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TEILHARD DE CHARDIN AND THE ORIENTATION OF EVOLUTION

A CRITICAL ESSAY

by Theodosius Dobzhansky

Man does not live by bread alone; he has a drive to understand himself and the universe in which he lives. There are several sources of understanding, and they are not equally congenial to different people. A powerful and articulate group holds that science is the sole and only valid source. At the opposite extreme are those who dismiss science as dealing with impersonal objects, and consequently irrelevant to problems of personal existence and selfhood. Such problems must, allegedly, be approached through personal involvement, art, poetry, mysticism, religious inspiration, and revelation. There is also a middle ground. Knowledge gained from science is as necessary as it is by itself insufficient. It must be supplemented by the insights of poets, artists, mystics, and by religious experience. Teilhard de Chardin stood firmly on this middle ground. I take my stand on this middle ground also, although my co-ordinates are not quite the same as Teilhard's.

The enterprise of science is at the same time highly individualized and socialized. Scientific facts are discovered, scientific laws are formulated, and theories are constructed by individual scientists. Even where scientific research is carried on by groups or "teams," the contribu-

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tions of the participants are as a rule recognizably individual. And yet the scientific movement is a corporate venture. It has its rules of the game. The basic rule is dispassionate objectivity. This does not mean that a scientist has no personal involvement in his work and no emotional attachment to its results. Any scientist worth his salt has both. Objectivity means only that observations and conclusions are recorded irrespective of whether they do or do not please the observer. Some beginners like to describe the difficulties they had and the hard labor they invested in their work; they have to be taught that this kind of information may be of interest only for their autobiographies or obituaries, and it does not belong in scientific publications. What matters are the results, not the difficulties. Science is mostly public rather than personal knowledge. Again, this does not mean that anybody can easily verify any scientific fact or theory to his satisfaction. Most of the "public" would have no idea how to go about such verification. Competence in science requires prolonged preparation and hard work; those willing and able to struggle through, however, will master at least that particular line of scientific endeavor which they find most interesting.

The public character of science means also that the same science is valid everywhere. The talk about bourgeois science, Communist science, Aryan science, Jewish science is rubbish. Hitler's racist "science" made as little sense in Germany as Lysenko's "michurinist science" made in Stalin's Russia, and vice versa. It is not an exaggeration to say that scientists form a subculture, international in scope, and distinguishable from the cultures and subcultures of the nations to which the scientists belong. The rules of the scientific game are not officially codified, yet are freely accepted and occasionally enforced. The scientific subculture has its specialized language and its patterns of thought. There ought to be no secret science; secrecy is incompatible with the mores of the scientific community. Because science is public rather than private or occult knowledge, it has a high degree of reliability and acceptance. It is really not a matter of personal taste, disposition, or preference whether to accept or to reject a scientific finding, a hypothesis, or a theory. After due consideration and repeated testing, the scientific community usually approaches a consensus, which becomes effectively binding to its members. This does not mean that anything in science is immune to questioning. Quite the opposite; any scientific statement is open to challenge. Yet at any given state of scientific knowledge, certain views command acceptance and others are rejected. Thus, any informed person accepts that biological evolution has taken place.

This is not because the evolution theory has become a "fact." A theory is based on facts, but it can never be transformed into a fact. Anti-evolutionists are outside the pale of the scientific community; they regard this an injustice, yet there is no other way, since they are unable to produce facts or arguments against evolution which stand scrutiny. However unlikely, it is thinkable that some day such facts will be discovered; if so, a revision of the whole of biology will become necessary.

Teilhard's Blend of Science and Mysticism

Teilhard de Chardin was an eminent scientist. His purely scientific writings are, however, seldom read, except by geologists and paleontologists. There is, to my knowledge, no plan afoot, to publish a complete collection of Teilhard's works, including his technical papers. Had he written only these papers, he would be remembered as a contributor to his special field of science. He was, however, more than a scientist; he was also a mystic and a poet. This is not altogether exceptional; there were other scientists who had, with more or less success, written poetry and the products of their mystical insights. Teilhard was not content to keep his science, his mysticism, his poetry, and his religion in separate compartments. He reached for a synthesis. In so doing, he collided with the accepted mores of both communities to which he belonged—the scientific and the religious. What many members of these communities failed to see, and many of them still fail to see, is that Teilhard did not seek to deduce, or even to support, his religious convictions by his scientific findings. Teilhard's writings are not natural theology; they deal with a theology of nature. Violent, and even venomous, attacks on Teilhard have been made by some scientists. This could be understood, if not excused, if all Teilhard's books were scientific monographs. In an unguarded moment, Teilhard claimed this for his major work, *The Phenomenon of Man*. Yet it is more than that: an attempt to formulate a world view, a Weltanschauung. His world view includes science as one of the components, though one of cardinal importance.

Raw materials of science are sense data. However, these sense data are recorded and interpreted by human observers, and this is where the personality of the scientist unavoidably enters. Nevertheless, the language of science is a spectator language, not an actor or participant language. It is the opposite in the arts, poetry, mysticism, and religion. A poet aims to convey some of his personal emotions or insights by composing word patterns in which subtly allusionary and metaphori-

cal, rather than the everyday, meanings of words are often predominant. Mystical and religious experiences are basically ineffable and can be communicated only by means of parables, symbols, paradoxes, if at all. An actor or participant language, if mistaken for a spectator language, may strike one as incoherent and even absurd. Teilhard has, in developing and presenting his synthesis, unavoidably used both spectator and participant languages. Let it also not be forgotten that poetry is notoriously difficult to translate into foreign languages, except perhaps by other poets whose perceptions are attuned to the poetry of the original. Mere knowledge of, say, English equivalents of the French words used by Teilhard is far from sufficient. Teilhard coined many of his own words and used many existing words, giving them his own special meanings; so much so that one of his French followers has published a dictionary of the Teilhardese. I have not seen this work, and it would probably be of small help to English readers.

Teilhard's failure to separate clearly his scientific generalizations from his mystical insights has been often regretted. To some extent, this is indeed unfortunate. Two things must, however, be said in this connection. First, it was his synthesis that Teilhard intended to communicate: his vision of the evolving universe, illuminated by his personal religious experience and his poetic inspiration. Second, Teilhard did not in the least try to hide his mysticism. One is liable to get a very incomplete picture of his Weltanschauung if one reads only *The Phenomenon of Man.* Though it is his chief work, it is a sequel to many previous essays in which ideas are presented that are taken almost for granted in *The Phenomenon of Man.* Teilhard's mystical vision and religious exaltation come through very clearly in, for example, *La Messe sur le monde, Le Christ dans la Matière,* and *Le Milieu divin.*

Evolution—General and Particular

There is no satisfactory or accepted definition of evolution. Evolution is change, but not all change is evolution. A most restrictive definition would recognize only biological evolution. The elementary events of which biological evolution is composed are easily specifiable—they are changes in the gene frequencies in living populations. Emergence of strains of bacteria resistant to antibiotics, or of insects resistant to insecticides, is a paradigm. Accumulation and integration of such genetic events over long periods of time lead to major biological change; it can transform an amoeba, or a primordial virus, into man or into an oak tree. Some three billion years ago life first arose on the

planet earth, and possibly elsewhere in the cosmos, as a result of a complex series of changes in the inorganic nature. And perhaps some two million years ago biological evolution produced an extraordinary species, mankind, capable of abstract thought, communication by symbolic language, and endowed with self-awareness and death awareness. Radical changes must have intervened between the "Big Bang," which five to ten billion years ago started the formation of chemical elements, and the appearance of conditions which made the origin of life possible. These changes constitute the cosmic, or inorganic, evolution. Mankind became the protagonist of a history in which the biological changes are outweighed, though not abolished, by changes in the cultural heredity, transmitted by instruction and learning. History of mankind is, in the main, evolution of culture.

The inorganic, organic, and cultural evolutions are constituent parts of the one grand process of universal evolution. Teilhard thought about evolution always in this inclusive sense. The broad definition of evolution should not be construed as an underestimate of the basic differences between the prebiological, biological, and the cultural (and, in a sense, postbiological) phases. They occur in different dimensions, or on different levels, of existence. On each succeeding level, we discover laws and regularities which do not apply to preceding levels. A single example will suffice here. Some authors like to describe the origin of life from non-living nature as a result of a kind of a natural selection; the history of culture is also alleged to be governed by a natural selection of ideas, instead of genes. This is perhaps acceptable as an instructive analogy, but miscomprehension results if the analogy is mistaken for a basic similarity or identity. Natural selection is differential reproduction of the carriers of different hereditary endowments. It could not start before there were self-reproducing systems capable of undergoing mutational changes. Such systems are already living, by any reasonable definition. Rivalry of ideas is not natural selection either; ideas do not reproduce themselves, except in an allegorical sense.

Universal evolution, and also biological evolution, can be considered in two aspects, which I would like to call the particular and the general. For example, one may investigate and describe the changes which took place in the evolution of the horse family, or in the ancestry of man, or in a given solar and planetary system, or in the Greco-Roman civilization. On the other hand, one may seek a general view of the universal evolution as a whole, or of the inorganic, organic, and human evolution as wholes. The general can hardly be investigated apart

from the particular, and of necessity a lion's share of evolutionary studies is concerned with particular evolutionary histories. And yet some scientists are by preference generalists, and others are specialists and particularists.

Teilhard has carried out several studies of particular histories of certain groups of fossils. What inspired him most was, however, not the particular but the general. Another characteristic of Teilhard's approach must be mentioned. Although his scientific life spanned the period when biology was making rapid advances in discovery of the causation of evolutionary changes, he had, perhaps surprisingly, little interest in or knowledge of these advances.

Chromosomes, genes, biochemical foundations of the evolutionary changes, the mechanisms of adaptation and of race and species formation, all these and many other important problems are rarely or not at all mentioned in his writings. This was, indisputably, a serious weakness; it made Teilhard the target of some not wholly unjustified criticisms by other scientists. On the other hand, it is too easy to criticize books for not being what their authors did not intend them to be. To Teilhard, only the universal evolution, considered as a whole, appeared meaningful. He viewed the evolution of the universe as a single creative process, composed of the inorganic, organic, and human phases. The particular histories are sequences of unique events; in the organic and the human histories these events are more and more individualized, and their sequences are unrepeatable. Yet when considered in the perspective of the evolution as a whole, these events cohere into a meaningful pattern. There seems to be a general direction or trend, which Teilhard found possible to discern. He went even further. If one understands what evolution has achieved from the beginning of the universe, say from the "Big Bang" to the present, then it may be possible to extrapolate and thus to predict its likely future course, from the present to eternity. This certainly was an audacity which few other evolutionists ever possessed.

Chance and Anti Chance in Particular Evolutions

The problem of directedness or directionality of evolution is an old one. It was debated by many authors before and after Teilhard. Condorcet was the first, or one of the first, to claim that the history of mankind moves in a discernible direction, through stages from primitive savagery to eventual perfection. Danilevsky, Spengler, Sorokin, and others saw the histories of civilizations moving in circles. Toynbee discerns cyclic movements as well as a general forward trend. Still

others see no general direction at all. No force, agency, or general principle is, however, discernible guiding the particular events of which the history of humanity is composed. These events are neither all good nor all evil, neither all aimed toward progress nor toward conservation, neither all guided by economic interests nor all by spiritual interests of the peoples involved.

In the biological realm, the causation of the particular evolutionary changes is at present reasonably well understood. The process of mutation yields the raw materials from which the evolutionary changes are compounded. The compounding is done by natural selection. Mutation is said to be a chance or random process. This is valid only in the sense that mutations arise regardless of whether they may be useful or harmful to a given kind of organism at a given time, or ever. In point of fact, most mutations are deleterious, and not a few are lethal. Which mutation arises in a given gene depends, however, on the structure of that gene and, consequently, is not a matter of chance alone. On the other hand, a gene can change presumably in numerous different ways, so an element of chance is introduced again.

Natural selection is, on the contrary, an anti-chance process. The selection perpetuates genetic constitutions which are adaptive in a given environment and fails to perpetuate the less well-adapted ones. The measure of the adaptedness is the reproductive performance of the carriers of a given genotype in relation to the performance of other genotypes in the same environment. The surviving "fittest" is then, contrary to the nineteenth-century views, nothing more remarkable than a parent of the most numerous viable progeny! Natural selection is a process conveying "information" about the state of the environment to the genotypes of its inhabitants.

It is nevertheless misleading to say that evolutionary changes are directed by the environment. The situation is actually more subtle. The environments present challenges to a living species—to which the latter may or may not respond by adaptive alterations—of its hereditary endowment. Successful responses mean survival, spread, and, sometimes, conquest of new opportunities for living; failure to respond, or a wrong response, may end in extinction. The environment is, however, neither static nor changing always in the same direction.

Teilhard was rather skeptical concerning the role of natural selection in biological evolution. Nevertheless, he gave a most apt characterization of the course of evolution, which can apply only to evolution by natural selection. Evolution proceeds by groping (*tâtonnement*).

A living species is groping, as though in the dark, for possibilities to survive and to spread. The groping may, however, end in breakdown and extinction, as well as in survival and discovery of new modes of life. Groping is evidently the antithesis of directedness. Particular evolutionary changes, at least on the biological level, show no indication of being, in any meaningful sense, directional.

General Evolution—Directed or Directional?

Lack of directionality in particular evolutionary changes does not preclude the possibility that it may be present in general evolution. The achievements of the evolutionary process can be described in both a spectator and a participant language. Conditions propitious for the origin of life have arisen as a result of stellar and planetary evolution, at least on earth and possibly elsewhere in the cosmos. Whether life arose on earth only once or repeatedly we do not know, but in at least one instance the newly arisen life was not snuffed out by hostile environments. On the contrary, life spread, evolved, and became marvelously diversified. There are about two million known species now living on earth, and possibly as many or even more as yet undescribed ones. Some of these forms of life appear to us strange, bizarre, almost whimsical creatures. Each and every one of them has, however, its ecological niche carved out of nature's domain. Some two million years ago, quite recently on the cosmic time scale, biological evolution transcended itself by giving rise to an extraordinary being, man. Mankind evolves not only by means of genetic changes as do all other living species, but also, and even mainly, by changes in what people learn themselves and teach to others.

Man is both an observer and an actor in the drama of evolution. Can one validly make the statement in both a spectator's and a participant's languages that evolution has been on the whole progressive? Despite numerous attempts, biologists have not succeeded in formulating a rigorous definition of what constitutes progress in biological evolution. And yet the progress is intuitively evident. As Ian Barbour put it, "By almost any standard, man represents a higher level than primeval mud." A biologist would go further: a bacterium represents a higher level than a virus, worm higher than bacterium, fish higher than worm, dog higher than fish, and man higher than dog. It must, however, be made very clear that evolutionary progress did not mean that lower organisms were in time always replaced by higher ones. Higher and lower organisms often coexist, each in its ecological niche.

Many forms of life, both low and high ones, ended in the history

of the earth by becoming extinct. Extinction is the price which has to be paid for evolution by groping. If particular evolutionary histories were all directed, extinction would be inexplicable. A direction which leads to extinction is misdirection. On the contrary, extinction of some branches of the evolutionary tree is virtually certain to occur if evolution proceeds by groping, that is, by natural selection. The same applies to human societies. By almost any standard, our society represents a level higher than that of a tribe of paleolithic hunters or of a band of australopithecines. Nevertheless, some primitive societies, though their days may be numbered, still exist alongside the burgeoning giant—the cosmopolitan, industrial civilization. Many societies of which historical records are available became lost, and doubtless many which left no record suffered the same fate. Nineteenth-century evolutionists might have said that the highway of progress is strewn with corpses. We are no longer so fond of such metaphors.

Teilhard's attention was firmly riveted to general evolution. His vision revealed to him that, "from the beginning stages of its evolution, the living matter which covers the earth manifests the contours of a single gigantic organism." In this planetary, or even cosmic, supra-organism he saw a process of paramount importance taking place, namely, "The grand orthogenesis of all that lives towards greater immanent spontaneity. . . . Without orthogenesis life would only spread; with orthogenesis there is the invincible ascent of life."

Teilhard at this point made no distinction between the general evolution of his planetary supra-organism and the particular evolutionary transformations. He erroneously believed that mutations "add up, and their sum grows in a predetermined direction." He thus seemed to accept, without considering them closely and critically, the orthogenetic and finalistic interpretations of evolution which were rather popular, at least in continental Europe, during the 1920's. Finalists, of whom Lecomte du Nöuy was a more recent and widely read representative, assumed a guidance of evolution by supernatural forces, or directly by God. There were several versions of orthogenesis. The assumption common to all of them was the evolutionary changes proceed in a predetermined direction, owing to forces "within" the organism. Versions bordering on finalism postulated a guiding agent transcending biology and physics, yet immanent in the organism itself. A more mechanistic version (that of L. S. Berg) envisaged the hereditary endowment constructed in a manner analogous to atoms of radioactive elements, which undergo predetermined changes in a fixed order. All theories of the above sorts are flagrantly inconsistent with Teil-

hard's own view that evolution proceeds by "groping." The inconsistency is not removed by the paradoxical assertion that "the groping is not chance alone . . . but directed chance." Yes, the groping is "directed" indeed by the anti-chance agency called "natural selection."

The evolution of the universe is directional, although not necessarily directed. There is no discernible directionality in particular evolutionary histories. This apparent contradiction is seen most clearly in biological evolution. The environment presents challenges to which the species living in it respond by genetic alterations. The alterations are usually adaptive, that is, as a rule they promote a harmonious adjustment of life to its environment. The alterations are, however, often opportunistic; they are adaptive in the environments which exist here and now and may be injurious in future environments. A species deeply specialized and committed to deal with its present environment may have lost its evolutionary plasticity. This is a consequence of "groping," and the groping often ends in extinction. And yet the three billion years of opportunistic groping have resulted, on earth, in some of the descendants of the "primeval mud" becoming marvelously contrived living systems which dominate their environments. One of these living systems has transcended biology by evolving self-awareness and death awareness. Teilhard's planetary supra-organism has risen certainly above the level of the primeval mud.

Except in man, no indication of planning, design, or conscious impulsion can be seen in evolution. Man and man alone has discovered that he is a product of an evolutionary process and that this process is still going on. Man may gain enough knowledge to direct the evolution of his own and of other species, ultimately perhaps that of the whole universe. If so, it will be man who will choose the direction and the goal, in accord with the dictates of his wisdom or unwisdom. Yet, if the evolution thus far was neither planned nor directed, how are its achievements explained? It was often progressive, despite some cases of standstill and of regressive episodes. Teilhard tried to answer this question in a poetic, participant's, rather than in a drier, spectator's language.

Things have their "insides" and their "outsides."[1] These are coextensive; the "inside" has, however, elements of consciousness and of spontaneity. Moreover, all energy is basically psychic[2] in nature. Energy "is divided into two distinct components: a tangential energy which links each element with all other elements of the same order (i.e., of the same complexity and the same 'centeredness') as itself in the universe; and a radial energy which draws towards ever greater

complexity and centeredness, in other words forwards." Now, Teilhard surely does not claim to have discovered two new kinds of energy previously unknown to physicists and to physiologists. Things may, however, be observed and studied in isolation or in their interrelations with the rest of the world. One may investigate things as they are or may try to discover how they got to be what they are and what they are likely to become in the future. When phenomena are studied in their connectedness, questions arise about their meaning and value in the general scheme of things and in the personal world view of the investigator. Questions of this last sort were basic in the highly personalistic approach to the world so characteristic of Teilhard's thinking and writing.

The achievements of the evolutionary process came about, in Ian Barbour's words, "not because of divine intervention but because of laws built into its structure. It would be precisely the operation of these laws—not their violation—which has brought about the intended result, and thereby displayed the divine purpose." Modern cosmological theories disclose a kind of orthogenesis (although this term is not used) in stellar evolution. There is a "main sequence" of stars, as well as its turns leading to "red giants" and "white dwarfs." A star burns its hydrogen "fuel" by means of thermonuclear reactions transforming hydrogen into helium and, further, its helium into carbon^{12}, oxygen^{16}, and neon^{20} with liberation of enormous amounts of energy. The surface temperature of a star and the emission of light change with the star's age; there may supervene a gravitational collapse, a sudden explosion with rapid release of more energy, and eventual "death" when the energy supply finally falls to low levels. This evolution is, at least as described by cosmologists, more rigidly directional and hence considerably less "free" than biological evolution. There is nothing, however, to suggest individual stars being stirred on their evolutionary courses by anything other than the general laws applying to all of them.

In biological evolution there is, as stated above, no orthogenesis. The groping course introduces an element of freedom, although evidently of freedom not in human sense. There is, rather, an interesting kind of indeterminacy; evolution is a succession of unique and unrepeatable events, and the events which actually occur are drawn out of vastly greater numbers of potentially possible events, most of which are never realized. Evolutionary changes, excepting the most elementary ones like mutations which confer drug resistance on bacteria, are irreversible and unrepeatable. This is not because of any mysterious

force which prevents their repetition, but simply because exact repetition has a probability close to zero.

The evolution on earth has culminated in man. It is most unlikely that anything even remotely like man has emerged in the evolution of extraterrestrial life, even if such existed; it is just as unlikely that, if mankind were destroyed or destroyed itself, a new mankind would evolve again. Suppose, however, that extraterrestrial life does exist, or that the life on earth will be destroyed and will arise again. If this were so, and if the new life did not become extinct soon after its origin, then this life would be virtually certain to undergo an evolutionary development and diversification. Moreover, this evolutionary development would, despite many false starts and blind alleys, be on the whole progressive. Only a very rash or very ignorant biologist could venture predictions as to just what sort of a living world would develop, except that it would not be the same as the one which actually exists on our earth at present.

For a biological evolution to occur, two necessary and sufficient conditions must be present: heredity and mutation. A corollary of these two is natural selection. Natural selection is the anti-chance agent which makes evolution in a sense directional: at least in a short run, evolution tends to be adaptive to the environment. Heredity rests on the ability of certain molecules or molecular aggregates to reproduce themselves, that is, to induce synthesis of their true copies from materials available in the environment. Heredity is a fundamental property of life. It provides a continuity and stability of the living systems. Yet the precision of heredity falls short of perfection. The self-copying is sometimes inexact; the new, mutant entity reproduces, however, its altered structure with a fidelity of about the same order as did the original one. In other words, an absolute fidelity of the process of copying and self-reproduction would make evolution impossible, and incessant mutability would make maintenance of life unlikely. In reality, mutations occur from time to time probably in all kinds of organisms. This is not surprising; the wonder is, rather, that the self-reproduction is generally as precise as it is, not that on rare occasions some mistakes do occur.

In sum, biological evolution is not directed but is directional, in the sense that it tends generally toward maintenance or betterment of the adaptedness to the environment. This is what Teilhard's "radial energy" really means in the living world. In *Some Reflections on Progress* (1941), he wrote: ". . . the fact remains that for 300 million years life has paradoxically flourished in the improbable. Does not this sug-

gest that its advance may be sustained by some sort of complicity on the part of the 'blind' forces of the universe—that is to say that its advance is inexorable?" Yes, indeed, life has paradoxically flourished and apparently not for three hundred million but three billion years! Let us, however, try to pinpoint where the "complicity" resides; it seems to be a consequence of the basic properties of all living matter—heredity and mutability. They make the adaptedness of evolutionary changes not exactly "inexorable" but at least very probable.

We do not know what primeval life was like. It is, however, a good guess that it was initially frail and that it could perpetuate itself only under some particularly favorable conditions, available perhaps in only a few places. Perhaps life arose repeatedly from a non-living, inert matrix. If so, most of these feeble beginners soon flickered out. At least one has, however, secured a firmer hold on its environment, multiplied, spread, and inherited the earth. We are its descendants. J. M. Thoday very perceptively pointed out that the probability of a unit of evolution having living descendants after the lapse of a long period of time is a meaningful criterion of fitness, durability, and of evolutionary progress. Primordial life had, in this sense, very low fitness, since it was at the mercy of its environment. By a lucky chance, one of its beginnings survived, however, and its descendants gradually mastered more and more environmental opportunities. The mastery of the environment has reached its climax in man. Mankind is unlikely to become extinct, except as a result of a suicidal folly of its own. It is the apex of evolutionary progress to date.

Mankind—the Privileged Axis

Teilhard complained that "men's minds are reluctant to recognize that evolution has a precise orientation and a privileged axis." The orientation, the "Ariadne's thread," is toward "cerebralization," rise of consciousness, of self-awareness—in short, toward mankind. Since we are not only spectators but also participants in the evolutionary process, an anthropocentric absorption is legitimate and in fact unavoidable. To man, the limb and the twig of the evolutionary tree leading to mankind indeed compose the privileged axis. The universe without man is meaningless. Any theodicy must necessarily make sense of the evolution as a whole, not of the human part alone. For otherwise what was God doing during the eons before mankind finally appeared? These eons are, to us, inevitably preparatory for the entrance of mankind on the cosmic scene. Teilhard has forcefully and eloquently made this clear.

A complementary analysis of the evolutionary process is just as legitimate and necessary. Evolutionary progress in general, and the emergence of man in particular, were neither foreordained nor were they lucky accidents in the cosmic game of chance. Was man latently present, but hidden and undeveloped, in the "Big Bang" at the beginning of the universe? This is trivial—a positive answer means only that man has in fact appeared. The same answer becomes misleading if it implies that some privileged axis was impelled, by its own constitution or by somebody's volition, to grow in the direction of man, regardless of its surroundings, of its environment in the widest sense of that word. Biological evolution consists, as stated above, of genetic responses of living species to the challenges of their environments. In the animal kingdom, the development of sense organs and of central nervous systems are examples of highly successful responses. In a single evolutionary line, that of mankind, there were added the crowning achievements —a capacity for symbolic thought, communication by language, and finally self-awareness and death awareness. A privileged status can objectively be claimed for this line in one sense only—that it has evolved a quite novel and highly effective form of adaptedness, transcending anything known in other animals. This, to be sure, is a great enough distinction. The evolution in the "privileged" line was, however, brought about by the same causes as in the unprivileged ones.

The finalist view, that either evolution in general, or at least that of the privileged line, was planned and piloted by some transcendental or occult forces, may be rejected as unnecessary and unenlightening as far as scientific understanding is concerned. There is, however, a debate among philosophers and theologians as to whether the past, the present, and the future are equally known to God and are simultaneously present to his view. Traditionalist religions answer this question in the positive, since God is believed to be omniscient. This amounts, however, to a denial of any genuine novelty or contingency in the cosmogenesis. The beginning and the culmination of the cosmos are equally predetermined and are exactly known to God, although not necessarily to man.

A different view is suggested by some process philosophers, especially Whitehead and Hartshorne, and by their followers among the theologians. God possesses a perfect knowledge of the past and the present, but not of the future. The future is not completely predestined because the world contains elements of freedom. Genuine alternatives do exist in cosmogenesis, and particularly in human evolution or noogenesis, to use Teilhard's term. God has voluntarily limited his omniscience

and omnipotence in order to endow his creation with freedom. Freedom is a divine gift, and its range increases as evolution proceeds.

Though Teilhard was apparently unfamiliar with Whitehead's philosophy, he had to deal with the problem of evolutionary determinism and freedom. This problem presents itself most insistently when human evolution, noogenesis, is considered. Mankind has reached the level of reflection and self-awareness. Moreover, man has discovered the phenomenon of evolution. Neither in the biological nor in the cultural dimensions is man any longer obliged to accept the evolutionary direction of blind forces of nature. Man can choose the direction himself. Being, within certain limits, a free agent, man can make wrong as well as right choices. In Teilhard's words: "The possibility must be faced that mankind will suddenly fall out of love with its own destiny," and also, "The components of the world may refuse to serve the world, because they think. More precisely, the world may refuse itself, perceiving itself through reflexion." Yet a refusal is improbable: "My purpose is not to show the existence of a necessary and infallible line of progress, but simply that for mankind as a whole a way of progress is offered and awaits us, analogous to that which the individual cannot reject without falling into sin and damnation." Teilhard was consistently optimistic, and although he realized that "sin and damnation" are possible, he felt secure that mankind will not choose the wrong road.

Optimism is a commodity in short supply in the modern world. Teilhard's optimism is surely one of the reasons for the wide appeal of his thought. The universe is not an absurdity, it is a cosmos, an increasingly orderly system; its history is not a farce but the cosmogenesis, the Creator's enterprise. The cosmogenesis had started before mankind appeared on the scene. The billions of years of the inorganic evolution are seen in retrospect as preparatory for the appearance of life; the billions of years of organic evolution were preparatory for the appearance of man. And one hopes that the presently known two million years of human evolution (in Teilhard's days, the estimates were even shorter than our present ones) must be preparatory for some sublime and infinitely precious future. The evolution of mankind is in the main the evolution of thought, noogenesis. And, "In the direction of thought, can the universe terminate in anything less than the measureless . . . ?" To Teilhard, this was far more than an inference from his scientific knowledge: "By definition and in its essence Christianity is the religion of the Incarnation: God uniting himself with

the world which he created, to unify it and in some way to incorporate it in himself." The ultimate goal of evolution is God-Omega.

The Omega is evidently no extrapolation, however bold, from scientific data. It is a prophetic vision. It is derived (although, perhaps strangely, Teilhard does not mention its source) from that other vision recorded in the Book of Revelation: "I am the Alpha and the Omega, the first and the last, the beginning and the end." The question that immediately suggests itself, is on what grounds we can be sure that the noogenesis is indeed directed toward, and will actually culminate in, the Omega. Can we ignore the potentiality of error and evil which are implicit in the gift of freedom which mankind received? Teilhard offers really no more than his assurance that it is simply unthinkable that the billions of years of cosmogenesis will finally come to naught. He is sustained by his religious faith and his mystical insight: "Let us suppose that from this universal center, the Omega point, there constantly emanate radiations hitherto only perceptible to those whom we call 'mystics.' Let us further imagine that, as the sensibility or response to mysticism of the human race increases with the planetisation, the awareness of Omega becomes so widespread as to warm the earth psychically while physically it is growing cold. Is it not conceivable that mankind . . . will detach itself from this planet and join the one true irreversible essence of things, the Omega point?"

Teilhard's predictions of the direction and the goal of cosmogenesis and noogenesis do not belong to the category of verifiable "public" knowledge. They are not derived from scientific data and cannot be tested by experiments, but only by following their author along the path of his faith and his mystical experience. It is nevertheless senseless to attempt to purge the Teilhardian synthesis of its religious, mystical, and poetic components, as some authors (e.g., Julian Huxley) tried to do. The value of the Teilhardian intellectual legacy lies precisely in his synthesis; the scientific and the religious components of the synthesis are not detachable from each other without making the whole lose its meaning. This is not to say that the synthesis is final and needs no revision and improvement. Such a claim would surely have been rejected by Teilhard as contrary to his convictions. No apology is therefore necessary for the present essay being in part critical.

Teilhard aimed at no less than a total integrated system of thought, which would show to modern man that he is placed on this earth not through some silly accident but that he is the vanguard of the billions of years of cosmogenesis and noogenesis. In this system of thought, science is an essential component, but only a component. The other

components do not conform to the patterns of thought of the scientific community and, consequently, do not command acceptance to the same degree as do scientific theories. It is nevertheless important that these other components are also not contradictory to any scientifically established facts or to scientific theories generally considered as valid. Nothing like Teilhardian synthesis could have been attempted by anyone lacking a first-hand familiarity with science. Yet Teilhard makes it abundantly clear that his message is addressed to the whole of mankind, not to scientists alone: "No evolutionary future awaits man except in association with all other men." Teilhard let slip in his now-published correspondence some statements which show that he was far from being a democrat. He nevertheless realized that "It is mankind as a whole, collective humanity, which is called upon to perform the definitive act whereby the total force of terrestrial evolution will be released and flourish; an act in which the full consciousness of each individual man will be sustained by that of every other man, not only living but the dead." Teilhard's religion was that of a great thinker who was aware that he lived in an age of science.

NOTES

1. In the original, "le dedans" and "le dehors," rendered in English also as "the within" and "the without."

2. In the first English translation (*The Phenomenon of Man,* p. 64), this is mistakenly printed "physical in nature," but this has been corrected in the paperback edition.