. For me the answer is obvious: the science of these beings with the capacity to reason and experiment would be exactly the same as ours, with a greater or lesser degree of development and extension according to the length of time involved in their efforts. By the way, this is the philosophical position of H. G. Wells in his book, *The First Men in the Moon.*

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From the respective natures of the mechanisms in the evolution of living organisms and of cultures on the one hand and from science on the other come the very different characters of these evolutions. First, their rate of evolution, since the sciences evolve on a scale of months and years, and more and more rapidly, whereas cultures evolve on a scale of decades or centuries and organisms on one of dozens of millennia or even millions of

years. It is the indirect method of selection which delays these latter evolutions.

The second and perhaps more essential difference between organic and cultural evolutions as compared with that of science is connected with the very idea of progress. We know that two schools of thought exist among biologists and philosophers concerning organic evolution. One school, examining the sequence of living creatures that have successively appeared on our globe, sees a directed, step by step advance toward more and more perfected beings and ending in Man. The other, feeling a touch of finalism in the first, maintains that evolution is in no way directed and that no principle that could be called progress guides the various steps. The first sees a permanent action of a principle of progress in evolution, an *élan vital*, to use Henri Bergson's term, or at least a principle of complexification. The other sees evolution as the result of an "exploration," as a drop of oil spreading farther and farther into the domain of possible, that is, viable organisms, rather than a progress or an advance in a direction defined by certain *a priori* criteria. Thus for the second school it would be statistical progress, the ensemble of species existing in a given epoch presenting a greater complexity than that ensemble in preceding epochs. No doubt a true progress can be discerned in limited phylogenetic series such as those of the ancestors of the horse, but they generally end in blind alleys or are interrupted. This is the case with the ammonites and dinosaurs of the secondary geological period and the abortive line of Neanderthal man. But it is the number of realizations that continually increases (especially if we include interrupted lines, that is, fossils), and in that multitude we can verify the appearance of more and more complex forms, acting as a sort of vanguard spreading out in all directions.

In this cautious and progressive invasion of the immense domain of the possible—the truly viable—species we find significant growth in complexity alongside stagnation and even regression, as is the case with fixed species and parasites. Stagnation and regression have also been present in particular lines in the cultural domain, alongside the increase in richness of the whole list. Thus we can only trace a definite line of progress in animal evolution by deliberately choosing the successive limits and

leaving aside the abundance of lines which do not show the progress we are seeking. It is the same with cultures. If we compare the literary or plastic works that have illustrated those cultures we find an immense variety, an increasing total wealth evidencing more or less happy innovations, but the term "progress" does not apply. If we deliberately and arbitrarily choose a line of works in a certain category we may see progress for a limited time, but it exhausts itself. We must then change the line, that is, the school, in order to find something resembling progress again. It is essentially a matter of an increase in the great number and richness of the achievements. Here, fossils of the series of living creatures would be represented by schools that were completely forgotten, but whose often startling successes have been made available to us by archaeology. They then take their place in the fresco of human endeavor and may even influence new schools. I think that we may also see a sort of "exploration of the possibles" in the case of ethics. Alongside developments of high and undisputable moral value in relationships between men and in their social systems, have we not witnessed, even recently, sudden setbacks? The road covered by man may at times turn back and follow very old trails in the course of this exploration!

But can we then say that there is progress in science since there is here also, almost certainly, an exploration of all kinds of possibilities, in theory as well as in experiment? I believe that the fact that there is a progress comes from science's having an absolute reference which is lacking in organisms and traditional cultures, such reference being constituted of all the natural laws, the most general as well as the most specific.

Of course, evolving living species are also subjected to the absolute reference of which the nature in which they live is made. Each mutation is the equivalent of an experiment, because it is in a way "tested" with respect to this reference, but this is done empirically, blindly, with no preconceived model, with no questioning. This explains the haphazard exploration in the domain of viable living organisms.

In the evolution of the systems of traditional, religious or metaphysical thought, it is on the contrary a matter of conceptual models and not empirical attempts, but it is precisely the

second term, that of direct confrontation with the absolute reference of nature that is lacking! In living species a confrontation without a system;[5] in traditional cultures a system without a direct confrontation. Science is the result of a double confrontation between man's thoughts and the world into which he is plunged. In this confrontation it is nature who commands and thought which follows, constructing conceivable and rationally coherent models with the means at hand, so that they may be tried out on nature.

Thus each time a more extensive or more precise examination shows defects in adaptation a new construction must be made, without the former being discarded, since it may often serve for a long time under limited conditions. The superseded theories then come little by little to furnish a sort of museum. Is there then progress in the proper sense of the word? If we consider theories alone, there is rather an exploration of all creations of which rational human thought is capable and the building of a collection of masterpieces. There is progress only because a better and broader coincidence with the external world gradually appears, a coincidence that is each time more extended or more precise, without any regression. It is in this correspondence, which can be called knowledge, that progress in the absolute sense of the word occurs. And this may also be why, in my opinion, science cannot enter the realm of cultures.

In the light of the above, it is logical to inquire into the possible limits of this progress of scientific knowledge. Can it go forward indefinitely, or does it have limits? Many have asked themselves this question; I myself attempted to answer it in an article appearing several years ago in the English journal, *The New Scientist*. In this connection it might be interesting to define three directions the progress of knowledge follows: that of extension, toward larger or smaller physical objects or parameters; that of perfection, toward precision in measurement and purity of material; and finally that of complexity. It is because of this third line of progress that I cannot imagine limits for scientific

[5] Moreover, there is indirect confrontation through the intermediation of a developed organism.

knowledge. The complexity of the arrangement of neurons in the brain could have a limit, but it can be relayed and extended with electronic instruments that are themselves of a growing complexity.

If the case of science is clear, those of techniques and even experimental scientific research itself are more complicated. It seems to me that it would be useful here to bring in the techniques included in cultures, keeping in mind that what we call the "culture" of men who lived before the invention of writing is essentially made up of their technical achievements. Technical creations are by man and for man, as are the works of artists and artisans and as such are achieved by architects and engineers. Formerly, and rightly so, Arts and Industries were associated: the example of Leonardo da Vinci suffices to prove the validity of this association. Thus the selection of innovations is made indirectly according to their success on the human level and even more their success on the social level. Techniques must bring advantages to the individuals and the groups who possess them. Among these advantages are technical means for scientific research, even that conducted for the sake of knowledge alone and not intended for immediate useful application. It is this more and more important intervention of technique in scientific research that may place the latter among the social activities and bring it closer to cultures, as has happened with the techniques themselves. But we must use caution here. Pasteur said that there is no applied science; there are only applications of science. Among these figure the means of research themselves, although in no way do they impose on scientific knowledge their relative nature or their interdependence with the social or cultural state.

It seems to me that these considerations may help clear up the controversy between the two great epistemological tendencies of the present day, those that we may call absolute and relative, for simplification and in order to keep them within the bounds of this study. That is why the idea of progress is relative here in techniques as it is for cultures; it does not have the absolute nature of theoro-experimental scientific knowledge. It is current today to ask oneself questions on the subject of technical "progress," for example, that of nuclear energy. Does it represent a

progress? That depends on the social criteria used. The only criterion for which the term of progress is justified is that of the power of Man over the external world, and we know that nothing can be obtained from Nature except by knowing her laws and obeying them.

It remains here to examine certain particularly dramatic aspects of the frontier between culture and science. We have seen that there has been a real encroachment of the latter into the former's territory. Science uses instruments of thought which are part of heredity and cultural tradition; conversely, culture tends to "phagocyte" scientific results and ideas. But coexistence may remain peaceful on the condition that the integrity of each of the domains is respected. A good example of this reciprocal respect is furnished by the response of DeLaplace to Napoleon, who had asked him what place God had in his system of the world: "Sire, I had no need for that hypothesis." No mixing: let cultures develop their multiple riches of beliefs and values, their esthetic, philosophical and moral principles and their codes of social relationships and personal life. They base their "values" on genetic structures of thought, on creations of the mind fixed in tradition, philosophical reflections such as positivism or pragmatism, on categorical imperatives, prophecies or simply on meditation. They are justified in an indirect way by their success in providing acceptable or even—why not?—happy lives for men and their societies. Here is a justification parallel to that of evolving species. Carrying the idea of justification a little further and admitting that for living beings this justification of their evolution may be true for life in general, we can establish a sort of ecological moral. Species living in biological equilibrium, forming a stable ecosystem, would represent a sort of ideal state that could only be shaken by important changes in external conditions or by the appearance of new species leading, after a troubled period, to new stable states. Could we base the idea of stable cultural ecosystems on a cultural ecology? And just as Man, a living species that thanks to thought has "exited" from evolution, has been able to destroy equilibriums but can also establish them by an ecological effort; Man, a cultural animal able to "exit" from the evolution of culture through science and able to destroy stable cultural ecosystems through

the intervention of techniques born of that science: can he also establish new and satisfying equilibriums through an ecological effort at the cultural level? That would be a true justification for that science, exited from the system of cultures, in addition to that resulting from its absolute progress. But perhaps there, too, is a justification of Man, not as individual nor as species, nor as a member of society, nor as the bearer of a traditional culture, but as the first living creature capable of knowing its own nature and its place in the universe.