NATURAL SELECTION AND GOD

by Ralph Wendell Burhoe

One of the prime elements of a scientifically grounded theology is the rebirth or renewal of credibility in an objective reality that determines destiny. Religious belief systems characteristically involve man's relation or adaptation to some ultimate realities which vastly transcend man's power and whose laws man must discover and obey if he is to be saved, that is, if he is to have a good life or even any life. Such realities are known as gods, or in the higher religions as the one God or the one ultimate reality. I wish to point out how closely contemporary scientific belief systems portray man's relation to a similarly all-encompassing and all-controlling reality and to examine the relevance of this scientific portrayal for religious belief in an age of science.

In scientific discussions there is little doubt about the function of what Darwin called "natural selection" in determining or shaping the evolution or destiny of organic species. Human genetic heritage, or man's genotype, is increasingly understood to have been established and continually maintained by natural selection. In this essay, I wish to examine some of the parallels between the religious concepts of, or characteristics ascribed to, God and the scientific concepts of, or characteristics ascribed to, nature and natural selection. If what appears to me to be the case is further substantiated, it may be that instead of a dead God killed by modern knowledge, as Nietzsche suggested, we may shortly come to see that we have a very live God, revealed (unveiled) by the sciences mostly since the time Nietzsche wrote. Moreover, I suggest that this God will be found to possess many of the same prime characteristics as the divinity of the higher religions and will become the focus of man's concern, the guide for his moral behavior, and the comfort of his soul—in short, the center of the rebirth of a religion adapted to universal viability among all people in a coming age of science and scientific technology in which man's civilization will rise to heights scarcely yet dreamed of by most men alive today.

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But in the Judeo-Christian culture of the West there are two big obstacles to understanding scientific accounts of natural selection as descriptive of God, that is, to understanding natural selection as the ultimate and fascinating power to which man may ascribe the marvels and wonder of the creation and continued ordering of all things, including man's own privileged powers as the most advanced creature on earth and as a subordinate cocreator; and to recognizing natural selection as the ultimate and aweful judge whose laws man must find and obey if he is to continue thus to flourish.

The first obstacle is the widespread misconception which supposes there is a dualistic character of the world of human experience, or a separation between man's spirit or mind on the one hand and the natural, physical, bodily world on the other. This dualism stems in the West more from the impact of Greek ways of viewing things a couple of thousand years ago than from the Judaic views. It is a prevalent or reigning view today not only among theologians but also among the scholars and practitioners (poets, artists, etc.) of the humanities in general, and saturates the literature and general culture that permeates the West. A similar dualistic misconception may inhibit a scientific doctrine of man in Eastern culture.

The important point is that, wherever it occurs, the belief that the universe (and man, too) is composed of two separate natures causes a logical chasm that disrupts making rational conclusions from material and scientific facts so that they apply to the other realm of human experience, which is the realm man naturally holds to be the significant one—the spiritual, mental, aesthetic, and volitional aspects of the universe, the gods, or men. The objection to this dualism is not with its assertion of the reality and importance for man of his feelings, wishes, desires, etc., but with the impotence of the dualistic system today to provide credible conclusions about consequences for human feelings by means of any statements that involve the natural, objective world. If the human mind, spirit, and feelings are presumed to be even only partly free from and independent of the natural world, this logical chasm confuses and frustrates any compelling and clear conclusions of any arguments that move from one of these separated domains to the other.

As a result, evidences from nature about God or morality tend to become ineffective. In a scientific world, this means the death of credibility in God. But the big obstacle to understanding the role of such a superhuman, objective reality or God as being played by "nature"—that is, by the scientifically described cosmic scheme in creating and supervising man's continuing development—is the as

yet poorly understood role of natural factors beyond man's control in the selection or shaping of human personal and social life.

The second obstacle is even some scientists' aversion to the role of "natural selection" in human personal and social affairs. This aversion stems in part from the same dualistic belief and also from a corrective reaction to an unwarranted spread of the somewhat badly conceived and unsubstantiated doctrines of social Darwinism in the late nineteenth century. During the succeeding half-century blackout on speculation about the processes of cultural evolution, only a handful of anthropologists have tried to form theories about it, and these did not gain widespread favor. The Marxist doctrines were perhaps discounted as being more political than scientific, and to the minds of sophisticated anthropologists, either the evolutionary theories of culture seemed to be too simplified to account for the subtle variety of observed facts about human culture or else data gathering seemed more important than theorizing.[1]

In psychology, there was also only a slim few who continued to feel that natural selection was important for human psychology, but often these were the ones who made the mistake of supposing that human behavior was, like animal behavior, fully programmed in the genetic heritage, who failed to understand the very real and important structuring of human behavior by external, nongenetic heritages, and who hence tended to be rejected.

By the middle of the twentieth century, with some stimulation from some geneticists like Theodosius Dobzhansky,[2] from some biological theoreticians of evolution like Julian Huxley, and from psychologists like B. F. Skinner, a new development in scientific circles about the nature of cultural heritage and its evolution began to take place. I find particularly significant, scientifically and theologically, the notion that the memory of partially random or accidental discoveries of men is transmitted (communicated and imitated or replicated) in the behavioral patterns of men, after being selected for their experienced or imagined usefulness. The psychological dynamics of this is illumined by the writings of B. F. Skinner suggesting that conditioning or reinforcement of behavior patterns was essentially a kind of natural-selection process in personal or individual development (ontogeny).[3]

But this new approach has just gotten under way, and the major part of both scientific and humanistic communities still shun a naturalistic doctrine of man. A complete analysis of the failure to find natural-selection doctrines for accounting for human behavior is

much more complex than this, but I shall only mention four other factors contributing to this failure.

1. The data gathering of the anthropologists contributed to the fact that there is a wide range of variable cultural patterns. From this fact developed the notion of "cultural relativity," the notion that different moral or value patterns existed in quite viable societies. From this, many commentators drew the false conclusion that patterns of human life could be anything anyone wanted. This tended to diminish the effectiveness of the notions of any natural necessities applying to human cultural and behavioral patterns.

2. The same tendency to diminish faith in any compulsions on man from nature was propagated by the understandable concern of social philosophers in recent centuries with the problem of "human freedom," and some interpreters of this borrowed erroneously from the early twentieth-century pronouncements concerning the Heisenberg principle of indeterminacy or uncertainty in physics. This was commonly interpreted to mean that if, even in physics (the heretofore most rigorously deterministic picture of the world), there was in the end no real determinism, then certainly there was no compulsion or necessity placed by nature upon man.

3. The notion of "natural selection" among geneticists has itself been stripped of its nineteenth-century connotation of explanation of survival by natural forces, and it has become more of a statistical or descriptive term referring technically only to the fact that certain genetic patterns are found to have more offspring than others. The attempt to theorize or demonstrate an explanation of how "fitness" or "adaptation" is worked out in terms of greater efficiencies of one or another kind of mechanism seems to play a lesser role than the definition of "fitness" as simply a measure of the "number of offspring."[4] While important for the development of evolutionary theory in terms of genotypic statistics, this trend has tended to mask analysis of the detailed mechanics of why the natural circumstances of the interacting elements result in the survival (in greater numbers or over longer time) of one species or genetic population than another.[5]

4. Lastly, during the past couple of centuries, the freedom of the scientific community to seek after its doctrines of "natural determinism" was won by a tacit truce with the humanities, still the dominant regime of the educational community in most places even today, whereby scientists kept hands off any attempts to explain human psychology and society in terms of natural law.[6] The psychosocial

"sciences" are only about a century old, they have been frightening to many in their deterministic expressions, such as Marxist social doctrine or Pavlovian and behavioral psychology, and their status as sciences is fought by partisans from both the humanistic and the scientific wings of our dualistic culture.[7] There has been a tendency to say "social studies" rather than "social sciences."

But, in any case, neither the humanistic philosophers nor the theologians have very often favored any doctrines that imply a natural selection or determination of the nature and behavior of man.

Natural Selection and the Death of God

Here we should look a little more closely at what the term "natural selection" does and can mean. Darwin used it to distinguish it from human selection used by agricultural breeders. It was also a term intended to assert that it was not so much a superanthropoid god who fabricated life as it was "nature": the natural world surrounding, or the environment of, living organisms. Strictly speaking, the nature that does the selecting includes not only the surrounding world but also the nature in the very guts of the living system itself, including the nature of the very molecules that make up the subunits and genetic memory of each cell. If one traces the history of evolving life back in time long enough, one comes to a point where the surrounding nonliving world is all there is, for no life has yet arisen. Hence, sooner or later in scientific explanation, the nonliving or physical nature of the world becomes the creator, guide, judge, and sustainer of life. Living systems are a special class of phenomena of the physical world. "Natural selection" is another way of saying "the naturally stable configurations reached by open systems of the matter of the universe through random trial-and-error motions." This is equivalent to "survival of the fittest," or, from the genetic perspective, "progeny (descendants or replications) that continue to exist in large numbers or, better, for a long time in the future."

Stable systems are systems that are not easily broken up by the randomizing energies in the habitat or environment which they inhabit. *Open* systems are defined by boundaries, like the skin of an organism, through which materials and energy may pass. A *living system* is a *stable, open* system which so selects the inflow and outflow of matter and energy and so regulates the behavior inside the bounding skin that the characteristic patterns of organization are maintained in spite of the randomizing energies and materials impinging on the system. The *skin* may range from the molecular film

covering a cell to the biosphere representing the boundary of living species that form a mantle on the earth's surface.

The recent scientific views of the prehuman and preanimate nature of the world as the creator and selector or judge of what shall live would, of course, be a denial of a god who operated anthropomorphically (that is, who worked and planned and designed the way men do). Hence, natural selection would seem to be a denial of divine creation by a manlike god. However, it should be noted that, from the view of god meaning the ultimate constellation of forces outside of and prior to life (including man) that did in fact create and sustain life, nature or natural selection is in reality a modern statement or revelation of such a god's nature. Darwin was accused of renaming God. The process of natural selection may be said to be a reformation of the doctrine of god, although the "nonhuman" character of this concept of the creator of man led theologians to reject it as what they and their predecessors meant by god.[8] But, it is this doctrine of elements intrinsic to nature as the source, creator, and judge of man which has been growing in the scientific and public mind in the century since Darwin. Since it is a widely accepted doctrine in the scientific community, theologians today, if they want to portray a living god rather than a dead god, ought seriously to consider integrating it into their systems of concepts.

As I have indicated above, one of the reasons this new revelation of the nature of the source and judge of our being is not adopted in the theological community is the fact that it has not yet been clearly visualized or adopted in the psychosocial sciences. However, even the theologians, at least many of the sophisticated ones, have within the century after Darwin pretty well accepted the doctrine of natural selection for organic evolution as "true" for science and public education, even though most of them seem to retain the conception that man's "spirit" is in a separate world. For a half-century, the liberal theologians have widely accepted this doctrine of natural selection to account for man's body, and even a century ago some daring liberal theologians (e.g., Francis Ellingwood Abbot)[9] had already accepted Darwin's picture of man's creation and evolution and had started to build a reformed theology in this light. In the 1970s it is only in the backwaters of fundamentalist orthodoxy and among the uneducated where the cultural lag permits serious doubt of organic evolution by natural selection. Of course, there are millions of poeple in the United States and in other parts of the world where modern evolutionary theory is not acceptable in public schools or in general conversation. There is still some organized resistance to it.[10] But

such backwaters of the old cultural riverbed, even when they are sizable, do not represent the trend of the future, when popular magazines like *Life* and when television shows present vivid pictures of recent evolutionary theory. Hence, neither these backwaters nor the clergy can be held to be serious stumbling blocks to theological acceptance that scientific doctrines of organic evolution are "true."

Western social philosophy, and the historical and some areas of psychosocial scholarship, may be more responsible than theology for our culture's shunning a doctrine of man's cultural and individual development as determined by some lawful selective process. Many have argued that man is free to make his own history and culture as he likes. Implicit in their image of man is the dualistic notion that the significant part of man's nature is independent of natural law, or determination or selection by nature. Many mistakenly used the implications of man's success in technological inventions to imply that he was master over nature rather than subject to natural laws. They were obviously unaware that technological increase in the amount of food or power comes *not* from a superior power in man's voluntarism or willing, but rather from man's better understanding of nature's laws and adaptation to what nature requires.

Theologians tended to find the dualistic view more congenial and not to see in nature or nature's laws their favored notions of God or man. It was natural, therefore, especially among "liberal" Christian theologians who were concerned with man's voluntaristic or "free" behavior to help himself and his fellowmen out of their miseries, that there would be a trend away from predestination by an almighty God toward the doctrines of man's independence from superhuman or objective laws. They found support for their convictions in the reigning interpretations of man derivable from some of the humanistic exponents of historical and psychosocial studies whose dualistic views of man also derived from the classical Greek philosophy that had become a part of Christian theology's frame. These doctrines found man transcendent over his natural environment and free to do many wonderful things of his own volition, independently of his environment, a view which is valid if explanation is not examined too deeply. Hence, if man had only his fellowmen to fear, since his scientifically based technology seemed largely to free him from fear of nonhuman nature, it would seem clear that theology and religious practice should turn more and more toward a moral or ethical exhortation of some presupposed human values that thus could be evoked.

One interpretation of recent religious history could be that, al-

though the old superman god or godman was still invoked as father and sponsor of the moral program, the public had decreasing faith that this god made any difference. It was doubtful that there was much reality in, or much room for significant and meaningful operations by, a god which, the theologians as well as other scholars had declared, was dissociated from the realm of the laws that do in fact rule nature, dissociated from the world the sciences reveal and a world in which most people sooner or later come to believe. often simply because of the success of technology. Moreover, whether or not God operates through physical nature, God's operations could hardly have any effect on a man who, as some theologians have implied, was in any case free to choose and make himself and his world what he willed, a man free from ultimate dominance or control by any outside realities. A philosophy that asserts existing human values are supreme and that man is not bound by some outside reality leaves man in charge of his own fate. It tends toward a doctrine of the sufficiency of man unto himself. It results in the declaration that "God is dead" or "God is absent."

Insofar as "God" is a term that means some superior, objective reality or power upon which man is dependent (and certainly this is one of the prime historical meanings of the term), it is easy to see why a "God is dead" theology and a "man is independent from nature" type of humanist philosophy are logically the same thing. The attempt of theologians in recent centuries to free their notion of God from the implications of scientific doctrine, because they did not like some of science's implications for their particular understandings of God, was dangerous. This attempt would be inherently disastrous for any credibility in God, if, as it turned out, more and more the scientific doctrines would shape the beliefs of people about the realities that do in fact create, sustain, and rule human life.

I believe that a careful historical review will show that religions have in the past been most effective in beneficially shaping the feelings, emotions, and moral behaviors of a population when their beliefs about the ultimate and sovereign realities were consonant with the "science" of their day. Perhaps most of the scholarship and creative arts of the humanities today are, along with theology with which they share the function of interpreting to man his religious and moral values, suffering from a cultural lag behind the advances in knowledge made by the natural sciences. This is dangerous for the arts and fields of the humanities, because they also become irrelevant and are rejected by a new generation raised in a culture whose beliefs about reality are incompatible with the traditional

culture. The new generation cannot avoid beliefs shaped by new and different models of reality derived from the new sciences, even when their sentimental feelings reject certain views ascribed to those sciences. But it is more dangerous because humanity as a whole cannot long survive without institutions that adequately structure its beliefs, feelings, and its emotional and moral behavior. The crisis is going to be more threatening to the traditional culture of the humanities and theology as the psychosocial sciences become more closely integrated with the natural sciences, and this would seem to be a strong trend soon to be accomplished. Each year new discoveries are revealing man more and more to be a part of a single natural system. This threat to the humanities side of our two cultures with its mind-body dualism may at the same time be the salvation of mankind if it provides a new route to an integrated culture and a credible God.

Natural Science and the Rebirth of Belief in a Suprahuman Power Ruling Man

In contrast with the above-mentioned dualistic views which portray man (and God) as significantly separate and independent from the natural world, the view that informs my attempt to develop a theology in the light of the sciences is a monistic view prevalent in the sciences. For theological as well as scientific purposes, I find congenial the notions of those scientists who find no absolute or ultimately real separation between human behavior and animal behavior, or between life and the lifeless matter and energy of the universe. This view flourishes more especially in those disciplines that have sought to understand behavior in terms of such disciplines as biochemistry; neurophysiology; cybernetic, homeostatic, information and general systems theory; behavioral psychology; and the like. These natural sciences have increasingly presupposed a faith in the continuity of all phenomena, in a monism (an integrated system rather than a dualistic or double nature) for explaining the world and life and men. This scientific hypothesis—that no phenomenon of human experience is in principle unconnectible in its history from other events and unexplainable in terms of some principles of invariance or lawful relationships—is very much akin to man's most primitive faith that the mysterious phenomena of experience are attributable to certain spirits or gods who characteristically behave in certain hypothecated ways to produce the otherwise unexplained phenomena. Furthermore, the strong tendency and phenomenal success of scientists, particularly in this century, to link all phenomena from astrophysics to life's genetic library and man's behavioral

and perceptual programming to a common interconnected history and system of invariant principles to explain them, is astoundingly akin to the hypotheses in many cultures of some 2,500 years ago that all phenomena are caused by a single universal and sovereign principle or god. Twenty-five centuries later, if we might be expected to generate an equal realism about the determiner of our destiny, I suggest that our most credible, real, and useful doctrines of God now can be found in the most physicalistic doctrines of the creation, sustenance, and trends of the evolution of life.

But before we attempt to show the equivalence of the mighty acts of God in history with the operation of natural selection, we must be clear that natural selection operates in the higher aspects of human development, including what we commonly call culture and mind, which the dualists suppose are somehow independent from the body and from the material universe. I shall therefore concentrate on some contemporary scientific views of natural selection operating in the development of individuals, of their cultures, and of their brains, which is the objective name for that which structures or patterns what many call mind, thought, perception, experience, feeling, emotion, etc. Probably as we examine these selective processes which shape mind and personal experiences, feelings, values, and choices, as well as shape the history of the larger world in which we live, we shall see how close they are to what the traditional religions have called gods. In particular, those who have been enculturated in the Judeo-Christian views will see how the characteristic operations of nature revealed by the sciences are quite close to the characteristics revealed in their tradition concerning the one, universal, omnipotent, sovereign creator of all that is, the definer of all that is good, building the kingdom of the good in history by surely destroying all that is evil.

Natural Selection in the Development of Human Individuals

It should be recalled that natural selection does not operate directly on the genes but operates on the phenotypes, or the living organisms.[11] Hence, it operates indirectly on the genotype. This genotype is the cumulated library of information which, when "read out" by a particular environment, informs the cell or the organism how to behave in the organized ways necessary for life. If the organism as thus directed behaves in the requisite ways to maintain life, the organism's cumulated internal genetic-heritage library is thus proven, tested, or selected by the organism as the library's viable product.

Since the organism, instructed by this "fit" genotype, also, as a part of *its* fitness, behaves to replicate an edition of its genetic library in a new organism of the next generation, then this genetic information is selected. If such reproductive procreation of information is not successful, the genetic information is "selected out" or "selected against," by its failure to include a satisfactory procreation program as a part of the organism it produces. Hence, selection of the genotype is by selection of the phenotype that is able to survive long enough to procreate. There is an interesting parallel here to a familiar religious admonition. In the Christian tradition there is a caution that it is not sufficient to be hearers of the word or merely mouthers of the true word, but one must also be a doer of the word. The genotype is the word (for the precultural phenotype), but unless it becomes incarnate and active in the flesh, it is worthless and will not itself survive.

Thus, natural selection is operating, as Darwin wrote,[12] at every instant on every aspect of the interdependent parts of a living system, whether that system be as small as a cell or as large as the earth's biosphere. Human organisms are no exception to this rule, although they have some very exceptional sources of information and ways of adapting to the natural realities in order to maintain and enrich life. The following notes give some recently developed pictures of the nature of the forces acting to select and hence to shape or determine the destiny of men as they develop from conception to death.

The behavioral and life sciences have gone beyond the old debate on "nature versus nurture," because both nature and nurture are seen as aspects of a single interacting system. New ways of thinking, including systems analysis, have provided a formal way for avoiding the impasses and paradoxes of older ways of viewing things. The development of the living human being, beginning at the point of conception, is now seen as the interaction between genetic heritage and environment. In computer jargon, it may be called a "readout" of the guidebook for living (encoded in the molecular patterns of the DNA of the genetic heritage or genotype) of the environment. It can be said that the genotype is a cumulative memory record of recipes for adaptations to a way of life that have thus far been successful among all prior constellations of the environmental niches of that life. Hence, it represents a cumulative wisdom for life selected by the historical events of the living systems in its world.

The immediately present environment of the DNA is a readout

mechanism for reading the recipe book and making a human being. By a readout mechanism I mean any negative-feedback or cybernetic system in which the input of data or information (including the internal memory of previously acquired information) is transformed into some output response which directs or adapts the system to maintain or extend its already acquired goals. A readout mechanism may be as simple as a thermostat that reads out the dropping temperature and turns on the heater. The process is of the same general form when a cook reads information from a cookbook, from materials in the cupboard, and from internal memory about certain goals and certain ways of behaving, where the output is a delicious cake. The readout mechanism whose output is a man, besides the very large recipe library in the DNA, involves several levels, including: (1) the cytoplasm of the egg cell, (2) the internal physiology of the mother and general behavior of the family, (3) the house, shelter, home, village, or local habitat in which the family dwells and which for humans includes the socially transmitted artifacts and habitual patterns of human behavior of a family and society that represent a new mechanism for transmitting and storing recipes on how to live—the cultural heritage going directly from brain to brain, (4) the larger habitat of the country—the larger culture, geography, climate, soil, etc.—where the home is found, and (5) ultimately the larger ecosystem or habitat which includes the sun and the cosmos.

The intimacy of the cosmic nature with life is often overlooked by those who are not close students of it. The nuclear fusion of a star directly and indirectly influences life and its development on earth and is an essential part of the positive readout mechanism for the recorded memory in plant genotypes and for men, for example, for eye development. Moreover, cosmic characteristics provide the everlasting source of the power and pattern that shapes all things. Its power and pattern permeate all structures of the world and of life from the creation of life long ago up through the present and, presumably, forevermore. The several stages or levels of the environment are all simultaneously active to supply the conditions for the interaction of the DNA recipe book with its environment, which interaction is the "readout" of the genetic code that programs or structures the development or behavior of the organism. I shall point out a reverse or reciprocal "readout" later—the readout of the environment by the genotype. While scientific evidence for the details of the complex interaction of genotype and environment remains far from complete, the new views and evidence for interaction

and joint selection of suitably matching genotypes and environments seem to warrant an end of former worrying as to whether the hen or the egg came first.[13]

In this picture of the developing person, it should never be overlooked that the genetic code, the genotype, is itself the heritage or memory of the successful interactions between living systems and environment produced over a time sequence of more than a billion years of evolution by innumerable trials and errors, always judged by natural selection. Thus, the genotype is itself essentially a symbolic codification of what the environment demands for life, which has been "read out" of a long history. Thus, the *genotype,* which is information for living that has been read out of the environment and recorded in nucleic acid by natural selection, is reciprocal to the *phenotype* (the body), which is a pattern of living being and activity that has been read out of the genotype by the immediate environment and incarnated in amino acid and other structures by natural selection. Since the genetic message is only transmitted when the succession of organisms instructed by it have been adapted successfully and continuously since it began, the message is an encoding of successful patterns of life in the environment, and hence can be regarded as a record of the environment. One could say that the DNA pattern is a condensed image of the environment internalized in cells to guide their life. The molecules of the genetic DNA chain differ from a randomly arranged chain of DNA molecules only in that they do in fact incorporate in a symbolic code a very precious heritage, memory, or register of information about how to live, derived from ages of experiences of evolving adaptations for life in the world.

It is a widely held hypothesis about animal and human development that, at every moment from the zygote or union of parental genes, through embryo, to death, "selection" is operating. That is, at every instant the production or behavior of the various chemicals by the natural interaction of genetic code and environing chemicals is such that feedback information (which may involve simply the concentration of certain molecular structures) will shut off or turn on at the right times the proper releases of energy and the proper manufacture of one chemical structure or another so that a viable organism is developed and maintained.

The selection is always a matter of viability or survival—one could say *stability* of the open system; for, as soon as the molecular structures and behaviors within and around the cellular structures of life (and the organic structures and behaviors that they produce) fail to

meet the multitudinous and complex requirements for the continuity of the organism within the environment, at that point the whole development is broken off and death occurs. If this developmental process fails to produce the required dynamic homeostasis at any point after birth (as in the case of failure to inhibit or prevent internal development of a certain type of destructive virus or bacterium or to regulate properly the internal temperature or food supply, etc.), the organism will die; that is, the *nature* of the situation removes the organism and its unadaptive behavior from the face of the world and from future history. Thus, nature (the physical nature of the interacting system) selects or weeds out bad or inadequate programs that are not adapted to life. The unadapted organism will cease; and, if it dies prior to its reproductive activities, its particular genotype will also be weeded out from the gene pool.

It should be noted that in primitive living systems, it is the "motherhood" or "fatherhood" of the general environment (the immediate ecosystem) that fosters or selects the development of the organism from the time the egg is fertilized or from the time it leaves protection by its organic parents. But in mammals, including man, the parental behavior of adult organisms becomes a vital part of the immediate environment of the embryo and infant, and hence of the selective process. In such cases, we note that parents, particularly the mothers, are genetically programmed to operate in ways protective of and nourishing to the development of their offspring. In any cases where this proper parental behavior has been inadequate, the infants die, and that is the end of that genetic line. Thus, selection operates to generate proper parental behavior, and parental behavior in turn selects the appropriate responses of the growing infant. Elaborate details of proper parental behavior are genetically programmed in many species. While only the larger outlines of parental behavior are genetically programmed in *Homo sapiens,* there are still millions of details to which cultural heritage has as yet contributed very little.

Natural Selection of the Culturetype

But, in addition to genetic programming of parental provision for children, individuals in human societies are also programmed by a tradition, a body of information, that is passed on, often more or less unconsciously at the most primitive levels, from parents, peer groups, and other instructors or shapers of the behavior that is characteristic in the society.

The cultural storage and replication of information are quite

different from the ways in which the storage and replication of information are carried on in the genotype or genetic heritage. Yet a systems analysis shows equivalency of function. Moreover, the role of "selection by the natural consequences of the interacting systems" (which is a good way of saying "natural selection") is identical for the establishment of both the genetic and the cultural patterns.

Because I believe the role of natural selection in establishing the cultural pool of information and its transmission as part of the input that patterns structures and behaviors is the essence for a scientifically grounded understanding of the reality and relevance of a doctrine of God (understood as a system of forces that did create and does determine human destiny, and whose rules man must accept if he is to have life), I shall outline some of what I think are significant new understandings of the mechanisms of cultural evolution and of the operations of natural selection in determining the ultimate patterns of human behavior regardless of whether these patterns are fabricated in the genotype or in the culturetype or by what is involved for every human, the joint input of both.

The structures and behaviors of all living creatures are informed (caused or made into their particular patterns) by the interaction between two systems: their genetic heritage, or genotype, and their environment. The environmental system may be analyzed concurrently into several subsystems from cell cytoplasm to cosmos. Ultimately, in the scientific view that I espouse, there is no separation between man and the cosmos. As Harlow Shapley has said, "We have evidence of a truly wide Cosmic Evolution from hydrogen to *Homo*. . . . We have in Cosmic Evolution a fundamental principle of growth that affects the chemical atoms as well as plants and animals, the stars and nebulae, space-time and mass-energy. In brief, everything we can name, everything material and non-material, is involved. It is around this Cosmic Evolution that we might build revised philosophies and religions."[14] The ultimate "parent" and ultimate "culture" may properly be said to be the cosmos.[15]

In this production of a living creature, the environment is much more important as an informing or structure-causing agent than some traditional genetics has supposed.[16] The information in the DNA of the genotype is no more than is necessary to produce the living organism by interactions in an environment which is also rather highly structured and hence a source of part of the necessary information as well as of the necessary energies and materials for living systems. A genotype will not result in a living being except in its proper environment. Genotypes are not effective apart from the

special cytoplasm of an egg; eggs must be incubated at suitable temperature; free oxygen and water and other molecules must be supplied at appropriate energy levels; and human infants must be reared in a society which communicates suitable information if they are to become viable adults and to procreate a viable species.

While some of the machinery of transmission of cultural heritage may seem to be just the opposite from that of genetic information, a closer analysis of the systems will show that basically the same sort of thing is happening. In the transmission of culture to determine the development of a child, the generating form, or pattern, or information is located outside the skin of the growing person, while the pattern of his genetic (DNA code) heritage is inside each of his hundred billion or so body cells. The structures or patterns of culture enter the individual only through his eyes, ears, and other organs for sensing his external environment. As noted above, the culture is a special subclass of the environment which is highly charged with information for how the receiver should develop or behave. But, while the DNA operates from the interior of the cell and the culture from outside the skin, a systems analyst can see that both the genotype and the culturetype are information inputs that structure the behavior of the growing and living person.

Natural Selection in the Brain

In higher animals, it is the brain that organizes behavior (I use "brain" to include the subsystems of the nervous system). Much of the information in the brain comes already prepared or "canned." The genotype gives it its basic structure and behavioral proclivities, although we should always keep in mind that the character of the egg cytoplasm, the embryonic environment, and the postnatal environment supplied by nature apart from culture always play an essential role in the structuring and behavior of the brain. But it is the large amount of cultural input into the human brain that makes man different from all other animals. Fortunately, most of this, like the genotypic information, also comes prepared, prefabricated, and ready for use.

At first, a human infant operates according to the dictates of a brain informed largely by the "canned" information of his genotype together with information acquired in a growth where environmental influences are very little and only indirectly informed by culture. The brain, and hence the child, performs in a very highly organized way to maintain the characteristic patterns or dynamic homeostasis of the organism. It may be said to resemble in general function the

orderly operation of a very complex cybernetic-computer machinery. It is so well informed about what is necessary for life that it performs billions of very highly complex and delicately integrated life-building and life-maintaining tasks every second, most of them in patterns that do not reach consciousness or awareness until some scientific research discovers what is going on. But in general we have learned enough about the behavior of the brain and the resulting behavior patterns that are visible to all observers that many scientists are quite confident that the brain is the prime organizer of human behavior above the level of the genetically (and environmentally) programmed biophysical chemical operations of the organism.

In addition to its largely genetically preprogrammed controls to keep the internal machinery of the organism running smoothly to produce its characteristic life, the brain provides a necessary map or model of the self in the external world. The map is made up out of the brain's abstractions from the contemporary and remembered input from the eyes and ears and other external sensory organs. The map is dependent upon the remarkable capacity, akin to that of the genotype, of memory and, further, upon the even more remarkable capacity to classify elements of its exceedingly complex memory record and current experience into a relatively small and manageable number of categories useful for defining behavioral responses proper for maintaining life. These categories may be said to be the abstractions of relatively invariant symbols of significant elements of the experienced history which, together with certain modifiers or quantifiers, provide a representation of the self and the world and the self's proper responses thereto such that life-sustaining behavior is the end result. The genotype, of course, is also such a map; but its capacity and its rate of modifiability are much more limited. The brain's map of self and world is built up from interactions of the brain with the total structures of the self and its relevant world, wherein selective mechanisms genetically built into the brain rapidly generate response patterns that are "successful" or "viable." Ultimately, of course, selection is made by whether or not the total life system is so adapted as to maintain itself in being as it interacts with its environment. The perceptual world of experience produced by the brain performs this necessary function or it will come to an end and cease to be. The prepared or already organized input patterns to the brain that produce the common categories of perception are representations of the energy and structure patterns characteristic of the organism's self and habitat for which the organism has sensory mechanisms.

These neurological abstract patterns or maps of self and the world are the stuff of which symbols are made, including the words of human language which are symbols of experiences that are readily communicable from man to man. A word is a symbol or code for a category of neurological pattern, and hence for an experiental or behavioral pattern like "red," or "round," or "run," or "rip." The brain's map of self and world is inextricably interlaced with the neurological patterns of words which are functionally isomorphic with the map, like the relation between the words or route numbers and the towns and roads on a map. The symbol system of words that constitute a language to label the map of the self and world also comes to the brain already prepared, "canned." Children do not have to invent language. The language comes already evolved out of hundreds and thousands of years of cultural evolution, selected for its efficacy in performing its tasks, which includes facilitating the internal processes of thinking and computing or anticipating the future as well as the communicating of "thought" from one brain to another. The language systems are remembered in brains (with help from such cultural artifacts as writing and books) and are transmitted by the human brain's capacities to remember and to relate or classify cultural symbol systems with its genetically and environmentally programmed map of self and the world. They are selected by their efficiency and usefulness in meeting the needs or wants of the population of a culture and hence by its viability as a subsidiary element of a culture and, in the long run, by the viability of the culture.

With the aid of the culturally evolved language systems, including mathematics and the sciences, the brain has increased capacity to revise and simplify its abstractions so as to provide ever better fits to the environment and ever better and simpler formulas for computing the future. The genotypes also do this in the collective gene pool of a population, but at a much greater cost and at a much slower rate. The evolutionary invention of the human brain as an agent for cultural evolution produced a new, less expensive, and more rapid instrument of evolution than the evolutionary invention of the DNA-structured genotype. The genotypes distributed in the population of a species can recombine their symbolic abstractions of life-structuring information by chance mutations and chance recombinations in bisexually reproducing organisms. But this kind of learning mechanism is very costly in terms of time and death.

Computing the future is necessary for organisms that are required to adapt themselves suitably in a changing environment. The

genotypes can and do compute the future insofar as the future is a simple projection of the past. They also provide for a variable and unpredictable future by providing within the population a statistical distribution of types, some of which are bound to meet the requirements of some likely set of future environmental demands. But brains and their capacity to provide symbolic maps of the world, which include logical-transformation operators (especially those of the sciences), can predict the future much faster and with less loss of life. When these maps and their transformation formulas can be remembered and transmitted as part of cultural patterns (languages, technologies, religions, sciences, etc.) within a population of people, successful cultural adaptations can become a valuable heritage like the genetic heritage in providing fairly surefire behavior for life in a more complex and faster-changing environment.

Hence, in human culture we find a new kind of heritage for life structure, based on the more rapidly adaptive reformability of memory possessed by brains than by genotypes. In brains, memory can be reformed (by "killing" or wiping out the previous pattern and substituting a new trial or mutation) many times a second and testing it many times a second for viability or selection in a moderately adequate or reliable model or map of the self and world internalized in the brain. Trial and error in the real world, as a method of evolution's prior search for better adaptations to the requirements for life, is much slower than trial and error in the brain because it requires the testing out of the whole organism, which takes a good deal of time. It is more costly since, if in the trials or mutations there must be a certain number of errors or deaths per successful adaptation, it will cost that many deaths of whole organisms (and of their genetic patterns) for each successful or adaptive trial. But in the case of trials by a modifiable model maker like the brain, where it is only the bad models which are "killed" and not the total mechanism for making the models, the cost is measured in terms of the time and energy taken to weed out bad models. This is relatively small.

In the brain, bad models can be weeded out very fast by fairly adequate internal selection processes. Internal selection is the first of the brain's programs of "natural selection" or screening for relevance. In a brain which has elaborate and well-tested maps of the self and world, this screening process (by unconscious and then by conscious, logical analysis of what fits and what is to be rejected) becomes a highly efficient and rapid program of "natural selection" in that, with a minimum cost of time and energy, new and higher levels of viable forms are evolved.

The patterns of behavior that pass this first screening or selection, by natural processes in the brain mechanisms for surveying its current inputs in terms of its cumulated memory of past inputs, may then be tested more slowly and more surely in the "real world" when the brain selects its best internal selection as a program for test through behavior of the organism operating in the "real" world. If the baby's hand misses the rattle or if his mouth fails to find the wanted and needed food, his brain will recompute and try again. But even this test or selection by the "real world" is much faster than waiting for a new generation from a genetic mutation. Moreover, the mutability of the brain means that nature selects against or weeds out only the wrong behaviors and not necessarily the whole organism.

Natural Selection in a Community of Brains

Human culture also has the advantage of multiple simultaneous trials or mutations in its seeking of viable response patterns to the requirements of the general environment or habitat for life. In a society of individuals, many brains can be simultaneously searching for better solutions of human adaptation. If one man invents a moderately successful way of flying, another may invent another, and the most economic or successful adaptation will finally be selected by the nature of the circumstances.

It should be noted that not only can cultural evolution be speeded up by multiplying the number of trials by the number of the population making trials, but the finally "selected" sucessful adaptation can immediately be spread throughout the whole population. This multiplies the beneficial spread of success by the number of the population. This is possible because brains are modifiable, and all the people who made the wrong, unsuccessful, or nonselected trials can immediately adopt the successful adaptation found or discovered by only one of their number. To make this possible, brains must not only be modifiable, but they must be able to receive a communication of the successful adaptation. Among the world's artistic inventors or creators and in the world's technical laboratories, thousands of aborted trials are made for every successful invention of a new poem, picture, pill, machine, or other cultural artifact that may be valuable for human life. But the successful outcomes are communicated and become available to all, not only to those who tried and failed, but even to those who never tried to solve that particular problem of finding a better adaptation. In earlier kinds of evolutionary adaptation by means of many trials

(polymorphism of genotypes in a population), each losing trial meant a costly death to a whole organism. In human culture, all trials and even all "dummies" who are not even playing the game can ultimately win because brains can be modified by communications of successful new adaptations.

Another example of the efficiency of human culture in the task of adapting to newer and higher levels of organization to live more successfully in wider and wider ranges of environmental circumstances is that of the social division of labor. The problem of inventing a single kind of flying machine, for instance, may be subdivided among whole groups of men drawing on information accumulated in various departments of the cultural heritage. A good example is the input from tens of thousands of men and many hundreds of special cultural disciplines that landed men on the moon. This speeded up the development of the possibility of landing on the moon in less than a decade from the time of the decision to do so. Left to isolated and random or unorganized applications of science by individual men, or to very small numbers of them working together, the project might have taken longer than the evolution of culture from the invention of the wheel to its application in the horseless carriage. Left to natural selection of genetic information, it would have taken more time than the earth has been in existence.

One should keep in mind that it was natural selection, however, that structured man's moon flight. As in the case of the operation of the individual brain, the first screening by natural selection was by imaginative games played internally in an interlinked net of brains enculturated with operable models of the structures and behavioral laws of nature: of gravity, of motion, of men, etc. Individuals and groups among these scientists and engineers selected certain of these "plays with symbols" as winners at the theoretical level. A second stage was in more expensive testing of more "realistic" models. The final selection, as always, is that made by the ultimately "real nature," the nature of the total factors involved when men actually landed on the moon. The selective process weeded out imaginative inventions that the inventor or his colleagues found were contradicted by any already known facts or theories, weeded out partial physical models that failed when tried, weeded out actual moon landing programs that did not sufficiently meet the full range of requirements laid down by the ultimate realities of the situation. The modern scientific maps of man and his world, and the technologies that are derived from them, provide human culture with its most advanced mechanisms of adaptation, of seeking and finding new and more advanced

ways to thrive in the "real" or "natural" world which is the ultimate judge of all that lives.

Thus, for rapidity and multiplicity of trials (mutations) and rapidity and multiplicity of testing them for viability against reality (selection), probably nothing in the evolution of life on earth has yet come to equal the system that we call human cultural evolution. This depends upon a population of brains each of which receives a treasured and rich sample from three sources of heritage. The human infant's brain becomes the memory center for information input from three sets of heritages: (1) the input from a highly structured genotype that is a randomly selected variant of the highly structured human gene pool, unsuccessful variants of which have been largely weeded out in the past by natural selection, that is, by the natural lack of those forms that are not adapted to successful continuation (homeostasis) or reproduction; (2) input from a random sample of a fairly stable and habitable world or habitat, unsuccessful variants of which have been weeded out by the fact that inhospitable habitats for the existence of either the parents or the offspring are quickly weeded out by their failure to tolerate parents or offspring; and (3) input from a random sample of a human culturetype, which is a complex structuring of the general environment or habitat into a *human* ecological niche by the memory and consequent activities of the brains of parents and other members of the infant's society, the inhospitable or nonviable forms of this culturetype having been weeded out by relative failure to be reproduced. The brain is structured and hence it operates (and the whole being thus operates) according to these three sources of memory, which are all aspects of a single evolving cosmos. In particular, the developing brain involves interactions of these three sources from which it is the task of the brain itself (as directed by its genetically structured memory) to select out and remember (and hence to utilize) some viable patterns that integrate from all three sources the proper response patterns for life. Natural selection is the name for the failure of erroneous (and hence unstable) conclusions or patterns to reproduce, to repeat, to survive.

Culturetypes may be seen both from the perspective of the society and from the perspective of the individual person. From the point of view of the society as a whole, the culturetype is analogous to the genotype, and it reorders or reorganizes the behavior of individual persons or groups of them so as to make a viable society. From the point of view of the individual, the culturetype becomes ingrained in his central nervous system by the reinforcement or inhibition of his

initial behaviors as directed by his genetically structured needs or desires and patterns for attaining them. The cultural system knows how to modify and elaborate genetically programmed behavioral systems by operating on the reward and punishment systems for reinforcing or repressing behavior already provided by the genotype. Pleasure and pain or demands for more or less of something were provisions of the genotype that more than a billion years ago were selected as necessary for life: it was necessary for the living being to shun the noxious and incorporate the nourishing elements from the environment. Each living unit had to be informed how to avoid evil and seek and attain the good in its environment. It thus generated mechanisms for seeking and avoiding.

It was a natural consequence that other organisms of either the same or a different species would be able to manipulate a given organism by manipulating that organism's seeking and avoiding mechanisms. Thus has nature selected programs for motivating sexual reproduction or the viability of the species by endowing the opposite sexes with genetically programmed mechanisms that make sexual recombination most attractive. An interspecific example is the genetically programmed machinery of a bee to sting which keeps men and beasts away from the bee's nest, at least until they learn how to avoid the consequence of a bee sting. It is in such ways by which other members of his society operate on his desire mechanisms that the human individual is motivated to operate according to the mores or customs of the society in which he has been enculturated. The brain of every human individual is thus programmed by his culture from outside as well as by his genotype from inside.

By providing a common culturetype that informs, shapes, and motivates the various individual men within it, common cultures in fact make "brothers" of men, brothers having a common "soul" or heritage insofar as a culturetype has become in fact a common pattern of a society's heritage. As cultural evolution advances and men have larger and larger portions of their nature structured by a common culture, they become more and more like brothers; in fact, they become more and more closely related as members of a common body or social organism.

It has been argued by some scientists[17] that the only successful and complex societies among animals (apart from man) have been among the insects, and that this is possible only because the whole society is made up out of and selected by the mechanisms of essentially a common genotype. It has been argued that natural selection of interbreeding genetic populations cannot produce self-sacrificial

behavior of one individual on behalf of other individuals of a different genetic line in the same population. Selection operates by the number of survivors, and if a genetic line produced individuals that gave up their lives for a second genetic line, the second genetic line would eventually be all that would be surviving. The different social castes in insect societies are differentiations made by differential information input from the environment during ontogeny, and hence the social specializations found here may be said to come not from a difference in genotype but by postnatal instruction. This postzygotic, extragenotypic differentiation of function is similar to that of a colony of cells that make up an organism. They all have the same genotype, but are given different structures and functions by information input from outside during ontogeny. Marked social differentiation of function is not found in higher animals, such as mammals, it is argued, because evolution did not find sufficiently powerful nongenetic ways for differentiating functions that all serve a common social goal to the extent that one individual will deny himself for the welfare of the total society.

The cooperating society of some hundred billion cells of the human body, that make me what I am and you what you are, is the product of a single genotype, a single egg. One theory suggests that each of the cells of the developing human is instructed in slightly different ways by the slightly different conditions of its immediate habitat (which, of course, includes other cells) so that the result is not a population of a few billion competing and quarreling individuals constituting a number of aggregates or nations all at war with one another, as is sometimes the threat among human populations; but the human body is a population of highly differentiated but faithfully cooperating cells several times more numerous than the human population of the world. Each cell's operations are so delicately subservient to the general welfare of the total organism that you by and large find yourself to be a quite wonderfully one, single, integrated being. A cancer is a case where certain cells take an independent stand for their own "tribe" or "nation."

In human populations, the genetic blockage to making a cooperative group out of varied and competing individuals from a polymorphic gene pool has been at least partially and potentially overcome by the provision of a common heritage through a common culture-type. The different informational input of a culture into a human population is capable of turning similar organisms into different social roles, such as tinker, tailor, cowboy, sailor, doctor, lawyer, Indian chief. But in *Homo* this has been accomplished in spite of the

fact that the human population is already highly differentiated in its genetic structures, which is not true for insects in insect societies—a matter that indicates something very special about the human genotype and its interdependence or symbiosis with a culturetype. In the past, certain religious and other cultural transmitters of common values have unified populations by producing a community of common aspiration, trust, and cooperation (even self-sacrificial behavior) throughout a numerous population of organisms whose genotypes would not be able to accomplish this without the added cultural input.

Natural selection, as I have been insisting, operates in establishing the seed, memory, or heritage of a culture, and an interesting question immediately arises as to why it is possible for nature to select a culturally programmed trait in which a man may be programmed to serve other men at sacrifices to himself while it may be impossible to do this by natural selection of genotypic programs. The answer is that the culturetype is common to each member of the whole population of a society, like the common genotype that provides the possibility for self-sacrificial social behavior in the social insects or in the cells of a single organism.

The selection among the social insects of traits that are useful in permitting the total society to survive at the cost of a specialized duty by some caste, say soldiers, which means that they cannot farm for food and must be dependent on others in the society for the food, and which may mean that they have to give up their lives while those they protect do not, has been made possible, it is suggested, by the fact that the common genotype and procreation system for all castes means that the sacrificing of some of them is not in the least lethal for that genotype, even though it may be lethal for many individual soldiers in the society. On the contrary, because of the brave and sacrificial defense of the soldier, the society may be more likely to survive, and hence that soldier's genotype, which is identical with the one that shapes the society, would be selected.

The same is true for human culturetypes, even though it may not be for human genotypes. Since the culturetype is common to a total human society—the way the genotype is common to a total insect society—then the bravery of soldiers, the hard work of farmers, or the devotion of all those who direct their labors to the commonweal may produce a society that is much better able to survive under certain conditions than one which had cowardly soldiers, or lazy farmers, or indifferent citizens. The thriving of the community or society as a whole is what selects a culture. (I am here leaving out of

consideration that different societies may have gene pools of different character and that this also may enter into the viability of the society, since I am here discussing only culturetype and not genotype.) In this situation, as in the case of insect societies, it matters little how dangerous or personally disadvantageous may be the lives of those in certain special occupations, as long as they can be motivated (by the culturetype operating in conjunction with the given genotypes and habitats in the population) to their task and as long as the danger to or loss of these individuals does not adversely affect any other aspects of the community's well-being. If a certain culture will produce a richer life for a greater number, it will continue to attract people at the expense of other cultures that may have produced more poverty, less opportunity and interest, etc.

An interesting example of how the life of a culture is partially separated from human genetic factors and is selected by the quality of the culture even though it may be genetically inferior is the reported fact that in the last few thousand years the reproduction rate of the human gene pool has been lower in cities than in rural areas. But the urban subculture attracts young people away from the rural areas, so that in fact the population of cities has been maintained or increased in spite of their smaller reproduction rate. Another interesting example to show the independence of culturetype from genotype is the fact that the various cultures of the world are buying or adopting the scientific-technological culture of the West because of its advantages to them compared with their previous cultural tradition. There are many problems for us and for them here, but we cannot treat them in this paper.

Some Cautions and Conclusions

I must briefly mention some matters that may be frightening, and some properly so. There are several dangers in programming by a culture. Some of these fears have been portrayed in part by such writers as Aldous Huxley in his *Brave New World.* But what most people do not realize is that society has for millennia been programming the behavior of each new generation through its culturetypes at least as completely as the programming portrayed by such fearful writings. But the results on the whole have been beneficial and have caused societies to flourish. A number of psychosocial scientists have in the past few decades been impressed with this, and their literature is a sobering and also heartening reminder of what tremendous gifts for enriching animal life comes from social imprinting, conditioning, reinforcement, and other programs for inducing certain behavior

patterns.[18] Every local culture, every language, every religion programs its population. We are as unable to avoid most of our being shaped by a culturetype as we are unable to avoid our genetic heritage. We can do little better in choosing our cultural "parents" than in choosing our genetic parents.

But the fearsome tales of *Brave New World* and *1984* and the like do not reveal the heart of the matter. The important point to note is that in any system of competing cultures or subcultures natural selection is continuously weeding out evil. The wicked do in fact perish, and the righteous are rewarded, if we take reward to mean that their "good" or "fit" patterns of life will survive. If you trust in the Lord of natural selection, you need not fear that the wicked will triumph. You will not join the alarmists in conjuring up mountainous threats out of molehill dangers inherent in selfish ignoramuses that have always populated human societies. Natural selection is certain to crush any competing individual or group that fails to follow the rules which the ultimate nature of things has defined as right or necessary for survival.

In fact, this is perhaps the primary point of this paper: that the sciences confirm what many of the traditional religious doctrines have long declared, that there is a superior power that creates and ordains life and judges, rules, or selects—punishes or eliminates what is wicked and rewards or causes to survive what is good. The notion that man is self-made or in control of his destiny and the notion that human desires or wants are necessarily the primary source or criterion of values are as wrong according to a scientific doctrine of man as they are according to many of the traditional religious doctrines. What is most important here is to note that this statement applies not only to man's emergence out of his earlier strata of cosmic chemicals and of animal nature, but equally to everything that happens at the highest levels of operation of the human brain and culture.

In cultural programming, what man needs to fear is not so much the wickedness of human tyrants or manipulators as it is his own (and his companions') failure to recognize that there is a sovereign power and authority, and his own failure to adopt or adapt to this authority. The clever schemes of the wicked to manipulate their fellow beings for their own private self-interest are statistically as impossible as is the survival of a genotype that does not produce a viable organism of cooperating cells. Cancerous (selfish) cells kill the genotype that programs them if they operate prior to natural selection's deadline. The problem of evil and evil men is a problem

where a scientific doctrine of man looks to me to be very equivalent to the best religious literature. But the significant first step in finding a correct and viable doctrine of man for our own welfare or salvation is our recognition of the reality or nature which far transcends all men in power and which weeds out the inadequate and favors those better adapted to that nature's ultimate requirements. As long as a significant population of men have freedom to adapt to the requirements of natural selection or the Lord, wicked men pose no serious threat to the coming of the Lord's kingdom of enriched life upon the earth.

This does not mean that men have no obligation to seek the good and to destroy evil, for they are agents of the Lord or natural selection in this process. What is important is that they need not fear that evil or inviable patterns will triumph in the end or survive. It is of the very nature of men that they will be continuously reinforced to seek the good and shun evil by pleasure and pain administered by selection pressures genetically from within, and from without by selection pressures from their habitat and their culturetype (social pressures). "Thou has made us for thyself, O God, and our hearts are restless until they find their rest in thee," as Saint Augustine put it. The grace here revealed by our understanding of an omnipotent natural selection is that we do not need to get panicky when we and our fellowmen make their inevitable mistakes in their necessarily imperfect search for the patterns of behavior that natural selection requires.

However, one serious problem for continued operation of natural selection in human culture should immediately concern us if we wish to see the Lord's kingdom of enriched life come to pass on earth, and that is that we must ensure that our system of life remains open or reasonably free to try or search for novel patterns of life, even at considerable cost. We can never avoid the punishment of natural selection's rule, for behavior that fails to meet nature's requirements for life is lethal, and our innovations now and in the future carry some of this risk of being detrimental, as they always have in past evolution. For this reason, we need to distribute risks, and not put all our eggs in one basket. A single, rigid, inflexible world culture might be the most dangerous situation we could put ourselves in. Evolution requires the freedom of different approaches in the search for true adaptations, different trials, many of which must be errors. We have to tolerate error and evil as a price for advancement of life. This is the way nature or the sovereign "Lord" has arranged things. As we come to an age in which we must have some degree of uniformity in

world culture (for we are now in reality an interdependent population forming a world society), we must at the same time see to it that tolerance for variance, for difference, for error, is built into our system—else we leave ourselves open only to the *negative* judgment of natural selection: death for man on earth.

The seeming paradox of evil in a world ruled by an omnipotent and just sovereign power—a problem that remains the same whether you call the power "God" or "natural selection"—dissolves when we understand the scientific revelations of the dynamic character of evolving systems of life. Viewed as a necessary part of the program toward the ultimate triumph of good, the "errors" or variation become necessary, and hence good rather than evil, for generating life. Viewed as a part of present human desires, themselves necessarily partly in error, the error is then evil rather than good. The only salvation for man is a cultural transmission of truths that enable him to transcend his limited private views and desires and to adopt a longer-range, more divine perspective, wherein he may recognize his present imperfection and suffering as a necessary element toward the long-range good guaranteed by God. Animals already behave with this "courage" and "hope" in the face of the same necessary danger and death, since their genotypes are adapted to this reality of life. In *Homo sapiens,* the genotype does not very adequately provide such courage and hope. For shaping man's morale and morals, as for his technology or language, man's genetic information must be supplemented by an adapted body of cultural information which we call religion.

Let us review how both culturetype and genotype find new and better adaptations and how the better adaptations are selected and maintained. My review of some recent notions of the natural causes of human behavior indicate that adaptive behavior patterns may be initiated by chance or random behavior at the level either of DNA molecules or of brain cells. The organized system of billions of DNA molecules of the genotype is a very different mechanism from the organized system of billions of brain cells. But both systems remember or store information learned in the process of living. They use this information to direct or organize the life behavior of the cells or organisms. Both systems when suitably stimulated by circumstances in their environment (habitat) will guide and organize activities that maintain life. By negative-feedback machanisms, they correct mistakes and correctly organize the life programs of which they are the long-enduring core, or we might call it the "soul." Both systems of remembering are capable of change or mutation; they are capable of

having their mistakes corrected and of discovering better ways of living, although this is an expensive statistical process requiring large numbers of independent units, most of which have to be sacrificed in order that a few are enabled to hit the mark of a new, successful adaptation. It is something like the "wastefulness" of shotgun ammunition, only a fraction of which will hit the target. What is central for this essay is to note that the eventual historical form or pattern of structure-behavior taken by man's "soul" (any of the persisting records or memories of experience distilled in DNA, culturetypes, etc.) and hence by human persons (phenotypes) is not decided or determined by the memory mechanism or even by the particular memory content, but by whether or not the remembered information has discovered ways of behaving that are in fact capable of keeping the open living system in being. This is what the terms "viable" and "adapted" mean; ability to behave so as to meet the requirements placed by the nature of the environment and the nature of all the detailed organization of the open living system so as to keep the living system in being—surviving, stable. Nature is sovereign and selects or judges the products of either of these systems of learning and memory.

Remembering that the nature that selects what shall live is the total nature, including the ingredients and behaviors inside the living system as well as the ingredients and dynamics of the environment—that is, selection is the stability or continuity of an evolving ecological niche—we have already noted that the nature that selects or judges is a complex operation of many subsystems all of which have to be kept integrated so that the life system maintains its balance, stability, or dynamic homeostasis.

We have also noted that living systems, including men, are the products of the history of nature, of a long history of evolving patterns, which modern science traces back to a time before there was any life. Thus, the nature that selected man is ultimately to be traced to the nature, described by the physical sciences—the basic nature of the earth and cosmos as it was before there was any subject matter for biological or psychological science.

As is increasingly demonstrated in the history of the sciences in the twentieth century, various aspects of biology are being illuminated by physics, including the machinery and behavior of genetics in terms of the nature and operations of DNA molecules; the machinery and behavior of the brain in terms of electrical, chemical, and molecular operations; the machinery and behavior of glands and muscles in terms of physical chemistry; and so on. Hence, we

may say that the nature of the physical world provides useful explanations about many of its subsystems, including the structures and dynamics (behavior) of living systems. This even applies to describing the way men think and feel, which, when understood in terms of the electromagnetic structures and energies of brain cells and their molecular subunits, is a description of a very complex physical subsystem. Thus, even the description of the dynamic equilibria of events inside the membrane of a living system, as well as of the dynamics of events in the environment, may be a description in terms of the same nature which physics has helped us to understand.[19]

The *nature* that selects any of its subsystems is now understood in terms of nature's invariances. Invariances are unchanging conditions and laws according to which we find the more changing phenomena of nature to be operating. The laws of physics are only a special class of the invariances revealed to the human mind and confirmed by human experience. In the history of human thought, among the earliest and most comprehensive systems of abstractions of invariance were those of primitive myths and theologies, which gave the names of gods to the sources of the invariant and powerful forces or laws which man had to obey if he was successfully to adapt to life.

One of the most comprehensive recent pictures of the total system of nature as it applies to the evolution of life and human life in my opinion is that presented by J. Bronowski in his "New Concepts in the Evolution of Complexity."[20] The progress in the evolution of life may be understood as the attainment of successive levels of increasing complexity which, according to nature or nature's laws, are permissible, stable, or viable when attained. One might say, in this picture, that these viability or stability levels are potentials (preexistent or proleptic) in nature. At successive stages of history, they may be attained provided the conditions that nature requires for their coming into being are met. In evolution these conditions have been met by chance, that is, by the random variations or trials that nature's energy sources make available. However, the *selection* of one or more of the trials and the *rejection* of most of the others *are not by chance, but by the requirements for stability inherent in the nature of the interacting elements, inherent in nature.*

This same principle is true whether we are talking about the random fluctuations of protons and electrons that are bound under certain conditions to stabilize as hydrogen or under other conditions as helium plus solar radiation, etc., or whether we are talking about

random searchings of men for better ways of ordering human life that are bound under certain conditions to stabilize as one of a limited number of highly complex organizations of hunting-and-gathering cultures, of agricultural cultures, or of worldwide technical-industrial societies, etc. Selection by nature is another way of saying that nature offers only a very restricted number of ways in which systems can persist, be stable, homeostatic, or alive. "Narrow is the gate and strait is the way that leadeth unto life."

SUMMARY

In brief, I have been suggesting: (1) "Natural selection" may be considered as a succession of stability levels existing in *nature* which are the *natural* outcome according to *natural* laws of the interaction of *natural* systems, even under random energies or motions. (2) Natural selection of *living systems* is no different except for the fact that living systems are a special class of the natural phenomena of open systems that are stable patterns because they are structured or defined by special memories and homeostatic (cybernetic) mechanisms to maintain or increase a degree of order or organization which is not possible in general and particularly not possible in closed systems where it is forbidden by the second law of thermodynamics. (3) Natural selection of living systems requires a "memory" sufficiently stable in its pattern to reconstruct or replicate essentially the same kind of organism or behavior, but sufficiently flexible (changeable or mutable) to allow for at least a small proportion of errors which are necessary as trials to find (to learn) a better adaptation of the living system to the demands and opportunities of nature. (4) Natural selection of the memory structures (including genotypes and habitats) is indirect by means of the selection (i.e., the viability, stability, or homeostasis) of the living structures (phenotypes) they reproduce. (5) Natural selection at the level of human life involves three quite distinguishable sets of memory or information; two of them (genotypes and habitats) are common to all other kinds of life on earth, and the third, or culturetype, is a special structuring of the habitat by parents and society and gives man his uniqueness among living species on earth. (6) Natural selection of the heritage of culturetypes involves selection of the memory or information patterns stored in the brain, but it is information which is transmitted to the brain from outside the brain rather than from inside the brain as is its information or heritage from the genotype.

In spite of the fact that Charles Darwin may have denied that he

was replacing the term "God" with "Natural Selection,"[21] I will quote from his *Origin of Species* (early in chap. 4) to show how closely the notion of natural selection does resemble the God of Western religious tradition (and I think it can be shown to be equivalent in many respects to most concepts of the ultimate powers):

It may be said that natural selection is daily and hourly scrutinizing throughout the world, every variation, even the slightest; rejecting that which is bad, preserving and adding up all that is good; silently and insensibly working, whenever and wherever opportunity offers, at the improvement of each organic being in relation to its organic and inorganic conditions of life.

I do not find this very far from the following, which was written more than two thousand years prior:

O Lord, thou hast searched me, and known me. Thou knowest my downsitting and mine uprising; thou understandest my thought afar off. Thou compassest my path and my lying down, and art acquainted with all my ways. . . . Search me, O God, and know my heart: try me, and know my thoughts; and see if there be any wicked way in me, and lead me in the way everlasting.[22]

NOTES

1. Hudson Hoagland and Ralph Burhoe, eds., *Evolution and Man's Progress* (New York: Columbia University Press, 1961); see especially pp. 67-69, in the chapter by Julian H. Steward and Dimitri Shimkin.

2. Theodosius Dobzhansky, *Mankind Evolving* (New Haven, Conn.: Yale University Press, 1962).

3. B. F. Skinner, "The Phylogeny and Ontogeny of Behavior," *Science* 153 (1966): 1205-13.

4. George Gaylord Simpson, *The Meaning of Evolution*, rev. and abr. ed. (New York: Mentor Books, 1949; New Haven, Conn.: Yale University Press, 1951), p. 95; or C. H. Waddington, *Towards a Theoretical Biology* (Chicago: Aldine Publishing Co., 1968), 1:19.

5. See Waddington, pp. 288 ff, and elsewhere; also, Ralph Wendell Burhoe, "Commentary on J. Bronowski's 'New Concepts in the Evolution of Complexity,'" *Zygon* 5 (1970): 36-40.

6. Clyde Kluckhohn, "The Scientific Study of Values and Contemporary Civilization," *Zygon* (1966): 230-43; see especially p. 236. It is common knowledge, or at least widely reported, that the sciences are low on the educational totem pole.

7. C. P. Snow, *The Two Cultures and the Scientific Revolution* (New York: Cambridge University Press, 1960).

8. An interesting commentary on Darwin's natural selection is to be found in Garrett Hardin's *Nature and Man's Fate* (New York: Holt, Rinehart & Winston, 1959), pp. 59-60.

9. Stow Persons. *Free Religion* (Boston: Beacon Press, 1947), p. 64.

10. See, for example, Oscar Riddle's evaluation of this in his "The Emergence of Good and Evil," *Zygon* 2 (1967): 34-42.

11. Ralph Wendell Burhoe, "What Specifies the Value of the Man-made Man?" *Zygon* 6 (1971): 224-46.

12. Charles Darwin, *The Origin of Species* (1859), early in chap. 4 on natural selection; it is on p. 97 of the Harvard Classics edition.

13. The computer-language description of living systems as cybernetic systems processing information has grown out of many studies in the past two or three decades about these systems; see, for instance, the various books and papers in this field by A. M. Turing, Norbert Wiener, W. Ross Ashby, Warren McCulloch, John von Neumann, J. Z. Young, Kenneth Boulding, Karl W. Deutsch, Garrett Hardin, and a multitude of others.

14. Harlow Shapley, "Life, Hope, and Cosmic Evolution," *Zygon* 1 (1966): 281.

15. Further details on this notion will be found in J. Bronowski's "New Concepts in the Evolution of Complexity: Stratified Stability and Unbounded Plans," *Zygon* 5 (1970): 18-35, and Burhoe's comment thereon (n. 5 above), especially pp. 39-40.

16. See Herbert A. Simon, *The Sciences of the Artificial* (Cambridge, Mass.: M.I.T. Press, 1969), especially p. 25: "A man, viewed as a behaving system, is quite simple. The apparent complexity of his behavior over time is largely a reflection of the complexity of the environment in which he finds himself." This book has many rich insights for anyone who wishes to understand the operation of selection in "learning" of all kinds, from genotypes, to brains, to computers.

17. E.g., Donald T. Campbell, "Variation and Selective Retention in Socio-cultural Evolution," *General Systems* 14 (1969): 69-85. See also G. C. Williams, *Adaptation and Natural Selection* (Princeton, N.J.: Princeton University Press, 1966), on which Campbell's argument is based.

18. Cf. C. H. Waddington, *The Ethical Animal* (New York: Atheneum Press, 1961), for a good review; B. F. Skinner's *Science and Human Behavior* (New York: Macmillan Co., 1953) is a basic text.

19. There is a vast literature on the understanding of living systems in terms of physical parameters by authors ranging from A to Z. As a beginning for persons not acquainted with this, I would highly recommend various books by Isaac Asimov and Dean E. Wooldridge.

20. Bronowski (n. 15 above), pp. 18-35.

21. Darwin (n. 12 above).

22. Psalms, chap. 139.